

NATIONAL
UNDERSEA
RESEARCH
PROGRAM

INFORMATION
FACTS AND STATISTICS

NATIONAL UNDERSEA RESEARCH PROGRAM

PURPOSE

DEVELOP KNOWLEDGE ABOUT PROCESSES IN BIOLOGICAL, CHEMICAL, AND PHYSICAL SYSTEMS IN THE OCEAN AND GREAT LAKES AND ACROSS THE BOUNDARIES OF THEIR BASINS IN ORDER TO PROVIDE A SOUND BASIS FOR DECISIONS GOVERNING USES AND RESOURCES OF THE OCEAN AND GREAT LAKES.

MISSION

PROVIDE A COORDINATED, COHERENT PROGRAM WHICH SUPPORTS AND SAFELY CONDUCTS IN SITU MARINE AND LARGE LAKE RESEARCH USING THE MOST MODERN TOOLS AVAILABLE, INCLUDING MANNED SUBMERSIBLES, AIR AND MIXED GAS SCUBA, REMOTELY OPERATED VEHICLES, AND UNDERSEA HABITATS.



NATIONAL UNDERSEA RESEARCH PROGRAM

NOAA's National Undersea Research Program (NURP) supports *in situ* investigations in the oceans and large lakes of the world. The program seeks to place investigators safely undersea to conduct manipulative experiments not possible within the limitations of traditional laboratory and ship-based research.

Research activities are aimed at increasing our knowledge of the structure and processes of the global ocean. With an understanding of how physical, chemical, biological, and geological processes control marine environments important to the nation, informed decisions can be made to improve the wise use of our marine resources.

Proposals are received from qualified investigators and peer reviewed through a competitive, national process. Support is awarded to investigators with scientifically meritorious projects. Specific program areas of undersea investigations are: 1) biological productivity and living resources, 2) coastal oceanic and estuarine processes, 3) pathways and fate of material in the ocean, 4) global and oceanic processes, 5) ocean lithosphere and mineral resources, 6) ocean technology, and 7) diving safety and physiology.

As part of the diving safety program, NURP supports research on diving physiology and hyperbaric medicine in cooperation with the U.S. Navy, U.S. Coast Guard, and recognized academic centers of excellence in these fields. Science activities in the ocean technology category include development of the tools required to facilitate undersea research.

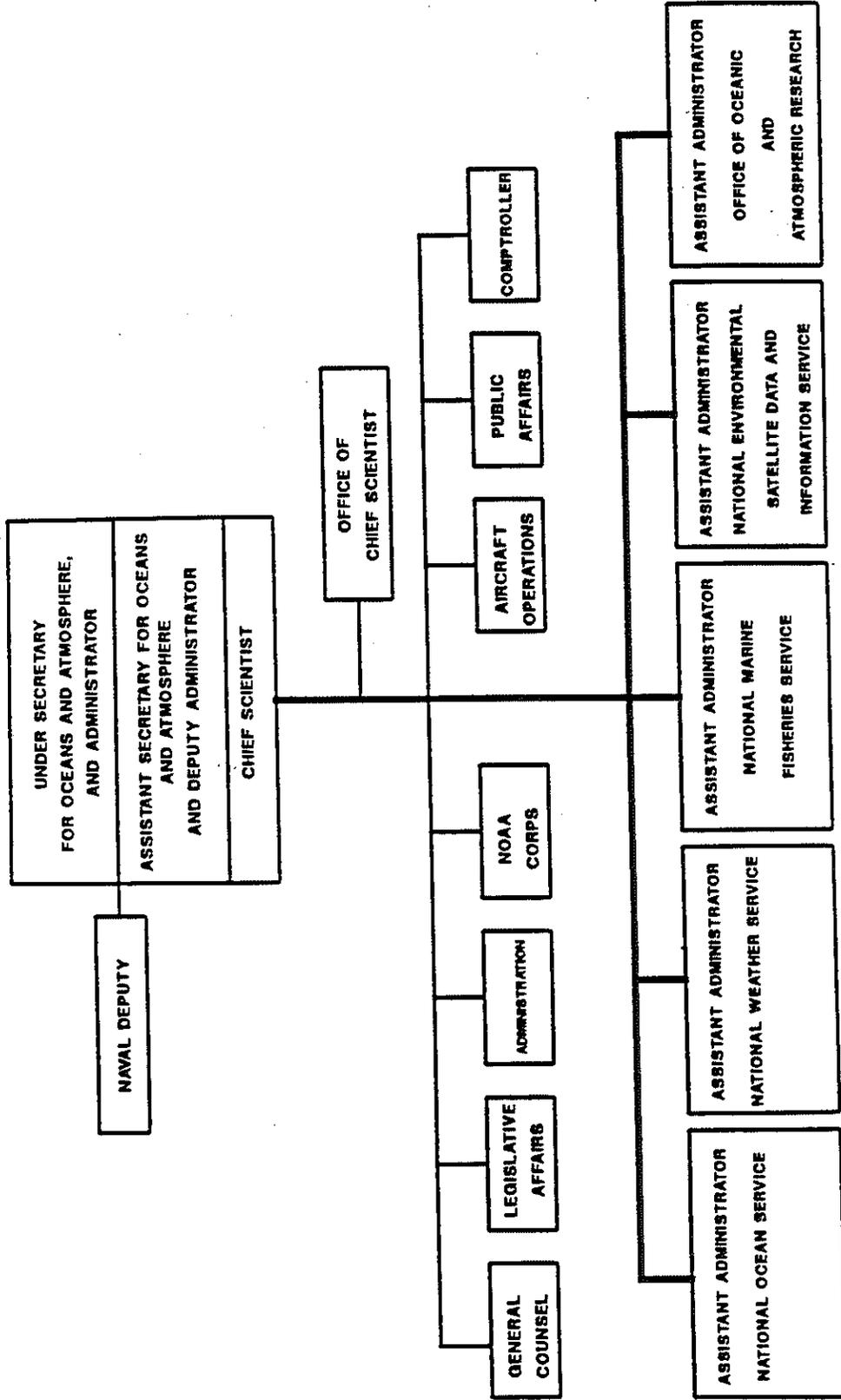
Major, integrated undersea programs now underway in the other five categories listed above include the processes governing seafloor venting, geochemical cycling of pollutants in the Great Lakes, ecology of seamounts, and the factors controlling primary productivity and nutrient cycling in diverse ecosystems ranging from the subarctic to tropical environments.

Program activities are supported with a wide array of advanced undersea sampling and sensing platforms including manned submersibles, remotely operated vehicles, and saturation habitats. Examples of this technology are the "ALVIN" and "PISCES V," two of the deepest diving submersible platforms available to the scientific community today, and the "AQUARIUS," a mobile deep-diving saturation habitat.

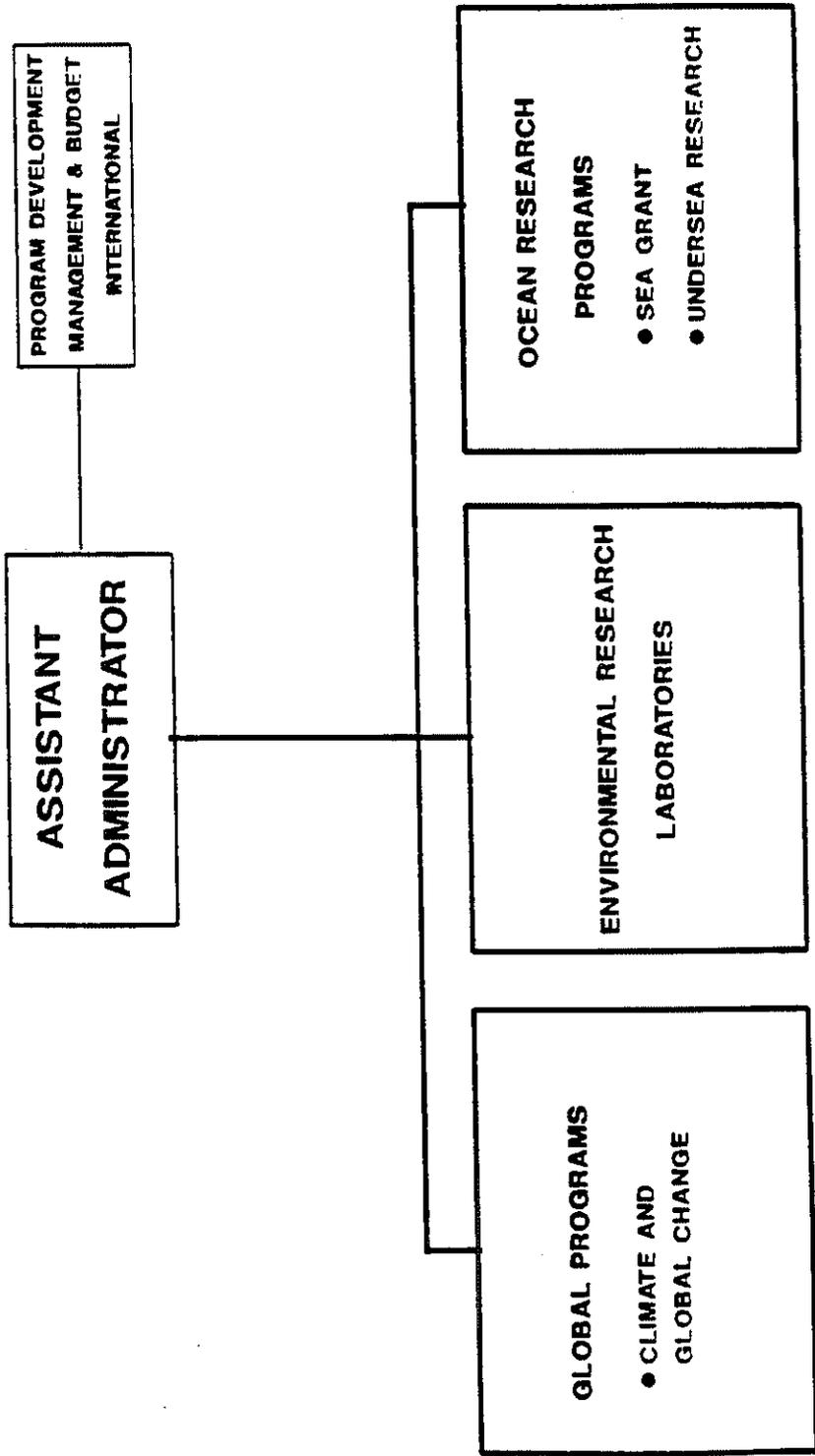
NURP is managed by the Office of Undersea Research in NOAA's Office of Oceanic and Atmospheric Research. The research community gains access to the program through five Undersea Research Centers strategically located around the U.S. Each Center has specific regional responsibilities. Centers are located at the Universities of Connecticut, Hawaii, North Carolina (Wilmington), and Alaska (Fairbanks), and the Caribbean Marine Research Center (West Palm Beach, FL).

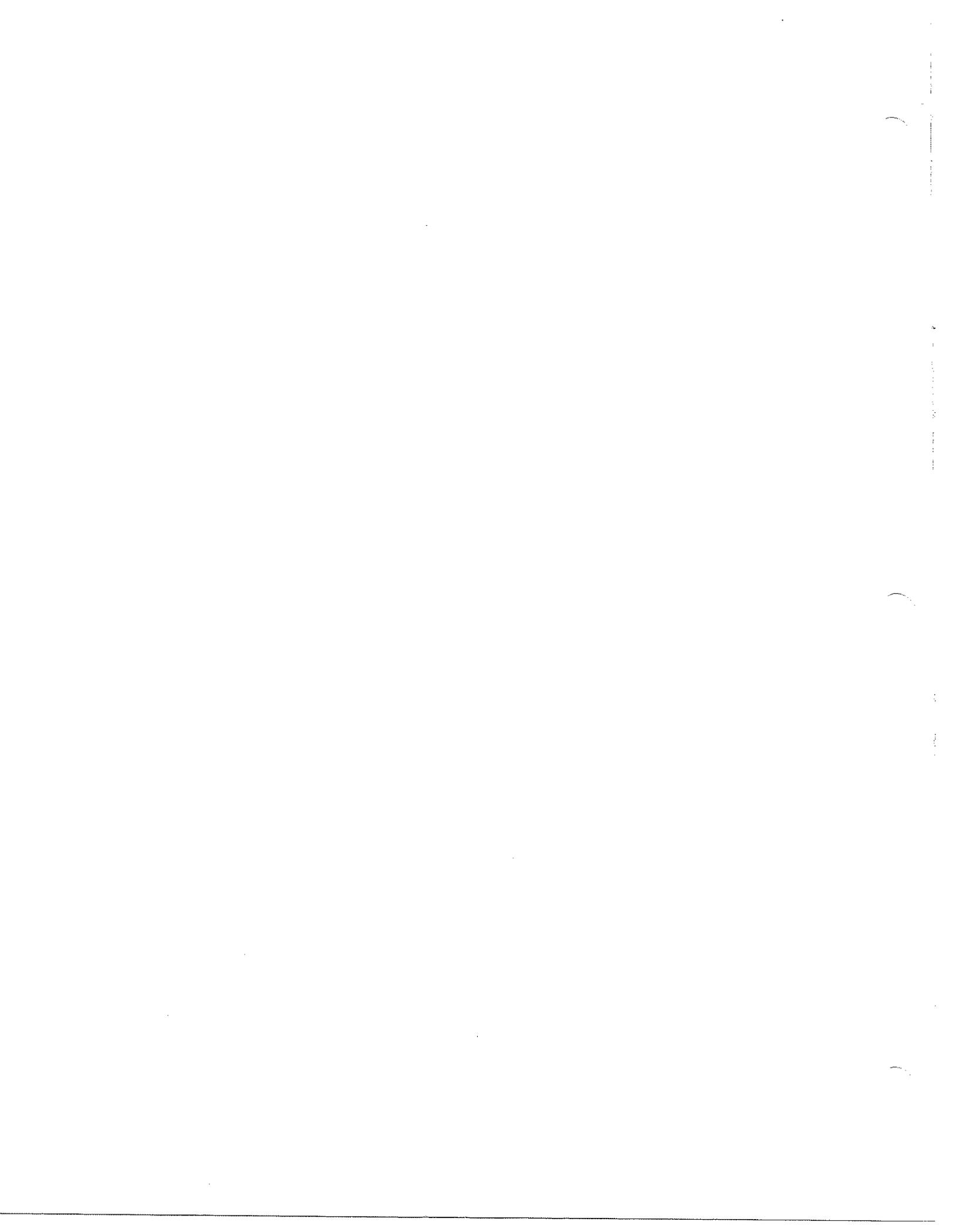
NURP provides the focal point for meeting the undersea research requirements of government, academia, and industry. Support provided by the program is generally accompanied by co-funding from traditional granting agencies such as the National Science Foundation, Office of Naval Research, National Sea Grant College Program, and the business community.

**U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION**



OCEANIC & ATMOSPHERIC RESEARCH





**NOAA's Undersea Research Program
1335 East-West Highway
R/OR2, Room 5262
Silver Spring, Maryland 20910**

**David B. Duane
Director**

**Algis N. Kalvaitis
Program Engineer**

**David Stein
Biological Scientist**

**N. Eugene Smith
General Engineer**

**Gregory Stone
Biological Science Associate**

**Odysseus Mikalis
Computer System Analyst**

**Marcia R. Collie
Editor**

**Joann Tubbs
Secretary**

**Shy Haywood
Secretary**



MARCIA R. COLLIE

Editor

Mrs. Marcia Collie is an editor with the National Undersea Research Program. In this capacity, she edits various publications including science reports, technical reports, symposium proceedings of the NURP-supported research, and papers from NURP-sponsored workshops. At the present time, she is heavily involved in the revision of the NOAA Diving Manual, which is the Government Printing Office's best seller.

She has been with NURP since 1983. Prior to this assignment, she was an editorial assistant with NOAA's Environmental Science Information Center where she worked on publications such as the Monthly Weather Review, a meteorological journal now published by the American Meteorological Society.

She is a graduate of Strayer College in Washington, D.C., and has been extensively involved in editing and preparing government publications since joining the Coast and Geodetic Survey in 1966.

DAVID B. DUANE

Director

Dr. David Duane is a marine geologist, who graduated with a B.A. degree from Dartmouth College and earned a Ph.D. in geology from the University of Kansas.

Prior to his assignment to NURP, he served as Head of the Non-Living Resources Division in the National Sea Grant Office. There, he managed multi-project grants at several of the 29 institutions in the Sea Grant network and helped determine and maintain the quality of the research as well as relevance of the projects to target user communities. In subject area specialties (marine geology and coastal processes), he had similar responsibilities, but throughout the network.

As DOC Science and Technology Fellow in 1979-80, Dr. Duane had a 10-month assignment as legislative assistant for marine related issues to U.S. Senator Lowell Weicker, Jr. (the 96th Congress). Following that assignment, he returned to Sea Grant to resume his previous responsibilities and activities.

Prior to joining NOAA in 1974, Dr. Duane's experience was focused on development of geologic resources, first with the Mobil Oil Company as an exploration geologist (oil and gas) and then with the U.S. Army Corps of Engineers (sand and gravel). As Geology Branch Chief with the Corps, he conducted and managed research on geological processes affecting erosion and deposition along coastlines and on the floor of the Great Lakes and continental shelf. He also helped organize and operate SCUBA groups at the Corps' Lake Survey District (now NOAA's Great Lakes Environmental Research Laboratory) and later at its Coastal Engineering Research Center where he was certified at the advanced scuba level and was diving officer. He currently holds a NOAA certification in diving.

Dr. Duane has more than 30 research publications to his credit as well as several chapters in books. He was an organizer and co-editor of the book Shelf Sediment Transport (1972) and was organizer and editor of a theme issue of the journal Marine Mining: Marine Sand and Gravel Mining (1988). Current research interests are metallogenesis at seafloor spreading centers; mineral resources of the continental shelf; use of the sea floor for disposal of waste materials; sediment movement under the influence of extreme events; and marine geo-political issues.

A. N. KALVAITIS

Engineering Manager

Mr. A. Kalvaitis is Engineering Manager for the National Undersea Research Program (NURP). As such, he is responsible for providing technical support and guidance on undersea platforms to the NURP Director and the National Undersea Research Centers. A primary goal is to ensure that NOAA's undersea research mission objectives and operations are technically feasible, safe, cost-effective, and efficient.

Prior to joining NURP, Mr. Kalvaitis was a program engineer with NOAA's Special Projects Office. He was responsible for managing several major projects associated with the Ocean Thermal Energy Conversion (OTEC) program that explored the ocean as a renewable power source. One of his OTEC projects was nominated by the American Society of Civil Engineers as an outstanding civil engineering achievement in 1984. Earlier, he was an engineer with NOAA's Engineering Support Office where he designed, tested, and evaluated instrumentation systems and platforms for oceanographic and meteorological measurements. Mr. Kalvaitis received his BSME from the University of Maine, Orono.

Mr. Kalvaitis has published articles on remotely operated vehicles, research habitats, OTEC developments, data quality assurance and marine instrumentation. He is a member of the Marine Technology Society's Undersea Vehicles/ROV Committee and the Current Measurement Technology Committee of the Institute of Electrical and Electronics Engineers (IEEE). In addition, he is a member of the Engineering Committee on Oceanic Resources (ECOR) Working Group on Marine Resources.

During the past several years, Mr. Kalvaitis has been Chairman of the Oceanic and Atmospheric Research (OAR) Equal Employment Opportunity Advisory Committee.

ODYSSEUS MIKALIS

Computer System Analyst

Odysseus Mikalis joins NOAA's National Undersea Research Program as a computer specialist after 5 years of consulting small business on computer applications, marketing, writing, accounting, and finance. He served as regional director of Senator Paul Sarbanes' congressional office in Wheaton, Maryland (1988-89), from which he handled liaison with government and private organizations. From 1984 to 1986, he worked at the National Endowment for the Arts.

Mikalis is a graduate of George Washington University (Political Science, 1979) and Montgomery College (Mathematics-Science, 1976). During his junior year, he interned under Senator Sarbanes, during which time he helped the senator with research on Alaska Lands Bill, Comprehensive Employment and Training Act, and foreign policy issues. Subsequent to graduating from George Washington University, Mikalis attended the University of Baltimore Law School (1982-83).

N. EUGENE SMITH

Operations Director and Program Director for Diving Safety and Physiology

Gene Smith received his B.S. in Mechanical Engineering and M.S. in Environmental Engineering from Kansas State University. He is a registered professional engineer. He has authored several technical papers and book chapters, primarily on diver thermal protection, and has served on technical committees related to diving in the United States and overseas. He is currently on the American Society of Mechanical Engineers main Committee on Pressure Vessels for Human Occupancy.

Gene comes to NOAA from San Diego, California. He has been involved with manned and unmanned undersea activities since 1967. He was with Sub Sea International (SSI) for over 15 years as engineering manager, operations manager, and the manager of an overseas (New Zealand) subsidiary. While with SSI, his major responsibilities were design and fabrication of saturation diving systems, development and implementation of underwater inspection tools and techniques, diving from dynamically positioned support vessels, lock-out submersible operations, remotely operated vehicle operations, and development of an R&D program that included complete revision of the decompression and therapeutic recompression tables and the operation and safety manuals.

Prior to his employment at SSI, Gene spent 7 years at the Westinghouse Ocean Research and Engineering Center in the Life Support Engineering group as a design engineer, project engineer, and project manager on manned submersibles and hyperbaric facilities, and diver-worn saturation diving equipment. He also directed a hyperbaric respiratory heat loss study.

DAVID L. STEIN

Program Director for Biological Sciences

Dr. David Stein is a Marine Ichthyologist. He received his B.A. degree from California State University at Humboldt, and M.S. and Ph.D. degrees in Fisheries from Oregon State University.

Before joining NURP, Dr. Stein was (successively) an Oceanographic Technician, Research Associate, and Assistant Professor (Senior Research) at Oregon State University College of Oceanography. In those positions, he spent over 3 years total time at sea on about 60 research cruises, mostly as Field Party Chief or Chief Scientist. He is a National Association of Underwater Instructors–certified scuba diver.

As a technician, Dr. Stein worked on the distribution of continental shelf benthic fishes, biology and behavior of deep scattering layer organisms, and taxonomy of fishes of the continental slope and abyssal plain. After receiving his Ph.D. in 1982, he obtained grant and contract support for research on deep–sea fishes down to 6000 m, development of deep sea large net trawling methods, taxonomy of the snailfishes, and fisheries biology of Pacific grenadier. He has also used submersibles for multi–year studies of upper subduction zone methane vents and of deep bank fishes off Oregon.

Dr. Stein has published over 30 research papers and has been an invited author or co–author of several book chapters. His current research interests are the taxonomy and natural history of snailfishes and deep–sea fishes, and the fisheries biology of continental slope fishes.

GREGORY STONE

Assistant Program Director for Biological Sciences

Mr. Gregory Stone was the 1989 Sea Grant Fellow assigned to the National Undersea Research Program (NURP). He is involved in many aspects of the national office including proposal reviews, long-range planning, preparing information for congressional briefings, and is specifically working on the Deep Ocean Exploration and Environmental Processes (DEEP) initiative. This fellowship is part of Mr. Stone's Master's Degree program in Marine Affairs at the University of Rhode Island (URI).

Prior to joining NURP, Mr. Stone was a research associate at the College of the Atlantic where he conducted research on whales and taught research diving and marine mammal courses. He has conducted field research on depleted whale species in the Antarctic, Caribbean, and the Gulf of Maine. He has worked for the New England Aquarium as chief scientist of the right whale project and at the Graduate School of Oceanography at URI as a marine research specialist conducting aerial surveys for whales and turtles. He was also principal investigator for cetaceans in the NOAA National Marine Fisheries Service Antarctic Marine Living Resources Program during 1986.

Mr. Stone is a recipient of the 1986 National Science Foundation and U.S. Navy Antarctic Service Medal and the 1989 John A. Knauss Marine Policy Fellowship. He is an instructor with the National Association of Underwater Instructors and has logged over 1,400 hours SCUBA diving. He is a member of the American Academy of Underwater Scientists and the International Society for Marine Mammalogy. He has over 10 scientific publications on whales and numerous other popular articles on marine topics.

During the period January 1990–January 1992, Mr. Stone has been assigned as NOAA's representative to the Japan Marine Science and Technology Center (JAMSTEC) in Yokosuka, Japan. While Mr. Stone has been in Japan and working at JAMSTEC, he has created new opportunities for U.S.–Japanese collaboration in undersea science research.



NATIONAL UNDERSEA RESEARCH PROGRAM OFFICE
SUBJECT AREA AND ADMINISTRATIVE ASSIGNMENT

DAVID B. DUANE

Geological Sciences
ALVIN and Submersible
Liaison with University National Oceanographic Laboratory System
(UNOLS), and Navy (OPS-23)
Program Development
Office Administration

A. N. KALVAITIS

Manned Submersibles
Safety and Standards
Habitats
Field Operation Scheduling
Facilities Maintenance and Operations Contracts
Program and Project Monitor
Special Events

ODYSSEUS MIKALIS

Computer Analyst

EUGENE SMITH

Diving Physiology, Health, and Safety of Aquanauts
Instrumentation Research and Development for All Systems
Operations Safety
Program and Project Monitor
Remotely Operated Vehicles

DAVID STEIN

Biological Sciences
Environmental Sciences
Project Program Monitor

MARCIA COLLIE

NURP Publications
NURP Manuals
NOAA Diving Manual
Visuals

GREGORY STONE

Biological Science Associate
Marine Mammals
US/JAPAN Cooperative Activities



Primary Areas of NOAA NURP Research Activities

The ocean can be divided into three major areas of interest:

Coastal Ocean

the ocean overlying the continental shelf from 10 to 100 m bottom depth, the area of man's greatest impact on the ocean.

Transitional Ocean

the ocean over the continental slope from 100 to 1000 m bottom depth, the transition from the Coastal Ocean to the Open Ocean.

Open Ocean

the deep sea where bottom depths exceed 1000 m.

Within this framework, areas of particular emphasis for research activities at NURP are:

Global Change Processes

ocean processes that affect and are affected by long-term climate (e.g., continuous in-situ water temperature monitoring)

Habitat Characteristics

interrelationships between marine organisms and their living space (e.g., preferred bottom type of commercially important species such as rockfish)

Ocean Lithosphere

characteristics of the ocean bottom with respect to their morphology, structural framework, and sediment distribution (e.g., origin and distribution of ferro-manganese crust on Pacific seamounts)

Material Flux

pathways and fate of materials in the ocean and role of submarine venting in the global chemical and thermal budgets of the ocean (e.g., presence and effects of anthropogenic materials on the sea floor, such as the 106-mi dump site)

Productivity

energy transfer through the marine ecosystem (e.g., the effects of methane vents on benthic communities)

Recruitment of Marine Organisms

identification of the causes of natural fluctuations in populations of marine organisms (e.g., dynamics of grouper spawning assemblages)

Other

other marine phenomena that affect our living world (e.g., the causes and effects of coral bleaching on reef communities)

In addition, NURP is responsible for the following areas of marine research:

Diver Safety and Physiology

research to improve the safety of undersea workers and better understand the physiological processes affecting man in the sea (e.g., improvement and validation of decompression tables)

Undersea (Ocean) Technology

develop and improve the capabilities of undersea research tools to better provide information needed by ocean scientist (e.g., precision undersea fluid sampling system for submersibles)

Abbreviations of Research Categories for Program Definition

Coastal Ocean (10 - 100 m)

Global Change	COGC
Habitat	COH
Lithosphere	COL
Material Flux	COMF
Productivity	COP
Recruitment	COR
Other	COO

Transitional Ocean (100 - 1000 m)

Habitat	TOH
Lithosphere	TOL
Material Flux	TOMF
Productivity	TOP
Recruitment	TOR
Other	TOO

Open Ocean (>1000 m)

Lithosphere	OOL
Material Flux	OOMP
Global Change	OOGC
Other	OOO

Diver Safety & Physiology DSP

Undersea (Ocean) Technology OT

Abbreviations for Regional Programs

Great Lakes	GL
Atlantic Ocean	ATL
Northwest	NW
(New England to Mid-Atlantic coast)	
Southwest	SW
(Mid-Atlantic to Florida coast)	
Gulf of Mexico	GMX
Caribbean	CRB
Pacific	PAC
Northeast	NE
(Alaska to Oregon)	
Southeast	SE
(California)	
Central	CTL
(Hawaiian Archipelago)	
Western	WST
(Island Territories)	
AQUARIUS Undersea Habitat	AQU
Office of Undersea Research (national or non-specific)	OUR

National Undersea Research Centers

UCAP	University of Connecticut - Avery Point
FDU	Fairleigh Dickinson University (closed in 1990)
UNCW	University of North Carolina - Wilmington
CMRC	Caribbean Marine Research Center
UAKF	University of Alaska - Fairbanks
UHI/M	University of Hawaii - Manoa (formerly Hawaii Undersea Research Laboratory(HURL))

NURP PROGRAM FY 1988
RESEARCH - TECHNOLOGY
(Dollars in Thousands)

COASTAL OCEAN	GL/	ATL	CRB	AQU	PAC	PAC	OUR
	ATL	SW/			NE/	CTL/	
	NW	GMX			SE	WST	
Global Change	67			149		71	
Habitat	448				173	106	
Lithosphere	326						
Material Flux	495	55		395	83		
Productivity	212	146	333	681			
Recruitment	92		288				
Other	112	667	513	1191	58	177	553
SUBTOTAL	1752	868	1134	2416	314	354	553
Section Total	7391						

TRANSITIONAL OCEAN	GL/	ATL	CRB	AQU	PAC	PAC	OUR
	ATL	SW/			NE/	CTL/	
	NW	GMX			SE	WST	
Global Change		66			86		
Habitat							
Lithosphere		152					
Material Flux							
Productivity						106	
Recruitment							
Other						71	7
SUBTOTAL	0	218	0	0	86	177	7
Section Total	488						

OPEN OCEAN	GL/	ATL	CRB	AQU	PAC	PAC	OUR
	ATL	SW/			NE/	CTL/	
	NW	GMX			SE	WST	
Global Change							
Habitat						775	739
Lithosphere						317	
Material Flux						71	
Productivity							
Recruitment							
Other						106	
SUBTOTAL	0	0	0	0	0	1269	739
Section Total	2008						

OTHER	GL/	ATL	CRB	AQU	PAC	PAC	OUR
	ATL	SW/			NE/	CTL/	
	NW	GMX			SE	WST	
Diver Safety/ Physiology							360
Ocean Technology	298			34	21		143
SUBTOTAL	298	0	0	34	21	0	503
Section Total	856						
CENTER TOTAL	2050	1086	1134	2450	421	1800	1802
APPORTIONED TOTAL	2222	1188	1229	2656	456	1951	1954
GRAND TOTAL	11656						

NURP PROGRAM FY 1989
RESEARCH - TECHNOLOGY
(Dollars in Thousands)

	GL/ ATL NW	ATL SW/ GMX	CRB	AQU	PAC NE/ SE	PAC CTL/ WST	OUR	
COASTAL OCEAN								
Global Change				390				
Habitat	143	32			446			
Lithosphere	78		31					
Material Flux	723	271			242			
Productivity	759	44	365		77			
Recruitment	61	5	444	575				
Other	1016	37	465	897			338	
SUBTOTAL		2780	389	1305	1862	765	0	338
Section Total	7439							

	GL/ ATL NW	ATL SW/ GMX	CRB	AQU	PAC NE/ SE	PAC CTL/ WST	OUR	
TRANSITIONAL OCEAN								
Global Change								
Habitat								
Lithosphere		291						
Material Flux		154			35			
Productivity						551		
Recruitment								
Other								
SUBTOTAL		0	445	0	0	35	551	0
Section Total	1031							

	GL/ ATL NW	ATL SW/ GMX	CRB	AQU	PAC NE/ SE	PAC CTL/ WST	OUR	
OPEN OCEAN								
Global Change							920	
Habitat								
Lithosphere						1597		
Material Flux		311				551		
Productivity								
Recruitment								
Other				664		441		
SUBTOTAL		0	311	0	664	0	2589	920
Section Total	4484							

	GL/ ATL NW	ATL SW/ GMX	CRB	AQU	PAC NE/ SE	PAC CTL/ WST	OUR	
OTHER								
Diver Safety/ Physiology		178		288			309	
Ocean Technology							60	
SUBTOTAL		0	178	0	288	0	369	
Section Total	835							
CENTER TOTAL		2780	1323	1305	2814	800	3140	1627
APPORTIONED TOTAL		2957	1408	1378	2993	852	3340	1734
GRAND TOTAL	14662							

R/OR-2
4/19/91
GDD

NURP PROGRAM FY 1988
RESEARCH - TECHNOLOGY
(Dollars in Thousands)

COASTAL OCEAN	GL/	ATL		AQU	PAC		OUR	
	ATL	SW/	CRB		NE/	CTL/		
	NW	GMX			SE	WST		
Global Change		67		149		71		
Habitat	448				173	106		
Lithosphere	326							
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TRANSITIONAL OCEAN	GL/	ATL		AQU	PAC		OUR	
	ATL	SW/	CRB		NE/	CTL/		
	NW	GMX			SE	WST		
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Section Total	488							

OPEN OCEAN	GL/	ATL		AQU	PAC		OUR
	ATL	SW/	CRB		NE/	CTL/	
	NW	GMX			SE	WST	
Global Change							
Habitat						775	739
Lithosphere						317	
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Productivity							
Recruitment							
Other						106	
SUBTOTAL		0	0	0	0	1269	739
Section Total	2008						

OTHER	GL/	ATL		AQU	PAC		OUR	
	ATL	SW/	CRB		NE/	CTL/		
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SUBTOTAL		298	0	0	34	21	0	503
Section Total	856							
CENTER TOTAL		2050	1086	1134	2450	421	1800	1802
APPORTIONED TOTAL		2222	1188	1229	2656	456	1951	1954
GRAND TOTAL	11656							

NOR-2
41991
GDD

NURP PROGRAM FY 1989
RESEARCH - TECHNOLOGY
(Dollars in Thousands)

COASTAL OCEAN	GL/	ATL	CRB	AQU	PAC	PAC	OUR	
	ATL	SW/			NE/	CTL/		
	NW	GMX			SE	WST		
Global Change				390				
Habitat	143	32			446			
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Section Total	7439							

TRANSITIONAL OCEAN	GL/	ATL	CRB	AQU	PAC	PAC	OUR	
	ATL	SW/			NE/	CTL/		
	NW	GMX			SE	WST		
Global Change								
Habitat								
Lithosphere		291						
Material Flux		154			35			
Productivity						551		
Recruitment								
Other								
SUBTOTAL		0	445	0	0	35	551	0
Section Total	1031							

OPEN OCEAN	GL/	ATL	CRB	AQU	PAC	PAC	OUR	
	ATL	SW/			NE/	CTL/		
	NW	GMX			SE	WST		
Global Change							920	
Habitat								
Lithosphere						1597		
Material Flux		311				551		
Productivity								
Recruitment								
Other				664		441		
SUBTOTAL		0	311	0	664	0	2589	920
Section Total	4484							

OTHER	GL/	ATL	CRB	AQU	PAC	PAC	OUR	
	ATL	SW/			NE/	CTL/		
	NW	GMX			SE	WST		
Diver Safety/ Physiology		178		288			309	
Ocean Technology							60	
SUBTOTAL		0	178	0	288	0	0	369
Section Total	835							
CENTER TOTAL		2780	1323	1305	2814	800	3140	1627
APPORTIONED TOTAL		2957	1408	1378	2993	852	3340	1734
GRAND TOTAL	14662							

RDR-2
41991
GDD

NURP PROGRAM FY 1990
RESEARCH - TECHNOLOGY
(Dollars in Thousands)

	GL/ ATL NW	ATL SW/ GMX	CRB	AQU	PAC NE/ SE	PAC CTL/ WST	OUR
COASTAL OCEAN							
Global Change	102				221		
Habitat	353				220		
Lithosphere			39				
Material Flux	1059	10					
Productivity	428				167		
Recruitment	143		806				
Other	207	239	672		186		479
SUBTOTAL	2292	249	1517	0	794	0	479
Section Total	5331						

	GL/ ATL NW	ATL SW/ GMX	CRB	AQU	PAC NE/ SE	PAC CTL/ WST	OUR
TRANSITIONAL OCEAN							
Global Change							
Habitat							
Lithosphere		675					
Material Flux	33						
Productivity							
Recruitment							
Other							
SUBTOTAL	33	675	0	0	0	0	0
Section Total	708						

	GL/ ATL NW	ATL SW/ GMX	CRB	AQU	PAC NE/ SE	PAC CTL/ WST	OUR
OPEN OCEAN							
Global Change							940
Habitat							
Lithosphere						1311	
Material Flux	993					1247	102
Productivity							
Recruitment							
Other						442	35
SUBTOTAL	993	0	0	0	0	3000	1077
Section Total	5070						

	GL/ ATL NW	ATL SW/ GMX	CRB	AQU	PAC NE/ SE	PAC CTL/ WST	OUR
OTHER							
Diver Safety/ Physiology		362					346
Ocean Technology				863			250
SUBTOTAL	0	362	0	863	0	0	596
Section Total	1821						
CENTER TOTAL	3318	1286	1517	863	794	3000	2152
APPORTIONED TOTAL	3500	1357	1600	910	837	3165	2270
GRAND TOTAL	13639						

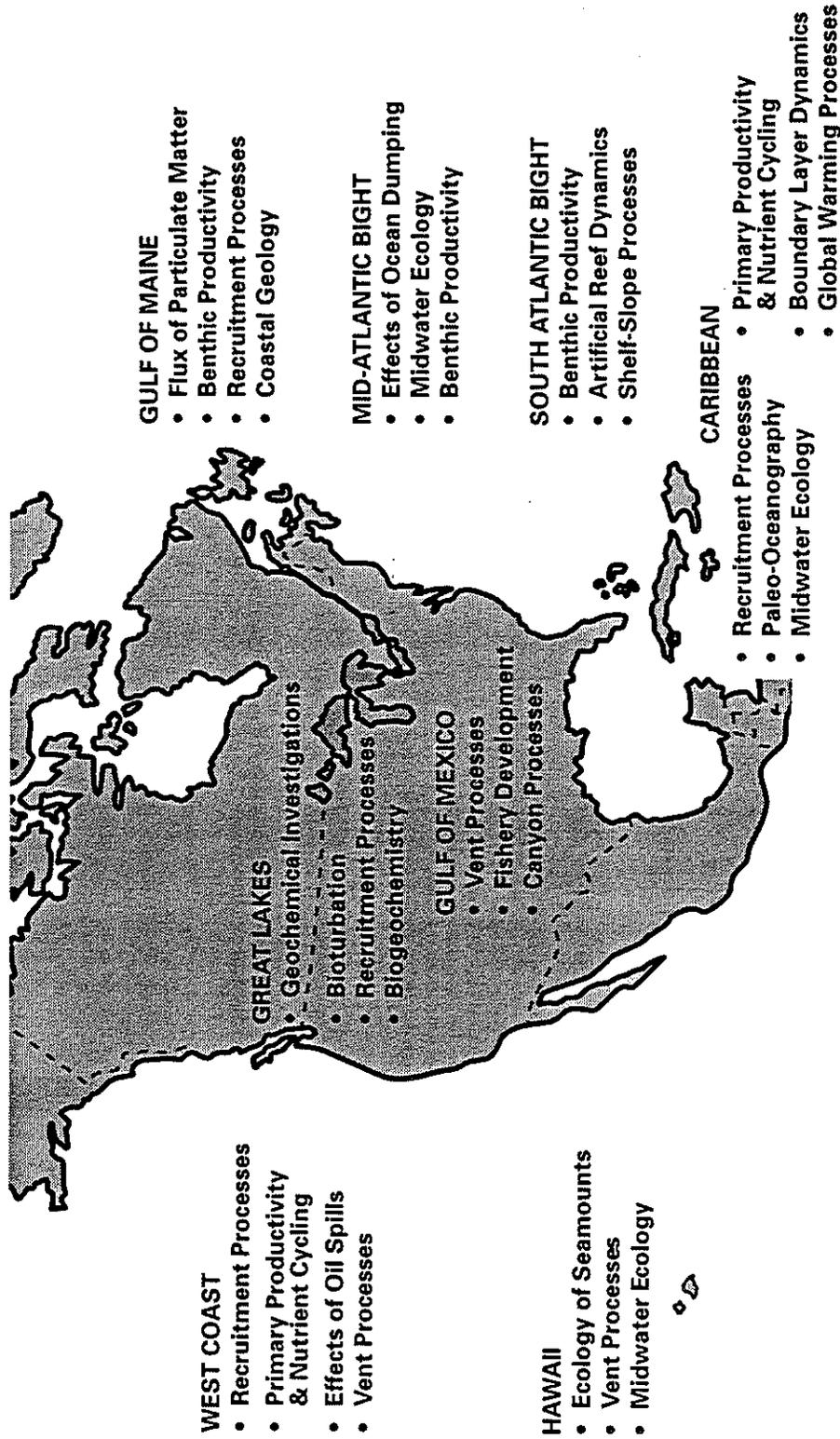
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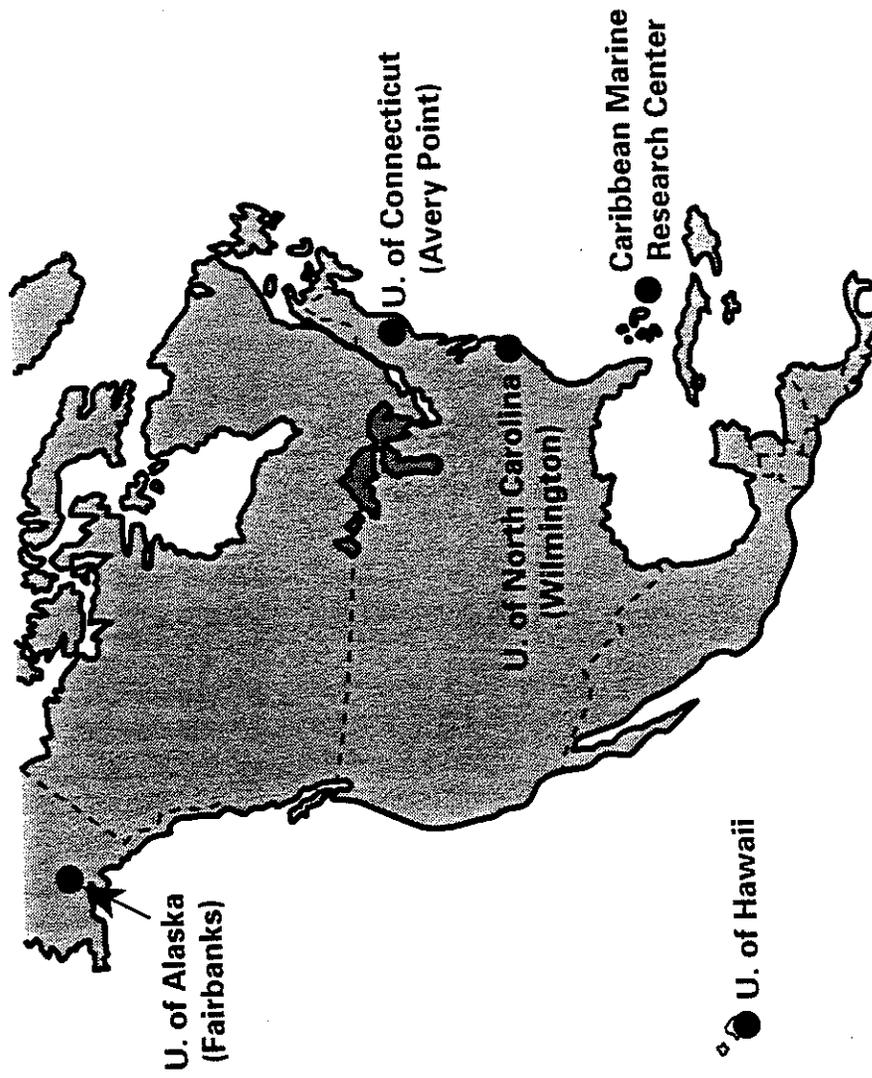
STAFF MONITORING AND SITE VISIT ASSIGNMENTS

<u>Research Center Programs</u>	<u>Monitor/Alternate</u>
University of Connecticut/Avery Point	Stein/Smith
University of North Carolina/Wilmington	Kalvaitis/Stein
University of Hawaii/Manoa	Kalvaitis/Stein
Caribbean Marine Research Center/ Riviera Beach, Florida	Stein/Smith
West Coast/Fairbanks, Alaska	Stein/Smith
<u>Project/Programs</u>	<u>Monitor/Alternate</u>
ALVIN and UNOLS	Duane/Kalvaitis
National Science Foundation	Stein/Duane
Diver's Alert Network	Smith
NOAA Diving Manual	Duane/Collie
Marine Resources Development Foundation	Kalvaitis/Stein
U.S. Navy Liaison	Smith/Stein

NATIONAL UNDERSEA RESEARCH PROGRAM PRINCIPAL SCIENCE THEMES BY REGION



NOAA'S OFFICE OF UNDERSEA RESEARCH CENTERS



NOAA'S NATIONAL UNDERSEA RESEARCH PROGRAM

National Undersea Research Program
Silver Spring Metro Center 1
1335 East-West Highway, Code R/OR2
Silver Spring, MD 20910

301-427-2427 (Voice)
301-427-2799 (Fax)

REGIONAL NATIONAL UNDERSEA RESEARCH CENTERS

**Northeastern U.S., Great Lakes, and
other Large Lakes of the World**

Director
National Undersea Research Center
University of Connecticut - Avery Point
Groton, CT 06340

203-445-4714 (Voice)
203-445-2969 (Fax)

**Southeastern U.S., Gulf of Mexico,
and AQUARIUS habitat**

Director
National Undersea Research Center
Univ. of North Carolina - Wilmington
7205 Wrightsville Avenue
Wilmington, NC 28403

919-256-5133 (Voice)
919-256-8856 (Fax)

Caribbean

Director
Caribbean Marine Research Center
National Undersea Research Center
1501 Northpoint Parkway, Ste. 102
West Palm Beach, FL 33407

407-688-0500 (Voice)

West Coast

Director
National Undersea Research
Center
School Fisheries and Ocean
Sciences
University of Alaska-Fairbanks
Fairbanks, AK 99775-1010

907-474-5870 (Voice)
907-474-5084 (Fax)

**Hawaii and other Pacific
Islands**

Director
Hawaii Undersea Research
Center
University of Hawaii - Manoa
1000 Pope Road, MSB 226
Honolulu, HI 96822

808-956-6802 (Voice)
808-956-2136 (Fax)

**NATIONAL UNDERSEA RESEARCH PROGRAM
SCIENCE DIVE ACTIVITIES**

SUMMARY OF 1988

Research Center	Manned Submersible/ Habitat*	Remote Operated Vehicle	SCUBA	Participants	Affiliations
Caribbean Marine Research Center	32	24	750	30	7
University of CT, Avery Point	215	217	709	186	70
University of NC, Wilmington	96	56	410	101	41
University of HI	81			36	18
Fairleigh Dickinson University	6*	7	523	60	25
West Coast Program	80	13		23	10
NOAA - ALVIN	20			12	9
TOTALS	530	317	2392	448	180

SUMMARY OF 1989

Research Center	Manned Submersible/ Habitat*	Remote Operated Vehicle	SCUBA	Participants	Affiliations
Caribbean Marine Research Center	6	4	6000	50	20
University of CT, Avery Point	177	270	104	240	79
University of NC, Wilmington	38	54	782	125	35
University of HI	10			5	2
Fairleigh Dickinson University	58/120*	7	511	107	48
West Coast Program	230	15		36	9
NOAA - ALVIN	7			20	9
TOTALS	526/120	350	7397	583	202

SUMMARY OF 1990

Research Center	Manned Submersible/ Habitat	Remote Operated Vehicle	Nitrox/ SCUBA	Participants	Affiliations
Caribbean Marine Research Center			3850	50	20
University of CT, Avery Point	259	282	305	245	39
University of NC, Wilmington	133	34	490	186	56
University of HI	33			28	7
Fairleigh Dickinson University			300	25	8
University of AK	109			35	9
NOAA - ALVIN	47			47	18
TOTALS	581	316	4945	616	157

*NOTE: AQUARIUS saturation habitat missions average 12 days in length and typically include 5 scientists



NOAA'S NATIONAL UNDERSEA RESEARCH PROGRAM
AT THE UNIVERSITY OF CONNECTICUT, AVERY POINT
1991

NOAA's National Undersea Research Center at the University of Connecticut, Avery Point (NURC-UCAP) was administratively established in 1983 and conducted its first diving operations in 1984. To date, NURC-UCAP has provided dive system (manned submersible, ROV, and SCUBA/NITROX) support to over 300 diver scientists from 16 states, 18 universities, 5 government agencies/departments, and 6 countries. A total of 245 research proposals have been submitted and reviewed with about 70% funded; science support (\$) was provided to approximately 25% of these scientists. A total of 1210 manned submersible, 1037 ROV, and 1197 SCUBA (Air and Nitrox) dives have been made in support of our science program (nationally and internationally) and public education.

Results of these diving operations are being published at an increasing rate. To date, there are 65 peer reviewed journal publications, 140 technical reports and 20 completed masters and Ph.D dissertations. These publications represent research conducted from 1985 through 1990.

The ultimate goal of NURC-UCAP's science program is to better understand the biogeochemical dynamics of our marine and fresh water environments and to predict the impact of stress, natural and man-made, on their living resource productivity and utilization for recreation. Our primary research efforts since 1984 have been directed toward a programmatic blend of "mission" oriented and "basic" research. Much of this research bears directly on some very pressing and serious issues facing NOAA and our coastal and Great Lakes states. These issues deal with (1) management and protection of commercial and recreational fisheries of the Great Lakes and N. W. Atlantic valued annually at over \$6 billion (value includes support industries such as marinas, tackle shops, boat sales, etc.), (2) aquatic pollution/human health issues that are more serious in the northeast U. S. than other regions of the country, and (3) the identification of critical habitats (spawning grounds, nursery grounds) for commercial and recreational fishes, crustaceans, and molluscs and their protection from physical and chemical abuse.

Habitat protection and the assessment of impacts from pollution relate directly to the well being of our living resources and man's ability to utilize these resources and their environments for commerce and recreation. Public perception of seriously polluted coastal environments and the living resources they support is a reality; reference the sewage sludge dumping/medical waste issues on the east coast, summer 1988 (Time and Newsweek Magazine articles



August 1, 1988). Estimates of lost revenues (significant reduction in tourism, reduced property values, reduced tax revenues, etc.) to the states of New Jersey, New York, Connecticut, Rhode Island, and Massachusetts during 1988-1990 are in the range of \$7-10 billion. The issue of human health as regards sewage sludge and medical wastes is not within the purview of NURC-UCAP, but the possible deleterious impacts on our aquatic living resources and their supportive habitats certainly is a responsibility of NOAA and is a central component of our science program.

NURC-UCAP's science program is comprised of seven (7) Research Themes that are addressed by the specific goals, objectives, and hypotheses presented in the research proposals presented herein for NURC-UCAP support in 1991. These research themes, presented below, represent the priority needs of three distinct geographic regions within the U. S.:

- I Environmental Factors Governing Growth and Survival of Marine Biota - Identify and quantify the chemical, physical, and biological environmental parameters that determine growth, survival, and therefore distribution and abundance of bottom oriented species living on hard and soft substrates in the Gulf of Maine and southern New England Continental Shelf Research is directed toward commercial and prey species and those species uniquely situated in the ecosystem to provide insight into the processes governing survival and growth. Included is an assessment of the resurging herring populations and gadoid (cod, haddock, and hake) populations of Georges Bank through studies of spawning and nursery grounds. Proposals by Witman, Witman and Sebens, Schick, Cahoon, Lough, Langton et al., and Auster and Malatesta are grouped under this theme.
- II Environmental and Resource Impact Assessment From Ocean Dumping - Estimate the likely impact(s) of four (4) years of sewage sludge dumping at the "106" dump site off New York/New Jersey. Research is directed toward an assessment of ocean floor animal community structure and species abundance along hypothetical transects leading N.E. and S.W. away from the dump site area, and chemical loading/contamination of bottom sediments and key "indicator species" most likely to demonstrate impact(s). Included is an examination for histological and pathological conditions usually associated with chemical "insult" on these key indicator species of commercial importance (red crab, four spot flounder, tilefish, and ocean quahog). The proposal of Cooper and Stewart addresses this theme.
- III Ecology and Energetics of Pelagic and Benthic Zooplankton Communities - Research is directed toward predator-prey relationships, defining metabolic rates of individual species, nutritional quality of species consumed, competition of macrozooplankton with commercially important fishes for a common prey source, the production of fecal pellets that settle



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
OFFICE OF OCEANIC RESEARCH PROGRAMS
1335 East-West Highway, Silver Spring, MD 20910

NOAA'S NATIONAL UNDERSEA RESEARCH PROGRAM
AT THE UNIVERSITY OF CONNECTICUT, AVERY POINT

1991

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- I Environmental Factors Governing Growth and Survival of Marine Biota - Identify and quantify the chemical, physical, and biological environmental parameters that determine growth, survival, and therefore distribution and abundance of bottom oriented species living on hard and soft substrates in the Gulf of Maine and southern New England Continental Shelf. Research is directed toward commercial and prey species and those species uniquely situated in the ecosystem to provide insight into the processes governing survival and growth. Included is an assessment of the resurging herring populations and gadoid (cod, haddock, and hake) populations of Georges Bank through studies of spawning and nursery grounds. Proposals by Witman, Witman and Sebens, Schick, Cahoon, Lough, Langton et al., and Auster and Malatesta are grouped under this theme.
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to the bottom providing a source of food for bottom organisms and a pathway for contaminants, and overall community structure and abundance of gelatinous and non-gelatinous zooplanktors. The importance of copepods in the Gulf of Maine in supporting a breeding population of marine mammals, including endangered species of whales, is included in this research theme. This theme is addressed through the proposal by Wishner and Winn.

IV Biogeochemical Pathways/Processes Governing Distribution and Transformation of Contaminants and Nutrients - Identify and quantify the pathways and processes at the air/water and sediment/water interfaces through which contaminants and nutrients are distributed and transformed. The fate and availability of contaminants (trace metals, organics, and hydrocarbons) and nutrients bear directly on the health and productivity of the marine and Great Lakes environment. Comparative studies in other Large Lakes of the World (Lake Baikal - Russia, Lake Kinneret - Israel, East African Rift Lakes Victoria and Tanganyika - S. E. Africa, Lake Yellowstone - Wyoming, and Lake Champlain - New York) will significantly add to our understanding of the biogeochemical dynamics of the U. S. Great Lakes, and how to wisely manage this very valuable aquatic resource. This theme will be addressed through the proposed research of Hinga and Pilson in marine waters and by Berman et al. and Nealson and Klump in the Large Lakes.

V Geophysical Research On Physical and Biological Processes of Sediment Transport - This research theme bears directly on the fate of contaminants and the redistribution of nutrients so important to the issues of environmental health and fish production and relates strongly to Research Theme IV. Included here is an assessment of bioerosion, a biological process of shelter formation by bottom oriented biota. The groundtruthing (calibration) of exposed sedimentary features, first defined by seismic profiling, is included in this theme. The proposals by Mart and Belknap, Horne, and Whitlatch will address this theme.

VI Biological Productivity and Ecosystem Energetics - This research theme is a major objective in the comparative study of "Large Lakes of the World." Research here concentrates on (1) assessing reasons for failure versus success of lake trout spawning in Lakes Michigan and Superior, a fishery valued at \$2 billion annually, (2) criteria by which larval sea lampreys (major predator of lake trout) choose offshore habitats to mature in, (3) bottom and water column community dynamics in the photic and aphotic zones, and (4) defining the linkage between fish production from deep versus shallow waters.

VII Education of Youth - High School Aquanaut Program - Introduce the subject/discipline of underwater research, its high technology methodology and exciting results to high school students. The goal of this program is to educate today's youth

to be more informed voters and aquatic resource managers of tomorrow. The High School Aquanaut Program (HSAP) seeks to develop a sense of stewardship towards our marine and fresh water environments. HSAP currently covers the states of Connecticut and Michigan and has been viewed as a "prototype" developmental youth education effort from 1988 through 1991. Program growth in the future will depend on non NURP funding support; several proposals are pending. This theme is addressed through the proposal by Cooper et al.

The proposed 1991 NURC-UCAP program will be concentrated on the east coast from the Mid-Atlantic Bight Region (New Jersey and New York) to southern New England (Connecticut, Rhode Island, and Massachusetts) and the Gulf of Maine. A total of 34 research proposals have been submitted to NURC-UCAP to both continue and initiate research in these regions. While our diving research efforts for 1991 will concentrate primarily on the marine scene, a minor level of activity will continue in Lake Kinneret, Israel, and Lake Baikal, Russia, to address the Large Lake comparison theme of our program.

Twelve research projects will be supported in southern New England and the Gulf of Maine, six (6) in the area of benthic and pelagic ecology and biogeochemical processes, five (5) in the area of fisheries, and one (1) in the area geological groundtruthing. Specific objectives of these proposals are presented in Section Two, while the general thrust of the proposed research is given above, grouped by Research Theme. ROV'S, manned submersibles, and NITROX diving will be used to conduct this research.

Several new or relatively new (1989, 1990) research initiatives, treated in the mode of "program development," comprise the remainder of the 1990 program. These components of the NURC-UCAP proposal represent a blend of "comparative-process oriented" research, and technology transfer/public education activities that fall within the rubric of activities supported by NOAA. Briefly stated, they are as follows:

ROV Research and Development - NURC-UCAP's responsibility to developing the science support capabilities of "low cost" ROV's and transferring this capability to other NURC centers will continue through 1991. The ROV has become a commonly used deep diving tool complementary to the manned submersible, in part due to NOAA's support of the R&D activities.

Large Lakes of the World - Israel - USSR Rift Lakes Study - On the international - Large Lakes of the World scene, two (2) research projects will be supported. For 1991 these proposals, although reviewed through the normal peer process, will be treated as program development projects. In Lake Kinneret, Israel, ROV's will be used to study the physical and biological processes at the sediment-water interface during strong thermal stratification. In Lake Baikal, the Soviet Unions' deep diving

PISCES submersible will be used to study the biogeochemistry of manganese and the geochemical process of mineral formation.

In depth studies of the biogeochemical processes governing fish production and the cycling/fates of nutrients and contaminants in Rift Lakes Kinneret and Baikal scheduled for 1991 and 1992. These investigations combined with the preliminary research initiated in 1988 and 1989 are necessary precursors to identify the research needs for each lake system, for comparison with the existing Large Lakes Program and for development of hypotheses for inclusion in a formal ARO slated to form the research strategy for 1990/1991 and 1991/1992. An ARO has been sent to the Israeli and American research community for research program definition for Lake Kinneret, Israel for 1991. The same procedure will be followed for African Lakes and Lake Baikal in 1991/1992; program development in African countries is a very slow process and NURC-UCAP is progressing cautiously in this regard.

Lake Baikal, Soviet Union, research interests have been strongly presented to NURC-UCAP by Large Lake scientists, including Soviet scientists, for support of operations in 1990 and beyond. One group of scientists from the University of Wisconsin, cooperating with Soviet scientists, is being supported by NURC-UCAP investigating hydrothermal vent processes of Lakes Yellowstone and Baikal. NURC-UCAP intends to develop a strong, cooperative program of research comparing the ecosystem of Lake Baikal with the other Large Lakes of the World program sites, probably Kinneret, Victoria, and Tanganyika.

NURC-UCAP/NURC-UH/Taiwan Cooperative Research Program

For 1991 preliminary investigations of the deeper (>30 m) waters of coastal Taiwan will begin through a cooperative program utilizing ROV's to address two major themes of coral reef ecology and comparative submarine canyon ecology. The majority of the funding for ship time and equipment shipping will be covered by the Taiwan National University, with NURC-UCAP's share being travel costs for four (4) people.



David Stein
8/91

Table 1: Proposals received by system requested and region.

System:	Region:	Number of Proposals Received
Deep Submersible		
	Region I	4
	Region II	6
	Region III	0
Shallow Submersible		
	Region I	4
	Region II	2
Remote Operated Vehicles		
	Region I	1*
	Region II	1*
	Region III	12
NITROX/Scuba support		
	Region I	5*
	Region III	1
Ocean Services		
		1
Grassle et al.		
		1
TOTAL		33

* - These proposals also requested submersible time which is indicated above.

Table 2: Reviewed research proposals recommended for support on 1991 listed by system requested and region of operation. The number of days and science support granted is also listed for each proposal.

PRINCIPAL INVESTIGATORS	PROPOSAL TITLE	Number of Days Granted	Science Support Granted
<u>Deep Submersible</u>			
<u>Region I</u>			
Wishner/Winn	Zooplankton and ecosystem studies of the Great South Channel and Endangered Baleen Whale Habitat	5	\$ 0
Witman	Benthic-pelagic coupling on cashes ledge: episodic fluxes of particulate food and larvae	6	\$ 30,980
Witman/Sebens	Long term dynamics of epifaunal invertebrate communities inn deep rocky subtidal habitats of the Gulf of Maine: A regional perspective	2	\$ 9,230
<u>Region II</u>			
Cooper et al	Assessment of impact of sewage sludge dumping (106 mile dump site) on ocean floor habitats and megabenthic fauna	13	\$ 92,826
Hinga	Organic matter remineralization by the upper continental slope benthos	7	\$ 1,665
Whitlatch	In-situ studies on animal-sediment relationships: the roles of biological and physical disturbance on the southern New England upper continental slope.	7	\$ 34,926
<u>Region III</u>			
Nealson/Klump	Biogeochemical benthic process research in a deep Ancient Rift Valley Lake, Lake Baikal: The Biogeochemistry of Manganese in Lake Baikal, USSR	6	\$ 36,878
<u>Shallow Submersible</u>			
<u>Region I</u>			
Cooper	The expansion of the High School Aquanaut Program	7	\$ 33,003
Langton	Determination of habitat range of the Atlantic wolfish, anarichus lupus, using acoustic tagging methods	5	\$ 1,550
Schick	Seasonal distribution of juvenile shrimp and juvenile groundfish relative to bottom type along a depth gradient in the Gulf of Maine	3	\$ 0

Region II

Auster	Faunal-substrate relationships across the Southern New England Continental Shelf	6	\$ 18,707
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Remotely Operated VehiclesRegion I

Cooper	The Expansion of the High School Aquanaut Program	20	\$ *
Lough	Distribution and resurgence of herring spawning grounds on Georges Bank	8	\$ 0

Region II

Auster	Faunal-substrate relationships across the Southern New England Continental Shelf	5	\$ *
Horne	Sampling late quaternary marine strata exposed along the lower slope of the Northeastern Shelf of Long Island Sound	6	\$ 0

Region III

Belknap	Submersible and ROV investigation of submerged coastal terraces off Northern Israel Evidence of sea-level variations in the Eastern Mediterranean	5	\$ 3,500
Berman	Physical and biological processes at the sediment-water interface during strong thermal stratification in Lake Kinneret	6	\$ 0
Galil	Daily cycle of activity of epibenthic fauna in the Achziv Canyon Head, Mediterranean coast of Israel	4	\$ 0

NitroxRegion I

Cahoon	Benthic productivity at Stellwagen Bank: benthic microalgae and demersal	8	\$ 9,987
Steneck	Changes in coastal food webs and benthic community structure in the Gulf of Maine due to fisheries-induced declines in large predatory fishes	8	\$ 15,980
Witman	Benthic-pelagic coupling on cashes ledge; episodic fluxes of particulate food and larvae	8	\$ 30,980
Witman/Sebens	Long term dynamics of epifaunal invertebrate communities in deep rocky subtidal habitats of the Gulf of Maine: A regional perspective	7	\$ 9,230



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NOAA's NATIONAL UNDERSEA RESEARCH PROGRAM
AT THE UNIVERSITY OF NORTH CAROLINA (WILMINGTON)

1991

The NOAA Research Center at the University of North Carolina at Wilmington (NURC/UNCW) was established to promote, facilitate, and conduct research in the southeastern United States utilizing undersea techniques, including advanced wet diving and both manned and unmanned submersibles. The program is designed to cover a large geographic area including the continental shelf off the coast of the southeastern United States, the southwestern Atlantic ocean and the Gulf of Mexico using mobile platforms to place the scientist in the sea. It provides an array of in-house and leased capabilities to meet the varied scientific needs.

NURC/UNCW retains a dive staff and owns equipment to support a NITROX, wet-diving capability through the use of a portable modular diving system which can be placed upon vessels of opportunity. In addition, NURC/UNCW operates a remotely operated vehicle and will continue to develop the in-house technical expertise in remotely operated vehicles (ROV). Future plans include operation of the AQUARIUS research habitat in the Florida Keys. A major initiative in 1991 will be the repair and refurbishment of the AQUARIUS habitat system which was recovered from St. Croix, USVI. In preparation for a future deployment in the Florida Keys, there will be science and technology studies to define research and engineering needs associated with the relocation of the habitat program.

RESEARCH

In 1991, NURC/UNCW emphasizes oceanographic research and diving safety and physiology research, marine education and training, and ocean technology. Activities are divided into three types of projects:

Core Projects are the submitted proposals which are the heart of the Center's activities in Oceanographic Research, Ocean Technology and Diving Safety and Physiology. Most other Center activities are devoted to accomplishing and strengthening core research. Core Projects are subjected to an external (mail and science panel) and internal (NURC and OUR) review process.

Development Projects are activities designed to enhance and develop better core research programs. Direct and active contact with the scientific community is not commonly attempted by other funding agencies, except by a passive process of mailings and research announcements. NURC/UNCW maintains a passive process, but also attempts to more actively generate interest and increase awareness.



of Center activities. This is done primarily through meetings, workshops and field demonstrations.

Collaborative Projects are co-funded collaborations with other NOAA programs, wherein UNCW usually provide the undersea science expertise and equipment, primarily the ROV and enriched air NITROX systems. In cases of collaboration with other NURP Centers, the projects are core projects (i.e., undergo full peer review) at other Centers. Collaborative projects are planned with CMRC and NURC-UCAP.

For 1991 scientific activities, NURC/UNCW encouraged: interdisciplinary oceanographic research projects studying continental margin processes, particularly the interactions and linkages between estuarine, continental shelf, and slope (including submarine canyon) environments; and secondly, diving safety and physiology projects designed to improve the safety and effectiveness of NURP's diving activities.

OCEANOGRAPHIC RESEARCH

More specific topics related to regional oceanographic research needs include the following:

Living Resources: recruitment and early life history studies, relationship between habitat and productivity (e.g., habitat enhancement), primary production and its control by nutrient input, and coupling of lower and higher trophic level productivity (e.g., determination of sources of primary production, predator-prey interactions).

Non-Living Resources: extent and nature of valuable marine mineral and petroleum reserves (e.g., phosphate, oil, and gas), consequences of exploration and exploitation of resources.

Pathways and Fate of Materials: effects of anthropogenic materials on marine ecosystem (e.g., nitrogen/phosphorus loading, dredge spoils, dumped materials), processes involved in transport of materials.

Coastal Oceanic Processes: fluxes of sediments and nutrients between estuarine, shelf and slope environments, effects of hydrographic conditions (e.g., Gulf Stream frontal events) on continental margin ecosystems, effects of physical disturbance (e.g., fishing gear) on marine ecosystems.

Global Change Processes: atmosphere-hydrosphere exchanges of critical elements (e.g., carbon, nitrogen, phosphate, sulfur), biogeochemical cycling and fates of critical elements in ocean water and sediments, role of cold seeps (e.g., hydrocarbons, groundwater) in determining composition of ocean water, sediments, and biotic communities.

DIVING SAFETY AND PHYSIOLOGY

Development of new gear and procedures (e.g., decompression diving) to enhance the safety and effectiveness of NURP diving activities. These include core and development projects that include the Nitrox Diving Research program that consists of laboratory and field tests that seek to identify the potential health risks associated with compressed ambient air and enriched air diving. Medical screening efforts ensure divers working with the Center do not expose themselves to unnecessary risks.

MARINE EDUCATION AND TRAINING

Marine Education and Training programs consist of activities that educate and train the public and science community and are valuable public awareness and service functions of the Center.

OCEAN TECHNOLOGY

Ocean Technology also includes core and development projects designed to enhance existing technology, primarily undersea sampling systems and tools, as well as promoting development of new and innovative technology. The goal is to increase the scientific effectiveness and productivity of the Center.

EXPANSION OF KEYS SCIENCE PROGRAM AND THE AQUARIUS UNDERWATER LABORATORY

With the acquisition of the AQUARIUS habitat system, NURC-UNCW is developing a comprehensive program in the Keys that addresses the following elements: (1) development of a science program including identification of science needs and coordination with current research programs; (2) an environmental study of potential AQUARIUS deployment sites; (3) initiation of the licensing and permitting clearances associated with the deployment and operations; (4) an assessment and evaluation of the engineering requirements associated with remote offshore operations in the Florida Keys; (5) a cost analysis of conducting a science program. A development project will be initiated to establish an integrated multidisciplinary effort in the Keys. This will include a NITROX and ROV cruise to introduce scientists to habitat deployment sites, characterize the benthic environment and initiate efforts to establish long-term ecological research in the region.



A. N. Kalvaitis
Program Monitor
8/91

Table 7. List of all 1991 proposed projects by project numbers, PIs, Project Totals (taken from the Project Summaries, see section 5.0 below) and co-funding. Project numbers UNCW9101 and UNCW9102 are the Science/Operations and Administration Budgets, described fully in sections 2.0 and 3.0, respectively, of this proposal.

PROJECT NUMBER	PI LAST NAME AFFILIATION	PROJECT TITLE	NURC COST	CO-FUNDING ¹
<u>OPERATIONS AND ADMINISTRATION</u>				
UNCW9101	Hulbert (National Undersea Res.)	Scientific and operational support for undersea research off the Southeast U.S.	\$2,627,375	\$ 0
UNCW9102	Hulbert (National Undersea Res.)	Administrative support for undersea research off the Southeast U.S.	\$ 911,667	\$ 0
<u>OCEANOGRAPHIC RESEARCH: SOUTH ATLANTIC BIGHT</u>				
UNCW9103	Ambrose (East Carolina University)	Structure of soft bottom communities associated with hard-substrate habitats in the South Atlantic.	\$ 17,158	\$ 0
UNCW9104	Blake (University of S. Florida)	The relationship of upwelling to the success of calico scallop stocks.	\$ 11,149	\$ 67,217 NOAA - NMFS
UNCW9105	Gilmore (Harbor Branch Oceanographic Institute)	Remotely operated vehicle observations of reproduction and ecology of the sand tiger shark, <u>Odontaspis taurus</u> (Rafinesque).	\$ 2,845	\$ 0
UNCW9106	Hulbert (National Undersea Res.)	Continental Margin Dynamics Program: Multidisciplinary undersea research on the mid-shelf region of Onslow Bay, North Carolina.	\$ 27,558	\$ 0
UNCW9107	Hulbert (National Undersea Res.)	Continental Margin Dynamics Program: Interdisciplinary undersea research near the Manteo Oil and Gas Lease Blocks, off Cape Hatteras, North Carolina.	\$ 15,567	\$ 0
UNCW9108	Laws (University of NC-Wilmington)	Composition, distribution and productivity of microphytobenthos on the continental shelf of southeastern North Carolina.	\$ 4,212	\$ 0
UNCW9109	Levin (NC State University)	Spatial heterogeneity of biogeochemical processes in continental slope sediments.	\$ 51,073	\$ 0

¹ Not yet certified by granting agency, amount shown is awarded co-funding reported by PIs for 1991 (one year totals), does not include submitted and pending grants.

Table 7 (cont.)

PROJECT NUMBER	PI LAST NAME-AFFILIATION	PROJECT TITLE	NURC COST	CO-FUNDING
<u>OCEANOGRAPHY RESEARCH: SOUTH ATLANTIC BIGHT</u>				
UNCW9110	Riggs (East Carolina University)	Evolution of hardbottom morphotypes: Onslow Bay, North Carolina continental shelf.	\$ 30,261	\$ 0
UNCW9111	Stancyk (University of S. Carolina)	Population biology and secondary production of the brittlestar <i>Ophiura sarsii</i> on the continental slope of North Carolina.	\$ 8,912	\$ 0
UNCW9112	Sulak (Atlantic Reference Center)	Characterization and quantification of near-bottom, deep-water fish faunas in relation to complex submarine topography.	\$ 3,656	\$ 0
UNCW9113	Tisue (Clemson University)	Chemical and physical dynamics of the sediment-water interface: Nutrient fluxes, chemical speciation, mixing and resuspension.	\$ 2,150	\$ 0
UNCW9114	Youngbluth (Harbor Branch Oceanographic Institute)	Mid-water appendicularians: Production, consumption and transformation of particles.	\$ 9,708	\$116,000
UNCW9115	Youngbluth (Harbor Branch Oceanographic Institute)	Metabolic rates and food habits of lobate ctenophores, hyperiid amphipods and myctophid fishes from deep-water pelagic environments at Cape Hatteras, North Carolina.	\$ 9,174	\$116,000
<u>OCEANOGRAPHIC RESEARCH: GULF OF MEXICO AND FLORIDA KEYS</u>				
UNCW9116	Brooks (Texas A&M University)	Gulf of Mexico hydrocarbon seep studies.	\$ 7,094	\$ 49,769 NOAA-TAMU Sea Grant \$129,640 Office of Naval Research \$ 20,000 NOAA-Louisiana Sea Grant
UNCW9117	Rabalais (Louisiana University Marine Consortium)	The use of remote and electronic surveillance to evaluate the impact of bycatch on fisheries resources.	\$ 23,005	\$ 66,667 Louisiana Board of Regents

Table 7 (cont.)

PROJECT NUMBER	PI LAST NAME, AFFILIATION	PROJECT TITLE	NURC COST	CO-FUNDING, ¹
<u>OCEANOGRAPHIC RESEARCH: FLORIDA KEYS</u>				
UNCW9118	Roberts (Louisiana State University)	Continued geological and biogeochemical investigations of bathymetrically stratified cold seep-related carbonate structures of the Northern Gulf of Mexico Continental Slope.	\$ 3,968	\$ 35,000 Sea Grant \$ 25,668 Center for Energy Studies
UNCW9119	Schroeder (University of Alabama)	Continental Shelf hardbottom environments.	\$ 3,307	\$ 76,986 MS-AL Sea Grant
UNCW9120	Hulbert (National Undersea Res.) Patterson (University of CA - Davis) Sebens (Northeastern University)	Florida Keys development program.	\$201,514	\$ 0 \$ 6000 University of CA-Davis \$ 44,000 National Science Foundation
<u>MARINE EDUCATION</u>				
UNCW9121	Ward (University of NC-Wilmington)	Summer ventures, 1991.	\$ 450	\$ 0
<u>OCEAN TECHNOLOGY</u>				
UNCW9122	Kier (University of NC-Chapel Hill)	The effect on limpet attachment forces of increase in ambient pressure due to depth.	\$ 1,342	\$ 25,000 National Science Foundation
UNCW9123	Shepard (National Undersea Res.)	Computer analysis for quantification of photographic and video imagery.	\$ 17,802	\$ 0
UNCW9124	Heinmiller (Orca Industries, Inc.)	Enriched air NITROX dive computers: Continued development of computers for different gas mixes and enhanced data-logger capabilities.	\$ 17,275	\$ 0
<u>DIVING SAFETY AND PHYSIOLOGY</u>				
UNCW9125	Vann (Duke University Medical Center)	Surface Interval Oxygen to improve NITROX diving efficiency.	\$ 58,413	\$ 0
UNCW9126	Moon (Duke University Medical Center)	Significance of Patent Foramen Ovale in the pathogenesis of decompression sickness.	\$ 52,365	\$ 0
TOTALS:			\$4,119,000	\$771,947



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
OFFICE OF OCEANIC RESEARCH PROGRAMS
1335 East-West Highway, Silver Spring, MD 20910

NOAA's NATIONAL UNDERSEA RESEARCH PROGRAM

AT THE CARIBBEAN MARINE RESEARCH CENTER

1991

BRIEF DESCRIPTION OF THE PROGRAM

Research at CMRC is organized into two categories: core program and extramural program. The core program includes seven projects plus administrative costs and program development support.

These projects include developing techniques for raising Tilapia, a fresh and brackish water fish, in salt water, making the species suitable for aquaculture on Caribbean islands. This will provide a relatively inexpensive additional source of protein for inhabitants and a potential source of income through export.

Conch are one of the most important commercial species in the Caribbean; their population dynamics and biology are poorly understood. Conch studies will be made to improve management and culture of the species.

Overfishing of spiny lobster is a critical problem in Caribbean fisheries. Research is underway to improve juvenile survival and increase management success.

Nassau grouper have been severely overfished in the Caribbean and Bahamas, yet little is known of their early life history, making management of the fishery difficult. Recruitment assessment, better knowledge of reproduction, and patterns and determinants of juvenile distributions are needed to improve management.

Coral bleaching is a significant problem in tropical regions, leading to deterioration of coral reefs. Its causes are unknown. Support is requested to develop methods for determining the health of corals and quantifying their extent, and correlating temperature and other environmental data with the occurrence of coral bleaching.

Temperature data has been collected since 1989 for use in projects requiring environmental data, such as the coral bleaching project described above. This continues support for data collection.

The eastern Bahamas are formed of carbonate rocks. The processes underlying formation, distribution, and causes of such carbonates are poorly known. Results of studies of these topics will be applicable throughout the region.



Program development monies are for discretionary funding of small projects by the center director. These projects consist of ideas that need to be explored, studies requiring preliminary data in order to develop a full proposal, etc.

Administrative costs are incurred in operating the CMRC. They include salaries and wages of center personnel, office equipment and supplies, travel between the Bahamas and the United States as well as within the U.S., costs of maintaining laboratory facilities, etc.

EXECUTIVE SUMMARY

Undersea research activities in the Caribbean will be supported by National Undersea Research Program / Caribbean Marine Research Center (CMRC) through five research projects proposed for funding in three NOAA research areas.

Recruitment of Marine Organisms

Most commercially important species in the Caribbean such as reef fish (snapper and grouper), conch, and spiny lobster have a protracted pelagic larval phase suggesting that individuals spawned in one area may recruit and enter the fishery at another location. This can make management of fishery stocks a multi-national problem. Organisms may, by proper timing of spawning and use of ocean-currents, remain within a region. In 1991 and 1992 we will attempt to test this hypothesis through a multiple-investigator coordinated sampling program of the three main components that may affect the development of a population of organisms. One is the spatial and temporal distribution of the pelagic larval phase (Cowen), 2) the origin and distribution of newly recruited individuals (Sale), and 3) spawning pattern and population dynamics of the adult population (Warner). By concurrently tracking all three aspects for a given species at a given location, we should be able to determine what proportion of local reproductive activity contributes to maintenance of local populations and what proportion is lost to other locations. This information should not only improve fishery management, but also the understanding of the linkage between the physical environment and ocean productivity.

Productivity and Material Flux

The Caribbean Deep-sea Studies Project (CARDS) will follow up on studies started in 1989 off St. Croix. This multi-disciplinary program will examine the interactions within the benthic-boundary layer resulting in benthic/pelagic coupling at a depth of 900 m. The benthic-boundary layer is a near bottom water mass that is usually richer in food resources than overlaying waters. This

layer may be particularly important for productivity in tropical oligotrophic waters. By sampling the benthic boundary layer and the bottom, researchers will measure the flux of organic material from the pelagic to the benthic system and identify the cause of enhanced productivity in this zone.

Global Climate Change and Ocean Lithosphere

In the Caribbean, as in much of the rest of the world, population growth has placed an ever-increasing burden on the fragile coral reef habitat. In addition, abnormal environmental conditions are suspected in recent region-wide coral-bleaching events, a major impact on tropical shallow-water systems. Without reliable baseline data it is impossible to determine if present day conditions are unusual or part of a long-term cycle. In 1991 we are continuing the Caribbean Coring Program through the deployment of the SCARID coral drilling rig developed by the NOAA NURP program (Gill and Hubbard). This highly modified coring equipment should extend our sampling capability far beyond those that presently exist. Based on the chronological record in coral growth bands we will attempt to hindcast environmental conditions over the last 100-300 yr at several Caribbean sites. Coral core analysis should provide the data necessary to test present day conditions against historical environmental data.

For the period 1 April 1991 to 31 January 1992 the Caribbean Marine Research Center under the auspices of the Perry Foundation requests a supplement to NOAA Grant No. NA88AA-D-UR024 to support these scientific programs.



David Stein
Program Monitor
8/91

PROJECTS RECOMMENDED FOR FUNDING

Tilapia aquaculture (\$225,000)

Principal Investigator: W. Watanabe, CMRC

Queen conch ecology and life history (\$225,000)

Principal Investigator: A. Stoner, CMRC

Spiny lobster survival and recruitment (\$140,000)

Principal Investigator: R. Lipcius, VIMS

Fisheries oceanography of Nassau grouper (\$196,000)

Principal Investigator: J. Shenker, Florida Inst. of Technol.

Caribbean coral bleaching (\$25,000)

Principal Investigator: J. Lang, U. of Texas

Caribbean temperature survey (\$15,000)

Principal Investigator: R. Wicklund, CMRC

Geology of Bahama islands (\$20,000)

Principal Investigator: R. Dill, U. of So. Carolina

Program development (\$43,000)

Principal Investigator: R. Wicklund, CMRC

Administration (\$700,000)

Principal Investigator: R. Wicklund, CMRC



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NOAA'S NATIONAL UNDERSEA RESEARCH PROGRAM

AT THE UNIVERSITY OF ALASKA FAIRBANKS

1991

The West Coast National Undersea Research Center at the University of Alaska Fairbanks was established in 1990 with a grant from the National Oceanic and Atmospheric Administration's (NOAA) Office of Undersea Research (OUR), which administers the National Undersea Research Program (NURP). Prior to 1990, undersea research projects on the West Coast were reviewed and supported directly through OUR. The need for a West Coast Center was clearly established by these earlier projects, and the establishment of a Center represents progress in providing services to marine scientists working on the West Coast and in Antarctica, which is also part of the region served by the Center.

In 1990, nine projects were approved for support, four in Alaska, two in Oregon, and three in California. Because of submersible scheduling problems, three of the projects were postponed to 1991 (2 in Alaska, 1 in California). Two of the California projects were handled by the national office (OUR) because they involved use of a Navy submersible. This was the first effort at developing a working relationship with the Navy and was best handled by OUR. Summaries of the projects administered by the new Center (1 Alaska, 2 Oregon) are included in the section on 1990 accomplishments.

A major submersible program is proposed for 1991, composed of new projects and projects postponed from 1990. Most of the projects are fisheries related and require a shallow-diving (330 m) submersible that will be chartered for a total of 148 days. One project, in Monterey Bay, CA, will require use of a Navy submersible that can operate at depths up to about 3000 m. Two projects will utilize an ROV. Funds allocated in 1990 for the postponed projects will be utilized for those projects in 1991. The budget request for 1991 operations is \$950,000.



1991 PROPOSED PROGRAM

WEST COAST RESEARCH PROGRAM

All of the research projects planned for 1991 fall under the NOAA research category Biological Productivity and Habitat Characteristics (Table 2.1). Traditionally, NURP has supported fisheries projects on the West Coast, and this is particularly true for 1991. Two projects also have major elements that fall under other NOAA research categories. Stevens' project at a fish waste disposal site also fits in the category Pathways and Fate of Materials in the Ocean and, to a lesser extent, Coastal Ocean Processes. The project by Taghon et al., in addition to the biological work, will make important contributions to Ocean Lithosphere and Mineral Resources and to Pathways and Fate of Materials in the Ocean research.

Science support, proposed matching, and co-funding for each project, exclusive of system cost, is given in Table 2.2.

PROPOSAL SUMMARIES

Project # CA91-1

Title: Development of Habitat Specific Stock Assessment
Methodology for West Coast Groundfish

Research Category: Biological Productivity and Living Resources

Principal Investigator: John L. Butler

Summary: This is a proposal to develop innovative stock assessment methodology to improve population estimates of important fishery resources in the U.S. Exclusive Economic Zone (EEZ). We will use an ROV or submersible equipped with both survey and video cameras and sidescan sonar to sample areas unavailable to traditional methods. Line transect estimates from the survey vehicle will be compared to traditional trawl estimates on trawlable substrate. Density estimates obtained from samples stratified by depth and bottom roughness will be used to make population estimates using stratum areas quantified by Seabeam. Integrating habitat specific estimates of fisheries resources with Seabeam data will provide a new application for existing NOAA Seabeam data as well as previously unattainable precision in fishery assessment. Survey data will provide in-situ evidence of habitat use by fishery resources. The analysis of trawl tracks will document the effect of man's activities (trawling) on this habitat.

Budget:

Salary (technician - 12 mos)	\$24,500
TOTAL	\$24,500

Project # AK91-1

Title: Use of a Remotely Operated Vehicle to Study Feeding Behavior and Prey Distribution of Humpback Whales, Megaptera novaeangliae

Research Category: Biological Productivity and Habitat Characteristics

Principal Investigator: Francis Fay

Summary: The use of remotely operated vehicles to study the feeding behavior of humpback whales Megaptera novaeangliae in southeastern Alaska will be evaluated. Associated prey densities and prey type will be determined using the ROV, video and still photographic systems, and conventional surface-based sampling gear. The proposed research will seek to understand how humpback whales are linked to oceanographic processes, in terms of their foraging ecology and the dynamics of the predator-prey relationship.

Budget:

Salary (graduate student)	\$4,036
Travel (domestic)	3,000
Contractual	10,775
Supplies	<u>1,000</u>

TOTAL 18,811

Project # OR91-1

Title: Inshore-Offshore Comparisons of Reef-Fish Associations Using Integrated Submersible and Acoustic Surveys

Research Category: Biological Productivity and Habitat Characteristics

Principal Investigators: Mark Hixon and Richard Starr

Summary: Since 1987, scientists from Oregon State University and the Oregon Department of Fish and Wildlife have sampled the three major deepwater rocky reefs off Oregon (Heceta, Coquille, and Daisy Banks), using submersibles to run replicated visual belt transects at fixed stations. Having completed our work on the outer continental shelf, we now propose to expand our studies to include the last unexplored major reef off Oregon: the relatively inshore and shallow Stonewall Bank, located 15nmi west of Newport and ranging in depth from 41m (135 ft) to over 70m (230 ft). We have three objectives: First, using the same transect methods as previous years, we will describe (for the first time) the assemblages of demersal fishes and macrobenthos occupying different subhabitats on Stonewall Bank and correlate these with different

bottom types. These data will allow unprecedented direct comparisons with the deeper offshore banks we sampled previously. Second, we will (for the first time) run paired day-night submersible transects to document diel cycles in fish distribution and behavior, and compare our results with previous day-night studies off California. Third, we will develop a means of using scientific echosounders to estimate the abundances of fishes schooling in midwater by ground-truthing from the submersible as it descends and ascends through schools. Given that our visual transects enumerate only demersal fishes, the acoustic method will allow complementary estimates of fish abundances in the water column above reefs.

Budget:

Salary (technician - 1 mo)	\$2,100
Travel (domestic)	600
Supplies	100
Contractual	<u>11,000</u>

TOTAL 13,800

Project # AK91-2

Title: Distribution of Pacific Ocean Perch, Sebastes alutus, in the Gulf of Alaska

Research Category: Biological Productivity and Habitat Characteristics

Principal Investigator: Kenneth J. Krieger

Summary: The Auke Bay Laboratory is responsible for monitoring commercial stocks of rockfish, consisting mainly of Pacific Ocean perch (POP), Sebastes alutus in the southeastern Gulf of Alaska. Stock assessments, based primarily on samples from bottom trawl surveys, are questionable because the catch efficiency of bottom trawls on POP is unknown, rugged substrate is not sampled, and POP catch rates are highly variable. A manned submersible will be used to improve POP biomass estimates by visually quantifying POP for comparison with bottom trawl catch rates, comparing their abundance in trawlable and untrawlable areas, and describing their spatial distributions.

Budget:

No science support

0

Project # AK91-3

Title: Recruitment of Juvenile Flatfish

Research Category: Biological Productivity and Habitat
Characteristics

Principal Investigator: Brenda L. Norcross

Summary: Nursery areas of juvenile flatfish are commonly found in shallow areas having fine-grained sediments. It is hypothesized that flatfish nursery grounds in Alaska will be on fine-grained sediments, but in deeper water, that are typically found in the Gulf of Alaska. In 1991, samples of fish and sediment will be made on the south and east sides of Kodiak to test this hypothesis. That research is being funded by NOAA's Saltonstall-Kennedy commercial fisheries research program. This proposal requests the use of an ROV for 2 weeks and 1 week of ship time to supplement the Saltonstall-Kennedy research. The ROV will provide a broader scale survey of sediment type than is possible from the bottom grabs planned under the Saltonstall-Kennedy funding. Additionally, the ROV will allow bottom type to be examined before deployment of the trawl net. This will save time and gear by sampling only appropriate bottom types. It is also hoped that flatfish will be able to be seen with the ROV so that assessment of nursery areas can be made visually, in addition to trawl samples.

Budget:

Salary (graduate student)	\$6,500
Travel (domestic)	800
Services	<u>5,800</u>
TOTAL	13,100

Project # AK91-4

Title: Definition of the Relationship Between Demersal Shelf Rockfish Abundance and Habitat Complexity Based on In-Situ Observation from a Submersible in the Eastern Gulf of Alaska

Research Category: Biological Productivity and Habitat
Characteristics

Principal Investigators: V.M. O'Connell and D. W. Carlile

Summary: Demersal shelf rockfish is one of only two groups of fishes for which the North Pacific Fishery Management Council does not have estimates of biomass needed to manage the species. We propose to continue using a manned submersible to quantify the relationship between rockfish abundance and habitat complexity by

estimating rockfish population density in association with habitat characteristics. The quantified habitat/abundance relationship will be used, along with habitat inventories, to yield population estimates needed to manage demersal shelf rockfish.

Budget:

No science support

0

Project # AK91-5

Title: Characteristics of Mating Tanner Crabs, Chionoecetes bairdi Captured In-Situ

Research Category: Biological Productivity and Habitat Characteristics

Principal Investigator: Bradley G. Stevens

Summary: Management of the Tanner crab, C. bairdi fisheries depends on the use of minimum legal sizes that are based on the median size at morphometric maturity in each stock. Managers assume that all crabs above this median size are capable of fully fertilizing female crabs in nature, and that all crabs below this size are immature but will eventually grow to legal size. Recent publications suggest that these assumptions are false, i.e., that maturity can occur over a wide range of sizes including sublegals, that no growth occurs after maturity, and that many legal crab are in fact not functionally mature.

Objectives of the proposed project would be to capture mating Tanner crabs, C. bairdi, in-situ, and determine the characteristics (size, shell condition, molt status, chela morphometry) that define them. Results will not be used to suggest alterations to current management strategies which would improve the conservation and management of this species.

Budget:

Travel (domestic)
Equipment

\$1,528
932

TOTAL 2,460

Project # AK91-6

Title: Effects of Kodiak Fish Waste Disposal Site on Benthic Habitat and Associated Water Quality

Research Category: Pathways and Fate of Materials in the Ocean, Coastal Oceanic Processes, Biological Productivity and Habitat Characteristics

Principal Investigator: Bradley G. Stevens

Summary: Kodiak canneries dump over 180t/day, or over 1.4 million gals/month of seafood processing waste into Chiniak Bay, at a site that has been used heavily for over a decade. Despite concerns expressed by EPA, NMFS, and the Alaska DEC, there has been no research to date on the effects of this waste dumping on the quality of receiving waters or the marine ecosystem. We propose to examine the dumpsite and determine if the quality of water or benthic habitat has been degraded, the fate of dumped material, and effects of dumping on epibenthic biota. This information is necessary for EPA and ADEC to estimate the effects of past use of this disposal site, and continued or future use of existing and proposed disposal sites, the outcome of which will have immediate economic impacts on the communities of coastal Alaska.

Budget:

Supplies		<u>1,000</u>
	TOTAL	1,000

Project # OR91-2

Title: Biology, Geology and Geochemistry of Active Methane Vents on the Oregon Continental Shelf

Research Category: Biological Productivity and Habitat Characteristics

Principal Investigators: Gary Taghon, Robert Collier, Marvin Lilley, David Stein, Lavern Kulm, William Percy, Richard Starr

Summary: Study Plans for 1991 and 1992

During the next 2 years, our goals are (1) to assess the temporal variation in venting-related processes at the Greenie Spot and (2) to gain a regional perspective of the importance of active pockmarks on the continental shelf of southern Oregon and Northern California.

Temporal variability in venting

We have now visited our primary site (43°01.90N, 124°39.90W) twice. Our subjective impression was that the pockmark was less active in 1990 than in 1989 in terms of ebullition rate and abundances of organisms in the vicinity. Unfortunately, we have no quantitative data from 1989. There is little information on temporal variability of pockmark-related fluid venting, yet such information is crucial toward understanding the impact of pockmarks on continental shelf processes. Therefore, we plan to return to the Greenie spot for the next 2 years and repeat our sampling protocol (as detailed in our main proposal).

Regional perspective

Complementing our goal of documenting temporal variation in methane venting, we plan to visit other active vents for comparison

with the Greenie Spot. This will help us to develop a model for the impact of methane venting on regional geochemical, microbiological, and macrobiological processes. We have two targets. One is on Heceta Bank and was discovered after the 1990 pockmark cruise by investigators participating in a submarine study of Heceta Bank fishes (Hixon, Stein, Percy). The second is in shallow water (50 m) directly off Eureka, California, and has been studied in preliminary fashion by investigators at Humboldt State University's Department of Oceanography. We are working with Dr. Jerry Borgeld at Humboldt State to coordinate our work at this site.

Sediment and porewater chemistry

We will focus considerable effort on studying the anomalous fluids in the vent sediments. We will have to collect deeper samples that will require submersible-assisted gravity cores as well as submersible-deployed box cores. We will include more isotopic analyses to understand the origin of the gases and low salinity fluids in the sediments.

Bacterial mats

Many more samples of the mats must be collected for isotopic and metabolic studies. We will modify samplers, based on our experiences in 1990, to allow collection and separation of the two main morphologies of bacterial mats. A combination of filtration, box coring, and dredge/grab sampling will be used.

Gases

Gas samples will be collected to evaluate temporal changes at the Greenie Spot and spatial variation at the three target sites for the 1991 program. The latter measurements will help to understand what constraints the bulk gas flows may place on the local biological processes.

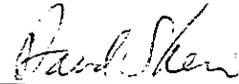
Macrobiology

A major but unfilled goal of the biology program is sampling of the benthic infaunal community. Because of the sedentary life style of many benthic organisms, we would expect that they would be most responsive to any "unusual" geochemical features of the environment near pockmarks. Unfortunately, equipment failure prevented us from obtaining samples. We plan on modifying the submersible-deployed box corer in order to more reliably take samples in sandy sediments. In the event these sediments cannot be sampled by this box corer, we will also use a surface ship-deployed grab sampler.

Submersible transects for evaluating the abundance and distribution of nekton, as performed during 1990, will be conducted at all three sites. Trawling will not be possible at the Heceta Bank vent because of the rocky substrate there, but we will trawl at the Greenie Spot and the vent off Eureka.

Budget:

Salary (technician - 3 mos)	\$11,009
Travel (domestic)	2,500
Equipment	<u>4,000</u>
TOTAL	17,509



David Stein
Program Monitor
8/91

Table 2.1. Research proposals for West Coast NURC support in 1991.

Principal Investigators	Project Title	System	Dates	No. Days
<u>ALASKA</u>				
Fay, F. H.	Use of a remotely operated vehicle to study feeding behavior and prey distribution of humpback whales (<i>Megaptera novaeangliae</i>)	ROV	June	5
Krieger, K. J.	Distribution of Pacific Ocean perch (<i>Sebastes alutus</i>) in the Gulf of Alaska	Sub	June	12
Norcross, B. L.	Recruitment of juvenile flatfish	ROV	Aug.	7
O'Connell, V. M. & D. C. Carlile	Definition of the relationship between demersal shelf rockfish abundance and habitat complexity based on <i>in-situ</i> observations from a submersible in the eastern Gulf of Alaska	Sub	May	8
Stevens, B. G.	Characteristics of mating Tanner crabs, <i>Chionoecetes bairdi</i> , captured <i>in-situ</i>	Sub	April	13
Stevens, B. G.	Effects of Kodiak fish waste disposal site on benthic habitat and associated water quality	Sub	May	5
<u>CALIFORNIA</u>				
Butler, J.	Development of habitat specific stock assessment methodology for West Coast groundfish	Navy Sub	Sept	8
<u>OREGON</u>				
Hixon, M. A. & R. M. Starr	Inshore-offshore comparisons of reef-fish associations using integrated submersible and acoustic surveys	Sub	Sept	10
Taghon, G. L., <i>et al.</i>	Biology, geology, and geochemistry of active methane vents on the Oregon Continental Shelf	Sub	Sept	18

Table 2.2. Science support, matching funds and co-funding for 1991 projects. System costs for submersibles and ROVs are not included.

Principal Investigator	Science Support	Matching	Co-Funding
<u>ALASKA</u>			
Fay, F.	\$18,811.00	\$ 8,426.00	None
Krieger, K. J.	None	A	None
Norcross, B. L.	13,100.00	0.0	\$168,507.00
O'Connell, V. M. & D. C. Carlile	None	40,798.00	None
Stevens, B. L.	2,460.00	37,500.00	48,749.00
Stevens, B. L.	1,000.00	18,737.00	17,977.00
<u>CALIFORNIA</u>			
Butler, J. P.	24,500.00	B	B
<u>OREGON</u>			
Hixon, M. A. & R. M. Starr	13,800.00	27,000.00	435,444.00
Taghon, G. L., <i>et al.</i>	18,509.00	C	C

A Not specified but P.I. salary and travel expenses provided by NMFS.

B Not specified but several salaries and a variety of expenses will be provided by the Southwest Fisheries Center. The submersible will be provided by the Navy. The cost of the submersible time in the commercial market would be at least \$100,000.00. At this time, it is not possible to estimate the considerable contribution from the Monterey Bay Aquarium Research Institute, but it involves the use of a state-of-the-art ROV and support vessel.

C Not specified but several salaries provided by other sources.





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1335 East-West Highway, Silver Spring, MD 20910

NOAA'S NATIONAL UNDERSEA RESEARCH PROGRAM
AT THE UNIVERSITY OF HAWAII

1991

BACKGROUND

In July of 1980, the Hawaii Undersea Research Laboratory (HURL) was established by a cooperative agreement between the National Oceanic and Atmospheric Administration (NOAA) and the University of Hawaii. HURL is one of the five national undersea research centers sponsored by NOAA's National Undersea Research Program. HURL is the only undersea facility in the world whose sole mission is to study deep water marine processes of islands in the Pacific Ocean. Its location in Hawaii provides a unique opportunity to study natural resources, oceanic processes, and man's impact upon the submarine environment of Pacific islands.

The major HURL facilities presently consist of the two-person, one-atmosphere submersible MAKALI'I that is currently on a standby status; the three-person, deep-diving (2,000 m) submersible PISCES V; two Launch, Recovery and Transport vehicles (LRT's); the remotely operated vehicle RCV-150; an acoustically navigated, ship-tethered bottom camera system; and, when needed, leased surface support vessels. A new ship is being outfitted and will be available for use as a submersible support vessel in 1992. The research submersibles are used primarily for projects accepted by a national science review panel that approves and ranks solicited proposals. To date, the MAKALI'I has completed 389 NOAA-approved dives. The PISCES V, which became operational in 1987, has completed 166 dives.

PROGRAM

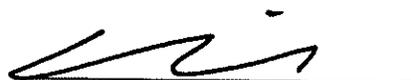
Several major projects will be undertaken in 1991; these include an ocean resources program, the Loihi submarine volcano program, and the modification of a submersible support ship. Specifically, the ocean resources program focuses on ocean lithosphere, mineral resources, and biological resources. The Loihi program consists of in situ studies on the Loihi submarine volcano which represents the southernmost activity of the Hawaiian hot spot. The ship conversion effort represents the redesign and modification of an existing 180-foot seismic vessel into a 220-foot submersible support ship. The ocean resources program focuses on hydrothermal sulfites, manganese crusts, and seamount biological resources. The sulfite part of the program will concentrate on the Northern Marinas and in Loihi Seamount. The Loihi work consists of detailed mapping



chemistry of the vent waters and continuous monitoring through the use of a bottom station. Loihi is becoming a better understood system and may serve as a model for other, analogous submarine and terrestrial deposits. Several missions will concentrate on manganese crust. This work will involve several seamounts and plateau areas in the Hawaiian and, eventually, Johnson Island EEZ's. The NURC-UHI marine minerals program will directly address NOAA's national ocean resource goals and attempt to provide background for decisions about future marine minerals developments based on a thorough understanding of the marine benthic environment and the processes of marine minerals formation and minerals enrichment.

The NURC/Hawaii program on Loihi is focused on the study of the dynamic processes of Loihi. These studies include Loihi hydrothermal vent microbiology, Loihi magma injection/seawater interaction processes, temporal observations of hydrothermal vent pulsations, temperature variations and vent longevity, edifice inflation, and hydrothermal plume generation. The unique location of Loihi has allowed the development of a multi-disciplinary program that utilizes the underwater volcano as a laboratory. A self recording instrument package will be deployed during 1991. Long term plans include the installation of a 34-km fiber optic cable and observatories on the summit. This will allow the real-time monitoring of visual data, temperature, chemistry, and seismicity of the hydrothermal vents.

A major program element continues to be the ship conversion. The ship is being designed according to similar conversions undertaken by the HBOI submersible support vessels, SEWARD JOHNSON and EDWIN LINK. The 1991 program will concentrate on vessel completion. The anticipated ship construction costs are \$3.5 M; this figure doesn't include the original acquisition costs and the work-to-date.



A. N. Kalvaitis
Program Monitor
8/91

HAWAII UNDERSEA RESEARCH LAD
 TABLE OF 1991 MURP PROPOSALS

<u>Project Leader</u>	<u>Proposal Title</u>	<u># of Dives Granted</u>	<u>Salaries & Fringe Benefits</u>	<u>Field Operations</u>	<u>Travel</u>	<u>Equipment</u>	<u>Supplies Publications & Indirect Cost</u>	<u>MURP Total</u>	<u>Co-funding Amount</u>
David M. Karl Professor Dept. of Oceanography University of Hawaii 1000 Pope Road Honolulu, HI 96822	Submersible Support for the Study of Microbial Processes at Loihi Seamount	8	\$16,206	\$44,570	\$1,000	\$52,451	\$46,229	\$160,457	\$20,779
Fred T. Mackenzie Chairman of Marine Geochemistry Dept. of Oceanography University of Hawaii 1000 Pope Road Honolulu, HI 96822	The Fate of Magnesian Calcites Produced on Submerged Platforms: Link to Climate Change	4	\$11,038	\$29,730	\$1,000	\$36,662	\$31,431	\$109,861	\$120,000
James G. Moore U.S. Geological Survey 345 Middlefield Road Menlo Park, CA 94025	Submerged Reefs on the Haleakala Reef Material for Radioelectric Dating	4	\$11,038	\$29,730	\$1,000	\$36,662	\$31,431	\$109,861	
Alexander Malahoff Professor Dept. of Oceanography University of Hawaii 1000 Pope Road, MSB 310 Honolulu, HI 96822	The Geological Setting of Hydrothermal Vents and the Neovolcanic Zone of Loihi Seamount, Hawaii (Photogeology and Ocean Floor Sensors)	6	\$13,622	\$37,150	\$1,000	\$44,557	\$38,831	\$135,160	\$39,989
Alexander Malahoff Professor Dept. of Oceanography University of Hawaii 1000 Pope Road, MSB 310 Honolulu, HI 96822	Continuum of Ferrannganese Pavements on Seamounts of the Hawaiian EEZ	5	\$13,622	\$37,150	\$1,000	\$44,557	\$38,831	\$135,160	\$38,114
James F. Cowen Assistant Researcher Hawaii Institute of Geophysics 1000 Pope Road Honolulu, HI 96822	The Role of Microorganisms & Microbiogenic Detritus in the Growth & Composition of Ferrannganese Crusts at Loihi Seamount	4	\$11,038	\$29,730	\$1,000	\$36,662	\$31,431	\$109,861	\$97,000

<u>Project Leader</u>	<u>Proposal Title</u>	<u>Grants</u>	<u>Salaries & Fringe Benefits</u>	<u>Field Operations</u>	<u>Travel</u>	<u>Equipment</u>	<u>Supplies Publications & Indirect Cost</u>	<u>KURP Total</u>	<u>Co-Funding Amount</u>
Michael Garcia Professor Geology-Geophysics University of Hawaii 2525 Correa Road Honolulu, HI 96822	Origin of Hawaiian Submarine Ridges	4	\$11,038	\$29,730	\$1,000	\$36,662	\$31,431	\$109,861	\$175,000
Michael Garcia Professor Geology-Geophysics Dept. University of Hawaii 2525 Correa Road Honolulu, HI 96822	Temporal & Spatial Variations of Lavas on Loihi Seamount, Hawaii	2	\$11,038	\$29,730	\$1,000	\$36,662	\$31,431	\$109,861	\$175,000

Science Proposals follow in order of their ranking.

PUBLICATIONS

The National Undersea Research Program (NURP) publishes reports generated by its activities in three series, described below.

Research Reports -- NURP sponsors symposia and workshops to disseminate results of past investigations and to possibly guide future research activities. Publication of papers presented at such meetings is intended to provide the marine community with results of program-sponsored activities in a timely fashion. In the majority of instances, participants are reporting on results of NURP-sponsored research so the printing of their papers meets report requirements of grantees to the Office of Undersea Research.

From time to time, NURP will gather together and print as a Research Report reprints of papers from sponsored studies which bring attention to a specific geographic area, issue, or technology. Normally the appropriate staff member with cognizance over the topic will contribute an overview statement which is suited to the situation.

Technical Reports -- The Technical Report series is intended to provide the marine community with results of NURP-sponsored research sooner than is normally possible through professional society journals and in greater detail by presenting all of the relevant data developed in the course of the research. Results reported herein may be preliminary or require further development, refinement, or validation. Accordingly, reports in this series do not carry any endorsement or approbation on the part of NURP, nor can the NURP accept any liability for damage resulting from incomplete or incorrect information.

Program Summary -- On a near annual basis, the NURP office summarizes its activities for the previous year. Reported on are its research missions, technology development, and international activities. Statistics relating to operations and program thrusts are also compiled and reported. The Summary serves to describe to the interested reader the scope and nature of the Office of Undersea Research's activities for the specified period.

NOAA DIVING MANUAL

In addition to the various report series, the NURP also produces the NOAA Diving Manual. Now printed in loose-leaf format, periodic updating of tables, procedures, paragraphs, or even entire chapters of text is made easier. This format also makes possible more timely changes at a much reduced cost.

SYMPOSIUM SERIES FOR UNDERSEA RESEARCH

- Vol. 1, No. 1 The Ecology of Deep and Shallow Coral Reefs. Marjorie Reaka, editor, December 1983. 149 pp. (Only xerox copies are available.)
- Vol. 2, No. 1 Undersea Research and Technology--Scientific Applications and Future Needs--Abstracts Symposium May 22-24, 1984, at Avery Point, Groton, CT, April 1984. 18 pp. (Only xerox copies are available.)
- Vol. 2, No. 2 Scientific Applications of Current Diving Technology on the U.S. Continental Shelf--Results of a Symposium Sponsored by the National Undersea Research Program, University of Connecticut at Avery Point, Groton, Connecticut, May 1984. Richard A. Cooper and Andrew N. Shepard, editors, August 1987. 266 pp.
- Vol. 3, No. 1 The Ecology of Coral Reefs. Marjorie Reaka, editor, September 1985. 208 pp. (Only xerox copies are available.)
- Vol. 4, No. 1 Proceedings of the Eighth Meeting of the United States-Japan Cooperative Program in Natural Resources (UJNR) Panel on Diving Physiology and Technology, Washington, DC, and Honolulu, Hawaii, June 6-17, 1985. 1986. Out of Print.

(The Symposium Series for Undersea Research has been replaced by NURP Research Reports and/or NURP Technical Reports.)

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NURP RESEARCH REPORTS

- RR 88-1: Biogeochemical Cycling and Fluxes Between the Deep Euphotic Zone and Other Oceanic Realms. Catherine R. Agegian, editor, May 1988. 176 pp.
- RR 88-2: Mass Bleaching of Coral Reefs in the Caribbean: A Research Strategy. John Ogden and Robert Wicklund, editors, May 1988. 51 pp.
- RR 88-3: Benthic Productivity and Marine Resources of the Gulf of Maine. Ivar Babb and Michael De Luca, editors, May 1988. 276 pp.
- RR 88-4: Global Venting, Midwater, and Benthic Ecological Processes. Michael De Luca and Ivar Babb, editors, July 1988. 442 pp.
- RR 88-5: Results of a Workshop on Coral Reef Research and Management in the Florida Keys: A Blueprint for Action. James W. Miller, editor, September 1988. 49 pp.
- RR 89-1: Workshop on Enriched Air Nitrox Diving. R. W. Hamilton, Dudley J. Crosson, and Alan W. Hulbert, editors, September 1989. 153 pp.
- RR 89-2: North Carolina Coastal Oceanography Symposium. Robert Y. George and Alan W. Hulbert, editors, December 1989. 573 pp.

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NURP PROGRAM SUMMARY

A Summary of Research Activities, 1985-1986. May 1988. 144 pp.

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NURP TECHNICAL REPORTS

- TR 88-1A: REPEX: Development of Repetitive Excursions, Surfacing Techniques, and Oxygen Procedures for Habitat Diving. R. W. Hamilton, D. J. Kenyon, R. E. Peterson, G. J. Butler, and D. M. Beers, May 1988. (This has a companion report--TR 88-1B.) 161 pp. (This is out of stock and available only through the National Technical Information Service (NTIS), Springfield, VA.)
- TR 88-1B: REPEX Habitat Diving Procedures: Repetitive Vertical Excursions, Oxygen Limits, and Surfacing Techniques. R. W. Hamilton, D. J. Kenyon, and R. E. Peterson, May 1988. (This has a companion report--TR 88-1A.) 125 pp.
- TR 89-2: Guidelines for the Gas-Pressure Management of Decompression Sickness and Gas Embolism Occurring During Nitrox and Air Saturation-Excursion Diving. Russell E. Peterson, May 1989. 23 pp.
- TR 89-3: Bathymetric Comparison of Three Mid-Ocean Ridge Areas With Slow-Spreading Characteristics. Kay L. Miller and Peter A. Rona, November 1989. 41 pp.
- TR 90-1: Chisat I, Extension and Validation of NOAA's REPEX Procedures for Habitat Diving: A Chinese-American Collaboration. R. W. Hamilton and William Schane, October 1990. 95 pp.

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**Government Agencies Participating in
NOAA's National Undersea Research Program
1971 - 1990**

Atomic Energy Administration
Defense Nuclear Agency
Department of Defense
Office of Naval Research

 U.S. Army
 U.S. Army Corps of Engineers
 U.S. Coast Guard
 U.S. Marine Corps
 U.S. Navy

Department of Energy
Department of Interior

 Bureau of Land Management Minerals Management Service
 U.S. Fish and Wildlife Service
 U.S. Geological Survey

Department of Transportation
Environmental Protection Agency
Energy Research and Development Administration
Florida Department of Marine Resources
Hawaii Department of Planning and Economic Development
Maine Department of Natural Resources
Massachusetts Department of Marine Resources
National Aeronautics and Space Administration
National Institute of Standards and Technology
 (formerly National Bureau of Standards)
National Institutes of Health
 National Cancer Institute
 National Heart and Lung Institute

National Institute for Occupational Safety and Health
National Science Foundation
Nuclear Regulatory Administration
Occupational Safety and Health Administration
Oregon Division of Fish and Wildlife
South Carolina Department of Wildlife and Marine Resources
Veterans Administration
Virgin Islands Department of Fish and Game

**Other Institutions Participating in
NOAA's National Undersea Research Program
1971 - 1990**

American Museum of Natural History
Arctic Health Research Center
Battelle Memorial Institute
Battelle Northwest Laboratories
Bishop Museum
California Academy of Sciences
Dauphin Island Sea Laboratory
Flower Garden Ocean Research Center
Harbor Branch Oceanographic Institute
Hawaii Institute of Marine Biology
Institute for Environmental Medicine
International Pacific Halibut Commission
Lamont-Doherty Geological Observatory
Lawrence Livermore National Laboratory
Marine Biomedical Institute
Marine Technology Society
Monterey Bay Aquarium Research Institute
Moss Landing Marine Laboratory
National Academy of Engineering
National Academy of Science
National Aquarium
National Geographic Society
National Research Council
Natural Energy Laboratory
Natural History Museum of Los Angeles County
Naval Medical Research Institute
Perry Foundation
Puerto Rico International Underwater Laboratory
Scripps Institution of Oceanography
Shoals Marine Laboratory
Skidaway Institute of Oceanography
Smithsonian Institution
Tiburon Center for Environmental Studies
Undersea Hyperbaric and Medical Society
Virginia Institute of Marine Science
Virginia Mason Research Center
Woods Hole Oceanographic Institution

Domestic Academic Institutions Participating in
NOAA's National Undersea Research Program
1971 - 1990

Adelphi University
Auburn University
Barnard College
Brigham Young University
Brooklyn College
California State University
Catholic University
Central Michigan University
Clemson University
College of the Virgin Islands

Columbia University
Cornell University
Duke University
Fairleigh Dickinson University
Florida Institute of Technology
Florida State University
Fordham University
Fresno State University
Georgia Institute of Technology
Gaucher College
Harvard University
Humboldt University
Johns Hopkins University
Lamar University
Lehigh University
Loma Linda University
Louisiana State University
Mary Washington College
Marymount Palos Verdes College
MIT

Miami-Dade Junior College
Michigan State University
Old Dominion University
Oregon State University
Purdue University
Rice University
Rutgers University
San Diego State University
San Francisco State University
Sarah Lawrence College

Slippery Rock State University
Southeastern Mass. University
Stanford University
State University of Florida
State University of New York/Buffalo
State University of New York/Stony Brook
Texas A&M
Trenton State University
Trinity College

University of Alabama
University of Alaska
University of California/Berkeley
University of California/Davis
University of California/Los Angeles
University of California/San Diego
University of California/Santa Barbara
University of Chicago
University of Cincinnati
University of Colorado
University of Connecticut
University of Delaware
University of Florida
University of Georgia
University of Guam
University of Hawaii
University of Maine
University of Manchester
University of Maryland
University of Massachusetts

University of Miami
University of Michigan
University of Minnesota
University of New Hampshire

University of North Carolina/Chapel Hill
University of North Carolina/Wilmington
University of Northern Colorado
University of Pennsylvania
University of Puerto Rico
University of Rhode Island
University of Rochester
University of South Alabama
University of South Carolina
University of South Florida
University of Southern California
University of Virginia
University of Washington/Seattle
University of West Florida
University of West Indies
University of Wisconsin/Madison
University of Wisconsin/Milwaukee
Utah State University
Vassar College
Virginia Polytechnic and State University
Walla Walla College
Western Washington State University
William and Mary, College of

Foreign Academic Institutions Participating in
NOAA's National Undersea Research Program
1971 - 1990

Australia

University of Sydney

Belgium

University of Liege

Brazil

University of Du Sol

Canada

Dalhousie University

University of British Columbia

University of Toronto

University of Western Ontario

France

University of D'Aix-Marseille

University of Nice

Germany

University of Bochum

University of Kiel

Norway

Trondheim University

Turkey

University of Turkey

United Kingdom

University of Newcastle-upon-Tyne

Other Foreign Institutions Participating in
NOAA's National Undersea Research Program
1971 - 1990

Australia

Australian Institute of Marine Science

Bahamas

Bahamas Undersea Research Foundation

Barbados

Bellairs Research Institute

Bermuda

Bermuda Biological Station

British Virgin Islands

Bitter End Field Station Cuba

Cuban Academy of Sciences

France

Centre d'Etudes et de Recherches Technique Sous-Marine

Center Oceanologique de Bretagne

Institut Francais de Recherche pour l'Exploitation de la Mer

Laboratoire de Biologie et d'Ecologie Marines

Laboratoire de Biologie Generale

Germany

Biologische Anstalt Helgoland

Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schifffahrt

Israel

Israel National Institute of Oceanography

Israel Oceanographic & Limnological Research Ltd.

Kinneret Limnological Laboratory

Jamaica

Discovery Bay Marine Laboratory

Japan

Japanese Marine Science and Technology Agency

Kenya

International Center of Insect Physiology and Ecology

Kenya National Academy of Science

Kuwait

Kuwait Institute for Scientific Research

Poland

Sea Fisheries Institute of Gdynia

United Kingdom

Admiralty Experimental Diving Unit

Institute of Geological Sciences

Institute of Oceanographic Sciences

Numbers of principal investigators and participants in NURP programs from 1972-90. For 1972-1986, participants were estimated by adding four persons to each principal investigator. For 1987-1990, participant numbers were provided by NURC's.

YEAR	P. I.	PARTICIPANTS
1972	45	180
1973	30	120
1974	20	80
1975	32	128
1976	17	68
1977	13	52
1978	14	56
1979	12	48
1980	12	48
1981	36	144
1982	65	260
1983	66	264
1984	52	208
1985	36	144
1986	39	156
1987	74	388
1988	81	448
1989	96	583
1990	<u>103</u>	<u>616</u>
	843	3991