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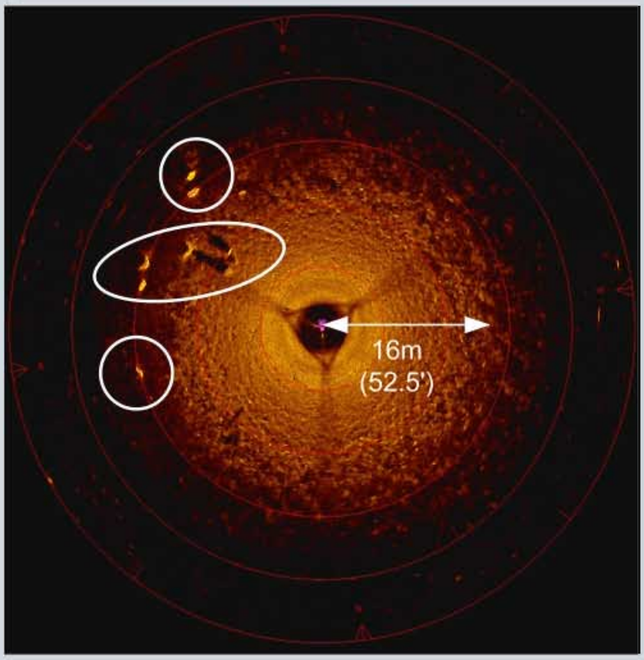
# Acoustic Incident Angles

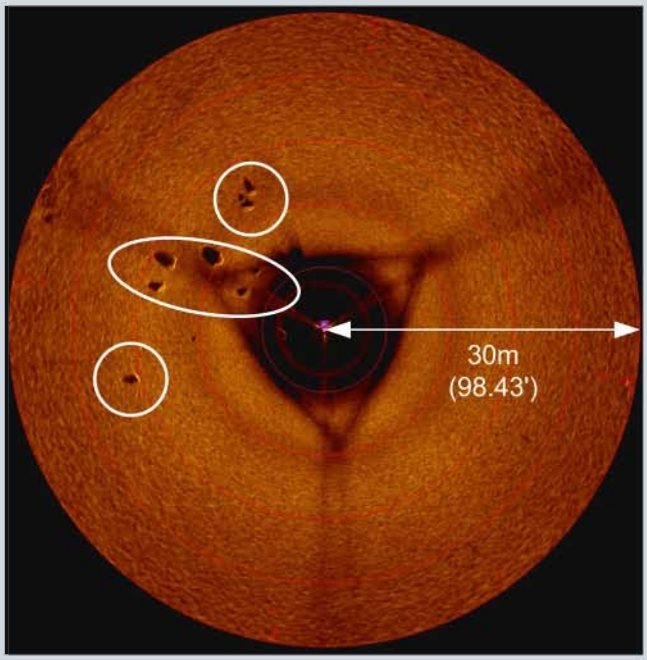
Success in collecting high quality sonar data is dependent on paying strict attention to the acoustic geometry. Remember the phrase:

***"When in doubt, draw it out!"***

If it makes geometric sense, chances are that using default sonar settings will result in a good record. If there is any question about the acoustic geometry, take a piece of graph paper and draw a ***scaled*** sketch of the position of the sonar head, its height above bottom, target range and its incident angle to the beam, and depth below the surface. Also calculate the sonar beam's transverse coverage in both the horizontal and vertical planes.

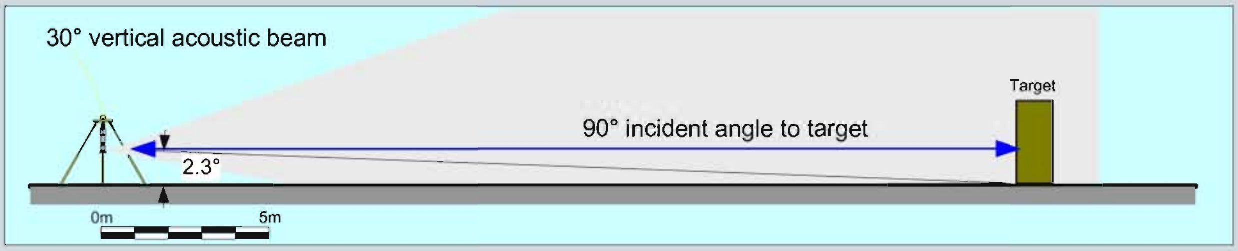
## Insufficient range due to refraction:




These records show the affect of thermal layering close to the sonar transducer. The 675kHz high resolution scanning sonar is capable of collecting images to 100+ metres range. The left image, however, has no usable data beyond 16m with the head positioned 1.4m (4.6') above the lakebed. Common targets in both records are identified. At this location, a cold water layer was present just a few centimetres (inches) below the sonar transducer. In the right record, the sonar was lifted to 3m (9.64') above bottom; the difference in sonar height changed the sound incident angle and dramatically altered the record. Remember the phrase: ***"Sound is lazy!"*** Sound 'bends' (refracts) to the colder layer with the slower speed.

## Insufficient range due to incident angle:




Acoustic reflectivity is highly influenced by incident angle, target composition (in particular the characteristics of the target's 'skin') and the sonar frequency. The scaled drawing shows the sonar transducer positioned at 1.4m above the seabed. At a 30m range the beam incident angle to the target is 90° - but the incident angle to bottom is 2.3°.

***At 100m range*** the target's incident angle remains 90° but the incident angle to bottom is 0.9°. It is unlikely the acoustic backscatter from soft sediment would be sufficient enough to be detected by the sonar at that low a grazing angle.

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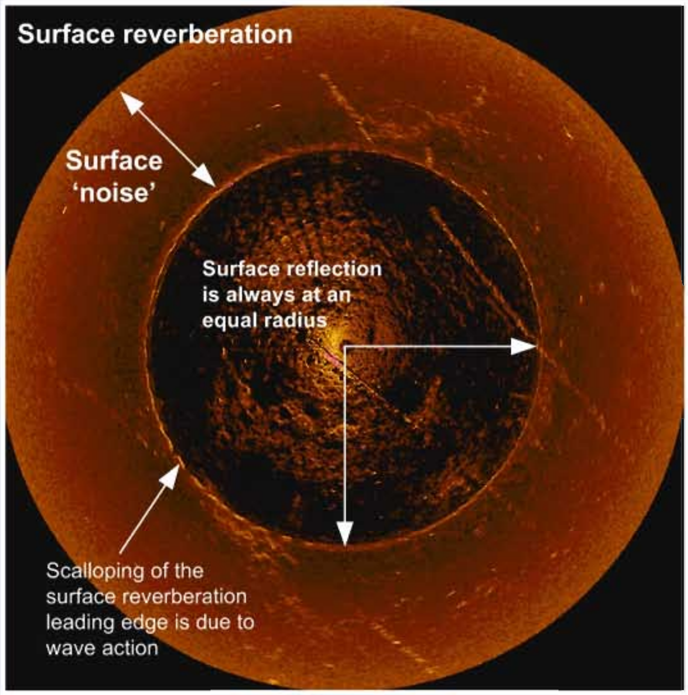
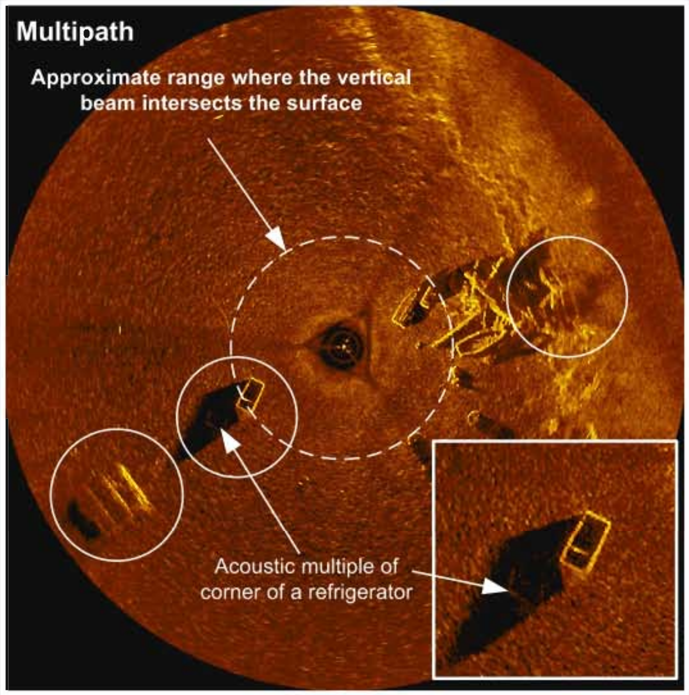
# Surface Reverberation and Multipath

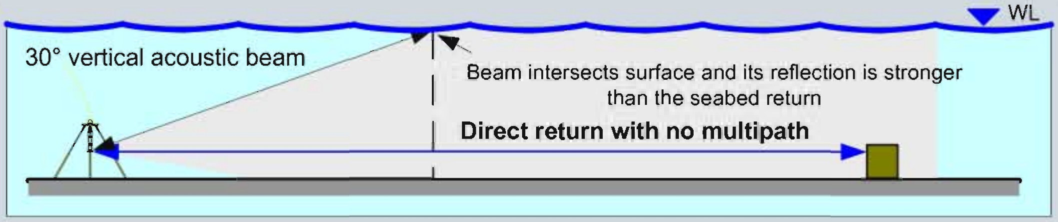
As the acoustic pulse travels through the water column it proportionally expands with respect to its beam angle in both the horizontal and vertical planes. In shallow water operations, the air/water interface is often a better reflector than the seabed because of its speed of sound difference between the two, and incident angle. When the water's surface is relatively flat the transmitted acoustic pulse can mirror off its surface as can the echoed return from the target. This creates a condition known as ***multipath.***

When the water's surface is choppy the incident angle of the vertical beam is steeper and the amplitude of the echoed return from the air water interface can be higher than that of the seabed or target on bottom or in the water column. Called ***surface reverberation***, this backscattered surface 'noise' may mask targets of interest..

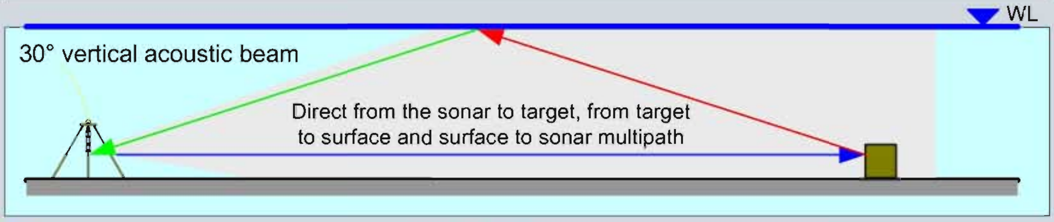


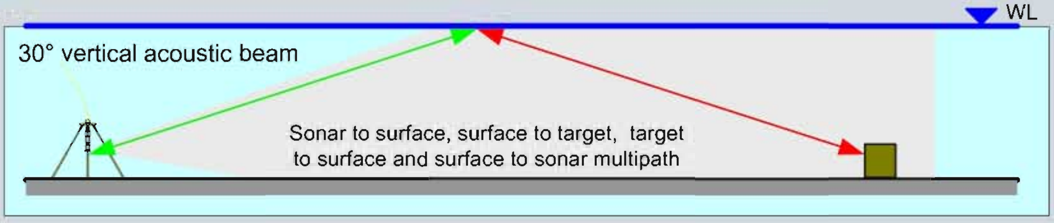

**Surface reverberation**




**Multipath**




**Multipath**




Surface reverberation and multipath occur when the vertical beam intersects the water surface

**THE FULL PICTURE**