Abstract: The results of recent target strength measurements of walleye pollock from the North Pacific are presented. Results using a lowered-transducer system which allows the transducer to be moved closer to the target fish thus reducing the well-known bias of in situ target strength measurements due to range-dependent noise thresholds are discussed. Comparisons of measurements using a conventional system with the transducer mounted on the research vessel and this system are presented. The AFSC currently uses a target strength-to-length relationship (TS=20log(L)-66.0; L, length in centimeters) to scale echo integration information to estimates of fish density. Caveats regarding the limitations of in situ target strength measurement techniques are presented and suggestions for appropriate conditions for such measurements are provided.

TARGET STRENGTH MEASUREMENT

The importance of knowledge about the target strength (TS) characteristics of the surveyed fish population to the accuracy of acoustic assessments using echo integration is well known. The most reliable measurements of fish target strength are made using in situ techniques, in which measurements are made of live, free-swimming fish in their natural environment. In situ target strength measurement techniques can be separated into two categories -- indirect and direct. Indirect techniques remove the effect of directivity from a collection of echo levels, using a probabilistic procedure. Although some successes have been reported, the indirect techniques are susceptible to statistical errors and do not work well in many cases of interest (1). Direct measurement techniques remove the beam effect directly from each individual echo. There are two direct measurement techniques commonly used-- dual beam and split beam. The theoretical error structure of the two techniques have been described (1). Implementation procedures for the dual beam and the split beam techniques are available (2,3).

It is rarely possible to make target strength measurements in the field. The requirements for field measurements of target strength are fairly stringent. A significant problem with in situ TS measurement involves the ability to obtain a representative trawl sample to associate with the collected TS information. Suitable fish aggregations must also be located fairly close to the transducer due to: 1) the bias imposed against small targets at greater range due to the noise threshold and 2) the requirement that most of the fish be observed as single targets (i.e. less than one fish per pulse resolution volume). The latter requirement also restricts appropriate samples to fairly low density situations. In addition, to ensure that changes in selectivity of the trawl over the length range captured does not significantly bias the results, only monospecific samples of a fairly restricted length range are appropriate for establishing the relationship between fish length and TS.

The most common approach is to, over time, develop a target strength to length relationship for the fish being investigated. The most common form for the relationship is

\[ TS = 20 \log_{10}(L) - b \]

where L is length in cm and b is a constant. An example of a target strength to length relationship used by the Alaska Fisheries Science Center for walleye pollock is shown in Figure 1.
FIGURE 1. Target strength to length relationship for walleye pollock (Therastra chalcogramma). The solid line represents the current target strength to length relationship used for walleye pollock by the Alaska Fisheries Science Center (TS=20\log_{10}(L)-66.0). Individual measurements are indicated by solid symbols.

A significant problem with in situ target strength measurement techniques is that they work well only at close ranges (less than about 100 m from the transducer) and in low density situations. For many fish species, this only occurs rarely, primarily during nighttime periods. Thus, most of the measurements shown in Figure 1 are nighttime measurements. However, this relationship is used to scale echo integration data collected during daytime periods when the fish are aggregated. The Alaska Fisheries Science Center has developed a lowered transducer system to allow TS measurements to be made at greater depths. This will allow measurements to be made in a wider range of fish behaviors, allowing us to test the validity of applying target strength measurements made from shallow, low density, nighttime aggregations to pollock aggregations that are deeper and more tightly aggregated. An example of range-induced thresholding of target strength data was obtained from a sample collected from the Bering Sea in summer, 1996 is presented in Figure 2.

FIGURE 2. Example of range-induced bias in fish target strength measurements. The data are from a mixture of walleye pollock (Therastra chalcogramma), myctophids and smelt located approximately 210 to 260 m depth. Target strength measurements were made on the same fish using a vessel-mounted transducer (fish data range 200-250 m; solid bars) and with a lowered-transducer system (fish data range 65-115 m; open bars).

REFERENCES