Observation and explanation of systematic split-beam angle measurement errors

Experiments conducted at the Qualark Creek acoustic site on the Fraser River have shown unexpected systematic errors in the split-beam angle measurement. A tethered dead salmon with a target strength of approximately –30 dB was used as a target at 3.7 m range. A signal-to-noise ratio of ~12 dB was observed. This target strength and signal-to-noise ratio are typical in some rivers where migrating adult salmon are observed. The target's location was measured both from the frame used to position the target in the beam and from the acoustic data. Comparison of these two sets of measurements demonstrated a bias that increased with the target's distance off the beam axis. The acoustically measured target locations were closer to the beam axis than the actual locations. Each acoustic estimate represented the mean location obtained after 3 000 pings. Results from a simulation model that includes the effects of random noise on the split-beam angle measurement reproduce the systematic underestimate of these angles. This bias increases rapidly with increasing off-axis target location and decreasing signal-to-noise ratio. The bias has been observed for circular and elliptical beams and the model accurately predicts the magnitude and direction of the systematic part of the angle measurement error in both cases. Results for a circular transducer are used here to illustrate the situation. The presence of this bias can affect measurements of fish density and migration speed. At the low signal-to-noise ratios often obtained in riverine environments, those who use a split-beam system for observation or estimation of fish should be aware of this phenomenon.

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