MARINE RESEARCH 1973

A CATALOG OF UNCLASSIFIED MARINE RESEARCH ACTIVITIES SPONSORED BY FEDERAL AND NON-FEDERAL ORGANIZATIONS

Prepared by
National Oceanic and Atmospheric Administration,
Department of Commerce

for
Interagency Committee on Marine Science and Engineering,
Federal Council for Science and Technology

October 1973

Foreword

This second edition of the Catalog of Marine Research is an updating of the original Catalog, published in 1969. Its general purpose is the same—to provide for exchange of information and ideas among the increasing number of individuals and organizations involved in marine science and technology. The users of this document include, among others, institutions of higher education; Federal, State, and local agencies; international groups; industrial firms; and nonprofit organizations. The resumes contained in this volume are limited to projects that are either continuing or have been completed in calendar year 1973.

The structure and organization of this volume are identical with the first Catalog, but there are other changes. For example, the number of resumes or project descriptions has risen from 2,600 to some 4,600, an increase of nearly 80 percent. Federal agencies submitting resumes have increased in number from 25 to 31, reflecting a broadened interest and involvement in marine activities. Also there has been a substantial increase in response rate of non-Federal and foreign sources. Not only has the number of sponsoring organizations risen to 700, but also reports from more than 4,800 principal investigators are included.

Among the reasons for this increase in activity are the growing national concern for the critical problems of conserving our marine environment and careful development of our marine resources. This concern has been expressed by significant legislative actions in recent years, including the Clean Water Restoration Act; the National Sea Grant College Act; the Water Quality Act; the Ports and Waterway Safety Act; the Coastal Zone Management Act; the Marine Protection, Research, and Sanctuaries Act; and the Marine Mammal Protection Act. The National Environmental Policy Act is also highly important in marine exploration and development because it is the basic policy-setting statute relating to protection of the physical environment. Additionally, there have been a number of relevant Executive Orders and Reorganization Plans, in particular the Reorganization Plans 3 and 4 of July 9, 1970, which established the Environmental Protection Agency and the National Oceanic and Atmospheric Administration.

The result of the above has been increased authority and responsibility to the major Federal marine funding agencies, requiring increased effort not only in government but also in the scientific and academic communities which have much of the required capabilities and skills.

There is no doubt that the oceans will increasingly contribute to the solution of our national economic and resource requirements. In anticipation of this and the increasing quantity of information that will become available, we are exploring various approaches for presenting this information in the future to insure its most efficient dissemination among the marine user community.

Dr. Robert M. White
Chairman,
Interagency Committee on
Marine Science and Engineering

Editor's Note

Marine Research—1973 was prepared by the Smithsonian Science Information Exchange at the request of the Environmental Data Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. This catalog is a part of the Exchange's continuing support of marine research information activities. The scope of its coverage is the same as that found in *Marine Research—Fiscal Year 1968,* a catalog prepared by the Exchange for the National Council on Marine Resources and Engineering Development.

The current catalog contains information on 4,555 ongoing and recently completed projects funded by both Federal and non-Federal organizations. Summaries for each of the projects carried out under Federal support have been reviewed, updated, and approved for inclusion in the catalog by the Federal agencies which originally furnished the information to the Exchange. The projects are assigned to chapters and subchapters according to their subject content.

In addition to the summaries of the projects, the catalog contains the following indexes: Subject Index, Investigator Index, Contractor Index, and Supporting Agency Index. The information which appears in the summaries and indexes was taken directly from the project records as received by the Exchange. Each project in the Subject Index is indexed to an average of six terms arranged in hierarchies indicating relationships between broader and narrower concepts. Index terms are followed by project titles and identifying chapter and subchapter numbers.

All terms were selected to emphasize the marine aspects of the projects and are as specific as the language of the summaries. A project which deals with crabs is indexed to the specific term "Crabs" under a hierarchy consisting of the term "Eucarids" and the still broader term "Crustacea." Thus, one must turn to the high-level term "Crustacea" to find projects concerning crabs, where studies of other crustaceans will be found as well. Looking under the term "Crabs," one would find the notation "See Crustacea, Eucarids" and also "See Food Fish and Shellfish," indicating that studies of crabs can be found under both headings in the Subject Index. "See Also" terms are also used to indicate other hierarchies under which identical terms can be found.

To further aid in locating subject areas, the first high-level hierarchical term to appear on a left-hand Subject Index page is also printed on the upper left-hand corner of that page, and the last high-level term to appear on the right-hand page will also appear on the upper right-hand corner of that page in dictionary fashion.

The Supporting Agency Index consists of a single alphabetic listing of both Federal and non-Federal sources of support. All investigators cited on the source documents are included in the Investigator Index. An asterisk is used to designate the individual specified as principal investigator. However, in a few instances, it is apparent that the "Principal Investigator" is, in fact, a program manager who may not be working at the contractor location given with the project summary. The Contractor Index is an alphabetic listing of the performing organizations and their locations.

All of the indexes in this catalog were computer generated by SSIE. Use of the computer for this purpose necessitated a limitation on the number of characters available for index terms and captions. Thus, in some instances abbreviations had to be used. A list of abbreviations used to designate Federal supporting organizations is included immediately following the table of contents.

David F. Hersey

David F. Hersey
President
Smithsonian Science Information Exchange

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Abbreviations Used for Federal Supporting Organizations *

U.S. Dept. of Agriculture	
A.R.S.	—Agricultural Research Service
P.S.R.	—Plant Science Research Division
S.W.C.	—Soil & Water Conservation Research Division
C.S.R.S.	—Cooperative State Research Service
F.S.	—Forest Service
U.S. Dept. of Commerce	
Bur. of Dom. Com.	—Bureau of Domestic Commerce
Maritime Admin.	—Maritime Administration
N.B.S.	—National Bureau of Standards
N.O.A.A.	—National Oceanic & Atmospheric Administration
U.S. Dept. of Defense	
A.R.P.A.	—Advanced Research Projects Agency
U.S. Dept. of Hlth. Ed. & Wel.	—U.S. Department of Health, Education & Welfare
F.D.A.	—Food & Drug Administration
H.S.M.H.A.	—Health Services & Mental Health Administration
N.I.H.	—National Institutes of Health
U.S. Dept. of Interior	
Bu. Sport Fish.	—Bureau of Sport Fisheries & Wildlife
O. Wtr. Res. Rch.	—Office of Water Resources Research
U.S. Dept. of Transportation	
F.H.A.	—Federal Highway Administration
Off. Sec.	—Office of the Secretary
U.S. Environ. Protect. Agency	—U.S. Environmental Protection Agency
O.O.W.P.	—Office of Water Programs
O.R.M.	—Office of Research & Monitoring
N.E.R.C.	—National Environmental Research Center
U.S. Natl. Wtr. Commission	—U.S. National Water Commission
U.S. Natl. Aero. & Space Adm.	—U.S. National Aeronautics & Space Administration
U.S. Upper Gr. Lks. Reg. Com.	—U.S. Upper Great Lakes Regional Commission

* Federal agencies not abbreviated in the catalog are not included in this listing.

Contents

DESCRIPTIONS OF RESEARCH PROJECTS

1. PROPERTIES OF SEA WATER

1A. ACOUSTICAL PROPERTIES

See Chapter 7g for Acoustical Properties of Sediments.

1.0001, STUDIES OF ECHOLOCATION SYSTEMS
K.S. NORRIS, Univ. of California, School of Medicine, *Los Angeles, California* 90024

This request is for a one-year extension of Grant No. NS 05427-07, to complete data analysis and report preparation. Unexpected leads and difficulties in the originally scheduled work have extended the experimental period through the present year and are expected to continue up to the termination of the normally scheduled grant period. Most data are gathered now and by September of this year it is expected to be complete on seven aspects of the sound systems of odontocete cetaceans. The progress to date is described in detail in the Process Report.

Work in the 1971-1972 year will involve considerable photographic and spectrographic data reduction, some mathematical analysis, and considerable writing, figure preparation, etc. Much of the acoustic data will require analysis using the various kinds of electronic analyzing gear assembled during this program. No new equipment is needed.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

1.0002, NAVY ENVIRONMENT - POTENTIAL BIOLOGICAL SOURCES OF INTERFERENCE WITH ACOUSTIC SYSTEMS
H.R. FERNANDEZ, Univ. of Southern California, School of Letters, *Los Angeles, California* 90007 (N00014-67-A-0269-0013)

Navy underice submarine operations and acoustic communications, detection, surveillance and weaponry require detailed knowledge of biological populations which degrade acoustic signals. The objectives of this task are to identify the kinds of organisms in the Arctic ocean, determine their temporal and spatial distributions, biologically characterize each of the three layered water masses of acoustic significance, and to provide evidence of potential ambient noise sources and acoustic scatter layers of biological origin.

Utilizing drift station T-3 as a research platform, sampling devices are used to collect all types of organisms in the water column from bottom to surface. Special techniques are employed to collect the unique assemblages living on the sea bottom and the lower surface of the ice cover. Organisms are identified, their quantities measured, and their vertical and horizontal distributions related to physical and chemical environments. Special emphasis is placed upon determination of populations associated with each of the three major, layered water masses, Arctic, Atlantic and bottom water, which have distinct acoustic properties.

Supporting Agency Address Information: Office of Naval Research 415, Arlington, Va. 22217.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0003, LOCATING AND POSITIONING OBJECTS ON NAVAL SEAFLOOR SITES BY ROTATING ACOUSTIC SCANNER
R.D. HITCHCOCK, U.S. Navy, Civil Engineering Lab., *Port Hueneme, California* 93041

Devise a bottom stationed, rotating acoustic scanner system whereby: (1) Objects can be accurately positioned on the seafloor relative to the earth's coordinates and other objects on the seafloor, and also can be located and retrieved by the mating of the emplacement PPI plot with the retrieval unit's PPI, and (2) moving objects, such as navy seafloor excavator, may have their course, speed, and location monitored.

(1) Conduct a brief state of the art survey on rotating acoustic scanner systems and determine whether an existing system could be adapted for seafloor positioning, (2) Design and construct hardware for utilizing scanner system to determine azimuth and range of seafloor objects within coverage of the scanner system. This hardware will be a bottom mounted structure (e.g., a tripod) with a mechanism for rotating the scanner at a uniform rate at one elevation and then repeating the circular scan at a different elevation. Each 360 degree scan will generate a linear side scan or PPI record matching of corresponding target signals will allow range to be computed. Bearing will be computed by comparing the side scan or PPI records with a recording of scanner azimuth angle versus time. (3) Conduct sea trials of rotating scanner system in 100 feet of water, emplace sonar targets (by divers) within coverage circle of scanner system, match record pairs and determine optimum coverage and elevation difference between scan positions. Determine positioning errors of sonar targets and write report on findings.

(Nov 70-May 71). The NAVSEC (Naval Ship Engineering Center) MK-1 side scan sonar system has been found to be suitable for demonstrating the rotating scanner concept. The support and drive mechanism design was completed in March 1971.

Supporting Agency Address Information: Naval Material Command, Washington, D.C. 20360.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0004, ACOUSTIC ENVIRONMENTAL STUDIES
R.H. ALLEN, U.S. Navy, Undersea Res. & Dev. Center, *San Diego, California* 92132

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0005, SQNAR ENVIRONMENTAL SUPPORT
P.A. BARAKOS, U.S. Navy, Undersea Res. & Dev. Center, *San Diego, California* 92132

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0006, SEA FLOOR STUDIES (FOR SONAR PERFORMANCE, NAVIGATION AND OCEAN ENGINEERING)
E.C. BUFFINGTON, U.S. Navy, Undersea Res. & Dev. Center, *San Diego, California* 92132

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0007, GLASS ELEVATOR - DIRECT OBSERVATION OF ACOUSTIC SCATTERERS
M.W. COOKE, U.S. Navy, Undersea Res. & Dev. Center, *San Diego, California* 92132

SUPPORTED BY U.S. Dept. of Defense - Navy

1. PROPERTIES OF SEA WATER

1.0008, OCEANOGRAPHIC DATA STUDIES
J.D. PUGH, U.S. Navy, Undersea Res. & Dev. Center, *San Diego, California* 92132

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0009, NAVY ENVIRONMENT--INFRARED MEASUREMENT OF HEAT FLOW AT THE SEA SURFACE
T.D. FOSTER, Univ. of California, Graduate School, *San Diego, California* 92038 (N00014-69-A-0200-6009)

Radiative flux and thermohaline convection at and near the sea surface affect the electromagnetic and acoustic properties of the water which are of concern to non-acoustic and acoustic ASW systems. The object of this research is to investigate these phenomena in order to determine their effects on water temperature structure in the uppermost layers.

Theoretical, laboratory, and field studies will be made of radiation flux, and convective processes using infrared and Schlieren techniques, and confirmed by conventional methods. These investigations will involve the use of surface platforms and an oceanographic aircraft equipped with an infrared scanner and dual-wavelength radiometer.

Supporting Agency Address Information: Office of Naval Research 482, Arlington, Va. 22217.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0010, NAVY ENVIRONMENT - DELINEATION OF SEA FLOOR PHYSIOGRAPHIC PROVINCES AND GEOMAGNETIC LINEATIONS OF IMPORTANCE TO SOUND PROPAGATION
H.W. MENARD, Univ. of California, Graduate School, *San Diego, California* 92038

The effectiveness of naval operations which utilize long-range sound propagation and bottom bounce sonar is strongly dependent upon the physiography of the ocean bottom and the acoustic properties of sediments. In addition, naval capabilities in the magnetic detection of submarines can be substantially increased by having prior knowledge of the earth's magnetic field. The objectives of this research are to determine the geographic variation of sea-floor topography, and its interrelationships with geomagnetic field strength variations and with the properties and distribution of sediments.

Marine magnetic and bathymetric data which are already available will be supplemented by similar field data from selected areas of the Pacific Ocean. Emphasis this year will be placed on investigating the character, geographic extent, and evolution of widespread small-scale topography whose linearity parallel to magnetic anomalies has recently been observed. In addition, several previously unnoticed major topographic features of the North Pacific Basin will be investigated.

The increase in size of submarine volcanoes with increased distance from mid-ocean ridge crests suggests that they remain active as they drift with the oceanic crust away from the crests. The lack of active drifting volcanic islands rising from oceanic crust less than 100 million years old places a limit on their maximum rate of growth. The rate of subsidence of oceanic crust as it moves away from a ridge crest averages about 9 cm/1000 years for the first 10 million years, 3.3 cm/1000 years for the next 30 and 2 cm/1000 years thereafter. Published report: C.G. Chase, et al, 1970, 'History of Sea-Floor Spreading West of Baja, California', Bull. Geol. Soc. Amer., V 81, PP-491-498.

Supporting Agency Address Information: Office of Naval Research 483, Arlington, Va. 22217.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0011, SURVEILLANCE - UNDERWATER ACOUSTICS
F.A. ANDREWS, Catholic University of America, School of Engineering, *Washington, District of Columbia* 20017 (N00014-69-A-0432)

The objective of this work is to contribute understanding for the use of acoustics for underwater surveillance and particularly for the detection of submerged objects. Work involving the generation, transmission, and reception of acoustic information in the sea is pursued.

The contractor will conduct a program of applied research to develop improved analytic, experimental, and computer-aided solutions to Navy-related problems in radiation, propagation, and scattering of underwater sound; interdisciplinary interactions will be stressed.

Supporting Agency Address Information: Office of Naval Research 468, Arlington, Va. 22217.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0012, PHYSICAL ACOUSTICS
M. GREENSPAN, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia* 20234

Reasons for starting or progress last year: (1) Liquid-filled double Helmholtz resonators, having possible application as fast cycling, heavy-liquid chambers, were further developed. Careful measurements failed to reveal the persistent microbubbles reported by Sette, et al., to occur in neutron-irradiated solutions of uranium nitrate and 1 percent methanol. (2) The acoustic interferometer intended for precision measurements of the speed of sound in water was redesigned. (4) A literature search on acoustic emission was made.

Approach: (1) Remove naturally occurring nuclei, which are variable, and substitute reproducible ones using ionizing radiation. Make absolute measurement of sound pressure at 'threshold' and study as function of nucleus (neutron-recoil, a-recoil, fission), liquid properties, and temperature. (2) Develop instrument based on radiation theory; operating principle as different as possible from existing types. Similar to conventional interferometer, but with progressive waves (simulated by long pulse) and with small baffled transducers for which far field paraxial theory applies. (3) Elastic constants from speed-of-sound measurements, L-waves and polarized S-waves, using a refined pulse technique. Dielectric measurements when suitable. (4) Avoid specimen resonances by testing long wire which supports only longitudinal waves.

Expected results: Analysis of data on temperature dependence of neutron and fission cavitation thresholds on various organic liquids; further analysis of and experiments on resonator method for sound absorption in liquids; acquisition of accurate speed-of-sound data in water; design of apparatus for measurement of elastic constants of single crystal ice down to liquid He temperatures; design and construction of apparatus to detect and analyze acoustic emissions due to stress and to phase transformations.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

1.0013, NAVY ENVIRONMENT - BIOLOGICAL EFFECTS ON UNDERWATER SOUND-MULTIFREQUENCY FIELD INVESTIGATIONS OF SONIC SCATTERING LAYERS
W.D. CLARK, Westinghouse Electric Corp., *Washington, District of Columbia* 20006

The Navy's underwater systems for surveillance, guidance, and communications are based upon acoustic transmission in sea water and are, consequently, limited in their effectiveness by the acoustic scattering layers which attenuate sonic signals. This study will quantitatively define the composition of the scattering layers, in terms of the various species of organisms present and the sonar frequencies which they affect.

The research is divided into three phases: in phase I the systems to be used for measurement of acoustic backscatter will be designed and fabricated. Phase II will be devoted to equipment testing, and to oceanographic experiments designed to define the biological elements of the scattering layers with respect to their effects on underwater sound. Oceanographic experiments to be conducted in the San Diego trough will combine quantitative biological sampling with visual and photographic observations from a manned submersible, while the acoustic return from multiple frequency irradiation of the scattering layer is recorded. Phase III will be the data reduction and reporting.

Phases I and II have been completed. Phase III A, consisting of oceanographic experiments at sea designed to determine the biological components of scattering layers, is now complete; phase III B is the data analysis stage and forms the final portion of the investigation. This data analysis stage is currently underway. Published report: G. A. Bank, W. D. Clarke, A. Haury, A. Kirst,

Jr. W. P. Muellenhoff and D. D. Skinner, 'Engineering Report for Phase H of Study of Sound Scattering in the Ocean' ONR contract N00014-68-c-0366, Westinghouse Research Laboratories Report 70-9S10-OCEAN-R1, 79 pages, August 1970.

Supporting Agency Address Information: Office of Naval Research, Arlington, Va. 22217.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0014, SURVEILLANCE - TIME-VARYING PROPAGATION MODELS - STRAITS OF FLORIDA AND WEST CENTRAL ATLANTIC

M. KRONENGOLD, Univ. of Miami, School of Marine Science, *Miami, Florida* 33149 (N00014-67-A-0201-0015)

Navy objective is improved underwater sound propagation models for prediction of the performance of fixed and mobile sonar systems. Technical objectives are to determine the influence of environmental phenomena on the fluctuations of amplitude and phase of an underwater acoustic signal, and to develop time-varying sound propagation models which will predict acoustic fluctuations.

The studies of analytical and empirical propagation models will continue. In cooperation with Rensselaer Polytechnic Institute, the effects on propagation loss and phase of time-variations of a bilinear model of the sound speed profile in the deep sound channel will be determined; the linear empirical model developed using statistical analysis of time-series of acoustic and environmental factors will be enlarged to include transport fluctuations from electrode installations at several points across the straits; the problem of enlarging the analytical models to include the problem of broadband signals will be considered.

Supporting Agency Address Information: Office of Naval Research 468, Arlington, Va. 22217.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0015, NAVY ENVIRONMENT - RELATION OF TIDES AND CURRENTS TO ACOUSTIC TRANSMISSION IN FLORIDA STRAITS

C.N. MOOERS, Univ. of Miami, School of Marine Science, *Miami, Florida* 33149 (N00014-67-A-0201-0013)

For ASW and other operations, the Navy has need of improved ability to predict how environmental changes affect sonar detection and communication. This research aims at the quantitative determination of the variations caused in the Florida current by various external forces such as local wind fields. Furthermore, the effects of these forces on acoustic transmissions across the current are sought.

This research task consists of theoretical studies and analysis of field measurements. The amplitude and phase fluctuations observed in the 400 Hz acoustic signals transmitted across the straits are related to temporal variations in the temperature structure and current velocity in the acoustic transmission path. Simple, yet realistic models of the internal tides will be obtained for the acoustician to apply to propagation models. Environmental data will be used to estimate the parameters of the internal motion models.

Supporting Agency Address Information: Office of Naval Research 481, Arlington, Va. 22217.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0016, FISHERIES ENGINEERING PROGRAM/ACOUSTICS SYSTEM

W.H. STEVENSON, U.S. Dept. of Commerce, Fishery Engineering Laboratory, *Bay Saint Louis, Mississippi* 39520 (28121007)

Technical Objectives: The objectives are to: develop tools to efficiently locate, identify and quantify living marine resources; establish new techniques to effectively sample living marine resources; and develop systems for more efficient analysis and display of resource information.

Approach: The technical approach is to: Test the validity of the concept of using hydroacoustic methods to conduct biomass measurements.

Progress: Non-biological target arrays were designed, constructed and installed for acoustical systems developmental tests conducted in conjunction with MIT and the Pascagoula Fisheries Laboratory. MIT is presently analyzing the resulting data.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0017, MARMAP III - COASTAL PELAGIC FISH - HYDROACOUSTICS

A. KEMMERER, U.S. Dept. of Commerce, Southeast Fishery Ctr., *Pascagoula, Mississippi* 39567 (78121012)

Technical Objectives: Determine the availability and abundance of coastal pelagic fish.

Approach: Evaluate hydroacoustic theory for quantifying pelagic fishes.

Progress: The hydroacoustic experiment was designed, implemented, and initiated through the cooperative efforts of Massachusetts Institute of Technology, Fisheries Engineering Laboratory, and Pascagoula Laboratory personnel. Presently, the hydroacoustic experiment has been initiated and the first series of data are being collected. Completion of the experiment is expected in late September with 1-1/2 months of analysis and the final report due in January.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0018, FISHERIES ENGINEERING PROGRAM/HYDROACOUSTIC SYSTEM DEVELOPMENT AND ANALYSIS

W.S. SHEPARD, Mississippi St. University, School of Engineering, *State College, Mississippi* 39762 (281785)

Technical Objectives: The objectives are to: develop tools to efficiently locate, identify and quantify living marine resources; establish new techniques to effectively sample living marine resources; and develop systems for more efficient analysis and display of resource information.

Approach: The technical approach is to: test the validity of the concept of using hydroacoustic methods to conduct biomass measurements.

Progress: Nonbiological target arrays were designed, constructed and installed for acoustical systems developmental tests conducted in conjunction with MIT and the Pascagoula Fisheries Laboratory. Fisheries Engineering Laboratory has provided all engineering and data analysis tasks associated with the facility and hardware systems for conducting the test. Test and data analysis requirements will continue through February.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0019, SURVEILLANCE - ASYMPTOTIC TECHNIQUES FOR PROBLEMS OF WAVE PROPAGATION, SCATTERING, AND ELASTICITY

J.B. KELLER, New York University, School of Arts, *New York, New York* 10003 (N00014-67-A-0467-0006)

This research relates to the naval surveillance function through use of acoustic detection. Mathematical methods to be developed here are needed to identify shapes and location of sources of underwater sound signals, and also for design of Navy vehicles to minimize undesirable underwater noise.

Broad ranging research in the mathematics of wave-propagation in fluids and solids is in progress. Special interest is centered on applying general theory to specific problems in underwater sound, where the procedure is usually to find asymptotic solutions to linear partial differential equations containing appropriate parameters.

Supporting Agency Address Information: Office of Naval Research 432, Arlington, Va. 22217.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0020, SURVEILLANCE - DETERMINATION OF THE CHARACTERISTICS OF UNDERWATER EXPLOSIVELY GENERATED SOUND WAVES

G.R. HAMILTON, Columbia University, Lamont Doherty Geolog. Observ., *Palisades, New York* 10964

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1. PROPERTIES OF SEA WATER

This task is oriented to solving problems of immediate concern to improved long range acoustic detection, location, classification, analysis and communications for such applications as search and rescue at sea. Technical objectives are determination of spatial and temporal sound-speed fluctuations, sound-speed gradient fluctuations, and determination of the spatial and temporal characteristics of internal waves in the deep ocean.

Underwater explosion phenomena are studied in relation to the environment. Experiments will be conducted, using explosions as the acoustic source to study the variability of sound velocity in the deep sound channel as well as other propagation modes. Equipment and techniques are developed to locate and identify underwater acoustic signals of interest. Data on the partition of energy in underwater explosions will be studied in various environments. The investigations under this work unit are primarily experimental in nature, supported where possible by analysis. The sound-speed and sound-speed gradient fluctuations studies utilize precise equipment developed by the contractor. Emphasis in the coming year will be on studies off Bermuda in areas of naval interest.

The contractor participated in approximately 20 tests of interest to the Polaris/Poseidon program. Measurements made under this task were vital in that within 24-36 hours the results obtained indicated whether or not the missile functioned properly. Reports under this task are sensitive and limited in distribution since they are indicators of how the overall program is progressing. The reports are not available to DDC. Work is now being carried on by Palisades Geophysical Institute under contracts N00014-71-c-0067 and 0068.

Supporting Agency Address Information: Office of Naval Research, Arlington, Va. 22217.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0021, NAVY ENVIRONMENT - CHEMICAL EQUILIBRIA IN SEA WATER AND THEIR EFFECTS ON ACOUSTIC PROPERTIES

G. ATKINSON, Univ. of Oklahoma, Research Institute, *Norman, Oklahoma* 73069 (N00014-72-C-0285-0001)

The absorption of acoustical energy in sea water affects the performance of all underwater acoustic systems including those used for submarine detection, classification and tracking. The physics of absorption processes is only partially understood; one area of uncertainty is the effect of pressure changes on the equilibria of ions in sea water. The purpose of this research is to investigate this effect.

This task involves the laboratory measurements of the thermodynamic and kinetic parameters of Mg2 ion equilibria with sulfate, carbonate, bicarbonate and hydroxyl ions. The techniques used in these kinetic investigations will be stopped flow, ultrasonic absorption and temperature jump. The results will be used to make a detailed calculation of the excess absorption in the sea water over the frequency range of ten to a million hertz.

Supporting Agency Address Information: Office of Naval Research 481, Arlington, Va. 22217.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0022, NAVY ENVIRONMENT--USE OF ON-LINE COMPUTERS FOR ENVIRONMENTAL RESEARCH

W.V. BURT, Oregon State University, School of Science, *Corvallis, Oregon* 97331 (N00014-68-A-0148)

The objectives of this research are to increase our ability to predict acoustic conditions as they affect Navy sonar systems, and to predict water motions as they affect vehicle operations and underseas construction. Such predictive ability depends on a thorough knowledge of the energy exchange processes taking place between the ocean and the atmosphere. This program seeks to perfect numerical and theoretical models for predicting these processes as well as equipment and data handling techniques for their continuous monitoring.

The program is directed toward the application of modern computer techniques to oceanography on a real-time basis. To accomplish this, first mathematical models to describe the exchange processes taking place within a given volume of the ocean will be developed and then, using moored buoys and other platforms to measure the oceanographic and meteorological parameters, compare the model (in a hybrid-analog/digital computer) with the actual measurements, correcting the model as necessary to duplicate the real environment. In addition, the computer will be used to change the sensor sampling rate and sequence to provide the best data for given environmental conditions.

Supporting Agency Address Information: Office of Naval Research 481, Arlington, Va. 22217.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0023, NAVY ENVIRONMENT - UNDERWATER ACOUSTICS/BIOLOGICAL SOUND SCATTERING IN THE OCEAN

W.G. PEARCY, Oregon State University, School of Science, *Corvallis, Oregon* 97331 (N00014-67-A-0369-0007)

The Navy's underwater systems for surveillance, guidance and communications are based upon acoustic transmission in sea water and are consequently limited in their effectiveness by the acoustic scattering layers that attenuate sonic signals. This study will describe the dynamics of biological communities of midwater animals that are associated with sound scattering layers at several widely used frequencies. Such aspects as species composition, vertical migration, species interaction and spatial variability of scattering organisms will be included in the study.

A unique conducting cable-midwater trawl system has been developed by the principal investigator. This system will be used to sample oceanic animals at discrete depths in relation to sound scattering layers, while the actual scattering layers will be observed and monitored at 34, 12, and 3,5 kHz on an echo sounder. Examination of swimbladder morphology of mesopelagic fish collected by the sampler will be an important inclusion to the study. Light, temperature, salinity and oxygen measurements are planned to complete the environmental information gathered.

Supporting Agency Address Information: Office Of Naval Research 484, Arlington, Va. 22217.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0024, NAVY ENVIRONMENT - BIOLOGICAL SOURCES OF AMBIENT SEA NOISE - IDENTIFICATION & BIOACOUSTIC ANALYSIS OF SONIC EMISSIONS OF FISHES

M.P. FISH, Univ. of Rhode Island, Narragansett Marine Laboratory, *Kingston, Rhode Island* 02821 (N00014-68-A-0215-0003)

The effective naval usage of underwater acoustics for surveillance, communication, and guidance systems is severely impaired by contributions of animals to the ambient sea noise. A high ambient noise level will distort or mask the desired acoustic target or communication signal. This research effort is identifying characteristics, as well as the spatial and temporal distribution of the animals.

The reference file of underwater biological sounds has been established for the collection, assembly and integration of material contributed by bioacousticians throughout the world. Specifically identified recordings, detailed analyses, graphic representation of each sound, and pertinent data on the natural history and geographic distribution of the producer are provided. In a related program, year- round simultaneous data stations at seven Atlantic coastal sites collect data on seasonal, diel, and migratory changes in ambient noise levels.

Supporting Agency Address Information: Office of Naval Research 484, Arlington, Va. 22217.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0025, EQUIPMENT FOR RESEARCH IN NONLINEAR ACOUSTICS, MARINE DATA PROCESSING, AND SUBMARINE SOIL MECHANICS

V.A. NACCI, Univ. of Rhode Island, School of Engineering, *Kingston, Rhode Island* 02881

The researchers plan to augment the research capabilities of the new Ocean Engineering Laboratories at the University of Rhode Island in the three areas of underwater acoustics, marine data processing and submarine soil mechanics.

SUPPORTED BY U.S. Natl. Science Foundation

1.0026, NAVY ENVIRONMENT - BIOLOGICAL SOURCES OF AMBIENT SEA NOISE - BIOACOUSTIC BEHAVIOR AND SENSORY CAPABILITIES OF FISHES AND CETACEANS (WHALES)

H.E. WINN, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881 (N00014-68-A-0215-0003)

The Navy's effective use of underwater acoustics for surveillance, communications and guidance systems is severely impaired by contributions of soniferous animals to the ambient sea noise and by the attenuation and reflection of underwater sound by scattering organisms. A high ambient noise level will completely mask a desired acoustic target or communication signal as will a scattering organism. This work will identify some of the ambient acoustic sources, investigate potential false acoustic targets and provide a basis for predicting geographic and temporal distribution of the responsible organisms.

Whale sonic emissions will be recorded and analyzed in detail with reference to their repertoire of sounds. Four different whale species will be studied in this regard. Playback experiments of selected sounds will be conducted in an effort to associate sound with whale behavior. Both captured and wild, free swimming whales will be used. With at least one species, video recordings of sound emissions for further correlation of sound with behavior will be made. Detailed acoustic analyses in real time will be made for all the calls.

Supporting Agency Address Information: Office of Naval Research 484, Arlington, Va. 22217.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0027, BIOLOGICAL REVERBERATION AS IT AFFECTS ASW OPERATIONS

C.L. BROWN, U.S. Navy, Underwater Systems Center, *Newport, Rhode Island* 02840

Investigate and identify marine scattering organisms that limit active sonar operations by causing biological volume reverberation. Study the biological-acoustical characteristics and the spatial and temporal (seasonal) distribution of these organisms to develop a predictive capability of their migration habits, population density, frequency range, and scattering strengths in critical test areas of the Atlantic ocean and Mediterranean sea such that predictions may be made of biological and acoustical conditions that affect sonar performance.

Identify the organisms of the deep scattering layer (DSL), determine variation of the spatial and temporal density of these organisms as a function of time of day, depth, geography, season, temperature gradient, and physical-chemical water structure, etc. This will be done in concert with associated acoustical measurements.

Supporting Agency Address Information: Naval Ship Systems Command 901, Washington, D. C. 20360.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0028, ASU ENVIRONMENTAL SUPPORT--OCEANOGRAPHY

G.S. COOK, U.S. Navy, Underwater Systems Center, *Newport, Rhode Island* 02840

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0029, ACOUSTIC ENVIRONMENT DUE TO THE TURBULENT-NONTURBULENT INTERFACE IN THE UPPER OCEAN

R.C. ELSWICK, U.S. Navy, Underwater Systems Center, *Newport, Rhode Island* 02840

Determine the effects on acoustic propagation of the sharp, random density discontinuity observed at the turbulent-nonturbulent interface located in the vicinity of the thermocline of the upper ocean.

Model the fluid mechanics of the turbulent-nonturbulent interface theoretically, and determine statistics of this density discontinuity surface with a view towards their implications for acoustic penetration of the interface and for waveguide modes of propagation, particularly in long range propagation at lower frequencies.

Supporting Agency Address Information: Naval Underwater Systems Center MAT03L4, Newport, R.I. 02840.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0030, DEEP OCEAN SONAR ENVIRONMENTAL INVESTIGATION

M.P. FECHER, U.S. Navy, Underwater Systems Center, *Newport, Rhode Island* 02840

Analyze physical properties of the marine acoustic environment, including temporal and spatial variability, to support a determination of environmental influences during concurrent NAVSHIPS acoustic projects investigating ambient noise, sonar performance and sound propagation in deep ocean areas.

Measure thermal structure, salinity, sound velocity, ocean currents and meteorological conditions at the air-sea interface as a function of time, depth, and range, coincident with sonic and infra-sonic ambient noise measurements. Moored sub-surface environmental arrays and surface-penetrating floats will be utilized. From long-term hydrometeorological records obtained during FY68-72, reports will be prepared on: (1) low frequency fluctuations in sound speed structure across the Sargasso Sea, (2) weather influences on the near-surface acoustic medium, (3) prediction of mean surface temperature distributions, and (4) correlation of long-range propagation variability with thermocline characteristics. Investigate prediction of sound transmission based on limited oceanographic data for a particular geographic region.

Supporting Agency Address Information: Naval Ship Systems Command 901, Washington, D.C. 20360.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0031, BOTTOM ENVIRONMENTAL ACOUSTIC CHARACTERISTICS

J.J. GALLAGHER, U.S. Navy, Underwater Systems Center, *Newport, Rhode Island* 02840

Evaluate and define the critical properties of those ocean bottom sediments which influence design and detection capabilities of bottom bounce sonar systems.

Investigate and define the physical and chemical properties of ocean bottom water and the underlying sediments, and the statistical character of the bottom topography, and relate these parameters to acoustic reflection, scattering, and attenuation. Analyze interrelationships of sediment mass - physical, geochemical, acoustic, and geotechnical properties in acoustic test areas to improve prediction of acoustic propagation performance per physiographic province in model and field experiments.

Supporting Agency Address Information: Naval Ship Systems Command 901, Washington, D.C. 20360.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0032, SURFACE WAVE FIELD INTERACTION WITH SCATTERED ACOUSTIC FIELDS FOR SONAR SYSTEM STUDIES

J. GORMAN, U.S. Navy, Underwater Systems Center, *Newport, Rhode Island* 02840

In support of acoustic propagation studies for use in SONAR systems, conduct extensive and detailed investigations of the dependency of acoustic scattering from the random free surface of the water medium on the physical and statistical (oceanographic) descriptors of that diffused dynamic interface. Determine the effect of variations in the form of the spectrum and the content of the statistics of this free pressure release surface, especially those of surface wave height, on reflected and scattered acoustic signals. Develop and/or adapt theoretical models for the scattering process in order to determine model description of the process.

Conduct prolonged and comprehensive measurements of the entire scattered acoustic pressure field, i.e., from backscatter through specular reflection and beyond in the plane of acoustic transmission as well as continuous measurements of the surface

wave field. With an array of wave staffs, utilize the band of acoustic frequencies 30-100 kHz in order to allow a quantitative determination of the impression made on the spectrum of the incident acoustic radiation by the particular surface wave field in effect at the time.

Supporting Agency Address Information: Naval Underwater Systems Center MAT03L4, Newport, R.I. 02840.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0033, CHEMICAL RELAXATIONAL ASPECTS OF EXCESS SOUND ATTENUATION

E.N. JONES, U.S. Navy, Underwater Systems Center, *Newport, Rhode Island* 02840

Develop a chemical relaxation model that will explain why acoustic energy transmitted through seawater at frequencies below 10 kHz suffers excess attenuation. Detailed mechanisms for several hydration pair reactions will be investigated to determine how they contribute to the sound attenuation anomaly.

Max Planck Institute for physical chemistry at Gottingen, in agreement with NUSC, has performed P-jump experiments with aluminum sulfate solutions in an effort to resolve the cause of the sound attenuation anomaly. These experiments show the presence of a relaxation near 1 kHz but the magnitude of the absorption appears to be small because of the low concentration of dissolved aluminum in seawater. Since the value of the attenuation coefficient depends on the rate constants of the assumed reaction mechanism, it is necessary to evaluate the rate constants quite precisely to obtain a valid number for the magnitude of the absorption. It is in this area that efforts will be concentrated since many of the rate constants are virtually unknown.

Supporting Agency Address Information: Naval Underwater Systems Center MAT03L4, Newport, R.I. 02840.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0034, OCEANOGRAPHY - GEOLOGICAL EFFECTS

R.W. MORTON, U.S. Navy, Underwater Systems Center, *Newport, Rhode Island* 02840

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0035, ACOUSTIC DETECTION OF OBJECTS BURIED IN BOTTOM SEDIMENTS

R.I. WELSH, U.S. Navy, Underwater Systems Center, *Newport, Rhode Island* 02840

Investigate the feasibility of using pure surface shear waves to detect and locate objects such as mines, etc., buried in ocean bottom sediments and determine the dynamic shear moduli of the sediment layers in order to be able to predict acoustic propagation and attenuation in marine sediments.

Conduct studies by generating surface shear waves in the upper layer of ocean bottom sediments and detecting the reflected signal from a buried object. Additional measurements of the transmitted wave made near the shear wave generator provide data for determining shear speeds, attenuation, and shear moduli.

Supporting Agency Address Information: Naval Material Command MAT0314, Washington, D. C. 20360.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0036, OCEAN WIND WAVE EFFECTS ON SONAR PERFORMANCE

R.G. WILLIAMS, U.S. Navy, Underwater Systems Center, *Newport, Rhode Island* 02840

Develop effective techniques for studying the properties of ocean wind waves by means of underwater acoustic measurements for use in sonar detection and submarine communication studies. Develop methods for computing the array gain for acoustic signals reverberated by the rough sea surface.

Extend theory of scattering to include a time-varying surface and multiple reflections on a shallow surface duct. Develop a numerical model from surface forward scatter as a function of the ocean wave spectrum. This model will provide the necessary input parameters for sonar detection and communications systems, extend theory to predict signal coherence as a function of the ocean wave height spectrum.

Supporting Agency Address Information: Naval Underwater Systems Center MAT03L4, Newport, R.I. 02840.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0037, NEAR-SHORE ASW ENVIRONMENTAL INVESTIGATIONS

R.G. WILLIAMS, U.S. Navy, Underwater Systems Center, *Newport, Rhode Island* 02840

Investigate and describe the environmental properties of shallow water and continental shelf areas pertinent to ASW operations. Develop an oceanographic model as part of a general propagation loss model which will enable significant improvement in sonar range prediction, selection of optimum sonar operating frequencies, and design of target detection systems.

Design and execute experiments to investigate the temporal and spatial distributions of environmental variables affecting naval operations. The variables include the physical and dynamic characteristics of the air/sea boundary, the water column and the bottom. Develop a prediction model of the time-varying properties of acoustic signals as a function of these properties of the ocean.

Supporting Agency Address Information: Naval Ship Systems Command 901, Washington, D.C. 20360.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0038, NAVY ENVIRONMENT - NONLINEAR ACOUSTICS TRANSMISSION IN AIR OR WATER

D.T. BLACKSTOCK, Univ. of Texas, Applied Research Laboratories, *Austin, Texas* 78712 (N00014-70-A-0166-0004)

The objective is the determination of important factors controlling propagation of nonlinear acoustic noise such as shock waves in the atmospheric or oceanographic environment. Shocks arising from high speed aircraft or explosions are modified by variations in the propagation medium and control the wave shape, intensity, and path of the noise as it propagates.

Finite amplitude acoustic waves having a time profile shaped like the letter N are generated and propagated through spherical medium- velocity discontinuities, which refract and diffract the waves causing rounding or peaking of the N-profile, dependent upon whether the velocity discontinuity is higher or lower than the surrounding medium. The theory of these propagation changes is developed and checked experimentally and may be a means of deducing properties of the environment through which the wave has traveled.

Supporting Agency Address Information: Office of Naval Research 468, Arlington, Va. 22217.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0039, ACOUSTICAL DETECTION OF MARINE ORGANISMS

T.J. BRIGHT, Texas A & M University System, School of Science, *College Station, Texas* 77843

Objectives: 1. Produce a library of marine animal sounds from the Texas Coast. 2. Pursue and perfect techniques for utilizing underwater habitats as bases for bio-acoustical investigations. 3. Define aspects of the acoustical behavior of certain dominant sound producers (particularly members of the family Holocentridae). 4. Define relationship of sound production to feeding behavior of certain predaceous and grazing fishes.

How information will be applied: 1. Ultimately, in the production of an instructive bulletin for laymen which will enable them to interpret sounds detected on reefs and other fishing grounds; 2. In relating sound production patterns to distribution and behavior of sport and commercial fishes frequenting hard bottom marine habitats.

Accomplishment during past twelve months: 1. Analysis of data gathered during 7 day saturation dive in Hydro-Lab underwater in Bahamas. 2. Preparation for publication of six scientific papers on the results of our study and presentation of two verbal reports to National and State scientific societies.

For additional information pertaining to this project contact Dr. Robert C. Stephenson, Director, Center for Marine Resources, Texas A & M University, College Station, Texas 77843.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0040, NAVY ENVIRONMENT - TURBULENT AND MIXING PROCESSES IN THE OCEANS IMPORTANT TO SOUND PROPAGATION

T. ICHIYE, Texas A & M University System, School of Geosciences, *College Station, Texas* 77843 (N00014-68-A-0308-0002)

Naval operational forces need to know of changes in environmental conditions which will affect significantly the current regime and sound propagation field of a given area. This effort is research on the origin, dynamics, and life history of geostrophic eddies which break off from the loop current in the Gulf of Mexico and from the Gulf Stream in the western North Atlantic. Such current rings are known to occur frequently and cause profound environmental changes over areas as large as 400 miles, but the ability to predict their occurrence awaits more knowledge of them.

A series of experiments on wind driven circulation will be carried out in a rotating scale model of the Gulf and Caribbean Sea. These experiments will investigate the transient behavior and interaction of eddies and the loop current. A field investigation will include a hydrographic survey in and around the Gulf loop current. Available hydrographic data for the area will also be analyzed. Theoretical models of different water masses will be studied from the aspect of internal waves and their breaking.

Supporting Agency Address Information: Office of Naval Research 481, Arlington, Va. 22217.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0041, ACOUSTIC COMMUNICATIONS

S. RITER, Texas A & M University System, School of Engineering, *College Station, Texas* 77843

Objectives: 1) To evaluate the effects of the underwater acoustic communications environment on frequency shift keyed telemetry signals. 2) To determine the optimum signal structure for this channel. 3) To compare the performance of the optimum signals with easily instrumented practical signals.

How information will be applied: This information can be used by individuals engaged in the design of acoustic communications, navigation, and depth sounding equipment to choose practical signal shapes and receiver structures.

Accomplishments during the past twelve months: 1) Developed techniques for detecting underwater acoustic signals using a level crossing counter. 2) Developed techniques for optimizing the shape of acoustic signals transmitted through a dispersive medium and observed in the presence of non-white sea noise. 3) Designed, built, and tested a low cost acoustic detector based upon the results of accomplishment (1).

For additional information pertaining to this project contact Dr. Robert C. Stephenson, Director, Center for Marine Resources, Texas A&M University, College Station, Texas 77843

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0042, SURVEILLANCE - ENVIRONMENTAL RELATIONSHIPS OF ORGANISMS INTERFERING WITH HYDROACOUSTICS IN THE ARCTIC

T.S. ENGLISH, Univ. of Washington, School of Arts, *Seattle, Washington* 98105 (N00014-67-A-0103-0005)

Navy submarine operations, acoustic systems of under-ice communication, detection and surveillance, and the role of organisms in fouling of structures and instruments require knowledge of biological populations in the Arctic ocean. The objective is to quantitatively analyze marine populations, relate these to their physical and chemical environment, and provide interpretations of relationships permitting prediction of occurrence of ambient noise sources and deep acoustic scatter layers.

Temporal distribution of phytoplankton, zooplankton and particulate organic detritus is determined for the total water column, at ice surfaces and within the ice, and annual biological productivity measured. Organisms - their size, absolute abundance, life history stages and movements - are investigated in relation to physical factors of the environment. Sonar and photographic techniques are to be used to identify acoustic scatterers. Special emphasis is placed upon quantity of light at various depths and to the transfer of radiant energy to chemical energy by phytoplankton populations. Productivity is measured by carbon-14 techniques and energy transfer is followed through several trophic levels of consumer populations of animals.

Supporting Agency Address Information: Office of Naval Research 415, Arlington, Va. 22217.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0043, MARINE ACOUSTICS PROGRAM

S.R. MURPHY, Univ. of Washington, School of Arts, *Seattle, Washington* 98105

Objectives: The broad objective of this program is the development and application of acoustic techniques to the assessment of biological populations with an emphasis on resource assessment. Objectives for 1973: 1. Completion of target strength measurement program. 2. Further development of theoretical and simulation models, particularly aspects of models concerning distribution of target strength and echo amplitude. 3. Collection and analysis of target strength information on various fish species. 4. Complete documentation of research accomplishments between 1968 and 1972. 5. Continue to give technical support to field assessment programs in cooperation with various management agencies. 6. To meet the above objectives with an interdisciplinary blend of associate investigators: Dean W. Lytle (Electrical Engineering), Ole A. Mathisen and Richard E. Thorne (Fisheries), William C. Acker and Henry R. Feldman (Applied Physics Laboratory), T. Saunders English (Oceanography).

How information will be applied: Present equipment and techniques are being applied for population assessments in cooperative efforts between this project and various management agencies, including NMFS, WDF, ADF&G, Quinault Indians, Seattle City Light, Chelan County PUD, Argonne National Laboratories and International Pacific Salmon Commission. Some of these agencies, especially EDF, ADF&G, Argonne and IPSC are purchasing their own equipment and developing the capability to routinely apply the techniques with our assistance.

Accomplishments during the past twelve months: 1. Completed development and testing of prototype digital echo integration system. 2. Improved portable data acquisition system. 3. Began development of hardware and software for in situ target measurement system. 4. Developed acoustic assessment procedures for hake populations. 5. Obtained data for testing prototype target strength program being developed under the Marine Acoustics Program. 6. Initiated acoustic assessment studies on herring populations in Puget Sound and southeastern Alaska. 7. Largely completed field work and analysis of the Iliamna Lake studies, which will be presented as an M.S. dissertation by Mr. E.H. Nunnallee.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0044, RESEARCH ON ACOUSTIC METHODS FOR RESOURCE ASSESSMENT

R.E. THORNE, Univ. of Washington, School of Fisheries, *Seattle, Washington* 98105 (0181201)

Technical Objective: A program in acoustic systems and techniques for fishery resource assessment was developed at the University of Washington and has been widely applied in both fresh water and marine environments. Further development of these techniques under the terms of the contract will result in the completion of a Digital Data Acquisition and Processing System (DDAPS) for National Marine Fisheries Service. In its present configuration, DDAPS operates as a 20 channel echo integrator. The speed and versatility of the system will be increased with the addition of a program for target strength measurement and completion and full utilization of the digital tape controller.

1. PROPERTIES OF SEA WATER

Approach: The DDAPS is ideally suited for collection and analysis of in situ target strength measurement as a critical parameter in absolute estimation and as an indication of fish size. One of the practical problems of target strength measurement in situ has been the complicating presence of multiple target echoes. This problem has been partially avoided by the use of an extremely high resolution system, including a 1-1/2 degree full angle beam. While this system makes the occurrence of multiple targets improbable, it also reduces the sampling power of the instrument, as well as making a stabilized transducer mandatory. The approach would be to use a moderately high resolution system, still with satisfactory sampling coverage, but to separate the multiple and single targets. There are several physical parameters of fish echoes which can be used for this purpose. Two, in particular, which are technologically feasible, are pulse length and phase. A third possibility is frequency difference using a frequency-modulated pulse. A combination hardware-software package for DDAPS will be developed to detect and isolate individual fish targets, measure and categorize their amplitudes, and calculate the target strength distribution and mean target strength of the fish. The original DDAPS design included provision for a digital tape controller with 4K of additional memory. Several software packages will be developed to work in combination with the tape controller to increase the speed and versatility of the system. These include program input routines, so that basic programs, such as the integrate program, can be loaded into the computer in milliseconds rather than minutes.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0045, SURVEILLANCE - RELATIONSHIPS OF THE EARTH'S MAGNETIC FIELD AND BOTTOM SEDIMENTS AS THEY RELATE TO ACOUSTIC PROPAGATION AND COMMUNICATIONS

D.L. CLARK, Univ. of Wisconsin, School of Natural Sciences, *Madison, Wisconsin* 53706 (N00014-67-A-0128-0002)

Navy submarine and surface operations and bottom bounce sonar applications to antisubmarine warfare systems require knowledge of the earth's magnetic field, acoustic and mechanical properties of sediments, and ice distribution and characteristics. The objective of this task is to analyze arctic sediment cores to determine sediment dispersal patterns, sedimentation rates, chronology of climatic changes, the origin, environmental control and persistence of pack ice and the physical, chemical and biological properties of sediments.

Sediment cores obtained from ice island T-3 are analyzed by spinner magnetometer for magnetic stratigraphy; for evidence of reversal of earth's magnetic field which provides time markers for establishment of sedimentation rates; and for gross mineralogy by X-ray diffraction techniques. Geological and climatic history are determined by analysis of the microscopic fossil content of the sedimentary column. Arctic temperature history is further established by analysis of temperature- dependent, structural variations in certain species of animal fossils.

Supporting Agency Address Information: Office of Naval Research 415, Arlington, Va. 22217.

SUPPORTED BY U.S. Dept. of Defense - Navy

1B. CHEMICAL PROPERTIES

1.0046, TRACE-METAL ASSOCIATIONS IN SUB-ARCTIC FJORD ENVIRONMENTS

D.C. BURRELL, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735 (AT(45-1)2229,TA)

During the 1972-73 period it is proposed to concentrate on determining the soluble inorganic species of (primarily) copper present at the fresh water-marine interface, and to study the uptake characteristics of these compounds on the sediment in the various transportation stages. Trace metal analytical capabilities will be further developed as required to service these objectives.

Results: Results from this project have been distributed in open- literature publications and technical reports.

SUPPORTED BY U.S. Atomic Energy Commission

1.0047, DISTRIBUTION OF ORGANICS FROM SALMON DECOMPOSITION

J.J. GOERING, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735

This investigation will be concerned with the distribution and fate of the organic material resulting from salmon-carcass decomposition. Preliminary studies were concerned with rates and mechanisms of the chemical transformations that accompany the breakdown of fish flesh, and the resultant effects on the water chemistry of the receiving estuary where decomposition and deposition take place. At this time, it is proposed to determine remineralization rates and transport mechanisms for the organic compounds resulting from the step-wise decomposition process. Attention will also be directed to an investigation of the estuary sediment to determine its composition. The approach will be through the use of 15N-labeled compounds and the 12C/13C isotope ratio and tracer technique, as well as through an intensive water-chemistry study.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0048, TRANSITION METAL COMPLEXATION IN SEA WATER

P.J. KINNEY, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735

The thermodynamics of complexation of transition metals, with both inorganic and organic ligands in sea water will be determined by a method utilizing Electron Paramagnetic Resonance Spectroscopy (EPR) and Laser Raman Spectroscopy (LR). Major emphasis will be in high molecular weight, polymeric organic ligands with numerous complexing sites and on mixed-ligand inorganic systems. Two approaches to experimentally determining thermodynamic parameters in the complicated sea water system will be pursued concurrently. In the first approach, model organic and inorganic systems will be constructed with species which have been identified as existing in sea water. In the second case, natural organic material will be used which has been previously fractionated. Then EPR and LR spectroscopy will be applied to determine the nature and concentrations of complexes with transition metal ions.

SUPPORTED BY U.S. Natl. Science Foundation

1.0049, DISSOLVED ORGANIC NITROGEN IN SEA WATER

G.A. MAJOR, Comm. Sci. & Indus. Res. Org., *Cronulla, New South Wales, Australia*

Objective of project: To develop a routine method for estimating total dissolved organic nitrogen in sea water.

Description of project: Methods which are currently available for the determination of organic nitrogen in the dissolved fraction of sea water have disadvantages of one kind or another. Ultra-violet irradiation, pyrolysis, and electrolytic techniques are being investigated in a study to devise a method which is more convenient and more reliable.

Address for Correspondence: C.S.I.R.O., Division of Fisheries and Oceanography, Box 21, P.O., Cronulla, N.S.W. 2230.

SUPPORTED BY Australian Government - Canberra

1.0050, NAVY ENVIRONMENT - THE EFFECTS OF SURFACE-ACTIVE AGENTS ON SOME CORROSION REACTIONS IN SALINE WATER

I. CORNET, Univ. of California, School of Engineering, *Berkeley, California* 94720

The objective of this research is to understand the effects of surface-active agents on mass transfer controlled corrosion reactions of the type occurring when steel or bronze corrode in aerated sea water. This understanding may improve our methods of combatting corrosion of ship hulls, propellers, and submerged marine structures.

The potentials of Monel, nickel and copper cathodes in synthetic sea water solutions are being measured and compared with those obtained when small amounts of surface active agents are added to the electrolyte. The cell consists of rotating concentric cylinders whose speed of rotation may be varied to effect

changes in boundary layer conditions. Surface-active agents that bond both physically and chemically are being studied. An attempt is being made to correlate the properties of these agents with their ability to affect the potential of metals in aerated sea water and to understand the mechanisms involved. The ability of these materials to act as corrosion inhibitors will also be assessed.

Experiments to date indicate that the long-chain polar amine compounds investigated (alkylammonium acetates of various chain lengths) form films on cathodic surfaces, and that these films act as resistances to mass transfer and cathodic reduction of oxygen. In aerated sodium chloride solutions the proposed mechanisms consist of (a) The formation of amine molecules in the boundary layer of the Monel cathode by reaction of aminium ions with the hydroxyl ions formed by the cathode corrosion reaction, and (b) The adsorption and/or precipitation of amine molecules at the cathode surface. The shift of mass transfer limiting currents to lower values with increasing chain length of the amine was related to the change in solubility and adsorptivity of the amine molecules as a function of chain length. Published report, I. Cornet, and D. Fuerstenau, 'Interface Effects in Mass Transfer Controlled Corrosion Reactions' TR, 1 July 70.

Supporting Agency Address Information: Office of Naval Research, Arlington, Va. 22217.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0051, CHEMICAL COMPOSITION OF THE OCEAN USING A DIRECT MEASURING OCEANOGRAPHIC ELECTROCHEMICAL PROBE

I.R. KAPLAN, Univ. of California, School of Letters, *Los Angeles, California* 90024 (AT(04-3)-34)

The study was initiated for the collection of chemical data in the ocean by use of an in situ electrochemical probe constructed at UCLA. Measurements are to be made in the laboratory and in the ocean on the saturation of calcium carbonate in seawater under various environmental conditions. The recording system is to be changed to allow for 10 hours recording.

Thermodynamic data is to be collected on the behavior of sulfide in seawater, in order to interpret electrochemical sulfide measurements in the ocean.

Mathematical models are to be established for data handling and interpretation. Models will also be established for the circulation of carbon in the ocean.

Results: Several ocean profiles have been measured to determine the saturation of calcium carbonate. It is apparent that data obtained by the probe differs from data measured by conventional chemical methods. Circulation models of carbon dioxide in the ocean have been published.

SUPPORTED BY U.S. Atomic Energy Commission

1.0052, MECHANISM FOR CARBONATE SOLUTION IN THE OCEANS

I.R. KAPLAN, Univ. of California, School of Letters, *Los Angeles, California* 90024

It is proposed to use an oceanographic probe developed at UCLA to undertake in situ saturometry studies with various forms of calcium carbonate in the ocean, to gain an understanding for the mechanisms by which carbonate dissolution occurs on the ocean floor. In this way, it is hoped to explain the apparent discrepancy between the 'carbonate compensation depth', the 'lysocline' and calcium carbonate saturation in the ocean. This understanding will not only increase our knowledge of ocean chemistry but will also be important for the rational use of these indices in paleoecology.

The following studies are proposed: 1. Calcite and aragonite saturation in the water column at specific locations. 2. Ratio of calcite and aragonite solubilities. 3. In situ saturometry with planktonic formifers and calcarous ooze. 4. Carbonate content of sediment in relation to saturation of overlying water. 5. Models for carbonate dissolution in the ocean.

SUPPORTED BY U.S. Natl. Science Foundation

1.0053, AMINO ACIDS IN SEA WATER

J.L. BADA, Univ. of California, Graduate School, *San Diego, California* 92038

Funds from this grant continue support by the National Science Foundation of a detailed investigation of the amino acids dissolved in the sea. Specifically, the investigation concerns (1) the identification of free amino acids, (2) the ratio of D forms to L forms of these compounds, and (3) their distribution in deep-sea water masses.

SUPPORTED BY U.S. Natl. Science Foundation

1.0054, GEOCHEMICAL OCEAN SECTIONS STUDY - GEOSECS- SHIPBOARD AND LABORATORY MEASUREMENTS

H. CRAIG, Univ. of California, Graduate School, *San Diego, California* 92038

The Geochemical Ocean Sections Study, GEOSECS, is a coherent oceanographic research program whose purpose is to make detailed measurements of oceanic constituents at all depths from the Arctic to the Antarctic. The purpose of these measurements is to provide, for the first time, a set of physical and chemical parameters measured on the same water and applying the same analytical techniques for each compound on an oceanwide basis. The results of these measurements will provide data for quantitative studies of oceanic mixing and organic productivity and simultaneously serve as a baseline for the levels of fission and waste products being added to the sea.

This proposal concerns support for measurement programs on GEOSECS involving hydrography, stable isotopes, rare gases and helium, and several radioactive isotopes.

SUPPORTED BY U.S. Natl. Science Foundation

1.0055, MATHEMATICAL MODELING OF FRESH-WATER AQUIFERS HAVING SALT-WATER BOTTOMS

C.F. MEYER, General Electric Company, *Santa Barbara, California* 93101

This project is an application of early research which developed mathematical methods for modeling a groundwater aquifer in which fresh water floats upon and mixes with salt water. Such aquifers are found in many volcanic islands and along sea coasts. Skillful management of the transition zone between fresh and salt water is essential to maximize the amount of fresh water which can be developed and to control encroachment of saline water into wells. Special digital computer methods are required in order to simulate the flow of groundwater when such an interface occurs. Methods for modeling the local behavior of the isochlors are valid only if the background flow in the entire system is adequately modeled.

The research is oriented toward the specific problems of the Honolulu Board of Water Supply on the island of Oahu. Detailed study of one small test area has been completed.

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1.0056, A THREE-DIMENSIONAL FINITE DIFFERENCE MODEL FOR ESTUARIES - PRINCIPLES OF COMPUTATION CONDITIONS

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Development of a three-dimensional finite difference model for simulation of flow, water levels, transport of dissolved substances and temperature distributions in estuaries and lakes, with density variations due to salinity and temperature, is considered.

A finite difference model is proposed which not only approximates the mathematical formulation of the problem, but also conserves during the simulation important physical quantities such as mass, mass of constituents and energy.

An extensive analysis will be made of the computational behavior of the model. The model will be evaluated during an associated research effort using extensive field data.

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