



# **BOB**

**Survey planning, Data collection and Processing software  
for Marine Magnetics magnetometers**

**User Manual**

**Revision 2022-12-20**

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# 1 Introduction to BOB

BOB is the companion software to all Marine Magnetics towed magnetometers. It provides a graphical interface that allows you to communicate with the magnetometer, log and plot incoming data, apply data corrections and export survey data in a customizable format. The optional BAM (BOB Analytic Module) extension adds data analysis, visualization, mapping and target selection.

BOB is the helpful and friendly fellow you want to have around, because he knows how to plan and run the survey, and can help process and visualize your data.

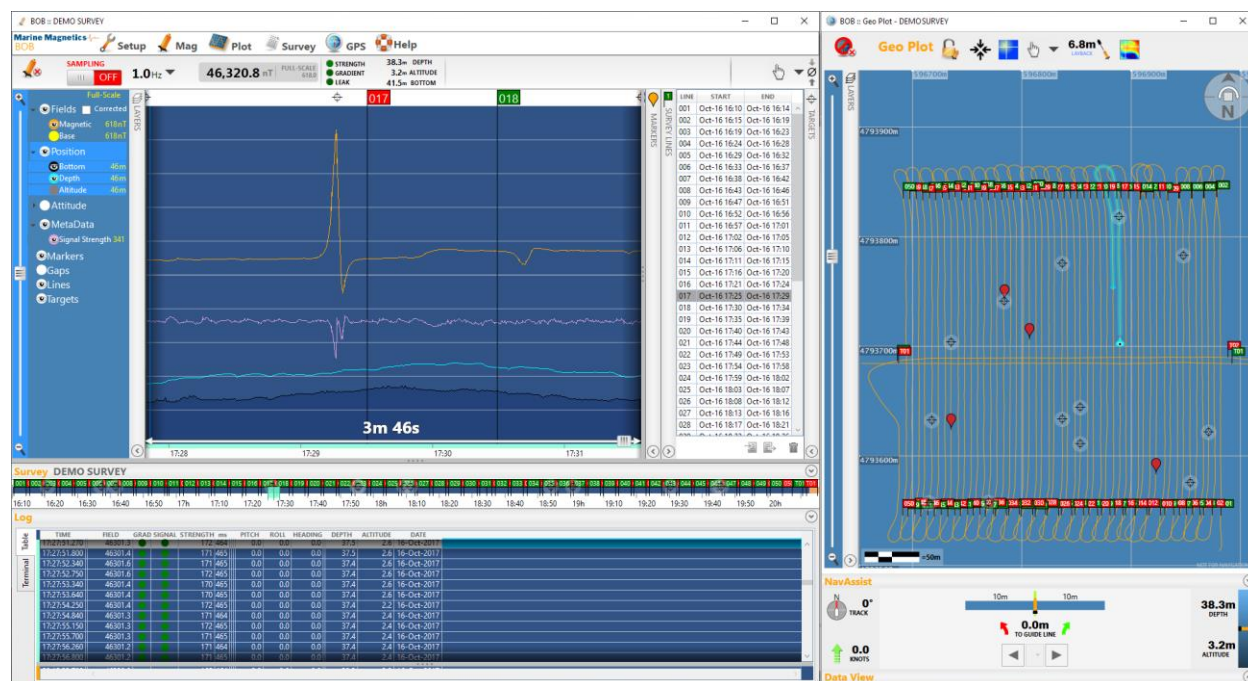


Figure 1-1: BOB user interface consists of two windows: Main window and GeoPlot, offering both a profile view and map view of the survey, as well as a set of essential tools for planning a survey guide grid, navigating the vessel along planned grid and analyzing the data. BOB Analytic Module (BAM) expands functionality to include magnetic mapping tools.

## 1.1 System Requirements

<b>OS</b>	Windows 10 64-bit, or newer. BOB may work on Windows 7 64-bit, but we do not recommend it due to lack of technical support for Windows 7.
<b>RAM</b>	8GB or more
<b>Storage</b>	2GB or more, depending on number and size of surveys
<b>CPU</b>	Intel Core i5 2.0 GHz or equivalent. Intel Core i7 or better recommended with SeaQuest gradiometers, or when processing larger surveys and using BAM.
<b>Display</b>	HD resolution (1920 x 1080) provides the minimum recommended amount of screen space for all features. Larger display or dual monitor configuration recommended for data processing.  Daylight-visible display highly recommended for field use.

## 1.2 Installing BOB

The recommended way to install BOB is from an online link shown below, which can also be accessed from the Marine Magnetism web site. This guarantees that you will get the most up-to-date version, and will enable automatic updates.

<https://bob.marinemagnetism.com/>

BOB can also be packaged as an off-line installer. However this method will require you to manually check for updates, and manually un-install the old version of BOB each time you need to update it.

The setup program will guide you through the installation of BOB and other required software.

## 1.3 Running BOB



Click the BOB icon on your Desktop, or look for BOB App in the Start menu.

## 1.4 Text Conventions Used in This Manual

- Controls (buttons, menus, etc.) are displayed in **bold**.
- Menu selections and the associated functions are displayed in **bold: Menu > Function**.
- 

## 1.5 Important Note regarding data collection and storage:

Near the top of the Main BOB window is a sampling button, which also serves as indicator of data logging status and sampling rate.



Figure 1-2: Sampling Button/Indicator in BOB

**If Sampling is ON**, all of the data that is collected from the magnetometer and GPS are automatically stored in the survey, which is kept in an internal database file.

You can exit BOB at any time, and your data will be available the next time you start BOB, in the list of available surveys. There is no need to “save your work” unless you want to save an additional copy of a survey as backup, or to be transferred to a different computer.

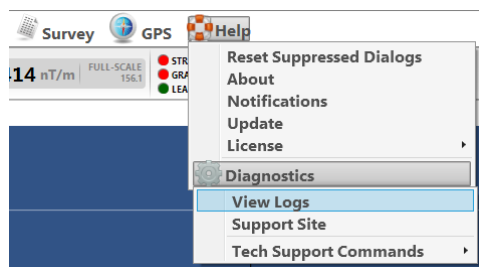
**If Sampling is OFF**, or accidentally becomes turned OFF during a survey, **data are not being stored** in the survey database.

The user is responsible for monitoring the status of the sampling indicator throughout the survey to ensure data is getting captured and stored.

## 1.6 BOB Diagnostic Logs

BOB keeps Diagnostic Log files of everything it receives from the connected devices, such as the magnetometer and GPS. Data captured during the survey also get stored into diagnostic logs, which can serve as backup in an emergency. This requires the diagnostic logs to be identified and forwarded to Marine Magnetism for data recovery.

Diagnostic Logs can be accessed through the Help menu in the Main BOB window.



There may be rare situations where the magnetometer will continue taking and sending readings even if sampling accidentally gets turned OFF. Although these readings will not be saved into the survey database, they may still get saved into diagnostic logs, from which data may be subsequently recovered in an emergency.

GPS data are always saved into the diagnostic logs, as long as GPS is connected (in GPS Setup tab) and is sending data.

## 2 Get to Know BOB

This section describes BOB interface and general workflows.

Since BOB can be used for both data collection and post-processing, not all of the steps listed below are necessary in every situation and the procedures are not necessarily linear.

### 2.1 BOB Workflow Overview for Data Collection

Key steps for setting up BOB for data collection:

- Start a new survey, and choose a magnetometer type
- Alternatively, load a saved survey from the list, or use the current survey to continue data logging
- Connect to GPS
- Connect to magnetometer
- Configure the time synchronization settings
- Set the layback distance and set the zero level for the depth sensor
- Ready to collect data!

After you enter all the required settings (or confirm settings for an existing survey) and click the **Done** button, BOB will close the Setup Assistant and open the Main Window.

The above steps exclude the survey planning stage. To plan a survey block in BOB ahead of the actual data collection, follow these steps:

- Start a new survey, and choose a magnetometer type
- Skip the Setup Assistant and go directly to GeoPlot
- Design a survey grid using GeoPlot's Guide Grid tool.
- Loading a background map, chart or satellite image for reference will simplify the survey block design.  
You may import a background image from a GeoTiff file.

### 2.2 Collecting Data

Turn sampling ON in the main window.

After the magnetometer starts outputting data at the specified frequency, the profile plot area will begin to fill up with data graphs, and readings will be shown in the table below the profile plot. All readings are saved in a database managed by BOB as long as the sampling status is ON.

As soon as you have collected some data, you can add markers and survey lines from the Main or Geo Plot windows.

BOB allows you to review existing data while collecting new data in real-time thanks to the split-view features of both the profile plot and data log table below it.

### 2.3 Saving and Exporting Data

At any time during the survey you can export the data to an ASCII text file (.CSV).

Among other options, you can specify which channels/columns to output, and whether the output is comma or space delimited.

A backup copy of the BOB survey can also be saved in MMS format, which packages the entire survey database along with GeoPlot data into a single file that can be transferred between different computers running BOB.



## 2.4 BOB Interface Overview

BOB has three windows: the Setup Assistant, the Main Window, and the Geo Plot Window.

## 2.5 Setup Assistant

The Setup Assistant is the first window that opens when you start BOB. It allows you to either create a new survey, to continue the current survey, or open one of the earlier surveys for processing. It also allows you to manage the list of stored surveys, create backup copies, or restore a survey from a backup copy transferred from a different computer.

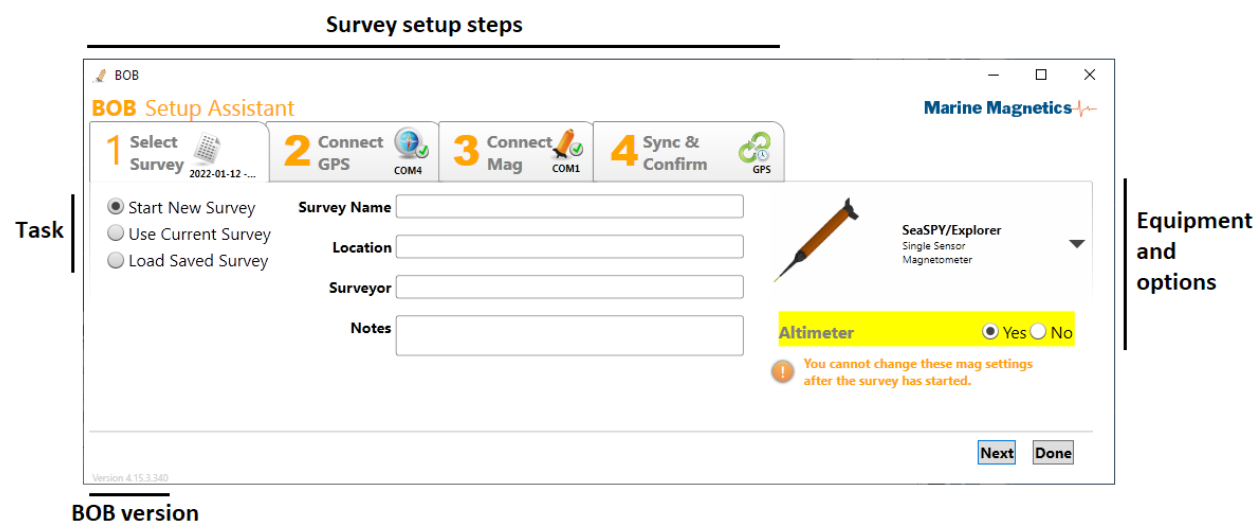


Figure 2-1: The Setup Assistant.

The Setup Assistant has four tabs that represent different steps in setting up a survey:

- Select Survey / Start new survey
- Connect GPS
- Connect Magnetometer
- Sync and Confirm

Certain types of magnetometer configurations (e.g. VectorMag) will show an additional tab, for connecting extra equipment, while others (e.g. Explorer+AUV) will skip the Setup tabs and go directly to the processing window.

The Setup Assistant can also be accessed at any time from the Main Window by clicking the **Setup** button in the menu. This allows you to check the connection status of the GPS and magnetometer, and check the time synchronization, or add survey notes in tab 1, before returning back to the Main Window.

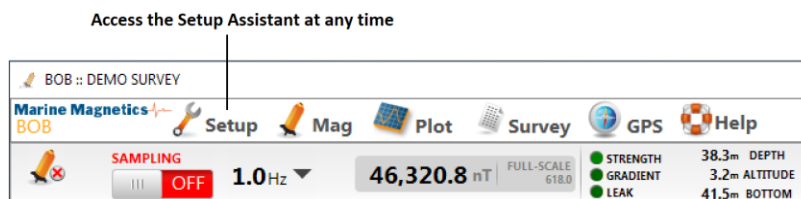


Figure 2-2: Setup Assistant can be accessed at any time during the survey or processing, to add notes, check GPS status or time sync settings.

## 2.6 Main Window: Profile Plot and Data Log table

The Main Window shows all controls and information that you need during a survey or post-processing and analysis. All panels can be hidden or shown by clicking on their title bar, to customize the work space.

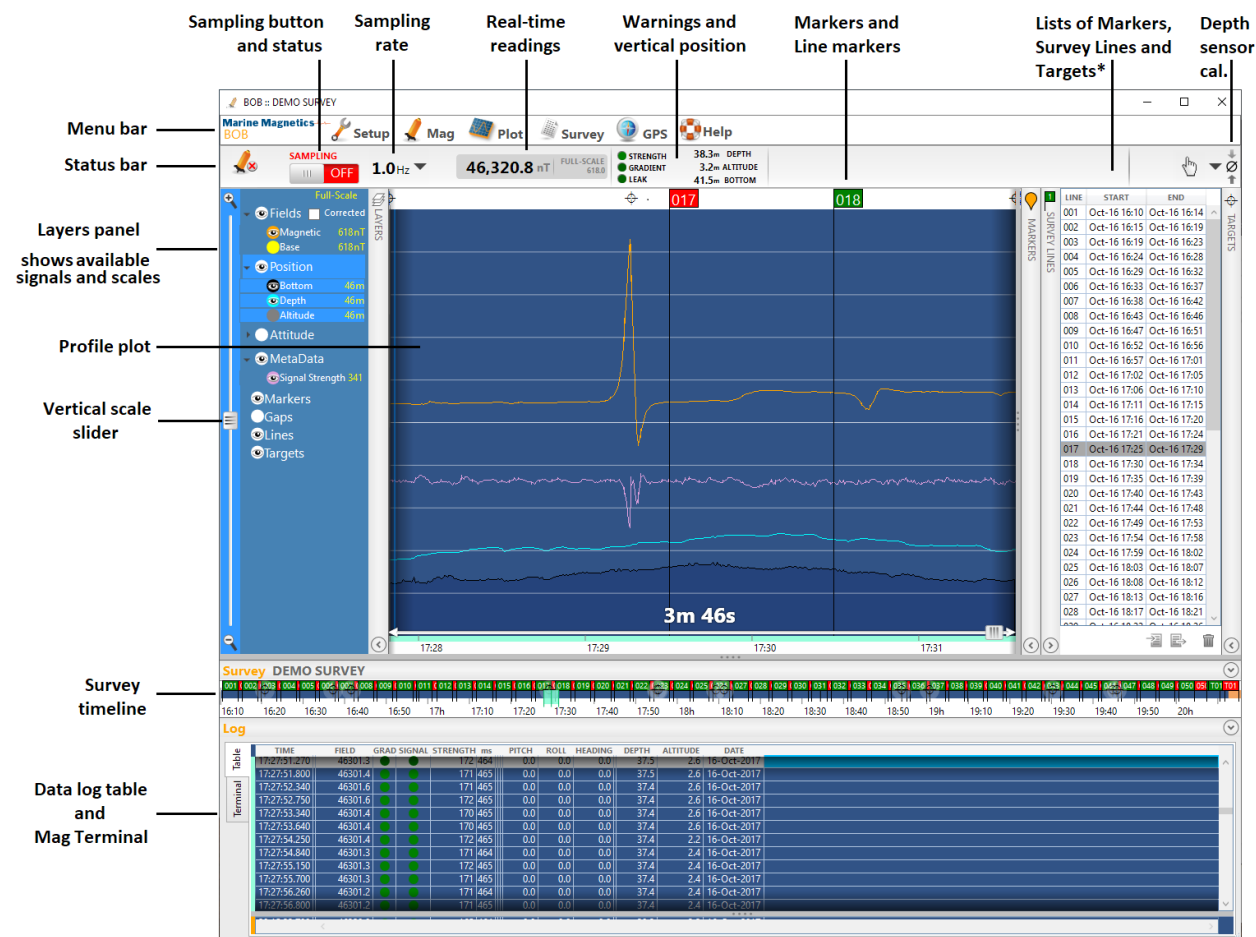


Figure 2-3: The Main Window is used for both data collection and post processing.

Most of BOB's functions can be accessed through the menu bar in the Main window.

Status bar displays the magnetometer connection status, sampling rate and sampling status, as well as any warnings that require your attention. Vertical towfish position area also allows you to set custom thresholds for depth and altitude, enabling BOB to alert you during survey when the towfish is outside its optimal survey zone.

The plot area is featured in the center of the window, showing graphs of available survey signals (channels) plotted over the selected time interval. Multiple profile traces can be shown simultaneously with individual scaling for each trace.

Layers panel to the left of the plot allows you select signals to be displayed and set custom vertical scale for each group, or each individual signal.

Panels to the right of the plot allow you to manage Markers and Survey Lines, as well as Targets with the optional BAM extension (\*).

Survey timeline below the plot allows you to quickly navigate through all collected data and change the horizontal scale of the plot. It can be configured to display time gaps for surveys consisting of multiple segments, and show the start and end points for all Survey Lines marked by the user, as well as Targets.

Below the timeline is the Data Log table, with a tab for the direct Terminal interface and monitoring.

## 2.7 Main Window: Split view for data review

BOB allows you to monitor the real-time data while simultaneously reviewing and analyzing earlier data.

Both the Profile window and Log table contain divider bars, which can be moved to any position for dual data display.

During survey data collection, as much as 3 minutes of real-time data can be shown in the Latest Readings pane, while the Latest Readings pane can contain any duration of data, up to the whole survey.

A cyan selection on the time line below the profile will indicate the width and position of the review data window on the overall timeline.

Similarly, the Log Table contains a horizontal divider which can be dragged up and down.

Moving the cursor over the profile view will move the corresponding row selection in the Log Table review pane.



Figure 2-4: Split view feature showing both real-time and earlier data, for both the profile and log table

**Note:** sea floor depth is only shown for magnetometers equipped with both altimeter and depth sensor.

## 2.8 Geo Plot Window

GeoPlot window contains all of the tools and layers needed to visualize the position of the vessel and the towfish, mark encountered anomalies, set up guide line grids and monitor the towfish position relative to guide lines.

To open the GeoPlot window from Main window, use the menu **GPS > Show Geo Plot**.

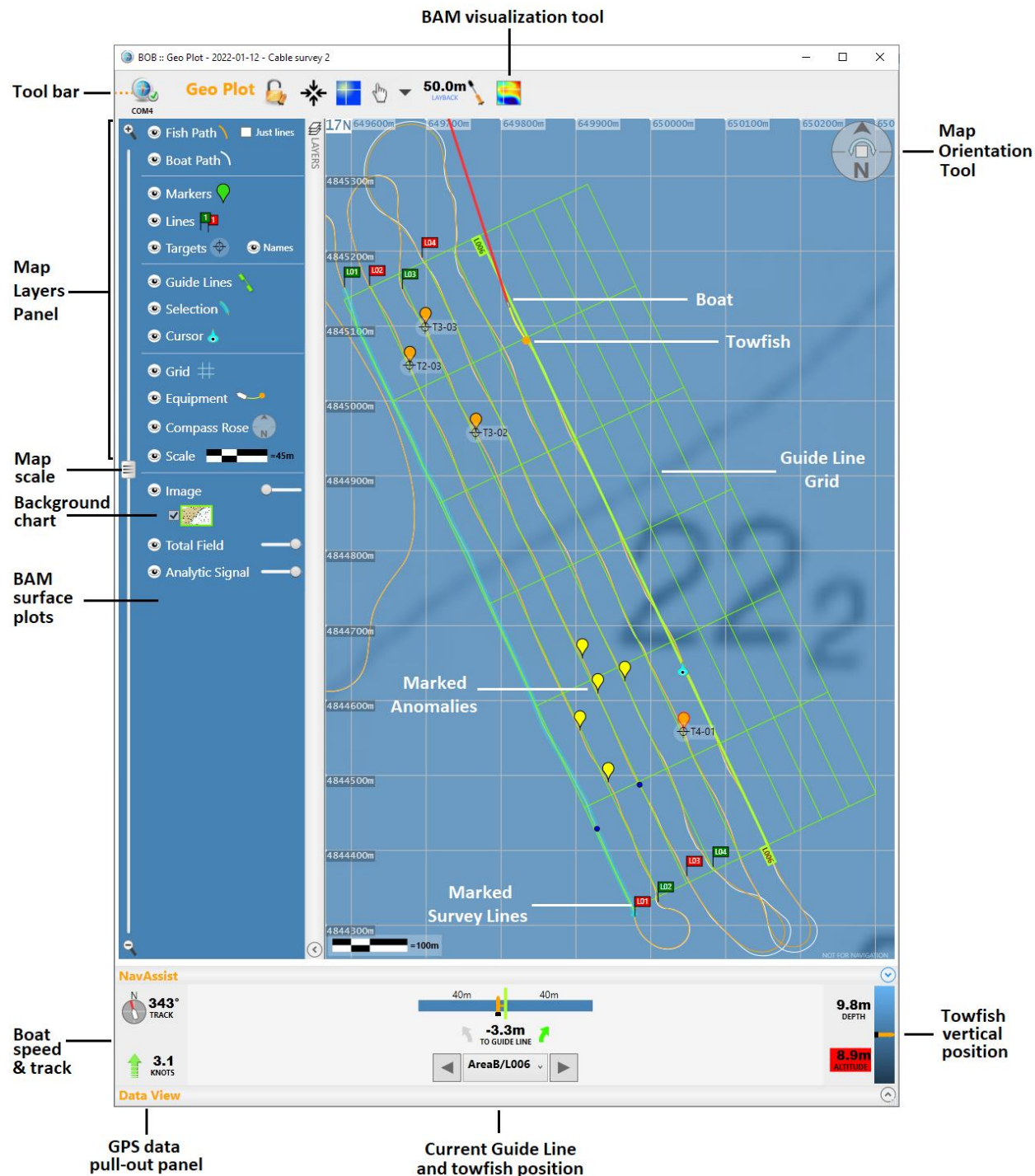


Figure 2-5: Geo Plot window overview

A summary of key features of the GeoPlot window are highlighted in the figure below:

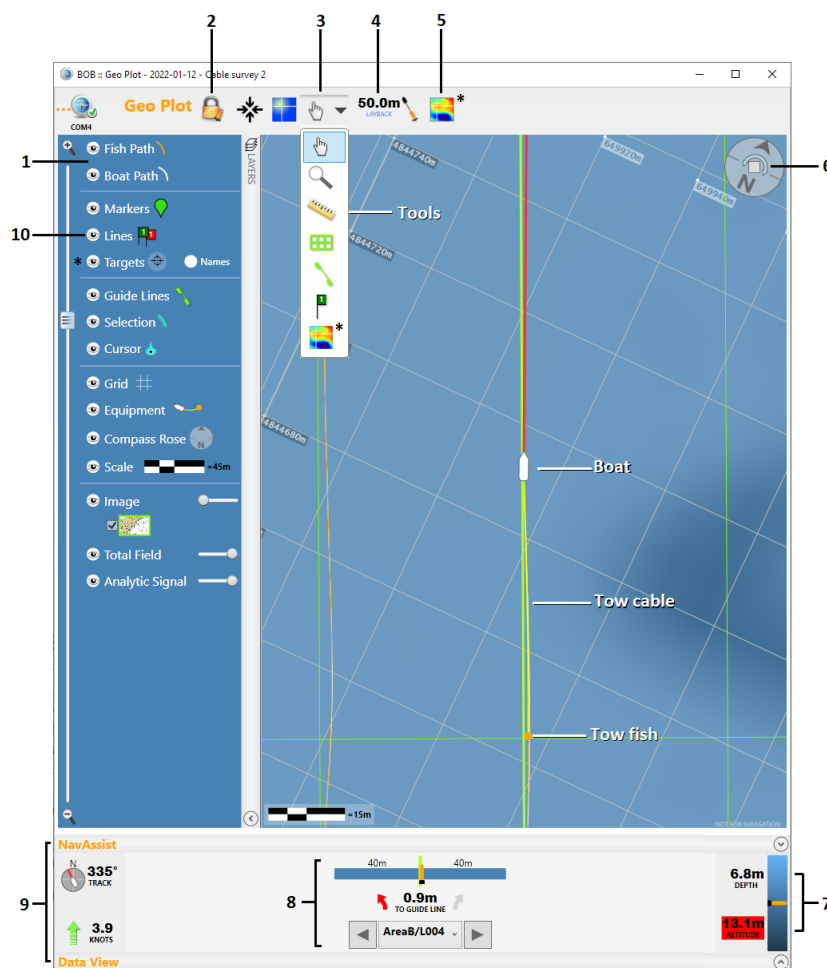


Figure 2-6: GeoPlot detailed view

1. Towfish path can be shown as distinct from the Boat path to eliminate uncertainty in towfish position
2. Boat position can be locked to the center of the screen, allowing the map to scroll, or unlocked to keep the map from scrolling
3. A drop-down menu offers several useful tools for measuring distances and bearings, drawing grids of guide lines, marking survey lines, and making magnetic maps of a selection (\*with BAM activation)
4. Layback and relevant offsets can be configured and updated right in the GeoPlot
5. BAM surface plot tool is integrated into GeoPlot (\*with BAM activation)
6. Map view can be rotated using the Compass Rose tool to fit the survey orientation or driver preference
7. Customizable thresholds for towfish altitude and depth enable visual alerts to the user when towfish is outside of the optimal survey altitude zone
8. NavAssist panel shows the current guide line and towfish offset relative to the current guide line in an intuitive way helping the boat operator with steering directions
9. Pull-out panels for Layers, NavAssist and GPS Data View offer additional flexibility
10. Individual map layers can be hidden or shown to customize the view, with opacity adjustment for some

For further details on these features, please refer to the subsequent sections.

### 3 Setting Up a Survey in Setup Assistant

Before you start collecting data, you need to create a new survey, or open an existing one.

Once a survey has been created, you will be able to:

- Configure the magnetometer and GPS communication ports
- Specify the time synchronization device
- Specify tow cable length and offsets relative to GPS
- Calibrate the depth sensor zero level (for magnetometers equipped with a depth sensor)
- Continue to the Main window for data collection

#### 3.1 Start a New Survey

In Step 1 of the Setup Assistant, select the magnetometer type and any options (e.g. altimeter).

Enter survey details, and click **Next**.

This will create a new blank survey and add it to the list of surveys in BOB.

**HINT:** Entering as much detail as possible into Notes can help simplify the work of data analyst later during post processing and interpretation. Such details can include tow cable length and offset from GPS antenna, vessel speed and type, weather and sea state, current, marine traffic, whether a base station had also been deployed, etc.

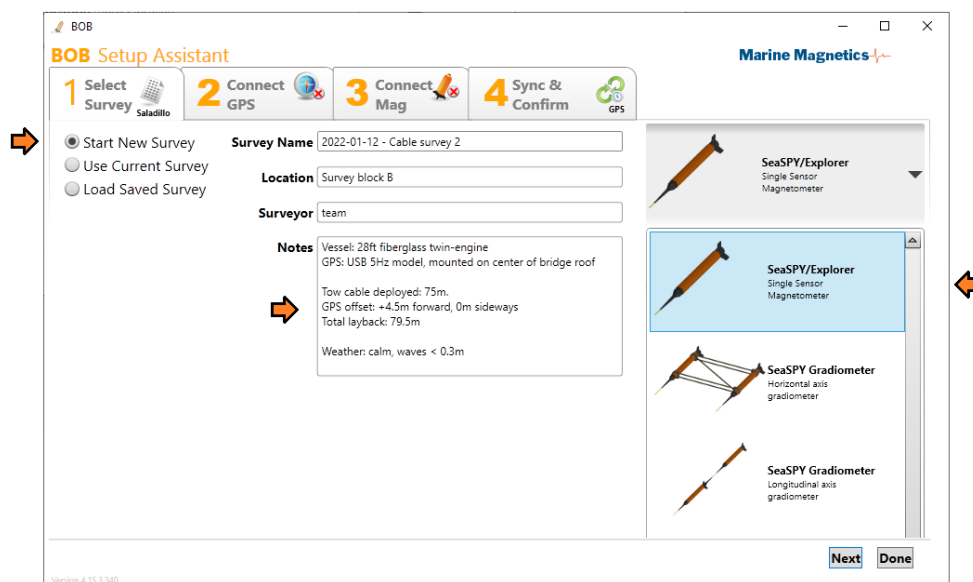


Figure 3-1: Creating a new survey in the Setup Assistant.

You can return to the Setup Assistant at any time during or after the survey, to add edit Notes and other fields.

The Notes box can also be used to keep track of optimal post-processing parameters, such as any heading bias correction, layback correction, repeated survey lines, etc.

**Note:** Once a survey is created with a specific magnetometer model and options (e.g. altimeter), that model cannot be changed. A new survey would have to be created if a different magnetometer type is used.

**Note:** Survey start and end date and time will be set to default values while the survey is blank, until actual data readings are collected.

## 3.2 Open the current survey to continue recent work

Use **Current Survey** option allows you to continue a previously started survey.

From here you can either continue collecting data into the current survey, or start data analysis and post-processing.

- Click **Next** to continue to GPS and Mag settings tabs.
- Click **Done** to go straight to the Main Window (for post-processing).

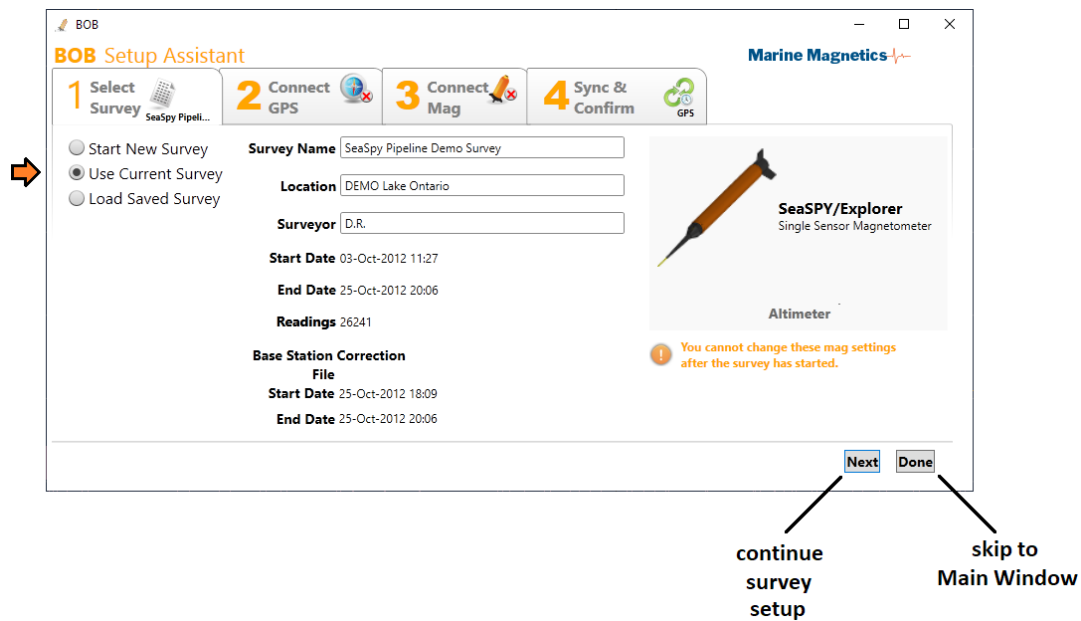


Figure 3-2: Opening the last-used survey to continue data collection, or post-processing

**Note:** Magnetometer model and options (e.g. altimeter) cannot be changed for an existing survey.

If you have mistakenly collected a substantial amount of data into a survey with the wrong magnetometer type or altimeter option, and wish to correct the magnetometer model and altimeter option, send a backup copy of your survey (MMS file) to Marine Magnetics technical support to have your survey database format changed.



### 3.3 Open an Existing Survey from a List

**Load Saved Survey** option allows you to open an existing survey from the list to continue data collection, or for post-processing and analysis.

You can add a survey to the list by importing (restoring) it from a backup (MMS) file.

You can also select one or more surveys in the list and create backup copies using the Backup button.

- Click **Next** to continue to GPS and Mag settings tabs.
- Click **Done** to go straight to the Main Window (for post-processing).

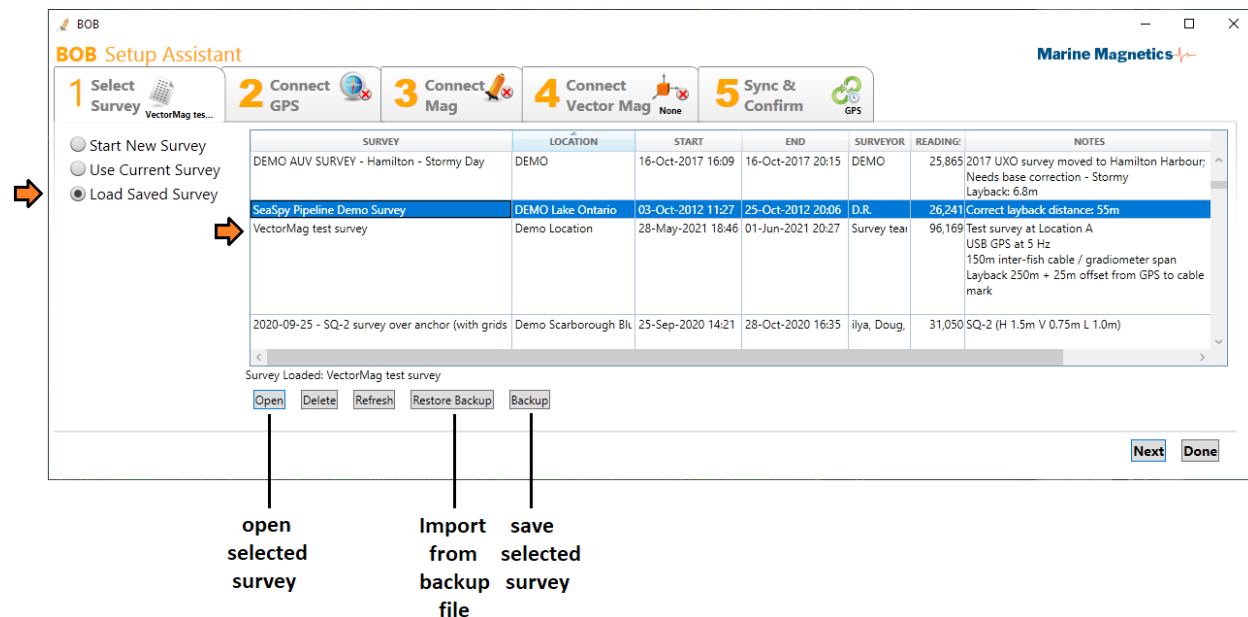


Figure 3-3: Opening an existing survey from a list in the Setup Assistant.

BOB saves survey backups in a single MMS file, which contains all of the data and maps, markers and survey lines in a single database. MMS backups can be transferred between computers for data exchange and post-processing.

**Note:** BOB keeps local copies of the listed surveys in a secure location protected from the user, for data security reasons. Creating a backup copy will create a snapshot of the current state of the survey in a separate MMS file.

Deleting a survey from the list will permanently delete BOB's internal copy of it. Make sure you have saved a backup copy before deleting any surveys.

**Note:** The same survey MMS file cannot be imported into BOB more than once. Changing the name of the survey doesn't change the actual MMS file content, and may look like the same survey to BOB. If you have an updated copy of the survey from a different computer, you will need to first delete the existing survey from the list before importing / restoring the updated copy.

**Hint:** Post-processing settings and features such as Markers, Survey Lines, Targets and Guide Lines can be easily transferred between computers by exporting corresponding lists to files. This may eliminate the need to update actual surveys. Refer to sections on Markers, Survey Lines and Guide Lines for details.



### 3.4 Connect a GPS Device

1. Make sure your GPS device is capable of generating NMEA data as GPRMC and GPGLA messages, and configured for output rate of 2 Hz or higher. 4 Hz recommended for best responsiveness of the GeoPlot navigation view. While 1Hz is acceptable, its slow data rate will increase positional uncertainty for data points as well as increase the response time for steering the boat. 10 Hz is the maximum GPS data for BOB.
2. Configure the COM port used to connect the GPS. If using a USB-to-Serial converter, you can find the COM port number in Windows Device Manager > Ports.  
**Hint:** on Windows 10, hit "Win + X" on your keyboard to access Device Manager via the handy Quick Link menu.
3. Click the **Connect** button. The incoming GPS data will be displayed in the terminal area, and BOB will refresh the GPS information summary as new data arrives.  
If you do not see anything in the data terminal, check your COM port settings, and all cable connections.
4. You may configure the Layback and offset at this point, or do so later in the Main BOB window, or the GeoPlot window. Layback can be specified at any point during the survey and adjusted as many times as necessary. Refer to Section 3.6 for details on determining the Layback.
5. Click **Next** to continue to the Mag Connection tab.

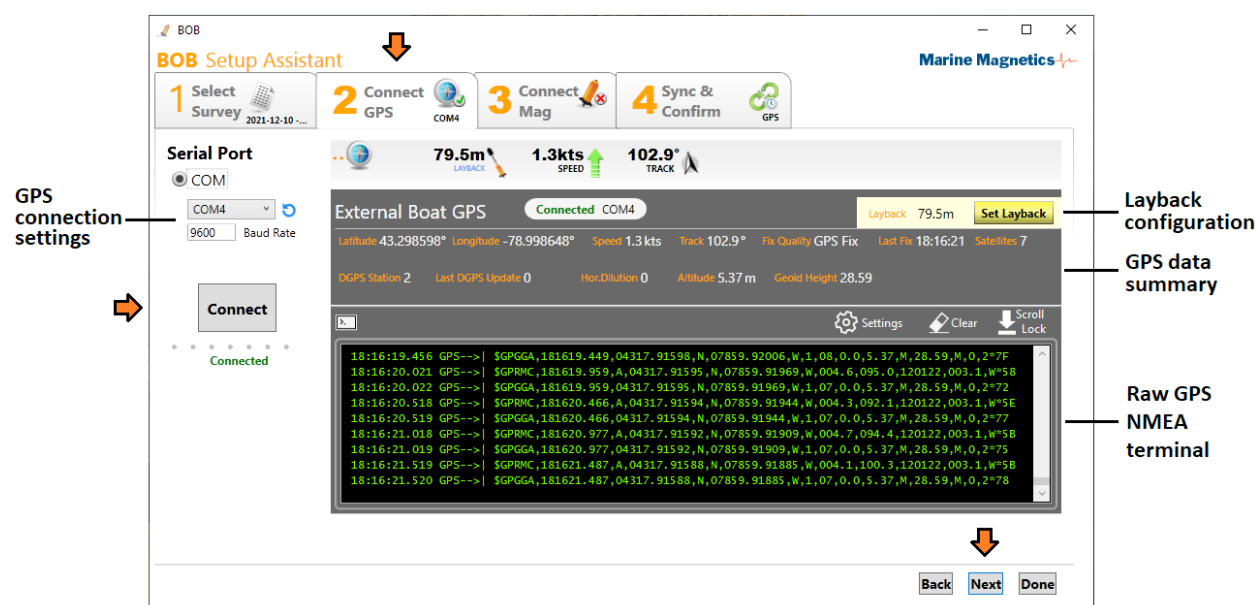


Figure 3-4: GPS Connection tab in Setup Assistant.

**IMPORTANT:** Your GPS must output either GPGLA or GPRMC NMEA data for BOB to process it. Ideally both. These NMEA data formats are considered required minimum and contain all the important parameters used by BOB.

## 3.5 Tow Cable Layback

Bob stores two sets of coordinates with every magnetic field reading: the GPS position and the towfish position.

Towfish position is computed based on the GPS position and the layback distance entered by the user, while accounting for the actual boat path through turns and maneuvers. Take care when specifying the layback as it affects the positional accuracy of magnetic maps generated from the data, and alignment of data on adjacent survey lines.

The layback is the horizontal distance from the magnetometer's sensor at the back of the towfish, to the GPS antenna, or any other positioning system's point of reference. For example, if the source of coordinate data is a USBL system, the layback to enter would be the distance between the transponder/pinger and the magnetometer's sensor.

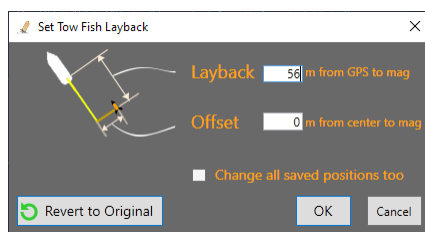


Figure 3-5: BOB accounts for both the layback and the transverse offset between the GPS antenna and the tow cable spool. In this diagram, the boat symbol represents the GPS antenna.

### 3.5.1 Determine the layback distance for each deployment

Layback should include the Tow cable length, any GPS offset from the distance mark on the cable, and the towfish length.

Layback can be changed at any point of the survey, including during post-processing. Different layback values can be used for different sections of the survey. An option to **Revert to Original** layback is offered for post-processing phase, which resets any adjustments entered after the survey back to values entered during the survey.

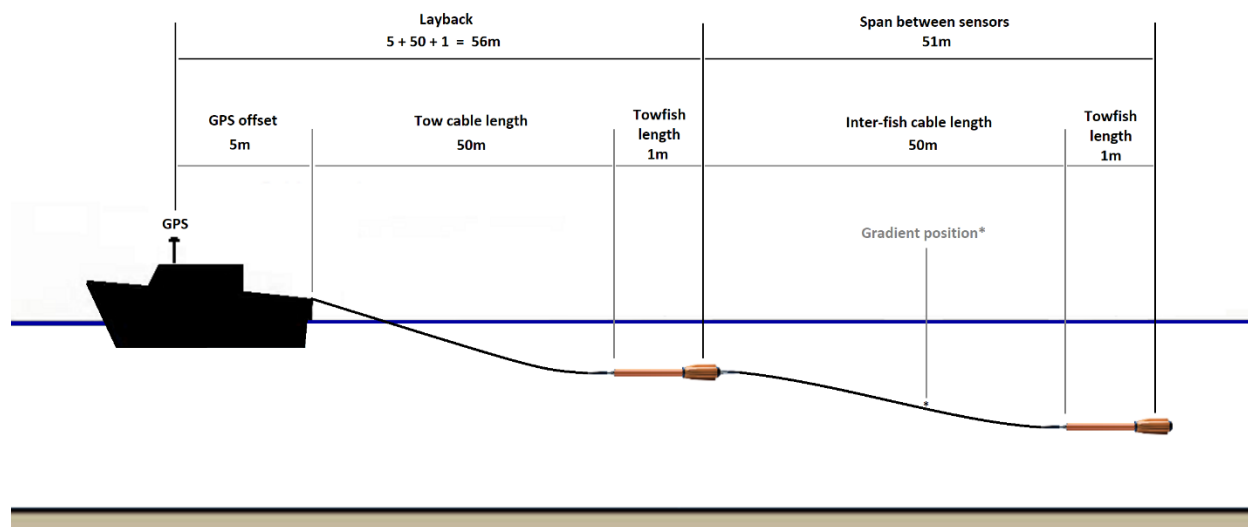


Figure 3-6: Towfish layback includes tow cable length, GPS offset and towfish length. For longitudinal gradiometers Sensor Span is configured in Step 1 of survey setup.

**Note:** BOB does not take towfish depth into account when applying the layback, since typical tow cable will sink to only 10% of the deployed length, leading to insignificant change in overall length. However, when heavy or armored tow cable is used, user needs to account for the added depth, and enter the layback distance accordingly.

### 3.5.2 Towfish length offset

The offset between the end of tow cable and the location of the magnetometer's sensor varies depending on the towfish configuration, and needs to be accounted for when determining the layback:

#### Layback adjustment for different magnetometer models

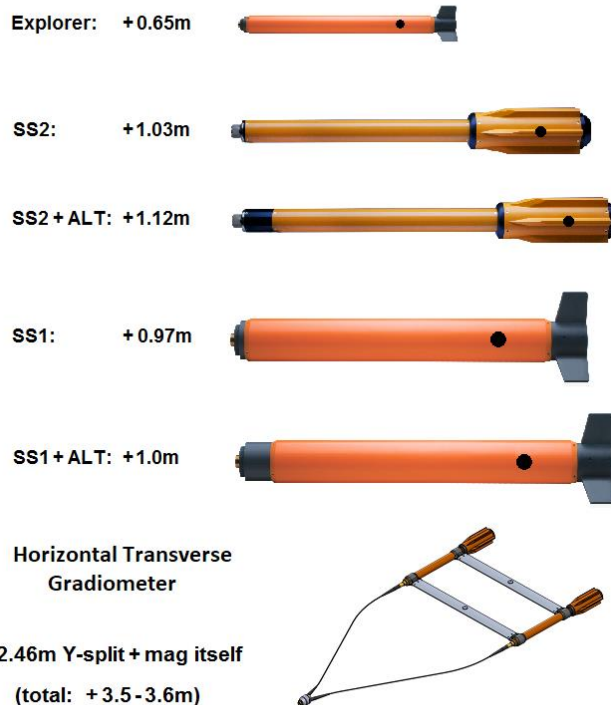


Figure 3-7: Towfish length needs to be accounted for when determining the layback

### 3.5.3 AUV layback determination

In the case of AUV-towed surveys, the layback must include the distance from the AUV's coordinate center to the actual magnetometer sensor. The AUV coordinate center could be the location of the INS, and depends on AUV model and its software. The magnetometer's sensor is located in the aft-end of the magnetometer body, as shown in the diagram below.

Having the correct layback specified during AUV data import into BOB is essential to guarantee the accuracy of post-processing and the resulting magnetic maps.

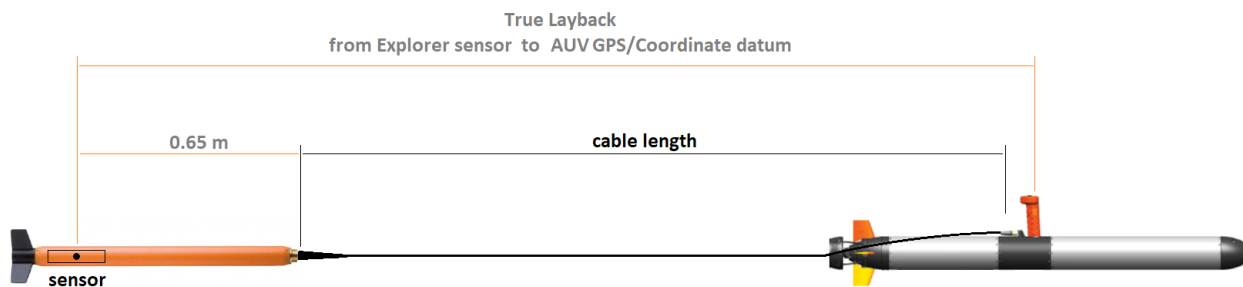


Figure 3-8 - Layback determination for AUV-towed survey

### 3.6 Connect a magnetometer

1. Make sure your magnetometer is connected to the isolation transceiver and to the computer, as described in the magnetometer's operating manual.
2. Configure the COM port used to connect the isolation transceiver / magnetometer. If using a USB-to-Serial converter, or the USB cable supplied with the transceiver, you can find the COM port number in Windows Device Manager > Ports. **Hint:** in Windows 10, hit "Win + X" on your keyboard to access Device Manager via the handy Quick Link menu.
3. Click the **Connect** button.
4. The incoming magnetometer data and responses will be displayed in the data terminal area. If you do not see anything in the terminal, try clicking the Test Sampling button to test the connection. If there is no response from the mag, check your COM port settings, and all cable connections.
5. You may calibrate the Depth Sensor zero level at this point, or do it later in the Main Window.

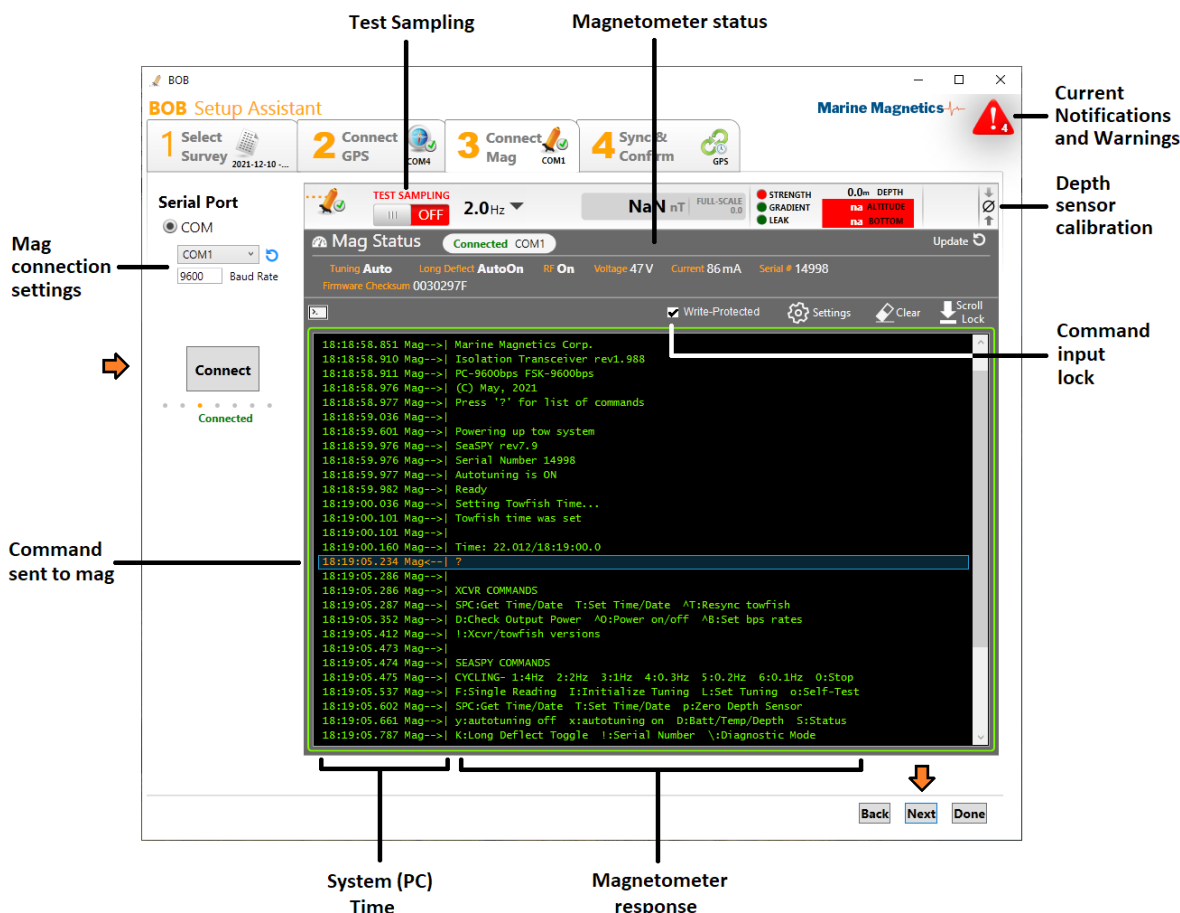


Figure 3-9: Mag Connection tab in Setup Assistant

**Note:** Terminal window uses green text to display data and responses received from the mag, and orange text to show commands sent to the magnetometer (by BOB or the user).

**Note:** Terminal window is locked from user entry by default, to prevent inadvertently sending commands to the magnetometer. If you are familiar with the command interface, you may send commands after unlocking the Write-Protected box above the terminal. For details on the command interface, refer to the magnetometer operating manual.

**Note:**

### 3.7 Test Sampling

**Test Sampling** is a mode designed to test communication with the magnetometer, and is distinct from actual Sampling found in the Main Window: The purpose of Test Sampling is to check magnetometer connection and quality of the readings.

During Test Sampling, a clear “Test sampling” will appear above the sampling switch, and **data will not be saved into the survey database.**



Test sampling can only be initiated from the Setup Assistant windows, and will stop automatically as soon as the focus is off of the Terminal window, or the user switches to a different tab. However, if you have both the Main window and Setup Assistant open at the same time (e.g. on different screens), and you initiate test sampling from the Setup terminal window, the Main window will also show the samples received from the magnetometer, but will display ‘Test Sampling’ above the sampling switch. For this reason, always initiate the actual survey sampling from the Main window.

### 3.8 Diagnostic Logs

For added security and redundancy, in addition to the survey database, BOB also maintains diagnostic data logs for each of the connected devices. The logs record all information exchanged with the connected devices, regardless of the state of the sampling switch. These diagnostic logs can be accessed through the Help menu, and can be useful in restoring data in case of unforeseen survey issues, or when contacting Marine Magnetics for technical support. Please refer to Section 1.6 for details on Diagnostic Logs.

### 3.9 Depth sensor calibration

If there the magnetometer is equipped with a depth (pressure) sensor, it must be set to zero meters at sea level before every deployment to eliminate any temperature-related offset. This is due to the fact that the 0m level of the depth sensor is a relative value, and will vary slightly with temperature. For more information on the pressure sensor, refer to the magnetometer operating manual.

Zero-level calibration should be done after the magnetometer housing has reached the water temperature at the survey location.

If the water temperature is similar to the air temperature, this can be done on the deck of the vessel when the towfish has already cooled (or warmed) to the ambient air temperature.

If the water temperature is significantly different from the air temperature, the towfish may need to be immersed in water for 5-10 minutes to allow it to adjust to the water temperature, then raised back to the surface (or slightly above the surface) before the pressure sensor zero-depth level can be set. This will ensure the most accurate depth readings during survey.

Both the Setup Assistant and the Main window offer a button that sets the zero level, found near the top-right hand corner.



Alternatively, you may zero the depth sensor with the **p (lower-case p)** command in the command terminal. You will be prompted for confirmation before the sensor is zeroed.

**Caution:** The scale and range of the depth sensor can be set using the **P (capital P)** command.

You **should not change** this calibration unless you suspect an issue with the depth measurement range.

In that case, please contact the technical support at Marine Magnetics.

### 3.10 Configure the Time Sync Device and Confirm Settings

**Sync & Confirm** tab in the Setup Assistant gives you a status summary on the magnetometer and GPS. You can re-adjust the layback, calibrate the depth sensor, and set the time sync device that BOB will use as reference for the magnetometer.

Time synchronization is very important when collecting survey data, as it helps relate the magnetometer readings with GPS positions. If the time offset between the GPS and magnetometer clocks is greater than 1s, towfish positioning accuracy can be compromised. BOB will alert the user if time synchronization changes during the survey.

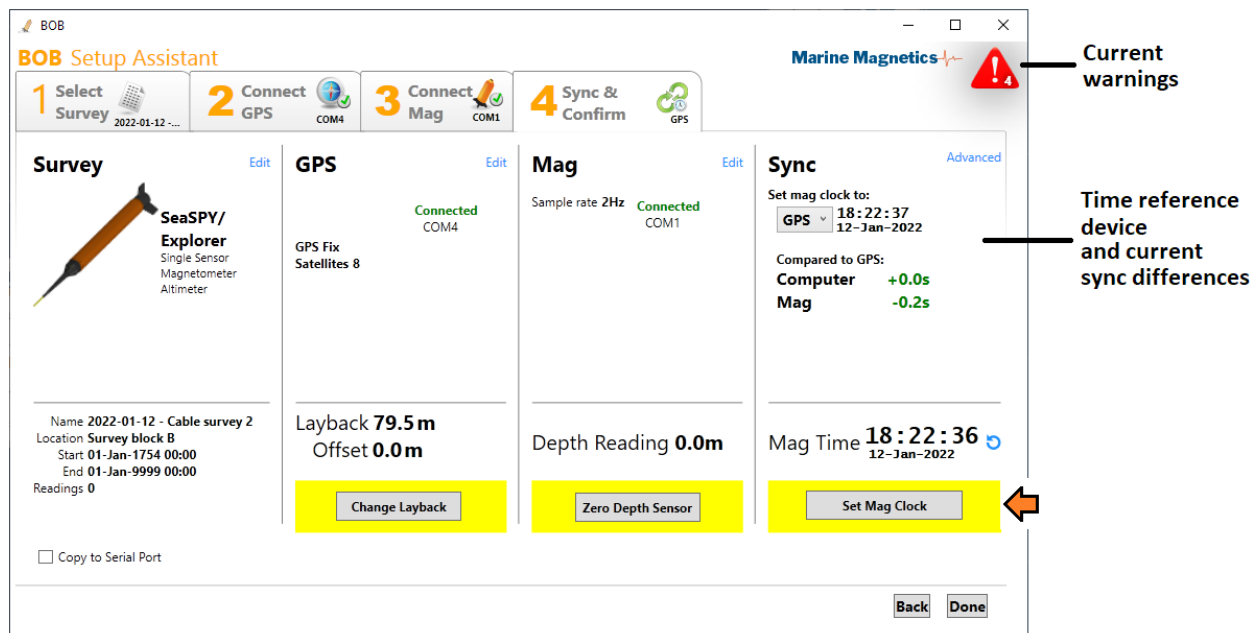
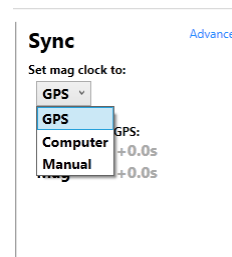


Figure 3-10: Sync & Confirm tab of the Setup Assistant contains time synchronization options and details.

In this example GPS is selected as time reference device, and relative time offsets are shown for each of the devices connected.

Always use the GPS as your time reference device unless you have a compelling reason to choose either the PC time (e.g. when GPS is not available), or use a manually-entered time via the Advanced option.

At any time during the survey the user can open the Setup Assistant and re-sync the mag clock if necessary.



For best results, set the time on the PC as accurately as possible, as well as the time zone, before you start the survey.

**Note:** All times shown in BOB are in Universal Coordinated Time (UTC) unless marked otherwise.

During data collection, BOB always saves both the Reading Time (i.e. magnetometer time) and the System time (i.e. computer time) with each magnetometer reading, for redundancy and added data integrity.

**Note:** The **Reading Time** corresponds to the time when the reading was taken, based on the magnetometer's internal clock.

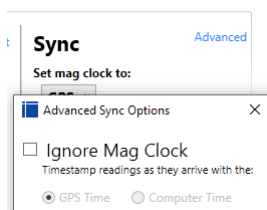
The **System Time** reflects the computer time when the data reading was received by the computer, and can be subject to varying time latencies associated with the serial port / USB connection and data buffering.

### 3.11 Advanced Sync option

The Advanced Sync Option allows you to set BOB to ignore the magnetometer reading time.

If the magnetometer clock cannot be set (for example, your setup might only allow for one-way communication), check the **Ignore Mag Clock** checkbox to activate Topside Timing mode. In this mode, BOB uses the time when the magnetometer reading is received and ignores the time on the magnetometer reading.

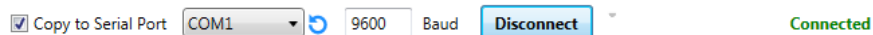
If Topside Timing is not activated and BOB detects magnetometer readings that are not synchronized with the selected time source, it will display a **Check Mag Synchronization** pop-up window.



### 3.12 Copy mag data to Serial Port

BOB can forward the raw ASCII data from the magnetometer to an available COM port for use by other programs.

To activate this option check the **Copy to Serial Port** checkbox, then select an available COM port, and click the connect button. BOB will copy the raw ASCII data from the magnetometer to the serial port.



The resulting data output will be formatted as shown below, beginning with the magnetometer data string, followed by the approximate X,Y position of the towfish (using the current layback setting).

The X,Y position consists of UTM coordinates, followed by UTM zone, and then Latitude and Longitude using WGS84):

```
*22.146/19:02:40.5 F:49602.082 S:199 D:-000.9m A:000.00m L0 0465ms Q:99      X:662219.7 Y:4796076.5 Z:17N x:-79.000044 y:43.300038
*22.146/19:02:41.5 F:49602.309 S:197 D:-000.9m A:000.00m L0 0465ms Q:99      X:662219.7 Y:4796075.8 Z:17N x:-79.000044 y:43.300032
*22.146/19:02:42.5 F:49601.271 S:199 D:-000.8m A:000.00m L0 0465ms Q:99      X:662219.7 Y:4796074.9 Z:17N x:-79.000044 y:43.300024
*22.146/19:02:43.5 F:49602.834 S:199 D:-000.9m A:000.00m L0 0465ms Q:99      X:662219.7 Y:4796074.2 Z:17N x:-79.000045 y:43.300018
```

All values are separated by spaces. Magnetometer data begins with \*, followed by date (Julian format) and time (UTC). There are 6 spaces preceding the X coordinate, reserved for error flags associated with magnetic field data.

For a full description of the magnetometer data string please refer to the magnetometer operating manual.

## 4 Collecting Data with BOB

Please review section 2.6 for an introduction to BOB Main window interface features.

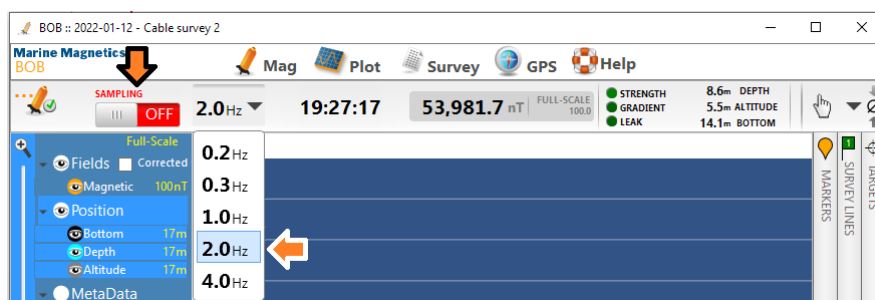
When all devices are connected, and magnetometer time is synchronized to the GPS or PC, BOB is ready to start collecting readings.

During data collection you will be able to see a plot for all the available signals and readings in the Plot area, a tabulated view of the readings below the plot, and real-time display of the time and magnetic field above the plot.

At any time during the survey, whether sampling is ON or OFF, you can add, edit, and remove survey lines and markers in the Main window as well Geo Plot window.

### 4.1 Start and stop sampling

Select the desired sampling rate from the drop-down list in the Main window, and click on the Sampling switch. You can change the sampling rate at any time, but you may need to restart sampling in some cases.



You should see the sampling indicator to briefly switch from 'OFF' to 'Starting', and then to 'ON'.

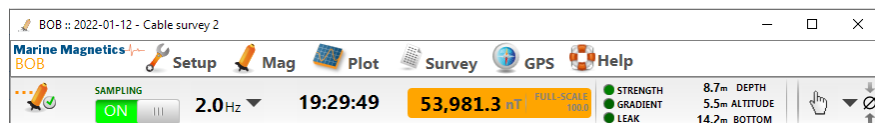
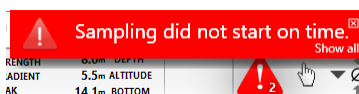


Figure 4-1: The state of magnetometer sampling is shown with a Green/Red indicator in the tool bar, which also acts as a switch.

If BOB may displays a warning: "Sampling did not start on time" but sampling starts immediately after that (as indicated by the ON status), you may ignore this warning. This may happen when you are starting sampling for the first time, and initial auto-tuning process may take up to 5 seconds before the first reading is received from the magnetometer.

If you see this warning and sampling indicator remains in the red / off state, check the magnetometer communication in the Setup Assistant.



**Note:** Sampling can also be started or stopped by manually sending a corresponding command to the magnetometer via the Terminal view, either in the Main window Terminal panel, or in the Setup Assistant's Connect Mag tab.



## 4.2 Magnetometer Status

The status bar summarizes the key parameters of the magnetometer's status and vertical position in the water column.

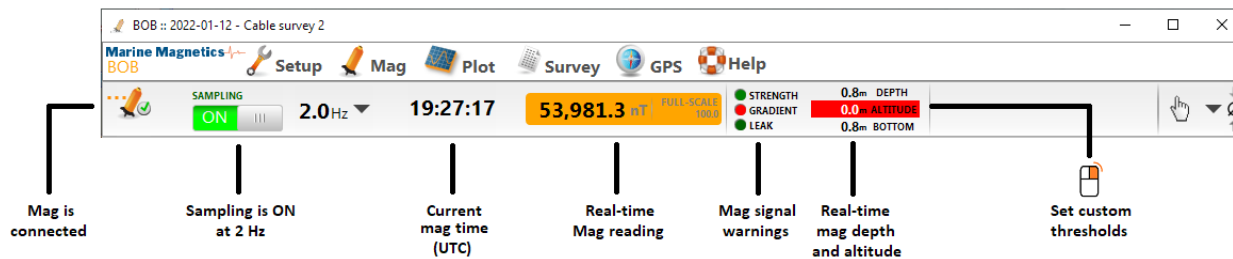


Figure 4-2: Magnetometer status bar shows a summary of all key survey parameters in real time

### Connection

The magnetometer icon will display a red "X" mark if the magnetometer is disconnected.

### Sampling

The switch also indicates the state of sampling. Operator is encouraged to monitor this indicator in case sampling gets stopped inadvertently, or stops for any reason.

### Current time

This is the magnetometer time estimated using the PC/System clock and the mag time offset from the latest reading received. Hover the mouse pointer over this area to display the synchronization options.

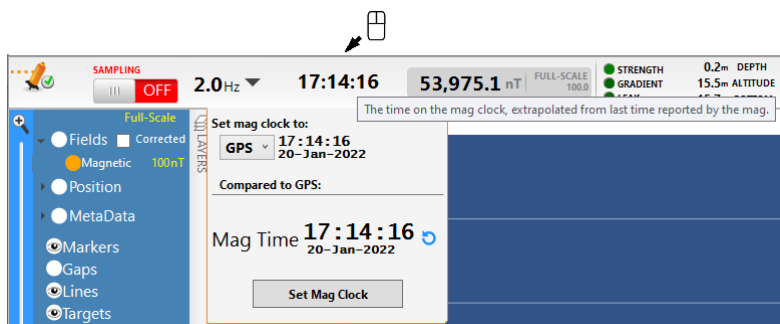


Figure 4-3: Time sync status can be checked and changed by hovering the cursor over the clock display

### Mag Reading

The latest magnetic field, or latest gradient reading if you are using a gradiometer.

### Warnings

Yellow and Red indicators alert you whenever signal strength is low, gradient condition, or leak detected. Yellow indicates a less-than-optimal value, while a red may require the user to take immediate action. A low signal strength combined with a gradient condition constitutes a bad reading, and BOB will ignore such readings during any analysis.

### Vertical position

The latest towfish depth and altitude above sea bottom readings are shown here. Bottom depth is computed as a sum of towfish depth and altitude, and will not be shown for magnetometers not equipped with an altimeter.

Custom thresholds can be set for towfish depth and altitude, enabling BOB to warn the operator whenever either parameter goes outside the optimal range. This is especially important when operating close to the bottom, or near the maximum depth rating of the towfish.

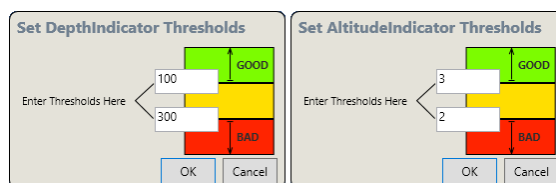


Figure 4-4: Right-click on either Depth or Altitude in the Status bar to set custom thresholds.

## 4.3 Magnetometer Diagnostic Information

**Magnetometer Status panel** shows a summary of current settings, which may be helpful during troubleshooting.

The Status can be accessed from the Main window under **Mag** menu > **View Mag Status Panel**, and also in the Setup Assistant above the magnetometer terminal view.

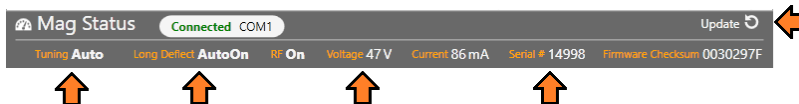


Figure 4-5: Mag Status Panel shows a summary of mag configuration

Be sure to click the Update button to get the latest values for key parameters are highlighted in the figure.

Consult your magnetometer operation manual for details.

## 4.4 Towfish Attitude Indicator

For the magnetometers equipped with an IMU, such as the SeaQuest2 and VectorMag, the real-time orientation of the towfish can be monitored using the Attitude Indicator display, found in the **Mag** menu > **Attitude Indicator**.

These values represent the Euler angles reported by the integrated IMU, and include the gyro corrections.

The attitude indicator is designed to represent the “driver’s seat view” of the horizon, similar to that of the aircraft attitude indicator.

Please refer to the magnetometer operating manual for details on the specific IMU and coordinate system / axis convention used by the IMU.

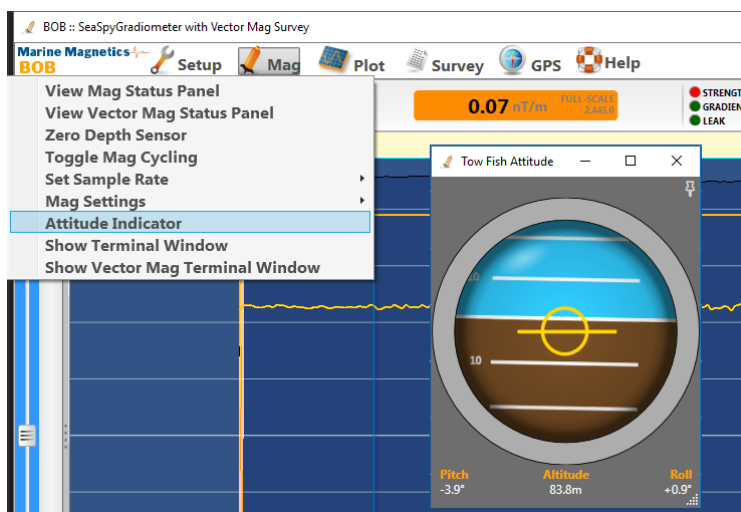


Figure 4-6: Towfish Attitude Indicator

## 4.5 Profile Plot Features

Earlier in Section 2 the general layout of Profile Plot in the Main Window was presented.

Described below are several features that may help with data analysis.

### 4.5.1 Split View profile presentation

Split View allows the Profile Plot to be divided into two panes: the Latest Readings (Real-Time) and Past Readings, by dragging the divider from the right edge of the plot.

Each pane can have its own horizontal (time) scale, but both will have the same vertical scale.

Latest Readings pane is limited to a maximum of 3 minutes of the latest data, while Review pane can be set to any length, by either dragging the horizontal slider, or selecting one of the available preset spans using the mouse right click.

The time interval shown in the Review pane will be highlighted on the timeline below in cyan.

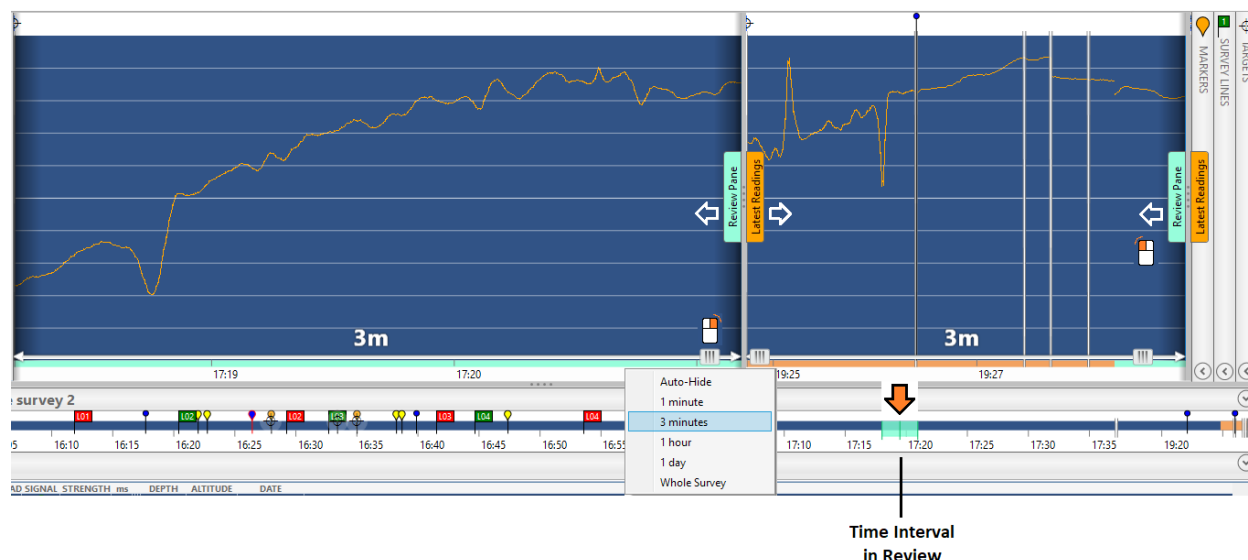


Figure 4-7: Customizing the Split View presentation on Profile Plot

### 4.5.2 Cursor Panel

Cursor panel adds a quick summary of the readings corresponding to the cursor's position on the plot.

Right-click anywhere on the blue area of Profile Plot, and select Toggle Cursor Panel.

Repeat the steps to close the Cursor Panel.

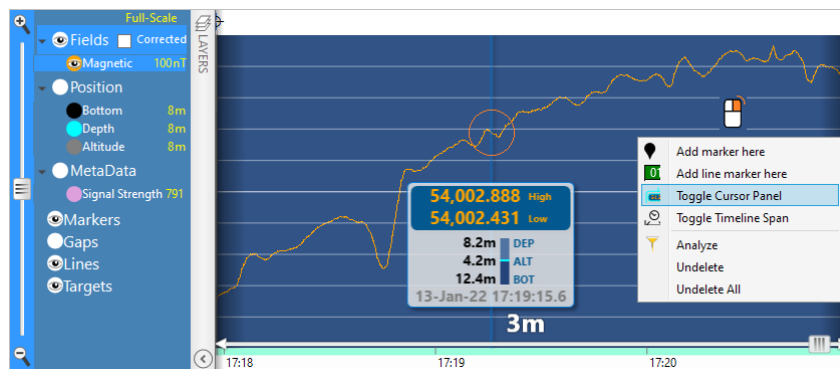


Figure 4-8: Profile Plot cursor panel shows readings at the cursor position

### 4.5.3 Selecting a range of profile data

To select a range of profile data, use Alt + mouse.

Right-click on the selection to open a context menu, containing several options such as mark survey line or show summary analysis (available with BAM activation).

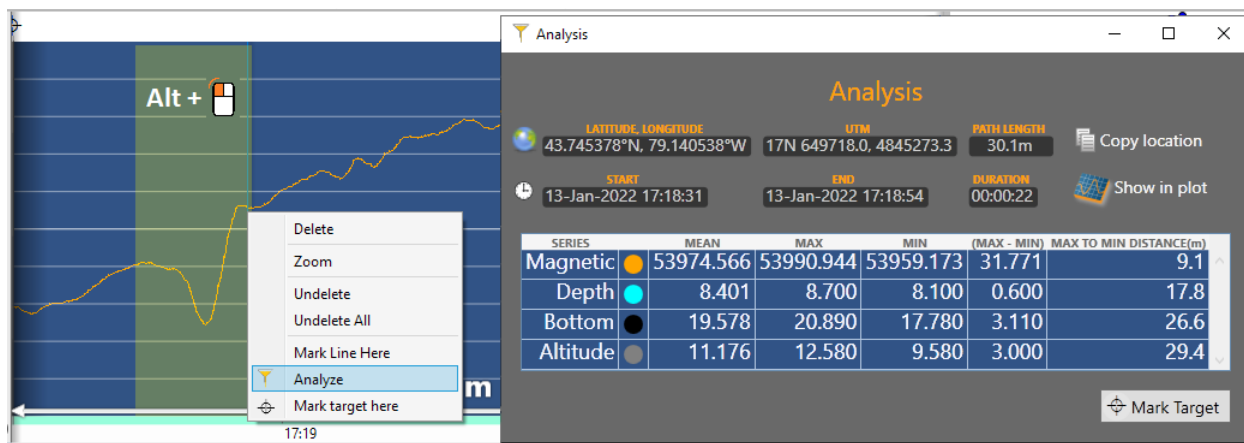


Figure 4-9: Selecting a range of data using Alt+mouse allows several operations including summary analysis (a BAM feature)

## 4.6 Markers

Markers are a useful tool during data collection as well as post-processing.

A marker in BOB represents a moment in time or a specific reading.

Use markers to keep survey notes along the way, or label any of the following:

Anomalies	Magnetic anomalies, points of interest along the survey path, or any other anomalies (e.g. altitude, depth) that you wish to make note of.
Events	Operational notes, retrieval and re-deployment, or passing objects that could cause an anomaly (buoys, docks, known obstacles, other vessels etc.) Mark those to avoid misinterpreting them later as true anomalies.
Changes in survey parameters	BOB creates automatic markers each time the user changes the sampling rate or the layback. You may also want to mark major changes in survey speed or depth, wind, sea state etc. Any survey notes that could be useful to know for the data analyst when interpreting the data.

**Important:** A marker is a point in time along the survey path, representing a specific magnetometer reading or a specific anomaly. As such, its geographic coordinates are determined by the layback, as it represents the position of the towfish at a specific point in time. Changing the layback for the past data will also affect the coordinates of all markers on that stretch of survey, but will not offset the markers relative to original anomalies or specific readings they identify. This feature of markers can be used to determine and apply lag correction by fine-tuning the layback. See Section 3.5 Layback Correction for details.

### 4.6.1 Placing markers

You can place a marker at any time, anywhere along the profile or the survey path on the GeoPlot.

Simply **right-click on the profile** (or path location) and select **Add marker here** from the menu.



Figure 4-10: To add a marker to the profile, right click on the specific point and select “Add marker here”. Assigning colors to marker sets helps distinguish them on the timeline, profile and map view.

The *Add Marker* dialog will ask you to enter a label (or name) for the marker, and select which group or marker set it should be listed under. By default, all markers will be added to the *User Markers* set. You can create your custom sets and assign colors to each set to help differentiate markers on both the profile and the GeoPlot. Each set can be shown or hidden as needed.

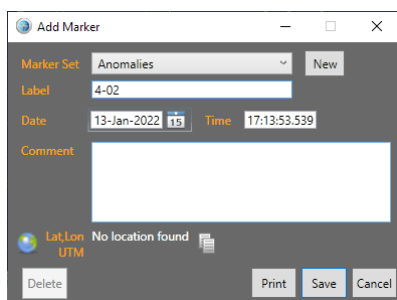


Figure 4-11: Add Marker dialog allows you to enter a label as select the marker set. You can also edit the exact time associated with the marker

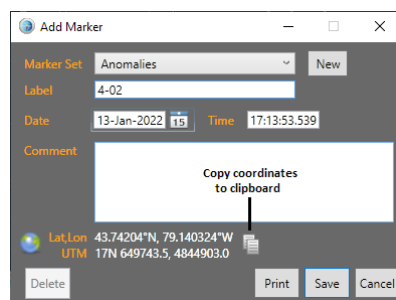


Figure 4-12: After the marker has been created, BOB will assign coordinates to it based on layback. These can be copied to the clipboard if needed

You will see your newly-added marker on the Profile, in the Marker List panel to the right of profile, on the survey timeline below the profile, as well as on the GeoPlot.

You can access the marker properties by right-clicking on the marker flag above the profile or on the GeoPlot, or in the list.

### 4.6.2 Opening a marker

You can open the marker's location on the profile by right-clicking the marker on the list, and selecting **Goto** option.

To move a marker, simply move its flag on the Profile, or the GeoPlot.

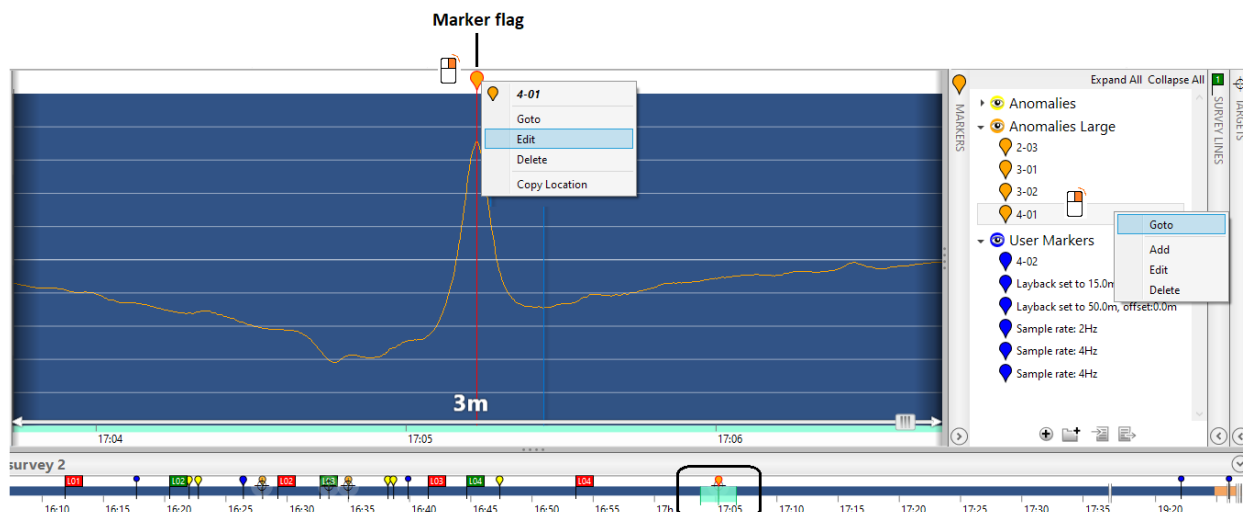


Figure 4-13: Right-click on the listed marker as select Goto to open the corresponding profile interval

### 4.6.3 Managing the marker list

Marker list can be used to organize the markers, move them between marker sets, export the list to a file, or import marker list from a file. This allows you to keep more than one list of markers (helpful during post-processing), or transfer markers from another computer. You can also save the list as backup in case you accidentally delete or modify markers.

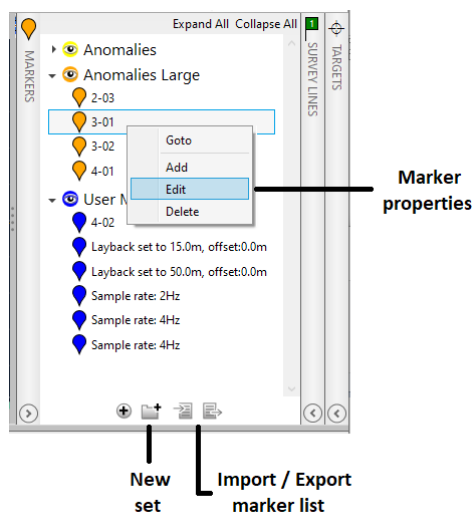


Figure 4-14: Marker List panel

**Hint:** Markers can be used to determine the exact layback during post-processing, since they represent mag anomalies rather than specific coordinates. If the same anomaly is encountered on two or more adjacent survey lines with opposite headings, placing markers on the actual magnetic anomalies in profile view will reveal the location of anomaly peaks on the GeoPlot. If an offset between markers is seen on the map, offset may indicate a slight error in layback. Correcting this layback error will improve the data quality and anomaly alignment on the map view.

## 4.7 Survey guide grid design

Please review section 2.8 Geo Plot Window for an introduction to GeoPlot interface features.

### 4.7.1 Guide Grid overview

The tool for creating grids of guide lines is found in the drop-down tool menu in the GeoPlot.

**Guide Lines** is the term used in BOB for planned survey lines. The term Survey Lines refers to user-marked stretches of covered survey path that represent completed lines. Refer to section 5 for details on Survey Lines.

Use the guide grid tool to draw a survey outline. Note the **Rotate** button in the center, and **Resize** button in the bottom-right corner. Click the **Accept** button once the shape and orientation of the survey block is approximately correct.

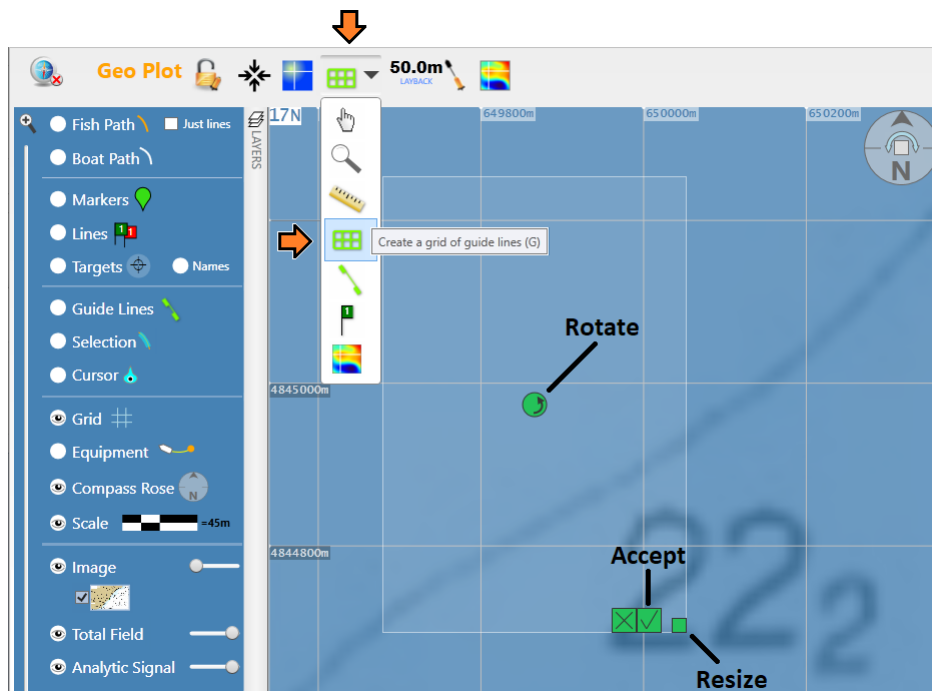


Figure 4-15: Use the Guide Grid tool to draw an outline of your survey block

After you click **Accept**, the **Configure Guide Grid** dialog will open, where you can customize the coordinates of the origin, the number and spacing of both lines and tie lines, as well as the bearing. By default, BOB will use 10m line spacing, and North-South orientation, with the origin in the North-West corner of the block.

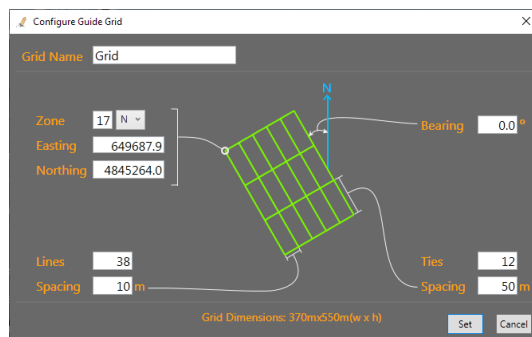


Figure 4-16: Configure Guide Grid dialog offers options to customize line orientation and spacing, as well as exact origin location.

Leaving the settings unchanged, you will see a guide grid similar to the one below.

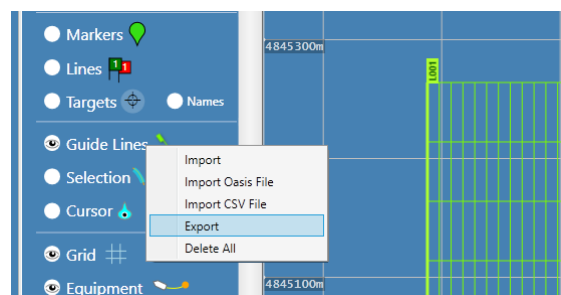


Figure 4-17: Default Guide Grid settings use North-South line orientation with 10m line spacing, and the origin in the NW corner.

To edit the guide grid, right-click on the line number label while having the Guide Grid tool cursor selected, and select Edit.

#### 4.7.2 Save guide grid to a file, or import one from file

The guide line grid can be saved to a file with XML extension if you right-click on the Guide Lines in the Layers panel, and select Export.



The Import option will import an XML file created by BOB.

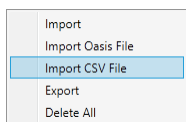
You may choose to have several guide line grids, for different sections of the survey.

The Edit Guide Grid dialog offers an option to give unique names to guide grids.



### 4.7.3 Import survey guide lines from 3<sup>rd</sup> party software

BOB supports two basic (ASCII) text formats for importing survey guide lines from a file: Generic CSV file, and Oasis motaj XYZ line file.



#### 4.7.3.1 Import guide lines from a generic CSV file

A generic CSV file must contain a header row as shown below (without spaces), and must be formatted as follows:

```
Line_Name,Start_Latitude,Start_Longitude,End_Latitude,End_Longitude
L001,43.693011,-79.247878,43.703941,-79.229123
L002,43.692890,-79.247743,43.703819,-79.228989
L003,43.692768,-79.247609,43.703698,-79.228855
L004,43.692647,-79.247475,43.703577,-79.228721
Etc.
```

Line name must start with a letter, and may contain 1-4 digits

#### 4.7.3.2 Import guide lines from an Oasis montaj XYZ line file

Oasis montaj XYZ line files do not require a header row, but must be formatted as follows to be imported into BOB, with line name, followed by starting point and end point coordinates on separate lines:

```
L001
43.693011, -79.247878
43.703941, -79.229123
L002
43.692890,-79.247743
43.703819,-79.228989
L002
43.692768,-79.247609
43.703698,-79.228855
```

### 4.7.4 Add a background map or image

Having a background map, chart or satellite image may simplify the job of planning a survey grid. If you have a marine chart or map of the area in GeoTiff format, you may add it as a background image by right-clicking on either the Image group in the Layers panel, or anywhere on the map itself. **Note** that BOB only accepts GeoTiff images saved with WGS84 UTM projection, saved as a single TIFF file.

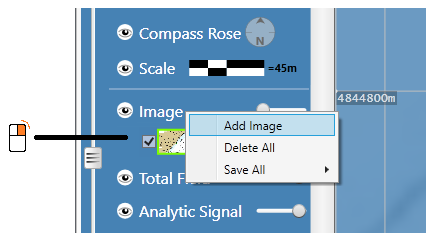


Figure 4-18: Add a background map or image, provided it is saved as GeoTiff with WGS84 UTM projection.

## 5 Importing survey data into BOB (e.g. AUV, UAV or Base station)

BOB allows previously-collected survey data to be imported into a blank survey for AUV or UAV survey types.

The following AUVs and UAVs are currently supported:

- L3 Iver 2 and Iver 3 AUVs
- Teledyne Gavia AUV
- GEM Systems DRONEmag (GSMP-35)
- GEM Systems Overhauser base station (GSM-19)

The vehicle type will be automatically recognized by BOB based on the file content.

### 5.1 Importing AUV survey data into BOB

AUV data can be imported either during the initial creation of a new blank survey, or from the Main Window using the menu Survey > Import AUV.

The menu method allows multiple files to be imported (e.g. from several consecutive surveys in the same area).

NOTE: When importing data from multiple files, BOB requires that you import them in chronological order.

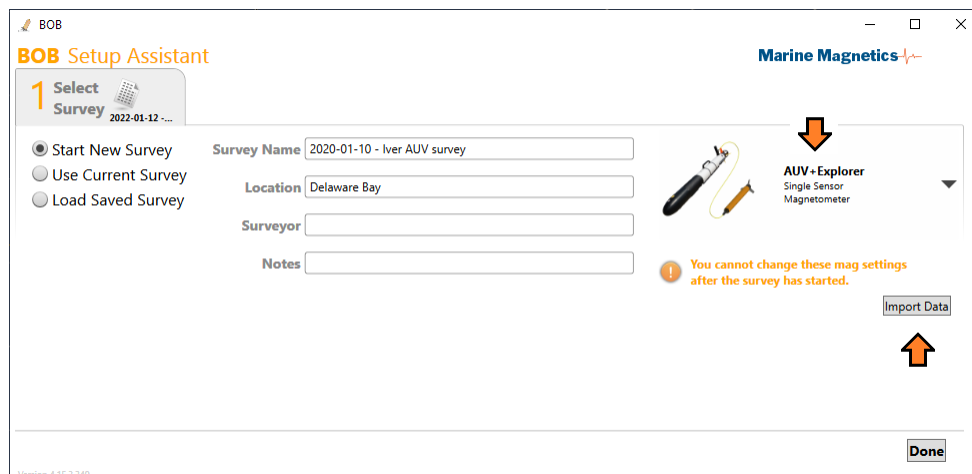


Figure 5-1 - To import AUV data while in the Setup Assistant, use the Import Data button below the magnetometer type

Once imported, an AUV or UAV survey can be processed or inspected the same way that a towed magnetometer survey would.

Please refer to section **3.5.3 AUV layback determination** for details on layback computation in AUV-towed surveys.

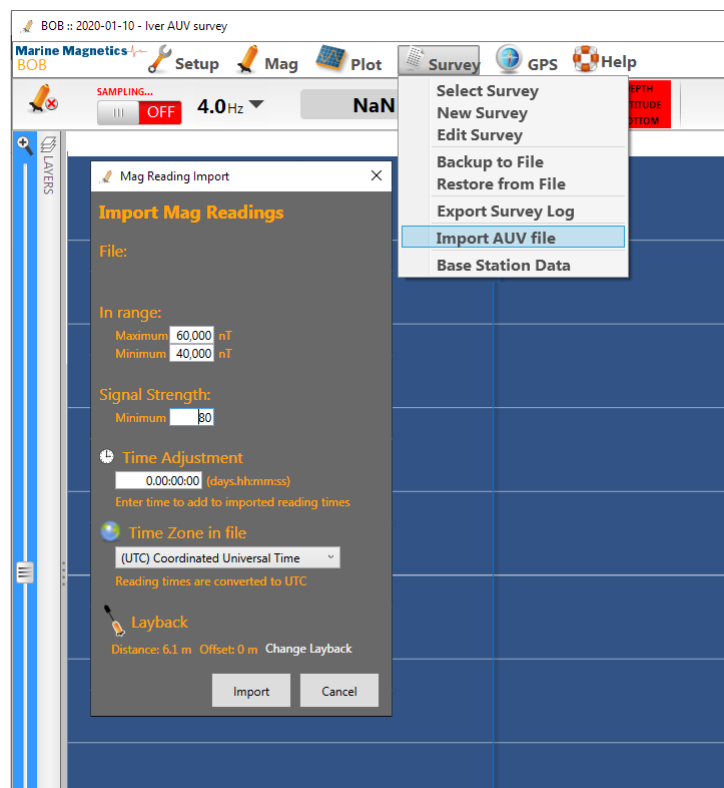


Figure 5-2 - To import AUV data while in the Main Window, use the menu Survey > Import AUV file.

This method allows multiple files to be imported, in chronological order.

Recommended filter settings are shown in Table 5-1. Important parameters are marked with (\*).

Table 5-1 - Data Import filter settings for AUV-towed magnetometer data

Import filter	Recommended setting
Maximum Magnetic Field	60,000 nT is the default setting. Adjust if needed.
Minimum Magnetic Field*	Use this parameter to eliminate unwanted drop-outs and bad readings (e.g. values corresponding to AUV being near the support vessel or launch dock) 20,000 nT is the default setting, which may be too low for most situations. Use the lowest expected valid field value for the survey area. You may need to preview the data first, and determine the lowest valid total field value. E.g. 46,000 nT for most mid-latitude locations.
Signal strength*	A minimum value of 80 is recommended for Explorer magnetometer. Use a higher value if too many bad readings get imported on the first attempt.
Time Adjustment	Do not modify unless you suspect a time offset relative to UTC time in the survey data.
Time Zone in file	Do not modify unless you have a specific reason to do so.
Layback*	6.1m is the default setting for the Iver AUV towing an Explorer with a 5m tow cable. Modify if using a different AUV or tow cable configuration.

## 5.2 Importing Base Station data into BOB

The import process for base station files is similar to that for AUV data, with the exception of the Layback setting.

For details on Base Station data formats and import steps, please refer to section **6.3 Base Station Correction**.

The following base station data formats are currently supported in BOB:

- Sentinel and Sentinel2
- GEM Systems Overhauser base station (GSM-19)
- Intermagnet IAGA observatory formats (<https://www.intermagnet.org/>)
- Generic CSV data format, consisting of the following columns: Date, Time, Magnetic\_Field

## 5.3 Importing GEM Systems DRONEmag data into BOB

The import process for GEM DRONEmag data is similar to that for AUV data. Flight data are downloaded from the UAV/drone, and then imported into a survey in BOB as part of post-processing. Multiple flight log files can be imported into the same BOB survey, provided it is done in chronological order.

First a blank new survey is created in BOB, with a DRONEmag magnetometer type selected. See Figure 5-3.

If the UAV/drone is equipped with an auxiliary altimeter (e.g. laser altimeter), select the corresponding option at this time.

There are two options for importing the flight data files:

- Using the Import Data button in BOB Setup Assistant, as seen in Figure 5-3
- Using the Import AUV file option in the Survey menu, as seen in Figure 5-2

In both cases, the Mag Reading Import dialog will be shown, with options for selecting the source flight log file, and specifying the import filter parameters.

Determining the optimal filter settings may require you to import the data first into a temporary survey and review it carefully; and then create a new BOB survey into which data can be re-imported using specific filter settings for cleaner data.

Recommended filter settings are shown in Table 5-2. Important parameters are marked with (\*).

The screenshot shows the 'BOB Setup Assistant' window with the '1 Select Survey' tab active. Under 'DRONEmag D...', the 'Start New Survey' radio button is selected. The 'Survey Name' field contains 'DRONEmag Demo Survey - FL 2022', 'Location' is 'Florida RC club field', and 'Surveyor' is empty. There are empty fields for 'Start Date' and 'End Date'. The 'Readings' section has a 'Notes' text area containing: 'GSMP-35U DRONEmag', 'DJI M600 drone', 'Sentinel2 base station mag as diurnal reference', '5m line spacing, 7m alt (drone altitude)', and '5 test targets laid out across RC flying field'. On the right, a drone icon is shown next to 'GEM Drone Mag' and 'GEM Single Sensor Magnetometer'. Below this, the 'Altimeter' section has a yellow background and 'Yes' is selected. A warning icon and text state: 'You cannot change these mag settings after the survey has started.' An 'Import Data' button is at the bottom right, and a 'Done' button is at the very bottom right. The version 'Version 4.16.1.422' is in the bottom left corner.

Figure 5-3 - GEM Drone Mag device type is used when importing UAV/drone flight data into BOB.

**Mag Reading Import**

**Import Mag Readings**

File:  
C:\SURVEYS\Airborne\_220914142826-FL05.txt

In range:  
Maximum: 60,000 nT  
Minimum: 46,000 nT

Signal Strength:  
Minimum: 90

Time Adjustment  
0.00:00:00 (days.hh:mm:ss)  
Enter time to add to imported reading times

Time Zone in file  
(UTC) Coordinated Universal Time  
Reading times are converted to UTC

Layback  
Distance: 0.5 m Offset: 0 m Change Layback

Import Cancel

Figure 5-4 - Data import filter settings specific to UAV/DRONEmag data

Table 5-2 - Data Import filter settings for DRONEmag flight data

Import filter	Recommended setting
Maximum Magnetic Field	60,000 nT is the default setting. Adjust if needed.
Minimum Magnetic Field*	Use this parameter to eliminate unwanted drop-outs and bad readings (e.g. values corresponding to UAV in landed position) 20,000 nT is the default setting, which may be too low for most situations. Use the lowest expected valid field value for the survey area. You may need to preview the data first, and determine the lowest valid total field value. E.g. 46,000 nT for most mid-latitude locations.
Signal strength*	A minimum value of 90 is recommended for the GSMP-35 magnetometer. Use a higher value if too many bad readings get imported on the first attempt.
Time Adjustment	Do not modify unless you suspect a time offset relative to UTC time in the survey data.
Time Zone in file	Do not modify unless you have a specific reason to.
Layback*	0.5m is the default setting for UAV/DRONEmag with a sensor suspended on a tether below. Modify if using a different sensor mount or configuration.

## 6 Data Processing with BOB

BOB offers the following data processing tools:

- Survey line marking
- Anomaly marking (using Markers)
- Deleting bad or unwanted readings
- Layback fine-tuning (lag correction)
- Heading bias correction
- Data export in customizable CSV format

With the additional BAM activation, the following features are added:

- Summary analysis for a selected range of profile data
- Total Field surface plot generation
- Analytic Signal (Total Gradient) surface plot generation (derived from a Total Field grid)
- Target marking and export
- Plot data export in grid exchange (GXF) and GeoTiff formats

### 6.1 BOB Workflow Overview for Data Processing

Key steps for setting up BOB for data collection:

- Mark Survey Lines on the completed survey path in GeoPlot to exclude unwanted turns and transits
- Review each marked line in Profile view to identify and remove bad readings
- Use markers to identify clear anomalies in profile view.  
Hint: using a systematic naming scheme may help keep track of anomalies on a list. (e.g. 02-01 may represent line 2 anomaly #1)
- Separate anomalies into types, as needed, using marker sets (e.g. Large vs Small anomalies)
- Identify possible false anomalies resulting from towfish coming too close to the bottom, looking for matching peaks in magnetic field and bottom topography
- Inspect the positions of anomaly markers on the GeoPlot view, looking for possible correlations between adjacent lines
- Apply layback correction using clear anomalies corresponding to the same source, but collected on lines covered in opposite directions. (i.e. adjust layback to make such anomalies match)
- Import base station data, if available, and apply base station correction
- Create magnetic and gradient maps using BAM (if activated)
- Mark targets over anomalies of interest.  
Targets will contain key statistics of the each anomaly profile (magnitude, length, altitude, etc.).
- Save resulting maps, export lists of Targets and Markers
- Save backup copies of markers, survey lines and targets lists, as well as the entire survey

## 6.2 Survey Lines

Marking the survey lines on the completed survey path is usually the first step of preparing the dataset for analysis.

A survey line in BOB is an interval of time, and is marked with start and end flags on both the Profile and the GeoPlot.

The green flag denotes the start of a line, and the red flag denotes its end.

Survey Lines can be marked in real-time during data collection, but are normally marked during post processing.

Survey Lines are distinct from Guide lines used to design a survey block and follow the grid.

Similar to markers, the coordinates of the start and end points of a survey line are dependent on the layback, because they identify specific magnetometer readings, not specific locations. Changing the layback for the survey during post-processing will also change the coordinates associated with the start and end points of survey lines.

### 6.2.1 Marking a survey line in Profile view

Marking survey lines is easiest if you have both Profile and GeoPlot windows open side by side.

There are several ways to mark survey lines in BOB. Please refer to the GeoPlot section for alternative ways.

To mark a survey line in Profile view, start by selecting a time interval on the profile that corresponds to the right location stretch on the map view, then right-click anywhere on the profile area and select “Add line marker here”.

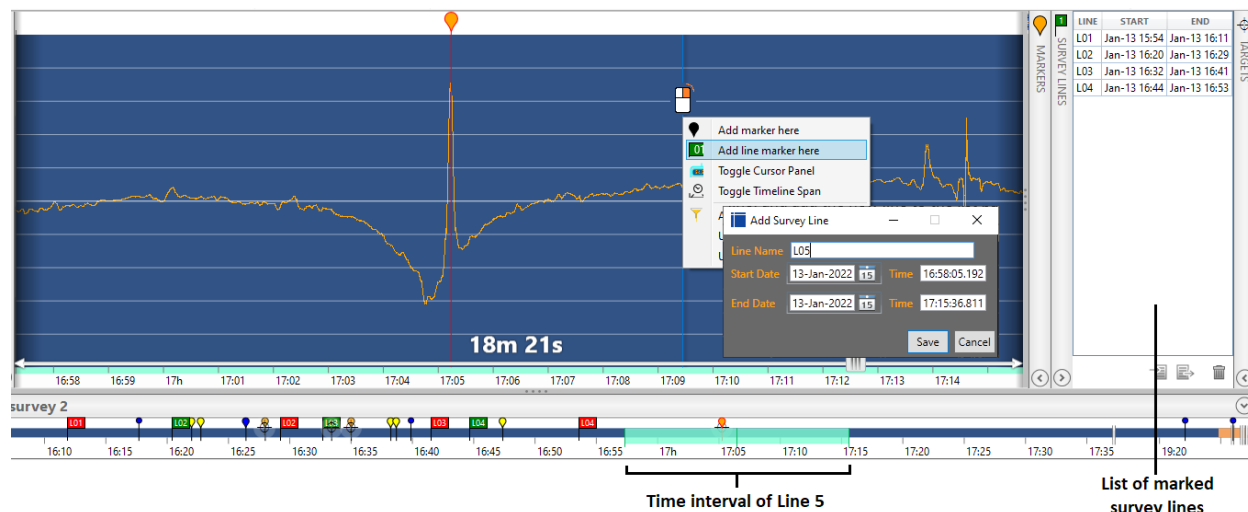


Figure 6-1: To mark a new survey lines, zoom to the corresponding time interval, and right-click on the profile area to open a menu

BOB will mark the entire visible area as a line, and add the new line to the list panel. You can adjust the position of the start and end flag simply by moving them with a mouse.

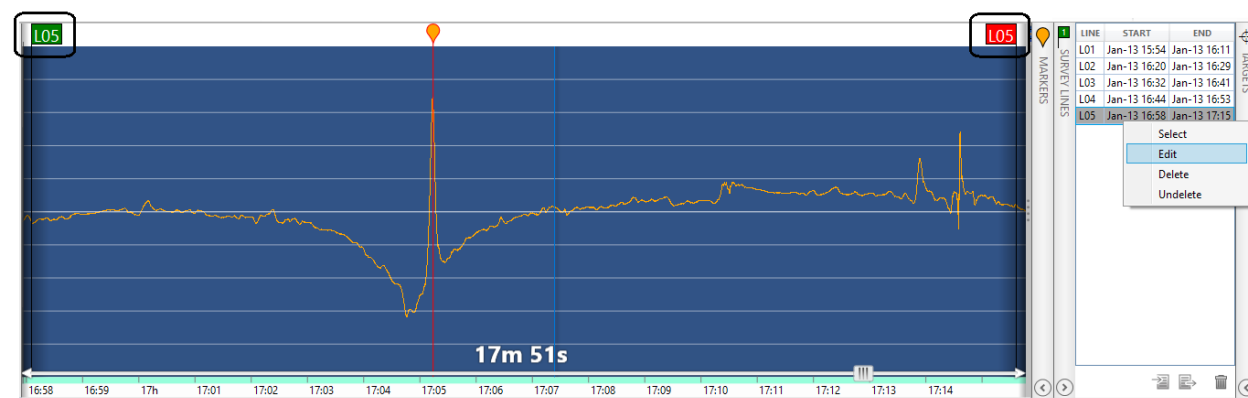


Figure 6-2: Selecting a survey line from a list will open it in the Profile view.

An alternative way to mark a survey line is to make a selection on the profile (using Alt+mouse), and then right-click to open the menu.

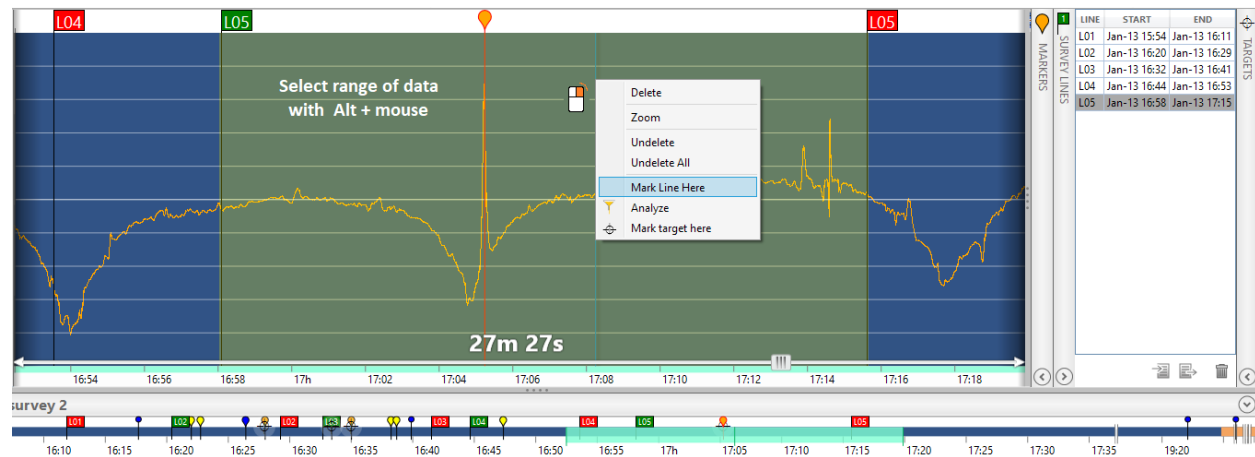


Figure 6-3: You can also mark a survey line base on a range of profile data, using Alt+mouse to select.



## 6.2.2 Marking a survey line on the GeoPlot

Having the GeoPlot window open while marking survey lines is the easiest method. You can use it to verify that your profile selection matches the actual survey path stretch. Alternatively, use the line marking tool in the drop-down toolbar to mark a survey line right on the GeoPlot. Please refer to section 6.2.3 for the fastest method of cutting the survey path into individual lines.

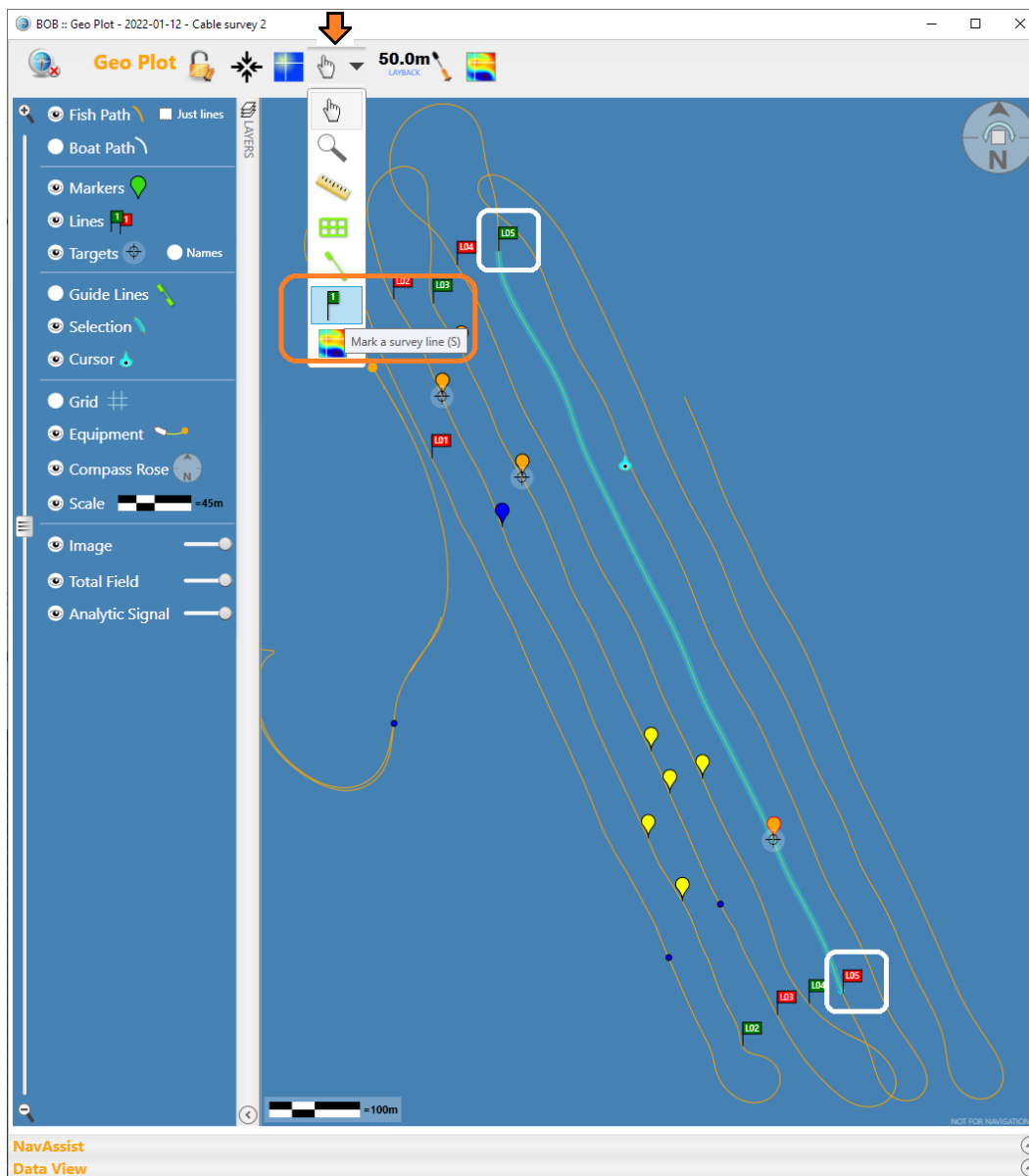


Figure 6-4: GeoPlot toolbar offers a line marking tool. Use it to place start and end flags right on the survey path. This can be done during data collection and during post-processing.

**Note:** Survey lines cannot overlap. If your selection includes a start or end flag from another marked line, you will not be able to define a new survey line unless you adjust the selection.

### 6.2.3 Marking survey lines using a marquee selection box and automatic numbering

Beginning in December 2022, BOB allows automatic line marking within a selected area on a GeoPlot, as well as automatic re-numbering for a list of marked lines. Follow the steps below to use the automatic line cutting tool.

1. If the survey lines aren't oriented N-S or E-W, use the North Arrow tool to rotate the map view such that survey lines are oriented parallel to the sides of the GeoPlot window.
2. Select the automatic line cutting tool from the drop-down tool menu.
3. Draw a rectangular marquee selection box over the survey area, to include all the survey lines but exclude the turns and unwanted segments of survey path.
4. In the Auto-label dialog prompt, specify the first number, and prefix if needed. Click OK to complete.

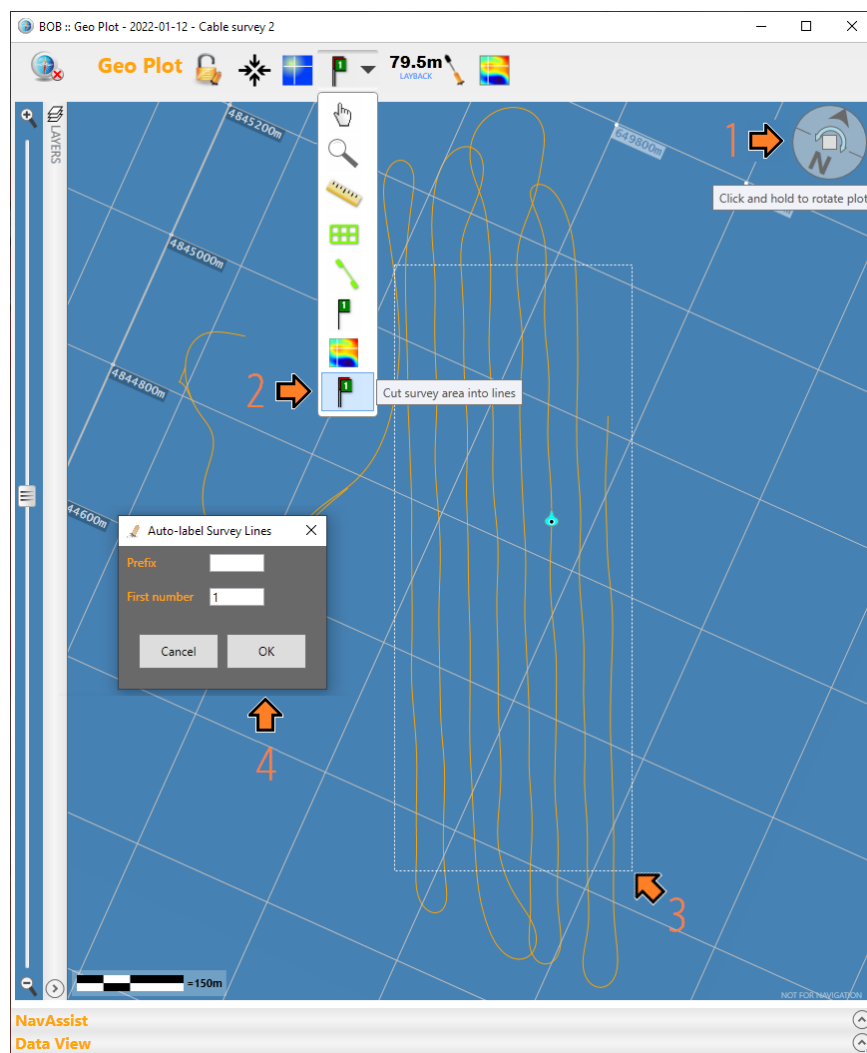


Figure 6-5: Automatic line cutting tool places line start and end markers where survey path intersects the box drawn by the user, and assigns line numbers

BOB will automatically place survey line start and end markers on the survey path where it intersects the drawn box, and assign line numbers in chronological order. Pre-existing marked lines will be skipped automatically.

Use the Survey Lines list panel in the main BOB window to review the list of newly-created survey lines.

Automatic line numbering may create several short segments wherever irregular survey path crosses the drawn box boundary.

Such short line segments can be deleted from the list manually, and the list re-numbered again to start from the desired starting number.

Including a prefix when assigning numbering can be helpful to identify individual survey blocks.

(e.g. A001,A002,..... B001,B002, ...)

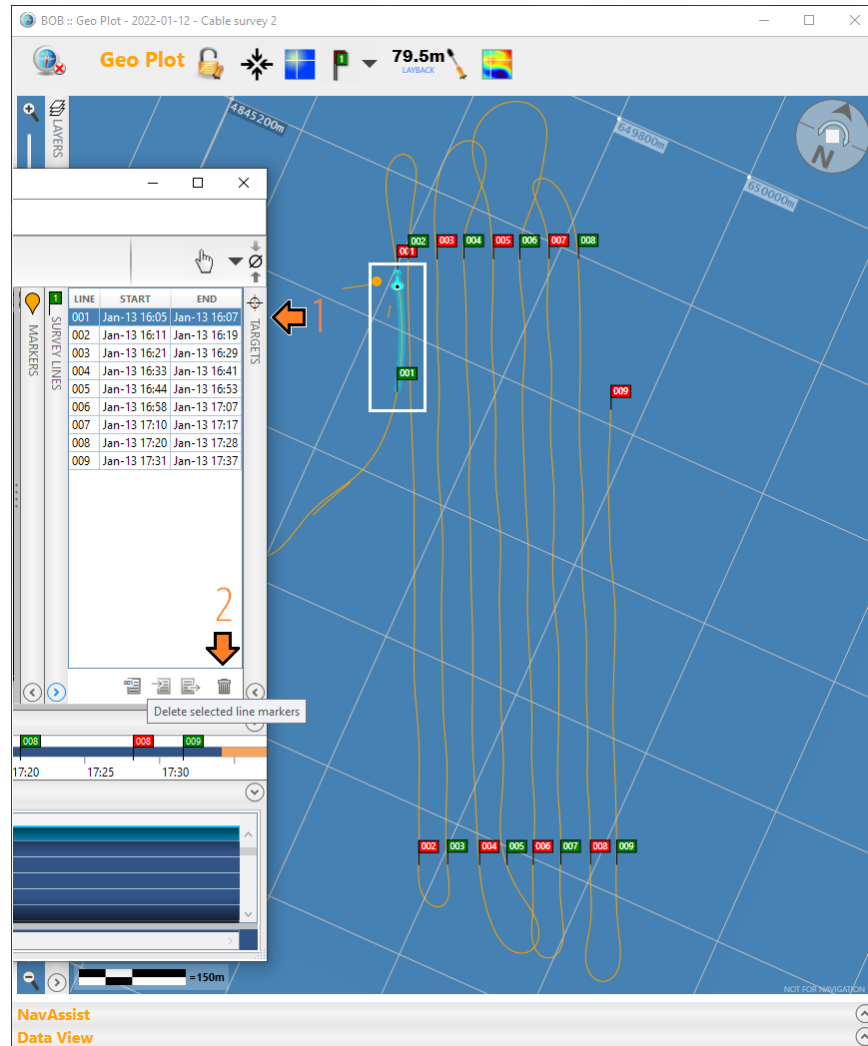


Figure 6-6: Review the list of created lines to look for short irregular segments that may need to be deleted

After deleting unwanted line segments, you may need to re-number the list from the first number.

Select the lines you wish to be re-numbered and click the Re-number button found near the bottom of the list panel.

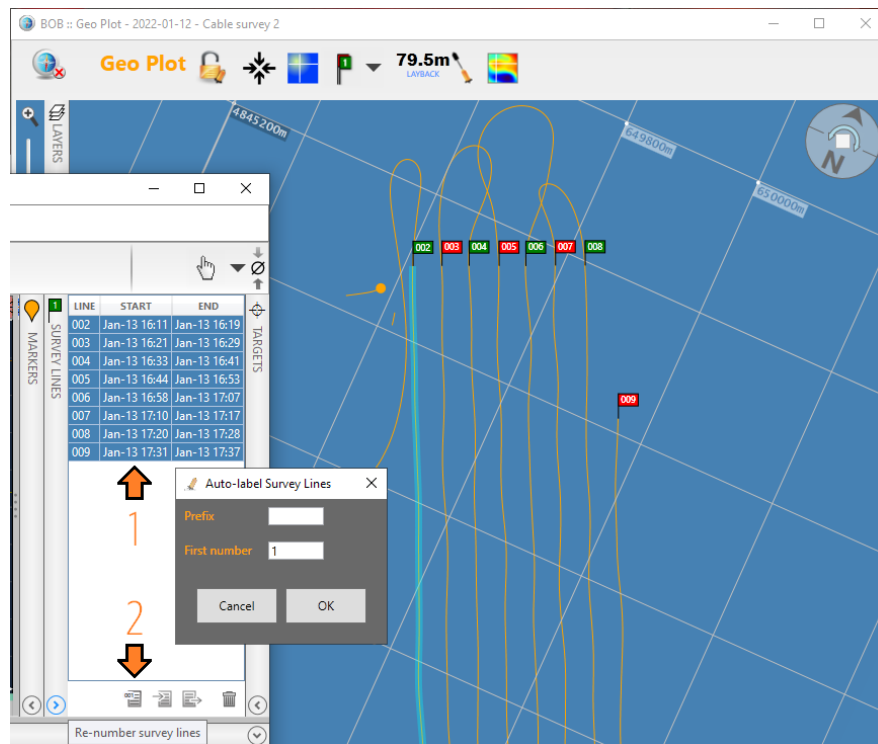


Figure 6-7: If needed, re-number the selection of good lines using the dedicated button found near the bottom of list panel

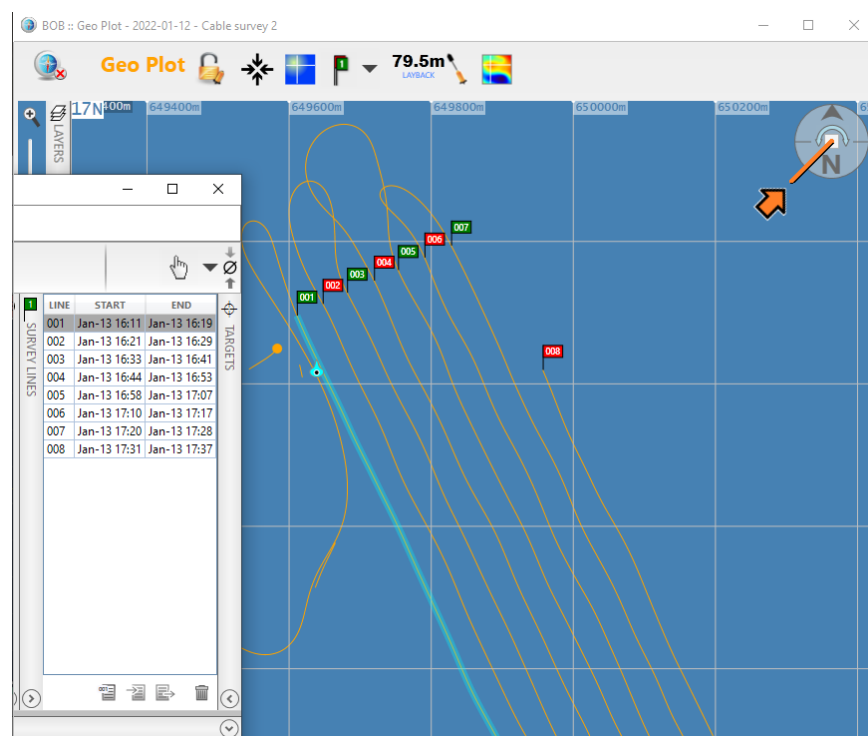


Figure 6-8: Return GeoPlot to the default North-Up orientation by clicking on the center of the compass tool

### 6.2.4 Marking survey lines during data collection

GeoPlot allows you to mark start and end points of the current survey line using keyboard shortcuts:

**S** (or **L**): Mark Start of new line here

**E** (or **R**): Mark End of new line here

For a list of all keyboard shortcuts in BOB, refer to Appendix G. Mouse and Keyboard Shortcuts.

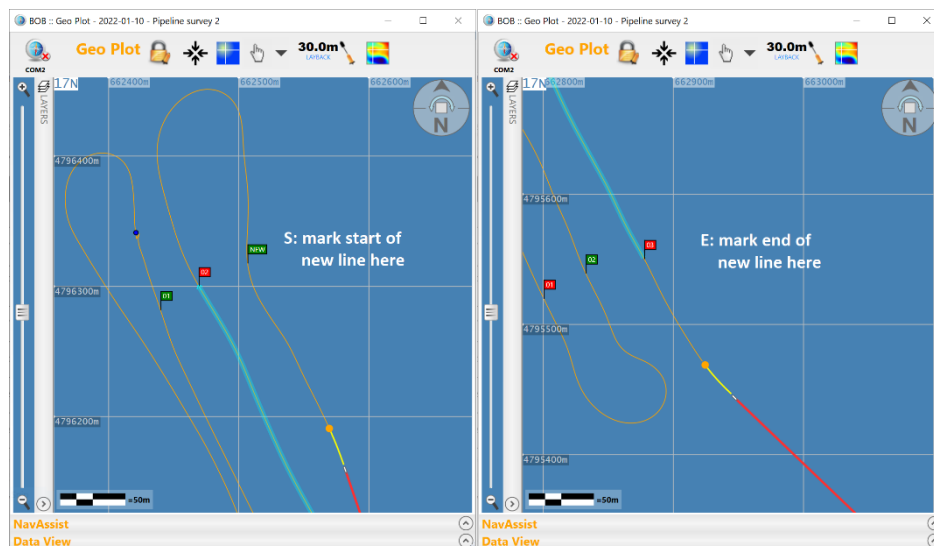


Figure 6-9 - Survey Lines can be marked in real time during data collection using keyboard shortcuts.

### 6.2.5 Managing the list of survey lines

Once you have your survey lines marked, you can open any line in profile quickly simply by selecting it on the list.

Each line's properties can be edited by selecting the line on the list, or by manually moving the start and end flags on either the profile or the GeoPlot.

The list of survey lines can be exported to a file, or imported from a file. This can be useful during post processing, or when transferring line sets between computers. Saving a list to a file can also serve as backup, in case you accidentally delete a survey line.

**Hint:** You can have more than one list of survey lines for the same survey, with each set corresponding to different parts of the survey, or even to specific anomalies. Switch between sets of survey lines by exporting your current list and importing a different one from a file.

## 6.3 Base Station Correction

BOB allows base station data to be imported and applied to the survey readings. Base station data can be a file from the Marine Magnetics Sentinel base magnetometer, or from the Intermagnet network of magnetic observatories. BOB also accepts basic CSV file format when importing base station data, allowing any magnetometer to be used as a base reference.

Base Station correction allows you to eliminate the effects of background changes in the overall magnetic field, so as to highlight or reveal the magnetic properties of the area under survey. Much like tide correction for bathymetric or hydrographic surveys, the effect of magnetic base correction varies each day, and is more valuable when background variation is high.

In order for base station correction to be effective, the base station must be located close enough to your survey site as to be exposed to the same exact background magnetic field variation, and to be representative of the geological setting. The greater the physical distance and the more dissimilar local geology between the survey site and observatory site, the less representative will base station be for your survey.

For optimal effectiveness, the base station should be located within a few kilometers of your survey area, either on land or underwater, and must be away from any sources of human-caused or interference, traffic, or industrial infrastructure. For specific recommendations on Base Station deployment, please refer to the **Sentinel2 Operating Manual**.

### 6.3.1 Importing Base Station data into BOB

Base station data import dialog is found in the Survey menu.

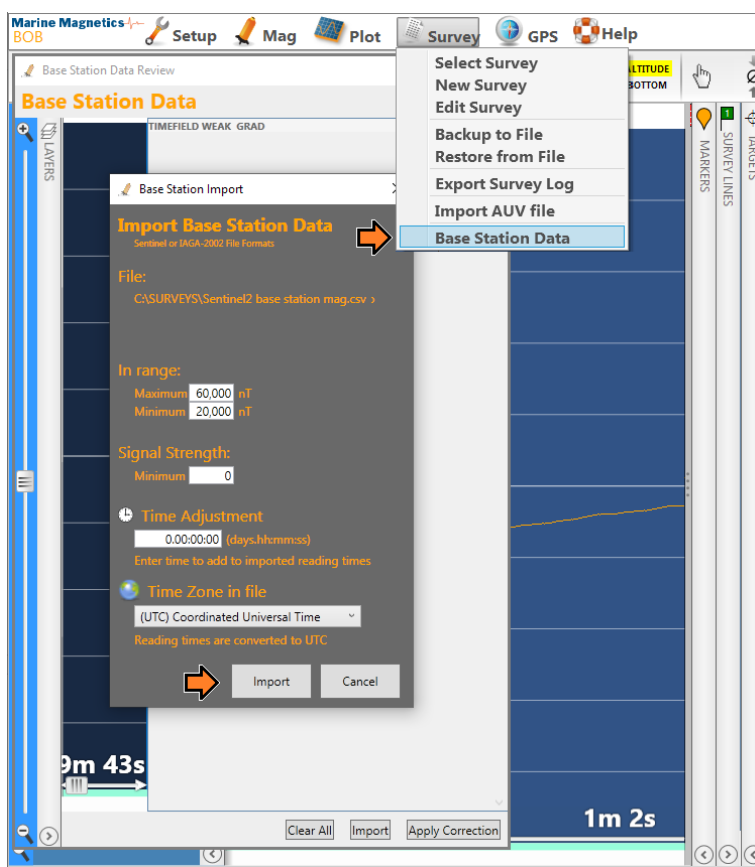


Figure 6-10 - Base Station data import dialog is found in the Survey menu

**Note:** BOB will search through the specified base station file and only import base station readings whose time stamps fall within the survey interval, discarding the rest. No data will be imported if there is no time (or date) overlap between the survey data and the base station data.  
Review the Import Log after the import to ensure all the data were imported correctly.

Table 6-1 - Data Import filter settings for base station data

Import filter	Recommended setting
Maximum Magnetic Field	60,000 nT is the default setting. Adjust if needed.
Minimum Magnetic Field*	20,000 nT is the default setting, which may be too low for some situations. Use this parameter to eliminate unwanted drop-outs and bad readings (e.g. values corresponding to interference from nearby vehicles or persons approaching the base station) Use the lowest expected valid field value for the survey area. You may need to preview the data first, and determine the lowest valid total field value. E.g. 46,000 nT for most mid-latitude locations.
Signal strength*	0 is the default setting, which applies in most situations. Signal strength filtering is only supported for Sentinel2 data. A minimum value of 90 can be used for Sentinel2.
Time Adjustment	Do not modify unless you suspect a time offset relative to UTC time or relative to survey data.
Time Zone in file	Do not modify unless you have a specific reason to.

Once data is imported successfully, the **Base Station Data Review** window will appear (Figure 6-11).

In this window the user may choose to selectively delete certain entries if necessary (i.e. entries corresponding to interference from vehicles or persons approaching the base station, etc.).

**HINT:** Use the Alt+Mouse selection to zoom in on areas of interest in the profile.

When ready, click **Apply Correction**.



Figure 6-11 - Review and clean up (if necessary) the base station data before applying it to your survey

A new 'Base' signal will be added to the Fields group on the Layers panel.

A check box beside the Fields group allows user to show data with or without base correction applied.

Example showing longitudinal gradiometer survey profile:

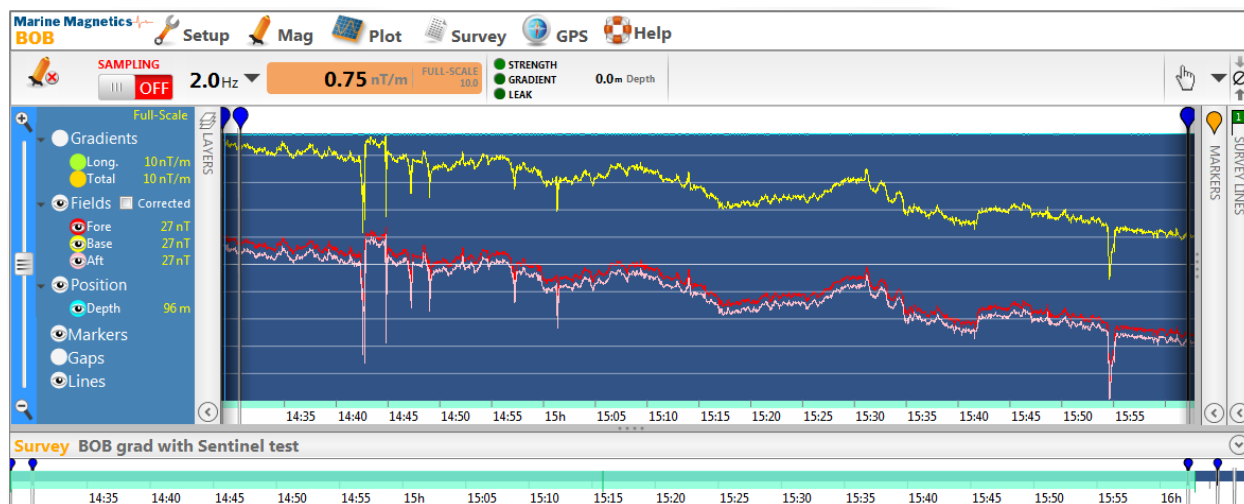


Figure 6-12 - Base station data (yellow trace) looks very similar to the towed magnetometer data (red and pink traces)

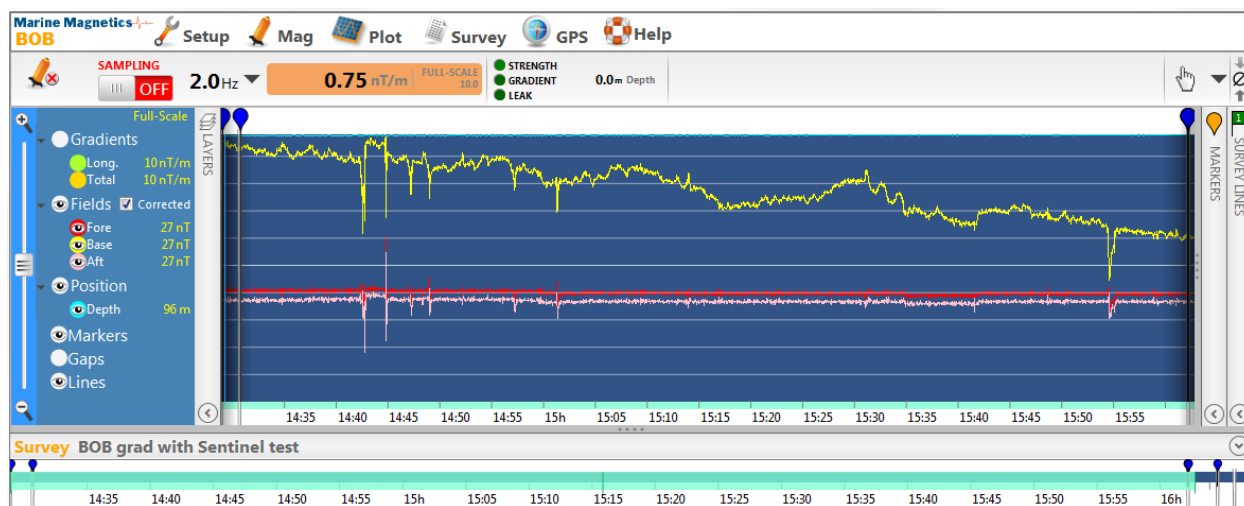


Figure 6-13 – After base correction is applied: Towed magnetometer data flattens out, and shows only anomalies encountered during the towed survey, without any of the background and ambient field changes.

### 6.3.2 IAGA Observatory base station data format

A world-wide network of magnetic observatories provides free reference data on the Intermagnet.org web site.

If you are fortunate to have one of the magnetic observatories near your survey site (normally within 100km radius for best result), you may be able to apply base station correction using that data.

BOB supports the IAGA data format in which observatory files are stored.

Simply download the appropriate file(s) from Intermagnet.org, and point BOB's base station import to that file.



### 6.3.3 Sentinel and Sentinel2 base station data formats

BOB automatically recognizes Sentinel and Sentinel2 data files. To import Sentinel log files, use the menu Survey > Base Station Data. Click the Import button in the Base Station Data dialog. (See Figure 6-10 - Base Station data import dialog).

Sentinel1 base station log files are saved by the Sentinel software BaseLink as a plain text files with **.mag** extension, and are formatted as follows. Each row begins with a Julian date (YY.DDD/) followed by time in UTC and Total Magnetic Field (nT).

```
18.026/15:33:53.0 053914.65
18.026/15:33:54.0 053914.01
18.026/15:33:55.0 053914.09
18.026/15:33:56.0 053914.06
18.026/15:33:57.0 053913.97 G
```

Sentinel2 base station log files are saved as plain text CSV, and are formatted as follows:

```
Reading_Date,Reading_Time,Magnetic_Field,Signal_Strength,Measurement_Duration,Flags (GPWM) ,System_Date,System_
Time
2022-11-28,14:27:52.000,53471.081,187,965, ,2022-11-28,14:27:54.134
2022-11-28,14:27:53.000,53471.221,186,965, ,2022-11-28,14:27:55.037
2022-11-28,14:27:54.000,53471.282,186,965, ,2022-11-28,14:27:56.052
2022-11-28,14:27:55.000,53471.220,186,965, ,2022-11-28,14:27:57.059
2022-11-28,14:27:56.000,53471.234,187,965, ,2022-11-28,14:27:58.127
```

### 6.3.4 Generic magnetometer CSV data format

BOB allows a basic CSV file containing base magnetometer data to be imported

BOB will treat the first three columns of a CSV file as base station data, and will assume that those are assigned as follows:

Date, Time, Magnetic Field

All additional columns will be ignored.

Example:

```
Reading_Date,Reading_Time,Magnetic_Field
2022-02-16,20:11:15.200,21232.345
2022-02-16,20:11:19.000,22786.364
2022-02-16,20:11:19.500,19075.748
2022-02-16,20:11:20.000,20721.584
2022-02-16,20:11:20.500,18645.730
2022-02-16,20:11:21.000,18493.846
```

**HINT:** The support for CSV format allows you to use data from one of your SeaSPY or Explorer magnetometers to be used as base-correction data for your other magnetometer(s). Simply export what you consider to be reference data with the above three columns to a separate CSV file, and then import the file into the survey you wish to correct.

### 6.3.5 GEM Systems Overhauser base station data format

GEM Systems Overhauser base station default format is shown below.

Note that the data rows contain only time, magnetic field and signal quality values, but does not contain a calendar date for every reading. Instead, the survey date is specified once at the top of the file header, at the end of the line beginning with /ID.

**IMPORTANT:** If the line beginning with /ID is missing from the file header, BOB will not be able to import the base station readings due to lack of a calendar date, which must match that in the survey data.

```
/Gem Systems GSM-19FB 2069188 v9.0 2 VI 2022 M elf@v9ob
/ID 1 file 1 survey.b 20 IX 22
/datum 48000.00
/ 045.2605444 016.9103740
/UTC+00:00
/33T
/GPS version 2018/Aug/24
/50Hz AC filter
/12.3V +31.25C
/time nT sq
101826.8 48129.86 99
101827.0 48129.95 99
101827.2 48130.16 99
101827.4 48129.77 99
101827.6 48129.54 99
101827.8 48129.78 99
101828.0 48129.99 99
101828.2 48129.62 99
101828.4 48129.61 99
101828.6 48129.68 99
```

Calendar date format samples formatted as Roman numerals:

```
/Gem Systems GSM-19 v9.0 22 IX 2022 M 1
/ID 1 file 1 survey.b 01 I 22
/ID 1 file 1 survey.b 01 II 22
/ID 1 file 1 survey.b 01 III 22
/ID 1 file 1 survey.b 01 IV 22
/ID 1 file 1 survey.b 01 V 22
/ID 1 file 1 survey.b 01 VI 22
/ID 1 file 1 survey.b 01 VII 22
/ID 1 file 1 survey.b 01 VIII 22
/ID 1 file 1 survey.b 01 IX 22
/ID 1 file 1 survey.b 01 X 22
/ID 1 file 1 survey.b 01 XI 22
/ID 1 file 1 survey.b 01 XII 22
```

## 7 Exporting data and saving backups

You can set BOB to export survey data to a text file, or print data in real time. Additionally, you can archive a full survey to a backup file.

Refer to section 2.3 for an introduction to export data formats and options.

### 7.1 Backup a Survey

A backup copy of the entire survey and all GeoPlot data can be saved as a single MMS file. MMS (Marine Magnetism Survey) files can be transferred to a different computer running BOB, or saved as a backup archive. MMS files is a Microsoft SQL Server database file that can be restored on any computer with Microsoft SQL Server 2008 R2 (the Express edition is a free download from Microsoft).

1. Click **Survey > Backup To File** in the main window menu bar.
2. Select the file location, enter the file name, and click the **OK** button. A MMS file that contains all of the survey data will be created.

### 7.2 Export Select Survey Data to a Text File (CSV)

Click **Survey > Export** to open the Export Log dialog (Figure 7-1).

The Export tool offers great flexibility when exporting data for post processing in other software.

You may select specific data columns to include, type of coordinates, and corrections that need to be applied.

You can specify which data columns or corrections to include in the export file. The selection can also be saved as a preset:

Heading Bias Correction tool allows you to apply a constant offset to each survey line, by specifying the general direction of the survey lines, and a degree range within which the direction will be considered the same. BOB will apply a positive shift to all lines oriented in the positive direction, and a negative shift to those in opposite direction.

Tie Line bias will be applied to any 'tie' lines that are oriented at 90 degrees to the average survey line direction.

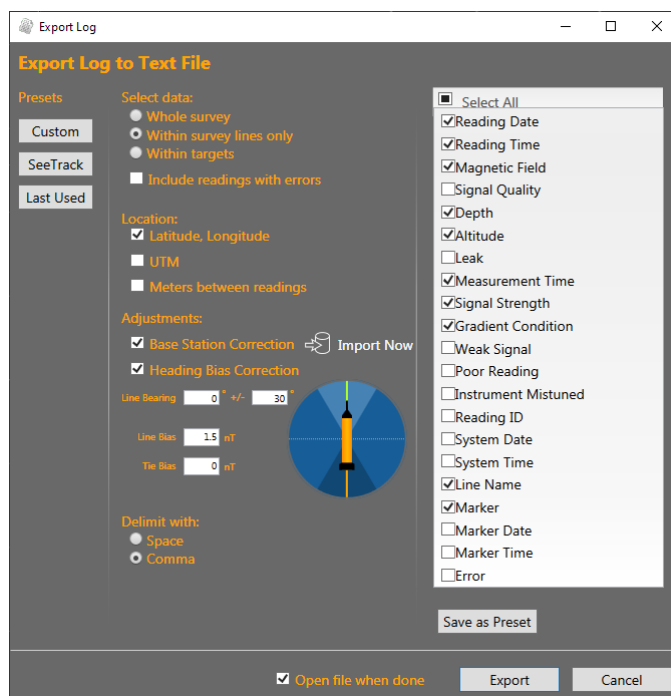


Figure 7-1: The Export Log dialog

Table 7-1 - Customizable columns when exporting survey data as CSV file

Latitude/Longitude	Export coordinate data in decimal degree units
UTM (WGS-84)	Export coordinate data in northing meters, easting meters, and UTM zone format.
Show markers	Export markers.
Apply base station correction	Use base station data to correct field readings. A separate column titled 'Magnetic_Field_Corrected' will be added to the file.
Show readings outside survey lines	By default, data that is not inside a survey line will not be exported. Check this box to export all data.
Show readings with time errors	Export data with a timestamp flagged as invalid.
Delimit with:	Click <b>Space</b> to generate a *.txt file that separates values with spaces, or <b>Comma</b> for a *.csv file that uses commas instead.
Open file when done	BOB will use the default program to open the *.txt or *.csv file after the export operation has finished. In most cases, these will be Notepad for a space-delimited file and Excel for a comma-delimited one.

Click the **Export** button after you have configured all settings. The progress bar at the bottom will reflect the export operation progress, and the Export Log dialog will close when the progress is complete. If you have selected **Open file when done**, the newly created file will be opened as well. See for log examples.

## 7.3 Export Markers or Survey lines to a CSV file

Refer to section 4.6 (Markers) for a quick summary of export to file functions for lists of markers or survey lines.

## 7.4 Export Guide Lines or Guide Line Grids to a file (XML format)

Refer to section 4.7.2 (Survey guide grid design) for a quick summary of export to file functions for lists of markers or survey lines

Support for KMZ and KML formats is coming soon!

## 7.5 Export survey map as GeoTiff

The current view of the GeoPlot window can be exported as a georeferenced raster image (GeoTiff) exactly as it seen.

Hide or show the map layers you wish to include, then right-click on the map and choose Export.

You will be asked to modify the output file resolution (if necessary), and then for the output file name.

**IMPORTANT:** To save the file as GeoTiff, select the GeoTiff file format when entering the file name.

## 8 BAM (BOB Analytic Module) Overview

### 8.1 BAM Introduction

BAM is an extension to BOB, offering a set of tools for data analysis and visualization. BAM is activated from within BOB using a license key, after BOB is installed on your system.

BAM adds the following functionality to BOB:

1. Data profile summary analysis
2. Target markers
3. Surface plot generation for Total Field measurements.
4. Analytic Signal generation from Total Field plot. (On SeaQuest 3-axis gradiometers, the Analytic Signal is measured directly in real-time. BAM creates a surface plot of the direct measurements from Analytic Signal).
5. Map export (as GeoTiff)
6. Surface Plot export as both GeoTiff and as raw data in Grid Exchange format (.GXF)

For details on the features and techniques enabled with the BAM extension, please refer to the BAM user guide.

### 8.2 Export BAM generated surface plots

BOB allows the magnetic maps (surface plots) to be exported, both as georeferenced raster images (GeoTiff) as well as actual underlying grid data (GXF ASCII format).

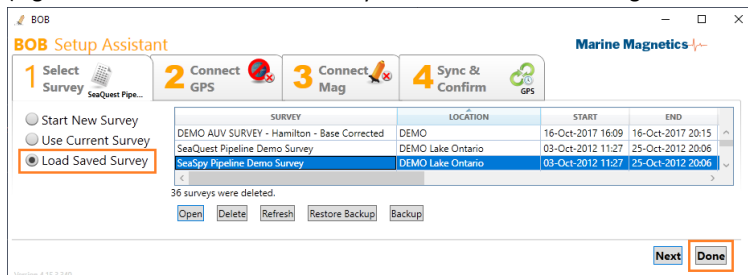
Simply right-click on the surface plot thumbnail in the GeoPlot layers panel, and choose either Export Data or Export Image.

Please refer to the BAM user guide for detailed instructions.

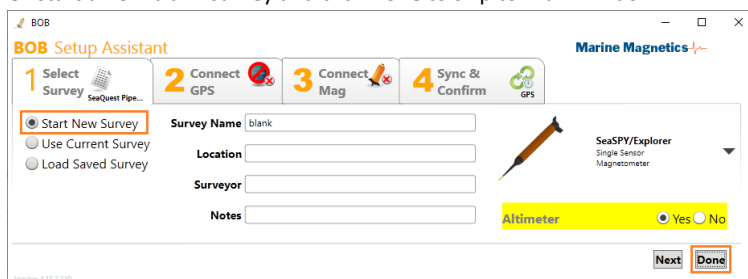
## 8.3 Activating your BAM license

Once you receive a BAM activation key from Marine Magnetics, please follow these steps to activate BAM functionality on your computer. You can move your BAM license between computers by first deactivating it on one computer, and then activating it on another, provided that both computers are connected to the Internet.

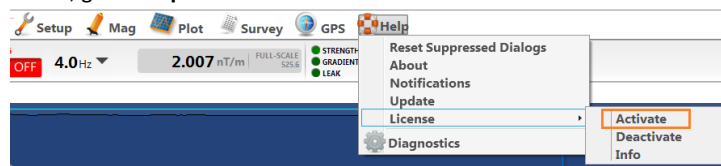
1. Start BOB
2. Navigate to the Main Window using one of the following two options:
  - a. Either open one of the existing surveys on the list, and click **Done** to skip to Main Window (e.g. use one of the demo BOB surveys available for downloading on the BOB installation page)



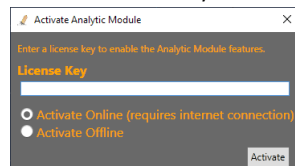
- b. Or start a new blank survey and click **Done** to skip to Main window



3. In the menu bar, go to **Help > License > Activate**



4. Copy your BAM Activation Key from the BAM License email and paste it into the Activation box:



5. You should see a new window, confirming that BAM has been activated on your computer.

## 9 Appendix A. Signal Layer descriptions for Main Window Plot

BOB displays Markers, Gaps, and Lines layers for all magnetometers. The following tables show descriptions for device-specific layers.

### 9.1 Explorer and SeaSPY Magnetometers

Layer group	Layer	Description
Fields	Magnetic	Total magnetic field reading. Units: nanoTeslas (nT)
Position	Depth	Distance between water surface and magnetometer. Shown for magnetometers with depth sensor option. Units: meters (m)
Position	Bottom	Distance between water surface and water bottom (water column) calculated from depth sensor and altimeter readings. Shown for SeaSPY magnetometers with depth sensor and altimeter options. Units: meters (m)
Position	Altitude	Distance between magnetometer and water bottom. Shown for SeaSPY magnetometers with altimeter option. Units: meters (m)

### 9.2 SeaSPY Gradiometers

Layer group	Layer	Description
Gradients	Hor.	Horizontal gradient. Difference between two sensors along the horizontal (transverse to the direction of travel) axis divided over the distance between them. Shown for horizontal gradiometers. Units: nanoTeslas/meter (nT/m)
Gradients	Long.	Longitudinal gradient. Difference between two sensors along the longitudinal (along the direction of travel) axis divided over the distance between them. For horizontal gradiometers, the calculated along-track gradient. Units: nanoTeslas/meter (nT/m)
Gradients	Total	Pythagorean addition of all individual gradients. Units: nanoTeslas/meter (nT/m)
Fields	Port	Port sensor total magnetic field reading. Shown for horizontal gradiometers. Units: nanoTeslas (nT)
Fields	Starb.	Starboard sensor total magnetic field reading. Shown for horizontal gradiometers. Units: nanoTeslas (nT)
Fields	Fore	Fore sensor total magnetic field reading. Shown for longitudinal gradiometers. Units: nanoTeslas (nT)
Fields	Aft	Aft sensor total magnetic field reading. Shown for longitudinal gradiometers. Units: nanoTeslas (nT)
Position	Depth	Distance between water surface and magnetometer. Shown for magnetometers with depth sensor option. Units: meters (m)

Position	Bottom	Distance between water surface and water bottom (water column) calculated from depth sensor and altimeter readings. Shown for magnetometers with depth sensor and altimeter options. Units: meters (m)
Position	Altitude	Distance between magnetometer and water bottom. Shown for magnetometers with altimeter option. Units: meters (m)

### 9.3 SeaQuest Gradiometers

Layer group	Layer	Description
Gradients	Hor.	Horizontal gradient. Difference between two sensors along the horizontal (transverse to the direction of travel) axis divided over the distance between them. Units: nanoTeslas/meter (nT/m)
	Long.	Longitudinal gradient. Difference between two sensors along the longitudinal (along the direction of travel) axis divided over the distance between them. Units: nanoTeslas/meter (nT/m)
	Vert.	Vertical gradient. Difference between the port and starboard average and the vertical sensor reading, divided over the distance to the vertical sensor. Shown for gradiometers with a vertical sensor.
	Total	Total gradient (analytic signal). Pythagorean addition of all individual gradients. Units: nanoTeslas/meter (nT/m)
Fields	Port	Port sensor total magnetic field reading. Units: nanoTeslas (nT)
	Starb.	Starboard sensor total magnetic field reading. Units: nanoTeslas (nT)
	Vert.	Vertical sensor total magnetic field reading. Shown for gradiometers with a vertical sensor. Units: nanoTeslas (nT)
	Aft	Aft sensor total magnetic field reading. Shown for gradiometers with an aft sensor. Units: nanoTeslas (nT)
Position	Depth	Gradiometer depth below water surface. Units: meters (m)
	Bottom	Overall water column depth. Calculated as a sum of depth and altitude. Units: meters (m)
	Altitude	Gradiometer altitude above sea floor. Units: meters (m)
Attitude	Pitch	Angle between track and the direction the gradiometer nose is facing. Units: degrees (°)
	Roll	Angle between horizon line and the plane created by the gradiometer wings. Units: degrees (°)
	Heading	Heading, relative to magnetic north. Units: degrees (°)



## 10 Appendix B. Warnings

The following table shows the thresholds for each of the warnings in the status bar.

Label	Green	Yellow	Red
<b>Signal Strength (SeaSPY &amp; Explorer)</b>	Good: >150 Excellent: >180	Acceptable: 110-150	Poor: <110
<b>Signal Strength (SeaQuest)</b>	Good: >200 Excellent: >300	Acceptable: 150-200	Poor: <150
<b>Gradient</b>	Gradient conditions are satisfactory for survey operations		Gradient conditions are not acceptable for survey operations
<b>Leak</b>	No leak detected (0-1)	Leak is likely (2)	Leak has occurred (3-9)
<b>Depth</b>	Good: Within operating range		Check magnetometer
<b>Altitude</b>	Good: Within operating range		Increase altitude

## 11 Appendix F. Timekeeping in BOB

BOB keeps track of several clocks / time values simultaneously. All use UTC time.

PC / System	The time provided by the PC clock in UTC (based on the time zone configured in Windows).
Magnetometer	The time extrapolated from the last magnetometer time response.
GPS	The time extrapolated from the last valid GPS fix.
Internal GPS	This is the same as the magnetometer clock. BOB does not have access to the internal GPS clock. When you synchronize the magnetometer to the internal GPS using BOB, a command is sent to the magnetometer, which does the synchronization internally.

### 11.1 Time Extrapolation

The GPS time is calculated using the last fix received from the GPS. BOB records the difference between the GPS time and the PC time as an offset. This offset is added to the PC time to calculate the current GPS time when needed. Likewise, BOB records the difference between the magnetometer clock and the PC clock when a response to the “get time” command is received from the magnetometer.

### 11.2 Changing the PC Clock

BOB will detect if the PC is changed, and try to get a new time string from the magnetometer to recalculate the offset. BOB will update the GPS offset when the next GPS fix is received.

Changing the PC time when sampling is on is not recommended. For best results, set the PC time as accurately as possible at the start of the survey. To change the PC time after the survey has started, turn sampling off first and synchronize the magnetometer and GPS again after changing the PC time.
















### 11.3 Automatic Synchronization at Startup

BOB will synchronize the magnetometer to the GPS only the first time they are both connected. If you reconnect either, they will not be automatically synchronized, unless you have restarted BOB before connecting either device. To synchronize to a different device, select the device from the dropdown list and click the **Set Mag Clock** button in the Confirm & Configure tab.

### 11.4 Out of Sync Data

If a magnetometer reading is dated earlier than previously recorded data, BOB will flag it as invalid and save it to the database, but it will not be shown on the screen. The Export Log dialog has the option to include invalid readings in the exported text file. If one or two magnetometer readings jump ahead far into the future, they will be ignored, assuming there are spurious characters in the magnetometer data string.

## 12 Appendix G. Mouse and Keyboard Shortcuts

Key	Mouse action		Result
Main window plot area			
-		Drag sideways	Move <i>Review</i> pane time range.
-		Drag up and down	Move (offset) selected data layers. The <i>depth</i> , <i>altitude</i> , and <i>bottom</i> layers cannot be offset.
Shift		Move sideways	Move <i>Review</i> pane time range.
Shift		Move up and down	Move (offset) selected data layers.
Ctrl		Drag sideways	Scale selected time range.
Ctrl		Drag up and down	Scale selected data layers.
Ctrl-shift		Drag up and down	Scale selected data layers, but keep the same time range.
-		Scroll	Move <i>Review</i> pane time range.
Ctrl		Scroll	Scale selected time range.
Ctrl-shift		Scroll	Scale selected data layers.
Geo Plot window plot area			
-		Drag	On the path: Move the selection point. Off the path: Pan the plot.
-		Click near a path	Move the selection point.
-		Scroll	Scale the plot.
Ctrl		Click near a path	Add a marker instantly.
Alt		Drag sideways or up/down	Create a survey line.
S	-	-	Mark the start of a new survey line at the current time.
E	-	-	Mark the end of a new survey line at the current time.
L	-	-	Mark the start and end of a new survey line at the current time.