

Reports

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Research on Chesapeake Bay and contiguous waters of the Chesapeake Bight of the Virginian Sea at the Virginia Institute of Marine Science, Gloucester Point, Virginia and Wachapreague, Virginia 1973-74 edition.

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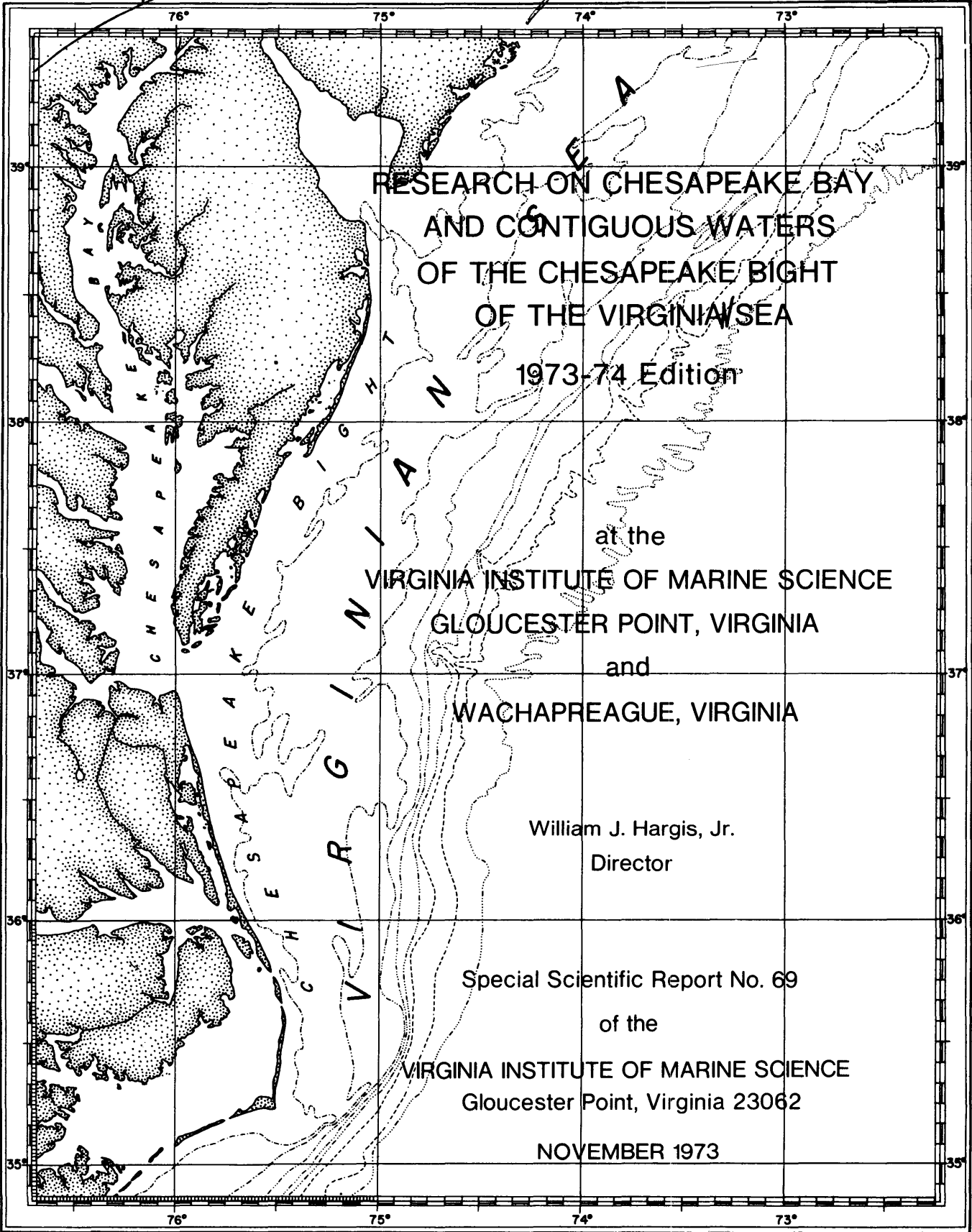
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William J. Hargis, Jr.



RESEARCH ON CHESAPEAKE BAY
AND CONTIGUOUS WATERS
OF THE CHESAPEAKE BIGHT
OF THE VIRGINIA SEA
1973-74 Edition

at the
VIRGINIA INSTITUTE OF MARINE SCIENCE
GLOUCESTER POINT, VIRGINIA
and
WACHAPREAGUE, VIRGINIA

William J. Hargis, Jr.
Director

Special Scientific Report No. 69
of the
VIRGINIA INSTITUTE OF MARINE SCIENCE
Gloucester Point, Virginia 23062

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RESEARCH ON CHESAPEAKE BAY
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STAFF AND PROJECTS RELATED TO THE
ENVIRONMENTS AND RESOURCES OF
THE CHESAPEAKE BAY
AND
ADJACENT WATERS OF THE CONTINENTAL SHELF

These brief status reports are provided to assist those who wish to know the scope and nature of VIMS' programs pertinent to the Chesapeake Bay and the contiguous waters of the Virginian Sea. More detailed information may be obtained from the personnel listed with each status report. Information is also provided on research by staff personnel in localities other than Chesapeake Bay.

Status statements are intentionally short and sometimes contain information which has not been published or, in some cases, not even reported upon. Accordingly, care should be taken in quoting the material.

A list of those projects described in the 1972 report which have been completed or terminated for various reasons is appended with annotation to indicate reports developed or reason for termination. This report and the VIMS organization list are considered up-to-date as of November, 1973.

This report is updated on an annual basis so as to better inform planners and managers of research in progress and to facilitate research coordination and planning in Chesapeake Bay.

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RESEARCH IN PROGRESS BY
PROGRAMS WITHIN ORGANIZED
RESEARCH

Programs within Organized Research

1. Preservation of Coastal Environments

Preserve and improve the quality of life and ecology in the marine coastal environment and provide for multiple use which will include open spaces for recreation and public use.

Develop the ability to predict and modify accidents of natural or human origin affecting the marine environment.

2. Biological Resources of the Coastal Zone

Utilize tidal waters and wetlands to promote economic strength.

Assist in the development of plans to utilize marine resources for optimum multiple use.

Explore for unused or underutilized resources.

3. Biology of Coastal Waters and Wetlands

4. Coastal Zone Hydrography and Geology

Explore and investigate estuarine waters and wetlands and the contiguous continental shelf to extend our understanding of their phenomena, processes, and resources.

5. Advisory Services Related to Marine Resources

Disseminate and interpret the results of research to government agencies responsible for managing coastal zone resources.

Encourage the growth of private initiative in the preservation and optimum multiple use of the coastal zone and its resources.

Promote local, state, regional, national, and international cooperation in marine affairs.

PROGRAM 1:
Preservation of Coastal
Environments

PROJECT TITLE: A STUDY OF THE MOLLUSCAN POPULATION TO THE
NORTH OF THE NEWPORT NEWS SHIPBUILDING AND
DRYDOCK COMPANY

INVESTIGATORS:

Dexter S. Haven, Department Head and Senior Marine Scientist
Joseph G. Loesch, Associate Marine Scientist
James P. Whitcomb, Assistant Marine Scientist

PROJECT SUMMARY:

The objective of this project is to investigate clam and oyster populations in the area to be filled just upriver from the Newport News Shipbuilding and Drydock Company shipyards.

The methods to be used will be:

- (1) Sample at randomly chosen stations with a hydraulic tow dredge within the one-half square mile area,
- (2) Determine density of clams and oysters per unit area, and
- (3) Determine sediment type.

STATUS: Active. Field work was completed in August, 1972. Additional studies may be asked for.

FINANCIAL SUPPORT:

Newport News Shipbuilding and Drydock Company
Virginia Institute of Marine Science

KEY WORDS:

Molluscan populations

PROJECT TITLE: A STUDY OF THE CONSTRUCTION OF THE SECOND TUBE
AT HAMPTON ROADS

INVESTIGATORS:

Dexter S. Haven, Department Head and Senior Marine Scientist
Reinaldo Morales-Alamo, Assistant Marine Scientist

PROJECT SUMMARY:

This is a part of a larger program involving several other departments. Others on the project include Drs. Boesch, Fang, Byrne and Neilson.

This department's part of the project is to study the distribution of the hard clam in the Hampton Roads area and to estimate what effects construction activities may have on this population. Other departments will evaluate aspects of benthic ecology, current patterns, and siltation.

STATUS: Active. The Program started in June 1973 and runs for 15 months.

FINANCIAL SUPPORT:

Virginia Department of Highways
Virginia Institute of Marine Science

KEY WORDS:

Molluscs, sediment distribution

PROJECT TITLE: SYNERGISTIC EFFECTS OF SEWERAGE EFFLUENTS AND
LOW OXYGEN ON BENTHIC BIVALVE MOLLUSCS

INVESTIGATORS:

Dexter S. Haven, Department Head and Senior Marine Scientist
Dennis Walsh, Graduate Student

PROJECT SUMMARY:

The effects of low oxygen and high levels of hydrogen sulfide are being evaluated on larvae and adults of the hard clam *Mercenaria mercenaria* and *Crassostrea virginica*. Reactions are evaluated on the basis of pumping rates, filtration rates, rates of biodeposition and mortality.

STATUS: Active. (A part of this project represents Walsh's thesis research).

FINANCIAL SUPPORT:

National Science Foundation
(RANN Program)
Virginia Institute of Marine Science

KEY WORDS:

Crassostrea virginica, low oxygen, *Mercenaria mercenaria*,
molluscs

PROJECT TITLE: A BIOLOGICAL, CHEMICAL, AND PHYSICAL STUDY
OF THE LOWER YORK RIVER

INVESTIGATORS:

Michael E. Bender, Head, Division of Environmental Science
and Engineering
Robert A. Jordan, Associate Marine Scientist
~~Robert~~ Virnstein, Graduate Assistant
Labbish N. Chao, Graduate Assistant

PROJECT SUMMARY:

Objectives are:

- (1) Summarize existing biological and water quality data pertaining to the study area,
- (2) Assess the quality and quantity of the aquatic biota and the quality of the water within the study area for a two year period prior to the operation of an additional unit (Unit 3) at the VEPCO Yorktown Power Station,
- (3) Make similar assessments for a two year period after the initial commercial operation of Unit 3.

STATUS: Active. Phase 1 is completed. Phase 2 is in progress.

FINANCIAL SUPPORT:

Virginia Electric and Power Company
Virginia Institute of Marine Science

KEY WORDS:

Power plant, York River

PROJECT TITLE: EFFECTS OF ABOVE AMBIENT TEMPERATURE ON THE
CHRONIC TOXICITY OF METHOXYCHLOR

INVESTIGATOR:

Michael E. Bender, Head, Division of Environmental
Science and Engineering

PROJECT SUMMARY:

The objectives of this research project are: (1) to conduct a chronic bioassay on an estuarine fish using a compound of ecological significance, i.e., to establish water quality for methoxychlor on *Fundulus heteroclitus*; (2) to evaluate several enzyme and physiological parameters which might be used to circumvent such costly and laborious long term tests; and (3) to identify the products or at least quantitate the breakdown rate of methoxychlor in fish.

Measurement of response: The major variable to be measured as a function of methoxychlor concentration in the chronic test will be reproductive success. This will entail not only eggs produced but probably more importantly fry survival. Growth will be evaluated by determining initial weight of the fish in each experimental unit, determining the weight of any fish lost from the unit, and a final weight determination on the unit after spawning. This procedure is very inaccurate, but it is believed minimal disturbance of the animals will lead to more valuable data from the reproductive studies. Oxygen consumption has been indicated by Bender and Merna (1970) as increasing as a function of pesticide concentration during long term bioassays. The mechanism to account for this observation are not known, but it may have important physiological manifestations since, along with increased oxygen consumption, anomalies in digesting were noted. To evaluate it, in fact, oxygen consumption is affected by chronic methoxychlor exposure, the separate study described in the methods section will be conducted. Enzyme determinations on several constituents will be used to study the responses of the fish to chronic methoxychlor exposure.

STATUS: The project has been terminated, results of preliminary bioassays are available and being prepared for publication.

FINANCIAL SUPPORT:

Virginia Electric and Power Company
Virginia Institute of Marine Science

KEY WORDS:

Fishes, pesticides

PROJECT TITLE: VEPCO - SURRY PRE- AND POST-OPERATIONAL STUDIES

INVESTIGATORS:

Michael E. Bender, Head, Division of Environmental
Science and Engineering
Marvin Hedgepeth, Graduate Assistant

PROJECT SUMMARY:

Pre- and post-operational studies on the benthic fauna of the James River have been conducted since May 1969. At present, these studies have been modified to the collection of benthic organisms at 16 stations on a quarterly basis. Laboratory studies have been and are being conducted on several aspects of the thermal problem by various graduate students. These studies are outlined in their reports. Field studies have been initiated on zooplankton populations to determine the levels of primary production in this reach of the James.

Further investigations in the area are presently in progress. These include methodology to establish zones of passage for migrating fishes and the effect of entrainment on larval fishes (complete).

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Electric and Power Company
Virginia Institute of Marine Science

KEY WORDS:

Benthos, power plants

PROJECT TITLE: A STUDY OF HEAVY METAL CONCENTRATION BY THE
MARSH CLAM, *RANGIA CUNEATA*

INVESTIGATORS:

Michael E. Bender, Head, Division of Environmental
Science and Engineering
Robert J. Huggett, Assistant Marine Scientist
Robert E. Croonenberghs, Graduate Assistant

PROJECT SUMMARY:

This project is designed to assess the distributions and concentrations of the heavy metals, cadmium, copper, zinc, and lead, in the brackish water clam (*Rangia cuneata*).

Previous studies on oysters have indicated that a natural distribution of heavy metals exists in Virginia's estuaries. Unfortunately, the eastern oyster (*Crassostrea virginica*) has a limited habitat due to its salinity requirements. An organism whose habitat overlaps that of the oyster's and extends into fresh water was needed. The brackish water clam seems appropriate.

The clams will be extensively sampled in the James and Rappahannock River systems and analyzed for heavy metals. The metal concentrations in the clams will be correlated to those of oysters in the overlap zones, hopefully leading to a method of detecting metal pollution over the entire estuarine segment of the rivers.

STATUS: Active. This project represents, in part, Croonenberghs' thesis research.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Clams, metals

PROJECT TITLE: PESTICIDE MONITORING PROGRAM

INVESTIGATORS:

Robert J. Huggett, Department Head and Associate Marine Scientist
Michael E. Bender, Head, Division of Environmental Science
and Engineering
Thomas E. Barnard, Assistant Marine Scientist

PROJECT SUMMARY:

The National Marine Pesticide Monitoring Program in which VIMS participates, is designed to determine pollution from pesticides in the marine environment.

Previously, oysters were used as sampling organisms but now fish of various trophic levels will be utilized.

STATUS: Active. This is a continuation of a program in which VIMS has participated since 1965.

FINANCIAL SUPPORT:

Environmental Protection Agency
(National Marine Pesticide Monitoring Program)
Virginia Institute of Marine Science

KEY WORDS:

Marine environment, pesticides

PROJECT TITLE: HEAVY METALS IN SEDIMENTS AND OYSTERS

INVESTIGATORS:

Robert J. Huggett, Department Head and Associate Marine Scientist
Michael E. Bender, Head, Division of Environmental Science
and Engineering
Harold D. Slone, Assistant Marine Scientist

PROJECT SUMMARY:

This project is designed to assess the distributions and concentrations of cadmium, copper, lead, mercury, and zinc in the southern Chesapeake Bay and its major tributaries.

The Eastern Oyster (*Crassostrea virginica*), the brackish water clam (*Rangia cuneata*), and bottom sediments are being taken from numerous locations in the James, York, Rappahannock, Elizabeth Back, Poquoson, Piankatank Rivers as well as Mobjack and Lynnhaven Bays. The areas between these tributaries, in the Chesapeake Bay, are also being sampled.

Analyses are being performed by Atomic Absorption spectrophotometry.

STATUS: Active. This project represents, in part, Huggett's dissertation research.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Metals

PROJECT TITLE: BASELINE STUDY OF ORGANIC COMPOUNDS IN THE
BAY ENVIRONMENT

INVESTIGATORS:

Rudolf H. Bieri, Section Head and Senior Marine Scientist
Robert J. Huggett, Department Head and Associate Marine Scientist
Various personnel from NASA

PROJECT SUMMARY:

During the past year, the analytical facilities and capabilities at both VIMS and NASA to investigate the presence of natural and man-introduced organic compounds in waters, sediments and biota of the Bay have been developed. One of the mass-spectrometers (CEC 104) has been modified and converted to a GC-MS system; major improvements now allow fast scan (mass 12-400 in 1 sec) and proportional signal enhancement with mass. To facilitate compound identification, which at this time still requires a human interface, this system will have to be computerized. A Finnigan GC-MS system with a dedicated computer has been equipped with a tape interface to a CDC-6000 computer for catalogue search. This instrument has been used extensively throughout the development of extraction methods and has yielded valuable information about the detailed composition of water soluble phases of No. 2 and 6 fuel oils. Preliminary analyses of natural samples (waters, sediments, clams) are also available. Limitations due to sample contamination from a number of sources have been recognized and are being worked on.

STATUS: Active. This is a cooperative program with the Langley Research Center of National Aeronautics and Space Administration, Hampton, Virginia.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science
National Aeronautics and Space Administration
(Langley Research Center)

KEY WORDS:

Organic compounds

PROJECT TITLE: EVALUATION OF EFFECTS CAUSED BY EFFLUENTS
FROM A BILGEWATER TREATMENT PLANT PROPOSED
FOR CHEATHAM ANNEX

INVESTIGATORS:

Michael E. Bender, Assistant Director and Senior Marine Scientist
Rudolf H. Bieri, Section Head and Senior Marine Scientist
Robert J. Huggett, Department Head and Associate Marine Scientist
Various Personnel from NASA

PROJECT SUMMARY:

Efforts to clean up the environment must include treatment facilities for bilge and ballast waters capable of operating efficiently and economically (this is especially important for estuary based harbors such as Hampton Roads.) One such effort has been proposed for the Cheatham Annex site by the Department of Commerce, Maritime Administration. Unfortunately, very little is known about how such waste products should be treated to prevent damage to the estuarine biota by the plant effluent. Since the toxic effects of a compound depend not only on the particular physical and chemical properties of the compound itself, but also on the availability to the biota (which involves the feeding habits or other specific uptake mechanisms), it is important to know in what form the pollutant is entered (dissolved, emulsified, adsorbed or as a coating on small solid particles) or how the natural environment dissipates, transforms or concentrates the effluent. It is proposed that the effluent from a pilot plant is first used for the determination of acute bioassays, that the baseline concentrations of a number of hydrocarbons in water, sediments and in oysters near the outfall be established and, if the acute bioassay indicates no major danger, that the area near the outfall be biologically (chronic effects) and chemically monitored for 6 months after the plant has started operation.

STATUS: Active. This is a cooperative program with the Langley Research Center of NASA, Hampton, Virginia.

FINANCIAL SUPPORT:

U.S. Department of Commerce (Maritime Administration)
(pending)
National Aeronautics and Space Administration
(Langley Research Center)
Virginia Institute of Marine Science

KEY WORDS:

Bilgewater treatment plant, waste disposal

PROJECT TITLE: ROUTES, FATE AND EFFECTS OF OIL SPILLS ON
MERCENARIA MERCENARIA and MYA ARENARIA IN
A SEMINATURAL ENVIRONMENT

INVESTIGATORS:

Rudolf H. Bieri, Section Head and Senior Marine Scientist
Michael E. Bender, Assistant Director and Senior Marine Scientist
Robert J. Huggett, Department Head and Associate Marine Scientist
Various personnel from NASA

PROJECT SUMMARY:

The purpose of this investigation is to provide answers to the question of whether oil spills may be responsible for lesions, observed by a researcher of the EPA Rhode Island Laboratory, in clams collected from the Searsport area after a No. 2 fuel oil spill. Rather than try to duplicate the living conditions of clams, the flux, the routes and the ultimate fate of oil components in a laboratory experiment, it was decided to perform the experiment in a modified natural environment. Plans are to dose transplanted clam populations within enclosed compartments of approx. 6,000 ft² area in a restricted access intertidal creek. Exchange with surrounding water will be possible at the subtidal level. The flow of oil components through these "mini" ecosystems" will be followed through analysis of water sediment and clam tissue samples, mainly by gas chromatography and gas chromatography combined with mass spectrometry. Clam samples for pathological investigations will be sent to EPA. No. 2 fuel oil and spent crankcase oil will be used for the dosing.

STATUS: Active. This is a cooperative program with the Langley Research Center of NASA and the Rhode Island Laboratory of EPA.

FINANCIAL SUPPORT:

National Aeronautics and Space Administration
(Langley Research Center).
Virginia Institute of Marine Science

KEY WORDS:

Clams, *Mercenaria mercenaria*, *Mya arenaria*, oil spills

PROJECT TITLE: SUBLETHAL EFFECTS OF BUNKER C OIL ON A WETLAND
COMMUNITY

INVESTIGATORS:

Michael E. Bender, Head, Division of Environmental
Science and Engineering
Carl H. Hershner, Graduate Assistant

PROJECT SUMMARY:

This project is designed to investigate the sublethal effects of chronic oil pollution on a salt marsh ecosystem. No. # 2 fuel oil will be applied to a section of marsh, and parameters such as primary productivity, community diversity, and detrital export will be monitored over a two year period. A nearby section of marsh will be utilized as a control area.

In addition, laboratory studies will evaluate the influence of # 2 fuel oil on respiration and other physiological parameters. Community dominants will be used in this phase of the study.

It is hoped that the study will elucidate changes in energy flow through the wetland ecosystem as caused by an environmental stressor such as oil.

STATUS: In preparation. This project represents, in part, Hershner's dissertation research.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Oil, wetlands

PROJECT TITLE: HEAVY METAL DISTRIBUTION IN BOTTOM SEDIMENTS
OF THE LOWER CHESAPEAKE BAY

INVESTIGATORS:

Robert J. Huggett, Department Head and Associate Marine
Scientist
Michael E. Bender, Head, Division of Environmental Science
and Engineering

PROJECT SUMMARY:

A previous study on the Rappahannock River has indicated that the heavy metals copper and zinc are predictably partitioned between inorganic and organic fractions in bottom sediments. The extent of partitioning appears to be a function of both pH and salinity and their effects on adsorptive and precipitation phenomena.

A thorough understanding of the controlling mechanisms for sediment metal concentration would allow better management of estuarine systems with respect to heavy metal pollution. To check the hypotheses formed from the Rappahannock River study, the James and York River sediments will have been sampled and analyzed for the heavy metals. Laboratory experiments will be performed to check adsorption parameters and will be compared to the natural systems.

Since there are known unnatural metal sources in the James system, a check on the validity of these hypotheses will be available, and a mathematical model will be possible.

STATUS: Active. This is a subproject of the "Waste Water Treatment Program" of the Chesapeake Research Consortium Inc.

FINANCIAL SUPPORT:

National Science Foundation
(RANN Program)
Virginia Institute of Marine Science

KEY WORDS:

Metals, sediments

PROJECT TITLE: NOBLE GASES IN THE ATMOSPHERE BETWEEN 40 AND 50
KM HEIGHT

INVESTIGATORS:

Rudolf H. Bieri, Section Head and Senior Marine Scientist
George M. Wood*
Billy Upchurch*
David Hughes*

PROJECT SUMMARY:

It is generally assumed that the mean molecular mass of the atmosphere remains constant up to about 80 km height. However, the precise assessment of the gaseous composition of the upper atmosphere is still in an infant state, and only recently has it become possible to collect large and unmodified samples which allow a detailed analysis of trace components. The analysis of the noble gas content in such samples is essential as a check of the integrity of the collection and for the determination of the molecular hydrogen content. Three samples, one of surface air and two from a collection between 40 and 50 km on May 23 over White Sands, were sent by Dr. Martell of the National Center of Atmospheric Research and will be analyzed on the CEC-104 mass spectrometer for their Hg, Ne, Ar and Vr content.

STATUS: Active. This is a cooperative program with the Langley Research Center of NASA, Hampton, Va.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science
National Aeronautics and Space Administration
(Langley Research Center)

KEY WORDS:

Noble gases

*George M. Wood, Electronics Engineer;

*David Hughes, Electrical Engineer; Langley Research Center, Hampton, Va.

*Billy Upchurch, Associate Professor of Chemistry, Old Dominion University, Norfolk, Virginia.

PROJECT TITLE: EVALUATION OF A NEW STRIPPING SYSTEM FOR THE
EXTRACTION OF ORGANIC COMPOUNDS FROM NATURAL
WATERS

INVESTIGATORS:

Rudolf H. Bieri, Section Head and Senior Marine Scientist
Robert J. Huggett, Department Head and Associate Marine Scientist
Stanley P. Wasik *

PROJECT SUMMARY:

A new extraction method employing electrolysis has been developed at the National Bureau of Standards (S. P. Wasik). This device appears to be extremely attractive for the quantitative determination of organic compounds accommodated in water as well as for the separation of different compound groups, and a number of applications to problems in marine science will be investigated.

STATUS: Active. This is a cooperative program with the National Bureau of Standards, Division of Physical Chemistry, Gaithersburg, Md.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science
National Bureau of Standards

KEY WORDS:

Organic compounds extraction

* Physical Chemist National Bureau of Standards.

PROJECT TITLE: INVESTIGATION OF THE APPLICABILITY OF
MICROWAVE SPECTROMETRY TO ATMOSPHERIC
POLLUTION PROBLEMS

INVESTIGATORS:

Rudolf H. Bieri, Section Head and Senior Marine Scientist
Robert J. Huggett, Department Head and Associate Marine Scientist
William White*

PROJECT SUMMARY:

Extremely high resolution specificity, relative ease of compound identification and for highly polar molecules good sensitivity are some of the important characteristics of microwave spectrometers. Interfacing such an instrument to a computer results in additional useful features, such as application of signal enhancing techniques, programmed research, and compound identification from a file. In principle, such an instrument should be close to ideal for the assessment of organic (and some gaseous inorganic) pollutants in the atmosphere. However, since the presence of water vapor in atmospheric samples is one of the main limiting factors, sampling apparatus reducing the vapor pressure of water in samples but leaving the integrity of the pollutants intact must first be developed. As of this date, moderate success has been achieved with a cryogenic collection system, while chromatographic columns tried so far have not met requirements. Development of suitable collecting systems is continued.

STATUS: Active. This is a cooperative program with the Langley Research Center of NASA, Hampton, Virginia.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science
National Aeronautics and Space Administration
(Langley Research Center)

KEY WORDS:

Atmospheric pollution, microwave spectrometry

*William White, Aerospace Technologist
Langley Research Center, NASA, Hampton, Virginia

PROJECT TITLE: VIRGINIA WETLAND INVENTORY, MAPPING, AND
CLASSIFICATION PROGRAM

INVESTIGATORS:

Gene Silberhorn, Associate Marine Scientist

PROJECT SUMMARY:

The Institute, as required by the Wetlands Act of 1972, is inventorying and classifying its tidal wetlands by type, and is also developing guidelines concerning the consequences of various uses of wetlands.

Sketch maps of wetland areas are being prepared. Boundaries of dominant vegetative communities are delineated also. Estimates of the ecological significance of each wetland unit are also made using acreage, shoreline length, percent flooded daily and relative values of plants to wildlife and marine life.

Inventories of Lancaster and Mathews counties have been completed and work is in progress in York County and the City of Newport News.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Inventory, marshes, wetlands

PROJECT TITLE: APPLICATION OF RECOGNITION REMOTE SENSING FOR
THE INVENTORY OF WETLAND VEGETATION

INVESTIGATORS:

Gene M. Silberhorn, Associate Marine Scientist
Ruth I. Whiteman*

PROJECT SUMMARY:

This project combines the resources of the Institute and the Langley Research Center of the National Aeronautics and Space Administration in an effort to develop a technique whereby wetland vegetation can be identified, inventoried, and mapped by aerial photography.

Overflights of selected wetlands, using a SH-3A research helicopter, occur at intervals during the growing season. Photographs are taken at various altitudes and with various focal length lenses in order to provide a set of vertically-nested or "telescoped" images of key wetland plants.

The recognition of characteristic patterns of vegetation species and the optimum season for photographing are the main objectives of the study. The technique is being tested on areas from which ground truth data has not been collected, and an analysis of the feasibility of the technique for extensive wetland inventorying and mapping is being made.

STATUS: Active. This is a subproject of the "Edges Program" of the Chesapeake Research Consortium, Inc.

FINANCIAL SUPPORT:

National Aeronautics and Space Administration
(Langley Research Center)
National Science Foundation
(RANN Program)
Virginia Institute of Marine Science

KEY WORDS:

Remote sensing, wetlands

*Ruth I. Whitman, Langley Research Center, NASA, Hampton, Virginia

PROJECT TITLE: SERUM CHEMISTRY OF THE COMMERCIALY IMPORTANT MARINE ORGANISMS

INVESTIGATORS:

Maurice P. Lynch, Senior Marine Scientist
Kenneth L. Webb, Associate Marine Scientist
James Colvocoresses, Graduate Assistant

PROJECT SUMMARY:

Variation of some of the serum constituents of the blue crab, *Callinectes sapidus*, is being studied for the purpose of determining if any of these various constituents can be used as indicators of physiological condition of the blue crab populations and subpopulations, if such are present, in the Chesapeake Bay. Screening of serum constituents of other marine invertebrates (the rock crab, *Cancer irroratus*, and the oyster, *Crassostrea virginica*, in particular) is done on an irregular basis.

STATUS: Continuing.

FINANCIAL SUPPORT:

National Oceanographic and Atmospheric Administration
(Office of Sea Grant Programs) (1969-1971)
U. S. Public Health Service (Biomedical Sciences Support
Grant to the University of Virginia) (1971-1972)
Virginia Institute of Marine Science.

PUBLICATIONS:

- (1) Lynch, M. P., K. L. Webb, and W. A. Van Engel. 1973. "Variations in serum constituents of the blue crab, *Callinectes sapidus*: Chloride and Osmotic concentration," *Comp. Biochem. Physiol.* 44A: 719-734.
- (2) Lynch, M. P. and K. L. Webb. 1973. "Variations in serum constituents of the blue crab, *Callinectes sapidus*: Total serum protein," *Comp. Biochem. Physiol.* 44A: 1237-1249.
- (3) Lynch, M. P. and K. L. Webb. 1973. "Variations in serum constituents of the blue crab, *Callinectes sapidus*: Glucose," *Comp. Biochem. Physiol.* 45A: 127-139.
- (4) Lynch, M. P. and K. L. Webb. 1973. "Variations in serum constituents of the blue crab, *Callinectes sapidus*: Free amino acids and total ninhydrin positive substances," *Comp. Biochem. Physiol.* 45B: 407-418.
- (5) Colvocoresses, J. A., M. P. Lynch and K. L. Webb. 1973. "Variations in serum constituents of the blue crab, *Callinectes sapidus*: Major cations," *Comp. Biochem. Physiol.* (in press).

KEY WORDS:

Blood studies, *Callinectes sapidus*, crabs, crustaceans, indices, molluscs, oysters

PROJECT TITLE: NORFOLK CANYON CRUSTACEAN BLOOD STUDIES

INVESTIGATORS:

Maurice P. Lynch, Senior Marine Scientist
William D. DuPaul *

PROJECT SUMMARY:

Baseline values of various serum constituents of crustaceans from the Norfolk Canyon and adjacent continental shelf areas are being determined for the purpose of defining normal, seasonal, sexual, molt stage and environmentally caused variability of these constituents.

During the summer 1973 phase of the program, approximately 500-600 samples of serum from *Geryon quinquidens*, *Homarus americanus*, *Cancer irroratus* and *Cancer borealis* have been analyzed for Na, K, Mg, Ca, Cl, Cu, Zn, total protein, total lipid and total osmotic concentration. Subsequent sampling during other seasons is planned in 1974 and 1975.

STATUS: Active.

FINANCIAL SUPPORT:

National Science Foundation (vessel support)
Virginia Institute of Marine Science

KEY WORDS:

Biochemistry, blood studies, *Cancer borealis*, *Cancer irroratus*, crabs, crustaceans, *Geryon quinquidens*, *Homarus americanus*, Norfolk Canyon

*William DuPaul, Massachusetts Maritime Academy, Buzzards Bay, Massachusetts.

PROJECT TITLE: NEUTRON ACTIVATION ANALYSIS OF CHESAPEAKE BAY SEDIMENTS

INVESTIGATORS:

Paul L. Zubkoff, Department Head and Senior Marine Scientist
J. Ernest Mariner, III, Assistant Marine Scientist
Walter E. Carey*

PROJECT SUMMARY:

Selected sediments from tributary rivers of the Chesapeake Bay will be subjected to a neutron flux of 2×10^{11} neutrons $\text{cm}^{-2} \text{sec}^{-1}$ for either 5 minutes or 2 hours.

The resulting gamma-ray spectra will be analyzed using NaI (Tl) crystal for the measurement of Na, Mn, La and Sc content.

These samples will be used for the preparation of radioactive sediment particles for exploring mechanisms of particulate injection by invertebrates.

STATUS: Inactive.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Heavy metals, James River, metals, minerals, sediments

*Walter E. Carey, Director, Nuclear Reactor Laboratory, Ohio State University, Columbus, Ohio

PROJECT TITLE: OPERATION AGNES

INVESTIGATORS:

William G. MacIntyre, Associate Marine Scientist
Craig L. Smith, Associate Marine Scientist
Carol A. Lake, Assistant Marine Scientist
James L. Lake, Graduate Assistant
John G. Windsor, Graduate Assistant

PROJECT SUMMARY:

The effect of flooding caused by Hurricane Agnes in the summer of 1972 on the nutrient distribution in Chesapeake Bay is being investigated. Samples from transects of the Bay near Tangier Island, and at the Bay Mouth were analyzed for total and dissolved phosphorous, total Kjeldahl nitrogen and dissolved nitrate and nitrite. A follow-up study of the Bay during slackwater was made in 1973 to estimate recovery of the Bay system's nutrient balance.

STATUS: Active. This project is scheduled for completion this year, and is part of a larger program of biological, geological, and hydrological work.

FINANCIAL SUPPORT:

National Science Foundation
NOAA
U. S. Army Corps of Engineers
Environmental Protection Agency
Virginia Institute of Marine Science

KEY WORDS:

Bay Mouth studies, eutrophication, nitrogen, nutrients,
storms, turbidity

PROJECT TITLE: PHOSPHOROUS EXCHANGE WITH SEDIMENTS IN A CHESAPEAKE BAY ESTUARY

INVESTIGATORS:

W. G. MacIntyre, Associate Marine Scientist
C. A. Lake, Assistant Marine Scientist
C. L. Smith, Associate Marine Scientist

PROJECT SUMMARY:

Phosphorous distribution in overlying and interstitial water and sediments in the vicinity of the Lamberts Point sewage treatment plant outfall in the Elizabeth River will be determined over a period of one year.

A laboratory phase of this project will consider the significance of organophosphorous adsorption on sedimentary materials in regulating the distribution of phosphorous in the sediment - water system.

Utilizing data from the laboratory and field studies, a model will be attempted which will enable the prediction of the partitioning of phosphorous between water and sediment given the concentration of the phosphorous compounds in the source (effluent) streams.

STATUS: Active. This is a subproject of the "Waste Water Treatment Program" of the Chesapeake Research Consortium, Inc. The laboratory work represents Lake's dissertation research.

FINANCIAL SUPPORT:

National Science Foundation
(RANN Program)
Virginia Institute of Marine Science

KEY WORDS:

Estuaries, phosphorous, sediments

PROJECT TITLE: NUTRIENT FLUX IN CHESAPEAKE BAY MOUTH

INVESTIGATORS:

W. G. MacIntyre, Associate Marine Scientist
C. L. Smith, Associate Marine Scientist
C. A. Lake, Assistant Marine Scientist
J. L. Lake, Graduate Assistant
J. C. Windsor, Graduate Assistant

PROJECT SUMMARY:

Nutrient measurements were made across a section of the Bay mouth and used in conjunction with simultaneous current measurements to obtain estimates of total P and N fluxes through the section.

STATUS: Active. The field work and chemical analysis are complete. A final report is in preparation and will be delivered on November 1, 1973.

FINANCIAL SUPPORT:

National Science Foundation
(RANN Program)
U. S. Army Corps of Engineers
National Oceanic and Atmospheric Administration
Virginia Institute of Marine Science

KEY WORDS:

Estuaries, nitrogen, nutrient flux, nutrients, phosphorous

PROJECT TITLE: ORGANIC COMPLEXING OF TRACE METALS IN MARINE SEDIMENTS

INVESTIGATOR:

William G. MacIntyre, Associate Marine Scientist
John G. Windsor, Graduate Student

PROJECT SUMMARY:

Investigations will begin with some laboratory analyses of transition metal complexing. A program of determination of trace metal and potential organic ligand compounds in Chesapeake Bay sediments will be initiated. Attempts at structure analysis of some ligands will be made. Initial analytical work is in progress.

STATUS: Active. This project represents Windsor's dissertation research.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Complexing, marine sediments, trace metals

PROJECT TITLE: DETERMINATION OF OIL SLICK LEEWAY

INVESTIGATORS:

Craig L. Smith, Associate Marine Scientist
William G. MacIntyre, Associate Marine Scientist

PROJECT SUMMARY:

This project involves the determination of oil slick leeway as a function of varying wind and sea conditions. The approach is direct, employing time-sequential aerial photography of the separation of oil slicks of five different oil types from a dyed water mass in wind speeds ranging from 5-25 kts. The purpose of this research is to enable accurate predictions of oil slick movement in the event of an accidental oil spill so that appropriate warnings may be made, and preventive action initiated.

STATUS: Active

FINANCIAL SUPPORT:

U. S. Coast Guard
Virginia Institute of Marine Science

KEY WORDS:

Aerial photography, oil, pollution, prediction, transport

PROJECT TITLE: ANALYSIS AND EVALUATION OF REMOTE-SENSOR DATA
FOR MARINE-SCIENCE APPLICATIONS

INVESTIGATORS:

Hayden Gordon, Assistant Marine Scientist
Michael Penney, Research Assistant

PROJECT SUMMARY:

The scope of this program is to analyze and evaluate imagery obtained from overflight by NASA aircraft in three program areas:

- (1) Water temperature patterns at the Hog Point (Surry) power plant.
- (2) Tonal variations in wetlands imagery to enhance applicability of remote sensing to species identification in marsh systems.
- (3) Morphological changes in beaches and inlets on the Eastern Shore of Virginia and tidal volumes in the interior lagoons.

In each case a ground-truth program is executed to acquire the relevant surface information so that meaningful correlations may be made with the imagery.

STATUS: Active. Final report in December 1973.

FINANCIAL SUPPORT:

National Aeronautics and Space Administration
(Wallops Island)
Virginia Institute of Marine Science

KEY WORDS:

Marshes, remote sensing, shorelines, thermal impact

PROJECT TITLE: BIOTA-RELATED STUDIES OF CHESAPEAKE BAY

INVESTIGATORS:

Marvin L. Wass, Department Head and Senior Marine
Scientist

Donald F. Boesch, Associate Marine Scientist

PROJECT SUMMARY:

Previous objectives of this CRC controlled and U.S. Army Corps of Engineers' funded project were met by publication of a final report covering the first grant period as a supplement in *Chesapeake Science*, to which six VIMS scientists contributed. The 290 page "Check List of the Biota of Lower Chesapeake Bay," edited by Wass, was partially funded by this grant. Nine VIMS scientists contributed sections of this list. A biotic code, developed as part of the project, awaits publication.

Present objectives involve: 1) Updating the check list, 2) Assessment of extant and proposed water quality criteria or standards on the biota of Chesapeake Bay, and 3) Definition of biological research needs, particularly those leading to predictive capability, in the Bay.

Other facets, to be done by scientists at the Smithsonian Institution or the Chesapeake Biological Laboratory, include: 1) Summaries of biology of the most important Bay organisms, 2) Descriptions and evaluations of biotic communities in the Bay, and 3) Applicability of the Chesapeake Bay hydraulic model for solutions to biological problems.

STATUS: Active

FINANCIAL SUPPORT:

U. S. Army Corps of Engineers, Baltimore District
Chesapeake Research Consortium, Inc.
Virginia Institute of Marine Science

KEY WORDS:

Biotic communities, hydraulic models, water
quality criteria

PROJECT TITLE: EFFECT OF CONSTRUCTION OF THE SECOND HAMPTON ROADS
BRIDGE-TUNNEL ON BENTHIC COMMUNITIES

INVESTIGATOR:

Donald F. Boesch, Associate Marine Scientist

PROJECT SUMMARY:

The effects of dredging for tunnel construction and the effects of spoil disposal and storage on benthic animal populations is being studied. Advice will then be offered as to the impact of ongoing practices and possible modifications to lessen impact in the design and construction of future bridge-tunnels.

STATUS: Active

FINANCIAL SUPPORT:

Virginia State Department of Highways
Virginia Institute of Marine Science

KEY WORDS:

Benthos, bridge-tunnel

PROJECT TITLE: EFFECTS OF TROPICAL STORM AGNES ON BENTHIC INVERTEBRATES
IN CHESAPEAKE BAY ESTUARIES

INVESTIGATORS:

Donald F. Boesch, Associate Marine Scientist
Marvin L. Wass, Department Head and Senior Marine Scientist
Robert J. Diaz, Assistant Marine Scientist
Rosalie M. Vogel, Graduate Assistant

PROJECT SUMMARY:

Station locations previously sampled by D. F. Boesch in the York estuary and by R. J. Diaz in the James estuary were resampled in late summer, 1972, after severe flooding lowered the salinity. Community composition and structure will be compared to pre-flood conditions in order to detect changes attributable to the flood. Additional sampling is planned for summer, 1973, in order to detect recovery.

STATUS: Active

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Agnes, benthos

PROJECT TITLE: DEVELOPMENT OF MATHEMATICAL TECHNIQUES FOR THE STUDY
OF MARINE AND ESTUARINE COMMUNITIES

INVESTIGATORS:

Donald F. Boesch, Associate Marine Scientist
Robert J. Diaz, Assistant Marine Scientist

PROJECT SUMMARY:

Multivariate techniques designed to classify and ordinate field ecological data and to describe the structure of biotic communities are being applied to data on benthic, planktonic and nektonic communities. A series of computer programs which performs an array of analyses has been developed and is being refined. These analyses include diversity indices, similarity measures and cluster analyses. The programs are compatible with the standardized biological collections format and the taxonomic code developed at VIMS.

STATUS: Continuing

FINANCIAL SUPPORT:

Virginia Institute of Marine Science
U. S. Army Corps of Engineers, Baltimore District

KEY WORDS:

Data analysis, data storage and retrieval

Virginia Institute of Marine Science
Office of Special Programs

PROJECT TITLE: CHESAPEAKE RESEARCH CONSORTIUM INCORPORATED (CRC)

INVESTIGATORS:

William J. Hargis, Jr., Institute Director and Institutional
Representative to CRC Board of
Trustees

John M. Zeigler, Assistant Director, Member CRC Board
of Trustees

Maurice P. Lynch, Senior Marine Scientist and CRC
VIMS Coordinator

*Theodore Chamberlain, CRC Director

PROJECT SUMMARY:

The Chesapeake Research Consortium Inc., consisting of the Virginia Institute of Marine Science, The Johns Hopkins University, The Smithsonian Institute and The University of Maryland are cooperating in bay-wide inter-disciplinary studies in several areas. Present programs in which VIMS participated are:

- (1) Waste Water Treatment and Siting Criteria (Formerly Emissions and Additions)
- (2) The Edges of the Bay (formerly Wetlands, Shorelines, and Shallows)
- (3) The Biota of Chesapeake Bay
- (4) The Effects of Tropical Storm Agnes on Chesapeake Bay

STATUS: Active. Specific Programs and Subprojects are described elsewhere in this volume.

FINANCIAL SUPPORT:

National Science Foundation
(RANN Program)

U.S. Army Corps of Engineers, Baltimore District

The Johns Hopkins University

University of Maryland

Smithsonian Institute

Virginia Institute of Marine Science

KEY WORDS:

Hurricane Agnes, interdisciplinary research, waste water treatment, wetlands

*Dr. Theodore Chamberlain, Director
Chesapeake Research Consortium, Inc.
100 Whitehead Hall
The Johns Hopkins University
Baltimore, Maryland 21218

PROJECT TITLE: EFFECTS OF A MAJOR FLOOD ON THE CHESAPEAKE
BAY SYSTEM (OPERATION AGNES)

INVESTIGATORS:

William J. Hargis, Jr., Institute Director and
Ad Hoc Coordinator, Bay-Wide Studies--
Operation Agnes.

W. Jackson Davis, Assistant Director and VIMS
Coordinator--Operation Agnes

PROJECT SUMMARY:

The objective of this study is to describe and explain the effects of the flood resulting from Tropical Storm Agnes in June 1972 on the Chesapeake Bay System. The study is a joint effort of the Chesapeake Bay Research Council*, with VIMS working mainly in the lower Bay, its tributaries, and on the Continental Shelf.

Description of changes in hydrography is being accomplished by measuring salinity, turbidity, dissolved oxygen, and temperature on frequent slack-water runs during the period of freshwater influence. Water flux is being measured on transects of the rivers and in Chesapeake Bay. Coupled with measurement of water flux is analysis of transport of sediments nutrients, pesticides, and heavy metals. Study of sedimentological effects is to be based on more than 10,000 samples that have been collected in the lower Bay and its tributaries, on turbidity measurements, and on remote sensing data.

Biological investigations have been aimed at description of immediate effects, such as displacement or death of organisms, and at effects which will not be apparent for a few months to a few years, such as disruption of reproduction. The planktonic, benthonic, and nectonic communities are being monitored to determine the nature and extent of changes.

STATUS: Active.

FINANCIAL SUPPORT:

National Ocean Survey - Chesapeake Bay; National Oceanic and Atmospheric Administration; National Science Foundation; U. S. Army Corps of Engineers; National Marine Fisheries Service; Environmental Protection Agency; Food and Drug Administration; Virginia Institute of Marine Science; State Civil Defense; Office of Emergency Preparedness; Virginia Pilots Association; Virginia Marine Resources Commission.

KEY WORDS:

Hurricane Agnes

*Chesapeake Bay Research Council includes Chesapeake Bay Institute, Chesapeake Biological Laboratory, and the Virginia Institute of Marine Science.

PROJECT TITLE: CHESAPEAKE BAY RESEARCH PLANNING AND MANAGEMENT

INVESTIGATORS:

William J. Hargis, Jr., Institute Director
John L. Wood, Associate Director and Sea Grant
Coordinator
Michael E. Bender, Assistant Director
W. Jackson Davis, Assistant Director
John M. Zeigler, Assistant Director
Maurice P. Lynch, Senior Marine Scientist and
CRC Coordinator

PROJECT SUMMARY:

This effort is designed to continually examine and maintain up-to-date the elements and research needs of the lower Chesapeake Bay System and the adjacent inshore waters of the Atlantic Ocean as well as contiguous littoral and lagoonal systems.

Significant attention is being focused on the national problems of the Coastal Zone and its systems. This will lead to the development of statements of research and goals of wide applicability.

Particular emphasis is placed on developing or obtaining statements of informational needs from agencies legally responsible for planning for and management of the marine and estuarine resources.

STATUS: Continuing.

FINANCIAL SUPPORT:

National Oceanic and Atmospheric Administration
(Office of Sea Grant Programs)
National Science Foundation
(RANN Program)
Virginia Institute of Marine Science

KEY WORDS:

Information needs, management, planning

PROJECT TITLE: A POLICY STUDY OF MARINE AND ESTUARINE SANCTUARIES

INVESTIGATORS:

Maurice P. Lynch, Senior Marine Scientist and CRC Coordinator
Theodore F. Smolen, Assistant Marine Scientist
Beverly L. Laird, Laboratory Specialist
Martha A. Patton, Laboratory Specialist
William J. Hargis, Jr., Institute Director

PROJECT SUMMARY:

A comprehensive review of background information relative to marine and estuarine sanctuaries (as defined in The Coastal Zone Management Act § P. L. 92-583.) and The Marine Protection Research and Sanctuaries Act (P. L. 92-532) is being conducted. Included in the study are reviews of legislative history; major federal, state and privately supported studies; federal, state and privately support related programs; and attitudes and policies of private organizations, Institutions, and interest.

STATUS: Active.

FINANCIAL SUPPORT:

U. S. Department of Commerce
National Oceanic and Atmospheric Administration
(Office of Coastal Zone Management)
Virginia Institute of Marine Science

KEY WORDS:

Estuarine sanctuaries, marine sanctuaries

PROJECT TITLE: A STUDY OF COMMON LAND IN VIRGINIA

INVESTIGATORS:

Theodore F. Smolen, Assistant Marine Scientist
William J. Hargis, Jr., Institute Director
Maurice P. Lynch, Senior Marine Scientist

PROJECT SUMMARY:

The project is a study of common lands from a legal-historical perspective, the ultimate object of which is to locate the geographical boundaries of common land in Virginia, with emphasis on marsh areas. A nexus will be established between common lands and the public trust theory.

In order to understand the modern concept of "common lands" it is necessary to understand the development of this now rather obscure form of land tenure. Therefore, a section of the study will examine, at least cursorily the development and evolution of common lands throughout history from 2500 B. C. (Babylonia) to the present. Because of their significance special emphasis will be placed upon Roman and English law concept of common rights and ownership of real property.

A detailed analysis will be conducted of the evolution of the "common land" concept in Virginia from the establishment of the colony at Jamestown in 1607 to the present. This analysis will entail a detailed historical study of events pertinent to common land and a legal analysis of these events within the rubric of Virginia case law and statutes.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science.

KEY WORDS:

Commonland, marshes, ownership

PROJECT TITLE: VIRGINIA'S COASTAL ZONE, DEFINED

INVESTIGATORS:

Theodore F. Smolen, Assistant Marine Scientist
Maurice P. Lynch, Senior Marine Scientist

PROJECT SUMMARY:

This study will culminate in a proposed geographical definition of Virginia's Coastal Zone in accordance with the Coastal Zone definition set forth in the Federal Coastal Zone Management Act of 1972. Criteria applied, *inter alia* will be population density, location of the fall line, marine oriented industry, industries having any physical effect upon the zone, the fishing industry, and existing political and administrative subdivisions.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Coastal zone definitions

PROJECT TITLE: THE EVOLUTION OF VIRGINIA'S NAVIGABILITY RULE

INVESTIGATOR:

Theodore F. Smolen, Assistant Marine Scientist

PROJECT SUMMARY:

This is a study analyzing the evolution and application of the rule of navigability of watercourses in Virginia. Particular concern will be focused in application of the large body of case law developed with regard to navigability to present day environmentally related problems.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science.

KEY WORDS:

Navigability rule

PROGRAM 2:
Biological Resources of the
Coastal Zone

PROJECT TITLE: MANAGEMENT OF LARVAE, SUPPLY OF FOOD, AND
SETTING OF LARVAE

INVESTIGATORS:

John L. Dupuy, Associate Marine Scientist
Franklin D. Ott, Assistant Marine Scientist
Samuel Rivkin, Research Assistant

PROJECT SUMMARY:

Objectives of this project are:

- (1) Development of methods to produce and handle oyster, clam, Bay scallop, and Calico larvae to post-setting juveniles for field use,
- (2) Development of methods to fatten, condition, and spawn parent stocks,
- (3) Development of two methods for obtaining cultch-free oyster spat (completed)
- (4) Bioassay of phytoplankton isolates for foods for invertebrate larvae,
- (5) Bioassay of "red water" organisms with invertebrate larvae (continuing), and
- (6) The application of these methods to hatchery operation (beginning).

STATUS: Continuing.

FINANCIAL SUPPORT:

National Oceanic and Atmospheric Administration
(Office of Sea Grant Programs)
Virginia Institute of Marine Science

PUBLICATIONS:

- (1) "Cultch Free Spat, Present and Future," Proceedings of the 1st Annual Workshop, World Mariculture Society.
- (2) The development of laboratory techniques for the production of cultch-free spat of the oyster, *Crassostrea virginica*, *Chesapeake Science* 13(1):45-52.
- (3) Larval Culture of the Calico Scallop, *Argopecten gibbus* Proc. Nat. Shellfish. Assn, 6B:72-76.
- (4) Translation of Mariculture Research Into A Commercial Oyster Seed Hatchery. Proceedings of the 9th Annual Conference of the Marine Technological Society. 677-685.

KEY WORDS:

Cultch-free spat, molluscs, oyster

PROJECT TITLE: A STUDY OF THE VIRGINIA OYSTER INDUSTRY

INVESTIGATORS:

Dexter S. Haven, Department Head and Senior Marine Scientist
Paul Kendall, Research Assistant

PROJECT SUMMARY:

An in-depth study is being prepared which covers all phases of the Virginia oyster industry from 1931 to 1971.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Virginia Oyster Industry

PROJECT TITLE: SURVEY OF PUBLIC OYSTER GROUNDS IN THE STATE
OF VIRGINIA AND MONITORING SPAT FALL

INVESTIGATORS:

Dexter S. Haven, Department Head and Senior Marine Scientist
Paul Kendall, Research Assistant

PROJECT SUMMARY:

This study monitors the public oyster rocks in Virginia to evaluate quantities of shell, oysters, and spat. Data are recorded in terms of spat, shells, or oysters per bushel. Data are also collected on predators such as *Urosalpinx cinerea* and mortalities based on box counts.

A second aspect of this program is the monitoring of oyster spatfall in the rivers and tributary creeks. Data are collected weekly at over 30 locations each year beginning in June and ending in October by placing strings of shells in representative locations. After being in the water a week, the shells are removed and taken to the laboratory where attached spat are counted. Survival of set is also monitored by placing bags of shells in representative locations in the spring and counting surviving set in the fall. Results of this study are published weekly and mailed to over 1500 persons.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Seed oysters, *urosalpinx cinerea*

PROJECT TITLE: A STUDY OF THE PUBLIC OYSTER ROCKS IN VIRGINIA, AND
SEASONAL CHANGES IN MEAT QUALITY

INVESTIGATORS:

Dexter Haven, Department Head and Senior Marine Scientist
Frank Walker, Laboratory Technician
Ken Walker, Laboratory Technician

PROJECT SUMMARY:

Surveys of the principal public oyster rocks are made at intervals during the year to determine the magnitude of the existing shells and any unusual situation due to hydrographic conditions. Quality of the meats of oysters is determined monthly at 14 locations. Results are reported in the Institute's Marine Resource Information Bulletin.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Oyster Surveys, meat quality

PROJECT TITLE: A STUDY OF SEASONAL SETTING OF THE AMERICAN
OYSTER IN VIRGINIA

INVESTIGATORS:

Dexter Haven, Department Head and Senior Marine Scientist
Frank Walker, Laboratory Technician
Ken Walker, Laboratory Technician

PROJECT SUMMARY:

Each year seasonal setting of the American Oyster, *Crassostrea virginica* is followed in the principal rivers of Virginia.

The study is based on number of oyster larvae attaching weekly to oyster shells suspended in the water at representative locations. Results are reported bi-weekly during the season in the Institute's Marine Resource Information Bulletin.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Oyster Setting in Virginia

PROJECT TITLE: A SURVEY IN THE ELIZABETH RIVER, VIRGINIA FOR
OYSTERS, CLAMS AND SHELLS IN THE VICINITY OF
THE PROPOSED TRANSCO - SITE

INVESTIGATORS:

Dexter S. Haven, Department Head and Senior Marine Scientist
Paul Kendall, Assistant Marine Scientist

PROJECT SUMMARY:

The distribution of oysters, clams and shells was determined in a 363 acre area at the site of a proposed channel in the Elizabeth River, Virginia.

STATUS: Completed in 1973.

FINANCIAL SUPPORT:

Woodward Envicon Inc.
Virginia Institute of Marine Science

KEY WORDS:

Molluscan populations, Elizabeth River

PROJECT TITLE: AN INVESTIGATION OF THE SEED OYSTER RESOURCES IN VIRGINIA AND TECHNICAL DEVELOPMENT OF GEAR TO HARVEST OYSTERS

INVESTIGATORS:

Dexter S. Haven, Department Head and Senior Marine Scientist
Joseph G. Loesch, Associate Marine Scientist
James P. Whitcomb, Assistant Marine Scientist

PROJECT SUMMARY:

Objectives of this project are:

- (1) To determine through sub-sampling with patent tongs the magnitude of Virginia's seed oyster resources in the James, Greater Wicomico and Piankatank rivers.
- (2) To modify and test an oyster harvester developed previously at the Virginia Institute of Marine Science.

STATUS: Active. This program started in July 1973.

FINANCIAL SUPPORT:

National Oceanic and Atmospheric Administration
(National Marine Fisheries Service)
Virginia Institute of Marine Science

KEY WORDS:

James River, seed oysters

PROJECT TITLE: STUDY OF THE ECOLOGY OF THE SOFT CLAM, MYA
ARENARIA

INVESTIGATORS:

Dexter S. Haven, Department Head and Senior Marine Scientist
Jon Lucy, Graduate Assistant

PROJECT SUMMARY:

The ecology of the soft clam, *Mya arenaria*, is being studied at two stations in the York River, Virginia. One aspect of this study is to investigate time of setting and the abundance of juveniles during the first year. Also, included in the program are an investigation of the gonadal cycle and a study of the relation between the substrate and depth of burial. Growth studies are also included.

STATUS: This project represents Lucy's dissertation research.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Ecology, *Mya arenaria*, salt clam

PROJECT TITLE: TECHNICAL STUDIES ON THE ENGINEERING AND BIOLOGICAL ASPECTS OF CONTROLLED PURIFICATION OF THE EASTERN OYSTER

INVESTIGATORS:

Dexter S. Haven, Department Head and Senior Marine Scientist
Reinaldo Morales-Alamo, Research Assistant

PROJECT SUMMARY:

This is a joint project involving the Department of Applied Science and the Bacteriology Section of the Department of Microbiology-Pathology. The purpose of this study is to determine if the eastern oyster may be depurated in this region and the factors involved. Oysters with high coliform and fecal coliform levels will be held in flowing water under varying conditions of turbidity, O_2 , temperature and salinity. Bacterial levels will be monitored. A pilot sized depuration plant will be constructed and operated. Techniques included in evaluating bacterial levels will be explained.

STATUS: Active.

FINANCIAL SUPPORT:

Department of Health Education and Welfare
Food and Drug Administration
Virginia Institute of Marine Science

KEY WORDS:

Depuration, oysters

PROJECT TITLE: THE BLUE CRAB OF CHESAPEAKE BAY

INVESTIGATOR:

W. A. Van Engel, Department Head and Senior Marine Scientist

PROJECT SUMMARY:

Information on the relative magnitude and value, historical and current situation, biology of the blue crab, commercial fishery catch and methods of fishing, fluctuations in abundance, estimates of population size, parent-progeny relationship, and management of the blue crab stocks of the Chesapeake Bay and of the bays of the ocean side of the Eastern Shore of Virginia and Maryland is being summarized.

STATUS: Active. A manuscript is in preparation.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Blue crabs, *Callinectes sapidus*, crabs, crustaceans

PROJECT TITLE: BLUE CRAB BIBLIOGRAPHY

INVESTIGATORS:

W. A. Van Engel, Department Head and Senior Marine Scientist
Paul A. Haefner, Jr., Associate Marine Scientist

PROJECT SUMMARY:

Revision of the bibliography on the blue crab, *Callinectes sapidus* and other species of the genus *Callinectes* has been temporarily set aside while other studies are being conducted. The revision will result in publication of a working KWIC index or an annotated bibliography, or both.

STATUS: Continuing.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Bibliography, blue crabs, *Callinectes sapidus*, *Callinectes sp.*,
crabs, crustaceans

PROJECT TITLE: STUDY OF THE VIRGINIA WINTER DREDGE FISHERY FOR
BLUE CRABS

INVESTIGATORS:

W. A. Van Engel, Department Head and Senior Marine Scientist
Mark E. Chittenden, Jr.*

PROJECT SUMMARY:

The objective of this project is to determine the effects of the Virginia winter dredge fishery on blue crab stocks of the Chesapeake Bay.

The winter dredge fishery of 1969-1970 was investigated and described to serve as a guide for development of a research program. A series of possible programs was drawn up to estimate costs and benefits of different studies.

A program was selected to provide information on population size, total catch, and fishing mortality of blue crab stocks vulnerable to the 1970-71 winter dredge fishery in Chesapeake Bay. Data were tabulated and transferred to IBM cards to permit computer analysis.

STATUS: Completed. A manuscript is now in preparation.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Blue crabs, *Callinectes sapidus*, crabs, crustaceans, dredge fishery, population dynamics

*Dr. Mark E. Chittenden, Jr., former VIMS Scientist, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, Texas 77843

PROJECT TITLE: A STUDY OF THE FEASIBILITY OF PRODUCING MARKETABLE
QUANTITIES OF SOFT ROCK CRABS, *CANCER IRRORATUS*,
IN VIRGINIA

INVESTIGATORS:

Paul A. Haefner, Jr., Associate Marine Scientist
W. A. Van Engel, Jr., Department Head and Senior Marine Scientist

PROJECT SUMMARY:

The potential production of soft rock crabs during winter is being studied. The long-term objective is to define the levels of water quality, the physical plant required for most successful production, and the quality and quantity of rock crabs that can be used.

STATUS: Active. A manuscript describing various aspects of the biology of the molting cycle is in preparation. This is a subproject of the Improvement of Fisheries for Crustaceans program of the Sea Grant Program.

FINANCIAL SUPPORT:

National Oceanic and Atmospheric Administration
(Office of Sea Grant Programs)
Virginia Institute of Marine Science

KEY WORDS:

Cancer irroratus, crabs, crustaceans, rock crab, soft crab

PROJECT TITLE: DEVELOPMENT OF TECHNIQUES FOR PREDICTION OF BLUE
CRAB STOCKS

INVESTIGATORS:

W. A. Van Engel, Department Head and Senior Marine Scientist
Mark E. Chittenden, Jr. *

PROJECT SUMMARY:

The objective of this program is to use estimates of relative abundance obtained from trawl surveys to make predictions of blue crab stocks.

VIMS' current and historical trawl survey data have been analyzed to describe the effects of stations (salinity), seasons, temperature, dissolved oxygen, and tidal conditions on the catch and distribution of blue crabs.

STATUS: Continuing. A report based on historical data and describing the distribution of blue crabs in the York, James, and Rappahannock rivers was prepared by Dr. Mark E. Chittenden, Jr. and included in the Sea Grant Progress Report submitted by the Crustaceology Department in 1971.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Blue crabs, *Callinectes sapidus*, crabs, crustaceans, prediction

*Dr. Mark E. Chittenden, Jr., former VIMS Scientist, Department of
Wildlife and Fisheries Sciences, Texas A&M University,
College Station, Texas 77843

PROJECT TITLE: DEVELOPMENT OF ESTIMATES OF RELATIVE ABUNDANCE OF
JUVENILE AND ADULT CRABS

INVESTIGATORS:

W. A. Van Engel, Department Head and Senior Marine Scientist

PROJECT SUMMARY:

Monthly trawl surveys are made using R/V *Pathfinder* or R/V *Langley* at stations on the York (4 stations), James (4 stations), and Rappahannock (5 stations) rivers, to obtain estimates of relative abundance of juvenile and adult blue crabs. Information is obtained that may be used to make estimates of: seasonal distribution, longitudinal distribution, sex composition, growth and mortality, and movements of blue crabs. General hydrographic data are obtained at each station.

Weekly pushnet surveys are made during April-November at stations located off VIMS' beach to obtain estimates of relative abundance of juvenile blue crabs. General hydrographic data are obtained each sampling day.

Data are tabulated and transferred to IBM cards which will allow computer processing.

STATUS: Continuing.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Blue crabs, *Callinectes sapidus*, crabs, crustaceans, James River, prediction, Rappahannock River, York River

PROJECT TITLE: EXPLORATION OF METHODS FOR IMPROVING THE PRODUCTION OF SOFT CRABS, *CALLINECTES SAPIDUS*

INVESTIGATORS:

Paul A. Haefner, Jr., Associate Marine Scientist
W. A. Van Engel, Department Head and Senior Marine Scientist

PROJECT SUMMARY:

The objective of this study is to define the criteria for the efficient production of soft crabs. The study is involved with the following:

- (1) Demonstrating to industry the feasibility of shedding crabs in tanks laid out on piers or over land, with running or recirculated salt water.
- (2) Developing plans for physical plants.
- (3) Developing guidelines for acceptable levels of water quality: temperature, salinity, speed of water flow, dissolved oxygen, dissolved nitrogenous substances, pH, for example.
- (4) Developing guidelines for quality and quantity of crabs that can be held.
- (5) Developing a program for studying mortalities among crabs, to explain their causes and, ultimately, to control them.

STATUS: Active. This is a subproject of the Improvement of Fisheries for Crustaceans program of the Sea Grant program.

FINANCIAL SUPPORT:

National Oceanic and Atmospheric Administration
(Office of Sea Grant Programs)
Virginia Institute of Marine Science

KEY WORDS:

Blue crabs, *Callinectes sapidus*, crabs, crustaceans, soft crabs

PROJECT TITLE: DISTRIBUTION, ABUNDANCE AND BIOLOGY OF THE ROCK
CRAB, *CANCER IRRORATUS* IN CHESAPEAKE BAY AND
COASTAL WATERS OF VIRGINIA

INVESTIGATORS:

W. A. Van Engel, Department Head and Senior Marine Scientist
Paul A. Haefner, Jr., Associate Marine Scientist

PROJECT SUMMARY:

A composite of information on the rock crab, obtained from studies in the Chesapeake Bay and continental shelf waters, has begun. Manuscripts are planned on 1) Distribution, abundance, and biology, and 2) morphometric studies.

STATUS: Active.

FINANCIAL SUPPORT:

National Oceanic and Atmospheric Administration
(Office of Sea Grant Programs)
Virginia Institute of Marine Science

KEY WORDS:

Cancer irroratus, Chesapeake Bay, continental shelf, crabs,
crustaceans

PROJECT TITLE: BIOLOGY OF DECAPOD CRUSTACEA OF NORFOLK CANYON WITH PARTICULAR EMPHASIS ON THOSE OF COMMERCIAL IMPORTANCE

INVESTIGATORS:

P. A. Haefner, Jr., Associate Marine Scientist
W. A. Van Engel, Department Head and Senior Marine Scientist

PROJECT SUMMARY:

The objectives of this research are (1) to determine composition and spatial distribution of decapods in the Norfolk Canyon and to compare them with communities from a nearby "open slope" area and from the contiguous continental shelf adjacent to Chesapeake Bay; (2) to investigate biological aspects such as reproduction and intermolt cycle, of selected dominant species in order to recognize seasonal patterns; (3) to obtain as much biological data as possible from less dominant and rare species; (4) to relate these data to the measured environmental parameters.

The dominant decapods include four species of known commercial importance: American lobster, *Homarus americanus*; red crab, *Geryon quinquedens*; jonah crab, *Cancer borealis* and rock crab, *C. irroratus*. A fifth species *Bathynectes superbus* is a portunid crab of doubtful commercial value.

STATUS: This project was initiated June, 1973 and has the potential of future sampling in association with the project on the ecology of fish communities on Norfolk Canyon, J.A. Musick, Principal Investigator.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science
National Oceanic and Atmospheric Administration (Office
of Sea Grant Programs)
National Science Foundation (J. S. Musick, Principal
Investigator)

KEY WORDS:

American lobster, *Bathynectes superbus*, *Cancer borealis*,
Cancer irroratus, continental shelf, crabs,
crustaceans, *Geryon quinquedens*, *Homarus americanus*,
jonah crab, Norfolk Canyon, portunid crabs, red crabs,
rock crab

PROJECT TITLE: FACTORS INFLUENCING BIOCONCENTRATION PHENOMENA
IN THE AMERICAN OYSTER

INVESTIGATORS:

John D. Lunz, Research Assistant
Robert J. Huggett, Department Head and Associate Marine
Scientist

PROJECT SUMMARY:

Combined laboratory and field observations propose a correlation between certain environmental factors and the tendency toward bioconcentration of trace substances from the hydrosphere. The importance of soluble and particulate pathways, as well as the significance of variable salinity, temperature, and pH are being investigated. Of particular interest are factors regulating concentration of trace metals and the role of naturally occurring chelating and ion exchange substances in the marine environment.

STATUS: In progress.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Bioconcentration, oysters

PROJECT TITLE: ANALYSIS OF SPORT CATCHES OF STRIPED BASS IN THE
LOWER YORK RIVER, 1967-1972

INVESTIGATORS:

C. E. Richards, Assistant Marine Scientist
G. C. Grant, Associate Marine Scientist
J. V. Merriner, Associate Marine Scientist

PROJECT SUMMARY:

Sex, length, weight and gonad condition data were collected and age analyses done for 3,330 striped bass collected over term of study. These data are now being examined and readied for publication. These data are a portion of VIMS study of the Striped Bass as funded by P. L. 89-304.

STATUS: Active.

FINANCIAL SUPPORT:

Bureau of Sport Fisheries and Wildlife
Virginia Institute of Marine Science

KEY WORDS:

Striped bass

PROJECT TITLE: STRATIFIED RANDOM SAMPLING OF ESTUARIES AS A
MODEL APPROACH TO ASSESSMENT OF FISH STOCKS
AND PRODUCTION

INVESTIGATOR:

John V. Merriner, Associate Marine Scientist

PROJECT SUMMARY:

A program was initiated in July 1972 on the York River to evaluate the applicability of stratified random sampling in estuarine waters. The York estuary is divided into North, South and Channel strata and partitioned into 600 m grids. Randomly selected grids in each stratum are sampled monthly with a 16' semiballoon trawl. Seasonal and spatial distribution of fishes, diversity, and abundance data are being recorded. These data will provide the basis for an ecological description of the York estuary relative to ichthyofauna and further the knowledge of ecological segregation by co-occurring species within Chesapeake Bay tributaries.

The technique, if shown to be reliable, will be applied to other Virginia estuaries. These surveys will thus provide a monitoring system for estuarine stocks in Virginia waters as well as furnish critical ecological and habitat utilization data which at present is lacking for all but a few select estuaries on the Eastern Seaboard.

STATUS: Active.

FINANCIAL SUPPORT:

Bureau of Sport Fisheries and Wildlife
Virginia Institute of Marine Science

KEY WORDS:

Estuaries, fishes, food chains, inventory, management,
marine ecology, nursery grounds, research needs

PROJECT TITLE: INDEX OF YEAR CLASS STRENGTH FROM A SUMMER BEACH
SEINE SURVEY OF VIRGINIA RIVERS

INVESTIGATOR:

John V. Merriner, Associate Marine Scientist

PROJECT SUMMARY:

Selected seine stations in the James, York and Rappahannock Rivers are sampled once each two weeks from July through October. Fish lists and a ranking of abundance for each station and each river are compiled from this summer's collections. A relative abundance index (average number of fish per tow) is generated which allows prediction of future sport and commercial fishing success in these rivers.

STATUS: Continuing.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Estuaries, fishes, nursery grounds, prediction

PROJECT TITLE: PROPOSED ARTIFICIAL REEF PROGRAM IN VIRGINIA

INVESTIGATOR:

John V. Merriner, Associate Marine Scientist

PROJECT SUMMARY:

Passage of P. L. 92-402 has resulted in the formulation of a proposed state program. Activities are being coordinated through the Virginia Marine Resources Commission. Provision is being made to coordinate and integrate existing reef associations within Virginia through the program. Reef structures and sites are being selected and proposed to provide benefit to offshore, nearshore, and Bay fisheries.

STATUS: Continuing, research program pending.

FINANCIAL SUPPORT:

Virginia Marine Resources Commission
Virginia Institute of Marine Science

KEY WORDS:

Estuaries, fisheries, fishes, marine ecology

PROJECT TITLE: ASSESSMENT OF ESTUARINE FISH POPULATIONS

INVESTIGATOR:

Walter J. Hoagman, Associate Marine Scientist

PROJECT SUMMARY:

- (1) To conduct a semi-annual intensive survey of the Chesapeake Bay and lower rivers to determine the abundance and year class success of the migratory marine component.
- (2) To determine aspects such as mean weights, length, dominance, biomass and areas of greatest productivity through random stratified sampling in mid-June and early fall.
- (3) To issue fishing projections to the commercial and recreational fishery and serve the Commonwealth through identification of key areas of productivity.

STATUS: Continuing, began June 1973.

FINANCIAL SUPPORT:

National Marine Fisheries Service
Virginia Institute of Marine Science

KEY WORDS:

Estuaries, fishes, population dynamics

PROJECT TITLE: ANALOG COMPUTATION AND FISH POPULATION STUDIES

INVESTIGATOR:

C. E. Richards, Assistant Marine Scientist

PROJECT SUMMARY:

This project is involved with simulation of population dynamics and theoretical modeling of multi-species systems as exist in the Northwest Atlantic.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Population dynamics

PROJECT TITLE: ECOLOGY OF DEMERSAL FISHES OF NORFOLK CANYON AND
ADJACENT CONTINENTAL SLOPE

INVESTIGATOR:

J. A. Musick, Associate Marine Scientist

PROJECT SUMMARY:

Seasonal otter trawl survey based on stratified random sampling. Hydrography: all fishes identified, measured, weighed. Computer diversity, species associations, etc.

STATUS: Active. Field work one fourth complete.

FINANCIAL SUPPORT:

National Science Foundation
Virginia Institute of Marine Science

KEY WORDS:

Fishes, Norfolk Canyon

PROJECT TITLE: FOOD AND FEEDING OF DEMERSAL FISHES OF NORFOLK CANYON
AND THE ADJACENT CONTINENTAL SLOPE

INVESTIGATORS:

J. A. Musick, Associate Marine Scientist
George Sedberry, Graduate Assistant

PROJECT SUMMARY:

Food habits as related to morphology and ecology of dominant species of archibenthic fishes.

STATUS: Active. This project represents Sedberry's thesis research.

FINANCIAL SUPPORT:

National Science Foundation
Virginia Institute of Marine Science

KEY WORDS:

Feeding habits, fishes, Norfolk Canyon

PROJECT TITLE: REPRODUCTIVE BIOLOGY OF DEMERSAL FISHES OF NORFOLK
CANYON AND ADJACENT CONTINENTAL SLOPE

INVESTIGATORS:

J. A. Musick, Associate Marine Scientist
Joel Janosky, Graduate Assistant

PROJECT SUMMARY:

Histological study of modes of reproduction in dominant species from fish communities on continental slope.

STATUS: Active. This project represents Janosky's thesis research.

FINANCIAL SUPPORT:

National Science Foundation
Virginia Institute of Marine Science

KEY WORDS:

Fishes, Norfolk Canyon

PROJECT TITLE: STUDY OF THE REPRODUCTIVE BIOLOGY, BEHAVIOR AND
POPULATION DYNAMICS OF BLACK SEA BASS (*CENTROPRISTIS
STRIATA*)

INVESTIGATORS:

John A. Musick, Associate Marine Scientist
Linda P. Mercer, Graduate Student

PROJECT SUMMARY:

The northern black sea bass is a protogynous hermaphrodite. Females predominate in the smaller size and younger age groups, whereas larger and older fish are usually males. It was postulated that females change into males as they grow larger. This is substantiated by the presence of regressing ovarian tissue in mature testes and developing testicular elements within the ovaries of functional females. Size and age at first maturity are highly variable for both sexes as apparently are size and age at sex reversal for hermaphrodites. Not all individuals are hermaphroditic, some maturing first as male and remaining male, others being female throughout their life. Recent studies have shown that sex reversal in fishes (including serranids) may be controlled by social interactions within the population. Black sea bass have apparently been overharvested in the Middle Atlantic Bight. Landings have dropped sharply in recent years and fewer large and medium size fish are caught. In comparison South Carolina landings have increased due to the increase in fishing effort. Before it is possible to establish sustained yield fisheries for black sea bass it is necessary to know what percent of the population is hermaphroditic or potentially so, what mechanisms control sex reversal and what level of sexual unbalance can be sustained before the reproductive potential of the population becomes limited.

STATUS: Active. This project represents Mercer's dissertation research. Data are presently being collected.

FINANCIAL SUPPORT:

Sport Fishery Research Foundation (pending)
Virginia Institute of Marine Science

KEY WORDS:

Centropristis striata, fishes, population dynamics, sea bass

PROJECT TITLE: FECUNDITY RELATIONSHIPS OF RIVER HERRINGS, PUFFER,
AND WHITE PERCH IN VIRGINIA RIVERS

INVESTIGATOR:

John V. Merriner, Associate Marine Scientist

PROJECT SUMMARY:

Ovaries are being processed to obtain fecundity estimates for alewife, blueback, northern puffer, and white perch from Virginia rivers. Data will be related to age, weight and length of fish. Results will be related to an overall ecological study of life history of estuarine fishes. Other estuarine species will be analyzed upon completion of the present study.

STATUS: Continuing.

FINANCIAL SUPPORT:

National Marine Fisheries Service
Virginia Institute of Marine Science

KEY WORDS:

Alewife, *Alosa spp.*, Alosids, eggs, estuaries, fishes, life cycles, *Morone americana*, puffer, river herring, *Sphaeroides maculatus*, white perch

PROJECT TITLE: BIOLOGY AND MANAGEMENT OF RIVER HERRING AND SHAD

INVESTIGATORS:

Walter J. Hoagman, Associate Marine Scientist
J. V. Merriner, Associate Marine Scientist
R. A. St. Pierre, Assistant Marine Scientist

PROJECT SUMMARY:

Objectives of this project are:

- (1) To measure fishing effort and estimate catch per unit of effort for river herring and shad in lower Chesapeake Bay and its tributaries,
- (2) To sample the adult populations of alewife, blueback and American shad to determine the general population parameters necessary for calculation of mortality rates, age, specific sizes, fecundity, time of spawning and ratios of abundance,
- (3) To determine an annual index of the number of juveniles in the nursery of each river system, and to evaluate the index as a predictor of fishing success in future years,
- (4) To determine food selectivity and feeding periodicity of juvenile alewife in the James River and derive season energy budgets by integration of ingestion, egestion, respiration and growth rates,
- (5) To develop culture methods for *Alosa* spp from egg through juvenile stage and conduct, tolerance preference, and pollutional experiments on the young at various life stages,
- (6) Determine rates of exploitation by foreign and local fisheries with an extensive mark and recapture program directed at post spawning fish,
- (7) To determine the non-migratory, competitive fish populations of the *Alosa* nursery grounds by mid-winter surveys in all the rivers.

STATUS: Continuing.

FINANCIAL SUPPORT:

National Oceanic and Atmospheric Administration
(National Marine Fisheries Service)
Virginia Institute of Marine Science

KEY WORDS:

Alosa, estuaries, fishes, population dynamics, river herring,
shad

PROJECT TITLE: COBIA TAGGING STUDY

INVESTIGATOR:

C. E. Richards, Assistant Marine Scientist

PROJECT SUMMARY:

Twenty cobia were tagged, with five returns after 24-1121 days out. All returns were from Chesapeake Bay and within 36 nautical miles of release and all by sport gear.

STATUS: Continuing.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Cobia, tagging study

PROJECT TITLE: RED DRUM (*SCIAENOPS OCCELLATA*) AGE, GROWTH AND DISTRIBUTION

INVESTIGATOR:

C. E. Richards, Assistant Marine Scientist

PROJECT SUMMARY:

Data tabulation and analysis are under way for age-growth study for *Sciaenops ocellata*. Tagging of adult channel bass to estimate mortality, distribution, and to corroborate age-growth estimates is being done.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Red drum, *Sciaenops ocellata*

PROJECT TITLE: AN ANALYSIS OF THE WHITE MULLET (*MUGIL CUREMA*)
IN VIRGINIA

INVESTIGATORS:

C. E. Richards, Assistant Marine Scientist
Michael Castagna, Associate Marine Scientist

PROJECT SUMMARY:

This project is a study of growth, predation, and distribution of the white mullet, *Mugil curema*, in Virginia including Chesapeake Bay and Seaside Eastern Shore.

STATUS: Pending.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Mugil curema, white mullet

PROJECT TITLE: FOOD, FEEDING HABITS, GROWTH RATES, AND ENERGY TRANSFORMATIONS IN JUVENILE ALEWIFE (*ALOSA PSEUDOHARENGUS*) IN THE JAMES RIVER AT HOPEWELL, VIRGINIA

INVESTIGATORS:

W. Jackson Davis, Head, Division of Fisheries Science and Services and Acting Head, Department of Ichthyology
James E. Weaver, Graduate Student

PROJECT SUMMARY:

The objectives of this project are to determine:

- (1) Food and feeding habits of juvenile alewife,
- (2) Growth of juvenile alewife, and
- (3) A seasonal energy budget for juvenile alewife by assessing ingestion, egestion, and respiration rates.

Surface and midwater trawls for juvenile alewife in the James River at Hopewell, Virginia were made every 3 hours during a consecutive 24-hour period in the months of July, August, and September, 1972. Some specimens from each 3-hour period were frozen on dry ice and returned to the laboratory to determine: (1) lengths and wet weights of fish, dry and ash weights of a sample of fish, and caloric content of samples of whole fish for estimation of growth, (2) wet and dry weights of stomach contents to ascertain feeding periodicity, and (3) caloric content of samples of stomach contents to estimate daily ration (with appropriate corrections for feeding and stomach evacuation rates between 3-hour periods). Some specimens from each 3-hour period were preserved in 10% formalin to determine food and prey selectivity in correlation with replicate plankton samples taken each 3-hour period. Living alewife were collected in the summer and fall, 1972 by beach seine for laboratory determinations of respiration, stomach evacuation, and egestion rates at 15, 20, 25, and 28 C.

STATUS: Active. This project represents Weaver's dissertation research.

FINANCIAL SUPPORT:

National Science Foundation (Traineeship)
National Oceanic and Atmospheric Administration
(National Marine Fisheries Service)
Virginia Institute of Marine Science

KEY WORDS:

Alosa pseudoharengus

PROJECT TITLE: PRODUCTION OF SUPERIOR OYSTERS FOR MARICULTURE-
A GENETIC BREEDING PROGRAM

INVESTIGATORS:

Jay D. Andrews, Department Head and Senior Marine Scientist
John L. Dupuy, Associate Marine Scientist, Section of Algal-
Larval Culture
Michael Frierman, Research Assistant

PROJECT SUMMARY:

The objective of this program is to breed, test, and select genetic lines of superior broodstocks of oysters for mariculture in Chesapeake Bay. Several laboratory-bred lines of selected oysters going back to 1964 are available for breeding.

Oysters are selected for rapid growth, superior breeding characteristics, quality of meats and shells, and disease resistance. Progeny testing of pair and group breedings under field conditions is followed by inbreeding and outbreeding to attain broodstocks for hatchery use. Unselected native stocks, both wild and hatchery reared are used as background lots for evaluation of results. Diseases are monitored routinely in test and native stocks.

Hatcheries are being vigorously encouraged to supplement natural seed supplies in Chesapeake Bay following a bay-wide failure of spatfall in 1972. Mariculture requires that brood stock used in hatcheries exhibit disease-resistance, uniformity of shape and quality and rapid growth for early marketing (18 to 24 months). Genetic manipulation of seed stocks and use of cultchless spat in hatcheries and nurseries before planting on natural beds is a major objective.

STATUS: Active. This program has been active for about ten years. Large genetic variations have been observed, and manipulation of inbred lines to produce hybrid vigor and desired traits is promising.

FINANCIAL SUPPORT:

National Oceanic and Atmospheric Administration
(National Marine Fisheries Service)
National Science Foundation
(RANN Program) (June 1971-May 1972)
National Oceanic and Atmospheric Administration
(Office of Sea Grant Programs) (March 1973 to Feb. 1974)
Virginia Institute of Marine Science

KEY WORDS:

Broodstocks, *Crassostrea virginica*, Genetics, Hatcheries,
Mariculture, Oysters

PROJECT TITLE: OYSTER SETTING PATTERNS IN VIRGINIA

INVESTIGATOR:

Jay D. Andrews, Department Head and Senior Marine Scientist

PROJECT SUMMARY:

Setting records on weekly, seasonal, and annual basis were kept for a twenty-two year period. The data was tabulated as collected, but explanations and summaries were not written except for the first few years. The data contains information on setting patterns, fouling, changes in populations and predation. It is related mostly to public oyster beds.

STATUS: The data are organized by rivers; most tables have been completed. Write-up of this data is partially complete.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Crassostrea virginica, oysters setting

PROJECT TITLE: MSX AND SALINITY IN JAMES RIVER SEED AREAS

INVESTIGATOR:

Jay D. Andrews, Department Head and Senior Marine Scientist

PROJECT SUMMARY:

This work was completed and the manuscript written in 1965. It describes the distribution of MSX in 1964 and 1965, a year of maximum penetration of the seed area, and the effects of spring salinities in permitting oysters to reject MSX infections.

STATUS: The manuscript awaits publication in the monograph on the James River.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

diseases, James River, oysters, salinity

PROJECT TITLE: TECHNICAL STUDIES ON THE ENGINEERING AND BIOLOGICAL ASPECTS OF CONTROLLED PURIFICATION OF THE EASTERN OYSTER (Bacteriology Portion)

INVESTIGATORS:

John L. Wood, Associate Director
Aleta J. Ott, Assistant Marine Scientist

PROJECT SUMMARY:

To establish an effective statistically valid bacteriological monitoring program to:

- (1) Determine maximum permissible levels for indicator organisms at the time of harvest.
- (2) Compare standard bacteriological procedures with at least one rapid test procedure.
- (3) Develop guidelines for sampling methods, frequency of sampling, end product bacteriological standards, and develop bacterial reduction curves.

STATUS: Active

FINANCIAL SUPPORT:

U. S. Department of Health Education
and Welfare (Food and
Drug Administration)
Virginia Institute of Marine Science

KEY WORDS:

Bacteriology, oysters, shellfish, water quality

PROJECT TITLE: BACTERIOLOGY OF SHELLFISH GROWING AREAS

INVESTIGATORS:

John L. Wood, Associate Director
Aleta Ott, Assistant Marine Scientist

PROJECT SUMMARY:

Objectives of this project are:

- (1) To determine sources of and reasons for high coliform counts in certain Virginia shellfish growing areas,
- (2) To determine sources, movement, effects, and fate of selected groups of bacteria in shellfish growing areas, and
- (3) To compare bacteriological methods available for routine monitoring of water quality in shellfish growing areas.

STATUS: Active

FINANCIAL SUPPORT:

National Oceanic and Atmospheric Administration
(Office of Sea Grant Programs) (1972 only)
Virginia Institute of Marine Science

KEY WORDS:

Bacteriology, oysters, water quality

PROJECT TITLE: IMPROVED MANAGEMENT AND UTILIZATION OF ESTUARINE RESOURCES

INVESTIGATORS:

William J. Hargis, Jr., Institute Director
John L. Wood, Associate Director and Sea Grant Coordinator

PROJECT SUMMARY:

This project represents the Sea Grant Program at VIMS supported in calendar year 1972. Subprojects include:

- (1) Sea Grant Program administration, planning and coordination.
 - (a) Administer Sea Grant Program and plan for future.
 - (b) Coordinate and integrate the Sea Grant Program with other programs at VIMS,
- (2) Research on biological resources.
 - (a) Improvement on fisheries for crustaceans.
 - (b) Improvement of fisheries for molluscs.
 - (c) Management of larvae, supply of food.
- (3) Research on environmental resources.
 - (a) Study of ocean wave refraction for Virginia's coastline.
 - (b) The mineral resources of the Continental Shelf off Chesapeake Bay. (Sea Grant support 1972 only).
- (4) Advisory Services.
 - (a) Extension Agent services.
 - (b) Publications and public information.

STATUS: Active. See the subprojects listed under various departments

FINANCIAL SUPPORT:

National Oceanic and Atmospheric Administration
(Office of Sea Grant Program)
Virginia Institute of Marine Science

KEY WORDS:

See individual projects.
Advisory services, management, planning, resource use

PROJECT TITLE: PREPARATION OF AN INFORMATION BASE IN AQUACULTURE

INVESTIGATORS:

James A. Lanier, M. A., Information Officer
John L. Dupuy, Ph.D., Associate Marine Scientist
Michael Castagna, M.S., Senior Marine Scientist

PROJECT SUMMARY:

Articles pertinent to aquaculture of fresh water, brackish or marine organisms are indicated for inclusion in the Aquaculture information system under development by the Environmental Data Service.

STATUS: Active.

FINANCIAL SUPPORT:

Funding National Oceanic and Atmospheric Administration
(Sea Grant)
Virginia Institute of Marine Science

KEY WORDS:

Aquaculture

PROJECT TITLE: STUDIES ON MARICULTURE OF HARD CLAM, *MERCENARIA MERCENARIA*

INVESTIGATORS:

Michael Castagna, Senior Marine Scientist
William P. Duggan, Assistant Marine Scientist

PROJECT SUMMARY:

The objective of this project is to develop methods that are practical to the seafood industry to farm hard clams from brood stock to marketable product.

Phases include:

- (1) Develop culture methods to spawn and grow clams from eggs to juveniles,
- (2) Develop methods of growing post set juveniles to a size large enough for field plantings, and
- (3) Develop protection methods to grow clams in the field to market size without serious predation losses.

STATUS: Active. Protection methods are presently being tested.

FINANCIAL SUPPORT:

National Oceanic and Atmospheric Administration (Office of Sea Grant Programs)
Virginia Institute of Marine Science

PUBLICATIONS:

- (1) Michael Castagna. Field experiments testing the use of aggregate covers to protect juvenile clams. Proceedings of the National Shellfisheries Association, Vol. 60, June 1970.
- (2) Hard clam culture method developed at VIMS. Marine Resources Advisory Series, No. 4, June 1970.

KEY WORDS:

Mariculture, *Mercenaria mercenaria*

PROJECT TITLE: STUDIES ON MARICULTURE OF BAY SCALLOP, *ARGOPECTEN IRRADIANS*

INVESTIGATORS:

William P. Duggan, Assistant Marine Scientist
Michael Castagna, Senior Marine Scientist

PROJECT SUMMARY:

The purpose of this project is to develop methods that are practical to the seafood industry to farm bay scallops from brood stock to marketable product.

Phases include:

- (1) Develop inexpensive culture methods for handling eggs and growing larvae,
- (2) Develop practical methods of growing post set juveniles to size adequate for field planting, and
- (3) Develop protection and containment methods adequate and practical for growing scallops to market size.

STATUS: Active. A cooperative experiment with industry was concluded. A cost-profit estimate was completed. A large scale planting within Bradford's Bay on seaside of Eastern Shore is being carried out to evaluate the harvestability of an unenclosed population of a known size and to assess movement of some tagged individuals. Several depth and density experiments were completed to find optimum holding conditions.

FINANCIAL SUPPORT:

National Oceanic and Atmospheric Administration (Office of Sea Grant Programs)
Virginia Institute of Marine Science

PUBLICATIONS:

- (1) Michael Castagna and William P. Duggan. Rearing the bay scallop, *Aequipecten irradians*. Proceedings of the National Shellfisheries Association, Vol. 61, pp. 80-85, June 1971.
- (2) Michael Castagna and William P. Duggan. Mariculture experiments with the bay scallop, *Argopecten irradians*, in waters of the seaside of Virginia. Bulletin of the American Malacological Union, Inc., February 1972.
- (3) Spawning and rearing the bay scallop. Marine Resources Advisory Series No. 5, August 1971.
- (4) William P. Duggan. Growth and survival of the bay scallop, *Argopecten irradians*, at various locations in the water column and at various densities. Proceedings of the National Shellfisheries Association, Vol. 63, pp. 68-71, June 1973.

KEY WORDS:

Argopecten, mariculture

PROGRAM 3:
Biology of Coastal Waters
And Wetlands

PROJECT TITLE: SPECTRAL ANALYSIS OF PHYTOPLANKTON SPECIES OF
CHESAPEAKE BAY

INVESTIGATORS:

John L. Dupuy, Associate Marine Scientist
Franklin Ott, Associate Marine Scientist

PROJECT SUMMARY:

The absorption spectra of thirty species of phytoplankton, primarily dinoflagellates, have been completed. The results indicate that this method may be able to fingerprint different species to enable the identification of species from unknown samples.

STATUS: Continuing. A publication is now in preparation.

FINANCIAL SUPPORT:

National Oceanic and Atmospheric Administration
(Office of Sea Grant Programs)
National Aeronautics and Space Administration
(equipment use)
Virginia Institute of Marine Science

KEY WORDS:

Phytoplankton, spectral analysis

PROJECT TITLE: IDENTIFICATION OF PHYTOPLANKTON SPECIES BY THE
USE OF A TURNABLE LASER WITH A RADAR SCANNER

INVESTIGATORS:

John L. Dupuy, Associate Marine Scientist
Franklin Ott, Assistant Marine Scientist
Peter Mumola*

PROJECT SUMMARY:

The objective of this project is the development of a methodology to utilize (1) a turnable laser for excitation of fluorescence and (2) scanning by radar to identify phytoplankton.

STATUS: This project began 1 July 1972.

FINANCIAL SUPPORT:

National Aeronautics and Space Administration
(Langley Research Center)
Virginia Institute of Marine Science

KEY WORDS:

Laser, phytoplankton, radar

* Peter Mumola, Langley Research Center, NASA, Hampton, Virginia

PROJECT TITLE: SEASONAL AND ECOLOGICAL SUCCESSION OF BENTHIC
MACROINVERTEBRATES IN NATURAL SUBSTRATES

INVESTIGATORS:

Joseph G. Loesch, Associate Marine Scientist
Peter F. Larsen, Graduate Assistant

PROJECT SUMMARY:

The purpose of this study is:

- (1) To establish existence and manner of succession in the benthic marine environment, and
- (2) To determine the means of recolonization of a "new" substrate, i.e., by setting of larvae or by immigration from adjoining areas.

The methods to be used include the following:

- (1) A series of cores containing natural substrate that has been voided of living organisms will be placed on several environments.
- (2) The cores will be pulled up at periodic intervals and analyzed. The fauna associated with each core will be compared with the other cores and with the community which is known to exist in each area.
- (3) Subtopics related to the above include the determination of:
 - a. The depth of the various components of the benthic community.
 - b. Periodicity and density of setting of benthic fauna.
 - c. Survival rates of larvae in several sediment types.

STATUS: This project represents Larsen's dissertation research.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Ecological succession, macroinvertebrate

PROJECT TITLE: EFFECTS OF LOW OXYGEN ON PUMPING AND FILTRATION
RATES OF OYSTERS

INVESTIGATORS:

Dexter S. Haven, Department Head and Senior Marine Scientist
Robert Quensen, Graduate Student

PROJECT SUMMARY:

The purpose of this study is to establish the relation between filtering efficiency and pumping rates of the oyster under varying O_2 concentrations and several levels of hydrogen sulfide. The methods used will be:

1. Hold oysters in flowing sea water where O_2 levels are regulated by bubbling nitrogen gas through sea water. H_2S levels will be regulated by adding H_2S from a cylinder.
2. Measure pumping rates by the Carmess Cone technique.
3. Measure particle filtration techniques by holding oysters in flowing systems and measuring particle levels before and after water passes over the oyster with a Coulter Electronic Particle Counter.

STATUS: Active. This project represents Quensen's thesis research.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Low oxygen, oyster filtration

PROJECT TITLE: BIOLOGY OF CRANGON SEPTEMSPINOSA

INVESTIGATORS:

Paul A. Haefner, Jr., Associate Marine Scientist
W. A. Van Engel, Department Head and Senior Marine Scientist

PROJECT SUMMARY:

Information on various aspects of the biology of the sand shrimp is presently available for populations in the waters of Newfoundland, Maine, and Delaware. Investigation of Chesapeake Bay stocks has been initiated to detect latitudinal differences in temperature and salinity tolerance, osmotic regulation, reproductive biology, age and growth, and relationships that exist with other carideans (*Palaemonetes* spp., *Hippolyte* spp., e.g.).

Field sampling of both shallow and deeper waters of the southern part of Chesapeake Bay and the York River is being undertaken to locate and determine size of available stocks. Various aspects of the biology of this shrimp will be studied as the situation dictates.

STATUS: Continuing.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Carideans, *Crangon septemspinosa*, crustaceans, osmotic regulation, salinity, shrimp, temperature, tolerance limits

PROJECT TITLE: POPULATION DYNAMICS OF CARIDEAN SHRIMP IN THE LOWER YORK RIVER ESTUARY

INVESTIGATORS:

P. A. Haefner, Jr., Associate Marine Scientist
Michael A. Cavell, Graduate Student

PROJECT SUMMARY:

The objectives of this research are to determine the interaction of caridean shrimp (*Palaemonetes pugio*, *P. intermedius*, *P. vulgaris* and *Crangon septemspinosa*) commonly occurring in the lower York River estuary. Data on population density, length frequency distributions, sex ratios, and reproduction will be obtained monthly for channel, shoal and beach strata over a one-year period of time. Such information will provide some means of evaluating population movements of the species in reference to environmental temperature and salinity. Data collection began in April 1972 and is continuing.

STATUS: This project is Cavell's thesis research. It was initiated in February 1973 and is continuing.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science
Virginia Electric and Power Company

KEY WORDS:

Carideans, *Crangon septemspinosa*, crustaceans,
Palaemonetes sp., shrimp, York River

PROJECT TITLE: EFFECT OF TEMPERATURE AND SALINITY ON MORTALITY,
AND OXYGEN CONSUMPTION OF CHESAPEAKE BAY POPULA-
TIONS OF SAND SHRIMP, *CRANGON SEPTEMSPINOSA*

INVESTIGATORS:

P. A. Haefner, Jr., Associate Marine Scientist
Elizabeth G. Lewis, Graduate Student

PROJECT SUMMARY:

This study is designed to determine the influence of temperature and salinity on the mortality and oxygen consumption of the sand shrimp. Data from this study will be compared with the results of similar research on shrimp from the Gulf of Maine and should indicate if any latitudinal differences exist.

This research will complement the results of field sampling of this species in Chesapeake Bay and should provide insight into the seasonal and geographic distributional patterns observed.

STATUS: This project was initiated in January, 1973 and represents Lewis' thesis research.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Crangon septemspinosa, Crustaceans, mortality, oxygen consumption, salinity, shrimp, temperature

PROJECT TITLE: GILL AREA, OXYGEN CONSUMPTION AND HABITAT IN
FOUR XANTHID CRABS OF THE YORK RIVER, VIRGINIA

INVESTIGATORS:

W. A. Van Engel, Department Head and Senior Marine Scientist
Douglas H. Wood, Graduate Assistant

PROJECT SUMMARY:

Previous studies have shown that the xanthids, or mud crabs, are important scavengers in oyster beds. Some species are known to utilize shelter in the intertidal zone as part of their habitat while others apparently cannot do so. This study attempts to relate differences in physiological adaptation to habitat differences in four sympatric species.

Gill surface area and oxygen consumption were measured. Species composition was compared at a station in the intertidal zone and three in the subtidal.

It appears that differences in physiological adaptation interacting with competition are partly responsible for observed differences in species composition among the stations.

STATUS: This project represents Wood's thesis research. Research is completed, writing of thesis is underway.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Crustaceans, marine ecology, mud crabs, oxygen consumption,
xanthids, York River

PROJECT TITLE: ECOLOGY OF *EMERITA TALPOIDA* AND THE INFLUENCE
OF ENVIRONMENTAL FACTORS ON THE DISTRIBUTION
OF LARVAE

INVESTIGATORS:

W. A. Van Engel, Department Head and Senior Marine Scientist
H. Ellen Hunter, Graduate Student

PROJECT SUMMARY:

It is proposed to determine the distribution of larvae of *Emerita talpoida* in the ocean and nearshore in the water column and in sediments; to study the juvenile and adult community structure on the ocean beaches; to examine mechanisms contributing to the onshore movement of larvae; to study the salinity tolerance of larvae.

STATUS: Active. This project represents Hunter's thesis research.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Crustaceans, *Emerita talpoida*, juveniles, larvae, salinity,
tolerance limits

PROJECT TITLE: THE EFFECTS OF SALINITY AND SEX ON THE OXYGEN
REQUIREMENTS OF THE BLUE CRAB, *CALLINECTES*
SAPIDUS

INVESTIGATORS:

Michael E. Bender, Head, Division of Environmental
Science and Engineering
Charles A. Wenner, Graduate Student

PROJECT SUMMARY:

A 5 x 2 factorial design will be employed (5 levels of salinity: 5, 10, 15, 20, and 25‰; 2 levels of sex, male and female) to determine the lower lethal oxygen concentrations for intermolt blue crabs. Animals will be acclimated to the test salinities for one week in holding tanks and then tested individually for the lower lethal oxygen concentration by decreasing the oxygen levels in ten gallon test vessels by passing nitrogen gas through the media. Behavioral observations will be made during the course of the tests, and oxygen levels will be determined by Winkler titrations. The criteria for death will be lack of movement after mechanical stimulation.

STATUS: In progress. This project represents Wenner's dissertation research. It is a subproject of the "Waste Water Treatment Program" of the Chesapeake Research Consortium Inc.

FINANCIAL SUPPORT:

National Science Foundation
(RANN Program)
Virginia Institute of Marine Science

KEY WORDS:

Blue crabs, oxygen

PROJECT TITLE: MONITORING PHYSIOLOGICAL CHANGES IN *CRASSOSTREA*
VIRGINICA IN RESPONSE TO ENVIRONMENTAL STIMULI

INVESTIGATORS:

John D. Lunz, Research Assistant
Grady Merriman*

PROJECT SUMMARY:

Initial laboratory experiments seek to refine techniques for measuring the cardiac response of intact oysters to changing environmental conditions. These conditions consist of variations in salinity, temperature, and dissolved oxygen as well as water quality alterations due to various marine "pollutants". Ultimate application will entail the development of remote sensing instrumentation for fourteen in situ studies of oysters in their natural habitats.

STATUS: Active.

FINANCIAL SUPPORT:

National Aeronautics and Space Administration
(Langley Research Center)
Virginia Institute of Marine Science

KEY WORDS:

Oysters, physiological monitoring

* Grady Merriman, Langley Research Center, NASA, Hampton, Virginia.

PROJECT TITLE: DETRITUS FLUX IN TIDAL MARSHES

INVESTIGATORS:

Michael E. Bender, Head, Division of Environmental Science
and Engineering
Kenneth Moore, Graduate Assistant

PROJECT SUMMARY:

The objective of this research project is to determine the import and export of detritus during complete tidal cycles at various times of the year. Samples taken at intervals of one hour are analyzed for the concentration of the dissolved and the particulate organic carbon fraction, the inorganic carbon fraction, and the ATP concentrations. Preliminary results indicate that the concentration of carbon in the water is highest at low slack tide and lowest at high slack, suggesting a net export of the material. In addition, seasonal differences in dissolved organic and particulate organic carbon are apparent; summer and early spring fluxes. The quantity of carbon present in particulate form exceeds that of the dissolved, and the patterns of flux as a function of tide stage are different.

The analyses for ATP, initiated in January 1972, have shown fluxes in living material in marsh water relative to the tide when carbon analyses have not presented conclusive data.

STATUS: Active. This project represents, in part, Moore's thesis research. It is a subproject of the "Edges Program" of the Chesapeake Research Consortium Inc.

FINANCIAL SUPPORT:

National Science Foundation
(RANN Program)
Virginia Institute of Marine Science

KEY WORDS:

Detritus flux, marshes

PROJECT TITLE: WETLANDS PROPAGATION STUDY
PART I - SEED GERMINATION AND SEEDLING DEVELOPMENT

INVESTIGATORS:

Gene M. Silberhorn, Associate Marine Scientist
Thomas A. Barnard, Assistant Marine Scientist

PROJECT SUMMARY:

The purpose of the project is to study aspects of marsh grass seed germination and seedling development in the laboratory (greenhouse).

Seed of various marsh plants will be harvested from selected marshes in the Lower Chesapeake Bay area. Experiments will be carried out in the laboratory in order to determine optimal germination and seedling success.

The results and utility of this project will give additional knowledge as to the necessary prerequisites needed to initiate a workable wetland propagation program.

STATUS: This project is in its initial phase.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Marsh grass, wetlands propagation

PROJECT TITLE: POSSIBLE ROLE OF MARSHES IN PREVENTING
EUTROPHICATION OF ESTUARIES

INVESTIGATORS:

Michael E. Bender, Head, Division of Environmental Science
and Engineering
Harold D. Slone, Assistant Marine Scientist
Donald Axelrad, Graduate Assistant

PROJECT SUMMARY:

Completed and current estuarine studies indicate that the nutrient budget of a highly enriched tidal system cannot be followed from the source of enrichment to the mouth. Analytical and physical data indicate that nitrogen and phosphorus compounds are "lost" within the system and cannot be accounted for in soluble, suspended, or deposited forms.

As estuarine waters flood tidal marshes, the grasses, the phytoplankton, and the algae assimilate the nutrients and incorporate them as new growth. Subsequently, the plant materials may be eaten by other higher organisms or may die and be washed out of the marsh. The eventual release of their nutrients to the water via the processes of decomposition starts the cycle anew.

Preliminary results of the research indicate that river water tends to supply inorganic nitrogen to the marshes, but the marshes supply phosphates, organic nitrogen compounds, and ammonia nitrogen to the river. In addition, there appears to be a tendency for slightly more primary production to occur in marsh waters on flooding tides than on ebbing tides.

The objectives of the research are to determine, quantitatively, the forms of dissolved nitrogen and phosphorus entering and leaving marshes, the ratios of similar forms and the rates of conversion of nutrient forms unavailable. Answers to these questions may prove highly significant in evaluating wetland areas in terms of their influence on the rates of eutrophication of estuaries.

STATUS: Active. This project is, in part, the subject of Axelrad's dissertation research. It is partially supported by the "Edges Program" of the Chesapeake Research Consortium, Inc.

FINANCIAL SUPPORT:

Office of Water Resources Research
National Science Foundation
(RANN Program)
Virginia Institute of Marine Science

KEY WORDS:

Eutrophication, marshes

PROJECT TITLE: BIOCHEMISTRY, DEVELOPMENT AND ECOLOGY OF CHESAPEAKE BAY
JELLYFISHES

INVESTIGATORS:

Paul L. Zubkoff, Head, Environmental Physiology
Dexter S. Haven, Head, Applied Marine Biology
Reinaldo Morales-Alamo, Research Assistant, Applied Marine Biology
Dale R. Calder, Associate Marine Scientist, Invertebrate Ecology
Kenneth L. Webb, Associate Marine Scientist, Environmental Physiology
*Robert E. L. Black, Associate Marine Scientist

PROJECT SUMMARY:

- (1) To elucidate metabolic pathways and biosynthetic processes of the stages of the Chesapeake jellyfishes,
- (2) To investigate further the developmental events associated with the process of strobilation,
- (3) To clarify further the ecological role of jellyfishes with special reference to their position in the food chain.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

PUBLICATIONS:

Five contract documents and approximately 20 publications have been contributed to the primary literature.

Black, R. E. and K. L. Webb. 1973.

Metabolism of ^{131}I in relation to strobilation in *Chrysaora quinquecirrha* (Scyphozoa). Comp. Biochem. Physiol. 45: 1023-

Calder, D. R., 1973.

Laboratory Observations on the life history of *Rhopilema verrilli* (Scyphozoa, Rhizostomeae). Marine Biol.

Lin, A. L. and P. L. Zubkoff. 1973.

Malate dehydrogenase and tetrazolium oxidase of scyphistomae of *Aurelia aurita*, *Chrysaora quinquecirrha* and *Cyanea capillata* (Scyphozoa: Semaestomeae). Helgoländer wiss. Meeresunters. 25.

Morales-Alamo, R. and D. S. Haven.

Atypical mouth shape of polyps of the jellyfish *Aurelia aurita* from Chesapeake Bay, Delaware Bay, and Gulf of Mexico. Chesapeake Science (submitted).

KEY WORDS:

Aurelia, *Chrysaora*, *Cyanea*, enzymes, feeding habits food chains, jellyfish, life cycles, lipids, metabolism, Mobjack Bay, *Rhopilema*, strobilation, York River, zooplankton

*Dr. Robert E. L. Black, also Professor of Biology, College of William and Mary, Williamsburg, Virginia.

PROJECT TITLE: DEVELOPMENTAL STUDIES ON CHESAPEAKE BAY JELLYFISHES

INVESTIGATOR:

Robert E. Black*, Associate Marine Scientist

PROJECT SUMMARY:

Temperature conditioned polyps, polyps in early and late strobilation, and cysts will be examined for the formation of unique subcellular structures associated with this reproductive process. These developmental studies will provide insight into the mechanisms of strobilation.

STATUS: Active. This is a subproject of "Studies on Chesapeake Bay Jellyfishes".

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

PUBLICATIONS:

- (1) Bynum, M. M.S. Thesis, College of William and Mary.
The ultrastructure of *Chrysaora quinquecirrha* strobilae.
- (2) Bynum, M. and R. E. Black.
Ultrastructure of the mesoglea in strobilating polyps of *Chrysaora quinquecirrha* (Scyphozoa).

KEY WORDS:

Aurelia, *Chrysaora*, *Cyanea*, jellyfish, strobilation

*Dr. Robert E. L. Black, also Professor of Biology, College of William and Mary, Williamsburg, Virginia.

PROJECT TITLE: BIOCHEMICAL STUDIES ON CHESAPEAKE BAY JELLYFISHES:
CARBOHYDRATES

INVESTIGATORS:

Paul L. Zubkoff, Department Head and Senior Marine Scientist
Edward P. Gardner, Graduate Student

PROJECT SUMMARY:

The jellyfishes are representative members of the Cnidarians (and Coelenterates), the phylum where the rudiments of a third germ layer are first recognized. In order to define the constituents of this rudimentary germ layer, the mesoglea is analyzed for its constituent polysaccharides, with particular emphasis on the complex carbohydrates. These complex carbohydrates which are associated with the attachment of collagen and connective tissue in higher organisms may ultimately provide a unique model system for studying the biosynthesis and attachment of connective tissues.

STATUS: Polymeric carbohydrates have been isolated from *Chrysaora quinquecirrha* and are undergoing further fractionation and characterization.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Complex carbohydrates, *Chrysaora quinquecirrha*, jellyfish, polysaccharides

PROJECT TITLE: BIOCHEMICAL STUDIES ON CHESAPEAKE BAY JELLYFISHES: METABOLISM

INVESTIGATORS:

Paul L. Zubkoff, Department Head and Senior Marine Scientist
Alan L. Lin, Graduate Assistant

PROJECT SUMMARY:

The identification of the enzymes associated with energy transformations and the isozyme changes during development are analyzed using polyacrylamide gel electrophoresis.

STATUS: Several dehydrogenases have been detected using gel electrophoresis. These studies will constitute part of A. L. Lin's Ph.D. Dissertation. This is a subproject of "Studies on Chesapeake Bay Jellyfishes".

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

PUBLICATIONS:

Zubkoff, P. L. and A. L. Lin. 1973
Dehydrogenases of the Cnidarian, *Chrysaora quinquecirrha*.
9th International Congress of Biochemistry, 1-7 July 1973,
Stockholm, Sweden. Abstract 2d20.

Lin, A. L. and P. L. Zubkoff. 1973.
Malate Dehydrogenase and Tetrazolium Oxidase of Scyphistomae
of *Aurelia aurita*, *Chrysaora quinquecirrha* and *Cyanea
capillata* (Scyphozoa: Semaestomeae). Helgolander wissen
Meer.

KEY WORDS:

Aurelia, *Chrysaora*, *Cyanea*, enzymes, jellyfish, metabolism,
strobilation

PROJECT TITLE: ULTRAPLANKTON HETEROTROPHY IN CHESAPEAKE BAY

INVESTIGATORS:

Kenneth L. Webb, Associate Marine Scientist
Leonard Haas, Assistant Marine Scientist

PROJECT SUMMARY:

Various lines of evidence indicate that a much overlooked assemblage of organisms, the ultraplankton, because of their large numbers and small size, may make a greater metabolic contribution to the plankton community than the larger net plankton which are easier to observe. Their small size, 0.5-10 microns, and fragile nature have resulted in almost a complete lack of information regarding their taxonomy, ecology, and physiology.

Although much recent work of Wright and Hobbie (*Ecology*, 1966, 47: 457-464), as well as others, indicates that bacteria and not algae are responsible for the uptake of dissolved organics from sea water, the ultraplankton are comparable in size to some bacteria and have similar surface-to-volume ratios. They may thus be competitive in membrane phenomena such as uptake of dissolved materials. The reports of apparently viable pigmented phytoplankton below the photic zone (e.g., Fournier, 1966, *Science* 153: 1250-1252) are difficult to explain if they are not heterotrophs living on dissolved organic matter. Other reports of high numbers of nonpigmented ultraplankton in ocean waters (e.g., Pomeroy and Johannes, *Deep Sea Research* 13: 971-973) suggest an important ecological role for these obviously heterotrophic organisms.

Exploratory evaluations of the role of both pigmented and non-pigmented ultraplankton in the cycling of dissolved organic matter, especially free amino acids, in estuarine waters will be made. Cultures of some of the more common species will be developed. The cultured organisms will then be evaluated both for their ability to remove C-14 labelled dissolved substrates (i.e., amino acids) from solutions containing the substrates at naturally occurring concentrations and for their ability to utilize ingested bacteria as a source of nutrition.

STATUS: This project represents Haas' dissertation research.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

amino acids, detritus, dissolved organics, flagellates, heterotrophy
metabolism, phytoplankton

PROJECT TITLE: PRODUCTIVITY MEASUREMENTS OF THE LOWER CHESAPEAKE BAY

INVESTIGATORS:

J. Ernest Warinner, III, Assistant Marine Scientist
Paul L. Zubkoff, Department Head and Senior Marine Scientist

PROJECT SUMMARY:

The primary productivity and heterotrophic potentials of the lower Chesapeake Bay and particularly a station of the York Spit area are under surveillance in conjunction with studies on the "red water" occurrence and development.

STATUS: Active. This is a subproject of the "Waste Water Treatment Program" of the Chesapeake Research Consortium, Inc.

PUBLICATIONS:

- (1) Haas, L. W. and P. L. Zubkoff, "The Estuarine Ecosystem: Heterotrophy in a Chesapeake Bay Estuary," American Society for Limnology and Oceanography, Tallahassee, Florida, March 1972.
- (2) Warinner, J. E. and P. L. Zubkoff, "The Estuarine Ecosystem: Primary Productivity in a Chesapeake Bay Estuary," American Society for Limnology and Oceanography, Tallahassee, Florida, March 1972.
- (3) Zubkoff, P. L., L. W. Haas, and J. E. Warinner, "The Estuarine Ecosystem: Primary Productivity Potential and Heterotrophy of a *Gymnodinium splendens* bloom," American Chemical Society, 163rd National Meeting, Boston, Massachusetts, April, 1972.

FINANCIAL SUPPORT:

National Science Foundation
(RANN Program)
Virginia Institute of Marine Science

KEY WORDS:

Continental Shelf, diatoms, dinoflagellates, dissolved organics, dissolved oxygen, emissions and additions, estuaries, floods, heterotrophy, James River, Mobjack Bay, phytoplankton, plankton, prediction, productivity, "red water", salinity, temperature, York River, zooplankton

PROJECT TITLE: NITROGEN CYCLE IN ESTUARIES AND OTHER COASTAL ZONE MARINE ENVIRONMENTS

INVESTIGATOR:

Kenneth L. Webb, Associate Marine Scientist

PROJECT SUMMARY:

The long term projected goal is to model the cyclic flow of nitrogen in shallow water marine environments, especially those estuarine in nature. Standing concentrations, flux, and turnover times of various nitrogen compounds are being determined. The influence of various environmental and biological parameters is being investigated and basic hypotheses related to the operation of the cycle are being tested. Preliminary modeling of the system is planned.

Qualitative and quantitative information on free amino acids in the York River seasonally and from numerous depths and latitudes have been assembled. Both the supplying and utilizing organisms for dissolved free amino acids have been investigated, and results have been presented in several publications. Changes in ammonia, nitrate, dissolved organic and particulate organic nitrogen in water flowing over a coral reef have been determined. This latter aspect of the work is being extended to Chesapeake Bay and the Eastern Shore estuaries, and the resulting hypotheses tested.

STATUS: Active.

FINANCIAL SUPPORT:

National Science Foundation
(Coral reef studies in collaboration with R. E. Johannes
and W. J. Wiebe of the University of Georgia)
National Aeronautics and Space Administration
Virginia Institute of Marine Science

PUBLICATIONS:

- (1) Johannes, R. E. and others. 1972.
Bioscience 22: 541-543.
- (2) Webb, et al.
Paper at International symposium on coral reefs, June 1973.
Eniwetok Atoll: Aspects of the nitrogen cycle on a coral reef.

KEY WORDS:

Amino acids, coral reefs, detritus, dissolved organics, Eastern Shore, eutrophication, Metabolism, nitrogen, nutrients, phytoplankton, York River

PROJECT TITLE: SIGNIFICANCE OF MICROFLAGELLATES IN THE OUTWELLING PHENOMENA

INVESTIGATORS:

Kenneth L. Webb, Associate Marine Scientist
Leonard Haas, Assistant Marine Scientist

PROJECT SUMMARY:

Outwelling from bays and estuaries is thought to have considerable impact upon adjacent coastal waters. Nutrients that are concentrated and recycled by estuaries come to a large degree from the ocean and, in contrast, the excess of organic productivity of the fertile estuaries is exported to the adjacent less fertile oceans. Export from bays such as on the Virginia Eastern Shore is often greater than from river-fed estuaries. Organic materials exported can be either in the form of living plankton or of detritus and contribute to the secondary productivity of the coastal waters. It would clearly be of significance to evaluate the amount of export in outwelling, its destination (i.e., coastal waters or the next inlet downstream), and its effect upon the recipient environment. It would also be ideal if the flow of matter and energy could be described by remote sensing.

The inverse size metabolism relationship holds for most organisms for respiratory metabolism. There is also some evidence that indicates autotrophic microflagellates often dominate primary productivity even when their contribution to the total biomass is small, and that a larger fraction of this production may be released in the soluble form than from larger autotrophs. We propose to isolate a number of autotrophic flagellates of varying sizes from Eastern Shore bays, inlets, and offshore, and test the hypothesis that microflagellates are capable of higher rates of photosynthesis (fixed carbon per unit effective pigment) and greater loss rates of dissolved organics than larger organisms. Pigment signatures will also be determined of the cultured organisms, and, after the metabolically dominant forms are determined, the feasibility of remote sensing of these organisms can be tested.

It has been proposed that flagellates, both pigmented and nonpigmented, associated with detritus particles are major contributors to nutrient regeneration (N, P). We propose to isolate and culture some of these organisms from export detritus particles and to investigate their mode of nutrition.

STATUS: Active.

FINANCIAL SUPPORT:

National Aeronautics and Space Administration
Virginia Institute of Marine Science

KEY WORDS:

Bacteria, bay mouth studies, Eastern Shore, estuaries, flagellates, metabolism, nutrients, phytoplankton, remote sensing, wetlands

PROJECT TITLE: PLANKTONIC FOOD CHAINS

INVESTIGATOR:

Paul L. Zubkoff, Department Head and Senior Marine Scientist

PROJECT SUMMARY:

Selected lipid constituents of estuarine organisms are used as tracers for ascertaining planktonic food webs.

Fatty acid content is quantitated using thin-layer and gas-liquid chromatographic techniques. The gas-liquid chromatograms are differentially compared with respect to 16:0, 16:1 ω 7, 18:0, 18:1 ω 9, and 20:5 ω 3 for ascertaining those components which are degraded, modified, or nonmetabolized.

STATUS: Active .

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

PUBLICATION:

Joseph, J. D., P. L. Zubkoff, and E. B. Joseph. 1972.
Comparative Biochemistry of Jellyfish: Fatty acids of Scyphozoan polyps and medusae and the effect of diet on fatty acid position. Symposium: Lipids of Aquatic Animals
46th Annual Fall Meeting, Am. Oil Chemists Society, Ottawa, Canada, September 25-27.

KEY WORDS:

Chrysaora, *Cyanea*, fatty acids, feeding habits, food chains
jellyfish, plankton, York River, zooplankton

PROJECT TITLE: BIOGEOGRAPHY OF CAPE HATTERAS AREA

INVESTIGATORS:

John A. Musick, Associate Marine Scientist
J. D. Lazell*

PROJECT SUMMARY:

This project is a long-term study of distribution of plants, reptiles, amphibians, and mammals on the barrier beaches from Cape Henry, Virginia, to Cape Lookout, North Carolina. The study is conducted primarily on weekends.

STATUS: Continuing. A Publication is in press.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science
Personal

KEY WORDS:

Biogeography, Cape Hatteras

*J. D. Lazell, Massachusetts Audubon Society

PROJECT TITLE: AN ICHTHYOLOGICAL SURVEY OF ATLANTIC COASTAL SURF
ZONE FISHES FROM CAPE HATTERAS, NORTH CAROLINA TO
CAPE HENRY, VIRGINIA

INVESTIGATORS:

John V. Merriner, Associate Marine Scientist
Robert K. Dias, Graduate Student

PROJECT SUMMARY:

A beach seine survey of the surf zone from Cape Hatteras to Cape Henry will be conducted monthly using standardized replicate tows blocked on light-dark and tidal phase. Data will be analyzed to define the composition of the resident and transient fish populations, seasonal occurrence, relative productivity of various surf zone fishes and changes in species diversity, biomass and composition as they relate to changes in latitude, tide, and light.

STATUS: This project represents Dias' thesis research. The program is scheduled to commence in July 1973 and terminate December 1974.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Check list, fishes, inventory, juveniles, marine ecology,
shallows, shorelines

PROJECT TITLE: CATALOGUE OF THE FISHES AND HERPETOFAUNA OF THE
CHESAPEAKE REGION

INVESTIGATOR:

J. A. Musick, Associate Marine Scientist

PROJECT SUMMARY:

Continual updating of knowledge of animals listed in VIMS
SSR #65. Particularly those parts of the fauna cited as being
poorly known.

STATUS: Continuing.

FINANCIAL SUPPORT:

U. S. Army Corps of Engineers
Virginia Institute of Marine Science

KEY WORDS:

Fishes, herpetofauna

PROJECT TITLE: PESTICIDES AND HEAVY METALS IN TISSUES OF STRIPED
BASS TAKEN IN WATERS NEAR CAPE HATTERAS, NORTH
CAROLINA AND IN VIRGINIA

INVESTIGATORS:

John V. Merriner, Associate Marine Scientist
Peter Sheridan, Graduate Student
Charles Wenner, Graduate Student

PROJECT SUMMARY:

Tissues from 12 adult striped bass obtained in a haul seine during January 1973 at Cape Hatteras, North Carolina and 10 fish each from the James, York, and Rappahannock rivers are being analyzed for pesticide residues, PCB's, and heavy metals. Liver, mesentery fat, gonads, and muscle are being examined. Relationships of residues present to age and weight of fish specimens shall be evaluated as to possible effects upon spawning success of striped bass and to provide baseline data for each sampling area.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

DDT, estuaries, heavy metals, James River, *Morone saxatilis*,
PCB's, pesticides, Rappahannock River, striped bass,
York River

PROJECT TITLE: EFFECTS OF METHOXYCHLOR ON THE CONDITIONING OF STRIPED
BASS TO AN OLFACTORY STIMULUS

INVESTIGATORS:

John A. Musick, Associate Marine Scientist
Gregory Murray, Graduate Assistant

PROJECT SUMMARY:

Three groups of striped bass will be used---one control and two experimental groups. The two experimental groups will be exposed to two concentrations of methoxychlor. One-half of each group will be positively-conditioned to the introduction of an odor. The other half will be negatively-conditioned. Differences in response to the stimulus and time required for conditioning will be looked for. Some histological work may be done.

STATUS: Active. This project represents Murray's thesis research. Research was temporarily suspended until student completed active duty in the U. S. Army. Continued in June 1973.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science
EPA Fellowship Support (Pending)

KEY WORDS:

Fishes, pesticides, striped bass

PROJECT TITLE: COMMUNITY ECOLOGY OF ESTUARINE DEMERSAL FISHES

INVESTIGATORS:

John A. Musick, Associate Marine Scientist
James Colvocoresses, Graduate Assistant

PROJECT SUMMARY:

A four-year field program of monthly stratified sampling of the lower York River by trawl is underway. This sampling will provide pre- and post-operational data for determination of effects (if any) of VEPCO plant enlargement on community structure. Supplementary data are being collected in a contiguous area as far upstream as West Point.

Analysis of trends in seasonal species dominance and diversity of fish taken in monthly Bay-River trawl surveys based on stratified random sampling.

STATUS: Active. 1-1/2 years of data collection are complete. This project represents Colvocoresses' dissertation research.

FINANCIAL SUPPORT:

Virginia Electric and Power Company
Virginia Institute of Marine Science

KEY WORDS:

Estuaries, fishes

PROJECT TITLE: PARASITOLOGY OF DEMERSAL FISHES OF NORFOLK CANYON
AND ADJACENT CONTINENTAL SLOPE

INVESTIGATORS:

J. A. Musick, Associate Marine Scientist
E. Lynn Suydam, Graduate Student

PROJECT SUMMARY:

Life history, host specificity and site specificity of
parasites of dominant species of demersal slope fishes.

STATUS: Active. This project represents Suydam's dissertation research.

FINANCIAL SUPPORT:

National Science Foundation
Virginia Institute of Marine Science

KEY WORDS:

Norfolk Canyon, parasites of fishes

PROJECT TITLE: COMMUNITY ECOLOGY OF OFFSHORE DEMERSAL FISHES

INVESTIGATOR:

John A. Musick, Associate Marine Scientist

PROJECT SUMMARY:

This project is a study of community relationships among fishes of the continental shelf, based upon trawl catches of the R/V *Sea Breeze* and *Albatross IV*. Analysis of distribution by season, temperature, and depth for all species and dominance affinity among stations is complete. Diversity analyses and Fager's analysis are four fifths complete.

STATUS: Active.

FINANCIAL SUPPORT:

National Marine Fisheries Service
(collection)
Virginia Institute of Marine Science
(collection and analysis)

KEY WORDS:

Continental shelf, fishes

PROJECT TITLE: SYSTEMATICS AND ECOLOGY OF WESTERN NORTH ATLANTIC
ALEPOCEPHALID FISHES

INVESTIGATORS:

J. A. Musick, Associate Marine Scientist
Douglas Markle, Graduate Assistant

PROJECT SUMMARY:

The Alepocephalidae are a poorly known family of deep sea fishes which occur in the meso- and bathypelagic, archi- and abyssobenthic zones of the ocean. The systematics and ecology of selected taxa within this family are being studied from material and data from the USNM, University of Miami, AMNH, etc., and VIMS Norfolk Canyon Study.

STATUS: Active. This study represents Markle's dissertation research.

FINANCIAL SUPPORT:

National Science Foundation
Virginia Institute of Marine Science

KEY WORDS:

Fishes

PROJECT TITLE: ECOLOGY AND SYSTEMATICS OF ATLANTIC AMERICAN SCIAENIDS

INVESTIGATORS:

J. A. Musick, Associate Marine Scientist
L. N. Chao, Graduate Student

PROJECT SUMMARY:

Part 1. Ecology of young sciaenids in York River and lower Chesapeake Bay system. The four most abundant species of sciaenids in lower Chesapeake Bay are: *Bairdiella chrysura*, *Cynoscion regalis*, *Leiostomus xanthurus*, and *Micropogon undulatus*. They use this estuary as a nursery ground for post-larvae and juveniles and as a seasonal feeding ground for the adults. Their temporal, ecological and geographical distribution overlap in the estuary. How do they coexist? Four major subjects will be examined in this study: (1) Numerical abundance and biomass (2) spatial and temporal distribution (3) feeding mechanisms and morphological adaptation (4) food specialization and overlap. Also the habitat preferences of each species with regard to environmental factors; D. O., salinity, temperature and bottom types will be analyzed.

Part 2. Systematics of the sciaenids of the Atlantic coast of the U. S.; there are 12 genera with 22 species of sciaenid fishes in the study area. Many recently rediscovered important characters, such as the otoliths (sagitta and asteriscus), swim bladder, snout pore and mental barbel and pore, will be examined. The study will emphasize the relationship between genera, and several species of monotypic genera, i.e., *Larimus*, *Leiostomus*, *Micropogon*, *Odontoscion*, *Sciaenops* and *Stellifer*, in this area.

STATUS: Active. This project represents Chao's dissertation research. Preliminary results of Part 1 were presented in the annual meeting of "American Society of Ichthyologists and Herpetologists" (ASIH), June 26, 1973 in San Jose Costa Rica. Part 2 is in progress.

FINANCIAL SUPPORT:

Virginia Electric and Power Company
Virginia Institute of Marine Science

KEY WORDS:

Bairdiella chrysura, *Cynoscion regalis*, fishes, *Leiostomus xanthurus*,
Micropogon undulatus

PROJECT TITLE: STUDY OF HABITAT PREFERENCE OF CERTAIN SCIAENIDAE
FROM THE CHESAPEAKE BAY AREA

INVESTIGATORS:

John A. Musick, Associate Marine Scientist
A. Carter Cooke, Graduate Student

PROJECT SUMMARY:

This study will investigate the depth preference, substrate preference and color preference of two sizes of at least four and possibly five species of Sciaenidae; spot, *Leiostomus xanthurus*; silver perch, *Bairdiella chrysura*; sea trout, *Cynoscion regalis*; croaker, *Micropogon undulatus* and kingfish, *Menticirrhus saxatilis*, as they become available.

STATUS: This project represents Cooke's thesis research. Experimentation is just beginning.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Bairdiella chrysura, croaker, *Cynoscion regalis*, fishes,
Kingfish, *Leiostomus xanthurus*, *Menticirrhus saxatilis*,
Micropogon undulatus, sea trout, silver perch, spot

PROJECT TITLE: EARLY LIFE HISTORY AND ECOLOGY OF THE SPOTFIN
KILLIFISH, *FUNDULUS LUCIAE* (PISCES, CYPRINODONTIDAE)

INVESTIGATORS:

J. A. Musick, Associate Marine Scientist
Donald Byrne, Graduate Student

PROJECT SUMMARY:

Eggs, larvae, habitat and faunal associates are being described as well as physical and chemical parameters within which the species occurs in nature.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Early life history, ecology, *Fundulus luciae*, high marsh,
killifish, spotfin

PROJECT TITLE: ASPECTS OF THE LIFE HISTORY AND COMMENSAL
BEHAVIOR OF A NEW SPECIES OF THE GENUS
LIPARIS (CYCLOPTERIDAE) FROM THE WESTERN
NORTH ATLANTIC

INVESTIGATORS:

John A. Musick, Associate Marine Scientist
Kenneth Able, Graduate Student

PROJECT SUMMARY:

A new species of cyclopterid fish in the genus *Liparis* differs from its congeners in a number of morphological characters and in the commensal association which it establishes with the mollusk, *Placopecten magellanicus*. Past references to this association which have referred to other species of *Liparis* have apparently been in error. More than 6000 specimens collected from scallops between Nova Scotia and Cape Hatteras are this new species. Spawning occurs in the spring. The eggs are demersal and adhesive. The pelagic larvae descend to the bottom at about 10 mm in length and enter live *Placopecten*. Laboratory and field observations indicate the *Liparis* occupies scallops during the day and forages at large at night. Sexual maturity is attained in one year. The species has spawned in the laboratory, and the eggs and yolk-sac larvae have been documented. Also, plankton collections have yielded yolk-sac and later larval stages and small juveniles.

STATUS: This project represents Able's dissertation research. Write-up of this data is partially completed. Completion is scheduled in the fall of 1973.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Fishes, *Liparis* sp.

PROJECT TITLE: UROPHYCIS BIOLOGY

INVESTIGATORS:

John A. Musick, Associate Marine Scientist
D. Cohen*

PROJECT SUMMARY:

Compilation of accounts of all species of *Urophycis* is underway for inclusion in *Fishes of the Western North Atlantic*. This effort is approximately 75% complete.

A racial study of *U. chuss* for the International Commission on North Atlantic Fisheries is approximately 75% complete.

STATUS: Active.

FINANCIAL SUPPORT:

National Marine Fisheries Service
Virginia Institute of Marine Science

KEY WORDS:

Fishes, *Urophycis*

*D. Cohen, National Marine Fisheries Service

PROJECT TITLE: ZOOGEOGRAPHY OF CHESAPEAKE BAY AND THE ADJACENT SHELF

Marvin L. Wass, Senior Marine Scientist
Donald F. Boesch, Associate Marine Scientist

PROJECT SUMMARY:

Preliminary work indicates considerable overlap of species but striking differences if level of abundance is used as a distributional criterion. Various aspects of this interesting phenomenon are to be pursued.

STATUS: Temporarily in abeyance, to be dealt with as time permits.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Continental Shelf, zoogeography

PROJECT TITLE: DISTRIBUTION AND STRUCTURE OF MACROBENTHIC COMMUNITIES IN
THE CHESAPEAKE-YORK-PAMUNKEY ESTUARY

INVESTIGATOR:

Donald F. Boesch, Associate Marine Scientist

PROJECT SUMMARY:

The nature of faunal change in a homeohaline (stable salinity gradient) estuary is under investigation. Multivariate gradient analyses have been used to analyze the rate of change in the composition of macrobenthic communities and the effects of seasonality on this change. Community structure has been analyzed in terms of species diversity and its components, dominance and intracommunity patterns of relative abundance. The information will be used as a basis for classifying reaches of Virginia's estuaries into "ecosystem management units" which have some degree of internal biological homogeneity.

STATUS: Papers reporting results are in preparation.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Benthos, estuaries

PROJECT TITLE: THE NUDIBRANCHS OF CHESAPEAKE BAY AND THE EASTERN
SHORE OF VIRGINIA

INVESTIGATORS:

Marvin L. Wass, Senior Marine Scientist
Rosalie M. Vogel, Graduate Assistant

PROJECT SUMMARY:

The nudibranch fauna of this area, particularly in the lower Bay, is poorly known. This project was begun at CBL and is being continued at the Gloucester Point and Wachapreague installations of VIMS. It will involve descriptions of adults and egg cases, as well as life histories and local distributions of these unusual predators.

STATUS: This project represents Vogel's dissertation research.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Invertebrates, nudibranchs

PROJECT TITLE: THE HYDROIDS OF PELAGIC *SARGASSUM*

INVESTIGATORS:

Donald F. Boesch, Associate Marine Scientist
David H. Rackley, Graduate Student

PROJECT SUMMARY:

Collections of *Sargassum* from the Gulf Stream and Sargasso Sea are being examined:

- (1) To determine which species of hydroids are found on pelagic *Sargassum*.
- (2) To observe instances of hydroid specificity for particular types of *Sargassum*.
- (3) To establish an illustrated taxonomic key for the hydroids found.

STATUS: This project represents Rackley's thesis research.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Hydroids, jellyfish, *Sargassum*

PROJECT TITLE: SHELF INFAUNA STUDIES

INVESTIGATORS:

Marvin L. Wass, Senior Marine Scientist
Donald F. Boesch, Associate Marine Scientist

PROJECT SUMMARY:

Several cruises over the inner shelf off Virginia since 1964 have produced benthic samples. These samples have been sorted and identified, except for 100 samples taken across the shelf to the Norfolk Canyon on the Ridgely-Warfield, May 14, 1973. This last material is divided into 1.0 and 0.5 mm fractions. Analysis of these samples and their comparison with data from previous cruises will give us a much better picture of shelf infauna. The last cruise was specifically designed to compare with a similar shelf transect made off Beaufort, N. C., by John Day of South Africa.

STATUS: Inactive.

FINANCIAL SUPPORT:

National Science Foundation (use of Ridgely-Warfield)
Virginia Institute of Marine Science

KEY WORDS:

Continental Shelf, infauna

PROJECT TITLE: INVERTEBRATE REFERENCE MUSEUM

INVESTIGATORS:

Marvin L. Wass, Department Head and Senior Marine Scientist
Rosalie M. Vogel, Graduate Assistant

PROJECT SUMMARY:

Specimens have accumulated for over a decade, but were never catalogued. A card file catalogue system begun in 1972 has now been completed, with information on date and collection site being recorded. The present phase is directed toward maintenance and improvement of the collection.

Specimens recorded in the VIMS check list but not present in the collections will be sought. Attempts will be made to create a duplicate collection of smaller animals, such as polychaetes, amphipods and most gastropods, which are particularly subject to destruction because of their fragility and frequent use for identification purposes. The accumulation of photographs of the exterior valves of local bivalves to illustrate a key will continue.

STATUS: Active

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Invertebrates

PROJECT TITLE: SHIPWORM SURVEILLANCE AT GLOUCESTER POINT

INVESTIGATORS:

Marvin L. Wass, Senior Marine Scientist
Dale R. Calder*
Rosalie Vogel, Graduate Assistant

PROJECT SUMMARY:

Begun in 1958, this project was originally a cooperative venture with the William F. Clapp Laboratories, but is now handled entirely by VIMS. It involves using pine boards put down for six months and controls for one month. Some information on fouling organisms is obtained along with that on borer infestation.

STATUS: Continuing, but with little time involvement. Dr. Calder has recently compiled information for an educational leaflet applicable to the marine borer situation in this area.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Invertebrates, shipworms

* Dr. Dale R. Calder, Marine Resources Laboratory, South Carolina Wildlife and Marine Resources Department, Charleston, S. C.

PROJECT TITLE: FLUCTUATIONS OF FOULING ORGANISMS WITH WEATHER
AND IMPACT ON COMMERCIAL MOLLUSK SPECIES

INVESTIGATOR:

J. D. Andrews, Department Head and Senior Marine Scientist

PROJECT SUMMARY:

The dry years of 1963 through 1966 permitted many meso-haline species to move upstream in Chesapeake Bay and become established as pests and competitors. These dry-period communities were dramatically reduced or eliminated in the very wet years of 1971 and 1972 with Hurricane Agnes as a climatic factor. The recovery and readjustment of fouling, epifaunal, and predator species as salinity regimes normalize are informative of community dynamics and important to commercial shellfish species. Monitoring by SCUBA, tray observations and oyster-bed dredging is to be done in limited mesohaline areas for several years.

STATUS: The effects of Agnes on epifaunal communities has been summarized and accepted by *Chesapeake Science* for publication. Studies are continuing.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

epifauna, fouling organisms, infauna, mariculture,
marine ecology, mollusks, salinity, SCUBA,
taxonomy

PROJECT TITLE: ECOLOGICAL, LIFE HISTORY, AND ULTRASTRUCTURAL STUDIES
OF MARINE PROTOZOA IN THE LOWER CHESAPEAKE BAY

INVESTIGATOR:

Frank O. Perkins, Department Head and Senior Marine Scientist

PROJECT SUMMARY:

Marine protozoa of the lower Chesapeake Bay with emphasis on pathogenic species are being studied. The seasonal distribution with respect to host or other substrate and the ultrastructure are being considered. Information derived from these studies is being used to determine the life histories of the organisms.

STATUS: Continuing

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Life cycles, protozoa, ultrastructure

PROJECT TITLE: STUDIES OF MARINE COCCOID FUNGI AND PROTOZOA OF THE
LOWER CHESAPEAKE BAY, VIRGINIA

INVESTIGATOR:

Frank O. Perkins, Department Head and Senior Marine Scientist

PROJECT SUMMARY:

Ecological, morphological, and taxonomic studies of the marine coccoid fungi and Protozoa found in the York River and Hampton Roads areas of Virginia are being conducted. A diverse group of coccoid, heterotrophic, eucaryotic micro-organisms, both free-living and parasitic, which are not uniflagellated Phycomycetes, is known to exist in the lower Chesapeake Bay and in the marine environment in general, but it is not known whether they are fungi, Protozoa, achlorophyllous algae, or encompass species of all groups. Some appear to be Phycomycetes of the order Saprolegniales, others appear to be related to the Labyrinthulia of the Protozoa, and some appear to be colorless forms of chlorococcalean algae. A morphological study at the light and electron microscope levels is being conducted in an effort to determine the taxonomic and phylogenetic affinities of the fungus and protozoan species in the study area. Those which appear to be chlorococcalean algae are not being studied extensively. An ecological study of selected species is also being pursued in which salinity, temperature, and temporal ranges are being determined. Both saprophytic and parasitic species are being studied from sediments, sea water, algae, invertebrates, and angiosperm detritus.

STATUS: Active

FINANCIAL SUPPORT:

National Science Foundation
Virginia Institute of Marine Science

KEY WORDS: Fungi, Protozoa; ultrastructure

PROJECT TITLE: ECOLOGICAL, LIFE HISTORY, AND ULTRASTRUCTURAL STUDIES
OF MARINE FUNGI IN THE LOWER CHESAPEAKE BAY

INVESTIGATOR:

Frederick Y. Kazama, Associate Marine Scientist

PROJECT SUMMARY:

Selected biflagellate and uniflagellate fungi of the Class Phycomycetes are being studied on a continuing, long-term basis. Seasonal distributions as a function of substrate, temperature, and salinity are being observed. The cell biology, with emphasis on ultrastructure as a means of elucidating the taxonomy, is being studied. Life histories are being determined from accumulated data.

STATUS: Continuing.

FINANCIAL SUPPORT:

National Science Foundation
Virginia Institute of Marine Science

PUBLICATIONS:

- (1) Kazama, F. 1972.
Ultrastructure of *Thraustochytrium* sp. zoospores I.
Kinetosome. Arch. Mikrobiol. 83:179-188.
- (2) Kazama, F. 1972.
Ultrastructure of *Thraustochytrium* sp. zoospores II.
Striated inclusions. J. Ultrastruct. Res. 41:60-66.
- (3) Kazama, F. 1973.
Ultrastructure of *Thraustochytrium* sp. zoospores III.
Cytolysomes and Acid Phosphatase Distribution. Arch.
Mikrobiol. 89:95-104.
- (4) Kazama, F. (in preparation)
Ultrastructure of *Thraustochytrium* sp. zoospores IV.
External morphology of the flagella.

KEY WORDS:

Fungi, life cycles, ultrastructure

PROJECT TITLE: THE EFFECT OF THE IONIC ENVIRONMENT OF PROTEIN SYN-
THESIS IN A MARINE FUNGUS

INVESTIGATORS:

Frank O. Perkins, Department Head and Senior Marine Scientist
James P. Amon, Graduate Assistant

PROJECT SUMMARY:

An estuarine fungus has been isolated from the green alga *Bryopsis* and is being investigated to determine how the major cations in seawater affect protein synthesis throughout its life cycle. In addition, studies on how environmental ionic factors affect the synthesis of RNA will be studied.

Since this organism is most likely a decomposer in the marine environment, this investigation may provide insight into the role of decomposers in the variable ionic conditions prevalent in estuaries. Present research shows differential requirement for Na⁺ during cell cycle.

A characterization of the optimal ranges of the major cations (Na⁺, K⁺, Mg⁺⁺, Ca⁺⁺) is complete. Methods for establishing well synchronized cultures have been worked out. The profile of protein and RNA synthesis in the early life cycle is complete. Factors affecting the synthesis of one protein, lactate dehydrogenase, are presently under study.

STATUS: Active. This project represents Amon's dissertation research.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Enzymes, fungi, proteins

PROJECT TITLE: FUNGI ASSOCIATED WITH DECAYING *SPARTINA* SP.

INVESTIGATOR:

Frederick Y. Kazama, Associate Marine Scientist

PROJECT SUMMARY:

Sampling stations have been established on the Mattaponi and the York Rivers as well as on the Eastern Shore of Virginia to determine the mycoflora of decaying *Spartina* sp. After isolation, the fungi will be examined to determine which are cellulose and/or pectin degraders. We expect to determine:

- (1) The mycoflora of decaying *Spartina* sp.,
- (2) The succession of fungi on decaying *Spartina* sp.,
- (3) Which fungi are capable of degrading plant cell wall material, and
- (4) The distribution of fungi associated with decaying *Spartina* sp. along a salinity gradient.

STATUS: Active .

FINANCIAL SUPPORT:

National Science Foundation
Virginia Institute of Marine Science

KEY WORDS:

Food chains, fungi, marshes

PROJECT TITLE: TISSUE CULTURES OF *ROCCUS SAXATILIS*

INVESTIGATOR:

Frederick Y. Kazama, Associate Marine Scientist

PROJECT SUMMARY:

Using standard tissue culture techniques and commercially available growth media, we have been able to obtain primary monolayer cultures of trypsinized gonadal tissue. These cells have proven to be refractory to further subculturing, and we have not been able to establish any continuing cell lines.

STATUS: Intermittent experiments are being conducted.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Tissue culture, striped bass

PROJECT TITLE: IMPACT OF PARASITIC INFECTIONS ON THE STRIPED BASS,
MORONE SAXATILIS

INVESTIGATORS:

Frank O. Perkins, Department Head and Senior Marine Scientist
Ilan Paperna*
David E. Zwerner, Assistant Marine Scientist

PROJECT SUMMARY:

A one year pilot study of the parasites and the pathological changes they cause has been made on York River populations of striped bass, year classes 0+ to 3, in order to determine how the parasites affect their host and how much of the so called "total natural mortality" is caused or influenced by parasites. Data was collected to define the fish population (age, sex, condition, factor, etc.), the population of parasites (counts of individuals, maturity, stages, etc.) and to assess the degree and kind of pathological change associated with the parasites. The biology of three parasites (*Ergasilus labracis*, *Philometra rubra* and *Pomphorhynchus rocci*) found in abundance and associated with definite pathological changes has been initially studied to better explain the dynamics of infection. Data from all studies are being compared and correlations made where possible. Information on the impact of parasite infections in striped bass will aid in optimum management of the resources and act as a model study for other estuarine fish parasite studies.

STATUS: A one year pilot study has been completed. Support of an in depth 3 year proposed study is pending. This project replaces a previous project entitled "Dynamics of parasitic ecosystems of estuarine fishes", p. 108, 1972 edition.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

PUBLICATIONS:

Paperna, I., and D. E. Zwerner. 1973. Preliminary report on the dynamics of parasitic infections in the striped bass, *Morone saxatilis* (Walbaum), from the York River, Va. Acad. Sci. Mtgs 4 May 1973.

Paperna, I., and D. E. Zwerner. (In press). *Xudoa cerebralis* sp. n. (Myxosporidea, chloromyxidae) from the striped bass, *Morone saxatilis* (Walbaum). J. Protozoology.

KEY WORDS:

Morone saxatilis, parasites, striped bass

*Dr. Ilan E. Paperna, former NSF Senior Foreign Scientist Fellow, School of Marine Science, College of William and Mary.
Present address: 12 Atzmon St., Ramat-Hasharon, Israel.

PROJECT TITLE: BIOLOGY OF A MARINE BACTERIOPHAGE

INVESTIGATORS:

Frank O. Perkins, Department Head and Senior Marine Scientist
Arthur Zachary, Graduate Assistant

PROJECT SUMMARY:

Bacteriophages have been isolated from numerous salt marsh habitats by enrichment with a marine host bacterium. The phages are being characterized, replicative cycles will be studied by thin-section electron microscopy, and host ranges will be determined. The effect of some environmental parameters on the replicative cycle will also be studied. In addition sampling of selected estuarine areas will also be attempted. These studies will provide a basis for comparison of marine and freshwater bacteriophages and ultimately some insight into the types, numbers, and distribution of bacteriophages in marine waters.

STATUS: This project represents Zachary's dissertation research.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Bacteria, estuaries, viruses

PROJECT TITLE: ULTRASTRUCTURE OF THE ZOOSPORES OF *PHLYCTOCHYTRIUM* SP.,
A MARINE UNIFLAGELLATE FUNGUS

INVESTIGATOR:

Frederick Y. Kazama, Associate Marine Scientist

PROJECT SUMMARY:

A marine chytrid was recently isolated from the green alga, *Bryopsis plumosa*. The zoospores showed a marked positive phototactic and chemotactic response. In order to determine whether there is a detectable morphological basis for these responses, an ultrastructural study has been undertaken. Preliminary observations indicate that there is present a heretofore undescribed organelle within the zoospores which may be partially responsible for the tactic responses. The organelle appears to be a fenestrated system of membranes possessing a regular hexagonal array. This organelle is located just beneath the surface of the zoospore.

Presently, the origin of the organelle as well as its eventual fate is being studied. Ultrastructural techniques such as negative staining, thin sectioning, and freeze-etching are being used.

STATUS: Continuing.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

PUBLICATION:

Ultrastructure and phototaxis of the zoospores of *Phlyctochytrium* sp. an estuarine chytrid. J. gen. Microbiol. 71:555-566.

KEY WORDS:

Chytrids, fungus, ultrastructure

PROJECT TITLE: VARIATION IN MORPHOLOGY OF THE ENDOBIOTIC SYSTEM OF
PHLYCTOCHYTRIUM, A MARINE CHYTRID

INVESTIGATOR:

Frederick Y. Kazama, Associate Marine Scientist

PROJECT SUMMARY:

The most important morphological feature separating the genus *Phlyctochytrium* from *Rhizophydium* is the presence or absence of an expanded portion of the rhizoidal system termed the apophysis. Preliminary studies indicate that the apophysis may not be a consistent feature of the Chytridiaceous fungus originally identified as *Phlyctochytrium* on its "natural" substrate, *Bryopsis plumosa*. Here, an apophysis is present, but when the fungus is grown in axenic culture on agar, the presence of the organelle is variable.

In broth culture, the apophysis is very rarely observed. It is hypothesized that the mechanical resistance of the substrate may be partially responsible for the development of the apophysis; the more resistant the substrate the more apt that an apophysis will be formed. Currently, the ultrastructure of the endobiotic system is being studied while the fungus is growing on "natural" substrates and on agar. Later, silica gels of various mechanical strengths will be prepared and the fungus inoculated on these gels. These inoculated pieces of gels will be floated on nutrient media. The answer as to whether the mechanical resistance of the substrate is responsible for apophysis formation should then be forthcoming.

STATUS: Continuing

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

PUBLICATION:

Development and morphology of a chytrid isolated from
Bryopsis plumosa. Can. J. Bot. 50:499-505 (1972).

KEY WORDS:

Chytrid, fungi, ultrastructure

PROJECT TITLE: HERPES-LIKE VIRUS INFECTING *THRAUSTOCHYTRIUM* SP.

INVESTIGATOR:

Frederick Y. Kazama, Associate Marine Scientist

PROJECT SUMMARY:

A DNA containing, enveloped virus has been observed in one isolate of *Thraustochytrium* sp. The fungus culture which yielded virus particles was obtained from a single zoospore isolated in 1970. Re-examination of electron micrographs taken in 1970 revealed particles which until recently occurred very rarely.

The virus replicates in the nucleus and becomes surrounded by the two nuclear membranes. These two membranes are lost and the particles, now in the cytoplasm, acquire a coat. They appear to acquire the envelope while traversing membranes of the Golgi complex, plasmalemma, or the vacuoles of the host cell.

The virus is highly integrated and becomes apparent only under certain conditions. Research is now being conducted to determine conditions under which the cells become permissive.

STATUS: Active.

FINANCIAL SUPPORT:

National Science Foundation
Virginia Institute of Marine Science

PUBLICATIONS:

- (1) Herpes-type virus particles associated with a fungus. Science 177:696-697
- (2) Ultrastructure of a fungus herpes-type virus. Virology 52: 478-487.

KEY WORDS:

Fungi, ultrastructure, viruses

PROJECT TITLE: FATTY ACIDS OF THE ZOOSPORES OF *PHLYCTOCHYTRIUM* sp.

INVESTIGATORS:

Frederick Y. Kazama, Associate Marine Scientist
Paul L. Zubkoff, Senior Marine Scientist, Department of
Environmental Physiology

PROJECT SUMMARY:

Recently, the zoospores of a species of *Phlyctochytrium* were found to be positively phototactic. Ultrastructural studies revealed a complex of membranes, lipid droplet, and an electron dense body which may be responsible for photoreception.

If the lipid droplet plays a role in photoreception, then we do not expect it to play a role in energy metabolism. Preliminary evidence indicates this to be true. Since phototaxis is extremely rare in fungi (reported in approximately five species), characterization of the photoreceptive system would be very significant. Preliminary analysis indicates some unusual long chain fatty acids as well as unusual sites of unsaturation.

STATUS: Active

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Chytrids, fatty acids, fungi, ultrastructure

PROJECT TITLE: BIBLIOGRAPHY OF THE MONOGENETIC TREMATODE
LITERATURE OF THE WORLD, 1758 TO PRESENT

INVESTIGATORS:

William J. Hargis, Jr., Institute Director
David E. Zwerner, Assistant Marine Scientist

PROJECT SUMMARY:

A necessary tool and natural product of any comprehensive literature review is an accurate, up-to-date bibliography. Such a bibliography has resulted from the Parasitology Section's taxonomic work on monogenetic trematodes (Platyhelminthes: Trematoda) and as a consequence of data accessioning for an analysis of the host-specificity of this interesting group of parasites. The publication of a complete bibliography on these parasites is a valuable aid to their study. The basic Bibliography was published in September 1969. It is hoped to keep the Bibliography current with supplements every one or two years. Supplement 1 to the Bibliography was published in February 1970, and Supplements 2 and 3 were published in March 1971 and 1972 respectively.

STATUS: Continuing.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Bibliography, monogenetic trematode

Virginia Institute of Marine Science
Microbiology-Pathology Department
Section of Parasitology

PROJECT TITLE: TRANSLATIONS OF MONOGENETIC TREMATODE LITERATURE

INVESTIGATORS:

William J. Hargis, Jr., Institute Director
David E. Zwerner, Assistant Marine Scientist
John E. Simmons*

PROJECT SUMMARY:

In conjunction with a comprehensive literature survey on the host-specificity and taxonomy of the Monogenea, it has been necessary to translate many foreign works on the subject, most of them in Russian. To date, the Section has caused 45 foreign papers to be translated; 40% of these have been edited by Section personnel and published for use by other scientists.

Two lengthy translations (Ivanov, 1952, and Bychowsky, 1937) have been edited by Dr. Simmons and are being readied for publication in the VIMS Translation Series.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Monogenetic trematodes, translations

*Dr. John E. Simmons, Department of Zoology, University of
California, Berkeley, California

PROJECT TITLE: A STUDY OF CERTAIN ASPECTS OF HOST-SPECIFICITY,
ZOOGEOGRAPHY, AND PHYLOGENY OF MONOGENETIC
TREMATODES

INVESTIGATORS:

William J. Hargis, Jr., Institute Director
David E. Zwerner, Assistant Marine Scientist
Adrian R. Lawler*

PROJECT SUMMARY:

Ectoparasites of the order Monogenea exhibit a high order of host-specificity. As a result, it seems probably that more thorough study of the order will yield interesting information concerning host-specificity, zoogeography, and phylogeny of both hosts (fishes and some reptiles and amphibians in general) and parasites.

To accomplish this, pertinent data extracted from a comprehensive literature survey, as well as from our own taxonomic work on monogenetic trematodes collected from around the world, are recorded in a Key-Sort card catalog. Analysis of this data yields: (1) An understanding of the distribution patterns of monogeneid species; (2) Elucidation of the distribution of monogenetic trematodes; (3) Paleodistribution and histories of isolated populations of fishes as indicated by occurrence of monogeneids in contemporary species; (4) The possible phyletic origin and evolution of monogeneid flukes, and (5) Possible applications of host-specificity patterns of monogeneids in clarifying the relations of the fish hosts.

STATUS: Continuing. A portion of this project represents Lawler's dissertation research which should come out as a VIMS publication shortly.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

PUBLICATION:

Lawler, A. R. (in press). Zoogeography and host-specificity of the superfamily Capsaloidea Price, 1936 (Monogenea: Monopistocotylea). VIMS publication.

KEY WORDS:

Host-specificity, monogenetic trematodes, phylogeny, zoogeography

*Dr. Adrian R. Lawler, Gulf Coast Research Laboratory, Ocean Springs, Mississippi

PROJECT TITLE: PARASITES OF WESTERN NORTH ATLANTIC FAUNA WITH
EMPHASIS ON THE CHESAPEAKE BAY AREA

INVESTIGATORS:

David E. Zwerner, Assistant Marine Scientist
Ilan Paperna*

PROJECT SUMMARY:

Knowledge of the parasite fauna of marine vertebrates and invertebrates from the waters of the Virginia sea coast and Chesapeake Bay is sparse. Knowledge of the dynamics of parasite populations and their importance to the populations of free-living animals and the ecosystem in general is for the most part lacking. A survey of the parasites, mostly from fishes, is being made from the various collections made previously and new collections are being made to help fill in the gaps. An attempt to determine the pathology caused by the parasites and their effect on the condition of the fishes is also being made. The parasite section of the VIMS checklist was recently up-dated to include many new parasite records resulting from these surveys; and additional up-dating is necessary now.

STATUS: Continuing.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

PUBLICATION:

Paperna, I. and D. E. Zwerner (in press). Massive
leech infestation on white catfish (*Ictalurus catus*),
a histopathological consideration. *Proc. Helm. Soc. Wash.*

KEY WORDS:

Chesapeake Bay, marine fauna, parasites, Western North Atlantic

*Dr. Ilan E. Paperna, former NSF Senior Foreign Scientist Fellow, School of Marine Science, College of William and Mary. Present address: 12 Atzmon St., Ramat-Hasharon, Israel

PROJECT TITLE: SURVEY OF THE DISEASES AND PARASITES OF MARINE
FISHES, THEIR SYMPTOMS AND CONTROLS

INVESTIGATORS:

David E. Zwerner, Assistant Marine Scientist
Adrian R. Lawler*

PROJECT SUMMARY:

The diseases and parasites of marine fishes and the methods for controlling them are being studied through a review of the literature and a compilation of our own data. It is hoped to publish this information in an easily used format. Special emphasis is being placed on the symptoms exhibited by the host and on the different methods of controlling the disease agent.

A glossary of terms applicable to fish diseases is being prepared in addition to a fairly comprehensive bibliography on the controls of these diseases.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Bibliography, controls, diseases, marine fishes, parasites

*Dr. Adrian R. Lawler, Gulf Coast Research Laboratory, Ocean Springs,
Mississippi

PROJECT TITLE: MONOGENETIC TREMATODES OF MENHADEN

INVESTIGATORS:

William J. Hargis, Jr., Institute Director
David E. Zwerner, Assistant Marine Scientist

PROJECT SUMMARY:

A detailed collection of juvenile and adult clupeids (primarily of the genus *Brevoortia*) was made from many stations along the Atlantic and Gulf coasts in order to check seasonal, geographic, host age variability of infestation, intraspecific, intrageneric, and intrafamilial parasite distribution, and thus derive a more detailed understanding of some of the factors acting in host-parasite relationships.

STATUS: Continuing, maintenance of collection only, additional support needed.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Atlantic coast, Gulf of Mexico, menhaden, monogenetic trematodes

Virginia Institute of Marine Science
Microbiology-Pathology Department
Section of Parasitology

PROJECT TITLE: POLYCLAD OYSTER ASSOCIATES

INVESTIGATORS:

William J. Hargis, Jr., Institute Director
Adrian R. Lawler*
Dexter S. Haven, Head of Department of Applied
Marine Science
James P. Whitcomb, Assistant Marine Scientist,
Department of Applied Marine Biology

PROJECT SUMMARY:

One paper has been published on *Coronadena mutabilis* (Verrill) in Virginia. A paper is planned with Haven on the polyclads of the James River.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Flatworms, oysters

* Dr. Adrian R. Lawler, Gulf Coast Research Laboratory, Ocean Springs, Mississippi

PROJECT TITLE: STUDIES ON PARASITIC DINOFLAGELLATES OF
CYPRINODONTIDS OF VIRGINIA AND NORTH CAROLINA

INVESTIGATORS:

William J. Hargis, Jr., Institute Director
Adrian R. Lawler*
Jiri Lom*
Gail Makiernan*

PROJECT SUMMARY:

Oodinium cyprinodontum Lawler, 1967 has been found on the gills of *Fundulus majalis*, *F. heteroclitus*, *F. luciae*, *Cyprinodon variegatus*, *Lucania parva*.

The following studies are being made under this project:

- (1) With Makiernan, a description of dinospore formation.
- (2) With Lom, EM study of attachment and relation to host tissue (completed).
- (3) With Lom, a redescription of *Oodinium cyprinodontum* and a discussion of its taxonomic position.
- (4) Papers in progress by Lawler on: (a) incidence and intensity of infestation of each host species in Virginia and North Carolina, (b) seasonality of infestation, (2) life-history, and (d) other miscellaneous smaller papers.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

PUBLICATION:

- (1) Lom, J., and A. R. Lawler (in press). An ultrastructural study on the mode of attachment in dinoflagellates invading gills of Cyprinodontidae. *Protistologica* 9(2).

KEY WORDS:

Dinoflagellate, fish, parasite

*Dr. Adrian R. Lawler, Gulf Coast Research Laboratory, Ocean Springs, Mississippi

*Dr. Jiri Lom, Institute of Parasitology, Czechoslovakia

*Gail Makiernan, George Washington University

PROJECT TITLE: MONOGENETIC TREMATODES OF AMPHIBIANS AND
REPTILES OF VIRGINIA

INVESTIGATORS:

William J. Hargis, Jr., Institute Director
Claude Combes*

PROJECT SUMMARY:

Very little work has been done on the monogenetic trematodes from amphibians and reptiles of Virginia. An examination of these parasites should prove both enlightening and interesting. Collections of 758 host individuals representing 73 species were made in 1959. At present, these parasites are being worked up, and the host-parasite data will be added to our host-specificity file.

STATUS: Collection is now in the hands of Professor Combes who will co-author with Dr. Hargis.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Amphibians, monogenetic trematodes, reptiles

*Professor Claude Combes (Maitre de Conférences, C.S.U.,
Avenue de Villeneuve, 66 Perpignan, France),
Co-investigator with Dr. Hargis

PROJECT TITLE: STUDIES OF LARVAL MONOGENEA OF FISHES FROM
THE CHESAPEAKE BAY AREA

INVESTIGATORS:

N. Kingston*
W. A. Dillon*
William J. Hargis, Jr., Institute Director

PROJECT SUMMARY:

Knowledge of the taxonomy of larvae of known adult monogenetic trematodes would provide much information on the ontogeny and phylogeny of the group and determine to a greater or lesser degree if the base of our taxonomy of adult worms is sound.

Adult monogenetic trematodes, collected from Chesapeake Bay area fishes, were placed into small dishes of sterile sea water and allowed to deposit eggs. Upon hatching, larvae were studied both alive and in fixed preparation.

In 1969, a portion of the work conducted by the principal investigator (N.K.) during several summers at VIMS was published.

STATUS: Continuing.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Larvae, monogenetic trematodes

*Dr. Newton Kingston, Division of Microbiology and Veterinary Medicine,
Box 3354, University Station, University of Wyoming,
Laramie, Wyoming, Participant in VIMS Summer Program
*Dr. William A. Dillon, University of Tennessee at Martin, Martin,
Tennessee

PROJECT TITLE: PARASITES OF VERTEBRATES (MOSTLY FISHES) FROM
THE ANTARCTIC AND SOUTHERN PACIFIC OCEANS WITH
EMPHASIS ON THE SYSTEMATICS OF MONOGENETIC
TREMATODES

INVESTIGATORS:

David E. Zwerner, Assistant Marine Scientist
William J. Hargis, Jr., Institute Director
William A. Dillon*
Adrian R. Lawler*
Robin M. Overstreet*
E. Lynn Suydam*

PROJECT SUMMARY:

Knowledge of the parasitic fauna of the marine vertebrates from the waters around Antarctica and near the surrounding land masses is very sparse. Since monogenetic trematode parasites of fishes are quite host specific and in view of the indicated ancient geographic relationships of these land masses, studies here should prove fertile and measurably increase our understanding of the paleodistribution of both host and parasite. Studies of taxonomy and host-specificity should add to our knowledge of both host and parasite phylogeny. Extensive collections of host material, for both endo- and ectoparasites, have been made from the following areas utilizing the mass collection technique developed by Hargis: McMurdo Sound, Antarctica - 1958, 1959, 1964, 1965; New Zealand - 1960; Windmill Islands, Wilkes Station, Antarctica - 1961-62; Australia - 1962; Chile and Drakes Passage - 1962; Palmer Station, Antarctica Peninsula- 1967-68. All of the collections have been processed for study (mounted on slides), and taxonomic study of the parasites is in various stages of completion. To date, eight publications and three M.A. theses have resulted.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Antarctica, fishes, monogenetic trematodes, southern Pacific Ocean

*Dr. William A. Dillon, Department of Biological Sciences, University of Tennessee, Martin, Tennessee

*Dr. Adrian R. Lawler, Gulf Coast Research Laboratory, Ocean Springs, Mississippi

*Dr. Robin M. Overstreet, Gulf Coast Research Laboratory, Ocean Springs, Mississippi

*Mr. E. Lynn Suydam, Rappahannock Community College, Warsaw, Virginia

PROJECT TITLE: THE ZOOPLANKTON OF LOWER CHESAPEAKE BAY

INVESTIGATORS:

George C. Grant, Associate Marine Scientist
John E. Olney, Research Assistant
Burton B. Bryan, Graduate Assistant
Fred Jacobs, Graduate Assistant

PROJECT SUMMARY:

A randomized, stratified monthly sampling of zooplankton from the lower Chesapeake Bay was conducted for a two-year period, August 1971-July 1973. These samples are being successively split into aliquots - larger for less abundant taxa, smaller for more abundant taxa - for identification and enumeration. Results will be presented by major groups such as Copepoda, Chaetognatha and Cladocera, showing seasonal distribution and relation of species abundance to hydrography.

Biomass estimates will include measurements of settled volume, dry weight and protein content. Biochemical constituents being measured include, in addition to protein, lipids, carbohydrates and selected analyses of fatty acids.

This project will provide background data necessary for more restricted studies of the effects of sewage emissions on secondary production.

STATUS: Active. This is a subproject of the "Waste Water Treatment Program" of the Chesapeake Bay Research Consortium, Inc.

FINANCIAL SUPPORT:

National Science Foundation (RANN Program)
Virginia Institute of Marine Science

KEY WORDS:

Biomass, chaetognatha, Chesapeake Bay, cladocera, copepoda,
secondary production, zooplankton

PROJECT TITLE: ZOOPLANKTON OF NORFOLK CANYON AND ADJACENT CONTINENTAL
SLOPE WATERS

INVESTIGATORS:

George C. Grant, Associate Marine Scientist
John E. Olney, Research Assistant

PROJECT SUMMARY:

A qualitative and quantitative study of the as yet undescribed zooplankton communities existing in the waters of Norfolk Canyon is the purpose of this project. A preliminary series of plankton tows, 0-400 meters in depth, were obtained in August 1969 on board the R/V *Albatross IV* (NMFS). These were repeated at six-hour intervals over a 24-hour period. Initial examinations revealed the presence (in summer) of an unsuspected boreal fauna at depth.

Spring fauna was sampled in April 1971 via the R/V *Eastward* (NSF) (an attempt to reach the area in November 1969 on this vessel failed). This vessel returned to the study area in May 1972.

An extensive series of surface (0-150 m) zooplankton samples, stratified diurnally and by bottom depth, were obtained in June 1973 on the R/V *Columbus Iselin* (University of Miami). Two subareas were sampled, one in the immediate Canyon area, the other over the open slope south of Norfolk Canyon.

STATUS: Active. Zooplankton work not yet funded; benthic fish studies supported by NSF.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Continental slope, Norfolk Canyon, zooplankton

PROJECT TITLE: THE ECOLOGY OF THE CLADOCERA OF LOWER CHESAPEAKE BAY

INVESTIGATORS:

George C. Grant, Associate Marine Scientist
Burton B. Bryan, Graduate Assistant

PROJECT SUMMARY:

The distribution and abundance of Cladocera in lower Chesapeake Bay are being described and analyzed from monthly collections obtained from August 1971-July 1973. Field data will be employed in the design of laboratory experiments to show the influence of hydrography on fluctuations in distribution and abundance, especially for the abundant summer species *Penilia avirostris* and *Evadne tergestina*.

Four other species are encountered in lower Chesapeake Bay: *Evadne nordmanni*, *Podon intermedius*, *P. leuckarti* and *P. polyphemoides*, the latter being present year-round.

STATUS: Active. This project represents Bryan's dissertation research.

FINANCIAL SUPPORT:

National Science Foundation (RANN Program)
Virginia Institute of Marine Science

KEY WORDS:

Chesapeake Bay, cladocera, *Evadne*, *Penilia*, *Podon*

PROJECT TITLE: SEASONAL VARIATION IN POPULATION STRUCTURE AND BIO-CHEMICAL COMPOSITION OF THE MYSID, *NEOMYSIS AMERICANA*, IN THE YORK RIVER, VIRGINIA

INVESTIGATORS:

George C. Grant, Associate Marine Scientist
Fred Jacobs, Graduate Assistant

PROJECT SUMMARY:

Monthly plankton samples, covering a wide salinity gradient, have been obtained since January 1973. These night-time meter net hauls are sampling *Neomysis americana* in the York and Pamunkey Rivers in an effort to determine distribution, growth rate and generation time of the species. In the Chesapeake Bay area there are 2 and possibly 3 generations per year, each exhibiting distinct morphological and biochemical characters.

The study is developing an annual model of the population dynamics of *N. americana* in this river system and comparing the lipid and fatty acid content of morphologically distinct generations. Additional measurements include dry weight, total protein, carbohydrate, chitin and ash weight.

Laboratory studies determining survival and biochemical composition in different salinity regimes are being considered to help interpret field results.

STATUS: Active. This project represents Jacobs' dissertation research.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Biochemical composition, fatty acids, lipids, mysids, *Neomysis*

PROJECT TITLE: HETEROCYCLIC COMPOUNDS AND LIPIDS ASSOCIATED WITH
PLANKTON

INVESTIGATORS:

George C. Grant, Associate Marine Scientist
Paul L. Zubkoff, Head of Department of Environmental Physiology
Fred Jacobs, Graduate Assistant

PROJECT SUMMARY:

Zooplankton obtained from monthly plankton tows of the lower Chesapeake Bay are being analyzed for biochemical constituents, including protein, carbohydrates, lipids, (particularly fatty acids), and some selected pigments.

When possible, planktonic organisms which are available from cultures are also analyzed.

STATUS: Active

FINANCIAL SUPPORT:

National Science Foundation
(RANN Program)
Virginia Institute of Marine Science

KEY WORDS:

Carbohydrates, fatty acids, lipids, protein, zooplankton

PROGRAM 4:
Coastal Zone Hydrography
And Geology

PROJECT TITLE: STUDY OF NEARSHORE SURFACE CURRENT PATTERNS IN
THE ATLANTIC OCEAN OFF DAM NECK, VIRGINIA

INVESTIGATORS:

Michael E. Bender, Head, Division of Environmental
Science and Engineering
Kenneth L. Marcellus, Associate Marine Scientist
Mark Luttrell, Assistant Marine Scientist

PROJECT SUMMARY:

The intent of this study is to determine the movement and general behavior of surface currents in the Atlantic Ocean off Dam Neck, Virginia, in order that constant, seasonal, or periodically recurring drift patterns can be identified and evaluated. Ultimately, this information will facilitate prediction of onshore points of return for suspended or dissolved materials released on the Atlantic Shelf off southeastern Virginia.

Surface drifter devices are dropped at 3,000 foot interval stations up to two miles off the coast each month. By comparison of recovery location and frequency with respect to prevailing winds for the period adrift, general surface currents in the area and their dependence on atmospheric conditions can be determined.

STATUS: This project is entering its terminal phase and the report is being prepared.

FINANCIAL SUPPORT:

Hampton Roads Sanitation District Commission
Virginia Institute of Marine Science

KEY WORDS:

Drift patterns, surface currents

PROJECT TITLE: SHORE EROSION IN TIDEWATER VIRGINIA

INVESTIGATORS:

Robert J. Byrne, Department Head and Senior Marine Scientist
Gary Anderson, Research Assistant

PROJECT SUMMARY:

In an effort to assess the extent of shoreline erosion of the Virginia tidewater within the Chesapeake Bay system, the topographic map series of 1850 and 1940 were used to distinguish erosion zones. Over 3,000 miles of shoreline have been studied with a statistical compilation from approximately 1,800 reaches. The parameters taken for each reach are:

- (1) Area eroded or accreted,
- (2) Average erosion distance and erosion rate,
- (3) Length of shoreline, and
- (4) Volume of material eroded or accreted.

The results, which exclude the ocean shoreline, indicate over 20,000 acres have been eroded for a 100 year period.

STATUS: Completion is expected in October, 1973. A report is in preparation. This is a subproject of the Wetlands Program of "Chesapeake Bay Research" of the Chesapeake Research Consortium, Inc.

FINANCIAL SUPPORT:

National Science Foundation
(RANN Program)
Virginia Institute of Marine Science

KEY WORDS:

Chesapeake Bay, erosion, shorelines

PROJECT TITLE: HISTORICAL AREAL CHANGES OF EASTERN SHORE
MARSHES

INVESTIGATOR:

Robert J. Byrne, Department Head and Senior Marine Scientist

PROJECT SUMMARY:

The topographic surveys of 1852-70 have been compared with the planimetric surveys of 1962. These data indicate areas of marsh erosion and growth. Approximately 11% reduction of marsh area has occurred since 1852.

STATUS: Active. Report in preparation.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Eastern Shore, erosion, marshes

PROJECT TITLE: EROSION OF BARRIER ISLANDS - HISTORICAL

INVESTIGATOR:

Robert J. Byrne, Department Head and Senior Marine Scientist

PROJECT SUMMARY:

The erosion rates for the barrier islands have been determined using U. S. Coast and Geodetic Survey data from historical topographic and hydrographic surveys which were initiated in 1852. The shoreline position plots have supplied acreages lost due to erosion and zones of accretion.

STATUS: Final report is being prepared.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Barrier islands, Eastern Shore, erosion, shorelines

PROJECT TITLE: A STUDY OF SAND TEXTURAL AND MINERALOGICAL
CHARACTERISTICS OF THE VIRGINIA BARRIER ISLANDS

INVESTIGATORS:

Robert J. Byrne, Department Head and Senior Marine Scientist
Carey Ingram, Graduate Assistant

PROJECT SUMMARY:

The purpose of this study is to see what, if any, differences exists in sand textural characteristics and mineralogy between and within barrier islands. Furthermore, the moments of the distribution will be studied to see if it is possible to delineate the sediments of the foreshore, berm, backshore, and dune.

STATUS: Active. This project represents Ingram's thesis research.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Barrier islands, erosion, sediments, shorelines

PROJECT TITLE: CIRCULATION IN EASTERN SHORE MARSH-LAGOON COMPLEX

INVESTIGATORS:

Robert J. Byrne, Department Head and Senior Marine Scientist
John D. Boon III, Assistant Marine Scientist

PROJECT SUMMARY:

The goal of this project is to elucidate the gross circulation within the inlet-lagoon-marsh channel complex on Virginia's Eastern Shore Atlantic Coast. The studies thus far have concentrated on the northern half of the system from Wachapreague Inlet to Wallops Island. Field measurements include tidal range and phase in the system and tidal discharge in the inlets and major conveyance channels within the system. Aside from using the data to detail areas for intensive study, the field data will be used to develop formulations on the hydraulic geometry of inlets and marsh channels.

STATUS: Active. Report in preparation.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Barrier islands, hydraulics, marshes

PROJECT TITLE: LONG-TERM BEACH CHANGES IN SOUTHEASTERN VIRGINIA

INVESTIGATOR:

Victor Goldsmith, Associate Marine Scientist

PROJECT SUMMARY:

Beach erosion studies have centered on southeastern Virginia from Dam Neck to the North Carolina State line.

Approximately 15 permanent beach profile locations have been measured at one month intervals and before and after major storms. Most of the beach profiles are located precisely at profile stations monitored by previous observers with some of the data going back to the mid 1960's. Thus, this research program is focusing on delineating and understanding long-term shoreline trends.

STATUS: Active

FINANCIAL SUPPORT:

U. S. Army Coastal Engineering Research
Center (pending)
Virginia Institute of Marine Science

KEY WORDS:

Beach changes, erosion, shorelines

PROJECT TITLE: SHORELINE SITUATION REPORTS FOR VIRGINIA

INVESTIGATORS:

Robert J. Byrne, Department Head and Senior Marine Scientist
John M. Zeigler, Head, Division of Physical Science and Coastal
Engineering
William Athearn, Assistant Marine Scientist
Carl Hobbs III, Assistant Marine Scientist
Gary Anderson, Research Assistant

PROJECT SUMMARY:

The goal of this program is to supply, on a county by county basis, the baseline information which planners and management agencies will need to develop comprehensive shoreline management schemes. Our studies include:

- (1) Present erosion characteristics,
- (2) Effectiveness of shoreline protection structures,
- (3) Distribution of shoreline by type,
- (4) Biological characteristics of shoreline,
- (5) Existing pollution problems, and
- (6) Assessment of potential shoreline utilization.

STATUS: Active. This is a subproject of the "Edges Program" of the Chesapeake Research Consortium, Inc.

FINANCIAL SUPPORT:

National Science Foundation
(RANN Program)
Virginia Institute of Marine Science

KEY WORDS:

Chesapeake Bay, coastal zone planning, erosion, shorelines

PROJECT TITLE: MECHANICS OF BEACH CUSP FORMATION

INVESTIGATORS:

Robert J. Byrne, Department Head and Senior Marine Scientist
Asbury H. Sallenger, Jr., Graduate Assistant

PROJECT SUMMARY:

The goal of this study is to gain definitive field measurements of input variables and beach response during the formation of cusps (60 to 90 feet in wavelength) and to evaluate existing theories in the light of thorough field evidence.

STATUS: Active. This project represents Sallenger's dissertation research.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Beach cusps, erosion, shorelines

PROJECT TITLE: WAVE REFRACTION ON THE CONTINENTAL SHELF AND SHORELINE OF VIRGINIA

INVESTIGATORS:

Victor Goldsmith, Associate Marine Scientist
Robert Byrne, Department Head and Senior Marine Scientist

PROJECT SUMMARY:

Wave refraction diagrams are being prepared for the entire Virginia continental shelf and shoreline for a variety of wave directions, periods, and heights with a linearized bottom friction term in the formulation. The computer output includes maximum orbital velocity at the bottom, gradient of wave power, and the longshore current at the shoreline.

STATUS: Active.

FINANCIAL SUPPORT:

National Oceanic and Atmospheric Administration (Office of Sea Grant Programs)
National Aeronautics and Space Administration (Langley Research Center)
Virginia Institute of Marine Science.

PUBLICATIONS:

- (1) Goldsmith, V., W. D. Morris, R. J. Byrne, C. H. Sutton. 1973. The Virginian Sea Wave Climate Model: A Basis for the Understanding of Shelf and Coastal Sedimentology (Abs.) Northeastern G.S.A. Mtg. 5(2): 167.
- (2) Goldsmith, V., J. M. Colonell, R. J. Byrne. 1973. The causes of non-uniform wave energy distribution over the shelf and along the shoreline (Abs.): Inter. Symp. on Interrelationships of Estuarine and Continental Shelf Sed., Univ. de Bordeaux, Talence, France.
- (3) Goldsmith, V., W. D. Morris, and R. J. Byrne. 1973. (In press) Wave Climate Model of the Mid-Atlantic Continental Shelf and Shoreline. VIMS SRAMSOE No. 38.
- (4) Goldsmith, V., A. H. Sallenger, Jr., and W. D. Morris. 1973. The Virginian Sea Wave climate model: application to shoreline problems in Virginia (Abs.): Va. Academy of Sciences Annual Mtg., Williamsburg, Va.,
- (5) Colonell, J. M., V. Goldsmith, and S. Farrell. 1973. Wave refraction analysis: aid to interpretation of coastal hydraulics: A.S.C.E. Hydraulics Div. Conf.: Hydraulic Engineering and the Environment, Montana State Univ., Bozeman.
- (6) Goldsmith, V., R. J. Byrne, and A. H. Sallenger, Jr. 1973. The influence of waves on the origin and development of the offset coastal inlets of the Delmarva Peninsula: 2nd International Estuarine Conference: Myrtle Beach, S. C.

KEY WORDS:

Continental shelf, erosion, shorelines, waves

PROJECT TITLE: RESPONSE CHARACTERISTICS OF TIDAL INLETS (THE EFFECT OF HYDRAULIC FORCES AND SEDIMENT SUPPLY)

INVESTIGATORS:

Robert J. Byrne, Department Head and Senior Marine Scientist
C. S. Fang, Head of Department of Physical Oceanography and
Hydraulics
Joseph T. DeAlteris, Graduate Assistant
Gerald Sovich, Graduate Assistant

PROJECT SUMMARY:

The goal of the proposed research is to document the response of inlet configuration to short term variations in hydraulic input and littoral drift and to relate the observed responses to the relative variability of the input processes. Wachapreague Inlet, an inlet within the barrier island complex of Virginia's Eastern Shore, has been selected for study.

The study is comprised of five elements:

- (1) Monitoring inlet response with respect to cross-sectional area changes and the relation of these changes to inlet currents
- (2) A study of sediment variability (spatial and, temporal) and the geologic controls on the inlet,
- (3) A study of the distribution of bottom shear stress in the inlet channel,
- (4) Formulation of a one-dimensional numerical flow model for the inlet channel, and
- (5) Influence of the inlet currents on adjacent beaches.

STATUS: Item (2) represents DeAlteris' thesis research. Active.
Item (5) represents Sovich's thesis research.

FINANCIAL SUPPORT:

Office of Naval Research
Virginia Institute of Marine Science

KEY WORDS:

Eastern Shore, hydraulics, inlets

PROJECT TITLE: SOUTHERN CHESAPEAKE BAY WATER COLOR AND CIRCULATION
ANALYSIS USING SKYLAB IMAGERY

INVESTIGATORS:

Maynard Nichols, Associate Marine Scientist
John DuPuy, Associate Marine Scientist
Hayden Gordon, Assistant Marine Scientist
Michael Penney, Research Assistant
Galen Thompson, Assistant Marine Scientist

PROJECT SUMMARY:

This investigation is to assist NASA in determining the utility of SKYLAB imagery for mapping and analysis of water color and circulation in southern Chesapeake Bay. Surface observations of water color, turbidity and phytoplankton are made simultaneously with acquisition of satellite imagery and aircraft coverage. Data are being analyzed to chart water mass boundaries from the imagery and to evaluate distributions of color that relate to phytoplankton blooms, sediment dispersal and pollution.

STATUS: Active. Completion in May 1974.

FINANCIAL SUPPORT:

National Aeronautics and Space Administration
Virginia Institute of Marine Science

KEY WORDS:

Hydrography, phytoplankton, remote sensing, sediments.

PROJECT TITLE: HYDROGRAPHIC STUDIES OF CHESAPEAKE BAY - COLLECTION
OF HYDROGRAPHIC DATA ON CHESAPEAKE BAY AND TRIBUTARIES

INVESTIGATORS:

C. S. Fang, Department Head and Senior Marine Scientist
E. P. Ruzecki, Associate Marine Scientist
J. P. Jacobson, Assistant Marine Scientist

PROJECT SUMMARY:

Hydrographic data consisting of measurements of tidal elevation, current velocity, temperature, and salinity are being collected from the Virginia waters of Chesapeake Bay and its major tributaries within Virginia, the James, York, and Rappahannock Rivers, Pocomoke Sound and the Bay. The field work is directed toward the verification of the Chesapeake Bay Hydraulic Model being built under the supervision of the Corps of Engineers, Baltimore District, in cooperation with Chesapeake Bay Institute and Chesapeake Biological Laboratory, who are working primarily within the Maryland section of the Bay system.

Field data for the Rappahannock River, James River, York River, Lower Bay and Mobjack Bay have been reduced and tabulated. Preliminary data for tides, temperature, and salinity have been tabulated and furnished to the Corps of Engineers.

STATUS: Active.

FINANCIAL SUPPORT:

U. S. Army Corps of Engineers
Virginia Institute of Marine Science

KEY WORDS:

Currents, estuaries, hydraulic model, salinity

PROJECT TITLE: SUSPENDED SEDIMENT STUDIES AT NORFOLK NAVAL BASE PIER 12

INVESTIGATOR:

E. P. Ruzecki, Associate Marine Scientist

PROJECT SUMMARY:

A series of studies are being conducted to determine the quantity for size distribution of suspended sediment in the region of pier 12 at the Norfolk Naval Base. Determinations are being made of suspended sediment, temperature, salinity, currents over one complete tidal cycle under varying conditions of river flow, tides and wind.

STATUS: Active - Data will be furnished to the Navy for analysis.
They will attempt to determine the sediment source.

FINANCIAL SUPPORT:

U. S. Navy
Virginia Institute of Marine Science

KEY WORDS:

Currents, estuaries, piers, salinity, suspended sediment, temperature

PROJECT TITLE: LONG CREEK/CANAL CHANNEL EROSION STUDY

INVESTIGATORS:

B. J. Neilson, Associate Marine Scientist
Vincent Hsiao, Graduate Assistant

PROJECT SUMMARY:

This study is being conducted in conjunction with the Geological Oceanography Department to determine the causes of bank and channel-bottom erosion in the Long Creek canal connecting Lynnhaven Bay with Broad Bay. Tide heights have been monitored at seven locations in the bays and connecting waterways for a period of one month. Current measurements over a complete tidal cycle were made to determine the proportion of the water flowing through the canal and the creek.

Since the geometry of the system is relatively simple, harmonic analysis of the system will be used to model the tidal regime. If it should prove difficult to obtain sufficiently accurate results with this technique, a finite difference technique to model the oscillating flows will be used. This model of the system will be used to determine the equilibrium conditions for the system, and thereby determine whether or not additional increases in current velocities in the waterways can be anticipated.

The flow patterns in the near vicinity of the Route 615 bridge will be studied to determine the effects of the channel constriction. Initial observations would indicate that the constriction increases water velocities significantly and produces a level of turbulence that is great enough to erode both the channel bottom and the side banks. Field measurements to determine the present flow regime will be made. Following a study of these measurements recommendations for means of reducing water velocities and erosion will be suggested.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science
City of Virginia Beach

KEY WORDS:

Channel constrictions, erosion, tides

PROJECT TITLE: CONTINENTAL SHELF DATA ACQUISITION DESIGN STUDY

INVESTIGATORS:

J. M. Zeigler, Assistant Director
C. S. Fang, Department Head and Senior Marine Scientist
C. S. Welch, Associate Marine Scientist
P. V. Hyer, Associate Marine Scientist
E. P. Ruzewski, Associate Marine Scientist

PROJECT SUMMARY:

Management of the Virginia Coastal Zone will require a system of regular synoptic sampling of oceanic parameters. Scientists from VIMS are collaborating with NASA Langley Research Center in a project to design such a system using remote sensing in conjunction with remote interrogations of *in situ* sensors. The core of the system will be a method for directly measuring or inferring circulation of the continental shelf waters. In addition, methods of interfacing other current available data with the circulation data are being devised.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science
National Aeronautics and Space Administration
(Langley Research Center)

KEY WORDS:

Circulation, continental shelf, remote sensing, synoptic sampling

PROJECT TITLE: NEWPORT NEWS CIRCULATION BASE STUDY

INVESTIGATORS:

J. M. Zeigler, Assistant Director
C. S. Fang, Department Head and Senior Marine Scientist
R. J. Byrne, Head, Department of Geological Oceanography
C. S. Welch, Associate Marine Scientist

PROJECT SUMMARY:

Part of the mission of VIMS is to act as consultant to other state agencies. In consultation with the state highway department, scientists at VIMS are studying the circulation in the close proximity of Newport News Point. The object of the study which includes a model test in addition to the direct current study, is to predict the effect which a proposed new bridge tunnel will have on the circulation of the lower James River. In particular, the data gathered will provide information to studies of erosion due to the changed current patterns.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

PUBLICATIONS:

"Physical and Geological Studies of the Proposed Bridge-Tunnel Crossing of Hampton Roads near Craney Island."
Special Report in Applied Marine Science and Ocean Engineering Number 24, August 1972.

KEY WORDS:

Circulation, erosion, estuaries

PROJECT TITLE: NEARSHORE CIRCULATION PROJECT

INVESTIGATORS:

J. M. Zeigler, Assistant Director
C. S. Fang, Department Head and Senior Marine Scientist
R. J. Byrne, Head Department of Geological Oceanography
C. S. Welch, Associate Marine Scientist

PROJECT SUMMARY:

During the year, two field exercises have been run at Wachapreague Inlet in order to determine the flow pattern of the inlet and the local continental shelf region. Particular emphasis has been placed on estimating the amount of water exchanged between the shelf and the marsh during a tidal cycle. Preliminary indications are that the offshore flow is extremely wind dependent, the direct tidal influence of the inlet decaying rapidly away from the mouth.

The same surface radar drogued buoy system was used in the Chesapeake Bay Mouth during an ebb tide in support of Skylab. The buoys added more data pointing to a complex structure of flow around Cape Henry.

Development of a transponding Omega navigation buoy for more offshore work continues. A prototype buoy has been demonstrated here and development is centered around the prototype, which will operate in the differential mode. Construction of the first model buoys should be complete by the end of this year.

STATUS: Active. Annual report in preparation.

FINANCIAL SUPPORT:

National Aeronautics and Space Administration
(Wallops Island Station)
Virginia Institute of Marine Science

KEY WORDS:

Circulation, coastal marshes, continental shelf, exchange,
Omega navigation buoy, radar drogued buoy

PROJECT TITLE: FIELD STUDIES OF WASTE AND DISPERSION CHARACTERISTICS
OF THE ELIZABETH RIVER

INVESTIGATORS:

C. S. Fang, Department Head and Senior Marine Scientist
B. J. Neilson, Associate Marine Scientist
A. Y. Kuo, Associate Marine Scientist

PROJECT SUMMARY:

Hydrographic surveys will be conducted in the Elizabeth River to determine the nature of the water quality and circulation patterns. Temperature, salinity and current velocity and direction will be monitored intensively. Dissolved oxygen, biochemical oxygen demand and nutrient levels will be monitored on a less intensive basis. During the survey periods dye releases from one or more of the sewage treatment plants will be conducted to follow the dispersion of the effluent. The hydrographic data and the dye study data will be used to construct a mathematical model of the river. This model will be used to examine three possible courses of action for the sewage treatment plant-river system: (1) Upgrade the level of treatment at present plants, (2) relocate and redesign the present outfalls, (3) remove the outfalls from the river (ocean outfall).

A second aspect of the study will involve comparisons of the Elizabeth River with other major sewage treatment plant outfall locations. From the data gathered a generalized model of the dispersion characteristics of outfall locations will be developed, which will allow for comparisons of outfalls in main channel and minor tributaries of the James River.

STATUS: Active.

FINANCIAL SUPPORT:

National Science Foundation
(RANN Program)
Virginia Institute of Marine Science

KEY WORDS:

BOD, circulation, dispersion, dye releases, estuaries,
mathematical model, model, nutrient levels, outfalls,
water quality

PROJECT TITLE: ESTUARINE MIXING AND TRANSPORT

INVESTIGATORS:

C. S. Fang, Department Head and Senior Marine Scientist
B. J. Neilson, Associate Marine Scientist
A. Y. Kuo, Associate Marine Scientist

PROJECT SUMMARY:

The goal of the studies is to determine how substances introduced into the James River are mixed into the body of water and how they are transported to other points. The primary emphasis of the studies during the summer of 1972 will be the dispersion and diffusion of conservative liquid additions. These processes will be studied by following the "batch" release of the dye, Rhodamine WT. It is believed that for the portion of the James between Richmond and Hopewell (and the Appomattox River too) a one-dimensional approach is appropriate. Dye concentrations will be measured at fixed points as the dye cloud passes upstream and downstream. In addition, samples will be taken from moving boats to investigate lateral variations and to obtain at least one example of concentration variation with distance at a (more or less) fixed time. Other longitudinal distribution curves will be constructed from the data collected at fixed points following the method used by Fischer. The dispersion coefficients will then be calculated by using the "change-of-moment method".

For the portion of the estuary from Hopewell to Hampton Roads, it will be necessary to use a two-dimensional approach. The dispersion of batch releases of dye will be measured by having moving boats transect the dye cloud both longitudinally and laterally at specified time intervals. The dispersion coefficient will be calculated from the changing pattern of dye concentration. In addition the dye concentration will be monitored at one or two fixed points to determine the time of passage.

In addition to the dye studies, temperature, salinity, dissolved oxygen, BOD and currents will be measured to model the dissolved oxygen regime. Special attention will be given to the oxygen sag near sources of organic pollution. (e.g. below Richmond and Hopewell.)

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science
Virginia State Water Control Board

KEY WORDS:

Diffusion, dispersion, dissolved oxygen, estuaries, mixing

PROJECT TITLE: CIRCULATION AND MIXING IN THE AREA OF THE VIRGINIA CAPES

INVESTIGATORS:

C. S. Fang, Department Head and Senior Marine Scientist
A. Y. Kuo, Associate Marine Scientist
Evon P. Ruzicki, Associate Marine Scientist

PROJECT SUMMARY:

A mathematical model of the coastal sea around Chesapeake Bay entrance and the adjacent continental shelf area which, given wind stress and heat flux on the sea surface, together with some conditions on the bottom and boundaries, should be able to describe the general distribution of currents, temperature, and salinity, is being developed. After proving satisfactory, the model can be used for oceanographic forecasting, such as invasion of long waves from the ocean, the distribution of pollutants, the effect of dredging, and beach erosion.

Preliminary field work was carried out in September and October 1971. Results of this work are being used to design further field studies directed towards determining surface velocity fields in the study area.

STATUS: This project represents Ruzicki's dissertation research.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science
National Science Foundation (pending)

KEY WORDS:

Chesapeake Bay, coastal sea, continental shelf, currents,
dredging, energy, erosion, forecasting, model, pollution,
salinity, temperature

PROJECT TITLE: MATHEMATICAL MODELS OF WATER QUALITY AND SALT INTRUSION FOR THE JAMES RIVER ESTUARY

INVESTIGATOR:

A. Y. Kuo, Associate Marine Scientist

PROJECT SUMMARY:

Two mathematical models were developed for the James River Estuary. The models were derived from the one-dimensional mass balance equations. The equations were solved numerically with a finite difference implicit scheme. The 'real time' model was used to predict the salinity, DO and BOD concentrations along the estuary. The 'slack tide approximation' model was used to predict the long term variation of salt intrusion. Both models have been calibrated with field data collected in the summer of 1971.

STATUS: A report is in preparation.

FINANCIAL SUPPORT:

Cooperative State Agencies
(State Water Control Board)
(Virginia Institute of Marine Science)

KEY WORDS:

Dissolved oxygen, estuaries, mathematical models, prediction,
salt intrusion

PROJECT TITLE: A MATHEMATICAL MODEL OF TIDAL HYDRAULICS IN ESTUARINE RIVER

INVESTIGATORS:

A. Y. Kuo, Associate Marine Scientist
Fwu-Ding Lin, Graduate Assistant

PROJECT SUMMARY:

One-dimensional continuity equation, momentum equation, and mass balance equation of salt have been derived by averaging the general three-dimensional equations over cross-section of estuarine river. The equations will be applied to the James River Estuary and solved numerically with a finite difference implicit scheme. The predicted water velocity, depth and salinity distribution will serve as input information of water quality model.

STATUS: This project represents Lin's thesis research.

FINANCIAL SUPPORT:

Cooperative State Agencies
(State Water Control Board)
(Virginia Institute of Marine Science)

KEY WORDS:

Continuity equation, estuaries, finite difference implicit scheme,
mass balance equation, model, momentum equation

PROJECT TITLE: DRIFT BOTTLE/SEABED DRIFTER ANALYSIS

INVESTIGATORS:

C. S. Welch, Associate Marine Scientist
John J. Norcross, Senior Marine Scientist

PROJECT SUMMARY:

Drift bottle/sea bed drifter data from project MACONS* have been analyzed with respect to use in coastal management. In particular, their relation to the siting of offshore ports and sewage outfalls has been considered. The results are currently being prepared for publication.

STATUS: Active

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Drift bottle, energy, MACONS, offshore dredging, offshore dumping,
offshore ports, offshore power plants, pollution, seabed
drifters, sewage outfalls

*Mid-Atlantic Continental Shelf Study

PROJECT TITLE: A TWO-DIMENSIONAL MATHEMATICAL MODEL FOR THE COASTAL SEA
OFF THE CHESAPEAKE BAY MOUTH

INVESTIGATORS:

A. Y. Kuo, Associate Marine Scientist
E. M. Stanley, Graduate Student

PROJECT SUMMARY:

Two-dimensional continuity equation, momentum equation, and mass balance equation of salt have been derived by integrating the general three-dimensional equations over depth. The equations will be applied to an area of coastal sea off the Chesapeake Bay mouth. A numerical program will be set up to solve the equations with specific boundary conditions pertaining to the area. The model is expected to predict the coastal circulation pattern under varying conditions of tide, winds and freshwater discharge from the bay.

STATUS: This project represents Stanley's thesis research.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Chesapeake Bay, circulation, continental shelf, estuarine discharge,
model

PROJECT TITLE: TWO-DIMENSIONAL JET DISCHARGING INTO AMBIENT FLUID
OF CROSS STREAM

INVESTIGATORS:

A. Y. Kuo, Associate Marine Scientist
M. L. Crane, Graduate Assistant

PROJECT SUMMARY:

Numerical computation was performed for a two-dimensional flow field induced by a plane jet discharging into ambient fluid of cross stream. The boundary conditions simulate the flow of water from the Chesapeake Bay into the Atlantic Ocean. Coriolis parameter was included in the computation.

Steady flow patterns have been computed for several values of the ratio of jet velocity to ambient fluid velocity. Unsteady flow pattern is under investigation.

STATUS: This project represents Crane's thesis research. It is a subproject of the "Waste Water Treatment Program" of the Chesapeake Research Consortium, Inc.

FINANCIAL SUPPORT:

National Science Foundation
(RANN Program)
Virginia Institute of Marine Science

KEY WORDS:

Jet, near-shore circulation, steady state, two-dimensional flow, unsteady state

PROJECT TITLE: WIND-GENERATED INERTIAL CURRENTS

INVESTIGATORS:

C. S. Welch, Associate Marine Scientist
W. Saunders, Graduate Assistant

PROJECT SUMMARY:

Inertial currents in the Atlantic Ocean are being studied in an effort to better understand the way in which these currents are wind generated. Data from an array of current meters and anemometers are being used and a mathematical model is used to predict the inertial currents. This model includes the effects of the wind field over the array.

STATUS: This project represents Saunders' thesis research.

FINANCIAL SUPPORT:

National Aeronautics and Space Administration
(Wallops Island Station)
Virginia Institute of Marine Science

KEY WORDS:

Atlantic Ocean, inertial currents, wind generation

PROJECT TITLE: SURFACE TIDAL CIRCULATION OF MOBJACK BAY

INVESTIGATORS:

C. S. Welch, Associate Marine Scientist
Eddie Wu, Graduate Assistant

PROJECT SUMMARY:

Seven current meter stations' Eulerian measurements and the drifting buoys' Lagrangian observations' data have been calculated. By using two different methods (direct and indirect), the comparison of the total differentiation of surface (2 ft.) current velocity with respect to time can be made.

Power spectra of current velocity measurements have been analyzed to find out the semi-diurnal and diurnal constituents for deriving the tidal ellipses of each station.

A spar buoy has been designed and the triangulation technique has also been employed for collecting the field Lagrangian data.

STATUS: This project represents Wu's thesis research.

FINANCIAL SUPPORT:

National Aeronautics and Space Administration
(Wallops Island Station)
Virginia Institute of Marine Science

KEY WORDS:

Estuaries, Lagrangian measurements, surface currents, tidal ellipses

PROJECT TITLE: VIMS-NASA-LRC COOPERATIVE SHELF CIRCULATION STUDY

INVESTIGATORS:

J. M. Zeigler, Assistant Director
C. S. Fang, Department Head and Senior Marine Scientist
P. V. Hyer, Associate Marine Scientist

PROJECT SUMMARY:

A pilot project has been undertaken to develop a joint program for studying circulation over the continental shelf. A data base has been delineated and an experiment definition has been generated. The purpose of the experiment is to study turbulent water-mass exchanges over the continental shelf and slope. The experiment features NOAA-II photography for rapid detection of warm-water intrusions and air deployment of free-drifting telemetering buoys for study of evolution of these features.

STATUS: Active. An annual report is in preparation.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science
National Aeronautics and Space Administration
(Langley Research Center)

KEY WORDS:

Circulation, continental shelf, satellite photography

PROJECT TITLE: OPERATION AGNES

INVESTIGATORS:

A. Y. Kuo, Associate Marine Scientist
C. A. Lake, Assistant Marine Scientist
J. Windsor, Graduate Assistant

PROJECT SUMMARY:

This project is one of the many phases of studies concerning the effects of Hurricane Agnes on the environment and organisms of Chesapeake Bay and adjacent continental shelf. The purpose of this study is to monitor the effects of the flood water on the circulation of the Bay System and on the transport of material substances including nutrients, suspended sediments, pesticides and metals. Other phases of the study focus on the impact on biologic components. This project emphasizes the path of the Susquehanna River water as it passes down the bay, out of the mouth and onto the shelf.

The data being analyzed include:

- (1) Current at transects across bay mouth and across mid-bay between Smith Point and Tangier Island,
- (2) Temperature, sediment concentration, salinity, nitrate and nitrite, orthophosphate, total soluble phosphorus and Kjeldahl nitrogen, Cu, Cd, Zn, and Pb in water samples collected at the stations in the lower bay.
- (3) Temperature, salinity, nitrogen and phosphorus in water samples collected at the coastal sea off the bay mouth.

STATUS: Active.

FINANCIAL SUPPORT:

National Science Foundation
Virginia Institute of Marine Science

KEY WORDS:

Chesapeake Bay, continental shelf, estuaries, floods, heavy metals,
Hurricane Agnes, material fluxes, pesticides, transport

PROJECT TITLE: RAPPAHANNOCK RIVER MONITORING STATION

INVESTIGATORS:

C. S. Fang, Department Head and Senior Marine Scientist
G. L. Parker, Graduate Assistant

PROJECT SUMMARY:

Two water temperature and salinity monitoring stations have been installed on the Rappahannock River. The upstream station is mounted on Lighted Tower Structure Number 9, off Smokey Point near Waterview; the downstream station on one of the concrete piers at the south side of the channel under the Norris Bridge at Greys Point. At each station there are two sets of temperature-salinity sensors. InterOcean Model 513 probes, one located six feet below mean low water level and the other approximately six feet above the bottom. In the case of the Smokey Point station where the water depth is 22 feet, the lower probe is at minus 16 feet; at Norris Bridge where the depth is approximately 35 feet, the lower probe is at about minus 30 feet. The sensors are mounted on trolleys which ride vertically in tracks secured rigidly to the structures on which they are mounted. In this way the instruments may be readily withdrawn from the water for inspection and servicing by means of attached nylon lines. Each probe has its own track with a stop to prevent the trolley from descending below its proper depth.

The data from these sensors are recorded in digital form on one-quarter inch magnetic tape within a Braincon Type 710 Data Acquisition Package. Sampling rate is once every thirty minutes. Power required is plus and minus 18 volts D. C. This is provided by battery at the Smokey Point tower. At Norris Bridge power is supplied through an appropriate conversion power supply from Vepco A. C. sources with a battery back-up system.

STATUS: Active.

FINANCIAL SUPPORT:

U. S. Army Corps of Engineers, Norfolk District
Virginia Institute of Marine Science

PUBLICATION:

Fang, C. S., Parker, G. L., Hargis, W. J. Jr., Salinity & Temperature Monitoring Stations at Lower Rappahannock River. Special Report in Applied Marine Science and Ocean Engineering Number 32.

KEY WORDS:

Estuaries, monitoring, salinity, temperature

PROJECT TITLE: PAMUNKEY RIVER MONITORING STATION

INVESTIGATOR:

C. S. Fang, Department Head and Senior Marine Scientist

PROJECT SUMMARY:

There are two stations currently installed and operating in the York River System, one on the Ferry Pier at the Virginia Institute of Marine Science, Gloucester Point, Virginia and the other at Olssons Landing on the Pamunkey River, about three and one half miles northwest of West Point. Both stations monitor water temperature and salinity continuously. The sensors are InterOcean Model 513 probes and the recorders are Rustraks, Model 288, plus and minus 12 volt D. C. Power is supplied from local Vepco A. C. sources through an appropriate power supply, with a 12 volt back-up battery system to take over in event of a power failure.

The sensors at both the VIMS pier and at Olssons Landing are placed at six feet below mean low water. To keep the instruments in position and yet readily retrievable for inspection and servicing, they are mounted on a trolley which can run in a vertical track rigidly secured, in each case, to a piling on the pier. A length of nylon line permits the sensor to be lowered to the proper depth and to be raised whenever necessary.

STATUS: Active .

FINANCIAL SUPPORT:

Virginia Electric and Power Company
Virginia Institute of Marine Science

KEY WORDS:

Estuaries, monitoring, salinity, temperature

PROJECT TITLE: BATHYMETRIC STUDY OF LOWER YORK RIVER ADJACENT TO VEPCO
YORKTOWN POWER STATION

INVESTIGATORS:

John Jacobson, Assistant Marine Scientist
W. Athearn, Assistant Marine Scientist

PROJECT SUMMARY:

VIMS is under contract to Vepco to perform three comprehensive nearshore bathymetric surveys of the York River adjacent to the Yorktown Power Station. These surveys are to be carried out just prior to installation of a new discharge pipe - diffuser system, just after completion of the pipe - diffuser and two years after this system has been in place. The first phase of this project, bathymetry prior to installation, was completed in October, 1972. Construction of the pipe - diffuser system is now in progress.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science
Virginia Electric and Power Company

KEY WORDS:

Bathymetry, diffusers, estuaries, power plants

PROJECT TITLE: FATE OF WASTE HEAT DISCHARGED INTO THE JAMES RIVER
ESTUARY BY THE SURRY NUCLEAR POWER STATION AT HOG POINT,
SURRY COUNTY, VIRGINIA

INVESTIGATORS:

C. S. Fang, Department Head and Senior Marine Scientist
E. A. Shearls, Assistant Marine Scientist
S. N. Chia, Research Assistant

PROJECT SUMMARY:

Temperature profiles in the vicinity of the mixing zone of the heated water discharge plume are being determined. Deduced thermal patterns will be compared with those obtained from previous model studies under similar wind and flow conditions to evaluate the relevance of model studies for these purposes. The importance of winds on the movement of the thermal effluent is under particular consideration.

STATUS: Active.

FINANCIAL SUPPORT:

U. S. Atomic Energy Commission
Virginia Institute of Marine Science

PUBLICATIONS:

- (1) Bolus, R. L., S. N. Chia, C. S. Fang.
The Design of the Monitoring System for the Thermal Effect Study of the Surry Nuclear Power Plant on the James River. Special Report in Applied Marine Science and Ocean Engineering Number 16.
- (2) Chia, S. N., C. S. Fang, R. L. Bolus, and W. J. Hargis, Jr.
Thermal Effects of the Surry Nuclear Power Plant on the James River, Virginia, Part II. Results of Monitoring Physical Parameters of the Environment Prior to Plant Operation, Special Report in Applied Marine Science and Ocean Engineering Number 21.
- (3) Shearls, E. A., S. N. Chia, W. J. Hargis, Jr., C. S. Fang, and R. N. Lobecker.
Thermal Effects of the Surry Nuclear Power Plant on the James River, Virginia, Part III. Results of Monitoring Physical Parameters of the Environment Prior to Plant Operation, Special Report in Applied Marine Science and Ocean Engineering Number 33.

KEY WORDS:

Estuaries, heated effluents, nuclear power plants

PROJECT TITLE: STUDY OF THE PHYSICAL EFFECTS OF THERMAL DISCHARGES INTO
JAMES RIVER BY SURRY NUCLEAR POWER PLANT

INVESTIGATORS:

C. S. Fang, Department Head and Senior Marine Scientist
S. N. Chia, Research Assistant

PROJECT SUMMARY:

A mathematical model is developed to predict the temperature distribution of the plume in James River which is caused by the discharging of the cooling water of VEPCO's Surry County nuclear power plant. Based on the river condition and the geometry of the James River, two and three-dimensional models will be developed. Three data collecting systems - the moving boat system, *in situ* (tower) system, and an over-fly system, are constructed to take field data. From the measured data, several physical parameters such as heat exchange coefficient, equilibrium temperature, and cloudiness ratio, will be evaluated such that the prediction of the model is available. Statistical analysis, analysis of variance or regression analysis, for the moving boat system data, and time-series analysis of the tower system data are also included to make the data more useful.

STATUS: This project represents Chia's dissertation research.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Data collection, estuaries, heated effluent, moving-boat method,
nuclear power plants, time series

PROJECT TITLE: BEHAVIOR OF WASTEWATER-ORIENTED NONCONSERVATIVE SUBSTANCES

INVESTIGATORS:

C. S. Fang, Department Head and Senior Marine Scientist
B. J. Neilson, Associate Marine Scientist
A. Y. Kuo, Associate Marine Scientist

PROJECT SUMMARY:

In conjunction with the "mixing and transport" studies, the behavior of nonconservative substances, coliform bacteria in particular, will be investigated. Chlorination at selected sewage treatment plants will be halted for specified periods of time. Samples will then be collected to determine the spatial and temporal variations of the coliform count. Currents, tidal fluctuations, and other data collected in previous and concurrent studies will be used to predict likely geometries of the effluent plume throughout the tidal cycle. Sampling points and frequency of observation will be chosen using these predictions in order to obtain as accurate a picture as possible.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia State Water Control Board
Virginia Institute of Marine Science

KEY WORDS:

Bacteria, estuaries, non-conservative substances, prediction,
sewage effluent

PROJECT TITLE: I-64 FIELD SURVEY FOR I-664 BRIDGE-TUNNEL DESIGN

INVESTIGATORS:

C. S. Fang, Department Head and Senior Marine Scientist
B. J. Neilson, Associate Marine Scientist

PROJECT SUMMARY:

Model studies of the I-664 bridge-tunnel crossing of Hampton Roads indicated several areas of environmental concern. Since the second tunnel for the I-64 crossing (Hampton Roads Bridge-Tunnel) is under construction, a field survey of the construction of that tunnel will be conducted to provide additional information for the design of the I-664 crossing.

An intensive field survey will be conducted to note and document if changes to the natural environment occur. In particular, water quality will be monitored to see if significant amounts of nutrients are released from the bottom sediments during dredging and thereby reduce the dissolved oxygen content of the overlying waters. Modifications to the flow patterns will be studied using both fixed point current meters and drogued buoys. Two points of special interest in this portion of the study are the flow patterns around the tunnel islands and the modification of the flow by the trench dredged for the tunnel segments.

Results of the physical studies will be coordinated with geological, benthic and shellfish studies to provide a complete multidisciplinary survey of the crossing corridor and the environmental changes occurring during construction.

STATUS: Active

FINANCIAL SUPPORT:

Virginia Institute of Marine Science
Virginia State Highway Department

KEY WORDS:

Environmental change, estuaries, flow patterns, nutrients,
obstacles, sediments

PROGRAM 5:
Advisory Services Related
to Marine Resources

PROJECT TITLE: EXTENSION SERVICES

INVESTIGATORS:

Bruce W. Mattox, Department Head and Chief Economist
Robert K. Dias, Marine Advisory Specialist
Jon A. Lucy, Marine Advisory Specialist

PROJECT SUMMARY:

The personnel associated with this project conduct informal educational programs and provide a mechanism for transferring information concerning uses of marine resources. The objectives being pursued are: 1) Establish and maintain contacts with entities having interests in coastal areas. 2) Secure and communicate information to those needing such information to solve marine-related problems. 3) Develop and maintain knowledge of other programs of information transfer so as to foster cooperation with these related programs. 4) Develop and maintain proficiency in identifying, selecting and using methods of communication which are appropriate to meet the needs of target audiences. 5) Promote understanding and cooperation within the marine community.

The following statements indicate a few of the most recent accomplishments which have been realized through this project: Initiated and continued contacts with entities having interests in coastal areas; held workshops for the Oyster Industry, the Boating Industry, and the Menhaden Industry; co-sponsored a workshop for state and local officials concerning Development and Conservation of Wetlands; compiled and supplied data on the effects of Tropical Storm Agnes to appropriate state and federal agencies; synthesized and supplied information on various disaster assistance programs to clients; sampled oyster mortalities to help users determine eligibility for disaster loans; helped detect and monitor and advised industry of outbreaks of "Pink" oysters and "Black" oysters; assessed benefits and costs of previous involvement with "Pink" oyster problem; worked closely with researchers and industry on clam, oyster and crab aquaculture projects; attended numerous meetings and workshops with industry, academic and government personnel; prepared marine exhibits for various audiences; supplied users with information on a wide spectrum of topics; thesis research regarding the economics of selected segments of Virginia's fishing industry was initiated.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Advisory Services

PROJECT TITLE: FISH DISEASE ADVISORY SERVICES

INVESTIGATORS:

Frank O. Perkins, Department Head and Senior Marine Scientist
David E. Zwerner, Assistant Marine Scientist

PROJECT SUMMARY:

Diagnosis of diseases (including metazoan parasite problems) and identification of abnormalities in fishes both from fresh and salt water environments are made for both the lay and scientific communities in Virginia. Advice concerning the significance of the condition, and when possible, methods to control or alleviate the problem are offered.

Information and experience gained from these advisory services are important inputs to our general "Survey of the diseases and parasites of marine fishes...".

STATUS: Continuing

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Advisory Services, diseases, fish

PROJECT TITLE: DEVELOPMENT OF A RAPID ACCESS DATA STORAGE AND RETRIEVAL SYSTEM

INVESTIGATORS:

Richard W. Moncure, Computer Systems Analyst
J. P. Jacobson, Assistant Marine Scientist

PROJECT SUMMARY:

A Master Indexed Sequential Data File will be created. Rapid access will be provided through the use of keys. Maximum utilization will be made of existing data handling facilities of the System 360 Operating System and Sort/merge utilities.

A control program will be developed to provide retrieval by any parameter or combination of parameters desired. Facilities will be provided for rejecting or accepting a retrieved record based on pre-defined conditions. Options will be included to allow for sorting of retrieved data and for saving retrieved data on magnetic tape for analysis.

STATUS: Active.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Data retrieval

PROJECT TITLE: INVENTORY OF EXISTING DATA BASES IN THE
CHESAPEAKE REGION.

INVESTIGATORS:

William DuPaul*
John V. Merriner, Associate Marine Scientist
Kenneth Moore, Assistant Marine Scientist

PROJECT SUMMARY:

VIMS is attempting to develop an accurate and complete inventory of coastal zone data available in the Chesapeake Economic Region. The completed data file descriptions become part of the Environmental Data Base Directory (EDBD) System portion of the Environmental Data Service Environmental Data Index (ENDEX) effort.

The EDBD System focuses on descriptions of data files from sources outside of National Data Centers.

STATUS: Active.

FINANCIAL SUPPORT:

National Oceanic and Atmospheric Administration
(Environmental Data Service)
Virginia Institute of Marine Science

KEY WORDS:

Data bases, data inventory

*William DuPaul, Massachusetts Maritime Academy, Buzzards Bay, Massachusetts.

PROJECT TITLE: MARINE ENVIRONMENTS AND RESOURCES RESEARCH AND MANAGEMENT SYSTEM (MERRMS)

INVESTIGATORS:

William J. Hargis, Jr., Institute Director
John B. Pleasants, Assistant Marine Scientist

PROJECT SUMMARY:

This project includes development of informational resources. These include:

- (1) Collecting and continuously updating cartographic data. These consist of topographic maps, aerial photographs, county and city highway maps, and National Ocean Survey (NOS) charts, a multi-projector random access slide system for rapid retrieval of pertinent data.
- (2) A special purpose microfiche library devoted to coastal zone management, plus a means of distributing this information.
- (3) Files of permits for alterations to the coastal zone, and a predictive capability relative to the effect of such alterations on wetlands, shorelines, and shallows.
- (4) Hardware and software - including computer techniques - to permit rapid access and interpretation of the above data for interdisciplinary and nonspecialist users.

MERRMS is designed to provide a point source of data on the coastal zone of Virginia. It is intended to enable managers and technical advisors to rapidly review all available information on any problem in the area of concern. It is intended to act as an interpretive interface between scientific specialists and managers.

Future developments include real-time access to computerized data banks, as well as computer searches for information in microfiche files.

Although the initial emphasis has been on Virginia's coastal zone, this project is intended to expand to cover the entire Chesapeake Bay as well as the Middle Atlantic coast.

STATUS: Active. This is a subproject of "Chesapeake Bay Research" of the Chesapeake Research Consortium, Inc.

FINANCIAL SUPPORT:

National Science Foundation
(RANN Program)
Virginia Institute of Marine Science

KEY WORDS:

Coastal zone management, data collections, informations systems management

PROJECT TITLE: INVENTORY OF MARINE ENVIRONMENTAL DATA IN THE
MID ATLANTIC REGION

INVESTIGATORS:

Maurice P. Lynch, Senior Marine Scientist
Morris H. Roberts, Associate Marine Scientist, Invertebrate
Ecology
C. S. Fang, Senior Marine Scientist, Physical
Oceanography and Hydraulics
John M. Zeigler, Assistant Director, Physical Science and
Coastal Engineering

PROJECT SUMMARY:

An inventory of environmental and socio-economic data from the coastal region from Sandy Hook, New Jersey to Cape Canaveral, Florida is being assembled to provide a background for the Council for Environmental Quality and the Bureau of Land Management planning for possible exploration and exploitation of offshore energy resources.

STATUS: Active.

FINANCIAL SUPPORT:

Council for Environmental Quality
U. S. Department of Interior (Bureau of Land Management)
Virginia Institute of Marine Science

KEY WORDS:

Data inventory

PROJECT TITLE: THE CHESAPEAKE BAY BIBLIOGRAPHY

INVESTIGATOR:

Susan O. Barrick, Head Librarian

PROJECT SUMMARY:

This project is designed to provide an initial bibliography and periodic updating of studies related to the estuarine portion of the Chesapeake Economic Region. To provide as rapid utility of this project as possible, incremental portions of the bibliography are prepared and disseminated. Volume I, The James River, was prepared and distributed with support from IRRPOS, Sea Grant, and NASA, Langley Research Center. Volume II, The Lower Bay, was prepared and distributed with support from NSF-RANN and CRC, Inc. Present efforts are aimed at extending the scope of the bibliography to include the upper Bay.

STATUS: Active.

FINANCIAL SUPPORT:

National Science Foundation
(RANN Program)
Chesapeake Research Consortium, Inc.
Virginia Institute of Marine Science

KEY WORDS:

Bibliography

**Other Geographical
Areas**

PROJECT TITLE: ECOLOGICAL AND TAXONOMIC INVESTIGATIONS ON BENTHIC ANIMALS
IN AUSTRALIAN ESTUARIES

INVESTIGATOR:

Donald F. Boesch, Associate Marine Scientist

PROJECT SUMMARY:

These studies involve:

- (1) Taxonomic, biogeographic, ecological, and evolutionary research on estuarine peracarid crustaceans (amphipods, isopods, tanaids).
- (2) An investigation of the distribution and structure of benthic communities along an estuarine gradient.

In the first part, a faunule of over thirty species will be described and approximately 12 new species await description. The peracarid faunule of Australian estuaries contains cosmopolitan estuarine species and genera, Indo-Pacific estuarine genera, and endemic estuarine genera.

The salinity along the estuarine gradient studied varied greatly from the dry to the wet season. The community distribution pattern along the estuarine gradient reflected high river-flow, wet season conditions.

STATUS: One taxonomic paper has been published and several new species await description. A report on the community studies is in preparation.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science
Fulbright-Hays Program (Australian-American Educational Foundation)

KEY WORDS:

Australia, estuaries, taxonomy

PROJECT TITLE: PARASITIC COPEPODS FROM MARINE FISHES OF NEW
ZEALAND AND AUSTRALIA

INVESTIGATORS:

William J. Hargis, Jr., Institute Director
G. C. Hewitt*
David E. Zwerner, Assistant Marine Scientist

PROJECT SUMMARY:

Numerous parasitic copepods were collected in conjunction with the Parasitology Section's survey of the monogenetic trematodes of fishes of New Zealand and Australia under the direction of Dr. W. J. Hargis, Jr.

In view of their potential aid in the study of the total parasitic fauna of fishes and for their own sake as ectoparasites, a systematic study was undertaken in conjunction with Dr. Hewitt. Processing, involving whole mounts, dissections, and systematic descriptions is underway.

STATUS: Continuing.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Australia, fishes, New Zealand, parasitic copepods

*Dr. G. C. Hewitt, Victoria University of Wellington, Wellington,
New Zealand

PROJECT TITLE: MONOGENETIC TREMATODES OF FISHES OF PUERTO RICO

INVESTIGATORS:

William J. Hargis, Jr., Institute Director
David E. Zwerner, Assistant Marine Scientist

PROJECT SUMMARY:

A collection of fishes was made from the marine waters of Puerto Rico. Many of the trematodes obtained from these fishes will undoubtedly be new to science, and their systematic innovations will shed light on the relations of one taxon to another.

Collections were made using the mass collection technique developed by Hargis. Some of the material resulting from this collection was processed for study. Host-parasite data will be incorporated into our host-specificity file.

STATUS: Continuing, maintenance of collection only, additional support needed.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Fishes, monogenetic trematodes, Puerto Rico

PROJECT TITLE: PARASITES FROM INDIAN OCEAN FISHES WITH EMPHASIS
ON MONOGENETIC TREMATODES, THEIR SYSTEMATICS,
ECOLOGY, AND PHYLOGENY

INVESTIGATORS:

William J. Hargis, Jr., Institute Director
David E. Zwerner, Assistant Marine Scientist
Robin M. Overstreet*

PROJECT SUMMARY:

Considerable ignorance exists concerning the parasite fauna of coastal and deep-sea fishes of the Indian Ocean. Increased knowledge of the Monogenea from these important areas is essential to the Parasitology Section's project on the systematics, host-specificity, zoogeography, and phylogeny of the Monogenea.

Collections of fishes were made by our field collectors from March 1963 through November 1964, while participating in IIOE cruises 1, 2, 4B, 5, and 8. Collections were made using the mass collection techniques developed by Hargis. The great amount of material resulting from these collections has to be processed for study.

Dr. Overstreet will work-up the Digenea from this collection as soon as the material can be culled out and outstanding host indentifications made.

STATUS: Continuing, maintenance of collection only, additional support needed.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Digenetic trematodes, fishes, Indian Ocean, monogenetic trematodes

*Dr. Robin M. Overstreet, Gulf Coast Research Laboratory, Ocean Springs, Mississippi

PROJECT TITLE: MONOGENETIC AND DIGENETIC TREMATODES OF MIDDLE
CONTINENTAL SHELF OFF WEST AFRICA

INVESTIGATORS:

William J. Hargis, Jr., Institute Director
David E. Zwerner, Assistant Marine Scientist
Robin M. Overstreet*

PROJECT SUMMARY:

A total of 1044 fishes from the Gulf of Guinea was collected utilizing the mass collecting technique developed by Hargis. Forty-six percent of the hosts have been examined yielding about 660 monogenetic trematodes, and other parasites. This good collection from previously unexamined hosts and localities when finally worked up will do much in elucidating the systematic scheme of the Monogenea as well as providing important data for host-specificity studies.

Dr. Overstreet will work up the digenetic trematodes in conjunction with some of his own material from Africa.

STATUS: Continuing, maintenance of collection only, additional support needed.

FINANCIAL SUPPORT:

Virginia Institute of Marine Science

KEY WORDS:

Africa, digenetic trematodes, fishes, monogenetic trematodes

*Dr. Robin M. Overstreet, Gulf Coast Research Laboratory, Ocean Springs, Mississippi

APPENDIX I

Appendix I is a listing of locations of those staff and students who are no longer with VIMS but whose work was described in the 1972 Edition of this Volume.

Staff

Bolus, Robert L., Ph.D. Program, University of New Hampshire, Durham, New Hampshire.

Calder, Dale R., Marine Resources Research Laboratory, Charleston, South Carolina.

Chia, S. N., State Water Control Board, P. O. Box 11143, Richmond, Virginia.

Chittenden, Mark E., Department of Wildlife and Fisheries Sciences, Texas A & M University, College Station, Texas.

DuPaul, William D., Massachusetts Maritime Academy, Buzzards Bay, Massachusetts.

Hill, Richard, Water Control Board, P. O. Box 11143, Richmond, Virginia.

Lunz, John, Office of Dredged Materials Research Program, Waterways Experiment Station, U. S. Army Corps of Engineers, Vicksburg, Mississippi.

Luttrell, Mark, Woodward-Ervicon, Houston, Texas.

Marcellus, Kenneth L., Office of Environmental Affairs, ConEdison, New York, New York.

Moncure, Richard W., Smithfield Packing Company, Smithfield Virginia.

Rhodes, William R., Ph.D. Program, University of Wisconsin, Madison, Wisconsin.

St. Pierre, Richard, National Marine Fisheries Service, Water Resources Division, Gloucester, Massachusetts.

Wang, S. N., Steel Construction Company, Manassas, Virginia 22110.

Students

Crane, Michael L., (completed requirements for BS). Naval Oceanographic Office, Washington, D. C.

- Croonenberghs, Robert E., (completed requirements for MS).
- Hyland, Jeffrey L., (Completed requirements for MA). Naval Research Laboratory, Ocean Science Division, Washington, D. C.
- Larsen, Peter F., (Completed requirements for MS). Fisheries Research Laboratory, Department of Marine Resources, West Boothbay Harbor, Maine.
- McEachran, John D., (Completed requirements for Ph.D). Department of Wildlife and Fisheries Science, Texas A & M University, College Station, Texas.
- Manzi, John J. (Completed requirements for Ph.D). Department of Biology, College of Charleston, Charleston, South Carolina.
- Meyer, Henry L., (Completed requirements for MA). Minister of Religion with the Church of Jesus Christ of the Latter-day Saints, Mission Home, Rome Italy.
- Olmon, Janet E., (Completed requirements for MA). Hawaii Institute of Biology, Kaneohe, Hawaii.
- Orzech, Mary Ann. (Completed requirements for MA). Ph.D. Program, Case Institute of Technology, Cleveland, Ohio.
- Peddicord, Richard K., (Completed requirements for Ph.D). Bodega Marine Laboratory, Bodega Bay, California.
- Sheridan, Peter F., (Completed requirements for MS). Florida State University, Tallahassee Florida.
- Tennyson, Edward J., Withdrew from the Ph.D. Program, now residing in Gloucester Point, Virginia.
- Witherington, Phillip D., (Completed requirements for Ph.D). Science Department, Atlantic Christian College, Wilson, North Carolina.
- Wu, Hsien Eddie, (Completed requirements for BS). Scripps Institute San Diego, California 92117.

APPENDIX II

PROJECTS COMPLETED SINCE 1972 EDITION

OFFICE OF SPECIAL PROGRAMS

1. Status of Environments and Resources of the James River.

Awaiting publication.

2. Transport and Movements of Oyster Larvae in the James River.

Awaiting publication.

3. A Review of States' Mineral Leasing Policies and Legislative Proposals for the State of Virginia.

Wardrop, William J. "Model Legislation for the Administration of Subaqueous Hard Mineral Resources within Virginia Waters," VIMS Thesis (College of William and Mary).

DEPARTMENT OF DATA PROCESSING AND STATISTICAL SERVICES

1. Development of Young Bluefish (*Pomatomus saltatrix*) and Distribution of Eggs and Young in Virginian Coastal Waters.

Awaiting publication.

2. Transport of Oyster Larvae in the James Estuary: Development of Methods.

Awaiting publication.

3. The Bathymetric Distribution of Phytoplankton in Virginian Coastal Waters.

Awaiting publication.

DEPARTMENT OF APPLIED MARINE BIOLOGY

1. An Investigation into Commercial Aspects of the Hard Clam Fishery and Development of Commercial Gear for the Harvest of Molluscs.

DEPARTMENT OF APPLIED MARINE BIOLOGY (Cont'd)

Final report submitted to funding agency.

2. Control Measures for Chesapeake Bay Jellyfishes: Nutrition Studies.

Final report submitted to funding agency.

3. A Study of the Molluscan Populations in the Portsmouth to Newport New Bridge Tunnel Area.

Final report submitted to funding agency.

DEPARTMENT OF CRUSTACEOLOGY

1. Oxygen Consumption of the Blue Crab, *Callinectes sapidus* Rathbun.

Laird, Chae E. "The Effects of Intrinsic and Environmental Factors on the Oxygen Consumption of the Blue Crab, *Callinectes sapidus*, Rathbun," VIMS Thesis (College of William and Mary).

2. Distribution, Abundance, and Ecology of the Rock Crab (*Cancer irroratus*) in Virginia Coastal Waters.

Shotton, Lewis R. "Biology of the Rock Crab *Cancer irroratus* Say, 1817, in the Coastal Waters of Virginia," VIMS Thesis (University of Virginia).

3. Relative Growth, Reproduction, and Distribution of the Rock Crab, *Cancer irroratus*, in Chesapeake Bay.

Terretta, Roy T. "Relative Growth, Reproduction and Distribution of the Rock Crab, *Cancer irroratus*, in the Chesapeake Bay during the Winter," VIMS Thesis (College of William and Mary).

DEPARTMENT OF ICHTHYOLOGY

1. Feasibility of Increasing Striped Bass Populations by Stocking of Under-Utilized Nursery Grounds.

Final report submitted to funding agency.

DEPARTMENT OF ICHTHYOLOGY (Cont'd)

2. Black Drum (*Pogonias cromis*) Age, Growth, and Distribution.

Richards, C. E. "Black Drum (*Pogonias cromis*) Age, Growth, and Distribution," Trans. Amer. Fish. Soc. 102(3), 1973.

3. Biology and Distribution of Seven Species of Skates (*Raja*) of the Continental Shelf of the East Coast of North America (Cape Hatteras to the Gulf of St. Lawrence).

McEachran, John D. "Aspects of the Distribution and Biology of 7 Species of Skates (Pisces: Rajidae) which Occur on Continental Shelf of East Coast of North America (Cape Hatteras, North Carolina to Nova Scotia)," VIMS Dissertation (College of William and Mary).

4. The Comparative Ecology of Two Species of Pipefish in the York River.

Mercer, Linda P. "Th Comparative Ecology of Two Species of Pipefishes (Syngnathidae) in the York River, Virginia," VIMS Thesis (College of William and Mary).

5. A Comparative Study of the Retention and Escapement Characteristics of Pound Nets as a Function of Poundhead Mesh Size.

Meyer, Henry L. "Retention and Escapement Characteristics of Pound Nets as a Function of Poundhead Mesh Size," VIMS Thesis (College of William and Mary).

DEPARTMENT OF INVERTEBRATE ECOLOGY

1. Existing Conditions of the Biota of Chesapeake Bay.

"Biota of Chesapeake Bay," Chesapeake Science (Special Edition), Vol. 13, December 1972.

2. Checklist of the Biota of Chesapeake Bay.

Wass, M. L. (Editor). 1972. Check List of the Biota of Lower Chesapeake Bay, VIMS SSR No. 65.

3. Life History of the Scyphozoan *Rhopilema verrilli*.

Calder, D. R. "Laboratory Observations on the Life History of *Rhopilema verrilli* (Scyphozoa, Rhizostomeae)," Mar. Biol. (accepted).

DEPARTMENT OF INVERTEBRATE ECOLOGY (Cont'd)

4. Control Measures for Chesapeake Bay Jellyfishes: Field Observations on Strobilation in *Chrysaora quinquecirrha*.

Final report submitted to funding agency.

DEPARTMENT OF MICROBIOLOGY-PATHOLOGY

1. Studies of the Biophysical Characteristics of Bacterial Cell Surfaces.

Final report submitted to funding agency.

2. Ultrastructure of Rhizoidal Systems in Marine Monocentric Fungi.

"The Ultrastructure of Holdfasts, 'Rhizoids', and 'Slime Tracks' in Thraustochytriaceous Fungi and *Labyrinthula* spp.," Arch. Mikrobiol. 84: 95-118.

"Observations of Thraustochytriaceous (Phycomycetes) and Labyrinthulid (Rhizopodea) Ectoplasmic Nets on Natural and Artificial Substrates-- and Electron Microscope Study," Canad. J. Bot. 51: 485-491.

3. Ultrastructure of the Paranuclear Body of *Paramoeba pemequidensis*.

Perkins, Frank O. and Michael A. Castagna. "Ultrastructure of the Nebenkörper of 'Secondary Nucleus' of the Parasitic Amoeba, *Paramoeba pemequidensis*. (Amoebida, Paramoebidae)," J. Invert. Pathol. 17: 186-193.

SECTION OF ALGAL-LARVAL CULTURE

1. Temporal and Spatial Heterogeneity of Diatom Populations in the York River, Virginia.

Manzi, John J. "Temporal and Spatial Heterogeneity of Diatom Populations of the Lower York River, Virginia," VIMS Dissertation (College of William and Mary). (Awaiting defense of the dissertation).

2. Variations in Seasonal Fluctuations and Vertical Distributions of Thecate Dinoflagellates and Diatoms in the Mobjack Bay and York River as Determined by Species Observed, Population Density, Equability, Redundancy, and Species Diversity.

Stofan, Paul E. "Phytoplankton Community Structure: Mobjack Bay and York River Sub-Estuarines, Chesapeake Bay, Virginia," VIMS Dissertation (College of William and Mary). (Awaiting defense of the dissertation).

DEPARTMENT OF PHYSICAL OCEANOGRAPHY AND HYDRAULICS

1. James River Hydraulic Model Tests for the I-664 Tunnel-Bridge Crossing.
Fang, C. S., et al. 1972. "Physical and Geological Studies of the Proposed Bridge-Tunnel Crossing of Hampton Roads near Craney Island," VIMS SRAMSOE No. 24.
2. A Water Quality Management Model for James River Tidal Portion, Virginia.
Fang, C. S., et al. 1973. "Hydrography and Hydrodynamics of Virginia Estuaries, V. James Estuary Water Quality Sampling and Mathematical Modeling," VIMS SRAMSOE No. 41.
3. Investigation of the Water Table in a Tidal Beach.
Fang, C. S., et al. "Investigation of the Water Table in a Tidal Beach," VIMS SSR No. 60.
4. Estuarine Computer Model of Salinity and Dissolved Oxygen Distribution--Rappahannock River (Data Collection and Processing for State Cooperative Mathematical Model).
Final report submitted to funding agency.
5. The Long-Term Variation of Salinity Intrusion into an Estuarine River.
Orzech, Mary Ann. "The Long-Term Model of Salinity Intrusion into Estuarine Rivers," VIMS Thesis (College of William and Mary).

DEPARTMENT OF GEOLOGICAL OCEANOGRAPHY

1. Effectiveness of Sequential Photography for Coastal Oceanography.
"Dynamic Composition of Coastal Waters Apparent in Aerial Photography," (abstract), Second National Coastal and Shallows Water Research Conference.
"Sequential Photography of Coastal Features," (abstract), Thirteenth International Conference of Coastal Engineering, Vancouver.
2. Mineral Resources of the Continental Shelf off Chesapeake Bay.
Thompson, G. 1973. "Inner Shelf Sediments off Chesapeake Bay," VIMS SSR No. 67.

DEPARTMENT OF GEOLOGICAL OCEANOGRAPHY (Cont'd).

3. Development of the Turbidity Maximum in a Coastal Plain Estuary.

Final report submitted to funding agency.

4. Sediment Transport in Low-Order Tidal Marsh Channels.

Boon, John D., III. "Sediment Transport Processes in Marsh Creeks," VIMS Dissertation. (College of William and Mary). (Awaiting defense of the dissertation).

5. Ecology and Distribution of Foraminiferida in an Estuarine Marsh System.

Norton, C. Warren. "Distribution of Foraminiferida in an Estuarine Marsh System," VIMS Thesis (University of Virginia). (Awaiting defense of thesis).

6. Bathymetric Map of the Virginian Sea: Part I--Cape Henlopen to Cape Hatteras, Continental Shelf and Upper Slope. (This report was initiated and completed since the 1972 Edition of this volume).

Goldsmith, Victor, Sutton, C. H., and Davis, J. S. 1973. "Bathymetry of the Virginia Sea-Continental Shelf and Upper Slope, Cape Henlopen to Cape Hatteras: Bathymetric Map," VIMS SRAMSOE No. 39.

DEPARTMENT OF ECOLOGY-POLLUTION

1. James River 3-C Comprehensive Water Quality Management Study.

Final report submitted to funding agencies. Awaiting publication.

Section of Environmental Biology

1. Study of the Fauna of the Upper James Estuary.

Peddicord, Richard. This project is continuing under another title: "A Biological Chemical and Physical Study of the Lower York River.

2. Growth and Distribution of *Rangia cuneata* Gray.

Peddicord, Richard. "Growth and Condition of *Rangia cuneata* in the James River, Virginia," VIMS Dissertation (University of Virginia).

DEPARTMENT OF ECOLOGY-POLLUTION (Cont'd).

Section of Environmental Biology

3. Comparative Hematology of Yellow and Silver Eels, *Anguilla rostrata*.

Wenner, C. A. and P. F. Larsen. "Food Habits and Seasonality of the American Eel, *Anguilla rostrata* from Three Virginia Estuaries," Chesapeake Science (submitted).

5. Estuarine Benthic Recruitment in Dredged Areas.

Duncan, Thomas K. "Benthic Infaunal Community Formation on Dredged Bottoms: Hampton Roads, Virginia," VIMS Thesis (University of Virginia). (Awaiting defense of the thesis).

6. Effects of Oil Pollution on Intertidal Communities.

Hyland, Jeffery L. "Acute Toxicity of No. 6 Fuel Oil to Intertidal Organisms in the Lower York River, Virginia," VIMS Thesis (College of William and Mary).

7. The Uptake, Concentration, and Retention of DDT by Tissues of the Blue Crab, *Callinectes sapidus*.

Sheridan, Peter F. "Uptake, Metabolism, and Distribution of DDT in Organs of the Blue Crab, *Callinectes sapidus*," VIMS Thesis (University of Virginia).

Section of Environmental Chemistry

1. Pre-Dredging Sediment Analysis from Channels Leading from the Chesapeake Bay into Norfolk and Newport News Harbors and the York and Rappahannock Rivers.

Final report submitted to funding agency.

Section of Wetlands Research

1. Marina Development in the Proposed York River State Park--An Appraisal.

Final report submitted to funding agency.

DEPARTMENT OF ENVIRONMENTAL PHYSIOLOGY

1. Control Measures for Chesapeake Bay Jellyfishes: The Role of Iodine in Strobilation of Jellyfish Polyyps.

Olmon, Janet. "Iodine Metabolism in Sessile Stages of Chesapeake Bay Sanaeostome Jellyfish," VIMS Thesis (College of William and Mary).

2. Distribution and Abundance of Dissolved Free Amino Acids (DFAA) in Marine Systems.

Awaiting publication.

3. Internal Mechanisms of DFAA Regulation in Marine Organisms.

Results of this research project are included in the dissertation of W. D. DuPaul. (See the following item).

4. The Metabolism of Free Amino Acids Involved in the Isosmotic Intracellular Regulation of Marine Bivalve Molluscs.

DuPaul, William D. "Mechanisms of Isosmotic Intracellular Regulation in Marine Molluscs," VIMS Dissertation (College of William and Mary).

OTHER GEOGRAPHICAL AREAS

DEPARTMENT OF MICROBIOLOGY-PATHOLOGY

1. Studies on the Monogenean Funa of African Inland Water Fishes.

Paperna, I. "Monogenean of Inland Water Fish in Africa I. Monogenea of Cichlidae," Ann. Musee de L'Afrique Centrale No. 8 (in press).

Paperna, I. "Monogenea of Inland Water Fish in Africa II. Monogenea of Cyprinidae," Ann. Musee de L'Afrique Centrale No. 8 (in press).

Paperna, I. "Monogenea of Inland Water Fish in Africa III. Monogenea of Fish Other than Cichlidae and Cyprinidae and General Discussion of the African Monogenean Fauna," Ann. Musee de L'Afrique Centrale No. 8 (in press).

2. Studies on Diseases and Infection in Fish Populations on East African Lakes.

Paperna, I. 1972. "*Ichthyophthirius multifiliis* (Ciliata, Holotrichia) in Fish in Uganda," Prog. Fish. Cult. 34 (3): 162-164.

Paperna, I. (in press). "Occurrence of Cnidospora Infections in Fresh-water Fishes in Africa," Bull. de L'I.F.A.N.

Paperna, I. (in press). "Skin *Epithelioma* in the Electric Catfish *Malapterurus electricus* from Lake Albert, East Africa," Bull. de L'I.F.A.N.

Paperna, I. (in press). "Larval *Contracaecum* in the Pericardium of Fishes from East African Lakes," Bull. de L'I.F.A.N.

Paperna, I. (in press). "Lymphocystis in Fish in East African Lakes," Bull. de L'I.F.A.N.

Paperna, I. (in press). "Host Distribution and Pathology of Infections with Larvae of Eustrongylides (Dioctophymidae, Nematoda) in Fishes from East African Lakes," Bull. de L'I.F.A.N.

DEPARTMENT OF ECOLOGY-POLLUTION

1. Description of Paguridae Collected by the International Indian Ocean Expedition.

Witherington, Philip D. "The Hermit Crabs (Crustacea, Decapoda, Anomura), Collected by the International Indian Ocean Expedition, 1943-1964, with Notes on Their Distribution and the Zoogeography of the Western Indian Ocean," VIMS Dissertation (College of William and Mary).

APPENDIX III

PROJECTS LISTED IN THE 1972 EDITION BUT NOT INCLUDED IN THIS EDITION

DEPARTMENT OF CRUSTACEOLOGY

1. Local Distribution of Xanthid Crabs and Their Adaptations for Life in the Intertidal zone.

Wood, Douglas H. (with W. A. Van Engel). This project represents Wood's thesis research. The title has been changed in this edition to "Gill Area, Oxygen Consumption and Habitat in Four Xanthid Crabs of the York River, Virginia."

DEPARTMENT OF ICHTHYOLOGY

1. A Study of the Age and Growth of the Black Sea Bass, *Centropristis striata* (Linnaeus).

Dias, Robert K. (with J. V. Merriner). This project represents Dias' thesis research. The title and topic have been changed: "An Ichthyological Survey of Atlantic Coastal Surf Zone Fishes from Cape Hatteras, North Carolina to Cape Henry, Virginia."

2. Electrophoretic Analysis of Striped Bass Subpopulations in Chesapeake Bay.

Gardner, Edward P. (with J. V. Merriner). This project represents Gardner's thesis research. The title and topic have been changed: "Biochemical Studies on Chesapeake Bay Jellyfishes: Carbohydrates," found in the Department of Environmental Physiology.

DEPARTMENT OF PLANKTOLOGY

1. Multivariate Statistics in Taxonomy.

Grant, George C. This project is totally inactive.

2. Role of Copepods in the Food Chain of the Lower York River.

Bryan, Burton B. (with G. C. Grant). This project represents Bryan's dissertation research. The title and topic have been changed: "The Ecology of the Cladocera of Lower Chesapeake Bay."

DEPARTMENT OF PHYSICAL OCEANOGRAPHY AND HYDRAULICS

1. Tidal Circulation in Eastern Shore Marsh-Lagoon Complex.

Wu, H. Eddie (with C. S. Welch). This project represents Wu's thesis research. The topic and title have been changed: "Surface Tidal Circulation of Mobjack Bay."

DEPARTMENT OF INVERTEBRATE ECOLOGY

1. Hydroids of Cape Cod Bay, Massachusetts.

and

Hydroids from the Coastal Water of Georgia.

Calder, Dale R. This research represented work from other geographical areas. Calder has since left VIMS and has taken the work with him.

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