HydrOffice QC Tools Manual

Release 3.6.1

2022, CCOM/JHC,UNH

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CONTENTS

CHAPTER ONE

IN BRIEF

QC Tools assist in the review of various types of data occurring all throughout the ping-to-public process.

Accepted data inputs are bathymetric grids, feature files, sounding selections, and directory structures. 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-chart.

CHAPTER

TWO

USER MANUAL

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 the 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 Survey Validation

2.2.1 Overview

The **Survey Validation** tab will:

- Receive bathymetric grids and feature file inputs for analysis (see *Data inputs*).
- Scan grids for anomalous grid data "fliers" (see *Detect fliers*).
- Scan grids for empty grid nodes that meet NOAA NOS Hydrographic Survey Specifications and Deliverables (HSSD) definitions of "holidays" (see *Detect holidays*).

- Compute basic grid statistics to ensure compliance to uncertainty and density requirements prescribed in the HSSD (see *Grid QA*).
- Scan grids to ensure the eligibility of soundings designated (see *Scan Designated*).
- Scan features to ensure proper attribution (see *Scan features*).
- Ensure surveyed features are properly accounted for in the gridded bathymetry (see *VALSOU checks*).
- Export bottom samples to a text file for archival (see *SBDARE export*).
- Ensure the survey deliverables and directory structure are complete and meet requirements prescribed in the HSSD. (see *Submission checks*).

2.2.2 Data inputs

Receive bathymetric grids and feature files.

- Select the **Survey Validation** tab on the QC Tools interface.

In **Data inputs:**

- Drag-and-drop any number of grids and/or features files, anywhere onto the interface. The **"+"** browse button may also be used.
- The directory and filename of accepted grid and feature files will populate in the respective locations of Data inputs.
- With the addition of a grid and features, the **Detect fliers**, **Detect holidays**, **Grid QA**, **Scan designated**, **Scan features**, **VALSOU checks**, and **SBDARE export** tabs on the bottom of the interface are now available (Fig. 2.2).
- Note that any unaccepted file types will be rejected with a message to inform the user (Fig. 2.3).
- 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. 2.4, pane A). The outputs are stored directly under the default or user-defined location.
  - Only the **Per-tool sub-folders** flag set (see Fig. 2.4, 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. 2.4, 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. 2.4, 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.

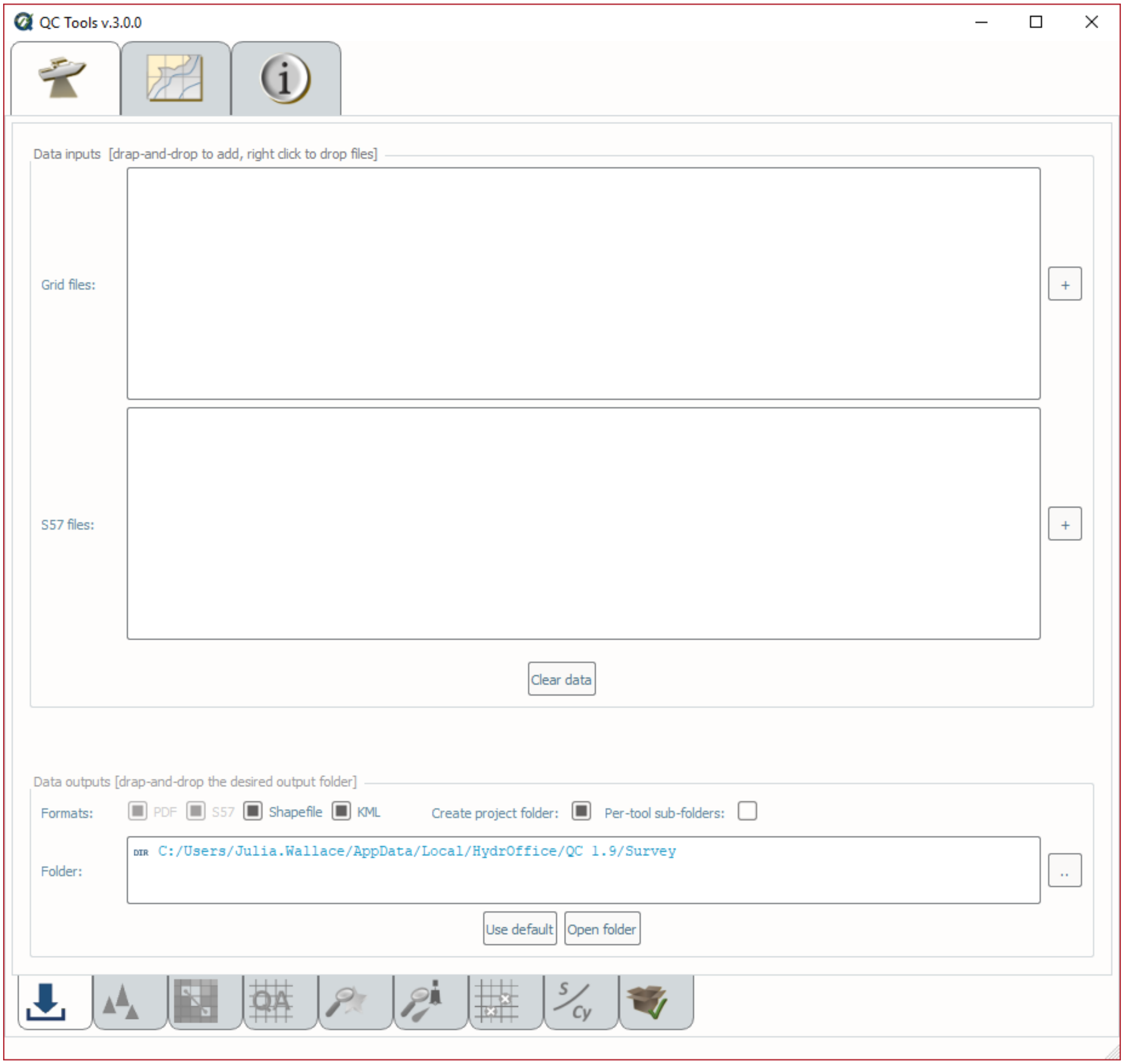


Fig. 2.2: Data inputs and outputs for the *Survey* tab.

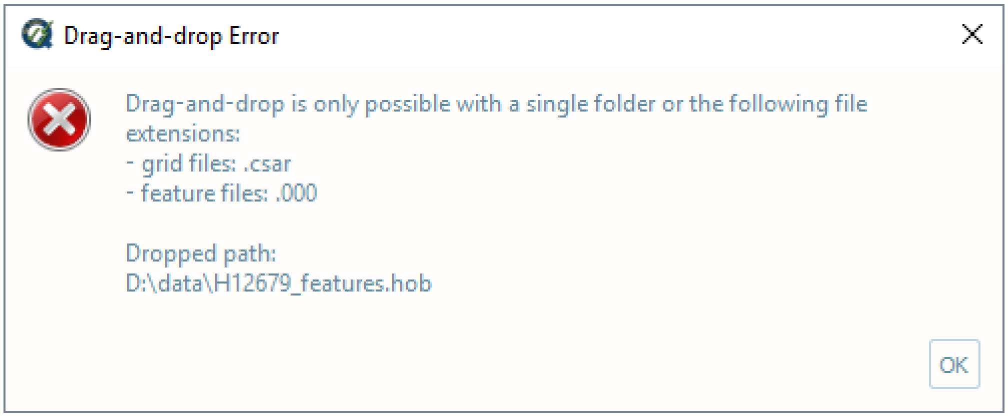


Fig. 2.3: The error message for unsupported formats.

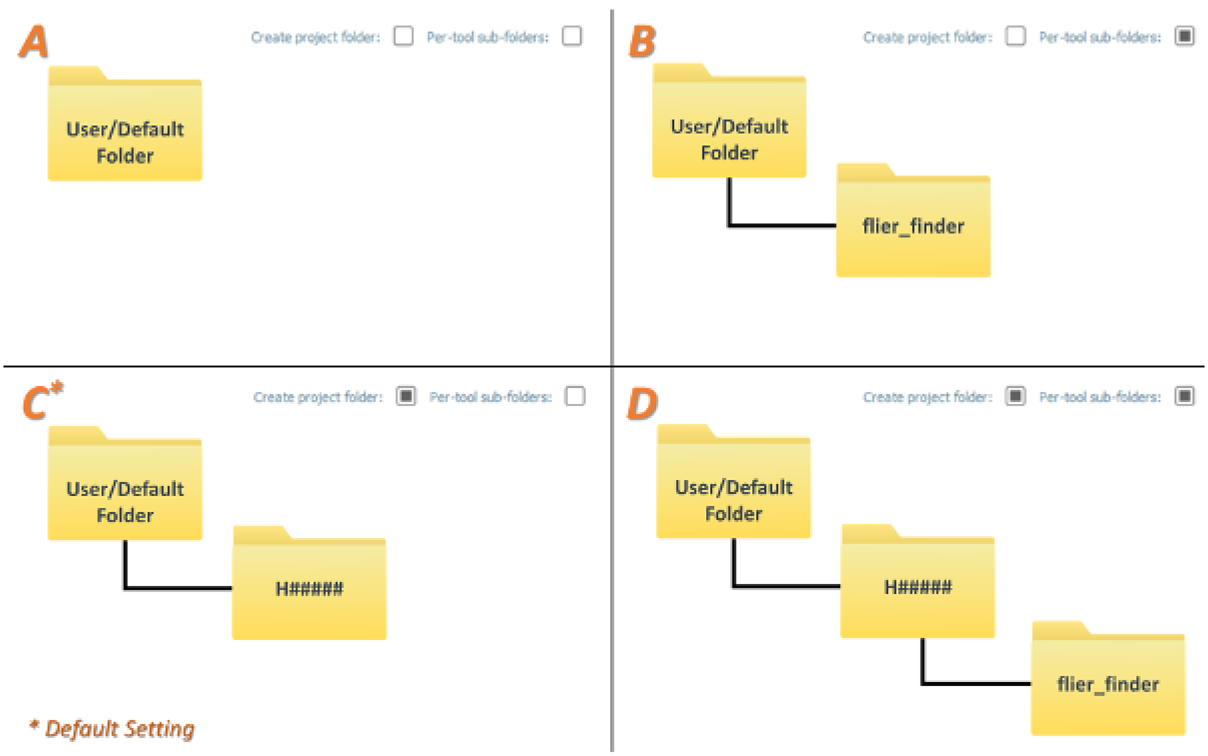


Fig. 2.4: The resulting folder structure based on the four available combinations of output flags.

2.2.3 Detect fliers

How To Use?

Scan grids for anomalous grid data "fliers".

- Select the **Detect fliers** tab (Fig. 2.5) on the bottom of the QC Tools interface.
- For **Flier finder v9**, first consider **Settings:**
  - The **Flier height** will be determined automatically by the program and does not need to be set, but the user may choose to do so in order to run a specific **Flier height**.
  - The automatic determination of **Flier height** is performed per tile, and is based on the median depth (characteristic depth), the MAD (variability in range), and the standard deviation of the gaussian curvature (roughness).
  - The selected **Checks** are enabled by default. You can enable or disable them in order to run custom analysis (see the "How Does It Work?" section below).
- To change the **Settings** for **Flier finder v9**:
  - Click the **Unlock** button, and click **OK** to the dialogue.
  - If desired, enter a desired Flier search height in meters in the **Force flier heights** box.
    - A single height may be entered to apply to all loaded grids, or multiple heights may be entered (separated by comma) to apply to each grid loaded.
    - These values, if entered, will override any **Estimated heights** determined by the program.
  - Enable or disable the specific **Checks** to run.
  - If desired, modify the filtering horizontal and vertical distances from the closest point feature or designated sounding.
  - Enable or disable the specific **Filters** to run.
- In **Execution** for **Flier finder v9**:
  - Click **Find fliers v9**. After executing, the output window opens automatically (Fig. 2.6), and the results are shown:
- An output window will open in File Explorer. From the output window, drag-and-drop the desired output file into the processing software to guide the review. Each candidate flier is labeled using the identifier of the algorithm that detected it (e.g., "2" for Gaussian Curvature).
- The output file names adopt the following convention:
  - [grid filename].FFv9.chk[identifier of each selected algorithm].flt[identifier of each selected filter]

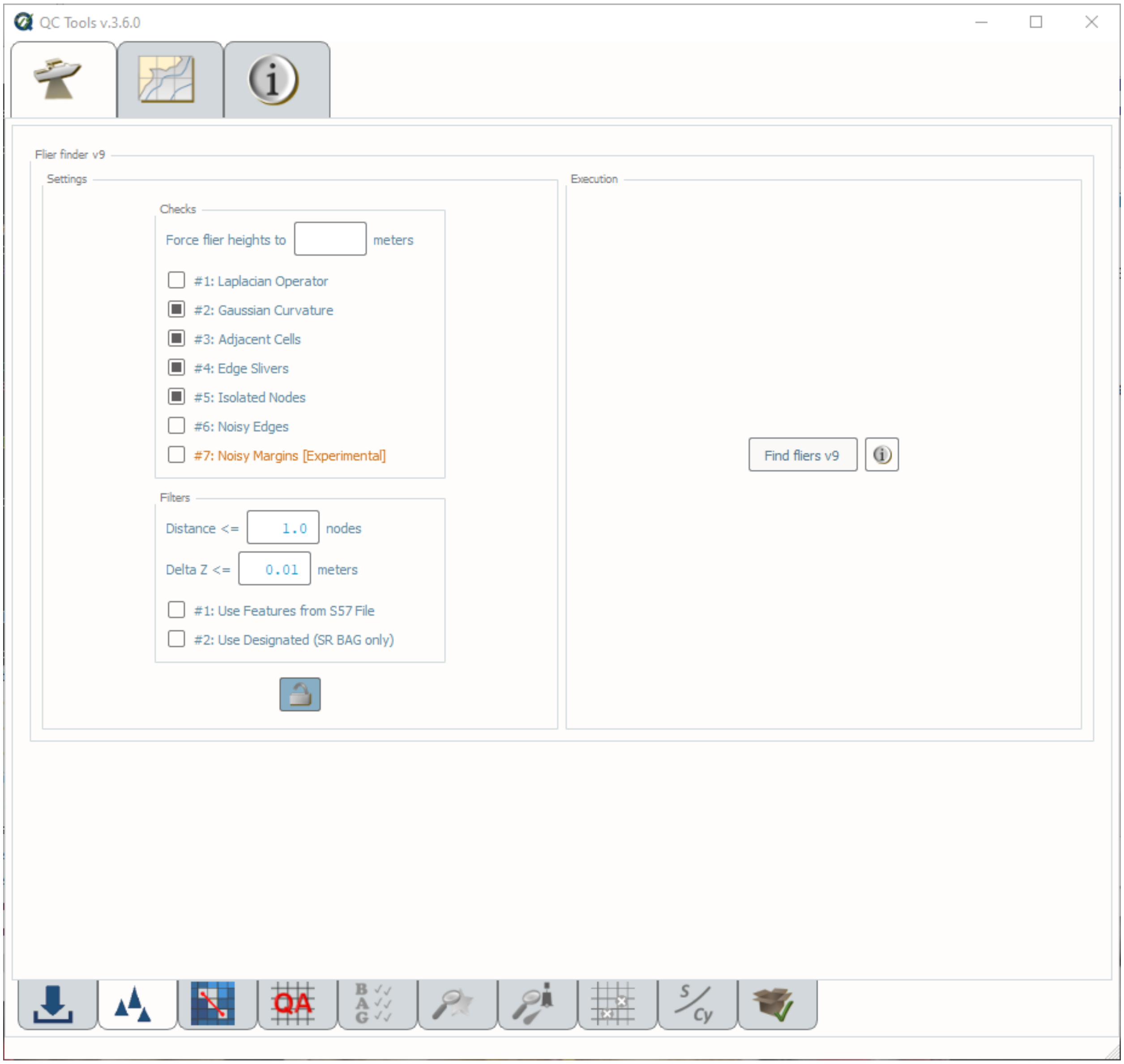


Fig. 2.5: The **Flier finder fliers** tab.

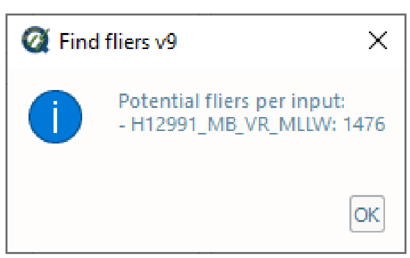


Fig. 2.6: The output message at the end of **Flier finder v9** execution.

How Does It Work?

Flier finder v9:

Estimate height:

First, a base height from the median depth of the grid is assigned:

Depth Interval	Base height
if < 20	1.0
if < 40	2.0
if < 80	4.0
if < 160	6.0
if >= 160	8.0

Then, the base height is incrementally increased by the level of depth variability and roughness of the grid:

- Depth variability is estimated by proxy using the Normalized Median of Absolute Deviation (NMAD) of the grid, which is derived by dividing the absolute difference of depth mean and depth median by depth standard deviation.
  - The lower the NMAD, the more depth variability we estimate.
  - An increase in the Base height of the flier search height estimation is warranted if NMAD is less than 0.20 (1 increase) or less than 0.10 (2 increases).
- Roughness is estimated by the standard deviation of the Gaussian curvature (STD_CURV).
  - The Gaussian curvature is a measure of concavity at each node, whether concave up (shoal) or concave down (deep).
  - The higher the STD_CURV, the rougher the surface.
  - An increase in the Base height of the flier search height estimation is warrented if STD_CURV is greater than 0.01 (1 increase) or greater than 0.10 (2 increases).

Increases are +2.0 meters, unless the Base height is 1.0 meter, then the increase is +1.0 meter. In this manner, Estimated flier heights are always on the interval scale of 1 (minimum), 2, 4, 6, 8, 10, 12, 14, 16 (maximum).

For example:

- If a surface has depth median = 12 m, NMAD = 0.15, and STD_CURV = 0.005, then the Estimated height = 2.0 m.
- If a surface has depth median = 75 m, NMAD = .04, and STD_CURV = 0.08, then the Estimated height = 10.0 m.

Checks:

Laplacian Operator

The Laplacian Operator is a measure of curvature at each node. It is equivalent to summing the depth gradients of the four nodes adjacent (north, south, east, and west) to each node. If the absolute value of the Laplacian Operator is greater than four times the flier search height, the node will be flagged.

In the example below, a 3 m flier search height would register 1 flag, while a 2 m flier search height would register 4 flags, and a 1m search height would register 7 flags.

Depth Layer					Laplace			
9	9	9	9		0	1	0	3
9	8	9	6		1	4	10	9
9	9	3	9		0	7	24	9
9	9	9	9		0	0	6	0

The algorithm is effective, but may be prone to excessive flags, as demonstrated in the above example. Testing showed that it generally did not reveal fliers not already revealed by the other algorithms. For these reasons, it is disabled by default, but is recommended as an additional check in those situations when the other algorithms return very few or no flags.

The example in Fig. 2.7 shows grid nodes (depths in meters) recommended for further examination by the Laplacian Operator (indicated by 1s) and a 6m estimated search height.

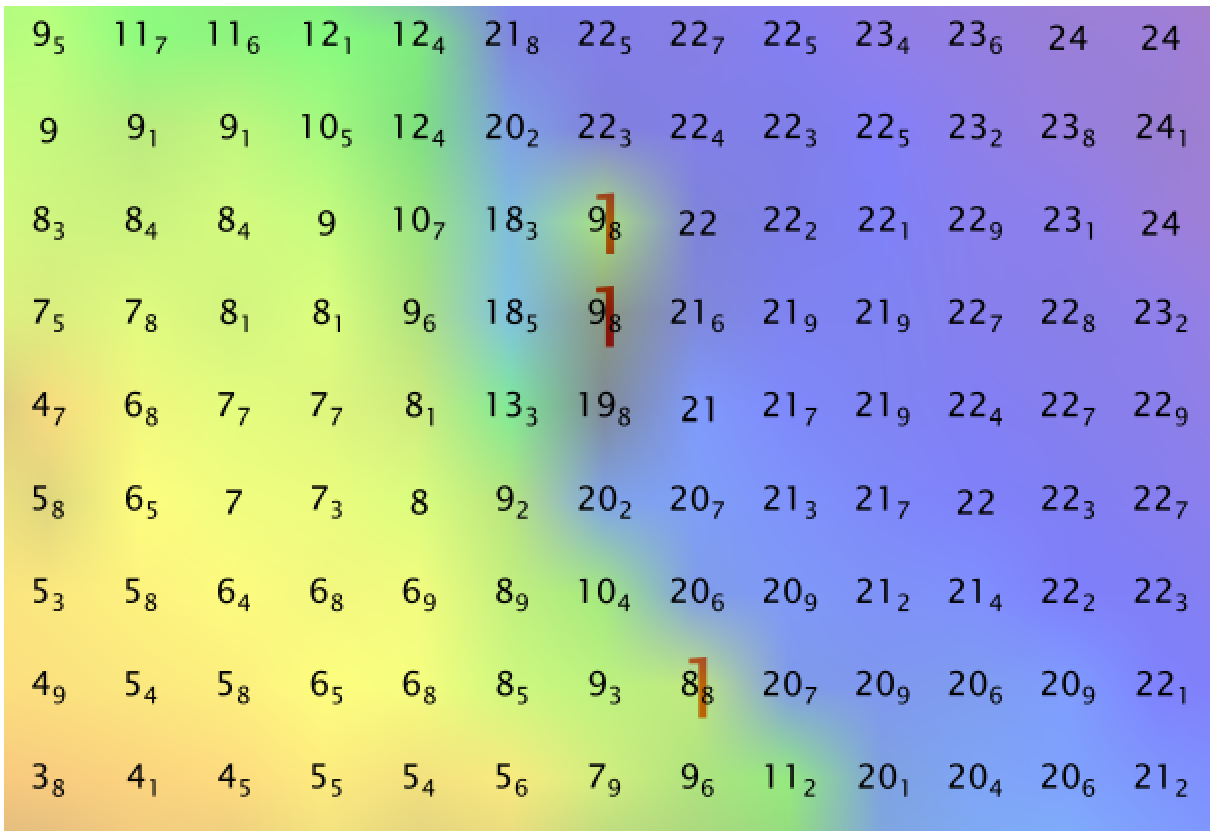


Fig. 2.7: Laplacian Operator.

Gaussian Curvature

The Gaussian Curvature is a measure of concavity at each node. The gradients are taken in the x and y directions to establish gx and gy, and repeated on each gradient again in the x and y direction to establish gxx, gxy, gyx, and gyy (note that gxy = gyx). The gaussian curvature at each node is then determined by:

(gxx * gyy - (gxy * gyx)) / (1 + (gx^2) + (gy^2))^2

Note that this algorithm is dependent on the standard deviation of the tile's gaussian curvature.

In the example below, a single flier is found (regardless of flier height).

Depth Layer					Gaussian Curvature			
9	9	9	9		-1	0	-1	-.09
9	8	9	6		0	-2.3	0	-.14
9	9	3	9		-2.5	0	20	0
9	9	9	9		0	-9	0	-36

Testing showed that the algorithm on occasion offered unique value by flagging a flier not captured by other algorithms, while also it is not prone to excessive flags. For these reasons this algorithm is enabled by default.

The example in Fig. 2.8 shows grid nodes (depths in meters) and a deep flier found by the Gaussian Curvature (indicated by the red 2).

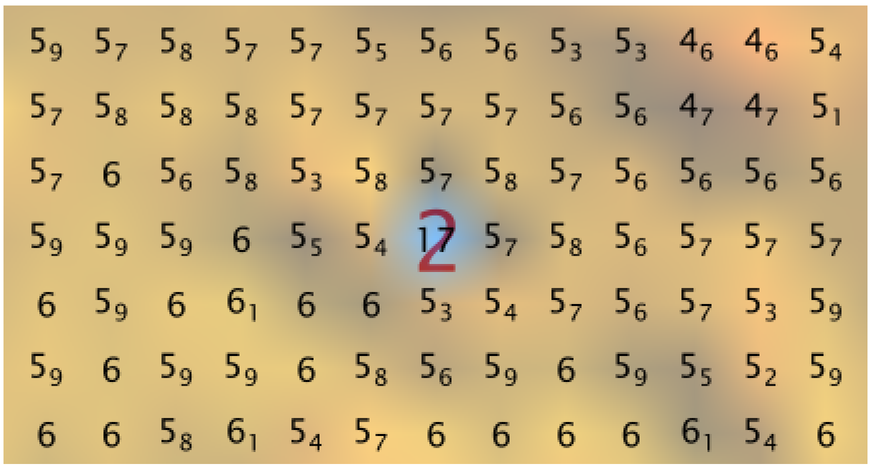


Fig. 2.8: Gaussian Curvature.

Adjacent Cells

This algorithm examines the nodes that are adjacent to a single node. There are a maximum of 8 adjacent nodes (N,NW,W,SW,S,SE,E,NE), but there could be less than 8 if the node resides on a grid edge.

The algorithm crawls across empty cells (2 nodes diagonally, and 3 nodes in the cardinal directions) in order to establish neighbors. For example, the image below shows that 6 neighbors were found for the flagged node; previous versions of Flier Finder would only have identified 4 (Fig. 2.9).

The depth is differenced with each adjacent cell identified, and the number of times the difference is greater in magnitude than the flier search height is tallied. If the ratio of this tally to the number of adjacent cells available is 0.8 or greater, then the node is flagged.[1]

In the example below, a 3 m flier search height would register 2 flags, while a 2m search height would also register 2 flags, and a 1m search height would register 3 flags.

Depth Layer					Adjacent Cells(3m)			
9	9	9	9		0	0	.2	.33
9	8	9	6		0	.13	.25	1
9	9	3	9		0	0	1	.4
9	9	9	9		0	.2	.2	.33

[1] In the case that node has only 4 neighbors, and 3 of these have a difference greater than the search height, the ratio of 0.75 will trigger a flag on the node. This exception has been made because it has been observed so frequently during testing.

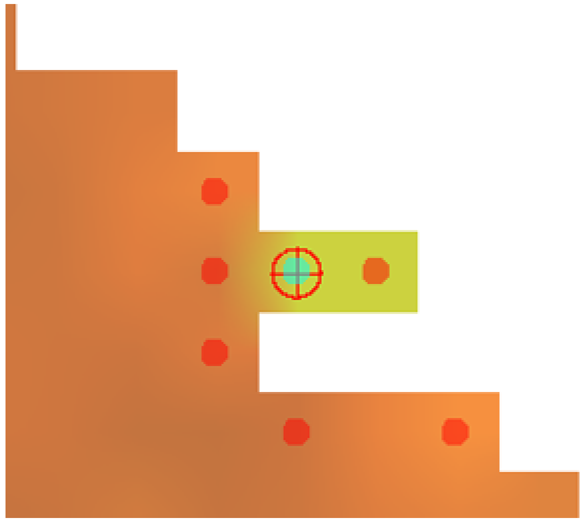


Fig. 2.9: Crawling example.

Testing showed that the Adjacent Cells algorithm offers unique value by flagging fliers not captured by the other algorithms (especially those residing on grid edges), and is not as prone to excessive flagging as the Laplacian Operator. For these reasons, it is enabled by default.

The example in Fig. 2.10 shows grid nodes (depths in meters) and the type of flier that Adjacent Cells (indicated by the red 3) identifies with particular effectiveness, in this case with a 4m search height.

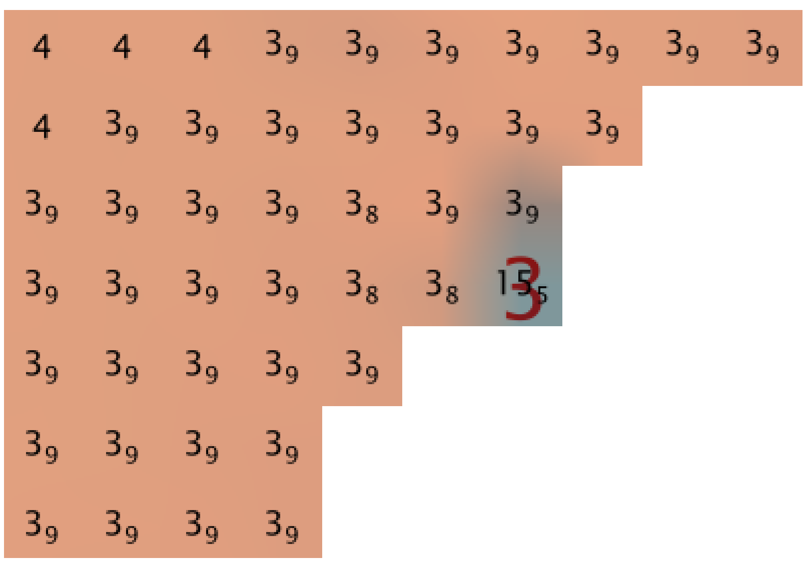


Fig. 2.10: Adjacent Cells.

Edge Slivers

The Edge Slivers algorithm identifies small groups of connected nodes (3 nodes or less) that are detached (but within 5 nodes) from the grid. If the depth difference between the nearest detached node and the valid connection to the grid is greater than half the flier search height, a flag is registered.

Testing showed that the algorithm offers unique value by identifying the quite common fliers that result in areas of sparse data density. For this reason, it is enabled by default.

The example in Fig. 2.11 shows grid nodes (depths in meters) and the type of detached nodes that Edge Slivers flags, in this case with a 4m search height.

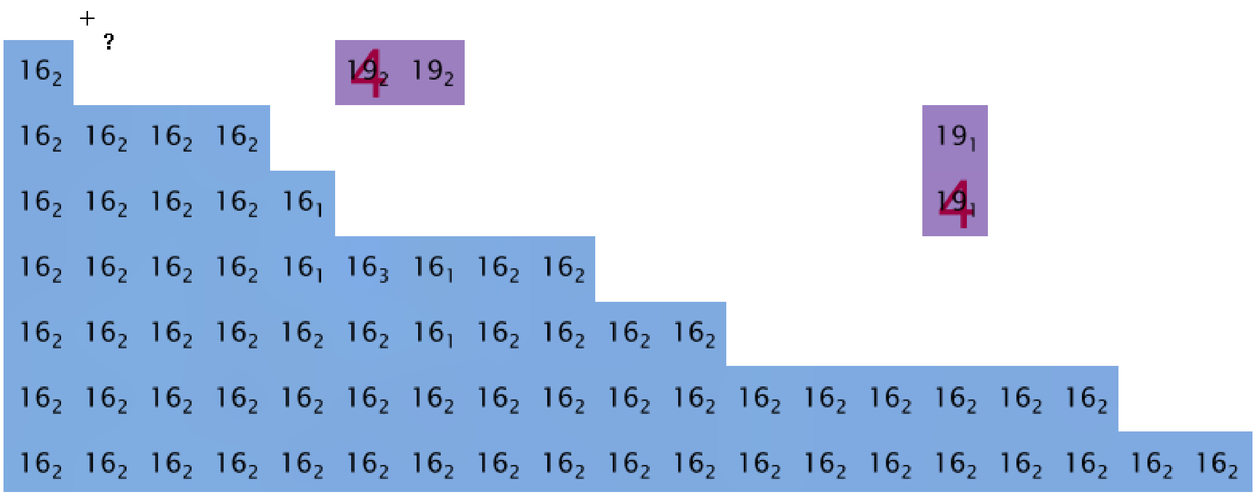


Fig. 2.11: Edge Slivers.

Isolated Nodes

The Isolated Nodes algorithm identifies small groups of connected nodes (3 nodes or less) that are detached (but outside of 5 nodes) of the grid. Effectively it is identifying the remaining isolated nodes not caught by Edge Slivers, however, it is independent of flier search height, meaning that all small groups of isolated nodes will be flagged.

Testing shows that the algorithm offers unique value by identifying nodes far detached from the grid that the reviewer may wish to exclude. Because it is identifying any detached nodes and not considering their associated depth, it is largely considered a separate tool to be used on an "as-needed" basis. Therefore, it is not enabled by default.

The example in Fig. 2.12 shows a grid node far detached from the main grid, found by Isolated Nodes (indicated by a red 5).

Noisy Edges

The Noisy Edges is tailored to identify fliers along noisy swath edges.

The algorithm crawls across empty cells (2 nodes diagonally, and 3 nodes in the cardinal directions) in order to establish the *edge nodes*. In the specific, an edge node is identified when 6 or less adjacent valid neighbors are present in the surrounding 8 directions (N, NW, W, SW, S, SE, E, and NE).

Once that an edge node is identified, the least depth and the maximum difference with its neighbors are calculated.

The least depth is used to calculate to local Total Vertical Uncertainty (TVU), which is used for the flagging threshold. The TVU is calculated per NOAA specifications:

$$TVU = \sqrt{A^2 + (B * Depth)^2}$$

where $A = 0.5, B = 0.013$ for Order 1 (depths less than 100 m), and $A = 1.0, B = 0.023$ for Order 2 (depths greater than 100 m).

Fig. 2.12: Isolated Nodes.

Note: Since the TVU is based on the local least depth, the algorithm automatically adapts the threshold calculation to the proper Order (1 or 2). For example if the edge node in question is 102m and its neighbors are 99m, the TVU will be calculated at Order 1 specifications.

Finally, an edge node is flagged when the maximum depth difference with its neighbors is greater than the flagging threshold.

Fig. 2.13 shows an example of a flagged 18.7m edge node. Since the shallowest node in the neighborhood is 17.4m, the flagging threshold developed from TVU was 0.549m. The maximum difference between the node and its neighbors is 1.3m, therefore the edge node was flagged.

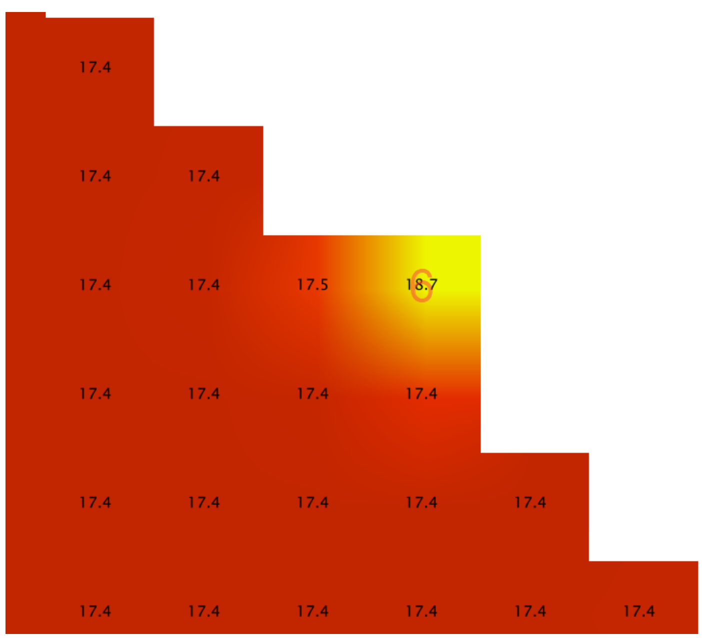


Fig. 2.13: Noisy edges.

Noisy Margins *(experimental)*

The Noisy Margins is tailored to identify fliers along noisy swath edges.

The algorithm crawls across empty cells (2 nodes diagonally, and 3 nodes in the cardinal directions) in order to establish a margin. A margin is identified when a node is missing two neighbors in the surrounding 8 directions (N, NW, W, SW, S, SE, E, and NE).

Once that a margin node is identified, the least depth and the maximum difference with its neighbors are calculated.

The least depth is used to calculate to local Total Vertical Uncertainty (TVU), which is used for the flagging threshold. The TVU is calculated per NOAA specifications:

$$TVU = \sqrt{A^2 + (B * Depth)^2}$$

where $A = 0.5, B = 0.013$ for Order 1 (depths less than 100 m), and $A = 1.0, B = 0.023$ for Order 2 (depths greater than 100 m).

Note: Since the TVU is based on the local least depth, the algorithm automatically adapts the threshold calculation to the proper Order (1 or 2). For example if the edge node in question is 102m and its neighbors are 99m, the TVU will be calculated at Order 1 specifications.

A noisy margin is flagged when the maximum depth difference with its neighbors is greater than the flagging threshold. To prevent too many flags, the algorithm searches the nearest three nodes and if any of those nodes contain a flag, it will not be flagged. If a flag is not present in a three node area, the flier is flagged.

Fig. 2.14 shows an example of a flagged 4.5m edge node. Since the shallowest node in the neighborhood is 3.7m, the flagging threshold developed from TVU was 0.502m. The maximum difference between the node and its neighbors is 0.8m, therefore the margin node was flagged.

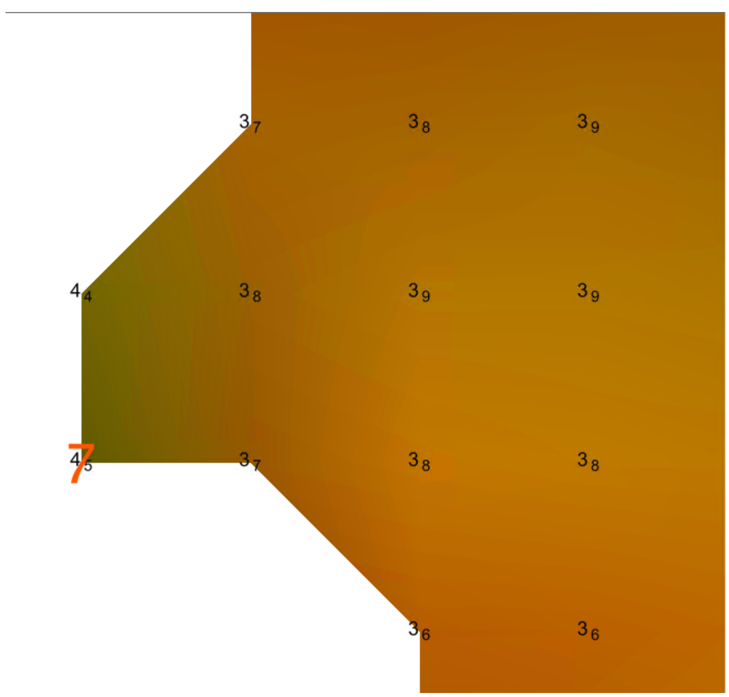


Fig. 2.14: Noisy margin.

Which Flier Finder Algorithm Should I Use?

For basic use:

- For standardized operation of this tool, the automatic estimated search height and the following checks are recommended:
  - Gaussian Curvature
  - Adjacent Cells
  - Edge Slivers

For advanced use:

- If the default options generate too few flags, and/or it is desired to perform a custom search, you may force a smaller flier height, and/or utilize the "Laplace Operator" algorithm.
- The "Isolated Nodes" algorithm is used to find nodes detached from the grid and is an independent check to be used on an as-needed basis.
- The "Noisy Edge" algorithm is used to identify fliers along survey edges. It is recommended for use with surveys that are utilizing corresponding side scan coverage.

A summary of the checks is shown in the table below, and also see the "How Does It Work?" section to understand how each check works.

	Lap #1	Gau #2	Adj #3	Edg #4	Iso #5	Nsy #6	Nsy #7
Flier height estimated	x		x	x			
Prone to excessive flags	x				x	x	x
Enabled by default		x	x	x	x		
Use on as-needed basis	x					x	x

Filters:

After the algorithm has completed identifying fliers, an optional final step compares those fliers against point features with a depth (when *Use Features from S57 File* is checked) and/or designated soundings (when *Use Designated (SR BAG only)* is checked).

Both filters work in a very similar way. By default, the filters remove a flier candidate when the distance of a designated sounding/point feature is:

- Horizontally, less than (or equal to) 1.0 times the resolution (e.g., 1m for 1-m grid).
- Vertically, less than (or equal to) 0.01 meters.

It is also possible to modify the above filtering criteria. And, if the user does not want to apply the filters, they may be turned off.

Note: The *Use designated* filter does not work with CSAR files because of the current CSAR SDK limitations, and the designated soundings are currently not written by CARIS applications in VR BAGs.

What do you get?

Upon completion of the execution of **Flier Finder** you will receive a pop-up verification if your surface contains potential fliers or not (Fig. 2.15).

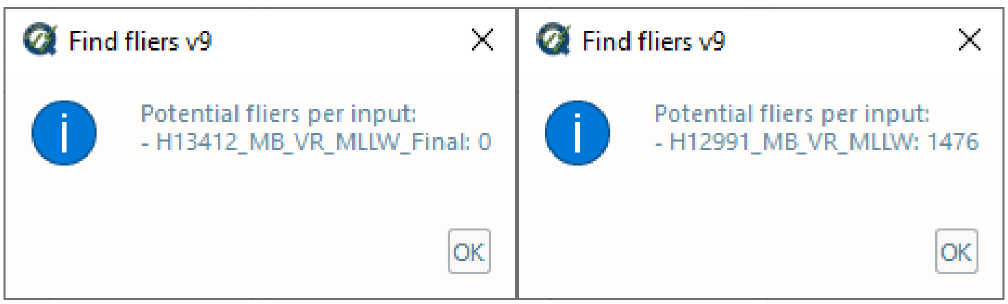


Fig. 2.15: The **Flier Finder** output message.

Flier Finder produces two .000 files containing the locations of potential fliers. These can be loaded into your GIS software of choice for further analysis.

One type of .000 file is called the "blue notes" which is a file containing $CSYMB features. The NINFOM field of the $CSYMB feautres contains the algorithm detected (e.g., "2" for Gaussian Curvature).

The other type of .000 file is a sounding file that contains SOUNDG features. The depth of each SOUNDG feature identifies the algorithm that detected it (e.g., "3" for Adjacent Cells).

2.2.4 Detect holidays

How To Use?

Scan grids for unpopulated nodes ("holidays").

- Select the **Detect holidays** tab (Fig. 2.18) on the bottom of the QC Tools interface.
- In **Parameters**, turn the knob to select **All holes**, **Object detection**, or **Full coverage**, depending on the analysis you wish to run based on the coverage requirements of the survey (see 2.2.4.2 How does it work?)
- To change the **Parameters** for **Holiday finder v4**:
  - Click the **Unlock** button, and click **OK** to the dialogue.

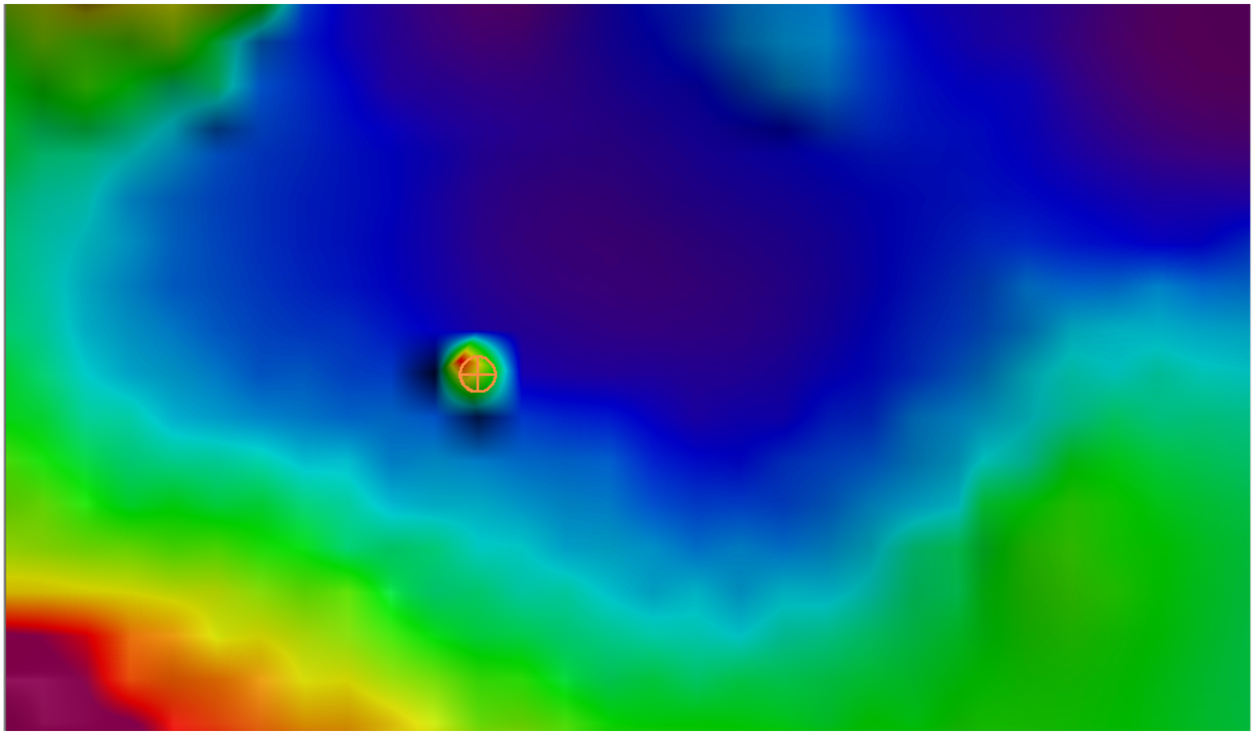


Fig. 2.16: An example of a potential flier identified with a blue note ($CSYMB).

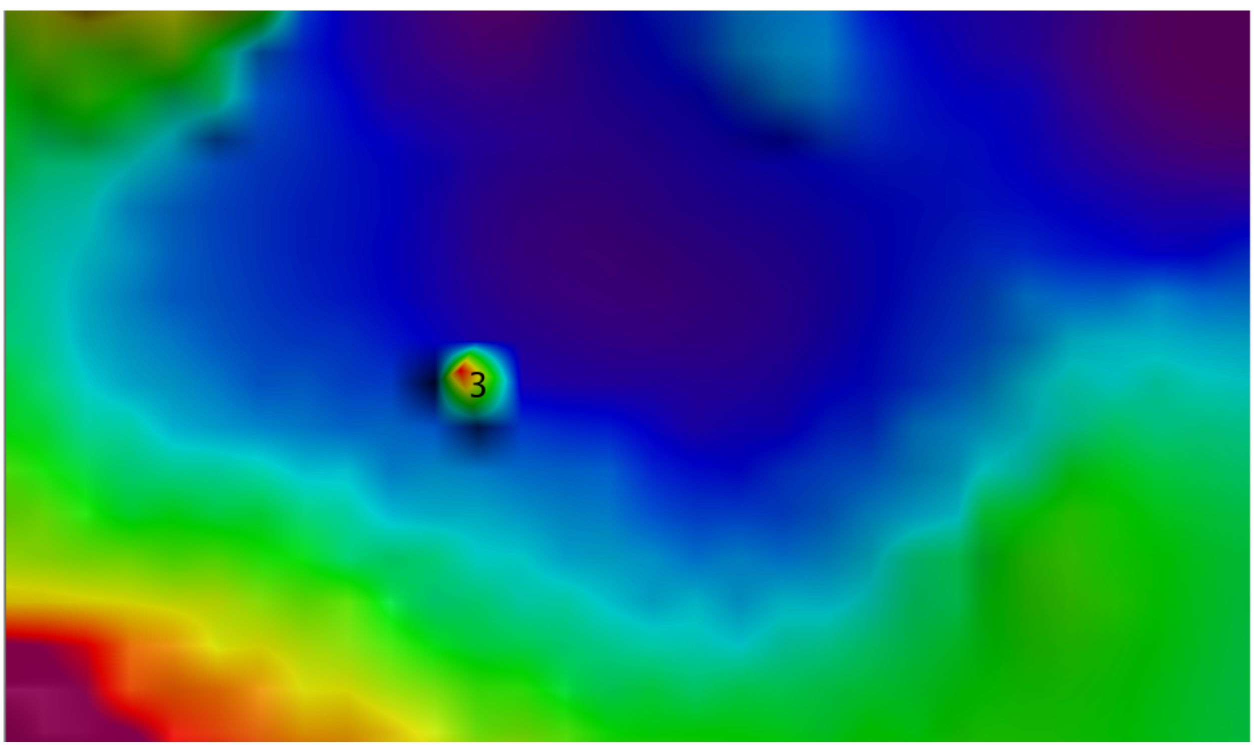


Fig. 2.17: An example of a potential flier identified with a sounding (SOUNDG).

  - Set the **Upper holiday area limit (as multiple of minimum holiday size)**. Unpopulated parts of the grid larger than this setting will not be flagged as holidays.

- In **Execution**, click **Find Holiday v4**.

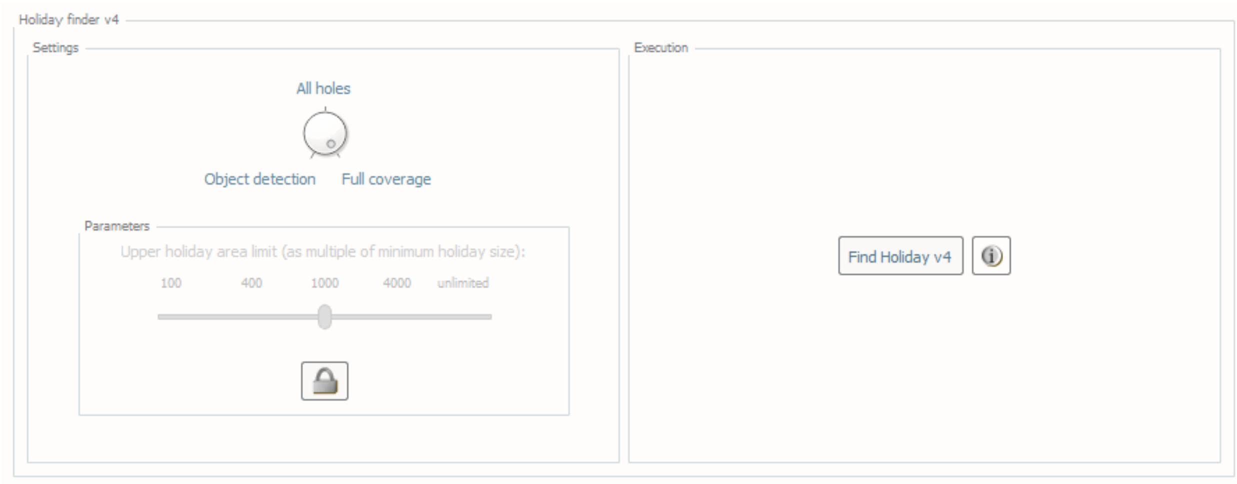


Fig. 2.18: The **Detect holidays** tab.

- After computing, the output window opens automatically, and the results are shown (Fig. 2.19).

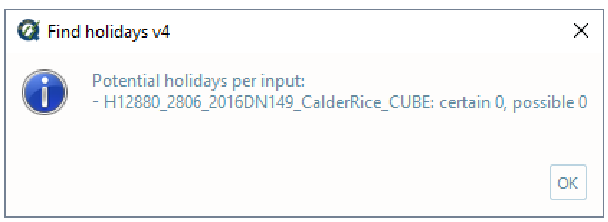


Fig. 2.19: The output message at the end of **Find holiday v4** execution.

- An output window will open in File Explorer. From the output window, drag-and-drop the desired output file into the processing software to guide the review.
- The output file names adopt the following convention:
  - [grid filename].HFv4.["all" for *All holes* | "obj" for *Object detection* | "cov" for *Full coverage*].[min size]

Note: For proper visualization, the software adopted to analyze the S57 output of VALSOU Checks has to represent the sounding values in meters.

How Does It Work?

The grid is scanned, and any empty grid nodes ("holes") surrounded by populated nodes are identified. These are flagged as holidays based on 2018 NOAA NOS Hydrographic Survey Specifications and Deliverables.

The specifications have different criteria by which holidays are defined based on coverage requirements:

- A holiday under **Object Detection** coverage requirements is defined as collinear, contiguous unpopulated nodes sharing adjacent sides.
- A holiday under **Full Coverage** requirements is defined as a box of unpopulated nodes.
- There is also the option to simply flag all unpopulated nodes as holidays, by selecting the **All holes** setting.

The holiday size is calculated in number of nodes based on the minimum allowable resolution and the grid resolution, per this formula:

floor((minimum allowable resolution X 3) / grid resolution)

Only in the case of a variable resolution input, all the tiles are re-sampled to create a single resolution grid (selecting the highest resolution among all the grid tiles).

The minimum allowable resolution is determined based on the resolution pairing from the median value of all the node depths belonging to the holiday perimeter per the below tables (Fig. 2.20) for Object Detection Coverage and Complete Coverage as defined by NOAA Specifications.

Object Detection

Single Resolution Surfaces	
Depth Range (m)	**Resolution (m)**
0-20	0.5
18-40	1
36-80	4
72-160	8
144-320	16

Variable Resolution Surfaces	
Depth Range (m)	**Resolution (m)**
0-20	0.5
20-40	1
40-80	4
80-160	8
160-320	16

Complete Coverage

Single Resolution Surfaces	
Depth Range (m)	**Resolution (m)**
0-20	1
18-40	2
36-80	4
72-160	8
144-320	16

Variable Resolution Surfaces	
Depth Range (m)	**Resolution (m)**
0-20	1
20-40	2
40-80	4
80-160	8
160-320	16

Fig. 2.20: NOAA specifications for object detection (left) and complete coverage (right) require multibeam surfaces to have the above grid-resolution thresholds as a function of depth range.

Note: The output of Holiday Finder is a sounding, with a value of "1" for certain holidays, and "2" for possible holidays.

The following images illustrate the outcomes of the three algorithms applied to a single-resolution grid (with the minimum allowable resolution equals to the grid resolution):

- In the example in (Fig. 2.21), the **All holes** setting marks three holes of 12, 7, and 2 nodes.

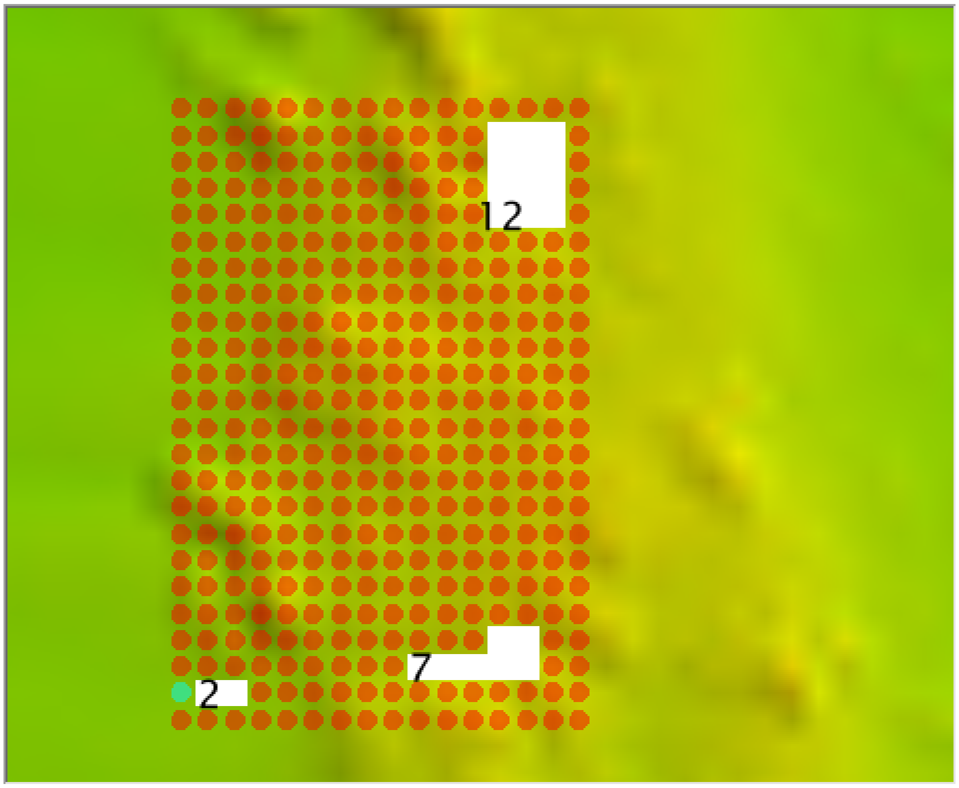


Fig. 2.21: Example for All holes.

- In the example in (Fig. 2.22), Object Detection requirements identify the holes of 12 and 7 nodes, because each has 3 collinear, contiguous unpopulated nodes. The hole with 2 grids does not.
- In the example in (Fig. 2.23), Full Coverage requirements identify the hole of 12 grid nodes, because there it contains an instance of 3x3 unpopulated grid nodes. The holes with 7 and 2 nodes do not.

A candidate hole is flagged with a “1” (if certain) or a “2” (possible holiday).

Note that the default **Upper holiday area limit (as multiple of minimum holiday size)** is set to 1000, meaning that an unpopulated part of the grid will be flagged only if smaller than 1000 times the minimum holiday size. This setting exists so the search can be refined at the user’s discretion.

For example:

- If desired to search for only the smallest of holidays, the **Upper holiday area limit** might be set at **100**.
- If desired to flag all unpopulated parts of the grid, regardless of their size, the **Upper limit** would be set at **unlimited**.
- Settings in between are used at the discretion of the user, to identify holidays, while also preventing undue clutter in the output.

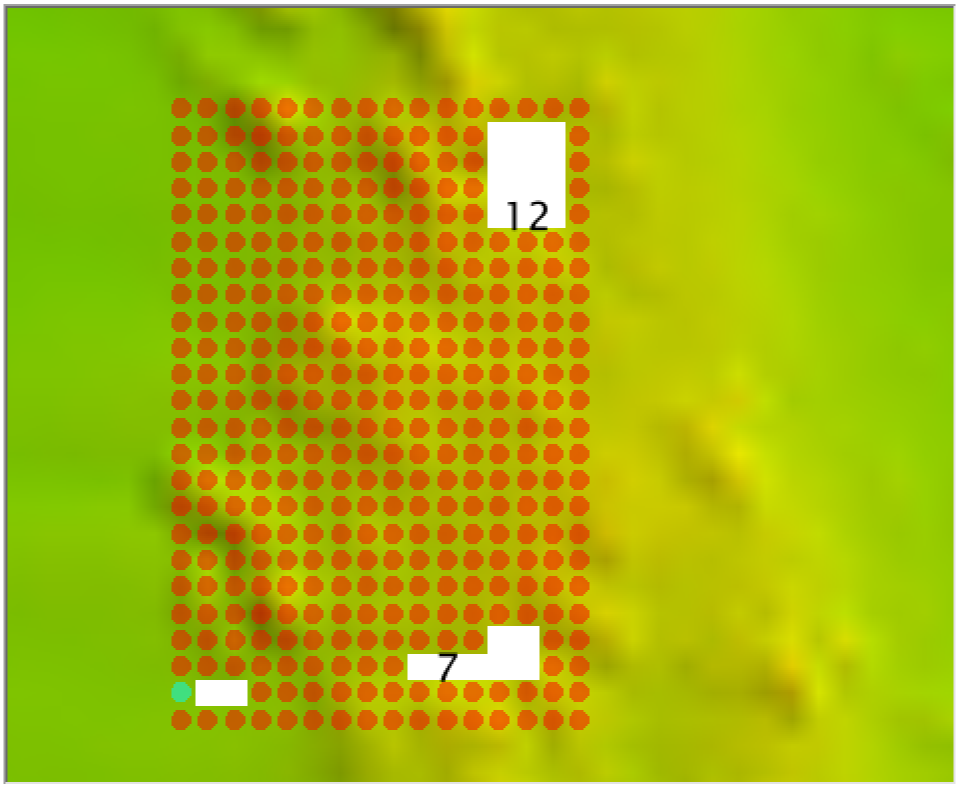


Fig. 2.22: Example for Object detection.

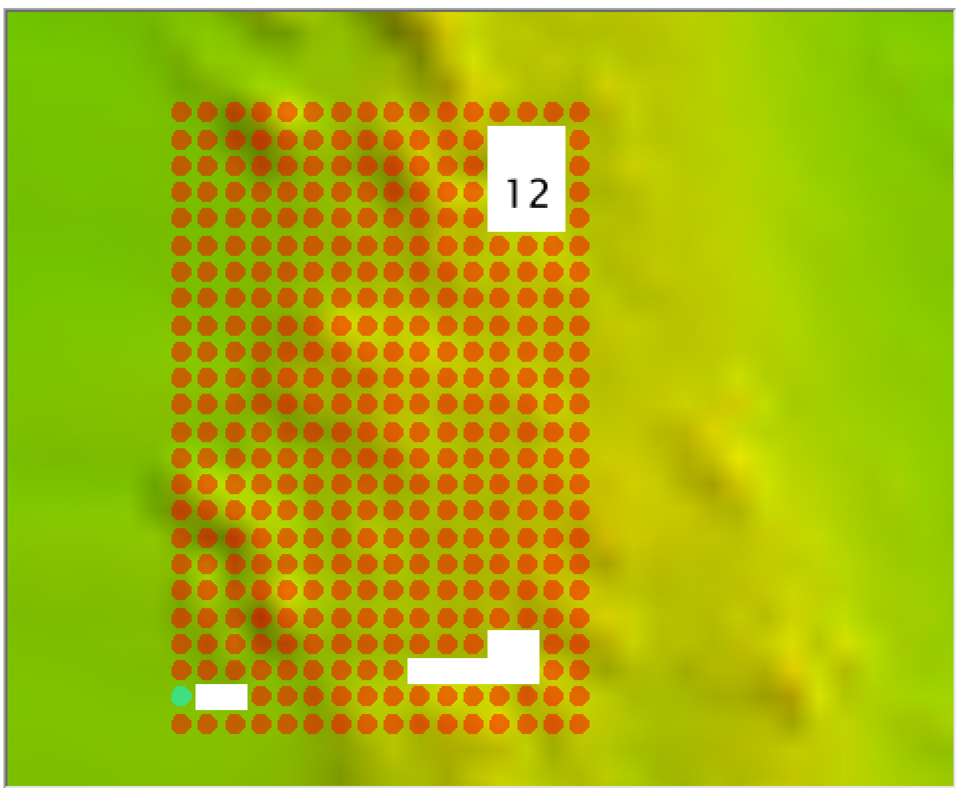


Fig. 2.23: Example for Full coverage.

What do you get?

Upon completion of the execution of **Detect Holidays** you will receive a pop-up verification if your surface contains potential holidays or not (Fig. 2.24).

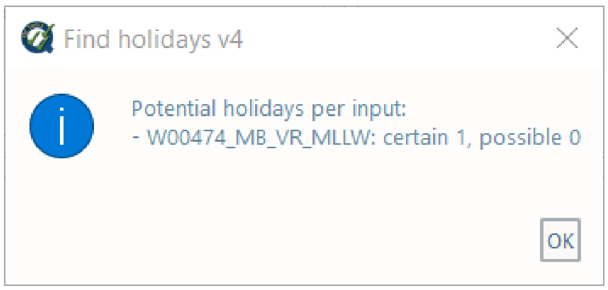


Fig. 2.24: The output message at the end of **Find holiday v4** execution.

Detect Holidays produces one .000 files containing the locations of potential holidays represented as soundings. Certain holidays are represented with 1 and possible holidays are represented at 2.

2.2.5 Grid QA

How To Use?

Computes grid statistics to ensure compliance with uncertainty and density requirements.

- Select the **Grid QA** tab (Fig. 2.26) on the bottom of the QC Tools interface.
- Check the boxes that correspond with the plots you wish to generate.
- In **Execution**, click **Grid QA v6**.
- After computing, the output window opens automatically, and the results are shown (Fig. 2.27).
- From the output window, view each plot to assess the grid compliance to uncertainty and density specifications.

Note: The **Plot depth vs. density** and **Plot depth vs. TVU QC** can potentially require a large amount of memory (i.e., when the input grid contains hundreds of millions of nodes). As such, both plots are unflagged by default. You can flag them if you need their output. If having both plots selected triggers a memory error, you may try to flag these plots once at a time.

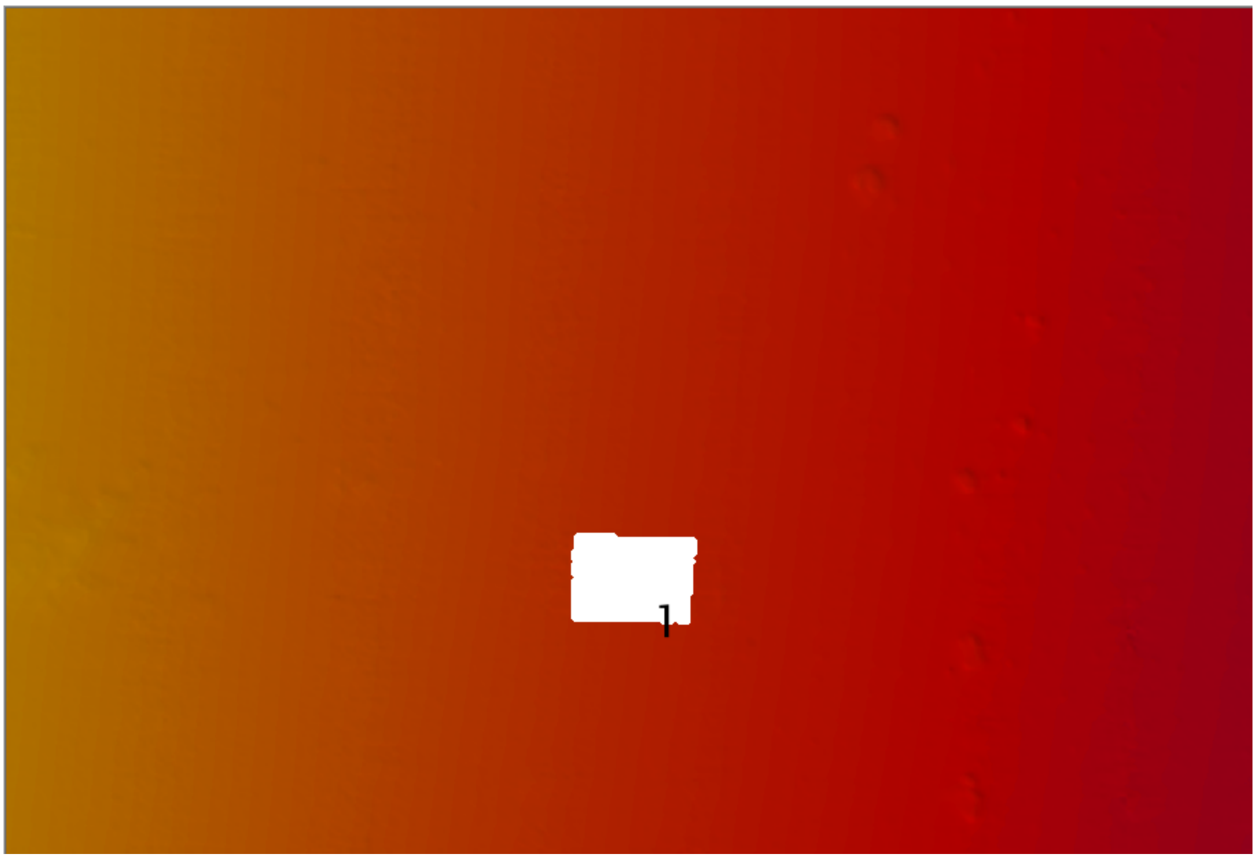


Fig. 2.25: An example of a certain holiday identified with a sounding.

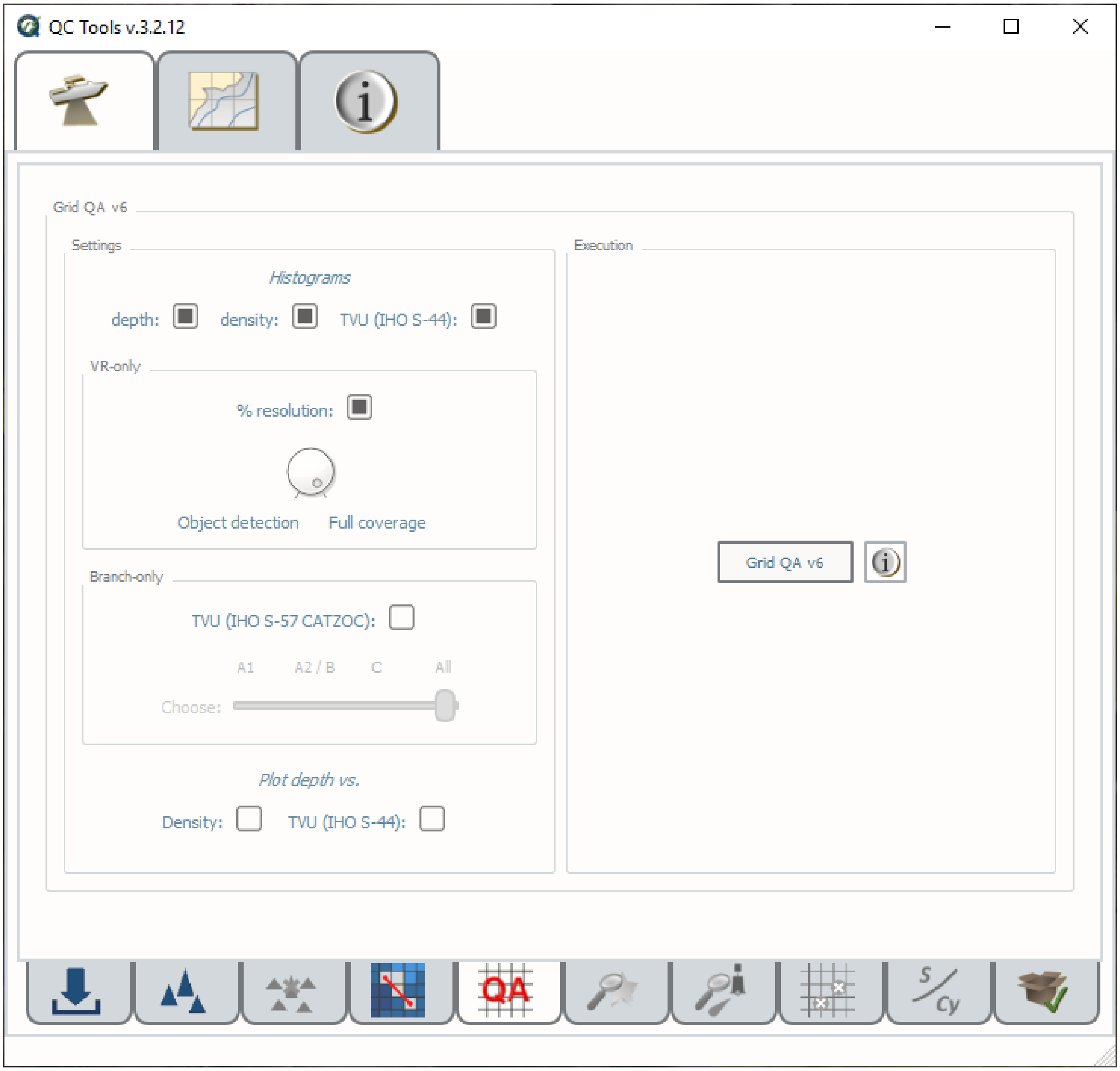


Fig. 2.26: The **Grid QA** tab.

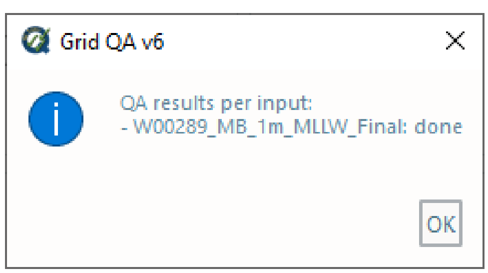


Fig. 2.27: The output message at the end of **Grid QA v5** execution.

How Does It Work?

The Depth, Uncertainty, Density (if available), and a computed Total Vertical Uncertainty (TVU) QC layer are used to compute particular statistics shown as a series of plots.

The following plots are the output of Grid QA:

- The Depth layer is plotted as a distribution (plot entitled **"Depth Distribution"**).
- The Density layer is plotted as a distribution (plot entitled **"Data Density"**).
  - Percentages of nodes less than 5 soundings per node fall in the red shaded region of the plot and together must be less than 5% of all nodes in order to "pass".
- TVU QC (IHO S-44) is plotted as a distribution (plot entitled **"Uncertainty Standards - NOAA HSSD"**).
  - Percentages of nodes with TVU QC greater than 1.0 (indicating that the allowable error has been exceeded) fall in the red shaded region of the plot, and together must be less than 5% of all nodes in order to "pass".
- Only for Variable Resolution grids, a histogram with the percentage of nodes at the prescribed resolution is created. This histogram can be used to evaluate whether *"95% of all surface nodes [..] have a resolution equal to or smaller than the coarsest allowable resolution for the node depth"* (NOAA HSSD).
- *TVU QC (IHO S-57 CATZOC) [Branch]* is plotted as a distribution (plot entitled *"Uncertainty Standards - CATZOC . . . "*).
- Density is plotted against the corresponding Depth of the node (plot entitled **"Node Depth vs. Sounding Density"**).
- TVU QC (IHO S-44) is plotted against the corresponding Depth of the node (plot entitled **"Node Depth vs. TVU QC"**).

TVU QC Calculations

The TVU QC layer is calculated on-the-fly by the program. TVU QC based on IHO S-44 Orders 1 and 2 is in alignment with the requirements set forth by the HSSD and is determined by a ratio of uncertainty to allowable error. It is calculated as such:

$$TVU\,QC_{(IHO\ S\check{}44)} = Uncertainty/\sqrt{A^2 + (B * Depth)^2}$$

where $A = 0.5, B = 0.013$ for Order 1 (depths less than 100 m), and $A = 1.0, B = 0.023$ for Order 2 (depths greater than 100 m).

TVU QC based on IHO S-57 CATZOC is used by the hydrographic branch to evaluate the quality of bathymetry for surveys that are not subject to the HSSD. **This check should NOT be used by NOAA field units or contract field units.**

For TVU QC based on IHO S-57 CATZOC, TVU QC is calculated as such:

$$TVU\,QC_{(IHO\ S\check{}57\ CATZOC)} = Uncertainty/(A + (B * Depth))$$

where for:

CATZOC A1: $A = 0.5, B = 0.01$

CATZOC A2 and CATZOC B: $A = 1.0, B = 0.02$

CATZOC C: $A = 2.0, B = 0.05$

What do you get?

Upon completion of the execution of **Detect Holidays** you will receive a pop-up verification if your statistics are complete (Fig. 2.28).

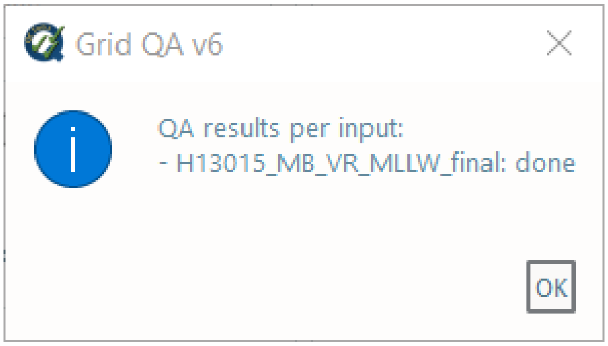


Fig. 2.28: The output message at the end of **Grid QA** execution.

Grid QA produces images representing specific statistical analysis:

- Depth Distribution (Fig. 2.29).
- Data Density (Fig. 2.30).
- Uncertainty Standards - NOAA HSSD (Fig. 2.31) and CATZOC (Fig. 2.35).
- Resolution Requirements *(only for VR grids)* (Fig. 2.32).
- Node Depth vs. Sounding Density (Fig. 2.33).
- Node Depth vs. TVU QC (Fig. 2.34).

2.2.6 BAG Checks

How To Use?

Evaluates BAGs to ensure compliance with NOAA NBS and BAG specification requirements.

In order to access this tool, load in a BAG file into the **Data Inputs** tab.

- Select the **BAG Checks** tab (Fig. 2.36) on the bottom of the QC Tools interface.
- Check the boxes that correspond with the checks you wish to perform.
- In **Execution**, click **BAG Checks v1**.

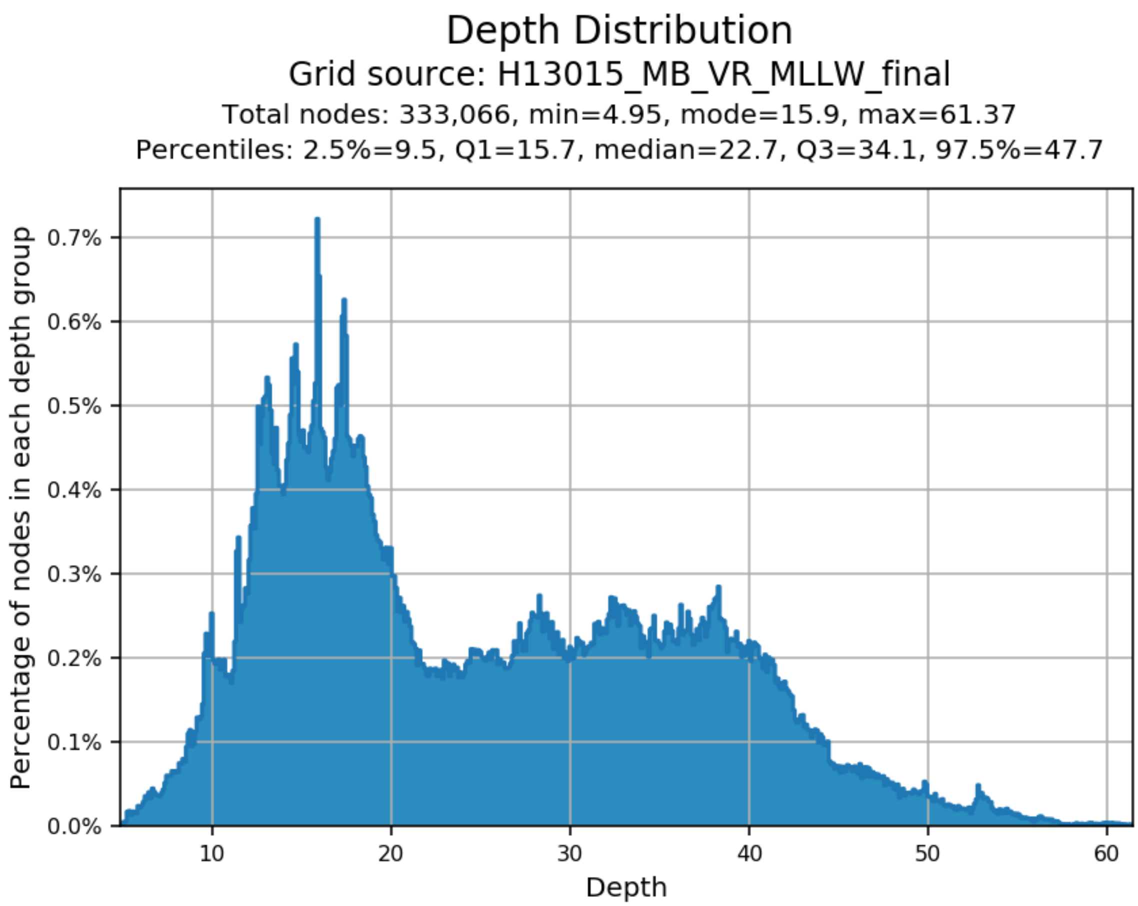


Fig. 2.29: A histogram of the percentage of total nodes at each depth represented in the surface.

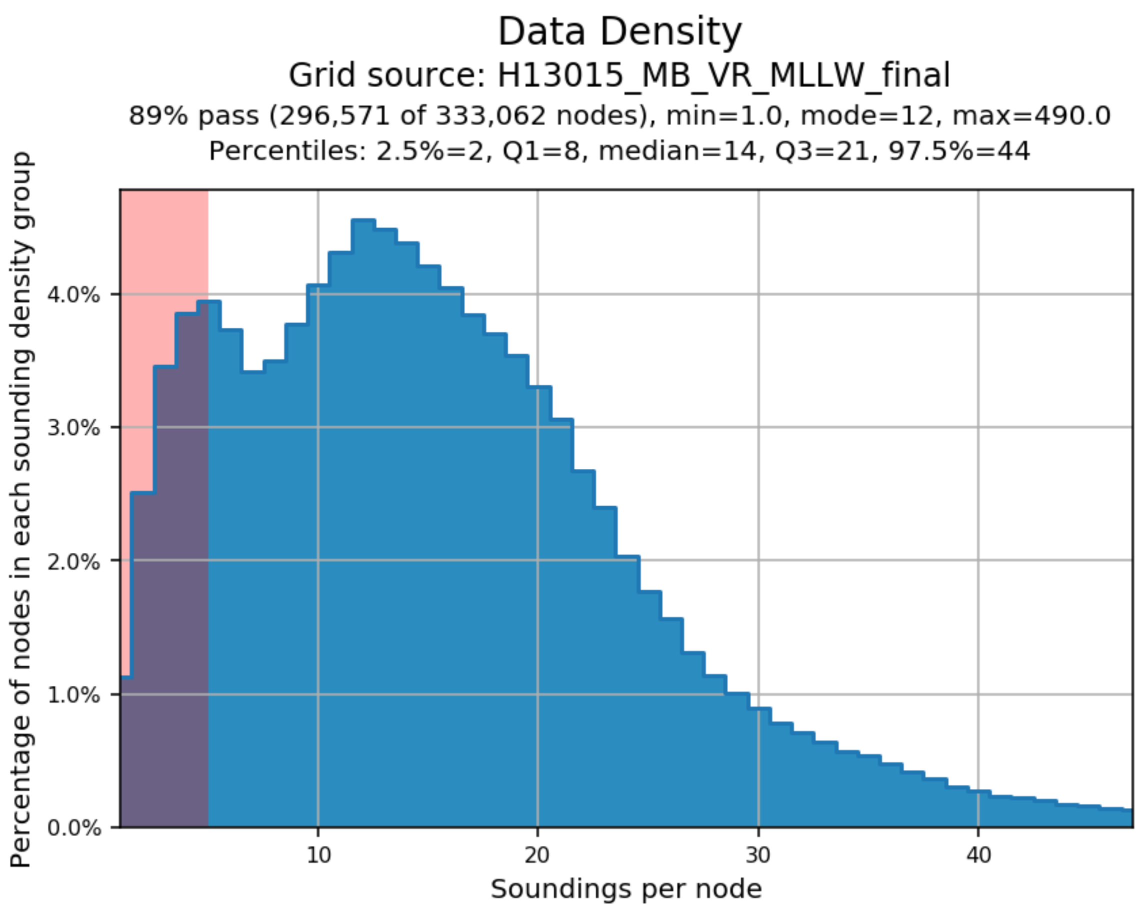


Fig. 2.30: A histogram of the percentage of total nodes that contain a specific sounding per node. To pass a node must have at least 5 soundings contributing to the population of that node.

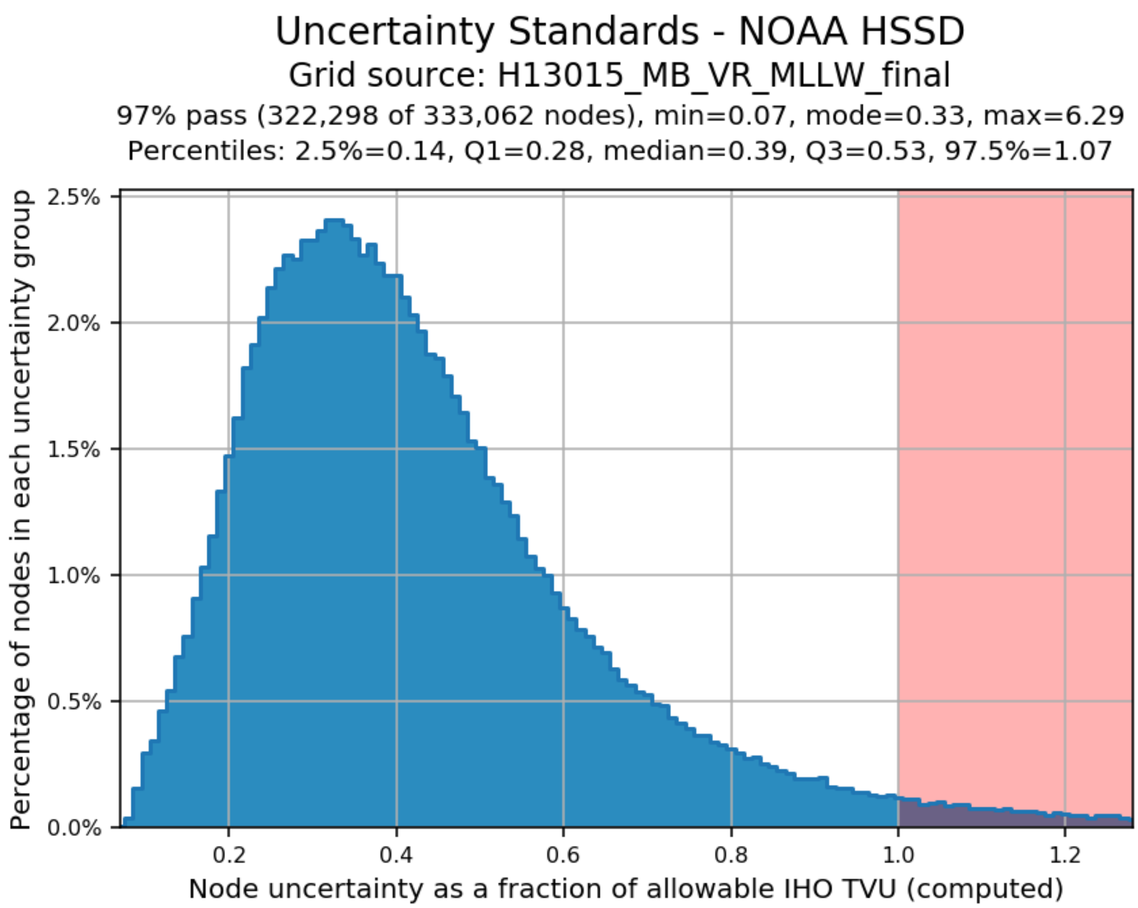


Fig. 2.31: A histogram of the percentage of total nodes that contain a node uncertainty as a fraction of the IHO TVU. Anything over 1.0 does not pass uncertainty requirements.

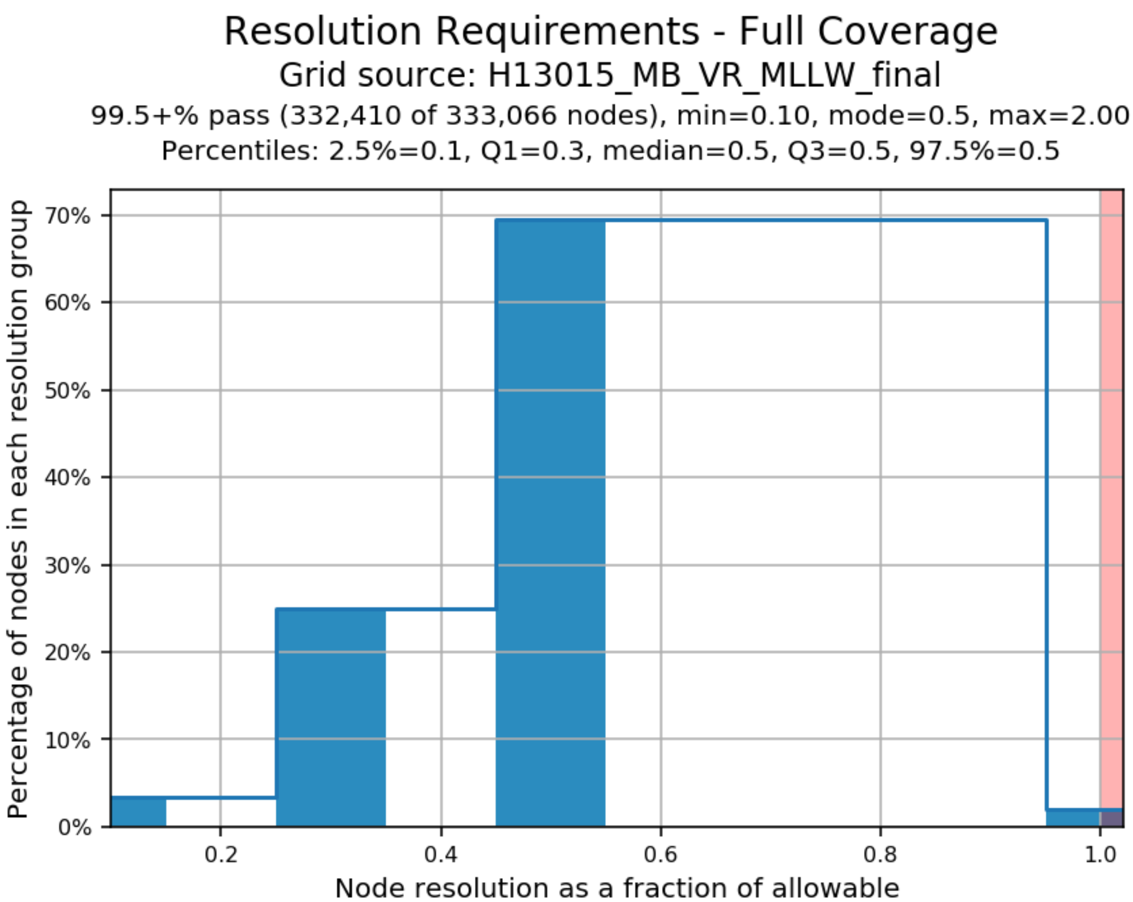


Fig. 2.32: A histogram, created only for VR surfaces, that shows the percentage of nodes that have a node resolution as a fraction of the allowable resolution at that depth. Anything over 1.0 does not pass uncertainty requirements.

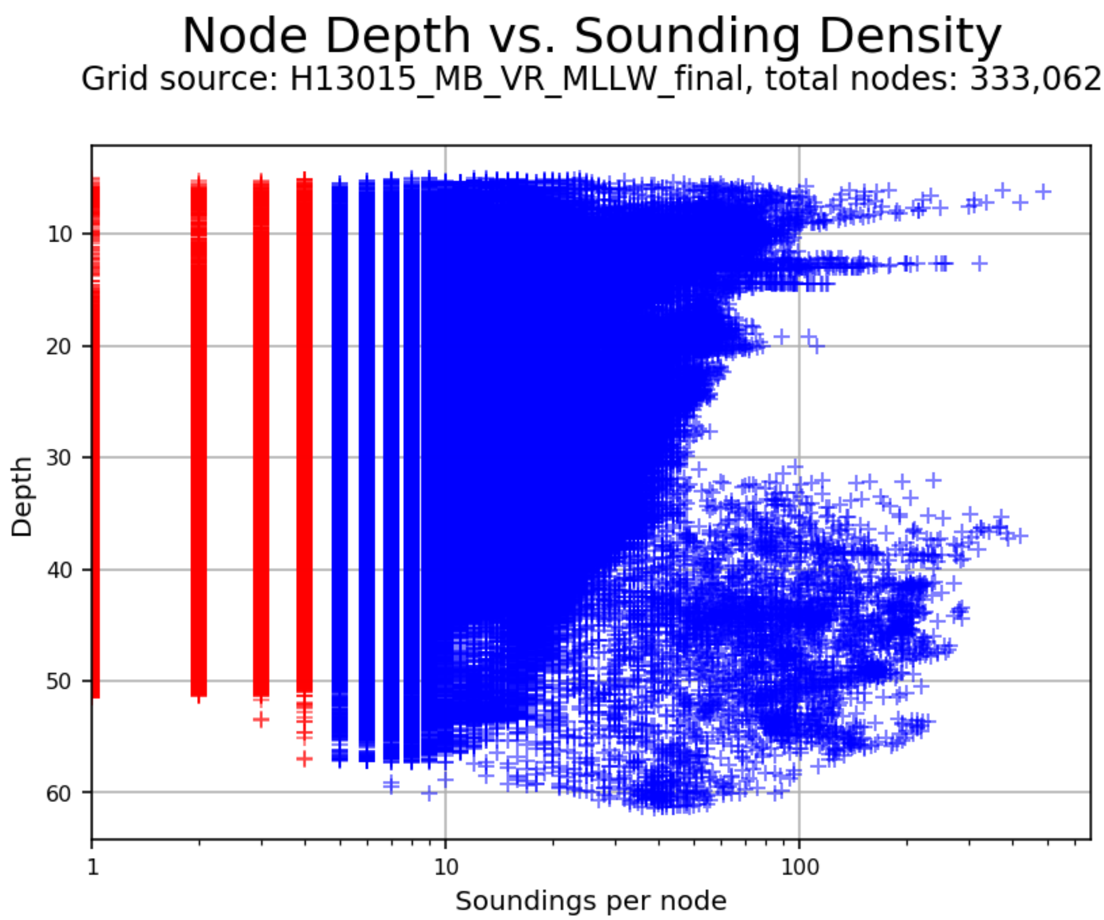


Fig. 2.33: A plot of every node represented in the surface in plotted as its depth on the y axis and its density on the x axis.

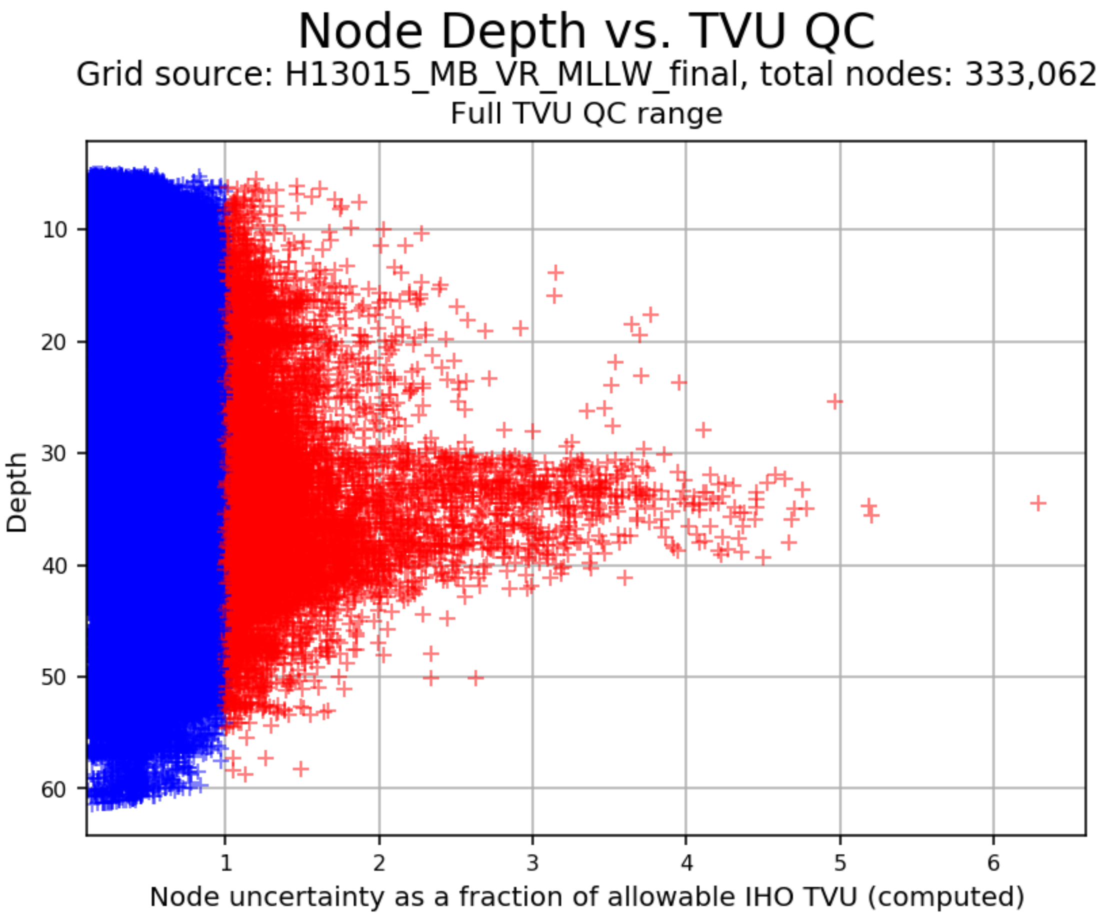


Fig. 2.34: A plot of every node represented in the surface in plotted as its depth on the y axis and its uncertainty as a fraction of the IHO TVU on the x axis.

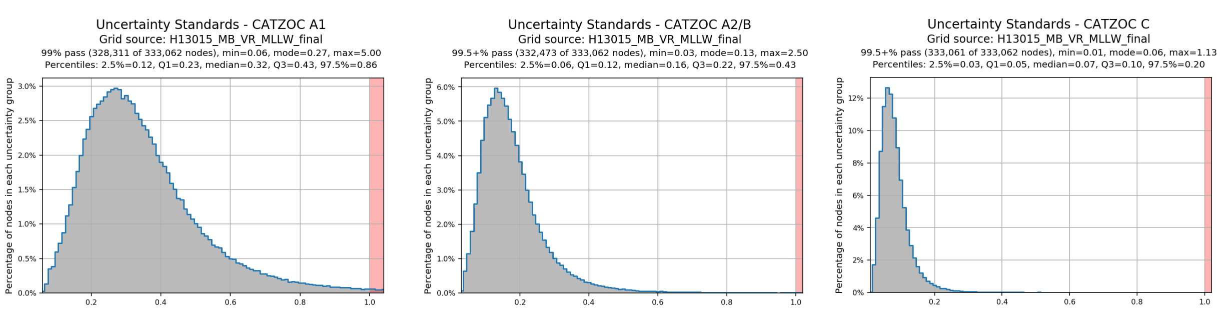


Fig. 2.35: Similar to the uncertainty plot, the CATZOC uncertainty shows a histogram of the percentage of total nodes that contain a node uncertainty as a fraction of the specific CATZOC TVU value. Anything over 1.0 does not pass the requirements.

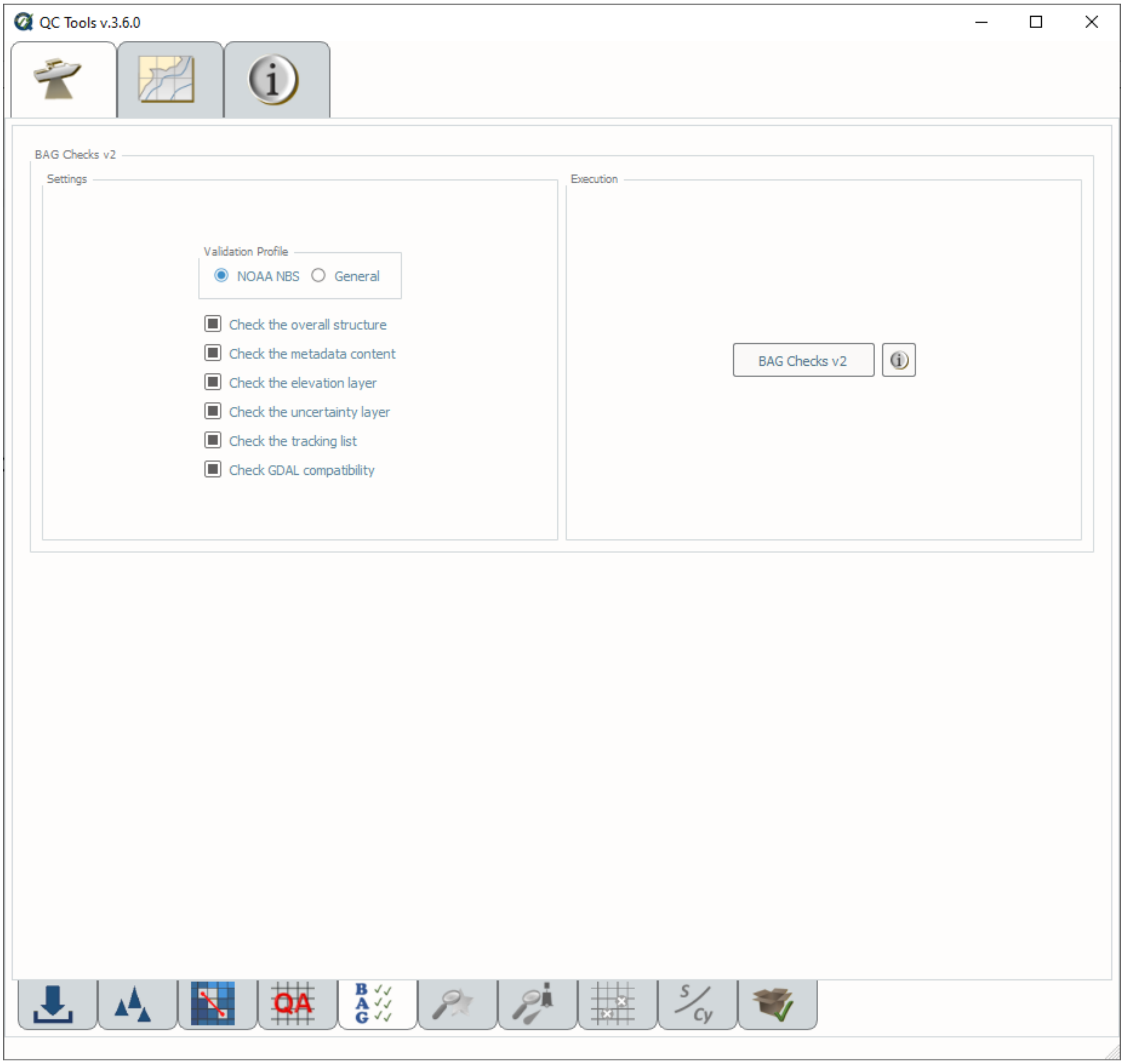


Fig. 2.36: The **BAG Checks** tab.

How Does It Work?

The BAG files are inspected to ensure compliance with NOAA NBS requirements and BAG Format Specification Documents.

Check the overall structure: Check that the critical components of BAG structure are present.

- BAG Root group
- BAG Version attribute
- Metadata dataset
- Elevation dataset
- Uncertainty dataset
- Tracking List dataset
- **For VR Surfaces:**
  - VR Metadata dataset
  - VR Refinements dataset
  - VR Tracking List dataset

Check the metadata content: Checks to ensure that metadata associated with the BAG are appropriately attributed. Checks for

- Metadata dataset
- VR Metadata dataset (VR only)
- **For NOAA NBS Profile:**
  - Spatial reference system is projected.
  - Vertical datum is defined.
  - Creation date
  - Survey start date
  - Survey end date
  - Product Uncertainty

Check the elevation layer: Checks to ensure the validity of the elevation layer of BAG. Checks the following:

- For the presence of a Elevation dataset
- All depth values are not NaN
- VR Refinements (VR only)

Check the uncertainty layer: Checks to ensure the validity of the uncertainty layer in the BAG. Checks the following:

- For the presence of an Uncertainty dataset
- All values are not NaN

- Uncertainty values are only positive
- VR Refinements (VR only)
- **For NOAA NBS Profile:**
  - Uncertainty values are not too high[1]

Check the tracking list: Checks to ensure the validity of the tracking list. Checks the following:

- For the presence of the Tracking List dataset and the VR Tracking List dataset (VR only)
- Validity of the entries in the 'row' column
- Validity of the entries in the 'col' column

Check GDAL Compatibility: Checks to ensure that the surface is compatible with GDAL. Checks the following:

- Checks that that the grid does not have more than 10,000,000 refinement grids which will result in a GDAL error

What do you get?

Upon completion of the execution of **BAG Checks** you will receive a pop-up verification "pass" if your surface passes all the checks, or "fail" if your surface fails any one check (Fig. 2.37).

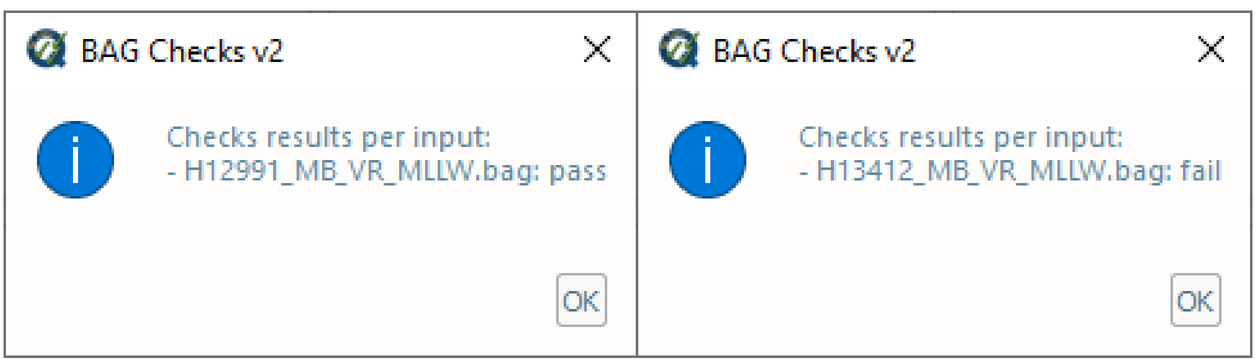


Fig. 2.37: The **BAG Checks** pop-up output.

BAG Checks produces a PDF report that indicates what checks were performed and the results of the checks (Fig. 2.38). At the end of the report a summary indicates how many warnings and errors were identified for the surface (Fig. 2.39).

[1] High uncertainty is calculated as 2.0m + 0.05 * maximum depth of the surface.

B.2. Check that the spatial reference system is projected

OK

B.3. Check the presence of the creation date

OK

B.4. Check the presence of the survey start date

[WARNING] Unable to retrieve the survey start date.

B.5. Check the presence of the survey end date

[WARNING] Unable to retrieve the survey end date.

B.6. Check the selection of Product Uncertainty

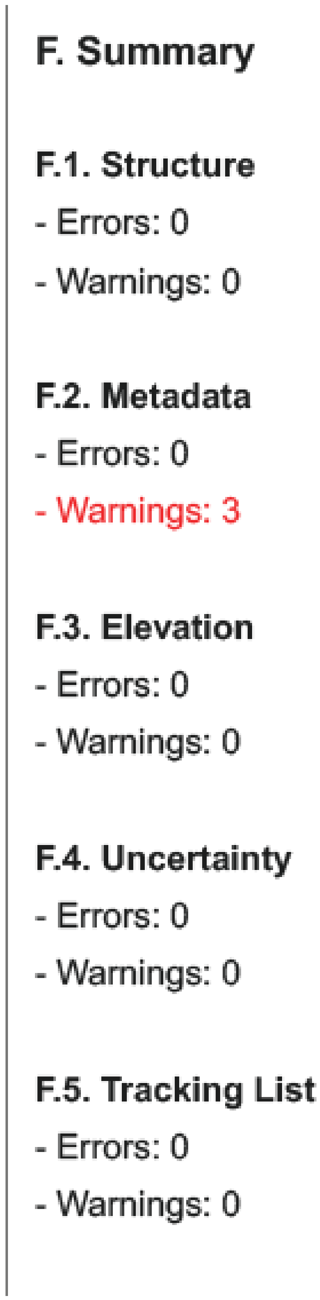
[WARNING] The Uncertainty layer does not contain Product Uncertainty: Unknown

C. Elevation

C.1. Check the presence of the Elevation dataset

OK

Fig. 2.38: An example of a **BAG Checks** PDF report.



F. Summary

F.1. Structure

- Errors: 0

- Warnings: 0

F.2. Metadata

- Errors: 0

- Warnings: 3

F.3. Elevation

- Errors: 0

- Warnings: 0

F.4. Uncertainty

- Errors: 0

- Warnings: 0

F.5. Tracking List

- Errors: 0

- Warnings: 0

Fig. 2.39: An example of the **BAG Checks** summary.

2.2.7 Scan Designated

How To Use?

Scans grids to ensure the validity of any soundings designated. Currently, only **Single-Resolution BAG** files are supported.

In order to access this tool, load a BAG and an S-57 file into the **Data Inputs** tab.

- Select the **Scan Designated** tab (Fig. 2.40) on the bottom of the QC Tools interface.
- In **Parameters**:
  - Turn the knob to select the applicable year as pertaining to required NOAA NOS Hydrographic Survey Specifications and Deliverables (HSSD).
  - Enter the **Survey scale**. Any designated soundings that have a more shoal designated sounding within 2mm at survey scale will be flagged as invalid.
  - If desired, check the box **Evaluate neighborhood** as an estimate of designated sounding height 1 meter off the seafloor. Note this is a subjective check to be overrided by the hydrographer's discretion.
- In **Execution**, click **Designated Scan v2**.

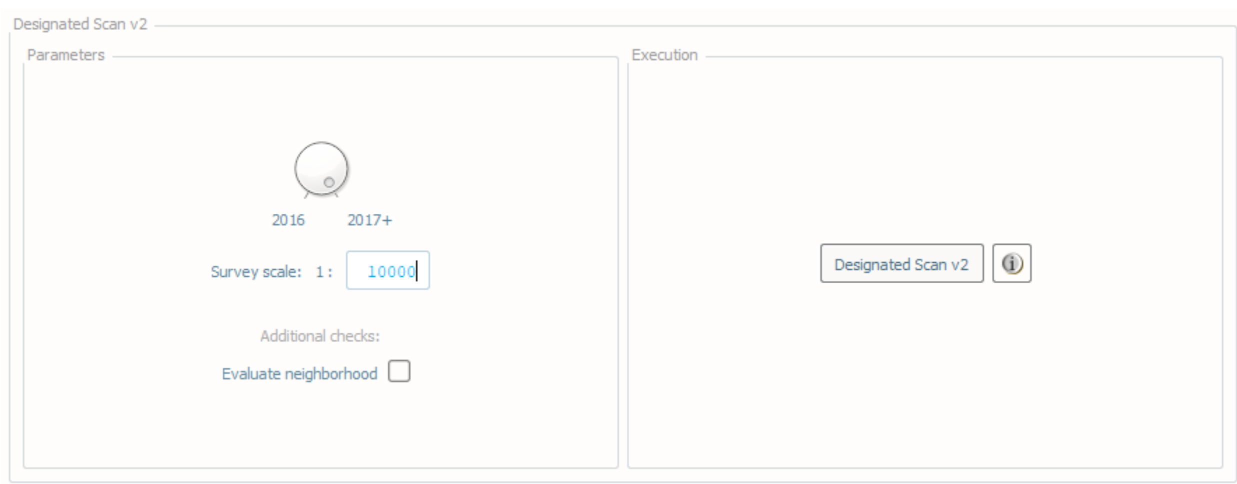


Fig. 2.40: The **Scan Designated** tab.

- After computing, the output window opens automatically.
- From the output window, drag-and-drop the output into the processing software to guide the review.
- The output names adopt the following convention:
  - [grid filename].[s57 filename].DESIGNATED_SCAN_v2.[HSSD year]

How Does It Work?

The grid is scanned to ensure the validity of designated soundings per NOAA NOS HSSD. According to the HSSD 2018 (see, 5.2.1.2.3), a designated sounding need not be created unless the following conditions are true:

1. The top of the natural topography is greater than 1m proud of the surrounding seafloor.

As shown in the example in Fig. 2.41, the designated sounding appears less than 1 meter off the seafloor when viewed in both sounding and grid data. This check is not definitive, however, and should only be used if useful. The hydrographer's discretion may override the output.

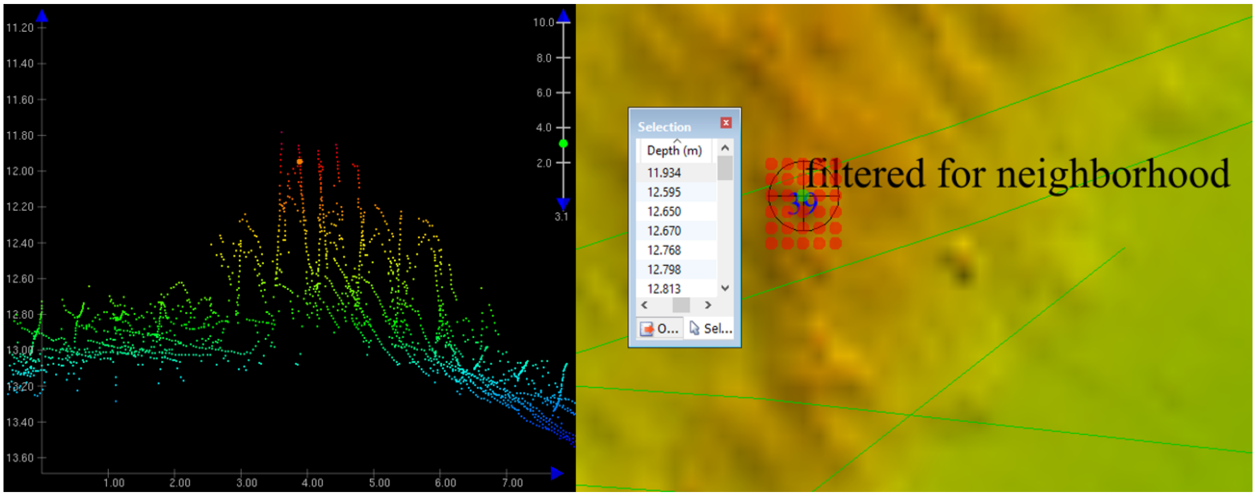


Fig. 2.41: Example of possible unnecessary designation.

2. The difference between the gridded surface and potential designated sounding is greater than the allowable TVU at that depth:

   - half the allowable TVU (in depths < 20 meters) or the full allowable TVU (in depths >= 20 meters) *[2016]*.
   - the full allowable TVU *[2017]*.

The grid nodes are scanned and any node with a depth adjusted by designated sounding is checked to ensure that the difference between the original depth and the new depth (i.e. the designated depth) meet the requirement as related to TVU.

As shown in the example in Fig. 2.42, the vertical distance between the grid and the designated sounding (0.134 m) is less than half the allowable TVU for this depth (0.269 m based on HSSD 2016), thus designation of this sounding was not necessary.

3. In addition, no sounding shall be designated that is within 2 mm at the scale of the survey (i.e., 20 m for 1:10,000 scale) of another shoaler sounding.

As shown in the example in Fig. 2.43, at the survey scale of 1:20,000, there is a more shoal sounding designated (51 feet) approximately 31 meters away, which is within 2mm at survey scale (40 meters), thus the designated sounding of 53 feet is not necesssary.

4. Finally, a designated sounding is valid if a feature exists within 1 grid node and that feature has a VALSOU value within 1 centimeter of difference from the designated sounding depth.

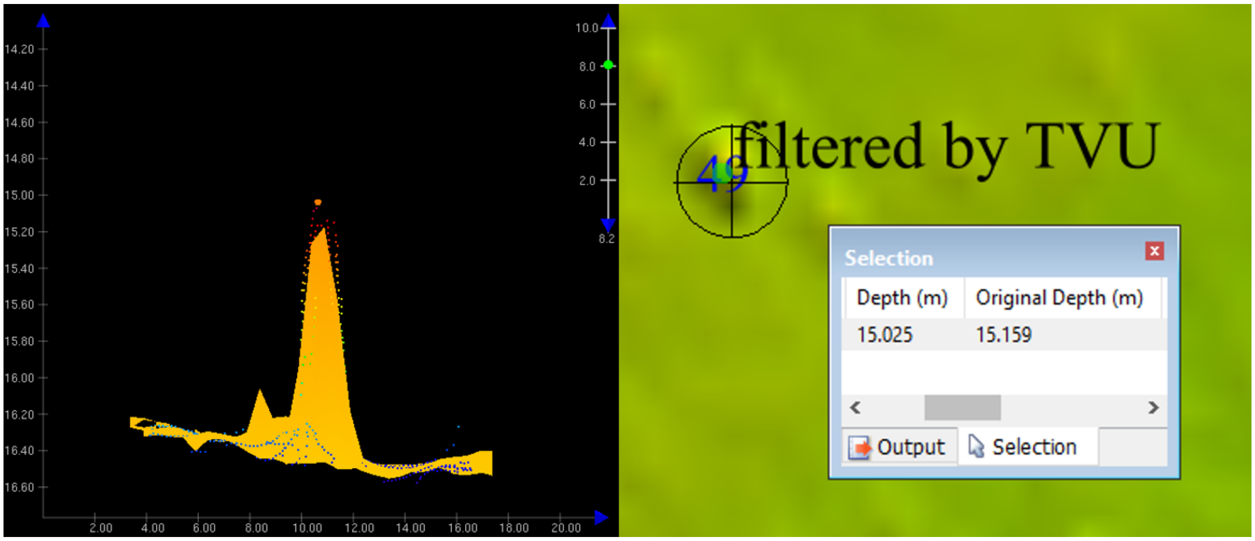


Fig. 2.42: Second example of unnecessary designation.

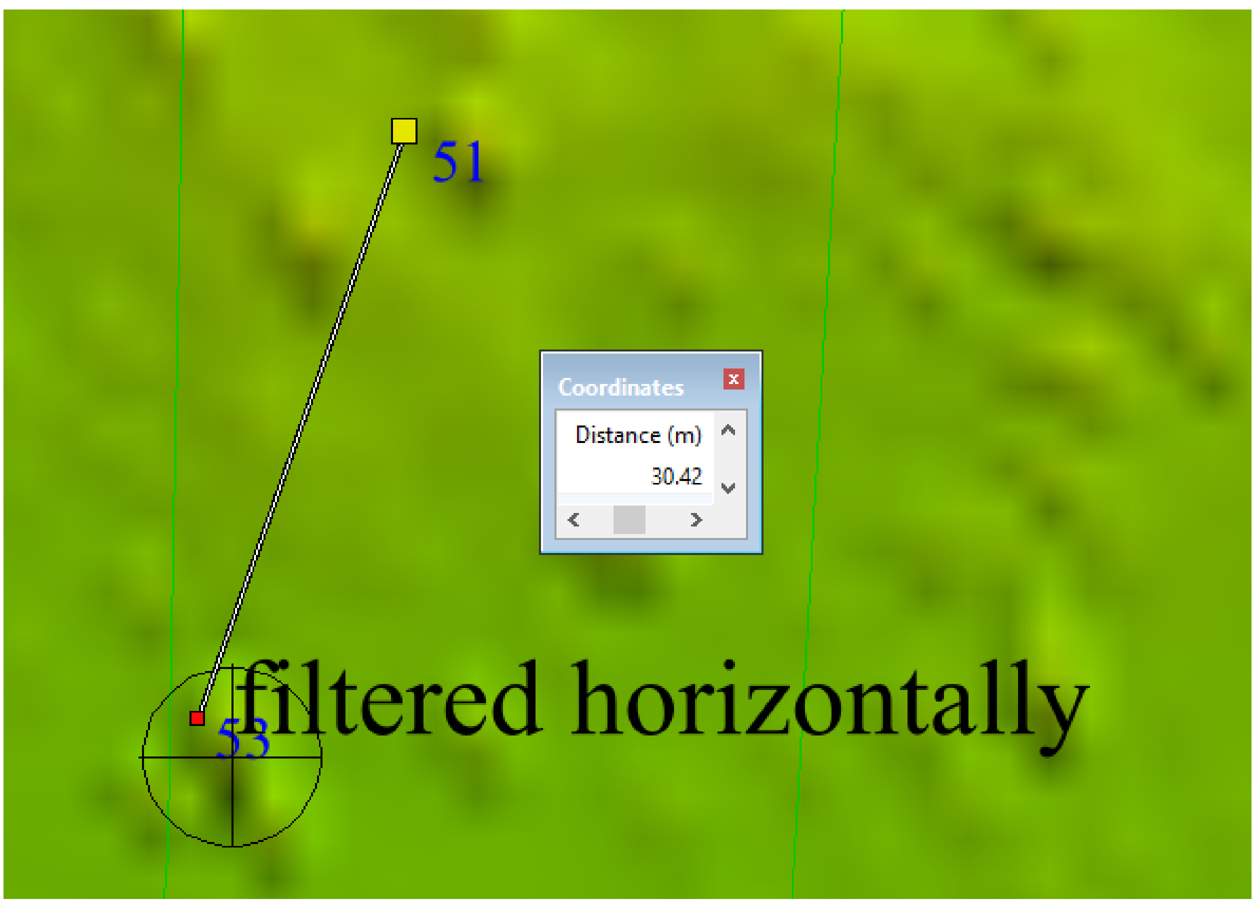


Fig. 2.43: Third example of unnecessary designation.

2.2.8 Scan features

How To Use?

Scan features to ensure proper attribution.

In order to access this tool, load an S-57 file into the **Data Inputs** tab.

- Select the **Scan features** tab (Fig. 2.44) on the bottom of the QC Tools interface.
- In **Parameters**:
  1. Turn the knob to select either the **Office** or **Field** profile.
  2. Turn the knob to select the applicable year as pertaining to required HSSD.
  3. Select **Use settings for Great Lakes area** if your survey is located in the Great Lakes region. This functionality is used when analyzing the WATLEV of features.
  4. When **Check Image Names** is set, the tool will check image names for compliance with the HSSD or with HTD 2018-4 (SBDARE features) and HTD 2018-5 (non-SBDARE features), depending on the year selected. This check can only be disabled in the Field mode for 2019. In Office mode, the HTD or HSSD checks automatically run.
  5. When **Select the path to the images folder** is set, the user can navigate to their multimedia or images folder upon execution of the tool. When this is unchecked, Feature scan will search in the relative path that the feature file is located.
  6. **MHW** value is required to check proper attribution of WATLEV per the HSSD. Enter MHW value as a positive number.
  7. When **SORIND** and **SORDAT** are set, the entered values are compared to the attribution of new and updated features.
- In **Execution**, click **Feature scan v11**.
- After computing, the output window opens automatically, the results are shown(Fig. 2.45).
- From the output window, drag-and-drop the output file(s) into the processing software to guide the review.
- In addition, the results are printed to PDF for a documented summary.

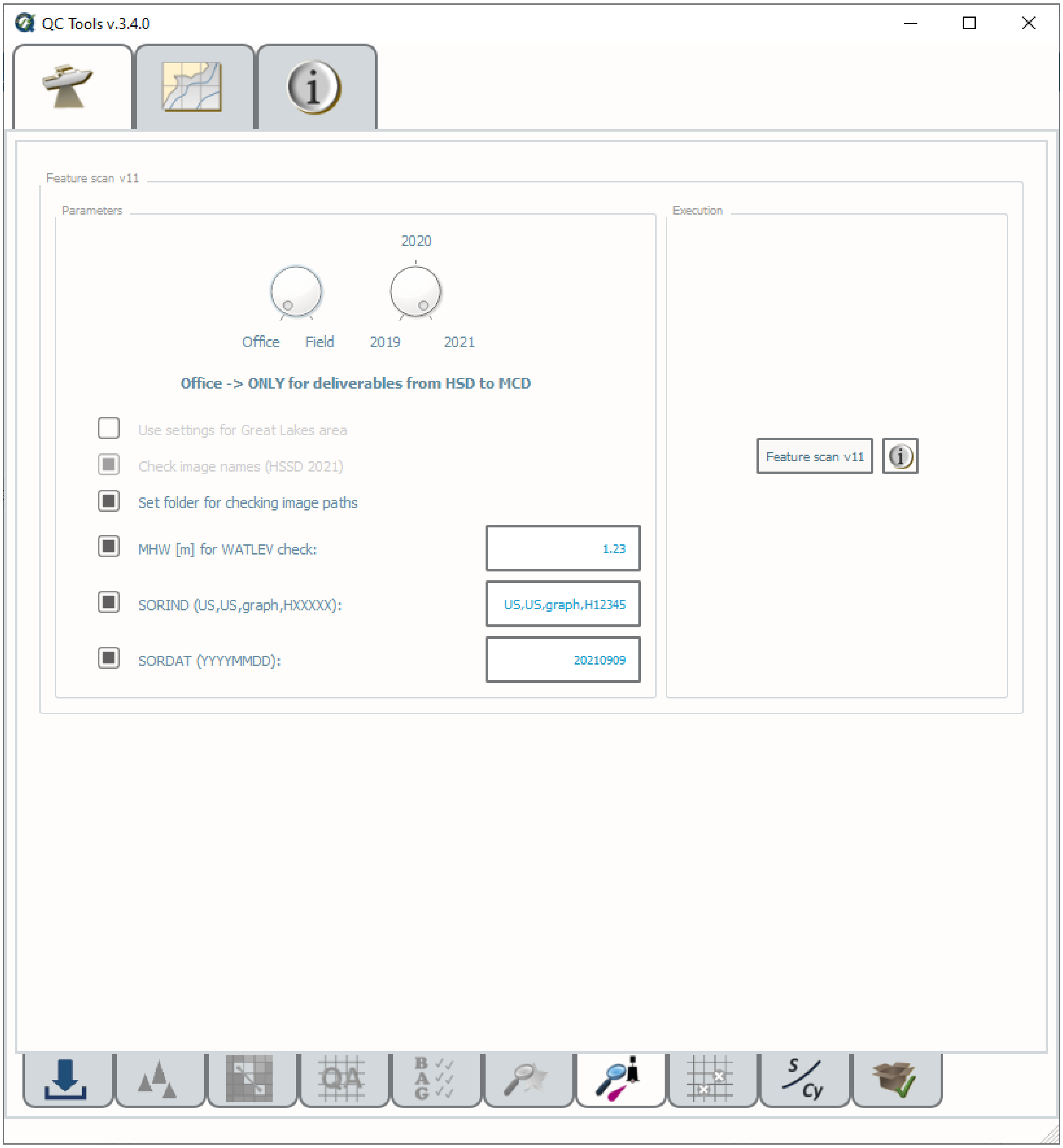


Fig. 2.44: The **Scan features** tab.

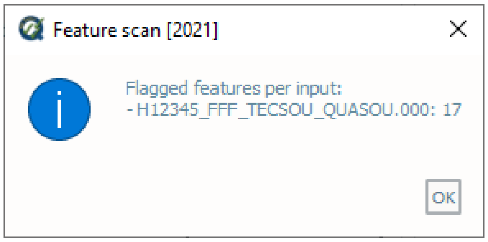


Fig. 2.45: The output message at the end of **Feature scan** execution.

How Does It Work?

The S-57 features are scanned to ensure proper attribution per the required year of HSSD.

The logic for the 2021 QC Tools feature scan is shown below. For previous years, refer to the HSSD for that year.

- **Checks for feature file consistency:**
  - Check to ensure no feature redundancy. Features that have the same position, acronym, and attribution are flagged.
  - No features with text input fields exceeds 255 characters.
- **Assigned features = all features with asgnmt = 2:**
  - All Assigned features must have **descrp** and **remrks.**
- **All new and updated features except $AREAS, $LINES, $CSYMB, $COMPS, and $TEXTS:**
  - Must have **SORIND** and **SORDAT** and that they are in the proper formats.
  - **Check for agreement of SORIND and SORDAT values when entered in the Parameters.**
    - If MHW flag is set, features with **VALSOU** are checked for valid value and proper **WATLEV** attribution.[1]
    - All new or updated features with a VALSOU have a correct **QUASOU** per the HSSD.[2]
    - All features with **ELEVAT** are checked for valid value.
- **New or Deleted features = all features with descrp = 1 or 3:**
  - All New or Deleted features must have **remrks** and **recomd.**
- **All features with images:**
  - All **images** contain the correct naming convention and they have a corresponding image in the multimedia folder.
  - Receive a warning if an image is used on multiple features.
- **Sounding features = all SOUNDG.**
  - All Sounding features must have **TECSOU** and **QUASOU.**
- **DTONs = all features with descrp = 1 or 2, sftype = 3:**
  - All DTONs must have **images.**
- **Wrecks = all WRECKS with descrp = 1 or 2:**

[1] Allowable combinations of **WATLEV** per **VALSOU** depending on location are shown below as stated in Appendix E in the 2021 Hydrographic Specifications and Deliverables.

[2] Allowable combinations of **TECSOU** and **QUASOU** are shown below.

- **All Wrecks must have images, CATWRK, and VALSOU.**[Page 45, 3]
  - **If Wreck has VALSOU:**
    - Must have **WATLEV**, **QUASOU**, and **TECSOU**.
  - **If Wreck does not have VALSOU:**
    - Must have **QUASOU** and **TECSOU** of null/undefined.
    - Receive a warning if **WATLEV** is not "unknown".

- **Rocks = all UWTROC with descrp = 1 or 2:**
  - **All Rocks must have VALSOU.**[3]
    - **If Rock has VALSOU:**
      - Must have **WATLEV**, **QUASOU**, and **TECSOU**.
    - **If Rock does not have VALSOU:**
      - Must have **QUASOU** and **TECSOU** of null/undefined.
      - Receive a warning if **WATLEV** is not "unknown".
- **Obstructions = all OBSTRN with descrp = 1 or 2:**
  - All Obstructions (excluding foul areas) must have **images**.
  - All obsructions (excluding foul ground and foul areas) must have **VALSOU**.[3]
  - **If obstruction has VALSOU:**
    - Obstruction must have **WATLEV**, **QUASOU**, and **TECSOU**.
  - **If obstruction does not have VALSOU:**
    - Must have **QUASOU** and **TECSOU** of null/undefined.
    - Receive a warning if **WATLEV** is not "unknown".
  - **If obstruction is foul ground:**
    - Must have **WATLEV**.
    - Must have **VALSOU**, **QUASOU**, and **TECSOU** of null/undefined.
  - **If obstruction is a foul area:**
    - Must not have **VALSOU** populated.
    - Receive a warning if **WATLEV** is not "unknown".
    - **QUASOU** must be "depth unknown".
    - Must have **TECSOU** of "unknown".
- **Offshore platforms = all OFSPLF with descrp = 1 or 2:**
  - All Offshore platforms must have **images.**
- **Seabed areas:**
  - **Seabed area lines and areas = all SBDARE with line or area geometry.**
    - All Seabed area lines and areas must have **NATSUR** and **WATLEV.**
  - **Seabed area points = all SBDARE with point geometry.**

[3] **VALSOU** is optional for rocks, wrecks, and obstructions if it is unsafe to obtain the least depth. If missing a warning flag is issued.

    * All Seabed area points must have **NATSUR.**
    * All Seabed area points must have as many **NATSUR** attributes as **NATQUA** and/or **COLOUR.**
    * All Seabed area points must have an allowable combination of **NATSUR** and **NATQUA.**[4]

- **Mooring Facilities**
  - All MORFAC must have **CATMOR**.
- **Coast lines and shorelines:**
  - All **COALNE** must have **CATCOA.**
  - All **SLCONS** must have **CATSLC.**
- **Land elevations:**
  - All **LNDELV** must have **ELEVAT.**
- **Metadata coverages:**
  - All **M_COVR** must have **CATCOV, INFORM,** and **NINFOM.**
- **Specific for the Office Profile:**
  - All features must have **onotes.**
  - All features must have **hsdrec.**
  - Checks for features that are prohibited by MCD (**DRGARE, LOGPON, PIPARE, PIPOHD, PIPSOL, DMPGRD, CBLSUB, CBLARE, FAIRWY, CBLOHD, BCNSPP, BRIDGE, OBSTRN with CATOBS = 5**, and **MORFAC** with **CATMOR = 7**.
  - Flags ATONS if they are found in the file. MCD defines ATONS as: **LIGHTS, BOYLAT, BOYSAW, BOYSPP, DAYMAR, FOGSIG, RTPBCN, BOYISD, BOYINB, BOYCAR, BCNSPP, BCNLAT, BCNSAW, BCNCAR**, and **BCNISD**
  - All **M_QUAL** features must have **CATZOC, SURSTA, SUREND,** and **TECSOU.**
  - All features must have **descrp** and **remrks**.

TECSOU		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Q	1														
U	2														
A	6			o	o		o						o		
S	7														
O	8														
U	9		o												
	NULL	o						o			o				

TECSOU: found by echosounder (1), found by side scan sonar (2), found by multibeam (3), found by diver (4), found by leadline (5), swept by wire-drag (6), found by laser (7), swept by vertical acoustic system (8), found by electromagnetic sensor (9), photogrammetry (10), satellite imagery (11), found by levelling (12), swept by side-scan sonar (13), and computer generated (14).

QUASOU: depth known (1), depth or least depth “unknown” (2), least depth known (6), least depth “unknown”, safe clearance at value shown (7), value reported (not surveyed) (8), value reported (not confirmed) (9), and NULL (undefined/blank).

[4] Allowable combinations of **NATSUR** and **NATQUA** are shown below.

Classification	Always Underwater	Awash	Covers & Uncovers	Always Dry
Elevation (VALSOU or HEIGHT)	> 0.1 m below chart datum (e.g., MLLW or LWD⁺)	< 0.1 m above chart datum (e.g., MLLW) to 0.1 m below chart datum (e.g., MLLW)	0.1 m ≥ chart datum (e.g., MLLW) to 0.1 m SPOR (e.g., MHW)	> 0.1 m SPOR (e.g., MHW)
S-57 Object	UWTROC OBSTRN WRECKS	UWTROC OBSTRN WRECKS	UWTROC OBSTRN WRECKS	LNDARE & LNDELV* OBSTRN** WRECKS**
WATLEV Value	3	5	4	none
Vertical coordinate system is positive up for elevations and positive down for depths				

⁺In the Great Lakes, rocks, obstructions, and wrecks are defined in relation to Low Water Datum.

*A rock becomes an islet at 0.1 meters above SPOR (e.g. MHW). LNDARE point or area objects are used to characterize islets. Elevation for islets is encoded using the object LNDELV, with attribute ELEVAT, and are shown relative to the SPOR.

**When the depth of an obstruction or wreck is greater than 0.1 meters above MHW, HEIGHT attribution is required rather than VALSOU. As with ELEVAT, heights are shown relative to SPOR (e.g., MHW). In this situation, WATLEV and VALSOU are left null.

NATQUA		1	2	3	4	5	6	7	8	9	10
N	1					o	o	o	o	o	o
A	2					o	o	o			o
T	3					o	o	o			o
S	4	o	o	o			o		o	o	o
U	5								o	o	
R	6								o	o	
	7								o	o	
	8								o	o	
	9								o	o	
	11								o		
	14				o						
	17				o					o	
	18								o	o	

NATQUA: fine (1), medium (2), coarse(3), broken (4), sticky (5) soft (6), stiff (7), volcanic (8), calcareous (9), hard (10)

NATSUR: mud (1), clay (2), silt (3), sand (4), stone (5), gravel (6), pebbles (7), cobbles (8), rock (9), lava (11), coral (14), shells (17), boulder (18)

What do you get?

Upon completion of the execution of **Feature Scan** you will receive a pop-up verification if your surface contains potential fliers or not (Fig. 2.46).

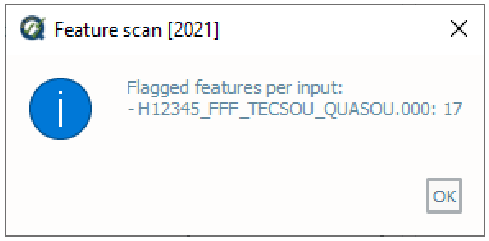


Fig. 2.46: The **Feature Scan** output message.

Feature Scan produces a .000 files containing "blue notes" which helps the user identify the locations flagged features. Each test that results in a flag will have a corresponding feature in the output file. The **NINFOM** field is used to describe the warning or error associated with the feature. The **INFORM** field contains the corresponding test number from the PDF Report (Fig. 2.48). These can be loaded into your GIS software of choice for further analysis.

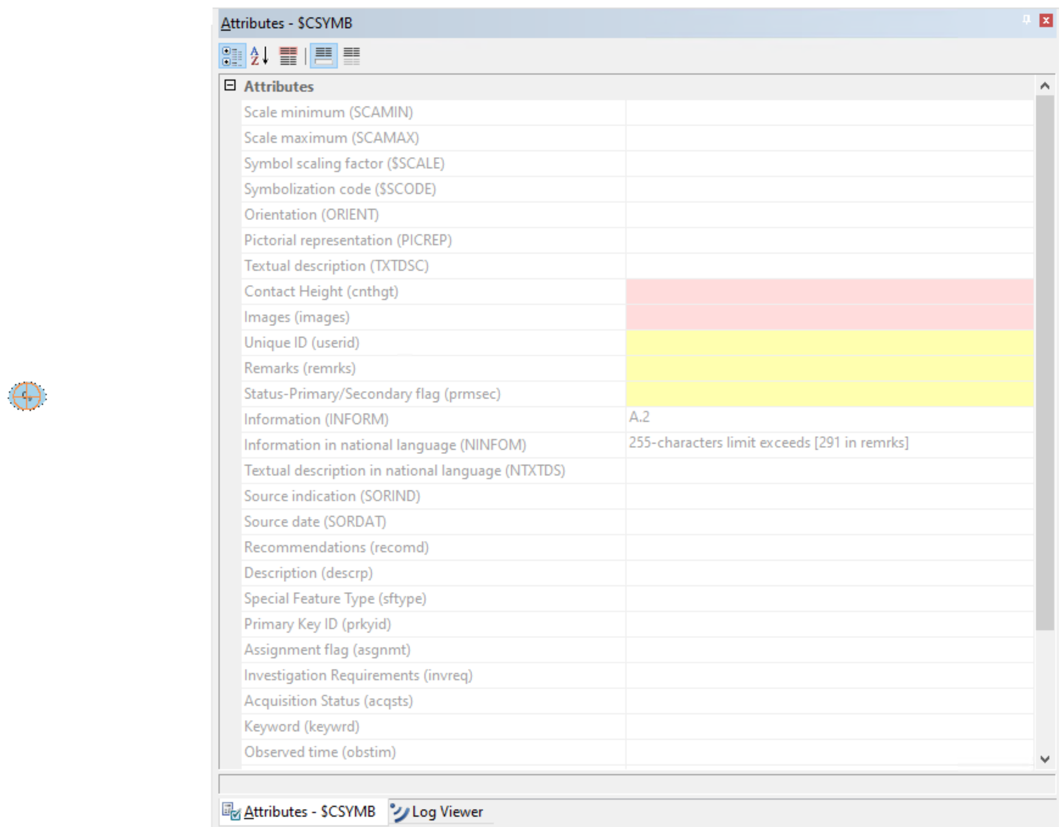
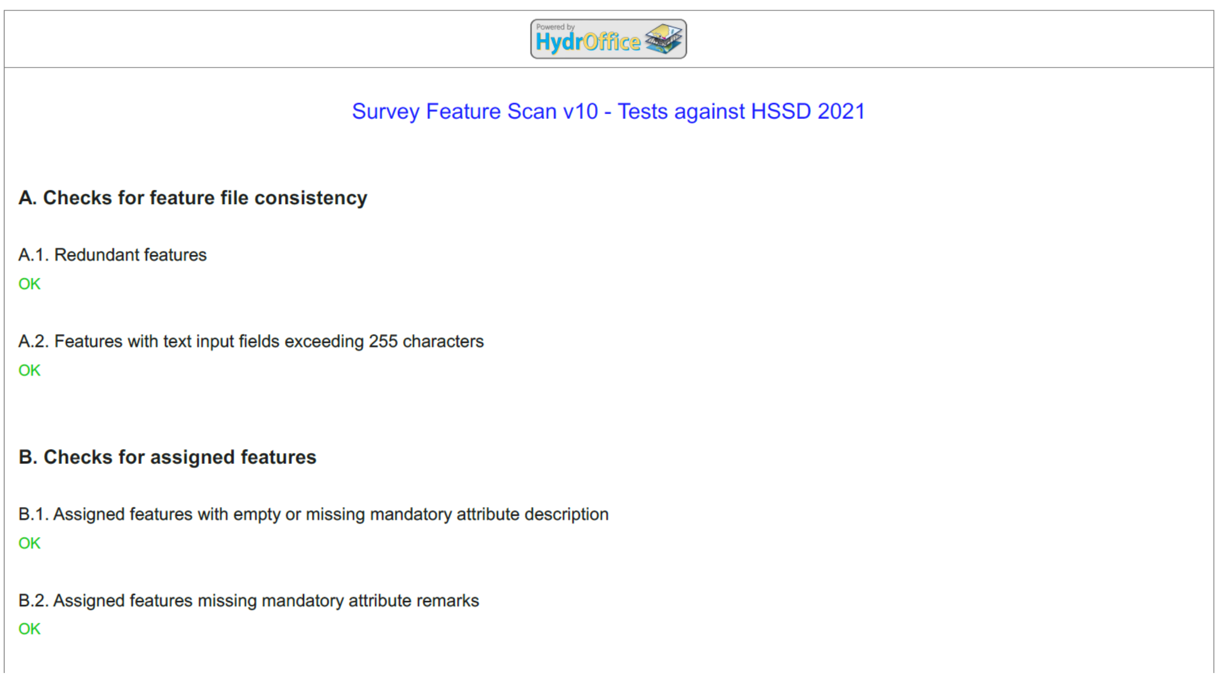


Fig. 2.47: An example of a warning associated with an obstruction identified with a blue note ($CSYMB).

Feature Scan produces a PDF report that indicates what checks were performed and the results of the checks (Fig. 2.49). At the end of the report, a summary indicates how many warnings and errors were identified grouped by type (Fig. 2.50).

Information	Information in national language
J.8	invalid/prohibited value for TECSOU
J.2	warning: missing VALSOU
J.7	warning: missing attribute: WATLEV
E.1	missing images folder

Fig. 2.48: An example of one feature with multiple flags. The "Information" field shows the corresponding section from the PDF Report, the "Information in national language" field shows a description of the flag.



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Survey Feature Scan v10 - Tests against HSSD 2021

A. Checks for feature file consistency

A.1. Redundant features

OK

A.2. Features with text input fields exceeding 255 characters

OK

B. Checks for assigned features

B.1. Assigned features with empty or missing mandatory attribute description

OK

B.2. Assigned features missing mandatory attribute remarks

OK

Fig. 2.49: An example of a **Feature Scan** PDF report.

R. SUMMARY

R.1. Summary by section:

- Section A - Checks for feature file consistency: 0
- Section B - Checks for assigned features: 0
- Section C - Checks for new or updated features: 26
- Section D - Checks for new or deleted features: 0
- Section E - Checks for images: 0
- Section F - Checks for soundings: 0
- Section G - Checks for DTONs: 0
- Section H - Checks for wrecks: 0
- Section I - Checks for underwater rocks: 0
- Section J - Checks for obstructions: 0
- Section K - Checks for offshore platforms: 0
- Section L - Checks for seabed areas: 0
- Section M - Checks for mooring facilities: 0
- Section N - Checks for coastlines and shorelines: 0
- Section O - Checks for land elevations: 0
- Section P - Checks for meta coverages: 0
- Section Q - Checks ONLY for office: 0

Fig. 2.50: An example of the **Feature Scan** summary.

2.2.9 VALSOU checks

How To Use?

Ensure surveyed features are properly accounted for in the gridded bathymetry.

In order to access this tool, load a grid and an S-57 file into the **Data Inputs** tab.

- Select the **VALSOU check** tab (Fig. 2.51) on the bottom of the QC Tools interface.
- In **Parameters**:
  - Turn the knob to select the survey mode: **Full coverage** or **Object detection**.
  - The **Deconflict across grids** checkbox may be enabled if the grids that are loaded have overlaps. If a feature has no grid data directly underneath, the nodes of the other grids in memory will be searched to find a valid match.
  - The **Include TECSOU=laser** checkbox may be enabled (in the event of lidar bathymetry wherein we'd expect features to be represented in the grid), or disabled (as in the case of shoreline investigations wherein we'd not have this expectation).
- In **Execution**, click **VALSOU check v8**

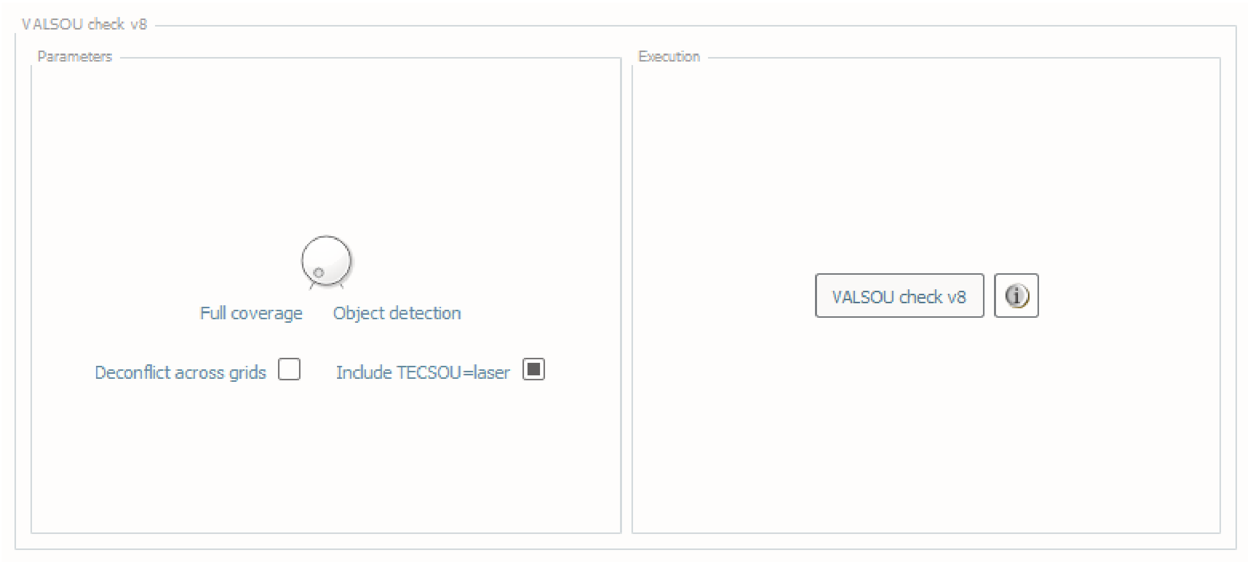


Fig. 2.51: The **VALSOU check** tab.

- After computing, the output window opens automatically, and the results are shown (Fig. 2.52). Note, the check considers all combination of grids and features files loaded. If there is no overlap found between a grid and feature file, no output is generated, and the summary will report "no overlap".
- From the output window, drag-and-drop the output into the processing software to guide the review.
- The output names adopt the following convention:
  - [grid].[s57].VCv8.[version].[".las" -> **Include TECSOU=laser**][".dec" -> deconfliction]["od"|"fc" -> mode]

Note: **VR CSAR**: this tool may provide false positives due to current limitations in accessing designated soundings through the CARIS SDK.

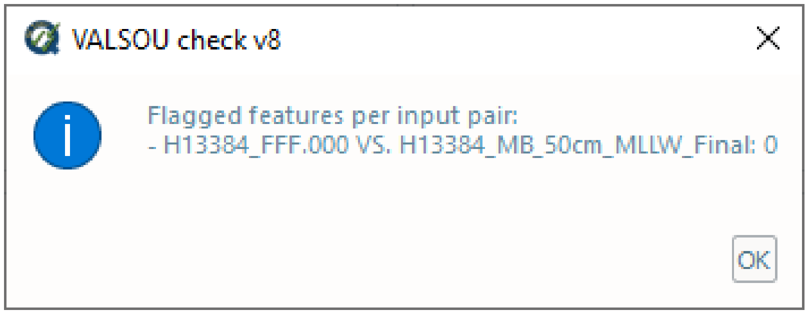


Fig. 2.52: The output message at the end of **VALSOU check v8** execution.

Note: **VR BAG**: this tool may provide false positives because grids created with CARIS apps do not currently contain the location of designated soundings.

How Does It Work?

The grid is scanned for features expected to be represented in the grid as per specification. These features are new or updated wrecks, rocks, and obstructions, and a grid node should be found that agrees with the feature VALSOU.

For each feature, 9 grid node depths are selected: the grid node depth closest in position to the feature, and the 8 grid nodes surrounding it (Fig. 2.53). The minimum depth is selected from those 9 grid node depths, and that minimum depth must match the feature VALSOU (to centimeter precision). If not, a flag is raised. Note, this check not only ensures parity between feature VALSOUs and the grid, but it will also ensure the VALSOU entered is the most shoal depth among the 9 grid nodes atop the feature.

Note: If the input grid files follow the NOAA OCS naming convention (e.g., having "_1m_" in the filename), this information is retrieved and used to only evaluate the features with VALSOU value in the corresponding validity range (e.g., 0 - 20 m).

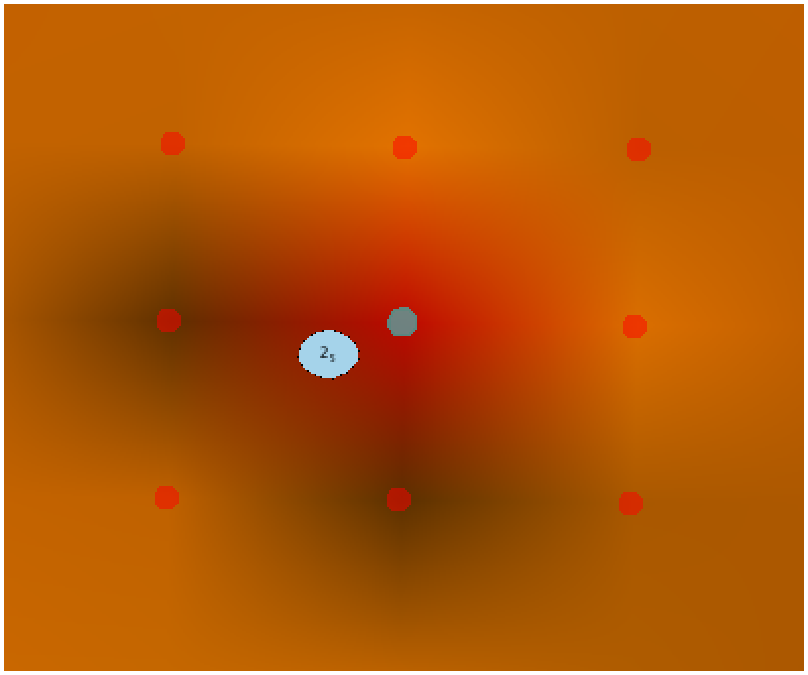


Fig. 2.53: The grid node closest in position to the feature and the 8 grid nodes surrounding it are included in the search. The minimum of these nodes must match the feature VALSOU.

What do you get?

Upon completion of the execution of **VALSOU Checks** you will receive a pop-up verification if your surface contains potential discrepancies with your S-57 features and/or your designated soundings (Fig. 2.54).

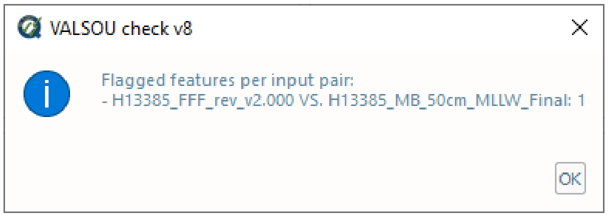


Fig. 2.54: The output message at the end of **VALSOU Checks** execution.

The output of this tool is a .000 file that contains $CSYMB features which provides the location of the potential discrepancy. Drag and drop in your GIS of choice. The NINFOM field indicates the reason for the flagged object.

2.2.10 SBDARE export

Generates a text file and shape file for archival that includes, if available, linked bottom sample images and a translation of the S-57 attribution to the Coastal and Marine Ecological Classification Standard (CMECS).

In order to access this tool, load a grid and an S-57 file into the **Data Inputs** tab.

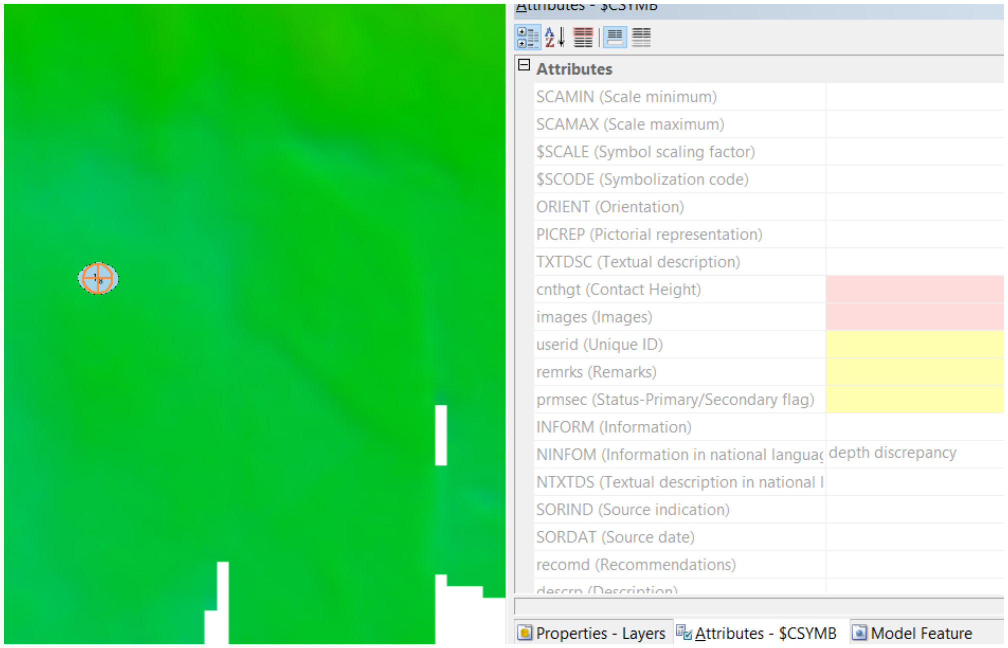


Fig. 2.55: Example of a flagged depth discrepancy found with scan designated. The orange symbol is the flag.

How to Use?

- Select the **SBDARE export** tab on the bottom of the QC Tools interface.
- Click **SBDARE export v5** (Fig. 2.56).
- A window will appear requesting the user to identify the path to the images. If your bottom samples do not contain images you may select "Cancel".
- After computing, the output window opens automatically, and the results are shown. Any errors that occur while processing will appear in the output message.
- The output positions are in **WGS84 coordinates**.
- The output is in the proper format for archival.

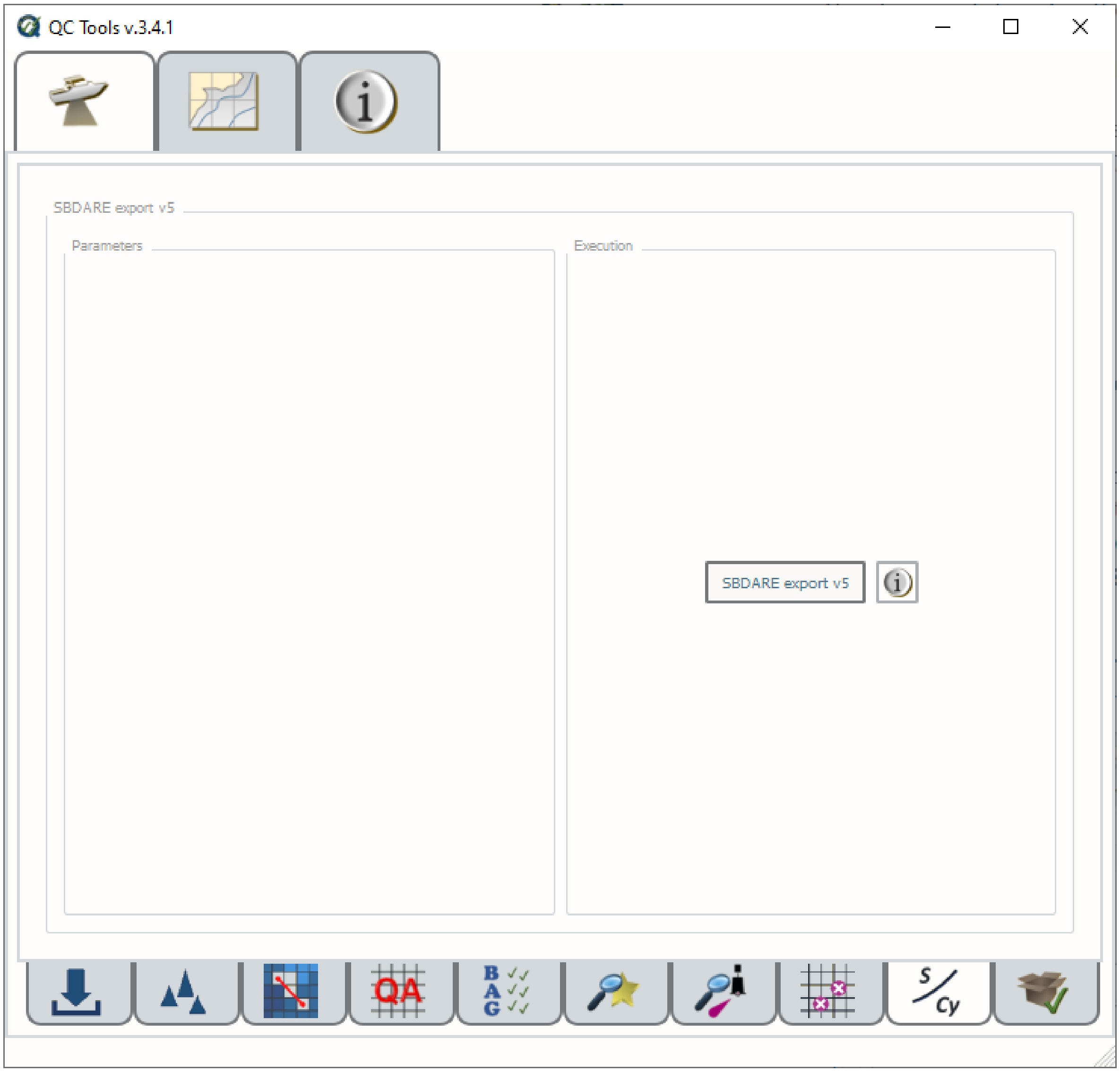


Fig. 2.56: SBDARE exports interface.

How Does It Work?

SBDARE export selects only SBDARE point features in the feature file and exports them into the appropriate outputs per the Bottom Samples and CMECS Translation for submittal to NCEI SOP.

Both the semicolon delimited ASCII file and the shape file contain the following information: Latitude, Longitude, Colour, Nature of surface - qualifying terms, Nature of surface, Remarks, Source date, Source indication, Images, CMECS Co-occurring Element 1 Name, and CMECS Co-occurring Element 1 Code, CMECS Co-occurring Element 2 Name, and CMECS Co-occurring Element 2 Code.

Colour, **Nature of surface - qualifying terms** (NATSUR), and **Nature of surface** (NATQUA) are all limited to three or fewer terms. If the feature file contains more than three terms per attribute, the first three are selected. Additionally, only a maximum of four **images** are allowed per feature. If there are more than four images for a feature, the first four are selected for export.

All associated images will have the GPS metadata in the JPEG file match the location of the bottom sample in the feature file. This allows future users to utilize these images in GIS software as they are geotagged.

SBDARE export translates the **NATSUR** and **NATQUA** to the appropriate Coastal and Marine Ecological Classification Standard June 2012 (**CMECS**) standard. A crosswalk table used for this classification can be found in the Bottom Samples and CMECS Translation for submittal to NCEI SOP.

A zip file is created containing the shape file and "Images" folder with the images. If no images are available, a text file is created indication that the image folder is intentionally left empty.

What do you get?

Upon completion of the execution of **SBDARE Export** you will receive a pop-up about the number of bottom samples that were exported. The number of warnings associated with the output are also provided (Fig. 2.57).

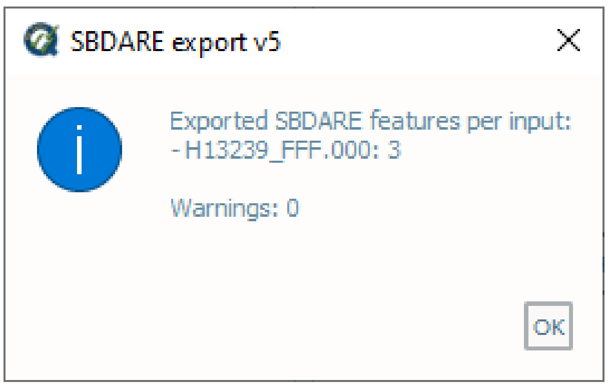


Fig. 2.57: The output message at the end of **SBDARE export v5** execution.

SBDARE export v5 produces an ASCII file or a zip file, containing a shapefile with bottom sample locations and an images folder with georeferenced images (Fig. 2.58), for NCEI archival. Attributes includes NOAA S-57 attribution and CMECS translations.

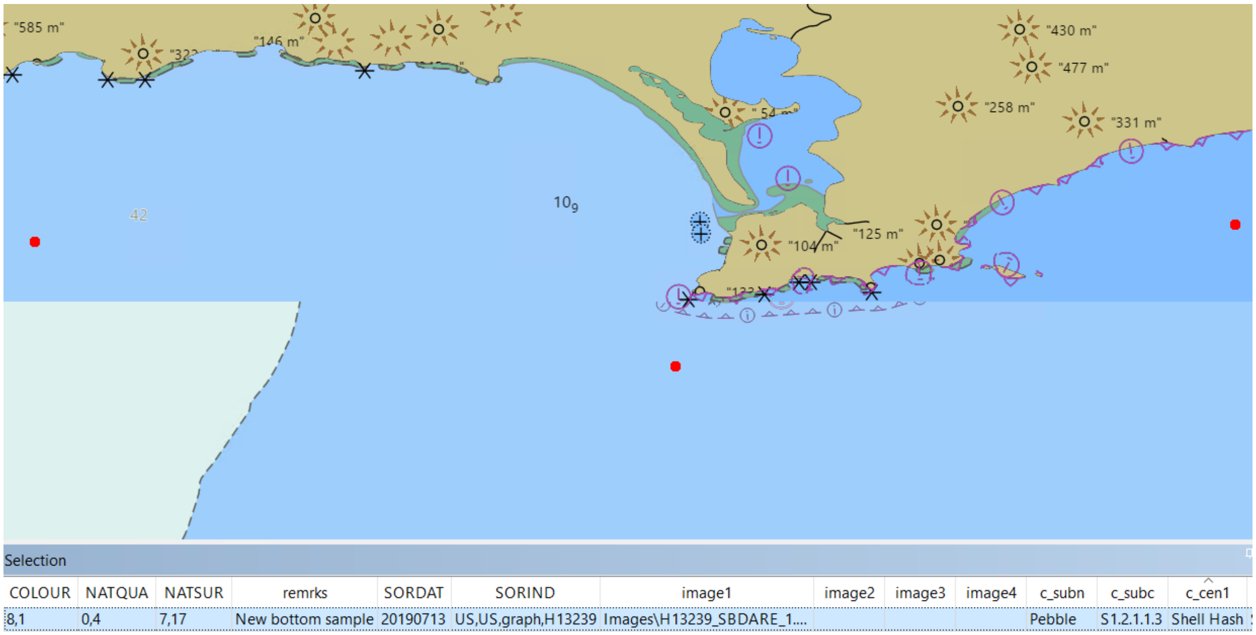


Fig. 2.58: Bottom samples shown as red circles with an ENC in the background.

2.2.11 Submission checks

How To Use?

Ensures the required directory structure and completeness of survey deliverables.

- Select the **Submission checks** tab on the bottom of the QC Tools interface.
- Drag-and-drop (or browse **"+"** to) the directory to be examined. This can be at the survey level (**"X#####"**). Alternatively, the root folder may be at the project level (**"OPR-X###-XX-##"**), which will then examine all survey folders and project reports found within.
- Flag the **Non-OPR project** check if the submission survey folder does not start with **OPR-**.
- In **Parameters** (Fig. 2.59, left side):
  - Turn the knob to select either the **Field** or **Office** profile.
  - Turn the knob to select either **Exhaustive** or **Recursive** settings. If an error is found, **Recursive** will stop at the level of the error; conversely, **Exhaustive** will continue to check sub-folders that are likely to perpetuate the error found at the higher level.
  - Turn the knob to select the applicable year as pertaining to required Hydrographic Survey Specifications.
  - Flag the **HXXXXX_GSF (NOAA only)** check if the submission is from a NOAA field unit.
- In **Execution** (Fig. 2.59, rigth side), click **Submission checks v4**.
- After computing, the output window opens automatically, and the results are shown.
- Note that the project level (**"OPR-X###-XX-##"**) contains all the results from the surveys (**"X#####"**) contained within; thus the number of errors and warnings is equivalent to the sum of the individual components.
- The results are printed to PDF, one for each root folder.
- The output names adopt the following convention:

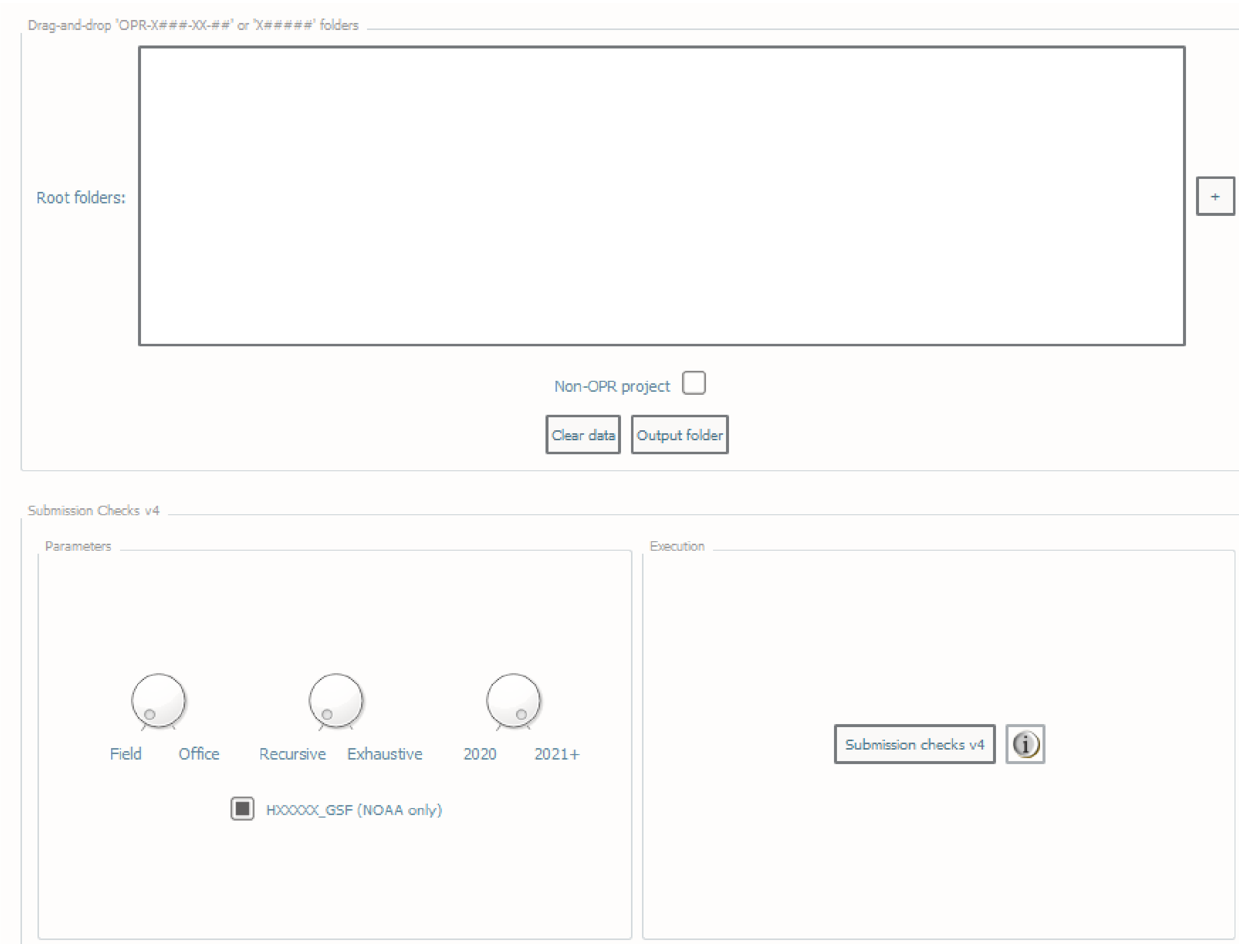


Fig. 2.59: The **Submission check** interface.

    - [project].SCv4.["project" | "X#####" | "report"].[HSSD].[profile].["rec" for recursive | "exh" for exhaustive]

- The output will be exported under a subfolder (**H#####**) in the output location defined on the data import tab. If "sub-folders" is selected in the import tab, the file will be placed in an additional "submissions" sub-folder within the survey folder.

How Does It Work?

Root folders have the following requirements:

- A project root folder must be in the format of **"OPR-X###-XX-##"** or **"OPR-X###-XX-##_Locality_Name"** (unless the **Non-OPR project** check is on).
- A survey root folder must be in the format of **"X#####"** or **"X#####_Sublocality_Name"**.
- A project reports root folder must be in the format of **"Project_Reports"**.

The ensuing submission check will scan the directories of the root folders to ensure compliance with Appendix J of the HSSD.

The logic for the 2021 QC Tools submission check is shown below. For previous years, refer to the HSSD for that year.

- **OPR-X###-XX-##**
    - **X#####**[1]
        - **Raw**
            - Features
            - MBES
            - SBES
            - SSS
            - SVP
            - WC
        - **Processed**
            - GNSS_Data
            - SBET
            - Multimedia
            - **Reports**
                - **Project**
                    - **DAPR**

[1] Subfolders will not be checked if an error is found at this level (**Recursive** setting only).

            - Report
            - Appendices
          - **HVCR**
            - Digital_A-Vertical_Control_Report
            - **Digital_B-Horizontal_Control_Data**
              - ATON_Data
              - Base_Station_Data
          - Project_Correspondence
        - **Survey**
          - **Descriptive_Report**
            - **Appendices**
              - I_Water_Levels
              - II_Supplimental_Records
          - Public_Relations_Constituent_Products
      - **S-57_Files**
        - Final_Feature_File
        - Side_Scan_Sonar_Contacts
      - **Sonar_Data**
        - HXXXXX_GSF[2]
        - **HXXXXX_HDCS**[3]
          - HXXXXX_MB
          - HXXXXX_SB
          - HXXXXX_SSS
          - HXXXXX_WC
          - VesselConfig
        - HXXXXX_MB[4]
        - HXXXXX_SB[4]
        - HXXXXX_SSS[4]
        - HXXXXX_WC[4]
        - VesselConfig[4]
      - SVP
      - Water_Levels

Additional Checks:

- An empty folder will be flagged as an error.

[2] For NOAA only submissions.
[3] For submissions with CARIS projects.
[4] For submissions without CARIS projects.

- No filepaths may exceed 200 (field) or 260 characters (office).

What do you get?

Upon completion of the execution of **Submission checks** you will receive a pop-up verification that the tool has completed and if there were any errors or warnings associated with the data structure (Fig. 2.60).

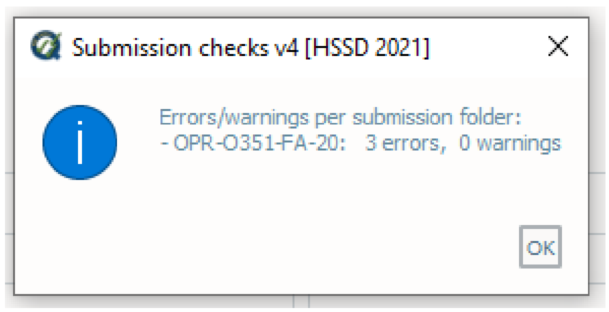


Fig. 2.60: The output message at the end of **Submission checks** execution.

Submission checks produces a PDF document that indicates if there were errors or warnings with specific folders in the data submission structures.

A.20. Check for OPR-O351-FA-20/H13398/Processed/Reports/Survey/Descriptive_Report/Appendices/I_Water_Levels

OK

A.21. Check for OPR-O351-FA-20/H13398/Processed/Reports/Survey/Descriptive_Report/Appendices/II_Supplemental_Records

Unable to locate I:\New_Incoming_Surveys\OPR-O351-FA-20\H13398\Processed\Reports\Survey\Descriptive_Report\Appendices\II_Supplemental_Records

A.22. Check for OPR-O351-FA-20/H13398/Processed/Reports/Survey/Descriptive_Report/Report

OK

Fig. 2.61: An excerpt from the **Submission checks** pdf report.

2.3 Chart Review

2.3.1 Overview

The **Chart Review** tab will:

- Ingest a bathymetric grid, sounding selections, and feature files (see *Data inputs*).
- Truncate grid elevation to decimetric precision (see *Grid truncate*).
- Export grid elevation as ASCII XYZ file (see *Grid xyz*).
- Truncate all "z" values in an S57 file to decimetric precision (see *S57 truncate*).
- Scan HCell features to ensure proper attribution (see *Scan features*).
- Evaluate chart-scale soundings and features versus survey-scale soundings via "triangle rule" (see *Triangle rule*).

2.3.2 Data inputs

Ingest bathymetric grid(s) (.bag), a feature file (.000), and a (dense) survey soundings selection (.000).

- Select the **Chart Review** tab on top of the QC Tools interface.

In **Data inputs:**

- Drag-and-drop any number of grids (.bag only) onto the Grid files field. The **"+"** browse button may also be used.
- Drag-and-drop a feature file (.000 only) onto the S57 CS file field. The **"+"** browse button may also be used. Note that this feature file must also contain the CS soundings.
- Drag-and-drop a dense, survey sounding selection (.000 only) onto the SS file field. The **"+"** browse button may also be used.
- The directory and filename of loaded data will populate in the respective field of **Data inputs**.
- With the addition of a grid, feature file, and survey sounding selections, the **Grid truncate**, **Grid xyz**, **S57 truncate**, **Triangle Rule**, and/or **Scan Features** tabs on the bottom of the interface will become available (Fig. 2.62).
- 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. 2.63, pane A). The outputs are stored directly under the default or user-defined location.
  - Only the **Per-tool sub-folders** flag set (see Fig. 2.63, 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. 2.63, 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. 2.63, 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**.

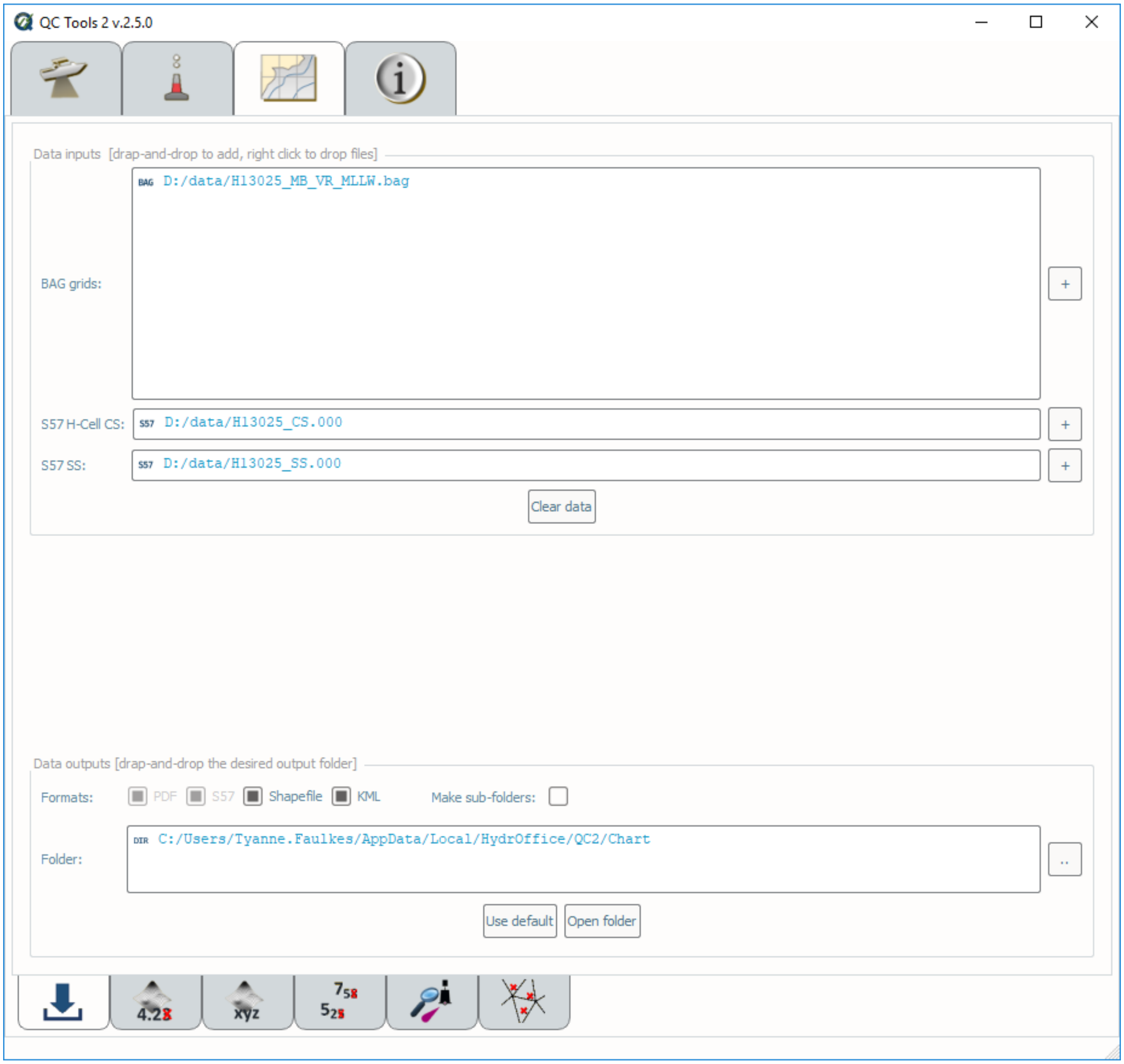


Fig. 2.62: Chart review tab.

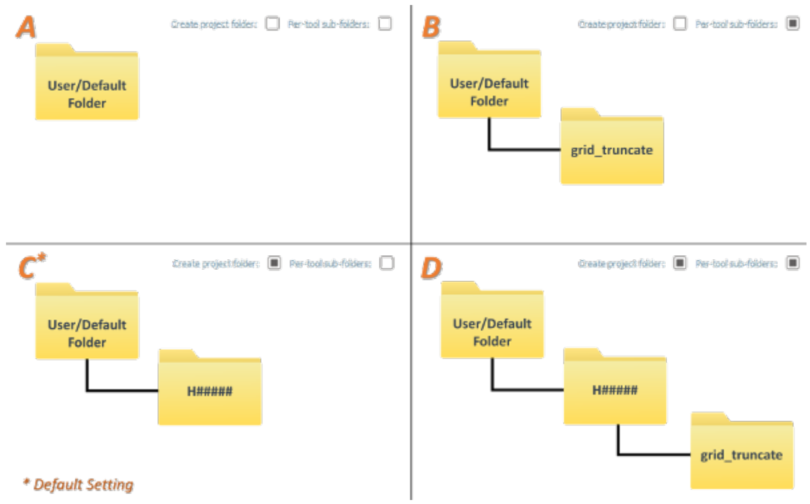


Fig. 2.63: The resulting folder structure based on the four available combinations of output flags.

- 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.

2.3.3 Grid truncate

How To Use?

Truncate grid elevation to decimetric precision.

- Select the **Grid truncate** tab on the bottom of the QC Tools interface.
- Define the decimal place of the truncation (default is 1, thus decimetric truncation).
- In **Execution** (Fig. 2.64), click **Grid Truncate v2**.
- After computing, the output window opens automatically, and the truncated BAGs are ready to use for chart compilation.

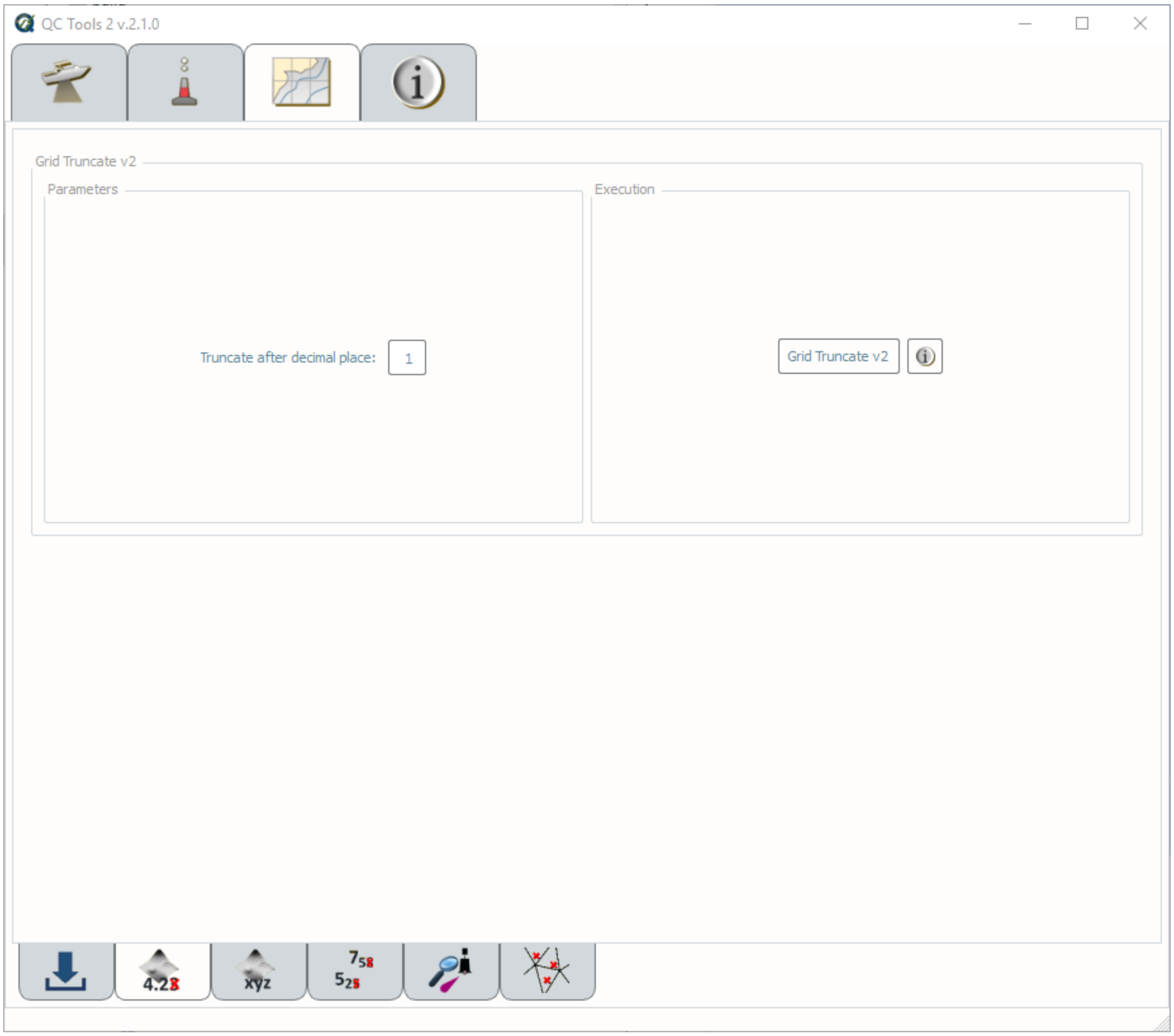
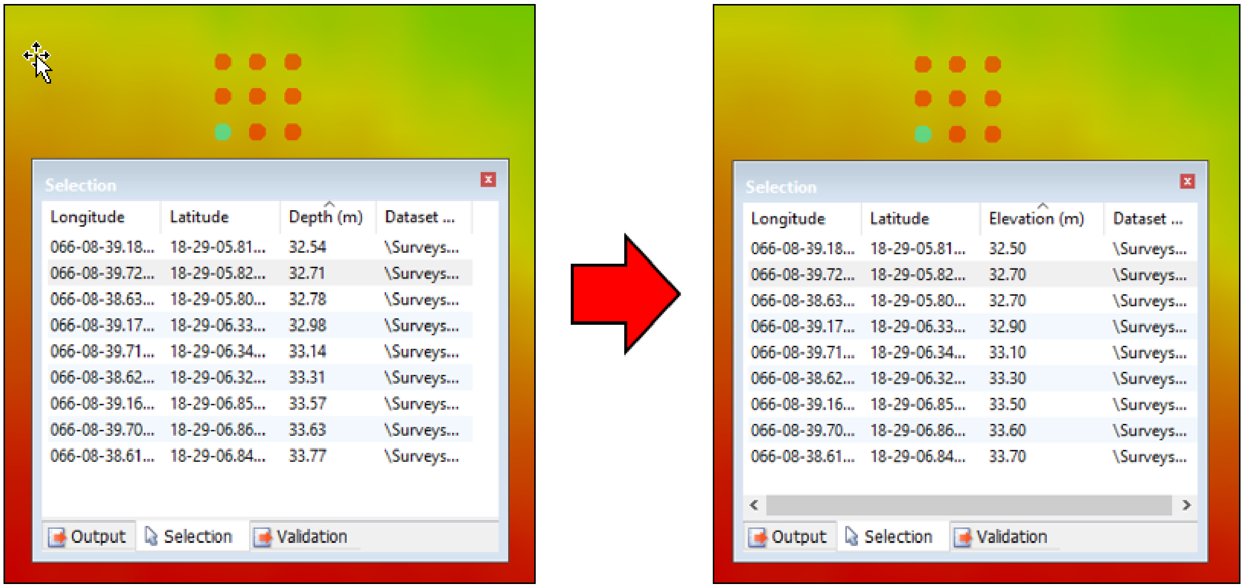


Fig. 2.64: Grid truncate's interface.

How Does It Work?

All elevation values in the grid are truncated to decimetric precision, as shown in the example below. The truncation to decimeter precision facilitates creation of the HCell (per 2016 HCell Specification units and precision).



2.3.4 Grid xyz

How To Use?

Export elevation values as a point cloud.

- Select the **Grid xyz** tab on the bottom of the QC Tools interface.
- Choose the coordinate reference system that the user would like the file to be exported. The user may keep the **original coordinate reference system**, convert to **Geographic WGS84**, or convert to a specific **EPSG code** using the radio buttons.
- Choose the Z convention of either **Depth** (positive down) or **Elevation** (positive up).
- The user optionally can choose to truncate the depth after a specific decimal place.
- The user may also choose the output order of the latitude/northing, longitude/easting, and depth/elevation to suit their needs.
- In **Execution** (Fig. 2.65), click **Grid XYZ v2**.
- After computing, the output window opens automatically.

Fig. 2.65: Grid XYZ's interface.

How Does It Work?

A text file with three columns is created.

2.3.5 S57 truncate

How To Use?

Truncate all "z" values in a feature file (.000) to decimetric precision.

To access this tool, load an S-57 (.000) file into the S57 H-Cell CS box in the **Data Inputs** tab.

- Select the **S57 truncate v1** tab on the bottom of the QC Tools interface.
- Define the decimal place of the truncation (default is 1, thus decimetric truncation).
- In **Execution** (Fig. 2.66), click **S57 Truncate v2**.
- After computing, the output window opens automatically, and the truncated feature file is ready to use for chart compilation.

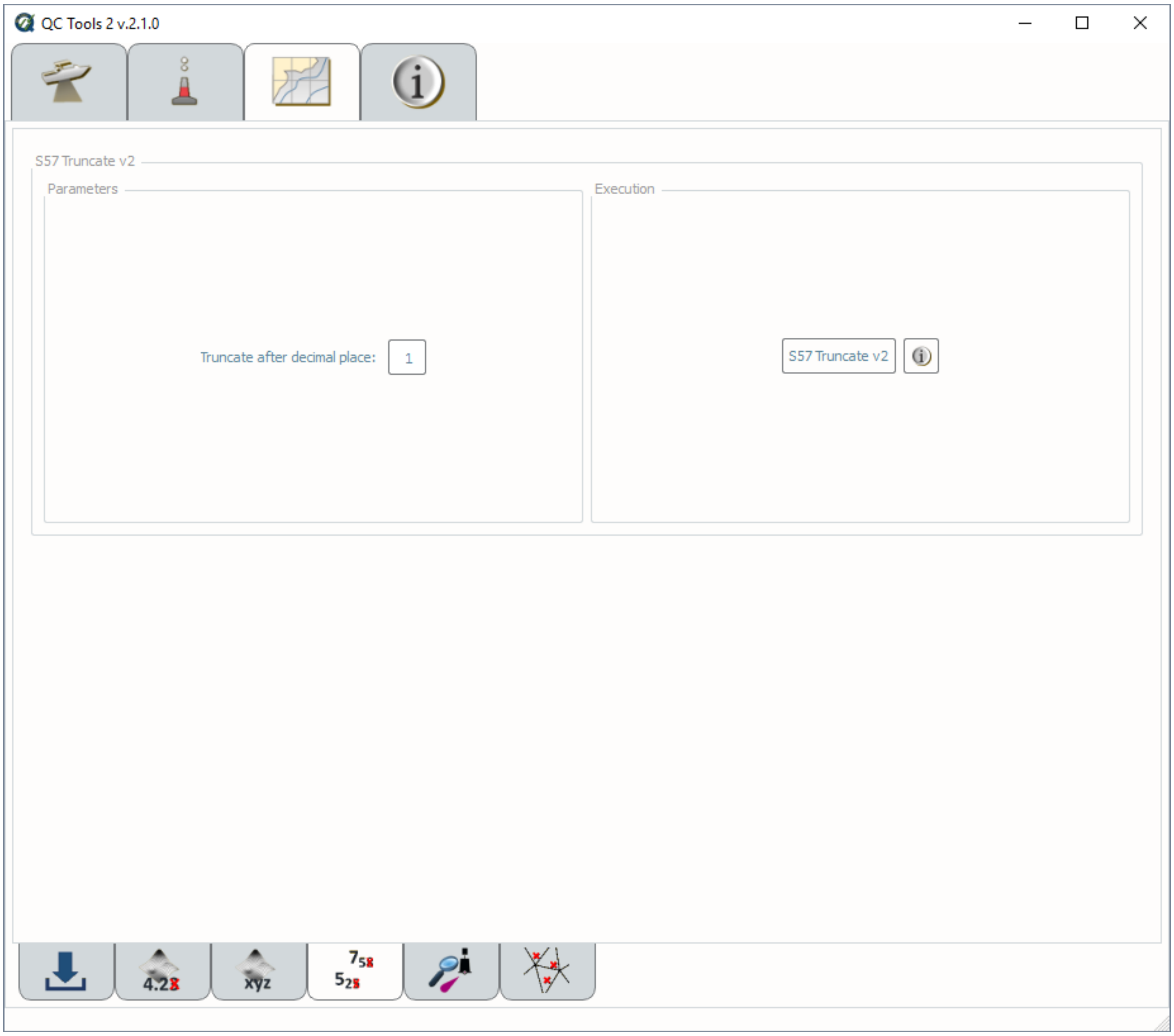


Fig. 2.66: S57 Truncate.

How Does It Work?

All "z" values in the feature file are truncated to decimetric precision, as shown in the example in (Fig. 2.67). The truncation to decimeter precision facilitates creation of the HCell (per 2016 HCell Specification units and precision).

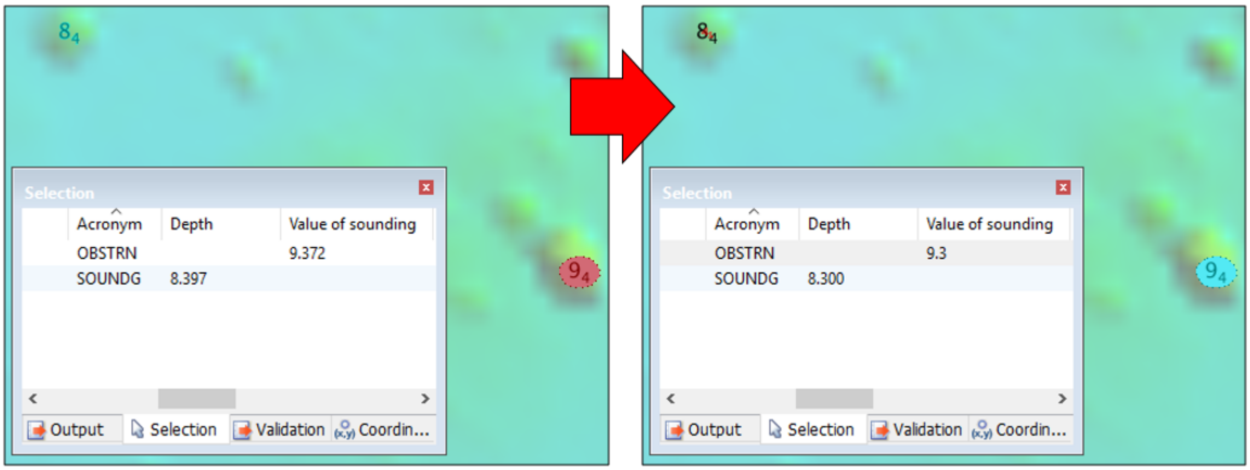


Fig. 2.67: S57 Truncate's example.

The S57 attributes that will be truncated are listed below.

For **SOUNDG** objects:

- **Depths**

For **all** objects:

- Value of Sounding (**VALSOU**)
- Height (**HEIGHT**)
- Value of depth contour (**VALDCO**)
- Depth range value 1 (**DRVAL1**)
- Depth range value 2 (**DRVAL2**)

2.3.6 Scan features

How To Use?

Scan features to ensure proper attribution and cartographic disposition.

- Select the **Scan Features** tab on the bottom of the QC Tools interface.
- In **Parameters** (Fig. 2.68, left side), turn the knob to select the required year of HCell Specification. Currently, the '2018 test' is duplicative to 2016.
- In **Execution** (Fig. 2.68, right side), click **Feature scan v2**.
- After computing, the output window opens automatically, and the results are shown (Fig. 2.69).
- From the output window, drag-and-drop the output into the processing software to guide the review.
- In addition, the results are printed to PDF for a documented summary.

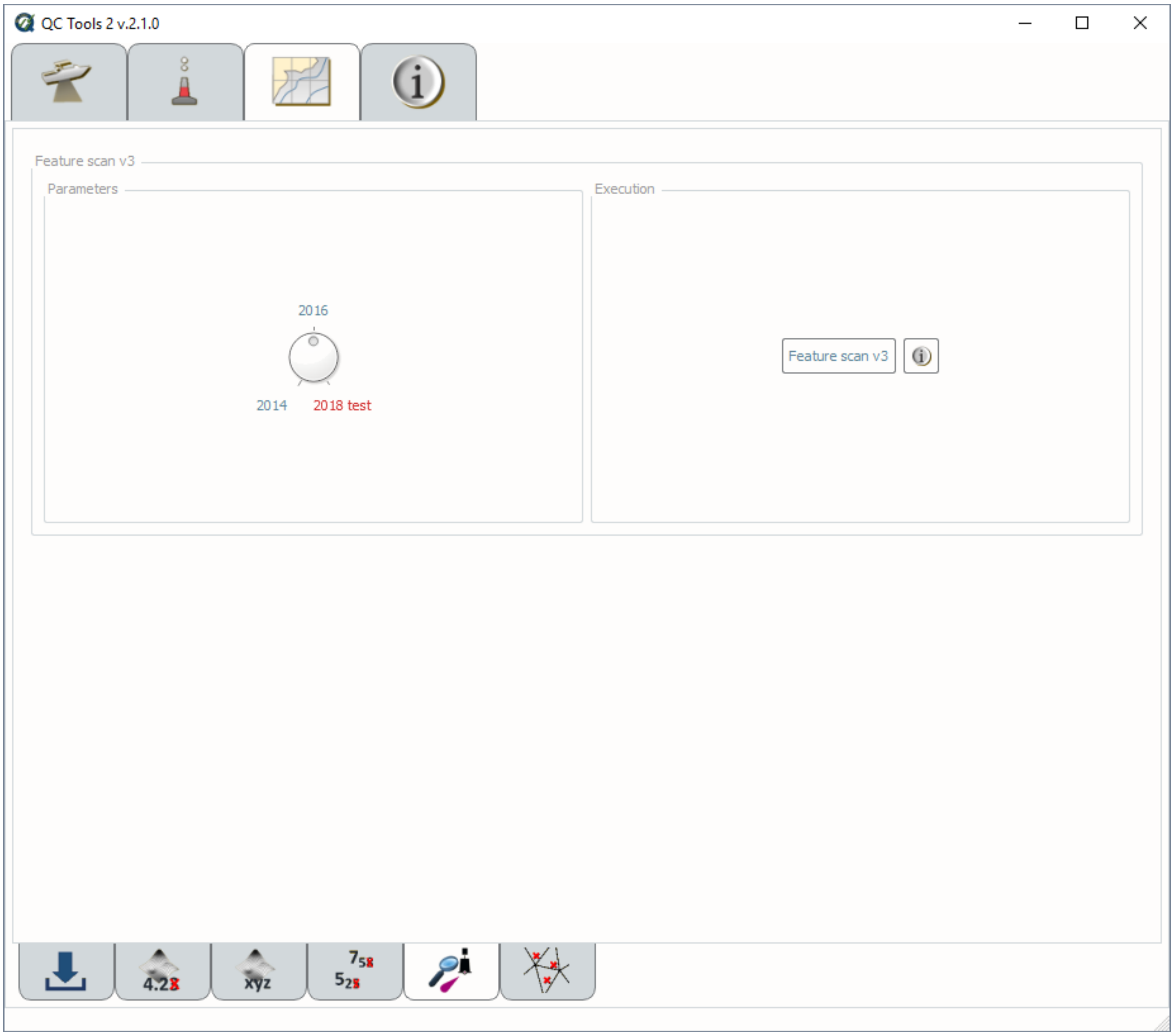


Fig. 2.68: Feature scan's interface.

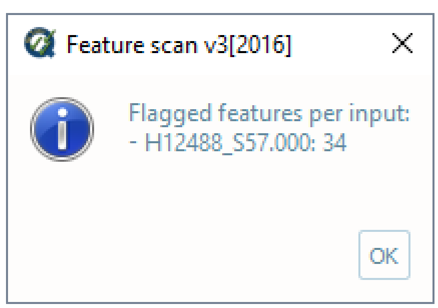


Fig. 2.69: Feature scan's output message.

How Does It Work?

The S-57 features are scanned to ensure proper attribution and chart disposition per the required year of HCell Specification. Listed within the specification are mandatory requirements and S-57 attribution.

The QC Tools Chart feature scan will ensure the following:

- No **redundant features**.
- **CS Soundings** have an accompanying **SS Sounding**.
- All feature **VALSOU** have an accompanying **SS Sounding**.
- No feature **VALSOU** coincide with a **CS Sounding**.
- No **objects** have prohibited attribute **SCAMIN**.
- No **objects** have prohibited attribute **RECDAT**.
- No **objects** have prohibited attribute **VERDAT**.
- All **objects** have mandatory attribute **NINFOM**.[1][2014]
- All **objects** have **SORIND**.[2]
- All **objects** have **SORDAT**.[2]
- No **SOUNDG** have prohibited attribute **STATUS**.
- All **Wrecks** must have mandatory attributes **CATWRK, WATLEV, VALSOU,** and **QUASOU**.
- All **Wrecks** with **WATLEV** = 5 (**awash**) must have mandatory attribute **EXPSOU**.[2016]
- All **UWTROC** must have mandatory attributes **VALSOU, WATLEV,** and **QUASOU**.
- All **OBSTRN** must have mandatory attributes **VALSOU, WATLEV,** and **QUASOU**.
- No **OBSTRN** with **CATOBS** =6 (**foul area**).[?]
- All **MORFAC** must have mandatory attribute **CATMOR**.
- No **MORFAC** have prohibited attributes **BOYSHP, COLOUR,** or **COLPAT**.[2016]
- All **SBDARE** points must have mandatory attribute **NATSUR**.
- No **SBDARE** points have prohibited attributes **COLOUR** or **WATLEV**.
- All **SBDARE** points have an allowable combination of **NATSUR** and **NATQUA** noted by ‘x’ in the table below.

[1] Excludes **SOUNDG, M_COVR, M_QUAL, M_CSCL,** and **DEPARE**.

[2014] Only for 2014 HCell Specification

[2] **2016** excludes **LNDARE, DEPARE, and DEPCNT** from the check for **SORIND** and **SORDAT**.

[2016] Only for 2016 HCell Specification

NATQUA		1	2	3	4	5	6	7	8	9	10
N	1					o	o	o	o	o	o
A	2					o	o	o			o
T	3					o	o	o			o
S	4	o	o	o			o		o	o	o
U	5								o	o	
R	6								o	o	
	7								o	o	
	8								o	o	
	9								o	o	
	11								o		
	14				o						
	17				o					o	
	18								o	o	

NATQUA: fine (1), medium (2), coarse(3), broken (4), sticky (5) soft (6), stiff (7), volcanic (8), calcareous (9), hard (10)

NATSUR: mud (1), clay (2), silt (3), sand (4), stone (5), gravel (6), pebbles (7), cobbles (8), rock (9), lava (11), coral (14), shells (17), boulder (18)

- All **SBDARE** lines and areas must have mandatory attribute **NATSUR** and **WATLEV**.
- All **COALNE** must have mandatory attribute **CATCOA**.
- No **COALNE** have prohibited attribute **ELEVAT**.
- All **CTNARE** must have mandatory attribute **INFORM**.[Page 71, 2016]
- All **SLCONS** must have mandatory attribute **CATSLC**.
- All **M_QUAL** must have mandatory attributes **CATZOC, TECSOU, SURSTA,** and **SUREND**.
- All **M_CSCL** must have mandatory attribute **CSCALE**.
- All **M_COVR** must have mandatory attribute **CATCOV**.
- All **cartographic objects** must have mandatory attributes **NINFOM** and **NTXTDS**.[3]?
- All **cartographic objects** must have mandatory attribute **INFORM**.[3]?
- All objects with **NOAA extended attributes** still populated are tallied and presented (display only) as a reminder to clear before final submission.

2.3.7 Triangle rule

How To Use?

Evaluate chart-scale soundings and feature versus survey-scale soundings via "triangle rule".

- Select the **Triangle Rule** tab on the bottom of the QC Tools interface.
- In **Parameters** (Fig. 2.70, left side):
  - Check the **Use VALSOU features** checkbox if you wish for any feature VALSOUs to be included with the chart-scale soundings in the evaluation.

[3] Cartographic objects include **$CSYMB, $LINES,** and **$AREAS**.

   – Check the **Use DEPCNT features** checkbox if you wish that points from the DEPCNT features are included with the ENC soundings in the evaluation.
   – Set the **Force threshold (m)** value to set a minimum threshold in meters (only active when **Meters** units are selected)
   – Check the **Detect deeps** checkbox if you want that the deep discrepancies are also evaluated.
   – Turn the knob to the applicable chart units.

- In **Execution** (Fig. 2.70, right side), click **Triangle Rule v2**.

Fig. 2.70: Triangle rule's interface.

- After executing, the output window opens automatically, and the results are shown by textbox (Fig. 2.71).

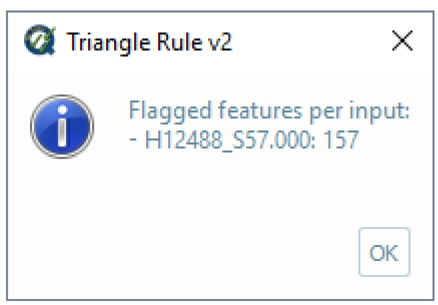


Fig. 2.71: Triangle rule's output message.

- After executing, the results are also shown graphically (Fig. 2.72). Chart-scale soundings are colored by depth, and flagged survey-scale soundings that may not be adequately represented 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 both a TIN (triangulated irregular network) of the chart-soundings (and feature value of soundings, if included) and flags atop survey-scale soundings that may not be appropriately accounted for by the prospective chart-soundings.
- The magnitude of the discrepancy against the chart-scale soundings is printed to the S57 attribute NINFOM, for easy sorting and identification of the most significant discrepancies.

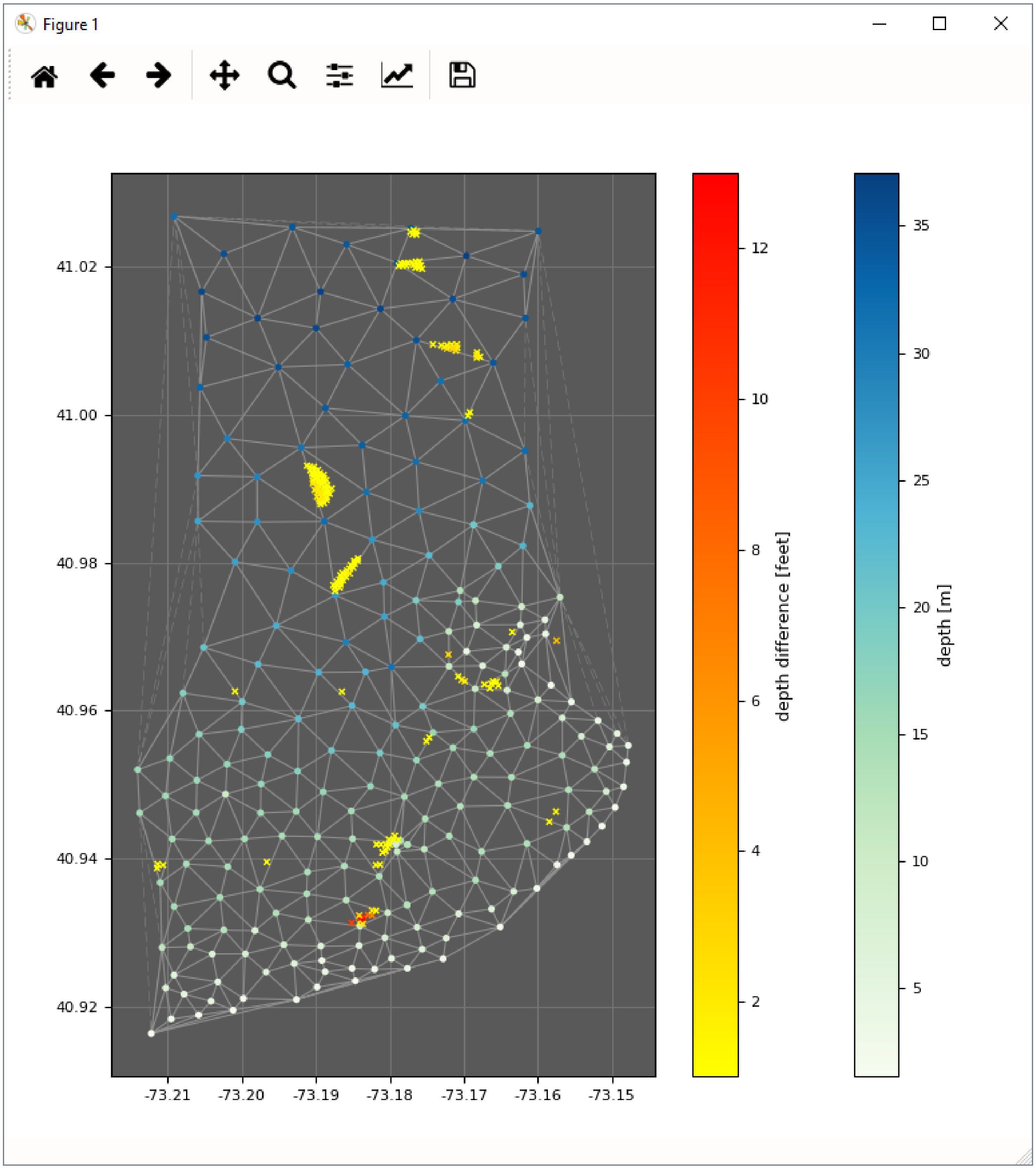


Fig. 2.72: Triangle rule's output display.

How Does It Work?

A TIN is created from the chart-scale soundings (and feature value of soundings, if included). The survey-scale soundings are categorized within the triangles of the TIN, and if any survey-scale sounding is shoal of the three vertices of the triangle it falls within, it is flagged. The flags might alert a cartographer to survey-scale soundings that may not be adequately represented by the chart-scale soundings.

The shoal determination factor is based on sounding rounding of the chart unit. For example, survey-scale soundings that are shoal of the chart-scale soundings are only flagged if the difference is more than a chart scale unit (either in feet or fathoms, as prescribed in the parameters).

Note that, if the sounding unit is set to meters, then the difference in depth is evaluated againt the **Force threshold (m)** value.

In the example in Fig. 2.73, the shoal soundings flagged by the red circles may need additional consideration by the cartographer; in particular, the 13 foot sounding in the southwest (near the 17 foot chart sounding) could be dangerous to navigation if not better represented.

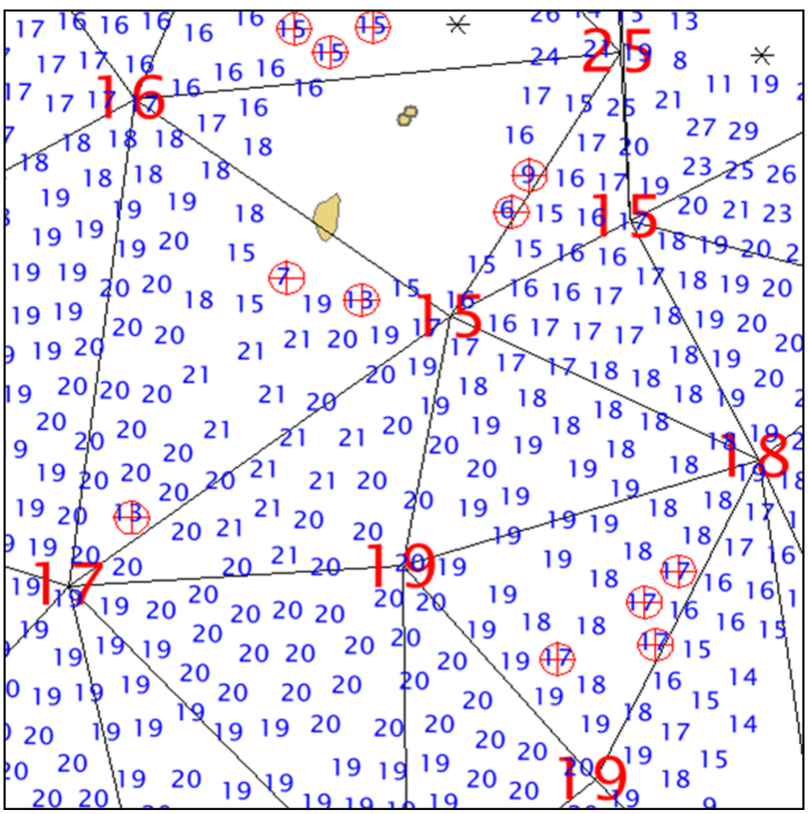
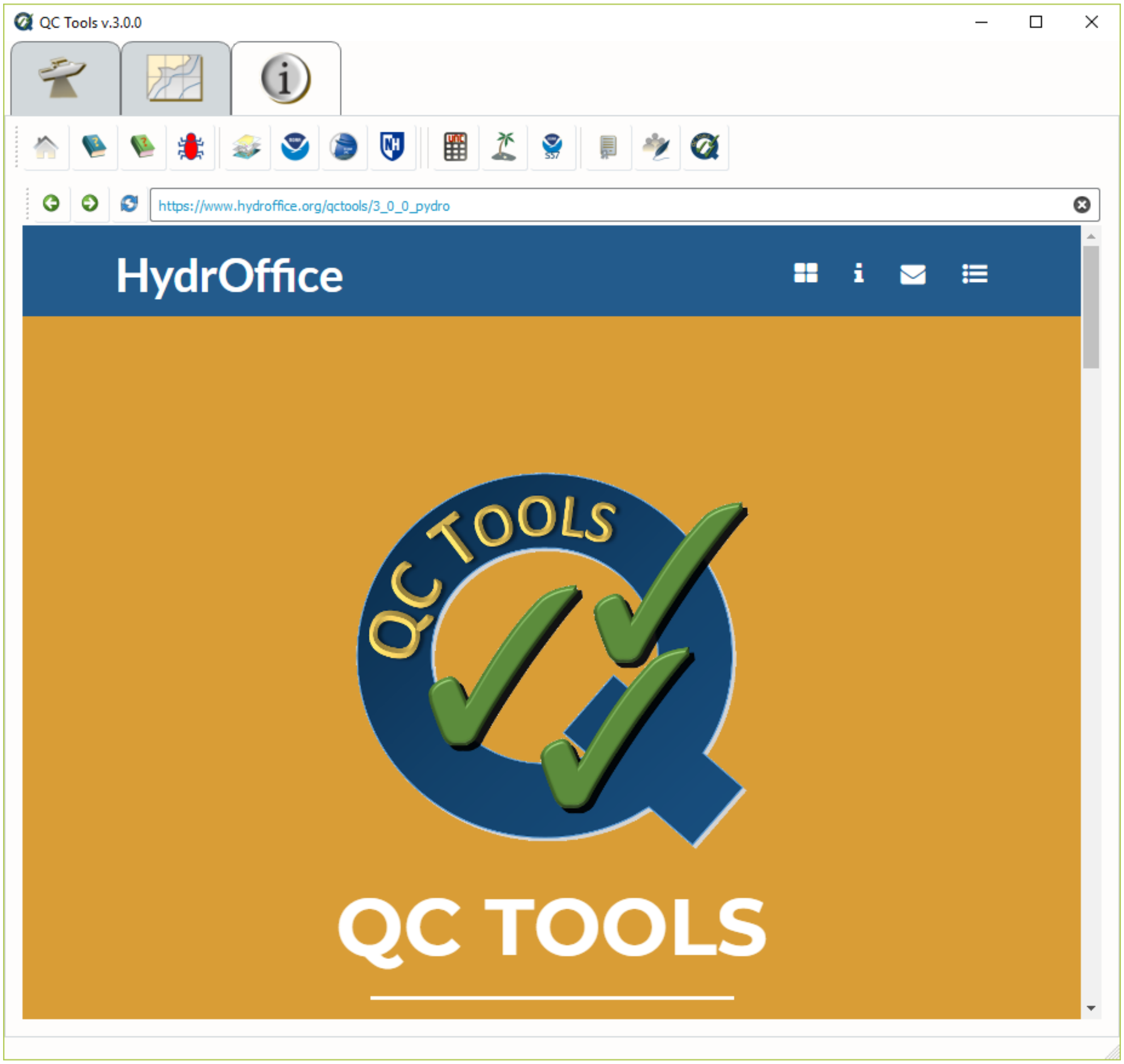


Fig. 2.73: Triangle rule's example.

2.4 Info Tab

The Info Tab contains numerous helpful links and utilities:

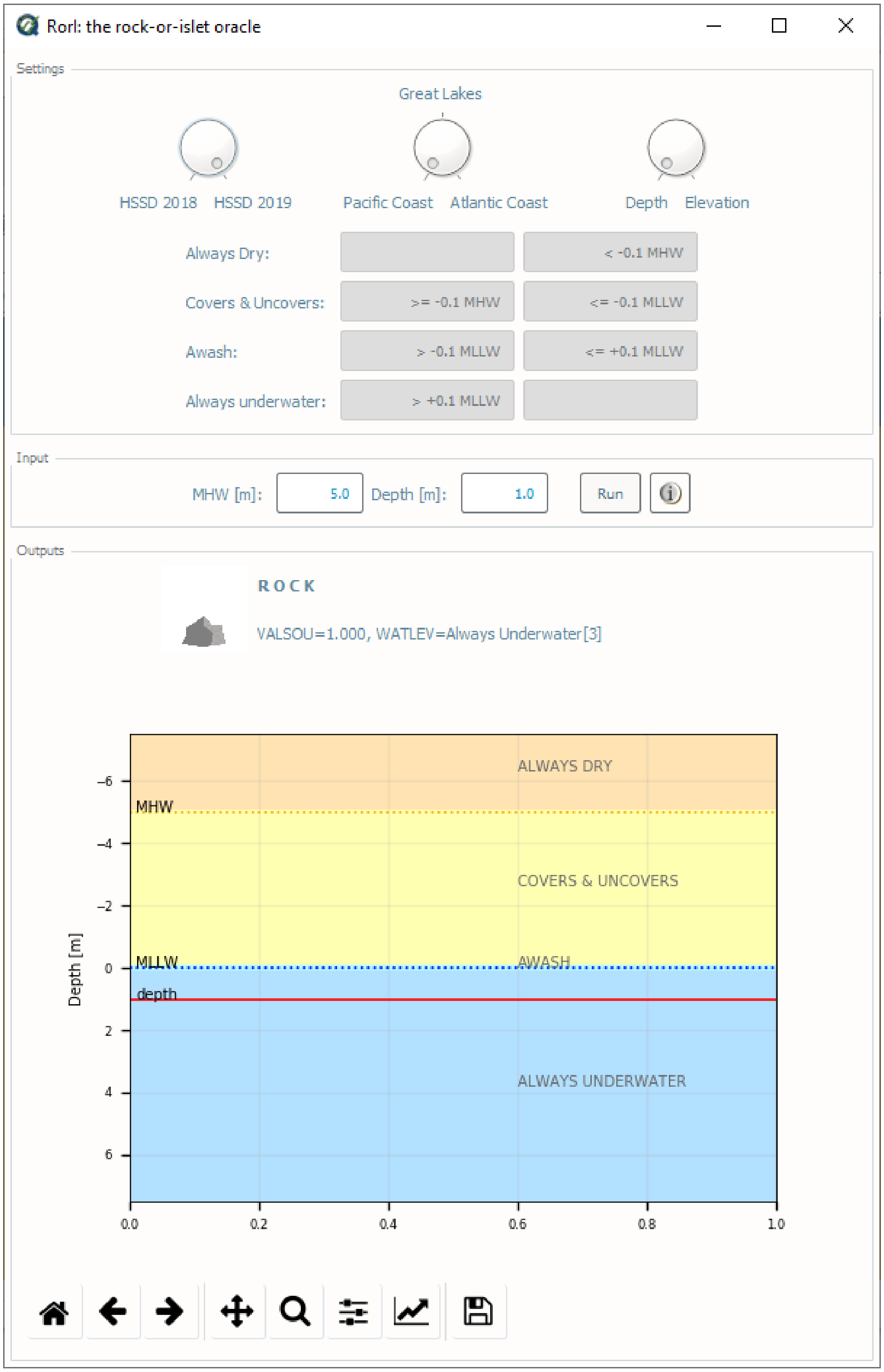
- The HydrOffice QC Tools website
- The Online User Manual
- The Offline User Manual (PDF)
- A User Bug Report Tool
- The HydroOffice Main Page
- The NOAA Nautical Charts Home Page
- The Center for Coastal and Ocean Mapping Main Page
- The University of New Hampshire Main Page
- Uncertainty Calculator
- The Rock or Islet oracle
- NOAA S-57 Support Files for CARIS
- License Information
- Contacts List
- QC Tools Software Information


QC Tools v.3.0.0
https://www.hydroffice.org/qctools/3_0_0_pydro
HydrOffice
QC TOOLS
QC TOOLS

2.4.1 RorI: Your Rock-or-Islet Oracle

How To Use?

RorI has been created as a tool to help hydrographers determine if their feature is a rock or an islet. RorI is a standalone tool that is launched from the button at the top of the Info tab.


RorI: the rock-or-islet oracle
Settings
Great Lakes
HSSD 2018
HSSD 2019
Pacific Coast
Atlantic Coast
Depth
Elevation
Always Dry:
< -0.1 MHW
Covers & Uncovers:
>= -0.1 MHW
<= -0.1 MLLW
Awash:
> -0.1 MLLW
<= +0.1 MLLW
Always underwater:
> +0.1 MLLW
Input
MHW [m]:
5.0
Depth [m]:
1.0
Run
Outputs
ROCK
VALSOU=1.000, WATLEV=Always Underwater[3]
ALWAYS DRY
MHW
COVERS & UNCOVERS
MLLW
AWASH
depth
ALWAYS UNDERWATER
Depth [m]

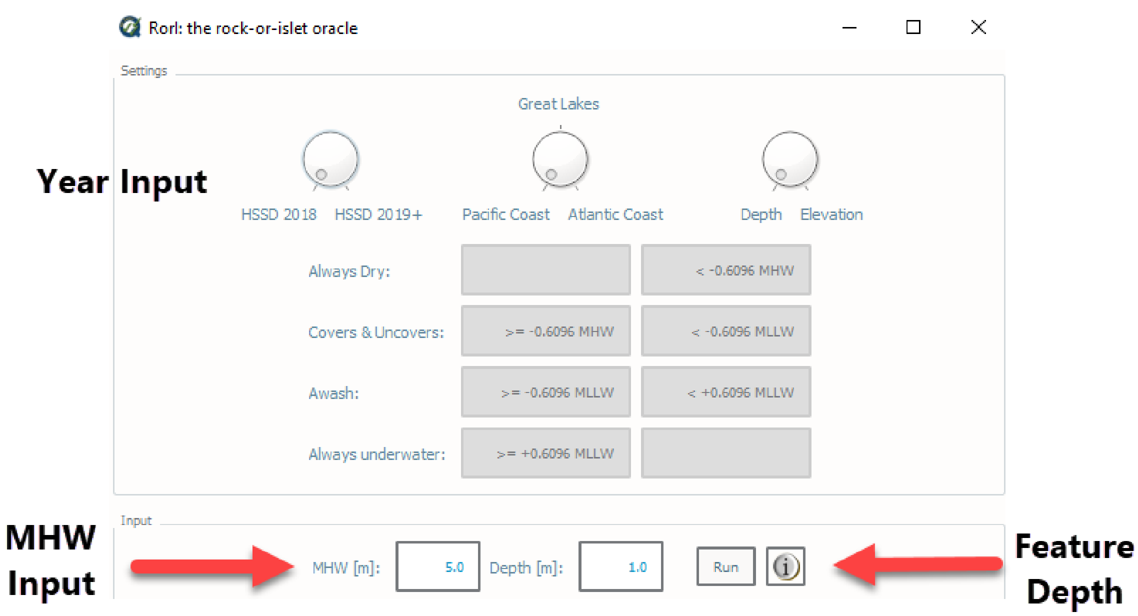
How Does It Work?

At the top of RorI there are three toggles. In 2019, NOAA's Marine Chart Division updated how to define the WATLEV of rocks and redefined when a rock becomes an islet.

Pre-2019, how rocks and islets were defined depends upon where you were surveying due to the tidal range that occurs in these areas. NOAA had three discrete regions: The East Coast (including the Gulf Coast), the West Coast (including Alaska), and the Great Lakes. The user will set the first toggle depending on the location of their survey.

For 2019 and beyond, the definition has been unified from coast to coast. The only difference between the three options in the second toggle is that the Great Lakes region is referenced to LWD.

The third toggle does not have an impact on how RorI is doing its calculations. The toggle controls two visualizations. First, the boxes below which show you the math being used to define the different WATLEV values. You can either view these values in an elevation (positive up) or depth (positive down). The boxes below show the math behind of each WATLEV value which are derived from NOAA's Hydrographic Specifications and Deliverables for their respective years.



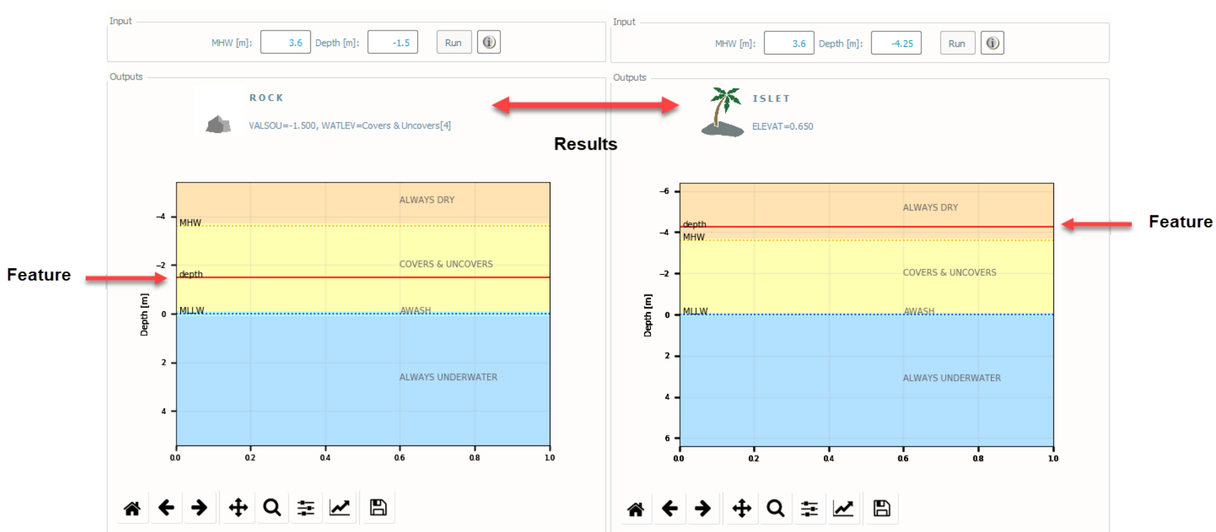
The user will then enter two very important pieces of information: the MHW value and the depth of the feature. The hydrographer will retrieve the MHW value from their tide note. The feature shall be tidally corrected and be referenced to MLLW. That means all depths above MLLW shall be negative! Note for the Great Lakes, all data is referenced to LWD, therefore there is no input needed by the user.

Next, RorI will crunch the numbers and tell you if your feature is a rock or islet. If it is a rock, it will let you know its depth (VALSOU) and water level effect (WATLEV). If your feature is an islet, it will reference the elevation (ELEVAT) to MHW (LWD for the Great Lakes).

RorI does not use magic to calculate the difference between a rock or and islet. What it does is some simple math. The tool compares the depth to the MHW value (or LWD for the Great Lakes) which are both entered by the user. If the rock is higher in elevation than the following values, then it is an islet.

RorI is based on the following specifications:

- **HSSD 2018**:
  - Atlantic Coast: 0.3048 m
  - Pacific Coast: 0.6096 m
  - Great Lakes: 1.2192 m
- **HSSD 2019+**:
  - All regions: 0.1 m



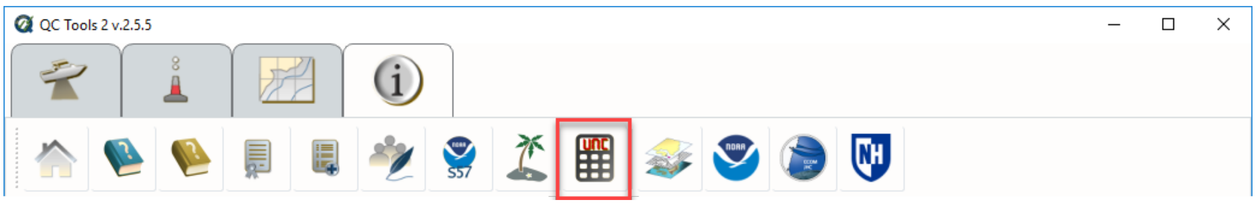
RorI also helps the hydrographer visualize the difference between a rock and an islet for their survey using a graphic.

2.4.2 Uncertainty Calculator

How To Use?

Uncertainty Calculator is a standalone tool to help you calculate the total vertical uncertainty and total horizontal uncertainty of hydrographic data.

To launch the tool, click the button at the top of the Info tab.



The user can toggle between Special Order, Order 1, and Order 2 requirements.

The user inputs the depth and displayed below are the results of both the IHO and NOAA Specifications.

How Does It Work?

IHO and NOAA TVU calculations are identical per S-44 and the Hydrographic Survey Specifications and Deliverables.

$$TVU\,QC = Uncertainty/\sqrt{a^2 + (b * depth)^2}$$

where:

- $a = 0.25m, b = 0.0075$ for Special Order
- $a = 0.5m, b = 0.013$ for Order 1 (depths less than 100 m)

- $a = 1.0m, b = 0.023$ for Order 2 (depths greater than 100 m)

IHO and NOAA THU utilize the same formula but with different variables.

$$THU\,QC = (k + p * depth)$$

where:

- IHO:
  - Special Order: where $k = 2m, p = 0pct$
  - Order 1: where $k = 5m, p = 5pct$
  - Order 2: where $k = 20m, p = 10pct$
- NOAA:
  - All Orders: where $k = 5m, p = 5pct$

The graph at the bottom of the tool is interactive and visually represents the total vertical and total horizontal uncertainties at that order.

2.5 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

CHAPTER

THREE

COMMAND LINE INTERFACE

3.1 General Commands

3.2 Find Fliers

CHAPTER

FOUR

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 neeed 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`

CHAPTER

FIVE

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Version 3, 29 June 2007

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CHAPTER

SIX

CREDITS

QC 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.

For bugs and feature requests: qctools@hydroffice.org

NOAA bugs and feature requests: ocs.qctools@noaa.gov

Feel free to contact us for comments and suggestions:

- Giuseppe Masetti
- Tyanne Faulkes
- Julia Wallace
- Matt Wilson