UNIVERSITY-NATIONAL OCEANOGRAPHIC LABORATORY SYSTEM

An association of institutions
for the coordination and support
of university oceanographic facilities

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August 29, 1989

To: Worth Nowlin
Chair, FIC

From: William D. Barbee *Bill*

Subject: UNOLS Fleet Improvement Plan

Worth:

I've enclosed my comments on the 23 August draft UNOLS Fleet Improvement Plan. Comments are enumerated and then shown on the mark-up on your draft.

None of my comments are especially significant, although some of them denote errors, omissions or glitches of some kind.

Good job.

WDB/cml
Enclosures

Fleet Plan

p. 10 Add "endurance" to Mission Obsolescence statement.

Last paragraph, second line: delete "that" - and (that) the median age . . .

p. 12 Paragraph one, third line: should read such a plan cannot be overstated.

p. 17 Last paragraph, line two: cite as the NSF-ONR-NOAA submersible science study.

p. 23 Last paragraph: Suggest that this "recommendation" be strengthened: "The FIC believes this study should receive serious, thorough consideration as a candidate for any new UNOLS research vessel having those general mission requirements."

p. 24 Second paragraph, fifth line: Add renovation of KNORR and MELVILLE.

p. 31 Third paragraph: Add "and user assessments."

pp. 34, 35 Question: If the Glosten design were built, would it not be a Large, Median endurance? pp. 34, 35 seem to put it in the Large, High endurance category.

pp. 35, 36 Last paragraph, p. 35: Should note that numerical replacement for ALPHA HELIX may be by a larger vessel.

Also, presume you want the second p. 35.

p. 37 First paragraph: Change first sentence to imply NSF's RVIB in Antarctic -- will then be.

File: FIC 1989

UNIVERSITY-NATIONAL OCEANOGRAPHIC LABORATORY SYSTEM

UNOLS Fleet Improvement Plan

A Report from the
UNOLS Fleet Improvement Committee

Prepared as Part of an
Overall Fleet Planning Study

UNOLS Fleet Improvement Committee

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This report may be cited as:

UNOLS Fleet Improvement Committee, UNOLS Fleet Improvement Plan, UNOLS Fleet Improvement Committee Report, 31 pp, UNOLS Fleet Improvement Committee Office, c/o Department of Oceanography, Texas A&M University, College Station TX 77843-3146, 1989.

UNOLS Fleet Improvement Plan

A Report of the
UNOLS Fleet Improvement Committee

Draft, 23 August 1989

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I. Background

One purpose of the University-National Oceanographic Laboratory System (UNOLS) is to assess the match between facilities to support academic oceanographic research and the oceanographic research program needs, and then to make recommendations for replacing, modifying, or improving the number and mix of facilities. It has long been recognized that maintenance of a fleet of modern, capable research vessels is essential to the outstanding success of the U.S. program in academic oceanographic research.

In 1984, based on recommendations of its Advisory Council, UNOLS established an ad hoc Fleet Replacement Committee (FRC) charged with planning for the orderly replacement of the UNOLS Fleet. The charge to the FRC was:

1) Make an immediate start on planning for replacement of Class A and Class B ships (large, long-range vessels, some of them with special purposes). Some of these must be retired by the 1990s. Such ships are essential to our capability for modern oceanography. Planning for replacement must begin. The committee will prepare and propose mechanisms for drawing specific plans for new platforms.

2) A full schedule for replacement of intermediate and coastal vessels (Classes C and D) must be prepared. Planning must begin for at least one replacement in the late 1980s.

3) Detailed consideration is required of new means to promote greater cost efficiency, particularly fuel efficiency. Needed is specific anticipation to meet the needs of oceanography in the 1990s.

The FRC formulated scientific mission requirement for six classes of oceanographic vessels: three large, one intermediate, and two small. That committee concentrated its efforts on the preparation of plans for refitting the KNORR and MELVILLE and for construction of additional new large vessels with improved scientific capabilities. It commissioned and supervised six new concept designs, worked with the U.S. Navy in the preparation of two others by Naval Sea Systems Command (NAVSEA), and published in 1986 summaries of ten concept designs (including two commissioned by the University of Texas) for large oceanographic research vessels in three sub-classes; SWATH, high-endurance monohull, and medium-endurance monohull. Finally, before dissolving, the FRC prepared "A Plan for Improved Capability of the University Oceanographic Research Fleet" dated June 1986. This plan included by reference a "Summary of Concept Designs", "Science Mission Requirements for New Oceanographic Ships", and six reports of individual new ship design studies.

So successful was the FRC, that in November 1986, UNOLS established a standing Fleet Improvement Committee. The purpose and organization of that committee, as adopted by UNOLS in October 1988 as an Annex to its Charter, follow.

"*Purpose*. The Fleet Improvement Committee works to assure the continuing excellence of the UNOLS fleet, to improve the capability and effectiveness of individual ships and to assure that the number, mix and overall capability of ships in the UNOLS fleet match the science requirements of academic oceanography in the U.S. To that purpose, the Committee maintains the currency of a dynamic *UNOLS Fleet Improvement Plan*. The plan, updated periodically, includes:

Assessment of the number and mix of ship capabilities needed in the UNOLS fleet,

Development of science mission requirements for all size- and capability-classes of ships,

Definition of roles and the need for innovative research platforms,

Consideration of means for acquiring the needed vessels, including new construction, modification to existing UNOLS ships, conversions, private acquisition and leasing,

Development of conceptual or preliminary plans for ships to fill the needs identified, and

Development of a schedule for improvement and replacement of vessels so as to assure continuing fleet excellence.

The Fleet Improvement Committee will serve as a *liaison and planning activity as well as an information source* for federal agency representatives concerning long range planning, and funding for design, construction, or renovation of vessels for the UNOLS fleet.

Organization. The Chair and seven additional members of the Fleet Improvement Committee are appointed by the UNOLS Chair with recommendations from the UNOLS Council from UNOLS institutions. Those appointed should be experienced in ship operations and from institutions which are either operators or users of UNOLS research vessels. The Chair and at least three other members will be from UNOLS operator institutions, at least two members will be from institutions other than operators, and two members may be from any UNOLS institution. The FIC Chair is, ex-officio, a member of the UNOLS Council. Terms for all members are three years, for no more than two consecutive terms.

Demands on the Fleet Improvement Committee may be intense, and the development of ship plan may require significant financial management. With the approval of the UNOLS Chair and UNOLS Council, the FIC may arrange for staff and financial support for their activities. Proposals and grants for such support may be through the UNOLS Office or a UNOLS institution, as appropriate."

The UNOLS "fleet" considered in this plan comprises seagoing ships over 100 feet in length operated by U.S. academic institutions. The size of the operational fleet varies somewhat, but in recent years it has remained within 10% of 20 vessels. In 1988, UNOLS ships comprised a 20-ship fleet operated by 15 institutions, as shown in Table 1. The operating institutions are autonomous, but scheduling and performance standards are coordinated by the group acting jointly through UNOLS.

According to the UNOLS charter, "UNOLS vessels are those so designated by the UNOLS Council. They are those United States research vessels generally operated in support of national oceanographic research programs, by academic [UNOLS member] institutions and are significantly funded by the federal government. They are operated in accordance with UNOLS safety standards, subject to regular, recognized ship inspection programs, scheduled by established UNOLS procedures and meet cruise reporting, cruise

Table 1. The UNOLS Fleet – 1988

SHIP NAME	LOA (Feet)	DATE BUILT	DISPL. TONS	OWNER	OPERATOR
LARGE HIGH-ENDURANCE SHIPS ≥ 200 Feet					
None					
LARGE MEDIUM-ENDURANCE SHIPS ≥ 200 Feet					
MELVILLE (AGOR-14)	245	1969	2,075	U. S. Navy	Scripps
KNORR (AGOR-15)	245	1969	1,915	U. S. Navy	Woods Hole
T. WASHINGTON (AGOR-10)	209	1965	1,362	U. S. Navy	Scripps
T. G. THOMPSON (AGOR-9)	209	1965	1,302	U. S. Navy	U. of Washington
CONRAD (AGOR-3)	209	1962	1,425	U. S. Navy	Lamont-Doherty
MOANA WAVE (AGOR-22)	210	1973	1,403	U. S. Navy	U. of Hawaii
INTERMEDIATE SHIPS 150-199 Feet					
OCEANUS	177	1975	960	NSF	Woods Hole
WECOMA	177	1975	1,015	NSF	Oregon State U.
ENDEAVOR	177	1976	962	NSF	U. Rhode Island
GYRE (AGOR-21)	182	1973	980	U. S. Navy	Texas A & M
ISELIN	170	1971	830	NSF	U. of Miami
NEW HORIZON	170	1978	830	U. of California	Scripps
FRED MOORE	165	1967	992	U. of Texas	U. of Texas
SMALL SHIPS 100-149 Feet					
POINT SUR	135	1981	539	NSF	Moss Landing Marine Lab.
CAPE HATTERAS	135	1981	539	NSF	Duke U.
ALPHA HELIX	133	1965	554	NSF	U. of Alaska
CAPE HENLOPEN	120	1975	165	U. of Delaware	U. of Delaware
R. WARFIELD	106	1967	162	NSF	Johns Hopkins
R. G. SPROUL	125	1981	520	U. of California	Scripps
SPECIAL SHIPS Submersible-Support					
ATLANTIS II	210	1963	2,300	NSF	Woods Hole
Ice-Capable					
None					

assessment, cost accounting and performance standards according to UNOLS uniform practices. UNOLS vessels... are regularly available to users outside of the operator institution provided that funding is available...."

A useful comment on this definition (George Keller, UNOLS News) follows: "Being a UNOLS vessel does not carry with it any commitment for funding by federal agencies.... Certainly in many cases the funding pattern will not change from when the vessel was not part of the UNOLS fleet.... One might say UNOLS has become a certifier of academic research vessel operations to ensure that the research community has quality facilities from which to operate.... being designated a UNOLS vessel will mean that it is basically certified to safely and effectively carry out academic research as well as being available to the community for scheduling."

Most of the basic research projects of the Federal oceanographic program are carried out by ships of this fleet. The ships are, therefore, primarily general purpose types with special capabilities in the basic sciences disciplines. Chief sponsors for the utilization of UNOLS ships are the National Science Foundation and the Office of Naval Research. However, to some extent oceanographic projects of most Federal agencies are included in UNOLS ship operations. Nine of the nineteen UNOLS ships were built under grants from NSF and six are owned outright. Seven, including most of the larger UNOLS vessels, were built and are owned by the Navy (Office of Naval Research).

Over the past decade several reports have dealt with the role of UNOLS vessels either as a separate fleet or part of the more encompassing Federal Oceanographic Fleet. These reports include but are not limited to:

- Capital Structure for Ocean Science — 1975 (Center for Naval Analysis)
- Ocean Services for the Nation (NACOA, January 1981)
- Technology and Oceanography (Office of Technology Assessment, June 1981)
- Academic Research Vessels, 1985-1990 (Ocean Sciences Board, National Research Council 1982)
- Composition, Distribution, and Management of the UNOLS Fleet

(UNOLS Advisory Council, 1984)

- Secretary of the Navy Initiatives for Naval Oceanography (1984)
- Federal Oceanographic Fleet Study (Federal Oceanographic Fleet Coordinating Council, 1984)
- Emergence of a Unified Ocean Science: Long-range Plan for the Ocean Sciences Program of the National Sciences Foundation (Advisory Committee on Ocean Sciences, May 1985
- A Unified Plan for Ocean Science: A Long-Range Plan for the Division of Ocean Sciences of the National Science Foundation (Advisory Committee on Ocean Services, revised August 1987)
- Scientific Requirements for the UNOLS Fleet (UNOLS Fleet Improvement Committee, 1988)

Many additional ocean science planning documents have been prepared by the scientific community under the aegis of the various global science initiatives, such as TOGA, WOCE, GOFS, and RIDGE.

These reports document various views of where oceanography might be going as seen at various times in the past. The NSF Ocean Sciences Advisory Committee documents recommend in addition to a strengthening of ongoing discipline oriented programs, large-scale new interdisciplinary initiatives in global studies of the ocean and the underlying lithosphere. The 1984 Navy document expresses the intent of that organization to regain its position of leadership in oceanography, in order to undergird its ability to operate its new 600 ship force more effectively.

These initiatives imply a need for seagoing facilities of greater capability to upgrade our research fleet over the next fifteen years and maintain its effectiveness into the future.

If, as additional ships are accepted, the size of the UNOLS fleet grows beyond needed levels, the most capable vessels will be supported; others may not receive levels of support adequate to maintain them in good working condition. Another factor to consider is that the NSF and ONR have generally agreed to provide maintenance support levels for vessels they own.

II. Need for Continuing Fleet Improvement

The need to plan for new, more capable research ships to conduct scientific programs at sea has become virtually self evident. Numerous studies have demonstrated that our ships, mostly constructed in the 1960s and early 1970s, are becoming obsolete in their capability to support oceanography for the 1990s and beyond. The 1984 Federal Oceanographic Fleet Study (FOFCC) reported that two of its major findings give cause for concern:

- "Within the next fifteen years over 70% of the Federal fleet will have become overage and obsolete."
- "No agency has an approved plan for the replacement of ships as they become obsolete."

It concluded that the issue of fleet improvement is a matter of urgency and is to be considered one of the priority matters resulting from the Federal Fleet Study.

The 1982 NAS/OSB study on the needs for academic research vessels examined the growing demands being placed upon these ships. It noted the following: Much scientific equipment, especially that going onto or into the bottom, has increased in weight, bulk, and complexity, therefore requiring deployment from large, stable ships. Increasing complexity of electronic sensors and shipboard computers often result in an increase in the number of technicians who must go to sea, rather than a reduction in their number. The nature of new interdisciplinary ocean science research projects requires that several scientists from different disciplines be able to work on the same ship at the same time. This increases the demand for laboratory, storage and other working spaces aboard ship. Larger high performance overside handling arrangements and modern state-of-the-art shipboard laboratories will be needed to support major ongoing ocean programs. In addition, a high-quality working and living environment is essential in order to attract competent seagoing personnel.

Such studies illustrate that oceanographic ships are subject to two distinct forms of obsolescence:

Platform Obsolescence. Like any ship, an oceanographic vessel ages, eventually becoming either so mechanically outdated or so physically "worn out" that it is no longer economical to operate, repair, or upgrade.

Mission Obsolescence. Due to scientific and technical progress an oceanographic vessel may become unable to perform a useful oceanographic mission, not because it is obsolete or worn out as a ship, but because the mission itself has evolved out of reach. For example, a ship that was satisfactory when built may be unable to take useful data today because it is too noisy, too small, too slow, or too un-seakindly for today's oceanographic mission or simply because it cannot successfully support modern oceanographic equipment.

The factors which define platform obsolescence have no set value. They include material condition, maintenance costs, habitability, and the capability to "keep up" with the changing needs of scientific requirements. The most commonly used measure is age. In time, conditions will deteriorate to a point where the platform is no longer tolerable. The life span of a contemporary research ship is generally regarded to be 30 years; this can vary from 20—40 years, depending on its construction, maintenance, and service. Likewise, mission obsolescence results because requirements evolve in time beyond the capability of the ship to respond. Here the time scale is often shorter than in the case of platform obsolescence.

In addition to planning for fleet improvement by refits and replacements of conventional ships, it is important that UNOLS planners maintain a current awareness of special facilities and innovations that could improve the fleet. For that reason, the Fleet Replacement and Improvement Committees have developed scientific mission requirements for Small Waterplane Area Twin Hull (SWATH) research ships in three size classes and have published concept designs on large and medium SWATH general-purpose research ships. The FIC has developed scientific mission requirements for a manned spar buoy laboratory and an intermediate ice-capable research vessel. Further, mission profiles are under development for a research submarine and plans are to develop mission requirements for a large submersible-support ship.

The UNOLS Fleet Replacement Committee (FRC) considered the UNOLS fleet as of 1985. At that time, the average age of the fleet was 14 years and ~~that~~ the median age was 13 years. Actual ages ranged from 5 to 24 years. However, considering the larger ships as a separate asset, the average and median ages were 20 years. On this basis, the case was made in 1984–1986 by the FRC that planning for replacement of the larger ships was the most pressing issue. Actions taken during the past five years by the Federal agencies supporting oceanography have gone far to redress this need by conversion, mid-life refits, and new construction of a total of four research vessels greater than 274 ft in length. (See section *V* for details.)

Even so, study of Table 1 indicates strongly the need for long-term planning for the refit and replacement of the academic fleet. As one example, 5 of the 6 intermediate ships now operating will be eligible for mid-life refit within a 6-year period; later, they will all reach retirement age within a period of equal length. During these same periods, one large and one small vessel will reach refit and retirement ages. It probably is not realistic to anticipate 7 new ships during a 6-year span. Instead, new ship replacements must be planned to occur over a larger time period. Some ships will be expected to operate past a nominal 30-year retirement age. If fleet capability is not to be jeopardized however, replacement should begin as early as budget planning allows.

Moreover, examination of Table 1 reveals that no ice-capable vessels exist in the UNOLS fleet — nor are such vessels available to U.S. scientists from other U.S. operators. There is the need for such capability in both polar regions (as is discussed later). Also evident is the advanced age of our submersible-support vessel, the ATLANTIS II.

Beyond the needs for improving our existing fleets, as individual ships move into obsolescence, the programs and concepts embraced by the science planning documents clearly indicate a need to acquire ships having new and increased capabilities. This implies ships of somewhat larger size but probably no increase in numbers of ships.

In summary, at this time both the composition of the fleet with regard to age and scientific mission requirements indicate that, though we should maintain attention on the completion of construction, conversion and refitting of the large ships, we must now begin preparing studies (comparable in detail to those prepared for large vessels) for upgrading our intermediate and coastal components. And, we should give due attention to special facilities and capabilities as we plan our fleet of the future.

III. Development of a Plan

A goal of UNOLS — and one of the objectives for which UNOLS was established — is to develop and update a long range plan for university oceanographic facilities. The importance of such a plan cannot be understated. Because most oceanographic facilities, especially ships, are built with Federal funds, all new acquisition must compete in an increasing rigorous manner for support. Unless requests for new ships and other facilities are accompanied by substantive, credible, and approved plans showing how such new facilities fit into the needs for future oceanographic research, those requests will have little likelihood of succeeding.

Two previous long range plans had a significant impact on the development during the 1960s and 1970s of university oceanographic facilities. One of these was the 1959 National Academy of Sciences Committee on Oceanography (NASCO) Report "Oceanography 1960 - 1970". The other was the U.S. Navy's first long range oceanographic planning document "Ten Years of Oceanography (TENOC)".

The UNOLS planning process was initiated with:

- Preliminary Report, UNOLS Long Range Planning Meeting, May 1975.
- a UNOLS Advisory Council report "On the Orderly Replacement of the Academic Research Fleet", July 1978.

These were followed by the final report of the UNOLS ad hoc Fleet Improvement Committee, "A Plan for Improved Capability of the University Oceanographic Research Fleet", June 1986.

The goals of the FRC study were to:

- Develop the requirements for new research ships based on the best possible projections of ocean science and engineering,
- Produce concept designs of new classes of research ships which meet the stated requirements in terms of size, science capabilities, and other characteristics, and

- Develop a plan for the orderly replacement of the existing UNOLS Fleet incorporating a recommended mix of ship sizes and types along with priorities, time frame, and construction costs.

The Fleet Improvement Committee has furthered these goals of the FRC and in addition has initiated the pursuit of preliminary design studies (with that of a large, medium-endurance monohull ship). Beginning with the FRC fleet improvement plan, and incorporating its studies and new developments in ocean sciences, the Fleet Improvement Committee has prepared a revised plan for the continued improvement of the UNOLS fleet.

This proposed UNOLS fleet improvement plan is based upon needs envisioned by CY 2000. Overall numbers and mix of ships probably will not differ significantly from current inventories. Changes are anticipated in areas of special capabilities such as geophysics, submersible handling, and polar research. Most important, however, is the capability of new ships to successfully do the kinds of science which our present ships cannot now do, and to do them in places, times, and sea states in which our present ships are prohibited.

Basic criteria of the plan are:

- To be responsive to the anticipated future trends and needs of oceanographic research and engineering,
- To be realistic in terms of the national economy,
- To bear the general approval of the academic community,
- To be sufficiently credible to compete in the Federal funding infrastructure,
- To provide a logical implementation scheme bridging the current and projected time frame, and
- To provide for periodic updating.

The time frame for retiring of existing ships should be based upon:

- Age and material condition of existing ships,
- Deficiencies in capability of existing ships, and
- The needs of ongoing and projected science irrespective of existing ships.

IV. Recommended UNOLS Ship Capabilities

A. Scientific Mission Requirements

The beginning point for any facility planning is an orderly statement of the mission requirements. In the case of research vessels, it is the science requirements which define the type of ship along with the size, speed, endurance arrangements, and overall capability. Habitability, safety, and cost are important aspects and can have a significant impact on ship design, but these are either mandatory or statutory and usually are defined elsewhere.

Work to date has compiled nine sets of mission requirements:

- Large, high-endurance, general-purpose research ship—size range 250–300 ft
- Large, medium-endurance, general-purpose research ship—size range 200–249 ft
- Large, general-purpose, SWATH, research ship—size range over 200 ft
- Intermediate general-purpose research ship—size range 150–199 ft
- Intermediate, ice-capable, general-purpose research ship—size range 150–199 ft
- Intermediate, general-purpose, SWATH research ship—size approximately 150 ft
- Small, general-purpose, SWATH research ship—size approximately 100 ft
- Small, general-purpose, research ship—size range 100–149 ft
- Manned spar buoy

Scientific mission requirements for a research submarine are under development. There are plans for development of requirements for a large submersible-support ship.

Based on concept designs completed to meet these scientific mission requirements, the intermediate SWATH ship may have more improvements and fewer disadvantages (relative to monohulls) than the large SWATH. However, this could result from having placed too stringent requirements on a large SWATH. Therefore, the mission requirements for the large, general-purpose SWATH are being reconsidered by the FIC.

These scientific mission requirements define needs for operational capabilities, working environment, science accommodations, and outfitting of the kinds of ships which the UNOLS Fleet Improvement Plan has identified.

Each set of requirements defines the general-purpose (multidisciplinary) science role for which that ship type is intended. Requirements for enhanced capabilities or "options" such as multichannel seismic capability may be added to the basic requirements as dictated by specific ship planning. (see section IV.B.)

Current editions of requirements are published separately. These have been developed by working groups of practicing, seagoing scientists. As much as possible they have been, and continue to be, reviewed and revised throughout the community. The final design, construction, and outfitting of future new ships will be based on the contents of these requirements. It is important that all seagoing science persons give serious attention to their content.

In any statement of requirements, an ordering of priorities is important for the guidance of follow-up activities leading to the design and construction of the facility. In the case of research vessels the following factors have been ranked by groups of practicing investigators from all disciplines. As with any set of priorities interpretations will differ between ship sizes and areas of use. The following is a majority viewpoint but not a consensus:

Table 2. Priorities for Research Ship Requirements

- Seakeeping
  - Station Keeping
- Work Environment
  - Lab Spaces and Arrangements
  - Deck Working Area: overside handling; winches and wire
  - Flexibility
- Endurance
  - Range
  - Days at Sea
- Science Complement
- Operating Economy
- Acoustical Characteristics
- Speed
  - Ship Control
- Pay Load

– Science Storage
– Weight Handling

Most respondents agreed that seakeeping, particularly on station, and work environment were the two top priorities. But the remaining requirements were ranked so closely together that they become of equal importance. The stated scientific mission requirements which are set for each of these areas then become threshold levels, and any characteristic which falls below the threshold becomes a high priority. For example, speed, which is ranked relatively low in Table 2, would become a matter of concern if a proposed ship showed a design speed below the required, or threshold, level.

This emphasizes the importance of assigning genuine, realistic requirements. The acceptance of a design characteristic less that the original requirement signifies either that the original requirement was not well established, or that the ship may not measure up to its intended service.

B. Special Capabilities

The needs of some scientific disciplines and of operating environments dictate that special capabilities must be incorporated in some vessels of the UNOLS fleet. These are briefly described here.

Special geophysical and geological sampling equipment. According to the Federal Oceanographic Fleet Study (1984), Marine Geology and Geophysics (MG&G) ship time requirements amounted to over 21% of the total ship needs for all Federal Agencies in the years 1983 - 85. Within the UNOLS Fleet component, which is concerned with basic research, the MG&G requirements was 34% of total ship needs. Only a small fraction of this ship time is required for multi-channel seismic work — probably less than one ship year annually at present.

Multichannel seismic capability Perhaps the most demanding design aspect for ships enhanced for seafloor studies is the requirement for a multichannel seismic profiling (MCS) system. These MSC systems are the essential tool for probing the deep geologic structure beneath the seafloor. In fact, no other shipborne geophysical technique can provide the scientist with such detailed, structural images and direct measurements of mechanical properties of seafloor materials.

Major components of an advanced multichannel seismic system for academic research are:

- Streamer—A 3600-6000 m seismic streamer with reel. The reel is mounted near the stern, is 5 m high, has a 6-m x 6-m footprint, and weighs 15 to 20 tons.
- Acoustic sources—An array of up to 24 airguns towed from booms in strings or paravanes mounted on the stern. Deck equipment for handling airgun arrays and a close-by shop of maintenance are required.
- Compressors—Compressors that can supply up to 3000 SCFM at 2500 psi. Some of the compressors could be in vans.
- Storage Space—Ample storage space for streamer accessories such as tail buoys and spare sections is required.

Acoustic characteristics. [M.LANGSETH]

Deep-tow handling. [F.SPIESS]

Dynamic positioning. [M.LANGSETH]

Submersible Handling. The research usefulness of the Deep Submergence Vehicle ALVIN is a matter of record. According to the 1982 NSF-ONR-NOAA Submersible Study, the most outstanding requirement to further the effectiveness of ALVIN, was an adequate support vessel. In 1983 the R/V ATLANTIS II was converted to handle the ALVIN by a single point lift-stern "A"-Frame. The conversion entailed the installation of the A-Frame and associated machinery, hangar, deck modifications and shops. Some loss of laboratory space and science berthing resulted but the overall effect has been to drastically increase the utility of the submersible and make it a partner in other scientific investigations from the ship. Little of the general purpose capability of the ATLANTIS II has been lost but it has become evident that a replacement vessel should provide additional deck working area and science berthing. Such a vessel, even upgraded from the present, should remain within the medium-endurance size range.

Both the 1979 diesel conversion and the 1983 refit have contributed to an extended service life of the R/V ATLANTIS II. It seems reasonable to expect retirement and probable replacement later than indicated by age alone.

Although it is not the task of this report to include manned submersible requirements, it can be stated with some confidence that the requirement for at least one such vehicle will continue into the next generation of research vessels and bring about the need for a replacement submersible handling vessel on the occasion of the ATLANTIS II retirement. Furthermore, it can be forecast that the next generation of deep submersible probably will be a 6,000- to 10,000-m depth vehicle. Judging from DSV SEACLIFF such a submersible would weigh 25-tons compared with ALVIN at 16-tons. The ATLANTIS II would not be capable of handling such a submersible and continue to serve as a research vessel.

Ice-worthy vessels. The subject of a Polar Research Vessel has attracted a great deal of attention over past years along with no little controversy. According to a recent interagency report, "Polar Icebreaker Requirement Study" (Department of Transportation, 1984), issues surrounding the Polar Research Vessel include:

1. What *is* a Polar Research Vessel? The perception of what it is varies between agencies and even individuals.
2. Is there justifiable need for a research-dedicated vessel(s) for arctic and antarctic service? Should this include the capability for true polar ice-breaking?
3. If a vessel were to be acquired, what agency would be responsible for its operation, and in what manner and to what standards?

The 1984 study proposed the following definitions be applied to the various ice-worthy types of vessels.

• **Ice strengthened** - A vessel able to operate in very open pack (<3/10 concentration), first-year thin ice (or earlier stage of development), which is less than 1.4 feet think. The vessel is structurally strengthened around the waterline and has a conventional bow form. Safe navigation through sea ice is possible only under ice escort. The strengthening around the waterline is designed to minimize damage from the hull hitting sea ice at slow speed.

• **Ice-capable** - A vessel able to operate in open pack (4/10 to 6/10 concentration), first-year thin/medium level ice, which is 1.5-4.0 feet thick. The vessel is structurally strengthened around the waterline, has an ice-breaking bow form, and has more horsepower than required for transit through ice-free waters. Safer navigation can be accomplished independently in very open pack; however, in open pack (or greater concentration, it is prudent to navigate with an ice escort. For independent operations, the vessel must navigate at slow speed using available leads in the pack ice and/or by pushing the ice out of its path. An example of this vessel type is the former R/V ELTANIN.

• **Icebreaker** - A vessel able to operate independently in close pack (or greater), first-year thick to multi-year ice, which is greater than 4.0 feet in thickness. The vessel is structurally strengthened around the waterline, has an ice-breaking bow form, and has added horsepower and displacement to continuously break level first year pack ice without risk of hull damage. Vessel endurance, facilities and berthing are dependent upon the design mission needs. Examples of this vessel type are USCGS POLAR STAR (3.1 feet [CHECK] of level ice at 3 knots [CHECK]) and LEONID BRESHNEV (7.5 feet of level ice at 3 knots).

The need for a polar research vessel which meets one or more of these criteria has been reaffirmed consistently. In 1984 the Federal Oceanographic Fleet Coordination Council (FOFCC) undertook a study on the need for a Polar Research Vessel. Its findings showed shiptime requirements of 573 days about evenly divided between <u>icebreakers</u> and <u>ice capable</u> ships. It recommended that an <u>ice capable</u> vessel in the 250-275 ft range be acquired and operated by the National Science Foundation as a national facility. Earlier studies within the National Research Council identified the needs for ice worthy vessels in both arctic and antarctic regions.

More recently, the UNOLS Fleet Improvement Committee reports "Arctic Science Requirements for Ice-worthy Research Vessels" (Vera Alexander et al., 1988) and "Scientific Mission for an Intermediate Ice-Capable Research Vessel" (Thomas Royer et al., 1989) have documented special needs for ice-worthy research vessels in the Arctic. Selected UNOLS vessels should be prepared to operate in these regions. In many instances they will be the only ships available. In order to prepare for this, at least two ships in separate size classes — one large and one small-to-intermediate — should be ice-capable.

Twice in recent years the Research Vessel ALPHA HELIX (ABS Ice Class C) operating in northern Alaska waters sustained ice damage and failed to accomplish its scientific mission. Numerous other instances exist where relatively light ice has constrained UNOLS (and other) research ships from intended areas of investigation.

Polar research can, and should, be accomplished from ice-breakers and from lesser ice worthy but ice capable vessels dedicated to polar research. The Coast Guard is including a significant oceanographic capability in the design of a new replacement icebreaker.

In 1984 following an intensive search, NSF chartered the 219-ft Norwegian-built (1983), Canadian flag vessel POLAR DUKE. This ship, designed to Arctic Sealer specifications as an off-shore survey vessel, is ABS Ice Class 1AA and DNV-1A1-Sealer and meets the "ice capable definition" above. Its primary mission is logistic support for the Palmer Antarctic research station, but vessel time is available for oceanographic research assignments in that region.

Ice-capable UNOLS ships should be built to ABS Class 1AA standards. Special provisions should be included for overside and deck work in cold regions. However, such vessels should not be considered "dedicated" polar research ships and seakeeping should share equal, if not greater, importance to ice worthiness.

C. <u>Concept Designs</u>

An important step in the planning process is the "concept design" of new ships to meets the intended requirements.

The classic design spiral begins with the Concept Design phase, continues with the Preliminary Design phase, and ends with the Contract Design phase leading to construction. The sequence of steps may vary with the individual design problem and with individual design practice.

The concept design stage proposed here is the first step in translating the state requirements for a ship into the actual design process. It is a technical and engineering effort by a qualified naval architect to develop a hull form, machinery system, and general arrangements which integrates the various scientific requirements, combining laboratory arrangements, deck handling, storage and ship control into a single shipboard system. Here the requirements of the regulatory agencies, principally Coast Guard and the American Bureau of Shipping (ABS) are defined. From this the community of oceanographers can evaluate whether the ship thus described is what they really had in mind.

The scope of a concept design includes:

- Technical description of the vessel design
- Discussion of the vessel design and its responsiveness to the scientific requirements and ship characteristics stated
- Summary of ship specifications
- General arrangements plans
- Inboard profile and outboard profile plans
- Scientific arrangement
- Machinery arrangement
- Operating characteristics, including costs
- Estimated construction cost
- Artist's conception drawing

The concept design review provides the opportunity for feedback into the requirements and the testing of the many comments and suggestions which ought to be available at this stage. It is doubtful whether the next stage of the design process, the preliminary design, will closely resemble the conceptual design. But the concept design will have served its purpose if it permits the next stage to start with any reasonable degree of confidence.

Concept designs completed for UNOLS which should be considered as part of this revised fleet improvement plan are referenced in Table 3.

Table 3. Concept Designs Completed

Large, SWATH research ships

- 2,500-ton SWATH Oceanographic Research Ship; SSS Corp.; February 1985
- Semi-submerged Research Ship; Blue Sea ; April 1985
- Large Oceanographic Research Ship; SWATH AG(X); Naval Sea Systems Command, Preliminary Design Div.; August 1985

Large, high-endurance research ships

- Large Oceanographic Research Ship; MONOHULL AG(X); Naval Sea Systems Command, Preliminary Design Div.; August 1985
- High Endurance Oceanographic Research Ship; J. Leiby, Woods Hole Oceanographic Institution; December 1985
- Large Oceanographic Research Vessel; Rodney E. Lay & Associates; October 1985
- General Purpose Oceanographic Research Ship with Enhanced Marine Geology and Geophysics Capability; John W. Gilbert Associates; October 1985

Large, medium-endurance research ships

- "MG&G Friendly" Oceanographic Research Ship; Marinette Marine Corp.; May 1985
- Large Oceanographic Research Ship; M. Rosenblatt & Son, Inc.; October 1985
- Medium Endurance General Purpose Oceanographic Research Ship; Glosten Associates; November 1985

Intermediate research ships

- General Purpose SWATH Oceanographic Research Ship; SEACO; September 1988.

These designs have been printed and distributed as separate UNOLS reports of the Fleet Replacement and Fleet Improvement Committees. The concept design for an intermediate twin-strut SWATH ship is being modified in an attempt to improve station-keeping performance. A concept design for a small, general-purpose, SWATH research vessel is underway.

It is recommended by the Fleet Improvement Committee that concept designs be undertaken now for a tandem-strut intermediate SWATH ship, to compare potential performance with the twin-strut concept, and for an intermediate ice-capable general-purpose vessel for use in the western Arctic.

D. Preliminary Designs

Based on requirements for support of scientific missions aboard general-purpose oceanographic research ships, the UNOLS Fleet Replacement Committee initiated and oversaw concept design studies for three distinct large, medium-endurance monohull ships. The potential inherent in these designs was so great that UNOLS instructed its Fleet Improvement Committee to initiate and provide scientific guidance for a preliminary design of a large, medium-endurance, general-purpose oceanographic research ship combining the best features of the concept designs. The Committee selected for the preliminary design work the Glosten Associates, Inc., whose concept design was judged to have the most potential.

This study was funded by a grant from the National Science Foundation. The Scripps Institution of Oceanography was the prime contractor. Dr. Fred Spiess was the contractor's representative. A subcommittee of the UNOLS Fleet Improvement Committee consisting of Marcus Langseth, James Murray, and Fred Spiess (chairman) provided scientific guidance to Glosten Associates, Inc. during the study. The report from Glosten Associates, Inc., issued as a UNOLS FIC report, presents the preliminary design. The FIC believes this study has produced the design for a very capable vessel, a design that should be considered carefully for new research vessels with these mission requirements.

V. A Plan for UNOLS Fleet Improvement

A. Guiding Precepts

Several precepts have guided the development of a plan for improving the UNOLS fleet. The major ones are:

1. Many of the existing ships (and particularly the large ones) are not capable of meeting the present requirements of science at sea, and with the increased requirements foreseen for the future, these shortcomings will be exacerbated. The average age of the large ships at the start of 1989 was 23 years. The acquisition of BERNIER, OSPREY, and AGOR-23, as well as the renovation of the KNORR and MELVILLE and the retirement of CONRAD and THOMPSON will improve this. At the beginning of 1990, the average age of the fleet of large and intermediate vessels will be 15 years, the nominal mid-life of 30 years for vessels in this size range; the average age of the small-size vessels also will be 15 years, somewhat more than the desirable mid-life (25 years) for the smaller vessels. Two programs should be initiated and go forward in parallel: A long-term plan for construction of new hulls to replace the oldest ones; and a short-term plan for mid-life refits and upgradings to improve the remainder.

2. New ships should have improved seakeeping and station keeping characteristics; and should have upgraded laboratories, overside handling capability, and scientific outfitting. It is likely that this will lead to increased average size. To the extent possible, these improvements should also be made to existing ships during their mid-life refits; this may require stretches to accommodate improved equipment.

3. The numbers of future ships needed to support scientific requirements is not expected to be significantly different from the existing fleet. (To the extent that scientific productivity per ship can be increased, some reduction in the total number may be possible.) Thus, as noted earlier, as additional vessels are accepted into the UNOLS fleet, it may contain more ships than can be supported by traditional funding sources for academic oceanography.

4. The mix of ships is about evenly divided between the size classes, i. e., large, intermediate and small ships. However, the size of ships in all classes necessarily

increases to fulfill the UNOLS scientific mission requirements. Note also that vessels in the large size class now fall into two categories: those meeting the scientific mission requirements for high-endurance vessels, and those meeting the requirements for medium-endurance vessels.

5. Particular attention should be given to making both new and upgraded ships more economical to operate. While this will likely make the initial investment costs somewhat larger, it must be remembered that the cumulative life-time costs of operation are very large compared to the one-time costs of construction or modernization. Consideration should be given not only to more efficient equipment, such as fuel-efficient engines and improved anti-fouling and anti-corrosion systems, but also to lowered personnel costs through the use of unattended engine rooms and modern overside handling systems.

6. Several of the new or upgraded ships should have, in addition to multidisciplinary general purpose capabilities, the capability, or option, for a particular discipline or field of work. These include multichannel seismic capability, the handling of submersibles or extremely large pieces of equipment, or high-latitude work.

7. Consideration of the capabilities of the UNOLS fleet should include recognition of the potential impacts of availability of non-UNOLS vessels.

8. Necessary improvements to the UNOLS fleet are ongoing and must continue. Replacements should continue to be planned in a systematic manner to permit replacing small ships by their 25th year, and those of intermediate and large size by their 30th year. It is often mission obsolence and not platform obsolence which determines the optimum vessel lifetime.

9. Major refits or upgrades should be made to all ships at about their mid-life. These refits must be planned well in advance to optimize fleet utilization.

B. Summary of Present UNOLS Fleet Composition

Below are shown the UNOLS ships as of mid-1988 in order of decreasing age within size groups. Also shown is when each ship should be (or was) refit and when it should be replaced. The age of the ship is in parentheses following the year for each action.

Table 4. Beginning year of service and proposed year of refit and retirement for UNOLS ships in operation as of mid-1988.

SHIP NAME	INST.	IN SERVICE	REFIT	REPLACE
		LARGE HIGH-ENDURANCE SHIPS ≥ 200 Feet		
None				
		LARGE MEDIUM-ENDURANCE SHIPS ≥ 200 Feet		
CONRAD	LDGO	1962	1980 (18)	1989 (27)
T.G. THOMPSON	U. Wash.	1965	---	1989 (24)
T. WASHINGTON	SIO	1965	---	1991 (26)
MELVILLE	SIO	1969	1990 (21)	2010 (41)
KNORR	WHOI	1969	1989 (20)	2009 (40)
MOANA WAVE	U. Hawaii	1973	1985 (12)	2005 (32)
		INTERMEDIATE SHIPS 150–199 Feet		
FRED MOORE	U. Texas	1967	---	1988 (21)
ISELIN	U. Miami	1971	1988 (17)	1998 (27)
GYRE	TAMU	1973	1991 (18)	2003 (30)
OCEANUS	WHOI	1975	1992 (17)	2004 (29)
WECOMA	OSU	1975	1992 (17)	2004 (29)
ENDEAVOR	URI	1976	1995 (19)	2007 (30)
NEW HORIZON	SIO	1978	1995 (17)	2008 (30)

SHIP NAME	INST.	IN SERVICE	REFIT	REPLACE

SMALL SHIPS

100–149 Feet

SHIP NAME	INST.	IN SERVICE	REFIT	REPLACE
ALPHA HELIX	U. Alaska	1965	~1978 (13)	1993 (28)
R. WARFIELD	CBI	1967	---	1993 (26)
CAPE HENLOPEN	U. Del.	1975	---	1999 (24)
CAPE HATTERAS	DUKE	1981	1994 (13)	2011 (30)
POINT SUR	MLML	1981	1994 (13)	2010 (29)
R.G. SPROUL	SIO	1981?		

SPECIAL SHIPS

Submersible-Support

SHIP NAME	INST.	IN SERVICE	REFIT	REPLACE
ATLANTIS II	WHOI	1963	1982 (19)	1997 (34)

Ice-Capable

None

The following table lists, by decreasing size, the fleet which is expected to be in service in 1990. (Vessels noted with * are not part of the UNOLS fleet at this time.) This table is the basis for the suggested improvement schedule which follows.

Table 5. UNOLS ships, classed by decreasing size within class, expected to be in service in 1990+

SHIP	INST.	LOA (FT)	IN SERVICE	REFIT
		LARGE HIGH-ENDURANCE SHIPS		
KNORR	WHOI	245 (279)	1969	1989
MELVILLE	SIO	245 (279)	1969	1990
AGOR-23*	U. Wash.	274	1991	---
BERNIER*	LDGO	239	1990	---
		LARGE MEDIUM-ENDURANCE SHIPS		
OSPREY*	USC	220	1989	---
WASHINGTON	SIO	209	1965	---
MOANA WAVE	U. Hawaii	209	1973	1982
		INTERMEDIATE 150-199 Feet		
OCEANUS	WHOI	177	1975	---
WECOMA	OSU	177	1975	---
ENDEAVOR	URI	177	1976	---
GYRE	TAMU	174	1973	1975 (partial)
ISELIN	U. Miami	170	1971	1987
NEW HORIZON	SIO	170	1978	---
		SMALL 100-149 Feet		
CAPE HATTERAS	DUKE	135	1981	---
POINT SUR	MLML	135	1981	---
ALPHA HELIX	U. Alaska	133	1965	---
SPROUL	SIO	125	1981	---
CAPE HENLOPEN	U. Del	120	1975	---
WARFIELD	CBI	106	1967	---
PELICAN	LUMCON	105	1986	---
LONGHORN	U. Texas	105	1971	1986
		SPECIAL SHIPS Submersible-Support		
ATLANTIS II	WHOI	209	1963	1980
		Ice-Capable		
None				

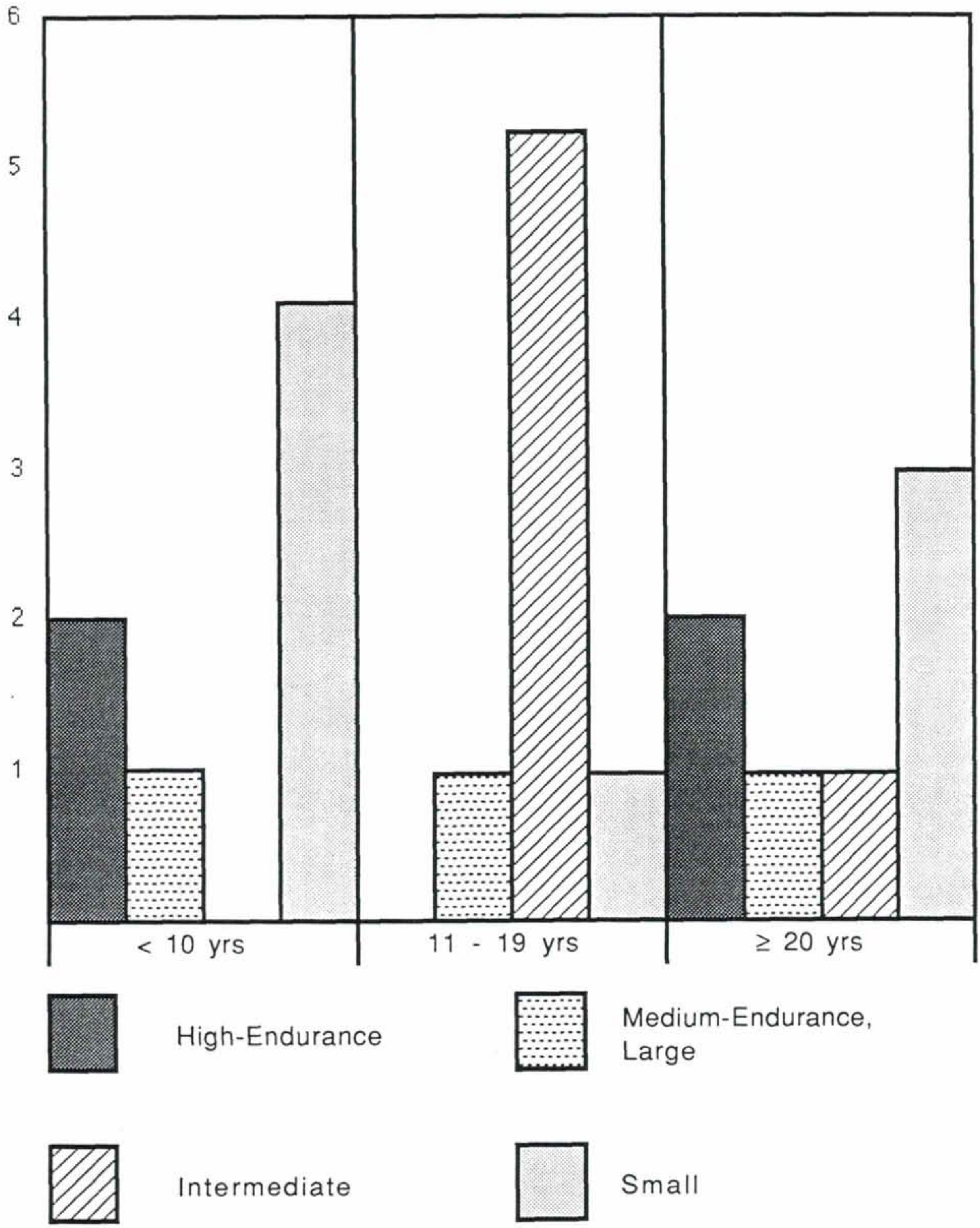
+ 1991 for AGOR 23

Note: In the "large ship" category, there is a decided break between those medium-endurance ships in the 210-220 ft range and the high-endurance ships of greater length and capability.

The age distribution of this fleet as of 1991 is shown graphically in Figure 1. We see that the large vessels, as a class, are about evenly distributed among these three age divisions. Looking in more detail, it is seen that the medium-endurance, large ships are as a sub-class older than the high-endurance ships. The small ships are well distributed by age, considering that one of the oldest (the WARFIELD) may not need to be replaced. It is the intermediate-size ships that are poorly distributed — all near mid-life and requiring refits or replacements within a short time period.

Note that this table does not include the submersible-support ship, ATLANTIS II, that will have been in service 18 years in 1991.

Age of UNOLS Ships 1991



C. <u>Suggested Improvement Schedule With Costs</u>

A plan for improvement of the fleet should take into account a meld of the following factors:

1. The needs of ongoing and foreseen science.
2. The material condition and scientific capability of existing ships.
3. The national economy and attitude toward research in general, and oceanography specifically.

The first factor should be periodically updated to reflect the changing research interests of the community, and the plans of sponsoring agencies such as NSF and ONR. These needs are translated into ship capabilities in the Scientific Mission Requirements for the various types of research vessels, developed and periodically updated by the UNOLS Fleet Improvement Committee.

The second group of factors should be regularly reviewed, based on the ship inspection programs of NSF and ONR, and user assessments.

While the last factor is impossible to predict over the long term, this plan is based on the hope for some improvement relative to the climate of the 1980s. It is emphasized that the "desirable" dates for upgrading and constructions have, in some cases, been modified to spread budget costs in a more realistic manner.

First is presented a proposed schedule of replacements and refits of existing vessels by year. Next the cost of this fleet improvement plan is presented and summarized by 5-year increments for the next 20 years. Finally, the recommended fleet profile is presented and discussed.

In Table 6 is presented a proposed schedule for refits of existing vessels and new construction. Replacements are designated as one-for-one of existing ships, although it is understood that replacements may not occur in this manner due to shifts in needs and capabilities of various institutions.

Table 6. Proposed Schedule of Refits and Replacements by Year

Year	Ships Refitted	Ships Replaced
1989	KNORR	---
1990	MELVILLE	CONRAD
1991	GYRE (partial)	THOMPSON
1992	OCEANUS, WECOMA	WASHINGTON
1993	SPROUL	ALPHA HELIX
1994	HATTERAS, SUR	---
1995	NEW HORIZON, ENDEAVOR	---
1996	PELICAN	---
1997	---	ATLANTIS II
1998	---	ISELIN
1999	---	HENLOPEN
2000	---	LONGHORN
2001	---	---
2002	OSPREY	---
2003	---	GYRE
2004	BERNIER	WECOMA, OCEANUS
2005	---	MOANA WAVE
2006	AGOR 23	SPROUL
2007	ALHA HELIX Replacement	ENDEAVOR
2008	WASHINGTON Replacement	NEW HORIZON
2009	---	KNORR, PELICAN
2010	---	MELVILLE, SUR
2011	---	HATTERAS
2012	ATLANTIS II Replacement	---

In the following Table 7, the ships denoted with "refit" are those to be modernized; the ships denoted with "new" are those to be replaced. The actions originally proposed for the 1986-1989 time frame are being achieved, so are shown for the record. Estimated costs are in millions of 1989 dollars.

Table 7. Fleet Improvement Plan by 5-year Increments for 25 Years

TIME FRAME	LARGE SHIPS	INTERMEDIATE	SMALL SHIPS
1990-1994	3 new ($) (THOMPSON, CONRAD, WASHINGTON) 2 refits ($) (MELVILLE, KNORR)	3 refits ($) (GYRE, OCEANUS, (WECOMA)	1 new ($) (ALPHA HELIX*) 3 refits ($) (HATTERAS, SUR, SPROUL)
1995-1999	1 new ($) (ATLANTIS II)	1 new ($) (ISELIN) 2 refits ($) (ENDEAVOR, NEW HORIZON)	1 new ($) (HENLOPEN) 1 refit ($) (PELICAN)
2000-2004	2 refits ($) (OSPREY, BERNIER)	3 new ($) (GYRE, WECOMA, OCEANUS)	1 new ($) (LONGHORN)
2005-2009	2 new ($) (MOANA WAVE, KNORR) 2 refits ($) (AGOR-23, WASHINGTON replacement)	2 new ($) (ENDEAVOR, NEW HORIZON) 1 refit ($) (ALPHA HELIX replacement)	1 new ($) (PELICAN)
2010-2014	1 new ($) (MELVILLE) 1 refit ($) (A II replacement)	---	2 new ($) (HATTERAS, SUR)
TOTALS:	7 new 7 refits	6 new 6 refits	6 new 4 refits

* ALPHA HELIX may be replaced by a vessel of intermediate size.

Note particularly regarding the foregoing actions that the simultaneous maturing of many of the intermediate ships leads to the need for concentrations of upgrading and replacements.

D. Profile of Planned UNOLS Fleet

The results of the foregoing actions are reported in Table 8. Note that the "existing fleet" is what is expected for 1991, as shown in Table 5. It will immediately be noted that for some classes, the number of ships in the recommended fleet is less than in the 1991 fleet. This results because we sized the recommended fleet to meet the projected needs of academic oceanographic research as traditionally supported in the United States. The size of the existing UNOLS fleet, on the other hand, is determined by the UNOLS Council based on a different set of criteria.

Table 8. Planned UNOLS Fleet Profile

	Existing Fleet	Recommended Fleet
LARGE, HIGH-ENDURANCE GENERAL-PURPOSE SHIPS (≥200ft)	4	5
LARGE, MEDIUM-ENDURANCE GENERAL-PURPOSE SHIPS (≥200ft)	3	1 or 2
INTERMEDIATE GENERAL-PURPOSE SHIPS (150–199ft)	6	6
SMALL GENERAL-PURPOSE SHIPS (100–149 ft)	8	2
SPECIAL SHIPS		
SUBMERSIBLE-SUPPORT (> 200 ft)	1	1
ICE-CAPABLE	0	1

i. *Large, general-purpose vessel needs in the UNOLS fleet.*

When the ongoing construction, refits, and conversions are complete there should be four vessels in the U.S. academic fleet meeting the UNOLS scientific mission requirements for high-endurance or medium-endurance large general-purpose vessels: AGOR 23 (THOMPSON), KNORR, MELVILLE, and BERNIER (EWING). It is not yet clear whether the OSPREY (VICKERS) will meet these requirements. The recommendation of the FIC, and of the Fleet Replacement Committee before it, is that the UNOLS fleet should include six such vessels. That recommendation is based on the historical makeup and usage of an academic fleet that has included six large vessels modified by the projected requirements of the global change programs for improved capabilities and global coverage. These projections may be somewhat optimistic considering the modest increases in science funding during the past few years, but in the view of the FIC the community should strive to obtain a fleet which will meet the projected requirements.

Thus, it is the recommendation of the FIC that the Navy construct an AGOR 24 for UNOLS usage. Moreover, the FIC recommends that the Navy seriously consider the attributes of the large vessel described in the preliminary design recently completed for UNOLS by the Glosten Associates.

If full utilization of this number of large general-purpose vessels does not materialize because of a lack of adequate science support, two options should be weighed. First, one of the general-purpose large vessels could be utilized as a submersible support vessel. Such a ship will be needed in that near to intermediate term because the ATLANTIS II is not a young vessel. Second, support could be suspended for the least capable of the other large vessels, raising the capability of the fleet. The Navy's capability now to construct AGOR 24 represents a significant opportunity to improve the capability of the academic fleet, and we should not lose it.

Table 8 is based on the assumptions that AGOR 23, AGOR 24, KNORR, MELVILLE, and BERNIER all qualify as large, high-endurance vessels and that at least one other large general-purpose vessel be included in the UNOLS fleet. [HERE REFERENCE WILL BE MADE TO COMPARISON OF CAPABILITIES WITH SMRS IN APPENDIX II.]

ii. *Medium, general-purpose vessel needs in the UNOLS fleet.*

The existing intermediate ships (all general-purpose) are ISELIN, GYRE, OCEANUS, WECOMA, ENDEAVOR, and NEW HORIZON. It is proposed that they be replaced one-for-one, with no net change.

iii. *Small, general-purpose vessel needs in the UNOLS fleet.*

The existing ships (all general-purpose) are ALPHA HELIX, CAPE HENLOPEN, WARFIELD, CAPE HATTERAS, SPROUL, PELICAN, LONGHORN, and POINT SUR. The only change proposed is construction of an ice-capable vessel as a numerical replacement for ALPHA HELIX. Others would be replaced one-for-one with no net view of the FIC the community should strive to obtain a fleet which will meet the projected requirements.

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iv. *Submersible-support ship.*

Planning should begin for the next submersible-support ship to replace the ATLANTIS II. The FIC recommends that preparation should be for a 6,000- to 10,000-m submersible and that the next support vessel have more capability for scientific support on long legs than the ATLANTIS II.

v. *Ice-capable ships.*

In no area should more integration of facilities be forthcoming than in polar research vessels. They are special, expensive facilities. Coordination between the Federal agencies is essential. At present, plans for ice-capable oceanographic research ships are being made and followed by Coast Guard, Navy, and NSF.

The U.S. academic community needs ice-breaking capability in the Southern Ocean. Because of the long transit times between the two polar regions of the globe and because of the need to sample in the Southern Ocean in all seasons, it is not feasible for *one* vessel to meet requirements in the Southern Ocean and in the Arctic.

It is recommended that the required ice-breaking capability in the Southern Ocean be provided by the NSF Division of Polar Programs (DPP), supplemented by U.S. Coast Guard ice breakers. The DPP is expected to lease a ship about 300 feet long—a 12,000-horsepower vessel capable of breaking three feet of level ice at three knots. It will have berths for 38 scientists, 4000 square feet of laboratory space, and 3000 square feet of working area at the fantail. Government furnished equipment on the vessel will include multi-channel seismic and swath mapping systems. The RFP went out early this year and included a set of technical requirements. Bidders are proposing their own designs to meet them. The vessel is to be leased for a 10-year period; an arrangement similar to the existing contract for the POLAR DUKE. This ship was not included in the planned UNOLS fleet profile, because it will not be operated by an academic institution, but it is needed by the UNOLS community.

U.S. oceanographic research needs are for ice-capable vessel operations in both east and west Arctic regions. It seems unlikely that we will have a vessel capable of regular, safe transit between these two areas. The needs for an ice-worthy (either ice-strengthened or ice-capable) ship in the western Arctic Basin is for 175–200 days per year (Royer et al., 1989). The FIC recommends that a concept design study be undertaken based on the provisional scientific mission requirements for an intermediate size vessel included in the report by Royer et al. That ship is included in the planned UNOLS fleet profile.

There also is a U.S. need for a second ice-worthy oceanographic research ship in the Arctic—namely for operation in the Greenland and Norwegian Seas and contiguous areas of the eastern Arctic, as documented by the report of Alexander et al. (1988). The Navy has plans to procure such a ship to be operated by the MSC. So, although tentative plans include use by the U.S. academic community, it is not included in the UNOLS fleet profile.

Appendix I: Reports of the UNOLS Fleet Improvement Committee

Alexander, Vera, *et al.*, Arctic Science Requirements for Ice-Worthy Research Vessels, UNOLS Fleet Improvement Committee Report, 21 pp., UNOLS Fleet Improvement Committee Office, Texas A&M University, College Station, TX 77843-3146, 1988.

Barber, Richard and T. K. Treadwell, Report of a Workshop on Mid-Life Refits and Improvements of Intermediate-Size Ships, UNOLS Fleet Improvement Committee Report, 19 pp., UNOLS Fleet Improvement Committee Office, Texas A&M University, College Station, TX 77843-3146, 1989.

Fisher, F.H., and F.N. Spiess, Draft Science Support Requirements for a Manned Spar Buoy Laboratory, UNOLS Fleet Improvement Committee Letter Report, 6 pp., UNOLS Fleet Improvement Committee Office, Texas A&M University, College Station, TX 77843-3146, 1989.

The Glosten Associates, Inc., Preliminary Design for Medium Endurance General Purpose Oceanographic Research Vessel, Final Report, File No. 8808, for the UNOLS Fleet Improvement Committee, 130 pp + 3 Appendices, UNOLS Fleet Improvement Committee Office, Texas A&M University, College Station, TX 77843-3146, 1989.

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Appendix II: Comparison of Existing UNOLS Ships with Scientific Mission Requirements

A. Intermediate Ships

This comparison was prepared using data from the UNOLS FIC Report of a Workshop on Mid-life Refits (1989), cruise planning manuals for ISELIN, GYRE, WECOMA, and a data sheet for the NEW HORIZON. No data were available on operations in different sea states; problems noted are from comments in the cited workshop report. For WECOMA class, we have no data on positioning precision and thrusters, and working deck areas were estimated from ship plans.

SHIP NAME	YEAR BUILT	LENGTH FEET	ENDURANCE DAYS	ENDURANCE MILES	SCIENCE BERTHS	CREW	SPEED CRUISING	SPEED MAX
OCEANUS*	1975	177	25	7200	12	10	12kt	14.5kt
WECOMA	1975	177	25	7200	12	10	12kt	14.5kt
ENDEAVOR**	1975	177	25	7200	16	10	12kt	14.5kt
GYRE	1973	182	21	8000	21	10	9.5kt	11.5kt
ISELIN	1972	170	30	9500	24	12	13kt	14.5kt
NEW HORIZON	1978	170	29	7500	13	12	10kt	12.3kt
UNOLS Intermediate General-purpose	----	177	30	8000	15–20	10–12	14kt	15kt

SHIP NAME	SEAKEEPING To SEA STATE 4	STATION KEEPING	ICE CLASS	DECK WORK AREA	A-FRAMES	CRANES	WINCHES
OCEANUS*	?	?	?	$1000ft^2$	1	1	3
WECOMA	?	?	?	$1000ft^2$	1	1	3
ENDEAVOR**	?	?	?	$1000ft^2$	1	1	3
GYRE	?	?	?	$1500ft^2$	2	2	3
ISELIN	?	?	?	$1500ft^2$	2	2	3
NEW HORIZON	?	?	?	$1500ft^2$	1	2	3
UNOLS Intermediate General-purpose	12k	SS5/+/-150ft	1C	$1500ft^2$	see notes	see notes	see notes

SHIP NAME	LABS NUMBER	LABS AREA	VANS	WORK BOATS	SCIENCE STORAGE	ACOUSTICAL SYSTEMS
OCEANUS*	2	900ft^2	1	1	In Labs ?	3.5, 12 kHz
WECOMA	2	900ft^2	1	1	Van, 80 ft^2	3.5, 12 kHz
ENDEAVOR**	2	900ft^2	1	1	In Labs ?	3.5, 12 kHz
GYRE	3	1000ft^2?	1	1	In Labs ?	3.5, 12 kHz
ISELIN	3	880ft^2	1?	1	In Labs?	3.5, 12 kHz
NEW HORIZON	3	1000ft^2?	1?	1	In Labs?	
UNOLS Intermediate General-purpose	---	2000ft^2	2	1	10,000ft^3	3.5, 12 kHz

SHIP NAME	NAVIGATION COMM	EXTERNAL COMM	SATELLITE MONITORING	DATA HANDLING	SHIP CONTROL	PROBLEMS
OCEANUS*	GPS, SN, O, LC	HF, VHF, ATS	No	SAIL	?	?
WECOMA	GPS, SN, O, LC	HF, VHF, ATS	IMARSAT ?	SAIL	?	Stability?
ENDEAVOR**	GPS, SN, O, LC	HF, VHF, ATS	No	SAIL	?	?
GYRE	GPS, SN, O, LC	HF, VHF, ATS	No	SAIL	Bow Thruster	?
ISELIN	GPS, SN, LC	HF, VHF, Sat	No	SAIL	Bow Thruster	?
NEW HORIZON			No		Bow Thruster	Stability
UNOLS Intermediate General-purpose	GPS,	VHF, UHF, Sat	Yes	SAIL	See Sta. Keep	---

* Data assumed to be same as for WECOMA.
** Has been altered; but probably is similar to other ships in class.