# Application Note:

Sidescan Sonar Range.

The range performance of sidescan sonar is a much talked about and often misunderstood issue. This application note attempts to clarify some of the parameters and conditions that affect the interpretation of a statement of range performance, and gives EdgeTech's definition of operating range, and some typical maximum operating range estimates.

Environmental Conditions:
The acoustic environment can have a severe affect on the operating range of a sidescan sonar. There are 4 primary factors which may affect range performance:

- ambient noise
- water temperature and salinity
- water depth
- sonar/towfish height above bottom (altitude)

**Noise:** The ambient noise level for sidescan sonar frequencies (100 to 500Khz typically) is mostly dominated by acoustic and waterborne electrical noise or interference from the vehicle platform itself. Careful attention to good noise suppression design and assembly techniques can assure this is not a governing factor in limiting the range performance of the system. Furthermore the use of chirp technology with very well controlled receiver filter characteristics such as is used in EdgeTech's Full Spectrum systems can ensure that out of band system noise does not limit range.
Further discussions of expected range assume vehicle ambient noise is not a limiting factor.

**Water Conditions:** The water temperature and salinity can have a dramatic affect on range performance. Statements of outrageous or excessive range performance by a manufacturer may well be true under one of the extreme conditions that can be found in nature. The 2 way transmission loss (the total drop in intensity a signal undergoes travelling to and from the target) for a 410Khz signal is shown graphically in Figure 1 for two extreme, but realistic conditions, of a warm tropical sea (Florida east coast), and a cold fresh water lake.

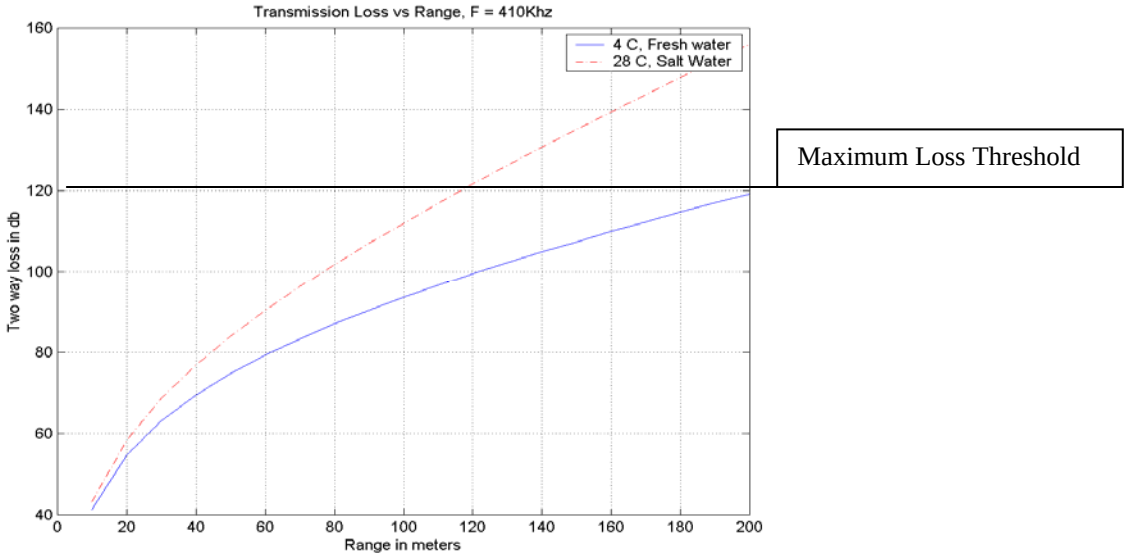


Figure (1)

The vertical scale is logarithmic, in dB (decibels) where every 20dB loss represents a ten fold weakening of the signal. A 120dB loss is therefore a millionfold reduction and is a typical loss that can be tolerated by good sonar systems.

A given sonar system with good range performance out to 120m in Florida waters, will achieve the same imaging performance out to beyond 200m in the conditions of a cold fresh water lake !.

**Water Depth:** The effects of water depth are illustrated in Figure 2.

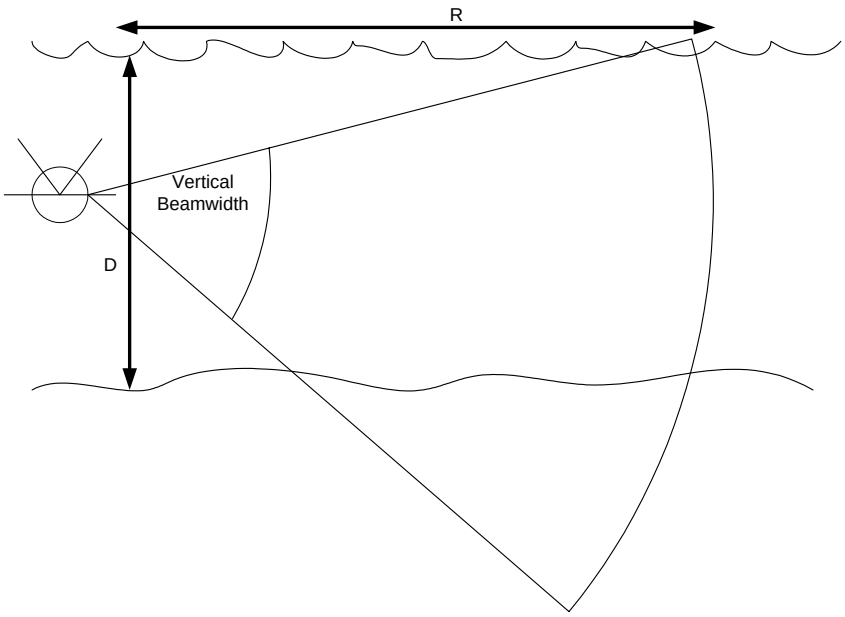


Figure (2)

The beamshape shown is highly idealized but illustrates the essential concepts.
The vertical beam shape of the sonar inevitably has some response to echoes returning from the surface. As the ratio of depth (D) to Range (R) gets increasingly smaller either by way of shallower water or longer range, the masking effects of the surface backscattered echoes become more pronounced resulting in a decrease in range performance. In shallow waters this effect is pronounced in the lower frequency ( hence longer range) systems.
It is worth noting that the frequency dependant loss experienced by the sound is weakly dependant on pressure (depth), and at extreme depths (>2000-3000m) longer ranges can be obtained.

**Altitude:** The backscattering strength of the sea floor (intensity of initial echoes) is a strong function of the grazing angle, or the acute angle between the line of sight to the sea bottom and the sea floor itself. At longer ranges/lower altitudes, this angle can become extremely small and all incident energy is reflected away from the source, and not back to the sonar. Thus maximum range is also limited by the altitude to range ratio. A typical and accepted value for Altitude/MaxRange for this purpose is 1/10. ( D/R in Figure 2)

Detection range
The meaning of "maximum range" itself is somewhat arbitrary and may vary from manufacturer to manufacturer, and may be exploited to give the highest possible number for their system.

Maximum Range may be given to mean the ability of the operator/observer to see the echo of a large target (ship wreck or similar) above the obscuring noise, or, at the other extreme, the ability of the user to use shadows in the image to aid in target identification.
The difference in the "maximum" range as defined by these two conditions for the **same** sonar may be as great as 30 to 50 % of stated range.

EdgeTech Maximum Range

The forgoing should make clear the huge variability that may be seen in the maximum range for a given sonar in practice.
EdgeTech's statement of maximum range for a system is given for the following general and typical conditions:

**Noise:** The ambient noise levels seen by the system are not expected to significantly exceed those of the sonar system itself. That is, it is our expectation that the platform/system noise is suitably suppressed or dealt with so that it is not a major consideration in range degradation. This is the case in majority of well designed systems we have been involved in.

**Water Conditions:** The stated ranges are for conditions of cool, salty water, typically between 6 to 10°C and salinity of between 32 to 34ppt. (typical North Sea). Higher deviations may be seen in the Mediterranean, and in Tropical Atlantic areas. Of course fresh water lakes will see much better ranges.

**Water Depth:** Water depth less than 30m (100ft) is definitely a range limiting factor for frequencies below 400kHz. Since our many of our Full Spectrum systems are designed for deep water operation (down to 3000 or 6000m), we give the expected range for deep water operation. Allowance must be made when using these systems in shallow water conditions.

**Altitude:** The expected altitude of the towfish is $1/10^{th}$ the maximum range.

**Detection range:** The EdgeTech definition of maximum range is that range where the system noise levels start to compete with, or are nearly equal to, the backscatter intensity from the sea floor. In this case, shadows cast by targets protruding clear of the sea floor should still be discernable, making the system capable of producing good sidescan imagery with shadows.

**Noise Part 2:** Unlike many systems built using conventional CW (non Chirp) technology, the receiver bandwidth of EdgeTech Full Spectrum sonars can be reduced (less noise) at the expense of some range resolution, while increasing the transmitted pulse length significantly (more energy) for even further improvements in range performance. This can be done "on the fly", and in software, by operator selection of suitable pulses. This enhanced long range capability is not taken into account when stating range.

Full Spectrum Sonar Systems.

Expected Operational Ranges, depending on Water temperature and salinity. (See Figures 3 and 4).
The absorption factor is estimated based on a model from Francois and Garrison, JASA 1982, and a depth of 50m.

Freq : 75kHz, Range: 700 to 800m. 1000m is possible at extreme depths and with special pulses

Freq : 120Khz, Range: 250 to 500m.

Freq : 270kHz, Range : 150 to 300m

Freq: 410kHz, Range: 130 to > 200m

Freq : 540kHz, Range: 100 to 150m

Freq : 850kHz, Range: 50 to 75m

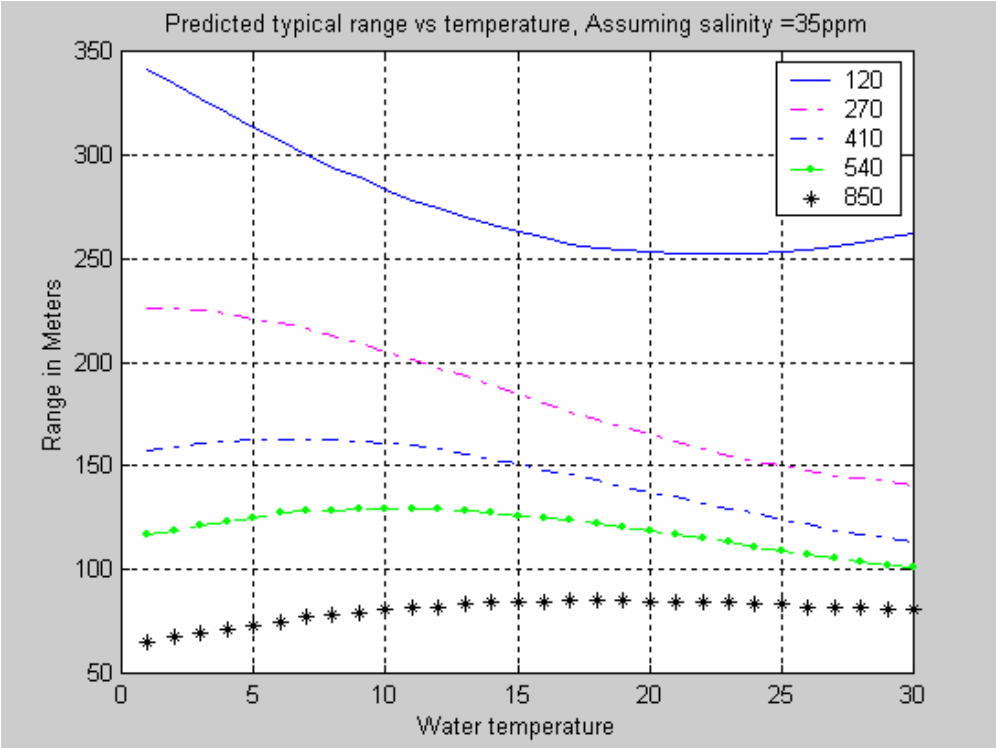


Figure 3: Typical Range versus water temperature for EdgeTech's Full Spectrum sonars, high salinity.

In Figure 3, the expected typical operating ranges for sea water with a high salinity of about 35ppm, is shown for 5 discrete frequencies. Note these plots assume that all other conditions such as sonar source level and local noise remain constant. At extreme depths (>3000m) a further reduction in the absorption factor is possible for even greater range.

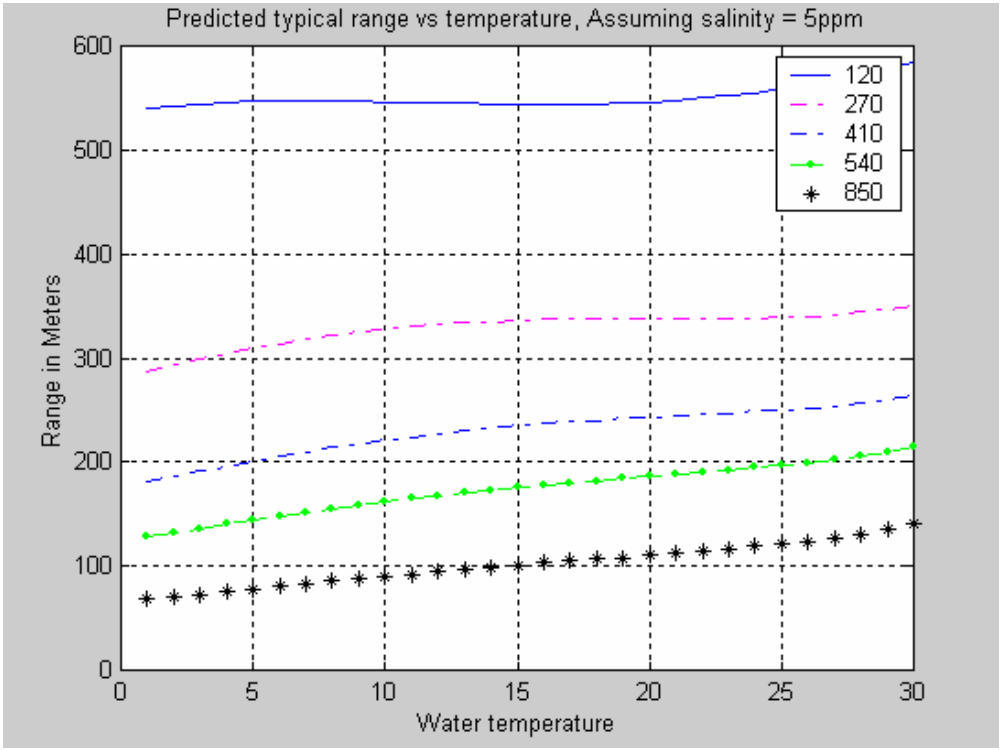


Figure 4: Range versus water temperature , low salinity water