Echoview Tutorial:

Introduction to Multibeam Target Data Processing

Contents

Overview

This tutorial is optimized for Echoview 15 and provides an introduction to target detection and analysis in multibeam data, such as imaging sonar data.

This tutorial is not intended as a comprehensive user manual.

Further information on Echoview tools and topics can be found in the latest version of the Echoview help file. This can be viewed online and is installed with Echoview. Press F1 when using Echoview to open the help file and read context-sensitive information.

Throughout this tutorial further reading is referred to the Echoview help file or other Echoview training materials: https://www.echoview.com/support

Prerequisites

This tutorial assumes you have Echoview installed, and the following skills and knowledge:

- Familiarity with the basic operation of Echoview. We strongly recommend that you complete the "Getting Started with Echoview" tutorial before beginning this tutorial.

- Familiarity with a supported Microsoft Windows™ operating system. For more information refer to the Echoview Help file page: Computer requirements.

- A basic understanding of echosounding techniques and hydroacoustic surveying. For more information, see texts such as *Fisheries Acoustics* (Simmonds and MacLennan, 2005, Blackwell Science, Oxford.).

- Microsoft Excel or a similar viewer for spreadsheets.

Echoview modules

This tutorial requires the Essentials and Multibeam Fish Tracking modules. The optional Automation module is used to run scripts. If you do not yet have access to an Echoview license with these modules, please contact info@echoview.com to request an evaluation license. Solution files are also included in the tutorial package to allow you to see the results of module-protected capabilities. Within the solution EV file, Marker regions indicate tutorial selection areas.

Contacting Echoview

For assistance with this tutorial please contact support@echoview.com.

Set up

We recommend extracting or copying the tutorial files to `C:\Echoview Software\Tutorials\`. If the files are not in this folder, use Windows Explorer to search for them. If they are not loaded on your machine, download and reinstall the tutorial from www.echoview.com or from the Echoview USB drive.

Troubleshooting

If you receive a message saying that the version of Echoview you are running cannot read the file you have opened, you may be running an old version of Echoview. You can download the latest version of Echoview from www.echoview.com.

Topic 1: Multibeam target data processing overview

Data characteristics

When you view multibeam data, particularly imaging sonar data, you can see fish swimming past the transducer. You internally process the time series information about fish shape, fish position and the strength of a fish echo.

The same data can be automatically processed and analyzed with software to estimate fish flux.

There are advantages in human analysis:

- sophisticated image and pattern recognition
- expert knowledge

There are advantages in software analysis:

- the ability to process large amounts of data
- the ability to work with data that the eye can miss
- the ability to automate routine analysis
- the ability to provide objective results

An effective and efficient analysis approach combines those two methods of analysis.

Workflow

The analysis of multibeam data is done in two stages: the development stage and the routine analysis stage. Both of these stages are discussed in detail in Appendix 1: Stages of multibeam target workflow.

Although there are many ways to approach or customize multibeam data analysis, the steps presented in this tutorial consists of:

| 1. Raw data, as recorded by the echosounder | 2. Background removal | 3. Data smoothing | 4. Multibeam target detection |

5. Data filtering, e.g. target length	6. Conversion of multibeam target data to single beam target data.	7. Fish track detection	8. Exporting fish track metrics, then performing further analysis such as flux calculations, fish property correlations.
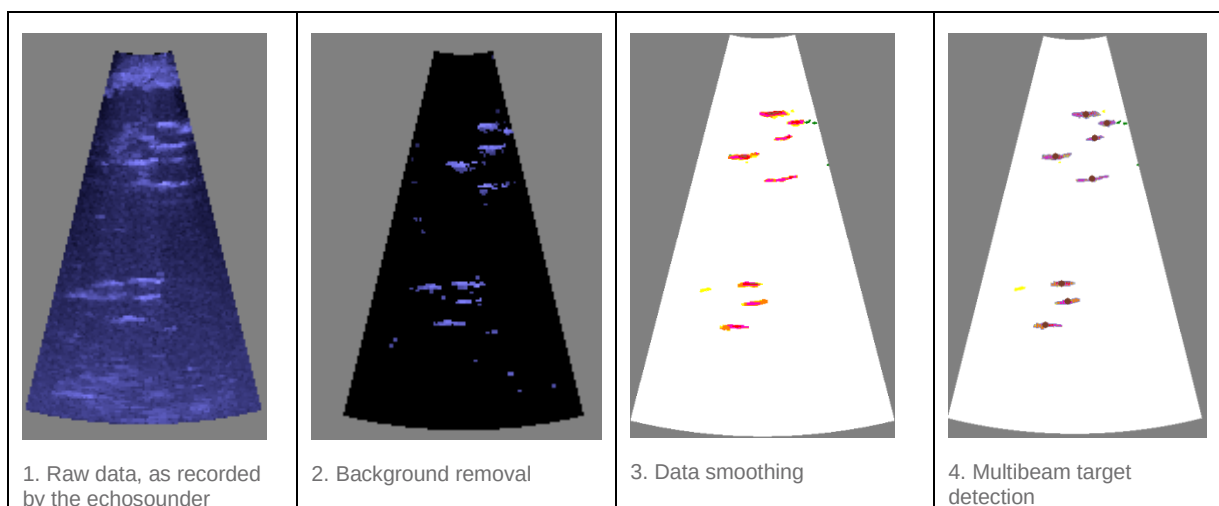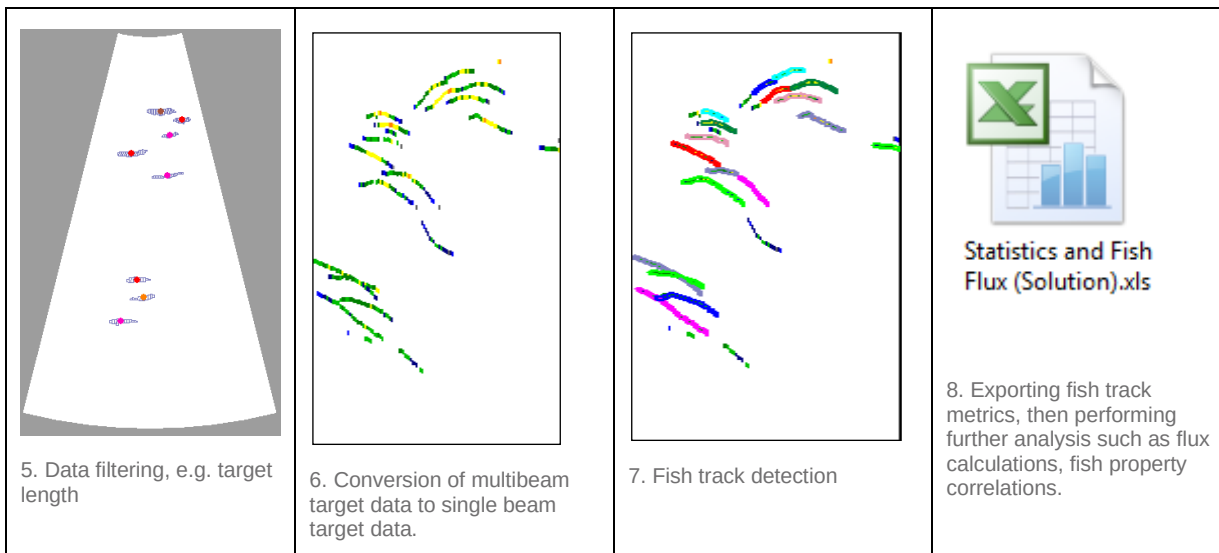
To see this in practice, we will examine a DIDSON EV file that has echograms showing each step.

1. Start Echoview by selecting it from the **Start** menu or by double-clicking the Echoview shortcut on the desktop.

2. On the **File** menu, click **Open**.

3. Browse to and select and open the MultibeamTargetDataProcessingOverview.EV file.

4. On the **Window** menu select **Arrange All.**

Figure 1. MultibeamTargetDataProcessingOverview.EV echograms, synchronized to show ping 34.

The echograms are in an auto-synchronized group. The color scales are optimized to display the data of interest.

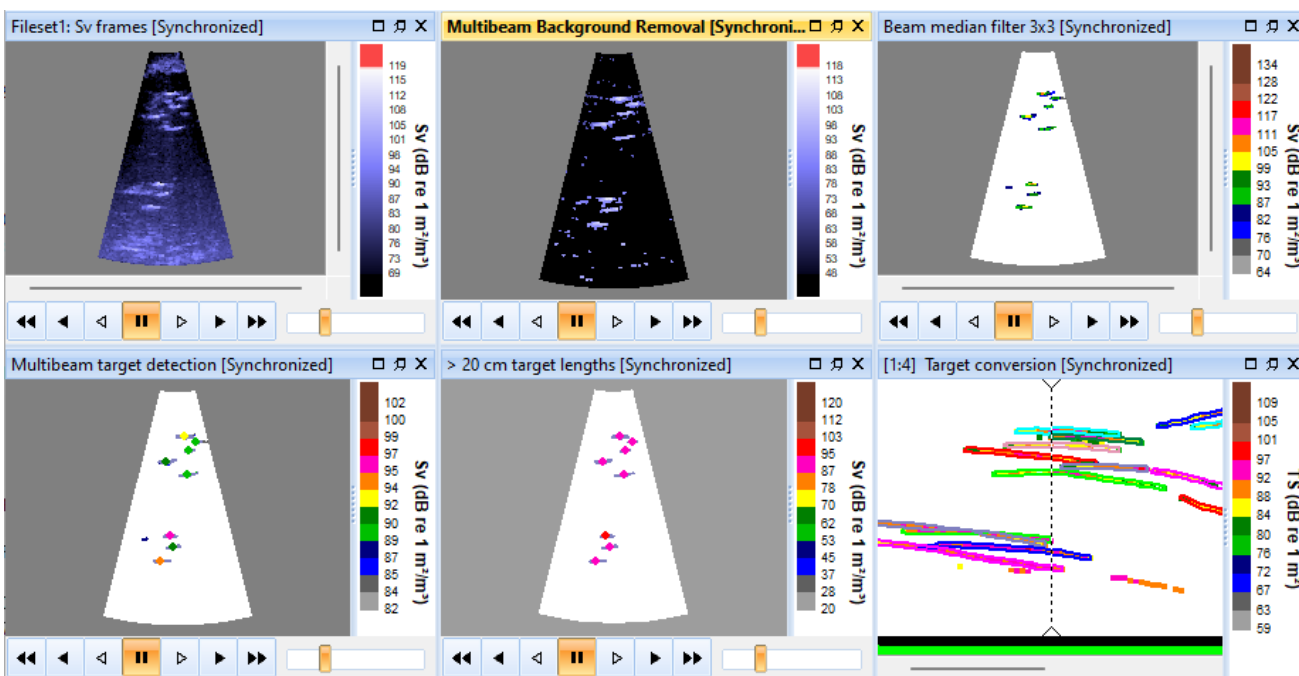| Variable name	Description
Sv frames	Displays the multibeam data.
Multibeam Background Removal	Displays the multibeam data with the background removed.
Beam median filter 3 x 3	Applies a median filter to the previous data. This step improves the definition of the targets.
Multibeam target detection	Applies a multibeam target detection algorithm to the previous data. Solid circles represent the detected targets. Outlines represent samples in the target.
> 20 cm target lengths	The Target property threshold operator applies a minimum target length threshold of 20cm to the target data.
Target conversion	Converts thresholded multibeam target data to single target data. Fish tracks have been detected on this echogram.

5. This shows the progression from raw data through noise reduction to specific detected multibeam targets. On the **File** menu, click **Close**.

Further information

- The latest information about new or improved multibeam and single targets operators appears in the Echoview Help file.

- New information about Multibeam target detection and new Target properties appears in the Echoview Help file under the **Contents** tab, **How to…** book**, Detect and Work with Multibeam Targets**.

Topic 2: Viewing multibeam data

To view multibeam data in Echoview you need to:

- create a new Echoview EV file

- add a multibeam data file to a fileset

- calibrate the data if you have calibration values

- examine the data

Create an EV file

1. Start Echoview.

2. On the **File** menu, click **New**. If the New EV File dialog box is displayed, click **No Template**.

3. For Fileset 1, in the Data Files section, click **Add**.

4. Use the Add Data Files dialog box to find the data file `2002-07-15_#018_HF_S001.ddf` and click **Open**.

   This data has been collected from a fixed platform with the transducer pointing across a river. GPS information is not included in the data file.

5. On the **Dataflow** window ![icon] click **Platform1,** on the **Shortcut** menu select **Platform Properties**.

6. On the **Platform Properties** dialog box select the **Position** tab
   Under **Platform type** select **Fixed** (if you had the GPS location for the fixed platform, you can enter location co-ordinates under **Location of GPS antenna**.).

7. Click **OK**.

Tips

- Echoview uses EV files to organize data files and filesets. You might create a single EV file containing all the data for a complete survey, an EV file for each transect of a survey, or an EV file for each day of a survey.

- Data files are never modified by Echoview.

- Refer to the Echoview Help file for more information regarding:

   o Filesets

   o EV files
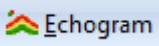
Calibrate

This DIDSON data can be displayed in DIDSON viewer software provided by Sound Metrics. The DIDSON software reports that the following information is recorded in the file:

- Under the Transmission Loss (2*A*R +N*Log R) Processing Parameters section:

   o Temperature = 9 ˚C

   o N = 40

   o A (Auto) = 1.1065 (Value for Absorption coefficient, modelling equation is unknown)

- Sound speed is 1457 m/s

- Frequency is 1.8 MHz

The Echoview Help file page, Sound Metrics notes, discusses the DIDSON transmission loss equation and lens mount orientation with respect to Echoview settings.

Other multibeam file formats may record instrument and environmental calibration values and Echoview may be able to read such values. When Echoview can't obtain calibration data, it uses default calibration values. It is advised that you assess whether default values are suitable for your data. An Echoview Calibration Supplement (ECS) file can be used to specify or overwrite calibration values.

8. On the Filesets window, in the *Raw variables* section, click **Sv frames** (to highlight).

9. Click the **Echogram** button .

10. In the echogram window, right-click and select **Variable Properties** (or press **F8**).

11. Click the **Calibration** tab of the Variable Properties dialog box. The settings are red, which indicates that they are all default values and not read from the data file.

12. Close the Variable Properties dialog.

13. In the Filesets window, click the **New** button in the **Calibration** section. At **Name** type DIDSON_Example and then press the **Save** button.

14. If prompted, use **Notepad** or another text editor to view ECS files.

15. An ECS file with default SOURCECAL settings will open in your text editor. In the ECS text file delete the comment symbols (#) at the start of the lines for the following settings, and enter the following values:

    AbsorptionCoefficient = 1.1

    SoundSpeed = 1457
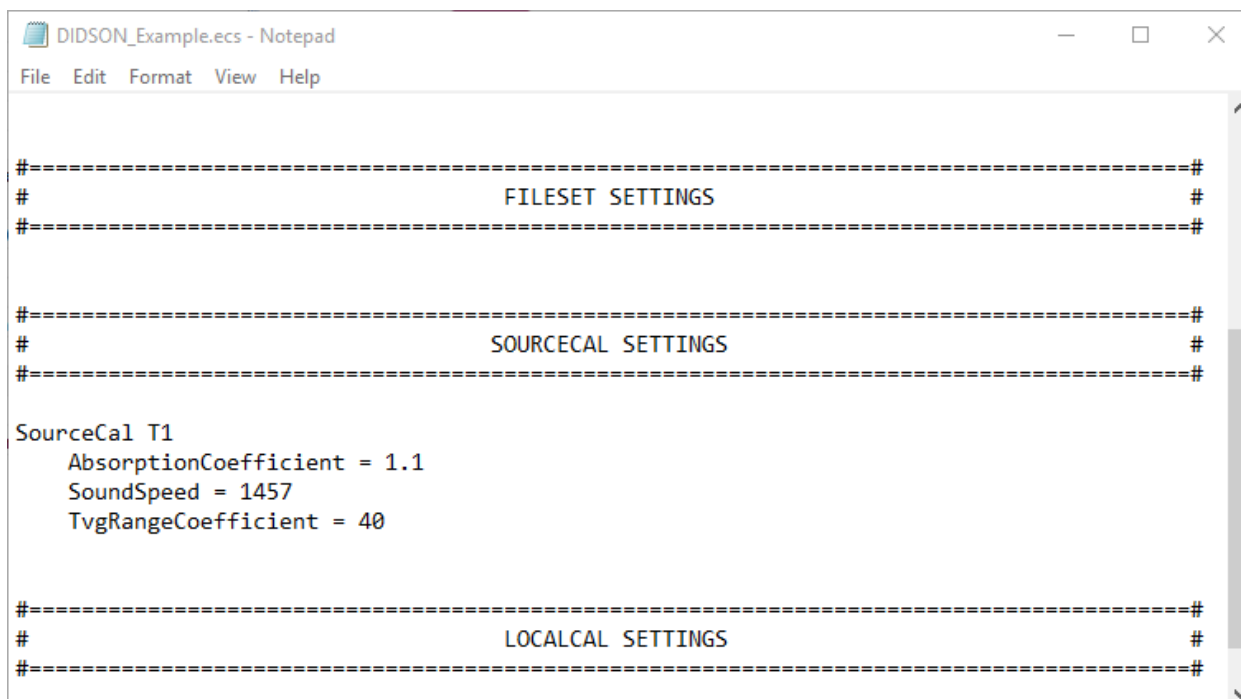
    TvgRangeCoefficient = 40

Figure 2. DIDSON_Example.ecs file with calibration setting edits.

16. Save the ECS file changes.

17. You will notice that the data in the Sv frames echogram looks different. This is because of the calibration settings that have been applied. Save and close the ECS file.

Tips

- The DIDSON color scheme gradually fades to black and as a result it can be hard to distinguish threshold values just above the color display minimum. You can try using another color scheme when tuning thresholds by eye.

- If real-world target locations are important, Echoview offers Transducer geometry settings for Location and Orientation.

- Sound speed and absorption coefficient in fresh water can be calculated. Echoview offers a Sonar calculator that calculates sound speed and absorption coefficient. It is available under the **Help** menu, **Sonar Calculator**. It is advisable to review the equations used by the Sonar calculator because the modelling equations have restrictions.

- Refer to the Echoview Help file for more information regarding:

    o Multibeam and imaging sonar data formats

    o Color schemes

    o Transducer geometry

    o Calibration

Inspect

18. In the Raw variables section of Fileset1, click **Sv frames**.

19. Click **Echogram**.

20. Use the DVD controls to navigate the frames of the echogram. Drag the slider to quickly view the ping data.

21. Press **F11** and **F12** to change the Color display minimum.

22. Right-click the Color Legend. Enter:
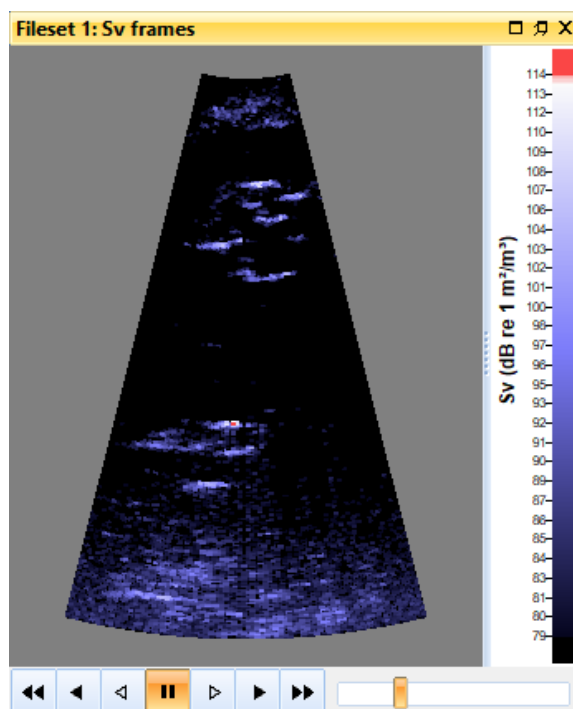   Display minimum = 79
    Display range = 35

Figure 3. DIDSON echogram in Echoview, showing the beam fan for one ping (ping 34).

23. Click the **Variable Properties** tool or press the shortcut key **F8**.

24. Select the **Echogram Display** tab.

25. From the **Color scheme** list, select **EK500**.

26. Click **OK**.

27. Press **F11** and **F12** to change the Color display minimum.

28. Revert to the DIDSON color scheme (use steps 22-25).

29. On the **Variable Properties dialog box** under *Echogram colors section* enter the settings:
    Color display minimum: 79
    Color display range: 40

30. Click **OK**.

31. Go to ping 34 of the echogram. (You can press CTRL+G to open the Go To dialog and then enter 34)

32. View the **Details** dialog box. Click the **Details** tool to open it if it is closed.

33. Move the mouse cursor over a fish.
    The Details dialog box, the Information toolbar and the Echoview status bar will update with information relating to beam, beam angle, range, depth, ping number etc.

34. Click the **Tape measure** tool .

35. Click and drag from one point to another.
    The distance is displayed.

36. Click the **Rectangle** selection tool .

37. Draw a selection around a feature.

38. Press **S** to zoom. Press **U** to zoom out.
    Zoom is also available with the mouse wheel and on the Zoom toolbar.

39. Save your progress: on the **File** menu, click **Save As**.

40. Select the folder in which the tutorial data have been saved.
    If you used the standard installation settings, this will be:
    `C:\Echoview Software\Tutorials`

41. In the **Filename** box, type `ViewingData`
    Echoview adds the .EV file extension automatically when you save the file.

42. Click **Save**.

Further information

- Further display settings are found on the **Display** page and the **Grid** page of the Variable Properties dialog box.

- The Details dialog box can be configured and locked. Information can be copied from the Details dialog box to another software program.

- When several windows are displayed, Echoview can arrange them using the options under the **Window** menu. They can also be synchronized with a Shortcut command (A) or added to a synchronized group using the **Autosynchronize window** tool .

- The **Variable Properties** dialog box (F8 or) settings affect variables.

- The **EV File Properties** dialog box settings (F6 or) affect the EV file.

- **Echoview Configuration** dialog box settings (**File** menu > **Configuration**) affect Echoview.

- Multibeam echogram analysis is made easier with multibeam keyboard display shortcuts, replay shortcuts and the playback rate shortcut.

- Refer the Echoview Help file for more information regarding:

  - Tools
  - Dialog boxes
  - Synchronization of echograms
  - About keyboard shortcuts
  - About user defined keyboard shortcuts

Topic 3: Background noise removal

In this topic you will learn about background noise removal techniques for multibeam data.

Operators in Echoview

A powerful way to process echogram data is to use synthetic or virtual echograms. Virtual echograms are called virtual variables in Echoview and are created using operators.

For further information, refer to the Echoview Help file Virtual variable applications page.

Note: The creation of new virtual variables can happen via a selected variable or via no selected variable. The New Virtual Variable dialog box filters offered operators in relation to a selected variable. To remove the filtering, especially in the selected variable case, clear the setting **Only show operators which are compatible with the selected variable**.

About background noise

Background noise in multibeam data can affect target detection and make the review of detected targets with respect to original data more difficult.

Sources of background noise include:

- Stationary objects
- Objects that move slowly

Echoview offers a number of tools to remove or minimize background noise. The Echoview Help file discusses:

- Background noise in Echoview
- Background noise removal

Multibeam background noise removal

The Multibeam Background Removal operator removes stationary and slow moving objects. It is designed for multibeam data and calculates a statistic from a window of pings around the current ping. This statistic is intended to capture the static background elements present in the data. It then subtracts that statistic from the current ping, leaving the data of interest without any background.

43. Open `ViewingData.EV` file that you saved earlier, or `ViewingData (Solution).EV` if you did not save an EV file in earlier steps.

44. View the **Dataflow** window (press F7).

45. Click in an empty area to ensure no variables are selected. Right-click and on the **Shortcut** menu select **New**, **Variable** to open the New Virtual Variable dialog box.

46. In the **Select operator** section, select **Multibeam background removal**, click **OK**.

47. On the **Variable Properties – Multibeam background removal 1** dialog box, use the **Operand 1** list to select **Fileset1: Sv frames**.

48. Select the **Name and Notes** page, under **Name** correct the name to **Background noise removal**.

49. Select the **Background Removal** page. Enter the following settings:

    o Window size = 41

    o Algorithm = Nth Percentile

    o Percentile = 60

    o Minimum SNR = 10

    Press F1 to display information on these settings.

50. Click **OK**.

51. Double-click the **Multibeam Background Removal** variable in the Dataflow window to view the echogram.

52. Close the Dataflow window, go to the **Window** menu and select **Arrange All** to automatically adjust the window sizes.

53. Use the DVD controls to view ping 34. Press A to synchronize the echograms. The Multibeam Background Removal operator has removed stationary objects, slowly moving objects and some noise, whilst leaving behind the fish moving through the beams, as shown in Figure 4 below.

54. Save the EV file as MultibeamBackgroundRemoval.EV. Close the EV file.
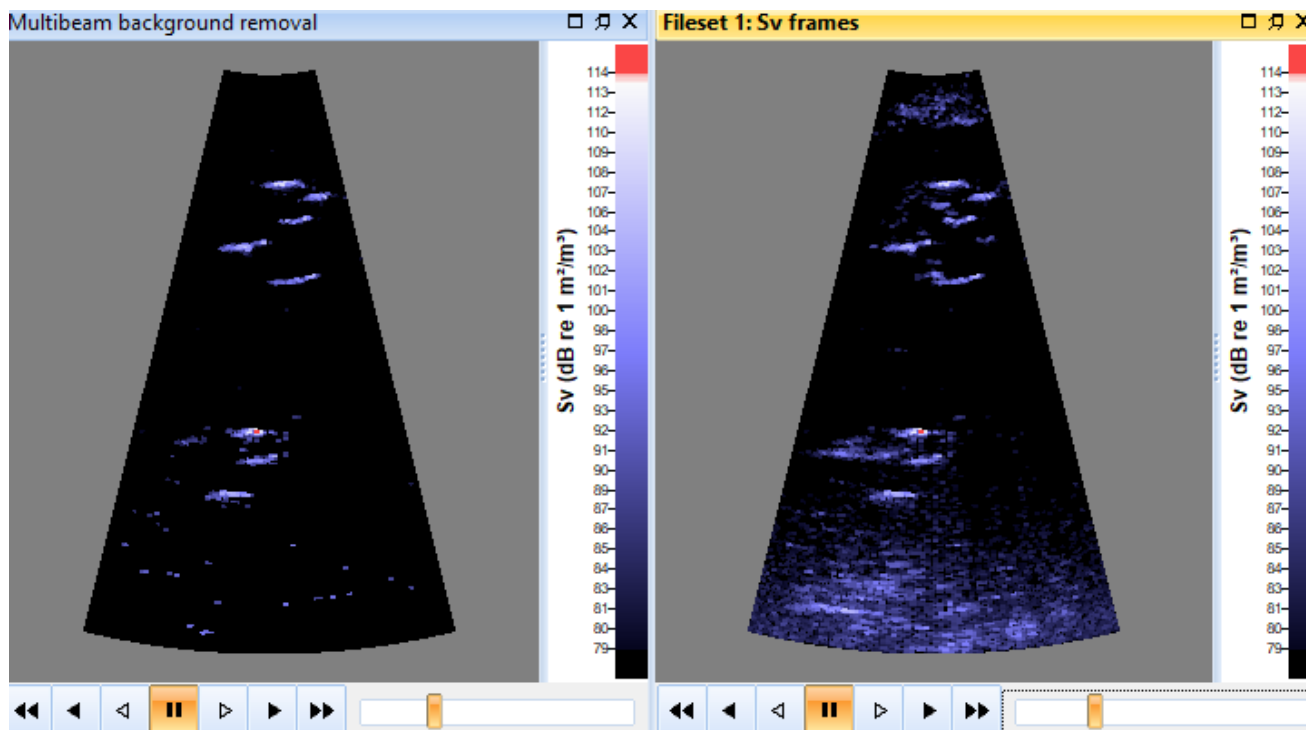

Figure 4. Sv frames and Multibeam Background Removal echograms (ping 34).

Further information

- Refer to the Echoview Help file for more information regarding:
  - Operators
  - Virtual variables
  - The Dataflow window
  - Multibeam echograms
  - Autosynchronization tool

Topic 4: Improving target definition

Our goal is to reliably and efficiently identify fish (or other targets) in multibeam data. To that end, we process the data with software tools so that fish are easy to see.

The verification of automated processing relies on the positive correlation of the numerical results with our inbuilt visual processing and expert knowledge.

The definition of targets prior to multibeam target detection can be improved in Echoview through:

- Echogram color display settings

- Data threshold settings

- Multibeam convolution operators

This topic uses the Beam median filter 3x3 operator as a mild smoothing filter – it smooths the image without significantly affecting fish shape. Further smoothing is possible using any combination of Echoview's multibeam convolution operators. For example, to preserve size use a dilation filter followed by an erosion filter.

Color scheme

It may be useful to change away from the default DIDSON color scheme when you're tuning the threshold by eye. The DIDSON color scheme gradually fades to black, which makes it very hard to distinguish low values.

Display and data thresholds

A data threshold must be set on the variable that acts as the source for the multibeam target detection operator. The threshold here is critical – it will determine what's detected as a multibeam target and what is not.

A single threshold is preferable because it makes results more repeatable and the thresholds easier to tune.

Using as low a threshold as possible is optimal because it preserves the fish image in one piece rather than breaking it into multiple fragments. It is preferable to have some "speckle" and the fish in one piece (as in Figure 5 below), than it is to remove all speckle and have broken fish. Speckle can be removed later via strategies such as thresholds, fish tracking and filtering with target properties.

An iterative strategy

Once you have a complete chain of virtual variables (to the step before fish tracking) choose a data threshold by locking it to the display threshold and adjusting the threshold while watching the resulting single targets echogram. There's usually a distinct transition where no extra fish are detected but lots of additional "speckle" starts to appear. If the transition isn't distinct, the speckle can be dealt with using a length threshold in an additional virtual variable.
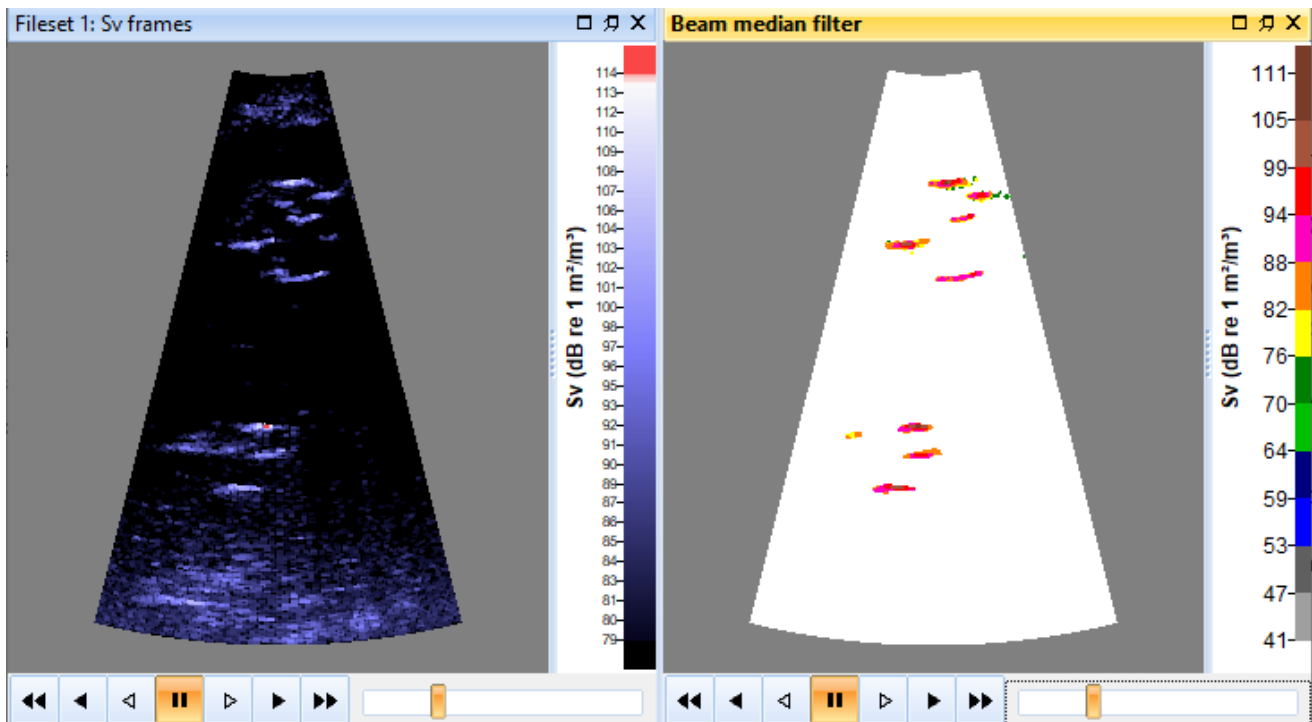
Figure 5. Sv frames (left), Beam median 3x3 median operator with EK500 color scheme (right).

Create a Beam median filter variable

55. Start Echoview.

56. On the **File** menu, click **Open**.
    Open your saved **MultibeamBackgroundRemoval.EV** file
    - OR -
    ```
    Echoview
    Software\Tutorials\IntroToMultibeamTargetDataProcessing\MultibeamBackgroundRem
    oval (Solution).EV
    ```

57. Close the Multibeam Background Removal echogram.

    Click the **Dataflow** tool

58. Click in an empty area to ensure no variables are selected. Right-click in an empty area of the Dataflow window and select **New, Variable** from the **Shortcut** menu.

59. In the New Variable dialog box, in the **Select operator** section, click **Beam median filter 3x3,** click **OK**

60. On the Variable Properties – Beam median filter 3x3 1 dialog box, use the **Operand 1** list to select **Multibeam background removal**.

61. On the **Name and Notes** page, under **Name** correct the name to **Beam median filter**.

62. Double-click on the **Sv frames** variable and the **Beam median filter** variable.

63. Close the Dataflow window.

64. Click the **Sv frames** echogram to activate it.

65. Check that the **Autosynchronization** tool is highlighted. If it is not, click .

66. Click the **Beam median filter** echogram.

67. Click **Autosynchronization** tool

68. Go to ping 34.

69. Click the **Variable Properties** tool ![icon] (while the Beam median filter echogram is active).

70. Select the **Echogram Display** tab.

71. In the *Echogram colors section* enter the settings:
    Color display minimum: 41
    Color display range: 70
    Color scheme: EK500

72. Select the **Data** tab.

73. Under Minimum threshold select **Apply**.

74. Under Maximum threshold select **Apply**.

75. Click **OK**.

76. Adjust the display and data thresholds on the median filter echogram using **F11**/**F12** keyboard shortcuts. Observe the behavior of the speckle and the integrity of the fish.

77. On the **File** menu click **Close** (to close the solution EV file).
    - OR –
    Save your EV file as **ImproveTargetDefinition** and **Close**.

Further information

Refer to the Echoview Help file for more information regarding:

- Convolution algorithms

- Convolution operators illustrated

- Variable properties dialog box Display page

- Variable properties dialog box Data page

Topic 5: Target detection

In this topic you will learn about multibeam target detection.

About multibeam targets

Echoview detects above-threshold clusters of samples and stores them as point targets with range, beam, mean_Sv (called TS) and target properties.

Multibeam target detection echograms show targets as large colored points. By default, samples that contribute to the target are displayed with a highlighted outline.
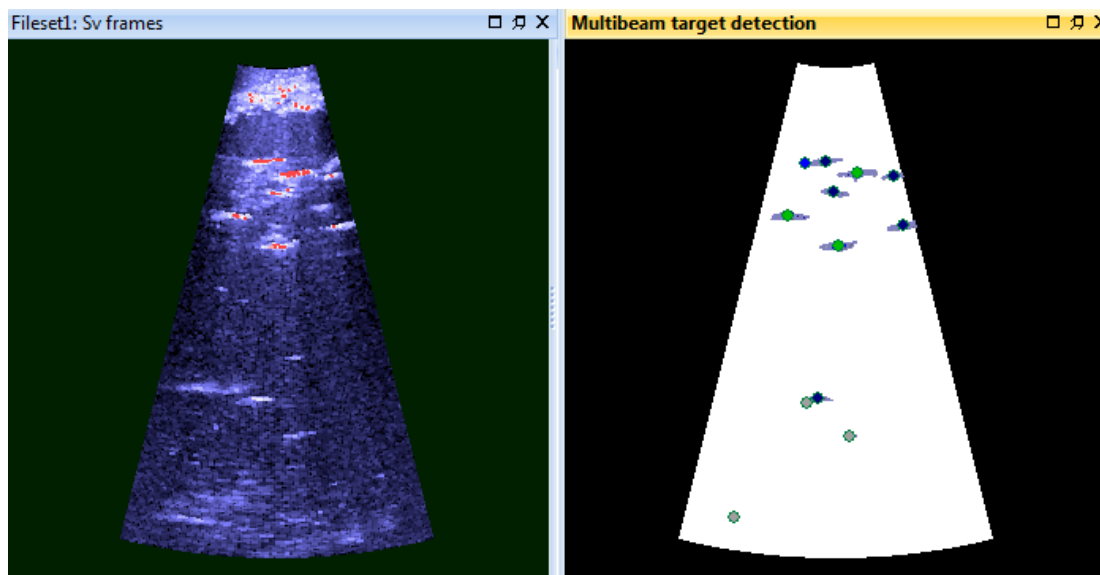
Figure 6. Sv frames (left), Multibeam target detection operator (right) using the EK500 color scheme.

Target properties

Target properties calculated in Echoview can be used in target filtering, target review and target classification. You can select the target properties to calculate – some properties may be more useful than others and virtual variable data generation times can vary for the number of and type of target property. By default, all target properties are calculated.

Target properties include:

- Target area (cm^2)
- Target area edge midpoints (cm^2)
- Target compactness
- Target compactness edge midpoints
- Target length (cm)
- Target length across beams (cm)
- Target perimeter (cm)
- Target perimeter edge midpoints (cm)
- Target intensity variation
- Target range extent (cm)
- Target orientation ($^{\circ}$)
- Target thickness (cm)

The following manual measurements can also be stored with targets:

- Target length (manual) made using the Tape measure tool.

- Target class applied using the Target classification tool.

Tips

Refer to the Echoview Help file for more information regarding:

- Target properties from multibeam data

- Target length manual and Target metadata

- The Multibeam target detection operator

- About surfaces. You can use Exclude above and Exclude below surfaces to limit the target detection to a suitable space. This may also improve detection time, because unwanted data is not processed.

Create a Multibeam target detection variable

1. Start Echoview.

2. On the **File** menu, click **Open**.
   Open your saved `ImproveTargetDefinition.EV` file
   - OR -
   `ImproveTargetDefinition (Solution).EV`

3. Click the **Dataflow** tool

4. Click in an empty area to ensure no variables are selected. Right-click in an empty area of the Dataflow window and select **New**, **Variable** from the **Shortcut** menu.

5. In the New Variable dialog box, in the **Select operator** section, click **Multibeam target detection,** click **OK**

6. On the Variable Properties – Multibeam target detection 1 dialog box, use the **Operand 1** list to select **Beam median filter**.

7. On the **Name and Notes** page, under **Name** correct the name to **Multibeam target detection**.

8. Click the **Target Detection** tab

9. Click the **Advanced** button to see the default target detection settings. Inspect the Advanced settings; use F1 to display context sensitive Help file information. Press **OK** to close this window.

10. Click the **Target** tab.
    You can select target properties to calculate – the default setting includes all target properties.
    You can also select a TS strength source from the list – the TS source affects the single target variable that can be created after the multibeam target detection stage.

    Note: The Target_length_across_beams property is faster to calculate than the Target_length property and it can be more accurate for situations where fish are swimming perpendicular to the central beam.

11. Click the **Echogram Display** tab, inspect the **Multibeam** settings for sample value display range and target-sample outline. Set **Color display minimum** = 66 and **Color display range** = 40.
    Under **Multibeam** select **Show input data under targets**, **Show target outlines** and **Show target sample outlines**

12. Click **OK** to close the Variable Properties dialog and create the new variable.

13. Double-click on the **Sv frames** and **Multibeam target detection** variables and close any other windows that may be open.

14. Click and drag the echogram windows to rearrange them so that they are side by side.

15. Click the **Sv frames** and then **Multibeam target detection** echograms. Check if the echogram is in an Autosynchronization group. If not, click the **Autosynchronization** tool

16. Go to ping 34 (press Ctrl+G to open the Go To dialog and then enter 34).
Both the **Sv frames** variable and the **Multibeam target detection** virtual variable are synchronized and display ping 34.

17. On the Multibeam target detection echogram zoom in on a target (refer to Topic 2). The color scheme for the input data under targets is controlled by the input operand Beam median filter 3x3. To match the inset for Figure 7 you may need to adjust the **Echogram color** settings of the **Beam median filter** variable. Beam median filter: Display minimum = 70 dB, Display range = 41 dB. Adjust F11/F12 on the Beam median filter echogram, while viewing the target.
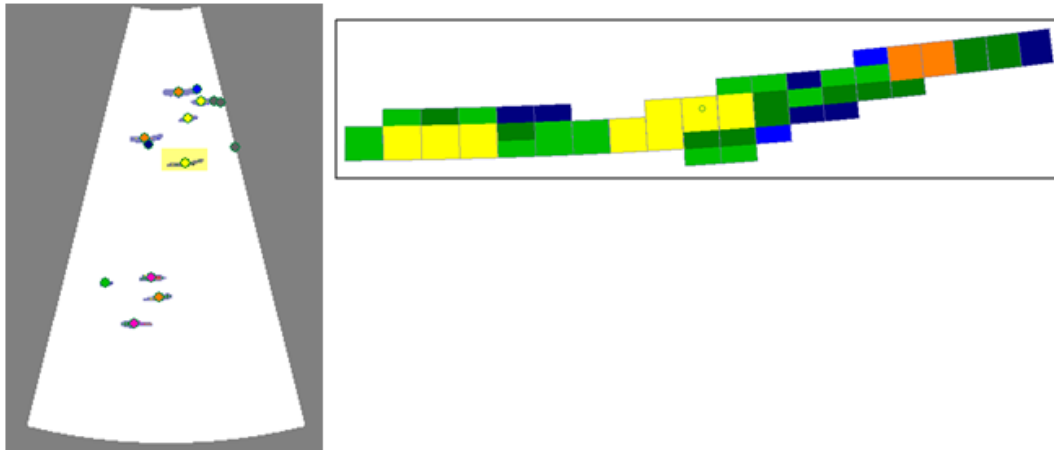
Figure 7. Close up of the highlighted multibeam target in ping 34.

18. The (highlighted) detected target at 6.1 m is represented by a colored circle. Samples that contribute to the target are shown and outlined.

19. Move the cursor over a detected target (marked by the colored circle) and observe the displayed

    information in the **Details dialog box** .
    Hint: You may need to scroll down in the Details dialog box to see the information in the Target section. Or you can use Details dialog box View list dialog to toggle Details sections that you want to minimize.

Manual target length

20. Observe the target length in the **Details dialog box**.

21. Click the **Tape measure** tool .

22. For this target, click, drag and release from one edge of the contributing samples to the other. The distance is displayed.

23. Move the cursor over the circle at the center of the target.

24. Right-click and select **Store Target Length** on the Shortcut menu.
    The manual target length measurement is stored with the target.
    The displayed target will now display a thick outline for the center circle to indicate that this target has a manual length measurement. The Length (manual) is also displayed in **Details**.

Figure 8. Detected target at 6 m now has a stored target length.

Tips

- **Length** and **Length (manual)** are both displayed in the Details dialog box.

- **View menu** > **Target Metadata** will open a window that manages manual target lengths. You can delete manual target lengths in this window.

- Use the **Maximum Intensity** operator to:

  o Identify targets missed by the multibeam target detection. This is useful when tuning the detection settings.

  o Identify target swim-shape and "tail beat" rate which can assist in species identification as discussed by Mueller et al. (2010).
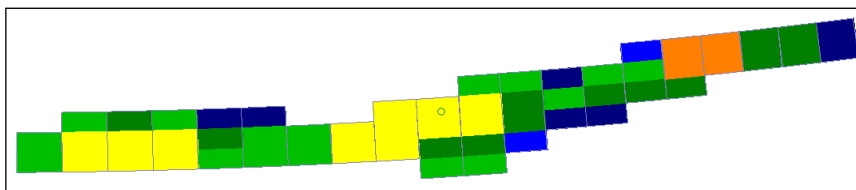
Create a Target property threshold variable

At this point a target property threshold can be applied to the multibeam target detection variable.

Alternatively, a target property threshold can be applied to the single target variable created by the target conversion of the multibeam target detection data.

The Target property threshold operator does not affect the attributes that are displayed in the echogram but does affect whether each target is included or not.

This topic will demonstrate a target property threshold applied to a multibeam target detection variable.

1. Click the **Dataflow** tool ![icon]

2. Click in an empty area to ensure no variables are selected. Right-click in an empty area of the Dataflow window, and select **New, Variable** from the **Shortcut** menu.

3. In the New Variable dialog box, in the **Select operator** section, click **Target property threshold,** click **OK**

4. On the Variable Properties – Target property threshold 1 dialog box, use the **Operand 1** list to select **Multibeam target detection**.

5. On the **Name and Notes** page, under **Name** correct the name to **> 20cm target length**.

6. Click the **Target Property Threshold** tab.
    For **Threshold targets by:** select *Target length*.
    Select **Apply minimum threshold**.
    Enter *20.00*
    Click **OK**

7. Double-click on the **> 20cm target length** virtual variable.
    Restore the **Multibeam target detection** variable.

8. Close the Dataflow window.

9. Tile the echograms side-by-side.

10. Click the **> 20cm target length** echogram.
    Hint: To see more target-circles with lengths greater than 20cm, the Color scheme display minimum and range may need adjustment.

11. Click **Autosynchronization** tool .

12. Observe the targets in the >**20cm target length** echogram – there are fewer targets than the Multibeam target detection echogram.

    The length filter removes a large proportion of the "speckle" targets as well as some genuine targets that were detected as fragments. Fish tracking on the single target data (converted from the multibeam target detections) would produce a set of tracks that require much less manual editing than those detected from the unfiltered target variable.

eso
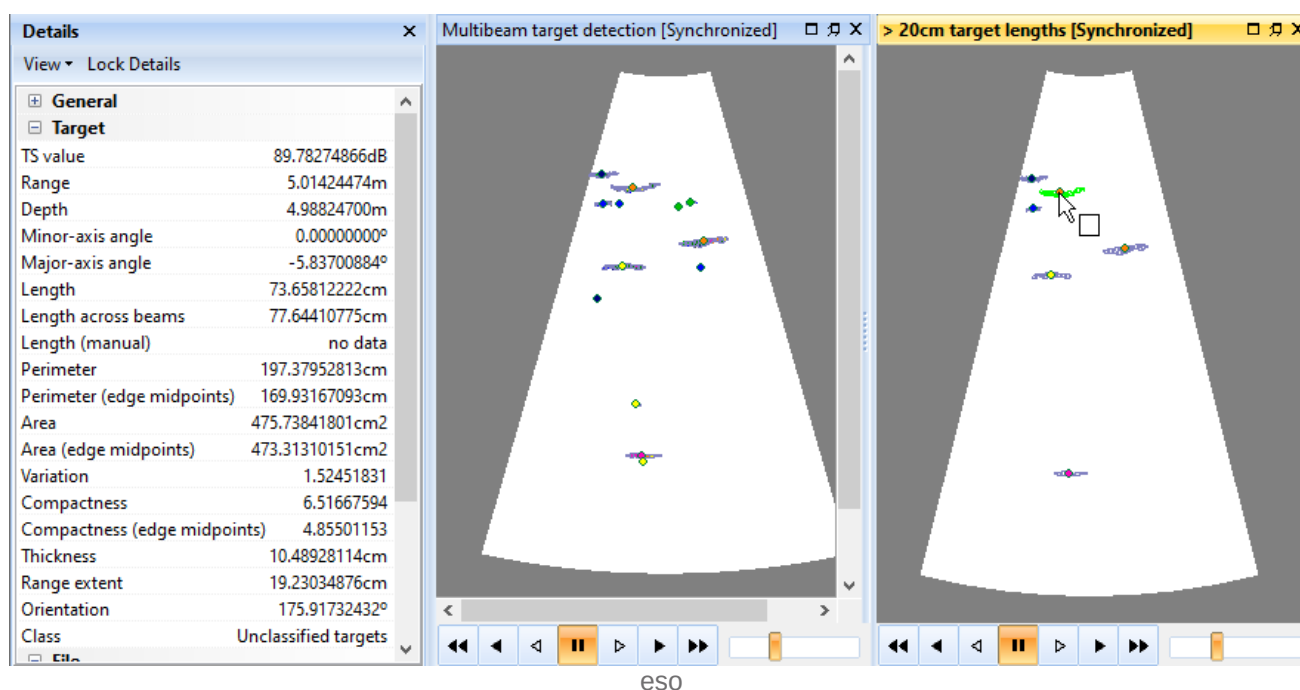
Figure 9. Ping 45. On the left the multibeam target detection variable is displayed. On the right the target property threshold variable displays all targets that are greater than 20cm in target length.

13. Close the >**20cm target length** echogram.

Target conversion

To be able to use more of Echoview's powerful tools with multibeam target data you need to use the Target conversion operator to convert multibeam target data to single target data.

Single target tools include:

- Visualization

- Data and analysis exports

- Fish tracking

- Graphs

The target conversion echogram represents multibeam targets as single target traces. The traces may indicate potential fish tracks that could be checked against detected fish tracks. In ideal data, traces should be complete (no missing pings) and they should not split or merge. It maybe useful to compare individual traces that show problems with the original multibeam image.
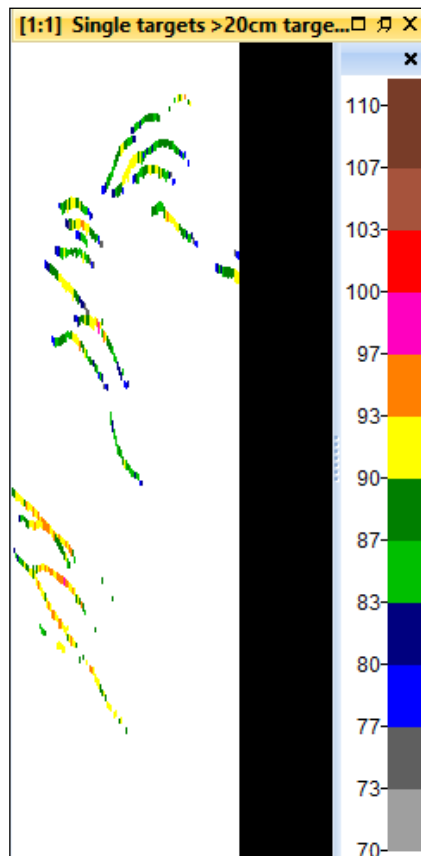
Figure 10. Single target variable derived from the Target conversion operator.

Create a Target conversion variable

14. Click the **Dataflow** tool

15. Click in an empty area to ensure no variables are selected. Right-click in an empty area of the Dataflow window and select **New > Variable** from the **Shortcut** menu.

16. In the New Variable dialog box, in the **Select operator** section, click **Target conversion,** click **OK**

17. On the Variable Properties – Target conversion 1 dialog box, use the **Operand 1** list to select **> 20cm target length**.

18. On the **Name and Notes** page, under **Name** correct the name to **Single targets > 20cm target length**.

19. Click the **Echogram Display** page.

20. In the *Echogram colors section* enter the settings:
    Color display minimum: 70
    Color display range: 40

    Under the Data page:
    Thickness source: Target thickness
    Thickness factor: 0.75
    Click **OK**.

21. Double-click the **Single targets >20cm target length** virtual variable.

22. Observe the groups of single targets and the traces they follow.

Tips

- If working with a large volume of data, a performance workaround can be achieved by using Echogram > Export > Single targets from a single target variable. If the resulting single target csv file is added to a new Fileset the performance for many operations (including basic navigation of the echogram) will be significantly improved. Target properties are preserved during the export/add loop. See Topic 9 for more details on this.

- For further discussion about target traces refer to Appendix 1.

- Refer to the Echoview Help file for more information regarding:

    o Analysis exports

    o Data exports

    o How to detect and work with single targets

    o Create a TS substitution variable

TS substitution

Target properties can be exported for analysis outside of Echoview but they can also be visualized within Echoview. The TS substitution operator creates a single target variable where other values can be substituted for TS and/or TS_uncomp.

TS substitution using Target length across beams

The Target_length_across_beams property is faster to calculate than the Target_length property and it can be more accurate for situations where fish are swimming perpendicular to the central beam.

23. Click the Dataflow tool

24. Click in an empty area to ensure no variables are selected. Right-click in an empty area of the Dataflow window and select **New > Variable** from the **Shortcut** menu.

25. In the New Variable dialog box, in the **Select operator** section, click **TS substitution,** click **OK**

26. On the Variable Properties – TS substitution 1 dialog box, use the **Operand 1** list to select **Single targets > 20cm target length**.

27. On the **Name and Notes** page, under **Name** correct the name to **Target length across beams**.

28. Select the **TS Substitution** page
In the *TS Value* section
Select **Target length across beams** from the **Populate TS with values from**: list.
Select the Echogram Display page
Color display minimum = 14.00
Color display range = 100

29. Select the Data page
Thickness source = Target thickness
Thickness factor = 0.2
Click **OK**.

30. In the Dataflow window double-click the **Target length across beams variable**.

You can arrange the echogram, Color legend, Details dialog and zoom like the following figure. The arrangement facilitates the visual scrutinization of detected targets with respect to Target_length_across_ beams.
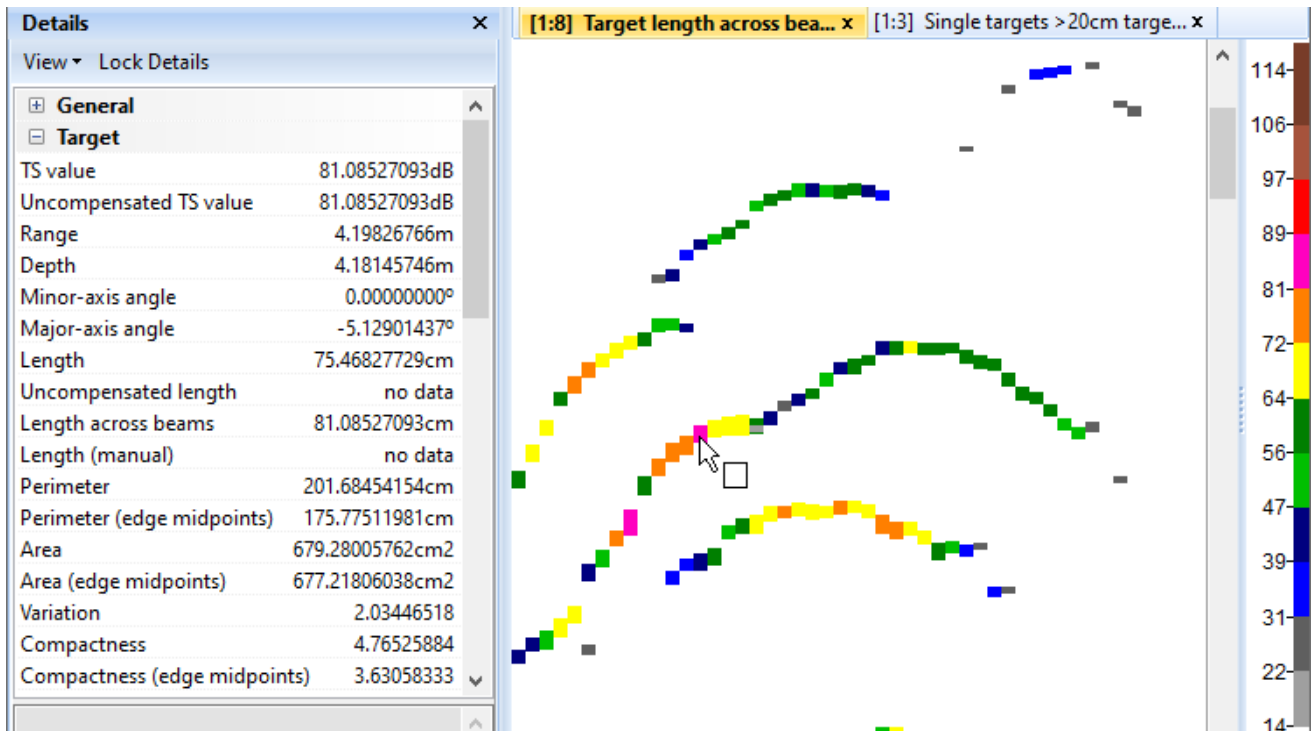
Figure 11. Target length across beams echogram.

The Target length across beams echogram displays single targets that are colored according to their Target_length_across_beams value. In the figure the mouse pointer is on a pink target. The highlighted area in the Details window shows the value of the Target_length_across_beams in "TS value" and the TS uncomp value of the target.

TS substitution using Target range extent

The Target range extent property could be used to analyze the target's swim-shape[1]. When Target_range_extent is of the order of the Target_thickness, the target is fully extended and straight. While the target swims the Target_range_extent will vary between the Target_thickness and the value that reflects the maximum swim-shape. This "Tail-beat" could be correlated to a selected (and repeated) value of Target_range_extent.

1. Click the Dataflow tool

2. Click in an empty area to ensure no variables are selected. Right-click in an empty area of the Dataflow window and select **New, Variable** from the **Shortcut** menu.

3. In the New Variable dialog box, in the **Select operator** section, click **TS substitution,** click **OK**

4. On the Variable Properties – TS substitution 1 dialog box, use the **Operand 1** list to select **Single targets > 20cm target length**.

5. On the **Name and Notes** page, under **Name** correct the name to *Target range extent*.

6. Select the **TS Substitution** tab
    In the *TS Value* section
    Select **Target range extent** from the **Populate TS with values from**: list.

![echoview]

7. Select the **Echogram Display** tab
   In the *Echogram colors* section,
   Color scheme: **DIDSON**
   Color display minimum = 3.00
   Color display range = 30.00

8. Select the **Data** tab
   Thickness source: **Target thickness**
   Thickness factor: **0.50**
   Click **OK.**

An echogram of Target range extent under a DIDSON color scheme displays target traces that look like caterpillars. With the Target range extent as the Thickness source, the tail-beat information can appear as (regularly-spaced) "legs" along the body of the caterpillar. The "legs" stand out from the "body" of the caterpillar in two ways. The color scheme assigns a light color to the big values of range extent and the target display thickness is at full extent.
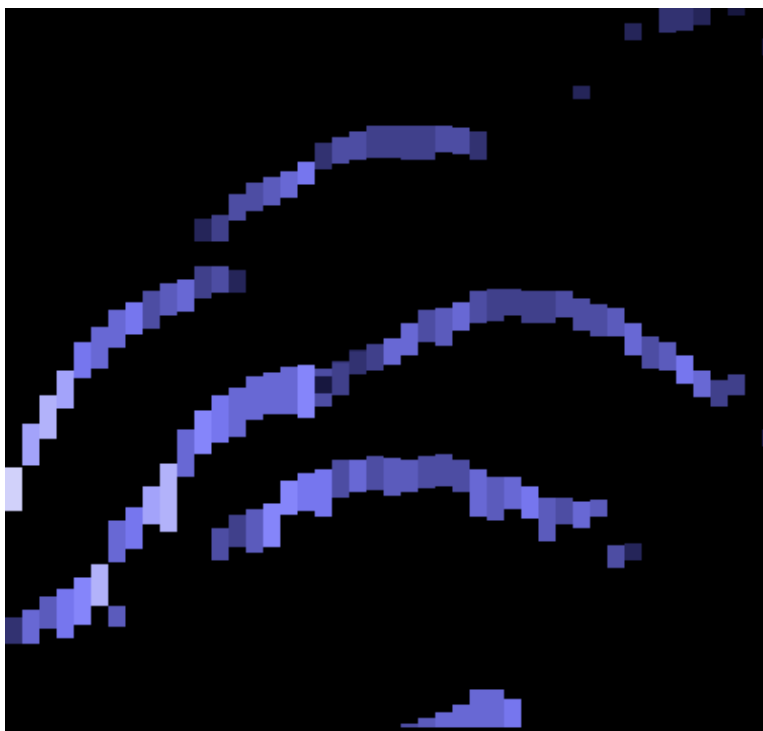
Figure 12: Target range extent substitution echogram.

TS substitution using Angle major axis

TS substitution using the major axis angle can be useful as a proxy to identify targets that swim through the beam and to separate target traces. A target that swims through the beam fan will display an expected progression of major axis angle values that can be visualized. The Sonic color scheme follows the colors of a rainbow. As a result, a target that passes through the beam fan will display the (orderly) colors of a rainbow. The steps to create a TS substitution variable with Angle major axis are similar to the Target range extent steps.
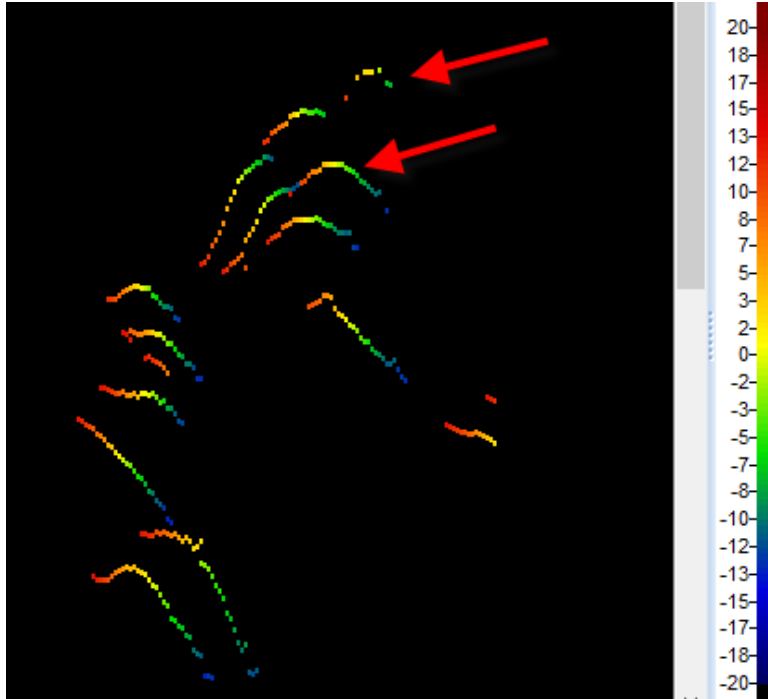
Figure 13: Angle major axis substitution echogram. The lower red arrow shows how the rainbow separates different target traces. The upper red arrow shows how the rainbow can provide insights for problematic targets.

Create a Multibeam overlay variable

The Multibeam target overlay operator overlays multibeam targets on specified multibeam data. This is useful in scrutinizing detected targets against original data (and can also be used to approximate the DIDSON viewer display).

Tips

- The display of multibeam target data from the first operand is affected by the color scheme of the Multibeam target overlay variable. Similarly, the multibeam target overlay Data tab minimum and maximum color display thresholds control the visibility of overlaid targets.

- Displayed echogram data from the second operand is affected by the settings of the second operand. It may be necessary to adjust the second operand's color display settings to improve the viewing of the specified multibeam data under the multibeam target overlay echogram.

1. Click the Dataflow tool

2. Click in an empty area to ensure no variables are selected. Right-click in an empty area of the Dataflow window and select **New, Variable** from the **Shortcut** menu.

3. In the New Variable dialog box, in the **Select operator** section, click **Multibeam target overlay,** click **OK**.

4. On the Variable Properties – Multibeam target overlay 1 dialog box, use the **Operand 1** list to select **Multibeam target detection.** Use the **Operand 2** list to select *Fileset1: Sv frames*.

5. On the **Name and Notes** page, under **Name** correct the name to *Overlay original data with detected targets*.

6. Select the **Echogram Display** tab
   In the *Echogram colors* section
   Color display minimum: **70**
   Color display range: **40**
   Color scheme: **EK500**

   In the *Multibeam display* section
   Select:
   Show input data under targets
   Show target sample outlines
   Click **OK** and view the echogram for the resulting variable.

7. On the Dataflow window, right-click the **Fileset1: Sv frames** object and select **Variable Properties**.
   Select the **Echogram Display** tab
   Color display minimum: **63.00**
   Color display range: **41.00**
   Color scheme: **DIDSON**
   Click **OK**

8. On the Multibeam target overlay echogram, move the Time slider back and forth to view detected targets overlaid on the primary data.
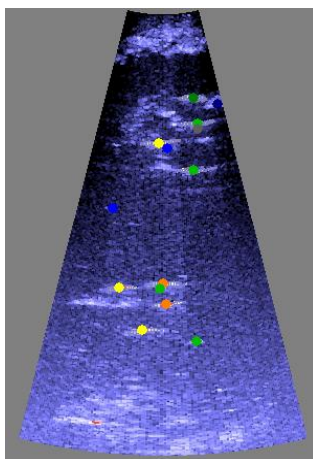
Figure 14: Multibeam target overlay, ping 31. Detected targets overlaid on Sv frames data.

Looped multibeam replay

The Looped multibeam replay feature synchronizes the display of selected single targets with data in multibeam pings. Use it to verify detected targets against original data.

1. Display the **Target range extent** echogram. Display the *Multibeam target overlay echogram*. You can arrange the Target range extent echogram (use zoom), Details dialog box and Target overlay echogram like the figure below. The arrangement facilitates the visual scrutinization of detected targets with respect to Target_range_extent and the original multibeam data.

2. Click the Rectangular selection tool .

3. With the mouse pointer, draw a rectangular selection around a target(s) of interest on the **Target range extent echogram**. The targets follow a trace – a potential fish track.

4. On the **Shortcut** menu choose **Looped multibeam replay**. Observe the synchronization between the single target echogram and the multibeam echogram, and the visual indicators shown on each.

5. New selections can be viewed by repeating steps 2, 3, 4.
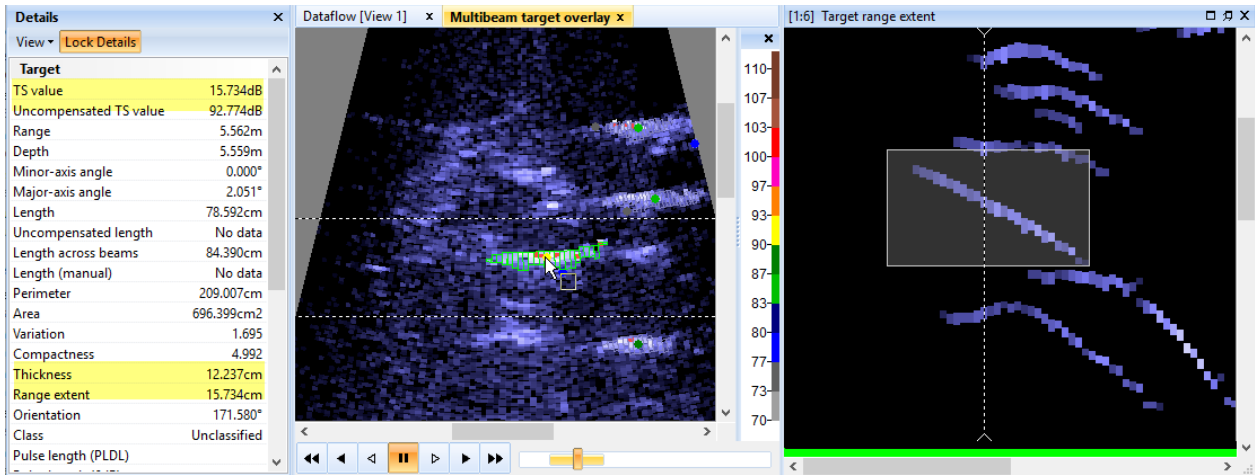
Figure 15. Using the Details dialog box, Multibeam target overlay variable and Target range extent variable and Looped multibeam replay to study fish swim shape and tail beat frequency.

6. To stop using the looped multibeam replay feature:
    Click the stop control on the multibeam echogram.
    On the **Time slider**, right-click and select **Clear replay limits**.

7. On the **File** menu click **Close** (to close the solution EV file).
    - OR –
    Save your EV file as **Multibeam target detection** and **Close**.

Further information

*   Looped multibeam replay can be used with echograms that are in an auto-synchronized group. This allows you to view the original data and other stages of the processed data.

*   Refer to the Echoview Help file for more information regarding:

    *   How to use looped multibeam replay

    *   Synchronized and auto-synchronized echograms

Topic 6: Fish tracks

Before you start this topic we advise you to complete Echoview's Introduction to Fish Tracking tutorial to gain some understanding and experience with fish track detection, editing, examination and analysis. Although it uses single beam data, the general philosophy for fish tracking in Echoview is the same for both single beam and multibeam data, with only minor differences.

In this topic you will learn about generating analyses of fish tracks from detected targets in multibeam data.

Fish tracking with multibeam data

Fish tracking for multibeam-derived single targets is slightly different than for split-beam targets because there isn't any minor-axis position information.

Tracking from multibeam data (for well-defined fish movements) often requires little editing of automatically-detected tracks, because the across-fan angle is well defined and very consistent compared with split-beam data. Having two axes, each with highly accurate positioning gives better results than three axes where there is relative positional inaccuracy on two axes.
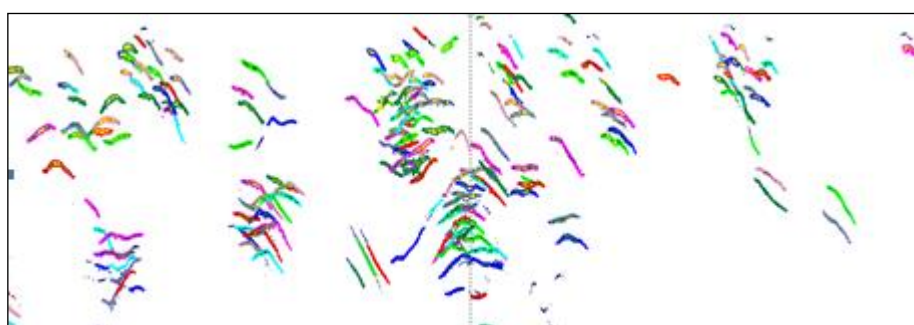
Figure 16. Detected fish tracks for targets in multibeam target data.

Analyzing the fish tracks produces a mean length and mean intensity statistic for each fish track, as well as other metrics.

Echoview provides two ways of generating analyses of fish tracks:

Method	Description
On-screen analysis	Displays a subset of analysis results for a single fish track.
Export analysis	Exports full analysis results for all fish tracks (or a selected class of fish track) in a selection or the whole echogram. The data are exported to comma-separated value (*.csv) files and can be opened in most spreadsheet applications. Some exports can also be formatted for use with database applications.

Detecting fish tracks

In this exercise you will detect fish tracks in a single target variable derived from multibeam target data. The settings for fish tracking are guided by the movement of the single targets (fish) in your data. An examination of the single target echogram and single target graphs may reveal the relative importance of things like major and minor axes, range and TS. The iterative tuning of the fish track detection settings is quick, as is the assessment of the resulting fish tracks.

The tutorial 'Introduction to Fish tracking' demonstrates the use of fish track editing tools and single target graphs.

A license for the Multibeam Fish Tracking module is required to detect fish tracks in multibeam data.

1. Start Echoview.

2. On the **File** menu, click **Open**.
   Open your saved **Multibeam target detection.EV file**
   - OR -
   ```
   C:\Echoview
   Software\Tutorials\IntroToMultibeamTargetDataProcessing\MultibeamTargetDetecti
   on (Solution).EV
   ```

3. Open the **Single target >20cm target length** echogram.
   Close all other echogram windows (if still open).

4. Click the **EV File Properties** tool

5. On the **Echogram** page, under the *Show on echogram* section, clear **Region classes**. This leaves the echogram display clear of the Region class name for every detected fish track.
   Click **OK**.

6. On the **Echogram** menu, select **Detect fish tracks**.

7. Click **Edit**.

8. In the *Region classes* section, click **New**.

9. On the **Name and Notes** page under **Name** enter **Greater than 20cm target length**.
   Click **OK**.

10. Click OK to close **EV File Properties** dialog box.

11. On the **Detect Fish Tracks** dialog box, under **Assign class** select **Greater than 20cm target length**.

12. Click **Properties** to enter track detection settings.
    On the **Algorithm** page.
    In the *Data* section select **4D**.
    In the *Track detection* section enter:
    Alpha: 0.5, 0.5, 0.5
    Beta: 0.2, 0.2, 0.2
    In the *Target gates* section:
    Exclusion distance: 0.2, 0.2, 0.2
    Missed ping expansion: 0.0, 0.0, 0.0

13. On the **Weights** page.
    Major axis: 100
    Minor axis: 0.0
    Range: 25
    TS: 50
    Ping gap: 50

14. On the **Track acceptance** page.
    Minimum number of single targets in a track: 8
    Minimum number of pings in a track: 3
    Minimum gap between single targets: 3

15. Click **OK**

16. Click **Detect**.
    The fish tracks are displayed as regions that enclose single targets on the echogram. You can use fish track editing tools to merge or split detected tracks and create tracks (that may have been missed by the detection). Single target graphs of fish tracks may be useful for fish track setting tuning.

    Note: The detection may flag the presence of invalid fish tracks. Information about the nature of the invalid tracks is sent to the Messages dialog box . See also Help file: About fish track regions: Validity.

On-screen analysis

17. Click the **Region Browser** tool .

18. Select a fish track (The region border around the active fish track thickens and becomes animated.)

19. On the **Shortcut** menu, click **Analyze Fish Track**.
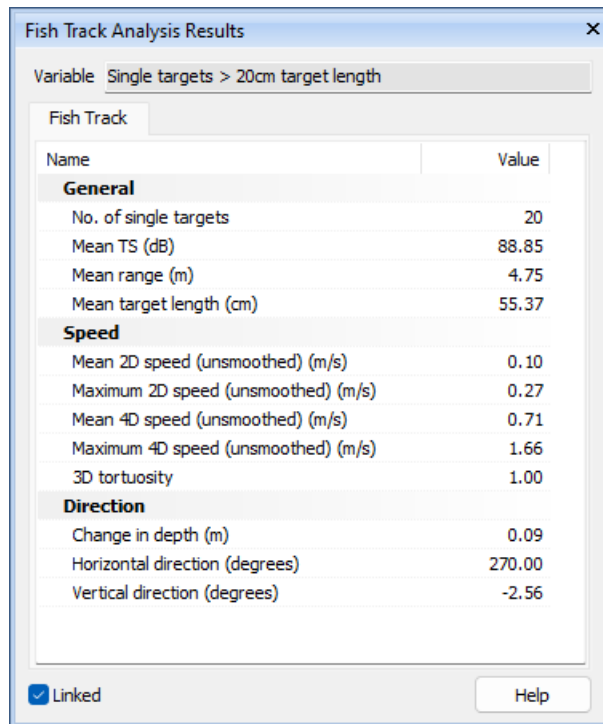
Figure 17. Fish track analysis results for Region 7 in the saved EV file or Region 8 in the solution EV file.

20. On the Fish Track Analysis Results dialog box select the Linked checkbox to synchronize the active fish track in the Region Browser or the Single targets >20cm target length echogram with the Fish Track Analysis Results dialog box.

21. On the Region Browser click the **Prev** and **Next** buttons to look at other fish tracks, or click on different tracks on the echogram itself.

Tips

- Refer to the Echoview Help file for more information regarding:

    o The Region browser

    o Fish track analysis variables

    o How to detect and work with fish tracks

Exporting fish tracks

A license for the Essentials module is required to export fish track analysis results.

To set up an export you will need to display a grid, select export variables and select the type of output file.

Note: Some analysis variables are exported automatically.

1. Close the Fish Track Analysis Results dialog box.

2. Click the Variable Properties tool .

3. Click the **Grid** page.

4. In the *Display and analysis grid* section enter the following:
Show time/distance grid: Time (minutes)
Time between grid lines (minutes): 0.5
Show depth/range/line-referenced grid: Water surface (depth of zero)

Separation (m): 12
Click **OK**

5. Click the EV File Properties tool .

6. Open the **Export** page.
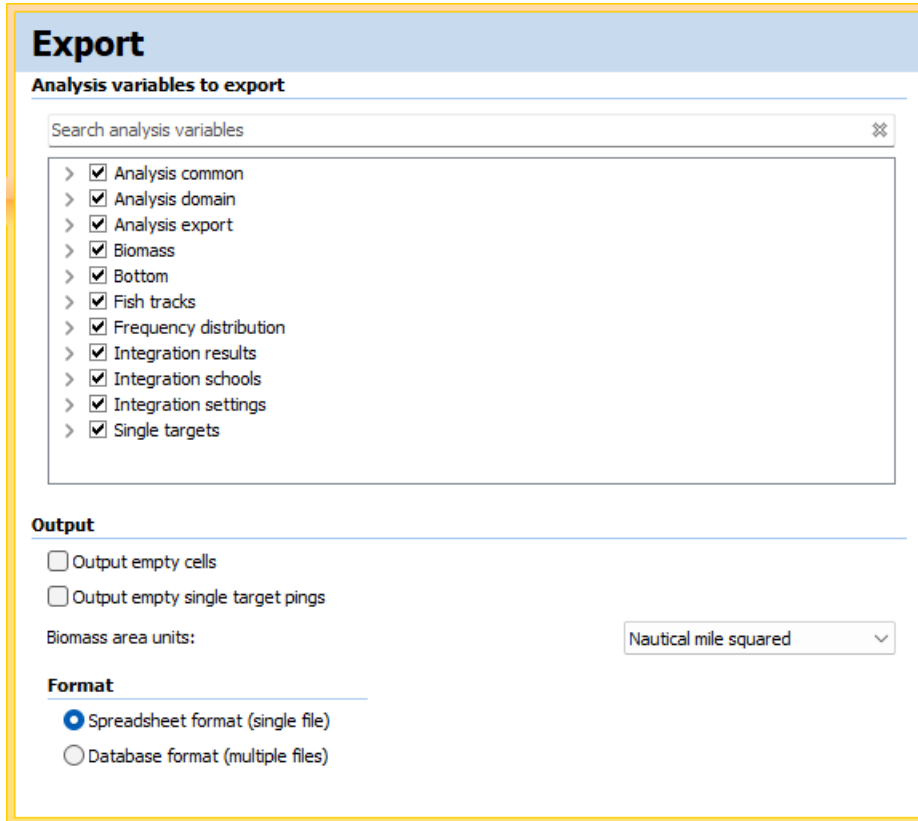
Figure 18. Export page of the EV File Properties dialog box.

Select the export analysis variables.

1. Clear these groups:
   Analysis domain, Biomass, Bottom, Frequency distribution, Integration results, Integration schools and Integration settings.
   Expand Analysis common and select
   Date_M, Dist_M, Lat_M, Lon_M, Num_intervals, Num_layers,
   Ping_M, Time_M

   Expand Analysis export and select:
   EV_filename, Processing_date, Processing_time, Processing_version,
   Program_version

   Expand Fish tracks and select
   Direction_horizontal, Fish_track_change_in_range, Speed_4D_mean_unsmoothed, Time_in_beam

   Expand Single targets and select:
   Num_targets, Target_depth_mean, Target_length_mean, Target_range_mean, TS_mean,

   Clear the checkbox of any variables that you don't want to export.

2. In the Format section select **Spreadsheet format (single file)**.
   Click **OK**.

3. On the **Echogram** menu select
   Export, Analysis by Cells, Fish tracks

   This opens the Export fish tracks – Select Classes dialog box.

4. Under the **Region classes to export:** section select **Greater than 20cm target length**.

5. Click **Export...**

6. Browse to the `IntroToMultibeamTargetDataProcessing` folder (e.g., `C:\Echoview Software\Tutorials\IntroToMultibeamTargetDataProcessing`).

7. For **Filename** enter **Greater than 20cm target length by cells**.

8. Click **Save**.

9. On the **File** menu click **Close** (to close the solution EV file).
   - OR –
   Save your EV file as MultibeamFishTtrackDetection and Close.

Tips

Create a Fish track analysis exporter object on the Dataflow window. An exporter enables repeatability and annotation of an export.

Further information

- Refer to the Echoview Help file for more information regarding:

   o Exporting analyses

   o Export variables

   o Spreadsheet and database export files

   o Cells, intervals and layers

   o About exporters

Topic 7: Calculations and graphs

Exported fish track analysis data can be processed in a number of ways to reveal useful numerical information and trends about the observed fish.

This tutorial shows you one variation of calculations and graphs that can be derived from the exported data in Topic 6.

.csv file processing

Valid *and* invalid fish track regions may have been exported into the .csv. Invalid fish tracks should be removed prior to further work on the CSV file.

1. With **Windows Explorer** open your export file **Greater than 20cm target length by cells.csv**
   - OR -
   `C:\Echoview Software\Tutorials\IntroToMultibeamTargetDataProcessing\Greater than 20cm target length by cells (Solution).csv`

2. Select the whole sheet.

3. On the Excel **Data** menu click **Sort**

4. *Under the Sort by section:*
   Select Num_targets, Smallest to Largest
   Click OK.

5. *Delete all rows where Num_targets equal 1 or -1, to remove invalid fish tracks.*

6. Select the whole sheet.

7. On the **Data** menu click **Sort**.

8. *Under the Sort by section:*
   Select Region_ID, Smallest to largest
   Click OK.

9. *Save the sorted file as* `Greater than 20cm target length by cells.xlsx`

Excel Workbook – Calculations and graphs

The prepared fish track data is copied to an Excel workbook that has been configured to run pivot table calculations, formulas and plot graphs.

The workbook has been set up to use prepared fish track analysis data. The prepared data must be copied to the Fish tracks worksheet.

If you want to use the data exports from Topic 6, use your saved .xlsx file or use the data from Greater than 20cm target length by cells (Solution).xls

1. Using **Windows Explorer** open `Statistics and Fish Flux (Solution).xlsx`

2. The worksheets of the workbook solution file have been protected (in a simple way, no password is used).
   To remove the protection for each sheet do the following:
   On the (Office 2010) **Review** menu select **Unprotect Sheet**

3. Examine the calculations and graphs in the workbook.

Tips

- You can use the workbook as a template for fish track analysis data exports that contain different analysis variables than those specified by this Echoview tutorial set. However you may have to reconfigure the source data for tables and graphs.

  - o   Refer to the Echoview Help file for more information regarding:

  - o   About fish track regions (Invalid fish tracks)

The Statistics and Fish Flux (Solution).xlsx workbook takes the exported data and displays the ways in which the data may be analyzed. A pivot table may be used to calculate fish flux. Various graphs on the Histograms and graphs sheet show analyses of Target length mean.

Configuration

This worksheet defines Named worksheet variables that are used throughout the workbook.

Example of Fish Track Analysis			
Configuration parameters			
Key Columns			
Date	Date_M		We use:
Time	Time_M		the mid time and date of fish tracks to estimate the time range of data collection.
Direction	Direction_horizontal		the direction for calculating flux
Class	Region_class		the region class for counting statistics by class
Arc of Confidence	120°		The arc, in degrees of confidence regarding direction of travel.
			At 180° all tracks will be classified as Upstream or Downstream
			At 0° all tracks will be classified as Uncertain

Figure 19. The Configuration worksheet.

Intermediate Calculations

This worksheet displays intermediate calculations for fish count and fish flux. Formulas use Excel Lookup functions and Named variables.

	D	E	F	G
	Angle	Direction		
	0°	Uncertain		
	30°	Upstream		
	150°	Uncertain		
	210°	Downstream		
	330°	Uncertain		
		Processed	Raw Date	Raw Time
	Start	15/07/2002 19:13:18.67(	20020715	19:13:18.6700
	End	15/07/2002 19:13:34.10(	20020715	19:13:34.1000
	Duration	0.004286111 hours		

Figure 20. The Intermediate calculations worksheet, data for a pivot table is displayed on the sheet.

Figure 21: Area used for pivot table calculations.

Histograms, graphs

This worksheet displays examples of how you can graph the detected fish tracks. Using other fish track data will require adjustments to formulas and the re-specification of graph data sources to suit.

Target length histogram:

Next to the Target length histogram graph, an area is reserved to calculate the target length frequency distribution. The Bins column holds the target length bin values that the Excel Frequency array function uses to sort target length data. The Frequency column is the space where the Frequency array places its results. Refer to online learning materials to find out how to set up and evaluate the Frequency array function.

Other graphs:

The XY graphs plot X - Target length data and Y – various fish track data.

The XYZ graph plots X, Y and Z data. In this example, the Z data is speed. Bigger circles represent higher speeds.

Basic statistics and fish flux

This worksheet displays downstream calculations for:

● Fish number via a pivot table.

● Fish number/hour via a formula that sources data from the pivot table and the workbook. The Net flux represents the net number of fish per hour. The Upstream direction is positive and Downstream is negative.

Example of Basic Statistics and Fish Flux

Count of Direction	Direction ▾			
Region_class ▾	Downstream		Grand Total	
"Greater than 20cm target length"	19		19	
Flux Table	**Downstream**	**Uncertain**	**Upstream**	**Net**
"Greater than 20cm target length"	4433 /hour			-4433 /hour

Figure 22. Basic statistics and fish flux worksheet, there are no data for Uncertain or Upstream categories in the exported fish tracks.

Tip

New data on the Intermediate Calculations page may require an Excel Refresh All for the pivot tables.

Fish Tracks

This worksheet contains processed fish track analysis export data.

	C	E	F	G	H	I	J	R	S	T	U	V	W	X	Y	Z	AA
1	Region_class	Interval	Layer	Ping_M	Dist_M	Date_M	Time_M	Num_targets	TS_mean	Target_range_mean	Speed_4D_mean_uns	Direction	Fish_trac	Time_in_	Target_depth_n	Target_length_mean	
2	"Greater than 20cm target length"	34225347	1	16	0	20020715	19:13:18.6700	33	91.989291	8.21162	1.0262	270	0.80089	4.73	8.170171	71.626105	
3	"Greater than 20cm target length"	34225347	1	20	0	20020715	19:13:19.2200	29	92.406214	8.331905	0.5823	270	0.45085	4.55	8.259584	58.152025	
4	"Greater than 20cm target length"	34225347	1	19	0	20020715	19:13:19.0500	35	91.666927	9.066239	0.7017	270	1.03862	5.1	9.005097	55.938834	
5	"Greater than 20cm target length"	34225347	1	26	0	20020715	19:13:20.1000	31	92.944919	8.869653	0.6226	270	0.44684	4.4	8.836413	50.314862	
6	"Greater than 20cm target length"	34225347	1	37	0	20020715	19:13:21.6300	10	82.482079	5.04583	0.3763	270	0.21509	1.7	4.951945	35.889253	
7	"Greater than 20cm target length"	34225347	1	31	0	20020715	19:13:20.8100	26	89.136332	5.620846	0.7295	270	0.54092	3.57	5.559369	60.028056	
8	"Greater than 20cm target length"	34225347	1	36	0	20020715	19:13:21.5200	20	88.848348	4.746641	0.7143	270	0.10402	2.74	4.700797	55.368945	
9	"Greater than 20cm target length"	34225347	1	36	0	20020715	19:13:21.5200	23	86.190747	5.276205	0.7477	270	0.1815	3.13	5.221911	41.778487	
10	"Greater than 20cm target length"	34225347	1	44	0	20020715	19:13:22.6200	17	91.136407	6.003377	0.5194	270	0.0425	2.26	5.945032	54.947458	
11	"Greater than 20cm target length"	34225347	1	42	0	20020715	19:13:22.3500	20	90.486927	5.003398	0.7431	270	0.24621	2.69	4.958587	56.050563	
12	"Greater than 20cm target length"	34225347	1	39	0	20020715	19:13:21.9100	33	88.20736	6.352289	0.6809	270	0.52644	4.56	6.290829	52.756071	
13	"Greater than 20cm target length"	34225347	1	53	0	20020715	19:13:24.8200	15	86.985623	6.411067	0.5796	270	0.56069	2.14	6.3553	57.225703	
14	"Greater than 20cm target length"	34225347	1	61	0	20020715	19:13:25.0900	20	86.708657	4.229382	0.6819	270	-0.5557	2.74	4.191558	55.29776	
15	"Greater than 20cm target length"	34225347	1	66	0	20020715	19:13:25.8100	19	86.019087	7.526563	0.781	270	0.74392	2.58	7.458106	55.131243	
16	"Greater than 20cm target length"	34225347	1	77	0	20020715	19:13:27.3500	17	86.290478	3.817779	0.5552	270	-0.149	2.25	3.790888	46.169275	
17	"Greater than 20cm target length"	34225347	1	82	0	20020715	19:13:28.0600	25	87.476767	4.383501	0.5758	270	0.0253	3.46	4.338174	54.189642	
18	"Greater than 20cm target length"	34225348	1	89	0	20020715	19:13:29.1000	24	86.079918	4.11387	0.4974	270	0.09063	3.79	4.077162	50.806014	
19	"Greater than 20cm target length"	34225348	1	94	0	20020715	19:13:29.8200	27	88.928758	4.93213	0.5665	270	0.38693	3.74	4.885283	50.996879	
20	"Greater than 20cm target length"	34225348	1	124	0	20020715	19:13:34.1000	14	88.617723	5.457468	0.5602	270	0.0954	1.87	5.39475	60.873178	
21																	

Figure 23. Fish tracks worksheet.

Topic 8: Using a template

In this topic you will learn how to create an Echoview template for loading multibeam data.

About templates

Creating new EV files based on a template is a useful way to efficiently process data in a standard way.

Template files are "normal" EV files stored in a templates folder without any reference to echosounder data files. New EV files based on templates contain a one-time copy of all the settings stored in the template and await the addition of data files.

Refer to the Using EV file templates page in the Help file for more information.

Creating a template

The MultibeamFishTrackDetection (Solution).EV file contains all the Echoview processing steps and settings required to prepare DIDSON data for fish track detection and fish track analysis export. This EV file can be used for additional data recorded under the same conditions. In effect the MultibeamFishTrackDetection (Solution).EV file can be used as a template.

1. Start Echoview.

2. On the **File** menu, click **Open**.
   Open your saved `MultibeamFishTrackDetection.EV` file
   - OR -
   `MultibeamFishTrackDetection (Solution).EV`

3. On the Filesets window, click **+**.

4. Click Fileset2, on the **Shortcut** menu select **Rename Fileset**, type *Exported single targets*.
   This is preparation for the template to accommodate the addition of an exported .csv file.

5. On the **File** menu select **Configuration**.

6. Click the File locations tab.

7. In the *Files types* section click **Templates**.

8. Click **Edit**.

9. Browse to your tutorial folder:
   e.g., `C:\Echoview Software\Tutorials\IntroToMultibeamTargetDataProcessing\`
   Click **New folder**.
   Type **Templates** to name the folder and press **Enter**.
   Click **Select Folder**.
   Click **OK**.

10. On the **File** menu find Save Template and click **Copy to New Template**.

11. Browse to the Templates folder:
    e.g., `C:\Echoview Software\Tutorials\IntroToMultibeamTargetDataProcessing\Templates`

12. Under **File name** type**:** *TutorialTemplate* and click **Save**.

13. On the **File** menu click **Close**.

Using a template

When new data is added to a new EV file based on a template, the one-time copy of the template settings is applied. You can then proceed to tune the settings for the new data (if required).

Before you add data to a new EV file based on a template you can view and change the variable properties of "unavailable variables". This ability facilitates work with templates and work with EV files where variables or data files have been removed.

For demonstration purposes, the new data file is recorded over a much shorter time interval and there are three fish.

When you create a new EV file, Echoview will offer you a list of available templates.

14. On the **File** menu click **New from Template …**

15. Click `TutorialTemplate.EV`
    Click OK.

16. On the **Fileset 1** window click **Add**.

17. Open the file `2002-07-15_#018_HF_s003.ddf`:
    e.g., `C:\Echoview Software\Tutorials\IntroToMultibeamTargetDataProcessing\2002-07-15_#018_HF_S003.ddf`

18. Click the **Dataflow** tool

19. Inspect the variables, virtual variables and settings in the EV file.

20. Display the echograms for **Sv frames, Multibeam target detection, >20cm lengths and Single targets >20cm target length**.

21. Arrange the echogram windows.

22. Put **Sv frames, Multibeam target detection** and **>20cm target lengths** echograms into an

    Autosynchronization group .

23. On the **Single targets >20cm target length echogram** use the **Rectangle tool** to select the single targets.

24. On the **Shortcut** menu select **Looped multibeam replay**.

25. On the **File** menu click **Close**.
    - OR –
    Save your EV file as `C:\Echoview Software\Tutorials\IntroToMultibeamTargetDataProcessing\TemplateWithNewData.EV`
    and **Close**.

Topic 9: Performance optimization

In this topic you will learn how to optimize Echoview's performance with data dense files and how to deal with many data files in a data set. A template and original data are used to recreate target data processing. Selected single target data are exported and are added to a second fileset.

Export/addition of single target data

When viewing a single target echogram derived from the multibeam target detection variable, Echoview re-generates data for display when you want to view data that is not on the screen. With data-dense echograms and a chain of virtual variables this generation process can take a long time.

To "break" the link to the multibeam target detection variable, you can export the single target data (along with all the target properties), re-import the file and add it to different fileset. As a result, Echoview's performance is significantly improved when you view the Sv frames echogram in synchronization with the echogram of the imported single target data. Note that if you want to improve any steps in the dataflow for multibeam target detection, you'll need to re-export the updated targets.
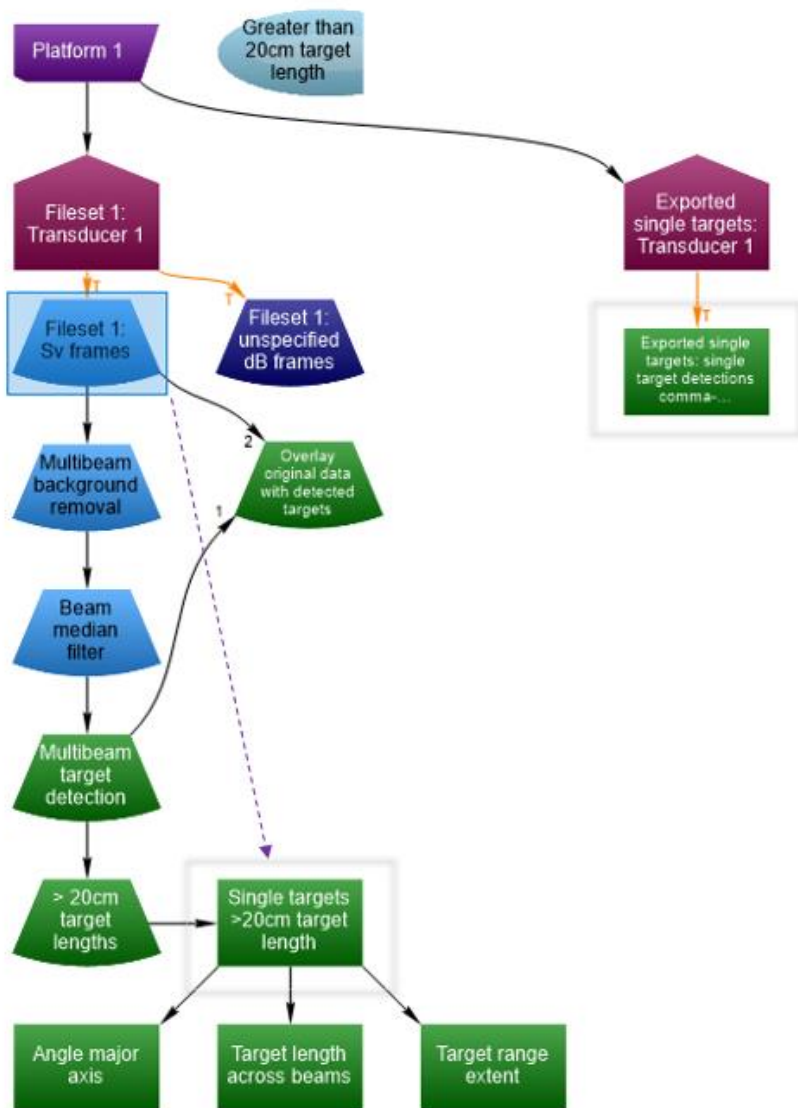
Figure 24 The multibeam target data processing dataflow for the tutorial's Performance optimization section. Note the framed single target data in both fileset s- the variables effectively contain identical data. The single target data in the Exported single targets fileset will display faster than the equivalent data in Fileset 1.The dotted arrow shows the virtual variable calculations required for the single target data in Fileset 1.

1. Start Echoview.

2. On the workspace click **Create a new EV file**.

3. On the New EV File dialog box select **TutorialTemplate** and click **OK**.

4. Under Fileset 1, click **Add**, browse to the file: "`2002-07-15_#018_HF_S001.ddf`"
   e.g., "`C:\Echoview Software\Tutorials\IntroToMultibeamTargetDataProcessing\2002-07-15_#018_HF_S001.ddf`"

5. Click Open. This recreates the MultibeamTargetDetection (Solution).EV file.

6. **Close** all echograms except for the **Single targets >20cm target length** echogram.

7. Click the echogram. On the **Echogram** menu select **Export, Single Target to CSV…**
   On the Export dialog box, select **All measurements** and click **Export**.
   For **Filename** type *SingleTargetsGreaterThan20cmTargetLength*.
   Click **Save**. This export can take some time for large amounts of data.

8. Return to the Filesets window.

9. Click the **Exported single targets** fileset tab. Click **Add**, browse to:
   "`C:\SVN\Echoview Doc\1500\Documentation\Tutorials\Tutorials\EV and data files\IntroToMultibeamTargetDataProcessing\SingleTargetsGreaterThan20cmTargetLength.target.csv`"
   Click **Open**.

10. Select single target detections comma-separated values.

11. Click **Echogram**.

12. Click the **Variable Properties** tool .

13. Click the **Echogram Display** tab.

14. This step will display the .csv data so that you can compare it with the original single target data.

    In the *Echogram colors* section:
    Color display minimum*:* 70
    Color display range*:* 40
    Color scheme*:* EK500

    In the *Echogram display limits* section:
    Upper display limit: 3
    Lower display limit: 12

    Under the **Data** tab, *Single target settings* section:
    Upper detection range*:* 0.00
    Lower detection range: 12
    Thickness source: Target thickness
    Thickness factor: 0.75
    Click **OK**.

15. Display these echograms, side by side:
    Sv frames echogram
    Single targets >20cm target length echogram
    Exported single targets: single target detections comma-separated values echogram.

16. Use **Window** menu > **Arrange All**.

17. On the **Shortcut** menu select **Synchronize**.
    Observe the two single target echograms – the displayed data are equivalent.

18. **Close** the **Single targets >20cm target length** echogram.

19. **Click** the **Sv frames** echogram.

20. Click the **Autosynchronization** tool .

21. Click the **Exported single targets: single target detections** echogram.

22. Click the **Autosynchronization** tool .

23. Use the Time slider to run forward and backward through the data.
The Exported single targets echogram responds quickly to changes in the position of the Time slider.

24. On the File menu click Close.
- OR –
Save your EV file as
```
C:\Echoview
Software\Tutorials\IntroToMultibeamTargetDataProcessing\TemplateWithExportedDa
ta.EV
```

Note: On the **Dataflow** window, the Exported single targets: single target detections comma-separated values variable may not be displayed. If not, place the mouse pointer over an empty space in the Dataflow window and use the **right-click** menu, **Show**. On the Show In View dialog box, select the item for Exported single targets: single target detections comma-separated values. Click **OK**.

COM Scripting

COM scripting is a powerful tool to process multibeam data files in Echoview. Many similar files can be processed quickly so that EV files and export files are ready for the review stage. Refer to the Echoview Help file for more information regarding COM scripting.

To complete this exercise, Echoview requires a license for the Automation module.

An example COM script has been prepared for this tutorial topic.

The COM script:

- Uses a template file:
  e.g., `C:\Echoview`
  `Software\Tutorials\IntroToMultibeamTargetDataProcessing\Templates\TutorialTemp`
  `late.EV`

- Processes raw data with the template. Raw data files:
  2002-07-15_#018_HF_S001.ddf
  2002-07-15_#018_HF_S003.ddf
  Found in the following example path:
  `C:\Echoview Software\Tutorials\IntroToMultibeamTargetDataProcessing`

Description of steps in the COM script

1. Create a new EV file using the template.

2. Add a data file to "Fileset1".

3. Export single target data from single target echogram to
"Script *DataFileName* single targets GT 20cm target length.target.csv"

4. Add the exported single target data to the "Exported single targets" fileset.

5. Detect fish tracks on the original single target echogram.

6. Export, Analysis by regions, Fish tracks to "Scripted *DataFileName* fish tracks GT 20cm target length.csv"

7. Save the EV file to "*DataFileName* Greater than 20cm target length.EV"

8. Repeat the process for any other data files in the specified location.

Run the script

1. Start Echoview.

2. Use Windows File Explorer to navigate to the following file in the tutorial folder:
`MultibeamTargetDataProcessing(COM script).vbs`

3. Double-click the file **MultibeamTargetDataProcessing(COM script).vbs**

4. Click **OK** when the script message appears.

5. The COM script saves and closes the new EV files.
The data files used are those that were used for the tutorial exercises. The script will produce viable fish track and single target export files. The new EV files that could be tuned further to achieve better detections.

6. Open the new EV files and inspect the echograms.

7. Close Echoview.

8. Use Windows File Explorer to inspect the exported CSV files in the `MultibeamTargetDataProcessing` folder.

Further information

- Echoview does not need to be opened for the COM script to work. If Echoview is not opened beforehand the script will use the system's last opened instance of Echoview.

- If you want to view the .csv files in parallel with the new EV files, you will have to make copies of the .csv files.

- To learn more about COM scripting you can download example scripts and a tutorial from the Echoview website.

References

Mueller AM, Burwen DL, Boswell KM, Mulligan T., 2010. Tail-beat patterns in dual-frequency identification sonar echograms and their potential use for species identification and bioenergetics studies. Trans. Am. Fish. Soc. 139(3): 900-910

Appendix 1: Stages of Multibeam Target data processing workflow

The analysis of multibeam data can be done in two stages: Development and then Routine analysis.

Development

The development stage characterizes the nature and limits of the data set. Different analysis pathways and parameters are explored to optimize target detection. Intermediary steps are examined to identify where problems occur and how they propagate through later processing steps. The Development stage would probably work with one data file at a time.

1. Load multibeam data files (typical, worst-case, best-case, unusual cases, etc.).

   Experiment with:

   - Multibeam Background Noise removal
   - Convolution and filtering
   - Multibeam target detection

2. View resulting echograms and compare with original multibeam data. Assess what steps and settings best preserve target size and area.

3. View the single target echogram that is the optimization of Step 1 and Step 2.

   Check target traces (this is before tracking). In ideal data, traces should be complete (no missing pings) and should not split or merge. Compare individual traces that show problems with the original multibeam image.

   For example, if target traces split the problem may be that the tail image separates from fish body image. This may be resolved through the adjustment of settings. Adjust if necessary and review results. This is an iterative process.

   View the single target echogram for estimates of other target attributes. Compare values of individual single target echoes with the corresponding target image on the multibeam echogram.

   Replay the multibeam echogram frame by frame and observe what happens to feature values. Look for unexpected values or patterns. Re-examine intermediary results from Step 1 to track an unexpected value to its source. This is an iterative process. Review, learn and improve.

4. For Steps 2 and 3 it is critical to have an exact alignment of single beam and multibeam echograms, i.e. exactly the same range interval needs to be shown, so you can relate the fish image on the multibeam echogram to the corresponding trace on the single target echogram. A vertical line on the echogram indicating the current frame helps relate the fish image to the corresponding single target echo.

5. When satisfied with the above, track single targets. Experiment with fish tracking parameters; perhaps generate several sets of tracking parameters, tailored to different environmental conditions or fish behavior. Review tracking results on the single target echogram; review the corresponding multibeam data in the manufacturer's application where tracks are questionable. Tweak tracking parameters to minimize the amount of editing that is necessary.

6. Make manual length measurements. Make on-the-fly comparisons with automatic measurements. Spread manual measurements over time, range, groups of fish etc.

7. Export tracked single target data. Plot manual vs. automatic measurement. Check correlation. If correlation is poor or inconsistent with previous correlations examine frames one by one to find the cause of the problem. (View the multibeam echogram and single target echogram side-by-side.) Possibly make adjustments to steps 2.

Routine analysis

The routine analysis stage estimates the rate of observed fish.

Identified methodologies from the development stage are used for routine analysis in a two part process.

The first part of the process is time-intensive and does not require user interaction. This can be achieved by running scripts in the background to produce pre-processed EV files and exported target data.

The second part of the process covers review, editing, and manual measurements and requires user-interaction. This is achieved by working with pre-processed and exported data in Echoview.

1. Run script for pre-processing. Use the set of image processing steps identified in the Development stage. Script will run in background and do the following:

    a) Load files into "Processing EV" file (contains all variables for processing steps b - e).

    b) Background Noise Removal.

    c) Target definition via using convolution, filtering and thresholds.

    d) Multibeam target detection.

    e) Conversion to single targets.

    f) Export single targets to cut the data link to multibeam data - this avoids time-intensive recalculation of single targets in Echoview

    g) Load single target and multibeam data files into a "Review EV" file.
        Review EV contains original multibeam data files and TS substitution single target variables - one variable for each estimated target attribute.

    h) Track fish

2. Open the "Review EV" file

3. Manually edit e.g. boat wakes or floating debris.

4. Make manual length measurements.

5. Review fish track detection,

6. Export tracked single target data, including manual length measurements.

7. Review the correlation between manual and estimated length measurements, if acceptable then move on to Step 8, otherwise make manual measurements for all "candidate" fish. Could use a combination of target property echograms as a guide to which fish to measure.

8. Summarization: calculate fish of given size class per hour. This step is best done in a third party application.