NOAA Ocean Exploration Advisory Working Group

Summary Workshop Report

Planning the Maiden Voyage of the *Okeanos Explorer*

May 10-11, 2007 Washington D.C.

1. Background

The NOAA Science Advisory Board (SAB) created the Ocean Exploration Advisory Working Group (OEAWG) to provide NOAA, through the SAB, with timely and expert guidance and oversight pertaining to: (1) general priorities for ocean exploration, including geographic areas of interest as well as subject matter topics, and (2) advice concerning emerging ocean exploration-relevant technologies. The OEAWG met in the Spring of 2006 in Silver Spring, MD to become acquainted with the existing NOAA Ocean Exploration (OE) Program. A subsequent meeting, in Fall 2006, was held in Los Angeles, CA to initiate planning for a workshop to identify targets for the new NOAA Ship *Okeanos Explorer* (EX) to investigate during its first two year of operations. This meeting also exposed the OEAWG and OE to the creative concepts of Walt Disney "Imagineering." On May 10-11, 2007, the OEAWG convened the EX planning workshop at the National Geographic Society in Washington D.C. in May 2007. This summary describes that workshop.

2. Workshop Goals

In the spring of 2008 NOAA expects to commission a dedicated ship of exploration, the *Okeanos Explorer* (EX). This vessel is intended to carry out a systematic global program of exploration in the oceans linked in real time through satellite and internet telepresence technology to the scientific community, educators, the media and the general public. More details on the anticipated capabilities of the EX are included in Appendix I. The OEAWG's first workshop was dedicated to developing recommendations on the maiden voyage of discovery for the EX.

Explicit goals of the workshop were:

1) To enable the OEAWG to make final recommendations to the SAB for high-priority survey areas for the EX, especially during its maiden voyage.
2) To work with invited participants, NOAA staff and members of the OEAWG to formulate recommendations for the operational paradigm that will guide them toward exciting and compelling voyages of discovery throughout its career.

Implicit goals of the workshop included:

1) To inform the ocean exploration community about the capabilities of the EX
2) To develop cross-cutting relationships amongst ocean explorers to further their own and NOAA's exploration goals
3) To solicit preliminary input on additional capabilities required on EX and by NOAA OE to effectively execute their mission

3. Workshop Process

The OEAWG organized and facilitated this workshop through a grant administered by Dr. Ballard's Institute for Exploration. These funds supported the travel costs of the workshop participants. OE assisted the OEAWG in publishing an announcement in the Federal Register that solicited the ocean research community for brief concept papers describing regions of high priority for exploration in the Pacific Ocean (due to the planned departure of EX from a West Coast port). The OEAWG then invited representatives to attend the workshop. Participants were chosen to represent themes, regions, and the community, not their individual research interests. Approximately 25 ocean researchers as well as the OEAWG and select NOAA staff attended the workshop. The National Geographic Society hosted the event.

The workshop announcement and agenda are included in Appendix II while a list of attendees is in Appendix III.

The OEAWG members served as hosts and facilitators of the workshop. Opening briefings provided attendees with baseline information on the role of the OEAWG, the OE program, the EX status and capabilities, the ROV being built for EX and a concept for an ocean exploration vision based on telepresence technology. These were followed by a series of breakout sessions discussing the regions of interest submitted by the community. While discussions focused on the regions and topics they also yielded valuable general insights on the EX concept and requirements. Breakout sessions reported back to the main group which reconvened its discussions as a whole. A plenary session on the second day focused on the technology needs identified for effective exploration, and then the event wound down with an effort to collect summary ideas and lay out next steps.

4. Major Recommendations

NOAA staff supported the OEAWG during the workshop by taking notes and offering some of the scheduled briefings. All breakout sessions were attended by at least one note taker. A significant volume of materials were collected. This section represents a distillation of those concepts that appeared to be most widely recognized as important and/or of interest to the workshop attendees. This summary is intended to be a representative, not exhaustive, presentation of the workshop recommendations.

Many of the more experienced ocean explorers at the workshop immediately identified the problem that the EX, equipped with a state-of-the-art ROV, is actually best suited for fine-scale observing and sampling, not broad reconnaissance. Therefore, until such time as the ship might acquire complementary tools such as towed or autonomous systems to enlarge its exploration footprint, it is essential that the targets chosen for exploration be "sure bets." In other words, the initial survey areas should be chosen such that the probability that fundamental new discoveries will be made is high regardless of the exact site of launching of the ROV. As one workshop participant expressed, the probability of finding a site of active hydrothermal venting at any location along the very linear and well-mapped midocean ridge system is remarkably low. Consider how many decades it took to find venting of any sort on the MidAtlantic Ridge!

With this concern in mind, the participants identified a number of targets in the Pacific where they considered the probability of fundamental discovery to be very high. These included:

- Seamounts, which offer rich potential for biological, geophysical and other oceanographic discoveries within a limited geographic area;

- Deep reefs, presenting similar value and increased odds of detection during exploratory cruises as seamounts;
- Major convergence zones where oceanographically different bodies of water meet, to determine whether midwater fauna also diverge across the boundary;
- Trenches, such as the Cayman Trough, where active venting and volcanism at higher pressures may harbor new extremophiles;
- Spatial and temporal congregations of organisms that are as yet unexplained, but potentially critical for species survival, such as the "white shark café."

Breakout groups provided, in varying level of detail, summaries of specific targets discussed. Unfortunately, due to limited time, not all good ideas were covered by the breakouts. Therefore, rather than recommend any specific target for ocean exploration based on incomplete deliberations, this report chooses to reference the abstracts submitted by the workshop attendees (Reference 3).

As the workshop evolved it became clear that the operational paradigm was a meaningful concept. The fundamental concept of operations (CONOPS) that was arrived at was termed "boxes and sticks." In this CONOPS "boxes" are target regions of high interest for targeted exploration (not full fledged research), while "sticks" reflect transits through unknown or poorly studied ocean areas where reconnaissance exploration could occur in more "underway" mode. Some breakout groups termed the targets as "sure bets" for discovery. These promising areas are connected by transit legs or sticks that provide an opportunity for executing underway exploration, including bathymetric and water column surveys.

4.1. Target Regions – the "Boxes"

Boxes, or target areas, were not universally defined by the workshop. One breakout group recommended that broad criteria to define "sure bets" would include: high energy, significant isolation and/or anomalous regions. Examples that fit this model could include seamounts, deep reefs or major ocean "intersections" like the Indo-Western Pacific or in the Atlantic, the Cayman Trough. A broader set of criteria for identifying such targets might include:

- Does the region have existing bathymetry and at what resolution?
- Has the region been surveyed and filmed by submersibles and how often?
- Has the region been sampled and how often?
- Are there indications of species richness and diversity?
- Are there indications of tectonic activity?
- Are there significant gaps between features in the region?
- Can the region be worked by the EX and during what season?
- Are there political considerations and challenges?
- Is there political interest in learning more about the region?

To fully develop the initial cruise track of the EX, these criteria plus logistic issues such as ports for fuelling and supplies should be used to define priority target "boxes."

4.2. Transits – the "Sticks"

The sticks provided much opportunity for creative thinking. The attendees recognized that modern-day oceanography is driven by schedules and logistics making transits "dead time." The model proposed converts transits into exploratory efforts in their own right, harkening back to the earlier days of oceanography in the 1950's and 1960's. Due to the opportunity the use of transits

offered for advancing programs such as the Census of Marine Life, the workshop attendees focused on brainstorming the nature of operations during transits, rather than identifying important regions to transect during transit. Considerations that arose include:

- Transits should be planned as much as possible to map unknown or poorly mapped areas within the depth range of the EX multibeam system. OE should consider complementing multibeam mapping with a sub-bottom profiler, and an AUV that can extend the area mapped.
- Ship should be stopped at least once per day to conduct a CTD cast and to tow a net to obtain samples of organisms from several depths within the water column, as well as to collect several bottom samples.
- During long transits, the ship should be stopped once every 3-days to conduct an ROV dive using the camera sled or full ROV to get a "look-see" view of the region.
- The program should consider what instruments and sensors to use during CTD casts and single ROV dives during transits – not to obtain as much information as possible, but to obtain enough information for reconnaissance.
- During transits, the scientists ashore, connected via telepresence, can assess the information coming in and make a decision on whether or not to proceed to the pre-determined target, or to stop and conduct an in-depth assessment of a different area, i.e., "redrawing the box."

The workshop attendees recognized that the transit model was not fully developed. Some further refinements considered alongside the funding and logistic constraints of OE would be necessary before the "sticks get laid" or any "boxes" are explored.

4.3. Exploration, reconnaissance or research

A key concern throughout the workshop was the need to differentiate the exploration voyages of the EX from other oceanographic expeditions. Effective coordination with UNOLS was also noted as a concern. Essentially this was a collective pondering of exploration versus research. The group agreed that the concept of reconnaissance was a key focus of the EX and that it would be more challenging to return the ship to transit than it would be to stop and explore. The discussion revolved around "How much is enough?" in terms of understanding when to leave an area. It was agreed that identifying an iconographic suite of products and deliverables for exploring both targets and areas while under transit would help further refine the decision points. The attendees also noted that it may be difficult for the academic community to consider, or even design, new products that do not meet the criteria of the university system for personal advancement, i.e., publishing in peer-review journals that focus on their discipline.

This discussion also engaged the issue of rights to data. With a paradigm calling for the active engagement of scientists ashore the workshop attendees recognized the need for a focus on data quality, clear understanding of data ownership/rights and on the business model of EX expeditions. Data quality and long term stewardship might be best addressed by protocols for collecting, processing, curating, and providing access to samples, as well as formal agreements with institutions that would be involved. It was noted that the Smithsonian Institution is interested in all samples that would be collected by the ship. Data rights discussions were spirited but all agreed that some fair use and compensation system would evolve.

In the context of data policies, there was widespread respect for the Integrated Ocean Drilling Program and the Ocean Observatory Initiative program of NSF. Both were suggested as models worthy of consideration, and possibly emulation, as the EX paradigm evolves.

More challenging was the discussion of the business model. Collectively there was much discussion of the "doctors on call" concept, but despite frequent references to doctors, paramedics and emergency rooms, this issue was not clearly resolved. However, there was a growing consensus that during the initial year of operations, the OE program could request proposals from "doctors on duty" – groups of interdisciplinary scientists who would work on shore from the Exploration Command Centers directing the work of the ship and onboard technicians to explore pre-determined "boxes" and "sticks" as described above, enabling the scientists to redraw the "box" when coming upon an unexpected discovery.

Another intriguing concept suggested was to look toward NASA. With space scientists routinely left "ashore" as unmanned vehicles explore new regions of space it may be that the NASA paradigms will offer valuable insights to OE as it initiates the voyages of EX.

Further consideration by NOAA, the ocean exploration community and the OEAWG is clearly required to refine the EX paradigm. The use of shakedown cruises and possibly even the inaugural exploration voyages will likely be required to develop a fully functioning model.

5. Minor Recommendations

In addition to the major points of discussion several valuable ideas were presented for consideration. Technology needs were often raised with differing suggestions from different disciplines and communities. Collectively these were captured by the note takers and will be used by the OEAWG in a follow-on workshop focused on the EX and exploration technology. The value of establishing telepresence command/observation consoles to major oceanographic institutions was suggested. Those individuals interested in this were encouraged to work directly with Dr. Ballard's engineers to determine the suitability of their site. With hardware costs in the mid five figures this was not seen as a critical item for discussion. A recurring technology need identified was optical survey of the seafloor at speeds faster than the ROV could deliver. The use of an advanced towfish and/or AUV was suggested frequently. Dr. Ballard's towed system, ARGUS, was offered to OE and will be considered as the inaugural cruise is planned. Procuring of an AUV was recognized as an important step, but specific technical input was deferred to the next OEAWG workshop (see below).

6. Next Steps

The workshop recommendations provide much valuable input to OEAWG and to NOAA. Additional tasks suggested to continue the development of a rich and successful ocean exploration program aboard the EX include:

- Development of list of iconographic products based on existing capabilities and that define the unique results of a reconnaissance – not research – mission. This essentially would provide the definition of a "box" and when it was "done." NOAA OE is encouraged to initiate this effort. Use of the anticipated shakedown cruises to develop prototype products is encouraged.
- The development of a model of underway (transit) operations based on existing capabilities is also suggested. This delineation of a "stick" will be valuable in planning

the initial transit of the EX from the West Coast to its first port of call, expected to be Honolulu. NOAA OE is again encouraged to begin this effort.

- NOAA is encouraged to develop connections with CoML, NSF, etc. to maximize the results of exploration expeditions. Close ties to the entire ocean research community will ensure maximum leverage of public resources and lead to the development of synergistic efforts. Ideally results of ocean exploration will feed the research "system" and increase the pace scope and efficiency of understanding and managing our ocean planet.

The final action, which will be undertaken by the OEAWG, is to conduct an additional workshop focused on the technology capabilities and needs of the EX and NOAA OE. Marcia McNutt has agreed to host this workshop at MBARI. Like this workshop it will involve invited participants from the ocean technology community as well as the OEAWG and select NOAA staff. The agenda is still under development but it will likely focus on the EX itself, over-the-side assets (ROVs, sleds, AUVs, etc.) and advanced technology research investments required to maintain a robust ocean exploration program into the future.

References

1) OEAWG (Ocean Exploration Advisory Working Group). 2007. Terms of Reference. National Oceanic and Atmospheric Administration Science Advisory Board. Washington, DC. Accessed 30 May 2007 online at http://www.sab.noaa.gov/Working_Groups/Ocean_Exploration/OE_WG_TOR_final.pdf.

2) J. Manley and B. Evers, "Evolution of a Deep Ocean Exploration ROV," *Proceedings of Underwater Intervention 2007*, ADC/MTS, New Orleans, LA, January 2007.

3) The agenda and introductory workshop materials are in Appendix II. The complete document including over 60 pages of exploration target recommendations is available online at: ftp://www.oarhq.noaa.gov/oe/OEAWG/OKEANOS%20Expedition%20Planning/OEAWG_Maiden_Voyage_Document_05072007.pdf

4) It is anticipated that briefings presented at the workshop will be made available through the NOAA Science Advisory Board website: http://www.sab.noaa.gov/

Appendix I: Anticipated Capabilities of the *Okeanos Explorer*

The vessel soon to be commissioned the NOAA Ship OKEANOS EXPLORER (EX) was transferred to NOAA from the US Navy as the USNS CAPABLE in for the express purpose of becoming the nation's first vessel dedicated to systematic ocean exploration. It is a 224' long, 42' abeam, T-AGOS ocean class vessel. The vessel was transferred to NOAA with dedicated funds to begin converting the vessel to its desired state for ocean exploration. Through a series of requirements meetings attended by select internal and external experts, NOAA developed a ship conversion, or refit, package that would turn the Cold War relic into a 21st century high-tech vessel of exploration. Three major dedicated capabilities were envisioned for this vessel as a result of these meetings.

Multibeam Mapping System. The first tool the vessel will receive is a next-generation hull-mounted deepwater, high resolution, 30 kHz multibeam mapping system. The system, a Kongsberg EM-302, will be the first produced by Kongsberg and will reach depths up to 7000 meters. Mounted in a new transducer faring below the ship, the system will provide explorers with the ability to obtain initial maps and bathymetry of areas previously unmapped or visited.

Science Class Remotely Operated Vehicle (ROV). The next asset required to accomplish the exploration objectives of the vessel is a dedicated deepwater science class remotely operated vehicle (ROV). Based on experience and external input, NOAA is developing a dual-body 6000 meter ROV system that will be permanently assigned and installed on EX to capture multimedia and samples from newly visited sites. The dual body system provides two vehicles and a third auxiliary vehicle all being built by Phoenix International. The first vehicle is a camera sled equipped with a high-definition video camera and lights to provide environmental or contextual imagery of the work environment of the second ROV. This system may also be towable as a camera sled to provide additional reconnaissance. The second vehicle or body is the primary science class ROV. This vehicle is equipped with four thrusters, two manipulators, DVL-Navigation, and a high-definition Insite Zeus camera with supporting lighting. It is envisioned that additional tool sleds will be borrowed, designed or incorporated in years to come to enhance the capabilities of this vehicle. The third vehicle is an ultracompact low-cost inspection or penetration vehicle called an X-BOT. This vehicle can quickly plug and unplug from the ROV and penetrate tight locations not possible with the ROV. It will also have a small high-definition camera and supporting lights. The combination of these three vehicles provides a flexible and robust reconnaissance and inspection system at depths up to 6000 meters.

Telepresence. The final unique and dedicated capability to support the prescribed systematic and efficient exploration is a telepresence system. Telepresence is the integration of information and communications technology and robotics to provide a person the sense of being present at a remote site and the ability to accomplish a high degree of operational performance. In the case of ocean exploration, telepresence refers to telecommuting from land as though an explorer were actually onboard the ship. Telepresence is made possible through a dedicated very high speed satellite internet connection to a University of Rhode Island house Inner Space Center which distributes the real-time imagery, communications and data to remote Exploration Command Centers around the world. To accomplish this, EX will be equipped with a 3.7 meter diameter broadcast satellite antenna and supporting audio, video and network hardware to produce real-time live audio and video feeds and distribute real-time ship and ROV sensor data to shore-based ECCs. Currently, there are six ECCs in the US with more being developed. By using telepresence and ECCs, a larger and more diverse body of explorers and scientists can participate in an exploration than is possible onboard a ship due to berthing limitations. As a result, a more

integrated and thorough assessment of an exploration site is possible leading to better results and information.

In addition to the above three major capabilities, the vessel will also be equipped with maneuverability, infrastructure, sensors, tools, labs and other accommodations to support primary, auxiliary and complimentary exploration operations. Following are a select handful of these systems. For additional information on the systems that will be installed, contact Craig.Russell@noaa.gov.

Dynamic Positioning. ROV and other similar operations require the vessel to remain on station with limited movement over ground. This requires a vessel to be able to control its movement in 360 degrees at all times while on station. This is provided by a dynamic positioning system installed on EX. The system is a Kongsberg DP System, meeting ABS DP1 standards. To support this system the vessel received upgraded navigation electronics, two new stern tunnel thrusters, and a new Thrustmaster 250 retractable azimuthing bow thruster.

ROV and Mapping Operations Control Room. The ship will have a seven station, aft-facing, dedicated control room for controlling and coordinating all exploration operations. The room will be equipped with video monitors for all ship and ROV cameras, including two large wall mounted flat screen LCD monitors for viewing high definition ROV camera imagery. The aft row of the control room is closest to the wall of monitors and provides permanent control stations for the ROV operations navigator, pilot, copilot and video engineer. Each of these operators has a bay of monitors and access to various computers to accomplish their work. The forward row of stations provides dual operations stations that can support either ROV data logging or multibeam mapping acquisition and processing. The room is also equipped with a map table for planning and media storage.

ROV Hangar and Workshop. The vessel will have a dedicated ROV hangar for storing and working on the ROVs in a dry environment. A track will guide the ROV in and out of the hangar onto the working mission deck. Attached to the ROV hangar is a dedicated ROV workshop for maintenance, repair and troubleshooting ROV systems. The ROV hangar is also equipped with a working “pit” to allow technicians access to the bottom of the ROV. The ROV pit is also suitable storage for a future accompanying tool sleds.

A-Frame. A Dynacon A-Frame, centered 3 feet off centerline starboard, will be provided to launch and retrieve ROVs, towed systems, and handle other scientific equipment. The A-Frame is 21 feet high and has a working width of 15 feet. The A-Frame has a safe working load overboard of 20,000 pounds and a safe luffing load of 8,000 pounds in sea state 4. Attached to the A-Frame is a 48” sheave with a 20000 lb. working load.

Traction Winch. A traction winch system, Dynacon Model 766, is already installed for deploying the ROV system and manage ROV operations. The traction winch is located below the aft deck in the traction winch room. The cable is led up from the traction winch room through a 48” diameter turning sheaves up along a longitudinal bulkhead of the new ROV hangar structure inside a cable trunk to a approximate height of six feet above the mission deck and then aft to the A-frame. Access is provided to facilitate reeling the cable through the sheaves from the winch to the A-frame. The traction winch system has 24,600 feet working length of 17 mm (0.68") armored electromechanical cable (Rochester 2351) and matching Lebus grooved shell. The winch is fitted with the Focal Technologies Corporation Model 176 Electrical Slip Ring combined with the Focal Technologies Corporation Model 242 Fiber Optic Rotary Joint. The electrical slip ring has four power passes each capable of 5,000 VAC and 10 Amps. The optic

rotary joint has 3 single-mode passes. The winch system is equipped with sensors to provide signals for line speed, tension, and line out and has a remote control located in the ROV Control Room.

Hydrographic Winch. A DESH-5 hydrographic winch, with turntable, will be installed on top of the ROV hangar with the capability to service the J-frame on the starboard side as well as the A-frame. The hydrographic winch system will be equipped with 8,000 m of 9.5 mm (0.375 inch) double served strength member, single conductor, and electromechanical cable such as Rochester Corp. type A216375. A matching Lebus shell and level-winding system are also provided. A four-conductor slip ring unit (Meridian Laboratory, Model MXO-4 or equal) will be installed on the winch. The hydrographic winch will be provided with three-sheave fairlead heads with sensors to provide signals for line speed, tension, and line out. The fairlead head supports a 1000 mm circumference measuring sheave, two guide sheaves and adjustable front guide rollers.

General Purpose Winch. A general purpose oceanographic winch, a Markey Machinery Company, Model COM-10, will be onboard and services the J-frame on the starboard side. The general purpose winch will be located on the top of the ROV hangar and is equipped with 3,000 m of 6.35 mm (0.25 inch) 3x19 torque balanced wire rope with a level-winding system. The winch has a minimum pull capability of 2,000 pounds at full spool and a minimum line speed of 100 feet per minute at minimum spool diameter.

J-Frame. A hydraulically operated J-frame for over-the-side handling of mission equipment will be installed on the starboard side. The J-frame will be rated for a 3,500 pound safe working load using a 0.375 inch electromechanical cable from the hydrographic winch discussed below. The J-frame will also have a towing capability of 3,000 pounds at angles of up to 45 degrees from vertical. The J-frame will have a clear vertical height over the forecastle deck edge of at least 17 feet. The offset arm to the sheave will be 5 feet aft from the vertical leg. The J-frame will pivot about a longitudinal axis, such that the cable shall plumb from at least 3 feet inboard to at least 10 feet outboard of the deck edge at a variable speed, in up to 30 seconds, full range, at SWL.

ROV Crane. A HydraPro knuckle-boom, 6500 SWL pedestal mounted hydraulic articulated crane is installed on the aft port quarter deck for launch and recovery of the ROV, AUV's and Side-scan Sonar equipment. The crane is suitable for deployments over the port side and stern and has a minimum reach of 20 ft beyond the ship to the side and aft over the stern within 5' of the water level at maximum reach with a full lift capacity of 7000 pounds safe working load (2.5m significant wave height 35 knot wind). The crane lift capacity at 10 foot radius for lifts (2.5m significant wave height, 35 knot wind) is 15000 pounds SWL. The crane utilizes 150 ft of 3/4" spectra line on a dedicated crane-mounted winch with tension readout. It is also equipped with a sway limiter and snubber to minimize equipment sway when hoisted.

ADCP. The vessel will have a phased-array Acoustic Doppler Current Profiler (ADCP) system, RD Instruments Model Ocean Surveyor, operating at 38 kHz and 150 kHz. Both systems will have speed log capability, and the 38 kHz system will provide remote display of speed at the Main Control Console in the Pilothouse. Each system will consist of a transducer assembly in the faring, a deck unit mounted in the rack room, an acquisition and display PC system in the dry lab/science technology center. The transducers will be mounted in the transducer fairing. The ADCP systems will be provided with, and configured to accept, inputs from the Inertial Reference System, Scientific GPS and gyrocompass. Data output from the acquisition and display system will be provided to the SCS and accessible from any network connection.

CTD/Water Column Profiling. Also onboard will be a water column profiling capability rated to 6800m - a SeaBird SBE 9-plus. The CTD Underwater Unit and Water Sampling Carousel will be configured for over-the-side operations with the Hydrographic Winch from the starboard side J-Frame. The CTD System Deck Unit will be interfaced to the electromechanical cable via the Hydrographic Winch slip rings. The CTD System Deck Unit will be rack-mounted in the Scientific Laboratory/Science Tech Center and provided with position data from the Scientific GPS. The data acquisition PC will be located in close proximity to, and interfaced with, the CTD System Deck Unit, and the PC will provide CTD depth information to the SCS making CTD data available to any network connection. The CTD will have a rosette size to accommodate the PMEL configuration of 24 1.7-liter bottles.

Sub-bottom Profiler. A low frequency (3.5 kHz nominal frequency) Sub Bottom Profiling system will be installed on the ship for obtaining information about the surficial and sub-bottom sediment structure and thickness. The Sub Bottom Profiler system is rated for full ocean depth, capable of obtaining sediment penetration up to 70 meters in soft sediments, and consists of an Knudsen Model 320BR hull-mounted transducer array (16 transducers in a 4 x 4 array), a Microsoft Windows-based data display/acquisition PC and all interconnecting cabling. The 4 x 4 transducer array will be installed in the transducer fairing described in Section 461 and configured to effectively provide a single 10 kW source with a beam width of 30 degrees. The Echosounder will be rack-mounted in the Rack Room, and the data display/acquisition PC will be installed in the Mapping Ops/ROV Ops control room. The Echosounder will be interfaced to the C-Nav positioning system, the Scientific GPS and Pos M/V, and will supply depth data to the SCS.

Tech Lab. Traditionally a dry-lab, the science technology center or tech lab will provide scientists access to computers for the ADCP, CTD and other over-the-side sensors systems. The lab will be equipped with PC computers, a fume hood and chemical storage. The tech lab is adjacent to the ROV/Mapping Control room and the Wet Lab.

Wet Lab. A standard wet-lab with sinks, counters, storage, fume hood and cold storage (sub-80^{o}C ultra cold freezer and under the counter flammable chemical rated refrigerator).

Constant Temperature Room. Adjacent to the wet lab is a constant temperature room with a temperature range from plus 1 degree Celsius to plus 35 degrees Celsius, inclusive with a tolerance of plus/minus 1 degree Celsius. CT Room Humidity range will be 20 percent RH to 95 percent, inclusive, with a tolerance of plus/minus 5 percent RH when operating at temperatures above approximately 40 degrees Fahrenheit.

Other Communications. In addition to the telepresence system, the vessel will have Inmarsat-B, Inmarsat-C, GSM cellular, and standard marine VHF communication systems.

Mission Boat. The vessel will be equipped with a workboat and davit installed on the upper deck starboard side. The boat, a Willard Marine, Inc. Non-SOLAS Approved, Sea Force 670 inboard diesel/water jet drive, is capable of speeds of 30 knots while fully loaded.

Dive Locker. A minimal dive locker with a 10 CFM air compressor and containment system will be onboard to support basic SCUBA diving for ship and science operations.

Science Advisory Board

The Ocean Exploration Advisory Working Group (OEAWG) Workshop Recommendations for Planning The Maiden Voyage of Discovery For NOAA's Dedicated Ocean Exploration Vessel, *Okeanos Explorer*

EXPLORE

May 10-11, 2007

Pre-Workshop Recommendations Sought

For Planning the Maiden Voyage of Discovery for NOAA's Dedicated Ocean Exploration Vessel, *Okeanos Explorer*.

The Science Advisory Board (SAB) of the National Oceanic and Atmospheric Administration (NOAA), has formed the Ocean Exploration Advisory Working Group (OEAWG)*, a standing external panel to provide general priorities for ocean exploration, including geographic areas of interest as well as subject matter topics; advice concerning emerging ocean exploration-related technologies; and to conduct periodic reviews of the program for the purpose of assessing program accomplishments and providing guidance and perspective for the program's future.

The OEAWG seeks recommendations for planning the 2008 maiden voyage of the *Okeanos Explorer*, NOAA's new ship dedicated for Ocean Exploration.

Important Dates

February 15, 2007
Deadline for all interested parties to submit a one-page recommendation to the OEAWG, identifying region(s) of the Pacific Ocean Basin where NOAA's *Okeanos Explorer* should first explore and why. These papers should describe what is known about the region(s) and provide a compelling rationale as to why the specific area has the highest potential for discovery. One-page submissions should be e-mailed to OEOffice@noaa.gov.

March 15, 2007
Deadline for the OEAWG to use the one-page recommendations and/or other means to select approximately 25 individuals to participate in a workshop in Washington, D.C. to help the OEAWG make final cruise-track recommendations to the NOAA SAB. Expenses of workshop participants will be provided through a grant from the Lounsberry Foundation to the Institute for Exploration.

May 9-11, 2007
Invited community workshop at the headquarters of the National Geographic Society to finalize recommendations concerning an initial *Okeanos Explorer* cruise-track in preparation for a series of expeditions in 2008.

Fall, 2007
Tentative timeframe for a follow-on workshop in Monterey, CA, to look specifically at the *Okeanos Explorer's* long-term technical capabilities.

Summer 2008
Expected first voyage of discovery for the *Okeanos Explorer*.

Background: Ocean Exploration and the *Okeanos Explorer*: NOAA's Ocean Exploration (OE) program (http://oceanexplorer.noaa.gov) is NOAA's response to the 2000 *Report of the President's Panel on Ocean Exploration*. The 2004 *U.S. Ocean Action Plan* restated support for ocean exploration for the purpose of discovery. The OE program's mission is:

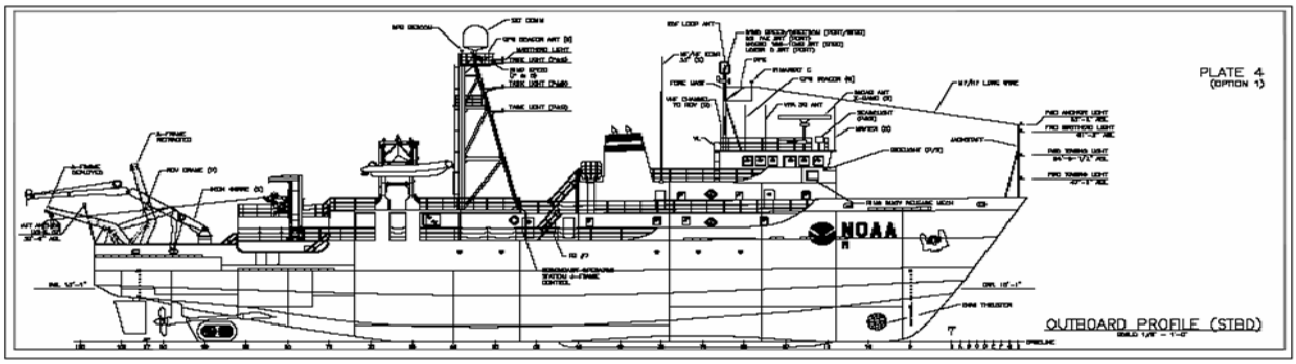
To support national and NOAA objectives by exploring the Earth's largely unknown ocean in all its dimensions for the purpose of discovery and the advancement of knowledge, applying advanced technologies in evolutionary and revolutionary ways.

In the spring of 2008, NOAA expects to commission a dedicated ship of exploration, the *Okeanos Explorer*. This vessel is designed to carry out a systematic, **global** program of exploration in the oceans linked in real time through satellite and internet telepresence technology to the scientific community, educators, the media and the general public. The primary purpose of this announcement is to solicit recommendations for discussion at a workshop designed to make final recommendations to the NOAA Science Advisory Board, for high-priority survey areas for the *Okeanos Explorer*. In its first year, the ship will operate in the Pacific, generally between the tropics of Cancer and Capricorn.

An equally important workshop objective will be to work with invited participants, NOAA staff and members of the OEAWG, to formulate recommendations for the operational paradigm that will guide this vessel efficiently toward exciting and compelling voyages of discovery. This paradigm will mirror the vessel's technical capabilities, and will survey large areas of the seafloor, complemented by layers of follow-on surveys designed to investigate discoveries at higher and higher levels of detail. The *Okeanos Explorer* will be equipped with a modern hull-mounted multibeam system for surveys of the seafloor at cruising speeds of ~10 kts, tool sleds and a compatible array of sensors for discovery-based surveys at speeds of ~1.5-4 kts and ROV/AUV capabilities for detailed studies of small areas.

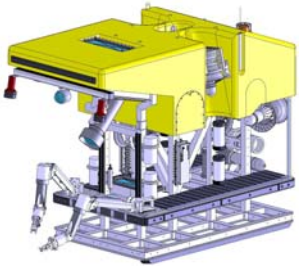
Okeanos Explorer will push back the frontiers of the unknown, generating hypotheses and making the data of discovery widely available in real time through high-speed Internet2 to the scientific community at Science Command Centers ashore, and via standard Internet to the public. The ship and shore-based exploration teams will then conduct preliminary additional investigations or move on, leaving behind an energized user community poised to use these frontier data for follow-on, hypothesis-based investigations.

Vessel Data



Ship Measurements: Length 224 ft, beam 43 ft, draft 15 ft
Status: In shipyard for retrofit. Operational in 2008
Missions: Reconnaissance, investigation of anomalies, interdisciplinary efforts providing baseline for future research/management and a foundation for education.
ROVs: A two-body system consisting of a camera sled and a 6,000 meter science class ROV, **Multibeam**: Hull-mounted
Telepresence: Live satellite communications
Ship's complement: 46, including both ship's crew mission support.

Proposed camera sled



6,000m ROV

***Information about the OEAWG and its members:**
http://www.sab.noaa.gov/Working_Groups/Working_Groups.htm

Agenda

Planning the Maiden Voyage of Discovery for
NOAA's Dedicated Ocean Exploration Vessel, *Okeanos Explorer*

May 9 National Geographic Society (NGS), Washington, D.C.

8:30-9:00 AM - Registration and light refreshments (Lobby Area)

9:00 - Convene in Plenary Session (North End Cafeteria)

9:10-9:20 – Introduction and welcome, logistics, etc.	Garcia
9:20-9:40 – Role of the OEAWG/SAB	Mayer/Ballard
9:40-10:00 – The OE Program, history, successes, prospects	Hammond

Coffee 10:00-10:30

10:30-11:30 – The *Okeanos Explorer* – expected capabilities, timeline for delivery, etc. Why the Pacific first?	Mcdonough/Manley/Coleman
11:30-11:45 – An Ocean Exploration paradigm – introduction to a vision	Ballard
11:45-12:00 – What the workshop must achieve	Mayer/Ballard

Lunch 12:00-1:00 PM (at NGS)

1:00-3:30 - Area Deliberations (*rooms TBD*)

Central: Vecchione, Bograd, Slattery, Gallardo, Haymon, Murton, Chadwick, Goetze, Hein; OEAWG liaisons – McNutt, Ausubel; NOAA OE liaisons (technical expertise) - TBD

North: Wilson, Yogodzinski, Embley, Etnoyer, Wheat, Baco-Taylor, Keller, Pietsch; OEAWG liaisons – Sigurdsson, Austin; NOAA OE liaisons (technical expertise) - TBD

South: Haddock, Miller, Pockalny, Blackman, Lonsdale, Levin, Watling; OEAWG liaisons – Rossby, Mayer; NOAA OE liaisons (technical expertise) - TBD

Coffee 3:15-3:45

3:45-5:15 - Plenary Session - Area presentations (*presenter for each group, TBD*), including time for group discussion.

3:45-4:15	Central
4:15-4:45	North
4:45-5:15	South

5:15 PM - Adjourn, Day 1.

Dinner – A list of local restaurants will be provided. Area groups will be encouraged to continue their discussions informally, in collaboration with OEAWG and NOAA OE staff members.

May 10

8:30-9:00 AM - Refreshments (Lobby Area)

9:00 – Convene in Plenary Session (North End Cafeteria)

9:00-9:30 – Summary, Day 1 area presentations, including group discussion. Moderator: Mayer

9:30-10:00 - Envisioned operational paradigm of the *Okeanos Explorer,* building upon past "telepresence" cruise experiences Ballard

Coffee 10:00-10:30

10:30-11:30 - Group discussion - operational paradigm, post-2008 and beyond Moderator: Ballard

11:30-12:30 PM - Technical capabilities (recap of Day 1 discussion), including potential new tools, of the *Okeanos Explorer* Manley/Coleman/TBD

Lunch 12:30-1:30 PM (at NGS)

1:30-2:30 - Group discussion: ship capabilities vs. envisioned operational paradigm. Moderator: McNutt *(What can the ship can do with present technical capabilities, and what could be done in future, assuming resources are available.)*

2:30-3:30 - Smaller groups (composition TBD), plan operations/lengths of time in each area. (*The goals here will be to identify priority areas for exploration/discovery, begin to assess what an operational plan might look like for Okeanos Explorer in each area,in 2008 and 2009(?), and address how parts of the OE program can interface with more traditional (e.g., UNOLS) assets.*

Coffee 3:30-4:00

4:00-4:45 Plenary Session - Planning the *Okeanos Explorer* Ship Track Moderator: Mayer
Reports from sub-groups on their operational strategy and rationale

4:45-5:00 - Wrap-Up: Where to from here? Mayer/Ballard
(A good time to introduce the plan for a second workshop in Fall, 2007.)

5:00 PM – Adjourn, Day 2.

(May 11 – meeting of the OEAWG, DC location TBD)

Appendix III: List of Attendees

Randy	Keller	Oregon State University
Amy	Baco-Taylor	Woods Hole Oceanographic Institution
Theodore	Pietsch	University of Washington
Robert	Embley	NOAA/ PMEL
Peter	Lonsdale	Scripps Institute of Oceanography
Peter	Etnoyer	Texas A&M Corpus Christi.
Geoff	Wheat	Monterey Bay Aquarium Research Institute
Gene	Yogodzinski	University of South Carolina
Cara	Wilson	NOAA NMFS/ Pacific Fisheries Environmental Laboratory
Lisa	Levin	University of California, San Diego
Les	Watling	University of Hawaii
Richard	Miller	University of Arizona
Steven	Haddock	Monterey Bay Aquarium Research Institute
Robert	Pockalny	University of Rhode Island
Miriam	Kastner	Scripps Institute of Oceanography
Steven	Bograd	NOAA-NMFS, Environmental Research Division
Marc	Slattery	Ole Miss
Victor	Gallardo	Universidad de Concepcion
Bramley	Murton	National Oceanography Centre, Southampton
William	Chadwick	Oregon State University
Erica	Goetze	Danish Institute for Fisheries Research/ University of Hawaii
Jim	Hein	U.S. Geological Survey
Rachel	Haymon	University of California, Santa Barbara
Michael	Vecchione	Smithsonian Institution
RADM	Debow	NOAA Marine and Aviation Operations
Steven	Hammond	NOAA Ocean Exploration
John	McDonough	NOAA Ocean Exploration
Reg	Beach	NOAA Ocean Exploration
Justin	Manley	NOAA Ocean Exploration
Nic	Alvarado	NOAA Ocean Exploration
Frank	Cantelas	NOAA Ocean Exploration
Joanne	Flanders	NOAA Ocean Exploration
Paula	Keener-Chavis	NOAA Ocean Exploration
Craig	Russell	NOAA Ocean Exploration
Cynthia	Decker	NOAA Science Advisory Board
Kristen	Laursen	NOAA Science Advisory Board
Jeremy	Potter	NOAA Ocean Exploration
Larry	Mayer	OEAWG
Robert	Ballard	OEAWG
Jamie	Austin	OEAWG
Jess	Ausubel	OEAWG
Terry	Garcia	OEAWG
Marcia	McNutt	OEAWG
Tom	Rossby	OEAWG
Dwight	Coleman	Institute for Exploration
Bradt	Laurie	Institute for Exploration
Meagher	Janice	Institute for Exploration
Witten	Sandra	Institute for Exploration
Max	Angerholzer	Lounsbery Foundation