UNOLS

Past Trends and Future Projections for the Academic Research Fleet

In the next two decades the ships in the academic research fleet will reach the end of their useful life. Intermediate ships are nearest to their retirement age while the larger ships will be retired later. By about 2007 we will have fewer ships days available per year than is normally used now. At the extreme, if we assume that no ships are replaced as they are retired, we will, by 2030 or so, have no operating academic research ships. The obvious conclusion is that we must replace UNOLS ships as they retire, we must plan on the use of non-UNOLS ships, or spend fewer days at sea than we have in the past. Assuming ship use continues as it has in the recent past, resources you are used to having will disappear unless action is taken soon. Ships are not designed, funding established and construction completed automatically. The oceanographic community must act.

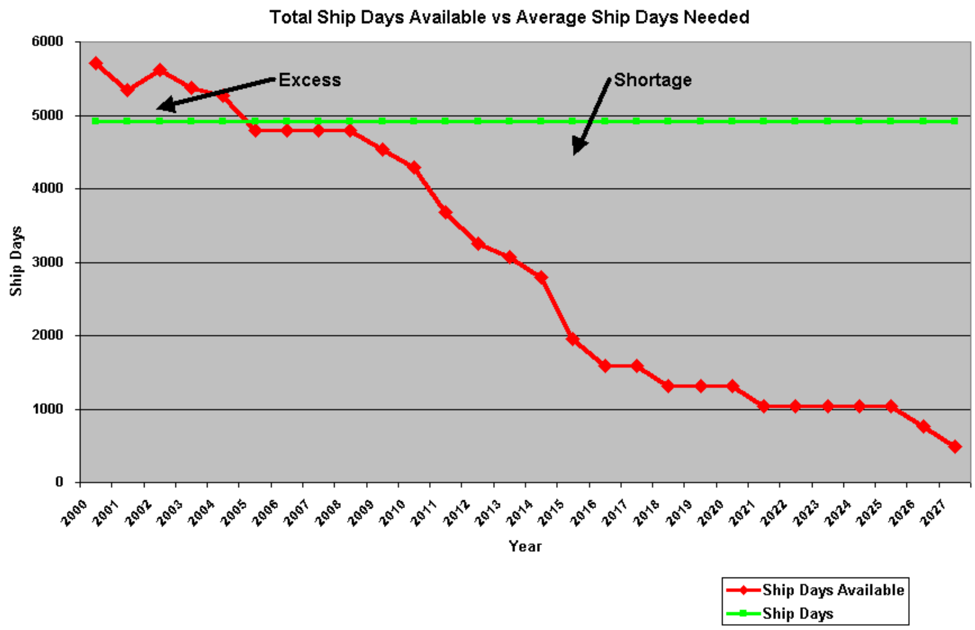
Introduction

The Fleet Improvement Committee (FIC) of the University National Oceanography Laboratory System (UNOLS), which consists of experienced ship using faculty from various universities around the U.S., is seriously concerned that the oceanographic research community as a whole does not appreciate the critical situation looming on the horizon. We are concerned because of the long lead-time to acquire new vessels and the apparent lack of Federal budget commitment. To help in the process of getting the academic user community involved FIC, with the assistance of the UNOLS office and interested colleagues, gathered and interpreted data showing past use and future projections so that the user community can better understand the situation. Since, in this case, a picture is worth more than a thousand words we have focussed the discussion around several key figures.

Throughout this paper you will no doubt see where different assumptions can be made that will affect the outcome. We hope you will agree that regardless of the assumptions there are some realities that cannot be avoided: ships get old, new science mission requirements appear, more research is done, and acquisition is a lengthy process.

Perhaps the best way to get your immediate attention is to show a projection of ship days available in the academic fleet in the future (Figure 1). This plot shows the days available in future years assuming that demand remains constant and ships are retired on schedule and not replaced. Clearly ships must be replaced and if research demands grow the fleet must grow.

Figure 1: The Future



In the following sections we will present past trends in academic research vessel capacity and use followed by projections into the future.

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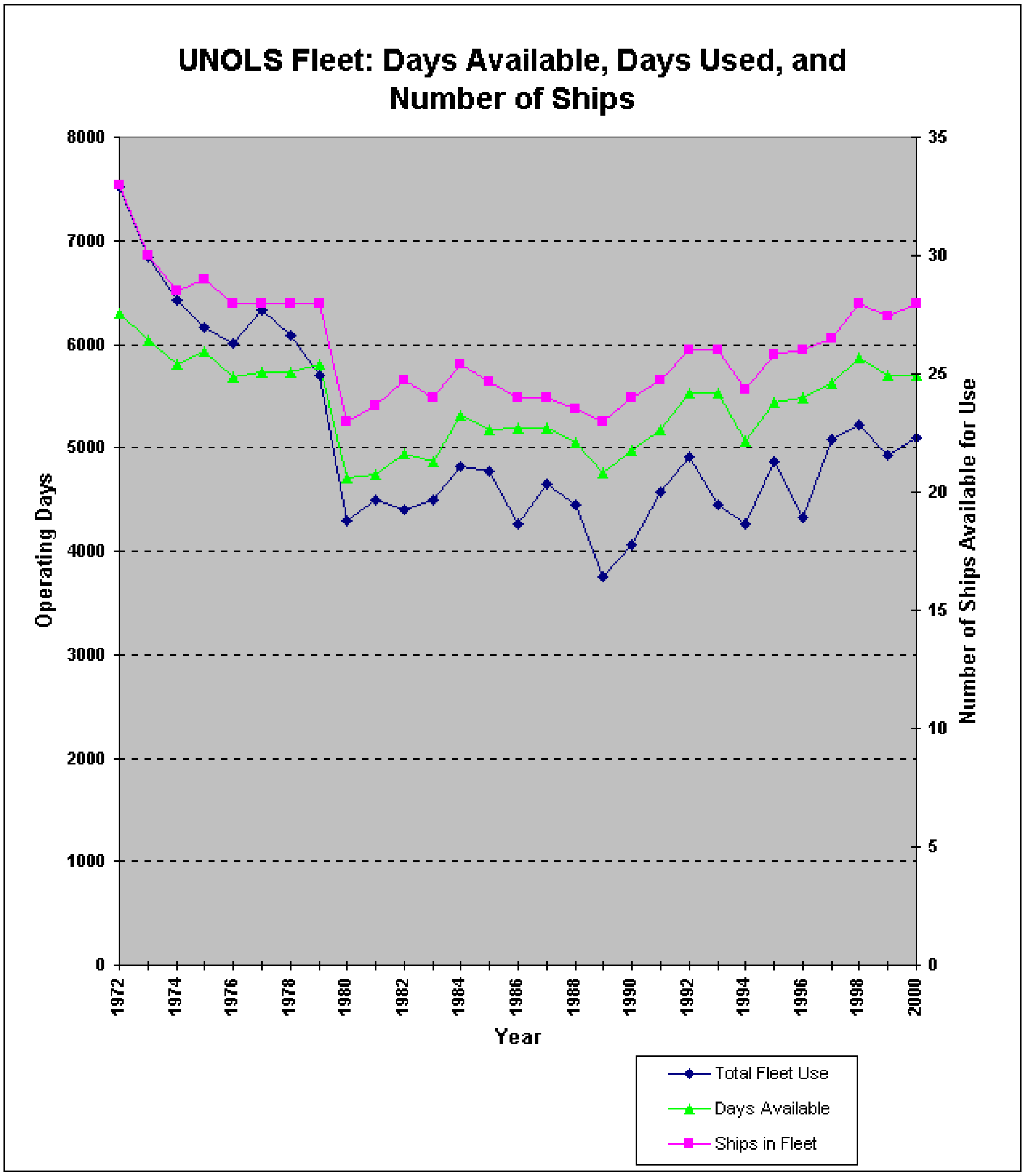
The Past

Overall Trends in UNOLS Fleet Capacity and Utilization

The trends in the number of ships, the days available* and the days used since 1972 is shown in Figure 2.

Figure 2: Ships in the fleet, days available and days used.



The number of ships in the fleet has varied from 33 in 1972 to the present level of 28. Prior to 1980 there were many smaller ships in the fleet and should not be considered in the analysis of the present situation. The trend since 1980 is probably more realistic suggesting an over all growth in the fleet of about five ships.

The total number of days available on UNOLS ships has varied from about 3800 4800 in 1980 to the present high of 5800 days per year. The number of days used has varied from a low of 3800 in 1990 to a high in 1998 of 5300.

The recent trend appears to be an increase of about 1000 days available and used over a period of about 10 years. This equates to an increase of about three to four ships over a ten-year period since a ship provides about 300 days per year. This is consistent with the actual number of new ships.

The recent variability in ship use amounts to about two ships (600 days per year). This variability has been reflected in the laying up of several ships every year for various amounts of time depending on the demand that year.

> **Conclusion:** Recent trends suggest that ship use is increasing at a rate of about 100 days per year with a variation of 600 days per year. If we assume this trend will continue we may face a situation in the future where the variation in demand cannot be met with the present excess ship time. Thus in about six years the size of the present fleet, assuming replacements when needed, will be adequate for the demand and there will be no capacity for years with excess demand.

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Definition of Global/Expeditionary, Regional/Intermediate, and Local/Near-shore Ships

The academic fleet is divided into classes: large and expeditionary, intermediate and regional, and local and near-shore. Other classifications have been used over the years (Class I, II, III and IV) but this division is most logical when considering the size combined with the funding mechanisms for construction.

Table 1: The UNOLS Fleet

UNOLS Global/Expeditionary Ships

SHIP	OPERATING INSTITUTION	OWNER	BUILT/CONV or M-L	SCIENCE BERTHS	LENGTH
MELVILLE	Scripps Institution of Oceanography	Navy	1969/1990	38	279 ft.
KNORR	Woods Hole Oceanographic Inst.	Navy	1970/1989	34	279 ft.
T. G. THOMPSON	University of Washington	Navy	1991	36	274 ft.
ROGER REVELLE	Scripps Institution of Oceanography	Navy	1996	37	274 ft.
ATLANTIS	Woods Hole Oceanographic Inst.	Navy	1997	24	274 ft.
MAURICE EWING	Lamont-Doherty Earth Observatory	NSF	1983/1990	32	239 ft.
AGOR 26 -SWATH	University of Hawaii	Navy	2002	31	182 ft.

UNOLS Intermediate/Regional Ships

SHIP	OPERATING INSTITUTION	OWNER	BUILT/CONV or M-L	SCIENCE BERTHS	LENGTH
MOANA WAVE	University of Hawaii	Navy	1973/1984	19	210 ft.
SEWARD JOHNSON	Harbor Branch Ocean. Inst.	HBOI	1984/1994	29	204 ft.
WECOMA	Oregon State University	NSF	1976/1994	20	185 ft.
ENDEAVOR	University of Rhode Island	NSF	1977/1993	18	184 ft.
GYRE	Texas A&M University	TAMU	1973/1980	23	182 ft.
OCEANUS	Woods Hole Ocean. Inst.	NSF	1976/1994	18	177 ft.
NEW HORIZON	Scripps Inst. of Oceanography	SIO	1978/1996	19	170 ft.
SEWARD JOHNSON II (EDWIN LINK old)	Harbor Branch Ocean. Inst.	HBOI	1982/1988	20	168 ft.
POINT SUR	Moss Landing Marine Lab.	NSF	1981	12	135 ft.
CAPE HATTERAS	Duke University/UNC	NSF	1981	12	135 ft.
ALPHA HELIX	University of Alaska	NSF	1966	15	133 ft.
ROBERT G. SPROUL	Scripps Inst. of Oceanography	SIO	1981/1985	12	125 ft.

UNOLS Local Near-Shore Ships

SHIP	OPERATING INSTITUTION	OWNER	BUILT/CONV or M-L	SCIENCE BERTHS	LENGTH
CAPE HENLOPEN	University of Delaware	UD	1976	12	120 ft.
WEATHERBIRD II	Bermuda Biological Stat. for Res.	BBSR	1981/1993	12	115 ft.
EDWIN LINK (SEA DIVER old)	Harbor Branch Oceanographic Inst.	HBOI	1959/1992	12	113 ft.
PELICAN	Louisiana Universities Marine Cons.	LUMCON	1985	15	105 ft.
LONGHORN	University of Texas	UT	1971/1986	12	105 ft.
F.G. WALTON SMITH*	University of Miami	UMiami	2000	16	96 ft.
URRACA	Smithsonian Tropical Research Inst.	STRI	1986/1994	10	96 ft.
BLUE HERON	University of Minnesota	U.Minn	1985/1998	5	86 ft.
LAURENTIAN	University of Michigan	UMich	1974	8	80 ft.
BLUE FIN	University System of Georgia	UG	1972/1975	8	72 ft.
CALANUS	University of Miami	UMiami	1971	6	68 ft.

CLIFFORD A. BARNES	University of Washington	NSF	1966/1984	6	66 ft.

* Replaced CALANUS in 2000 after successful completion of NSF ship inspection.

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Capacity and Utilization Trends by Ship Class

In this section we will look at the historic capacity and utilization of the fleet. We do not make any attempt to judge why plots appear as they do. For example the recent use of the UNOLS fleet by the Navy increased utilization. We make no attempt to make judgements on continued demand by any group. We have just looked at the trends (Figure 3).

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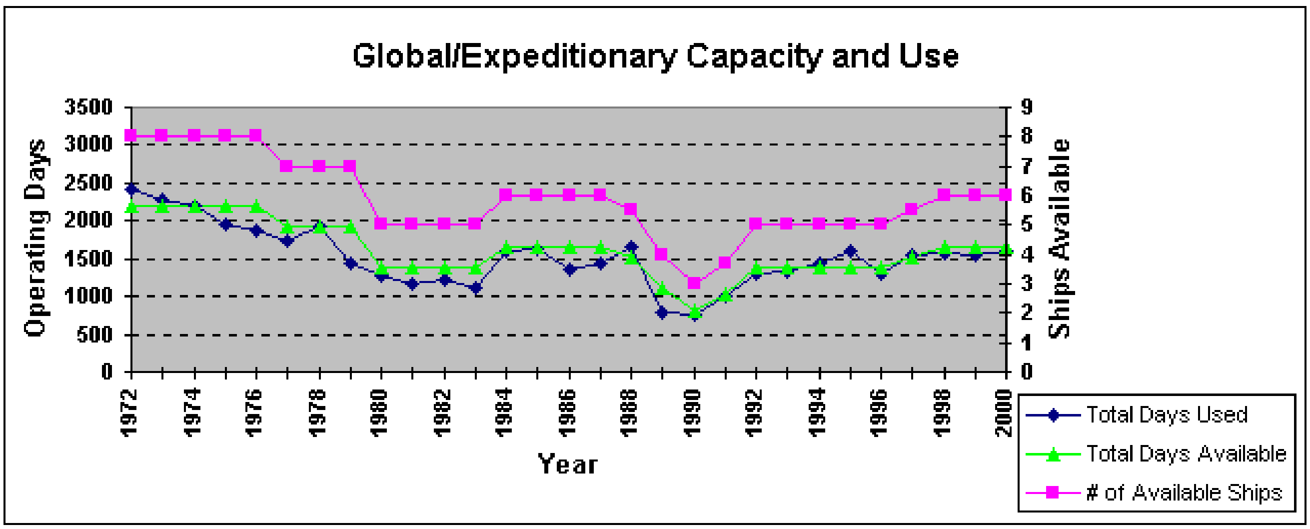
Figure 3: Capacity and Use by Class

Global/Expeditionary Trends:



Global and expeditionary ship numbers have increased since 1991. The result is that we now have six ships available and they provide about 1600 days per year and it is essentially all used. These ships have been operating at capacity since 1992 even as new ships are added to the fleet. There are now 700 more days available than there was in 1992. If this trend continues at least two and possibly four new ships will be required in the coming twenty years to meet the demand.

Conclusions:

- Global/expeditionary ships are operating at near capacity. The usage trend over the past decade suggests a need for between two and four new ships in the next twenty years assuming replacement of all existing ships.

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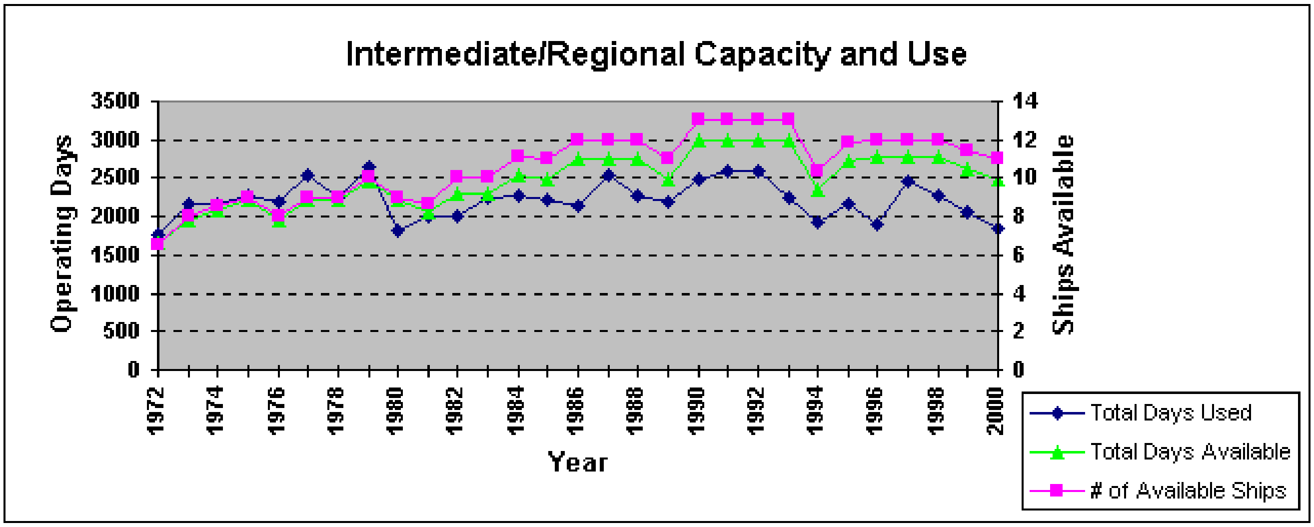
Intermediate/Regional Trends:



Intermediate and regional ship numbers have remained relatively flat constant with ten to thirteen ships in the fleet with an average of twelve. Those ships provide about 2800 days per year at sea. Of that available time the amount used has varied from 1900 days to 2500 days with an annual variation of about 500 days. This variation represents most of the variation in overall fleet utilization. There is no obvious trend in the total days used but the long term view suggests 2000 to 2500 days represents the demand. This class has, on occasion, an excess of two ships when demand is down and one ship when demand is up.

Conclusions:

- Intermediate/regional ships are not fully utilized and there is often an excess of two ships in the fleet. The trend over the past decade does not indicate a need for more intermediate vessels. The high variation in usage suggests some degree of over capacity is acceptable.

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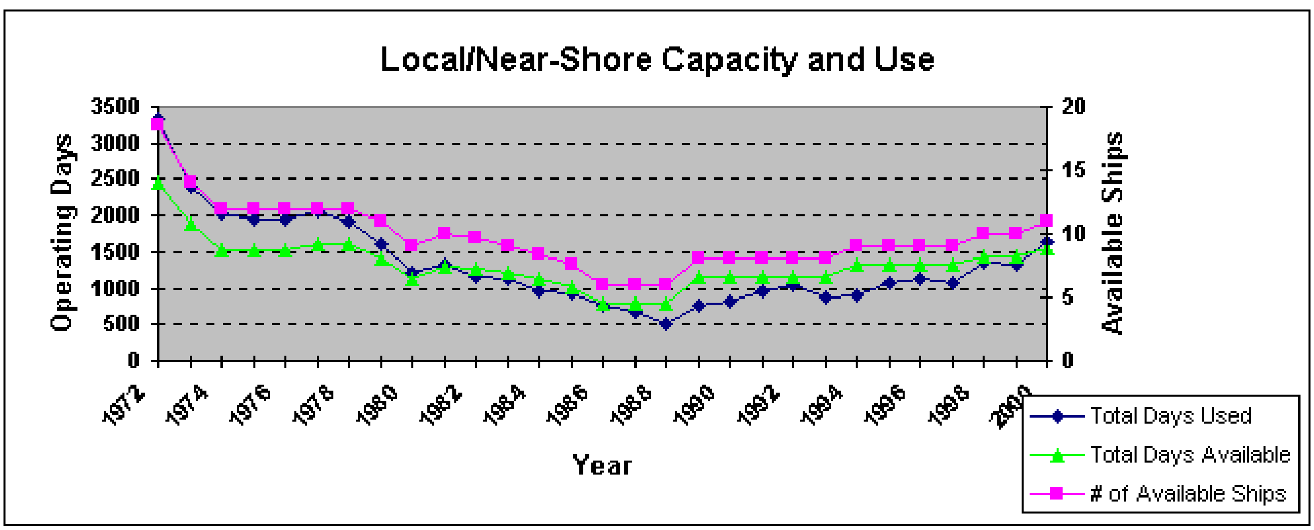
Local/Near-Shore Trends:



Local and near-shore ships number about ten and that has increased from a low of about six in the late 80's. All numbers related to these ships must be viewed carefully as this portion of the fleet is subject to local forcing outside the federal domain that we are addressing. Nevertheless these ships have an impact and use federal resources. The recent trend suggests an increase of the number of ships at about three over the last twenty years. The available operating days has increased from about 750 to 1500 over this time. Utilization in the past was considerably less that what was available but now these ships appear to be fully utilized.

Conclusions:

- Local and near-shore ship capacity is growing and the trends and usage suggest a need for three new ships in the next two decades in addition to replacing existing ships.

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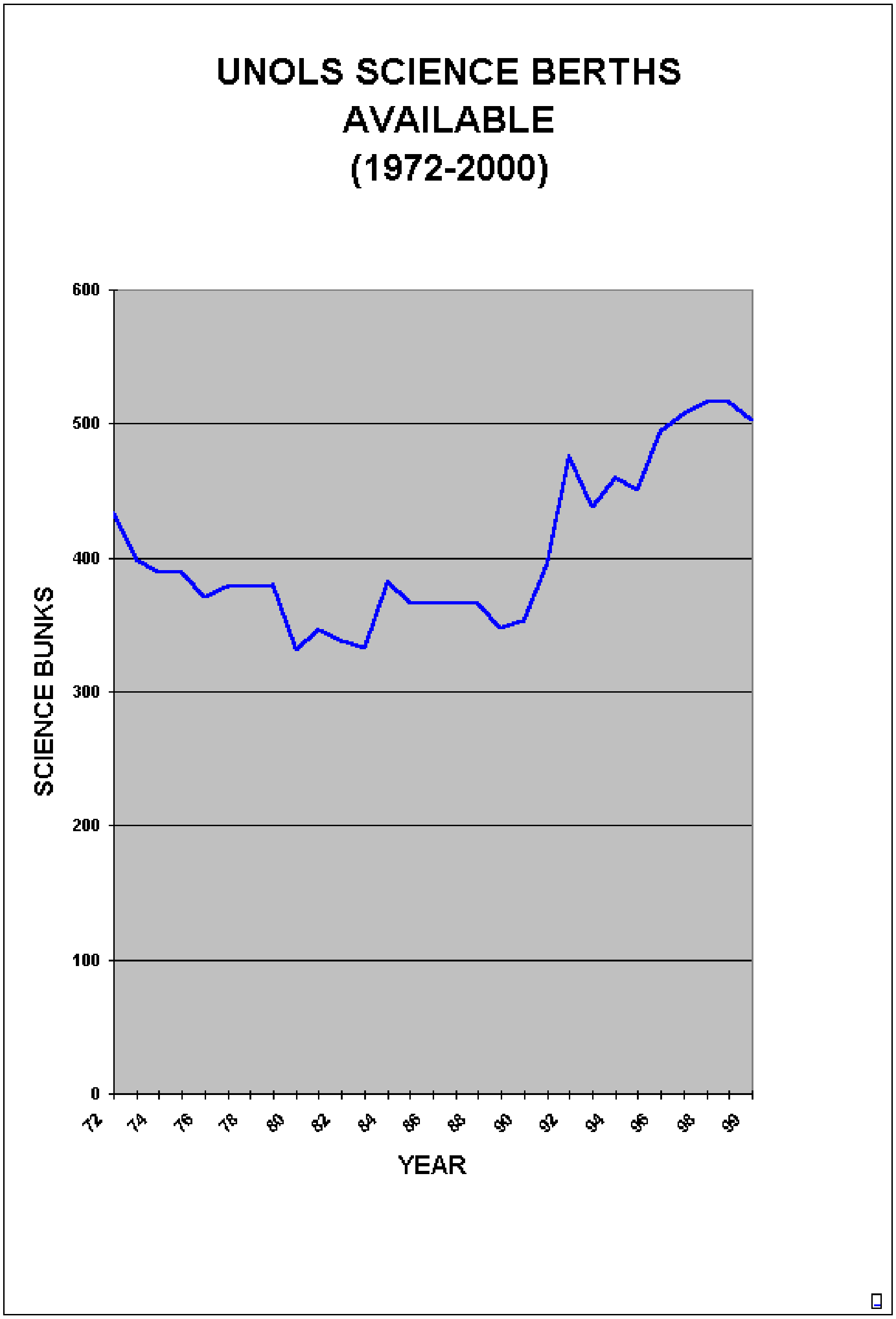
Scientific Berths Available in the Fleet

Scientific berths are one of the main constraints in ship requirements and the trend has been for more berths per ship. As would be expected from an overall increase in the number of ships, the increasing size of ships, and the allocation of more space to berthing the number of berths available. In the early 1980's about 330 berths were available and that has now risen to the present high of 503 berths (Figure 4). The trend suggests an increase of about 175 berths over the past ten years. This reflects the new large ships with more berthing capacity.

Figure 4: Fleet Berthing Capacity



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The Future

All ships have a finite lifetime. The usual assumption is that a ship can remain operational for about thirty years if there is major refit after about fifteen years. Of course many ships stay in the fleet longer and some for a shorter time. Figure 5 shows our best estimate of when presently existing ships will go 'off line'. This plot is not our endorsement of a retirement. It is merely an attempt by FIC,UNOLS, UNOLS and ship operators to look at the future.

The conclusions we make are based on the size of the fleet, the anticipated retirement dates and the projected demand. Clearly the demand is difficult to judge. We want to make it clear that we have stayed with the trend lines established in the 1990's. The reader can easily assume different demand projections and make their own assessment. We have made no attempt to assess regional requirements although we fully appreciate the regional demands on all classes of ships.

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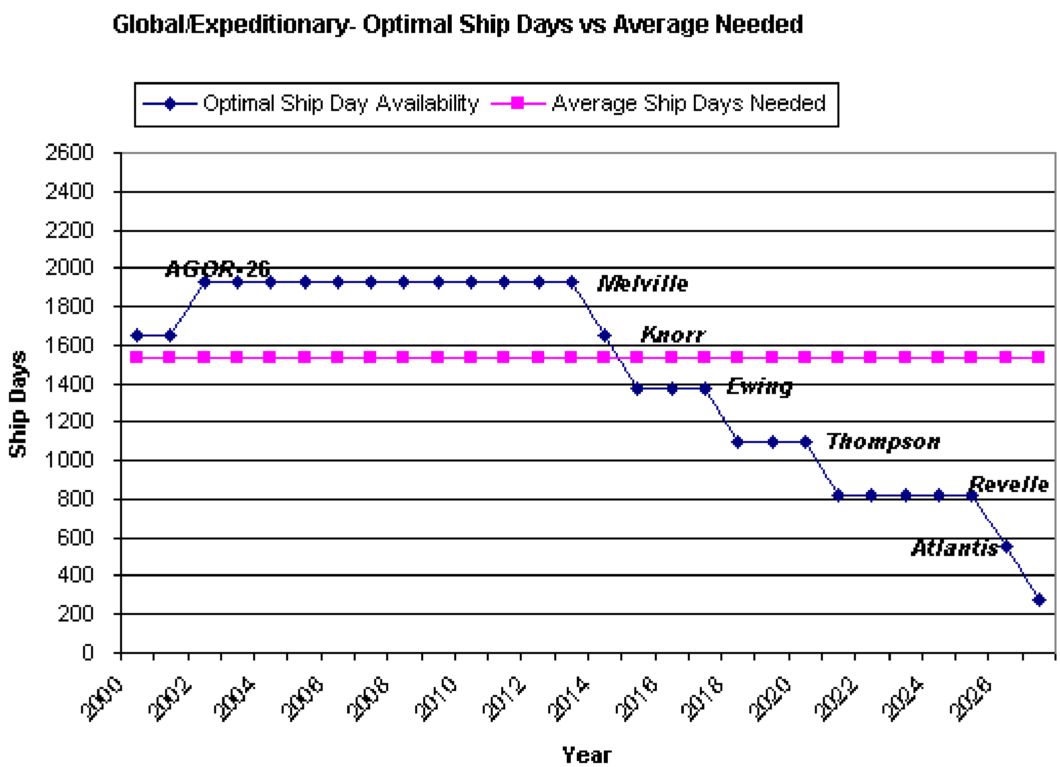
Figure 5: Projection of Ship Day Capacity and Utilization

Global/Expeditionary Ship Day Utilization:



Large/Expeditionary Ships: In 2002, with the inclusion of the AGOR-26 to the UNOLS fleet, 1900 days per year will be available. With our estimate of 1650 days per year of ship demand there may be an excess of about 250 days of large/expeditionary ship time until the first retirement in 2013. A modest increase in demand will eliminate that excess capacity. Our interpretation of recent trends suggest that the ships must be replaced and two to four added. Since it takes five to ten years to acquire a vessel in this class, time is available. However within the next two years replacement and addition plans should start.

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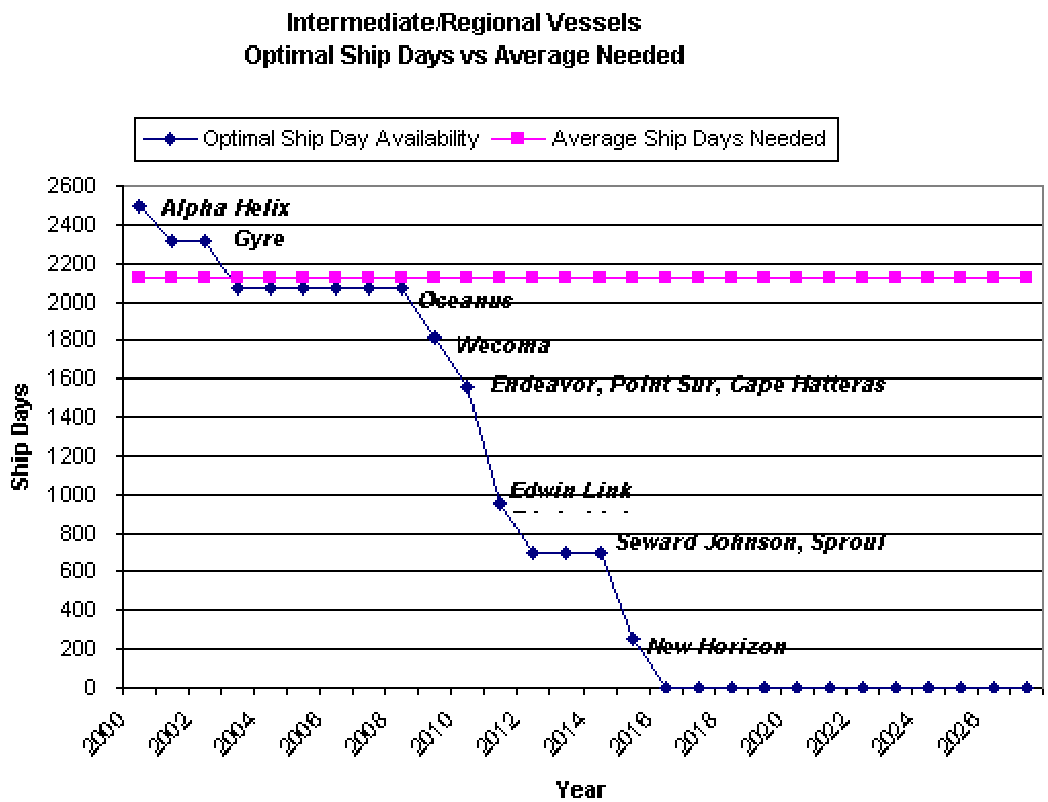
Intermediate/Regional Ship Day Utilization:



Intermediate and regional ship: The intermediate ships are in a very different situation than the larger ships. Many will reach their planned retirement date over an eight or nine year period between 2008 and 2016. With projected retirements the excess capacity will disappear by 2009. It is conceivable that the projected increase in large/expeditionary ship demand will be partly assumed by this class. The serious problem is, however, that many of the ships reach their retirement date in a short period of time. This class takes a shorter time to acquire so we must carefully assess the demand and regional requirements over the next few years.

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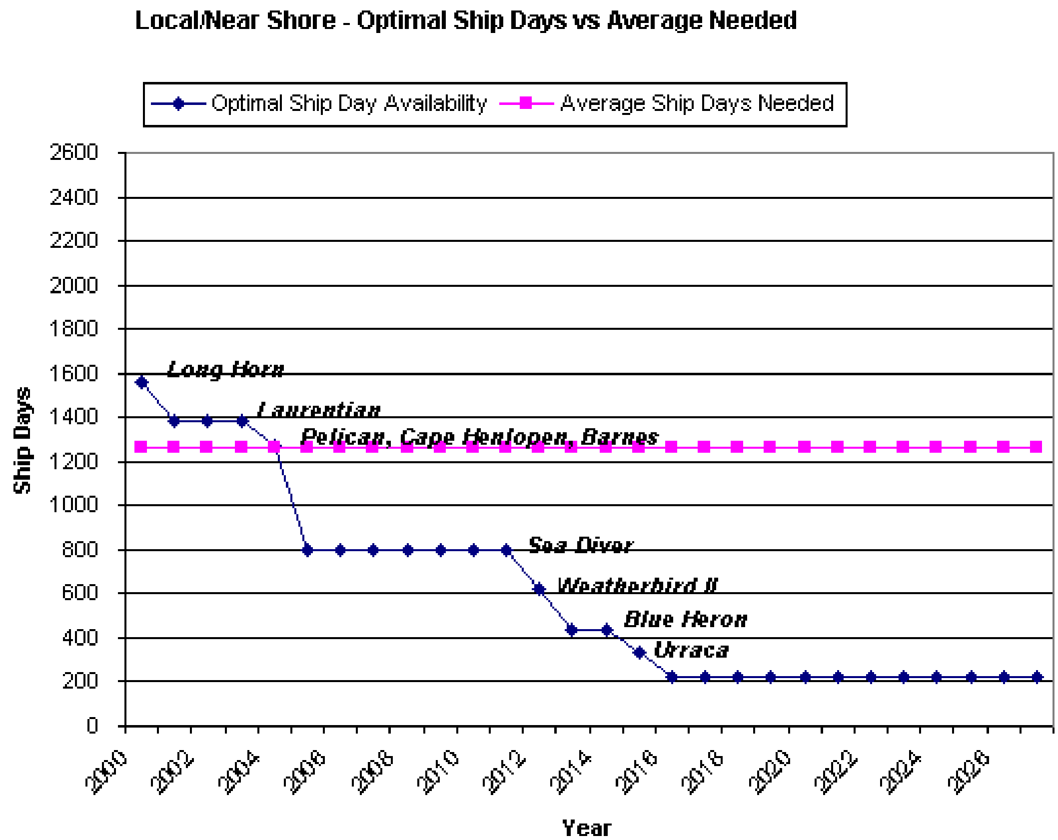
Local/Near-Shore Ship Day Utilization:



Local and near-shore ships: Several small ships are quite old and some are past their retirement date. In the next seven years four ships are reaching retirement age followed by a several year gap then between 2011 and 2016 all the remaining ships would be retired. The analysis of past trends suggested that there has been some modest growth (three ships increase over twenty years). Thus it seems that not only must these ships be replaced but as many as three new ships of the local and near-shore class must be added to the fleet. Since these ships are often acquired with non-Federal funds we assume the regional user community and operators will assess and address the situation.

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The Cost of Replacement

The schedule and cost for replacement of the fleet as each ship retires is obviously impossible to predict. Nevertheless it is informative to see one realistic scenario (Figure 6). In the next five years approximately $135M is required to and over the next 15 years about $540M is required. At present there is no public Federal agency plan indicating where that money will come from.

Figure 6: The Cost of Replacement

One-for-One Replacement Cost Estimate														
														Grand
Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
Global @ $60M														
(Melville, Knorr, Ewing)						Design 10M		60M	60M			60M		**$190M**

Intermediate/Regional @$30M/15M														
(Seward Johnson, Wecoma, Endeavor, Gyre, Oceanus, New Horizon, Edwin Link, Point Sur, Cape Hatteras, Alpha Helix, Sproul)	Design 3M	45M			30M	30M	30M	60M			30M	45M		**$273M**
Local @$15M														
(Cape Henlopen, Weatherbird II, Sea Diver, Pelican, Longhorn) Ships less than 100 ft are not included in the chart.	Design 2M 15M	30M							15M	15M				**$ 77M**
Grand Total	**20M**	**75M**	**0**	**0**	**30M**	**40M**	**30M**	**120M**	**75M**	**15M**	**30M**	**105M**	**0**	**$540M**
Notes														
Construction Times: Large Ship = 5 years, Intermediate = 3 years Small Ship = 2 years														
Cost Estimates are in FY2000 Constant Dollars.														
Gyre, Alpha Helix, and *Longhorn* are scheduled to go out of service before 2003.														

This scenario only replaces ships. However, as our discussion suggests, it is likely that new large/expeditionary ships and possibly intermediate/regional and small/near-shore ships will be required to meet future science needs. Those needs could exceed $200m placing the total cost through 2014 at nearly $800m.

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Lead Time in Ship Design and Construction

It takes at least five years to bring a large ship into the fleet and three and two years respectively for intermediates and small. Experience shows however that it takes much longer because funding must be obtained. Three Four recent examples for large ships are *Knorr/Melville*, *Thompson*, *Revelle* and *Atlantis*.

- *Knorr/Melville* (mid-life refit and conversion)
- 1983 - Science Requirements established
- 1984 - Navy initiative begun for funding
- 1986 - Funds available
- 1989 - (February) - Conversion begins
- 1992 - (October) - *Knorr* and *Melville* rejoin the fleet
- *Thompson* (AGOR - 23)
- 1983 - Science Requirements established
- 1984 - Navy initiative begun for funding
- 1985 - Design begun with community input
- 1986 - Funds appropriated
- 1986 (Nov.) - RFP released

- 1987 (Aug.) - Contract Awarded
- 1988 (Oct.) - Begin construction
- 1990 (Feb.) - Delivery
- 1991 - *Thompson* joins the fleet.
- *Revelle* (AGOR - 24) and *Atlantis* (AGOR - 25)
- 1993 - Begin Construction
- 1996 - *Revelle* joins the fleet
- 1997 - *Atlantis* joins the fleet
- AGOR - 26 (The new SWATH vessel for the University of Hawaii)
- 1997 - Funds appropriated
- 1999 - Construction begins
- 2002 - Anticipated delivery.

The point here is that planning must begin now.

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Planning for New and Replacement Ships and assessing future needs

The academic fleet is renewed through a process that includes all aspects of the oceanographic community. Without going into all the details we would like to mention that an important first step is for the user community of oceanographers to reach a consensus on what is needed in the future based on assessments of future trends.

Recently, NSF asked the oceanographic community to assess the future of the traditional four sub-disciplines of oceanography. The members of FIC reviewed these documents to determine if there was any requirements related to ship use. We did find some common threads through the reports. They are as follows:

- Launch and retrieve autonomous, remotely operated vehicles, and submersible.
- Send and receive large amounts of data
- High capacity shallow draft coastal vessels
- Service ocean observatories and moorings
- Sample ocean surface boundary layer and undisturbed surface waters
- Sample hydrothermal vents and the deep sea
- Support large multidisciplinary field experiments with several ships
- Deep crustal drilling and rapid drilling in sediment and shallow basement
- Long term geophysical deployments

The new aspects of this list are the arrival of undersea vehicles, the tending of ocean observatories, and the trend to even larger multi-disciplinary, multi-ship field experiments. These requirements in some cases do not imply significant changes to ship design but others require new features such as dynamic positioning and specialized winches.

The size of ships, the number of bunks, the special facilities and the regional location must be determined as well as possible for the fleet to operate effectively and efficiently. Assessing future needs is difficult but necessary to meet this task.

The science mission requirement process is specifically designed to address these needs.

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Conclusions and Recommendations

Recommendation number one is:

> Sit down with your colleagues and discuss the information presented. Discuss how the trends and projections will affect your research and, more importantly, the research of your younger colleagues. Participate in the process.

The construction and design of new ships, the replacement of retiring ships and the addition of new ships to the fleet require participation by the whole community. The scientific community must present the case to the funding agencies: What types of new ships are needed? Why are they needed? What new, exciting, relevant research can be done? What might be lost if ships are not replaced?

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Acknowledgements

This document would not have appeared without the initial help from Richard Pittenger (WHOI) and Annette DeSilva (UNOLS office) who gathered the data and made the original plots. We thank them. We also thank the operators and users who fill out the forms. Without information on each and every cruise we cannot make any projections on the future. Keep filling out the forms!

Figure Captions.

Figure 1. The Future. The number of available ship days in the academic research fleet assuming no ships are replaced as they are retired and that demand remains constant at the 1999 level. By 2007 there will be fewer day available than the demand.

Figure 2. Ships in the Fleet, Days Available and Days Used. Number of ships in fleet, days available and days used: 1972 to 1999. Since 1992 the number of ships and ship days available has increased steadily. The usage has also increased although with a good deal of variability.

Figure 3. Capacity and Use by Class. The number of ships available, the number of day s available and the number of days used for each of the three classes of research ships.

Figure 4. Fleet Berthing Capacity. The number of berths for scientists available in the whole fleet.

Figure 5. Projections of ship day capacity and utilization. The available ship days in each class assuming ships retire on schedule and are not replaced. Demand is assumed constant at 1999 levels.

Figure 6. The cost of replacement. The cost of replacement (2000 constant dollars) by year based on retirement schedules.

End Notes

* The Research Vessel Operators Committee recommended definition of a Full Operating Year (FOY): Ships 200'-300'=275 days, ships 150'-199'=250 days, ships 100'-149'=180 dyas, ships <100'=110 days.

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