# What is an Echogram - Full Water Column Echo Envelope?

*Echo sounder data can be more than simply a depth reading – how deep the water is under the boat. In addition to reducing the uncertainty surrounding the reported depth measurement, the full water column echo envelope "echogram" can help understand what surface is being registered as the bottom.*

When using a single beam echo sounder to measure water depth, a short sonar pulse - a ping - is emitted by the transducer which then listens for the returning echo from the bottom. A precise clock measures the time elapsed since the ping was emitted and the bottom echo reflected pulse is received. When the echo is registered, the elapsed time is multiplied by the known speed of sound in water (around 1500 m/s or 1640 ft/s), and then halved on account of the ping's two-way travel to give the depth. The echo sounder then reports the result as a digital value.

That might sound like the end of the story, as the basic principle is very easy to understand. However, the question that should be asked is **"how does the echo sounder recognize the right echo as the bottom echo?"** After the ping is emitted, the transducer listens for a response and the sound intensity is continuously measured. The ping may reflect off anything in its path to the bottom: suspended sediment, debris, fish, sub aquatic vegetation, loose silt and mud, or a harder compacted bottom beneath the surface. Low frequency sonar pings may also penetrate quite far into the sediment, and a strong echo could even be received from a rock several feet below the sediment surface.

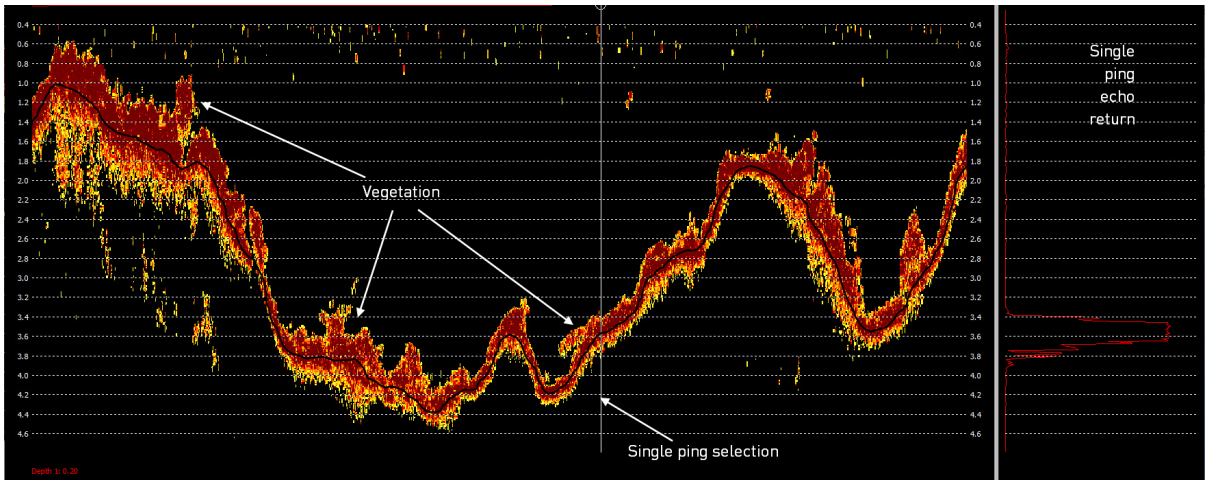


***Figure 1. 200 kHz CEESCOPE™ echogram from a river with sub aquatic vegetation.***

The total "listening period" for each ping is set as the time required for a ping to return from the maximum depth set by the operator in the echo sounder; the sonar cannot continue listening for ever as it has to get on with the job of emitting another ping. When the listening period is complete, the echo sounder has a record of echo intensity versus time (depth). This record may include some or all of the aforementioned features in addition to the desired bottom echo return. The echo sounder then has to determine the bottom depth among the various signals in the return, and it has not got long to complete the calculation. To output a depth value from this intensity record, known as a "digital depth" or "depth pick", echo sounders run a bottom detection algorithm that applies certain calculations to find the most likely candidate for the bottom echo. That result is then reported. Typically the echo sounder is looking for the "leading edge" of the first strong return. So, for each ping there are two separate pieces of data, the digitized depth result "depth pick" and the complete intensity record of the ping returned during the listening phase, the echogram "echo envelope" – the raw data. It should be fairly obvious that considering the multitude of potential echo returns, in some cases the echo sounder may not be able to correctly identify the "real" bottom in its depth pick output. So, being able to view and record the echogram in addition to the digital depth pick result is an important step in hydrographic survey quality control.

Basic "black box" echo sounders cannot output the echo envelope. These types are limited to relatively straightforward survey areas, where the digitized depth may be trusted resulting from a prior knowledge of the conditions. There is however always a risk that the digital output is incorrect and the surveyor has no means to validate the results without using a separate ground truth method.

Historically, survey echo sounders used a paper chart to record the echogram in analog form and the charts could be viewed in real time to ensure the bottom was being correctly identified. The paper roll served as a permanent QC record of the survey. While paper charts are still in use, nowadays echo sounders record a digital echogram. The complete echo intensity response is segmented into discrete fixed time slices over the entire active depth range (3200 per ping in the case of the CEESCOPE™ and CEE ECHO™). The sonic intensity measured in each time slice is assigned a value and recorded, leading to a digitized record of the echogram for each ping. So there are really 3201 numbers recorded per ping: the digital depth result and the 3200 separate measurements that were used to calculate it.

The benefit of the digitized echogram is that software can display the trace in real time, and data may be recorded on the survey PC. During the survey, echo sounder operation can be adjusted to maintain the desired bottom tracking, to maximize the quality of the resultant soundings. After the survey is complete, the digital echogram may be used to post-process sounding data; for instance removing the effect of vegetation or spurious signals as shown in Figure 1. The digital echogram also serves as a permanent record of the survey.