The University-National Oceanographic Laboratory System: Celebrating 25 Years a the Nation's Premier Oceanographic Research Fleet

Executive Summary

The University-National Oceanographic Laboratory System (UNOLS) is a consortium of 57 academic institutions with significant marine science programs that either operate or use the U.S. academic research Fleet. It is now entering its 25th year as the world leader in oceanographic facilities. The 27 research vessels in the UNOLS Fleet stand as the largest and most capable Fleet of oceanographic research vessels in the world.

UNOLS owes its success to a unique management strategy. The UNOLS Council, which consists of seagoing scientists, vessel operators and marine technicians, ensures that ship and equipment schedules are coordinated to make efficient use of finite resources. This coordination is governed by one simple reality - every dollar used to support ships is one less dollar for science. Part of the UNOLS management philosophy is to maintain an entrepreneurial spirit among the various operators of the ships. This fosters a competition among the ships for science operations that has resulted in a level of effectiveness not found in any other oceanographic fleet. The close integration between the users of the Fleet and the academic institutions that operate the research vessels also results in a substantial financial savings. The academic institutions that operate the vessels subsidize the costs through a variety of direct and indirect means. Operations of the Fleet are highly responsive to changes in the annual science needs. Each operator of a UNOLS vessel functions on a year to year grant basis. Funding is only available as required to provide the services needed by the scientific community.

In the past three years, the level of Federal funding for ocean science has decreased nearly 30%. The decrease in science funding is projected by UNOLS to lead to a long term excess capacity in the Fleet. If the trends in funding that we have seen over the past three years continue, the Fleet will have to change in one of two ways. Its size can be reduced to match its capacity to the smaller amount of research that will be performed with decreased budgets. Alternatively, other Federal and State users of the Fleet must be found.

The UNOLS Council is charged with planning for future facility requirements for ocean science research to ensure that the Fleet maintains its vitality. This includes planning for replacement of ships as they age (with a lifetime of about 30 years and 27 ships, that's nearly one a year). Despite the reduction in Federal support for oceanographic research, UNOLS must continue to plan for new facilities to replace our existing assets as they age, and to explore the requirements for new types of facilities as the needs of ocean science change.

Introduction

The University-National Oceanographic Laboratory System (UNOLS) is a consortium of 57 academic institutions (Appendix) with significant marine science programs that either operate or use the U.S. academic research fleet. In the early 1960's operators of oceanographic research vessels formed a Research Vessel Operators Committee (RVOC) to coordinate work on operational and regulatory issues. UNOLS was established in 1971, in recognition of the need to ensure scientific access to research vessels and to extend the work of RVOC. It is now entering its 25th year as the world leader in oceanographic facilities. The 27 research vessels in the UNOLS Fleet (Table 1) stand as the largest and most capable Fleet of oceanographic research vessels in the world. It is a substantial national asset. The UNOLS Fleet provides the platforms on which the bulk of American oceanographic research is performed. Research performed on ships of the UNOLS Fleet contributes to our understanding of interannual changes in climate that are driven by El Nino, formation of tropical storms, and fisheries management. The Fleet supports studies of global ocean circulation, fundamental studies of ocean acoustics and light scattering that are basic to the Navy's mission of national defense, and the pure research needed to manage the ocean wisely.

Table 1. UNOLS RESEARCH VESSELS

OPERATING INSTITUTION	SHIP	OWNER	LENGTH
	CLASS I/II		
Scripps Institution of Oceanography	MELVILLE	Navy	279 ft.
Woods Hole Oceanographic Institution	KNORR	Navy	279 ft.
University of Washington	THOMAS G. THOMPSON	Navy	274 ft.
Lamont-Doherty Earth Observatory	MAURICE EWING	L-DEO	239 ft.
Woods Hole Oceanographic Institution	ATLANTIS II	WHOI	210 ft.
University of Hawaii	MOANA WAVE	Navy	210 ft.
	CLASS III		
Harbor Branch Oceanographic Institution	SEWARD JOHNSON	HBOI	204 ft.
Oregon State University	WECOMA	NSF	185 ft.
University of Rhode Island	ENDEAVOR	NSF	184 ft.
Texas A&M University	GYRE	Navy	182 ft.
Woods Hole Oceanographic Institution	OCEANUS	NSF	177 ft.
Scripps Institution of Oceanography	NEW HORIZON	SIO	170 ft.
University of Miami	COLUMBUS ISELIN	UM	170 ft.
Harbor Branch Oceanographic Institution	EDWIN LINK	HBOI	168 ft.
	CLASS IV		
Moss Landing Marine Laboratories	POINT SUR	NSF	135 ft.
Duke University/UNC	CAPE HATTERAS	NSF	135 ft.
University of Alaska	ALPHA HELIX	NSF	133 ft.
Scripps Institution of Oceanography	ROBERT G. SPROUL	SIO	125 ft.
University of Delaware	CAPE HENLOPEN	UD	120 ft.
Bermuda Biological Station for Research	WEATHERBIRD II	BBSR	115 ft.
Harbor Branch Oceanographic Institution	SEA DIVER	HBOI	113 ft.
Louisiana Universities Marine Consortium	PELICAN	LUMCON	105 ft.
University of Texas	LONGHORN	UT	105 ft.
	<CLASS IV		
University of Michigan	LAURENTIAN	UM	80 ft.
University System of Georgia	BLUE FIN	UG	72 ft.
University of Miami	CALANUS	UM	68 ft.
University of Washington	CLIFFORD A. BARNES	NSF	66 ft.
New Ships:			
Scripps Institution of Oceanography	ROGER REVELLE (1996)	Navy	274 ft.
Woods Hole Oceanographic Institution	ATLANTIS (1997)	Navy	274 ft.

The ships of the UNOLS Fleet can be found operating around the world. Three Class I UNOLS ships (>2 have spent the past year in the Indian Ocean as part of an international effort to study the role of the Indian Oc and its yearly Monsoon in regulating annual climate differences (Table 2). However, the bulk of the work occ in or near U.S. waters where research may focus on questions of regional significance, such as fisheries pollution, as well as global questions that use local waters as model systems, such as processes that regul productivity of plants in the ocean. The UNOLS Fleet is distributed geographically around the coastal waters the U.S. to meet these needs.

TABLE 2. Indian/Southern Ocean Voyage Statistics

VOYAGE STATISTICS	KNORR	MELVILLE	THOMPSON
Dates	Dec 94 - Jan 96	Dec 94 - Dec 95	Oct 94 - Jan 96
Miles Steamed	50,531	49,180	54,454
# of Cruises	13	10	18
Days at Sea	367	298	393
Number of Stations	1244	n/a	450
# of Bottles Tripped	39,619		25,445
Water Samples Drawn	>400,000		>100,000
SeaBeam		49,180 nm	
Gravity		26,484 nm	
Seismic		1,860 nm	
Magnetics		32,683 nm	
Cores/Dredges		11 cores/80 dredges	50 cores
OBS Deployments		52	
Casts		447	1290
Moorings/Buoys Deployed		13	10
XBTs		143	
Net Tows			318
Total Science Party	273	143	444
Universities/Organizations	26	25	47
Nations Participating	7	7	18
Foreign Clearances	21	12	1

A Unique Management Strategy

UNOLS owes its success to a unique management strategy. UNOLS is governed by an elective body, th UNOLS Council. The Council, which is composed of sea-going scientists, vessel operators and marin technicians, ensures that ship and equipment schedules are coordinated to make efficient use of finite resource This coordination is governed by one simple reality - every dollar used to support ships is one less dollar fo science. As most of the Council members are seagoing scientists, there is a strong incentive to maintain a cos efficient and highly effective operation. The cooperation of scientists, operators and seagoing technician ensures that management issues are handled expeditiously and in a realistic manner. The benchmark for succes of the Fleet is the success of the research projects conducted on board each ship.

Part of the UNOLS management philosophy is to maintain an entrepreneurial spirit among the various operator of the ships. This fosters a competition among the ships for science operations that has resulted in a level o effectiveness not found in any other oceanographic fleet. For example, UNOLS vessels typically operate with

crew to scientist ratio of 1:2, while in most other fleets the ratio is closer to 2:1. The competition among operators mandates that they provide not only a cost-effective platform, but a highly capable ship. The science operations that are conducted on UNOLS research vessels represent the spectrum of the work done in our nation's premier scientific laboratories. This work may range from deploying large instruments such as Remotely Operated Vehicles (ROVs) and deep-sea moorings, to probing the atmosphere with laser based instruments, to studying trace elements under clean room conditions. Any ship that cannot excel at this spectrum of work will not remain competitive in the Fleet.

Although ships compete for the science user, there is also a high degree of cooperation which exists between oceanographic institutions that operate research vessels. This cooperation arises because of the nature of the ocean research that is performed on modern oceanographic ships. The work is interdisciplinary, often requiring scientists from many institutions to perform a single, successful cruise. The work must often be performed globally, which mandates a strong, geographically distributed Fleet. This cooperation manifests itself in several ways. It has lead to the establishment of high safety and operating standards for the entire Fleet. The safety standards set for ships of the UNOLS Fleet and for performance of the crews is in excess of the regulations set by the U.S. Coast Guard. The standards include at sea tests of ship and crew performance. These benefit the overall operating efficiency and reliability of the vessels. Any ship that cannot meet these standards does not remain in the Fleet.

The cooperation between operators also guarantees access to the ship support facilities of other institutions for all ships of the Fleet. It results in an exchange of information to address common problems across the operational spectrum, from equipment performance to establishment of physical and medical standards for ship crew. These exchanges are fostered within UNOLS by fleet-wide working groups of ship managers (RVOC) and marine technicians (RVTEC). This cooperation helps to maintain continuity among crews and technicians by providing alternative employment opportunities when research vessels are not operating.

Continuity in crewing is essential in the UNOLS Fleet because the ship's crew is highly integrated into science operations. They must be experienced in oceanographic research to maintain a safe and efficient operation at sea. The crew must be ready to adapt to constant changes in the type of science that will be performed and the services they must provide to the science complement. They play a critical role in properly handling and deploying instruments, station keeping and providing ship services that range from highly regulated electrical power for sensitive instrumentation to safe areas for research with radioactive isotopes. This type of experience is not developed elsewhere in the commercial shipping industry and the crew of the ships in the UNOLS Fleet represent a remarkable asset that has grown from within by long experience.

The close integration between the users of the Fleet and the academic institutions that operate the research vessels results in a substantial financial savings. The main costs for operating the UNOLS Fleet (about $45M per year) are borne by Federal agencies, such as the National Science Foundation and the Office of Naval Research that support oceanographic research. However, the academic institutions that operate the vessels subsidize the operating costs through a variety of direct and indirect means. The terms of the competition for the award of the latest generations of oceanographic ships have required substantial institutional commitments for cost sharing to support these vessels. Many operator institutions provide institutional and state ship time, salaries for support personnel, as well as support facilities for the ships. The close link to academia leads to a direct infusion of technical expertise that maintains shipboard science facilities and equipment at the forefront of technology. Most of the cost of fleet planning is contributed through the salaries of the academic scientists who perform extensive support functions at no charge.

Operations of the Fleet are highly responsive to changes in the annual science needs. Each operator of a UNO vessel functions on a year to year grant basis. Funding is only available as required to provide the servic needed by the scientific community. For example, the funds supplied to the Fleet by the Office of Na Research may fluctuate by nearly a factor of two on an annual basis as their needs for oceanographic resea change (Table 3). If fewer projects are planned in any one year, ships can be held out of service. It is comm for at least one vessel of the Fleet not to operate in a given year, and on occasion two or more will not opera The selection of the particular vessel(s) that do not operate depends on the geographic distribution of scie projects, the requirements for vessel size and capabilities, as well as needs for periodic maintenance. T cooperation among operators ensures that short-term lay-ups do not destroy a ships capabilities.

TABLE 3. UNOLS OPERATIONS SUPPORT (1993-2000) (funding in 'current' $K)

UNOLS	ACTUAL	ESTIMATED	ESTIMATED	ROUGH PROJECTIONS
TOTALS	1993	1994	1995	1996-2000
NSF	30,558	34,012	37,166	36,000
ONR/NRL	7,581	4,253	6,395	6,300
NOAA	1,981	1,975	2,280	1,000
OTHER	3,266	4,484	1,975	2,000
INST	2,790	2,342	1,787	2,000
	$46,176	**$47,066**	**$49,603**	**$47,300**

A privately operated, long-term contracted fleet cannot match this level of flexibility. Long-term contra essentially lead to great inflexibility in scheduling facilities to match the fluctuating needs of science. Resea vessels operating in this mode may end up carrying out "make work" projects with few scientists on board, weak scientific rationale and little oversight. They become, in essence, a block funded facility that exi regardless of the needs of the scientific users. This, in turn, results in excessive waste of resources that could otherwise dedicated to the long-term objectives of understanding the ocean/atmosphere system. Long-te contracting is suitable only for highly predictable operations with a regular schedule, such as nautical charti Slight overcapacity of the Fleet and the ability to fund ships on a year to year basis gives UNOLS flexibility t no other oceanographic fleet can match.

UNOLS - Future Challenges

The UNOLS Council is charged with planning for future facility requirements for ocean science research ensure that the Fleet maintains its vitality. This includes planning for replacement of ships as they age (wit lifetime of about 30 years and 27 ships, that is one a year) and planning for upgrades to national oceanograp facilities such as the Deep Submergence Vehicle, ALVIN. As a result of this effort, the Fleet is nearing completion of a decade that will see nearly $200M in capital improvements to the Fleet that have been funded the U.S. Navy and by the National Science Foundation. All of the Class I ships (>250') are either new or th have undergone major mid-life refits. Nearly all of the Class II and III ships (150' to 250') have undergone ma mid-life refits as well. The Class I ships ROGER REVELLE and ATLANTIS (both 274') will be delivered 1996 and 1997. They will be operated by Scripps Institution of Oceanography and Woods Hole Oceanograp Institution, respectively.

The changing nature of U.S. science will lead to a continual evolution of the UNOLS Fleet. In the past three years, the level of Federal funding for ocean science has decreased nearly 30%. The decrease in science funding is projected by UNOLS to lead to a long term excess capacity in the Fleet. This change in budget can be accommodated over short periods by operating the Fleet on a reduced schedule. This is best accomplished by periodically taking several ships out of service for several months to a year. UNOLS has regularly done this to accommodate small budget shortfalls. However, temporary lay-ups are not a viable solution for a large, long-term deficit. The cost of operating a research vessel is roughly divided into three fractions: one third for operational costs (fuel, food, etc.), one third for fixed crew costs and one third for equipment and maintenance. Substantial savings can be achieved when a ship is taken out of service only by laying off crew and deferring maintenance. Infrequent, short-term lay-ups can be accommodated by sharing crew between various UNOLS vessels. Long-term lay-ups of a vessel are invariably met by loss of this accumulated crew experience. Successful and efficient operations of the oceanographic Fleet require that most of the Fleet be used at near its capacity. Long-term underutilization saves relatively little money if the crew is retained and the ship maintained or it results in a low efficiency operation that will ultimately be rejected by users in the scientific marketplace.

If the trends in funding that we have seen over the past three years continue, the Fleet will have to change in one of two ways. Its size can be reduced to match its capacity to the smaller amount of research that will be performed with decreased budgets. Alternatively, other Federal and State users of the Fleet must be found. UNOLS is a substantial Federal asset and to the extent that it can be better utilized, other Federal users of the Fleet should be encouraged to employ it. UNOLS has begun to explore these pathways in a variety of discussions. If other agencies become users of the Fleet, it is clear that they must subscribe to the flexible, entrepreneurial atmosphere that has made UNOLS the success that it is today.

Despite the reduction in Federal support for oceanographic research, UNOLS must continue to plan for new facilities to replace our existing assets as they age, and to explore the requirements for new types of facilities as the needs of ocean science change. The time scale required to bring a new research vessel on line is roughly ten to 15 years from conception through construction. This requires that we begin planning now for the replacement of our coastal and intermediate class vessels. The growing importance of Arctic research, and the need for a platform capable of supporting modern, interdisciplinary studies in this region mandates that UNOLS keep planning for a dedicated Arctic Research Vessel.

Conclusions

UNOLS will continue to be a major presence in U.S. oceanography for the next 25 years. Today it stands as a model of interagency and Federal/Academic coordination. It has developed a flexible, cost-effective management structure. It emphasizes an entrepreneurial atmosphere to keep the Fleet at the forefront of technology while maintaining this cost effective structure. The close coordination with academic institutions results in a substantial cost savings. It encourages the collegial atmosphere that leads to close cooperation between the operators. As a result of these factors, the UNOLS Fleet is an integral part of our nation's science program. It cannot be easily or efficiently separated from it. UNOLS stands as an example to be emulated.

Appendix - A list of the 57 UNOLS institutions.

UNOLS DIRECTORY (with designated representatives)

Operator Institutions in **BOLD** Rev.

ALABAMA MARINE ENVIRONMENTAL SCIENCES CONSORTIUM
Dr. George F. Crozier

UNIVERSITY OF ALASKA Dr. Thomas Royer

BERMUDA BIOLOGICAL STATION for RESEARCH, Inc. Dr. Dennis Hansell

BIGELOW LABORATORY FOR OCEAN SCIENCES
Dr. David Townsend

BROOKHAVEN NATIONAL LABORATORY Dr. Creighton D. Wirick

UNIVERSITY OF CALIFORNIA, SAN DIEGO, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Dr. Robert Knox

UNIVERSITY OF CALIFORNIA, SANTA BARBARA
Dr. James P. Kennett

CAPE FEAR COMMUNITY COLLEGE Mr.Raymond P. Brandi

COLUMBIA UNIVERSITY, LAMONT-DOHERTY EARTH OBSERVATORY Dr. Dennis Hayes

UNIVERSITY OF CONNECTICUT Capt. Lawrence Burch

UNIVERSITY OF DELAWARE Dr. Carolyn A. Thoroughgood

DUKE UNIVERSITY/UNIVERSITY OF NORTH CAROLINA Dr. Dirk Frankenberg

FLORIDA INSTITUTE FOR OCEANOGRAPHY Dr. John C. Ogden

FLORIDA INSTITUTE OF TECHNOLOGY Dr. Richard Gerlick

FLORIDA STATE UNIVERSITY Dr. William C. Burnett

HARBOR BRANCH OCEANOGRAPHIC INSTITUTION
Mr. Richard Herman

HARVARD UNIVERSITY Dr. Michael B. McElroy

UNIVERSITY OF HAWAII Dr. Brian Taylor

HOBART & WILLIAM SMITH COLLEGES Dr. Donald L. Woodrow

THE JOHNS HOPKINS UNIVERSITY Dr. Gordon D. Smith

LEHIGH UNIVERSITY Dr. Bobb Carson

LOUISIANA UNIVERSITIES MARINE CONSORTIUM
Dr. Michael Dagg

UNIVERSITY OF MAINE Dr. Robert E. Wall

THE MARINE SCIENCE CONSORTIUM Dr. Darlene Richardson

UNIVERSITY OF MARYLAND Dr. Tom Malone

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Dr. John M. Edmond

UNIVERSITY OF MIAMI, ROSENSTIEL SCHOOL OF MARINE & ATMOSPHERIC SCIENCES
Dr. Otis Brown

UNIVERSITY OF MICHIGAN, CENTER FOR GREA LAKES & AQUATIC SCIENCES Dr. Theodore C. Moore,

MONTEREY BAY AQUARIUM RESEARCH INSTITUTE
Dr. Bruce Robison

MOSS LANDING MARINE LABORATORIES
Dr. Kenneth Johnson

NAVAL POSTGRADUATE SCHOOL Dr. Robert Bourke

UNIVERSITY OF NEW HAMPSHIRE
Dr. Wendell Brown

STATE UNIVERSITY OF NEW YORK AT STONY BROOK
Dr. Charles A. Nittrouer

UNIVERSITY OF NORTH CAROLINA AT WILMINGTON
Dr. Alan Hulbert

NOVA UNIVERSITY Dr. Julian P. McCreary

OCCIDENTAL COLLEGE Dr. John S. Stephens, Jr.

OLD DOMINION UNIVERSITY Dr. Larry Atkinson

OREGON STATE UNIVERSITY Dr. G. Brent Dalrymple

UNIVERSITY OF PUERTO RICO Dr. M.L. Hernandez-Avila

UNIVERSITY OF RHODE ISLAND Dr. Jeffrey E. Callaha

RUTGERS UNIVERSITY Dr. Frederick Grassle

SAN DIEGO STATE UNIVERSITY Dr. Clive Dorman

SEA EDUCATION ASSOCIATION Capt. Philip Sacks

SMITHSONIAN TROPICAL RESEARCH INSTITUTE
Mr. Howard Barnes

UNIVERSITY OF SOUTH CAROLINA Dr. Robert Thunell

UNIVERSITY OF SOUTH FLORIDA Dr. Peter R. Betzer

UNIVERSITY OF SOUTHERN CALIFORNIA Dr. Douglas Hammo

UNIVERSITY OF SOUTHERN MISSISSIPPI Dr. Denis Wiesenbur

UNIVERSITY SYSTEM OF GEORGIA, SKIDAWAY INSTITUTE OF OCEANOGRAPHY Dr. Richard Jahnke

UNIVERSITY OF TEXAS Dr. Terry E. Whitledge

TEXAS A&M UNIVERSITY Dr. Douglas Biggs

VIRGINIA INSTITUTE OF MARINE SCIENCE Dr. L. Donelson Wri

UNIVERSITY OF WASHINGTON Dr. Arthur Nowell

UNIVERSITY OF WISCONSIN AT MADISON Dr. Anders W. Andr

UNIVERSITY OF WISCONSIN AT MILWAUKEE
Dr. David E. Edgington

UNIVERSITY OF WISCONSIN AT SUPERIOR Dr. Mary Balcer

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