Appendix A: Terms of Reference

The Academic Research Fleet Review Panel is charged to provide a comprehensive and balanced evaluation of science support services and capabilities, ship operations, and organizational structure for the support of the Academic Research Fleet and to recommend actions by NSF to ensure the most cost-effective means of organizing and managing the academic fleet for support of research requirements. The review procedures will follow the principles outlined in the NSB Resolution concerning Competition, Recompetition, and Renewal of NSF Awards for facilities operations (NSB 97-224).

1) Review and evaluate the current and projected research vessel fleet required for research sponsored by the National Science Foundation within a national framework that includes research requirements of other federal agencies, state and local governments, and private sources.

   This review should be done in the context of environmental and geoscience research, in general, and the specific contributions the Academic Research Fleet provides to the research enterprise as a whole.

   Specific issues include:
   - Do the capabilities and operating modes of the academic ships meet research requirements?
   - Is the number of ships overall, and distribution within size categories, consistent with the level of research support and type of seagoing research projects expected in the future?
   - Are specialized capabilities required to meet research priorities adequately included in the overall fleet profile?

2) Review and evaluate overall management structure of the Academic Research Fleet; review and evaluate existing capabilities and services provided by the operating organizations; and review and evaluate possible future changes in academic fleet operations to ensure optimal operations of the academic fleet to support research requirements.

   The review context should include consideration of the distributed ownership of the fleet, cost sharing for both capital acquisition and operations and requirements of multiple research sponsors who participate in scientific, operational and financial support.

Specific issues include:

- Are organizational arrangements and structures appropriate?
- Can the Academic Research Fleet system be managed in a more cost-effective manner?
- Should elements of the research fleet or its operation be recompeted?

3) Provide recommended actions by NSF to improve the organization, management, and cost-effective operation of the Academic Research Fleet in support of scientific capabilities required to maintain world leadership in ocean and environmental science research.

   The recommendations should be formulated in the context of the results of the review and evaluations of the first two terms of reference. Key elements include providing a perspective on Academic Research Fleet operations within a national context, relevance and quality of scientific, educational, and technical support; and benefits and added value of any recommended actions for peer reviewed competition or recompetition of research fleet components.

*A*PPENDIX *B*: *C*OMMITTEE *M*EETINGS

The committee met four times to obtain information on U.S. Academic Research Fleet operations, science program requirements and financial and management data. The second meeting included a site visit to the marine facilities at Scripps Institution of Oceanography, including three ships in port there – R/V *Melville* and R/V *Sproul* operated by Scripps, and R/V *Atlantis* (with the submersible *Alvin*), operated by Woods Hole Oceanographic Institution.

Meetings were held as follows:

Meeting 1: National Science Foundation, Arlington, VA, 8-10 June 1998
Meeting 2: Scripps Institution of Oceanography, La Jolla, CA, 1-3 September 1998
Meeting 3: Graduate School of Oceanography, University of Rhode Island, Narragansett, RI, 2-3 December 1998
Meeting 4: National Science Foundation, Arlington, VA, 3-4 March 1999

Meeting agendas were as follows:

MEETING 1

<u>June 8, 1998</u>
Committee review
- Charge, Introductions

NSF Programs and Procedures
- Overview, Dr. Donald Heinrichs, NSF
- Ship Operations Program, Ms. E.R. Dieter, NSF
- Instrumentation and Technical Services, Dr. Alexander Shor, NSF
- Oceanographic Facilities, Dr. Richard West, NSF

UNOLS Executive Summary, Dr. Kenneth S. Johnson, UNOLS Chair
- UNOLS Functions
    1. Science Facility Support
    2. Access to the Sea
    3. Safety at Sea
    4. Operating Efficiency and Science Efficiency
    5. Planning the Fleet of the Future
- UNOLS Structure

Committee Executive Session
- Review Goals, Dr. Robert Corell, NSF

<u>June 9, 1998</u>
History and Evolution of UNOLS, Capt. Robertson Dinsmore, WHOI (Ret.)
Science Facility Support
- General Purpose Ships
    - Global/Expeditionary Ships, Dr. Robert Knox, SIO
    - Intermediate/Regional Ships, Dr. Michael Roman, U MD
    - Local/Near-shore Ships, Dr. Richard Jahnke, SkIO
- Specialized Capabilities

Submersible Science, Mr. Richard Pittenger, WHOI; Dr. Karen Von Damm, UNH
Multichannel Seismics, Dr. Dennis Hayes, LDEO
What Needs Are Not Being Met?, Dr. Kenneth S. Johnson, UNOLS Chair
UNOLS Support for Science at Sea
Ship Operations: Science/Facility Integration, Mr. Steve Rabalais, LUMCON
Role of the Ship Operator
Research Vessel Operators' Committee (RVOC)
Research Suppport Services: Research Vessel Technical Enhancement Committee's (RVTEC) Role, Mr. Steve Rabalais, LUMCON
Customer Feedback, Dr. Kenneth S. Johnson, UNOLS Chair
Access to the Sea, Mr. John Bash, UNOLS Executive Secretary
The UNOLS Scheduling Process
Safety at Sea, Mr. John Bash, UNOLS Executive Secretary
Inspection Program
RVOC Safety Standards, Safety Training Manual, Safety Video
Operating Efficiency and Science Efficiency
UNOLS Management, Dr. Kenneth S. Johnson, UNOLS Chair
Institutional Operations: Contributions/Benefits, Dr. Robert Knox, SIO

June 10, 1998
UNOLS Sponsor History and Trends
Sponsorship, Dr. Robert Knox, SIO
NSF, ONR, NOAA
Other Federal, State, Institution
Private, Industry, International
Science Trend Summary, Dr. Kenneth S. Johnson, UNOLS Chair
UNOLS Wrap-Up, Dr. Kenneth S. Johnson, UNOLS Chair
Committee Executive Session
Meeting Review

MEETING 2:

September 1, 1998
Site Visit to Marine Facilities, Including Research Ships Melville, Atlantis with Submersible Alvin, and Sproul.

September 2, 1998
First Meeting Review
Intersessional Items
Science Trends and Opportunities: Community Views
Ocean Studies Board and other Community Reports, Dr. Kenneth Brink, WHOI (and OSB Chair)
NSF Futures Workshops: Synopsis and Recommendations, Dr. Donald Heinrichs,NSF
Institutional Perspectives on Future Ocean Science Plans, Dr. John Orcutt, CORE
Scientist Survey: Responses to Request for Community Input, Dr. Donald Heinrichs
Comparative Operations: National and International

NOAA, Adm. William Stubblefield
NAVO, CDR James Trees
UK/NERC, Mr. Paul Stone
Canada, Mr. Stephen Peck
UNOLS, Dr. Kenneth S. Johnson

<u>September 3, 1998</u>
NSF Antarctic Program: Systems Integration Contractor, Mr. Al Sutherland, NSF OPP
Science Trends: Budgets and Priorities
National Science Foundation, Dr. Michael Reeve, NSF
Office of Naval Research, Dr. Steven Ramberg, ONR
Naval Oceanographic Office, CDR James Trees and Mr. Gordon Wilkes, NAVO
National Ocean Partnership Program, Dr. Steven Ramberg, ONR (and Chair, IWG)
Financial Management and Economic Analysis
Introduction of External Contractor
Discussion of Scope, Content and Issues for Financial Management and Economic Analyses, Mr. William Humphrey, Tecolote Research.
Committee Deliberations

MEETING 3:

<u>December 2, 1998</u>
Science Trends and Research Ship Capabilities: Scientist Views
Biological Oceanography: Present and Future Directions and Implications for the Academic research Fleet, Dr. Karen Wishner, URI
Marine Geology and Geophysics: Perspectives from a Non-Ship Operating Institution, Dr. Donald Forsyth, Brown University
New Oceanographic Observation Platforms: Implications for the Fleet, Dr. James Bellingham, MIT
Site Visit to UNOLS Office
Cruise Assessment Summaries: UNOLS, Mr. John Bash, UNOLS Executive Secretary
Preliminary Financial/Management Report, Mr. William Humphrey, Tecolote Research.

<u>December 3, 1998</u>
Committee Working Session
Findings and Recommendations
Preliminary Text/Content

MEETING 4:

<u>March 3-4, 1999</u>
Committee Working Session
Report Review.
Revised Text and Content.
Approved Findings and Recommendations.

APPENDIX C: DESCRIPTION OF UNOLS

The University-National Oceanographic Laboratory System (UNOLS) is a consortium of 57 academic institutions with significant programs in marine science that either operate or use the U.S. Academic Research Fleet. UNOLS is governed by an elective body, the UNOLS Council, and operates through six standing committees. The UNOLS office, with three staff members, provides organizational support.

UNOLS COUNCIL

The UNOLS Council includes seagoing scientists, vessel operators and marine technicians, and is charged to provide policy guidance and monitor committee activities. The focus is to ensure effective use of available oceanographic facilities and assure access to the federally supported facilities for scientists from other institutions. The Council, as the executive body, develops long range projections for operational support, identifies capital needs, and advises the federal agencies on fleet issues.

SHIP SCHEDULING COMMITTEE (SSC)

All ship operating institutions are members of the scheduling committee. The committee task is to work with the seagoing scientists, research sponsors and each other to provide an integrated set of ship schedules. They are to ensure the research ship fills science requirements, provide access to all scientists, minimize non-working transits, and accommodate geographic and seasonal research requirements.

RESEARCH VESSEL OPERATORS COMMITTEE (RVOC)

The RVOC addresses regulatory issues, crew training, medical standards, insurance and safety issues. The members are marine superintendents from UNOLS member institutions with representatives from other international research ship operators, commercial operators, regulatory bodies and inspection societies. The focus is on ship operating issues per se, meeting compliance with the complex of national and international laws and regulations, and ensuring reliable and safe ship operations.

RESEARCH VESSEL TECHNICAL ENHANCEMENT COMMITTEE (RVTEC)

Committee participation is open to technical and scientific personnel from all UNOLS member institutions and interested non-UNOLS organizations. The purpose is to promote the scientific productivity of research programs by improving technical support for at-sea operations. The focus is on the exchange of practical information on scientific instrumentation operations, standards and calibration, identification of latest technologies and developing data and operations standards for consistent information exchange.

FLEET IMPROVEMENT COMMITTEE (FIC)

The primary responsibility of the committee is to review the scientific capabilities of the present research fleet, identify future scientific trends and needed seagoing capabilities, and recommend facilities plans to meet science requirements. The members are research scientists with liaison representatives from the research vessel operators. Products include a periodic fleet assessment and recommendations, identification of scientific mission requirements for various ship categories and ad hoc assistance to ongoing construction projects.

ARCTIC ICEBREAKER COORDINATING COMMITTEE (AICC) AND DEEP SUBMERGENCE SCIENCE COMMITTEE (DESSC)

These two committees are special focus groups to specifically assist NSF and the U.S. Coast Guard with supporting research on USCG icebreakers in the Arctic and assisting NSF, ONR and NOAA in operating the submersible *Alvin* and related unmanned tethered vehicles respectively. In both cases, the committee members are research scientists with interest in the specialized facilities, and provide communication with the broader research community, oversight of facilities operations, and advice to the operators and federal sponsors.

APPENDIX D: NSF MANAGEMENT

This appendix details the mechanism for review of proposals within NSF which lead to scheduling oceanographic research projects on vessels of the U.S. Academic Research Fleet.

The first stage is the submission of research proposals to study ocean phenomena to any scientific program office in NSF. While the Division of Ocean Sciences is the primary NSF sponsor of research using the Academic Research Fleet, programs in earth and atmospheric sciences, biological sciences, education, polar programs, engineering, physics and chemistry have all sponsored projects in recent years. The research proposal must provide a compelling case for the science project, as for all proposals to NSF. As part of the proposal, a cruise plan must be included, outlining the sampling strategy, time required, location, and other pertinent data needed by an external reviewer to evaluate the seagoing phase of the project. The investigator may request a specific ship or simply general ship requirements. To simplify the process, and to ensure all required data is provided, a one-page ship time request form (NSF Form 831) is required in the proposal.

All NSF research proposals that request ship time from the U.S. Academic Research Fleet must be submitted in time for award decisions by July or August of the year before the cruise, i.e., July 1998 for all cruises in calendar year 1999. The merit review process for research proposals submitted to most NSF program offices takes about 6 months, thus proposals are submitted no later than February of the year preceding sea time. The final logistics plans, coordination of research projects, and assignment of specific research ships and cruise dates can only be done after the full mix of science projects is known.

At this point (July) in the process, the NSF projects requiring ship time in the following year are established and the schedule coordination begins. This expands the process from a NSF-internal proposal process to an interagency and community coordination activity. The academic research fleet is a national capability with multiple research sponsors, multiple operations, and ships of differing sizes and operating areas. During the time that NSF was reviewing potential projects, the other federal, state and private sponsors were conducting their 'science reviews.' By July, the ship operators have the general specifications for most cruises, and they identify projects they believe are suitable for their ships. Tentative schedules designed to match project requirements with ship capabilities, integrate seasonal and weather requirements, and minimize unproductive transits between project sites are prepared.

There is extensive communication among the ship operators, funded research scientists and agency program directors to ensure project requirements will be met, and that cost-effective and suitable ships are assigned when the scheduling is complete. The process is intense and iterative for most of the larger ships, as they compete for projects, and adjustments to one schedule can 'cascade' onto several other schedules. The scheduling of the local and regional ships is generally simpler, since science teams are smaller and most operating areas do not overlap. The challenge for the system as a whole is to match about 550 science projects for 5000 days at sea around the world for studies in many science fields, involving over 2000 researchers and students with 28 research ships.

THE SHIP OPERATIONS PROGRAM at NSF is the central element for the overall management and support of the research vessels and submersible of the fleet. Each ship operator must submit a 'master' proposal to NSF for operations in the following calendar year. These research ship and submersible operations proposals are exempt from external merit review as a service function in support of merit reviewed research projects. Guidelines for uniform project and cost accounting procedures are provided in 'Instructions for Preparation of Proposals Requesting Support for Oceanographic Facilities," NSF 94-124, which covers all the facilities support programs in Division of Ocean Sciences. The operations proposals request support for direct and indirect costs arising from the actual maintenance and operation of research vessels. Support for research science teams, including shipboard technicians, scientific instrumentation and major equipment, must be obtained separately based on merit reviewed proposals to other programs. Allowable ship operation costs include salaries and related expenses of crew members and marine operations staff; acquisition of minor or expendable equipment; maintenance, overhaul and repair; insurance; and direct operating costs such as fuel, food, supplies and pilot and agent fees. Shore facilities costs are provided only to the extent that they directly relate to the ship operations.

The guidelines require identification of each research project and the number of days at sea so that facilities costs can be directly allocated to the project and supporting agency. The specific source of funding is identified. The NSF Ship Operations Program conducts the annual administrative, management and financial analyses of the institutional proposals for all sponsors, i.e. a single negotiation is done with the institutions. All proposals are examined concurrently by the program to evaluate operating costs on a comparative basis and establish 'best practices' procedures. All costs must be fully justified. The NSF review and negotiated budget is used to calculate proportional costs, based on days of use, for all sponsors. Each research project sponsor is responsible for the ship operations costs of their projects. The NSF award to each institution aggregates all NSF-sponsored projects for the year in a single award based on the total days required.

NSF ship operations support for a given ship may vary significantly from year to year. Support depends on the number and size of NSF projects compared to other sponsors, which changes annually. Thus, precise NSF ship operation award levels for specific ships cannot be projected in advance. Most federal agencies and all other sponsors provide their share of operating funds directly to the operating institutions. NSF will, if asked, manage interagency transfers for other federal agencies for a small management fee. These funds, appropriately identified, are included in the NSF master award. Annual interagency transfers managed by NSF have ranged from $1 to $2 million in recent years.

THE TECHNICAL SERVICES PROGRAM at NSF operates in parallel with the Ship Operations Program, i.e., each research ship operator must submit a 'master' proposal to NSF for basic technical support for all users and sponsors in the following year. Each research project and days at sea must be identified, so that costs can be directly attributed to the science proposed and the research sponsor. These proposals undergo an external merit review every three years, with administrative budget and management reviews annually to respond to the changing research project balance between sponsors.

Support provided through the NSF Technical Services Program is principally for operating and maintaining basic, shared-use equipment and scientific instruments which are available to all vessel users. This includes such things as winches, wires, navigation systems, biological and geological sampling systems, CTDs for measuring water properties, and a variety of acoustic tools for geophysical, physical and biological oceanographic study. Some of these tools are provided as part of the basic technical services rate charged to all vessel users; some carry extra charges for operation, since (for instance) they are used for only a small portion of the projects, or they require several extra personnel for operation.

Changes implemented by NSF for CY1999 require that the full, annual cost of specialized shared-use systems offered for use by operating institutions must be included in the NSF Technical Services proposal, and that cost allocations to each user must be indicated. This provides budget and management oversight which was lacking previously. Costs can now be based on known schedules and reasonable (1-year) cost projections; previously they needed to be estimated much further in advance and without knowledge of funding status, since most specialized system usage fees were part of research awards rather than facilities awards.

NSF works with other federal agencies through the Federal Oceanographic Fleet Coordination Committee to ensure an appropriate match of ship size and capabilities, overall fleet size, and availability of research and operating funds to meet national requirements. All federal agencies are invited to actively participate in the ship scheduling process to ensure their interests are considered. ONR and NOAA are the primary other sponsors of research using the academic ships and provide 15 – 20 percent of operations support in comparison with 60 – 65 percent from NSF. The remaining support, about 20 percent, comes from a number of other federal agencies, Navy laboratories, industrial projects, and state and local sources.

ONR, in particular, as owner of six of the academic research ships works closely with NSF on operational, maintenance and technical support issues. A formal Memorandum of Agreement provides for consultation and cooperative efforts on academic fleet management issues. They participate as an active partner with NSF on most significant management decisions. The other federal agencies primarily participate in the scheduling process, and defer to NSF and ONR on operational decisions.

Appendix E: NSF Future Research Directions

NSF has recently sponsored discipline-based workshops in Biological, Chemical, Physical and Geological Oceanography to open a community dialogue which will lead to plans for future oceanographic research. Workshop titles and broad themes are listed below. Detailed workshop reports and community comments can be found on the World Wide Web at: http://www.joss.ucar.edu/joss_psg/project/oce_workshop

Future of Marine Geosciences (FUMAGES)

- mid-ocean ridges
- role of water in the lithosphere,
- formation and aging of oceanic plates,
- paleoclimate studies,
- converging and passive margins, and
- shelf sediments and transport and nearshore marine geology.

Future of Ocean Chemistry (FOCUS)

- role of important nutrients in community structure in the euphotic zone and relationship between photosynthesis and export of materials out of upper ocean,
- how ocean margins process materials exchanged with land and sea,
- define and identify controls of organic matter in seawater,
- effects of advective flow through ocean ridge systems, ocean margin sediments and through coastal aquifers,
- characteristics and forecast anthropogenic changes in ocean chemical and consequences
- document air/sea exchange rate of gases, and
- controls on the accumulation of sedimentary phases.

Ocean Ecology: Understanding and Vision for Research (OEUVRE)

- deep-sea hydrothermal vent community,
- biodiversity,
- human impacts on marine ecosystems,
- importance of nanoplankton for ocean productivity,
- dominant influences of fluid motions on populations and ecosystems,

- stewardship of marine resources and ecosystems,
- understanding causes and consequences of change on scales from hours to
- millennia, and
- understanding and forecasting of biological change, and restoration of damaged communities and the ecosystem services that they provide,

ADVANCES AND PRIMARY RESEARCH OPPORTUNITIES IN PHYSICAL OCEANOGRAPHIC STUDIES (APROPOS)

- ocean's role in climate,
- the hydrologic cycle,
- observing the ocean,
- coastal regions,
- inland waters and environmental fluid dynamics,
- turbulent mixing and unexplored scales, and
- numerical modeling as an integrative tool.

APPENDIX F: NSF USER SURVEY SUMMARY

NSF invited comments from the general community of marine scientists with experience on research vessels. The invitation was publicized in the Division of Ocean Sciences newsletter, science community electronic bulletin boards, and by the UNOLS office web site. The general terms of the Academic Fleet Review study were provided to help those who chose to reply make relevant comments. Forty-five replies were sent in over a period of 6 months. The replies represented scientists from twenty-four institutions and included researchers from oceanographic institutions, government agencies and private contractors. Replies came both from investigators at small and large UNOLS vessel operating institutions and from investigators from non-vessel operating universities. The data cover a wide range of users of all classes of UNOLS vessels and from a wide spread geographic region (all U.S. coasts plus Alaska and Hawaii).

The vast majority of respondents (84%) directly addressed satisfaction with the present NSF/UNOLS system as it applied to their personal research experience. A majority of these replies stressed the importance of vessel operation by academic centers with active oceanographic programs and the role of the vessel crews and technicians in the conduct of field work. The trend was to consider the vessel, crew and technicians as a system with high value on experience, training and long term involvement in the science. Of those responding, only a limited number had experience with both UNOLS vessels and those managed by other systems, including others nations. Most in that category discussed differences in management, facilities, and most importantly crew longevity, training , communication and dedication to the mission. The UNOLS vessels rated highly in these comparisons. It is clear in the replies that, given a working platform, it is the interaction with a talented helpful crew and technical staff which makes or breaks the research experience.

While investigators from most academic disciplines were included in the replies, the spread was skewed in the direction of marine geology and geophysics (MG&G) and those investigators who utilize multi-beam bottom mapping array sonars. Their comments appeared to assume a continuation of the UNOLS system, and pressed other discipline-oriented issues such as the availability and operation of MG&G equipment and the future availability of vessels and technical support to host such large fixed systems. A second bias in the responses was the large percentage with concern for having adequate small vessels for coastal and estuary work. Physical Oceanographers (PO), a significant portion of the ocean science community, may have been underrepresented.

The following major issues were identified in the comments:

1. There is a fear, real or perceived, that there will be a push to contract for oceanographic vessel services as a cost measure. Most discussing this issue were strongly against such a practice.
2. Experienced crew, technician and shoreside support of the science party is what makes the UNOLS system better than other current operational methods.
3. There is a perception that pending lay-ups will hurt crew and technicians with long term impact.
4. While an overwhelming majority like the UNOLS system, the scheduling process is a concern and perceived to be getting worse. This is impacting personnel and possibly increasing costs.
5. Technical and engineering support for onboard equipment is critical and must be a priority.
6. Some MG&G installed systems have fleet wide problems, with a parallel issue that multibeam data should be continuously taken and made available.
7. There is a fear, real or perceived, that the intermediate class vessels will disappear.
8. The current coastal/estuary research fleet is taxed to it's limit and should be augmented (West Coast)
9. UNOLS represents the ship operators better than the research user.

The following excerpts were taken from the replies to demonstrate the range and flavor of comments.

1. Whatever the conclusions of this review may be, I sincerely hope that they will include maintaining the strength of the concept that operational responsibility must reside within the immediate user community.... I worry about the possibility that there could be a recommendation that ship assignments MUST be rotated every 4 or 5 years.... There are so many decisions about manning, maintenance and improvements that have long time constants that this would be disastrous....
2. The UNOLS fleet, especially the smaller vessels, suffers in that it is completely devoid of any shallow and intermediate water swath mapping system....
3. I am writing primarily to express my concern that one of the options that the review committee is considering is that NSF charter commercial or industry vessels to conduct academic research cruises....
4. NSF must be concerned about and monitor the MCS [multi-channel seismic reflection] capability closely. Perhaps an "oversight" committee of some sort should be instituted to 1) project our MCS needs into the future and 2) develop a plan to respond to those needs....
5. I would like to advocate that the US ship operation remain in the university community and not be transferred to a private contractor....
6. The system has worked very well for me. I have found the crews, scientific liaisons, and computer techs to be highly professional and dedicated to making my experience successful scientifically. The specialized equipment like multi-beam

echosounding and precision gravimeters simply would not be available without a central-facility system like UNOLS....

7. It is my experience that on the whole the UNOLS vessels and other U.S. Academic Fleet Vessels were the best outfitted for and had crew most familiar with and competent at the types of operations required in the conduct of oceanographic research....
8. All of track and survey objectives were met....
9. The constitution, operation, and management of the UNOLS fleet is admirable. The USGS Coastal and Marine Program has made important and successful use of the UNOLS fleet on many occasions....
10. The single biggest problem that affects me as a scientist in using UNOLS vessels in the last 18 months has been equipment failure or poor performance.... I'm sure you are aware of the numerous problems being encountered on the AGOR vessels now equipped with SeaBeam 2100 systems. I have had occasion to use the systems on Revelle, Brown and Atlantis, and essentially they all suffer from similar problems.... The larger issue that has been mentioned regarding privatization of the fleet, seems to be quite unbelievable that such a thing would even be considered. These ships are quite different from any others operating on the worlds oceans, and are not at all suited to operations by a ship operator not involved in the science itself....
11. NSF proposal success rates are going down; the same is true at other agencies. Therefore, until funding decisions are settled, "draft" or "preliminary" schedules that incorporate many or all "pending" proposals are becoming increasingly less credible – there are simply too many schedule entries that will not in fact happen. This is not anyone's fault, it is just a mathematical fact of life as success rates decline....
12. I give high praise to the UNOLS system... I am very concerned about the future of intermediate-size ships, i.e., around 200 feet.... I see several huge new ships now in the field and I see the end of life for several mid-size ships....
13. First, I think that UNOLS is an extremely effective operation, and I strongly endorse the concept of many institutions operating ships rather than putting all fleet operations under the umbrella of one or a small handful of large oceanographic institutions....
14. I have been using ships for almost 30 years and am a frequent UNOLS ship user. My comments about the UNOLS fleet are in the "Everything is Fine" category.... My biggest concern here is not the local pinch on the ships but the potential loss of crew. I have had bad experiences on ships with non-oceanographic research crews.... Lay ups put the crews at risk...
15. While my experiences on non-UNOLS vessels were generally favorable, I can also state from first-hand experience that these vessels offered no research advantages over the UNOLS vessels and several disadvantages (crew and operators that answer to company, union or agency officials and not to the science users). Thus, I believe that the UNOLS fleet provides state-of-the-art platforms for U.S. marine research, no small accomplishment given the size and distribution of the fleet... I am very satisfied with the UNOLS fleet. Routinely, the crew and officers

go beyond their duties to assist the science operations and I feel that the UNOLS fleet has directly contributed to many of the achievements in marine research....

16. UNOLS has virtually no estuarine or nearshore operational capabilities on the West Coast...
17. I would like to see all UNOLS vessels provide the same services on a cruise....
18. I think it is in the best interest of the NSF to have the multibeam systems on the UNOLS fleet more freely available for scientists to use... The UNOLS ships should keep the multibeam systems up and running as part of their normal operating expenses....
19. For me, a physical oceanographer, the biggest drawback of the existing system is a lack of consistent marine technical support....
20. Nonetheless, from the perspective of the end user, the rapidly and significantly changing [ship scheduling] scenarios are incredibly frustrating. The logistics of organizing multi-institution programs with various technicians and students and faculty adhering to their own academic schedules is a nightmare when cruise dates and/or ports are changing from month-to-month (or even, week-to-week, a little over two years ago).... we got more science done than was planned because of good channels of communication pre-cruise and excellent communication at-sea with the ship's officers and technician staff... Time after time in my career, I've seen the benefits of the vast experience which the various operators of the academic vessels have brought to the sea-going projects....
21. In the realm of pre-cruise support my UNOLS experiences stand out (positively). The other end of that spectrum is probably ASA, although the Canadian Coast Guard does not score well there, either... The work SIO scientists do at sea is not cut-and-dry assembly line stuff (although occasionally some work is that way), but more let's-try-it-out-and-sea experimentalism. The fact that we are so closely tied with our operators has provided the best opportunity for us to do our science... I can think of no more effective scheme to provide vessel support for science excellence than is now provided to us by the interactions between the UNOLS organization, UNOLS operators, scientists, and funding agencies (primarily NSF)....
22. These problems arise because the current system provides no effective feedback to control the operators of the ships in these cases since they are active participants in the one organization that should be controlling them, i.e. UNOLS. Clearly we have a case of the foxes guarding the hen house.... On the other hand I have also seen a similar system operate on a US navy ship (Lynch) run by a civilian contractor. In this case the result was almost exactly the opposite, indifferent crew, no support despite massive overcrewing.... UNOLS recently asked for input regarding their charter and I wrote at that time that I believed that the problem was mainly a result of the fact that UNOLS as it currently operates represents ship operators rather than ship users...
23. I want to say what a pleasure it has been interacting with the different operators, Captains and crew, and scientific support staff at the different institutions. They all wanted to make things work and have us, the scientists, be a satisfied customer....

24. The present system of ship scheduling too often creates a situation where the cost of logistics supported by the science program (i.e., travel, shipping, etc.) cannot be determined far enough in advance....
25. I have used the academic fleet now for 25 years and am fairly well acquainted with its capabilities as well as limitations. Overall, I have been very satisfied with the fleet and it has served me well in many trips to sea... The ships in the academic fleet are literally the experimental tools needed to sustain the field, our telescopes or accelerators.... I personally do not believe that there is a long-term imbalance in the composition of the fleet and that the vitality of the large ship portion of the fleet should be maintained. Many programs we envision in the future, including the establishment and maintenance of a global observatory or observing system, will require all the capabilities we have and probably more...
26. Many of the members of the MG&G [marine geology and geophysics] community would be better served by having a greater number of intermediate-sized ships that are fully capable of doing blue water oceanography on a global basis....
27. The recent tendency to build larger ships has no advantage for marine G and G [geology and geophysics] – added running cost is a disadvantage.... The present system has many advantages for science operations, the most significant being that it retains good corporate memory and a pool of dedicated personnel. Management tends to understand and support science operations....
28. Three classes of research vessels are emerging today. The first and best .... is manned by highly knowledgable crews.... The second class of vessel is manned by crews willing to help but generally clueless.... The third class is the "bareboat" charter where the vessel's crew operates the ship but provides no help with science.... I strongly encourage the support/promotion of the first (vessel manning by knowledgable and helpful crews) and less focus on the daily rate....
29. The long-term need can only be addressed by planning for timely replacement and enhancement of UNOLS vessel capabilities for estuarine and coastal research, the needs for which were generally (although still with a coastal, open-ocean bias) represented in the 1994 UNOLS report....
30. Very high marks and grateful that the US has UNOLS and very capable ship operators to help organize, plan and provide equipment for fair and unfettered access to the world ocean and seafloor... Given my knowledge of the ship operations and facilities of other nations, primarily France and UK. I would unquestionably rate US academic research facilities and UNOLS as head and shoulders above them, both in terms of productivity, cost-effectiveness, and ease of access.... In recent years, scheduling decisions have been made very late in the process much to the consternation of the science community, the result being a general lack of confidence (at a certain level) of the process, UNOLS (with a trickle down of sentiment towards the various ship operators), and the federal agencies charged with this responsibility.... The cadre of well-trained and dedicated people, who understand how important it is to deliver on science at sea, even in challenging circumstances, is not large. Each time we lay up a ship at a UNOLS institution on a rotational basis we impact the lives of people and families who provide essential support to oceanography....

While UNOLS has its problems, a private contractor may well have other, unforeseen problems, and I doubt it will be as cost-effective in the long run. UNOLS may well need adjustment. I have no specific suggestions here. As a starting point, it probably needs to be reviewed more frequently than every 25 years. Incremental changes as needs evolve are usually easier....

44. The problem is that every PI has to reinvent such a system [transponder navigation system], at great expense and hassle, when the capability could be built in ... with the rest of most ship operations...
45. I have always thought that the system has worked well in providing platforms for the scientific community.

APPENDIX G:
UNOLS CRUISE REPORT SURVEY

SCIENTISTS CRUISE ASSESSMENT SUMMARY

SHIP	DAYS	REPORT RECV'D	REPORTED LOST TIME (days) WEA.	SHIP	SCI.	TOTAL%	SUCCESS FULL	PART.	UNSAT.	COMMENTS PRAISE	IMPROVE
MELVILLE	213	6	0.00	6.00	0.00	2.8	5	1	0	4	4
KNORR	258	12	2.50	1.50	1.00	1.9	11	1	0	11	6
REVELLE	163	7	1.00	0.75	1.00	2.0	6	1	0	7	5
ATLANTIS	177	13	4.00	0.00	0.00	2.8	13	0	0	10	3
THOMPSON	136	2	5.25	10.50	0.00	11.6	1	1	0	2	2
EWING	139	3	1.00	0.00	0.00	1.0	3	0	0	2	0
MOANA WAVE	0	0	0.00	0.00	0.00	N/A	0	0	0	0	0
SEWARD JOHNSON	254	9	1.00	5.50	0.50	2.8	8	1	0	9	7
WECOMA	199	18	12.00	0.00	7.75	9.9	12	5	1	16	7
ENDEAVOR	35	2	7.00	0.00	1.00	23.0	2	0	0	2	0
GYRE	181	13	5.25	1.25	11.25	9.8	12	1	0	12	3
OCEANUS	199	19	18.00	1.00	8.25	13.7	14	5	0	15	3
NEW HORIZON	180	9	4.00	3.00	1.00	4.4	7	2	0	9	2
EDWIN LINK	199	18	10.25	3.75	1.00	7.5	13	5	0	17	5
POINT SUR	97	14	0.50	5.00	0.50	6.2	14	0	0	14	4
CAPE HATTERAS	204	21	11.75	0.5	2.25	7.1	16	5	0	19	1
ALPHA HELIX	107	7	7.50	2.00	0.00	9.0	5	2	0	7	0
R. G. SPROUL	106	25	1.00	0.00	0.00	1.0	19	5	1	16	3
CAPE HENLOPEN	169	21	4.25	0.00	1.50	3.4	21	0	0	17	4
WEATHERBIRD II	140	46	4.50	0.00	2.00	4.6	42	4	0	29	7
SEA DIVER	67	7	2.00	0.50	0.00	3.7	5	1	0	6	0
PELICAN	133	20	3.25	0.25	0.00	3.5	18	1	0	18	4
LONGHORN	46	20	1	0.50	0.25	4	14	3	0	15	3
URRACA	58	3	0.00	1.00	0.00	1.7	3	0	0	2	2
LAURENTIAN	0	0	0.00	0.00	0.00	N/A	0	0	0		
BLUE FIN	31	38	0.00	0.00	0.00	0.0	16	3	0	7	0
CALANUS	111	13	0.00	0.00	0.00	0.0	13	0	0	11	0
BARNES	0	0	0	0	0	N/A	0	0	0	0	0
TOTALS	3602	366	107.00	43.00	39.25	5.2	293	47	2	277	75

SHIP CAPTAIN POST-CRUISE REPORTS

KEY:
E = EXCELLENT
G = GOOD
A = AVERAGE
B = BELOW AVERAGE
P = POOR

SHIP	ASSESS. REPORTS RECV'D	OBJECTIVES MET		ORGANIZATION					COMMUNICATIONS				
		YES	NO	E	G	A	B	P	E	G	A	B	P
MELVILLE	6	6	0	0	6	0	0	0	0	5	1	0	0
KNORR	14	12	1	2	9	1	1	0	2	10	1	0	0
ROGER REVELLE	0	0	0	0	0	0	0	0	0	0	0	0	0
ATLANTIS	15	15	0	1	12	2	0	0	1	12	2	0	0
THOMPSON	1	1	0	0	0	0	0	0	0	0	0	0	0
EWING	0	0	0	0	0	0	0	0	0	0	0	0	0
MOANA WAVE	21	15	5	5	13	2	0	0	5	13	2	0	0
SEWARD JOHNSON	5	5	0	1	4	0	0	0	0	5	0	0	0
WECOMA	18	15	3	3	8	5	2	0	4	11	2	1	0
ENDEAVOR	18	18	0	4	6	8	0	0	5	5	7	1	0
GYRE	13	13	0	3	6	3	1	0	6	4	1	1	1
OCEANUS	20	20	0	4	10	6	0	0	5	9	6	0	0
NEW HORIZON	9	8	1	3	3	1	0	0	2	4	1	0	0
EDWIN LINK	18	16	2	10	7	1	0	0	10	7	1	0	0
POINT SUR	35	35	0	11	20	3	1	0	7	25	3	0	0
CAPE HATTERAS	21	21	0	10	9	2	0	0	11	9	0	0	0
ALPHA HELIX	8	8	0	4	3	1	0	0	5	2	0	1	0
R. G. SPROUL	33	30	3	18	11	4	0	0	21	10	1	1	0
CAPE HENLOPEN	27	27	0	5	2	0	0	0	24	2	0	0	0
WEATHERBIRD II	52	52	0	50	1	1	0	0	50	2	0	0	0
SEA DIVER	8	7	1	3	4	1	0	0	2	5	1	0	0
PELICAN	1	1	0	1	0	0	0	0	1	0	0	0	0
LONGHORN	20	18	1	1	18	0	0	0	0	18	0	0	0
URRACA	0	0	0	0	0	0	0	0	0	0	0	0	0
LAURENTIAN	0	0	0	0	0	0	0	0	0	0	0	0	0
BLUE FIN	38	37	1	1	36	1	0	0	1	36	1	0	0
CALANUS	13	13	0	7	4	2	0	0	9	3	1	0	0
BARNES	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS	414	393	18	147	192	44	5	0	171	197	31	5	1

Appendix H: Comparison of Research Ship Operating Models

National Oceanic and Atmospheric Administration (NOAA)

NOAA owns and operates 15 research ships in support of the agency missions for charting, fisheries monitoring and research, oceanographic research and environmental assessment. The NOAA fleet profile has significant differences from UNOLS. Most of the ships are "special purpose" ships outfitted to meet specific mission requirements for fisheries assessment, monitoring and research (11 ships) and charting (2 ships). Only two ships are general purpose research ships, and one of these ships is dedicated to support of a tropical Pacific buoy array for climate studies. The fisheries ships also are generally assigned to a region and support NOAA centers and laboratories in that area.

The NOAA scheduling process, with the partial exception of the R/V Ronald Brown, their major general purpose research ship, is an internal agency process. The NOAA laboratories and centers submit requests for ship time to their management offices. After management review and prioritization, the requests from the major line organizations, Office of Oceanic and Atmospheric Research (OAR), National Oceanic Service (NOS) and National Marine Fisheries Research (NMFS), are submitted to the NOAA Fleet Allocation Council. A working group examines all requests for scheduling and time conflicts, days available, ship capabilities and repair/maintenance requirements for the ships. The working group develops an integrated operating plan for all 15 ships which undergoes final review and approval by the Fleet Allocation Council.

NOAA fleet operations are similar in most aspects to academic fleet operations. The 15 ships are dispersed and operate out of 6 home ports on both coasts and in the Gulf of Mexico. Technical support and shared-use instrumentation are provided to users. A safety inspection program, ship equipment upgrades, and maintenance and repair plans are similar in concept to the NSF programs for the academic fleet. The major difference is in the general management structure. NOAA operates their fleet through headquarters oversight by the Office of NOAA Corps Operations (ONCO) and two marine centers in Seattle and Norfolk. Purchasing, engineering, personnel support, and technical services and instrumentation systems are centrally managed. In contrast, each academic ship operator provides all services locally with coordination through UNOLS committees and the NSF program offices.

Crewing for the research ships is also distinctive. The academic fleet is staffed by licensed officers and crew who are university employees. NOAA ships are staffed by NOAA Corps officers, a uniform service similar to the Coast Guard, and government marine wage employees for crew.

Naval Oceanographic Office (NAVOCEANO)

NAVOCEANO owns and operates 8 survey ships to provide oceanographic military surveys for the operational Navy fleet. All of the ships are "special purpose" ships outfitted to meet classified, and occasionally unclassified, military surveys. The specialized measurement systems focus on geophysical mapping, acoustic surveys and hydrographic measurements. Seven of the eight ships are "forward deployed" and operate in distant offshore or littoral areas where data are sparse or non-existent.

The NAVOCEANO scheduling process is requirements-driven to meet specific needs of operational and system commands. Currently 240 ship years of requirements are identified and an extensive internal Navy process establishes the timing and location priorities. In essence, the NAVOCEANO survey fleet has a single sponsor and single client – the operational Navy.

NAVOCEANO ships are operated by the Military Sealift Command with civilian crews. The data collection team or scientific party consists of 10-15 NAVOCEANO oceanographers and contractors. Although the ships have a single nominal homeport in Gulfport, Mississippi, they do not operate from this port, but use military bases and commercial ports worldwide. The shipboard equipment and data collection technical teams are supported through a centralized office at the Stennis Space Center in Mississippi. Personnel are rotated between at-sea duties and shore-based data analysis activities. Approximately 300,000 pounds of sensor and support equipment and supplies are organized at Stennis and sent to the ships annually. Technical support is provided for onboard equipment. Technicians are assigned to vessels and periodically rotate to Mississippi for shore assignments.

Research Vessel Services (RVS), United Kingdom

Research Vessel Services (RVS) owns and operates 3 research vessels equivalent to one large expeditionary vessel, one intermediate and one Cape-class vessel to support university and research institution scientists. These ships are the United Kingdom's equivalent of the U.S. academic research fleet. The RVS is technically a division of the Natural Environment Research Council (NERC), the primary research sponsor, and "commissioned" to operate the research fleet and provide technical and instrumentation support. RVS fleet operations provides equivalent services to a U.S. academic ship operator in response to variable research project requirements in all oceanographic disciplines. The home port for all three ships is at the Southampton Oceanography Centre which is a joint venture between the University of Southampton and NERC. The university Geology and Oceanography Departments, four NERC ocean sciences research institutes, and Research Vessel Services are co-located in a single complex in the port of Southampton.

The RVS scheduling process has many similarities to the UNOLS ship scheduling procedure. Research projects from university scientists are merit reviewed through the NERC research councils. Research projects from the NERC research institutes at times directly compete with university projects through the research councils and sometimes are reviewed separately in context of the institute's mission responsibilities. Following review of the sea-going research projects, a "Sea Time Assessment Panel" meets to establish a priority order and general schedule. This framework is then refined into an operations schedule for the following year by RVS staff. With 3 ships instead of 28 ships, the system is less complex but based on the same principle – science drives ship operations. Due to the scale of the operation, a single operational site is sufficient to service the fleet.

The financial management model for the RVS fleet is evolving to be similar to the U.S. academic fleet with modest differences. The ship funding is divided into two accounts – infrastructure and superstructure. Infrastructure funding provides for base costs for ships and their operations to exist for the benefit of UK scientists. It includes facility management and building costs along with ship and shore-based staff and currently covers about 50 percent of total annual costs. This funding comes directly to RVS from NERC. Superstructure funding provides for a merit reviewed project to actually use a ship. These funds are included in the research project award and are calculated as a "day rate" for each vessel and the level of technical and instrumentation support required. Fuel, maintenance, sea-pay overtime, expendable supplies, food and all general operations cost are included. If a sufficient number of research projects to fully use the three ships are supported, then the system is in balance. If not, then a vessel or vessels must be laid-up or taken out of service for all or part of a year.

In recent years, RVS has had to lay-up individual vessels for as much as 5 months and does not project that sustained funding from NERC for infrastructure and superstructure will increase to fully use the ships. The RVS is investigating links to expand their sponsor base from NERC to agriculture and fisheries research organizations, defense research agencies and commercial environmental assessment work. The "new sponsors" are expected to cover full costs, i.e. infrastructure and superstructure. If successful in attracting new sponsors, the RVS operations will increasingly resemble the multiple sponsor, multiple mission support model for the U.S. academic fleet. However, with only 3 ships, a single operator and owner will remain in contrast to the multiple ownership and operations model in the U.S.

CANADIAN COAST GUARD (CCG), CANADA

In 1996, Canada reorganized and consolidated its marine operations into a single national fleet operated by the Canadian Coast Guard, a civilian organization. The CCG identifies 132 ships and tenders in the national fleet that range from heavy icebreakers (6) to small search and rescue lifeboats (41). The national fleet is multipurpose and covers activities ranging from icebreaking; marine navigation services; rescue, safety and environmental response; fisheries conservation and protection; and marine science. In the U.S., responsibility for the various tasks are distributed among the U.S. Coast Guard, NOAA, EPA, FEMA, USGS and research agencies such as NSF and ONR. The large majority of vessels in the CCG fleet are equivalents of the U.S. Coast Guard operations and navigation aids ships (108 ships) followed by NOAA-type fisheries vessels (12 ships), academic/government survey and research vessels (9 ships) and maritime training vessels (3 ships).

The larger ships operate out of 5 regional bases on both coasts with a number of smaller ships at about 60 coastal stations. All personnel are government employees. A small headquarters staff provides policy guidance, overall coordination of facilities and fleet services, communications support and cost accounting. Operational support is provided by the five regional bases similar to an academic or NOAA operations center.

The CCG fleet is funded by two methods and from several sources. The first method, or formula funding based on levels of service, applies to the "coast guard" functions for navigation, search and rescue, spill response, etc. and includes most of the ships (111 ships). The second method, buying ship days per project, applies to the fisheries and marine sciences ships (21 ships) and is functionally similar to the U.S. academic fleet support model where costs are tied to specific projects.

Scheduling for science or research projects is done on a three region basis – Atlantic zone, Central and Arctic region, and Pacific zone. Research sponsors include the Department of Fisheries and Oceans (DFO), Environment Canada, and the Canadian universities with NSERC support. The review process is variable with most university-based projects undergoing merit review, but agency projects may be submitted based on internal administrative and management review only. DFO projects have a scheduling priority but conflicts with other programs are rare.

Technical and instrumentation support is limited. The CCG provides ships and crew including support for operating heavy ships gear, e.g. winches, mooring deployment, etc. However, all specialized deck equipment and instrumentation is the responsibility of the scientific complements. In brief, the science projects are expected to provide most of the science systems in contrast to the shared-use instrumentation and technical services approach used for the U.S. academic research fleet.

Within the Canadian academic community marine science proposals are peer reviewed and rated by NSERC's standard grant selection committees. Investigators that require ship time include a ship-time request form that specifies the operating area, nature of operations, number of days needed and the type of vessel required. Funding for ship time may come from directed science programs or from a general ship time fund established by NSERC. All successful proposals are then reviewed by the ship time selection committee that:

1. Ensures that the program outlined is manageable on the type of vessel requested;
2. Sees where programs can be combined for more cost-effective use of ship time; and
3. Distributes the available ship time funds to those not funded through other sources.

While users are encouraged to use CCG vessels, NSERC does not require this. NSERC has, and will allow users to use their funding for any vessel (commercial, foreign, etc.) if the case can be made that it is the most cost effective and efficient use of funding.

APPENDIX I: CONSULTANT REPORT

Analysis of University-National Oceanographic Laboratory System (UNOLS) Ship Operations

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The University–National Oceanographic Laboratory System (UNOLS) is a consortium of academic institutions that either operate or use the U.S. academic research fleet. The goal of UNOLS is to optimize the scientific and economic efficiency of the fleet and to support national planning for new ships.

The purpose of this task is to provide financial management and economic analysis support for the NSF Academic Research Fleet Review. To assist in this evaluation, other government and commercial benchmark cost data was gathered. These rates were compared with UNOLS costs to evaluate the cost effectiveness of UNOLS services.

The data for the cost analysis, utilization rates, and sponsor history were collected from the National Science Foundation (NSF) cooperative agreements and cost data for operations of the ships. Data for 1993 through 1997, the last year with complete actual cost data, is shown in constant CY 1998 dollars.

2.0 PROCEDURES AND ASSUMPTIONS

The study focused on 29 ships, the 1997/98 UNOLS fleet. Table 2.1 lists these ships.

Expeditionary Ships:

Operator	Ship	Owner	Ship Length
Scripps Institution of Oceanography	Melville	Navy	279
Woods Hole Oceanographic Institution	Knorr	Navy	279
Scripps Institution of Oceanography	Roger Revelle	Navy	274
Woods Hole Oceanographic Institution	Atlantis	Navy	274
University of Washington	Thomas Thompson	Navy	274
Lamont-Doherty Earth Observatory	Maurice Ewing	NSF	239
Woods Hole Oceanographic Institution	Atlantis II	WHOI	210

* Atlantis II was retired in 1996 and replaced by Atlantis, which began operations in 1997.

Intermediate Ships:

Operator	Ship	Owner	Ship Length
University of Hawaii	Moana Wave	Navy	210
Harbor Branch Oceanographic Institution	Seward Johnson	HBOI	204
Oregon State University	Wecoma	NSF	185
University of Rhode Island	Endeavor	NSF	184
Texas A&M University	Gyre	TAMU	182
Woods Hole Oceanographic Institution	Oceanus	NSF	177
Scripps Institution of Oceanography	New Horizon	SIO	170
Harbor Branch Oceanographic Institution	Edwin Link	HBOI	168

Regional Ships:

Operator	Ship	Owner	Ship length
Moss Landing Marine Laboratories	Point Sur	NSF	135
Duke University/University North Carolina	Cape Hatteras	NSF	135
University of Alaska	Alpha Helix	NSF	133
Scripps Institution of Oceanography	Robert G. Sproul	SIO	125
University of Delaware	Cape Henlopen	UD	120
Bermuda Biological Station for Research	Weatherbird II	BBSR	115
Harbor Branch Oceanographic Institution	Sea Diver	HBOI	113
Louisiana Universities Marine Consortium	Pelican	LUMCON	105
University of Texas	Longhorn	UT	105

Local Ships:

Operator	Ship	Owner	Ship length
Smithsonian Institution	Urraca	SI	96
University of Michigan	Laurentian	UMich	80
University System of Georgia	Blue Fin	UG	72
University of Miami	Calanus	UM	68
University of Washington	Clifford A. Barnes	NSF	66

Table 2.1 UNOLS Academic Research Vessels

The major study objective was to develop a cost structure to support, evaluate and financially analyze the fleet in terms of operations, maintenance, acquisition, and the modification of ship capability. The chosen structure allows for an in-depth cost comparison between various approaches or alternatives designed to meet the needs of the members of UNOLS. In addition, the data structure allows for the identification and study of fixed and variable costs.

Cost Element Structure

The costs were broken down into eleven major cost element categories. The elements of Salaries and Wages (both crew and shore) and Other Direct Costs were further broken down. Indirect costs were identified separately.

The UNOLS daily operating costs presented in this report cover a standardized complement of cost elements. They include:

- Vessel and crew costs
- Fuel and lube, provisions, port and customs fees
- Shore support, headquarters overhead and overhead support
- Procurement office support and augmentation support
- Docking fees and cellular communications

- An additional Captain or Mate (if needed for 24 hour operations)
- Crew travel (transportation of relief crews to distant ports and the return)
- Faculty visitations and travel, per diem and berthing (not including scientific party wages)

Data Sources Include:

- NSF Co-operative Agreements and Proposals
- Ship Operator Institutions
- Office of Naval Research
- Federal Oceanographic Fleet Coordination Committee
- Industry and other sources

3.0 DATA COLLECTION

Budget projections and actual costs were collected for all UNOLS ships for 1993 through 1997. Budgeted data, where available, was used where cost data was unavailable.

3.1 Average Cost per Day and Ship Length

There is a statistical relationship between the size of the ships within the fleet and the cost of operation. The average cost of operating Expeditionary ships with an average length of 270 feet was $15,757 a day. The range of costs was between $12,574 to $16,906. The smallest Expeditionary ship, the Maurice Ewing (239 ft), had an operating cost of $16,637, while the largest, Melville and Knorr (both at 279 feet), were $16,582 and $16,906, respectively. Figure 3.1 displays the relationship between ship length and operating cost per day while Figure 3.2 compares each ship to class averages.

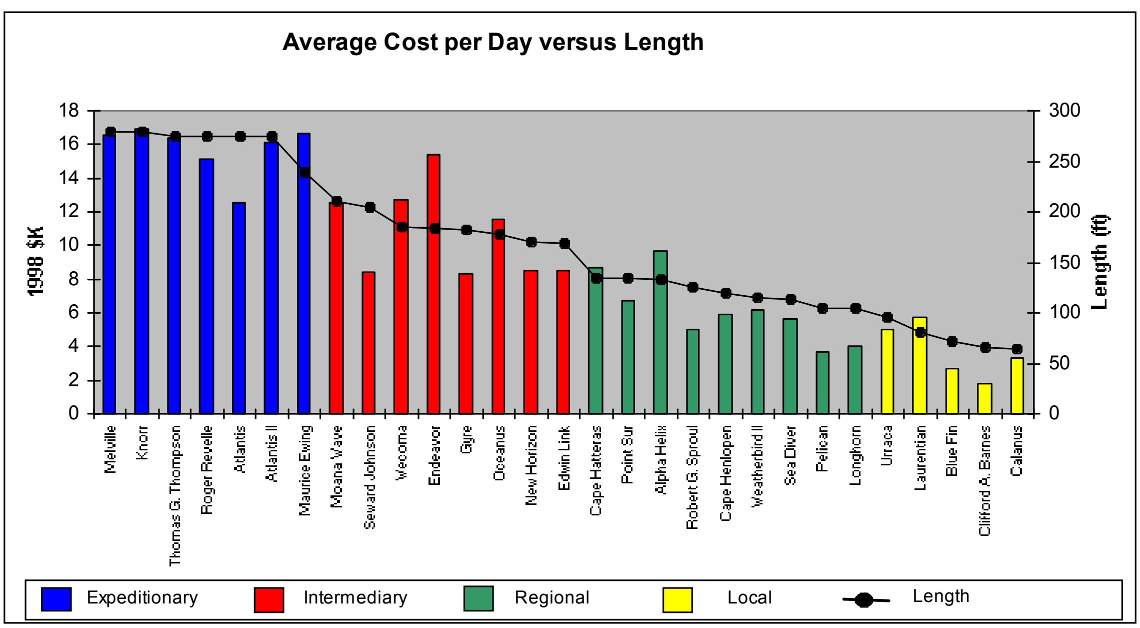


Figure 3.1 Ship Average Cost/Day and Individual Ship Lengths

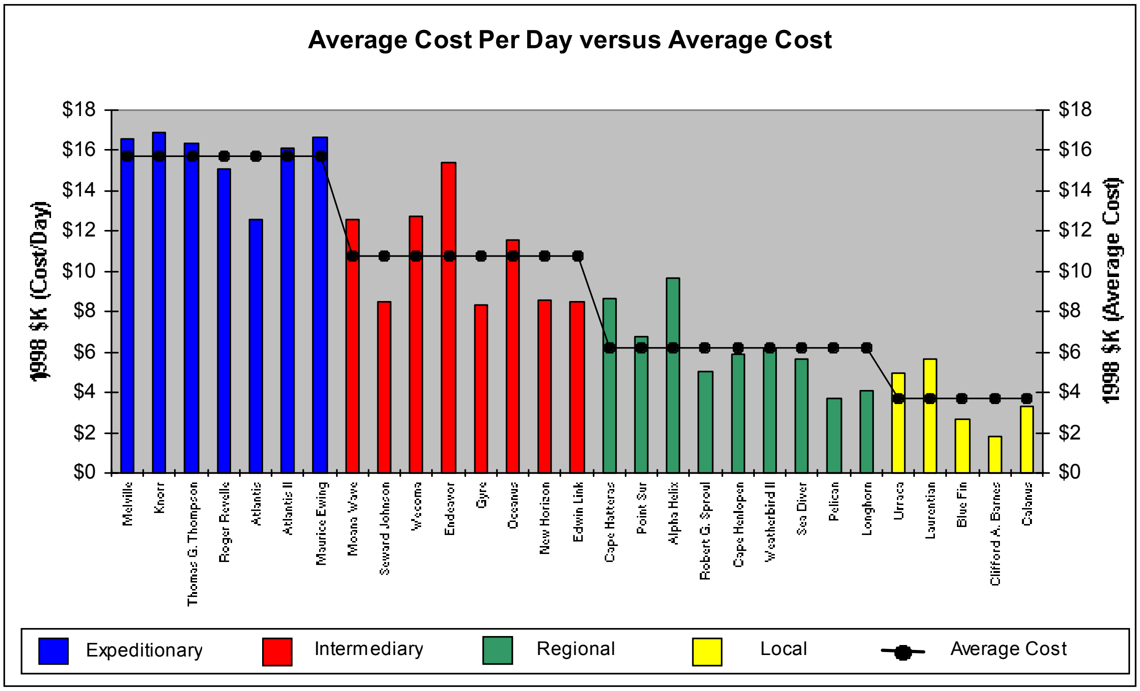


Figure 3.2 Ship Average Cost per Day and Class Average Ship Costs

3.2 Operating Cost Trends

Average cost data provides a frame of reference for comparing individual ships with their respective class average. Some variability of costs is attributed to differing research missions, ship utilization days per year, and special customer requirements and practices. The trend of data is most important, and costs have remained fairly constant between 1993 and 1997. Expeditionary ship operating costs decreased by 8.21% over the five-year period. This is approximately a two percent decline per annum. The average local ship cost per day increased from $2,910 in 1993 to $3,520 in 1997 (21%). It was the only class of ship that the cost per day increased. Figure 3.3 displays the class average cost per day for 1993 to 1997.

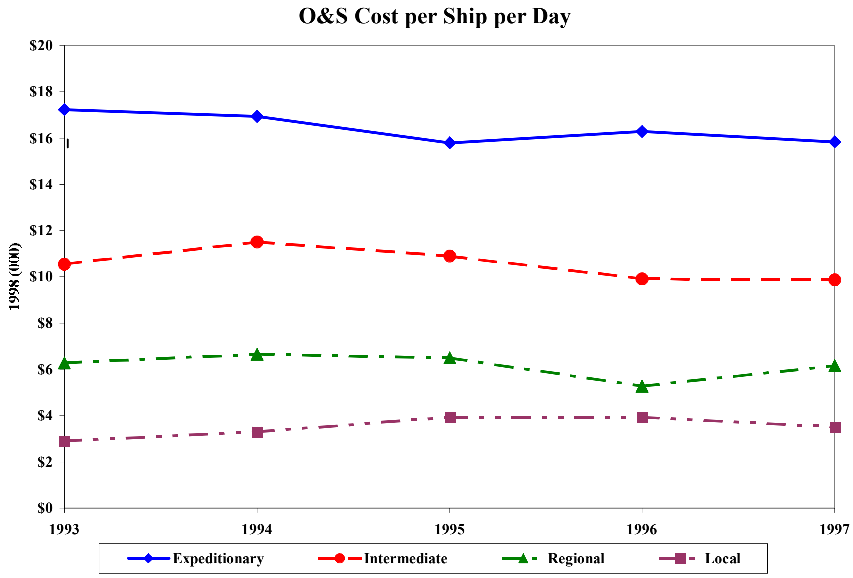


Figure 3.3 Ship Class Average Cost per Day

3.3 Utilization by Class

An analysis of the trend of operating costs is considered in respect to utilization levels. Utilization levels directly correlate with operating costs. The higher the number of days a ship is utilized the lower the cost per day, as there are more operational days to spread the fixed costs. The standard is the planning rate for the last five years. The average utilization rate and NSF standards for the fleet are:

Class	NSF Standard	Average
Expeditionary	300	285
Intermediate	275	188
Regional	180	152
Local	110	83

Although the five year averages are below the standard, the trend of the number of operating days per year has increased in all classes except for Regional ships. This is very positive. The Expeditionary class of ships has the highest utilization rate at 95% of the standard followed by Regional (84%), Local (75%) and Intermediate (68%). The Intermediate rate had increased to 77% by 1997. Figure 3.4 compares the operating days to the NSF Standard.

7

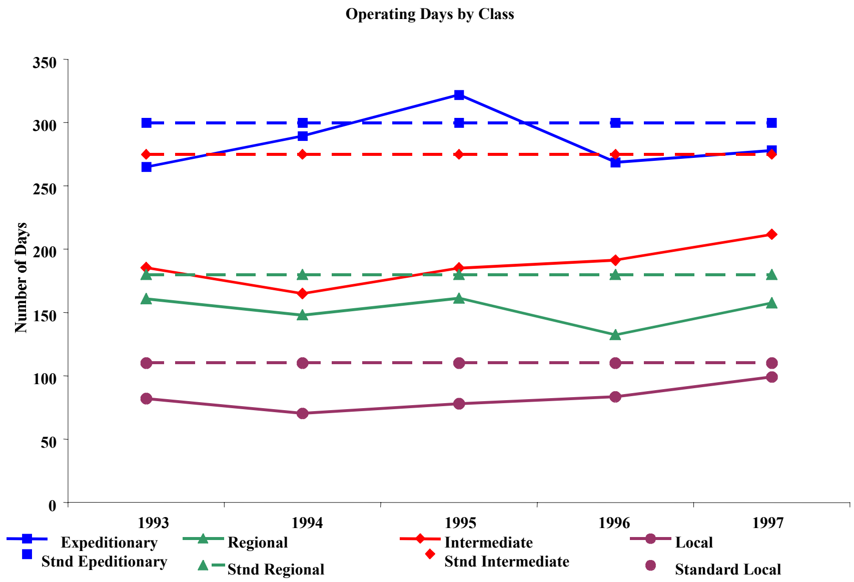
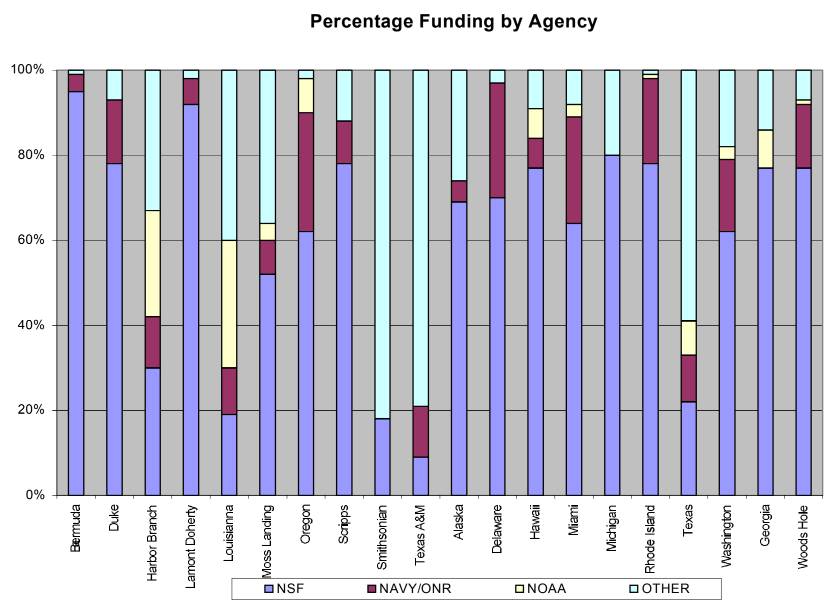


Figure 3.4 Operating Days to Standard

3.4 Funding Sources

Educational institutions conducting oceanographic research are funded from three major sources; NSF, Office of Naval Research (ONR), and National Oceanic and Atmospheric Administration (NOAA). Additional sources of funding include the Department of the Interior, National Institutes of Health, Environmental Protection Agency and a number of other federal agencies, state and local sponsors. Figure 3.5 shows the percent of each institution funding from the major sources.

Figure 3.5 Percentage of Funding by Agency



3.5 Cost Drivers

The major cost elements in the UNOLS daily rate are: Salaries & Wages (crew), Salaries & Wages (Shore Staff), Repair, Maintenance, and Overhaul, Other Direct Costs, and Indirect costs. Labor costs account for 48 percent (crew and shore staff combined) of the rate with Other Direct Costs being a distant second at 27 percent. Repair, Maintenance, and Overhaul costs are 13 percent while Indirect costs are 11 percent. Figure 3.6 depicts this data.

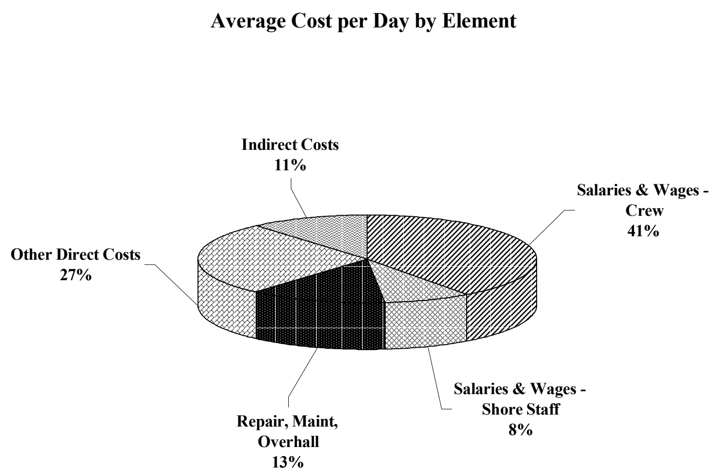


Figure 3.6 Costs per Day Cost Drivers

4.0 LAY-UP COSTS

Lay-up is the temporary removal of a ship from service. The removal may be for maintenance or to reduce operating costs. There are several management scenarios dictated by the lay-up duration. Lay-ups lasting several years reduce operating costs, due to decreased maintenance cost and no labor costs. No multi-year lay-ups occured in the academic fleet for 1993-1998. For periods of a year or less, there are a variety of costs incurred including dockage, preservation actions, insurance, security, shore support, and partial retention of the ships crew.

Short term lay-ups of three months or less are often done while retaining the crew. This is an institutional policy that has a major impact on lay-up costs, and is a critical factor in retaining scarce maritime skills. Short lay-ups do not typically result in significant cost savings.

Actual lay-up costs were available for the Endeavor (Intermediate) and the Cape Hatteras (Regional). Both were laid-up for one year. In both cases, approximately half the crew was retained to provide maintenance, security and some refurbishment of the ship. No Expeditionary ships were laid-up during the period of this report.

	Endeavor	Cape Hatteras
Crew Costs	$277,000	$317,000
Shore Staff	128,000	104,000
Insurance	32,000	25,000
Miscellaneous	57,000	13,000
Total	$494,000	$459,000

Lay-up scheduling among the operators is optimized to utilize anticipated down-time for maintenance. It would be beneficial to establish a more common criteria and procedure for placing vessels in lay-up. Nonetheless, the present system is working.

5.0 COMPARATIVE COSTS

The UNOLS daily costs presented in this report cover a standardized complement of costs including: vessel and crew costs, fuel and lube oil, per diem, provisions, port and custom fees, shore support, headquarters overhead, other overhead, procurement office support, docking fees, communications, an additional Captain or Mate (if needed for 24 hour operations), crew travel (to transport relief crews to distant ports and original crew to home port) and faculty visitations and travel. Per diem, berthing, but not wages, are paid for the complement of the scientific crew; scientists, technicians and students.

UNOLS rates are turnkey costs, encompassing vessel and crew costs as well as other factors not typically included in commercial rates. Although standardized, differences exist between the rate structures and accounting systems of different UNOLS institutions, ships performing different missions, and government-owned ships and academic-owned ships. A full assessment of these differences would require significant additional research. Comparative data is provided, however, to provide a preliminary comparison of UNOLS operating costs with governmental and commercially operated ships.

5.1 UNOLS and Naval Oceanographic Office Ships

Daily rates for the large UNOLS oceanographic research ships and similar Naval Oceanographic Office (NAVOCEANO) ships are shown below:

	NAVOCEANO	UNOLS
Cost per day	$22,000	$15,757

Several reasons explain the cost differences: 1) NAVOCEANO ships are larger and consequently have higher fuel and operating costs; 2) NAVOCEANO lifetime maintenance and overhaul and projected upgrade costs are included in the cost schedules; 3) Military Sealift Command (MSC) operation of NAVOCEANO ships provides forward-based support which is unavailable for UNOLS ships; and 4) Some overhead costs for UNOLS ships are not included in the daily rates, because they are borne by the ship owner (universities).

5.2 National Oceanographic and Atmospheric Administration (NOAA) Operations

NOAA daily operating costs include items not in the UNOLS rate. Those cost items are: general management and coordinating, some scientific equipment, safety inspections, fleet-wide computer systems, professional medical personnel, and limited technician support. Table 5.1 compares three NOAA ships with the UNOLS class average rates.

Ship	Length	Cost/Day	UNOLS Class Average
Ferrel	133	$ 6,033	$6,178
Oregon II	170	10,582	$10,753
Ronald Brown	274	13,513	$15,757

Table 5.1 Daily Rates for NOAA Ships

At a presentation held at the Scripps Oceanographic Institution during the fall of 1998, RADM William Stubblefield, head of the NOAA Corps, cited an operating cost for the Ronald Brown of $15,700 per day. These costs also included the costs associated with one survey technician. Updated cost data obtained from NOAA in early 1999 are shown below. According to NOAA, the Ronald Brown cost figure includes all the standard UNOLS cost elements. Like the UNOLS ship, this excludes scientists and technicians.

Table 5.2 shows a detailed comparison between the UNOLS ship Atlantis and the NOAA ship Ronald Brown on a per day basis. Atlantis and Ronald Brown are “sister ships” constructed to the same basic design and delivered for use starting in 1997 and 1998.

Cost Element	Atlantis	Ronald Brown
Salaries & Wages (crew)	$1,066	$1,780
Salaries & Wages (shore)	117	307
Repair, Maintenance, Overhaul	47	495
Fuel and Lube Oil	330	969
Food	71	99
Insurance	45	
Supplies and Minor Equipment	98	99
Travel	54	40
Shore Facilities Support	31	173
Miscellaneous	137	203
Total Direct	$ 1,997	$4,164
Indirect Costs	284	485
Total Costs	$ 2,281	$4,648
Operating Days	185	344
Daily Rate	$12,330	$13,513

Table 5.2 Atlantis/ Ronald Brown Comparison

It is important to note that the salaries for the scientists on Atlantis that support the manned submersible ALVIN are not included in the UNOLS rates. The berthing and per diem for those personnel are included. The above analysis shows how the number of operating days impacts the daily rate. The Ronald Brown annual operating cost was twice (204%) the cost for the Atlantis, but the daily rate was only nine percent higher. The Ronald Brown operated 159 more days than did the Atlantis.

5.3 Canadian Coast Guard/Department of Fisheries and Oceans

Table 5.3 shows the operating costs for 1998/1999 of selected Canadian Coast Guard/ Department of Fisheries and Oceans vessels. Supplemental data is provided to aid in the comparison with approximately comparable UNOLS ships.

Many ships are operated on a Lay Day system, usually on a 28-day on/off cycle, although others are operated on 14-day cycle. The complement refers to only one of the two crews - the TELEOST has a complement of 20 officers and crew, but in fact 40 people (plus relief) are assigned to the ship - 20 "on" and 20 "off."

The personnel costs are broken out into three subcategories: 1) salary and wages; 2) overtime; and 3) other personnel costs (which include bilingual bonuses, armed boarding training and allowance, search and rescue specialist training and allowance). Operating Costs are captured in the subcategories of Fuel and Lubricants, Provisions; Crew Changes (for example, the crew rotation taking place in a port other than the home port); and Voyage Repairs and Maintenance Consumables. The more current UNOLS ships have more scientists than crew, whereas most Canadian ships are older and more labor-intensive, and require larger crews.

UNOLS CLASS	CANADIAN VESSEL	TYPE	LENGTH	COST ($K/day)
EXPEDITIONARY				
	HUDSON	Ocean Research	275	$16.4 (CDN)
	Average Canadian Cost			$11.5 (US)
	Average UNOLS Cost			$15.8 (US)
INTERMEDIATE				
	JOHN P. TULLY	Ocean Research	210	$11.6 (CDN)
	PARIZEAU	Ocean Research	197	$11.0 (CDN)
	TELEOST	Research Trawler	192	$16.1 (CDN)
	W.E. RICKER	Research Trawler	177	$ 9.3 (CDN)
	Average Canadian Cost			$ 8.0 (US)
	Average UNOLS Cost			$10.8 (US)
REGIONAL				
	WILFRED TEMPLEMAN	Research Trawler	153	$14.0 (CDN)
	ALFRED NEEDLER	Research Trawler	153	$10.5 (CDN)
	VECTOR	Ocean Research	121	$ 6.3 (CDN)
	Average Canadian Cost			$ 7.2 (US)
	Average UNOLS Cost			$ 6.2 (US)
LOCAL				
	SHAMOOK	Research Trawler	76	$ 5.1 (CDN)
	CALANUS II	Research Trawler	61	$ 3.0 (CDN)
	OPILIO	Research Trawler	55	$ 1.1 (CDN)
	CALIGUS	Research Trawler	51	$ 1.0 (CDN)
	Average Canadian Cost			$ 1.8 (US)
	Average UNOLS Cost			$ 3.7 (US)

Table 5.3: Operating Costs for UNOLS and Canadian Research Vessels, 1998/1999

5.4 Charter/Contract Operated Ships

Costs for commercially chartered ships were compared to operating costs of UNOLS ships to a first order of magnitude. Many of the commercial rates as provided by industry appear competitive, but closer scrutiny reveals that commercial rates are not comparably calculated. Direct comparison of UNOLS and commercial rates is difficult, since commercial rates must be supplemented with mission specific costs such as fuel, crew travel, port fees, and other operating costs not included in "base rates."

Ship	Length	Commercial Base Daily Rate*	UNOLS Adjusted Rate**
R/V Ocean Ranger	242	$13,000	$9,837 - Expeditionary
R/V Atlantic Explorer	205	9,550	$9,181 - Intermediate
R/V Independence	200	9,500	
R/V Fox	190	8,950	
R/V Pacific Star	180	5,500	
R/V Davidson	175	6,500	
R/V McGraw	106	3,800	$4,894 - Regional
R/V Beacon	100	3,495	$3,232 - Local
R/V Heck	90	3,490	
R/V Southland	66	1,850	

* Does not include fuel, lube, customs, or dockage
** UNOLS rate without crew overtime, crew shore leave, fuel and lube oil, food, travel and miscellaneous

Table 5.4 Comparison between Commercial and UNOLS Rates

In summary, some quoted commercial rates do appear lower than those of comparable UNOLS ships, but the commercial rates omit the full complement of costs contained in the UNOLS rates.

While this analysis focuses on operating costs of UNOLS ships, ships operated by other institutions, and the commercial sector, additional considerations include research capabilities available on various ships. UNOLS ships come well equipped with laboratory equipment that has been optimized through years of experimental work. While many commercial ships have been chartered for scientific research, most have spartan laboratory facilities, if any at all. "Clean" power, a staple on research ships, may be unavailable, even unknown, on commercial, or even Navy, vessels. Furthermore, the crews on commercial vessels may not equal UNOLS fleet experience with scientific research missions.

6.0 CLOSING COMMENTS

This report is a short general summary of cost data for UNOLS ships and data provided by operators of similar research ships from government, commercial and international organizations for use by the Academic Fleet Review committee. Significant differences exist between the rate structures used by different institutions, ships performing different missions, and commercial, government and institution-owned ships. The comparative data, however, provides a preliminary comparison of UNOLS operating costs with governmental and commercially operated ships.

Academic Fleet Review Reports

Oceanography in the Next Decade: Building New Partnerships National Research Council (NRC), 1992

Opportunities in Ocean Science: Challenges on the Horizon National Research Council (NRC), 1998

The Ocean's Role in Global Change National Research Council (NRC), 1994

Global Ocean Science: Toward an Integrated Approach National Research Council (NRC), 1999

Projections for UNOLS' Future: Substantial Financial Challenges, University National Oceanographic Laboratory System (UNOLS), 1995

The UNOLS Fleet, Sea Technology Journal, 1998

The Academic Fleet: Past, Present and Future Marine Technology Society Journal 1998

UNOLS Fleet Improvement Plan Update: 1995, University National Oceanographic Laboratory System (UNOLS), 1995

GLOSSARY

ABS .... American Bureau of Shipping
ADCP .... Acoustic Doppler Current Profiler (instrument)
AGOR .... Auxiliary General Oceanographic Research (vessel designation, USN)
AICC .... Arctic Icebreaker Coordinating Committee (UNOLS)
Alvin .... Manned Research Submersible named after Allyn Vine
APROPOS .... Advances and Primary Research Opportunities in
Physical Oceanographic Studies
ASA .... Antarctic Science Associates
AUV .... Autonomous Underwater Vehicle
BBSR .... Bermuda Biological Station for Research
CCG .... Canadian Coast Guard
CoOP .... Coastal Ocean Processes
CORE .... Consortium for Oceanographic Research and Education
CTD .... Conductivity, Temperature and Depth (an instrument)
CY .... Calendar Year
DESSC .... Deep Submergence Science Committee (UNOLS)
DFO .... Department of Fisheries and Oceans, Environment Canada
DSV .... Deep Submergence Vessel
EPA .... Environmental Protection Agency (US)
FEMA .... Federal Energy Emergency Management Agency
FIC .... Fleet Improvement Committee (UNOLS)
FOCUS .... Future of Ocean Chemistry in the U.S.
FOFCC .... Federal Oceanographic Fleet Coordinating Council
FUMAGES .... Future of Marine Geosciences
FY .... Fiscal Year
GLOBEC .... Global Ocean Ecosystem Dynamics
HBOI .... Harbor Branch Oceanographic Institution
IDOE .... International Decade of Ocean Exploration
IGY .... International Geophysical Year
IWG .... Interagency Working Group
JGOFS .... Joint Ocean Global Flux Study
JOI .... Joint Oceanographic Institutions, Inc

LDEO .... Lamont-Doherty Earth Observatory
LUMCON .... Louisiana Universities Marine Consortium
MARGINS .... A major geological and geophysics program in the continental margins
MC&G .... Mapping Charting and Geodesy
MCS .... Multi-Channel Seismic Reflection
MIT .... Massachusetts Institute of Technology
MOP .... Major Ocean Program
MSC .... Military Sealift Command
NAS .... National Academy of Sciences
NASA .... National Aeronautics and Space Administration
NAVOCEANO ... U.S. Naval Oceanographic Office (or NAVO)
NERC .... National Environmental Research Council (UK)
NMFS .... National Marine Fisheries Service
NOAA .... National Oceanic and Atmospheric Administration
NOPP .... National Ocean Partnership Program
NOS .... National Ocean Service
NRC .... National Research Council
NSB .... National Science Board
NSERC .... National Science and Environmental Research Council, Canada
NSF .... National Science Foundation
OAR .... Office of Office of Oceanic and Atmospheric Research
ODP .... Ocean Drilling Program
OEUVRE .... Ocean Ecology: Understanding and Vision for Research
ONCO .... Office of NOAA Corps Operations
ONR .... Office of Naval Research
OPP .... Office of Polar Programs
OSU .... Oregon State University
PI .... Principal Investigator
PO .... Physical Oceanography
RIDGE .... Ridge Interdisciplinary Global Experiment
ROV .... Remotely Operated Vehicle
RSMAS .... Rosenstiel School of Marine and Atmospheric Sciences (University of Miami)
RVOC .... Research Vessel Operators Committee (UNOLS)
R/V .... Research Vessel

RVS .... Research Vessel Services (UK)
RVTEC .... Research Vessel Technical Enhancement Committee (UNOLS)
SSC .... Ship Scheduling Committee (of UNOLS)
SI .... Smithsonian Institution
SIO........................ Scripps Institution of Oceanography
SkIO .... Skidaway Institution of Oceanography
TAMU .... Texas A&M University
UCSC .... University of California, Santa Cruz
UD .... University of Delaware
UG .... University of Georgia
UK .... United Kingdom
UM .... University of Miami
U MD .... University of Maryland
UMICH .... University of Michigan
UNH .... University of New Hampshire
UNC .... University of North Carolina
UNOLS .... University-National Oceanographic Laboratory
URI .... University of Rhode Island
USCG .... US Coast Guard
USGS .... US Geological Survey
UT......................... University of Texas (at Austin)
UW .... University of Washington
WHOI .... Woods Hole Oceanographic Institution
WOCE .... World Ocean Circulation Experiment

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