# Antarctic Oceanography Planning Workshop: Possible Replacement of the *R.V.I.B. Nathaniel B. Palmer*

FINAL REPORT

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Conveners

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**The workshop's objective was to provide broad community input in the initial stages of design of a new ice breaker designed to replace the *R.V.I.B. Nathaniel B. Palmer*. As such, the attendees consisted of physical, chemical and biological oceanographers, as well as those involved in sampling ice and using remote sensing techniques or remotely operated platforms. As future research directions will drive the needs of the research platform, the workshop also included discussions of future research programs and directions. The major recommendations include the following for a replacement vessel:**

- **A larger vessel capable of holding ca. 40 researchers with endurance of up to 90 days;**
- **Modular design for laboratories to allow for efficient multiple use of ship;**
- **Incorporate into the design unique opportunities afforded by operating in a pack ice environment, such as booms and efficient surface access allowing deployment of multiple instrumentation systems simultaneously;**
- **Inclusion of a modular automated underwater vehicle deployment and recovery station to extend ship operations in space and in locations (e.g., under ice) where the ship cannot effectively sample;**
- **A design that forces ice away from the stern area to allow for efficient towing of nets and other gear; and**
- **A design that reduces acoustic noise and which allows for effective acoustic sampling from the hull.**

**Additional recommendations were also made that would enable the replacement vessel to clearly be the most capable research ice breaker in the world. It is expected (and desired) that interaction with the oceanographic community as a whole will continue throughout the planning of the vessel to insure that new and novel approaches to the problems of polar research are incorporated in the ship design.**

The requirements of the community for the replacement vessel were varied, but in large part were consistent with each other, or at least not mutually exclusive. These fell into overall needs (for example, those dealing with endurance, ice breaking capability, and science personnel needs) and more specific disciplinary needs (e.g., need for trace metal clean flowing seawater, aquaria accessibility). This report treats those separately, and describes the rationale that the group provided for each recommendation. A summary list of all recommendations is provided in Table 1.

## General Requirements for Replacement Vessel

The *N.B. Palmer* can presently accommodate 32 scientists and 7 Raytheon Polar Services technicians. While the needs for berthing space for some cruises is not severe, for some (particularly the larger programs such as JGOFS and GLOBEC) berthing space is the ultimate limiting factor in deciding what science objectives can be met. Indeed, both of those programs had up to 50% more requests for berths than they could accommodate. Hence, the scientific output of large, interdisciplinary programs is constrained by the personnel berthing. However, it was mentioned that vessels such as the *Polarstern* (which accommodates up to 55 scientists) often has difficulties in arranging wire time for all groups, and that the competition for the ship within a cruise was unproductive and to be avoided. As such, the group strongly felt that the new ship should be able to hold ca. 40 scientists, along with an increase in the number of RPS technical staff.

Such a ship would necessarily be larger, and it was felt that additional laboratory spaces should be included to make effective use of emerging technologies. For example, a moon pool is quickly becoming a tool that is used by all oceanographic disciplines (as evidenced by the recent addition of a moon pool to the *Palmer*), and that in the future even more use of this sampling system will occur. Simple and effective water-level access to the moon pool is needed (e.g., for nets, diving, AUV and ROV recovery and launching), and its location needs to be included in the early phases of design to allow sampling by all disciplines. Such a pool needs to be able to accommodate a CTD, as well as potentially be used as a means to deploy and retrieve ROVs and AUVs. Additionally, it might also be the site of acoustic sensors that collect data continuously. Design considerations need to take into account the wave generation issue within the pool and the need for proximity to the Baltic room.

Along with berthing capability and new design features, it was felt that the endurance and power (i.e., ice breaking capability) of the vessel need to be somewhat greater than that of the *Palmer*. The maximum cruise length was discussed, and it was felt that generally 75 days is close to the limit of human work capacity. This is near the longest cruise the *Palmer* has conducted, and during that cruise serious concerns were expressed about fuel consumption. Because some interdisciplinary projects and remote locations will require extended cruise deployments, this duration was deemed as the minimum that should be planned. Similarly, the power of the ship should be such that nearly all locations in the Antarctic can be safely and efficiently reached so as no science objectives are eliminated.

Ship design was discussed at length. For example, the present design of the *Palmer* makes it difficult at best to tow surface nets and vehicles while breaking ice, thus effectively precluding various types of studies. The new ship should definitely have a design that pushes ice away from the stern area and keeps this area relatively clean of ice. Similarly, the ship's acoustic noise presents a serious problem to those disciplines that rely on acoustic measurements, and careful attention needs to be paid to reducing the noise to scientifically acceptable levels. The technology presently exists to do so. Finally, alternate means of sampling were discussed, with one example of a new approach being the use of large booms to deploy/retrieve instruments using the ship's cranes. It was suggested that large, outrigger-type booms (30 m in length) could be used on the port side of the ship (the non-CTD side) to more effectively use this side of the ship. Inherent in the use of booms would be the approval to deploy more than one instrument at the same time. Additional materials have been assembled describing recent advances on the design of acoustic systems on modern fisheries research ships and can be viewed within the internet report (www.vims.edu/admin/sponpgms/palmer).

The laboratory design of the *Palmer* is quite acceptable, but it was felt that future needs will require the addition of specialized labs that would not be used for all cruises. Examples of such vans include radioisotope vans (like those now in use), trace metal-clean van (for sampling trace metals at the vanishingly low concentrations found in the Antarctic), and autopsy vans for marine mammal dissection. It is essential that all vans be modular and hence interchangeable with regard to hook-up with the ship. All will need adequate power supplies, fire alarms, intercoms/telephones for safety, computer network connectivity, and plumbing (running fresh water; drainage for sinks). Specialized drains may be required for some vans (e.g., isotope van). Positioning of the vans is also critical and must be considered early in the design phase (e.g., you do not want a radioisotope van placed a great distance from the incubators that hold the samples). Special considerations for some vans also need to be taken into account (e.g., positive pressure for the trace metal van; contained freshwater release from the radioisotope van).

The issue of helicopter use on a new vessel was discussed. Historically the *Palmer* has only rarely had helicopters, largely because of the extremely high costs associated with their operation. In addition, the helicopter hangar is used heavily for storage by all science parties, and the helicopter landing pad is the optimal location for isotope vans and incubators required non-shaded space. In addition, weather often severely limits the use of helicopters in the Antarctic. However, future needs require the maintenance of helicopter hangers and landing areas to allow for access to remote locations that would effectively enhance the operations of the ship. Permanent mounting of helicopters on the ship was not recommended. Both areas should continue to be effectively used by multiple purposes (incubator studies with running seawater; storage of science equipment; preparation of equipment such as sediment traps).

The *Palmer* in general is excellent for use in open waters, but it was recommended that the open water capabilities be improved to allow for year-round operation in the harsh environment of the Polar Front, in addition to the more coastal waters surrounding Antarctica.

**Specific Requirements for the Replacement Vessel**

New technologies are emerging that will soon be applied to Antarctic science. One of those disciplines is marine molecular biology. To adequately conduct these studies at sea, a gimbaled platform or laboratory is needed upon which centrifuges and electrophoresis equipment can be mounted, allowing samples to be processed in a timely manner. Such a platform might also be useful for on-board microscopy and flow cytometry as well. Some of the wet chemistry associated with modern molecular techniques also dictates that adequate fume hood space be designed into laboratories of the ship.

Maintenance of live animals aboard ship is not only useful for molecular biology but also permits physiological experimentation. To enable this work, good aquarium space should be incorporated into ship design. Overall design characteristics similar to those of the aquarium on the *L.M. Gould* (easily removable tanks, etc.), would permit flexible use of such space for other purposes during cruises that do not require this feature.

Recent studies (some conducted on the *Palmer*) have clearly shown the paramount importance of trace metals (particularly iron) to phytoplankton growth, and it is clear that studies of trace metals will continue to be an active area of research in the Antarctic. To facilitate these studies, not only is a trace-metal clean modular laboratory required, but flow-through water that is uncontaminated by the ship's superstructure is also needed. This flow-through system needs to be delivered to the trace metal clean van, as well as to the main laboratory, with little temperature modification. Furthermore, care must be taken to prevent clogging by ice. A second system of seawater delivery also needs to be maintained to provide water for heating/cooling of deck-board incubators and aquaria.

Much of future research will involve communication between the ship and the land-based laboratory, as well as direct use of the internet. As such, it is imperative that adequate through-hull communication ports be created to allow for complete networking of instruments. Furthermore, communication links to Antarctic stations and US laboratories need to be improved, and internet connectivity needs to be established. All communication links need to be able to deliver large packets of data over short time periods.

Experience with the Palmer has led to several suggestions for improved design or capabilities in a new vessel. For example, the cold rooms need to have better temperature control than on the Palmer, and some cruises may need an additional cold room (to be supplied as a laboratory van). A through-hull XBT launcher is needed to improve accessibility, safety and data integrity. The meteorological tower needs to be tested to insure that the wind velocity field interference is well known and documented. The shipboard ADCP that is presently on Palmer is 20-year old technology. Newer Doppler sonars and multi-frequency Doppler sonars would achieve deep velocity profiling (low frequency) and high resolution velocity profiling (high frequency) at frequencies that are also of biological interest. More and improved hood space is needed in laboratories where volatile chemicals are used (perhaps again in conjunction with a mobile laboratory). A means to transport crates and larger equipment between decks (and perhaps to the holds) is needed, and the concept of a "dumb waiter" was suggested. Within deck transport of gear also needs to be improved. At present the drainage on the decks on each side is inadequate to hold the large volumes of water and sediment that are washed overboard during coring activities, and the drainage capabilities need to be increased. Finally, better science shop facilities are needed to allow for work by scientists on equipment and shipping crates.

Because satellites will be used much more extensively in the coming decades, improved satellite communications are needed on a new vessel. This parallels the need for improved communication, and is part of that requirement. Satellite receiving capability is needed for both ice and pigment analyses, as well as tracking of AUVs and moorings via Argos. The new design should incorporate the latest satellite telephone capabilities, including communicating with surrounding moorings and buoys via Iridium modem. Implicit in this requirement is the training of RPS personnel to facilitate accessing these data.

It was also suggested that an ice tower be considered for inclusion in a replacement vessel. Such a tower would be able to house meteorological instruments (perhaps providing a less obstructed flow over the instruments), and reduce contamination and interference of the ship's stacks. This also would require enclosed access to monitor and service the instruments.

## Conclusions

In general, the *R.V.I.B. Nathaniel B. Palmer* is considered to be the premier oceanographic platform for use in polar waters, and it has been a tremendous asset to the US oceanographic community. It is, however, becoming "middle aged", and it is prudent to consider its replacement early enough to incorporate new technologies into its design. The committee was adamant on one point: ***that the scientific community should be involved not only in the initial stages of design, but throughout the entire design, construction and testing process.*** Errors in the past have occurred as ships were constructed, and it was felt that many of these errors might have been corrected had some group of scientists been consulted during the process of production. Furthermore, we recommend that an independent naval architect be retained as a consultant to the scientific steering group prior to and during the RFP process. While the *Palmer* remains an excellent platform, the opportunity for improving the oceanographic capabilities of the US are substantial, and the recommendations included in this report should facilitate the production of an improved ice breaker that will enhance US science efforts for years to come.

Table 1. List of recommendations of features to be included in the potential *Palmer* replacement vessel.

| Number | Recommendation |
|---|---|
| 1 | Increase size of ship to accommodate 40 scientists, 9 RPS personnel, and have a 75-day endurance capability; have power to sample 98% of all sites in Antarctica |
| 2 | Have a substantial number of modular laboratories that can be put in place when needed (e.g., isotope van, trace metal clean van, acoustic van, etc.) |
| 3 | Inclusion of an AUV with the capability of multiple sensors, along with simple deployment and recovery |
| 4 | Inclusion of a gimbaled platform for microscopy and molecular biology instruments |
| 5 | Purchase and outfitting of the following laboratories to be used as needed: trace metal clean van, isotope van |
| 6 | Include adequate bulkhead feed-through connections to allow for computer and instrument connectivity |
| 7 | Internet capability for a significant portion of the day |
| 8 | Have the capability of delivering high-quality, trace metal clean, unaltered seawater to all laboratories |
| 9 | Include helicopter pad even though helicopters might not be used on all missions |
| 10 | Need in-lab XBT launching capability |
| 11 | Need adequate aquarium facilities (temperature control, continuous flow-through seawater) to maintain specimens in good condition |
| 12 | Wells that can accommodate bigger transducers |
| 13 | Need to have a meteorological tower that is properly tested to define how it alters wind fields |
| 14 | Need “dumb waiter” to move boxes between decks |
| 15 | Cold rooms need improved temperature control; vans for ice core studies are needed |
| 16 | Adequate drainage on all decks, particularly so that they can handle rinsing of sediments and gear |
| 17 | Need better construction shop and materials for science use |
| 18 | Excellent open water capabilities (motion compensation) also required, particularly for winter work |
| 19 | Need improved hood space and ventilation in labs where volatile chemicals are used |
| 20 | Need improved satellite receiving capabilities |
| 21 | Improve the acoustic characteristics, especially in ice |
| 22 | Add multi-frequency Doppler sonars for deep velocity profiling and high resolution profiling at frequencies also of biological interest |
| 23 | Hire a naval architect prior to and during the RFP process for independent advice |