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PRELIMINARY REPORT OF THE FIRST JOINT USA-USSR HYDROACOUSTIC EXPERIMENT IN THE ICNAF CONVENTION AREA 11 March – 15 April 1974

By

K.I. Yudanov*, J.B. Suomala, Jr., V.M. Vorobyov*, and K.A. Smith

*Final review of this report has not been accomplished due to continuation of R.V. Khronometer research cruise to June 1974.

Preface

The activity described in this document was made possible through discussions and agreements between the responsible authorities of the Governments of the USA and the USSR.

The successful completion of the first USA-USSR hydroacoustical experiment in the ICNAF Convention area could not have been achieved without the dedicated and competent support of the operating personnel of R. V. Khronometer, Nikolai Shevchenko, Master.

Introduction

The objectives of the joint hydroacoustical experiment were:

To establish and implement standard calibration methods and procedures for all hydroacoustical equipment to be employed for aquatic biomass measurements.

To obtain hydroacoustical echo signals and other in situ data in raw, unfiltered form from aquatic animals (fishes) and the surrounding environment. These data are to be used to begin to understand and evaluate the feasibility and potential usefulness of hydroacoustical methods to obtain pelagic aquatic biomass estimations in the ICNAF Convention area.

To provide a detailed joint USA-USSR report of the findings and results of the hydroacoustical experiment and recommendations for future work at the annual ICNAF meeting, June 1974, Halifax, N.S.

Brief Description of Experiment Cruise

Following extensive calibration work on the various hydroacoustical instruments, the R.V. Khronometer was engaged in two survey activities.

Cooperative ICNAF Ground Fish Trawl Survey-Seventy-four trawl stations, each consisting of a thirty minute tow, were completed. This activity was begun 23 March and completed 6 April 1974.

Joint Hydroacoustical Experiment – This activity derived data from targets of opportunity during the trawl survey. Upon completion of the trawl survey the vessel was dedicated solely to hydroacoustical experiment activities, 6 April to 14 April 1974.

The cruise track extended 4200 nautical miles from Woods Hole, Mass. to Cape Henlopen, Del. to Woods Hole, over the continental shelf. Extensive search tracks were performed during the latter part of the cruise to locate suitable targets for hydroacoustical measurements.

During virtually the entire cruise hydroacoustical instruments, echo sounding and echo ranging, were in operation. The exceptions to this procedure was during severe weather, 4 April, and at times when R.V. Khronometer was in the immediate vicinity of Soviet fishing units which supplied data, via radio telephone, concerning the presence of pelagic fishes in these areas. Soviet fishing units continually supplied data concerning the presence and location of any pelagic fish concentrations in their operating areas.

Echograms for all trawl stations were routinely obtained and in specific instances echo signal recorded on U.S. instrumentation.

The best data for the purposes of the hydroacoustical experiments were obtained on 2 April, 00:10 to 04:05 hours, Lat. 39°52.8N, Long. 71°52.5W, and 13 April, 17:00 to 23:00 hours, Lat. 41°N, Long. 71°W.

Hydroacoustical Equipment Calibration

During the period 11 March – 14 March 1974 extensive hydroacoustical equipment test and calibration procedures were performed.

The calibration tests included the following:

1. Transducer Isolation
2. Transducer Resonant Frequency and Impedance Alignment
3. Transmitter Carrier Frequency
4. Transmitter Power
5. Transmitted Sound Pressure (Source Level)
6. Transducer Receiving Sensitivity (Voltage Response)
7. Equipment Receiving Sensitivity (Voltage Response)
8. Equipment and Ambient Noise (At Sea)

The calibration tests were performed on the following equipment:

Name	Type	Nominal Carrier Frequency – KHz
HAG 432	Sonar, Sounder	20
HAG 331	Sounder	30
PALTUS-M	Sonar, Sounder	30
OMAR	Sounder	25

All procedures, tests and results were carefully checked by US and USSR engineers. Joint agreement was reached on all points. In addition, a method of measuring and determination of receiving sensitivity (voltage response) employing pulse techniques was suggested by USSR engineers.

The method of measuring receiving sensitivity employing pulsed transmissions compared to continuous wave transmissions (C.W.) is to be investigated by both US and USSR engineers at their respective institutions, the results compared at the earliest possible date, and the resulting optimum method, or methods, adopted as a standard.

In addition US engineers have rechecked the characteristics of the US LC-10 test hydrophone and a similar USSR unit. The USSR hydrophone will be used in further tests by US engineers and the LC-10 loaned to the Soviet engineers for further tests in anticipation that this unit may become a standard reference hydrophone for future calibration activities.

Echo Signal Handling and Processing

The USSR engineers provided raw, unfiltered transmitted pulse/echo signals directly from various transducers to the US CRT oscilloscope, differential amplifier and broad band instrumentation analog tape recorder. The US provided time code identification and vessel roll and pitch attitude sensors and data which was also recorded on the analog tape.

Sea conditions on 2 April during data recording were ideal. The roll/pitch resultant angle of the transducer acoustic axis at no time exceeded 2.2° from the local vertical.

The echo signal data was manually processed on board using a method known as echo envelope sampling, using real time CRT oscilloscope photographs, shortly after the data was obtained.

The results of manually processing fifty photographs and applying the appropriate statistical methods, assuming that the target distribution was uniform, showed that the estimate of target density would be within a factor of two with a confidence interval of 99%.

It was not possible to obtain positive target identification of the aggregations insonified, therefore, the estimate of density may only be considered in a relative sense.

Further manual processing of an additional fifty CRT photographs reproduced from the analog data tape on 9 April showed no significant change from the original density estimate value of a factor of two, or the 99% confidence interval. It should be noted that the confidence interval is a function of

target density and the target strength of the individual targets within the insonified aggregation. Therefore, in the situation of 2 April, it is reasonable to state that, based upon the results obtained to date, if the target strength of the individuals in the insonified aggregation were known to the same precision as that of the density, the resulting estimate of the biomass would remain within a factor of two and at a confidence interval of 99%, assuming no systematic error, bias, existed at the time of observation.

Further examination of the data tapes of 2 April is to be performed to determine the presence of single targets, if any, and rigorous computer processing to verify the manually derived data.

The echo signal data gathered on the night of 13 April was from both echo sounder and net sounder on a pelagic trawl. The fish, sea herring, appeared to be widely scattered, in small aggregations, but were effectively recorded from the received signals of the echo sounder. Many single fishes were recorded from the net sounder and preliminary examinations of these data shows target strength information is available, but it seems unlikely that the fish would be in their natural state and attitude due to the presence of the net. Therefore, these target strength data cannot, at this time, be considered truly representative of fish in the wild.

All data recorded during the cruise was duplicated, by US engineers, on magnetic tape compatible with USSR recorders.

Experiment Area

During the latter part of the R.V. Khronometer mission intensive search activities for pelagic targets were conducted. The search tracks were typically oblique to the slope, canyons and channels. Except for the contacts of 2 April and 13 April, few targets were detected.

It is reasonable to state that, if there were any major fish concentrations in the area of operations, at that time, the probability of detection was very high.

General Comments

No equipment malfunctions or failures occurred during the R.V. Khronometer cruise which compromised the stated objectives.

Some problems with vibration, at a vessel velocity greater than 8 kn. which could have affected the fidelity of recording was experienced, but this did not occur during data gathering periods since vessel velocity was 1.5 to 4 kn. at that time.

Also, electromagnetic interference between various hydroacoustical instruments and other electrical and electronic sources of noise caused minor problems which were reduced to an acceptable level, but not completely eliminated.

Although the hydroacoustical data gathered during the cruise permitted the objectives to be achieved, both US and USSR engineers were prepared to accept and analyze more data than was available at the time.

The manual echo signal envelope sampling was simple, straightforward and allowed the detailed examination of the statistical properties of the received echo signals with regard to the relative density of fish aggregations shortly after the data was obtained.

Recommendations for Continuing Activities

The following recommendations are presented in the light of the experience and observations to date.

Hydroacoustical Equipment Calibration

Standard, comprehensive calibration procedures have been established.

Recommended:

The generation of a standard procedural document to formalize hydroacoustical equipment calibration procedures and tests. The form and content of the working document used in the joint experiment is recommended.

Echo Signal Handling and Processing

The real time recording in broadband analog form of the raw, unfiltered echo signal, along with other environmental data, provides the means to examine the events which occurred, without loss of vital data, which may be of great value in the light of further understanding of the problems associated with aquatic biomass measurements. The use of a high frequency, delayed sweep, CRT oscilloscope with a broad band differential amplifier is equally vital for real time evaluation of the quality of the data being gathered. The application of a manual, technically valid echo signal processing method as an adjunct to any automated echo signal processing can provide a convenient verification of the usefulness and potential accuracy of the data being gathered.

Recommended:

The continuation of the use of echo signal handling instrumentation equivalent to that provided on R.V. Khronometer for future experiments. In addition, continued collaboration in the application of manual echo signal processing to verify the usefulness and potential accuracy of hydroacoustical data.

Experiment Area

The necessity for the selection of the proper area and time is of primary importance. An area must be selected where fish of one species are known to aggregate. The time of aggregation must also be known. The aggregations must occur off the sea bottom or be of a species known to make vertical migrations during the time of hydroacoustical measurements. Ideally, the animals should be in mid water for several hours, approximately four, in a twenty-four hour interval.

Recommended:

The generation of a description of the behavior of the pelagic or semi-pelagic fish species in an experiment area. This information is to be supplied so that plans can be developed for future experiments to obtain the optimum data which can be used to expand the knowledge of the usefulness and potential accuracy of hydroacoustic methods for aquatic biomass measurements.

List of Principal Instrumentation

Hydroacoustical

HAG 432	Sonar, Echo Sounder
HAG 331	Echo and Net Sounder
PALTUS-M	Sonar Echo Sounder
OMAR	Echo Sounder

Echo Signal Handling and Recording

Type 547	– CRT Oscilloscope
Type 1A7A	– Differential Amplifier
Type C-27	– CRT Oscilloscope Camera
Type FR-1300	– Analog Tape Recorder
Type 8150	– Time Code Generator-Reader
Type W	– Differential Amplifier

Echo Signal Processing

Type HP-45	– Calculator

Vessel Attitude

Type AP-S3	– Accelerometers

Test

Type LC-10	– Hydrophone

Miscellaneous:	– CRT Oscilloscope, VTVM, Signal Generator, DVM, Frequency Counter and Attenuator