DOE/EV-0082

Ecological Research Division
Marine Research Program

May 1980

U.S. Department of Energy
Assistant Secretary for Environment
Office of Health & Environmental Research

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Ecological Research Division

Marine Research Program

May 1980

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U.S. Department of Energy
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Office of Health & Environmental Research
Washington, D.C. 20545

Available from:

National Technical Information Service (NTIS)
U.S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22161

Price:	**Printed Copy:**	$ 7.25
	Microfiche:	$ 3.00

Preface

The marine research program supported by the Office of Health and Environmental Research, Ecological Research Division, is focused to provide scientific information on questions surrounding three major environmental issues facing development and expansion of most energy technologies. These issues are: Waste
Siting
Alteration of climate

Recognizing that the sea is the ultimate receptor of waste from atmospheric, aquatic and solid wastes, the marine program is designed to provide answers concerning mobilization of pollutants, their migration, concentration and fate as well as their effects on the marine environment, including pathways back to human populations. Pressures for siting energy facilities in coastal areas continue to increase and competing demands on the environment must be balanced. Thus, air mass movements, water mass movements, ecosystem resilience, and stability of physical features have to be determined in order to make appropriate siting decisions. Alteration of climate could occur as a result of energy activities. Knowledge of the assimilative capacity of the marine system is necessary in order to predict and to prevent undesirable climatic changes.

Management of the marine program is carried out by a small, dedicated technical staff who administers the many facets of this program. Valued assistance is provided by the scientific community for review of programs and individual projects, as well as providing indepth analysis of on-going and proposed research at specific sights.

Questions or further information concerning the Ecological Research Division's Marine Research Program can be directed to the appropriate Program Managers identified in the description of each program.

Helen M. McCammon

Helen M. McCammon, Director
Ecological Research Division

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ECOLOGICAL RESEARCH DIVISION

MARINE PROGRAM

OVERVIEW

Evolution of Oceanography in the Department of Energy

In 1954, the contamination by radioactive fallout of a Japanese fishing boat and its load of fish from the Pacific atomic bomb tests, stimulated the development of an Atomic Energy Commission (AEC) program of oceanography. Questions asked were whether radioactivity released to the ocean would be transported into Japanese waters by the Kuroshio Current, whether fishes taken from contaminated areas of the ocean could be safely eaten, and what the ultimate fate of the radioactivity would be.

The oceanography work done, mostly by academic scientists, in response to the above questions led to the 1957 publication by the National Academy of Sciences-National Research Council of a book entitled "The Effects of Atomic Radiation on Oceanography and Fisheries." The introductory chapter, by Roger Revelle then at Scripps Institution of Oceanography and Milner Schaefer of the Inter-American Tropical Tuna Commission, called for "fundamental research--in the next decade--to learn more about the ocean and its contents than has been learned since modern oceanography began 80 years ago."

They listed the following major unresolved problems.

Dispersion in the upper mixed layer
Circulation in the intermediate and deep layers
Exchange between the surface layer and deeper layers
Sedimentation processes
Effects of the biosphere on the distribution and circulation of elements
Uptake and retention of elements by organisms used as food for man
Effects of radiation on populations of marine organisms

The oceanographic program, which grew in the 1960's, addressed the seven topics above. The problem was made easier by the pollutant itself. Radionuclides decay at fixed rates, and oceanographers were able to use a number of radionuclides to follow and time the processes occurring in the ocean. In 1971, the National Academy of Sciences published "Radioactivity in the Marine Environment" which synthesized what had been learned since the initial atomic bomb detonation in the Pacific. Almost all of this research was done by contractors to the AEC, a predecessor of the Department of Energy.

The wisdom in setting up the initial program to learn the processes in the ocean that affect behavior of radioactivity rather than to simply monitor radioactivity is now evident. The fundamental processes that govern the movement of radionuclides in the ocean also control the behavior of other pollutants in the marine environment; the inital program thus provided the tools and insight to proceed with the problem of other energy-derived pollutants.

In the early 1970's, fallout had subsided, and the new concern of the AEC was for radioactivity from shore-based nuclear plants, and the possibility of marine contamination from offshore nuclear power plants. In response, the oceanography program was moved into shallow coastal waters, where pollution problems are much greater. Boundary areas in the ocean are always productive, and the coastal zone with interfaces of land with water, and seawater with freshwater are especially productive and subject to damage from pollutants. At the same time, there is less water available in the shallow coastal waters to dilute the pollutants which flow into this area.

To attack the complex problems on the shelf more effectively, a program was initiated in the mid-1970's to create regional research teams made up of biologists, chemists, and physical oceanographers because interdisciplinary teams would more rapidly and effectively unravel the problems by working together. This concept is now operational in the New York Bight, the Southeast, California, and Northwest. A research team for the Gulf of Mexico has been postulated for several years, but has not yet been initiated. About 75% of the funds go to university contractors working together under regional coordinators, often in cooperation with other Government agencies.

The Department of Energy is gaining understanding of the cycling and behavior of energy-induced pollutants in the coastal zone from its long experience and by its focus on processes through the use of regional teams using radioactive tracers in the ocean, and limited laboratory studies. This long-term approach, to study continental shelf processes, is unique among government agencies with research efforts in oceanography, but it has been an important element in giving an understanding of the dynamics of the coastal areas.

Legislative Authority

Authority to support a research program in oceanography is given in the following legislation:

- PL 585, the Atomic Energy Act of 1946, authorized the conduct of research and development activities relating to utilization of fissionable and radioactive materials for medical, biological, and health purposes and for the protection of health during research and development activities.

- PL 83-703, the Atomic Energy Act of 1954, as amended, expanded the authority of the AEC to make arrangements for the protection of health and the promotion of safety during research and production activities, and the preservation and enhancement of a viable environment.

- PL 93-577, the Federal Non-Nuclear Energy Research and Development Act of 1974, authorized the initiation of a comprehensive non-nuclear energy research, development, and demonstration program to include the environmental and social consequences of the various technologies.

- PL 95-91, the Department of Energy Organizational Act of 1977, provided for the incorporation of national environmental protection goals in the formulation and implementation of energy programs and to advance the goals of restoring protecting and enhancing environmental quality in the pursuit of energy development.

Coordination With Other Agencies

Coordination of the marine program with other agencies takes place at the Headquarters level and at the regional level. At Headquarters, the staff maintains a close liaison with staff members of other agencies by attending program reviews held by other agencies, and inviting agency representatives to the DOE program reviews. Full cooperation and contribution of staff time and materials is being provided for the interagency Federal plan for ocean pollution, and there is participation in other interagency committees as well. These interactions provide a conduit for information on research by other agencies and more importantly provide an opportunity for multiagency funding of research projects that are of mutual interest to two or more agencies. Examples of cooperative projects with other agencies include:

National Oceanic and Atmospheric Administration (NOAA)/Department of Energy (DOE) studies of sediment transport in the New York Bight and estuarine studies in North Carolina; Bureau of Land Management (BLM)/DOE studies on hydrocarbon cycling in New York Bight, the fate of hydrocarbons off California, and water transport in the Southeast Region; National Cancer Institute (NCI)/DOE study on neoplasia (due to energy-related pollutants) in aquatic organisms; and National Bureau of Standards (NBS)/Environmental Protection Agency (EPA)/DOE intercalibration project of radionuclides in aquatic media. Also just completed /joint DOE/Office of Naval Research (ONR)/National Science Foundation (NSF)/ is a project for intercomparison of the collecting ability of sediment traps of different designs. In addition, DOE provides funds to help support the Ocean Science Board of the National Academy of Sciences (NAS), a scientific group of renown oceanographers that provides advice to the Federal agencies upon request and to the oceanographic community.

At the regional level, decreasing budgets coupled with rapidly escalating costs of carrying out marine research have forced a closer cooperation with other agency programs in all regions. By sharing equipment, facilities, acquired data and ship time, more can be accomplished together than by the agencies acting

individually. Thus, there is a strong emphasis in the regions to integrate DOE programs with those of other agencies. The regional coordinators in the four coastal regions, the Northeast, Southeast, Northwest, and California, are responsible for being familiar with other agency programs in their respective regions as well as making Department of Energy research known to these agencies.

Examples of this regional interagency coordination include the following:

BLM and DOE/supported oceanographers work together off the same ships in the South Atlantic Bight, providing a common data base. Logistic support from the U.S. Coast Guard and satellite data (from NOAA) foster the success of the operation, leading to a better knowledge of the region in anticipation of energy-related developments that are projected for the area.

In the Northeast Region, a close relationship with NOAA is maintained whereby their scientists go on DOE cruises, and in return DOE contractors are invited to work off NOAA ships. NOAA data on fish are provided to DOE contractors for correlation between food availability and fishery production. These data are then made available to NOAA.

In the California region, marine studies sponsored by the state provide support to DOE studies, and vice versa, to better understand the dynamics of this coastal area. NOAA personnel often participate in these joint DOE/California funded cruises, providing data on the feeding and growth of young fish.

NOAA is proposing to participate in the recently initiated DOE Quinault Canyon experiment in the Pacific Northwest, to define better the current patterns and to extend the studies deeper into the canyon, since the present DOE program is aimed at the shallower regions of the canyon near the shelf break.

In all regions, because of our association with University-National Oceanographic Laboratory Systems (UNOLS), researchers supported by either DOE or NSF combine facilities and ship time to make longer and more productive cruises than would be possible with only one sponsor.

Scientific Review of Research

New proposals received by DOE/Office of Health and Environmental Research (OHER) are sent out for peer review of the scientific merit of the research proposed. The reviewer's evaluations, together with programmatic relevance of the research, are utilized to determine whether projects should be funded. Investigators with ongoing projects submit a renewal proposal and progress report annually. Progress is measured chiefly by the number and quality of the publications resulting from the research.

Every three years, proposals for ongoing projects are sent out for peer review. This review covers all of the research carried out and progress made over the past three years. Termination, redirection or continuation of the project is determined at that time.

Coupled with this review are periodic site reviews of the projects, attended by three to five nationally recognized scientists. Annually, meetings are held in one or more of the four regional areas to review progress of the programs, to discuss ongoing coordination and integration of the program with all principal investigators, and to plan for future research based upon the needs of DOE and recent research findings. Other agencies are invited to participate in these reviews.

Program Areas

For administrative and management purposes, the marine program is subdivided into several categories. Programs developed in relation to specific technologies are described first. Those programs which are developed on a systems basis, utilizing integrated interdisciplinary studies, and not related to one specific technology are described following the technology-based programs.

A list of the programs along with budget levels from FY 1978 to FY 1980 are given in Table 1. Budget levels and abstracts of individual projects in each program, are given in the Appendix.

TABLE 1

MARINE PROGRAM SUBELEMENTS
AND BUDGET HISTORY

	(IN THOUSANDS $)		
	FY 78	FY 79	FY 80
FOSSIL			
Oil and Gas Program	194	500	527
RENEWABLE RESOURCES			
Solar-OTEC Program	43	519	616
Geothermal Program	55	14	55
NUCLEAR			
Marshall Islands Program	670	662	676
Stable & Radioactive Element Program	1862	2234	1735
MULTITECHNOLOGY			
Cooling Systems Program	1065	1181	971
MULTITECHNOLOGY-ENVIRONMENTAL BASE			
Regional Marine Programs			
Northeast Region	2148	2258	2106
South Atlantic Bight	1234	1432	1616
California Bight	607	779	692
Northwest Region	861	1035	1282
Estuarine Program	795	862	788
Great Lakes	200	200	207
Biochemical Studies	737	848	865
Support	37	239	104
TOTAL OF MARINE PROGRAM	10508	12763	12240

FOSSIL

OIL AND GAS PROGRAM

Program Manager: Janet Dorigan
(301) 353-3664
(FTS) 233-3664

Problem Definition

The ocean's responses to oil and gas development may be readily obvious, as is the case with oil spills, or may take many years to detect because of the dispersion and transformation of petroleum and its products. One aspect of the OHER Oil and Gas Program concerns pathways of chemical and biological transformation of hydrocarbons into compounds of greater or lesser toxicity, and the bioavailability of these toxic compounds released during petroleum exploration and development. The other aspect is based on the dynamic nature of the marine system and is more fully described under the multitechnology section. In this latter program, indices are being developed for determining flushing rates and current patterns of shelf areas to ascertain what areas may be affected by petroleum and other releases and the length of time the pollutants will remain in the marine system. Research emphasizes mapping patterns of natural variabilities within the ecosystem to differentiate between those of natural and those of anthropogenic origin.

Objectives

The major portion of OHER/ERD oil and gas program is integrated as part of the Regional Marine Program. It is directed toward understanding processes and dynamic conditions on the ocean shelf to better predict impacts that can be presented singly or synergistically. For research directly related to oil and gas exploration and development, hydrocarbon cycling and transformation bioavailability and identification of toxic compounds are being determined. However, the bulk of this directly related oil and gas research program was transferred to EPA in 1978, thus, only a few studies are present in this category. The specific objectives of the program are as follows:

- Predict transport and diffusion of releases in the coastal zone,
- Understand pathways and fates of organic and trace materials from different sources into physical and biological systems,
- Determine dynamic functioning of the ecosystem and its resilience to outside interference, and
- Evaluate the hazards of discharging oil drilling effluents into the marine environment.
- Determine transformation of hydrocarbons and the bioavailability of these compounds.

Research Plan and Current Program

The research plan described later under Regional Marine Program is also applicable to the Oil and Gas Program. The plan is to carry out regional integrated studies in physical, chemical, and biological oceanography. Parameters to be examined include currents, upwelling events, coastal boundary layers, flushing rates, sediment transport, and biologic productivity associated with these factors. Data will be obtained for areas off California, off the Pacific Northwest, the South Atlantic Bight, the Northeast, and certain estuaries. This information will be used to help assess the impact of petroleum-related as well as other energy-related activities.

Research directly applicable to petroleum technology involves the origin, depositional patterns and compositional changes of biogenic and anthropogenic hydrocarbons so that levels of these materials introduced into the marine environment can be differentiated. The effects of toxic fractions of hydrocarbons on marine biota are being identified. In addition, the toxic components of drilling muds and their adverse effects on commercially important shellfish are being determined. The effects of oceanic turbidity on growth, physiology, and behavior of benthic species will continue to be identified.

Accomplishments (1979-1980)

- Off Long Island, primary productivity is greatest near the shore in late winter and early spring, and peaks again in late fall. It is greatest in mid-spring and late spring in the mid-shelf area. Thus, the impact of an oil spill on availability of food for fish would vary depending on the time of year and location of the release.

- A mid-shelf jet stream discovered near Washington and Oregon moves in the same or opposite direction to the near-shore current depending on the wind direction. This is important for predicting dispersal of accidental releases along this coast.

- Most of the hydrocarbons in the New York Bight sediments are from coal sources and not from oil discharges, which means that the introduced hydrocarbons in the benthic organisms are from coal combustion sources or coal from older coal-powered vessels.

- Information on distribution of bird populations off the New England coastal areas has been compiled and data concerning occurrence and feeding habits of the birds are being synthesized.

- Stable isotopes, particularly $^{13}C/^{12}C$, $^{15}N/^{14}N$, and $^{34}S/^{32}S$, have been used in characterizing tars. This information will be used in determining the origin of weathered oils.

- Studies on the effects of drilling muds on marine bivalve molluscs determined that stress could be assessed by visual inspection of the organisms, feeding (filtration) rates, and elemental analyses.

Future Plans:

No expansion in this program is planned. The research will be phased down or redirected into generic studies.

A list of projects in the Oil and Gas program with budget levels from FY 1978 to FY 1980 are on page A-2 of the Appendix with abstracts of individual projects beginning on page A-3.

RENEWABLE RESOURCES

SOLAR

OCEAN THERMAL ENERGY CONVERSION PROGRAM

Program Manager: George Saunders
(301) 353-5548
(FTS) 233-5548

Problem Definition

Ocean thermal energy conversion (OTEC) technology is still in the early stages of development, but an OTEC-1 test platform and larger test platform should be completed within five years. Potential OTEC sites have been located in Hawaii, Guam, Puerto Rico, the Gulf of Mexico, and the South Atlantic. Although the environmental effects of OTEC development may be small even under large scale operation at the 100 MWE to 400 MWE output levels, more basic information concerning tropical marine systems is needed to adequately evaluate possible impacts of OTEC installations on marine systems. Research on the environmental effects of OTEC will help to determine the suitability of further development of the technology and to implement the controls necessary to obviate adverse effects on the marine ecosystem. Some environmental concerns related to OTEC development are changes in the physical and chemical structure of tropical waters brought about by the transport of large volumes of water needed to to drive turbines in an OTEC plant; release of toxic trace metals from deep ocean water or from metallic surfaces of an OTEC plant; potential deleterious effects of the chlorine used to clean heat exchanger surfaces; and massive kills of organisms due to impingement on intake screens or entrainment through the evaporative cooling system.

Objectives

The objectives of this program are to determine the physical, chemical, and biological structure at one proposed OTEC site near southeast Puerto Rico. This study will determine whether there are any endangered species in the area, whether there are any sensitive species that may be significantly impacted, and the kinds of studies that need to be conducted in future analyses at other possible sites.

Research Plan and Current Program

The OTEC environmental research program consists of characterization of the marine ecosystem structure at a proposed site and within an area thirty miles downstream from the site. It is a site specific study. The vertical physical structure of the water, stratified current velocities and directions, nutrient distributions, phytoplankton and zooplankton distributions and community structure, photosynthetic production, and vertical migration of zooplankton are being measured. The physical, chemical, and biological properties and

dynamics are being determined in order to provide a basis for conducting experiments and to estimate effects that an operating OTEC plant might have on a tropical marine ecosystem.

Accomplishments

The OTEC site specific program was initiated in November 1979. Two research cruises have been completed. Data sets are available but not fully interpreted.

Future Plans

The degree of homogeneity of the volume field in the area of a proposed OTEC plant site will be determined.

Milestones

FY 1982 - Complete study of structure of the tropical marine ecosystem at a proposed OTEC site.

Projects funded in the OTEC program are described in the Appendix on pages A-7 to A-9.

RENEWABLE RESOURCES

Geothermal Program

Program Manager: Robert Watters
(301) 353-5329
(FTS) 233-5329

Only one project is present in the OHER marine geothermal program. This is primarily an exploratory study to determine if there may be environmentally related problems associated with the development of submarine geothermal resources along our coastlines.

			FUNDING ($1,000)		
Project No.	Project Title	P.I.	78	79	80
7367	Properties and Impact of Submarine Geothermal Springs on the West Florida Continental Shelf	U. South Florida - Fanning	55	55	60

CONTRACTOR: University of South Florida

PRINCIPAL INVESTIGATOR: Fanning

CONTRACT NO: HA 020301 PROJECT NO: 7367

TITLE: Properties and Impact of Submarine Geothermal Springs on the West Florida Continental Shelf

This study tests the feasibility of using an existing natural submarine hot spring discharge as a model to predict the long-term effects upon shelf biota of thermal discharge from offshore power plants. The pilot program will assess the regional setting, magnitude, variability and properties of the mud hole submarine spring by means of geophysical, geological, chemical, hydrographic, and limited biological sampling. Reconnaissance and quarterly shipboard surveys will be supplemented by continuous in situ monitoring of flow rate and temperature and by periodic aerial mapping of sea-surface temperature patterns. Mathematical modeling of the spring's flow regime and its interaction with ambient shelf waters will help determine the near-field and far-field significance of the discharge plume in comparison with nutrient, trace metal, dissolved oxygen and primary productivity anomalies.

NUCLEAR

MARSHALL ISLANDS PROGRAM

Program Managers: Charles Osterberg
Robert Watters
(301) 353-3035
(FTS) 233-3035

Problem Definition

Prior to the start of nuclear weapons testing at Bikini and at Enewetak Atolls, the native populations were evacuated. Subsequent nuclear testing physically altered islands in these atolls and contaminated them and the lagoon with radioactivity. Since 1958 radioactivity levels at Bikini and Enewetak have been reduced by radioactive decay and decontamination processes. A group of Bikinians was allowed to return some years ago but the local diet produced radioactive body burdens which required evacuation of the island in 1978. Enewetak natives are pressing for return to their homeland after the completion of an extensive clean-up operation. The return of the Marshallese to either of these atolls requires a reliable assessment of an acceptable internal and external radiation dose that will be accrued for realistic living and dietary patterns.

Objectives

This research program is designed to provide the information on the present and future dietary and drinking water concentrations which are necessary to radiation dose assessments. A second objective is to develop a better understanding of the natural processes affecting the distribution of transuranic elements and long lived fission products in a coral-tropical environment.

Research Plan

Environmental investigations are underway at both Bikini and Enewetak Atolls. These deal with terrestrial vegetation, ground water, marine biogeochemistry and marine ecology. The program is designed to determine the distribution and mechanisms of mobilization of radionuclides and identify their pathways to the human population.

Current Program

The terrestrial program includes: test gardens at both atolls to evaluate concentration ratios for subsistence crops such as breadfruit, banana, sweet potato and papaya; testing the effect of fertilizers and other agricultural practices on the plant uptake of cesium 137; radiochemical analyses for cesium 137 and strontium 90 in coconut oil and copra grown at Bikini; and determination of the airborne radioactivity levels at the islands due to resuspension from dry surfaces and sea spray.

The ground water program determines the changes in recharge and water quality due to denudation of the surface during decontamination operations; effects of the burial of radioactive waste upon water quality; effects of pumping on water quality and water levels; and effects of tides and ocean levels on ground water movements. Results of these studies will be incorporated into a comprehensive model describing ground water hydrology, geochemistry and residence times of chemical species.

The marine program includes tests of the remobilization of plutonium and other radionuclides from the sediments of the atoll lagoons and the bomb craters; measurement of plutonium and other radionuclide concentration in reef fish; and sampling and analysis of the water area outside of Enewetak Atoll which was under the trajectory of the major fallout events of the weapons testing program.

The Mid-Pacific Research Laboratory (MPRL) at Enewetak provides chemical and biological laboratory facilities, including a scientific reference library, for visiting scientists. It acts also as a staging area for the study programs at both the Enewetak and Bikini Atolls and provides boats for marine sampling programs and inter-island transportation at Enewetak.

Accomplishments 1979-1980

- The data generated from the test gardens and from analyses of island grown coconut has been used to update the radiation dose estimates for possible Eneu Island (Bikini Atoll) resettlement. Radiation dose assessments from food crops grown over the last few years at Enjebi have been used is decisions regarding Enewetak Atoll resettlement.

- Surface resuspension studies show that the major source of airborne radioactivity is from surf spray rather than resuspension of soil particles by wind.

- Completion of the analysis of cesium 137 in coconut oil and copra will be used to make an assessment of the economic feasibility of a commercial crop on contaminated islands such as Bikini.

- Drilling and hydrologic testing of wells on Enjebi Island were completed and data accumulated for a model of ground water dynamics.

- An experiment was established to determine the recharge rate and water quality changes in the aquifer at Enewetak islands after removal of vegetation and other surface alterations associated with decontamination operation.

- Mullet and other reef fish samples have been collected and will be analyzed for plutonium and other radionuclides to increase the reliability of dose estimates from the marine food pathway.

- o Determination of soluble plutonium oxidation states in lagoon waters show a high proportion is in the Pu(V or VI) state. This information will be used in determining the rate of dissolution from bottom sediments and eventual transport to the open ocean.

Future Plans

- o Results of study plots of denuded surfaces should establish the vertical transport of radionuclides in the soil profile at Enewetak islands and the effect upon the aquifers. This study may establish the feasibility of denudation as a method of accelerating the natural decontamination processes at coral atolls.

- o Further studies of the biogeochemistry of the atoll lagoons will provide further data on the dissolution and sedimentation processes for radionuclides and how these affect marine food chains and flushing of radioactivity to the open ocean.

- o Manipulation of agricultural practices such as use of various fertilizer regimens will be used to develop possible simple techniques for reducing the radionuclide content of island grown foodstuffs.

- o Because of the extensiveness of contamination and disruption at Bikini and Enewetak, it is expected that the U.S. will continue to operate the Mid-Pacific Research Laboratory to cope with health and environmental problems as they appear, and to act as a logistics center for future radionuclide surveys and studies.

Milestones

To provide timely data for repeated updates of dose assessments in 1982-1987.

The list of projects, budget history and abstracts of the projects in the Marshall Islands Program begin on page A-11 of the Appendix.

STABLE AND RADIOACTIVE ELEMENT PROGRAM

Program Managers: Charles Osterberg
Robert Watters
(301) 353-3035
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Problem Definition

Radionuclides which enter the ocean, either from nuclear power plants, worldwide fallout or from natural sources, present us with both a problem and an opportunity. The problem is that marine food chains or processes might return certain radionuclides to humans. The opportunity resides in the fact that radionuclides, with their built-in timing mechanisms, are useful tools in determining the rates of oceanographic processes. Mixing rates, turnover times, and rates of sedimentation are examples of processes that have been greatly clarified by the use of radionuclides in the ocean.

Already the ocean is being used as a repository of low level wastes by many countries, even though the U.S. stopped this practice over 10 years ago. Now the ocean bottom is being considered for an engineered storage of high level wastes. A geologically quiet region at great depth with thick sediments and with high chemical exchange properties is being considered, although many questions remain to be answered.

While the cycling of some radionuclides has been well studied, the fate of transuranic radionuclides, such as plutonium, in the ocean is still being determined. In fact, scientifically based health and safety guides or criteria governing most radioactive wastes in the ocean are still being developed. Research results from the long term studies sponsored by this agency since the 1950's are being utilized for the safety guides and criteria development.

Objectives

The processes that effect the fate and behavior of radionuclides and analogous trace metals in the ocean are being studied, as well as the pathways that lead back to humans; a further goal is to relate radionuclide behavior to other trace elements in the ocean. Specific objectives are as follows:

- o Determine the geochemical behavior and effects of plutonium and other transuranics in the ocean;
- o Develop concentration factors, ecological pathways, and routes of transfer of stable and radionuclides in the ocean;
- o Identify major sinks and reservoirs of radionuclides in the ocean so that sinks of other trace elements behaving similarly can also be identified;

o Extend the capability of using radiotracers to follow and time natural processes in the ocean.

Research Plan and Current Program

The research plan is to use the best qualified researchers in the oceanographic community to help understand the many processes in the ocean that effect the movement and fate of radionuclides and other pollutants. The program is designed to take advantage of the unique properties of naturally occurring and artificial radionuclides, the extreme sensitivity of detection and the known rates of decay, to provide an insight into how fast materials in the ocean are turning over, and what are the major sinks and reservoirs.

Specific studies include: following mixed radionuclides from a nuclear fuel processing plant through all components of the marine environment; measuring transuranics and fission products in deep ocean profiles to determine rates and patterns of movement; using tritium to evaluate its use as a tracer of river waters entering the sea; and continue studying the properties of the ocean bottom particularly at the sediment water interface to assess the magnitude of sorption of trace materials at this surface and the dissolution, resuspension or remobilization of these materials.

Accomplishments FY 79

o A synthesis of several years of study has shown that many radioactive and other trace elements move laterally in the ocean often ending up back on continental shelves where they are concentrated at the sediment water interface.

o Fallout plutonium deposited in 4000m depths near Bikini has now been measured 1000m up into the water column indicating that Pu is being remobilized from the sediment, this is contrary to expectation and focuses concern for waste disposal of this material in the deep sea.

o The isotopes (seven and ten) of beryllium were explored as a timing device at an international symposium sponsored by ERD, and found to have much promise as an additional tool in determining air and water movement and interaction.

Future Plans

o Complete an assessment of models describing Pu concentrations and distributions in the Great Lakes system.

o Complete the assessment of Pu concentrations in mid-ocean profile samples as part of the baseline chemistry of the oceans.

o Publication in 1980 of "Transuranic Elements in the Environment" a synthesis volume for marine, freshwater, and terrestrial environmental research.

The list of projects, budget history and abstracts of the projects in the Stable and Radioactive Element Program begin on page A17 of the Appendix.

MULTITECHNOLOGY

COOLING SYSTEMS PROGRAM

Program Manager: D. Heyward Hamilton
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Problem Definition

Consumption of energy in the form of electricity will continue in the United States, since even with an extended period of zero population growth, a generation of growth in demand is expected to occur, and the use of very large volumes of fresh, brackish, and saltwater for cooling purposes will continue to grow concomitantly.

Legal decisions regarding the replacement of once-through systems with cooling towers under Sections 316A and 316B of Public Law 92-500 will increase. At the present time they have to be made with a maximum of judgment and a minimum of solid technical information. Serious environmental impacts may result from once-through cooling in OTEC (Ocean Thermal Energy Conversion) and FNP (Floating Nuclear Plant) facilities as well as conventional power generation plants. The chemistry of chlorine in seawater, because of the background halogen content, is difficult. Understanding of the extent to which chlorination of cooling water may disrupt fundamental ecological processes through formation of persistent organic compounds is inadequate.

Mortality of fishes and other organisms at intake structures is widespread and represents a problem both in terms of plant operation and in terms of resource impact. Finally, there is a definite need for alternate, effective means of controlling fouling of heat exchange surfaces.

Objectives

The objectives of the cooling systems program are to:

Provide sound ecological criteria for management of multi-purpose cooling impoundments (lakes, ponds, rivers, and reservoirs), particularly in the southeast;

provide an environmental basis for the choice and design of cooling system alternatives (open or closed systems) and for assessment of their costs in terms of resource impacts and potential for pathogen dispersal;

evaluate the environmental aspects of chlorination and alternative procedures for control of fouling in the open and closed systems of steam electric stations and in OTEC facilities; and

develop validated models permitting quantitative estimates of the impact of larval, juvenile, and adult mortality on representative freshwater, brackish water, and marine populations as well as to assess the effects of cooling systems effluents on organisms, particularly interactive effects.

Research Plan

The research supported by this program can be divided into scoping activities and into activities intended to provide environmental standards and criteria. Most of the work is in the scoping category. It is aimed at specification of the magnitude or scale of a group of inadequately specified cooling systems impacts. This work is of an analytical or theoretical nature and is not amenable to detailed planning because of the number of uncertainties involved.

Current Program

The major concern in the cooling systems area over the last several years has been chlorine. EPA is the other major source of Federal funds in this area; co-funding of three major conferences has assured a coordinated effort. EPA has concentrated on freshwater, particularly drinking supplies, while DOE activities have emphasized saltwater. Other agencies active in related subject areas with whom we have direct communications are the Nuclear Regulatory Commission, the Tennessee Valley Authority, the Corps of Engineers, the Power Plant Siting Team in the Office of Biological Services in the Department of the Interior, and the Electric Power Research Institute.

The longest lived and now mostly completed component of the cooling systems program concerned the following kinds of temperature effects or aspects: cold shock, temperature selection and avoidance, critical thermal maxima, temperature-growth relationships, effects of fluctuating temperatures, geographic differences in thermal requirements, chemosensory functions, interactive effects of temperature and trace metals, and temperature regulation mechanisms. A diminishing amount of direct effects work continues to be supported, as identified in the Appendix.

Planktonic and larval stages of many kinds of organisms, including fish, oysters, and crabs, are killed during passage through once-through cooling systems. Assessment of the significance of this mortality for the populations of the affected species is primarily a modelling issue. Substantial progress in this area continues at Oak Ridge National Laboratory where useful models for estuarine fish and for largemouth bass are in advanced stages of development.

The chlorine research activity is in marine environments because of poor understanding of the fate and effects of chlorinated compounds in brackish water and in saltwater. Further definition of significant problems is needed to guide support of work in this area. An evaluation of the biological effects of condensor ozonation in fresh and in brackish water is presently being concluded by Public Service Electric and Gas of New Jersey.

Accomplishments FY79

During FY79 the work on chlorine chemistry in seawater yielded two major results: a determination that existing methodologies for residual oxidants in seawater are inadequate and a tentative identification of one of the dissolved organic compounds

affecting chlorine toxicity in seawater. The existing methodologies are inadequate because significant biological effects occur at concentrations below their detection limits. Progress on adequate methodology is being made.

The environmental requirements of Legionnaire's disease bacterium were partially defined and several papers on its ecology published by biologists at the Savannah River Laboratory. A third and probably final national conference on "Water Chlorination: Environmental Impact and Health Effects" was sponsored by DOE and Oak Ridge National Laboratory. About 300 participants discussed a broad range of topics from epidemiological assessment of human helath impacts of tri-halo methanes in drinking water to effects of chlorinated materials on drinking water.

Expected 80 Accomplishments

During FY 80 the proceedings of the Water Chlorination Conference will be published. Evaluation of ozonation as an alternate to chlorination for condenser fouling control in fresh and in brackish water will be completed.

Final reports of our program on red-sore disease will be completed and this project terminated. Red-sore disease is a widespread bacterial disease of fish found in the sport fisheries of the Southeast. Results have demonstrated that outbreaks of the disease are a generalized response to stress from a number of factors, including temperature.

An evaluation of the interactive effects of chlorine, temperature, and copper on coastal plankton populations will be completed in FY 80.

Future Plans

The work described herein had its beginning in the "Calvert Cliffs" decision which made the Atomic Energy Commission legally responsible for nonradiological as well as radiological impacts of steam electric stations. Three years ago level of investment in this area was in excess of three million dollars, but because some problems proved to be generally intractable, the level of effort has been reduced to questions primarily concerning chlorine in saltwater. The activities at ORNL have recently been redirected toward structural and functional properties of multi-purpose cooling reservoirs, and some of the remainder of the work in the cooling systems area will also be reprogrammed into these areas.

A list of projects, budget levels from FY 1978 to FY 1980 and abstracts of the studies in the Cooling Systems Program begin on page A-29 of the Appendix.

MULTITECHNOLOGY

ENVIRONMENTAL BASE RESEARCH

REGIONAL MARINE PROGRAM

Problem Definition

The marine waters surrounding the U.S. provide food and resources on the one hand while assimilating discharges from various sources on the other. Different energy-related technologies can have similar impacts on the marine system, such as causing shifts in marine populations due to nutrient changes, disruption of breeding areas, increased incidence of diseased organisms, etc. In order to anticipate or predict these impacts and develop technologies to mitigate against serious damage, the functioning and dynamics of the marine system need to be studied particularly to understand which impacts can cause serious or long lasting injury and which ones can be assimilated with minimum perturbation. Furthermore, understanding of processes will aid in the technological development of new and innovative energy sources derived from the ocean system. Environmental concerns associated with energy development include:

- o undesirable erosion or accretion of shoreline due to sediment redistribution from the construction and operation of coastal or offshore activities,
- o accumulation of toxic materials from energy operations by marine organisms and the subsequent transfer to humans through the food chain,
- o nutrient enrichment caused by artificially induced upwelling resulting in changes in populations from economically important to undesirable forms,
- o increased turbidity due to transportation or production of energy sources causing weight loss and starvation in economically important benthic species,
- o contamination of coastal shelf sediments due to gradual accumulation of energy related discharges creating hazards to future renewable resources such as food supply and tourism,
- o identification of natural ocean fluctuations, including short term anomolous events, in order to distinguish them from perturbations of an anthropogenic origin,
- o mapping of coastal water movements to ascertain pollutant dispersion patterns.

Objectives

The broad objective of the regional marine program is to conduct research that will establish a base of knowledge that is necessary to evaluate the impact of both present as well as future energy development on the oceans particularly adjacent to the continental U.S. Specific objectives of the program are:

- To determine the movement of water masses in coastal shelf systems in order to explain how nutrients, energy-related chemicals, and living and non-living particles will be transported, distributed and deposited.

- To determine how this pattern of movement is modified by tides, weather, riverine and estuarine inputs, and intrusions and upwelling of oceanic water.

- To determine how the frontal zones between estuarine and coastal waters, and between water masses of different types, modify the chemistry of nutrients, trace elements and other pollutants, and how these zones control the intensity of biological activity and the assimilation of chemical substances by organisms.

- To determine the pathways and fates of energy-related pollutants in marine food chains and whether chemicals are transported predominantly through open food chains to fishes, through rapid settling to bottom sediments for subsequent utilization by benthic organisms, or through rapid transport and sedimentation to oceanic deeps.

- To determine the resilience of the marine coastal system disturbed by energy-related activities.

Research Plan

Within this program regionally directed studies are being conducted to define currents, upwelling events, coastal boundary layers, eddy diffusion, flushing rates and sediment transport. The nature and extent of continental estuarine and atmospheric inputs of energy-related materials to coastal marine waters will continue to be determined and fluxes of particulate matter, dissolved organic and inorganic compounds, and nutrients within water masses and between boundary layers (e.g., nearshore waters vs. deep water, sediment-water interface, beach areas) are being derived.

Integrated studies of physical, chemical, and biological oceanography are being conducted to determine the correlation of primary productivity levels, species composition, food chain dynamics and survival of eggs and larvae of higher trophic organisms impacted by variation of food supply. These variations are being analyzed with relation to natural and human induced environmental stresses.

To better manage the objectives of the program within different marine coastal system structures and morphologies, the coastal shelf area has been divided into the Northeast from New England to Cape Hatteras; the Southeast from Cape Hatteras to Florida; the Southwest in the California Bight; the Pacific Northwest off Washington and Oregon and two smaller programs in the Great Lakes and Estuaries. Each geographic program combines physical, chemical, and biological oceanography studies that share data for maximum use of information and share facilities and shiptime for maximum cost-effectiveness. These studies are closely coordinated with programs conducted by other agencies in these regions and are often carried out with their cooperation and support.

Regional coordinators are used by DOE/OHER in the four major coastal regions to plan with the investigators present and future direction of the program, and implement and coordinate the studies. Another major task of the coordinators is to keep other agencies informed of DOE activities as well as to be familiar with other agency activities to provide maximum use of data and facilities and prevent any overlap in studies.

A more detailed description of each subprogram follows.

NORTHEAST REGION

Program Managers: George Saunders
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Statement of Problem

The northeast coastal region is now influenced by and has the potential in the future for added exposure to pollutants from a number of energy-related activities. Within this coastal zone there are over 200 fossil fuel and 20 nuclear power plants, 4 LNG facilities, 12 large oil refineries, and two offshore oil lease areas, as well as major facilities for nuclear submarines at Norfolk, Virginia, New London, Connecticut and Portsmouth, New Hampshire. Pollutants from these present activities may be released directly into estuarine and coastal waters, be advected onshore from offshore waters, or may broadcast within the coastal region via the atmosphere. In previous years, about 34,000 containers of radioactive waste (including the pressure vessel of the Seawolf reactor) were dumped off the northeast coast between 1951-1967, the tragic loss of the Thresher occurred 300 km off Boston in 1963, while the collision of the tankers Texaco Massachusetts and Alva Cape led to their explosion in New York Harbor in 1966 and the Argo Merchant broke up on Nantucket Shoals in 1976. Future planned and unplanned events will probably impact this region also.

Water circulation patterns are known in general for the Mid-Atlantic Bight and water circulation and biological dynamics are being studied in detail for the northern end of the Bight from Long Island to Georges Bank. As much as 75% of the bottom water off New York has been identified as water from Georges Bank-Gulf of Maine area. However, aspects of water circulation and biology southward from the Hudson River area of the Bight to Cape Hatteras are not well known. Both the circulation and biology in this region of the Bight are influenced by inputs from the major estuaries (Hudson River, Delaware Bay, and Chesapeake Bay) and by outer shelf inputs of nutrient bearing oceanic water. The influence of the estuaries probably increases from north to south in relation to the size of each estuary.

Current Program

The current program is examining the physical, chemical, and biological properties in the section of the Bight influenced by inflow of the Hudson estuary and its movements down the New Jersey Coast. In subsequent years, the influence of the other estuaries and outer shelf intrusions will be determined.

Accomplishments FY 79

Organic particulate matter that enters the New York Bight settles more rapidly than previously believed; it is transported outward and deposited in canyons or on the continental slope and not on the shelf, suggesting that this is

an important CO_2 sink. Disruption of this production and transport may interfere with the extraction of significant amounts of CO_2 from the environment.

Primary production in the Mid-Atlantic Bight varies seasonally by a factor of ten, indicating the baseline variance against which manmade disturbances must be measured. This contrasts with the South Atlantic Bight where seasonal changes in productivity do not occur. In the Mid-Atlantic Bight, productivity is driven by shelf break intrusions of nutrient rich subsurface water, by tidal mixing on Georges Bank and its subsequent movement down current, and by estuarine discharge of increasing volume from north to south. Thus, if there is interference with or pollutant introduction into these intrusions or eddies, productivity in the region could be affected.

During the winter-spring season, nutrients are primarily utilized by bottom organisms which are the food sources for the ground fishery. During the summer and fall season, nutrients are transferred to the water column and are utilized by floating and swimming organisms which are the food sources for the pelagic fishery. Thus, the impact of an accidental spill or other major pollutant introduction would affect different fisheries depending on what time of the year the event took place.

Expected Accomplishments FY 80

Data on the transport and fate of spring phytoplankton bloom will be analyzed in order to define whether the major annual production of plants and the chemicals associated with them are transported mainly to the planktonic food chain, to a benthic food chain, or another sink.

Temporal changes in zooplankton populations will be followed in the cold pool of water upwelled on the shelf south of Long Island. This will determine whether zooplankton populations are coupled tightly to production of plants in the upper photic zone or to some other food.

Simultaneous measurement of water circulation, productivity, grazing, decomposition and regeneration processes south of Hudson River Estuary will provide quantitative information on how much material coming into the Mid-Atlantic Bight from the Hudson Estuary modifies what might be considered as the normal dynamics of that region of the Bight.

Abstracts of specific projects in the Northeast are given in the Appendix beginning on page A-39.

SOUTH ATLANTIC BIGHT

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Statement of Problem

The nearshore area of the South Atlantic Bight is influenced by a number of energy-related activities, particularly in the vicinity of Savannah, Georgia. The Savannah River watershed currently contains three operating production reactors, two chemical nuclear fuel reprocessing plants, and a nuclear fuel fabrication facility. Three commercial power reactors are presently operating and others are planned. Savannah is a major liquified natural gas terminal for the southeastern United States. In addition, the Bureau of Land Management will lease offshore continental shelf lands for the exploration of oil and gas resources. Charleston, South Carolina, is the home of a nuclear submarine base and another is being planned for Kings Bay, Georgia. Although the possibility of floating nuclear power plants is not imminent, hearings on permitting are continuing in the Florida area. Thus, the South Atlantic is presently and will continue to be exposed to many energy-related activities.

Water motion in the South Atlantic Bight moves generally northward from Florida to Cape Hatteras. Two flow regimes with different driving forces and exchange properties occur in the Bight. The outer shelf is influenced by Gulf Stream motions which force deep water intrusions bearing nutrients onto the outer and mid-shelf. The biological productivity of the coastal waters is dominated by these intrusions. The inner and mid-coastal waters are dominated by wind and tidal forces in the winter and additionally in summer by density driven flows. How these factors may disperse pollutants and affect productivity of this shelf is important to the understanding of the impact of energy systems in this region.

Current Program

The general physical, chemical, and biological properties of the Gulf Stream and inner coastal waters has now been determined. The research plan is to study the two flow regimes in sufficient detail at critical periods of the year. This will permit adequate understanding of the lower Bight region to reasonably predict biological effects due to natural and anthropogenic variation.

The current program is to complete the study of the dynamics of major intrusions driven by the Gulf Stream during the winter-spring transition period. Studies of the dynamics of the nearshore frontal zone will be expanded in the future as the off shelf program is phased down.

The studies are being carried out in coordination with the BLM program which shares the cost of transects, with U.S. Coast Guard which provides logistic support and NOAA which provides satellite data.

Accomplishments FY 79

Pollutants discharged from the rivers off Georgia, South Carolina, or Northern Florida, enter into a long shore circulation along the coast and flush only slowly into outer shelf waters. Pollutants in the mid shelf area are removed on an average of every 15 days. Flushing time of water masses at the shelf break is from 2 to 5 days.

Gulf Stream eddies and upwelling are the driving forces which vary the primary Productivity on the mid and outer shelf in this region. This is in sharp contrast to the Northeast region where primary productivity varies seasonally.

Nearshore waters off the Southeast states have consistently high productivity showing that the greatest possibility of pollutant transfer into the food chain occurs in this zone.

Expected Accomplishments FY 80-81

o Analysis of the shelf volume transport and circulation patterns will be completed so that a good estimate can be made of the residence time on the shelf of pollutants and the pattern in which they are transported and deposited.

o The detailed response of shelf waters to the Gulf Stream and wind forcing events during well-mixed winter conditions, vertically stratified summer conditions, and during transitions between these regimes will be compared in order to provide an integrated annual picture of the dynamics of processes in the South Atlantic Bight.

o Tidal inlet flow regimes will be compared with net nearshore transport for northeast Florida and Georgia to determine whether transport in these two regimes is controlled by the same or different forces.

o The dynamics of microbial populations in intrusions will be investigated to identify if they are the hot spots of biological activity and their role in the uptake of pollutants on particles.

o The chemical characteristics, the input rates, and the transport and exchange of trace elements and particles between zones of the nearshore area and between sediments and the water column in the nearshore area will be obtained. This will show how chemical species will be transported and how this transport will be controlled by biological and physical processes in the nearshore waters.

Specific projects in the South Atlantic Bight are described in the Appendix on pages A-47 to A-53.

CALIFORNIA BIGHT

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Statement of Problem

The California Bight has major transportation lanes that lead to offshore loading oil ports, onshore oil and gas exploration and development, several refineries, storage terminals, variously powered electric-generating plants, and numerous new developing energy activities, primarily solar and petroleum related. An understanding of the coastal system is important since it is heavily utilized by the human populations, as a recreational resource, as a fishery, and also as a discharge for many human-related pollutants.

The California Bight is essentially permanently stratified with occasional upwelling. It has a narrow shelf region and thus deep water relatively close to shore. Biological productivity varies yearly from low to high. The physical structure of the system and its biological productivity are controlled by climatic variables that are generated in the remote Pacific.

Current Program

The present program seeks to understand the driving forces for the marine food chain, for plankton production, the fates of the production, including fluxes of organic matter to deep water and sediments, and the roles of colloidal and dissolved organic matter in the carbon budget.

Several facets of this program have as their underlying theme determinations of factors controlling the rate of primary production and the nature and dynamics of the food chain. The food chain supports the higher trophic levels which are of economic and aesthetic importance. Emphasis is placed on (a) physical mixing processes which result in nutrients being brought into the euphotic zone, (b) analysis of the role of bacteria in secondary production and the dynamics of the microplankton food webs in which they participate, (c) the magnitude and chemical composition of particulate material falling out of the euphotic zone and the subsequent flux to the bottom sediments, (d) the concentration of microbial biomass and organic material in sediment core profile, and its relationship to biological activity in the overlying water column.

Accomplishments - FY 79

Large scale climatic events in the eastern North Pacific bring nutrients to the surface regulating the productivity in the South California Bight. A model coupling productivity with climatic changes, including sea surface temperature, has been developed to determine which increases of primary productivity in the Bight are related to these natural events versus those of anthropogenic origin.

Many pollutants introduced into the surface waters off Southern California are incorporated into the plankton and remain in the surface layer on the average of 20 days, with shorter time intervals during cold water upwelling and longer times during intrusions of warm sub-tropical water. If there is a release of a highly toxic product into the surface water of California, prediction of its length of time in these waters is now possible.

A predator on plankton in the surface waters is the northern anchovy. Relationships between schools of feeding anchovies and plankton blooms have been established and the resulting alteration of foodwebs determined. This information is important in providing knowledge of natural shifts versus human-related influences in available food for fisheries production.

Expected Accomplishments - FY 80-81

- o Mixing rates and the residence time of organisms within the coastal zone will be calculated to indicate how long anthropogenic chemicals might be expected to reside in coastal waters.

- o Particle paths for various models of waves propagated along the California coast will be determined. The time and space scales of these events will determine their biological importance and their relation to major discontinuities in distributions of marine organisms.

- o The importance of microscale nutrient pulses to phytoplankton will be compared with the well-stirred situation assumed by biological investigators. This will determine whether organisms respond to average concentrations as postulated or singular injections of nutrients. If the latter case is found, the quantitative understanding of phytoplankton dynamics will have to be revised.

- o The origin and uptake of nitrite by phytoplankton will continue to be investigated in order to understand plant production in terms of its role as a food source.

- o The importance of ultraviolet light in reducing the rates of photosynthesis in the sea will continue to be measured, to determine its importance in the quantitative role of phytoplankton populations in food chain dynamics.

- o The sinking of particles in the Bight and changes in the quality of the particles as they sink will be measured to provide an estimate of remineralization of organic matter and the production of pollutants and nutrients in the water column.

Abstract description and funding levels in this program begin on page A-55 of the Appendix.

NORTHWEST REGION

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Statement of Problem

The northern tier pipeline will bring supertankers into this region with a frequency far greater than the present oil traffic which supplies the cluster of refineries in this region. Within this coastal area are major fossil fuel and nuclear power plants, as well as a large smelter and a thriving pulp and paper industry. The pollution pressures on the air and water sheds will continue to increase. Marine studies are needed not only in Puget Sound and the Straits of Juan de Fuca where NOAA has an active program underway but along the outer coast as well where the DOE contractors are concentrating their efforts.

The northwest program is an integrated study of the interaction between the narrow coastal shelf waters and the offshore deeper waters in the productive Washington coastal zone. This zone is strongly influence by the Columbia River outfall which was intensely studied several years ago. Biological variability in this region is influenced by: the upwelling of deep water, the exchange of offshore water with near shore water, and water motion which is generally northward in winter months and southeastward in summer.

Current Program

The current program is designed to investigate the effect of submarine canyons on water motion, sediment deposition, and biological production in the coastal zone. A model of plankton production is being refined. The coastal surf zone which is extremely productive and supports the razor clam fishery is being integrated into this multidisciplinary program. The ongoing program will be phased into a study of the importance of plant production to benthic organisms and food web studies of the surf zone.

Accomplishments - FY 79

Mid-shelf water tends to move faster than near or outer shelf water in the same direction as the prevailing winds. Inner shelf currents often move in directions opposite to mid and outer shelf currents. This is important for predicting the dispersion of major spills that may take place in this region.

Canyons off Oregon and Washington are sinks for particles and organic matter showing that CO_2 sinks are present along the west coast as well as on the Northeast coast of the U.S. (see under NE Region Accomplishments).

A simple inexpensive model has been developed which incorporates the effects of bottom organisms on the transport of sediments and pollutants bound to sediments so that cycling and accumulation of pollutants can be predicted.

Expected Accomplishments - FY 80-81

- o Data on the effects of submarine canyons on biological oceanographic processes and controlling factors will be obtained. This information will be used to determine whether bottom topography has significant effects on biological dynamics in the Pacific Northwest.
- o A baroclinic model to predict water mass movement will be refined further.
- o Phytoplankton community structure will be correlated with dominant controlling factors on the Washington continental shelf to demonstrate if the quality of plankton production is controlled by specific genera or environmental variables.
- o Rates of microbial activity in the nepheloid layer will be measured to investigate if the nepheloid layer is a region of active mineralization of nutrients and other chemicals.
- o Effects of topographical changes, such as submarine canyons, on the circulation patterns on the Washington shelf will be measured to further assess the extent that general mass water transport is modified in specific predictable ways by bottom topography.
- o The effects of bottom organisms on near bottom water flow and sediment transport will continue to be studied to see whether bottom organisms function effectively as a trap for settling particles or tend to keep particles in motion and in transport to other areas.

Budget history and abstracts of individual projects begin on page A-59 of the Appendix.

ESTUARINE PROGRAM

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Statement of Problem

Estuaries have historically provided sheltered sites for ports as well as operation of industries, power plants, and refineries. At the same time, they serve as a natural resource for recreation and food supply.

The estuarine system is complex as it interacts with both the land and the ocean. Quantitative detail on these interactions is difficult to obtain, yet it is important for understanding the impact of our activities on fishery productivity and coastal ecology.

Current Program

The estuarine program has examined food web features of estuaries and projected a detrital-bacterial basis of food supply for fishes that use estuaries as a nursery. In Chesapeake Bay there are special physical-hydrographic features that produce frontal zones of biological activity which tend to maintain their position in the Bay and create shellfisheries. Unique circulation patterns also tend to produce and concentrate food organisms inside the Bay, that appear to be coupled to the occurrence of eggs of juvenile organisms.

The current program will examine how nutrients control the special features of food production relative to shellfisheries and finfisheries. It will examine the quantitative role of bacteria in mineralizing organic matter and as a food for bottom organisms. It will study the food of nursery fishes and the growth response of juvenile fishes to the supply and quality of food produced in estuaries. These studies are coordinated with NOAA research which concentrates on the fishes themselves rather than their food supply.

Formation of organic and inorganic particles and trace metal cycling is also being studied in the estuaries. The research is undertaken to determine the pollutant potential of these particles, and the extent of their availability to estuarine organisms.

Accomplishments FY 79

Suspended particles which adsorb chemical materials have been traced from the Susquehanna River at least 100 km into Chesapeake Bay.

Frontal zones are found to have high biological activity which can be used to analyze system performance in Chesapeake Bay. The frontal zones are related to locations of shellfish populations.

cpected Accomplishments FY 80-81

A model will be developed for predicting the distribution of particles and increased particulate load from resumption of coal mining in the Susquehanna Basin. This model can be used to suggest the biological processes and the hot spots that are likely to be most effected by leached chemicals. The role of the meiofaunal and bacterial populations in the estuaries and salt marsh sediments will be defined, and the relative importance of these groups as food for other organism will be determined.

Future Direction

This program is being gradually phased down and is being folded into the regional studies as the emphasis in the regional programs shifts to the near shore zone.

Budget history and abstracts of individual projects for the Estuarine Program begin on page A-67of the Appendix.

GREAT LAKES REGION

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Statement of Problem

The Great Lakes constitute the largest bodies of freshwater in the world and as such are a major natural resource for both the United States and Canada. The Great Lakes have been greatly affected by a diversity of human activities such as agriculture, industry, municipal wastes and energy production. The eutrophication of Lake Erie has been a graphic example of the effects of human activities in changing the nature of a very large body of water. The utilization of these waters will continue to increase in future decades. The proper regional management of these lakes requires an understanding of the physical motion of those waters and the biological changes that may occur in response to increased population pressures in the region.

The Great Lakes Research Program has focused on food chain dynamics in Lake Michigan. The program has attempted to analyze the effects of plant nutrients and trace metals on the biology of aquatic organisms. Lower Lake Michigan is impacted by heavy atmospheric and aquatic input of chemicals due to the high population density, heavy industry and petrochemical industry, and major river damage of both industrial and agricultural regions. There is also a concentration of power plants in this region.

This program involves the distribution and delivery of nutrients and heavy metals to both the nearshore and offshore waters and to the sediments. It has determined which major nutrients control plant production and the degree to which certain heavy metals are toxic to phytoplankton and zooplankton from Lake Michigan. It has analyzed specific modes of delivery and transport of chemicals in the nearshore and pelagic waters to phytoplankton in this transition zone. A major part of the program was transferred to EPA in 1979. Three projects from this program are still active.

Current Program

Environmental stresses resulting from human activities have the potential to affect the nearshore area to a greater extent than the offshore region. To affect offshore biological processes, river-borne pollutants and organisms must be transported through the nearshore zone. Ultimately, chemicals entering the lake must accumulate in the water or be deposited more or less permanently in the bottom sediments.

The three research projects remaining in the DOE program concern the manner in which phosphorous and trace metals influence the growth of phytoplankton assemblages in offshore Lake Michigan water and mechanisms by which organisms may detoxify trace metals; the manner in which dissolved organic substances in lake water may

ombine with trace metals and reduce their potential toxicity; and the chemical changes in sediments with depth and how well the sediments function as a permanent trap for trace metals introduced to the lakes.

Accomplishments FY 79

It has been confirmed that silica depletion due to high phosphorous loadings in Lake Michigan caused the phytoplankton community structure to change during summer to blue-green and green algae whereas it was formerly diatoms.

Cadmium and copper toxicity is reduced by complexation with natural dissolved organic substances in lakes. The circulations of organic matter required to do this are very low (micromolar). In the case of copper, it is the uncomplexed ion that is the toxic form.

Expected Accomplishments FY 80

Polyphosphate formation in phytoplankton will be evaluated as a detoxifying agent for heavy metals. This will permit prediction of the conditions under which phytoplankton may or may not be susceptible to heavy metal toxicity.

Research on the chemical speciation of heavy metals in the water colum will be completed. This will permit a correlation of metal species with possible toxic effects on phytoplankton in the natural system.

Future Direction

This program will be phased out in FY 1981.

Budget history and abstracts of individual projects in the Great Lakes begins on page A-73 of the Appendix.

ENVIRONMENTAL BASE RESEARCH
MARINE BIOCHEMICAL STUDIES

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Problem Definition

When humans impose energy-related stresses at low levels on natural communities, a chronic situation may become acute. Scientists are presently unable to predict with confidence the responses of these marine communities to many energy-related stresses in their environment. Much of the ignorance arises from the fact that energy-related changes in the oceans are not readily visible. The Marine Biochemical Studies Program is aimed at solving a major research shortcoming on the life-environment relation that has been made doubly important by present-day problems.

At present, the primary method of determining environmental stress in a population is to assess species diversity and species number. This approach focuses on the trees, not the forest, and requires extensive consumption of time and labor. A quicker, more reliable method of detecting stress in ecosystems is urgently needed. One approach that holds considerable promise is the analysis of biochemical responses to natural and artificially induced stress.

Objectives

By recognizing abnormalities in metabolism and biochemical constituents of populations or individuals that are under environmental stress, it is possible that systems damage can be predicted before it becomes manifestly obvious in the disruption of community structure.

Early identification of potential stress is clearly preferable in preventing permanent environmental injury in contrast to the unfortunate circumstance of becoming overwhelmed by the last stages of an acute ecological disaster. To avoid the pitfalls of subjectivity, it is necessary to develop appropriate criteria for evaluating the relative effects of stressors on the community and its organizational structure. The objective of this program is to develop the scientific methodology that can fulfill the dual purpose of predicting and identifying the source of potential adverse marine impacts.

Research Plan

Stresses arising from energy-related activities are becoming an increasingly important factor in marine environments. In order to evaluate the input of these stresses on marine communities, studies on physiological and cellular changes in organisms under natural and anthropogenic stresses are being conducted in several laboratories in order to develop methods for early identification of damage to marine populations.

Current Program

Because fatty acid patterns reflect the physiological state of an organism which varies in response to changes in the physical environment, comparisons are being made between the biochemical variability of populations in physically rigorous environments and in more benign locations. Plankton in three regimes (ocean, bay and lagoon) of increasing physical severity are being analyzed in regard to the physical environment, standing crop, and fatty acid composition. These "biochemical correlates" are proving to be useful in predicting ecological effects resulting from environmental stresses.

Under most circumstances, the concentrations of potentially toxic trace metals entering the environment from energy-related activities are extremely low or rapidly diluted. Marine animals possess mechanisms for the sequestration, detoxification, and elimination of those toxic metals and, thereby, tolerate and adapt to low-level metal exposure. Toxicity may occur when those mechanisms are saturated due to excessive exposure. At the present time, the mechanisms for the sequestration and detoxification of toxic metals are not well understood. Such information is needed to evaluate long-term, low-level exposure of marine organisms to metals. And, as a result, the role of low molecular weight, metal-binding proteins and lysosomes (two known cellular storage detoxification systems, respectively, for metals) in relationship to the toxicity of the metals are being examined in several marine invertebrate species.

Jellyfish are being employed as indicators of both genetic and somatic damage from exposure to energy-derived pollutants. The simple organization, asexual budding habit, and distinct life stages permit a relatively straightforward detection of changes or damage to this organism when exposed to various pollutants during its growth and development. Chromosomal changes, teratogenic effects, neuromuscular abnormalities, and physiologic damage are being studied.

Multidisciplinary groups are conducting research on factors that affect the biological availability of contaminants released to the marine environment from existing and developing energy technologies. The assessment of potential ecological damage requires not only understanding the toxicity of a specific element or compound, but also the knowledge of the total quantity present in the effluent in the toxic chemical form. In addition to the direct measurement of the biologically available forms in the water, research is being conducted on the factors that determine the release and complexing of contaminants by marine sediments.

Other investigations involve the availability of the sediment-bound contaminants and the role microbes play in mediating the distribution of metals between bioavailable and nonbioavailable forms. The combination of the water column and sediment research provides the insights needed to understand the major factors that affect a contaminant's bioavailability and, thus, its potential for damage to the environment.

Accomplishments - FY 1979

Fatty acid variation in three zooplankton communities has been found to display a unique pattern over an annual cycle with environmental change directly related to biochemical variability. The resulting biochemical message is complex but apparently highly informative: patterns of variation in the minor fatty acids are affected most strongly by physical environmental parameters whereas the variation of the major fatty acids is more responsive to differences in species composition, diversity and food web relationships. Taken together, these two aspects of biochemical pattern appear to characterize complex species assemblages. The result offers a new strategem for convenient assessment of continually changing states in a natural community.

Metal-binding proteins have now been found in all of the species studied (clams, mussels, and polychaetes). Exposure to mercury or copper results in the induction of a metal-binding protein and an increased binding of the respective metal. This binding appears to serve a detoxification function and to protect the organism from the potentially harmful effects of accumulated metal. Apparent saturation of the metal-binding protein and increased lysosomal activity is observed in stressed individuals and may be related to metal toxicity. Field studies using the marine mussel have indicated that metal-binding proteins are involved in the sequestration of mercury in mercury-contaminated environments.

Diverse biological effects caused by energy-related pollutants have been observed in jellyfish development. These abnormalities generally include inhibition or retardation of development in the asexual form, reduced iodide uptake into jellyfish polyps, and cessation of asexual reproduction and reversal to the polyp condition. More specific effects were observed in the sexual form of the jellyfish, including neurophysiological and morphological damage. Genetic implication in the control of the effects is suggested.

The bioavailability program has been investigating a model metal (copper) and the factors that control its availability to representative organisms. Work in the laboratory has shown that the quantity of copper that is measurable by differential pulse anodic stripping voltammetry (DPASV), not total measurable copper, is correlated to biological uptake and toxicity. The research has shown that natural seawater has a limited capability to complex ionic copper and make it biologically unavailable and nontoxic. Waters appear to contain a natural complexing capacity, and the addition of organic compounds such as tris, cysteine, glycine, sodium citrate and histidine increases the complexing capacity.

It appears that DPASV is a useful tool for the measurement of both bioavailable and, therefore, potentially toxic metals in an effluent stream or the environment, and the complexing or detoxifying capacity of water into which an effluent stream will discharge metals. The research has also shown that metals added to the water column in the ionic form quickly move to the organic fraction of the sediments. In the organic fraction, the metal is available to organisms that feed on sediments, but not available to organisms that feed from the water column.

Expected Accomplishments - FY 1980 - 1981

The correlation between a marine community's fatty acid pattern and changes in environmental variables will be interpreted further for potential management applications. Prediction of adverse impacts through biochemical analyses appears possible, because chemical reorganization takes place before any structural change in species representation occurs. To test this hypothesis, field experiments are being conducted in marine and estuarine habitats. The results, while not interpretable in the same manner as laboratory experiments, will have the enormous advantage of being a direct statement of natural organization and its propensity to change. Refinement of approach, to include a detailed study on positional isomers of the fatty acids, is also proposed for continuation, as well as the relative role of such factors as nutrition and species compositions.

Further characterization of metal-binding proteins and lysosomes and their roles in the detoxification and toxicity of metals is planned. Continued examination of field-exposed individuals will provide a bridge of understanding of the responses of organisms exposed in the laboratory with those in the natural environment.

Emphasis will be placed on cytological studies of the developmental processes in jellyfish. Surface changes will be investigated using scanning electron microscopy. Copperative experiments with geneticists are planned in order to follow the effects of energy-derived pollutants on chromosome structure and inherited morphological changes. Factors associated with thyroxine synthesis will continue to be investigated in the jellyfish and compared with vertebrate processes of iodine metabolism.

Future Plans

The long range objective of this program is to develop practical methods by which biochemical measurements can be used to assess both stress effectors and mediating processes in marine communities. The research direction will continue to encompass the areas under investigation (trace metal metabolism, bioavailability, genetic effects, and biochemical constituents), as well as lead into new directions as they are identified from research progress. Study of the dynamic processes involved in sediment/water/organism distribution of energy-related pollutants in the marine environment is being planned

in order to provide information on long-term accumulation and the relative concentration of compounds in animals and in sediments. Research on physical and biochemical factors affecting metabolism and/or excretion of xenobiotic compounds is also planned for incorporation into the marine biochemical studies. By recognizing normal and deviate biochemical processes in marine communities, limits may be established on the range of conditions to which marine organisms can adjust.

Budget history and abstracts of individual projects in the Marine Biochemistry Program begin on Page A-77 of the Appendix.

SUPPORT TO MARINE PROGRAM

This program includes two projects that are designed to calibrate methods of studying marine waters. One is to evaluate two different mathematical systems for analyzing current data by comparing quantitative data obtained from Eularian and Lagrangian measurements, and the second is calibrating traps that collected sedimenting particles in the water column.

Partial support is provided for the administration of the National Academy of Sciences, Ocean Affairs Board, and the National Science Foundation University National Oceanographic Laboratory System. Both organizations serve many interests of ocean science and provide an important service to the DOE marine program. A small proportion of this budget is allocated to the support of conferences of programmatic interest to OHER/ERD.

A description of the above projects begins on page A-83 of the Appendix.

APPENDIX

FOSSIL

OIL AND GAS PROGRAM

Current Projects of Oil & Gas Program

Project No.	Project Title	P.I.	Budgets in $1,000's 78	79	80
6334	Distribution and Fate of Biogenic and Petroleum-Derived Substances in Marine Sediments	UCLA I. R. Kaplan	125	143	141
7300	Biogeochemistry of Petroleum Components at the Sediment-Water Interface	WHOI J. Teal & J. Farrington	69	59	85
7662	Investigating the Impact of Drilling Mud and its Major Components on Bivalve Species of Georges Bank	New England Aquarium Corp. G. McLeod	0	90	90
7740	Distribution of Marine Birds on the Mid- & Atlantic U.S. Outer Continental Shelf	Manomet Bird Oservatory K. D. Powers	0	67	67
7833	Petroleum Effects on Neural Systems in Marine Organisms	UCLA J. Case	0	77	80
8244	Impact Assessment of Oil Spills on Marine & Estuarine Bird Populations	Point Reyes Bird Observatory D. G. Ainley	0	64	64
		TOTAL	194	500	527

CONTRACTOR: University of California, Los Angeles

PRINCIPAL INVESTIGATOR: I. R. Kaplan

CONTRACT NO: HA 0203010 PROJECT NO: 6334 Co-funded with BLM

TITLE: Distribution and Fate of Biogenic and Petroleum-Derived Substances in Marine Sediments

The following studies will be undertaken during the duration of this contract:

1. Evaluation and differentiation of marine and terrestrial contributions of carbon compounds to ocean sediments.
2. Fluxes of carbon, nitrogen, phosphorus and sulfur at the sediment-water interface.
3. Evaluation of and nitrogen fluxes into marine sediment as a function of climatic changes.
4. Differentiation of marine biogenic and petrochemical hydrocarbons.
5. Fate of hydrocarbons in the sediment column.
6. Role of sediment organic matter in mobilization and removal of trace metals.
7. Distribution of trace metals in sediment as a function of climatic changes.

CONTRACTOR: Woods Hole Oceanographic Institution

PRINCIPAL INVESTIGATOR: J. M. Teal and J. Farrington

CONTRACT NO: HA 0203020 PROJECT NO. 7300 Co-funded with BLM

TITLE: Biogeochemistry of Petroleum Components at the Sediment-Water Interface

This proposal explores the effects that marine organisms have on hydrocarbon redistribution and cycling in the environment. The study focuses on release of hydrocarbons at the benthic mud-water interface, with and without biological activity. Results will be developed from field samples and from experimental studies initiated in the laboratory and transferred to the field. Field sampling will be carried out in the Buzzards Bay area, which has a low but chronic oil release, and the New York Bight in areas of high, moderate and low contamination of sediments by petroleum hydrocarbons. An experimental chamber has been constructed containing representative sediment and infauna to determine the redistribution of ambient and injected petroleum from surface layers and from within the sediment.

CONTRACTOR: New England Aquarium Corporation

PRINCIPAL INVESTIGATOR: G. McLeod

CONTRACT NO: HA 0203020 PROJECT NO: 7662

TITLE: Investigating the Impact of Drilling Mud and its Major Components on Bivalve Species of Georges Bank

Exploratory drilling operations will probably result in the release of the equivalence of 10^5 tons of drilling mud into the Georges Bank area. Previous studies have shown that turbid suspensions of clay minerals, such as those used in drilling mud, can disrupt the metabolism of bivalve molluscs. Therefore, a research program is being conducted on populations of five commercially important bivalve species. These organisms are being placed in closely controlled environments and exposed to various loadings of drilling mud or one of its principal components. The effect of this exposure on tissue weight and feeding rate are being measured, and histological analyses are being employed to evaluate the mobilization of the organisms' defense mechanisms against the unwanted particulate material.

A second group of experiments will measure the tendency of these species to extract heavy metals from the drilling mud particles. Test populations will be exposed to suspensions of metal-enriched bentonite, attapulgite and plant starch. The organisms' response to the additional insult will be determined by physiological evaluation and by the analysis of tissue samples for heavy metal content. The results of these analyses will be compared to control populations and to the metal concentrations extracted from the particulate suspensions using four chemical treatments. This comparison will indicate which, if any, of the four treatments yields metal data most closely resembling the total metal load taken up by bivalve molluscs.

CONTRACTOR: Manomet Bird Observatory

PRINCIPAL INVESTIGATOR: K. D. Powers

CONTRACT NO: HA 0203020 PROJECT NO: 007740

TITLE: Distribution of Marine Birds on the Mid- & Atlantic U.S. Outer Continental Shelf

The objective of this project is to provide a quantitative statement of the distribution in time and space of seabirds in the northwest Atlantic, particularly, in the Georges Bank Area. Trained observers of opportunity and ships of opportunity are being employed to achieve an extensive, low cost data set on these distributions, which, when complete, will permit a direct assessment of large scale impacts due to oil exploration, extraction, and transport.

ONTRACTOR: University of California, Santa Barbara

PRINCIPAL INVESTIGATOR: J. Case

CONTRACT NO: HA 0203020 PROJECT NO: 7833

TITLE: Petroleum Effects on Neural Systems in Marine Organisms

The purpose of this project is to determine the effects of identified components of petroleum on neural systems in order to provide a basis for understanding how petroleum in the marine environment affects the activities of marine organisms. Primary emphasis will be upon systems found in marine organisms in which the actions of petroleum components can be studied in terms of their relatively direct effects upon cell membranes.

Examples of the three types of neuronal membranes--sensory, synaptic and conductile--will be studied. We will use two types of "sensory" or environmentally excitable membranes--the chemosensory receptors of crustaceans such as the crab, Cancer antennarius, and the lobster, Panulirus interruptus, and the mechanically excitable cell membrane of the dinoflagellate, Pyrocystis fusiformis. Effects on electrically excitable axonal membranes will be studied using a Panulirus giant fiber preparation and effects on transmitter-excitable synaptic membranes will be studied using identified central neurons of the marine mollusc, Aplysia. Further, since neuroplasmic transport is of importance in maintenance of both dendrites and axonal membranes, a simple test will be conducted on the effect of petroleum fractions on axonal transport. For comparson with excitable system, effects on membrane potential, measured with voltage-dependent fluorescent dyes, will be conducted on erythrocytes. These investigations are designed so as to determine both chronic and acute effects in experimental situations in which exposure to petroleum is limited to the membrane system under study and in which the dosage and composition of the petroleum elements under test is precisely known.

CONTRACTOR: Point Reyes Bird Observatory

PRINCIPAL INVESTIGATOR: David G. Ainley

CONTRACT NO: HA 0203020 PROJECT NO: 008244

TITLE: Impact Assessment of Oil Spills on Marine & Estuarine Bird Populations

It is well known that oil in the marine environment kills many organisms, the most obvious being birds. It is relatively easy to count numbers of oiled birds washed up on beaches, however, assessing the actual impact of oil-related mortality on bird populations has seldom been attempted in western North America. We propose to develop a model to determine the extent to which spilled oil, by directly killing birds, presently reduces the size or bird populations in the Gulf of the Farallones and its adjacent California estuaries. The model could predict the potential changes on present mortality rates caused by major oil

TITLE: Impact Assessment of Oil Spills on Marine & Estuarine Bird Populations (Cont'd)

spills of magnitudes comparable to those occurring in the Gulf during 1937 and 1971. The model should provide a technique to assess oil spill impact on marine bird populations along the west coast. During the study each species' vulnerability to oil spills of different magnitudes and at different localities will be investigated. We will also examine the ability of the various habitats within the study area to support different species and will identify those species whose populations would likely be significantly depleted were their habitat damaged by oil or destroyed by development.

RENEWABLE RESOURCES

SOLAR-OTEC PROGRAM

Budget History of Current Projects in the OTEC Program

Project No.	Project Title	P.I.	Budget in $1,000's 78	79	80
615	Puerto Rico OTEC Studies	CEER J. Gonzales		478	571
1326	Marine Ship Support	CEER J. Gonzales	43	41	45
		Total	43	519	616

CONTRACTOR: Center for Energy and Environmental Research, Puerto Rico

PRINCIPAL INVESTIGATOR: J. Gonzales

CONTRACT NO: HA 0203030 PROJECT NO: 000615

TITLE: Puerto Rico OTEC Studies

This program has been redirected to study the possible environmental effects of ocean thermal energy conversion platform operations at a potential OTEC site. The research consists of a characterization of the marine ecosystem structure at the potential site and within an area thirty miles downstream from the site. The vertical physical structure of the water, stratified current velocities and directions, nutrient distributions, phytoplankton and zooplankton distributions, community structure, photosynthetic production, and migration of zooplankton are being measured. Seasonal changes in the structure of this tropical marine system are also being determined.

CONTRACTOR: Center for Energy and Environmental Research, Puerto Rico

PRINCIPAL INVESTIGATOR: J. Gonzales

CONTRACT NO: HA 0203040 PROJECT NO: 001326

TITLE: Marine Ship Support

The Marine Ecology research program requires a large oceanographic research vessel for the major cruises to gather baseline data, a fixed working platform at Punta Tuna for fixed station observation and a smaller research vessel to perform short term experiments, to support studies on the working platform and to provide opportunity to check specific observations arising from the cruises without requiring the expense of the large vessel. The R/V Sultana provides the latter support services. Subcontracts with other sources will provide the working platform and the oceanographic vessel for cruises.

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NUCLEAR

MARSHALL ISLANDS PROGRAM

Current Projects of Marshall Is Program

Project No.	Project Title	P.I.	Budget's in $1,000's 78	79	80
661	Management of the Mid-Pacific Marine Laboratory, Enewetak Atoll, Marshall Is	U. Hawaii E. Reese	205	215	202
1168	Operation of LCU	NVOO R. Ray	350	-	-
1508	Biogeochemical Cycling of the Transuranics and Other Radionuclides in the Marshall Is	LLL V. Noshkin	350	381	404
1521	Hydrogeochemistry of Enewetak Atoll	U. Hawaii R. Buddemeier	65	-	-
1676	Marshall Is radioecology Studies for Dose Evaluation	LLL W. Robison	765	795	795
2571	Circulation and Chemistry of the Enewetak Atoll Lagoon	U. Hawaii S. Smith	50	-	-
3329	Hydrogeochemistry of Enewetak	LLL R. Buddemeier	-	66	70
		TOTAL	1785	1457	1471
Marine Portion of Marshall Island Budget			670	662	676

MARSHALL ISLANDS PROGRAM

ABSTRACTS OF INDIVIDUAL PROJECTS

CONTRACTOR: University of Hawaii

PRINCIPAL INVESTIGATOR: E. S. Reese

CONTRACT NO: HA 0203040 PROJECT NO: 000661

TITLE: Mid-Pacific Marine Laboratory

The Mid-Pacific Marine Laboratory operates to provide the facilities and equipment required to support scientific research in the Marshall Islands. Special emphasis is given to programs related to the distribution of radionuclides and other materials in an atoll ecosystem, the cycling of materials through such a system, and the possible implications of these processes to man.

CONTRACTOR: Nevada Operations Office

PRINCIPAL INVESTIGATOR: R. Ray

CONTRACT NO: HA 020304 PROJECT NO: 001168

TITLE: Operation of LCU

Ship support for the Marshall Islands program is provided through contract with the Nevada Operations Office. After 1979 funds for ship support come out of a different portion of the Office of Environment budget.

CONTRACTOR: Lawrence Livermore Laboratory

PRINCIPAL INVESTIGATOR: V. Noshkin

CONTRACT NO: HA 0203010 PROJECT NO: 001508

TITLE: Biogeochemical Cycling of Transuranics and Other Radionuclides in the Marshall Islands

A number of aquatic environmental investigations of the biogeochemical cycling of radionuclides are being conducted in the Marshall Islands concentrating on Bikini and Enewetak Atolls. Marine studies include: investigating the methods and rates of remobilizing the transuranics and other radionuclides from components of the lagoon environment to the lagoon water and then to the open ocean; and measuring concentrations of radionuclides in different tissues and organs of marine species from the Atoll and developing models to predict future levels expected in these organisms from different sources. We predicted and verified concentrations of plutonium and cesium 137 in fish from the California coastal environment, from other Atolls in the Pacific, and from other global locations using models developed from data at Enewetak. We are evaluating the significance of plutonium labeled marine particulates resuspended on the ocean-side reef at the Atolls and the processes redistributing plutonium deposited to the deep ocean sediments during the testing program. Groundwater studies at the Atolls provide data to:

- Evaluate transport mechanisms and cycling rates of radionuclides between terrestrial components and the aquatic environment,
- Assess the impact of soil cleanup operations on the chemical and radiological groundwater quality, and
- Determine correlations between radionuclide concentrations in the groundwater and various edible plant species at the Atolls.

CONTRACTOR: University of Hawaii

PRINCIPAL INVESTIGATOR: R. Buddemeier

CONTRACT NO: HA 020302 PROJECT NO: 1521

TITLE: Hydrogeochemistry of Enewetak Atoll

This study was transferred to the Lawrence Livermore Laboratory along with the transfer of the Principal Investigator. Thus, the abstract is given under Lawrence Livermore Project No. 00329.

CONTRACTOR: Lawrence Livermore Laboratory

PRINCIPAL INVESTIGATOR: W. Robison

CONTRACT NO: HA 0203040 PROJECT NO: 001676

TITLE: Marshall Island Radioecology

A program of radionuclide measurements in soil, water and biota, radioecological transport modeling, and dose evaluation in the Marshall Islands is designed to fullfill the immediate objectives of (1) meeting present high priority needs for effective rehabilitation of Enewetak Atoll and (2) supporting the ongoing evaluation at Bikini Atoll. The long-term goal is to identify the key parameters affecting dose to man, to determine the residence time of key radionuclides in the atoll environment, and to provide information required for implementation of resettlement and rehabilitation in both regions. Our program has the following specific objectives:

1. To make measurements that will delineate the rates of uptake, redistribution and removal of radionuclides in the ecosystem, and to develop or refine the concentration factors for the critical radionuclides, especially for food species.

2. To develop further understanding of the cycling of radionuclides in the terrestrial foodchains so as to derive guidelines for agricultural practices and agricultural development such that population exposure via terrestrial foods will be minimized.

CONTRACTOR: University of Hawaii

PRINCIPAL INVESTIGATOR: S. Smith

CONTRACT NO: HA 020301 PROJECT NO: 2571

TITLE: Circulation and Chemistry of the Enewetak Atoll Lagoon

The objective is to determine the physical circulation of the Enewetak Atoll lagoon and the flux of carbon, phosphorus and nitrate across the atoll's reef flats. A field measurement program will be conducted of physical properties using current meters and drogues and of selected nutrient chemical properties by sampling and analysis.

CONTRACTOR: Lawrence Livermore Laboratory

PRINCIPAL INVESTIGATOR: R. Buddemeier (formerly at Univ. of Hawaii)

CONTRACT NO: HA 0203020 PROJECT NO: 003329

TITLE: Hydrogeochemistry of Enewetak

The primary area of emphasis is the groundwater and its interaction with the soils, terrestrial vegetation and marine communities at Enewetak and Bikini Islands. The overall technical approach taken is to develop a quantitative model of the physical and chemical dynamics of island groundwater bodies for integration with the radionuclide data produced by other tasks. Specific experimental approaches include: 1) physical analyses of groundwater bodies and recharge dynamics (rainfall, freshwater inventory, tidal responses and hydrologic characteristics of the island medium); 2) chemical analyses designed to evaluate the freshwater inventory and persistence, solution/precipitation phenomena in the soil zone and the aquifer, and the extent of biological alteration of the soil-and ground water chemistry; and 3) tracer studies, primarily utilizing local excess 3-H (Tritium) to provide independent estimates of groundwater age, movement, and soil fallout leaching.

NUCLEAR

STABLE & RADIOACTIVE ELEMENT PROGRAM

Current Projects of Stable and Radioactive Element Program

Project No.	Project Title	P.I.	Budget in $1,000's 78	79	80
934	Transuranic Marine Studies	LLL V. Noshkin	55	56	55
1301	*Ocean Transport of Contaminants	SRL D. Hayes			
1309	Radionuclides in Coastal Environment	LLL V. Noshkin	248	257	202
2221	North Pacific Disposal of High Level Rad-Wastes	Sandia Corp. D. Anderson	297	308	101
2521	Transuranic Cycling of Windscale Wastes	ANL Nelson	40	40	50
2528	Radionuclide Sources in the Coastal Zone	ORNL N. Cutshall	107	102	101
3062	The Iron-55 Phenomenon	PNL E. Crecelius	0	71	70
6331	Marine Geochemistry Research	U. of CA E. Goldberg	75	77	75
6403	Geochemical Behavior of Uranium and Thorium Series Nuclides and of Plutonium in the Gulf of Mexico	Texas A&M U. M. Scott	80	91	90
6423	Radioelement Studies in the Ocean	WHOI V. Bowen	575	591	475
6427	Distribution of Some Chemical Elements Between Dissolved and Particulate Phases in the Ocean	WHOI D. Spencer	125	128	141
6430	The Fate of Nuclides in Natural Water Systems	Yale U. K. Turekian	65	88	91

*Description of this project in Regional Marine Program, South Atlantic Bight

STABLE AND RADIOACTIVE ELEMENT PROGRAM CONT'D

Project No.	Project Title	P.I.	Budget in $1,000's 78	79	80
6855	Plutonium, Cesium and Uranium Series Radionuclides in the Hudson River Estuary and other Environments	Columbia U. H. Simpson	65	70	70
7205	Cycling of Transuranic Radionuclides in the Columbia River	Oregon St. U. T. Beasley	130	133	141
8133	Integrated Study of the Behavior of Transuranic Elements in the Marine Environment	Florida St. U. Choppin	0	147	0
8134	Biogeochemical Studies of Technetium in Marine and Estuarine Ecosystems	Oregon St. U. T. Beasley	0	75	73
			1862	2234	1735

CONTRACTOR: Lawrence Livermore Laboratory

PRINCIPAL INVESTIGATOR: V. Noshkin

CONTRACT NO: HA 0203010 PROJECT NO: 00934

TITLE: Transuranic Marine Studies

This is a continuing study on the distribution of 90-Sr, 137-Cs, 238-Pu, 239-Pu, 240-Pu, and 241-Am in GEOSECS oceanic water columns. Each of these radionuclides has been introduced to the oceans as a result of atmospheric tests of nuclear explosives. In addition to providing baseline data on the concentrations and distributions on these long-lived radiotoxic pollutants in the world's oceans, the radionuclides are valuable tracers for oceanic water movement, for estimating the flux of particulate material, for assessing the sedimentation and removal rates of chemical analogs, and for revealing the net fluxes of atmospherically delivered pollutants to the sea surface. Emphasis is on plutonium analyses because of the ongoing efforts and interests in the geochemical behavior of this element in other aquatic environments. One additional purpose of this study, therefore, is to ascertain how far one can extrapolate the behavior of fallout plutonium in the world's oceans to other sites, such as coastal or off-shore reactor sites or the Marshall Islands which receive plutonium inputs from other sources.

CONTRACTOR: Lawrence Livermore Laboratory

PRINCIPAL INVESTIGATOR: V. Noshkin

CONTRACT NO: HA 0203010 PROJECT NO: 001309

TITLE: Radionuclides in Coastal Environment

The objectives of this program are to conduct sound and practical ecological research to aid in understanding how nuclear-related pollutants arising from routine releases of liquid effluents from nuclear facilities, fallout, and resuspension processes are dispersed and concentrated in components of aquatic environments. These investigations provide a basis for characterizing the rates and mechanisms of the various physical, chemical, and biological processes that control the behavior of these pollutants. For each pollutant, these environmental studies consider: (1) the rate of its release into the environment, (2) its persistence in the environment, (3) the rate of its depletion and turnover from the environment, (4) its concentration in aquatic compartments, and (5) its toxicity, both for organisms and man, at levels found in the specific environment.

CONTRACTOR: Sandia Corporation

PRINCIPAL INVESTIGATOR: D. Anderson

CONTRACT NO: HA 0203010 PROJECT NO: 002221

TITLE: North Pacific Disposal of High Level Rad-Wastes

The broad objective of the seabed program is to determine the technical feasibility, including the determination of environmental acceptability and comparability, of controlled emplacement of radioactive waste materials under the sediments of the deep ocean floor. Sub-objectives include: a) oceanographic investigations describe the modern ocean environment, determine present and past rates of the natural processes on and beneath the seafloor, and characterize the environmental media which will interact with the wastes once emplaced, b) effects investigations which will develop understanding of the interactions of the natural systems with the wastes and the emplacement operation, c) systems development engineering for transportation, handling and emplacement operational requirements and costs, d) site selection and survey for detailed information about the specific sites of interest, e) environmental assessment to determine those operational safety and emplaced waste effects on the environment, f) environmental impact definition which is simply those special effects of the operation and of the emplaced wastes on the natural system in a full operational phase. These objectives are being met by working within the established capabilities of several laboratories and oceanographic institutions as well as several engineering firms.

The Division of Ecological Research supported portion of the work, which is mostly conducted by Scripps Institute of Oceanography, concerns the respirometry and microbiology of deep ocean sediments, biological transfer processes across the benthic boundary layer, and biological transport mechanisms in the water column.

CONTRACTOR: Argonne National Laboratory

PRINCIPAL INVESTIGATOR: Nelson

CONTRACT NO: HA 0203010 PROJECT NO: 002521

TITLE: Transuranic Cycling of Windscale Wastes

This program investigates processes which govern the availability of transuranic elements for accumulation by biota, control their retention in the water column, cause their removal from the system either by sedimentation or transport in water masses as suspended sediment, and determine the critical pathways and dose to man as well as effects on marine biota. These studies are conducted in the Irish Sea, which receives wastes from the Windscale Reprocessing Plant, and where concentrations of transuranic elements are therefore up to four orders of magnitude greater than the global average. Initial results indicate that the majority of the plutonium in sea water close to windscale is in true solution and in the V or VI oxidation state. In the north sea the proportion of Pu as V or VI decreases and a signifcant fraction becomes associated with natural colloids. There is no evidence of a "colloidal" plutonium. In the sediments and on particulates, the plutonium is in the IV state.

CONTRACTOR: Oak Ridge National Laboratory

PRINCIPAL INVESTIGATOR: N. Cutshall

CONTRACT NO: HA 0203010 PROJECT NO: 002528

TITLE: Radionuclide Sources in the Coastal Zone

This program is designed to investigate rates of transfer of materials through the coastal marine environment. Artificial and natural radionuclides provide timing tracers of the transfer processes. By measuring the concentrations of radionuclides in environmental components, the rates and routes by which pollutants are dispersed and moved across the coastal zone into the deep sea can be estimated.

CONTRACTOR: Pacific Northwest Laboratory

PRINCIPAL INVESTIGATOR: E. Crecelius

CONTRACT NO: HA 0203030 PROJECT NO: 003062

TITLE: The Iron-55 Phenomenon

The goal of this program is to provide an understanding of the importance of chemical form in the biogeochemical behavior of anthropogenic airborne metals added to the marine environment. We have learned over the last several years that the radionuclide ^{55}FE enters the ocean with stratospheric fallout debris in a chemical form that is preferentially taken up by biota relative to the stable form in the ocean. This example shows how the cological consequence of a contaminant is difficult to predict unless the chemical forms are known. We suspect that other metals enriched in air particulates by man's activities will be far more biologically available than the same metals that have been mobilized by natural processes.

During the last year, the solubilities of a dozen elements in aerosols from different geographical locations (Washington, Alaska, and Montana) were determined. Air filter from the coastal site had high solubilities of Na, Br, K and Cs, reflecting their origin as sea salt. The marine air particulates also had higher solubilities of Zn, Cr, Fe, Co and Sc than continental samples and raises the question of the bioavailability of these metals. During the next year, the chemical forms of several of the more soluble metals (Zn, Co and Cr) will be determined. Plans and future research include the determination of chemical forms of soluble contaminants in coastal air particulates and the rate at which transformations in chemical form of the newly added contaminant occur after mixing with sea water. The final product or use of this program is in providing data on chemical forms that are vital to predicting the bio-availability of contaminants.

CONTRACTOR: University of California - Scripps

PRINCIPAL INVESTIGATOR: E. Goldberg

CONTRACT NO. HA 0203010 PROJECT NO: 006331

TITLE: Marine Geochemistry Research

The history of atmospheric fallout of transuranics (Pu-238, Pu-239+240, and Am-241) will be sought from the Greenland Glacier and from southern hemispheric coastal marine sediments to complement records from northern hemispheric coastal waters. The amount of transuranics that derive from crustal materials and are transported by winds and rivers and those transuranics from stratospheric fallout will be compared in sediment columns. Also, investigated are the chemical forms (dissolved, particulate or colloidal state; charges on dissolved phases) of the transuranic nuclides and of Pb-210, Po-210, U-238, and Th-238, and Th-232 in coastal marine waters. The sorption of these nuclides upon a variety of solid phases (seaweeds, anion and cation exchange resins, will be investigated on the basis of their isoelectric points and beta surface areas. Finally, a low-level beta counting system (scintillation counter with two dectors in coincidence with a anti-coincidence guard ring) will be developed for the measurement of Pu-241 in sediment, water and biological samples from ocean system.

CONTRACTOR: Texas A&M University

PRINCIPAL INVESTIGATOR: M. Scott

CONTRACT NO: HA 0203010 PROJECT NO: 006403

TITLE: Geochemical Behavior of Uranium and Thorium Series Nuclides and of Plutonium in the Gulf of Mexico

The geochemistry of plutonium in the Gulf of Mexico, and the factors controlling the behavior of uranium series daughters in sea water - sediment interactions will be studied. Plutonium isotopes will be measured in both oxic and anoxic sediments in the Gulf of Mexico and in suspended sediment from major rivers emptying into the Gulf. The measurements will be combined with Th228 and Po210 sedimentation rates to provide an estimate of the flux of Pu into the sediments. The influence of ligand concentrations on adsorption of Th and Ra onto clay will be measured experimentally in the laboratory, and also assessed by measuring ligand and isotope concentrations in the pore waters of sediments of varying chemical environments.

CONTRACTOR: Woods Hole Oceanographic Institution

PRINCIPAL INVESTIGATOR: V. Bowen

CONTRACT NO: HA 0203010 PROJECT NO: 006423

TITLE: Radioelement Studies in the Ocean

A long term study to lay the basis for prediction of the movements, rates and fates of long lived artificial radionuclides introduced into marine environments; this obviously requires clarification of the basic geochemical and biological processes in which they participate. Measurements are made both of soluble tracers like strontium 90 and cesium 127, and of largely particulate tracers like iron 55 and the transuranic nuclides. Samples of water (all depths), aerosols, biota and sediments are analyzed routinely for Sr 90, Cs 137, Fe 55, Pu 238,239 and 240, and Am 241; in special cases also for Pu 241, Am 242M, Cm 242, Cm 244, and many others. Stable element analyses also are made by a wide variety of techniques. Although most of study refers to fallout nuclides, waste disposal situations and experimental tracer introductions are also studied.

CONTRACTOR: Woods Hole Oceanographic Institution

PRINCIPAL INVESTIGATOR: D. Spencer

CONTRACT NO: HA 0203010 PROJECT NO: 006427

TITLE: Distribution of Some Chemical Elements Between Dissolved and Particulate Phases in the Ocean

Studies will be completed of the cycling of 210-Po and 210-Pb in inner shelf areas by examination of the seasonal variations in 210-Po and 210-Pb concentrations and fluxes in particulate matter in the Gulf of Maine and completion of the dissolved and particulate 210-Pb and 210-Po analyses from samples in the North Sea collected during flex 76 experiment. The work will then extend to the Outer Continental Shelf off the New England Coast to examine the deep water/shelf exchanges of these isotopes.

CONTRACTOR: Yale University

PRINCIPAL INVESTIGATOR: K. Turekian

CONTRACT NO: HA 0203010 PROJECT NO: 006430

TITLE: The Fate of Nuclides in Natural Water Systems

Efforts are concentrated on the behavior of natural and man-made radionuclides and selected trace metals in the coastal zone. In the water column Po-210, Pb-210, Th-229 and Th-234 and related nuclides provide information on the behavior or reactive nuclides, including man-introduced pollutants. The distribution of Pb-210, Th-234, Be-7 and C-14 in the sediment pile provides information on sediment accumulation rates and the extent and rates of biological and physical reworking. These results can be applied to the understanding of the fate of plutonium and trace metals in the coastal zone. The study of the atmospheric and riverine fluxes to the estuarine environment will be continued. Although Long Island Sound and its drainage basin (and the New York Bight), in part are major arenas of activity. Work in other areas is included as the need and opportunity arise.

CONTRACTOR: Columbia University

PRINCIPAL INVESTIGATOR: H. Simpson

CONTRACT NO: HA 0203010 PROJECT NO: 006855

TITLE: Plutonium Cesium and Uranium Series Radionuclides in the Hudson River Estuary and other Environments

Collection of sediment samples and water in the Hudson River estuary, will be continued and will be analyzed for Cs-137, Cs-134 and Co-60 by direct gamma counting and for Pu-239, 240 and Pu-238 by alpha counting. The purpose is to describe the behavior of fallout-derived plutonium in estuarine sediments as a function of a number of environmental parameters, and to exploit the reactor-release tag of Hudson sediments as an indicator of the sediment transport and accumulation patterns which control the distribution of plutonium in the sediments. Also, whether or not local transuranic releases to the Hudson have occurred will be investigated. Measurement of other transuranics will begin on some of the Hudson samples, and on samples from near two other nearby nuclear power plants. A field program will begin at two lakes to investigate the geochemical behavior of fallout transuranics in two highly unusual environments, and to explore the use of several other chemical tracers as indicators of hydrothermal and volcanic activity.

As a result of these research activities, the Investigator has been selected as a consultant for International Atomic Energy Agency committees on ocean waste disposal in Atlantic and Pacific Oceans.

CONTRACTOR: Oregon State University

PRINCIPAL INVESTIGATOR: T. Beasley

CONTRACT NO: HA 0203010 PROJECT NO: 007205

TITLE: Cycling of Transuranic Radionuclides in the Columbia River

Studies on the cycling of transuranic radionuclides in the Columbia River estuary and the North Pacific Ocean are being initiated. In addition, plans are to undertake investigations of the biokinetic behavior of transuranic radionuclide in selected fresh water and marine organisms. The proposed work involves the following three major activities: (1) Characterize the concentrations and distributions of plutonium and americium in the Columbia River sediment system, (2) Test the remobilization hypothesis which evolved from V.T. Bowen's work that indicates the plutonium can move vertically in the sediments over time, (3) Controlled laboratory experiments of uptake, loss and tissue distributions of Pu-237 which has proved to be an excellent tracer and can quickly assess distributions by standard NaI (TI) scintillation techniques.

CONTRACTOR: Florida State University

PRINCIPAL INVESTIGATOR: Choppin

CONTRACT NO: HA 0203010 PROJECT NO: 008133

TITLE: Integrated Study of the Behavior of Transuranic Elements in the Marine Environment

Although the radiochemistry of transuranic elements has been widely studied in the laboratory and numerous measurements made of their distribution in natural environments, insufficient knowledge is presently available to construct reliable predictive models of their potential behavior in the oceans. A new approach is proposed in which a researcher familiar with the chemistry of transuranic elements (Choppin) will work closely with a researcher familiar with marine chemistry (Morse). This approach will yield radiochemical data directly applicable to understanding the distribution and speciation of transuranic elements in the marine environment.

The basic plan is to start with a limited number of common sediment components (e.g., humic and fulvic acids and calcium carbonate) and determine what factors determine the partitioning of transuranic elements among these components.

The study will then proceed to "build up" a comprehensive set of data by studying other common sediment components (e.g., clays). From these data a predictive capability for the behavior of transuranic elements in the marine environment should evolve.

CONTRACTOR: Oregon State University

PRINCIPAL INVESTIGATOR: T. Beasley

CONTRACT NO: HA 0203010 PROJECT NO: 008134

TITLE: Biogeochemical Studies of Technetium in Marine and Estuarine Ecosystems

Technetium-99 is a fission product radionuclide produced in high yield in the thermal fission of both 235-U and 239-Pu. As such, it is present in rather high concentrations in existing fission product waste storage solutions, and will be produced in significant quantities in plutonium fast breeder reactors. Laboratory and field experiments will be conducted on the behavior of technetium in marine and estuarine ecosystems to acquire basic information on the fate of this element once introduced into the environment. Studies will include food chain transfer dynamics (phytoplankton-zooplankton-macrozooplankton-fish) as well as uptake, loss and distribution in various tissues of marine organisms of commercial importance to humans (shrimp, shellfish, benthic fishes). The importance of zooplankton metabolic activity (fecal pellet and moult production) as a mechanism for the vertical transport of the element from the surface layers of the ocean to depth will be investigated. Finally, geochemical data will be obtained on the behavior of the element in seawater, sediments and at freshwater-saline water interfaces.

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MULTITECHNOLOGY

COOLING SYSTEMS PROGRAM

Budget History of Current Projects in Cooling Systems Program

Project No.	Project Title	P.I.	Budget in $1,000's 78	79	80
609	Thermal Effects Studies	ORNL C. Coutant	310	308	303
669	Cooling Systems Effects	E. I. Dupont L. Tilly	202	212	176
1910	Effects of Energy Production on the Function of the Aquatic Environment	SREL M. Smith	136	185	136
3186	Cooling System Pathogens	SREL C. Fliermans	0	82	redirected
6371	Ecology of Subtropical Shallow Water Environments	U. of Miami J. Carpenter	108	89	89
6637	Effect of Cyclic Temperature on Marine Invertebrates	Duke U. J. Costlow	55	12	0
6796	Thermoregulation of Fish and Turtles in Thermally Stressed Habitats	SUNY J. Spotila	39	39	41
6848	Effects of Environmental Stresses on the Species Composition of Phytoplankton	WHOI J. Ryther	100	102	111
7058	Impact of Thermal Loading and Other Water Quality Parameters on the Epizootiology of Aeromonas Hydrophila Infections of Centrarchids	Wake Forest U. G. Esch	55	53	37

Cooling Systems Program - Cont'd

Project No.	Project Title	P.I.	78	79	80
7215	Comparative Evaluation of Effects of Ozonated and Chlorinated Thermal Discharges on Estuarine and Freshwater Organisms	PSEG, N.J. C. Guerra	60	60	18
7616	Fate of Chlorine in Seawater	Old Dominion U. G. Wong	0	39	60
			1065	1181	971

CONTRACTOR: Oak Ridge National Laboratory

PRINCIPAL INVESTIGATOR: C. C. Coutant

CONTRACT NO: HA 0203020 PROJECT NO: 000609

TITLE: Thermal Effects Studies

The program consists of four tasks: (1) benthic species interactions with predators; (2) forage species interactions with predators; (3) habitat selection by predators; and (4) synthesis and modeling.

The primary research site for each of these four tasks is Watts Bar Reservoir, Tennessee, accompanied by supporting laboratory and pond experiments. The focus of each task is two fold: First, to investigate the behavior, physiology, and dynamics of selected species within the benthic, forage fish, and predatory fish communities, and second, to investigate the interactions and food-web relationships among these three trophic levels and other components of the reservoir ecosystem. Characteristics of the system that are sensitive indicators of change due to a stress will be sought as a means of monitoring the pulse of the system. The long-term generic goal is to gain an understanding of ecological processes in southeastern reservoirs so as to better predict the environmental acceptability of various energy systems on these reservoirs.

CONTRACTOR: E. I. DuPont

PRINCIPAL INVESTIGATOR: L. J. Tilly

CONTRACT NO: HA 0203020 PROJECT NO: 000669

TITLE: Cooling System Effects

The objective of this task is to understand power plant cooling system effects on representative aquatic ecosystems. Several different aspects of cooling system operation are available for study at the Savannah River Plant (SRP). Aspects of the recirculatory cooling process are being examined using the Par Pond reactor cooling reservoir system and once-through cooling systems have been studied at the Flowing Streams Laboratory which is on the Plant site.

At this site studies have historically focused on in situ and laboratory experiments designed to measure responses of lower food chain organisms to thermal stresses associated with cooling system operation. Thermal studies of this type will be concluded in FY 1980 and emphasis will be shifted to studies dealing with biofouling in cooling systems and the problems resulting from chlorination and other antifouling procedures. The principal goal of the research for FY 1981 and beyond will be to evaluate the environmental impact of chlorination used for biofouling control in cooling systems at SRP and elsewhere and to develop an improved technology for combatting biofouling problems with less environmental effects.

CONTRACTOR: Savannah River Ecology Laboratory (SREL)

PRINCIPAL INVESTIGATOR: M. H. Smith

CONTRACT NO: HA 0203020 PROJECT NO: 001910

TITLE: Effects of Energy Production on the Function of the Aquatic Environment

Energy development technologies or industrial operations can cause environmental alterations which stress functional parameters of aquatic ecosystems, including those related to physiology or to population or community dynamics. Because of the variety of local habitats, the Savannah River Plant (SRP) provides an opportunity unsurpassed in the southeastern U.S. to assess the impact of energy or industrial development on functional aspects of the environment. In the past SREL has examined effects of thermal stress and post-thermal recovery primarily in the field, but complemented this work with laboratory experiments. Most of the studies have been at the organism or population level, although the examination of selected community characteristics has also been undertaken. With the capability of diverting and controlling the temperature and effluent flow from a reactor into an otherwise natural stream habitat (Castor Creek), the understanding of ecosystem vulnerability will be greatly enhanced and population studies will be strengthened through field experimentation. This project will greatly augment the present capability for ecological studies of the responses to stress in aquatic systems.

CONTRACTOR: Savannah River Laboratory

PRINICPAL INVESTIGATOR: R. Fallon

CONTRACT NO: HA 0203020 PROJECT NO: 003186

TITLE: Cooling System Pathogens

The objective of the microbial pathogen study in southeastern cooling systems is to determine the impact of fossil and nuclear fueled electrical generating facilities on the population density, distribution, survival and in situ physiology of a variety of human pathogens in waters downstream from the cooling system. Previous research in a 20-year cooling reservoir, Par Pond, has demonstrated that the survival and growth of specific pathogenic microorganisms are enhanced by cooling system operation. Present studies focus on defining the types of microbial pathogens associated with southeastern cooling systems and the adaption of specific bacterial, fungal and protozoan pathogens to in situ conditions. Studies include selection of specific study sites, identification of the pathogenic microbial populations and sensitivity of bacterial isolates to selected antibiotics. The study provides guidance for the proper use of waters associated with power plant cooling systems in the southeast.

CONTRACTOR: University of Miami

PRINCIPAL INVESTIGATOR: J. H. Carpenter

CONTRACT NO: HA 0203020 PROJECT NO: 006371

TITLE: Ecology of Subtropical Shallow Water Environments

The chemistry and toxicity of oxidants, such as copper and chlorine, added to seawater is strongly affected by interactions with naturally occurring dissolved organic matter. The objective of this project is development of procedures for assessment of the chelation capacity of sea water, definition of the variability of chelation capacity in different water masses, and partial characterization of the underlying structural properties.

CONTRACTOR: Duke University

PRINCIPAL INVESTIGATOR: J. Costlow

CONTRACT NO: HA 0203020 PROJECT NO: 006637

TITLE: Effect of Cyclic Temperature on Marine Invertebrates

This research includes a more extensive investigation of the effects of cyclic temperatures on the larval development of estuarine and shelf species of the three major groups of invertebrates. In essence the work entails: (1) examination of the relative roles of the temperature cycle constituents: i.e., rate of increase, rate of decrease, period of time at the maximum temperature, and period of time at the minimum temperature; (2) expanding the use of the cyclic temperatures to cover a more complete range of temperature as found within the natural environment; (3) further examination of the response of larvae to cyclic temperatures at the metabolic and biochemical levels; (4) further developing and refining the concept of "integrated thermal experience;" and (5) further studies on the interaction between cyclic temperatures and "artificial" environmental factors within the estuarine and coastal environments.

CONTRACTOR: State University of New York

PRINCIPAL INVESTIGATOR: J. Spotila

CONTRACT NO: HA 0203020 PROJECT NO: 006796

TITLE: Thermoregulation of Fish and Turtles in Thermally Stressed Habitats

The objective of the proposed research is to determine quantitatively some of the mechanisms by which large ectotherms adjust to thermal stress in their natural environment. Mathematical analysis has established a firm base for laboratory and field studies on the thermal relations of large ectotherms. Heat energy budgets and climate spaces have been completed and tested for alligators and turtles. The scope of the proposed technical program consists of a continuation of studies of the biophysical and temperature relationships of large ectotherms with their aquatic environment. Attention focuses on large turtles and large fish. A time dependent mathematical model is being developed to predict the body temperature of a fish and will be tested in the laboratory and the field. Physiological and behavioral adjustments of turtles to thermal stress produced by reactor effluents is being studied in the laboratory and in the field at the Savannah River Ecology Laboratory.

CONTRACTOR: Woods Hole Oceanographic Institution

PRINCIPAL INVESTIGATOR: J. H. Ryther

CONTRACT NO: HA 0203020 PROJECT NO: 006848

TITLE: Effects of Environmental Stresses on the Species Composition of Phytoplankton

This research involves a continuation of the bioassay work that has been in progress for the past two years to determine the impact of power plant chlorination practice on marine biota, particularly the plankton. The work involves six study areas; (1) chlorine chemistry in seawater, (2) zooplankton and fish studies including standard bioassays and the effects of sublethal exposure, (3) phytoplankton studies in continuous cultures, (4) field studies at local power plants, (5) work on macrophytes, and (6) simulated power plant studies to determine the minimum chlorine doses necessary to prevent biofouling.

CONTRACTOR: Wake Forest University

PRINCIPAL INVESTIGATOR: G. W. Esch

CONTRACT NO: HA 0203020 PROJECT NO: 007058

TITLE: Impact of Thermal Loading and Other Water Quality Parameters on the Epizootiology of Aeromonas hydrophila infections of Centrarchids

Studies are being conducted on the epizootiology of Aeromonas and Epistylis in largemouth bass in Par Pond, Aiken, South Carolina. An effort will be made to assess the impact of thermal effluent, dissolved oxygen, organic loading and other water quality parameters, on the nature and course of the disease produced by these organisms in largemouth bass. The serotypes of several strains of Aeromonas, isolated from diseased fish, will be compared with those isolated from the water column. Body condition of infected and non-infected bass will be compared with several blood parameters, including sodium, potassium, iron, total iron-binding capacity and thyroxine. Antibody titers of infected and uninfected bass from thermal and ambient locations will be compared on a seasonal basis. It is hoped that the results from these studies will ultimately allow prediction of epizootic outbreaks in reservoirs in the southeastern U.S. or prevent such outbreaks from occurring.

CONTRACTOR: Public Service Electric and Gas of New Jersey

PRINCIPAL INVESTIGATOR: C. R. Guerra

CONTRACT NO: HA 0203020 PROJECT NO: 007215

TITLE: Comparative Evaluation of Effects of Ozonated and Chlorinated Thermal Discharges on Estuarine and Freshwater Organisms

A comparative study of the effects of ozonated versus chlorinated effluents on fish metabolism has been completed at a generating station on brackish water in Bergen, New Jersey. The testing equipment has been moved to Mercer Generating Station on the Delaware River for similar studies on freshwater species. A final evaluation of the utility of ozonation as an alternate to chlorine for condenser fouling control should be available at the end of FY 80 at which time DOE support will terminate. Early results have been encouraging.

CONTRACTOR: Old Dominion University

PRINCIPAL INVESTIGATOR: G. T. F. Wong

CONTRACT NO: HA 0203010 PROJECT NO: 007616

TITLE: Fate of Chlorine in Seawater

The goal of this project is to identify the biproducts from chlorination and to estimate their rates of formation during the chlorination of seawater. As an initial step, the effects of bromide ion concentration, temperature, and sunlight on the rate of "chlorine" consumption will be followed by three methods: an amperometric titration with phenyl arsene oxide at pH 4 for hypohalites; an iodometric titration with sodium thiosulfate at pH 1.4 for hypohalites and some halates; and UV spectroscopy.

The first two analytical methods will yield information on absolute concentrations while the third approach may give some clues to the identify of the biproducts.

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MULTITECHNOLOGY-ENVIRONMENTAL BASE

REGIONAL MARINE PROGRAMS

NORTHEAST REGION

Budget History of Current Projects in the Northeast Regional Program

Project No.	Project Title	P.I.	Budget in $1,000's 78	79	80
737	An Inner Shelf Sediment Transport Experiment, Coastal Long Island	NOAA C. Swift	150	151	0
913	Coastal Shelf Transport and Diffusion	BNL T. Hopkins	454	267	262
1303	Food Chain Dynamics and Fish Mortality	BNL M. Dagg	377	400	404
1370	Coastal Shelf Productivity	BNL P. Falkowski	426	456	459
1538	Coastal Oceanography Ship Charter	BNL T. Whitledge	200	210	225
2546	Mid-Atlantic Bight Coordination	BNL B. Manowitz	25	25	40
2620	Ecosystems Analysis	BNL A. Tingle	95	87	85
6345	Transport and Transfer Rate in Waters of the Continental Shelf	Columbia U. P. Biscaye	421	488	459
7500	Coastal Shelf Transport and Diffusion	WHOI G. Csanady	0	174	172
		TOTAL	2148	2258	2106

CONTRACTOR: U. S. Department of Commerce, NOAA

NCIPAL INVESTIGATOR: D. Swift

CONTRACT NO. - HA: 0203030 PROJECT NO: 000737

TITLE: An Inner Shelf Sediment Transport Experiment, Coastal Long Island

The goal of the instep program is to resolve the pattern (rates and directions) of sediment erosion, transportation, and deposition on the inner continental shelf off Long Island, and to assess the extent to which this sediment transport system bears contaminants from human activity. The instep sediment transport program includes an instrumentation and data analysis work unit. A concentration-velocity probe (CV probe) measures sediment flux 100 cm off the bottom. A bottom concentration-velocity (BCV probe) measures sediment flux profiles between o and 100 cm off the bottom. In the suspended matter work unit, suspended matter concentrations will be correlated with near bottom fluid motions by means of CV probes. In the bottom erosion and deposition work unit, flux through and along the water-sediment interface will be measured with BCV probes. The bottom characterization work unit supports the sediment transport work units by gathering data on bottom characteristics.

CONTRACTOR: Brookhaven National Laboratory

PRINCIPAL INVESTIGATOR: T. Hopkins

CONTRACT NO. - HA: 0203030 PROJECT NO: 000913

TITLE: Coastal Shelf Transport and Diffusion

The goal of the project is to understand the processes of transport and diffusion as they relate to the possible environmental effects of energy-related activities in the Mid-Atlantic Continental Shelf (MACS) Region. These processes must be understood because of their direct effect upon the movement of pollutants and other materials and because of the important role of circulation processes in the dynamics of shelf ecosystems. Initial physical studies have emphasized the coastal boundary region while future studies will also include processes on the MACS proper and within the shelf-edge frontal region of high biological productivity. The core of the field program is a "state-of-the-art" automated physical oceanographic data collection and telemetry system (PODCATS) which was developed and tested in cooperation with BNL's instrumentation and Atmospheric Sciences Divisions and Woods Hole Oceanographic Institution (WHOI). The transport and diffusion project is an integral part of the total multidisciplinary program within the Oceanographic Sciences Division. It is coordinated with the studies of shelf productivity, food-chain dynamics, larval fish, and ecosystems analysis.

CONTRACTOR: Brookhaven National Laboratory

PRINCIPAL INVESTIGATOR: M. J. Dagg

CONTRACT NO. - HA: 0203030 PROJECT NO: 001303

TITLE: Food Chain Dynamics and Fish Mortality

The goal of this program is an understanding of coastal trophic-dynamics, as affected by natural stimuli and anthropogenic perturbations. This knowledge includes the responses of planktonic populations to natural and man-caused events and the ultimate effects of these events on the transfer of energy between trophic levels. Continental-shelf waters are subject to daily, weekly and seasonal stimuli and may be subject to high-amplitude perturbations in the future, such as offshore nuclear reactors and oil fields. Fish larvae and zooplankton are components of the coastal ecosystem extremely vulnerable to damage by entrainment in heat exchangers, by oil pollution, and by critical limitation of food supply. Mesoscale seasonal and geographical variations in coastal ecosystems are now reasonably well described, but the small-scale and short-term processes which appear to immediately control community structure and dynamics remain poorly understood. An understanding of these processes requires an integrated field program encompassing physical parameters, phytoplankton production and physiology, zooplankton and ichthyoplankton behavior, growth, and survival, and nutrient regeneration by bacteria and the higher trophic levels. Intensive ecosystem studies of a variety of coastal habitats coordinated with laboratory experimentation will provide the basis for predictive models and the evaluation of potential effects of human activities in the coastal environment.

CONTRACTOR: Brookhaven National Laboratory

PRINCIPAL INVESTIGATOR: P. Falkowski

CONTRACT NO. - HA: 0203030 PROJECT NO: 001370

TITLE: Coastal Shelf Productivity

The primary production and utilization program is designed to provide basic quantitative information on the primary producers and the predominant herbivorous zooplankton that can be directly related to the dynamics of the New York Bight eocsystem. Such information is necessary in order to understand the regulating and controlling factors for primary and secondary productivity in the coastal shelf waters and the mechanisms by which the significant factors work in the ecosystem. Without this understanding, the assessment and prediction of the effects of energy-related activities on the continental shelf will not be possible. Basic information on the effects of light (quality and quantity) and nutrients on phytoplankton growth ultimately can relate to the structure and function of phytoplankton communities. The disruption of timing and composition of the primary producers by energy-related perturbations would have effects on the structure and function of zooplankton communities. The mechanisms for this response can also be partially evaluated in laboratory situations. To relate laboratory-derived information to the ocean, it is necessary to use temporal and spatial scales relevant to the phytoplankton and zooplankton. The system selected is oriented around this approach. Biological instrumentation is being developed that ultimately will permit continuous, real-time evaluation of significant variables.

CONTRACTOR: Brookhaven National Laboratory

PRINCIPAL INVESTIGATOR: T. Whitledge

CONTRACT NO. HA 020304 PROJECT NO. 001538

..TLE: Coastal Oceanography Ship Charter

Research vessels are required for multidisciplinary studies of coastal oceanography at Brookhaven National Laboratory (BNL). This research includes projects on ecosystems analysis, primary productivity and utilization, food chain dynamics, larval fish, coastal transport and diffusion, and Mid-Atlantic Bight coordination. The closely-associated coastal meteorology and instrumentation development programs also require vessel support. Vessel requirements are based on the nature, location, and timing of the scientific work to be conducted. Shelf and shelf-break biological process cruises involve the investigation of biological, chemical, and physical phenomena and require cooperative effort among scientists representing the several disciplines. The resulting need for a large scientific complement together with a usable oceanographic platform during adverse conditions generally leads to the requirement for one or more large vessels. The well-equipped major vessels of the University National Oceanographic Laboratory System (UNOLS) meet these requirements and have been very effectively utilized. In addition, cooperative use of National Oceanic and Atmospheric Agency (NOAA) vessels has proved to be feasible and advantageous to both agencies. Vessels are also required for inshore biological process investigations and physical oceanography cruises associated with the mesoscale experiments (MESEX) and nearshore meteorology field work in support of the coastal meteorology program. These operations are carried out by the BNL-operated LCM and R/V Cobolt plus the charter of other small research vessels. Charter of the LCU operated by the U.S. Naval Underwater Systems Center has provided an effective support for the current-meter and fluorometer buoy programs.

CONTRACTOR: Brookhaven National Laboratory

PRINCIPAL INVESTIGATOR: B. Manowitz

CONTRACT NO: HA 0203040 PROJECT NO: 002546

TITLE: Mid-Atlantic Bight Coordination

The Department of Energy (DOE)-funded oceanographic programs in the northeastern United States include a diverse array of facilities, talents, and research objectives, and are located at geographically-dispersed laboratories and universities. The environments under study range from the open ocean, continental slope and shelf, estuaries, bays and coastal lagoons, to the intertidal zone, with particular strength in the study of estuarine and shelf ecosystems. The expertise and current research of the investigators include physical, chemical, and geological oceanography, several specialties within biological oceanography, and ecosystems analysis, with emphasis on the shelf and estuarine systems. In order to maximize the usable output from these programs, a high degree of coordination and communication among the DOE investigators and with other Federally-funded programs in the northeast is desirable. Using three types of meetings as primary mechanisms, Brookhaven National Laboratory (BNL) encourages better information exchange and liaison among the northeast DOE contractors. These meetings include: (1) annual program :eview meetings among this entire group of contractors, (2) meetings and/or experiments for the intercomparison of methods and instruments, (3) meetings on single topics of timely nature. Reports from these meetings are made available to DOE for the periodic reevaluation of program goals, deficiencies, and accomplishments.

CONTRACTOR: Brookhaven National Laboratory

PRINCIPAL INVESTIGATOR: A. G. Tingle

CONTRACT NO: HA 0203030 PROJECT NO: 002620

TITLE: Ecosystems Analysis

Environmental problems in the coastal ocean occur, by definition, at the system level of complexity and require a group effort of systems analysis as an approach to their solution. Studies of total marine ecosystems were advocated over 40 years ago but environmental problems are even greater now. The implementation of systems studies has had to wait on the development of an adequate technology and sufficient interest in a multidisciplinary group effort approach to oceanography. At Brookhaven National Laboratory (BNL) a research group has been assembled and has made significant progress towards the assessment of the coastal marine ecosystem. Over the years an enormous data base on the Middle Atlantic Bight has been acquired and successful data collection programs continue to expand this base. Part of the basic approach is to design computer models for various subcomponents of the ecosystem and the stress caused by human activities, in order to distinguish conservative and non-conservative properties within the context of natural variability of the system. The goal is to link the models in such a way that they can be used as a credible tool in the overall analysis, because the causes and consequences of ecosystem behavior are extremely difficult to identify. Solutions to problems at the systems level of complexity, such as the cause of a recent fish kill or the consequences of energy-related pollution, require that the data base be readily accessible for analysis and that a significant commitment to the reduction, presentation, and interpretation of data be supported.

CONTRACTOR: Columbia University

PRINCIPAL INVESTIGATOR: P. Biscaye

CONTRACT NO: HA 0203010 PROJECT NO: 006345

TITLE: Transport and Transfer Rate in Waters of the Continental Shelf

The objective of this project is to combine a number of physical oceanographic, geochemical and marine biological techniques to understand the pattern and the rates and scales of the active vertical and horizontal mixing processes and the variations in these parameters as a function of seasonal hydrographic regime, and other forcing functions such as storm induced wind and wave pulses. In addition, advection-diffusion models of mixing of shelf water and shelf water with open ocean water are being developed.

Suspended particulates, the natural carrier of most energy-related pollutants, are being studied by several microscopic, gravimetric, and other analytical and radioactive techniques.

CONTRACTOR: Woods Hole Oceanographic Institution

PRINCIPAL INVESTIGATOR: G. Csanady

CONTRACT NO: HA 0203010 PROJECT NO: 007500

TITLE: Coastal Shelf Transport and Diffusion

Summary of Proposed Work:

(1) Structure of flow and mixing processes in coastal boundary layer will be determined by data analysis, interpretation and associated theoretical development, following data collection phase which ended 1978. (2) Dynamics of shelf circulation, both mean and storm-driven transients, will be studied and related to simple conceptual models. (3) Conceptual models will be developed for dynamics of flow and mixing processes in shelf-edge frontal zone. (4) Parameterization schemes for vertical and horizontal turbulent transfer processes will be developed.

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MULTITECHNOLOGY-ENVIRONMENTAL BASE

REGIONAL MARINE PROGRAMS

SOUTH ATLANTIC BIGHT

Budget History of Current Projects in the South Atlantic Bight

Project No.	Project Title	P.I.	Budget in $1,000's 78	79	80
1301	Ocean Transport of Contaminants	SRL	128	326	282
6355	Flux of Energy and Essential Elements Through the Pelagic Portions of Continental Shelf Ecosystem	U. of Ga. L. Pomeroy	131	131	148
7000	Continental Shelf Processes Affecting the Oceanography of the South Atlantic Bight	SKIO L. Atkinson	106	129	212
7001	Trace Element Geochemistry of the South Atlantic Bight	SKIO H. Windom	98	107	111
7061	Coordination: Southeast Continental Shelf Studies	SKIO D. Menzel	211	288	318
7076	Continental Shelf Processes Affecting the Oceanography of the South Atlantic Bight	NC St. U. L. Pietrafesa	130	133	146
7153	Biological Processes in the Water Column of the South Atlantic Bight	SKIO G. Paffenhoffer	81	111	109
7158	Measurement of Gulf Stream and Wind Induced Shelf Circulation in the South Atlantic Bight	U. of Miami T. Lee	349	207	219
8131	Nearshore Transport Processes Affecting the Dilution and Fate of Energy Related Contaminants	SKIO J. Blanton	0	0	71
		TOTAL	1234	1432	1[illegible]

CONTRACTOR: Savannah River Laboratory

PRINCIPAL INVESTIGATOR: D. Hayes

ONTRACT NO. - HA: 0203010 PROJECT NO: 001301

TITLE: Ocean Transport of Contaminants

The objective of this program is to determine the transport, cycling, and ultimate dose-to-man from tritium and plutonium cycling into and through the estuarine, tidal marsh, and coastal regions of the Savannah and Newport rivers in the Southeastern U. S. Aqueous discharges from the Savannah River Plant Operations lead ultimately to radionuclides entering the Savannah river system. Plutonium and tritium from these low level releases provide a unique opportunity to study the cycling and transport of these radionuclides in a southeastern river system. Comparisons between the data from the Savannah River Estuary and the Newport River Estuary (a system receiving only fallout plutomium) permit the assessment of the impact of nuclear industry on the population and provide basic information on estuarine influences on the transfer of materials from a freshwater to marine environment.

CONTRACTOR: University of Georgia

PRINCIPAL INVESTIGATOR: L. Pomeroy

CONTRACT NO: - HB: 0100000 PROJECT NO: 006355

TITLE: Flux of Energy and Essential Elements Through the Pelagic Portion of the Continental Shelf Ecosystem

In cooperation with several other DOE contractors in the Southeast, we are examining the ecosystem of the southeastern continental shelf between Cape Hatteras and Cape Canaveral, to understand the interactions of the biological, chemical, and physical regimes. Boundary conditions of the system are the near-shore density fronts of river and estuarine water and the west wall of the gulf stream. These fronts control the inputs of essential nutrients, particularly nitrogen, and they control the rate of flushing of shelf water. We are in the final stages of measuring the biological effects of intrusions of gulf stream water on the outer shelf. We are in the developmental stage of defining biological processes in the near-shore region of density fronts. This is the area of major research effort at sea in this proposal. As our long range basic research goal, we continue to develop a paradigm of the food web in which microorganisms and detritus constitute significant pathways for energy and essential elements.

CONTRACTOR: Skidaway Institute of Oceanography

PRINCIPAL INVESTIGATOR: L. Atkinson

CONTRACT NO. - HA: 0203030 PROJECT NO: 007000

TITLE: Continental Shelf Processes Affecting the Oceanography of the South Atlantic Bight

Studies of continental shelf and shelf break processes affecting the oceanography of the South Atlantic Bight will continue in cooperation with other DOE contractors. Our principal activities will be to: 1) Conduct studies of hydrography and nutrient flux rates during the GABEX I experiment, 2) assist in preliminary studies of the hydrography, chemistry and biology of the near-shore zone, 3) analyze and synthesize recently acquired data from the Georgia Bight, and 4) analyze recently acquired data from the near-shore zone.

CONTRACTOR: Skidaway Institute of Oceanography

PRINCIPAL INVESTIGATOR: H. Windom, and G. Wallace

CONTRACT NO. - HA: 0203010 PROJECT NO: 007001

TITLE: Trace Metal Geochemistry of South Atlantic Bight

The proposed research is a continuation of trace element geochemical studies in the South Atlantic Bight. Next year's research will focus on:

1. Continuation of efforts to determine the influence of gulf stream intrusions on the biogeochemical cycling of trace elements in continental shelf waters.

2. An intensification of studies of the geochemical cycling of trace elements in the near-shore zone where elements may accumulate due to the limited exchange between near-shore and mid-shelf waters.

3. Studies of the estuarine transport of trace elements (focusing on the estuaries of the Savannah, Ogeechee, and Satilla Rivers) to better understand their fate in the near-shore zone.

4. The use of several naturally occurring radionuclides to assist in obtaining quantitative data on trace element accumulation in sediments of the near-shore zone.

5. The initiation of combined laboratory and field experiments to determine parameters which govern partitioning of trace elements between solid phases (sediment and suspended particulate matter) and dissolved phases in the near-shore zone.

CONTRACTOR: North Carolina State University

PRINCIPAL INVESTIGATOR: L. Pietrafesa

ONTRACT NO. - HA: 0203030 PROJECT NO: 007076

TITLE: Continental Shelf Processes Affecting the Oceanography of the South Atlantic Bight

This project is part of an integrated interdisciplinary oceanographic program in the South Atlantic Bight directed at understanding the interactions of physical, chemical, and biological regimes. Scientific objectives during the coming year include confirming new concepts of the mechanisms by which water masses break from the Gulf Stream and enter the continental shelf area; calculating statistically reliable estimates of momentum, heat, mass, vorticity, and nutrient fluxes onto and off the continental shelf in the Onslow Bay and Suryia regions of the South Atlantic Bight; quantitatively and definitively identify and calculate the source of the mesoscale turbulent, momentum flux fields along the shelf break strip and alongshore boundaries of the Carolina Capes in order to determine their role in driving or dumping the persistant circulation along the shelf; determine the response of the inner mud, and outer shelf waters to strong atmospheric forcing such as cold fronts and tropical storms; completing the analysis of a unique data set to determine the response of the continental margin to the passage of Hurricane Bell, August 1976. Additional interpretations of specific data sets from the Bight will be made cooperatively with chemical and biological oceanographers studying the Bight.

CONTRACTOR: Skidaway Institute of Oceanography

PRINCIPAL INVESTIGATOR: G. Paffenhofer

CONTRACT NO. - HA: 0203030 PROJECT NO: 007153

TITLE: Biological Processes in the Water Column of the South Atlantic Bight

The objective of our research is to understand factors controlling plankton productivity of the southeastern shelf. Our efforts during 1980-81 will be directed toward three projects: (1) GABEX I, (2) Inner-Middle Shelf Interaction, and (3) Summer Intrusion Study. The object of GABEX I is to study the effect of Gulf Stream disturbances on the plankton biology of the entire shelf of the Georgia Bight. The Inner-Middle Shelf Interaction Study will seek to determine if inner shelf frontal structures result in fundamental differences between inner and middle shelf plankton dynamics. The Summer Intrusion Study will be a continuation of our efforts to determine in situ transfer rates of mass and energy through a pelagic food chain within an identifiable water mass.

CONTRACTOR: University of Miami

PRINCIPAL INVESTIGATOR: T. Lee

CONTRACT NO. - HA: 0203010 PROJECT NO: 007158

TITLE: Measurement of Gulf Stream and Wind Induced Shelf Circulation in the South Atlantic Bight

The scientific objective of this research is to improve the capability for prediction of the physical environment on the continental shelf; the principal scientific task is to determine the relative importance of the forces driving circulation and exchange and to measure the shelf response over variable time and space scales. Our previous observations of a relatively small portion of the mid- and outer-Georgia shelf indicate that tidal, density, wind and offshore current (Gulf Stream) forces, such as wave-like meanders and eddy motions, are responsible for driving circulation, renewing waters and providing a major source of nutrients in the shelf environment.

This project is part of an integrated, focused, interdisciplinary study plan of the Georgia northeast Florida shelf waters aimed at understanding the important physical, chemical and biological processes and their interactions.

Emphasis for the funding period June 1, 1980, to May 31, 1981, is on analysis of the data collected with the GABEX-I array and preparation for GABEX-II which is to be deployed June 1981. The analysis will focus on determing the effects of Gulf Stream (meanders and eddies) and wind events on shelf circulation and exchange. Special emphasis will be placed on integrating data sets and conducting joint analysis with the other investigators of the DOE program to determine the effects of Gulf Stream eddies on shelf biological processes. Continued effort will be placed on reporting data and publishing results.

CONTRACTOR: Skidaway Institute of Oceanography

PRINCIPAL INVESTIGATOR: J. Blanton

CONTRACT NO. - HA: 0203010 PROJECT NO: 008131

TITLE: Nearshore Transport Processes Affecting the Dilution and Fate of Energy-Related Contaminants

Research proposed here focuses on the physical transport processes governed by tides and winds in the coastal zone off the Georgia coast from the estuaries to about 20 kilometers offshore. The research will complement existing OHER-funded programs in the mid and outer continental shelf and those focused specifically on the estuaries.

Nearshore Transport Processes Affecting the Dilution and Fate of Energy-Related Contaminants cont'd

Inputs of river water, associated trace elements, suspended sediments, and marsh-derived material are contained within a boundary zone 10-20 kilometers wide along the Georgia and South Carolina coasts. Gradients in the concentrations of these constituents suggest an onshore to offshore flux. A fickian description of this flux may have limited applicability to establish long term means, but offers little insight into the mechanisms causing the flux.

Large quantities of suspended and dissolved materials are transported by tides and by major wind events. The flow paths taken by these materials traverse an estuarine-type zone where fresher water overlies more saline water characteristic of the open continental shelf. Fluxes of materials through oceanic environments with such a density structure are usually governed to some degree by the dynamics of a partially mixed estuary. As in estuaries, the fluxes occur on two basic time scales conveniently separated one from another. The first occurs at the period of the semidiurnal tides (0.5 day); the second occurs at the less precise periodicity of the storm cycles (2 to 10 days).

The proposed research is designed to separately evaluate transport processes at these two times scales. Tidal fluxes will be studied during low and high runoff conditions using two moored ships anchored simultaneously for four or five consecutive tidal cycles. Some of the non-linear terms in the salt conservation equation will be directly measured. Wind-generated fluxes will be studied using a portion of a large shelf-wide current meter array.

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MULTITECHNOLOGY-ENVIRONMENTAL BASE

REGIONAL MARINE PROGRAMS

CALIFORNIA BIGHT

Budget History of Current Projects in the California Bight

Project No.	Project Title	P.I.	Budget in $1,000's 78	79	80
6329	Research on the Marine Food Chain	U. of Ca. R. Eppley	607	779	692

CONTRACTOR: University of California

PRINCIPAL INVESTIGATOR: R. Eppley

(RACT NO. - HA: 0203030 PROJECT NO: 006329

TITLE: Research on the Marine Food Chain

This is a multidisciplinary study of the relationships among planktonic organisms and their environment in the Southern California Bight. The Bight is an area of intensive human use. It is characterized by a narrow continental shelf, with deep basins and rises offshore. The purpose of the study is to evaluate effects of energy-related human activities in these waters against a background of rather high natural variability and changes resulting from other human activities. The study of this variability of plankton stocks and activities in relation to that of the physical and chemical environment is taking place on several time and space scales in order to use those natural fluctuations to reveal mechanisms of change. The time series of observations developed since 1974 is useful for this purpose and reveals order of magnitude temporal changes from extreme oligotrophy in "warm years" to high production during upwelling events. In particular we seek to understand the driving forces for plankton production, the fates of that production, including fluxes of organic matter to deep water and sediments, and the roles of dissolved and colloidal organic matter in the carbon budget. Studies of the food web this year emphasize the role of bacteria in secondary production and the dynamics of the microplankton food webs in which they participate. Population dynamics of the cladoceran, Evadne, an ecologically significant herbivore, will be studied in the laboratory and the results applied to understanding natural variations previously observed. Studies related to production biology this year will explore the apparent correlation of phytoplankton and kelp production, nutrient fluxes from sediments to plankton on the shelf, and further description of nitrogen and carbon budgets for the area. In addition to providing information on the Southern California Bight as a habitat for plankton, much of the work has implications for human affairs such as ocean photosynthesis as a sink for carbon dioxide, effects of UV-B on ocean photosynthesis, the nature and coupling of plankton to fisheries, waste disposal in the deep ocean, and effects of power generation using ocean thermal energy gradients (OTEC) on plankton species assemblages and their activities.

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MULTITECHNOLOGY-ENVIRONMENTAL BASE

REGIONAL MARINE PROGRAMS

NORTHWEST REGION

Budget History of Current Projects in the Northwest Region

Project No.	Project Title	P.I.	Budget in $1,000's 78	79	80
641	Chemistry of Ocean Solutions	PNL E. Crecelius	120	133	131
2547	West Coastal Zone Coordination	PNL W. Templeton	33	30	25
2737	Marine Science - Shiptime	PNL W. Templeton	22	30	50
6511	Mechanisms of Transfer of Energy and Biomass in Marine Coastal Ecosystems	U. of Wash. G. Anderson	281	299	325
6512	Pollutant Transport and Sediment Dispersal in the Washington-Oregon Coastal Zone	U. of Wash. Smith/Hickey	214	233	367
6513	Chemical and Geochemical Studies Off the Coast of Washington	U. of Wash. R. Carpenter	61	66	68
7240	Mesoscale Studies of Flow Regimes and Fluxes of Particulate Matter in Coastal Waters	OSU Pak/Zaneveld	120	149	146
7409	CTD System for West-Coast Contractors	OSU L. Small	10	10	0
8094	Coordination of Oceanographic Programs in Pacific Northwest Coastal Waters	U. of Wash. G. Anderson	0	85	170
		TOTAL	861	1035	1282

CONTRACTOR: Pacific Northwest Laboratory

PRINCIPAL INVESTIGATOR: E. Crecelius

CONTRACT NO. - HA: 0203030 PROJECT NO: 000641

TITLE: Chemistry of Oceans Solutions

This research program is examining the input rate of energy-related contaminants to the Pacific Northwest marine water and the rate of removal of contaminants from these waters. In order to predict the impact of energy-related contaminants introduced into the oceans, it is necessary to establish the input rate and investigate the biogeochemical and physical processes that control the distribution and behavior of these contaminants. The future environmental quality of the oceans is dependent upon man's knowledge of marine chemical processes and his ability to use this knowledge to prevent serious environmental insults from occurring. During the past year, the atmospheric input rate of a dozen elements was determined and the distribution of several elements in the water column established. Atmospheric input contributes more than 25% of several metals to Washington coastal waters compared to the Columbia River input. Measurements of the rate of transfer of elemental mercury vapor from air to sea water were made in the laboratory. These experiments showed that surface microlayer and suspended particulates are important temporary sinks for mercury entering sea water from the air.

During the next year, the atmospheric input rate of 15 combustion organic compounds (polynuclear aromatic hydrocarbons-PAH) will be determined for the Pacific Northwest. Also, the removal rate of several metals from water to sediments will be measured for the Washington Shelf waters. During the next several years, this program will continue to quantify the input rates of contaminants to the Pacific Northwest marine waters and examine the processes that remove contaminants from these waters. The final product of this program will be a descriptive model that will predict the concentrations and fates of various contaminants in the Pacific Northwest, assuming a given source term.

CONTRACTOR: Pacific Northwest Laboratory

PRINCIPAL INVESTIGATOR: W. Templeton

CONTRACT NO. - HA: 0203040 PROJECT NO: 002547

TITLE: West Coastal Zone Coordination

Energy-related programs currently sponsored by the Office of Health and Environmental Research are diverse in discipline and objectives, and are being conducted independently. Under the new responsibilities and objectives of DOE it is essential that the programs of these diverse contractors are focussed on DOE's programmatic marine science issues

TITLE: West Coastal Zone Coordination (continued)

and needs. OHER has appointed four coordinators, to cover three major geographica areas, who will provide coordination services. This proposal will provide for coordination of the entire Pacific coast region. In addition to monitoring on-going programs, the coordinator will continue to maintain familiarity with programs of NOAA, BLM, EPA, NSF and USGS in the area; and will promote regional symposia and workshops.

CONTRACTOR: Pacific Northwest Laboratory

PRINCIPAL INVESTIGATOR: W. Templeton

CONTRACT NO. - HA: 0203040 PROJECT NO: 002737

TITLE: Marine Sciences - Shiptime

Shiptime funding to support research projects involved in efforts of energy-related pollutants on west coast marine coastal ecosystems. The projects involved are marine chemistry of energy-related pollutants, bioavailability of energy effluent materials in coastal ecosystems; fate and effects petroleum hydrocarbons in marine ecosystems; and in-situ pollutant measurements.

CONTRACTOR: University of Washington

PRINCIPAL INVESTIGATOR: G. Anderson

CONTRACT NO. - HA: 0203030 PROJECT NO: 006511

TITLE: Mechanisms of Transfer of Energy and Biomass in Marine Coastal Ecosystems

The proposed research emphasizes studies of mechanisms of transfer of energy and biomass in coastal ecosystems, with particular reference to the waters over the continental shelf. A numerical model of phytoplankton production is being used as an investigative tool in the identification and quantification of the processes that determine the seasonal and vertical distribution of phytoplankton. Factor and cluster analyses are providing new insights into the processes of continental shelf dynamics; maps of the factor loadings are indicating areas where specific processes are most important in the Pacific Northwest coastal zone. Multiple discriminant analysis will be used to identify those parameters most valuable for distinguishing particular water types in situ. These statistical analyses are also providing a new conceptual framework for interpreting oceanographic data in the Pacific Northwest coastal zone.

The field and laboratory phytoplankton investigations emphasize physiological processes and responses to environmental stress. An immunofluorescent assay for marine nitrifying bacteria has recently been developed and will be used to study the role of nitrification in the nitrogen cycle in these waters. Studies of the microbial activity associated with the nepheloid layer will be initiated. A new analytical method for measuring micro-zooplankton grazing rates at sea has recently been developed and is being used to assess the role of these abundant organisms in trophic interactions. These experimental field studies complement our laboratory studies on growth and production of planktonic grazers. Measurements of phytoplankton pigment degradation products yield an independent estimate of herbivore grazing in the field, and, in addition, are providing information about the pathways and rates of transfer of organic matter to the benthos. Continuing goals of the benthic investigations are to reveal and quantify the component processes that control deposit feeding, dispersal, and recruitment. A model developed for a generalized deposit feeder is providing a conceptual framework for experimental field and laboratory studies of trophic interactions and bioturbation processes in the benthos. We are continuing studies of the physiological ecology of the components of the surf-zone community and of the transfer of biomass within that productive system.

CONTRACTOR: University of Washington

PRINCIPAL INVESTIGATOR: J. D. Smith, and B. Hickey

CONTRACT NO. - HA: 0203010 PROJECT NO: 006512

TITLE: Pollutant Transport and Sediment Dispersal in the Washington-Oregon Coastal Zone

This proposal requests continuing support for research on the transport of dissolved and suspended matter such as pollutants, nutrients, planktonic organisms and sediment in the coastal region. The goal of the program is to provide tested predictive models to characterize the velocity field and the associated movement of matter in coastal regions of the Pacific Northwest. Efforts during the next year will be focused on the following areas; 1) improvement of the shelf circulation model of Hamilton and Rattray (1978) to allow better resolution of vertical mixing processes and to include the poleward undercurrent that is a prominent feature on the continental shelf during spring and summer; 2) development of a model for the non-linear interactions between wind-driven currents and tidal currents in the bottom boundary layer; 3) testing and improvement of our sediment transport model; 4) examination of the mechanism of momentum transfer in hydrodynamically transitional and rough flows; 5) laboratory investigation of the influence of mucal binding on the transport of sediment; 6) examination of the role of submarine canyons (Astoria and Quinault) in the exchange of water between the shelf and slope and, ultimately, the effect of such canyons on the distribution of marine organisms (jointly with DOE biologists under Anderson); 7) Examination of the role of submarine canyons in the transport of sediment from coastal areas to the deep sea (jointly with geologists Carson, Baker and Nittrouer, supported by NSF); 8) investigation of the extent to which a submarine canyon causes perturbations in the velocity field over the continental shelf; 9) investigation of non-local effects on coastal processes in the Pacific Northwest. Both the investigation of the effects of submarine canyons and the investigation of non-local contributions to coastal processes will be supported by field experiments.

CONTRACTOR: University of Washington

PRINCIPAL INVESTIGATOR: R. Carpenter

CONTRACT NO. - HA: 0203010 PROJECT NO: 006513

TITLE: Chemical and Geochemical Studies off the Coast of Washington

The primary effort is now directed to developing a base for predicting and testing the behavior and fate of various trace chemicals in coastal and estuarine areas in general. The research is especially directed in defining and quantifying the transfer of some potential energy-related pollutants in the coastal marine ecosystems of the Pacific Northwest. The goal is to identify the major inputs, the major pathways by which these trace chemicals are transferred through some parts of the marine food web, their rates of transfer, their possible transformations into other chemical species with different biogeochemical behavior and/or different biological effects, and their ultimate fate.

The research proposed for the next year continues several lines of investigation begun in the last few years and which are in various stages of completion:

- Field studies using sediment traps to establish the role of large particulates such as zooplankton fecal pellets in the cycling and deposition of inorganic and organic trace constituents in well-defined parts of the marine environment.
- Studies of the behavior of ^{210}Pb, ^{210}Po, $^{239,240}Pu$, and ^{238}Pu in sediments off the Washington coast to learn more about the biogeochemical cycling of these isotopes and to use their vertical distributions in sediments to estimate sedimentation rates over the past 100 years and the depth and rate of mixing of the surface sediments.
- Investigations of aliphatic and aromatic hydrocarbons in some of the same samples of organisms, and in sediment cores whose accumulation rates and mixing characteristics we have determined with the ^{210}Pb and Pu isotopes. We consider this a good example of the application of DOE-funded research on radionuclides to the study of rates of processes affecting fossil fuel-related hazardous agents.

CONTRACTOR: Oregon State University

PRINCIPAL INVESTIGATOR: H. Pak, and D. Zaneveld

CONTRACT NO. - HA: 0203030 PROJECT NO: 007240

TITLE: Mesoscale Studies of Flow Regimes and Fluxes of Particulate Matter in Coastal Waters

This research will continue and expand the study of the water flow and concurrent flux and fate of suspended particulate matter (SPM) in selected areas off the Oregon and Washington coasts. The short time/space scale research in the Quinault Canyon off Washington will continue and be expanded to include more deep layer measurements. Long term temporal changes in SPM will be examined through frequent small-vessel cruises off the central Oregon coast, complimented by a single mooring in the sampling area. This research should ultimately lead to adequate models of fluxes and flows of materials in regions of different topography and bathymetry.

The general objectives of both the long- and short-term observations are to: 1) define the nepheloid and water column SPM simultaneously with major hydrographic variables; 2) determine the characteristic optical and morphological distributions through time in conjunction with the flow field, water density and nutrient field changes; 3) determine the biotic/abiotic fractionation of the SPM; 4) estimate or model the distributional changes of the abiotic/biotic fractions in conjunctions with changes in hydrographic and nutrient distributions; 5) determine the metabolism and potential metabolism of the biotic fraction of the SPM, and estimate the qualitative importance of the bottom nepheloid layer to the major nutrient cycles; 6) estimate or model these metabolic changes in conjunction with the hydrographic and nutrient distributions; and 7) obtain crude estimates of the grazing pressures in SPM layers.

The primary significance of this work rests with the near-synoptic, integrated measurement of many parameters of water flows and particle fluxes which when taken over the proposed time and space scales, will ultimately lead to adequate models of distribution and transport in nearshore environments.

CONTRACTOR: Oregon State University

PRINCIPAL INVESTIGATOR: L. Small

CONTRACT NO: HA 02030 PROJECT NO: 7409

TITLE: CTD System for West Coast Contractors

The funds for maintenance of CTD were switched to Project No. 8094.

CONTRACTOR: University of Washington

PRINCIPAL INVESTIGATOR: G. Anderson

CONTRACT NO. - HA: 0203040 PROJECT NO: 008094

TITLE: Coordination of Oceanographic Programs in Pacific Northwest Coastal Waters

This project is to provide coordination services for department of energy-supported oceanographic research in universities of the Pacific Northwest Region and for operation of the Chlorinity, Temperature, Density Unit. In addition, close liaison will be maintained with the Marine Science Programs at the Marine Research Laboratory, Battelle-Pacific Northwest Division, Sequim, Washington, and the DOE West Coast Coordination, Dr. William Templeton. Ship costs are included in the FY 80 budget.

MULTITECHNOLOGY-ENVIRONMENTAL BASE

REGIONAL MARINE PROGRAMS

ESTUARINE SYSTEMS

Budget History of Current Projects in the Estuarine Program

Project No.	Project Title	P.I.	Budget in $1,000's 78	79	80
6324	Transport and Reaction of Heavy Metals in Alaskan Fjord-Estuaries	U. of Alaska D. Burrell	58	59	58
6364	Biogeochemistry of Trace Metals in Chesapeake Bay	JHU O. Bricker	53	54	53
6365	Phytoplankton Growth, Dissipation and Succession in Estuarine Environments	JHU H. Seliger	136	139	146
6366	Effects of Energy Related Activities on the Plankton of Chesapeake Bay	JHU J. Taft	130	133	131
6536	Flow of Energy, Cycling of Elements, and Effects of Environmental Change in Estuarine and Nearshore Oceanic Ecosystems	NOAA/Beaufort F. Cross	418	429	351
8086	Environmental Effects of Offshore Energy Production in the Subtropics	FL Inter'l U A Thorhaug	0	48	49
		TOTAL	795	862	788

CONTRACTOR: University of Alaska

PRINCIPAL INVESTIGATOR: D. Burrell

CONTRACT NO. - HA: 0203010 PROJECT NO: 006324

TITLE: Transport and Reaction of Heavy Metals in Alaskan Fjord-Estuaries

The long term objective of this program is the identification and characterization of physical and chemical processes responsible for the cycling of heavy metals in Alaskan Fjord-Estuaries. Such work is a necessary precursor to predictions concerning environmental stress related to energy resource development. At the present time, research is focused on transport of chemical species to and from the fjord basin sediments and changes in chemical speciation within the surface sediments. The fjords studied have been chosen to serve as type examples of local coastal environments most likely to be impacted by energy resource development. The primary objective proposed here concerns the chemical and sedimentological character of the particulate sediment--the primary transporting medium--seasonally and within the basin column. Secondary objectives include work on better determining transport rates of soluble species away from the sediment boundary and on organo-metallic speciation within the interstitial water.

CONTRACTOR: Johns Hopkins University

PRINCIPAL INVESTIGATOR: O. Bricker

CONTRACT No. - HA: 0203010 PROJECT NO: 006364

TITLE: Biogeochemistry of Trace Metals in Chesapeake Bay

This project is a continuing study of the transport pathways of trace metals in the Chesapeake Bay. The principal goals are to understand pathways and mechanisms of particle-associated trace metal transport and alternations in sufficient detail to permit identification and projection of the effects of man's activities on a major estuary. Results to date indicate that metal rich Susquehanna River material dominates the surface water suspended sediment for a distance of 60-80 km from the river mouth and is a measurable constituent of the material for at least 140 km from the river mouth. These observations contrast with previous assumptions regarding the components of suspended sediment farther than 40-50 km from the river mouth. We propose to continue this work by obtaining detailed water column profiles of suspended sediment concentration and composition in the upper and middle Chesapeake Bay to be able to map and quantify the cycling of metal rich material in the Bay.

CONTRACTOR: Johns Hopkins University

PRINCIPAL INVESTIGATOR: H. Seliger

CONTRACT NO. - HA: 0203030 PROJECT NO: 006365

TITLE: Phytoplankton Growth, Dissipation and Succession in Estuarine Environments

The goal of this research program in estuarine phytoplankton ecology is to develop an empirical model for the observed seasonal, geographical, and annual distributions of the phytoplankton in an estuary such as the Chesapeake Bay.

The directions of the research program in understanding the dynamics of the natural phytoplankton populations of the Chesapeake Bay, the methodology, the statistical analysis, and the description of the system in terms of a potential minimum, are parallels to the requirements for environmental impact studies. A major implication of this work is that the methodology for assessments of environmental impacts flows naturally from basic ecosystem research programs.

Owing to the short generation times of phytoplankton, one would expect that their growth and physiological state might be strongly coupled to the physical and chemical environmental parameters characteristic of their particular geographic locations. As the consequence of this strong coupling, it is possible to describe the kinetics of growth and dissipation of phytoplankton standing crops in terms of forcing functions corresponding to defined natural perturbations of the ambient physical and chemical environment.

CONTRACTOR: Johns Hopkins University

PRINCIPAL INVESTIGATOR: J. Taft

CONTRACT NO. - HA: 0203030 PROJECT NO: 006366

TITLE: Effects of Energy Related Activities on the Plankton of the Chesapeake Bay

The principal goals of this program are to understand plankton interrelations in sufficient detail to permit identification and projection of the effects of man's activities on a major estuary, and to identify and quantitate biological processes influencing the flows of nutrients and organic material through the estuary. This project is concerned with: 1) initial carbon fixation by the phytoplankton and the transfer of carbon to zooplankton and bacteria, and 2) the effects of potential pollutants from energy technologies sited on Chesapeake Bay on these processes.

Objectives for the coming year involve both laboratory and field studies, and will heavily emphasize analysis of data already collected so as to round out the current three year contract cycle. A z-dimensional numerical model developed by the physical oceanography group as a tool for the further description of oxygen and nutrient dynamics in Chesapeake Bay will be tested. Also, the coupling of the hydrodynamic model to a simple nutrient cycle model which has already been developed and subjected to sensivity analysis will be examined. These models will provide a framework for further interpretation of much of the data collected during the last eight years.

CONTRACTOR: U. S. Department of Commerce, NOAA, Beaufort, NC

INCIPAL INVESTIGATOR: F. Cross

CONTRACT NO. - HA: 0203020 PROJECT NO: 006536

TITLE: Flow of Energy, Cycling of Elements, and Effects of Environmental Change in Estuarine and Nearshore Oceanic Ecosystems

The research program funded by relationship between fishery and ecosystem productivity in estuarine and coastal habitats of the southeastern U.S. and to develop the capability to predict effects of environmental stress resulting from energy-related activities on the production of ecologically and economically important species.

The research is determining (1) the interrelation between fishery organisms and their food sources in different estuarine and coastal habitat types, (2) the natural environmental processes which control the survival, growth, and reproduction of marine fishes, and (3) the physical and chemical processes which control the flux and bioavailability of selected elements.

The principal study area for most of the proposed research will continue to be the Newport River Estuary and associated sounds behind the barrier islands as well as waters over the continental shelf between Cape Lookout and Cape Fear (Onslow Bay). This study area offers a wide range of habitats within which to work which are characteristic of those found throughout the southeastern U.S.

CONTRACTOR: Florida International University

PRINCIPAL INVESTIGATOR: A. Thorhaug

CONTRACT NO: HA 0203020 PROJECT NO: 8086

TITLE: Environmental Effects of Offshore Energy Production in the Subtropics

The objectives are to assess energy related pollutant impact on nearshore semitropical seagrass communities (specifically, the effects of heat, high salinity, heavy metals, and radionuclides --Zn, Cf, Pd, Co, etc.--on the survival and productivity of the plant community and elements of the animal community) and to find alternatives, such as restoring plant communities to the pollution effects. Combined laboratory and field studies on the major plants in the ecosystem, including seagrasses, especially the dominant Thalassia testudinum, macroalgae, microalgae (epiphytes), and phytoplankton, are conducted. Field measurements include effect of heat, salinity, silt, heavy metals and radionuclides on standing crop and productivity. Laboratory measurements include defining lethal limits and effects of temperature, high salinity, light, heavy metals and radionuclides.

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MULTITECHNOLOGY-ENVIRONMENTAL BASE

REGIONAL MARINE PROGRAMS

GREAT LAKES

Budget History of Current Projects in the Great Lakes

Project No.	Project Title	P.I.	Budget in $1,000's 78	79	80
909	Environmental Research Program in Lake Sediments	ANL P. Frenzen	53	53	56
2522	Trace Element Cycling Processes	ANL H. Allen	51	51	55
6378	Nutrient Enrichment and Eutrophication of Lake Michigan	U. of Mich. C. Schelske	96	96	96
		TOTAL	200	200	207

CONTRACTOR: Argonne National Laboratory

PRINCIPAL INVESTIGATOR:

CONTRACT NO. - HA: 0203010 PROJECT NO: 000909

TITLE: Environmental Research Program in Lake Sediments

This program addresses the problems of the biogeochemical cycling of trace elements from fossil fuel conversion and combustion in the Great Lakes.

Significant amounts of trace elements input to the Great Lakes are associated with particles that settle to the sediments. This project will evaluate the flux of particles to the lakes, the potential availability of associated trace elements to the water column, and the rate of removal of those materials to the sediments. In other experiments, sediment cores are analyzed to provide estimates of historical inputs to the lakes and the magnitude of changes due to the use of fossil fuels. Characterization of the upper few centimeters of the sediment will be made because it is this surficial layer that controls the rate of release of trace elements from sediments to the overlying water and thus the rate at which pollutant concentrations in the lakes will change.

CONTRACTOR: Argonne National Laboratory

PRINCIPAL INVESTIGATOR: H. Allen

CONTRACT NO. - HA: 0203010 PROJECT NO: 002522

TITLE: Trace Element Cycling Processes

This research is designed to determine the extent of complexation reactions of trace elements by natural ligands and the effect of such reactions on the availability of trace elements for biogeochemical cycling, on food-chain accumulation, and on biological availability and toxicity.

Specifically, the complexing capacity of copper in water from Lake Michigan and other lakes will be determined. Algal bioassays of copper toxicity will be correlated with the concentration of free copper ion as computed from copper binding data, pH, and alkalinity. Anodic stripping voltammetry will be used to estimate copper ion activities.

CONTRACTOR: University of Michigan

PRINCIPAL INVESTIGATOR: C. Schelske

CONTRACT NO. - HA: 0203030 PROJECT NO: 006378

TITLE: Nutrient Enrichment and Eutrophication of Lake Michigan

The Grand River carries one of the largest tributary nutrient loads to Lake Michigan. The river plume is readily identifiable by higher specific conductance, greater nutrient concentrations and larger standing crops of phytoplankton than are found in the lake. In addition to these tracers of river water, the dominant phytoplankton species in the river and lake are quite distinct.

The research is a continuation of the study of the effects of trace metals and other nutrients, particularly phosphorus, on phytoplankton. This research will be divided into two broad categories: 1. ecological effects on phytoplankton populations and 2. physiological and cellular effects of nutrient-trace metal interactions.

The research objectives are:

1. To determine the effects of phosphorus, river water, and trace metal treatments on the growth of phytoplankton assemblages in offshore Lake Michigan water;

2. To determine interactions between trace metals and nutrient uptake, particularly phosphorus, as well as non-biological processes which may occur simultaneously;

3. To determine physiological reasons for the growth of "weed" algae at high trace metal concentrations, including the ultrastructural study of such organisms;

4. To determine if phosphate stored in the form of polyphosphate gives certain algal species a selective advantage if they are transported to phosphorus-poor water.

REGIONAL MARINE PROGRAMS

MARINE BIOCHEMICAL STUDIES

Budget History of Current Projects in Biochemical Studies

Project No.	Project Title	P.I.	Budget in $1,000's 78	79	80
644	Trace Metal Metabolism in Ecosystems	PNL G. Roesijadi	235	267	275
1332	Bioavailability of Energy Effluents on Coastal Ecosystems	PNL C. I. Gibson	369	377	384
1511	Pollutant Effects on Marine Organisms	LLL F. Harrison	94	97	101
7520	Fatty Acid Ecology of Plankton Communities	U. of RI P. Jeffries	39	47	45
7615	Effect of Pollutants on *Aurelia* Growth and Development	E. Va. Med. School D. Spangenberg	0	60	60
		TOTAL	737	848	865

CONTRACTOR: Pacific Northwest Laboratory

PRINCIPAL INVESTIGATOR: G. Roesijadi

CONTRACT NO: HA 0203020 PROJECT NO: 644

TITLE: Trace Metal Metabolism in Ecosystems

The coastal zone is both a site and a zone of impact for energy production and resource extraction. The ultimate energy-related consequences on local and regional marine ecosystems need defining in order for DOE to provide realistic assessments of the environmental perturbations resulting from energy technologies. To provide these descriptions, it is necessary to understand the effects of a pollutant or combination of pollutants on a single species or community. Along with the effects information must be data on the total amounts of contaminants taken up and in the ambient environment, and the metabolic pathways and cycling in marine organisms. The goal of this program is to provide biological information that may serve as a measure of environmental stress, using fluctuations in physiology and specific protein induction as a basis of analysis. The importance of metal-binding proteins in marine animals is receiving increasing recognition with respect to trace metal effects. Exposure levels, duration, and physiological conditions, both in the laboratory and under field conditions, will be studied in regard to the sublethal effects of trace metals associated with energy effluents on Pacific Northwest species and communities. As the data base grows and a better understanding of organism response to environmental insults is obtained, the information generated will be used to predict local and regional consequences of the development of energy technology on the coastal zone.

CONTRACTOR: Pacific Northwest Laboratory

PRINCIPAL INVESTIGATOR: C. I. Gibson

CONTRACT NO: HA 0203020 PROJECT NO: 1332

TITLE: Bioavailability of Energy Effluents in Coastal Ecosystems

The purpose of this program is to determine the bioavailability of the effluent materials and provide an understanding of the processes involved in the cycling of the materials through the coastal ecosystem.

The multidisciplinary studies include the identification of chemical forms of contaminants that are bioavailable, the role that chemical, physical, and biological factors have on determining the bioavailability of contaminants, and the ultimate fate of these contaminants in the ecosystem. This program is concentrating on the interactions that occur between the marine ecosystem compartments (e.g., sediment, water, biota) and the identification of the individual factors and processes that control the transport, transfer, and bioavailability of contaminants in the marine coastal ecosystem.

The task uses carefully designed laboratory systems to develop an understanding of the basic processes and mechanisms that control bioavailability, and follows up with field studies to relate the laboratory-generated information to the "real-world" situation.

If these interactions and effects are understood, then rational assessments of potential short and long-range ecological impacts can be made, and technologies can be designed and sited in a manner that will minimize impact and maximize the use of our resources.

CONTRACTOR: Lawrence Livermore Laboratory

PRINCIPAL INVESTIGATOR: F. Harrison

CONTRACT NO: HA 0203020 PROJECT NO: 001511

TITLE: Pollutant Effects on Marine Organisms

The effects on marine organisms of exposure to both acute and sublethal concentrations of energy-related pollutants are being evaluated. Acute levels are defined by exposing organisms to a range of concentrations, and responses to sublethal concentrations are evaluated by exposing animals continuously to low levels of pollutants and quantifying changes in genetic material and detoxification mechanisms. Effects on genetic material are determined by counting sister chromatid exchanges in dividing cells and by measuring the variability of DNA content of sperm. The effects on detoxification mechanisms are assessed by determining the latency of lysosomal enzymes and the concentrations of metals associated with metallothioneins and other metallo-binding proteins in control and exposed populations. Information on responses to sublethal concentrations will be used to evaluate the extent to which aquatic organisms are stressed by the release of energy-related pollutants.

CONTRACTOR: University of Rhode Island

PRINCIPAL INVESTIGATOR: P. Jeffries

CONTRACT NO: HA 0203020 PROJECT NO: 7520

TITLE: Fatty Acid Ecology of Plankton Communities

The research proposed deals with the chemical state of plankton communities. It is hypothesized that the fatty acid patterns of entire communities should be less variable and more predictable in offshore waters than in progressively more variable, physically controlled estuarine habitats. For ecological purposes it has been possible to express the complexity contained in a matrix of fatty acid concentrations as a simple trajectory in time. The pattern that results has features corresponding to ecological phenomena, e.g., seasonal replacement and response to perturbation. Our understanding of this special kind of community behavior would be greatly extended by the comparative study advanced here. It could conceivably lead to supplemental ways for assessing impacted situations and those requiring further study by more traditional methods.

CONTRACTOR: Eastern Virginia Medical School

PRINCIPAL INVESTIGATOR: D. Spangenberg

CONTRACT NO: HA 0203020 PROJECT NO: 7615

TITLE: Effect of Pollutants on Aurelia Growth and Development

The effects of energy-related pollutants on metamorphosis and budding of Aurelia is being studied under controlled laboratory conditions. Jellyfish polyps induced to metamorphose will be exposed to a range of pollutants and concentrations. The following developing structures will be closely observed: number and morphology of arms, lappets, mouths, rhopalia, gastric filaments, and muscles. Ephrae will be observed under the light microscope to determine the numbers of statoliths and nematocysts present. The regularity and rate of pulsing will also be studied.

Scanning electron microscopic studies will be made of the surfaces to determine whether flagellum formation and surface morphology in general are normal. Organsims showing aberrant structure formation will be further studied with the transmission electron microscope (to determine the cellular changes associated with the abnormality). The effects of the pollutants on budding in the Aurelia polyps will also be determined. The doubling times of chemically treated organisms will be compared with controls. Genetic basis for the abnormalities will be investigated using chromosomal studies and asexual reproduction techniques.

Results from this study will be correlated with current research on the effects of energy-related pollutants on other marine organisms. It is believed that developmental changes produced in this test environment will simulate effects in nature. The effects of the pollutants on development in the jellyfish will be used to predict morphological and physiological changes occurring in other larvae of marine organisms (including commercially valuable ones) in the oceans. The effects of carcinogenic compounds in the jellyfish are being compared to their toxicity in other marine organisms and in mammals, including humans, which ingest them.

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REGIONAL MARINE PROGRAMS

SUPPORT

Budget History of Current Projects of Support

Project No.	Project Title	P.I.	Budget in $1,000's 78	79	80
6540	Partial Support - Ocean Affairs Board	Dept. of Navy R. Vetter	30	30	30
7136	Partial Support of the U. Nat'l Oceanographic Lab System (UNOLS) Office	NSF M. Johrde	7	7	7
8067	Sediment Trap Intercomparison Experiment in the Panama Basin	Dept. of Navy Weinberg	0	33	33
8250	Lagrangian and Eulerian Diffusion Study (LEDS) In the Coastal Surface Layers	SUNY A. Okubo	0	169	0
	Conference Support				34
		TOTAL	37	239	104

CONTRACTOR: Department of the Navy

PRINCIPAL INVESTIGATOR: R. Vetter

CONTRACT NO: HA 0203040 PROJECT NO: 006540

TITLE: Partial Support - Ocean Affairs Board

The Ocean Sciences Board has evolved from the National Academy of Science Committee on Oceanography (NASCO) organized in 1957 in response to requests from Federal agencies concerned with oceanography for advice on a range of oceanographic problems.

The objectives of the Ocean Sciences Board are: a) to contribute to the advancement of the scientific understanding of the ocean by the maintenance of a continuing oversight of the health of ocean sciences and the stimulation of their progress as necessary; b) to foster the application of scientific knowledge to the wise use of the ocean and its resources; c) to assist in the formulation of policies that affect ocean science and the clarification of scientific issues that affect ocean policy in general; and d) to facilitate communication among ocean scientists and scientists from the basic disciplines and from related earth sciences.

To achieve its objectives, the Board acts as the National Research Council focal point for the identification and consideration of problems concerned with oceanographic research. The Board initiates and conducts timely studies as necessary, provides a broad NRC basis for advice on ocean science and ocean science related matters to concerned government agencies, and serves as a link between the National ocean science community and National and International ocean related groups. In this latter capacity, the Board serves as the U.S. National Committee to the Scientific Committee on Oceanic Research of the International Council of Scientific Unions.

CONTRACTOR: National Science Foundation

PRINCIPAL INVESTIGATOR: M. Johrde

CONTRACT NO: HA 0203040 PROJECT NO: 007136

TITLE: Partial Support of the University National Oceanographic Laboratory System (UNOLS) Office

The University National Oceanographic Laboratory System (UNOLS) Office objectives are to creat a mechanism for coordinated utilization and planning for oceanographic facilities through an association of academic institutions in a National system whereby institutions can work together and with funding agencies to assist in the effective use, assessment and planning for oceanographic facilities and to improve the level and stability of Federal support for academic oceanography, thereby continuing and enhancing the excellence of this Nation's oceanographic programs.

CONTRACTOR: Department of the Navy

PRINCIPAL INVESTIGATOR: Weinberg

CONTRACT NO: HA 0203010 PROJECT NO: 008067

TITLE: Sediment Trap Intercomparison Experiment in the Panama Basin

It is proposed that a sediment trap and in situ pump field intercalibration experiment be held in the Panama Basin in the summer of 1979. Many investigators are currently making measurements of the vertical flux of particulate matter in the ocean, using moored or free-floating devices to intercept the particulate flux. These devices differ widely in their design characteristics and it is not clear at this time how compatible the results from different experiments are. In order to resolve this problem, invitations to participate in an inter-calibration experiment were sent to all U.S. investigators known to be currently active in this field. At this time, 23 investigators, representing 11 different designs of moored sediment traps, 3 designs of free-floating sediment traps and 2 designs of in situ pumps, have agreed to participate. Samples from each trap will be split, weighed and sent to the investigators for measurement of basic properties (taxonomy, major elements, carbonate, organic C, N. P. and 230-TH and 210-PB). The results of the experiment will be discussed at a symposium in the late spring of 1980. The costs of the analyses will be borne by the on-going grants of the participants. This proposal covers costs for shipping, travel, mooring deployment and recovery, and ship time.

CONTRACTOR: State University of New York

PRINCIPAL INVESTIGATOR: A. Okubo

CONTRACT NO: HA 0203010 PROJECT NO: 008250

TITLE: Lagrangian and Eulerian Diffusion Study (LEDS) in the Coastal Surface Layers

In the proposed research we will conduct a series of diffusion experiments in the coastal waters off the south shore of Long Island.

Each experiment will consist of simultaneous measurements of dye diffusion, drogue dispersion, and eulerian current velocities in the same coastal locale. The diffusion characteristics obtained from these respective measurements may be compared properly, and any discrepancies in the estimation by these methods evaluated.

This study will provide a measure of the suitability of one particular experimental method in evaluating diffusion parameters.