MEMORANDUM

TO: Federal Oceanographic Facilities Committee
FROM: Agency Working Group
SUBJECT: Draft Discussion Document
DATE: December 5, 2000

This document is a draft discussion paper for your consideration entitled Charting the Future for the National Academic Research Fleet.

It is the result of several months of discussions of an informal working group of staff within the federal agencies most concerned with the administration and funding of the National Academic fleet. The working group regards this draft discussion paper as the beginning of an effort to tackle the issues of fleet renewal by the new Federal Oceanographic Facilities Committee. We envisage that, through a process of interactions with the interested external community, a plan will emerge which will be refined and updated at least every five years in response to emerging trends in oceanography, as part of an ongoing comprehensive review of oceanographic facilities.

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Charting the Future for the National Academic Research Fleet

A Draft Discussion Paper

December, 2000

Table of Contents

Executive Summary

1. The purpose of the Plan is to define a federal interagency strategy for the renewal of the national academic research fleet. The Plan was called for in the Academic Fleet Review (Schmitt et al., 1999), approved by the National Science Board in May, 1999. It should guide Federal Government agencies, Academia and Congress in maintaining and enhancing the academic fleet.
2. The origins of the modern post World War II national academic research fleet can be attributed to the early funding of research and the provision of ships by the Navy through the 1950s, augmented by National Science Foundation (NSF) research funding support and ship construction through the 1960s and 1970s, and the academic research and fleet operations of National Oceanographic and Atmospheric Administration (NOAA) after its establishment in 1970. Implementation of the University-National Oceanographic Laboratory System (UNOLS) in 1972 provided a coordination, management and advisory mechanism for the academic research fleet.
3. The Plan addresses ships of the academic research fleet over 40 meters in length, which, for the present (CY 2000), includes all but one of the federally owned vessels. Though smaller private- and State-owned vessels will remain vital to the academic research fleet's capabilities, larger vessels are expected to be predominantly federally owned, owing to their higher capital costs.
4. Over the next 20 years, the Plan calls for a fleet that is more capable than at present, but fewer in number. The vision for the fleet is based on a review of several trends. Most important is the assumption of stable to slightly increased federal funding for academic oceanographic research in the coming years, consistent with the experience of the last three decades. Although the past decade has shown modest fleet over-capacity and a consistent trend towards more oceanographic data acquisition from non-traditional platforms, there is a growing trend towards larger, interdisciplinary sea-going science teams using increasingly sophisticated research tools.
5. The Plan defines three basic vessel classes for the current and future fleet of ships over 40 meters:
   - Global Class - "Global" Class ships have high endurance, and can operate worldwide in ice-free water.
   - Ocean Class - "Ocean" Class ships will fulfill a critical need in fleet modernization, by replacing the aging "Intermediate" ships with vessels of increased endurance, technological capability, and number of science berths.

- Regional Class - “Regional” Class ships will continue to work in and near the continental margins and coastal zone, but with improved technology and more science berths than in current comparably-sized vessels.

6. Fleet configurations presented in this report are based on an average 30-year standard operational life. The geographical distribution is consistent with the anticipated future demand for federally funded academic research. Federal funds for ship construction and operation will be awarded on the basis of open competition.
7. Over the next two decades, at least one Global Class ship, six Ocean Class ships (one of which is presently under construction) and three Regional Class ships will be needed to re-invigorate the fleet as aging and less capable ships retire.
8. Ships will undergo continuous and significant technological “refreshers” over their lifetime to ensure that technological innovation is maintained in the fleet.
9. The Plan will be reviewed by the FOFC every five years and updated as required based on evolving science requirements and projections of available funds. In addition, the FOFC will provide an annual fleet status report to the NORLC.

Introduction

This report has been produced in response to a recommendation in the Academic Research Fleet Report (Schmitt et al., 1999) which was accepted by the National Science Board of the National Science Foundation (NSF). *"The Federal agencies funding research in oceanography should prepare and maintain a long range plan for the modernization and composition of the oceanographic research fleet which reaches well into the 21st century. This will avoid the high cost of obsolescent facilities and provide the Congress with a unified roadmap for out-year allocations for vessels to support oceanographic research."*

The Plan presents a vision for the larger ocean-going vessels in the academic research fleet, defined here as those exceeding 40 meters length overall (approximately 130 feet). The 16 existing vessels thus included account for about 80% of the total federal fleet operating expenditures, and all except four were built or acquired with federal funds. The Plan adopts retirement dates based approximately on a 30-year vessel service life, which is assumed to include a midlife upgrade, and calls for a schedule of new ship construction based on projected future science needs of the U.S. academic community.

The Plan will be reviewed and updated every five years by the Federal Oceanographic Facilities Committee (FOFC) to accommodate changing circumstances. This initial report does not address smaller coastal vessels, submersibles, remotely operated vehicles, ocean observatories, drifting or navigated sensor packages, or other facilities used in support of academic oceanographic research.

Acquisition and Funding of the Academic Research Fleet

Historical Perspective

U.S. oceanography grew rapidly after World War II, largely guided by the Office of Naval Research (ONR) established in 1946. NSF was established in 1950 with Alan Waterman, Chief Scientist of ONR, as its first Director. The International Geophysical Year of 1957-58 marked the first major NSF involvement in oceanography, with responsibility for administration of Congressionally appropriated funds for this significant program. During this period academic oceanographic ships either belonged to the institutions themselves, or were provided by the Navy. NSF-funded researchers usually gained access to ships through ONR omnibus contracts.

In 1959, two landmark reports were issued which set the tone for the upsurge of academic oceanography for the 1960s: the Navy "Ten Years in Oceanography (TENOC)" Report (Lill

et al., 1959) and the National Academy of Sciences "Oceanography 1960-1970" Report (NAS, 1959). The latter called for a doubling of research over 10 years, and recommended that the Navy, Maritime Administration and NSF finance new research ship construction. Early in the 1960s, NSF support for academic ocean research was becoming a significant fraction of the total, to the point where the NSF Associate Director for Research needed to establish a panel on Grants and Contracts for Ship Construction. This resulted in NSF funding the construction of three ships during that decade: R/Vs Eastward (1962), Atlantis II (1963) and Alpha Helix (1966).

The two reports and subsequent national attention resulted in the passage of the Marine Resources and Engineering Development Act of 1966, which established what has long been referred to as the Stratton Commission, whose report, "Our Nation and the Sea," (1969) would shape U.S. oceanography through the 1970s and beyond, and lead to the establishment of NOAA - the third major builder of oceanographic research vessels.

Towards the end of the 1960s, the Navy built two new Global Class vessels for the Fleet, R/Vs Knorr and Melville. In the 1970s NSF undertook the construction of six ships over 40 meters (130 feet). These were four Intermediate Class ships: R/Vs Iselin, Oceanus, Wecoma and Endeavor, which were in service by 1978; and two Regional Class ships (Cape Class vessels): R/Vs Cape Hatteras and Cape Florida (later re-named Point Sur), which were in service by 1981.

In the Regional Class, the R/V Alpha Helix has reached retirement age, and in 1990, NSF commissioned a design for a new Alaskan regional. The vessel however was not built and NSF is now funding a new design study based on updated science mission objectives. The other Intermediate and Regional Class ships built with NSF funds in the 1970s are also aging and will reach their 30-year design life over the next few years. The R/V Iselin has already left the fleet.

Global Class ships began reaching design life during the 1980s, and the Navy initiated a major program to re-engine, stretch and upgrade two vessels (R/Vs Knorr and Melville) and construct three new vessels which entered service during the last decade (R/Vs Thompson, Atlantis and Revelle). The aging R/V Conrad, built and outfitted by the Navy for specialized marine seismic research, was replaced about a decade ago by a relatively new ship originally built for oil exploration. Supported by NSF funds, the replacement vessel was purchased from the oil industry, renamed the R/V Ewing, and outfitted to perform general oceanographic work and specialized seismic work for the fleet.

Three principal methods have been successfully employed to acquire large oceanographic research ships: (1) construction of new ships through appropriated funds to Federal

agencies; (2) modification/conversion of commercial or federal non-oceanographic ships; and (3) lease of commercial vessels (see below regarding Antarctic and Ocean Drilling vessels). Federal, state and private funds were used to acquire these vessels.

Funding Projections

It is extremely difficult to accurately project funding for academic oceanographic research over the next 20 years. Funds are appropriated on an annual basis, and within agencies, changes in priorities can occur over time. Despite these difficulties, an examination of trends over the past 20 years may provide useful insight. Figure A provides data for two of the three major agencies which fund academic research (NSF and ONR).

Although there is a significant overall upward trend for both NSF and Navy during this period, when converted to constant dollars to account for inflation, the trend becomes much flatter, particularly during much of the 1990s. Extrapolating as far back as 1972 in the case of NSF (National Research Council, 2000a) shows real program growth of only about 20% over the past 28 years.

It is prudent, therefore, to adopt a conservative view of the future by projecting the funding level for academic oceanographic research to remain stable or slightly increasing, while recognizing that adjustments to the Plan may be required if circumstances change.

The University-National Oceanographic Laboratory System

Recognizing the need for coordinated use of federally supported oceanographic facilities, the community of academic oceanographic institutions which use and operate these facilities approved a charter in 1972 for an organization named the University-National Oceanographic Laboratory System (UNOLS). UNOLS also acts as an advisory body for the federal agencies that support oceanographic research. Execution of its recommendations are matters for its member institutions and for those agencies. The history of UNOLS and the most recent version of the UNOLS Charter can be viewed at www.UNOLS.org.

A major objective of UNOLS is to coordinate and review the access to and utilization of facilities for academic oceanographic research, and to assess the match of facilities to the needs of academic oceanographic programs. Another objective is to foster federal, state, and private support for academic oceanography, thereby continuing and enhancing the excellence of this nation's oceanographic program. UNOLS includes in its membership both ship operating (21) and non-operating (61) institutions whose scientists use the ships.

The UNOLS Fleet includes ships owned by the federal government, state governments and private institutions. They range in length from 20 to 86 meters (66 to 279 feet). The Navy owns five of the six largest vessels; NSF owns the sixth. The 16 intermediate and regional vessels are a mix of federal, state or privately-owned vessels, with NSF owning all six federally-owned ones. Except for one NSF-owned vessel and one owned by the Smithsonian Institution, the local/near shore UNOLS vessels are state or privately-owned.

The vessels within the academic fleet are a composite of different ship sizes, designs, and capabilities and serve both general and specialized purposes. All UNOLS vessels are equipped for multidisciplinary science. Two of these vessels have been equipped for specialized seismic (R/V Ewing) and deep submergence (R/V Atlantis) science operations.

Science Trends and the Changing Mix of Tools

The direction for both research and operational oceanography over the next two decades will be towards using new technology to make observations and gather data. Researchers increasingly will need 4-dimensional data to "explore in time." Operational predictive capability and the increasing recognition of variability on all scales necessitates long-term continuous observations. These dual requirements of "continuous" and "long-term" cannot be met using conventional ships, and require unattended, automated observation systems. Rapid advances in technology, including speed and miniaturization, are revolutionizing data collection and these trends will continue at an ever-increasing pace.

There are many examples of such trends. A major objective of the WOCE program through the first half of the last decade was to provide a "snapshot in time" of the circulation and chemical and physical properties of the world's oceans at all depths. Within the next five years the Argo project, which arose out of WOCE-funded technology development, will have implemented a continuous world-wide oceanographic survey of temperature and salinity to 2000 meters using 3,000 autonomous profiling floats.

There are other implemented or planned semi-autonomous data collection systems. The well-established LEO-15 shallow water observatory on the coast of New Jersey has demonstrated the capabilities of an unattended array that collects continuous multi-parameter data. The recent report of the Ocean Studies Board of the National Research Council, "Illuminating the Hidden Planet, 2000," (National Research Council, 2000b) calls for a future with increased emphasis on seafloor observatory science. The National Oceanographic Partnership Program (NOPP) has established the OCEAN.US Office to coordinate efforts of Federal agencies in building a national operational and research ocean observing system.

Both domestically and internationally, such observation systems are expected to proliferate over the next three decades, and will supply an ever-increasing quantity and proportion of oceanographic data (compared to ship-acquired data) to operational organizations and academic researchers. As a result, the role of ships as the primary source of collecting data at sea will diminish. In this respect, oceanographic data collection is following the path led by meteorological science, two or more decades earlier, where technological advances allowed for the remote collection of data. As data collection technology continues to evolve, so will the requirements of fleet support. The Fleet may need to take on a greater role in servicing and maintaining new observing equipment and will need to be flexible and increasingly prepared to support novel science missions.

A recent workshop supported by NSF (Cowles, 2000) asked the academic community to consider the future trends in oceanographic research and its implications for a changing mix of tools. The participants concluded that there will be a change in the balance between the use of ships to make observations and their use as "human-occupied laboratories and work sites." They cautioned that although the trend would be towards the use of unmanned systems to make observations, even in this instance, only physical parameters are currently amenable to this approach and important chemical and biological parameters still require "human efforts at sea on ships."

None-the-less, the balance between the traditional oceanographic expedition/cruise to make "observations and surveys in space" will yield to various forms of unmanned, automated "explorations in time." But, perhaps counter-intuitively, the vast increase in data, its assimilation into models and their analysis, will lead to a new era of interdisciplinary hypothesis testing, requiring a new generation of ships serving as highly capable sea-going laboratories. The workshop participants called for improved heavy weather capability as well as the hosting of ROVs, AUVs and submersibles, and a high-bandwidth communications capability.

The participants foresaw an increase in perturbation experiments, finescale, high resolution interaction experiments, real-time coupled observation-modeling experiments, and the increasing need to rapidly respond to events detected by automated observation systems. They also expected an increased demand for "traditional" ship activities such as deployment, recovery and servicing of unmanned systems, development of analytical procedures for the next generation chemical and biological sensors, and expanded site surveys for a new and enlarged Integrated Ocean Drilling Program (IODP).

Fleet Capacity and Usage

UNOLS vessel usage varies from year to year, depending on the amount of federally funded research that requires ship support. Generally, research programs are funded one or more years prior to the year(s) ship resources are needed, and ship requirements vary significantly from year to year, depending on the kind and amount of research funded. Consequently, some reserve capacity in the system is necessary, but it is also costly to maintain.

Defining the extent to which the Fleet approaches full utilization depends on having an accepted definition of a full operating year (FOY) and different definitions have been used by the oceanographic community over the years. The Plan follows the definitions in Schmitt et al. (1999), which are 300 days for Global Class vessels, 275 days for the Intermediate Class and the Ocean Class (discussed below), and 180 days for the Regional Class vessels. The UNOLS definition of an "operating day" (which includes days in transit) is used here. Although not absolute measures for any one vessel, these estimates are roughly comparable among classes, and are based on historical evaluations of ship capabilities, size and design, operating profiles and associated costs. Figure B illustrates average UNOLS ship operation days by class, in relation to FOY.

In the past decade, the average usage of Global Class ships increased sharply from the early to mid 1990s and then declined. This trend correlates with the implementation of the sea-going phases of the large JGOFS and WOCE programs. Most recently, the Navy increased its usage of the Fleet through an increase in surveys and other applied military research activities not performed by academic investigators. NOAA has also increased its usage of the Fleet over the past several years. Usage of Global Class ships has averaged about 90% of available capacity in the 1990s. There is usually some over-capacity in the global fleet, but it oscillates within tolerable limits.

Utilization of the Intermediate and Regional Ship Classes for the past twenty years has remained below the Full Operating Year capability for these size vessels. For the past decade usage has averaged about 70% of capacity. Over-capacity causes part and full-year lay-ups, which creates various problems including crew lay-offs and additional expenditures which otherwise would have been used to support research.

Following the lead set by the FOFCC in 1984, the Plan takes the service life of an oceanographic vessel to be 30 years, while recognizing that, "the factors which define ship obsolescence have no set values." Midlife refits and upgrades are assumed to be necessary over this time to ensure habitability or upgrade an older ship to extend its service life to 30 years, and perhaps beyond. Clearly, modern ships are more fuel efficient due to engine technology, hull improvements, and propeller design advances. Installation of automation

and modern safety and scientific equipment requiring minimum crew to operate and maintain will reduce shipboard staffing. New ships built with modern habitability and safety standards established by USCG, ABS, and SOLAS increase morale and reduce liability from work place injury and the potential loss of life.

From time to time, efforts have been made by both individual operators and federal agencies to increase utilization of the academic fleet by supporting projects not associated with the federal agencies' core research programs or "non-academic customers." For example, Ewing completed a commercial charter in 1998 and NAVO has successfully operated a program of surveys on academic research fleet vessels. Such use can be important to maintain facilities through temporary funding shortfalls, as discussed by Schmitt et al. (1999). The Plan recognizes that such activities can and will be carried out on academic fleet vessels on occasion, however this aspect of Fleet use is unpredictable and was not taken into consideration when evaluating optimal fleet size and composition.

Evolution of the Fleet over the Next Two Decades

Terminology: Ship Classes - Present and Future

The UNOLS Fleet is presently divided into five classes (UNOLS Fleet Improvement Committee, 2000), based approximately on vessel length overall (LOA). UNOLS Class I and II ships (70-85 meters or 230-280 feet) are usually considered together and referred to as the "Global" Class vessels. UNOLS Class III ships 51-62 meters (168-204 feet) are normally called "Intermediate" Class vessels. UNOLS Class IV, "Regional" Class ships, are 32-41 meters (105-135 feet); Class V, "Local" Class ships, include all vessels below 30 meters (100 feet).

As noted in the Introduction, the Plan focuses on vessels larger than 40 meters (about 130 feet), many of which are federally built or owned. This excludes the smaller UNOLS regional and local ships, most of which were acquired with non-federal funds, but does include the larger of the existing UNOLS Regional Class vessels (that subset commonly called the "Cape Class" which were built by NSF). The Plan advocates the establishment of three general categories of larger (>40 meter) vessels for the future. As in the recent past, the largest are called, "Global" Class vessels which are those vessels over approximately 70 meters (230 feet) LOA. A new term, "Ocean" Class, is introduced to describe ships in the length range of 55-70 meters (180-230 feet). The term "Regional" Class is retained, but

used only to refer to vessels in the 40-55 meter (130-170 foot) range. Vessels less than 40 meters would be considered in the "Local" Class.

Global Class vessels are exemplified by the AGORs #23-25 built by the Navy during the 1990s (R/Vs Thompson, Atlantis and Revelle). These are highly capable vessels, able to work worldwide in ice-free waters, with endurance of 50+ days, and the ability to carry more than 30 scientists and technicians. They have extensive deck space and equipment, as well as a broad and diverse complement of laboratory space and outfitting. They are equipped to handle a wide array of instruments, and to deploy suites of moorings, autonomous vehicles, large complex sampling tools and sophisticated sonars. The specialized capabilities (e.g. submersible support, seismic surveying) of specific vessels make them unique fleet assets. This Class is augmented by the older Global R/Vs Knorr, Melville and Ewing.

Ocean Class vessels are represented by AGOR 26 (presently under construction by the Navy for University of Hawaii) and the new vessels projected by the Plan. Designed to support integrated, interdisciplinary research, including within the exclusive economic zone of the U.S. (the 200-mile limit), these ships will have many of the capabilities of modern Global Class vessels. Being somewhat smaller and more efficient to operate however, they will substantially expand the existing capabilities provided by the Intermediate Class UNOLS ships. They will carry additional scientists, with increased laboratory and deck space, improved handling equipment, and sophisticated instrumentation, including instrumentation and equipment for ROV/AUVs operations. Some may be specially configured to accommodate ice margin research, fisheries related oceanography, shallow submersible and/or ROV/AUV support, or other specialized missions.

Regional Class ships are the smallest vessels addressed in the Plan . A need is projected for vessels with greater capability than the existing Cape Class UNOLS vessels to address the science of the inner shelf and coastal environments around the U.S. The science mission of these ships is "coastal oceanography" in the broadest sense. Though range, science complement and outfitting will be less than that for the larger vessel classes, the new ships in this Class should have the ability to carry about 20 scientists for up to a month, and to provide suitable laboratory space and instrumentation to allow significant multidisciplinary programs. Their design and outfitting will emphasize the scientific priorities of the shallower, coastal regimes in which they will operate. It is likely they will have a shallow draft, and the capability to deploy, supervise and recover autonomous systems.

The table below summarizes the broad concept of the three ship classes as outlined above.

	Global Class	Ocean Class	Regional Class
Ship Performance			
Endurance	50 days	40 days	30 days
Range	25,000 km	20,000 km	15,000 km
Length	70 – 90 meters	55 – 70 meters	40 – 55 m
Science berths	30+	25+	20+

Current Fleet Status and Future Needs

Three of the six Global Class ships are the youngest in the current UNOLS Fleet of vessels over 40 meters, having been built in the past decade, and a fourth is at its midlife. The other two were substantially upgraded about a decade ago, but are now over 30 years old and nearing retirement. The Intermediate and larger Regional Class vessels were mostly built in the 1970s, and although these have undergone major refits, most will be approaching the end of their useful lives by the end of this decade. None of the Intermediate Class vessels is younger than 15 years old, and five of the seven are well over 20 years. The three larger (over 40 meters) Regional Class vessels (R/Vs Cape Hatteras, Point Sur and Alpha Helix) are 19, 19 and 34 years old, respectively.

As a result of impending retirements, identifying funds for the construction of new ships is an issue which must be addressed now to meet fleet needs for the next two decades. This position was put forth strongly by the UNOLS Fleet Improvement Committee in an article in EOS (2000), the weekly AGU Newsletter. In addition to new ships, it will be important to identify incremental funds for the costly new shared-use instrumentation required to meet ocean science needs, as well as the training and support for personnel to maintain and operate these increasingly complex systems.

Global Class

As noted above, two of the Global Class ships (R/Vs Knorr, Melville) are over 30 years old, and are approaching retirement. The Plan makes no specific recommendation to replace these, recognizing that some of the present requirements that are currently being met with Global Class vessels will shift to the new Ocean Class ships as they come on line beginning in 2002. Three of the remaining Global Class ships (R/Vs Thompson, Atlantis, Revelle) are

sufficiently new that they will have 20 or more years of productive service. The sixth of the present Global Class ships (R/V Ewing) is anticipated to be retired during the second decade of the Plan, sometime after 2010. Its use as a specialized vessel for deep seismic imaging means that planning must address both the vessel and the special scientific needs in advance of that projected retirement. This ship and the R/V Atlantis, the two Global Class vessels expected to remain in service on the East Coast beyond the end of this decade, both have specialized missions, and are not extensively used for general purpose oceanographic projects. The global range of this class of vessels, however, makes the location of their home port less important to their mission than for the other vessel classes.

Ocean Class

All of the ships classified as Intermediate by UNOLS will have exceeded 30 years of service prior to the end of this decade. The federal agencies anticipate a clear need for New "Ocean" Class vessels: more capable, larger and more technologically sophisticated vessels to be built as these older vessels leave the Fleet. The Ocean Class vessels are viewed as a key element of the future academic research Fleet. Their development, already begun with AGOR 26, is expected to encompass some capabilities of both the Intermediate and Global Class vessels that will retire over the next decades.

After delivery of AGOR 26, the next Ocean Class vessel that will be required to meet existing science needs will be for operation in marginal ice zones of the Alaska coast, the adjacent Pacific and the Bering Sea. Although USCGC Healy addresses scientific needs in the ice-covered Arctic with its heavy ice-breaking capability, the increasing research needs along the ice margin exceeds the capabilities of the single, aging Regional Class vessel R/V Alpha Helix stationed in Alaska, placing heavy costs in time and transit on other ships available from ports further south. To meet these needs, design efforts are already underway for an Alaskan area research vessel that provides an ice strengthened platform suitably quiet for fisheries bioacoustic research, and large enough to work through the severe winter weather common to the region. Designs for such a vessel were initiated a decade ago, however the vessel was not built and a replacement is now a very high priority. Looking beyond the AGOR 26 and Alaskan regional needs, the Plan anticipates the need for four additional Ocean Class ships over about ten years to fill the research capacity that will be lost by the retirement of the remaining Intermediate Class vessels.

Regional Class

The Plan addresses only three of the existing Regional Class vessels, one of which (R/V Alpha Helix) is expected to be retired when an Ocean Class vessel is available to undertake the work in the Alaskan region. There is, however, a projected need for a new Regional Class vessel for the Gulf of Mexico, where three aging vessels (one Intermediate and two small Regional vessels) combine to handle about one operating year of work annually.

Although one new, capable Regional Class vessel could potentially handle most of the current Gulf of Mexico federal agency requirements, there are also larger and smaller ships in the area available for deployment to the Gulf of Mexico if needed. This coastal research ship would be the first of the new Regional Class vessels to be built, and it may serve as a design standard for two additional vessels needed over the subsequent decade, one each on the east and west coasts of the U.S.

Other Vessels, Current and Future

Global Vessels

There are seven other vessels, all of which would be classified as Global Class or larger and contribute to academic ocean sciences research in the U.S., but are not part of the UNOLS Fleet.

United States Coast Guard Cutters (USCGC) Polar Star and Polar Sea are multi-mission icebreakers, which provide logistical support for Operation Deep Freeze in the Antarctic. These vessels support science missions in both the Antarctic and Arctic. USCGC Healy is a new icebreaker operated by the Coast Guard with the special mission of supporting basic research in the Arctic Ocean. The Arctic Icebreaker science mission is largely planned and supported by the Arctic Sciences Section of the Office of Polar Programs (OPP) at NSF and is scheduled in coordination with UNOLS. UNOLS also advises on the vessel's technical support needs. USCGC Healy is expected to be used primarily or exclusively in ice-covered regions that are inaccessible to the UNOLS Fleet. In addition to this ship, two chartered vessels are used by OPP in support of research by the U.S. Antarctic Research Program: R/Vs Nathaniel Palmer and Gould, which have ice-breaking capabilities and serve as primary platforms for supporting U.S. science in Antarctic regions. R/Vs Palmer and Gould are not operated as part of the UNOLS Fleet but close communication is maintained between OPP's contractor for vessel support and UNOLS where needed, especially in the areas of operations and technicians.

Another vessel operating outside the UNOLS framework but used heavily to support NSF-funded ocean science is D/V JOIDES Resolution, a chartered drilling vessel that supports the international Ocean Drilling Program (ODP) led by the Division of Ocean Sciences at NSF. This unique platform for scientific ocean drilling is contracted by the prime ODP contractor, Joint Oceanographic Institution, Inc. (JOI), from an oil industry contractor. The Ocean Drilling Program ends in 2003 and plans are under development at NSF to procure new platforms for ocean drilling with international partners, should a new program start after that time.

Finally, the Global Class ship R/V Ronald Brown, is operated for oceanographic and atmospheric research by NOAA. Although scheduled with UNOLS and used collaboratively by university scientists, most R/V Brown programs are in support of NOAA scientists, and it is not separately considered here in the context of the academic research fleet. All of these ships have specialized missions, and except for USCGCs Polar Star and Polar Sea and D/V JOIDES Resolution, all are less than ten years old.

Fisheries Vessels

NOAA's current specialized fleet of fisheries vessels is near the end of its useful service life. At this time, four Fisheries Research Vessels (FRVs) have been authorized and a contract for the lead ship will be awarded in early FY2001. Design features of the ships include quieting to meet the International Council for the Exploration of the Sea (ICES) noise standards for research vessels, hydroacoustic sensors mounted on a retractable center board, multi-gear (e.g., trawl, longline, oceanographic) capabilities, and the speed, power and endurance to allow acoustic and trawl surveys at the shelf edge. In addition to this, NOAA will collaborate with UNOLS to develop a means of meeting a growing proportion of oceanographic ship needs with chartered vessels.

Great Lakes Vessels

The requirements of the Great Lakes were considered, but are not specifically addressed in the Plan. It seems increasingly desirable that a modern Regional Class ship replace the current small and medium sized research vessels in the area (both UNOLS and non-UNOLS vessels). It is recommended that the agencies and scientists most involved in Great Lakes research, address the specific issues and logistics of Great Lakes science to define mission requirements prior to planning a vessel design for the region. It is not clear whether having one substantially more capable vessel is a primary need or whether a more distributed fleet of smaller vessels is better suited to satisfy the research requirements.

Specific Recommendations for Fleet Retirement and Renewal

Figure C shows the Fleet retirement and new construction recommendations addressed in the Plan. The Plan is based on the following principles: (1) the expectation of an average vessel lifetime of 30 years, (2) a need to maintain the number of operating days as close as practical to a Full Operating Year, and (3) and an expectation of the need for a class of highly capable, state-of-the art research ships with interdisciplinary science parties, advanced sea-keeping characteristics, and ability to work in the Exclusive Economic Zone (EEZ) and adjacent ocean basins.

As new ships are constructed, vessel operators will be competitively selected to meet regional requirements thus affording the Government the best value. This scenario in the

2001 – 2020 time frame envisions a strategy for the evolution of a Fleet of academic research ships, 40 meters (130 feet) and larger, to be optimally distributed to support scientific needs and to operate efficiently forward two decades. The Plan calls for the acquisition over the next two decades of one Global Class vessel, six Ocean Class vessels and three Regional Class vessels to re-invigorate the academic Fleet as aging ships are retired.

Over the next two decades the optimal sequence of retirements and replacements, shown in five year increments (which is about the length of time required to design and construct a vessel), is:

2001-2005
AGOR 26, an Ocean Class vessel, will join the fleet by 2003. This vessel will provide service to the Pacific in the ice-free latitudes from its base in Hawaii. The vessel construction is funded by the U.S. Navy.

Design studies funded by NSF are currently in progress for an Ocean Class vessel for the Alaskan region. This vessel's ice strengthened hull would allow for high latitude operations in seasonal ice conditions. Funding for the construction of this ship must be identified.

Towards the end of this period, design studies for eventual construction of a Regional Class vessel to support science in the Gulf of Mexico would be initiated, and, after providing service for at least thirty years the R/V Alpha Helix, R/V Gyre and two of the Global Class ships, R/Vs Knorr and Melville, would begin the retirement process.

2006-2010
Design and construction phases would begin for three Ocean Class vessels for operation in the Northeast Atlantic and Northwest and Southwest Pacific regions.

In addition, during this five year period, four of the Intermediate Class ships, R/Vs Oceanus, Endeavor, New Horizon, and Wecoma, will face retirement.

2011-2015
A Global Class seismic survey vessel, one Ocean Class vessel to support the Southeast Atlantic, and two Regional Class vessels, one for the Atlantic and one for the Pacific will be phased into the fleet during this time period.

Several vessels including one Global Class ship, R/V Ewing, two Intermediate Class ships, R/Vs Seward Johnson and Edwin Link, and two Regional Class ships, R/Vs Cape Hatteras and Point Sur will begin the retirement process during this period.

2016-2020
From the present vantage point, the Fleet will not face any retirements or renewals during this period. Changing circumstances, however, and subsequent reviews of the Plan may modify this view.

If an acquisition program adheres to this schedule, the total ship days available will remain approximately constant over the next 20 years as vessels are retired. If future trends emerge that require more or less ship days, a review of this plan every five years will permit adjustments to be made in the rate of retirements and/or construction to accommodate such trends. Year-to-year variability can be handled by short-term increases in a ship's operating days per year, temporary lay-ups, and adjustment of retirement dates.

Continuous Improvement Planning

It is important in the Plan not only to develop guidelines for ship renewal, but also to improve the existing mechanisms used for upgrading and replacing the shared-use scientific instrumentation and shipboard equipment that is available on these platforms. The Plan recognizes that there is a need for continuous improvement planning to maintain a state-of-the-art scientific research capability on UNOLS vessels.

Many science systems require replacement not because they are physically obsolete, but rather because their performance has been superceded by newer technology with higher resolution, greater speed or superior capability. The continually and rapidly evolving nature of technology is exemplified and critically important in the areas of computing and communications technology, although by no means restricted to those fields. The challenge to operators and federal agencies is to maintain first class technology on the research ships in a time of rapid advance and constrained budgets.

As of FY2000, the aggregate support for new instrumentation and equipment provided by NSF and ONR, exclusive of that provided with new construction, is roughly $5-8 million annually. Much of this support, however, comes to UNOLS vessels via proposals to infrastructure programs that are not focused on ships, such as ONR's Defense University Research Instrumentation Program (DURIP) and NSF's Major Research Instrumentation Program (MRI). Although important to fleet evolution, the reliance on these broad based programs for a substantial percentage of fleet equipment renewal significantly limits forward planning and common system availability across the fleet.

The Plan recommends the major agencies involved in supporting UNOLS ship usage coordinate their consideration of infrastructure proposals. Annual evaluations of the quality of shipboard instrumentation and services, in consultation with the user community, should be used to help prioritize shared-use instrumentation acquisition recommendations to the operators. It is important to expand and maintain a steady influx of funds for enhancing shipboard technology, allowing the UNOLS vessels to remain capable of cutting edge research and preventing technical obsolescence.

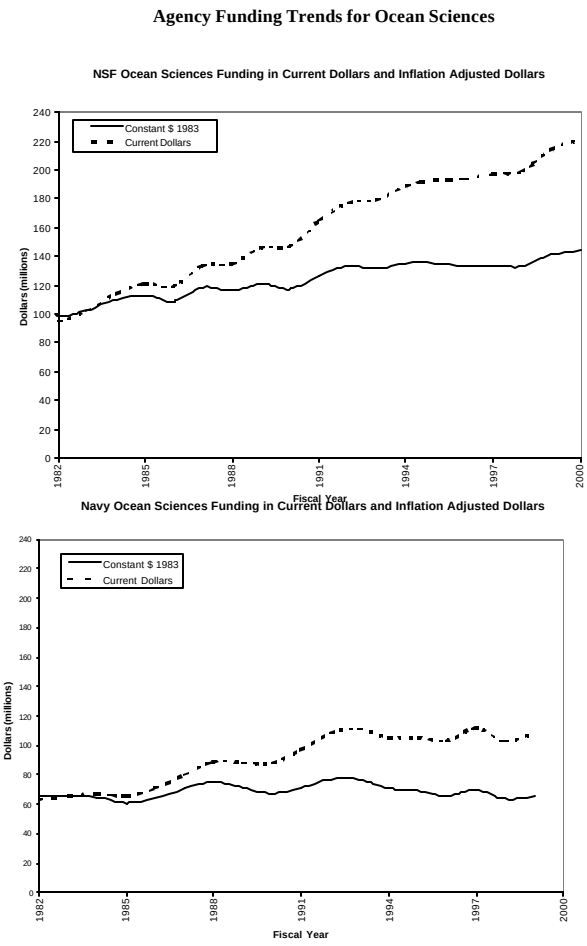

Figure A. Agency Funding Trends for Ocean Sciences

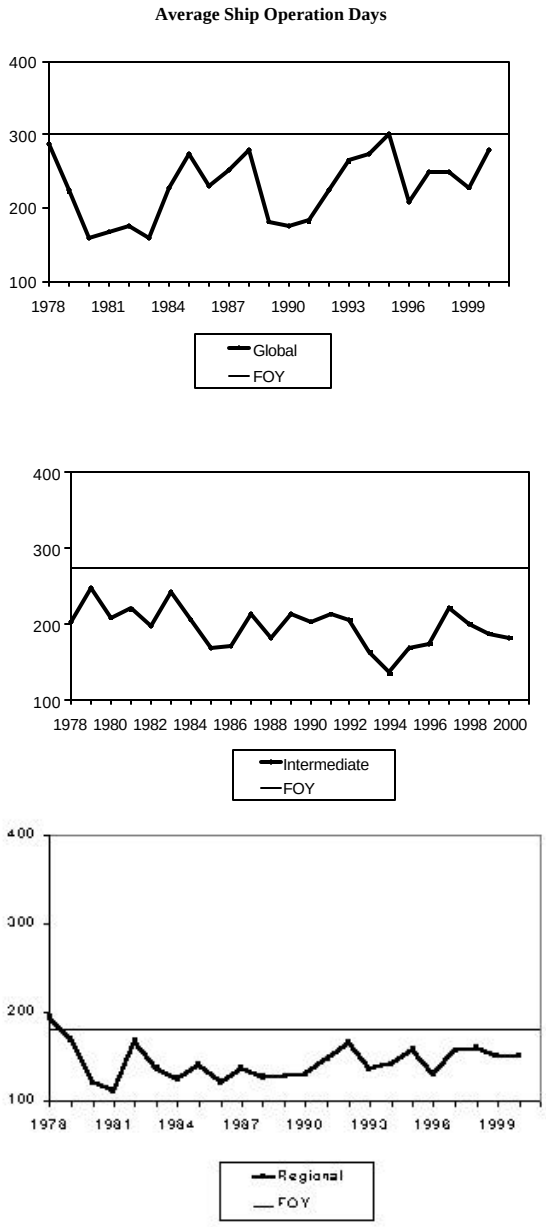

Figure B. Average Ship Operation Days by Class

Fleet Retirements and Renewals

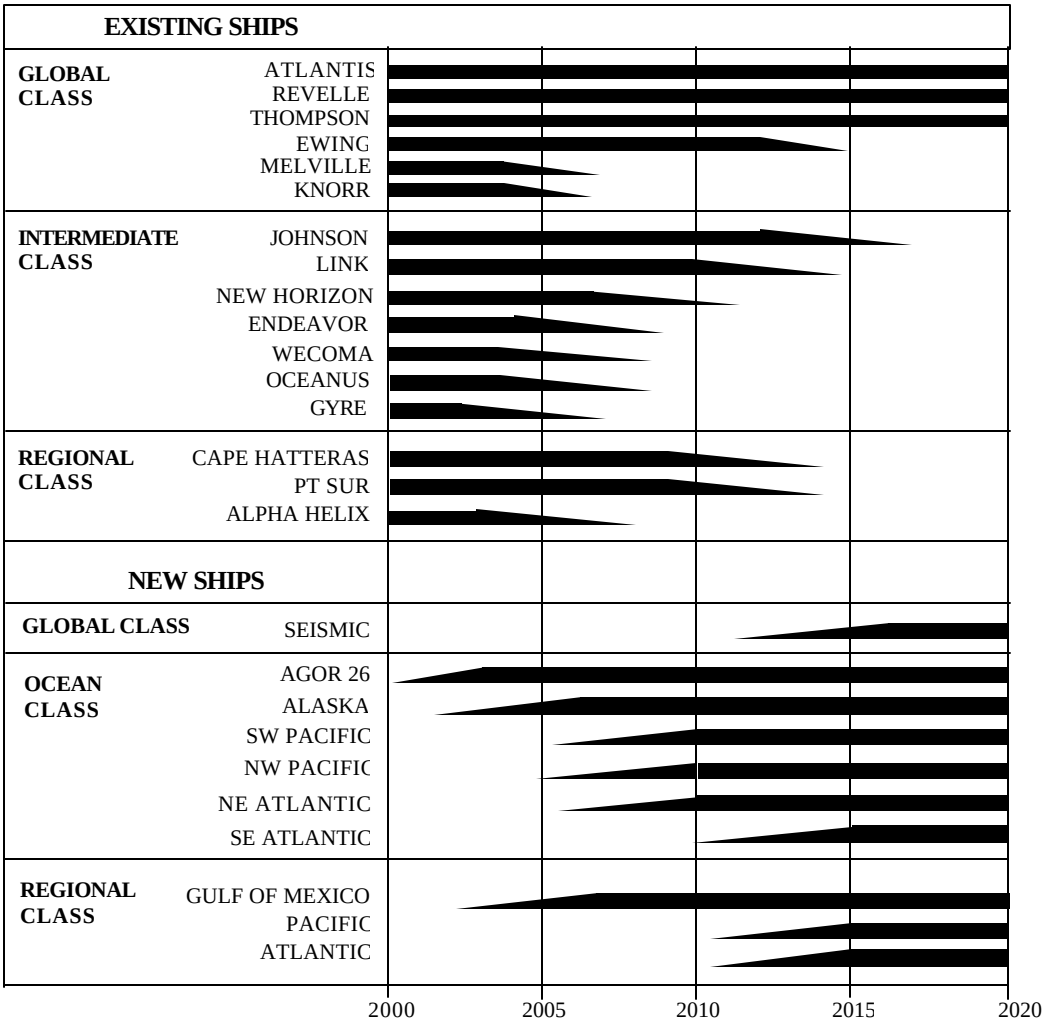

Figure C. Fleet Retirements and Renewals

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Acronym List

ABS – American Bureau of Shipping
AGOR – Auxiliary General Oceanographic Research
AGU – American Geophysical Union
AUV – Autonomous Underwater Vehicle
DURIP – Defense University Research Instrumentation Program
D/V – Drilling Vessel
EEZ – Exclusive Economic Zone
EOS - American Geophysical Union's weekly newspaper
FIC – Fleet Improvement Committee (UNOLS)
FOFC – Federal Oceanographic Facilities Committee
FOFCC – Federal Oceanographic Fleet Coordination Council
FOY – Full Operating Year
IODP – Integrated Ocean Drilling Program
JGOFS – Joint Global Ocean Flux Study
JOI – Joint Oceanographic Institution, Inc.
LEO-15 – Long-term Ecological Observatory at 15 meters
LOA – length overall
MRI – Major Research Instrumentation
NAS – National Academy of Sciences
NOPP – National Oceanographic Partnership Program
NOAA – National Oceanic and Atmospheric Administration
NORLC – National Ocean Research Leadership Council
NSF – National Science Foundation
ODP – Ocean Drilling Program
ONR – Office of Naval Research
OPP – Office of Polar Programs
ROV – Remotely Operated Vehicle
R/V – Research Vessel
SOLAS – Safety of Life At Sea
TENOC – Ten Years in Oceanography
UNOLS – University-National Oceanographic Laboratory System
USCG – United States Coast Guard
USCGC – United States Coast Guard Cutter
WOCE – World Ocean Circulation Experiment
www – World Wide Web