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Division of Ocean Sciences
Integrative Programs Section

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TO: Dr. Clare Reimers, Chair
UNOLS Fleet Improvement Committee

FROM: Bauke Houtman, Head
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C/c: Tim Schnoor, ONR
Rear Admiral David Score, NOAA Corps
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SUBJECT: Number of Regional Class Research Vessels (RCRV)

Summary: The Division of Ocean Sciences (OCE), in cooperation with its agency partners, is evaluating the need for new NSF-owned Regional Class Research Vessels. As stated in the original solicitation for design and construction of the RCRV, the actual number of vessels built would be based on: (1) projected science utilization; and (2) availability of funding. Availability of funding includes both construction and operational funding. Construction funding, if appropriated, would be through the Major Research Equipment and Facilities (MREFC) account. Given current and projected funding constraints, the federal agencies must carefully balance science support requirements over the next several decades against available science and operational budgets, which are separate from MREFC funds.

OCE has analyzed five different scenarios and made a preliminary determination that three (3) RCRV's are needed to meet regional coastal requirements and can be supported within the projected available budgets given the following assumptions:

1. FY22 Fleet Operating Budget remaining flat at FY14 level ($120M)
2. Annual inflation rate of 2.2%
3. Annual fuel price inflation rate of 2.9%
4. One (1) additional Ocean Class ship retired for a total Fleet size of 16 vessels

OCE is seeking UNOLS Community concurrence to move forward with a preliminary request for MREFC funding in FY 2017 to support construction of three RCRVs.

Project Status, Fleet Status and Timeline: Oregon State University (OSU) met the requirements for the Conceptual Design Review in December 2013 and OCE recommends award of funding in order to advance the project to the Preliminary Design Phase. The Preliminary Design Review is planned for August 2014. If successful, and approved by the Director and the National Science Board in 2015, NSF could include the RCRV project in an FY 2017 MREFC budget request.

In the on-going effort to control operational costs, Fleet "right-sizing" is already underway due to underutilization with retirements of *Wecoma* (2012), *Cape Hatteras* (2013), and the planned retirement of *Point Sur* (2014). At the same time, Fleet modernization is also advancing with *Sikuliaq* beginning science operations in late 2014 and *Neil Armstrong* and *Sally Ride* going into service in 2015 and 2016respectively. Fleet modernization was never intended to be a one-for-one replacement. The Academic Fleet will be smaller in 2022 than it is today; the question is how many ships are needed to meet scientific capability/capacity requirements and still be supported within the real-world budget constraints.

OCE presented a high-level evaluation to NSF leadership in November 2011 to support the requirement for three (3) vessels. This evaluation was based solely on past trends in utilization. A more thorough and rigorous projection must now be developed that includes the future needs of science programs as well as clearly illustrating OCE's ability to manage its facilities costs within available budgets.

Budgetary Constraints and Assumptions: OCE will not be able to advance the RCRV project without clearly illustrating (both internally and externally) how it will manage Fleet operational costs going forward. Justification for the number of RCRV's requested must be supported with realistic figures and be unambiguous to the outside observer. OCE recognizes that there are many variables which contribute to Fleet costs including personnel pay and benefits, fuel price volatility, modernization (new ships will be larger and more complex), standard commodities inflation rates, and aging of the existing Fleet. Certain assumptions must be made regarding the variables in order to project Fleet costs in 2022. For the purposes of RCRV projections the assumptions used by OCE are as follows:

1. Total Fleet Operating Budget: This is assumed to be **$120M** in FY2014 dollars from all agencies. This is the aggregate of $75M from NSF, $15M from ONR and $30M from "Other" (NOAA, BOEM, Institutional, etc.). It is based on the actual **cost** to operate the Fleet in FY14, **not** necessarily the publically available budget figures.
2. Operational Days: All vessels are assumed to operate at or slightly above the "Minimum Sustainable Days" (MSD) for their Class which is defined as: *"The number of sea days whereby the full time crew can be retained and all required maintenance conducted while keeping the daily rate reasonable and not requiring lay-up funds."* See Table 1 below. The operational days used for this exercise are well below full vessel utilization for each Class allowing more science to go to sea if funding were available. Note that

operational days includes days at sea, mobilization days away from home port, foreign port days, etc.

3. Daily Rates: Rounded ship and technical daily rates based on historical averages are used for each Class. Latest available projections from the OCRV and RCRV projects are used. *Langseth* is assumed to operate 40% of the time as a general-purpose platform and therefore has two technical services rates; one for seismic and the other for general purpose work. See Table 1 below.
4. Emergency Repairs: Major emergency repairs are not included in the daily rate or the total operational budget, but are assumed to be covered separately by the vessel owner.
5. Mid-Sized Infrastructure: The $120M figure does not include mid-sized facilities such as Deep Submergence, Long Core, Equipment Pools, etc. Any increases above the $120M would have to be taken from these other programs.
6. Inflation: OMB's Consumer Price Index (CPI) inflation rate of 2.2% for the period between 2014 and 2022 is used for all operational costs except for fuel. Fuel inflation rates of 2.9% are used based on the U.S. Energy Information Administration (EIA) projections for transportation diesel fuel (Delivered Sector Product Price) for the 2011 to 2040 period.

The following table shows the rates and days used in the analysis:

TABLE 1:

Vessel Class	Min. Sustainable Days	Assumed Operational Days (2022)	Rounded Ship Daily Rate (2012)	Rounded Technical Daily Rate (2012)
Global				
Thompson, Atlantis, Revelle	200	250	$37,500	$4,800
Sikuliaq	200	250	$40,000	$4,800
Langseth	200	200	$45,000	$21.0K/$4.8K
Ocean				
Kilo Moana	150	200	$35,000	$3,500
Sally Ride/Neil Armstrong	150	200	$33,000	$3,500
Atlantic Explorer	150	150	$22,000	$3,500
Regional				
RCRV	110	150	$16,500	$1,800
Hugh R. Sharp	110	150	$12,000	$1,500
Local	70	90	$3.0K - $12.0K	$1,000

Methodology: Using the assumptions above, OCE looked at five (5) basic scenarios. ***If required, the number of vessels within the other classes was then adjusted to stay at or below the available operating budget***. The five basic scenarios were:

1. Flat baseline budget; 3 New RCRV's; 17 total ships
2. Flat baseline budget; 3 New RCRVs; 16 total ships
3. Flat baseline budget: 2 New RCRV's; 16 total ships
4. 2.0% annual increasing budget; 3 New RCRV's; 17 total ships
5. 2.0% annual increasing budget; 2 New RCRV's; 16 total ships

Results: The following tables represent the findings from the methodology and assumptions described above and are based on total Fleet costs (all agency/user contributions). All assume that the AGOR-23 class completes the planned Service Life Extension and the University of Washington replaces the *Barnes* for a total of four (4) Local Class vessels in the Fleet. The total project baseline Fleet is therefore seventeen (17) vessels by 2022 which matches the current UNOLS Fleet Improvement Plan.

Available budgets include both ship and technical support and funding from all projected sources.

For reference, Table 2 below shows the percentage of total Fleet costs borne by NSF in CY 2014, excluding programs such as Deep Submergence, Shipboard Scientific Support Equipment, and Oceanographic Instrumentation. These percentages could increase in future years if other agency budgets do not at least remain flat, further impacting NSF's ability to fund ship time:

TABLE 2:

Class	NSF % (2014)	NSF Estimated Cost (2014) Ship & Tech
Global	67%	$51,466,000
Ocean	65%	$20,304,000
Regional	51%	$2,022,000
Local	30%	$1,498,000
		$75,290,000

Scenario 1 - Flat Baseline Budget; 3 New RCRV's; 17 Total Ships:

Assumptions:

Annual Inflation (OMB)	2.20%
Annual Fuel Cost Inflation	2.90%
Base Budget (Ship and Techs)	$120,000,000
Annual Budget Increase	0%
FY22 Available Budget	**$120,000,000**
Number of New NSF Regionals	3

Results (FY2022):

Class	Number	Estimated Operating Schedule	Average Days (2012-2014)	Total Fleet Cost ($M)
Global	5	250 (200)	262	$72.0
Ocean	4	200 (150)	199	$33.1
Regional	4	150	128	$15.3
Local	4	90	129	$4.9
	17			**$125.2**

This scenario shows that the current Fleet Plan is not sustainable under these assumptions with total costs being approximately $5M over budget. Further reductions in Fleet size or an increase in total available budget would be necessary as explored in the scenarios below.

Scenario 2 – Flat Baseline Budget; 3 New RCRV's; 16 Total Ships:

Assumptions:

Annual Inflation (OMB)	2.20%
Annual Fuel Cost Inflation	2.90%
Base Budget (Ship and Techs)	$120,000,000
Annual Budget Increase	0%
FY22 Available Budget	**$120,000,000**
Number of New NSF Regionals	3

Results (FY2022):

Class	Number	Estimated Operating Schedule	Average Days (2012-2014)	Total Fleet Cost ($M)
Global	5	250 (200)	262	$72.0
Ocean	3	200 (150)	199	$28.1
Regional	4	150	128	$15.3
Local	4	90	129	$4.9
	16			**$120.2**

To bring Fleet costs at or below budget, one (1) additional Ocean Class was retired from service; reducing the Fleet to sixteen (16) vessels. For this scenario the assumption was made that *Atlantic Explorer*, which has a Projected End of Service Life of 2026, was retired in 2022. RCRV would be able to meet *Atlantic Explorer*'s mission profile with added transit time if required. As can be seen, retiring *Atlantic Explorer* barely meets budget; giving no margin for added Fleet costs.

Retiring *Kilo Moana* instead produces an additional savings of roughly $4.5M. This could allow for additional ship & technical support if science funding were available, potentially increasing the days at sea above what is assumed in this analysis. It also allows some margin for added programmatic costs such as enhanced satellite communications, increasing vessel daily rates beyond basic inflation, and/or emergency vessel repairs. Additional savings could be achieved by retiring a Global Class vessel from service instead of an Ocean Class.

Scenario 3 - Flat Baseline Budget; 2 New RCRV's; 16 Total Ships:

Assumptions:

Annual Inflation (OMB)	2.20%
Annual Fuel Cost Inflation	2.90%
Base Budget (Ship and Techs)	$120,000,000
Annual Budget Increase	0%
FY22 Available Budget	**$120,000,000**
Number of New NSF Regionals	2

Results (FY2022):

Class	Number	Estimated Operating Schedule	Average Days (2012-2014)	Total Fleet Cost
Global	5	250 (200)	262	$72.0
Ocean	4	200 (150)	199	$33.1
Regional	3	150	128	$11.1
Local	4	90	129	$4.9
	16			**$121.0**

As with Scenario 2, this scenario reduces the Fleet to sixteen (16) vessels and is essentially at the affordable level. No margin exists for adding ship time above the days shown, increased programmatic costs, or emergency repairs.

Scenario 4- 2% Annual Increasing Budget; 3 New RCRV's; 17 Total Ships:

Assumptions:

Annual Inflation (OMB)	2.20%
Annual Fuel Cost Inflation	2.90%
Base Budget (Ship and Techs)	$120,000,000
Annual Budget Increase	2.0%
FY22 Available Budget	**$140,600,000**
Number of New NSF Regionals	3

Results (FY2022):

Class	Number	Estimated Operating Schedule	Average Days (2012-2014)	Total Fleet Cost
Global	5	250 (200)	262	$72.0
Ocean	4	200 (150)	199	$33.1
Regional	4	150	128	$15.3
Local	4	90	129	$4.9
	17			**$125.2**

This scenario allows for the current Fleet to be built and operated as shown in current UNOLS Fleet Improvement Plan projections. There is roughly a $15M margin available for additional ship time, increased programmatic costs, and/or emergency repairs.

Scenario 5 - 2% annual increasing budget; 2 New RCRV's; 16 total ships

Assumptions:

Annual Inflation (OMB)	2.20%
Annual Fuel Cost Inflation	2.90%
Base Budget (Ship and Techs)	$120,000,000
Annual Budget Increase	2.0%
FY22 Available Budget	**$140,600,000**
Number of New NSF Regionals	2

Results (FY2022):

Class	Number	Estimated Operating Schedule	Average Days (2012-2014)	Total Fleet Cost
Global	5	250 (200)	262	$72.0
Ocean	4	200 (150)	199	$33.1
Regional	3	150	128	$11.1
Local	4	90	129	$4.9
	16			**$121.0**

This scenario allows for the current Fleet to be built and operated as shown in current UNOLS Fleet projections; less one (1) RCRV. There is roughly a $20M margin available for additional ship time, increased programmatic costs, and/or emergency repairs.

OCE and Polar Science Program Inputs: The Science Sections within OCE and Polar were asked to provide their inputs on the changing needs of science and utilization for the Academic Research Vessel Fleet. Their inputs are included in Appendix A.

Vessel schedules in any given year are driven by the funded science which is based on scientific merit and the availability of funding within the science programs. OCE's budget is divided between facilities and the science programs. Therefore, any increases in facilities costs above the $120M in the flat budget scenario used in this analysis would have to be borne by cuts to the core science. Avoiding such cuts, and the associated negative impacts on OCE science programs, was why the methodology described above was used.

It is OCE's position that the number of high quality, unfunded science proposals is not germane to this discussion as a measure of "demand" since the budget realities are what dictate the amount of science that can be put to sea.

The Decadal Survey on Ocean Sciences (DSOS): The recommendations from the DSOS are expected to be presented after March 2015 when OCE plans to present the RCRV Project to the National Science Board. OCE will be monitoring preliminary outcomes as they develop. Given the RCRV timeline, there will be opportunities to adjust the Fleet modernization and "right-sizing" plan based on the final report from the DSOS Committee.

Conclusion: The Budget Control Act, which led to sequestration in FY 2013, allows for the possibility of modest growth beyond 2016. In the FY15 budget, the current Administration projects NSF going from $7.2B in 2014 to $8.9B in 2024 which equates to an annual increase of 2.2%. However, GEO's conservative estimate is for either zero or very limited growth within the Division for the foreseeable future. If growth does exceed expectations, there is a high likelihood that OCE's priority will be re-investment in the core science programs as opposed to facilities. Therefore, OCE must realistically assume the flat budget scenario for the purposes of estimating the number of RCRV's that are supportable.

Under the flat budget scenario, and based on the insights of OCE Science Programs given in Appendix A, OCE believes that three new RCRV's can be constructed and operated if the Fleet is further reduced to sixteen (16) vessels **or less** as shown in Scenario 2. **With these potential constraints in mind, OCE is considering pursuing construction of three (3) new Regional Class Research Vessels.** GEO and OCE will continue to monitor the DSOS process and agency budget projections going forward. OCE will work closely with the UNOLS community and its interagency partners as further Fleet "right-sizing" decisions are required.

APPENDIX 1 - OCE Science Program Inputs on Vessel Class Requirements

OCE Marine Geology and Geophysics Program: The Marine Geoscience community is currently dominated by users of global and ocean class research vessels. Our science requires the use of deep submergence tools (JASON, SENTRY, NEREUS, etc.); modest-to-large arrays of Ocean Bottom Seismometers (OBSs); IODP site survey cruises; sediment coring that allows the retrieval of long sedimentary records; 2- and 3-D seismic reflection studies; Magneto Telluric (EM/MT) studies; water column sampling with CTDs; deep dredging; and multi-coring. Many of these and the attendant technicians or collaborators require significant deck space for equipment and/or staging and bunk space.

Over the last 20 to 30 years, most MGG funded science has involved geographically wide-ranging, deep ocean, long haul projects where the science occurs in the middle of the ocean or far from US territorial waters. A reasonable number of these cruises have 20 or more science days. Depending on the deck requirements, cruise location, and size of the science party, our dominant needs have required global or ocean class vessels. That said, the past decade has seen an increase in collaborative studies along margins, extending across the continental shelf and somewhat beyond the slope.

As a group, we still see that these larger vessels will play a dominant role in serving our community's needs now and in the future. However, with Cascadia and the envisioned large OBS deployments on the Alaskan coast and East Coast of the US, in addition to the ramping up of the OOI cabled observatory to Axial Volcano, we see that there could be increased usage of regional class vessels for some geophysical and seafloor work.

Due to the importance of global class vessels to our science, we would like to retain no less than four in this class, since two, at this time, are relatively specialized (*Langseth* and *Atlantis*). This will prevent excessive wait times for MGG PIs to go to sea. For less deck-space intensive work and/or that which does not require extensive travel or deployment times, our PIs could use Ocean class vessels. We feel that preserving as many larger ships as possible, even if it means only adding two regional class vessels, one serving Atlantic and Gulf work and one serving the Pacific, would be optimal for our community. Our community does not, at the present time, use local vessels much, although instrument development groups (OBS, EM/MT, geodesy) do occasionally depend on them for testing which is crucial for proofing upgrades in technology.

OCE Biological Oceanography Program: The Biological Oceanography Program is an extremely diverse community. While we have observed an overall decline in ship requests recently the program consistently sees requests for ships that range the entire spectrum from Coastal to Global class. The decline in ship time requests is likely to change in the future and while we sometimes have specific needs such as an Ocean or Global class with AUV/Alvin requirements the program sees a pressing need to support the increasing demand associated with coastal science (Coastal SEES, coastal carbon cycle), and what we anticipate will be an increase in the number of requests in the future to work on, or around, OOI sites and LTERs. This will likely

include significant amounts of seasonal sampling (e.g., climate change related studies) that require access to vessels capable of sampling coastal seas under a variety of weather and sea conditions safely. Because of these identified needs we support a plan that would incorporate more Regional class vessels deployed strategically on the East and West coasts as well as the Gulf of Mexico. The cost effectiveness, combined with their geographic positioning and enhanced capabilities as a science platform, makes them the best strategic choice in our collective opinions.

OCE Chemical Oceanography Program: The perspective of the Chemical Oceanography Program and the needs of the U.S. marine chemistry community very closely match those of our counterparts in the PO and BO Programs and their associated extramural communities. Requests from the CO community for ship time on all platforms have been declining since as far back as 2006; the reason for this is not known for certain, but I suspect that multiple causes are likely. There will continue to be episodic requests for ocean class vessels for the foreseeable future, but the frequency is likely not to change significantly; with the exception of U.S.GEOTRACES, most of them will be for interdisciplinary efforts that also involve joint BO/CO/PO sponsorship; such technically complex, expensive, multi-disciplinary, multi-institutional proposals certainly have no greater likelihood of success than less ambitious ones. On the other hand, the demand for regional and coastal ship time is expected to remain steady – and perhaps increase if the OOI sites actually do manage to draw PIs away from their current research interests or else can be fitted into them in some way. The demand from chemists and geochemists for main deck space to accommodate specialized vans is not going to decrease, so it would be inadvisable to sacrifice main deck space for other facilities in the design of any new ships regardless of class. Even though the current range of sophisticated chemical sensors suitable for deployment on autonomous platforms is severely limited, we can expect that more and more chemists will need such platforms for future sensor development. To date, ocean chemists have rarely found much use for manned submersibles.

OCE Physical Oceanography Program: The Physical Oceanography perspective on the future make-up of the Academic Fleet is very much in line what the rationale of Biological Oceanography. While the overall requests have been declining in recent years due to reductions in science funding and the advent of autonomous platforms, satellites and models as mature tools to investigate ocean dynamics, we see a future need for new highly capable coastal vessels to conduct process experiments around some of the OOI sites year around, deploy and recover moorings and autonomous assets and support multi-disciplinary coastal studies that require biological and chemical measurements that can only be obtained from ships. If affordable in the context of fixed OCE budgets and a better balance between our investments in science and facilities, new RCRVs on the East coast, West coast and Gulf of Mexico would make sense. This may mean reducing the number of Global/Ocean class vessels further.

Division of Polar Programs; Antarctic Sciences (PLR/ANT): The PLR Division requirements in research vessels is qualitatively similar to those of the Ocean Sciences Research Section, along with the added complications of a) operation in remote and distant oceans and b) operation in

sea ice and in the close proximity of floating land ice and ice shelves. The vessel support base for these ships is typically far from U.S. territorial waters.

In PLR, the science disciplines range across physical, chemical, biological, microbiological, ecological oceanography, and also glaciological and geological realms. PLR ships have been used for geophysics and astrophysics platforms. Both ARC and ANT additionally have specific science programs that call out for systems science approaches to the integration of cross disciplinary approaches to polar science questions. ARC and ANT ships are often used to support other maritime and land based research disciplines. Because of the unique and varied constraints of working in ice environments, PLR tends to use the best vessel for the stated purpose. This includes UNOLS vessels (e.g. the *Point Sur* in 2013) and potentially the new RCRV depending on science requirements. Requirements have often lead to a ' lease' rather than 'own' operation of ships, including use of non-US flagged ships in certain circumstances.

The PLR oceangoing science community comes together from time to time to assess science based needs. One recent group was the 2012 committee chaired by Robert Dunbar (see http://www.unols.org/committees/fic/smr/prv/) which yielded design parameters with many options included. Program and Marine Managers from both ARC and ANT were present during these discussions. Science drivers for the ship requirements are also discussed. The overall document remains a report of community interest that has not been acted upon. ANT (Antarctic Sciences) currently charters two ships, the *NB Palmer* and the *LM Gould*. Other vessels that play an important part in the USAP (US Antarctic Program) are tanker and cargo ships operated through the US Materiel Support Command, together with an icebreaker (e.g. USCG *Polar Star*) at McMurdo. In recent times ARC has made regular use of the USCG *Healy* as a research platform.