NATIONAL SCIENCE FOUNDATION
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OFFICE OF THE
ASSISTANT DIRECTOR
FOR GEOSCIENCES

June 8, 2001

Dr. Robert Knox
Scripps Institution of Oceanography
Physical Oceanography Research Department
University of California
9500 Gilman Drive
La Jolla, CA 92093

Dear Dr. Knox:

On behalf of FOFC, I would like to express thanks to you and the entire UNOLS community for your valuable guidance in developing a National Academic Research Fleet Plan. We are carefully reviewing comments submitted to the UNOLS website, as well as those from the UNOLS Council and Fleet Improvement Committee. We appreciate the issues identified in the FOFC discussion paper, and in upcoming months, will incorporate this input into a more robust and representative national plan.

Impending vessel retirements, budgetary fluctuations, and the changing needs of science provide challenges in charting the future of the academic research fleet. By establishing a flexible national plan, we are positioned to surmount these challenges, and improve fleet management to better serve the science we support.

With the cooperative efforts of UNOLS and the ocean science community, we are well on our way to achieving this goal.

Sincerely,

original signed 6/8/01

Margaret Leinen
Assistant Director

UNIVERSITY-NATIONAL OCEANOGRAPHIC LABORATORY SYSTEM

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April 3, 2001

Dr. Margaret Leinen
Assistant Director for Geosciences
National Science Foundation
4201 Wilson Blvd.
Arlington, VA 22230

Dear Dr. Leinen:

The attached paper gives the response of UNOLS to your letter of December 7, 2000 soliciting the views of our common scientific community to the FOFC discussion paper *Charting the Future for the National Academic Research Fleet.* We took this task seriously, as befits the central importance of the subject for the future health of U.S. ocean science. We undertook a broad web-based request for feedback directed to the entire community. We were pleased that over one hundred and forty colleagues from numerous institutions responded thoughtfully. The UNOLS Council and Fleet Improvement Committee (FIC) have given considerable deliberation and discussion time to the results of this survey and have tried to integrate the web inputs with their own experiences and insights as ocean scientists to write the attached paper.

The result is a significant critique of the FOFC discussion paper, and particularly a recommendation that it should be redrafted to call for a future fleet prudently *larger* in number than today, providing a greater spectrum of vessel capability and availability to support ocean research. The details of this critique and the reasons for it, strongly rooted in the web survey results, are given in the attached paper.

Everyone involved on the UNOLS side is enormously appreciative of the fact that FOFC under your leadership has begun this important national fleet planning discussion and has sought early input from the scientific community *via* UNOLS. Everyone involved is keenly aware that the specific ship construction plans that will emerge eventually from this process will influence the observational capability of U.S. ocean scientists for decades to come, so that "getting it right" is of the highest importance. We have worked toward this end, we know that FOFC has worked and is working toward the same end, and we look forward to cooperating and continuing this essential effort in the months and years ahead.

Sincerely,

Robert A. Knox
UNOLS Chair, on behalf of the FIC and Council

Attachment: UNOLS Council and Fleet Improvement Committee input to FOFC regarding their draft discussion paper entitled: *Charting the Future for the National Academic Research Fleet.*

cc: M. Reeve, NSF
S. Ramberg, ONR
E. White, NOAA

UNOLS Council and Fleet Improvement Committee input to FOFC regarding their draft discussion paper entitled: *Charting the Future for the National Academic Research Fleet.*

1. INTRODUCTION

Dr. Margaret Leinen, chair of the Federal Oceanographic Facilities Committee (FOFC), wrote to UNOLS chair R. Knox on December 7, 2000 to request comment on the FOFC discussion paper *Charting the Future for the National Academic Research Fleet.* She asked UNOLS to ground its response in views of the scientific community. The letter and discussion paper were posted on the UNOLS website along with several questions intended to foster discussion, including open community comments on any aspect of the paper. Email calls and reminders requesting responses were widely disseminated by the UNOLS office. 130 responses representing over 140 individuals were received at the time of this writing. They and any subsequent additions remain available on the web at http://www.mlml.calstate.edu/unols/fltdisc/responses.html.

The FOFC paper brings new, significant and welcome momentum to national planning for renewal of the academic fleet in order to carry out the seagoing research of the future. Early calls for long-range fleet planning include the 1995 UNOLS report "Projections for UNOLS' Future - Substantial Financial Challenges" (the Betzer Report). Notwithstanding concerns about underutilization of existing ships it called for "the ocean sciences community and the involved federal agencies to continue planning for new generations of oceanographic facilities," recognizing the "fundamental mismatch in time scales" between a R/V lifecycle of three or more decades and a major research program lifecycle of five to six years. A 1996 white paper by former UNOLS chair K. Johnson noted that "UNOLS must continue to plan for new facilities to replace our existing assets as they age, and to explore the requirements for new types of facilities as the needs of ocean science change. The time scale required to bring a new research vessel on line is roughly ten to 15 years from conception through construction." The NSF disciplinary "Futures" reports did not explicitly address fleet renewal, but the report "Ocean Sciences at the New Millennium" written to synthesize the disciplinary reports, and chaired by P. Brewer and T. Moore gives as its first recommendation:

"A substantial, well-coordinated, multi-agency fleet replacement plan is needed to maintain United States leadership in sea-going capability in the coming decades. …. Maintaining a modern, well-equipped research fleet is the most basic requirement for a healthy and vigorous research program in the ocean sciences."

This recommendation meshes well with the final recommendation of "The Academic Research Fleet," the independent fleet review conducted for NSF in 1998-9:

"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."

To assess future scientific facilities required for oceanographic research (as opposed to considering research ships alone, crucial facilities though these are) NSF sponsored a workshop "Assessment of Future Science Needs in the Context of the Academic Oceanographic Fleet" at Oregon State University in 2000. The workshop was co-chaired by L. Atkinson, chair of the UNOLS Fleet Improvement Committee (FIC) and by T. Cowles of OSU. The workshop report noted the ongoing revolution in observing methods made possible by autonomous vehicles of various kinds, new modes of data exchange between vehicles, ships and shore, satellite observing systems, and other techniques. However, it equally clearly envisioned an *increasing* need for ships, not their replacement by the new methods of observation, because:

1. The new technology and emerging global observation sets will lead to new insights and new questions about ocean processes. For example, Argo float data will suggest unresolved issues about the details of deep convection or flow near topography, and these issues will demand new focused research programs that require shipboard support.

2. Many important chemical and biological variables cannot now be observed with unmanned vehicles and sensors, and this will remain true for the foreseeable future. Indeed, as remote or unattended sensors gradually become capable of measuring some simpler or routinely-measured variables, new techniques arise to sample previously unmeasured parameters of scientific importance, and these techniques almost always begin as ship-borne, laboratory-style analyses, often remaining in that style for years or decades.

3. The ability to plan intensive ship-borne process experiments guided by the context of global observations of basic physical fields means that those experiments will demand finer resolution in time and space, and that many of them will need to respond to sudden natural events. These factors imply an increasing demand for ship time, and indeed for fast-response ship time. A corollary of the latter consideration is that some level of "ready reserve" ship capability must be created and sustained.

4. The servicing of the ocean observing systems, deploying AUVs and other platforms such as ARGOS floats will require significant additional ship time. For example, servicing the U.S. part of the TOGA-TAO array takes one full year of ship time.

5. FIC analysis shows an upward trend in ship use over the past decade: 4574 days of use in 1991, 4949 days in 2000, and 5550 days in 2001. The 2001 number is of course an estimate at this time. The difference of 375 days 1991-2000 is greater than one full ship-year of use over the decade, and the difference (estimated) of 976 days from 1991-2001 is easily three ship-years in 1.1 decades. Funding is certainly the limiting factor, so changes in funding could drive the trend in any direction. Nevertheless the data suggest the need for about one new ship per decade, and perhaps more, in addition to the replacement of existing ships. Figure 1 shows this trend and its variability.

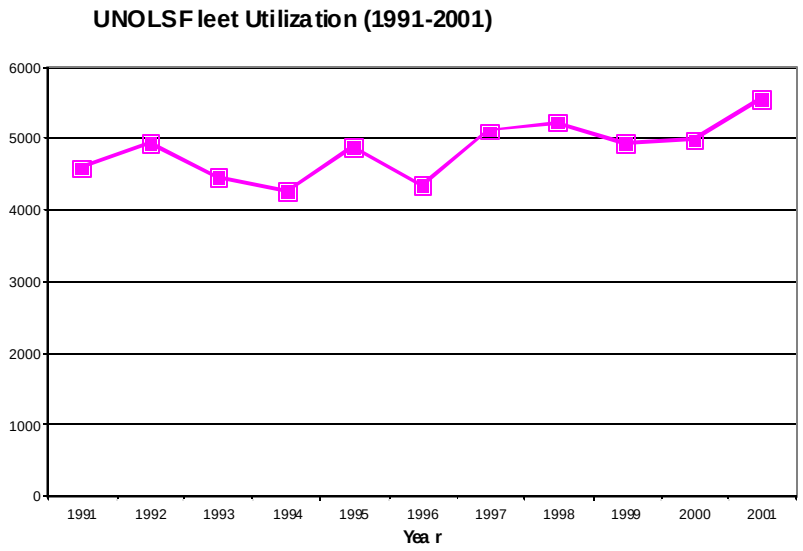

Figure 1. Overall UNOLS fleet utilization (days) 1991-2001. Value for 2001 is an estimate; other values are actual.

In the context of these reports, recommendations and committee discussions, our main concern with the FOFC planning paper can be simply stated:

Much of the FOFC paper appears to take the view that fewer, albeit more capable, ships will be needed, partly through ships being made obsolete by unmanned devices and methods. We believe that the conclusion or implication of reduced need for ships is wrong and that the proper projection is for judiciously more numerous and certainly more capable ships. The first posted response to the UNOLS web survey concisely stated the concern that "go-slow scenarios may become self-fulfilling prophecies," and we share this concern.

This is the strongest single message of the web survey and of our critique. Two analyses of survey responses that bear on this issue are shown in figures 2 and 3.

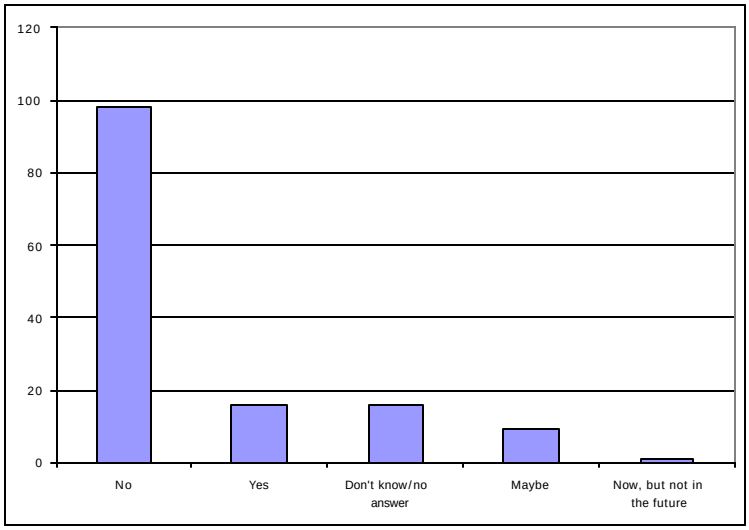

Figure 2. Survey responses categorized by their stances toward "does the plan meet the needs of marine science?" Vertical axis is numbers of responses.

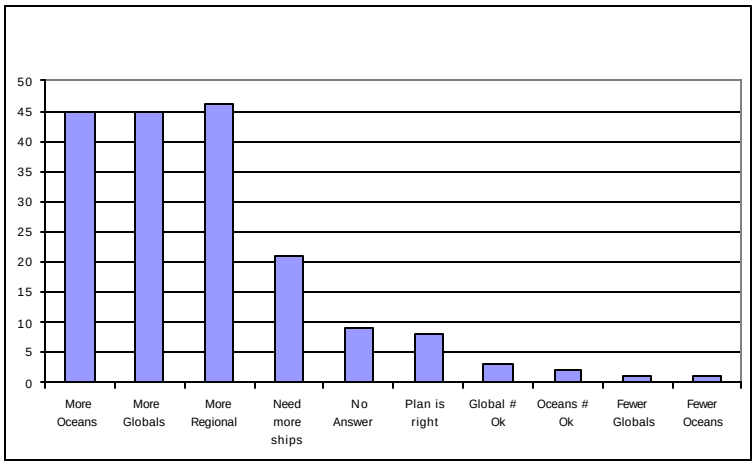

Figure 3. Survey responses categorized by their opinions toward numbers of vessels needed vs. numbers envisioned in the FOFC paper. Vertical axis is number of responses.

Figures 2 and 3 taken together clearly imply that fleet scope envisioned in the FOFC plan is too small to provide adequate support to seagoing ocean science in the coming decades, in the view of survey respondents.

We are realists. We understand that budgets, not effective or even urgent scientific plans, may well be the limiting factor for a fleet renewal program. Nonetheless, we think a proper base-level plan should be more aggressive than in the FOFC document. If future events cause the renewal to fall behind a proper plan, we will have to adapt to the outcome. However, if we do not make a strong case for a sufficient plan at this, the outset of planning, it is unlikely that future events can ratchet up the pace or scope of the renewal effort.

We are realists but not defeatists. If ever there was a time to make strong cases for the importance of national investment in basic oceanographic research it is now. The fleet renewal problem is just one venue in which such cases should be made. In the last two decades significant progress has been made in unraveling the physical, chemical and biological feedback loops that relate oceanic processes to Earth and climate systems. Basic interdisciplinary understanding has arisen from U.S. leadership of several large oceanographic field programs such as WOCE, RIDGE and JGOFS, as well as from field studies conducted by individual investigator-driven research programs. U.S. oceanographers are now poised to apply this basic knowledge to large regions of the ocean through remote sensing, autonomous vehicles and intense monitoring of regions identified as crucial pathways in the Earth-Ocean-Climate system. In addition, the development of new investigative tools and their application to interdisciplinary studies in key regions of the oceans will play a vital role in the ongoing work of disentangling the multitude of processes that set the current planetary homeostasis or that may alter it in significant ways in the future. The continued expansion of this knowledge base and its application to urgent societal problems such as climate change or sea level rise are crucial to developing sustainable social policies.

This work is heavily dependent on the availability of adequate modern research infrastructure. Advances in oceanographic understanding have nearly always been driven by observations, in

contrast to other fields of science where theoretical predictions have served to launch observational campaigns. The U.S. academic research fleet is the primary tool by which oceanic knowledge has been obtained. It will continue to be central to development of understanding whether directly, by facilitating shipboard oceanic research, or indirectly, by deploying autonomous vehicles, servicing moorings or calibrating remote observations. Since the acquisition of new research vessels can take as much as a decade or more, any future expansion of research effort required to address urgent societal problems will be constrained by lack of available infrastructure. To avoid this constraint a modern fleet renewal plan is required now that provides sufficient capacity to enable a rapid response to societal needs. The plan should not submit quietly to zero-sum considerations at the very outset of planning.

2. PARTICULAR ASPECTS OF THE FOFC PAPER

Several specific aspects of the FOFC paper warrant additional discussion. Some of these imply rewriting of existing text. Others imply addition of material to address important concerns not raised in the initial draft.

East/West Balance Of Ships

The distribution of ships presented in the paper favors the West Coast. This shift of vessels from the Atlantic to the Pacific was strongly criticized in the comments and does not appear to be supported by projections of the distribution of future ocean science investigations. In any event, it is unlikely that present projections about ocean science, which extend but a decade into the future, are going to be true for the three decade lifetime of the ships. Historical data for intermediate ships in the 5-year period 1995-1999 show 3221 total days of use in the North and South Pacific vs. 3447 total days in the North and South Atlantic, a near equality with slightly greater usage in the Atlantic sector. Figure 4 shows this regional distribution of use graphically.

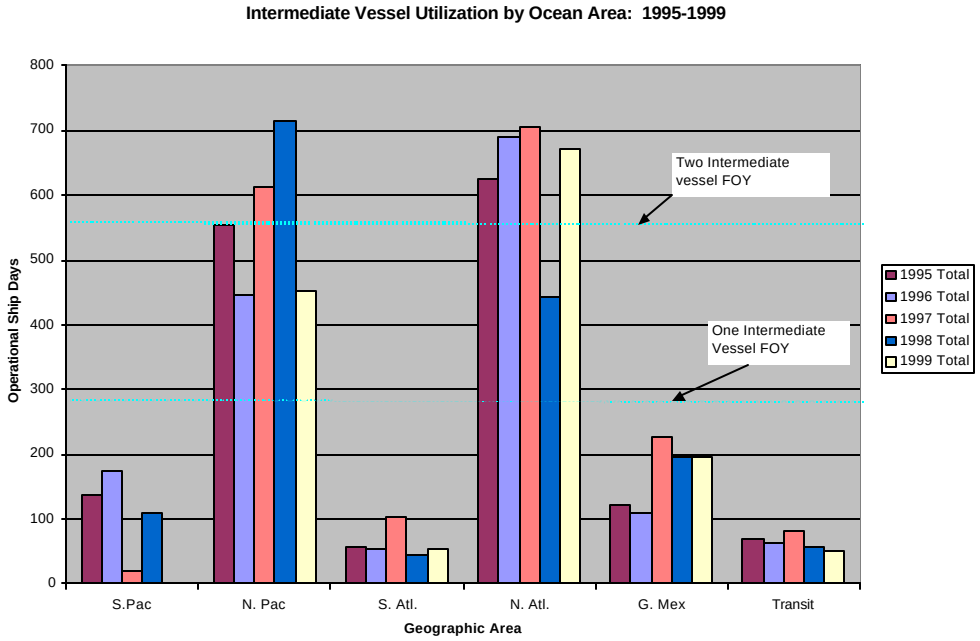

Figure 4. Intermediate vessel use by geographic region, 1995-1999

Figure 5, especially the first and third bars, depicts this east-west concern on the part of survey respondents.

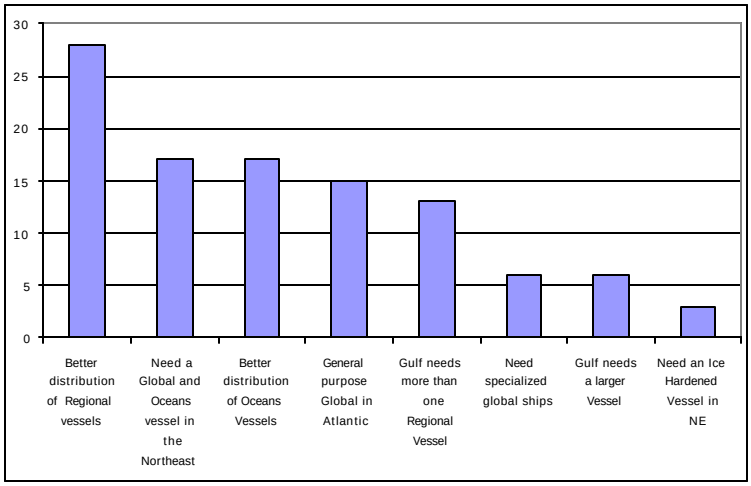

Figure 5. Survey responses categorized by desired distributions of vessels of various types. Vertical axis is number of responses.

More Capable But Larger Ships

The creation of the Ocean class of ships appears to be a good idea from safety and capabilities viewpoints. However, there is some concern in the community that the weighting of the fleet toward fewer larger vessels will make it more difficult for the individual investigator or small group of investigators to secure an appropriately-sized ship for their focused purposes, not necessarily as part of a multi-PI large program.

The new class falls in a capacity/expense range (~210 ft. and 25 scientists) between the current intermediate and global class vessels. Pressures to "fill" such a ship and to use it "effectively" may tend to disallow moderate-scale projects on its schedule as sole users. With the demise of the intermediate class vessels and their replacement with a smaller number of Ocean class vessels, "small" science programs may have to choose the lesser evil: awkward collaboration with another project(s) or use of a ship too small to do the job well. It is important to note that "small" science does not necessarily mean coastal science or science in sheltered waters. The "small" project may require a significant, seaworthy vessel simply to carry out the intended sampling in bad weather or to cover long distances, not to house a large scientific party or large lab establishment.

This situation is as much an agency scheduling policy issue as it is a ship construction issue. In many cases the ideal solution for a "small" project might be to use an Ocean-class vessel, thereby increasing the chances of success through greater vessel capability and seaworthiness. If the funding and scheduling systems take appropriate account of such cases, and do not discriminate against these ship uses merely through aversions to unfilled bunks or labs, then the system could work. The community concern expressed in the survey stems from experience that the "efficiency" considerations tend to drive the ship assignments to projects. Small programs could be squeezed or delayed if the future fleet has fewer of the ships that

projects with small science party numbers or lab/deck demands can realistically expect to use, in the manner of current intermediates.

Scheduling Efficiency Versus Effectiveness

Many respondents noted that the UNOLS/agency scheduling system is inflexible toward scientific needs but very flexible in maximizing financial efficiency, often making disadvantageous (to users) schedule changes uncomfortably close to sailing day. From the financial point of view, the optimum schedule is one in which every day not needed for maintenance or port calls is filled with scientific operations, and that contains no transits. From the point of view of an individual scientific project the optimum schedule is one that is set in stone as soon as the project has defined its plan and logistical *desiderata*, and never adjusts thereafter in response to any change request other than ones arising within the project itself. These two optimizations are mutually exclusive.

The ship-based financial optimization tends to be given the greatest weight. This occurs because the financial considerations of ship operations are obvious to the agencies but the financial consequences of lost or delayed research opportunities are difficult to quantify and are thus rarely considered. This may work against the larger optimization of research if it negatively impacts effectiveness in the research groups and projects concerned. This can happen through delays in programs awaiting limited access to ship time, through limitations in over-the-side sampling due to crowding too many projects on a cruise or through unduly compromised schedule solutions according sub optimal cruise lengths, seasons, ship assignments, etc. to various projects. Replacement of the current fleet with fewer and larger ships will also work against multi-ship operations, a mode of ship use that will increasingly be needed to resolve fine and mesoscale features in the ocean in both space and time.

The survey responses point to a need to enhance scheduling flexibility on behalf of scientific desirables. This necessarily leads to some slack capacity as measured against the purely financial optimum. This slack must be recognized and treated as a legitimate cost of scientific effectiveness, vs. fiscal efficiency. In particular, there must be a mechanism to keep crews and technical support personnel employed. The present system tends to treat idle ships as pariahs, seeking to cut their operational funding as much as possible. One way to turn this around would be to provide encouragement and support for crews and technical support personnel to undertake various maintenance and moderate upgrade tasks (not full shipyard overhauls) during such idle periods, thereby improving the ship for future users. Crew and technical education and training would also be good uses of such times. Allowing these kinds of slack periods to enter into schedules obviously will create pressure to raise the overall fleet census assuming, as we should, that the goal of getting funded projects to sea expeditiously on appropriate ships remains fundamental.

An additional facet of scheduling effectiveness concerns the ability of the large ships to work in remote areas. There has been a recent tendency to delay projects tied to remote regions, sometimes for many years. Again the ship-based fiscal efficiency driver is obvious, but the scientific losses and disincentives to work in such regions are real and serious and ultimately impact the ability of US scientists to work on important global issues. At some point the scientific losses should weigh more heavily than the fiscal efficiencies, and the system should schedule the project despite long transits. This leads toward more use of large ships. The

FOFC paper, however, may presage a net reduction of this fleet segment, depending on the capabilities and use patterns of some of the Ocean class vessels. If the Ocean class ships are not fully capable of these remote projects, or are routinely scheduled in non-remote areas, this shortfall in capability/usage needs to be rethought. Under "Schedule of Retirements" below we suggest a modest increase to plans for Ocean and/or Global vessels; the revised plan should consider this need of remote-area projects.

Event Response

A real concern expressed by several respondents and in the OSU workshop report is the capacity to respond to sudden events. Eruptions of seafloor vents and the rapid biological responses to them, upper ocean responses to severe storms, and ecosystem adjustments to abrupt inputs of new materials from natural or anthropogenic sources are examples. Our ability to detect such events, which will improve with the advent of continuous monitoring systems and observatories, now runs ahead of our ability to marshal the requisite seagoing resources to study the consequences of events as they unfold. If we continue to miss the chance for lack of ready resources, we will not push forward our understanding of how such events reset the state of the ocean. Again, the fleet reduction projected in the FOFC paper can only exacerbate this problem. The solution appears to lie in an expanded fleet, plus modes of operation and funding that allow some of the fleet to stand in "ready reserve" in order to respond to events.

Competition Of Operators

There is a general sense that competitions to select ship operators are desirable, coupled with fatalism about insulating such selections from political interventions. The general feeling is that fair and open competitions should be supported, and that creation of a good and well-received interagency plan for fleet renewal, while it cannot be a firm barrier to political intervention, is nevertheless the best available counterpoise.

Schedule Of Retirements

There is a general sense that the 30-year ship life metric adopted in the FOFC paper is a rule of thumb that can and should be modified by circumstances. There already exists a table of ship retirement dates adopted by UNOLS and essentially readopted in the NSF Academic Fleet Review, which in some cases are substantially different than the dates in the FOFC plan. There seems no need to confuse the community or legislators with a new and different lifetime metric and we think that FOFC and UNOLS should develop consensus regarding retirement dates. Towards that end we have reviewed the UNOLS dates with the ship operators and provide an updated chart and table below as Figures 6 and 7. The FOFC paper and its figure C should be recast accordingly. One can always retire a ship sooner if new capacity is available sooner. This could be reflected in a redrafting - e.g. by drawing timelines for new ships that are finalized before the endpoints of existing ships and by footnoting that some retirements could be advanced if new capacity is actually realized on schedule. If opportunities for enhanced maintenance or major overhauls are taken then the service life of some existing ships can be extended beyond the nominal retirement date. This would provide an implicit means of stretching out the plan (delays in new capacity) if future budgets so required without suffering a drop in fleet capacity.

Within figure C we recommend that the retirement of Moana Wave be shown; this is the other side of the coin for the advent of AGOR 26. This will compare apples to apples in the diagram with respect to retirements and new vessels - 17 ships at the outset of figure C vs. 13 at the end of it, under the FOFC plan. We next take stock of the fact that the paper would remove Knorr, Endeavor, Oceanus, Seward Johnson and Seward Johnson II (ex Link) in the Atlantic, and Gyre in the Gulf, rebuilding the Atlantic and Gulf sectors with two Ocean-class ships and two regional ships. In light of the foregoing discussion we believe the Atlantic replacements should number at least three. Whether these should comprise two Ocean and one Global vessel, or three Ocean vessels, is a refinement for subsequent discussion. The Gulf situation might involve additional regional vessels as noted below.

In the Pacific, the plan retires Melville, Wecoma, and New Horizon, again replacing them with two Ocean-class vessels, in addition to the plans for Alpha Helix and Moana Wave replacements that are currently in different stages of progress. We believe this group should change at least to three Ocean or two Ocean plus one Global, as for the Atlantic.

We also argue for two or three more regional ships nationwide in, say, the 2010-2015 time frame, given the strong desire for a larger number of moderate ships so as to schedule individual and multi-ship projects more readily. Particulars of timing and location remain to be worked out, but the overall adjustment seems well supported by our survey responses.

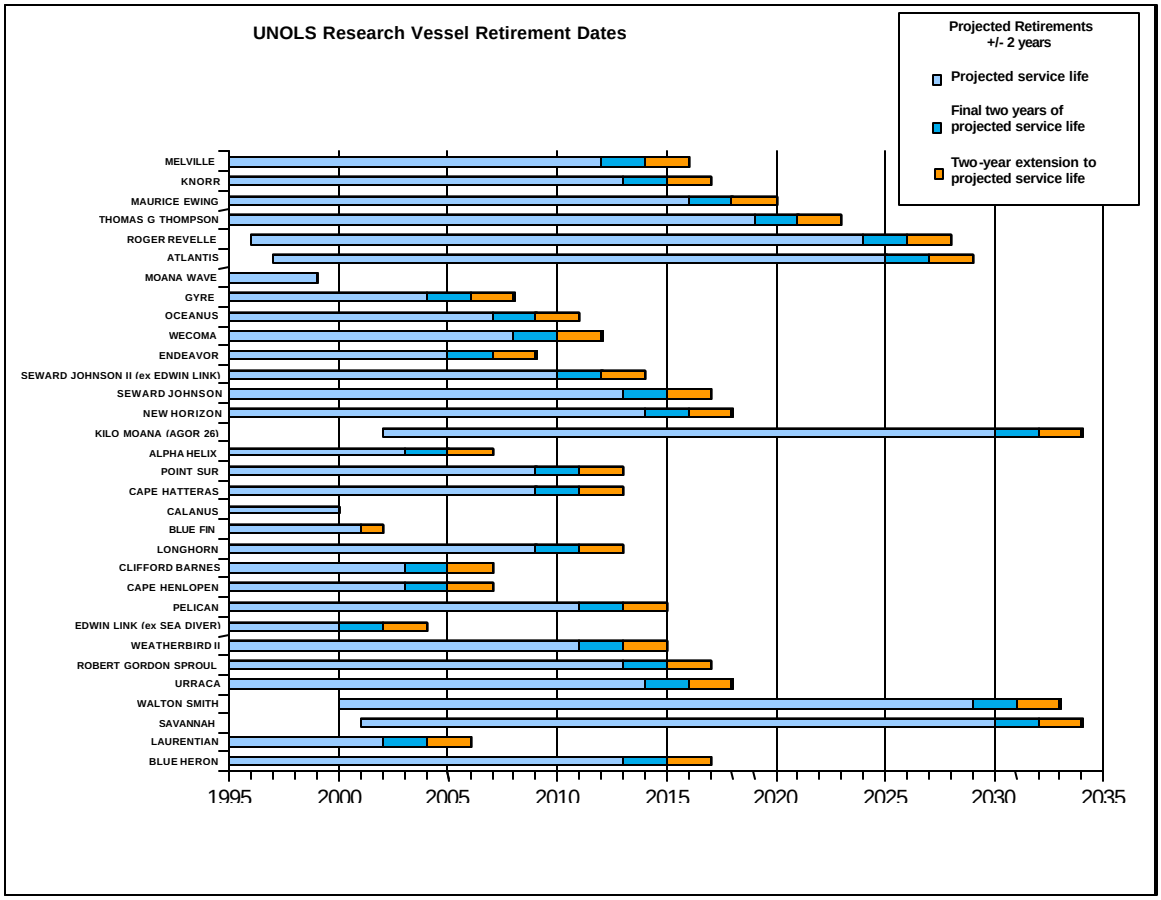

Figure 6. Chart of UNOLS recommended retirement dates.

	Published Retirement Dates				**UNOLS**
Global Ships	Yr Built	NSF AFR	UNOLS-FIC	FOFC PLAN	**Updated Dates**
MELVILLE	1969	2015	2014	2006	2014
KNORR	1970	2012	2015	2006	2015
MAURICE EWING	1983	2019	2018	2014	2018
THOMAS G THOMPSON	1991	2021	2021	>2020	2021
ROGER REVELLE	1996	2026	2026	>2020	2026
ATLANTIS	1997	2027	2027	>2020	2027
Oceans/Intermediate Ships					
MOANA WAVE	1973	2000	1999		1999
GYRE	1973	2003	2004	2006	2006
OCEANUS	1976	2014	2009	2007	2009
WECOMA	1976	2014	2010	2007	2010
ENDEAVOR	1976	2008	2011	2007	2007
SEWARD JOHNSON II (ex EDWIN LINK)	1982	2012	2012	2014	2012
SEWARD JOHNSON	1985	2015	2015	2016	2015
NEW HORIZON	1978	2016	2016	2010	2016
KILO MOANA (AGOR 26)	2002		2033	>2020	2032
Regional Ships					
ALPHA HELIX	1966	2000	2001	2005	2005
POINT SUR	1981	2010	2011	2011	2011
CAPE HATTERAS	1981	2010	2011	2011	2011
Local Ships					
CALANUS	1971	2001	2000		2000
BLUE FIN	1972	2001	2001		2001
LONGHORN	1971	2001	2001		2011
CLIFFORD BARNES	1966	2005	2005		2005
CAPE HENLOPEN	1976	2006	2005		2005
PELICAN	1985	2005	2005		2013
EDWIN LINK (ex SEA DIVER)	1959	2002	2012		2002
WEATHERBIRD II	1981	2013	2013		2013
ROBERT GORDON SPROUL	1981	2015	2015		2015
URRACA	1986	2020	2016		2016
WALTON SMITH	2000		2031		2031
SAVANNAH	2001		2032		2032
Great Lakes Local Ships					
LAURENTIAN	1974	2002	2004		2004
BLUE HERON	1985		2015		2015

Figure 7. Table showing different published retirement dates and current UNOLS recommended dates.

Non-Federal Ships

The FOFC plan currently lacks consideration of new ships built by non-federal bodies. Yet such ships exist, are in the offing, and will form an important part of the future academic fleet, particularly in the smaller size classes. The plan should address policies by which such ships can be well integrated into an overall fleet renewal.

It is hard to envision actual joint federal-nonfederal construction and subsequent ownership of a vessel - who would hold title? Perhaps the most useful planning statement would concern operations, not construction, and serve to welcome contributions of nonfederal ships provided they fit well in an overall plan and provided they are designed in cooperation with FIC so as to be broadly useful to science.

It is clear that ships built primarily with non-federal funds would be operated by the institutions that raised those funds, obviating the requirement for competitions that would pertain to ships built with federal funds.

3. CONCEPT DESIGNS

The value of sound concept designs has been demonstrated many times in the evolution of the UNOLS fleet, perhaps most notably in the large set of concept designs done under the auspices of the Fleet Replacement Committee (forerunner of FIC) in the 1980's. A concept design process brings solid naval architectural expertise to bear on the practicalities of various scientific desires for ship features and capabilities, and on the important question of generating credible cost estimates. Concept designs cost a small fraction of the finished ship, and are a sound investment in its success. A weak or rushed design process bodes ill for the scientific utility and operational economy of the ship.

In the 1980's process, various institutions submitted proposals to pursue concept designs, with various naval architectural firms as subcontractors, and the same process could work again. Other approaches are also possible. The important aspect is to get such designs started sooner rather than later, in view of the long times that typically elapse between concept and finished ship. There is no reason in principle why concept designs cannot be started well in advance of any actual construction appropriations. This may lead to designs being "on the shelf" for a time, but then they are ready to go when construction appropriations arise. If too much shelf time goes by, the designs can readily be refreshed at modest cost. Some designs may never be realized. This is not a bad thing; indeed, it is probably wise to divorce the prosecution of a concept design from any undertaking explicit or otherwise that the design institution(s) will eventually receive and operate such a ship. Under that ground rule a design that is not constructed is just a completed project and a useful educational experience, nothing more.

FIC is well-positioned to review and contribute to a concept design in order to ensure its broad usefulness to the national community beyond the institution and PI of the design. This has been the FIC *modus operandi* in several recent and current ship constructions, and it would be a straightforward matter to extend the process. It ensures an objective, experienced forum for community input on designs and thus fosters effective results. Institutions seeking to build

non-federal ships would also be well advised to avail themselves of FIC review in this manner. Some institutions have done and are doing precisely this. It should be encouraged.

One major reason for advocating a significant concept design effort, with multiple design projects, is that the UNOLS survey responses advocate a wide variety of ship types and features. There are the several size classes put forward by FOFC. Within each of these classes a range of ship capabilities may be desired. Some sense of this range is gained from figures 8 and 9.

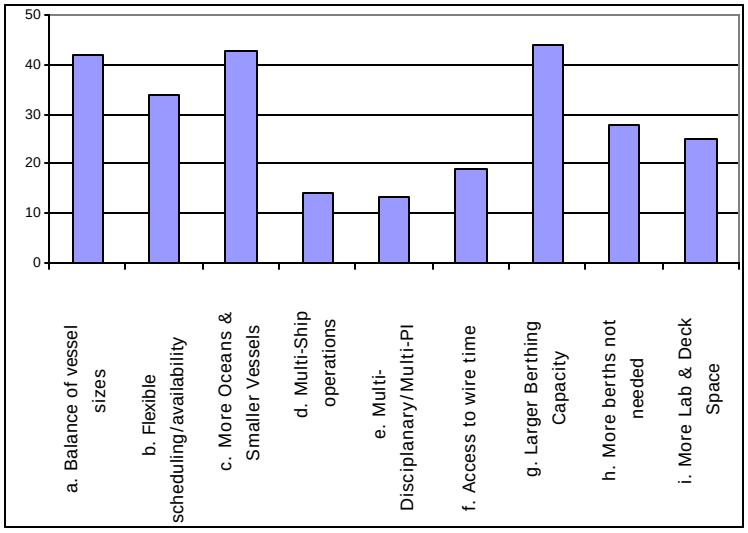

Figure 8. Fleet/vessel capabilities desired by survey respondents. Vertical axis is number of responses.

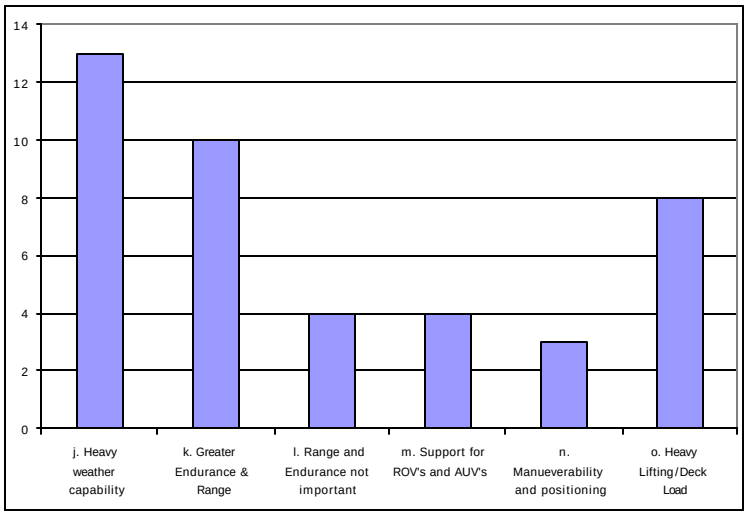

Figure 9. Other vessel capabilities desired by survey respondents. Vertical axis is number of responses.

Combining the capability spread implied by figures 8 and 9 with the desires for vessel sizes in figure 2 indicates that a rather large array of concept designs would be in order, and that the individual ships built within nominal classes (Ocean, Global, etc.) may and probably should be different in significant ways, not simply clones.

Another practical factor points to early use of the concept design process. This is the major shift in international law that may impact the option of constructing intermediate-scale "rule beaters" of less than 300 tons US measure, at least if these ships are to make any foreign voyages. The practical implications for construction costs and for operational costs, primarily crewing, are still in a state of some uncertainty. A thorough concept design coupled with serious estimation of both types of costs is an excellent way, perhaps the only way, to evaluate the tradeoffs that the new legal regime presents to the fleet renewal plan.

4. CONCLUSION

The FOFC paper is a commendable start on the vital work of planning the national research fleet in the first half of the 21st century. UNOLS, through the FIC and Council, believes the paper could be improved by adopting a more expansive, but not radically more expansive, approach toward the numbers and capabilities of vessels that will be needed in this period. Our view is that even conservative, slow growth of ship use implies at least the addition of one new ship per decade. The driving forces of scientific demand, excellent research proposals, and societal importance of the results and insights are clear and compelling. We should not unduly throttle these forces by adopting too constricted a plan at this point in time.

UNOLS has invested real effort in sounding the scientific community concerning the FOFC paper. We appreciate having been asked to do this. We stand ready and willing to assist FOFC in any way desired to create a second draft of this essential document.

5. REFERENCES

Federal Oceanographic Facilities Committee (FOFC). 2000. *Charting the Future for the National Academic Research Fleet*. A draft discussion paper transmitted in a letter from Dr. M. Leinen, NSF, to UNOLS Chair Dr. R. Knox 12/7/2000.

Betzer, P., D. Hayes, R. Knox, C. Mooers, R. Pittenger, R. Wall. 1995. *Projections for UNOLS' Future - Substantial Financial Challenges* (the Betzer Report). University National Oceanographic Laboratory System (UNOLS)

Johnson, K. 1996. *The University-National Oceanographic Laboratory System: Celebrating 25 Years as the Nation's Premier Oceanographic Research Fleet*. University National Oceanographic Laboratory System (UNOLS)

------. 2000. *The NSF disciplinary "Futures" Reports*. Web Pages [Accessed February, 2001]. Available through links from: http://www.unols.org/fic/biennial/biennial.htm#future.

Brewer, P., T. Moore. 2000. *Ocean Sciences at the New Millennium, Draft Report*. University Corporation for Atmospheric Research, Joint Office for Science Support. 2000

Schmitt, R., E. Doyle, S. Ramberg, H. Bezdek, C. D'Elia, E. Druffel, L. Mayer, and G. Weatherly. 1999. *The Academic Research Fleet*. A report to the Assistant Director for Geosciences by the Fleet Review Committee under the auspices of the Advisory Committee for Geosciences, National Science Foundation.

Cowles, T. 2000. *Assessment of Future Science Needs in the Context of the Academic Oceanographic Fleet*, Report of the Future Science Needs Workshop. Corvallis, Oregon, August 9-10. Sponsored by the National Science Foundation's Oceanographic Centers and Facilities Program, Division of Ocean Sciences.