FISHERIES WORKSHOP

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Use and Interpretation of Echo Sounding Equipment

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The intention of this paper is to provide a basic understanding of the operation of echosounders, and the interpretation of echosounder recordings. It is hoped that this information will help the fisherman gain better usage from equipment he now has, and help in the selection of future equipment. This discussion will concern itself with recorders and scope type displays, as these are the most widely used types of echosounders in the fishing industry.

Specifications of equipment which are particularly meaningful in selection of echosounders are: frequency, transducer beamwidth, pulse length, transmitter power, sensitivity, available depth ranges, and auxiliary features such as white-line, gray-line, scale expansion, and bottom locking.

Of course, whichever type of display is used, the transducer plays an equal part in the effectiveness of the equipment. The transducer converts electrical energy into sound waves on transmission, and sound waves into electrical energy on reception. The most common types are magnetostrictive, usually made of nickel or nickel alloy, and ceramic crystal, made from barium titanate or lead zirconate.

The efficiency – least loss of energy in the conversion from electrical energy to sound energy – is highest in the ceramics, as much as three times greater than the magnetostrictive. In addition to efficiency, the characteristics of transducers which influence performance are frequency and beamwidth. The frequency of the transducer you select should be determined by the type of fishing you intend to do. Most fishing type echosounders operate between 30 and 200 kHz. The lower the frequency the more depth range is possible, and the higher the frequency the more definition in shallow water. A frequency of more than 100 kHz would probably be unsuitable for depths greater than 200 meters.

Beamwidth is the angle at which the transducer pulse is transmitted. It is obvious that the narrower the beamwidth the more concentrated is the signal, and consequently more information about what is under the vessel will be received. However, a wide beamwidth will collect information over a larger area, and, especially in a small vessel which rolls and pitches, will provide more continuous information. The term "angular definition" is used to describe the ability of the echosounder to show hazards on the bottom and fish in small trenches or close to a sloping bottom. The wider the beamwidth, the less angular definition, due to masking of the desired echoes by side echoes. Consequently, beamwidth becomes more important the deeper one wishes to use the equipment. For vessels with need for relatively shallow depth, a wide beamwidth is acceptable. However, for greater depth, a beamwidth of between 10° and 20° would be considered optimum.

In the transmitter is determined the pulse length, which is important in determining the amount of radial definition and maximum depth. "Radial definition" is the term used to describe how well the recorder will show separate objects at varying depths. The shorter the pulse length, the greater this definition. However, for great depths, say 300 to 400 fathoms, a long pulse is necessary.

Transmitter power is important, but only when considered with receiver sensitivity – for instance, equipment today of only 100 watts power is often more sensitive than equipment of 15 years ago with 1000 watts of power.

There are many aspects of the recorder itself which are important. First is scale ratio – again the choice is between maximum depth and maximum definition. Most recorders have varying stylus speeds to offer selection of different ranges. For bottom fishing or trawling, or fishing great depths, the problem is to get good definition at or near the sea-bed. The most popular technique to maximize sea-bed definition at present is the "white-line" or "gray-line" technique. This offers no magnification of the echo, but, by a suppression of the very strong sea-bed echo, the fish echoes at the sea-bed are made much more distinctive. Now becoming more widely used is the technique of echo magnification, which enables the equipment to magnify a small segment, say 2 or 3 fathoms, of the depth. When this is coupled with "bottom locking" circuits, the best degree of information about the sea-bed is obtained. Bottom locking is the technique by which the sea-bed is displayed as a straight line regardless of the actual contour of the bottom. Scope type displays will give even better magnification information about fish near the bottom.

I will now mention a few points on interpretation of recordings. A hard flat bottom will be indicated by long black tails on the sea-bed echo. As one approaches rough bottom, tails will also appear on the echogram; this is due to additional reflection of the side echoes by the rough ground. When passing over mid-water fish, usually the echo will appear like an inverted "V." Schools of fish, thermal layers, and plankton will all show on the recording.

The reflected signal is very dependent on the target – that is, the relative consistence of the target as opposed to water, and an air-water boundary provides an almost perfect reflector. For this reason it is believed that the major portion of fish echo comes from the air bladder inside the fish. For the same reason, objects such as shrimp, which are very nearly the consistency of water, provide a poor reflector, and are difficult to observe on an echo sounder. Shrimp found in northern waters, in extremely dense shoals, are detectable on echosounders.

A difficulty is in discriminating between fish at the sea-bed from rocks. This is important for the fisherman in order to locate fish, and for the trawler to avoid an object which may foul his trawl. As mentioned before, the use of white-line or gray-line features enables this distinction to be made. From an ordinary "black-line" recording, it is very difficult to distinguish between fish and bottom, because the fish often will look like part of the bottom itself and will thus reduce the fisherman's possibility of detecting the fish. That is why the "white-line," scopes and other features like the so-called "bottom lock" system are used to a large extent for bottom trawling. By experience, the fishermen are also able to interpret the echograms and distinguish between different types of fish, based on the different markings obtained on the recording paper.

Inasmuch as experiments are now being made with mid-water trawling in the Caribbean area I will briefly comment on that subject. When mid-water trawling is used, it is of great importance to know the position of the trawl with respect to the vessel, the fish, and obstructions. It is also important to know how the trawl is moving, how the fish behave close to the trawl, and to what extent the trawl is filled.

The method of controlling the trawl's position by means of the echosounder depth measurements, adjustment of trawl wire length and trawl wire angle, and the speed of the vessel has gradually been improved by electronic instrumentation. This is a system which we call "trawl eye." The trawl eye is a mating of hydroacoustic sensing equipment on the trawl and recorder equipment onboard. The signal link is a special cable operated by various winch types. This system is capable of showing size and quantity of fish entering the trawl, fish passing over and under the trawl, and the head and ground rope and the trawl's distance to the sea bottom and the surface.

For smaller trawlers not able to handle a large system, a new smaller relatively inexpensive system has been developed. The components making up this system are an echosounder, a transducer unit and a strong electrical cable. In addition a cable winch strong enough to reel in the cable is needed. This system will give reliable information with cable lengths up to 1,500 feet using a standard echo sounder.

Even with all these facilities the trawl skipper is interested in more information. In particular he is interested in knowing the temperature conditions in the sea. Such information may be useful in the evaluation of fish existence. For this purpose we have developed a temperature indicator which is working with the trawl eye system. The temperature is recorded on the echogram which is made by the trawl eye recorder unit. Together with the recordings of fish and bottom, the temperature is also recorded as a thin continuous line on the echogram.

Finally a trawl system may include what we call a trawl watch. The trawl watch gives full information about the trawl's position in the water. Trawl depth and trawl openings are seen on the main echo sounder and superimposed on the echo sounder's depth recordings. Thus it will be possible to adjust the trawl to get the best fish concentrations. It gives audible and visual warnings of obstacles in the trawl's path with sufficient time to adjust the trawl. The trawl watch takes the signals from the trawl eye and converts them into markings on the main echo sounder together with the depth recordings. All the equipment I have mentioned here today is currently in production and available to anyone who feels he has a need for it.

If we try to look further into the future, I cannot see any new developments on the horizon that will revolutionize the field of fish detection instrumentation. Fish finding equipment will be basically what it is today for many years to come. However, a rapidly developing electronics technology will give us better and more efficient instrumentation as well as instruments that can do more jobs for us. For the mid-water trawl it will be very important to have an instrument that can inform or indicate the catch volume. Automatic control of trawl depths and trawl movements by means of winch operations controlled by computerized equipment certainly will come.