Instructions for using Whalength v6

Please see https://github.com/EvaLeunissen/Whalength for the latest version of the script.

V6 updates:

- Fixed bug in 5% width calculation (bug applied to all systems except I1P photos)
- Additional width measurements 'Width at dorsal fin'
- Zooming is now proportional to size of whale in image

To run the Whalength script:

1. Unzip the 'Whalength code' zip file. This folder contains the main function 'Whalength.m' and sub-functions that are automatically called from within Whalength.m. Please do not move any of these files from the folder as it was downloaded.

2. Start Matlab. In the 'HOME' tab, use the 'open file' button in the top left to browse to the 'Whalength code' folder and open the file 'Whalength.m' - the Whalength script will open in the editor.

3. Click on the 'EDITOR' tab and press the green 'Run' button. This will open the Whalength GUI.

Whalength.m runs the GUI for measuring the length and widths of whales in images, using image information (image name, tilt angle of drone (if known) and LIDAR height) provided in an Excel sheet created by the user. The measurements for each image are given as an excel sheet output. Instructions are provided in the GUI itself in most panels and above the image.

Note: Before running the program make sure the accompanying Excel sheet (with image names and LIDAR heights etc.) follows the template exactly (see Fig. 1), and make sure the names of the folders in the excel file match the names of the actual folders exactly. This GUI was built to accommodate the image folder structure and excel sheet layout used in the present study (the code can easily be altered to accommodate different structures). This assumes:

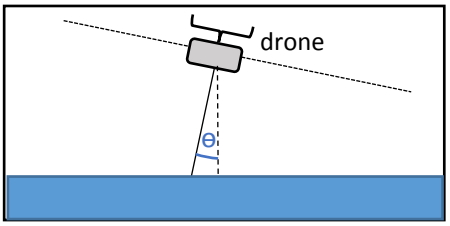
- There is a folder of images for each day, within this folder there should be subfolders within that contain the actual images (e.g. am and pm folders)

- The excel file is the same for each folder, with a different sheet for each day (the names of the sheets are arbitrary). Alternatively, a separate excel file can be made for each folder of images.

	A	B	C	D	E	F	G	H	I	J	K
1	**Folder**	Content	notes	**best image**			**Corrected time**		**Tilt**	**Lidar**	long
2	**2016-08-02am1**	mc		**DJI_0421.jpg**			**8:54:15**		**3.0**	**2595**	166.21348
3											
4	**2016-08-02am2**	mc	calf has white on tailstock	**DJI_0424.jpg**			**9:40:26**			**2916**	166.21493
5	**2016-08-02am2**	mc		**DJI_0448.jpg**			**10:22:20**		**4.0**	**2370**	166.22471
6	**2016-08-02am2**	1sa		**DJI_0465.jpg**			**10:31:44**		**1.0**	**2895**	166.22415
7	**2016-08-02am2**	mc	big lip callosities	**DJI_0477.jpg**			**10:34:26**		**2.0**	**2384**	166.22422
8											
9	**2016-08-02am3**	mc	no lip	**DJI_0497.jpg**			**10:53:40**		**4.0**	**2425**	166.22735
10	**2016-08-02am3**	mc	big lip callosities	**DJI_0504.jpg**			**10:56:06**			**2495**	166.22515
11	**2016-08-02am3**	mc		**DJI_0511.jpg**			**11:06:50**			**3064**	166.23361
12											
13	**2016-08-02am4**	2sa	both measureable	**DJI_0529.jpg**			**11:57:08**		**5.0**	**2246**	166.28131
14	**2016-08-02am4**	1sa		**DJI_0540.jpg**			**11:59:56**		**8.0**	**2915**	166.28114
15	**2016-08-02am4**	1a	low lip callosities	**DJI_0547.jpg**			**12:00:22**		**9.0**	**2551**	166.28117

Figure 1. Template for excel sheet containing image folder, image number, time and LIDAR height.

To use the code as provided, make sure the data in bold are in the correct columns, i.e. subfolder names in column A (NOTE change from previous versions, each row that contains an image name must contain a corresponding folder name), tilt angle of drone in degrees (see 'ɵ' in image below; If known, otherwise leave blank) in column I, LIDAR heights (in cm) in column J etc. 'Content' and 'Notes' are optional but, if provided in those columns, will be displayed above the image in the GUI. For Mac versions make sure to save this using .xls file type



Lens corrections

Lens distortion parameters have been calculated for one exemplar of each system - DJI Inspire 1 and 2 Pro (I1P and I2P) drone with Olympus M.Zuiko 25mm f1.8 lens - in order to correct photo-coordinates of points before calculating lengths in images. If the same system was used these corrections can be applied by the GUI (Fig. 2). This setting will be saved for future use but can be changed at any time before image processing. If using any other camera/drone systems or different image resolutions than 5280x3956 for I2P photos, 3840x2160 for I2P video stills, 4608x3456 for I1P photos or 3840x2160 for I1P video stills, the Matlab code must be altered with lens distortion parameters specific to that setup (which requires a separate calibration as described in the manuscript).

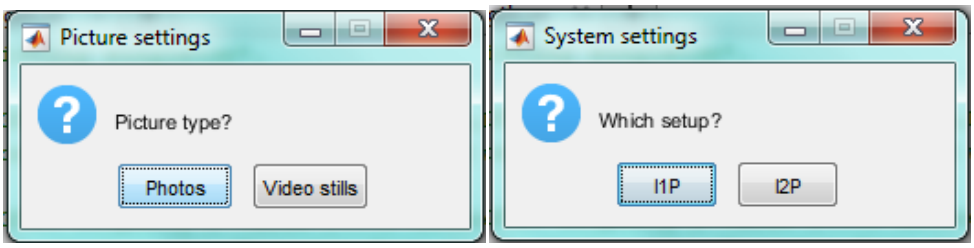


Figure 2

Offset between camera image plane and LIDAR

If the LIDAR and camera are mounted on the drone in such a way that they are at different heights from the ground, the offset can be accounted for in the GUI. A dialog box will appear after selecting the picture type (Fig. 3.1). For example, if the LIDAR is 1.5 cm higher above the ground than the camera image plane, enter the offset (-1.5) in centimetres, type a negative number if the LIDAR is higher above the ground than the camera image plane. The offset (in cm) will be printed next to the in the top left corner of the GUI next to the picture settings (Fig. 3.2). This offset will be saved for future use but can be changed at startup. The corrected height (accounting for the offset and, if provided, the tilt angle) will be given in the output excel file.

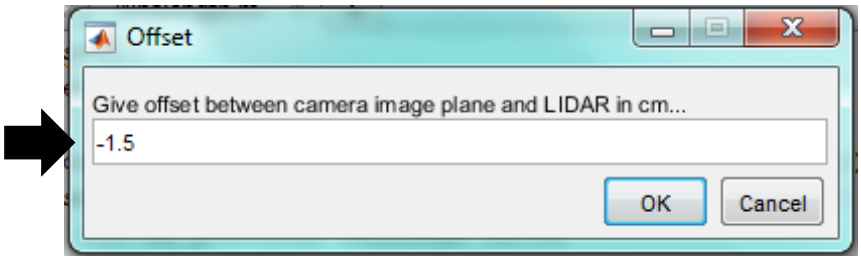


Figure 3.1

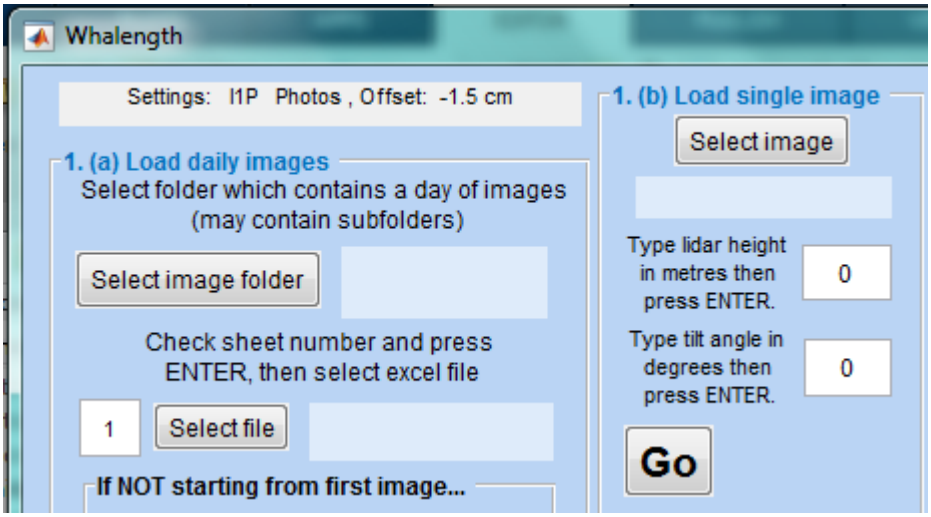


Figure 3.2

This program relies on each step being carried out in the correct order as described below. It is strongly advised to regularly check the output files to ensure it is as expected. For any questions or bugs please contact Eva Leunissen, eva.leunissen@gmail.com. See https://github.com/EvaLeunissen/Whalength for the latest version of the script.

NOTE: A folder named 'Whalength data' containing intermediate data files will be created in the same folder as the application or the shortcut to it. These files (named 'count', 'Imquals', 'fnsh', 'oops' and 'A') will be created (or overwritten) each time the program is run, and can be deleted afterward without affecting any data processing. The file named 'drone' stores the user-specified

drone/camera and offset settings. Do not delete these unless you no longer want to use these. The program will allow the user to specify settings at next startup.

Section 1. Steps for standard 'day-folder' processing

1. Click the 'Select image folder' button (Fig. 4) to select the folder that contains all the folders for a day of images (see figure 5 for subfolder structure which matches names in Excel sheet). A window will open that allows you to browse to the folder. Once selected the name of the folder will appear in the box beside the button (see figure 4).

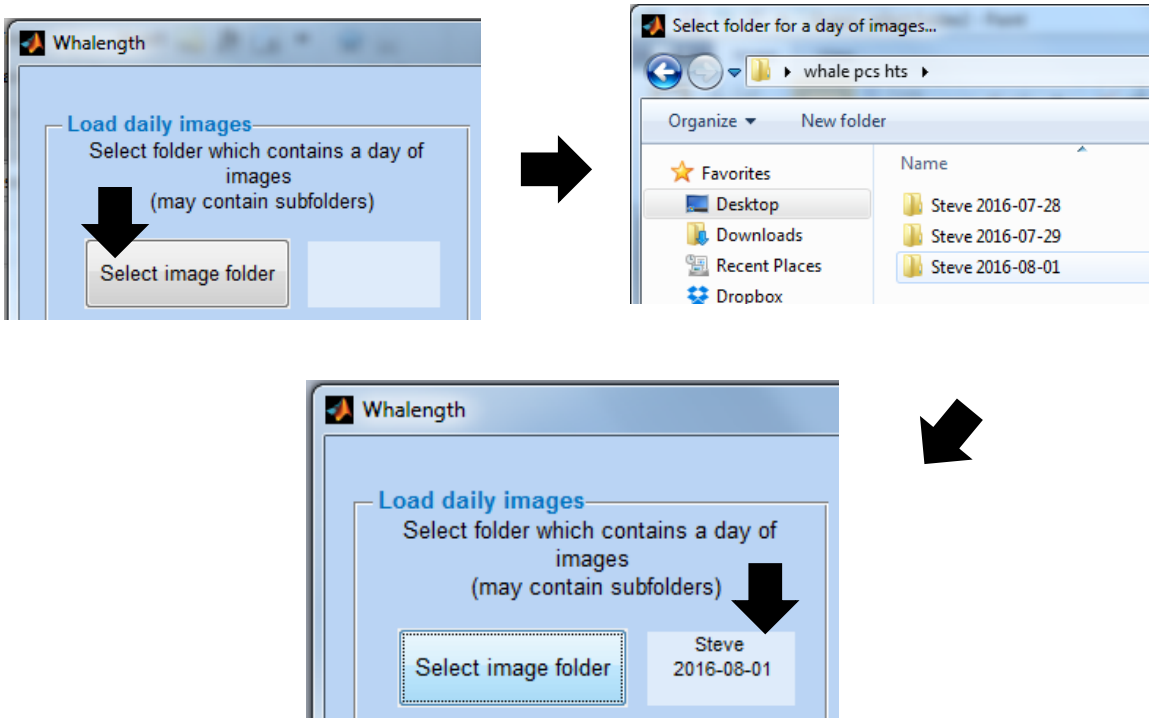


Figure 4.

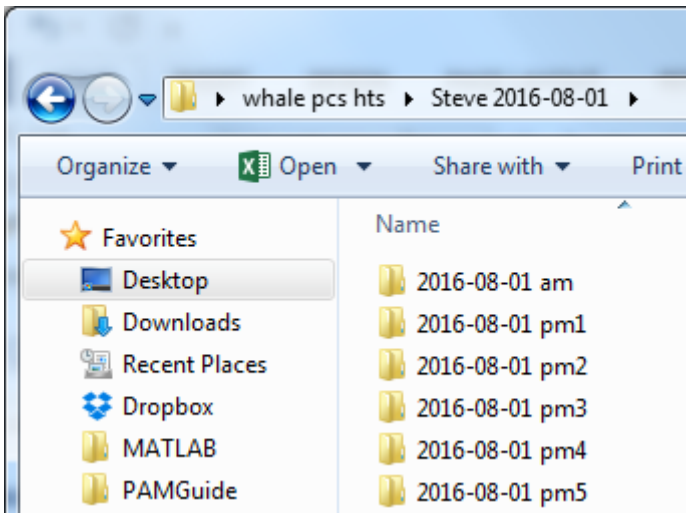


Figure 5. Subfolder structure of main folder selected in step 1. Subfolder names match those in excel sheet.

2. Change the sheet number in the white dialog box (indicated by arrow in figure 6) if the corresponding sheet number for the current working folder is different from the default ('1'). Once you have entered the number press ENTER on the keyboard. In this example the sheet which contains the data for the current folder of images ('Steve 2016-08-01') is the 3rd sheet so 3 is entered in the dialog box. Then click the 'Select file' button to browse to the excel file with image numbers and LIDAR heights (as in figure 1) - the file name will appear in the box next to the button. The file will have to be loaded each time a new image folder is loaded.

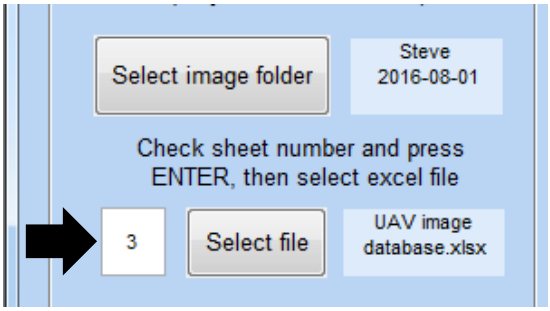


Figure 6. Step 2: select Excel sheet number which corresponds to current day of images then the file.

3. If the folder, Excel file and sheet number are all correct hit 'RUN' - this will bring up the first image and a cross in place of the mouse pointer - use it to drag a rectangle around the whale, make sure to include the entire whale (Fig. 7). The image will zoom in to this rectangle (Fig. 8), the mouse pointer will remain a cross (there were visibility issues with the crosshairs, used in previous versions of the program, on some screens).

Now there are 2 options: if the user wants to zoom on a section of the image, click the right mouse button in the region to be expanded. The zooming is set to a frame 500 pixels each side to the position clicked with the right mouse button, you cannot zoom further. Use the left mouse button to indicate the first location to measure from at the rostrum and the second location at the blowhole. Positions can be indicated without zooming.

Continue indicating points along the body axis (Fig. 9) (as many as you like, so long as they are sequential along the axis) to the notch in the tail then press ENTER. A smoothed curve will be fitted to the points and the length of this curve in metres will be displayed in the box below the image (Fig. 10). Note: If no LIDAR height was provided for the current image in the excel sheet, the length in pixels will be stored in the program to be used for width calculations, these width measurements will then be given as a percentage of the total length in the output file.

Any notes about the image can be entered into the dialog box below the image on the right, this will be stored in the output file with the measurement data.

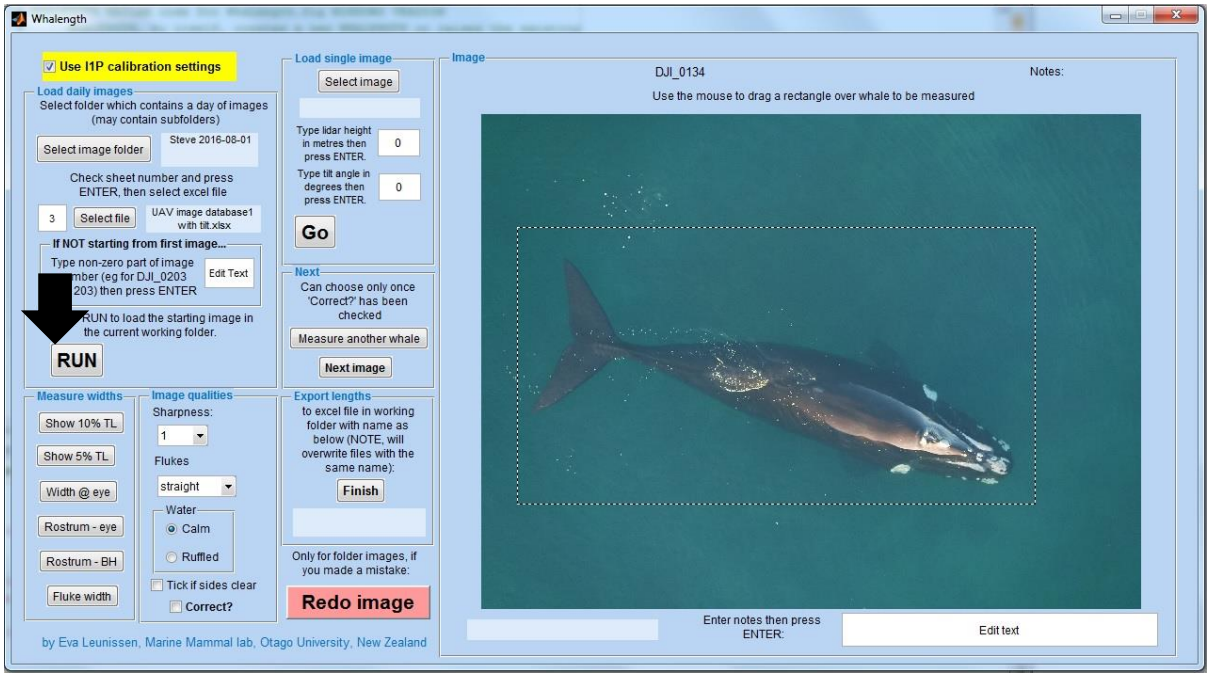


Figure 7. Use mouse to drag a rectangle around the whale

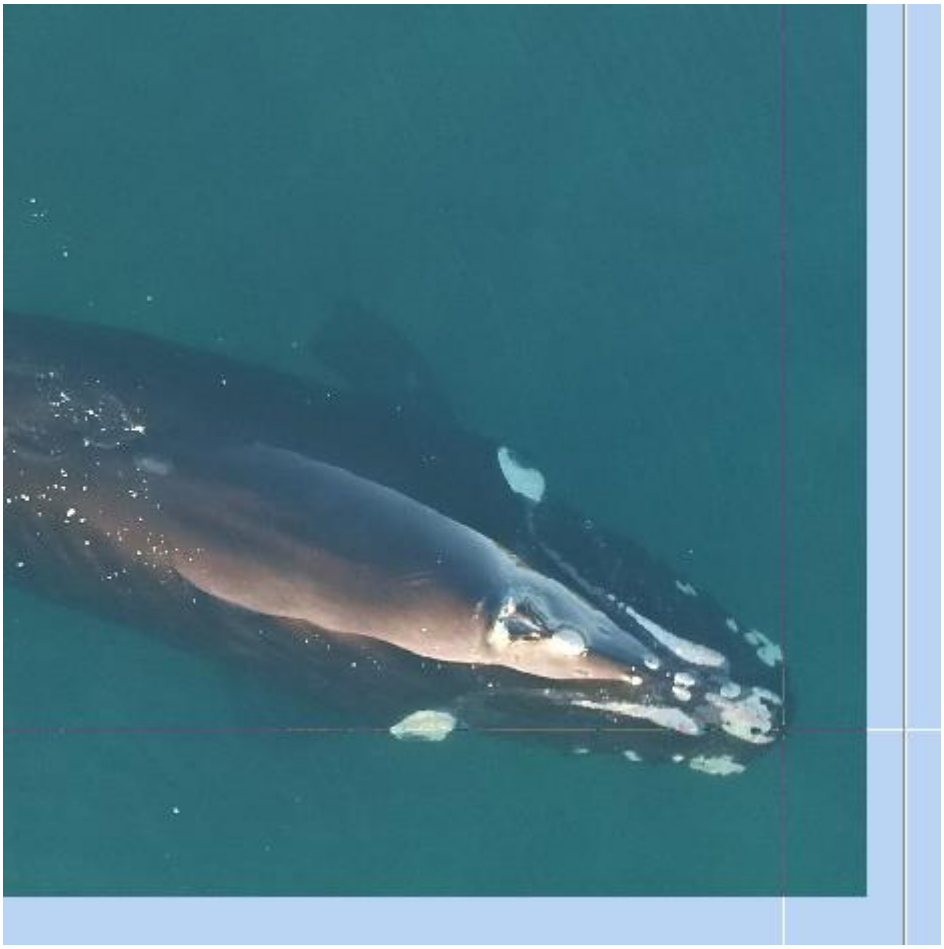


Figure 8. Using crosshairs indicate tip of rostrum as starting point for measuring length.

Figure 9. Indicate points along the body axis using the mouse, ending at the notch in the fluke

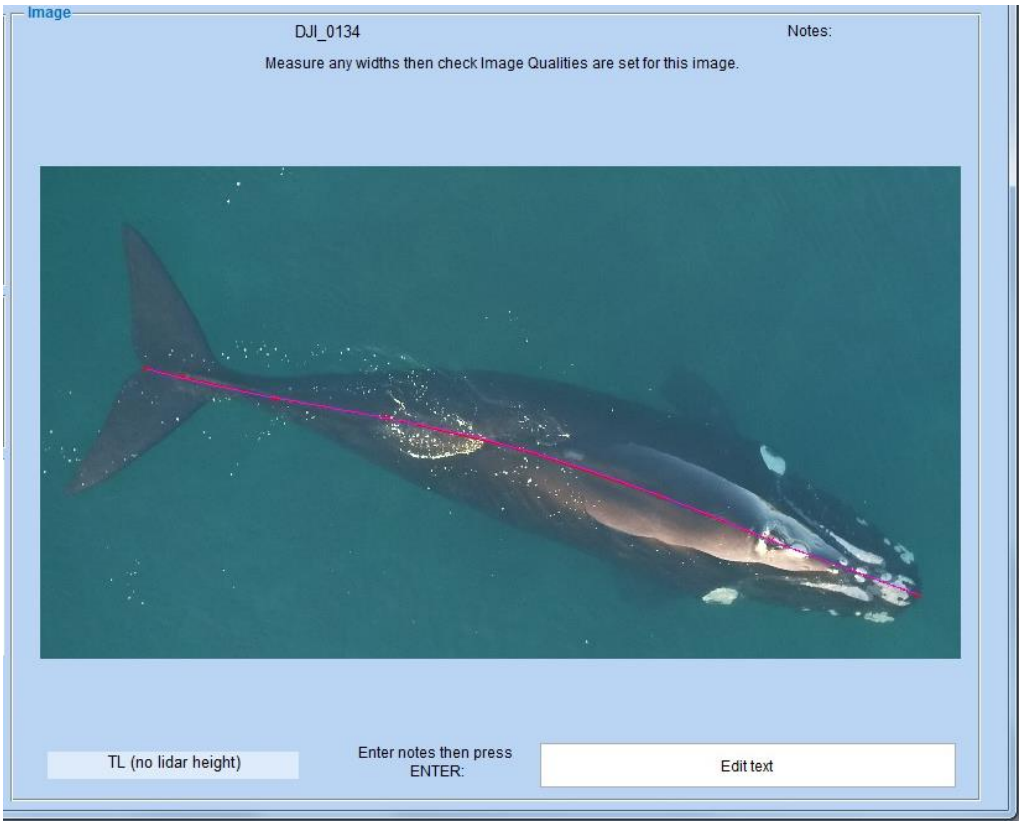


Figure 10. Press ENTER to calculate the length, the length (in m) will appear in the left box below the image

6. Using the buttons in the 'Measure widths' panel:

- “Show 10% TL” draws guiding lines at 10% intervals along the length of the whale, perpendicular to the body axis curve. Use the crosshairs to indicate where the edges of the whale meet these lines to measure the widths at these intervals (Fig. 11). If, for instance, the whale’s sides are obscured and the user wants to skip a width measurement, press ENTER.

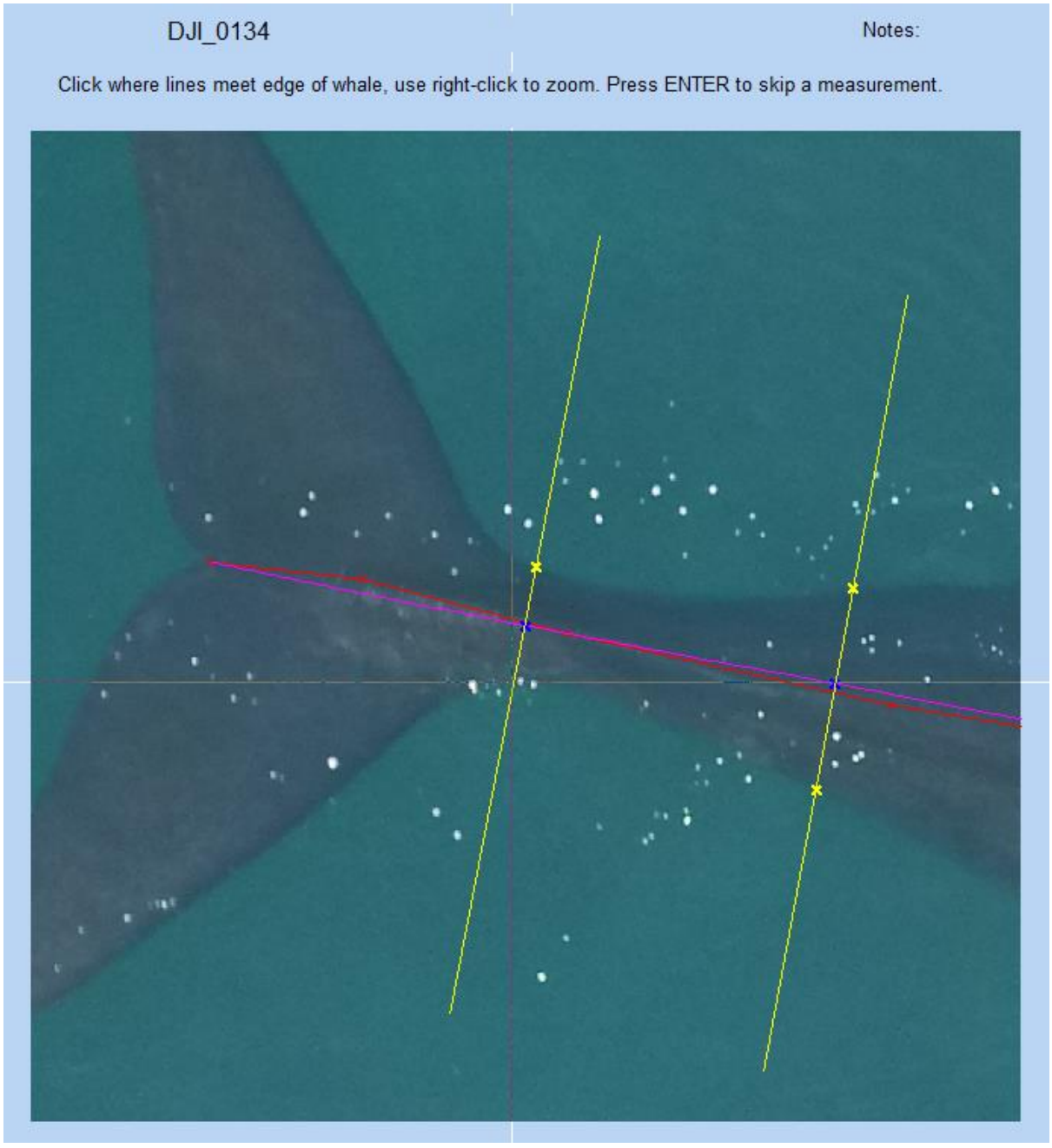


Figure 11. Yellow guide lines at 10% intervals along the body axis curve (pink line), with whale edges indicated by the user with crosshairs (shown as yellow crosses).

- “Show 5% TL”: as for “Show 10% TL” but with intervals spaced at 5% of the total length.

- “Width @ eye”, “Rostrum – eye”, “Rostrum – BH” (Rostrum to blowhole), “Fluke width”, and “BH – Dorsal fin insertion” are all measured using 2 points indicated by the user with the crosshairs which appear when any of these buttons is pressed. See for example for “Fluke width” below in figure 12.

- “Rostrum-DF” measures Rostrum to dorsal fin length, following the curve already fitted. Once this button is clicked, a cross will appear and the user indicates the location of the end of the dorsal fin. The program then redraws a black line from the rostrum, following the curve to the end of the dorsal fin.

Figure 12. Tips of flukes indicated by user to measure fluke width

7. Set the image qualities (OPTIONAL) in the ‘Image qualities’ panel: Sharpness from 1-4, fluke position – straight, @ surface or drooped; water surface – calm or ruffled, and tick if the whale’s sides are clear (or leave unchecked if not), then check the 'Correct?' box. Once this box is checked you can choose out of 3 next steps (Fig. 13):

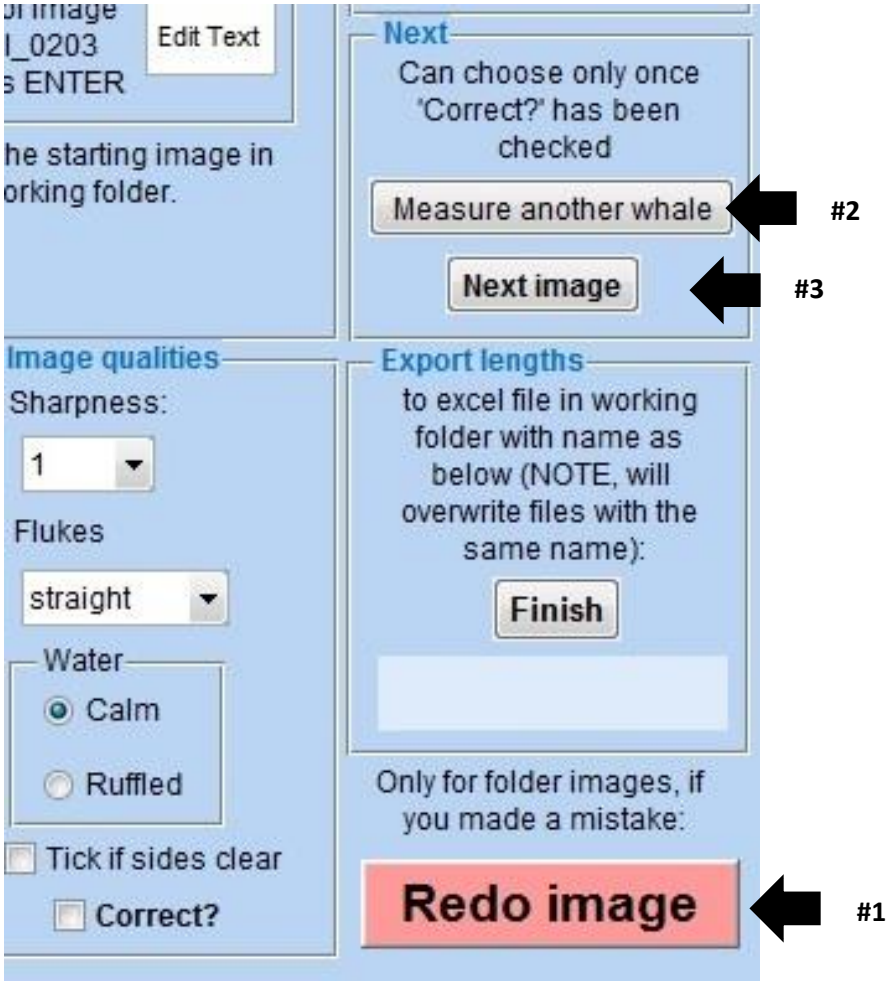


Figure 13. Three options after measuring a whale in an image.

- #1. 'Redo Image': if a mistake was made somewhere along the measuring process (e.g. drew a bad rectangle that cuts off part of the whale, drew a bad line along body axis, indicated a wrong width in the 10% interval measurements (all other width option mistakes can be fixed by simply clicking the relevant button again and cross hairs will reappear, the new measurement will overwrite the old one in the excel output) etc.) press the ‘Redo image’ button to reload the current image and start again. This button only has effect once the length of the whale has been measured and the 'Correct?' box has been checked. So, if a mistake is made early on you still have to go through these steps before pressing this button (you don't have to measure the whale properly or indicate the image qualities properly as these will be overwritten in the output file once you reload the image and repeat the measurements). This function cannot be used during single image analysis.

- #2. 'Measure another whale': if there is more than one whale in the picture press this button to restart the process for the same picture, but this time focusing on another animal. Once this button is pressed a dialog box will appear requesting a label for the most recent whale measured - this will be stored in the output excel file to help identify the whale in the image for photo ID purposes later on. Once the 'Correct?' checkbox has been ticked for the 2nd whale another dialog box will appear requesting a label for the second whale. **Note**: if a mistake has been made while measuring a second whale in the picture, it is still important to label the animals properly using the dialog box, as you will only be asked once to give identifiers. Other properties (e.g. image qualities) or measurements will be overwritten once the measuring process for that particular animal starts again.

- #3. 'Next image': Once all whales have been measured in an image use this button to move onto the next image in the folder. If the current image is the last image in the day-folder a message will appear next to the image name at the top of the GUI indicating this is the last image in the folder. At this point if you want to save the measurement data for this folder you will need to press the 'Finish' button (Fig. 14). This creates an excel file in the current working directory (which contains the day folder) with the name as shown in the box below the 'Finish' button (see Fig. 14) (Note that the output file is updated each time the 'Correct?' checkbox is checked so the measurements are already saved after each image is processed).

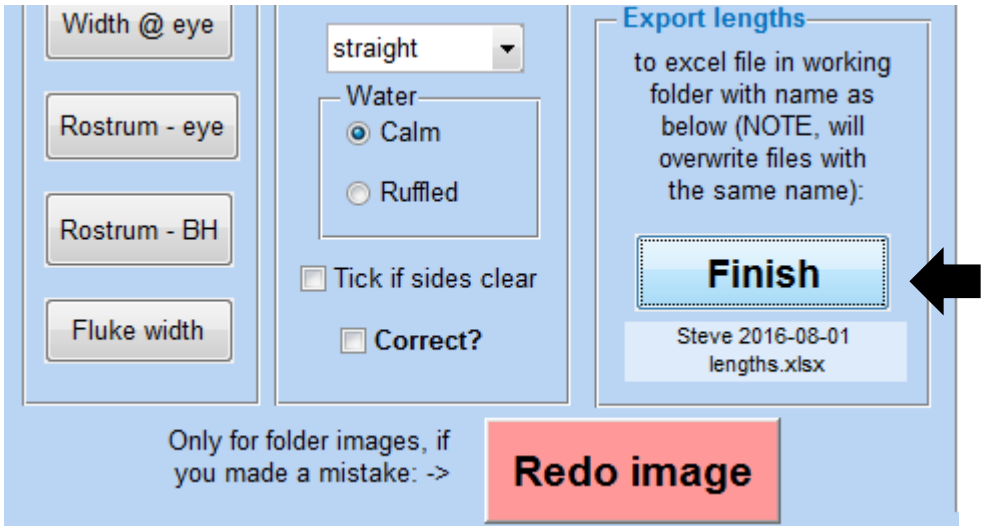


Figure 14.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1					Image quality							Body width along body axis at 10% increments				
2	Whale ID	Image date	Image time	Filename	Image sharpness (1-4)	Flukes up? (@surface/ straight/ drooped)	Water (calm/ ruffled)	Sides clear? (Y/N)	Tilt (degrees)	Corrected height (m)	Total Length (m)	Width at 10% TL	Width at 20% TL	Width at 30% TL	Width at 40% TL	Width at 50% TL
3		1-Aug-16	9:04:36	DJI_0134	1	straight	Calm	N	1.5	36.564	14.3569	1.5997	1.9604	2.4067	1.8786	1.7654
4		1-Aug-16	9:16:06	DJI_0160	1	straight	Ruffled	Y	0	N/A	TL	11.37294	16.915	20.577	19.295	18.977
5		1-Aug-16	9:36:10	DJI_0170	1	@surface	Calm	Y	2.1	29.09725	10.88406	1.5997	1.9604	2.4067	1.8786	0

Figure 15. Example output file

More on the 'Finish' button. This button can be pressed after measuring any image, it doesn't have to be the last image in the folder. The output Excel file (.csv file for Mac) will store the data of all the images measured so far. You need to create an output file for each day-folder - you cannot save data from multiple folders in the same output file. Beware that the Excel writing function creates a file

with the same name per day-folder each time images in that day-folder are processed, it will overwrite old files with the same name. Therefore if you want to save the old data make sure to rename it before creating a new output file for the same folder of images. If you do overwrite the old data it only overwrites the rows with the new rows just measured - so if there are more rows in the old file, the new file will contain rows from the old file.

Section 2. Steps for resuming 'day-folder' image processing

If the 'finish' button was pressed part-way through processing a day-folder of images it is possible to start from a user identified image in the folder (and the Excel sheet).

1. Ensure day-folder, sheet number and Excel file are entered as in step 1-2 in the previous section.

2. Enter the image name including extension in the dialog box found in the panel labelled "If NOT starting from first image…" (see figure 16). After entering the name press ENTER. NOTE this is different to the previous version which required specifying the image number only.

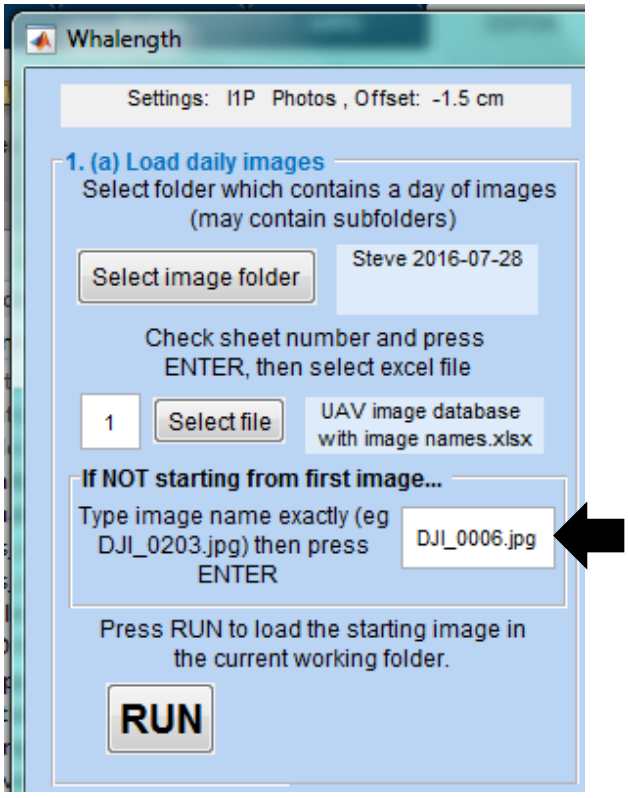


Figure 16.

3. Measure images using the process described in the previous section, steps 3-7. Note: before resuming processing make sure the file containing the previously processed images from this folder has been renamed by the user (e.g. Steve 2016-08-01 lengths **part1**.xlsx) otherwise the output file created from the current process (which will have the same default output filename as it is the same day-folder) will overwrite the old one.

Section 3. Single image processing

The measurement process can also be carried out on single images, rather than a folder of images, and does not require a corresponding Excel sheet.

1. In the panel labelled 'Load single image' click the 'Select image' button and browse to the image to be processed. Once the image is selected the name will appear below the button (see figure 17).

2. Enter the LIDAR height in metres in the dialog box then press ENTER, if not known leave as '0'.

3. Enter the tilt angle (if known) in the second dialog box and press ENTER.

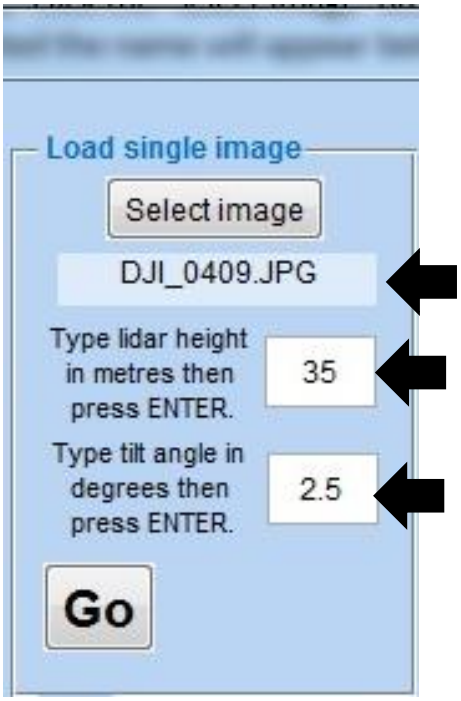


Figure 17

3. Press 'Go' – this starts the same process as 'Run' but for the single image. Measure as described in section 1 steps 3-7. Once all whales are measured in the image press 'Finish' - this creates an output file in the same folder as the image. The 'Redo image' button does not apply in single image processing.

NOTE: If continuing with day-folder image processing (section 1 and 2) following single image processing, **please restart the GUI** (*before* continuing with day-folder image processing) to ensure any stored image names are cleared.