



EIVA

NAVIPAC – SCANFISH

VESSEL-AIDED TERRAIN FOLLOW MODE

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1 Introduction

Traditionally EIVA's ScanFish ROTV (remotely operated towed vehicle) uses a built-in altimeter to follow the seabed and obstacle avoidance. This method, in instances of steep obstacles like shipwrecks and rocky outcrops, potentially avoids obstacles later than is ideal.

To further decrease risks of steep obstacles causing sudden movements (or in the worst case collision), EIVA has developed the **Vessel-Aided Terrain Follow** mode.

With the help of a multi-beam echo sounder (MBE) mounted on the towing vessel and NaviPac's calculated real-time digital terrain model (DTM), a new, smoother vertical route is calculated in the form of a smooth DTM (a digital terrain model corrected for smoothly avoiding the sudden steep incline/decline). This new vertical route takes obstacles in front of the ScanFish into account earlier on than an altimeter, and by corrections sent to the ScanFish Flight software, it changes altitudes accordingly. This results in safer operations and improves the quality of the data.

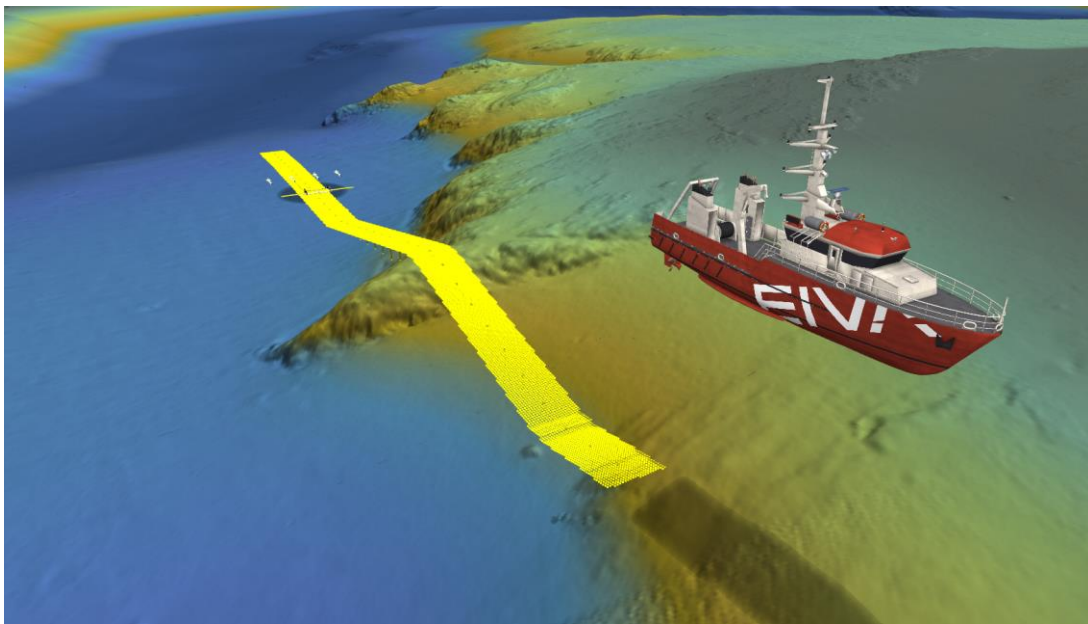


Figure 1 NaviPac example of Vessel-Aided Terrain Follow mode. In yellow, the calculated smooth DTM shows the corrected route made by Vessel-Aided Follow Terrain mode.

2 Vessel-Aided Terrain Follow view

To enable the Vessel-Aided Terrain Follow view, go to NaviPac's menu bar and click **Tools** > **Misc**

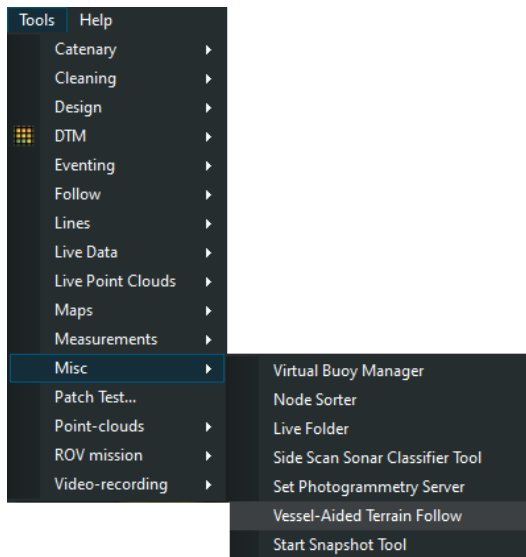


Figure 2 Enabling Vessel-Aided Terrain Follow view in NaviPac

2.1 ScanFish connection

After initiating the Vessel-Aided Terrain Follow view, the **ScanFish Connection** dialogue box will open, as shown in Figure 3.

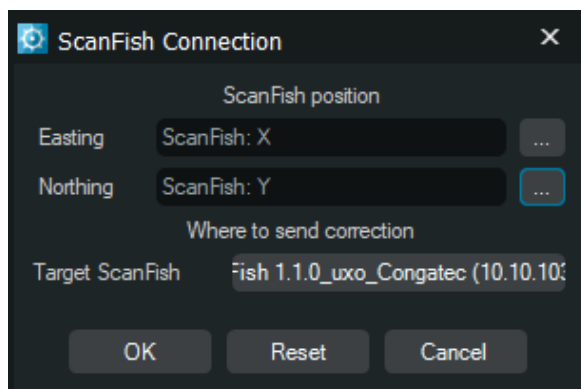


Figure 3 ScanFish Connection view

- The user should define the **ScanFish position** (Easting and Northing) received from the USBL system
- If the user does not use an USBL system, then instead select the calculated Eastern and Northern positions from the **Generic Cable Counter** function in **NaviPac**
- If the NaviPac computer is on the same network as the ScanFish, a connection will automatically be established between NaviPac and the ScanFish, as displayed on the button next to **Target ScanFish**. If the connection is not automatically established, the button will show **<None>**. When the button is clicked, the view in Figure 4 will appear.

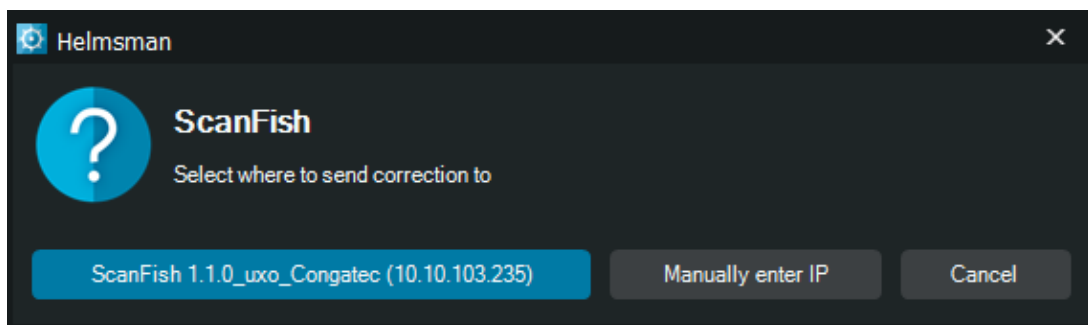


Figure 4 Helmsman view for setting up where to send correction to

Choose between different ScanFish on the network or try to manually connect to a ScanFish via the **Manually enter IP** option. When you establish connection to the ScanFish manually, you first select the I/O Type. Thereafter, you type in the IP for the ScanFish, which is the standard 10.10.103.XX(X) IP address, where XX(X) is the last two or three digits on the controller – as in Figure 5. The port number is standard set to 8844.

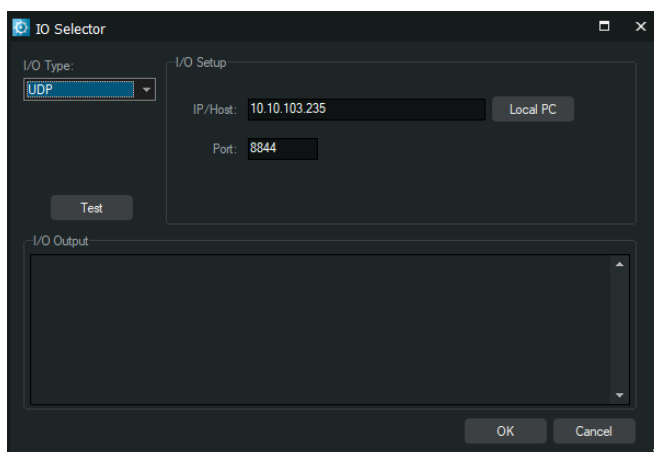


Figure 5 IO Selector view to manually establish connection to the ScanFish

If you press OK, the **Vessel-Aided Terrain Follow** option view in Figure 6 will open. The view can be freely docked and will show a **Correction** value in the top. The correction is calculated from the active **Surface** based on the user-defined **Settings**, and it is the output sent to the ScanFish to avoid an obstacle.

Details on these settings and how they affect the **Vessel-Aided Terrain Follow** mode will follow in the next sections.

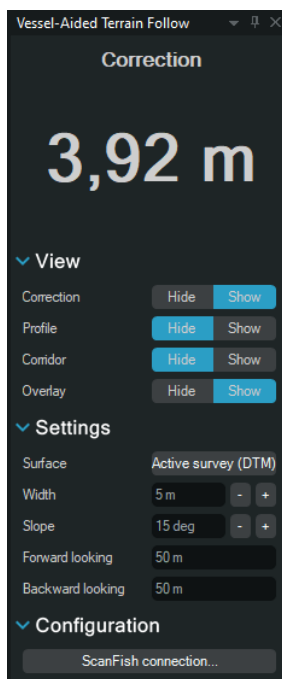


Figure 6 NaviPac: Layout of the Vessel-Aided Terrain Follow View

2.2 View

View options are Hide/Show buttons to visualise **Correction**, **Profile**, **Corridor** and **Overlay** in the NaviPac map view.

- **Correction**
Adds two grey ball-shaped objects with a line in between them to display the height of the correction.

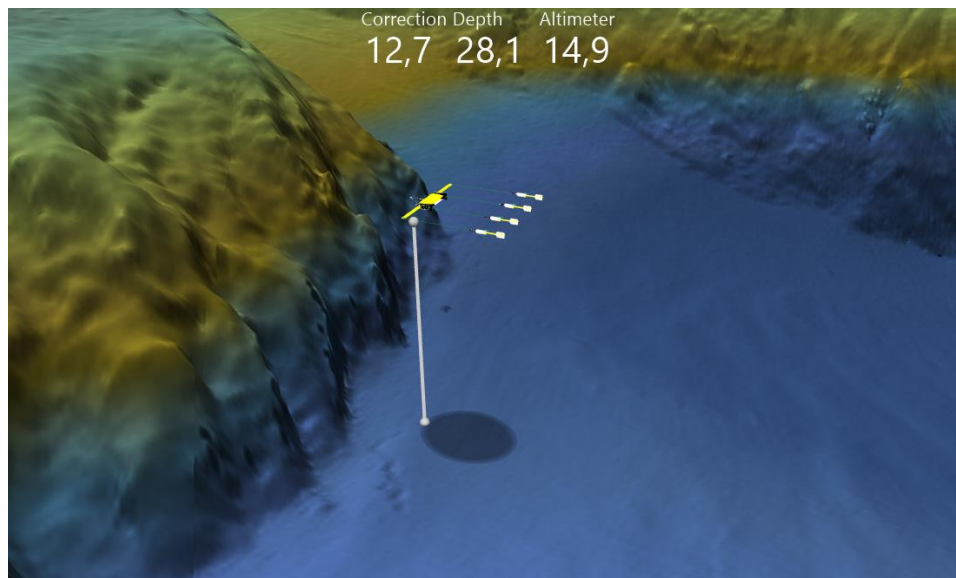


Figure 7 Correction to ScanFish route visualised as a line between two grey balls

- **Profile**
Displays the height of the correction as pillars. The distance in between the pillars are related to ScanFish position update frequency.

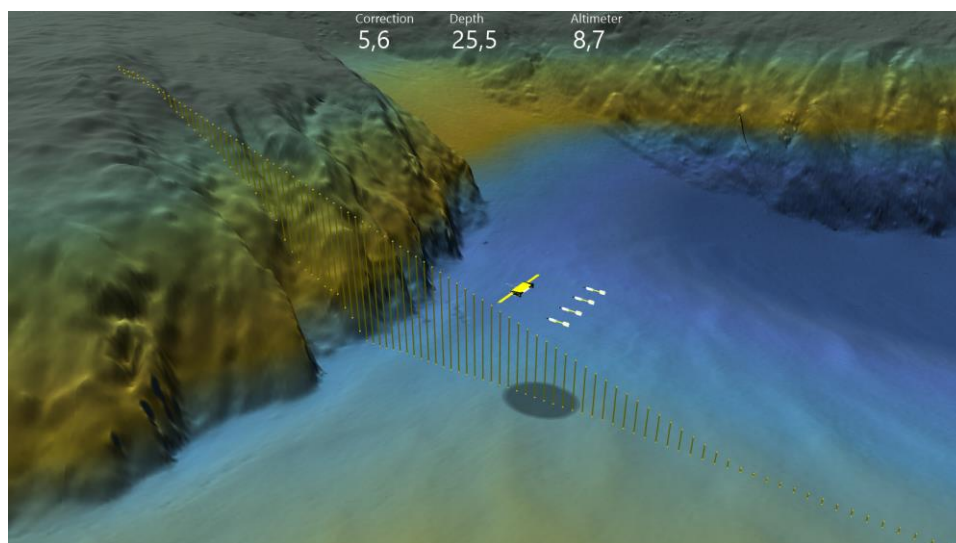


Figure 8 Profile view displays corrections as pillars looking forward

- **Corridor**

Displays a corridor of the corrected surface, which the ScanFish keeps a constant altitude relative to (rather than relative to the seabed).

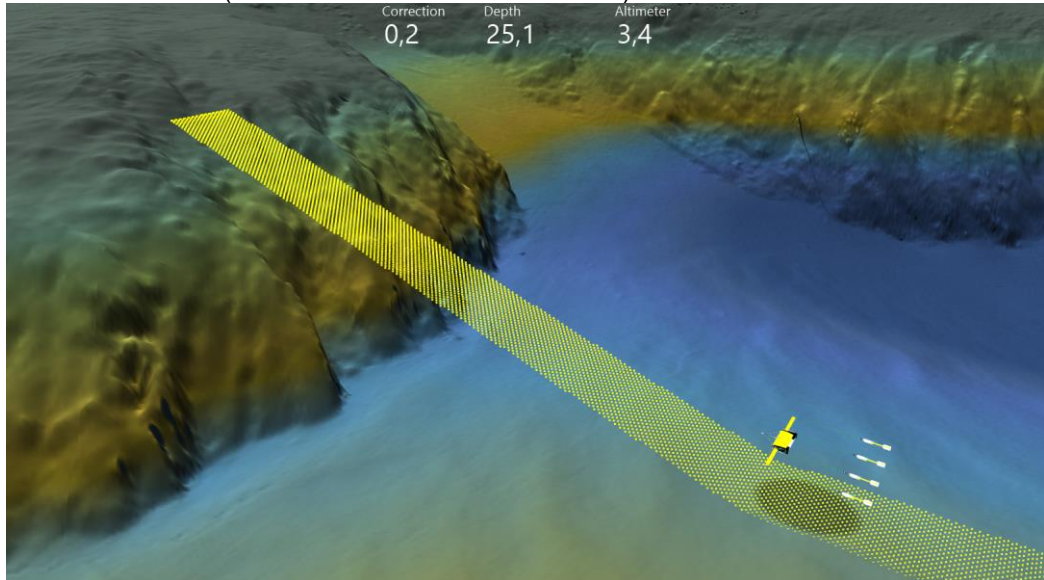



Figure 9 Corrected surface visualised as a corridor

- **Overlay**

If set to **Show**, this mode automatically displays the **Correction** value as an overlay at the top of the **Map View**. This is convenient since after all settings in the **Vessel-Aided Terrain Follow** option window have been configured, then you can set the window to **Auto Hide** (by pressing  in the top of the window), which leaves a cleaner screen while the **Overlay** view enables the user to still monitor the correction.

2.3 Settings

In this section, the different settings of **Vessel-Aided Terrain Follow** mode are described. Changing one of the values will affect the total outcome (seen as the **Correction** value in Figure 6), therefore consider carefully how each component will affect the others. This is the key to not only get a safer operation for the equipment but also improving the data quality.

- **Surface**

There are three options relating to selecting the **Surface** – meaning the DTM which the **Vessel-Aided Terrain Follow** mode will calculate the corrections it sends to the ScanFish based on (Figure 10):

- Active survey
- Online DTM
- Custom

By selecting the **Active survey**, the surface used for calculating corrections is the active DTM (bold) in the NaviPac **Project Tree**. Be careful with this option: if you import a DTM to your project, that DTM automatically becomes the active survey surface in the Project Tree. This is a default NaviPac setting that could potentially result in the ScanFish correcting for a wrong DTM.

If **Online DTM** is selected, the currently built DTM from the MBES via the NaviScan connection is used for corrections.

The **Custom** option gives the user the opportunity to use a specific DTM, for instance an old DTM from a pre-survey imported to the **Project tree**, for the **Vessel-Aided Terrain Follow** function, while modifications to other DTMs can be done simultaneously (to modify a DTM, it has to be active in the **Project Tree**).

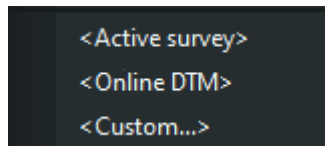


Figure 10 Surface options

- **Width**
It is possible to define the **Width** of the **Surface** considered by **Vessel-Aided Terrain Follow** when it is calculating corrections. The **Width** setting is the distance (m) to each side of the ScanFish position.

In the figure below, an example is shown of the difference between the corrections for a corridor set to a width of 5 m vs 13 m – for the same survey line. From the wider 13 m corridor, areas of the rocky outcrop to the right side of the survey line are registered as part of the surface to follow. So, in that part the corrections to the ScanFish's route give it a higher altitude. On the other hand, the narrow 5 m corridor is not detecting the outcrop, which is why the smooth DTM has no corrections. The **Width** should be a compromise between safety of the equipment and potential infill generated by an excessive value. The default value is set to 5 m.

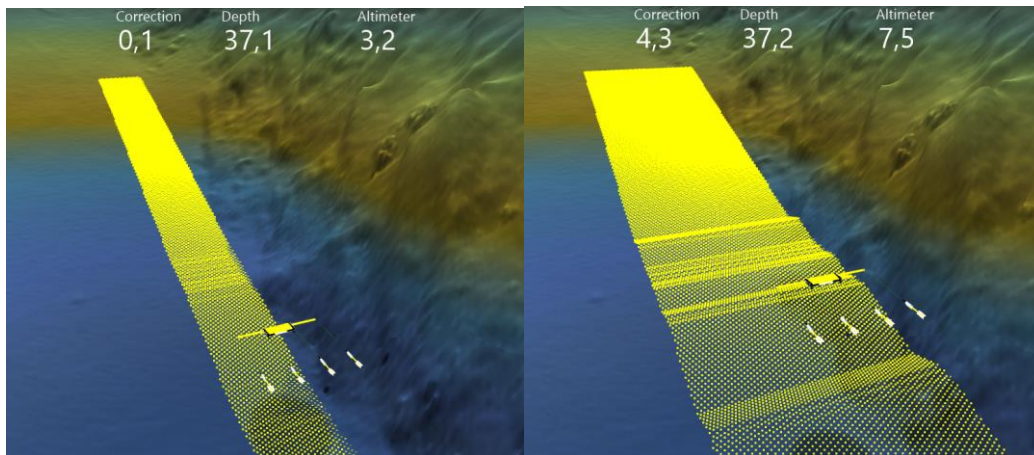


Figure 11 Corridor (smooth DTM) for widths of 5 m (left) and 13 m (right)

- Slope**
 Maximal angle of the smooth DTM. The ScanFish, when trying to avoid an obstacle, will follow a path which does not exceed this angle.

The example in Figure 12 illustrates the difference between a slope angle of 10 and 17 degrees for the same survey line. The difference reflects that with a gentler slope you bring the ScanFish up earlier, which might be safer, but also leaves a potentially greater gap in the data, if for instance the ScanFish tows magnetometers, that are required to stay within a certain altitude of the seabed. However, by increasing the angle, you could potentially make the inclination too steep for the ScanFish to safely ascend and keep the sensors stable during the ascent.

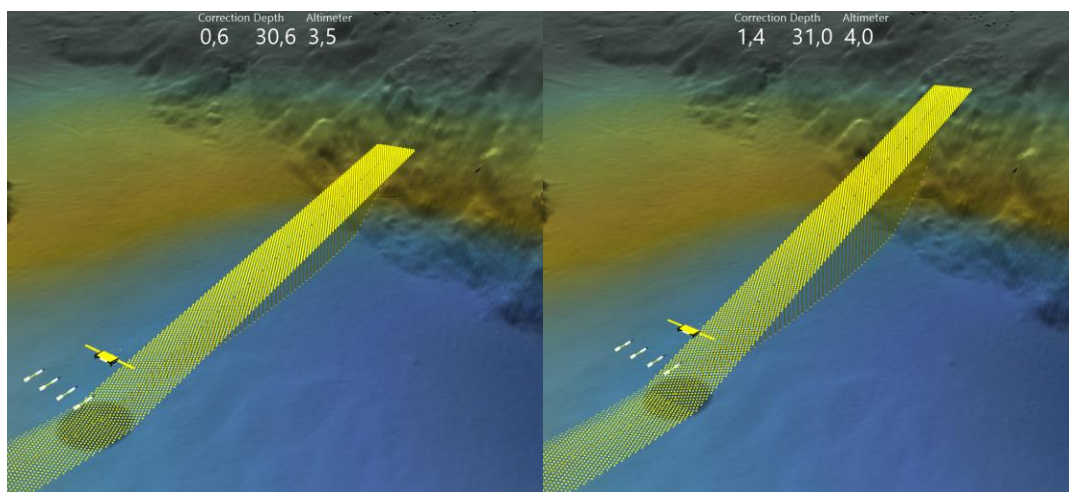


Figure 12 Difference between a corridor with Slope set to 10 degrees (left) vs 17 degrees (right)

There are physical limitations to the ScanFish's ability to ascend and descend. These are mainly a function of the speed through water (STW), cable layback and the setup of sensors on your ScanFish. In the ScanFish Flight software, the default ScanFish ascend/descend rate is set to 0.6 m/s.

Example: With a ScanFish Katria setup (equipped with four soft towed magnetometers), a STW of 4.0 knots is very common. For this setup, the default ascend/descend rate of 0.6 m/s works well. These values leave us with an approximate slope angle of 16.25 degrees (see calculation below). The default **Slope** value is set to 15 degrees.

Assuming the user maintains a constant ascend/descend rate, the slope angle setting must be changed accordingly with adjustments to the STW. Use the formula in below to calculate the correct **Slope**.

$$Slope = \tan^{-1} \frac{General\ rate}{STW}$$

$$General\ rate = 0.6 \frac{m}{s} * 0.514 = 1.17\ knt$$

$$Slope = \tan^{-1} \frac{1.17\ knt}{4.0\ knt} = 16.25^{\circ}$$

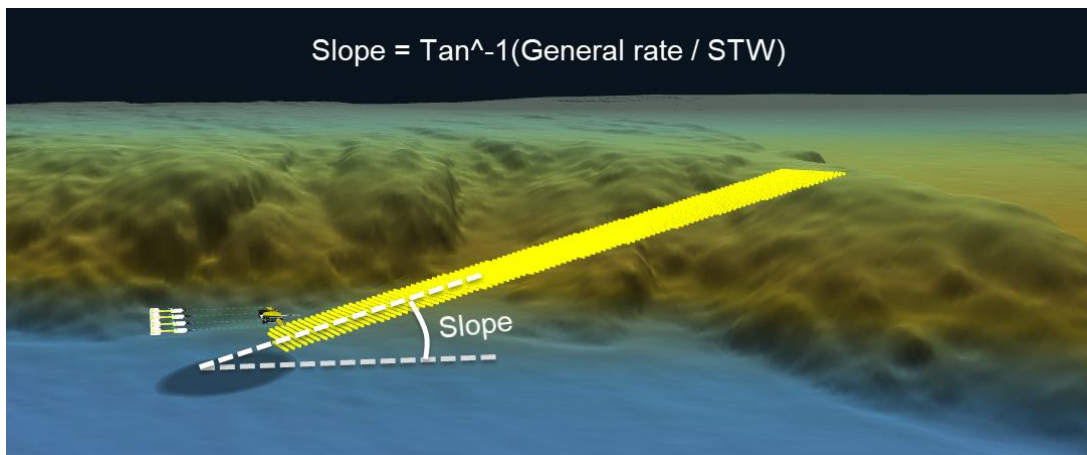


Figure 13 Slope angle and formula to calculate appropriate slope angle

- **Forward looking**

Value that is mainly used for a controlled ascent of steep-sided obstacles. This is a distance (m) ahead of the ScanFish position. The greater the **Forward looking** distance, the further you look ahead and the earlier the ScanFish will detect a seabed obstacle and start to compensate for it. This is illustrated in Figure 14, where the ascent happens sooner with a greater value. This function will only account for available data, so if the **Forward looking** value exceeds the edge of the selected **Surface**, the missing data will be read as zeros (no correction). The default **Forward Looking** value is set to 50 m.

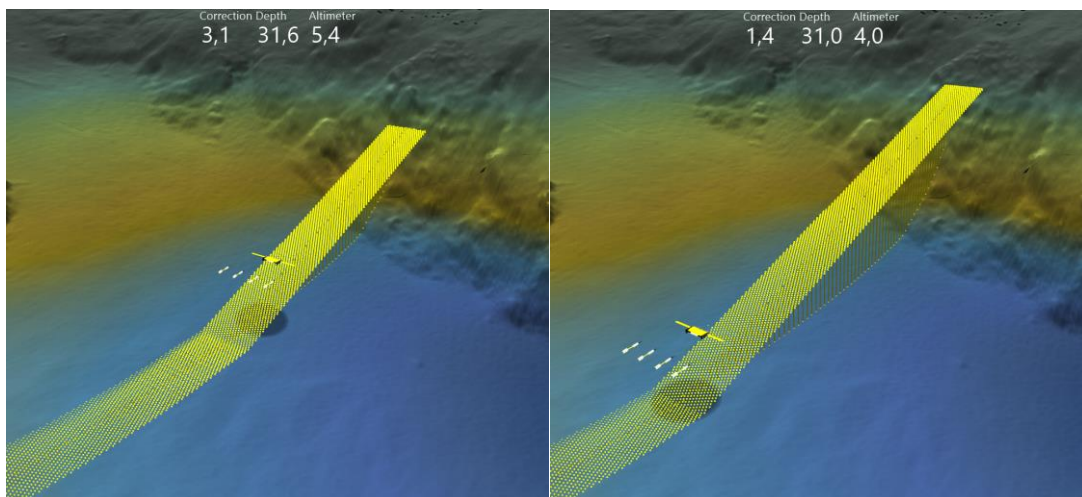


Figure 14 ScanFish ascending toward the right – the difference is shown between a corridor with Forward looking set to 30 m (left) vs 50 m (right)

- **Backward looking**

Value that is mainly used for a controlled descent at steep-sided drop-offs. In Figure 15, a great (50 m) and low (10 m) **Backward looking** value is

illustrated for the same survey line. The greater the value used, the more of the selected **Surface** is compensated for, resulting in a steady and more controlled descent (left) compared to the more sudden uncontrolled descent (right). Note that the **Forward looking** value in both cases is set to 0 m, as this effectively does not affect the descend. The default value is set to 50 m.

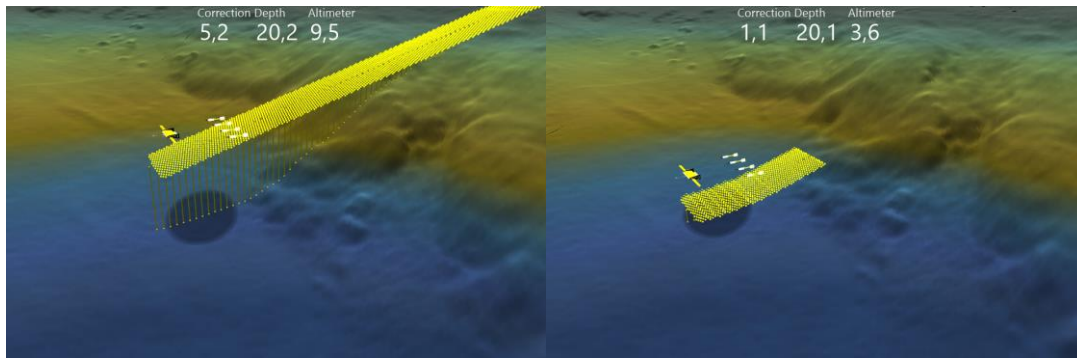


Figure 15 ScanFish descending toward the left – the difference is shown between a corridor with Backward looking set to 50 m (left) and 10 m (right)

2.4 Configuration

When you click the **ScanFish connection...** button, the **ScanFish Connection** view (shown in Figure 3) will open and the user can set up a new ScanFish connection by following the steps in section 2.1 'ScanFish connection'.

3 ScanFish Flight software

In the **ScanFish Flight** software, the flight mode **Vessel-Aided Terrain Follow** has been added to the **Flight Mode** drop down fan, which is shown when you click on the **Flight Mode** button, as shown in Figure 16.

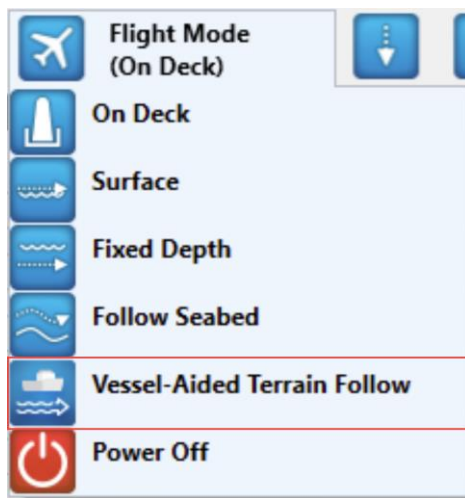


Figure 16 Flight Mode drop down fan to activate Vessel-Aided Terrain Follow mode

The **Vessel-Aided Terrain Follow** mode is built up like the **Follow Seabed** mode in the ScanFish Flight software. That basically means the ScanFish will follow the seabed at a user-defined altitude above the seabed – unless corrections are sent across from the NaviPac computer. It uses the same altitude from the **Set Follow Seabed** value in the **Tow** panel (Figure 17), so the ScanFish will keep x-meter altitude to the seabed plus the **Correction** value send from NaviPac.

As a safety precaution, if the ScanFish altimeter's reading is lower than the **Set Bottom Margin** value in the **Tow** panel, the ScanFish will make a manoeuvre to quickly get some distance to the seabed, just like when in **Follow Seabed** mode.

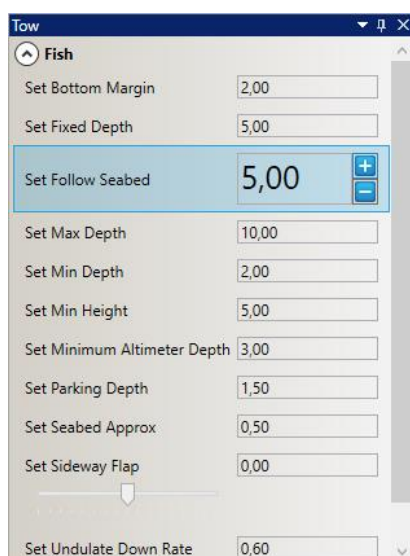


Figure 17 Tow panel, where Set Follow Seabed value controls the altitude for the ScanFish to follow in Follow Seabed and Vessel-Aided Terrain Follow modes

3.1 ScanFish Flight when NaviPac Vessel-Aided Terrain Follow mode is active

Figure 18 illustrates the behaviour of ScanFish Flight when the **Vessel-Aided Terrain Follow** flight mode is active. As described previously, the ScanFish follows the seabed using its sensors, then when there is a sharp obstacle registered in NaviPac, it instead follows the correction sent by NaviPac.

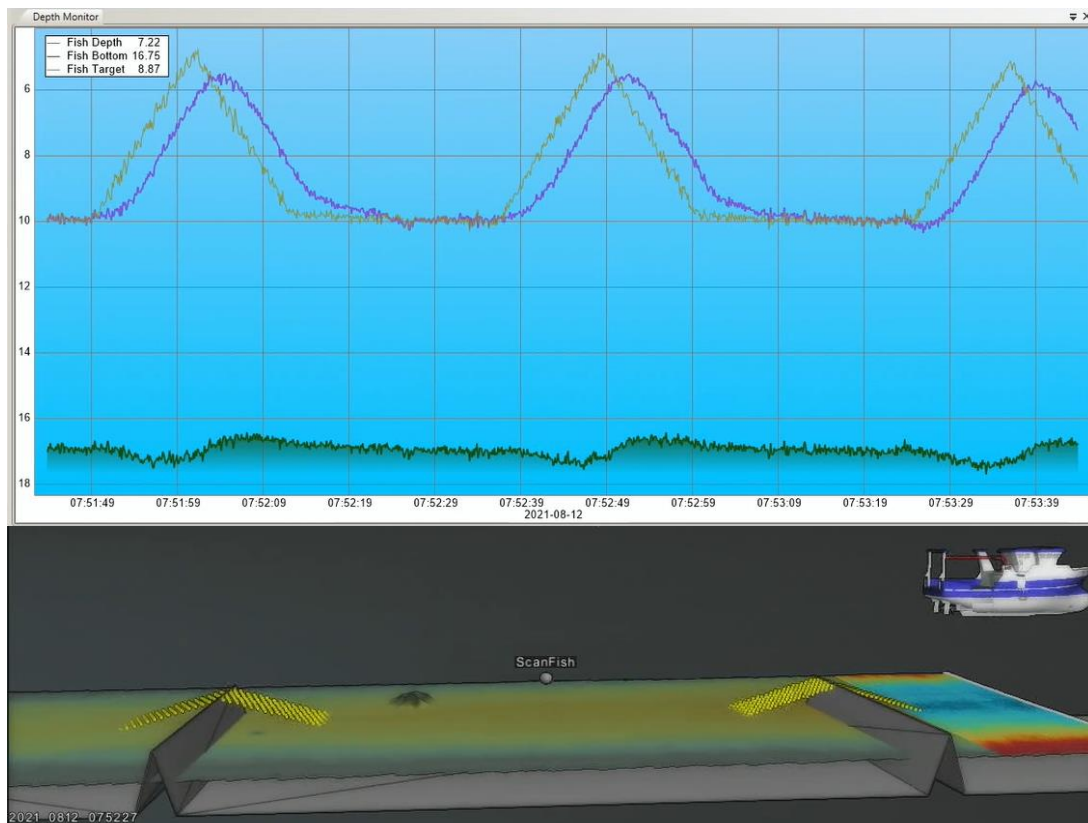


Figure 18 Vessel-Aided Terrain Follow mode test example as seen in NaviPac (below) compared to obstacle avoidance along the same route in ScanFish Flight software (above)

For this example, a user-generated TIN surface was selected as **Surface** to generate arbitrary seabed obstacles for the ScanFish to avoid.

In the NaviPac image, the yellow **Corridor** of the ScanFish's corrected route is shown creating a smooth **Surface** around the sharp obstacles. In the areas where only the DTM is shown, the ScanFish Flight software takes over and the **Fish Target** (orange line) is active in ScanFish Flight's **Depth Monitor** panel. When **Vessel-Aided Terrain Follow** mode is active and a sharp obstacle is encountered, the corrections sent from NaviPac take over control instead of ScanFish Flight target depth. The **Fish Bottom** (green line) is the calculated seabed depth generated from the ScanFish pressure sensor and altimeter readings. The Fish Depth (purple line) is the actual depth of the ScanFish ROTV.

4 Version descriptions

Version	Date	Author	Description
1.0	08.09.2022	ASM	New guide