## Coda Octopus Survey Engine® Automatic Detection Package (SEADP) Manual

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This image is Survey Engine® Automatic Detection Package (SEADP)
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Scope of Manual

This Manual covers the software aspects of the Survey Engine® Automatic Object Detection Package (SEADP).

SEADP is used primarily to automatically detect, measure and record boulders on the sea floor from sidescan sonar data.
## Glossary of Terms

The following terminologies having the meaning set out below:

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulder</td>
<td>A boulder is defined as a rock fragment with a diameter greater than 256 mm</td>
</tr>
<tr>
<td>Boulder Field</td>
<td>A boulder field is a surface covered by boulder-size rocks</td>
</tr>
<tr>
<td>SEADP</td>
<td>Survey Engine Automatic Boulder Detection</td>
</tr>
<tr>
<td>SSS</td>
<td>Side-scan sonar</td>
</tr>
<tr>
<td>TVG</td>
<td>Time-varying gain</td>
</tr>
<tr>
<td>Confidence Value</td>
<td>A QC tool within the software which scores the accuracy of the results.</td>
</tr>
</tbody>
</table>
Introduction

Benefits of SEADP

SEADP is designed to automatically detect boulders of varying sizes in processed sidescan sonar data which a “human” Geophysicist would be able to detect using the naked eye. The broad objective of SEADP is to deliver to the market significant time savings and repeatability of processes, through automating “repetitive” tasks. This therefore allows customers to use their talented geophysicists pool on more demanding tasks. SEADP therefore automates the process of identifying boulders.

There are many benefits from using SEADP for large survey projects including:

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Consistency across multiple survey lines that would require to be tagged by a team of geophysicists</td>
</tr>
<tr>
<td>2.</td>
<td>Multiple detections where the same sidescan data can be processed in SEADP several times using different detection parameters or filters</td>
</tr>
<tr>
<td>3.</td>
<td>Confidence based reporting of detections to allow further refinement of the detected boulders not captured by a human</td>
</tr>
<tr>
<td>4.</td>
<td>Automatic measures for every detection returned by SEADP for no additional processing effort</td>
</tr>
<tr>
<td>5.</td>
<td>Speed. SEADP reduces the tasks from “days” to “minutes”</td>
</tr>
</tbody>
</table>

Using your data with SEADP

The performance of SEADP Software is reliant on the quality and resolution of the processed sidescan data used. For example, if the quality and resolution of the data is so poor that a geophysicist would not be able to detect a boulder, SEADP also will not be able to detect the boulder. SEADP has been trained using human Geophysicist interpretations of real boulders in different seabed conditions.

As with manual detection, SEADP is optimized for:

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Post-processed data: (compensated by processes like TVG, zap filter, gain frequency filters, scaling)</td>
</tr>
<tr>
<td>2.</td>
<td>Source distance: The seabed level must be picked for the channels, this will be the reference for the individual measurements in the boulders.</td>
</tr>
<tr>
<td>3.</td>
<td>Avoid common distortion sources like: Suspended material, thermoclines, pycnoclines, acoustic interference, propellers noise, etc.</td>
</tr>
<tr>
<td>4.</td>
<td>Resolution: The frequency of the source and the sampling interval will determine the range (in meters), maximum level of resolution for the analysis (smallest objects to detect) and quality of the images in the near and far field.</td>
</tr>
</tbody>
</table>
**How much data can SEADP process?**

SEADP can create a queue of files that is going to be constrained by two factors: the amount of files that are imported into the Survey Engine’s project and the RAM memory in your computer.

It is recommended to have more than 16 Gb. of RAM in the computer in order to guarantee that a big number of files can be added to the batch processing queue in SEADP.

**Can SEADP process large SSS files?**

Yes, you can process individual SSS files up to 3Gb. size.

**How many SSS files can be included in a project?**

Your operating system (PC or other systems) will determine how much data you can process with SEADP.

Although our 64 bit architecture is designed to manage large projects and there are no specific limits as to how many files a Survey Engine (SE) project. However, it is important that you ensure that your operating system (PC) has sufficient processing capacity for the amount of information that is used in the project. The processing capacity in a computer is generally linked to hardware specifications like the speed of the processor and the RAM memory in the computer, these two will affect how much data can be processed on that operating system.

Apart from having sufficient space in disk for the amount of information in the project and the installation of Survey Engine, some recommendations for larger projects are:

<table>
<thead>
<tr>
<th></th>
<th>Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor</td>
<td>Quad Core – 2.0 GHz or faster, 64 bit supported</td>
</tr>
<tr>
<td>Memory</td>
<td>16 GB</td>
</tr>
<tr>
<td>Graphics Card</td>
<td>NVIDIA GeForce GTX 1660</td>
</tr>
</tbody>
</table>

For the case of hundreds of files (that could contain also many thousands of boulders), creating separate projects (in different computers) can make it easier to manage broad contract areas that are analysed for different interpreters.

**How long does it take to process SSS data with SEADP?**

Our various validation and benchmarking tests have shown that identification and interpretation of thousands of boulders can be reduced from days of work to only minutes with SEADP.

With the introduction of the batch processing in our latest version of SEADP the software is capable of automatically interpreting thousands of boulders and then commit them to the database for a batch of files rather than the single file processing that SEADP offered in previous versions.

It is worth noting that the processing time in SEADP will vary according to:
<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The option in the SEADP Software that is used when running the files (generic or optimized mode);</td>
</tr>
<tr>
<td>2.</td>
<td>The size of the targets that is being investigated in the optimized mode (0.3 to 5m);</td>
</tr>
<tr>
<td>3.</td>
<td>The amount of files added to the processing queue</td>
</tr>
<tr>
<td>4.</td>
<td>The individual size of the files (large files need to be pre-processed in order to administer the GPU resources)</td>
</tr>
</tbody>
</table>

**Different Modes in SEADP for Boulder Classification**

SEADP has different modes for Classification of Boulders. This is because different conditions present different challenges and we have therefore introduced different Models within our Software.

<table>
<thead>
<tr>
<th>Model</th>
<th>Recommendation for Use Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generic Mode</td>
<td>We recommend that this Model should be first run for the characterization of the Boulders. This is intended to characterize a broader range of Boulders (in terms of size). The data is interpolated to have a Width resolution of 1024. At this resolution, the network will detect all ranges of boulders but is inclined towards Large and Medium boulders that are readily visible.</td>
</tr>
</tbody>
</table>
| Optimized Mode   | This allows the user to set a minimum and maximum size of boulder within the dataset [0.3-5.0 m]. For a specified ‘min’ and ‘max’ boulder size, SEADP will calculate an optimal width and interpolate the data to this resolution. This optimal width will help the network to detect more boulders in this specified size range. It also detects some boulders outside of this range. Simply put, “Optimized” mode puts emphasis on the detection of boulders in specified size range. This speed of this mode depends on the calculated optimal resolution (usually slower).

For example, if there is an area with small boulders, then it would be better to run a smaller scale like 0.3-0.5m. For datasets with a mix of types of boulders, the best approach is to perform complementary runs (0.3-0.8m and 2-5m). Thus, merging the two sets would give a better result for the line.
Example of the use of the Generic and Optimized modes in SEADP
**Recommended Workflow for SEADP**

Below is a detailed workflow for how to use SEADP in a project context:

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>Import the files into Survey Engine (XTF, Coda, JSF formats are supported)</td>
</tr>
<tr>
<td>Step 2</td>
<td>Pick the seabed surface for the different files (port/starboard)</td>
</tr>
<tr>
<td>Step 3</td>
<td>Apply the process and Nav. Corrections the file could require</td>
</tr>
</tbody>
</table>
| Step 4 | Create groups of files that display the same geological or environmental settings, based on the size of the targets and seabed features in the data (ripples, dunes, boulder fields, sandstones, bedrock areas, trenches, etc)  
  a. **Optional:** For big projects (more than 30Gb), the different areas can be grouped in the same project but it is best practice to have each group in separate projects  
     i. Files can also be grouped depending on which channel will be ran for each case (port/starboard) or both of them |
| Step 5 | Test the SEADP on some representative files for each one of the areas. Determine the best parameters for each one of the areas on the generic or optimized modes. |
| Step 6 | With specific parameters for each region (channels, processes, size of the targets), run SEADP for the files |
| Step 7 | Use the confidence levels, filters, visualization and interpretation tools in Survey Engine to QC the data |
| Step 8 | Export the report and/or project deliverables |

*Figure 1: SEADP Workflow*
The Different Classification Models in SEADP Based on Boulder Size

**Boulders size range:**

The software supports two main modes: a default mode called *Generic* and a second customizable option called *Optimized*.

**Generic Mode:** The automatic detection will be run for the selected files with a fixed resolution (1024 samples) for any data file, regardless its sample frequency and range.

**Optimized Mode:** When this option is activated, the UI allows the selection of two values (between 0.3 and 5 m) that will be used as the minimum and maximum boulders size; these are visually estimated by the interpreter from the recorded data set; the number of samples that is used in the automatic detection will be adjusted according to these parameters too.

**Artificial Intelligence Models:**

In parallel with adjustment of the SEADP resolution for the different cases in the generic and optimized modes, the SEADP software also supports the alternation of two interpretation models in the optimized detection mode. These models are:

Model 1: Small Targets (<= 1m)
Model 2: Generic Mode and Big Targets (> 1m)

Thus, the first model will be used as the default case in the generic mode and smaller boulders, whereas a second interpretation model will improve the accuracy in measurements of larger boulders; this selection is automatically run when the user selects a range of detection with boulders larger than 1m.
How to Use SEADP

**Auto Boulder Set Up**

1. Click on the Interpretation Manager

2. Click on “Setup Measures” for the “Auto Boulder” interpretation type

   *The user selects which dimensions will be measured by SEADP’s algorithm for each detected boulder*

3. Tick the required measurements for the analysis:
   - **Length**: Measured in the along-track direction
   - **Width**: Measured in the across-Track direction
   - **Height**: Calculated from the length of the shadow.
Creating a New Type

When running the boulder detection, it is necessary to associate a single-point interpretation type, with default measurements associated. Thus, the system will find several features of this type and will measure its dimensions.

This procedure is useful in case that an additional interpretation type is needed:

1. Click on “Add” and select the option “Custom”

2. Click “OK” to save the data type.
Running the SEADP

1. Make sure that a preconfigured Interp. Type for Boulders detection is selected

2. Select the SSS lines that will be included in the analysis, right-click on them and select “Run”

3. Select the parameters and click on “Run”

Channel Selection:
- Port / Starboard / Both Channels

Processes:
- Raw / Processed / Processed+ Scaling

Measurement Type:
- Along-Across Track / Major Axis

Boulder Size Modes:
- Generic: Runs a fixed number of samples.
- Optimized: Runs the detection based on min a max values.

For best results, apply image processing techniques which make the boulders easily visible by the human eye.
Parameters for the SEADP

Selection of channels from Sidescan Data

Raw or processed data (TVG, filters)

Measurement Method

Channel selection:

For the data files that are selected at the moment of running SEADP, it is possible to choose which channels will be used for the automatic interpretation. The available options are:

**Port:** Will run the automatic detection only for the port channel(s) of the file(s) that are added to the processing queue.

**Starboard:** Will run the automatic detection only for the starboard channel(s) of the SSS file(s) that are added to the processing queue.

**Both:** Will run the automatic detection for the two channels (Port and Starboard) of the SSS file(s) that are added to the processing queue.

Note: Please avoid including SSS files that contain only one channel (Port or Starboard) in the same processing queue with files that contain two channels. Single channels should be processed separately.

The option “Both” will be selected by default at the moment of running SEADP.
Processing Options:

SEADP supports different levels of processing:

**Raw data:** When this option is selected, SEADP will use the input data from the different SSS lines as it was originally recorded. This means no additional processes or filters are applied and the original amplitude range of the information is preserved.

**Processed data:** This option will run SEADP on the selected data files and will include any of the enhancements that could be added on the processing menu of Survey Engine (TVG, Zap Filter, Frequency filters, etc.).

![List of the different processes and filters can be applied to SSS files in Survey Engine](image)

**Processed data + Scaling:** This option will run SEADP with the same processes as in the previous case, but it will also include any edition of the screen range that can be applied for each channel using the oscilloscope menu of the data window.

![The oscilloscope window is displayed at the top of the SSS waterfall view in the Data Window](image)

![The oscilloscope’s right-click contextual menu and the screen range edition in Survey Engine](image)
Configuration of the Interpretation Report for Boulders

1. Edit the settings of the Interpretation Report menu.

2. Select the Interpretation Type for the automatic detection of boulders

**Measurement Types:**

This menu allows to select the way in which the two measurements in the boulder’s high-amplitude backscatter highlight (Length and Width) are taken by the SEADP algorithm. The third measurement (Height) is not affected by the option chosen in this menu.

**Along/Across track Measurement:** In this case the measurement lines will be displayed in alignment to the survey direction. These measurements would resemble the sides of a bounding box enclosing the detected boulder.

**Major Axis Measurement:** The lines will be displayed as perpendicular segments, aligned to the principal axis of the feature.
3. Select the attributes that will be included in the report

4. Click on “Interpretation Report”

**Interpretation Report Output Format**

Once the interpretation report is generated, click on “Export” to launch the dialogue:

1. Select the output format for the report
There are multiple exporting formats:

- .txt
- .xlsx
- .html
- .xml

**Confidence Values**

For each automatically detected boulder in a SEADP project, a confidence value will be calculated by the AI algorithm, these numerical values can vary between 50 and 100 per cent and will be allocated in database of the project.

**How is this value obtained?**

When a SSS channel is run through the SEADP, this calculates two probability matrices. The first matrix holds the probability of an element (pixel) in input being a part of boulder and the second matrix holds the probability of each pixel being a part of a shadow. For all pixels in a boulder and its associated shadow, these are combined to give an overall confidence. This is then the thresholded at a probability of 0.5: thus a boulder detected by SEADP will never have a confidence value that is less than 50%.

The confidence value of a boulder can be:

a) Exported as part of an interpretation report,

| Line Name | Ping Time | Ping Number | Ping Existing | Ping Nothing | Easting (m) | Nothing (m) | Length (User Supplied) (m) | Width (User Supplied) (m) | Height (m) | Boulder Confidence (%)
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>tank_targeted</td>
<td>2014-01-01 10:50:05</td>
<td>52720</td>
<td>32141.968</td>
<td>3010009.018</td>
<td>32137.170</td>
<td>3010000.910</td>
<td>12.352</td>
<td>0.943</td>
<td>0.278</td>
<td>85</td>
</tr>
<tr>
<td>tank_targeted</td>
<td>2014-01-01 10:51:08</td>
<td>52721</td>
<td>32141.983</td>
<td>3010008.788</td>
<td>32140.648</td>
<td>3010002.798</td>
<td>1.584</td>
<td>0.951</td>
<td>0.851</td>
<td>88</td>
</tr>
<tr>
<td>tank_targeted</td>
<td>2014-01-01 10:51:08</td>
<td>52722</td>
<td>32142.714</td>
<td>3011000.208</td>
<td>32138.949</td>
<td>3011024.372</td>
<td>4.244</td>
<td>0.728</td>
<td>0.039</td>
<td>100</td>
</tr>
<tr>
<td>tank_targeted</td>
<td>2014-01-01 10:51:11</td>
<td>52723</td>
<td>32142.944</td>
<td>3011000.332</td>
<td>32138.431</td>
<td>3011119.824</td>
<td>8.458</td>
<td>0.981</td>
<td>0.324</td>
<td>97</td>
</tr>
<tr>
<td>tank_targeted</td>
<td>2014-01-01 10:51:11</td>
<td>52724</td>
<td>32142.494</td>
<td>3011000.362</td>
<td>32138.444</td>
<td>3011012.375</td>
<td>8.945</td>
<td>0.665</td>
<td>0.584</td>
<td>95</td>
</tr>
</tbody>
</table>

Figure 2: Example Interpretation Report

b) Inspected and edited in Survey Engine’s target manager,
NOTE: The Boulder Confidence field can be manually changed by the user, this will affect the confidence colour that is displayed for each detection.

c) Visualized using a colour code on both the GIS Window and the Data Window.

The SEADP colour code for the different confidence levels can be summarized as:

NOTE: As the confidence values generated by the automatic detection can vary between 50-100 %, a red (low-confidence) detection will only be obtained as result of a manual edition done by the user.
**Filtering Boulders**

A set of detected boulders can be filtered according different parameters, these are divided in two groups:

1) **Confidence Level:**

1. Click on Filter Boulders Button in the interpretation menu

2. Tick the option “Filter by confidence level”

3. Use the sliders to define the min. and max. confidence values and click on “Apply Filter” to update the visualization.

2) **Size:**

1. Click on Filter Boulders Button in the interpretation menu

2. Tick the boulder measurement(s) that you want to use for filtering boulders:

   (Length, width, height)
3. Introduce the min. and max. values (in meters) that will be used for filter for each selected measure and the click on “Apply Filter” to update the visualization.

Note: the button “Update Database” will exclude from the database all the boulders that are out of the filter range that is displayed in Survey Engine’s interpretation workspace (Survey Explorer and Data Windows). Once confirmed by the user, this change in the information is not reversible.
System Requirements

To run SEADP, you will need the other two Survey Engine® Sidescan+ and Mosaic+ modules.

Your laptop will need to meet the following standards:

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor</td>
<td>Quad Core -2.0 GHz or faster, 64 bit supported</td>
<td>Quad Core – 2.0 GHz or faster, 64 bit supported</td>
</tr>
<tr>
<td>Memory</td>
<td>8 GB</td>
<td>16 GB</td>
</tr>
<tr>
<td>Hard Disk</td>
<td>2 GB disk free</td>
<td>5 GB disk free</td>
</tr>
<tr>
<td>Display</td>
<td>Single Display 1920x1080</td>
<td>Dual Display 1920x1080</td>
</tr>
<tr>
<td>OS</td>
<td>Windows® 10. 64 bit supported</td>
<td>Windows® 10. 64 bit supported</td>
</tr>
<tr>
<td>USB Port</td>
<td>1 x USB port for security key</td>
<td>1 x USB port for security key</td>
</tr>
<tr>
<td>Graphics Card</td>
<td>NVIDIA GeForce GTX 1660</td>
<td>NVIDIA GeForce GTX 1660</td>
</tr>
</tbody>
</table>

*SEADP and Seabed Classification require a minimum of 6GB of dedicated memory in the GPU

**Only NVIDIA graphics card are supported

The graphic card must support CUDA SDK 9


Your GPU card [Compute Capability (CC)](https://developer.nvidia.com/cuda-zone) must be 3.0 or more.

A minimum dedicated RAM of 6GB is recommended for running SEADP.
Frequently Asked Questions

Question 1

I only see the message “Process stopped with error”?

This generally happens when there is a problem with the graphic resources on your operating system (such as your PC). This can be related to the dedicated RAM memory in the GPU.

Check the system requirements section for reference) or when the GPU’s driver is not working properly.

What can I do?

Updating the GPU driver should be the first action to take in this case and/or also make sure the GPU is recognized by Windows and is working normally.

The GPU and the driver versions can be checked on the Device Manager or the NVIDIA Control Panel:

![Device Manager](image1.png)

![NVIDIA Control Panel](image2.png)

Question 2

The progress bars seem stuck for all the files and the message “Detecting Boulders” is displayed after long time in SEADP’s window

This could be due to a problem in the regional configuration of Windows, when the system settings are wrong and instead of ‘.’(dot) for decimals, a ‘,’(comma) is used.

What can I do?

This can be changed as follows:

1) Use Win + R to open a run dialog
2) Type “intl.cpl” and click OK
3) Select “Additional Settings”:

4) Change “Decimal symbol” from ‘,’ to ‘.’ and then click OK

After the modification, try running SEADP under the new configuration.