The CCAMLR-2000 Krill Synoptic Survey of Area 48

Acoustic Sampling Protocols

The following protocols are set for the purpose of standardizing acoustic data collection and archival from multiple-ships during the multi-national effort to synoptically survey the entirety of Area 48 during the austral summer of 1999/2000. Methods for data analysis are not considered here, rather the primary objective of these protocols is to make the data collections as comprehensive and uniform as possible across all research platforms. Whenever possible, exact equipment, software, and settings have been dictated. In the cases where exact matches are not possible, pertinent comparative information has been specified.

Echosounder

Simrad EK500 scientific Echosounder, Modified Firmware V5.3 (Modified for 1 ms 200 kHz pulse duration)

Transducers

The following transducer models are strongly preferred:

- 38 kHz: Simrad split-beam ES38-B
- 120 kHz: Simrad split-beam ES120-7
- 200 kHz: Simrad single-beam 200-28

Suboptimal optional models include:

- 38 kHz: Simrad split-beam ES38-12
- 120 kHz: Simrad split-beam ES120-9

- All of the preferred transducer models have 7° conical beamwidths that allow approximately equivalent insonified volumes. This will be an advantageous for employing multi-frequency methods for taxa delineation.

- The transducer mounting configuration should be documented. Record should be made of blister, trunk, or towed-body dimensions and location on hull or location of tow-point; the window material and acoustic properties; and the transducer depths, dimensions and relative locations.
- The transducers should be mounted in the same blister, well, or towed-body if possible. This will be advantageous for employing multi-frequency methods for in-situ target strength measurements.

Transceivers

- TX1: 38 kHz split beam
- TX2: 120 kHz split-beam
- TX3: 200 kHz single-beam

Settings

- EK500 settings files should be agreed upon and used by all survey participants for the survey, calibration, and noise measurement operations; only settings determined by individual system calibrations might differ (eg. TS gain, Sv gain, beam angles, transducer depth, etc.).
- Following the initial calibration experiments, the settings files (see Appendices A-Survey; B-Calibration; and C-Noise Settings) should be updated for the system specific settings (eg. TS gain, Sv gain, beam angles, transducer depth, etc.), and written to CD-ROM for retained integrity ("CD-master files"). In this way, no changes will be made to the settings after the initial or pre-survey calibration experiments.
- The system specific settings files should be downloaded to the echosounder using EchoConfig at the beginning of each survey day, and each calibration and noise experiment.
- After each time the settings files are downloaded to the echosounder, the echosounder settings will be queried and checked for differences from the CD master file.
- Particularly Notable Settings:
    - A pulse repetition rate of 2.0 seconds will be used for survey, calibration, and noise measurements.
    - The Noise Margin will be set to 0 dB.
    - Pulse durations of 1.0 ms will be transmitted at all three frequencies.
    - Bandwidths will be wide, narrow and narrow for 38, 120, and 200 kHz, respectively.
    - The transducer depths will be set to the nominal mounting depths for each transducer.
    - A mean sound speed profile and mean absorption coefficients will be estimated for the entire survey area using CTD data from previous years; all echosounders will be set with the same profile settings.
    - Record Sv and TS for each ping and frequency from 0 to 500m.
    - The time-varied gain will be set to 20logR for Sv and 40LogR for TS measurements.

        - TS and Sv thresholds will be set to the minimum values of -100 dB.
        - TS-Detection settings (Min. TS = -100 dB; Min./Max. Echo length = 0.8/2.5; Max. beam compensation = 6 dB; and Max. phase jitter = 2 steps.)
    - EK500 time should be reset to correspond with logging PC/GPS time at the start of each day's survey.
    - The Log Menu/Distance will be set only once to 0.0 n.mi. at the end of the initial calibration.

Data Logging

- Data will be logged over an ethernet link with SonarData EchoLogEK and viewed and processed using SonarData EchoView software.
- For redundancy, the software will be run on two NT V4.0 Workstations with the following minimum configurations: 200 MHz Pentium II; 128 MB RAM; two 9 GB HDD; 4X CDROM writer.
- Data will be logged continuously on both workstations from the beginning of the first calibration to the end of the second calibration.
- On workstation No. 1, data collection will be viewed in real-time with SonarData EchoView software and written to CD at the end of each survey day.
- On workstation No. 2, data processing will be performed with SonarData EchoView software; at the end of the entire cruise, the entire data set will be written to a second set of CDs.

System Calibration

Standard sphere calibrations

- System calibrations will be performed at all three frequencies immediately before and after the survey in Stromness Bay, South Georgia (pre-cruise) and Admiralty Bay, King George Island (post-cruise).

- If at all possible, the transducer faces must be cleaned of debris and bio-fouling immediately prior to the initial calibration.

- Record must be made of the calibration: date; time; location; sea state (swell, wind, currents, ice); water temperature profile; salinity profile; sound speed profile; bottom depth; calibration apparatus; and ship's mooring configuration.

- The 38.1 mm WC sphere will be used as the standard target; all spheres will be purchased from a single production lot and each will be modified with small sputtered holes into which a single loop of monofilament attachment line will be glued.

- Theoretical TS=f(bandwidth and sound speed) will be obtained from Appendix D (theoretical TS values calculated for various anticipated sound speeds and for nomimal EK500 bandwidths).

- On-axis TS and Sa measurements will be made for each frequency at a range of 30m (see Simrad Calibration of the EK500 /EY500 - P2260/859-043867/4AA011, pp 1-36).

- The EK500 transceiver gain settings will be set to the calibrated Sv and TS gains.

- The EK500 transducer beamwidths should be set to the transducer calibration specifications provided by Simrad, as adjusted for sound speed (see Appendix D).

- The EK500 transducer off-axis angles should be set to 0.0 degrees.

- During the entirety of both pre- and post-survey calibration experiments, all acoustic data will be logged using EchoLogEK.

- Lobe files will also be logged whilst the TS gain is determined for the 38 and 120 kHz split-beam subsystems.

Multi-frequency Target Strength Calibrations

- The effectiveness of a split-beam echosounder system to reject echoes from unresolvable scatterers, thereby improving the measurements of *in-situ* target strengths (TS) of individuals, is dramatically enhanced by combining synchronized signals from two or more adjacent split-beam transducers of different frequencies. By utilizing the angular positional information from one of the split-beam transducers, additional corresponding TS measurements were shown to be obtainable from a juxtaposed single-beam transducer. Multi-frequency TS measurements provided information about the identity of constituents in a mixed species assemblage.

- To determine the positional transform equations for each transducer, three-frequency TS measurements should be made of the 38.1 mm WC sphere as it is moved throughout the beams of the three transducers; all echo-trace data from this exercise should be logged using EchoLogEK.

- To check the system calibrations, to determine positional transform equations for each transducer, and to demonstrate the TS versus scatter size relationships, TS measurements should also be made of 13.7, 23.0, and 60.0 mm Cu spheres at each of the three frequencies as they are moved throughout the beams.

- During the entirety of these calibration experiments, all acoustic data will be logged using EchoLogEK.

Calibration

- Selected shallow water survey transects should be repeated by each vessel; the seafloor scattering can thereby be used as the standard for comparisons. Sea state and ship speed and direction should be concurrently recorded with these measurements.

Characterization of System Noise

- Acoustic noise perceived by each of the three transducer/transceiver systems will be routinely monitored. Immediately following the conclusion of each day's acoustic survey effort, the Noise settings file (Appendix C) will be downloaded to the EK500 and for 10 minutes the ship will transit under survey conditions (survey course and speed). A separate Noise file will be logged using EchoLogEK. Concurrent observations of vessel speed, sea state, and ship's course relative to the wind and swell conditions will be recorded.

- With a Sv echogram threshold = -75 dB, banding free ranges (observed TVG rainbow effect) will be determined for each vessel under benign sea and weather conditions, at a ship speed of 10 knots - degradation of these "noise-free" observation ranges in excess of 10% will trigger remedial action (e.g. slowing ship speed, locating and eliminating noise source, etc.).

Survey Operations

- Whenever possible, survey at a constant speed of 10 knots; decreasing speed to reduce noise or increasing speed to maintain schedule as needed(provided noise level is acceptable).
- Survey recording data both day and night.

Necessary Preliminary Investigations

- Bench test EK500 using chosen settings and logging options.
- Identify mean sound speed and absorption coefficients to be used throughout the survey (estimate uncertainty in choosing mean values opposed to changing values frequently throughout the survey).

References

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K.G. Foote, "Maintaining precision calibrations with optimal copper spheres," *J. Acoust. Soc. Am.* **73**, 1054-1063 **(1983)**.

K.G. Foote, "Spheres for calibrating an eleven-frequency acoustic measurement system," *ICES J. Mar Sci.* **46**:284-286 **(1990)**.

D.G.M. Miller, "Suggested outline for the design and implementation of future near-synoptic krill surveys., WG-Krill-94/20

W.D. Tesler, "The preparation of recommendations and standard procedures for krill acoustic surveys, WG-KRILL-93/5