

The use of angle echograms in fish tracking and determining fish behavior

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Angle echograms are visual representations of the angle data derived from split-beam transducers. Like in the more conventional TS and Sv echograms, data is displayed in the 2 dimensions of range and time. Each data point on an angle echogram represents a position within the transducer beam, measured by the angle in the direction of the minor or major axis of the transducer, or a combination of the two angles. Angle echograms can be a powerful tool for fish track editing and determining fish behavior, especially when data is collected with stationary transducers (e.g. in-river applications that estimate fish passage). The implementation of angle echograms in Echoview® allows the user to:

1. Quickly and intuitively interpret the relative position and movement of targets; an entire page of the echogram can be assessed at one glance and without the need to draw selection boxes;
2. Distinguish the echotracelines of multiple fish that swim head-to-tail from interrupted echotracelines left by a single fish; synchronized with a single target echogram, the angle echogram is a valuable aid in editing fish tracks;
3. Delineate echogram areas that show distinct fish behavior (e.g. upstream, downstream movement, up/down in water column, milling): regions can be drawn directly on the angle echogram and be later used to exclude data or apportion biomass (or fish passage) estimates;

How to set up angle echograms in Echoview®

1. Load data files into a new EV file
2. Open echogram for **Raw variable** “angular position split beam pings”
3. Open its **Properties** dialog (F8). For the types of application described here, angle echograms are best interpreted when the two angles (major/minor) are displayed separately. Therefore, on the **Display** page of the **Properties** dialog, set the color scheme of the angle to be shown to e.g. “DT4”, and the color scheme of the other angle to “None”. Adjust the angle range depending on the size of the beam and the acoustic size of the targets. Experiment with different angle range settings until the echotracelines of targets passing through the beam cover most of the color spectrum.
(To view major and minor angles in two separate echograms create a copy of the raw variable “angular position split beam pings”. Set the display of the original to one angle and the display of the copy to the other angle, as described above.)

Note, starting with Echoview® version 3.20, angle echograms can be thresholded by target strength (TS). This is done by first creating a data range bitmap from the TS variable and then using it to mask the angle echogram:

1. Open the **Variables** window (F7)
2. Right-click in the **Variables** window and select **New...**
3. Select the **Operator group** “Bitmap operators” and the **Operator** “Data range bitmap”. Press **OK**.
4. On the **Operands** page of the Variable **Properties** window, select the **Operand** “Primary Fileset TS split beam”. On the **Data range bitmap** page set the TS threshold by entering the desired value in **Minimum in-range value**. On the **Notes** page, name the variable, e.g. “TS threshold”. Press **OK**.
5. Create masked angle echogram by right-clicking again in the **Variables** window and selecting **New...**
6. Select **Operator** group “Bitmap operators” and **Operator** “Mask”. Press **OK**.
7. On the **Operands** page of the Variable **Properties** window, select **Operand 1** “Primary fileset angular position split beam” and **Operand 2** “TS threshold” (variable name used in step 4). On the **Mask** page set the **Masked data values** to “No data”. On the **Notes** page, name the variable, e.g. “Horizontal angle with TS threshold”, and Press **OK**.

Examples

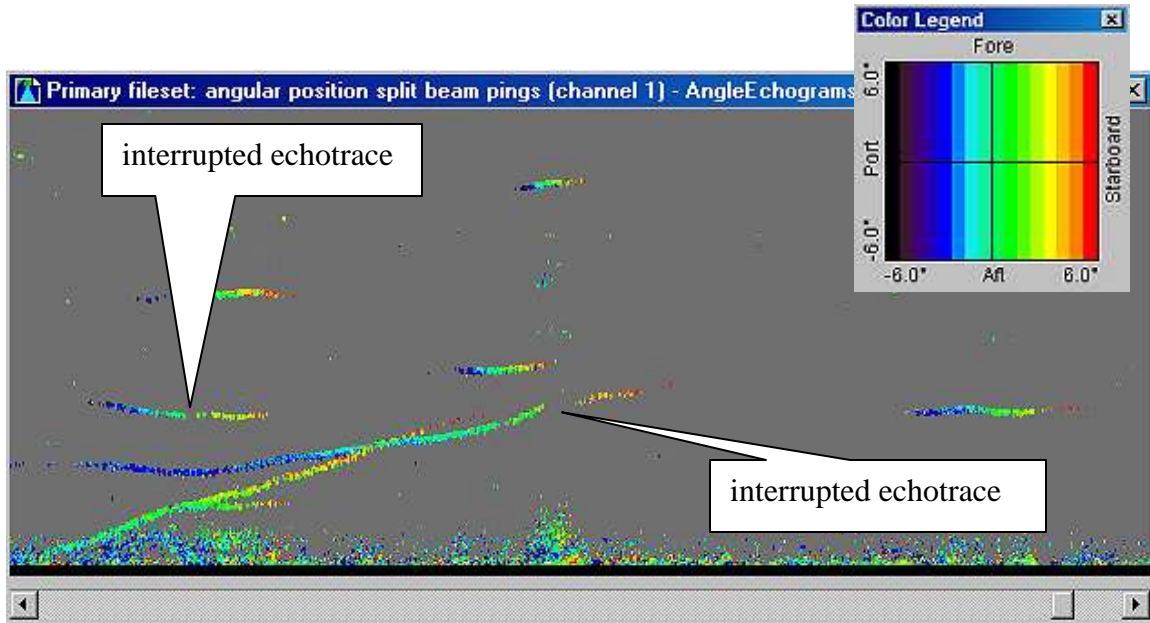


Figure 1 Angle echogram showing migrating salmon in the Copper River, Alaska. Transducer is mounted on the river bank, aimed perpendicular to the river current and with its right side (red in angle color spectrum) upstream. Upstream swimming fish leave echotraces that start in cold colors and end in warm colors.

(Reference: Lambert, M. B., D. J. Degan, A. M. Mueller, S. Moffitt, B. Marston, N. Gove, and J. J. Smith. 2003. Assessing methods to index inseason salmon abundance in the lower Copper River, 2002 Annual Report. US Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resource Monitoring Program, Annual Report No. FIS 01-021, Anchorage.)

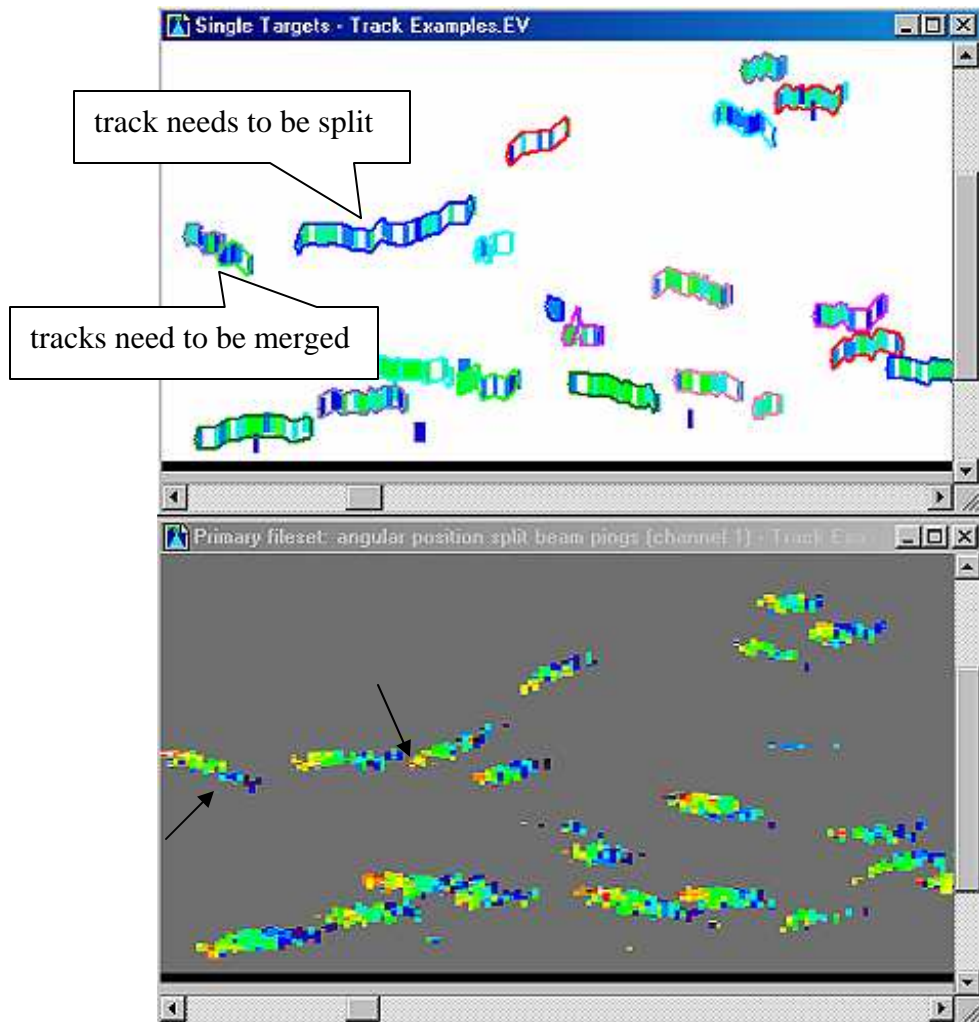


Figure 2 Synchronized single target and angle echograms showing migrating sockeye salmon in the Wood River, Alaska. Transducer is mounted on the river bank, aimed perpendicular to the river current and with its right side (red in angle color spectrum) downstream. Upstream swimming fish leave echotracess that transverse the color spectrum in reverse order compared to the previous example: traces start in warm colors and end in cold colors. Note tracks in single target echogram show one fish that was tracked as two and two fish that were tracked as one (see arrows).

(Reference: BioSonics, Inc., Alaska Statewide Sonar Project. Results of 1999 Field Demonstration, 1999. Report prepared for Alaska Department of Fish and Game.)

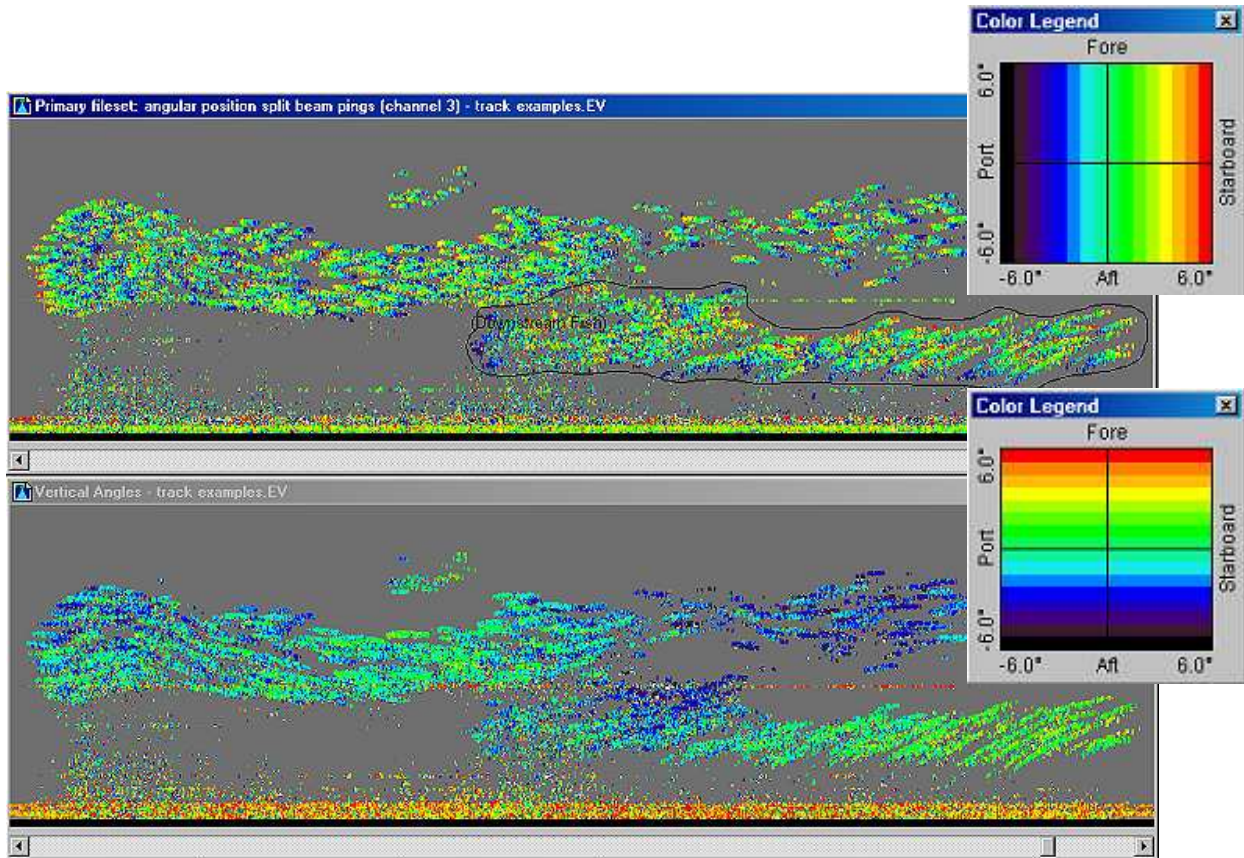


Figure 3 Synchronized horizontal and vertical angle echograms showing milling schools of pink salmon in the Ksi X'anmas River, British Columbia. In the horizontal angle echogram (shown at the top) red is downstream, and blue is upstream of the transducer. In the vertical angle echogram (shown at the bottom) red is towards the river bottom, and blue is towards the water surface (inverted transducer).

In Figure 3 note the two big schools of fish, one swimming upstream, the other (outlined as region in the lower right half of the horizontal angle echogram) swimming downstream. At the beginning of the echogram, the school of fish traveling upstream has some fish higher and some fish lower in the water column (see vertical angle echogram), then all its fish move down and then up in the water column. As the two schools pass in front of the transducer, the upstream swimming fish end up closer to the surface, while the downstream swimming fish go lower in the water column, at least relative to where each school started out (i.e. at that particular range). The schools encountered in this project were too dense to track individual fish. The data were therefore echo integrated. The angle echograms allowed us to define regions of downstream swimming schools and use the PRC_ABC (proportioned region to cell area backscattering coefficient) to apportion the ABC (area back scattering coefficient) and ultimately fish passage to downstream and upstream swimming schools.

(Reference: Bussanich, R. J., R. C. Bocking, D. J. Degan, and A. M. Mueller. 2003. Fixed-Location Hydroacoustics as a Method of Enumerating Adult Pink Salmon in the Lower Ksi X'anmas – A Comparison of Visual Counting and Split-beam Acoustics (2001-2002). Report prepared for Nisga'a Lisims Government.)