Mysticetus Theodolite User Guide

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Introduction

Configuring the Theodolite for running on Mysticetus has specific steps required. Not following these steps will result in frustration, time lost, angry calls to us, and general loss of sleep. Please read this carefully.

The steps are correct for all Mysticetus supported theodolites. Some examples directly apply to the Topcon DT205 which is still commercially available as of 2024.

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You will need the following accessories for your theodolite.

1) 9 pin to RS232 cable.
2) RS232 to USB A cable.
3) A reliable handheld GPS.
4) Windows laptop computer to run Mysticetus on.
5) Mysticetus installed and a license from us.
6) Power supply for laptop.
7) Replacement batteries for theodolite. We recommend rechargeable batteries.

Mysticetus supports the DT5, DT501, DT10, and DT205 series theodolites. What is important with your selected device is that the theodolite supports RS232 cable connection which is used to connect the theodolite to the Mysticetus laptop.

The basic steps in setting up the Theodolite/Mysticetus computer pair are:

1) Understand your project hierarchy. We create dedicated projects and we also create projects that are on a Grandparent->Parent>Child relationship.
2) Setup Initialization of the theodolite (DT205 herein) - the bit field (1's and 0's) within theodolite settings itself. This step is a one-time task.
3) Determine your vertical and horizontal reference points (lat/lon coordinates).
4) Set up the theodolite in an appropriate location.
5) Determine the theodolite waypoint locations (lat/lon coordinates).
6) Connect the theodolite to the laptop and determine its Com port.
7) Configure the theodolite within mysticetus and test communications.
8) Input the vertical and horizontal reference waypoints.
9) Calibrate the theodolite horizontal reference and set the theodolite altitude. This performed using the horizontal and vertical reference points.
10) Start taking data readings (you're operational).

Project hierarchy

Mysticetus uses two primary forms of project setup also known as data collection project. The simplest manner of setup for your project is it is a stand alone setup. This is common with a dedicated project setup that holds all variables related to the settings and the data collection. You change all template settings, set up your theodolite, and collect data within this environment. When you change template settings and setup the theodolite you simply save off the dedicated template via the command: Data->save->save template->okay.

The second form that your project might be setup in is the Grandparent->Parent->Child relationship. Now things are a little more complicated. Oh boy! The basics of this relationship is this:

- Grandparent holds your data collection standards. Your basic template is defined here.
- Parent holds local definitions unique to one of your projects such as input devices which includes theodolites, handheld optical devices, per project settings, assigned users, and data collection changes for unique child projects. In this model all your theodolite setup values are performed in the parent and “Deployed” to your particular project. When editing the parent, be sure to be running Mysticetus in “Advance” editor mode! Then go to project->save project and deploy to other projects. Typically, you’ll select only your particular data collection project.

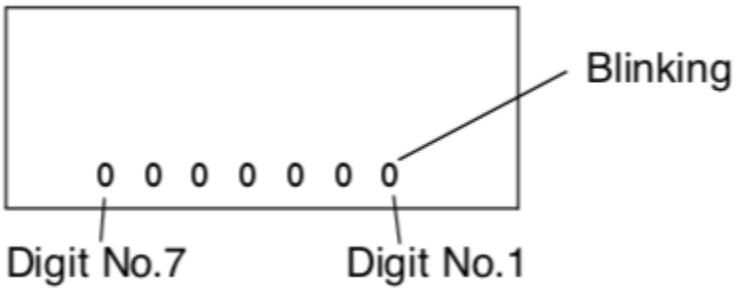
Navigating to the parent project is the simple task of changing projects in either the running of Mysticetus in editor mode or the advanced editor mode. You can learn more about this reviewing the Mysticetus Project Manager Operations Guide here: https://mysticetus.com/download/. The reader is encouraged to review this document’s discussions on this topic.

The power of the second form is the ability to manage many projects with a common set of data collection parameters. Then each project has their uniqueness defined in the parent project including theodolites. Mysticetus will set up (data collection) projects in coordination with you. Don't forget to ask!

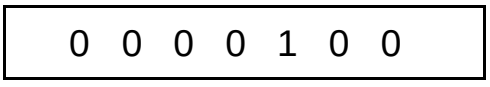
Setup Initialization of the DT205

This is a one-time task which requires that the theodolite serial communication port is enabled. The below steps are required for the DT205, older models (DT 5, DT 10, DT 501) steps may be different or not required (reference that device's user manual).

1. Enter SELECTING MODE 2 by turning the power ON while holding the [V/%] key.



2. Using the ◄ and ► buttons to select digits and the ▲ button to change the number, set Digit No. 3 to **1** and the rest to **0**.



3. Press and hold the [0 SET] key on the theodolite keypad and wait until you see 'SET' appear on the screen. Turn the power OFF.

The Vertical reference point

The Vertical reference is a known location at the water - that is where water meets an immovable object. This could be a pylon on a dock, a stick pounded into the bottom sufficiently long to protrude above the water for all tidal conditions, or maybe a bridge pylon. An ideal distance from the theodolite to the selected object is 50 to 250 meters. But it can be up to 1-2 kilometers further. Altitude reference is refreshed roughly every 30 minutes or so to capture tidal changes which also impacts calculation of distance. If you're working at Cook's inlet in Alaska 30 minutes is likely too long of a time between updates. In areas of very mild tidal changes the altitude reference may require less frequent updating. We recommend 30 minutes except for extreme areas of tidal flow such as Cook's Inlet (very extreme in this example). It is incumbent upon the user to make that determination for their area of activity.

Creating the vertical reference point requires picking one or two locations where water meets an immovable object then getting the lat/lon GPS coordinates for them using waypoint averaging with a handheld GPS. This is done at the base of the stationary object.

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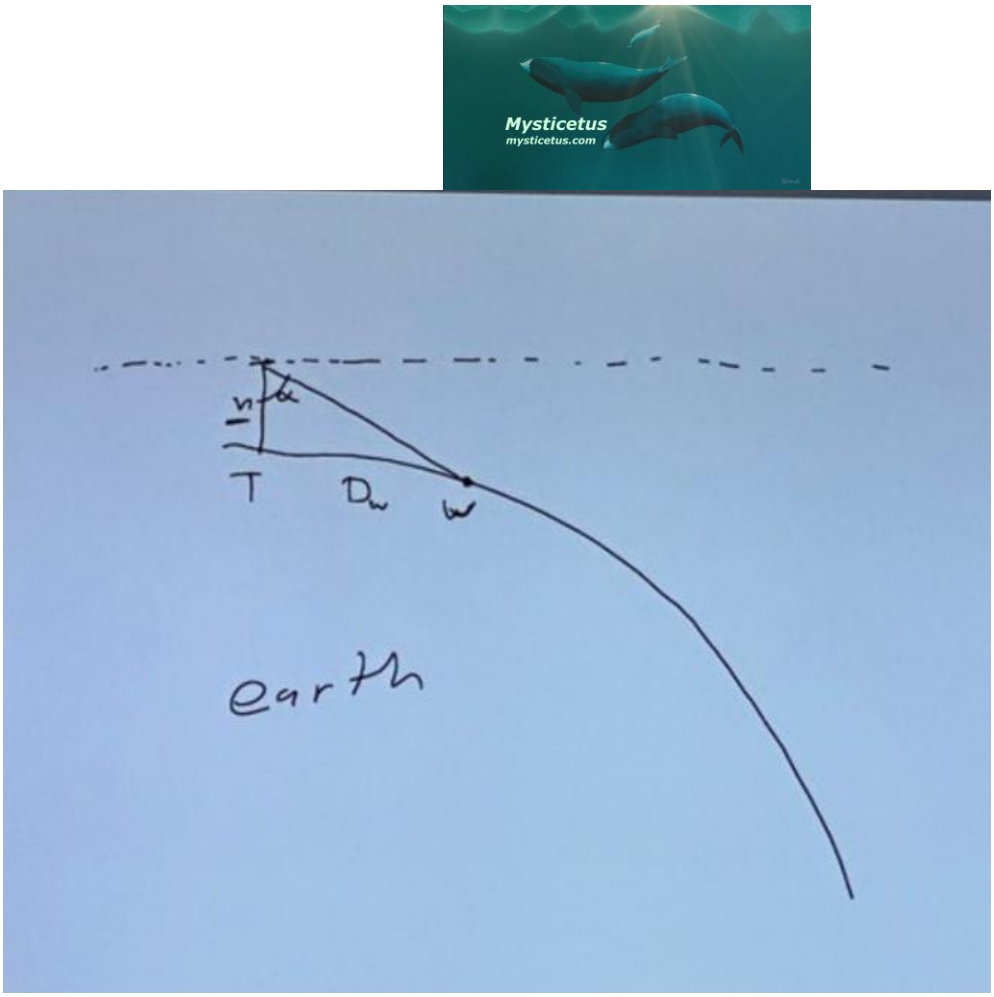

The challenge in selecting distance to the vertical reference point is error propagation due to manufacturer tolerances of the theodolite's vertical angle as the angle becomes increasingly shallow with increasing distance. This reference point is a major driver in the calculation of object distance and these errors can significantly impact this.

The Horizontal Reference

The horizontal reference is a known location in the distance. This location determines bearing to sighting. By using two measured points, theodolite position and the reference point position Mysticetus calculates true north and leverages the angle between true north and the angle between the reference bearing and bearing to the sighting to calculate angle from true north.

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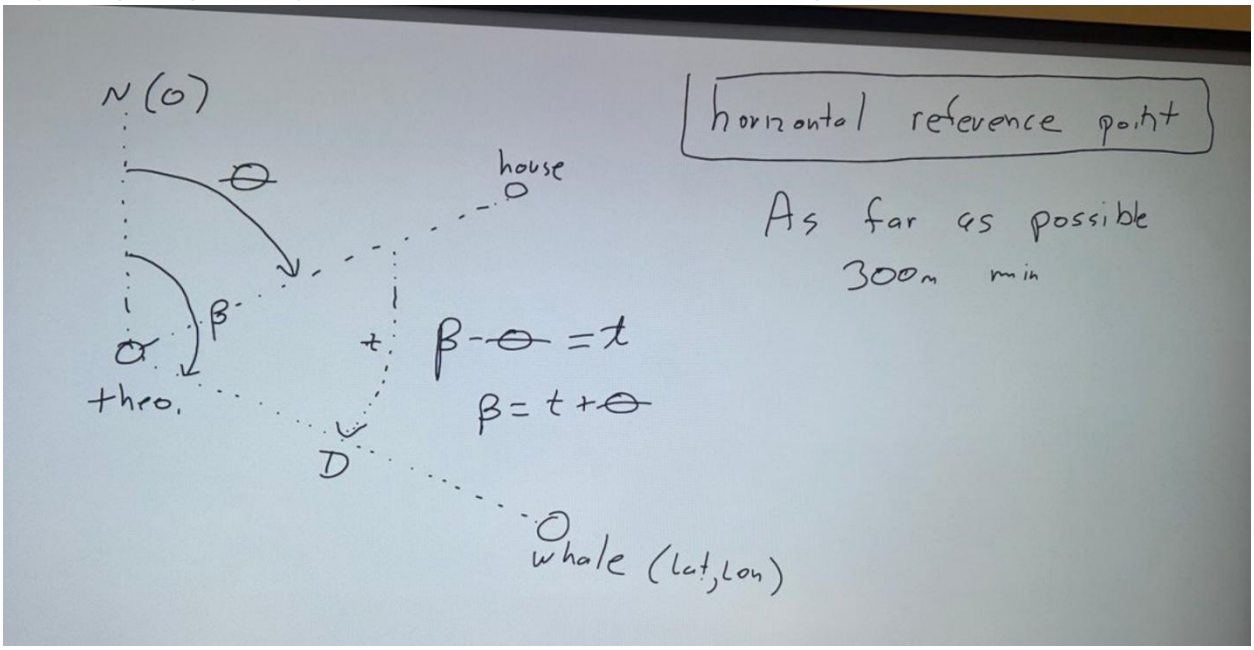
Creating the horizontal reference point requires picking one or two locations then getting the lat/lon GPS coordinates for them using waypoint averaging with a handheld GPS. This is done at the base of the stationary object.

Using the reference angle and the theodolite compute angle, τ, to a sighting mysticetus can compute the true heading angle (β) to the sighting from true north. β = θ + τ modulo 360. By modulo, mysticetus will strip 360 if the sum of the two angles is greater than 360. This solves the case where the sighting angle may be less than the reference angle, θ.



Setting your horizontal reference location is different from Vertical in that distance reduces error. We recommend around five hundred (500) meters or more. Though shorter distances will work some errors can creep in. The reference point or points should be fixed, immovable objects such as power poles, pilings, or a physical structure of some type. Avoid objects whose position could fluctuate due to influences such as the wind. Selection must have a clear line of sight to your theodolite placement and can be any point along that structure, remember that point and always use it. Again, the

latitude/longitude of this reference location is needed. This can be taken on the ground at the base of your reference point.

Reference: Bowditch's American Practical Navigator - dig in here to discover the derivative math.

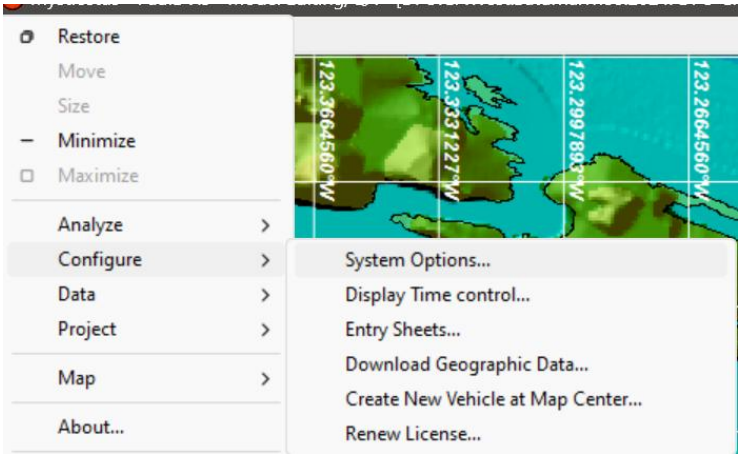
Creating Horizontal and Vertical Reference Points in Mysticetus

The creation of the vital horizontal and vertical reference points in Mysticetus is accomplished per the below process.

NOTE: If your project is a child project this must be done in the parent project and deployed to your child project via running Mysticetus in "Advanced" editor mode.

You need to create Waypoints in Mysticetus, and then assign them to the correct latitude and longitude. The following steps must be taken.

1. Choose Configure -> System Options -> Toolbar Buttons.



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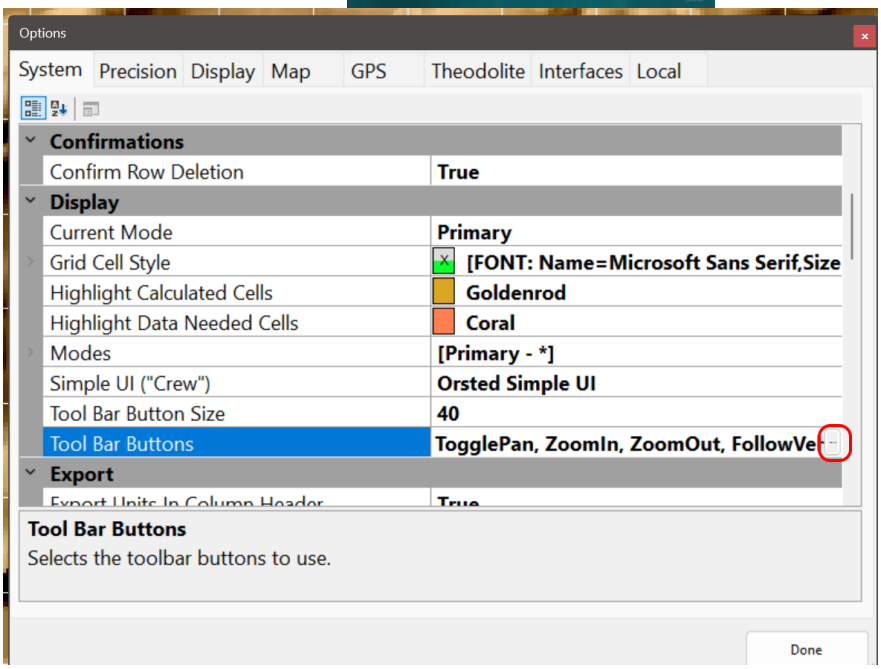
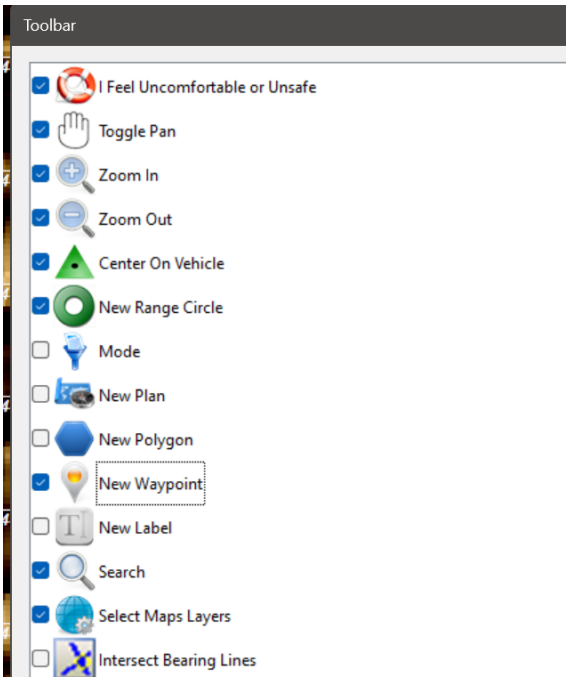


2. Scroll down to the display category. Select the ellipses to open the Toolbar configuration window



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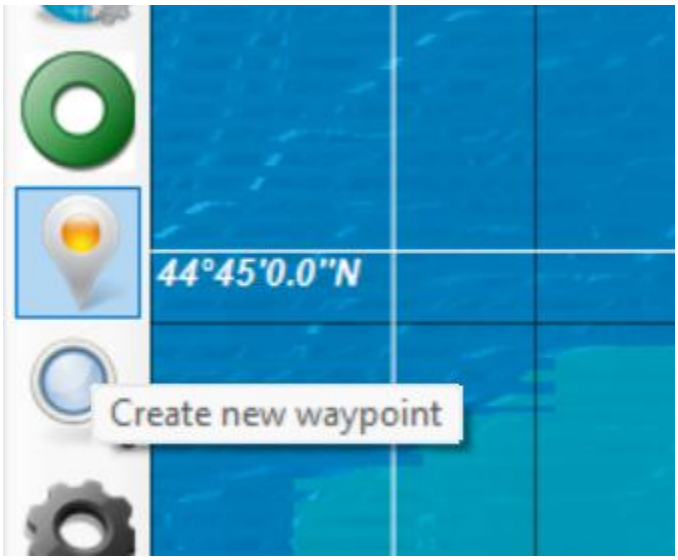
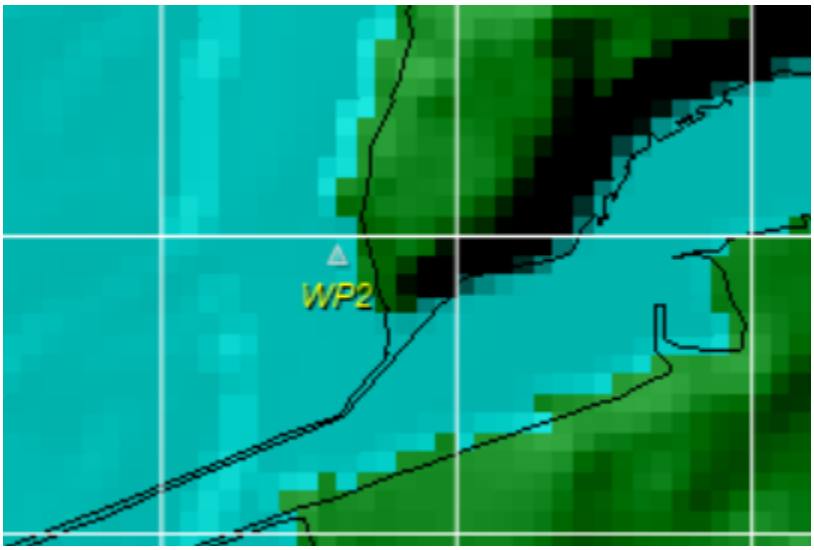
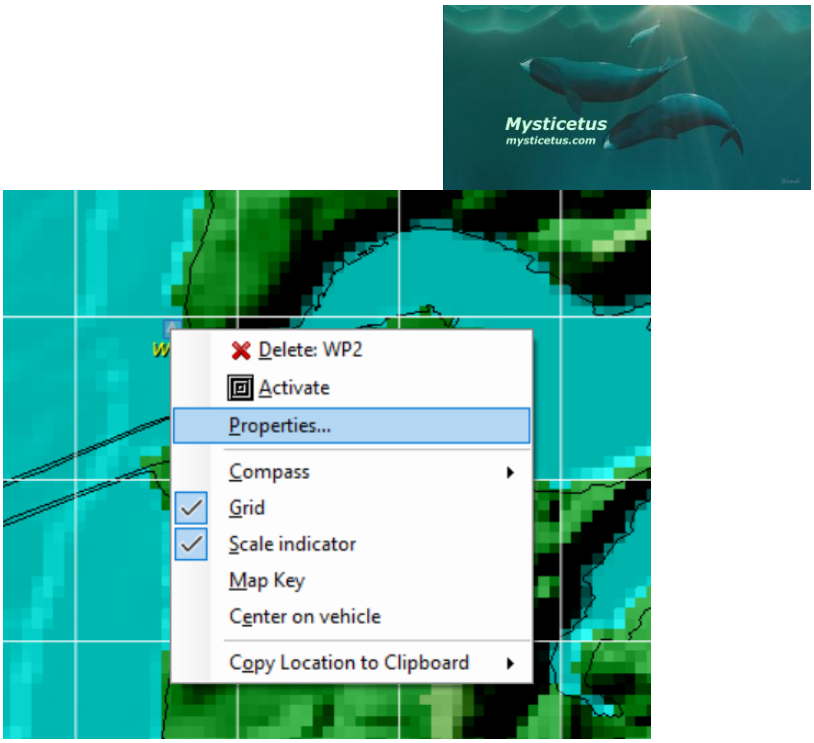
3. Enable the Create New Waypoint Toolbar button by clicking the box (this may already be selected).

1. Go back to the map, click the Waypoint toolbar button, this will cause the cursor to change shape. Then click on the map approximately near where it ultimately ends up. It doesn't have to be exact.

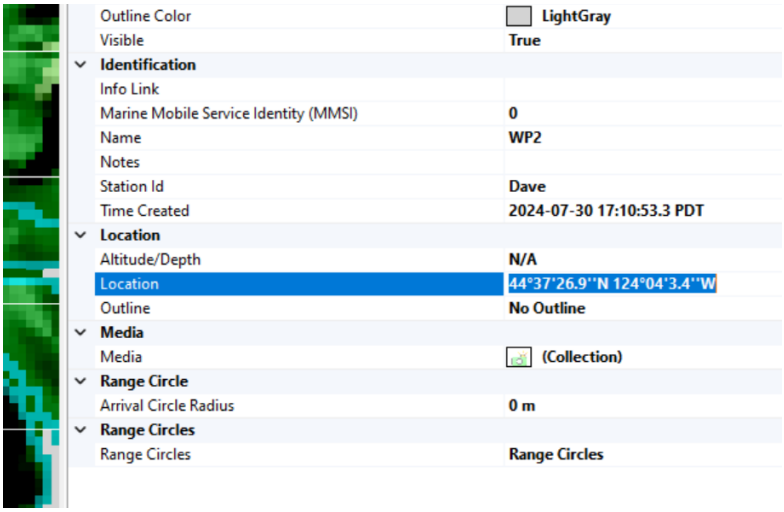




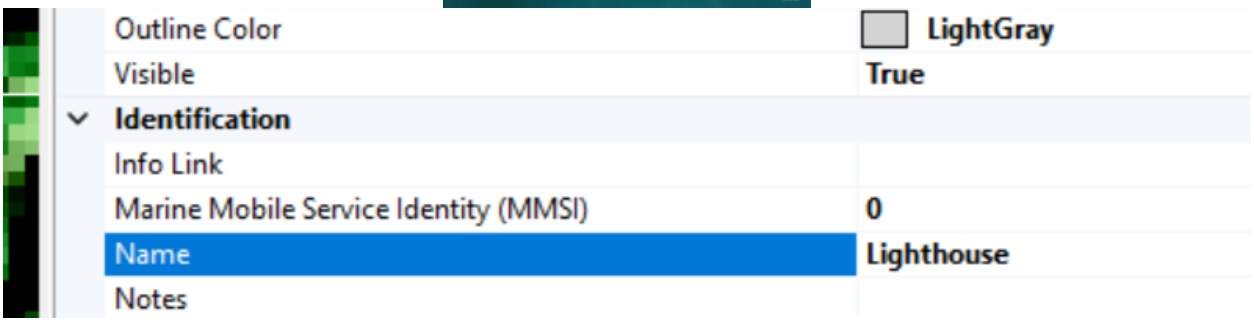
2. Right click on the new waypoint icon on the map (you may have to zoom in close to do so), choose Properties



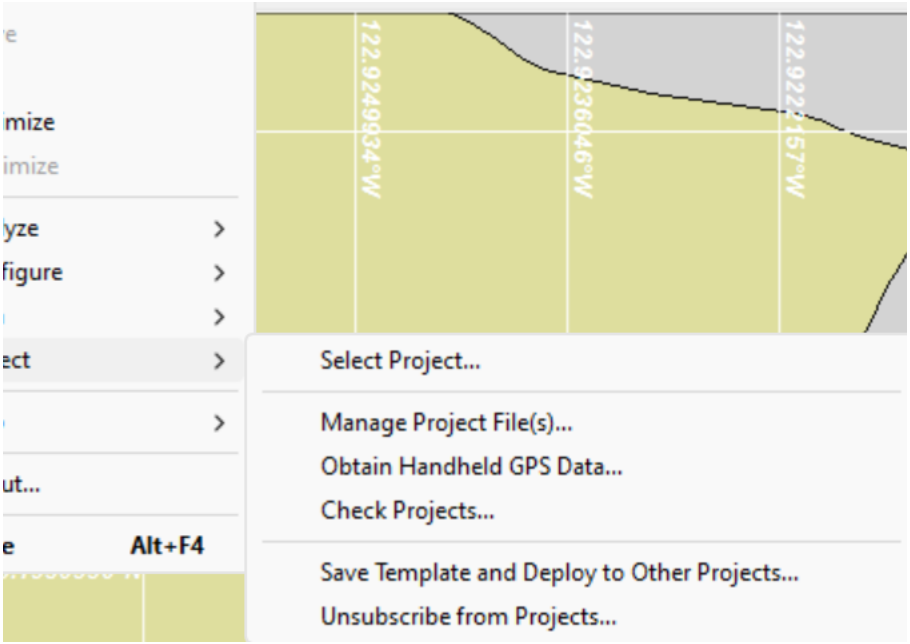
3. In the Properties window on the right, select the Location item, and paste or type in the correct latitude and longitude.



4. Select the Name field in the Location item, and enter a name for the waypoint (such as “Dock 17 Pylon”, “Granite rock at end of island”, “Crack in seawall”, “Lighthouse”, etc. These are what you will use when applying either horizontal or vertical calibrations.



5. Click Data -> Save - Save Template and save this new information into your project's template. Note: If you have been setup in the Grandparent->Parent->child relationship you will, instead, click project->Save template and deploy to other projects
    a. Then click the project selector button and click the deploy window.



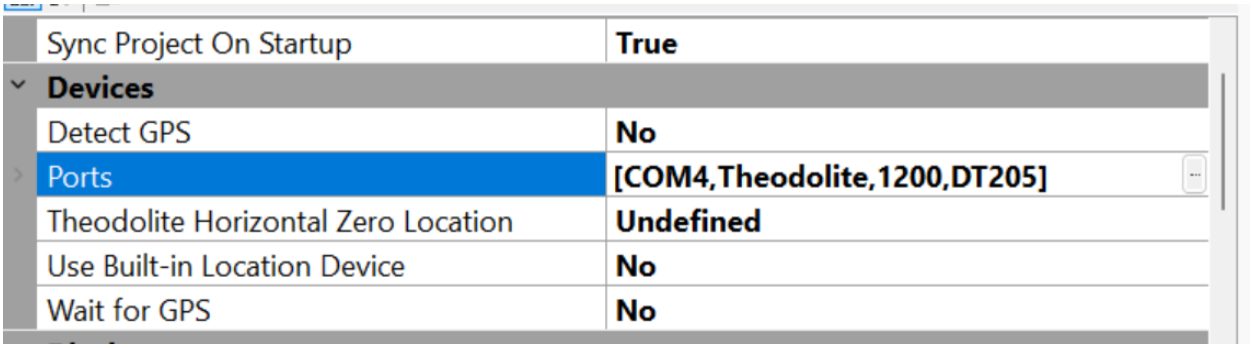
Connecting and reading the theodolite with Mysticetus has several steps involved.

Note: Setting up a particular theodolite/computer configuration is a onetime step typically. At the start of each day, you should always test the theodolite per the below.

1. Determine the com port number (eg Com 5) the theodolite is connected to via windows “device manager” application. This is used in configuring Mysticetus to correctly listen for the theodolite. You can close the device manager now.
2. Within Mysticetus editor mode - Configure Mysticetus port assignment to look for the theodolite on the in-use port (NOTE: always plug theodolite RS232 cable into same USB slot or COM assignment will change).

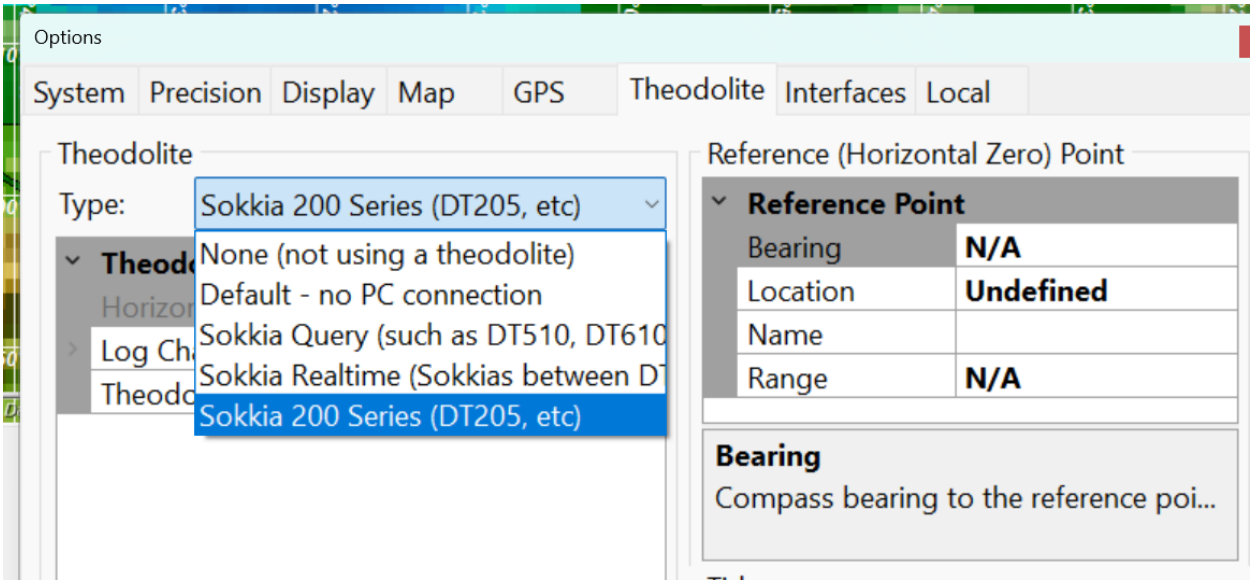
Need screen shot to local settings to set port to be com4, type

3. Note: theodolite communication speed of 1200 Baud is typical by all supported theodolites



4. Under the Theodolite tab indicate to Mysticetus which supported theodolite type is in use. Remember, these settings may be inherited

from the parent!



Initializing the Mysticetus theodolite interface must be performed whenever the theodolite is reconnected with the Mysticetus computer, typically daily.

Setting up a Theodolite in Mysticetus

The basic steps of setting up a theodolite is creating the theodolite, naming it and inputting its GPS location. For projects set up with the grandparent/parent hierarchy this'll be done there and deployed to the child project. Then the horizontal and vertical reference points are determined and inputted into Mysticetus. These two reference points are used to both set a determination of north and height above water and are mandatory steps in the accurate localization of objects of interest: animals, vessels, marine debris, etc.

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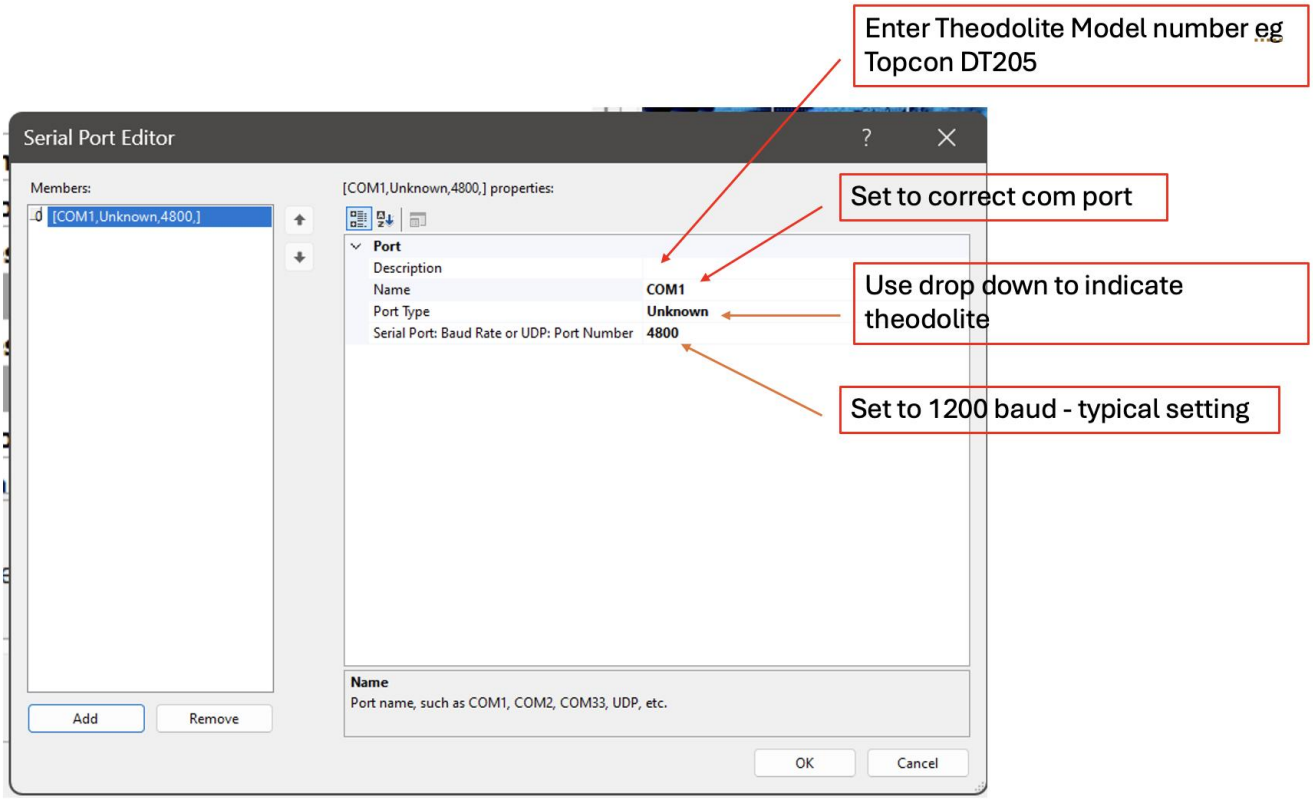

Initialization with Mysticetus requires the following steps:

Note: Follow these steps in order. For your sanity, READ and understand the steps below first!

1. Make sure Mysticetus is not running
2. Connect theodolite to Mysticetus computer and turn on computer (if not already).
3. Turn the power ON and wait for a horizontal readout to show.
4. **Press the [V/%] key to display a vertical readout** (this vertical readout step is for the DT205 only)**.** The theodolite is now ready to integrate with Mysticetus.
5. Start Mysticetus in mode “collection” and Mysticetus will detect the theodolite.

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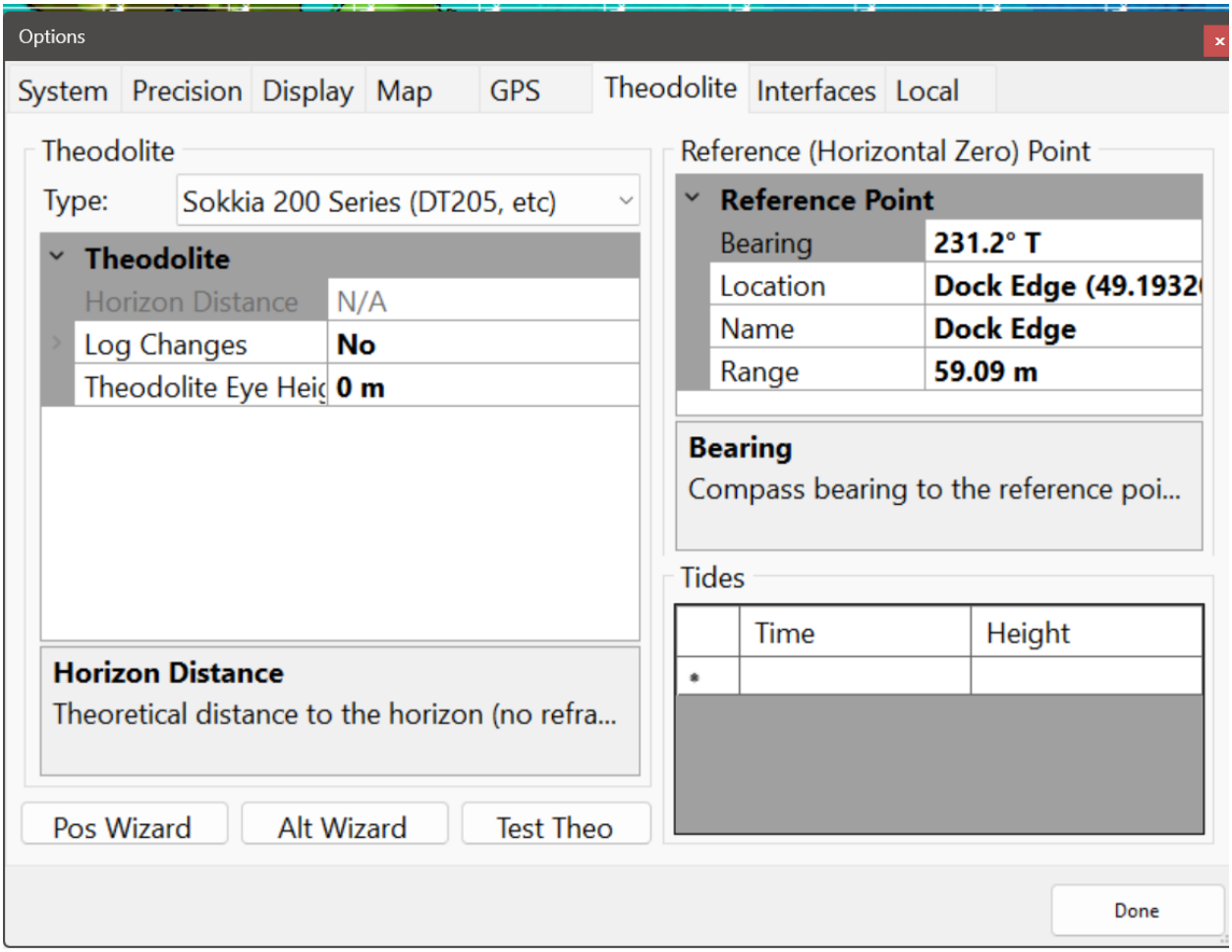
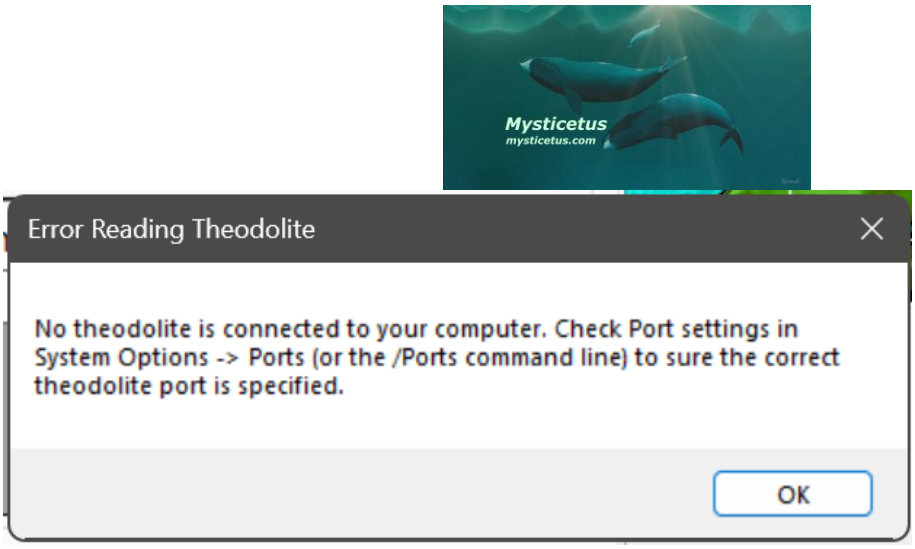
6. Test Mysticetus data capture within the theodolite interface **while running Mysticetus in data collection mode.**



Pressing the **Test Theo** button above will give you the theodolite vertical and horizontal azimuth angles if the connection is correctly defined. If it is not, you will receive an error message such as the below.



At the start of each day and periodically throughout the day Mysticetus needs to know and have refreshed the required reference points; - **Vertical and Horizontal references**.

Establish The Theodolite Height Above Water through the vertical reference point.

The Vertical reference is a known location at the water - that is where water meets an immovable object. This could be a pylon on a dock, a stick pounded into the bottom sufficiently long to protrude above the water for all tidal conditions, or maybe a bridge pylon. An ideal distance from the theodolite to the selected object is 50 to 250 meters. But it can be up to 1-2 kilometers further. Altitude reference is refreshed roughly every 30 minutes or so to capture tidal changes which also impacts calculation of distance. If you're working at Cook's inlet in Alaska 30 minutes is likely too long of a time between updates. In areas of very mild tidal changes the altitude reference may require less frequent updating. We recommend 30 minutes except for extreme areas of tidal flow such as Cook's Inlet (very extreme in this example). It is incumbent upon the user to make that determination for their area of activity.

NOTE: The theodolite's vertical angle should never exceed 180 degrees, if your angle is greater than that you simply need to rotate the theodolite head 180 degrees.

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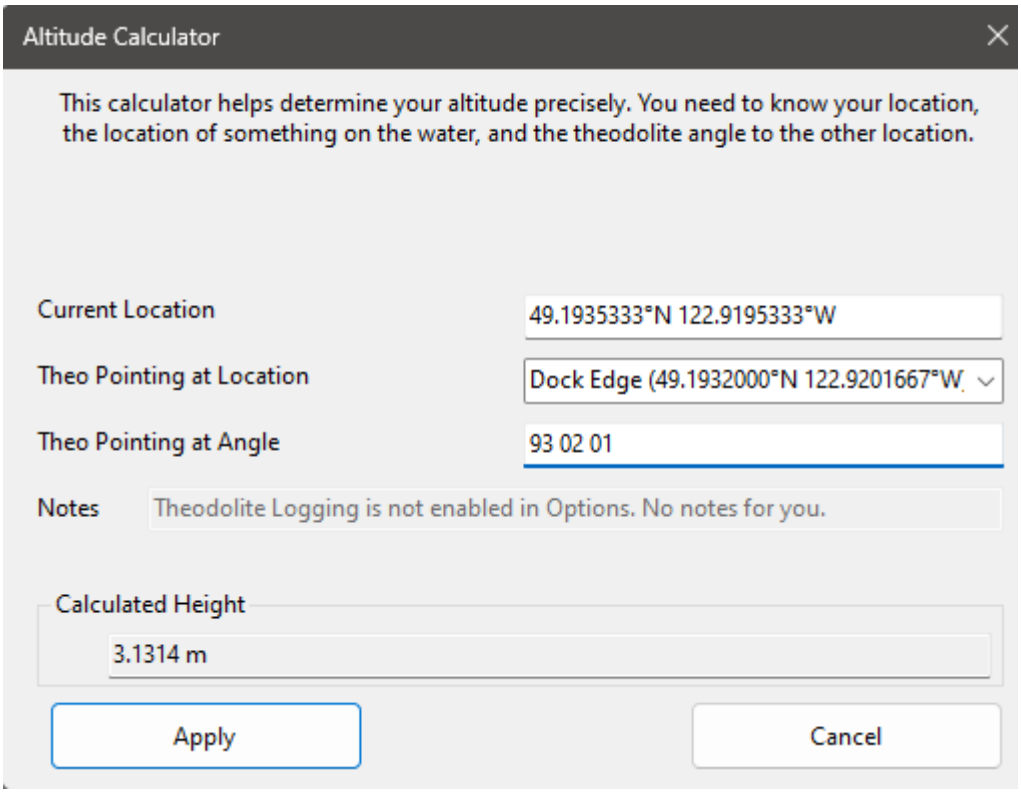

Confirm the angle matches the read out on the theodolite and hit apply.

Determine the Horizontal Reference (Daily)

Remember, the horizontal reference is a known location in the distance. This location determines bearing to sighting. By using two measured points, theodolite position and the reference point position Mysticetus calculates true north and leverages the angle between true north and the angle between the reference bearing and bearing to the sighting to calculate angle from true north.

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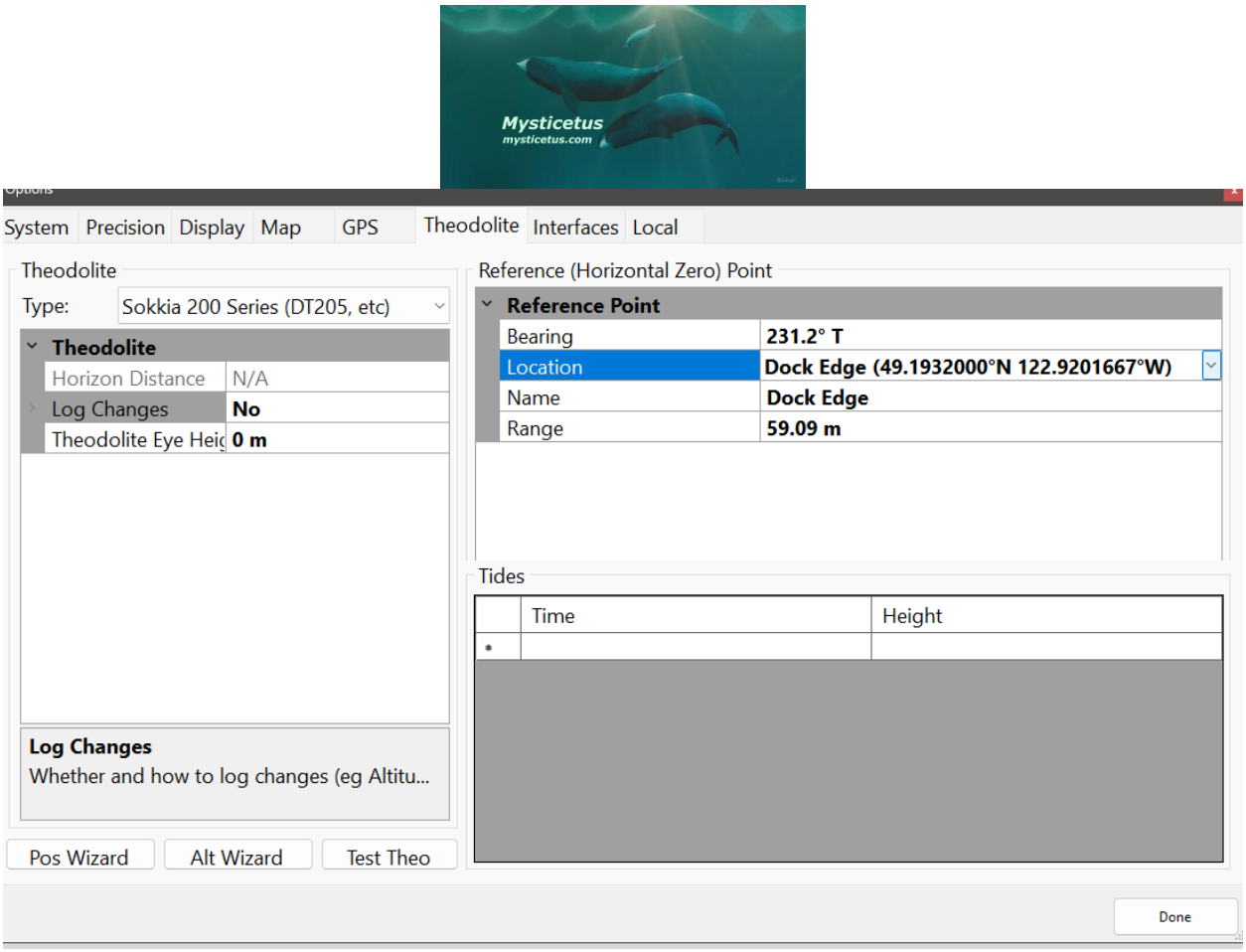

For the daily setting of the horizontal reference point align the theodolite to the horizontal reference location and press the “zero set” (0 SET) button twice on the theodolite. This step is required whenever the theodolite is moved. Moved could be the case where someone stumbles over the theodolite resulting in some movement of the theodolite - when in doubt reset the horizontal reference point.

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After hitting the “zero set” button twice the horizontal will read out as 0000 - Zeros. Make sure your referenced location, when there are multiple reference points, is correctly selected. In the above example a dock edge is defined.

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Now you are ready for data collection!

Some Important points for theodolite operation

Orientation of the theodolite viewer. When the theodolite is pointing straight up it should read zero, 0, degrees. When straight down it should read 180 degrees.

Your vertical angle should never read greater than 180 degrees. This is a very easy mistake to make. Simply spin the viewer around to fix.

When determining Lat/Lon of your reference points with a GPS using the waypoint tool or feature in your handheld GPS be sure to use waypoint averaging which'll give you best value with GPS "bounce" filtered. Using multiple waypoints for your horizontal reference point is advised in the case of one or another being obscured by weather, sudden arrival of construction material, etc.

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Additional Setting Options for DT205:

Selecting mode 2				
Digit No.	**Items**	**Contents**	**Setting value = 0**	**Setting value = 1**
1	[0 SET] key pressing once / twice	Choose once or twice for pressing the [0 SET] key.	Twice	Once
2	Compass ON/OFF	Set the function of compass (Vertical angle scale).	OFF	ON
3	RS-232 Output *1)	Set the function of sending the measured data.	OFF	ON
4	H Angle Memory	Horizontal angle set can be retained after the power is turned off.	OFF	ON
5	Tilt correction ON/OFF *1)	Set the function of the tilt correction.	OFF	ON
6 7	Unused	---	---	---

Theodolite Manuals

We have manuals for the Sokia DT200 series, DT500 series and DT5 series theodolites if you can’t find them online. Just ask.

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