MASTER OF SCIENCE
IN
PHYSICAL OCEANOGRAPHY

HIGH FREQUENCY SONAR COMPONENTS OF NORMAL AND HEARING IMPAIRED DOLPHINS

David C. Dye-Lieutenant, United States Navy
B.S., Jacksonville University, 1994
Master of Science in Physical Oceanography-September 2000
Advisors: Thomas G. Muir, University of Texas-Austin
Ching-Sang Chiu, Department of Oceanography

A data acquisition device was constructed and tested to obtain toothed whale (Bottlenose Dolphin and Beluga Whale) sonar signals and digitally store them to a PC hard drive. The device had the capability of capturing sonar signals by means of a two-hydrophone array, and a digital video camera in a submersible housing. Cooperation with marine biologists at SPAWAR Systems Center-San Diego enabled the sampling of three animals performing echolocation tasks. Their sonar signals, transmissions of rapid high frequency pulses called clicks, were recorded for further processing. Once the data was captured on video and hard disk drive, it was processed using MATLAB.

Data from three different toothed whales, a normal Bottlenose Dolphin, a Bottlenose Dolphin with a hearing impairment and a Beluga Whale, was analyzed. It was observed that the animals reduced the interval between clicks when they located a target. Correlating the signal data to the video data made this observation possible. It appeared the animals searched with widely spaced clicks, then narrowed the click period upon target detection. Also, it was noted that the frequency of isolated clicks decreased as click period decreased. However, the hearing impaired Dolphin maintained his click frequency regardless of click periodicity.

DoD KEY TECHNOLOGY AREAS: Electronics, Sensors, Computing and Software

KEYWORDS: Marine Mammal Systems, Bio-SONAR, Mine Detection, Dolphin SONAR, Echolocation Signals

U.S. AND AUSTRALIAN MINE WARFARE SONAR PERFORMANCE ASSESSMENT USING SWAT AND HODGSON MODELS

Barbra K. Dubsky-Lieutenant, Royal Australian Navy
B.Sc., University College of the University of New South Wales, 1992
Master of Science in Physical Oceanography-September 2000
Advisors: Robert H. Bourke, Emeritus Professor of Oceanography
James H. Wilson, Department of Oceanography

The purpose of this thesis was to investigate a shallow coastal region to compile a detailed environmental picture of its sediment composition and water characteristics and from this model MCM sonar performance at the FBE-H exercise location as a means to determine what parameters exerted the greatest effect on performance. Seven parameters were intercompared to assess their sensitivity in detecting mines: bottom type, SSP, water depth/sonar depth, mine depth, frequency, sonars and models. Performance was assessed using several measures of effectiveness including the signal to noise ratio and initial detection range.

Variations in these measures were analysed by investigating how TL and RL responded to changing parameters.

No one single parameter was identified that affected sonar performance significantly above all others. Of the environmental parameters considered, variations in bottom type exerted the most influence on TL and RL and ultimately on sonar performance. TL was clearly a significant factor when the bottom type is comprised of absorptive, fine-grained material. Of the sonar parameters, frequency exerted a significant impact on performance with TL the most sensitive term in this comparison. A higher TL associated with higher frequency reduced the signal level and consequently the bottom RL. The higher frequency displayed a stronger SNR than the lower frequency over short ranges, however the higher frequency was limited by TL at greater ranges with the lower frequency achieving greater initial detection ranges.

DoD KEY TECHNOLOGY AREA: Battlespace Environments

KEYWORDS: Reverberation, Bottom Backscatter, Mine Warfare, PC SWAT Model

INFERRING BOTTOM ACOUSTIC PROPERTIES FROM AN/SQQ-32 SONAR REVERBERATION DATA

Henry R.G. Howell-Lieutenant, Royal Navy
B.Sc., McGill University, 1987
Master of Science in Physical Oceanography-September 2000
Advisors: Robert H. Bourke, Emeritus Professor of Oceanography
James H. Wilson, Department of Oceanography

Inversion techniques are used to infer bottom geoacoustic properties using AN/SQQ-32 Reverberation Level (RL) data gathered by USS Avenger (MCM-1) in Rhode Island Sound in February 1993. Based on the hypothesis that the magnitude of backscattered energy is directly related to the acoustic reflectivity of the seabed, a statistical analysis of beam RL time series was conducted to determine its correlation with sediment geoacoustic character.

A technique was developed using the deviation of the RL for an individual ping/beam from an area-wide average RL to generate geographic maps illustrating bottom geoacoustic characteristics. Resulting plots of "relative reflectivity" not only agreed with the existing descriptions of sediment distribution, but also provided more detailed spatial representation of bottom geoacoustic distribution. This highlighted the gross inadequacies, particularly in spatial resolution, of existing information on bottom geoacoustic distribution.

These plots, when produced using appropriately small sample intervals, have sufficient spatial resolution to expose MCM clutter density information. Geographic maps of relative reflectivity can provide an invaluable aid to planning search strategy, a surveying tool to compare clutter densities, appropriate geoacoustic parameters for accurate model (including full wave) predictions, and a means of real time performance monitoring and assessment (providing the ability to revise and modify search strategy).

DoD KEY TECHNOLOGY AREAS: Battlespace Environments, Computing and Software, Sensors, Modeling and Simulation

KEYWORDS: Acoustics, Reverberation, Bottom Backscattering, Geoacoustics, Oceanography, Inversion Techniques, MCM Sonar Operations, AN/SQS-32

MINE BURIAL IN THE SURF ZONE

Wayne L. Plager-Lieutenant Commander, United States Navy
B.S., Iowa State University, 1988
Master of Science in Physical Oceanography-September 2000
Advisors: Thomas G. Muir, University of Texas-Austin
Edward B. Thornton, Department of Oceanography

The volumetric rate of scour and burial of a MK-83 mine by waves in the swash and surf zone were measured in two experiments. The beach was near planar with a 1:40 slope and mean grain size of 0.2 mm. The deep water significant wave height was about 2 m with peak periods of 13 sec. An Acoustic Doppler Velocimeter recorded orbital velocities of the waves. Three dimensional scour was measured manually and with video. Volumetric rate of scour over time relative to the volume of the mine was as high as one during the first hours of mine deployment. Maximum scour volume occurred at 6 hours after deployment and the scour changed from removal to fill after this time. The Shields parameter as a measure of total shear stress experienced by the sand bed was an order of magnitude greater than that required to initiate sediment transport. The mine was completely buried after 24 hours in the surf zone to a depth of 10 cm below the surface of the sand bed.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments

KEYWORDS: Mine Burial, Scour, Surf Zone, Mine Warfare