

**Report on the Deliberations and
Recommendations of the
Ocean Exploration Advisory Working Group**

April 2006 – March 2008

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Executive Summary:

At the March 2008 meeting of the NOAA Science Advisory Board (SAB), the SAB Chair requested that the Ocean Exploration Advisory Working Group provide a report covering deliberations since its establishment in 2006 including the recommendations to NOAA from two workshops held in 2007 on planning both the maiden voyage and technologies for the NOAA ship, *Okeanos Explorer*. The OEAWG has held two meetings (April 2006 and November 2006) and two workshops (May 2007 and October 2007) since its inception. The initial meeting focused on gathering information for the committee about the nature of the current (2006) OE program and plans for the future. Based on the information received, the OEAWG expressed concerns to the SAB about: 1) the long lag time between requests for proposals issued by the OE program and funding of project; 2) large fluctuations in annual funding levels for the program (making it difficult to plan large, complex, seagoing programs that need long lead-times); and 3) the uncertain role of Ocean Exploration within NOAA. In response to these concerns the OEAWG has learned that the long lag time was a systemic problem throughout NOAA and was being examined across the agency. On the positive side, this problem as well as the large annual fluctuation problem (which is often determined by forces external to NOAA), has been somewhat mitigated by the fact that NOAA can commit to out-year projects by funding in the current fiscal year. With respect to the role of OE within the NOAA mission, the answer was that ocean exploration was not addressed in the NOAA Organic Act. This was disappointing but with the introduction of H.R. 1834 and S. 39 in the 110th Congress, it is clear that ocean exploration has attracted the attention of legislators and it appears that ocean exploration should be fully and explicitly authorized within NOAA in the near future. The OE program also presented a new paradigm for ocean exploration that focused on plans for a dedicated ship of discovery (*The Okeanos Explorer*) carrying out a systematic program of exploration linked with telepresence to the scientific community, the media, and the general public. These plans were greeted enthusiastically by the OEAWG.

At the second meeting of the OEAWG a range of *Okeanos Explorer*-related topics were discussed including models for staffing, the operations tempo, data management and the proposed equipment suite. Included in these was discussion of the concept of “Paramedics on Board -- Drs. On Call” whereby a team of highly trained technicians man the vessel with shore-based scientists representing various disciplines ready to be called in via the telepresence console whenever a discovery was made. Variations on this theme were also discussed in which younger scientists may be part of the seagoing program but still have the backup of expert teams linked through telepresence at shore-based labs (“Interns on Board”). The second workshop also met with the senior management of Disney Imagineering who offered a number of suggestions including “humanizing” the remotely-operated deep-sea vehicles (i.e. giving them names and “personalities”), having some sort of uniform for shipboard participants, unique ship designs, building on drama, using multiple narratives, etc. While some of these would be a difficult sell to the scientific community, many of their ideas about developing a clear notion of the story that is being told (the “worldview” in their language) and creation and delivery (through the classroom, TV, the web, and movie theaters) of the story can be adopted by the OE community.

An Expedition Planning Workshop took place 10-11 May 2007 at National Geographic Society Headquarters. The overall objectives of this workshop were to raise awareness of the new

opportunities that the Ocean Exploration Program will offer to the broader ocean community, to engage the community in the evolution of a new approach to ocean exploration, and most importantly to seek community input on the highest priority targets for first year of operations of the *Okeanos Explorer* in the Pacific. Approximately 50 people attended the workshop representing a broad cross-section of the oceanographic community. A second workshop was held on 23-24 October 2007 at the Monterey Bay Aquarium Research Institute. The objectives of this workshop were to collect community input on appropriate technologies needed for ocean exploration and in particular to look at the outfitting of the *Okeanos Explorer*, identifying technology gaps and strategies for filling them. Thirty-five invited attendees participated in the meeting with representation from academia, industry, NOAA, and the National Oceanographic Center in the United Kingdom (U.K.). The recommendations from both of these workshops can be summarized as follows:

The OE Program should plan and execute a voyage of exploration in the Pacific with initial focus on regions of high-potential for discovery. This voyage should invoke a concept of operations that mixes target areas (BOXES) with developing protocols for systematic exploration during transit (STICKS).

The OE Program should use early shakedown trips and “gaming” exercises to develop protocols for its decision-making process (e.g. Doctors on Call, Interns on Board, etc.) and for establishing the trade-offs that distinguish cruises of exploration from standard oceanographic research cruises.

The OE Program needs to develop sampling protocols and data distribution policies as well as address identified technology gaps, particularly with respect to remotely-operated vehicle (ROV) and camera capabilities. Further discussion and development is also necessary with respect to “mid-scale” survey capability (e.g. autonomous underwater vehicles (AUVs) or towed sleds), water column capabilities, and on-station sampling suites.

The OE Program is making great strides in engaging the ocean science community but must manage expectations and move slowly to ensure initial success. It may make sense to initially borrow equipment while appropriate conceptual and technological approaches are being developed.

NOAA should take advantage of the tremendous outreach potential of Ocean Exploration to engage the broader science community, the general public and legislators.

The OEAWG believes it has been successful in raising awareness and excitement in the ocean community but believes that it needs to improve communication within NOAA and better define its interaction with the SAB.

INTRODUCTION:

NOAA's Science Advisory Board established the Ocean Exploration Advisory Working Group (OEAWG) as a standing committee in 2006. The mandate of the OEAWG is 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 is also charged with organizing and conducting periodic reviews of: the quality of the program's exploration and research; the relevance of program activities and goals to NOAA's Ecosystem Mission Goal and the Program Planning, Budget, and Execution System; and the performance of the program in meeting its research objectives and long-term goals as described in its Annual Operating Plan and other relevant NOAA plans and policies. Every three years the OEAWG will organize and conduct a peer review of the Ocean Exploration program for the purpose of assessing program accomplishments and providing guidance and perspective for the program's future. The initial task for the OEAWG has been to provide a perspective on priority ocean exploration topics and geographic areas of interest to help establish an initial schedule of operations for the new OE ship, the *Okeanos Explorer*.

MEMBERSHIP:

Members of the OEAWG are appointed for three-year terms, renewable once, and serve at the discretion of the NOAA Science Advisory Board chair. Initial appointments will include one-third each three-, four-, and five-year terms. Vacancy appointments shall be for the remainder of the unexpired term of the vacancy, and shall be renewable twice if the unexpired term is less than one year. The current membership of the OEAWG is:

Vera Alexander	University of Alaska
Jamie Austin	University of Texas
Jesse Ausubel	Rockefeller University – Sloan Foundation
Robert Ballard	Institute for Exploration - Co-chair
Terri Garcia	National Geographic Society
Bruce Gilman	Marine Technology Society
Larry Mayer	University of New Hampshire Co-chair
Marcia McNutt	Monterey Bay Aquarium Research Institute
Kym Murphy*	The Walt Disney Company
Tom Rossby	University of Rhode Island
Haraldur Sigurdsson	University of Rhode Island

*At the last meeting, Kym Murphy announced that he has retired from Disney and will step down from the Working Group.

MEETINGS:

Since its inception the OEAWG has held two meetings and organized two workshops:

First Meeting:	April 2006	NOAA HQ	Silver Spring MD
Second Meeting:	November 2006	Disney Imagineering	Burbank, CA
Expedition Planning Workshop	May 2007	National Geographic HQ	DC
Technology Workshop	October 2007	MBARI	Monterey CA

The meetings and workshops have also been attended and facilitated by representatives from the Ocean Exploration Program (though on occasion the OEAWG has met in executive session without representation from the OE Program) as well as a representative of the SAB.

This report will summarize the deliberations and recommendations that have resulted from these meetings and workshops. Detailed minutes from the meetings and workshops are attached in the appendices. It should be noted that the appendices were produced by representatives of the OE Program for programmatic use.

BACKGROUND:

The roots of NOAA’s Ocean Exploration (OE) Program (and thus the OEAWG) can be found in “Earth’s Final Frontier: A Strategy for Ocean Exploration” – The Report of the President’s Panel on Ocean Exploration, a report written in the year 2000 in response to a directive from the President to establish a panel of experts to make recommendations for a national oceans exploration strategy. The President’s Panel report called for:

- Systematic mapping of the physical, geological, biological, chemical and archaeological aspects of the ocean
- Exploring ocean dynamics and interactions at new scales
- Developing new sensors and systems for ocean exploration
- Reaching out in new ways to stakeholders

The President’s Panel also called for NEW funding for ocean exploration at levels on the order of \$75 million per year (excluding capitalization costs) and a “signature mission” – a multiyear interdisciplinary voyage of discovery.

The President’s Panel had hoped that the major agencies involved in ocean research (NOAA, NSF and ONR) would work together to form a national program of ocean exploration and discovery, but only NOAA stepped forward and established its Ocean Exploration Program (and with it the OEAWG). It should be noted that five members of the OEAWG (Dr. Alexander, Mr. Ausubel, Dr. Ballard, Dr. Mayer and Dr. McNutt) were also members of the President’s Panel; Dr. McNutt chaired the President’s Panel.

Since the President’s Panel Report, ocean exploration has also been the focus of a recommendation by the U.S. Commission on Ocean Policy (Recommendation 25-6):

“The National Oceanic and Atmospheric Administration and the National Science Foundation should lead an expanded national ocean exploration program, with additional involvement from the U.S. Geological Survey and the U.S. Navy’s Office of Naval Research. Public outreach and education should be integral components of the program.”
An Ocean Blueprint for the 21st Century: Final Report of the U.S. Commission on Ocean Policy, Sept. 2004

The value of ocean exploration has also been recognized by the Joint Subcommittee on Ocean Science and Technology of the CEQ Committee on Ocean Policy. In their Ocean Research Priorities Plan they state:

“It is essential that the nation cultivate and investigate new ideas about the ocean and new approaches for exploring the marine environment that may challenge existing interpretations. In doing so, society should recognize and even encourage risk-taking in supporting the most exciting and promising ideas for making progress in understanding the ocean.”

Charting the Course for Ocean Science, NSTC JSOST, Jan. 26, 2007

It is within this context of growing recognition of the important role of ocean exploration in the development of national priorities that the OEAWG began its deliberations.

APRIL 2006 OEAWG MEETING:

The first meeting of the OEAWG took place at NOAA HQ in Silver Spring on the 12th and 13th of April 2006. The meeting was hosted and facilitated by representatives of the Ocean Exploration Program. Detailed minutes of the meeting including a full list of attendees can be found in Appendix I.

The initial meeting of the OEAWG focused on information gathering. A series of presentations by NOAA OAR and Ocean Exploration program representatives were made that described the mandate of the OEAWG as well as the history, mission, vision and current state of the Ocean Exploration Program. The model of the Ocean Exploration Program at the time was (at least on paper) much like that of the National Science Foundation (NSF), with the program supporting research programs through an RFP process. The committee expressed its view there was great dissatisfaction in the community because it appeared that the OE program was only going through the motions of calling for proposals and that in reality much of the work funded was internal programmatic exercises carrying on “business as usual.” The OEAWG was pleased to see that these criticisms were being actively addressed by the OE management. The group was, however, very concerned to learn of the serious constraints on the OE funding mechanism caused by the very long lags (typically between 260 and 420 days!!) between the call for proposals and the receipt of funding. These long lags, combined with large annual fluctuations in budget levels, made it very difficult to support sea-going programs that often involve long preparation and lead times and large expenditures.

The working group also noted that if there was to be a true program of systematic exploration, the hypothesis-driven, Request for Proposals (RFP)-based model of NSF may not be the most appropriate mechanism. Instead a proposal was presented that combined the RFP mechanism

with a dedicated ship of discovery carrying out a systematic program of exploration linked with telepresence to the scientific community, the media and the general public. This program would take advantage on NOAA's newly acquired T-AGOS vessel, the former U.S. Navy vessel *Capable*, now renamed the *Okeanos Explorer*.

The OEAWG was quite excited about this new model believing that not only could such a model meet the discovery goals of an ocean exploration program but that this new model could also truly engage and inspire the public (and legislators), making them more aware of the value of ocean science and of NOAA's key role as the nation's "ocean agency." There was much concern however, about how exploration fit within NOAA's existing mission and vision statements, and particularly the constraint from the OEAWG terms of reference to fit OE within NOAA's Ecosystem Mission Goal.

Requests to the SAB from April 2006 OEAWG Meeting:

As a result of these deliberations, the OEAWG made the following requests to the SAB:

- 1- To investigate the causes of the long lag time between RFP and funding**
- 2- To seek mechanisms to dampen large annual fluctuations in funding levels**
- 3- To clarify the role of Ocean Exploration within NOAA – in particular whether OE is addressed in the NOAA Organic Act**

In response to these requests the OEAWG has learned that the long lag time was a systemic problem throughout NOAA and was being examined across the board. On the positive side, this problem as well as the large annual fluctuation problem (which is often determined by forces external to NOAA), has been somewhat mitigated by the fact that NOAA can commit to out-year projects by funding in the current fiscal year.

With respect to the role of OE within the NOAA mission, the answer was that ocean exploration was not addressed in the NOAA Organic Act. This was disappointing but with the introduction of H.R. 1834 and S. 39 in the 110th Congress, it is clear that ocean exploration has attracted the attention of our legislators and it appears that ocean exploration should be fully and explicitly authorized within NOAA in the near future.

OEAWG Actions Resulting from the April 2006 Meeting:

The OEAWG realized that for the new ocean exploration paradigm to succeed an effort must be made to educate and engage the ocean science community. We proposed to hold two community workshops, one focused on establishing high-priority targets for the initial voyages of the *Okeanos Explorer* and a second aimed at identifying the most critical technologies needed to conduct voyages of exploration. To support these workshops the co-chairs of the OEAWG

submitted a proposal to the Lounsbery Foundation through the Institute for Exploration. This proposal was funded (~\$100,000.00), providing the means to bring ocean scientists from around the country to both workshops. The results of these workshops are reported on below.

With the need to engage the ocean science community, the OEAWG also took on an action to explore new ways to engage the public and “market” ocean exploration.

NOVEMBER 2006 OEAWG MEETING:

The second meeting of the OEAWG took place in Burbank California on November 8 and 9, 2006. The venue was selected so that the OEAWG could take up an offer from the senior management of Disney Imagineering to meet and discuss marketing and outreach with respect to ocean exploration. The non-Disney component of the meeting focused on a series of updates on the OE program from NOAA staff and in particular an update on the conversion of the *Okeanos Explorer*. A range of *Okeanos Explorer*-specific topics were discussed including models for staffing, the operations tempo, data management and the proposed equipment suite. Included in these were discussions of the concepts of “Paramedics on Board -- Drs. On Call” whereby a team of highly trained technicians man the vessel with scientists representing various disciplines ready to be called in via the telepresence console whenever a discovery was made. Variations on this theme were also discussed in which younger scientists may be part of the seagoing program but still have the backup of expert teams linked through telepresence at shore-based labs (“Interns on Board”). Many of these topics would be covered in the upcoming workshops and much of the meeting was spent putting together detailed plans for the two workshops. Implementing the specific recommendations from the workshops will be the focus of future efforts.

The second day of the meeting was spent at the Disney Imagineering headquarters in Burbank. Along with the OEAWG and several representatives from the NOAA OE Program, there were nine very senior representatives of the Disney creative process including Marty Sklar, former executive vice-president of creative design and then president of Disney Imagineering. In these roles he was the individual responsible for the development of EPCOT Center, Tokyo Disneyland, the Disney-MGM Studios, Disneyland Paris, Disney's Animal Kingdom, Disney's California Adventure, Tokyo DisneySea, the Walt Disney Studios Park and most recently Hong Kong Disneyland. In addition to Sklar, attending the meeting from Disney were:

Tom Fitzgerald - Executive Vice President, Senior Creative Executive
Kathy Magnum – Executive Producer, Vice President
Tony Baxter – Senior Vice President, Creative Executive
Rick Rothchild – Senior Vice President, Executive Show Director
Joe Rhode – Executive Designer, Vice President
Tim Delaney – Executive Designer, Vice President
Kevin Rafferty – Sr. Concept Writer – Director
Pam Fisher – Show Writer

The discussions with the Disney team were frank and lively. They are well-aware of the power of the oceans to engage the public commenting that the Living Seas at EPCOT is their most popular attraction but, they believe we (the science community) tend to be our own worst enemy. They offered a number of suggestions including “humanizing” the vehicles (i.e. giving them

names and “personalities”), having some sort of uniform for shipboard participants, unique ship designs, building on drama, using multiple narratives, etc.). While some of these would be a difficult sell to the scientific community, many of their ideas about developing a clear notion of the story that is being told (the “worldview” in their language) and creation and delivery (through the classroom, TV, the web, and movie theaters) of the story can be adopted by the OE community. This is clearly an area where the oceanography community still has much to learn.

EXPEDITION PLANNING WORKSHOP:

The Expedition Planning Workshop took place 10-11 May at National Geographic Society (NGS) Headquarters in Washington D.C. The meeting was hosted by Terry Garcia from the NGS and was facilitated by members of the OEAWG and the Office of Ocean Exploration. Logistics were handled by the Institute for Exploration with funding for the non-government participants provided by a grant to IFE from the Lounsbery Foundation. The overall objectives of this workshop were to raise awareness of the new opportunities that the Ocean Exploration Program will offer to the broader ocean community, to engage the community in the evolution of a new approach to ocean exploration, and most importantly to seek community input on the highest priority targets for first year of operations of the *Okeanos Explorer* in the Pacific.

In preparation for the workshop the Ocean Exploration Program distributed to the broad ocean science community a description of the proposed workshop and a call for one-page white papers that described high-priority targets for exploration by the *Okeanos Explorer* during its maiden voyage in the Pacific. Forty-six white papers were received representing input from approximately 100 scientists. From these, a subcommittee with OEAWG and OE representation selected 25 non-government scientists to be invited to the workshop. These scientists were selected to represent themes and regions rather than their individual interests. With OEAWG and OE and other NOAA representatives, the total attendance at the workshop was approximately fifty. A detailed description of the workshop including a full list of attendees can be found in the Appendix.

After a series of presentations by members of the OEAWG and the OE Program describing the new paradigm for ocean exploration and the concept of a ship of discovery, the attendees were sent into breakout groups representing broad regional divisions. Each group was charged with identifying the highest priority themes and targets within their region. The result demonstrated that there were some easily identified themes that represented the highest priority for exploration. These themes were:

- Seamounts
- Hydrothermal vents and cold seeps
- Convergence zones
- Trenches
- Deep reefs
- Regions of unexplained spatial/temporal congregations of organisms (e.g. the “white shark café”).

Along with the selection of high-priority targets, a concept of operations also was developed. The general consensus was that as the program spun up, it should focus on those areas where

there was a known potential for new discovery (e.g. “sure bets”), but at the same time an approach to systematic exploration of unknown areas must be developed. From this came the concept of “boxes” and “sticks.” The “boxes” represented target areas of high interest – regions where there was some confidence that new discoveries would be made. These would become areas of focused exploration, but not full-blown research – full-blown research cruises would be left to traditional funding streams like NSF and ONR. The “sticks” would represent the transits from one target area to the next, typically through unknown, poorly studied regions where systematic reconnaissance mapping and sampling could take place at transit speed. It would be during these transits that the protocols for systematic exploration could be developed.

It was also concluded that the shakedown cruises of the *Okeanos Explorer* should be used to develop prototype data products and to help develop protocols for how decisions will be made when in the exploration mode. Who will make the decision to start a box or to leave a box? Different models were discussed including having highly trained technicians on board and teams of expert scientists on call at telepresence centers around the nation (the “paramedics on board” and “Drs. on call” model), or perhaps having young scientists on the vessel (“interns on board”). These are issues that will need to be worked out as the program develops. Whatever decision process is developed, it will have to be coupled with protocols for standard suites of data products and deliverables for both the sticks and the boxes as well as protocols for the collection, processing, curation, and distribution of samples. Data rights were also discussed with the overall assertion that data dissemination must be broad and fair. There is a growing recognition of the rights of all to samples collected with public funding and models developed for the Ocean Drilling Program, the Ocean Observatory Initiative, and NASA were presented as successful approaches.

Finally, the workshop looked at how voyages of exploration might integrate with University-National Oceanographic Laboratory System (UNOLS) cruises funded by NSF and Office of Naval Research (ONR) concluding that the model should be one where the results of Ocean Exploration cruises would serve as the seeds for research proposals submitted to the traditional agencies and that UNOLS vessels would then do the follow-up research. The overall recommendations of the workshop to the SAB will be presented in conjunction with the recommendations of the Technology workshop discussed below.

TECHNOLOGY WORKSHOP:

The Technology Workshop took place on 23-24 October at the Monterey Bay Aquarium Research Institute (MBARI). The meeting was hosted by Marcia McNutt and facilitated by OEAWG members and OE staff. Once again expenses for non-government participants were covered by the grant to IFE from the Lounsbery Foundation. The objectives of this workshop were to collect community input on appropriate technologies needed for ocean exploration and in particular to look at the outfitting of the *Okeanos Explorer*, identifying technology gaps and strategies for filling them. Thirty-five invited attendees participated in the meeting with representation from academia, industry, NOAA, and the National Oceanographic Center in the United Kingdom (U.K.). A detailed description of the workshop as well as a list of all attendees can be found in the Appendix.

The workshop began with a series of presentations that summarized the results of the Expedition Planning Workshop and the current status of the *Okeanos Explorer*. There were also presentations on the state-of-the-art of various types of technologies such as: Autonomous Underwater Vehicles (AUVs), Remotely Operated Vehicles (ROVs), and chemical sensors. Discussions then ensued focusing on the trade-offs technology development. There was a consensus that there needed to be balance between “bullet-proof” technologies and higher-risk new developments and that telepresence presents a unique opportunity for shore-based support of new technologies. It was acknowledged that the Ocean Exploration Program must be relevant to the NOAA mission but it was recognized that it can also strengthen relationships with the non-NOAA community. It was pointed out that the *Okeanos Explorer* with its telepresence capability can also add to “pervasive ocean presence”, that is to the growing observatory effort. Particularly useful were discussions led by MBARI researchers who have had substantial experience at the National Aeronautics and Space Administration (NASA) and on ONR-funded projects working in “collaborative workspaces” like that envisioned for a telepresence-driven ocean exploration program. Of particular note was the value of “gaming” exercises to develop optimal exploration protocols.

The comment was made that the legacy of the exploration program should be great images and maps. This led to much discussion of what distinguishes exploration from research. How much surveying and data collection is enough? The term used was the level of “rigor-osity” required. It was concluded that the goal should be to characterize an area or a phenomenon to the degree necessary to support a follow-up NSF science proposal.

Breakout sessions focused on the technologies and protocols needed for the “boxes” and the “sticks.” For site exploration (the boxes) complete multibeam sonar coverage was recommended. This would then lead to the selection of areas of interest for camera and ROV surveys as well as for sampling when appropriate. There was much discussion of the needed capabilities for the ROV and camera sleds and many suggestions were made, particularly with respect to lighting and tool capacity. These suggestions are being followed up with a more detailed report from the OE program.

There was also a broad suggestion that in the early days of technology development, while mission protocols are still being developed, it might make sense to borrow systems rather than investing large sums in systems that may later prove inappropriate. There were numerous offers made from those attending particularly with respect to an identified gap – the need for better medium-scale “scouting” tools like camera sleds or AUVs.

The more difficult discussion focused on the “sticks” and what the appropriate suite of underway reconnaissance tools should be. There is no question about the multibeam sonar and its ability to provide high-speed reconnaissance of the seafloor but the debate focused on what to do about the water column (physical, chemical and biological properties). A number of sensors that could be used for underway water column sampling were suggested including Acoustic Doppler Current Profiling (ADCP) instrumentation, EK-60 fish finder sonars, expendable bathythermographs (XBTs) continuous flow samplers, towed pumps, etc.. The concept of daily “Ewing Stations” was also discussed where the vessel would stop daily at some prescribed interval and collect data

on station. There was not a consensus about the relative merits of water column work; the trade-offs will have to be evaluated closely by the OE program in the coming months.

At the end of the workshop the OEAWG met in closed session and discussed the results of the two workshops. It is clear that many challenges face the OE Program and the *Okeanos Explorer* but there is great excitement in the community about the possibilities and it is well-worth pursuing. Among the challenges facing the program is a better definition of the trade-offs between “sticks” and “boxes,” further development of the decision making process and protocols for exploration, and a better understanding of the needs and trade-offs with respect to technologies available.

The OEAWG was particularly concerned that the OE program takes the time necessary to ensure that there will be initial success, as early failures could undermine the growing confidence and excitement in the community. Finally, the OEAWG was concerned that there still needs to be more communication about the great potential of the new program – both externally and within NOAA.

RECOMMENDATIONS OF THE OEAWG TO THE SAB AS A RESULT OF BOTH WORKSHOPS:

Given that the two workshops really represent a continuum of the components of the new OE/*Okeanos Explorer* program, the OEAWG offers a single set of recommendations that combine the outcomes of both workshops.

The OE Program should plan and execute a voyage of exploration in the Pacific with initial focus on regions of high-potential for discovery. This voyage should invoke a concept of operations that mixes target areas (BOXES) with developing protocols for systematic exploration during transit (STICKS).

The OE Program should use early shakedown trips and “gaming” exercises to develop protocols for its decision-making process (e.g. Drs. on Call, Interns on Board, etc.) and for establishing the trade-offs that distinguish cruises of exploration from standard oceanographic research cruises.

The OE Program needs to develop sampling protocols and data distribution policies as well as address identified technology gaps, particularly with respect to ROV and camera capabilities. Further discussion and development is also necessary with respect to “mid-scale” survey capability (e.g. AUV or towed sleds), water column capabilities, and on-station sampling suites.

The OE Program is making great strides in engaging the ocean science community but must manage expectations and move slowly to ensure initial success. It may make sense to initially borrow equipment as appropriate conceptual and technological approaches are being developed.

NOAA should take advantage of the tremendous outreach potential of Ocean Exploration to engage the broader science community, the general public and legislators.

The OEAWG believes it has been successful in raising awareness and excitement in the ocean community but believes that it needs to improve communication within NOAA and better define its interaction with the SAB.

APPENDIX I

NOAA Science Advisory Board

Ocean Exploration Advisory Working Group

Meeting Notes

April 12-13, 2006

Silver Spring, MD

The following is a brief overview of the Ocean Exploration Advisory Working Group (OEAWG) meeting held in Silver Spring, MD on April 12-13. The primary objectives of this meeting were to: (1) provide the OEAWG with an overview of the NOAA Ocean Exploration (OE) program and how it operates; (2) identify and discuss "drivers" and opportunities that may effect the future direction of the program; (3) identify and discuss the challenges the program currently faces; (4) review the OEAWG Terms of Reference; and (5) identify OEAWG activities that could assist NOAA with the evolution of the program. Please review these notes carefully to ensure they meet your understanding of what was accomplished at the meeting.

1. The Current NOAA OE Program

Overview – The NOAA OE program was formed in 2001 as part of the NOAA Office of Oceanic and Atmospheric Research (OAR) to address the growing need to learn more about the ocean environment, the resources it contains, and the processes that govern it. The program has evolved to accomplish this by supporting interdisciplinary projects and expeditions of discovery to unknown and poorly known areas of the world's oceans. The program is well integrated with other NOAA programs and other federal agencies that engage in exploratory activities, as well as with external partners in academia, and public and private institutions. The current guiding "Vision and Mission" statements are:

Vision

An informed society that uses a comprehensive understanding of the roles of the oceans in global ecosystems to make the best social and economic decisions

Mission

To conduct interdisciplinary ocean exploration that provides scientific information as well as technical and educational leadership that contributes to NOAA's evolving environmental and economic missions

Although these statements are consistent with the NOAA Strategic Plan and the NOAA Research Plan, it is recognized that they lack elements of "inspiration" and the excitement of discovery. However, the OE program is in the process of updating its Strategic Plan, and is considering revised Vision and Mission statements that better promote the unique quality and characteristics of the program.

NOAA OE Key Capabilities:

- Science (includes AO)
- Technology
- Data Management
- Education
- Outreach
- Operations
- Administration

In order to ensure a comprehensive approach to ocean exploration, the NOAA OE program has developed and organized several key capabilities to support the goals and objectives of the program. Staff and resources have been organized to support these capabilities, each with its own unique mission, goals and objectives, and challenges. This has allowed the program to function effectively and efficiently, and both prepare for and support projects and expeditions, and to develop products and mechanisms to disseminate results.

OEAWG Thoughts:

- Suggest OE continue to push future NOAA missions as opposed to having NOAA missions drive OE
- Agreed that OE could benefit from a strong Marketing Plan
- The concept of Ocean Exploration should be articulated in the NOAA Vision statement
- OE should develop Vision and Mission statements that capture excitement and inspiration resulting from exploration
- OE could consider internal and external Vision and Mission statements
- Recognize that budget oscillations represent a significant challenge to the OE program
- Recognize need to continue to develop working relationships with partners such as NSF to transition results

2. Drivers and Opportunities:

Reorganization – Dr. Rick Spinrad, Assistant Administrator of OAR reported that as part of the OAR reorganization approved by Congress in 2005, the NOAA OE program is in the process of merging with the NOAA Undersea Research Program (NURP), building on areas where the two programs currently collaborate, including but not limited to NOAA-wide strategic planning, operations, data management, education, outreach, and technology development. NOAA and OAR intend that the merger will combine the best and most viable elements of the two programs, and provide an increased emphasis on developing, deploying, and evaluating advanced technologies for undersea research and exploration, as well as to transition them appropriately to support operations. The merger also provides an opportunity to establish a stronger regional presence for the NOAA OE program.

However, the merger process has been complicated by the required restructuring of the existing NURP east coast centers based on the FY 2006 appropriation, and a phased approach is being considered, which is intended to: (1) strengthen existing areas of collaboration; and (2) develop a strategic and business plan that will provide for a fully merged functional program by FY 2009. Plans call for a series of internal and external workshops that will allow NOAA and its constituents, including the OEAWG, to provide input and expertise into the merger process.

OEAWG Thoughts:

- Congress has been supportive of the NOAA OE program but have not supported NURP
- The merger must not compromise the vision and mission of ocean exploration – the message must not be diluted

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- It is critical to maintain the title "Ocean Exploration"
 - The merger should not be viewed as a method for saving or protecting NURP
 - NURP restructuring should not negatively influence the OE program
 - Advanced technology development should not be focused regional centers – it should have a strong centralized core
 - The OEAWG should be provided information on the merger as it develops

EV Explorer – The new NOAA Ship *Okeanos Explorer* (currently undergoing conversion at Todd Pacific Shipyards Inc. in Seattle WA) provides a unique opportunity for the OE program to enhance the current proposal-centric model that drives the program. The ship will be outfitted to conduct deep water (to 6,000 m) multibeam mapping, investigate features and collect samples using a tandem ROV system similar to the *Argus* and *Hercules* that are owned and operated by the Institute for Exploration (IFE), and transmit data and information (including video) real-time from the ship and ROV using satellite technology. The ship will also be equipped to conduct standard oceanographic operations. In addition, Phoenix International is under a separate contract to NOAA to construct the tandem ROV system.

Given these capabilities and the capabilities of the Inner Space Center (ISC) that IFE and the University of Rhode Island (URI) are developing at URI, it is envisioned that the vessel will be populated with a "mission crew" consisting of technicians to operate the equipment, 1-2 key scientists, and on some cruises 1-2 educators, and that the science parties (in the traditional sense) will be stationed on-shore pulling watches in science command centers, managing the operations from these remote locations. Furthermore, it is envisioned that if the sensors on the ship or ROV observe a unique feature or phenomena that the science party is not equipped to investigate, a "rapid-response" team could be quickly pulled together to assess the information thoroughly before having the ship return to normal planned operations. IFE and OE have tested this model during a series of expeditions over the past two years, and the Willis Group has worked with the personnel involved in the most recent expedition and prepared a detailed evaluation that will be extremely useful as operations are planned for the *Okeanos Explorer*.

It is anticipated that the ship will be ready to sail in the spring of 2008, and that it is intended to complement, not replace, the work that OE is doing with other NOAA, UNOLS, and Charter vessels. Although a homeport has yet to be identified, the facility at Quonset Point in RI is being considered, and it is expected that a decision will be made later this year. OE continues to work with the NOAA Office of Marine and Aviation Operations, IFE, and other partners to develop a staffing plan, a data management plan, and a document describing several operating profiles for the ship – from simple mapping to complex interdisciplinary cruises.

OEAWG Thoughts:

- Agreed that developing and evaluating the operating paradigm for the ship is a critical endeavor for the OEAWG
- Buy-in and input from the science community could be established by an OEAWG workshop to develop a recommend cruise track for the first year of operations

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- The OEAWG could work on identifying new and complementary technologies to expand the ship's capabilities over time, including but not limited to AUVs and sensors
 - It is critical that the OE program does not become the *Okeanos Explorer* program – it must complement and expand on the current program model
 - Maintaining a dedicated mission is crucial – the ship should not become a "vessel of opportunity" for other types of operations
 - Operations and maintenance costs should be included in the NMAO budget to avoid the risk of draining OE funds
 - NOAA should be encouraged to change the name of the new ship to the EV OCEAN EXPLORER

3. Role of the OEAWG:

The Terms of Reference for the OEAWG describes three primary functions for the group:

- providing advice on geographic areas of interest as well as subject matter topics
- providing advice concerning emerging ocean exploration-relevant technologies
- organizing and conducting periodic reviews of program performance

The group reviewed these and added two functions: (1) to develop a new paradigm for Ocean Exploration based on the opportunities related to the NOAA Ship *Okeanos Explorer*; and (2) to provide advice on outreach and marketing to ensure the program continues to build on its current success and to further convey the excitement of exploration and discovery.

The group discussed the development of a new paradigm in more detail, describing how priorities and protocols for conducting reconnaissance/exploration missions could be established by ocean science luminaries, while young scientists and technicians would be deployed to conduct the work using the *Okeanos Explorer* and the science command centers. However, the challenges associated with funding these activities through the current Request for Proposal process were noted. Furthermore, the group discussed the need to phase in the new paradigm over time, complementing the current proposal-driven approach, and accommodating potential new ideas such as developing partnerships with commercial vessels to augment and accelerate the goals of ocean exploration.

4. OEAWG Subcommittees:

Expedition Planning:

Members – Jamie Austen (Chair), Marcia McNutt, Kym Murphy, Haraldur Sigurdsson, Larry Mayer, Tom Rossby

OE Primary Point of Contact – Reg Beach

The Expedition Planning subcommittee agreed to initially focus on conducting a workshop to establish expedition priorities for the first few years of operations for the *Okeanos Explorer*... The workshop would be designed to establish an optimal expedition profile, focusing on compelling targets and making the best use of transits through unknown areas. Emphasis would be given to an initial voyage focusing on issues of global relevance, highlighting the advanced technologies and capabilities being used, and ensuring media coverage to convey the excitement of and continued need for ocean exploration. Such an inaugural expedition

could include a major outreach effort such as the development of a short-film that could serve to "brand" the ship, crew, exploration approach, and the program. Over time, this group could engage in the further design and development of major expeditions, as well as combinations of expeditions.

Potential Workshop Location – National Geographic Society Grosvenor Auditorium
Date – TBD

Technology Development:

Members – Marcia McNutt (Chair), Robert Ballard, Tom Rossby, Bruce Gilman
OE Primary Point of Contact – Justin Manley

The Technology Development subcommittee agreed that it would be useful to stage a workshop to address the issue of technology in-terms of systems and sensors for the *Okeanos Explorer*, to identify issues that warrant a technology solution, and to identify viable methods for developing and testing these technologies. This would provide a forum for discussing technology in-terms of instruments to collect data and information, as well as for transmitting, processing, and disseminating the results. The materials generated from this workshop could be used to add to the capabilities of the *Okeanos Explorer*; to provide guidance to OE on enhancing the current approach used to advance technology, and to develop long-term strategies for expanding exploration activities. In addition, this subcommittee can provide guidance and advice on methods for investing in, encouraging, and supporting technology development beyond standard NOAA grant and contract mechanisms.

Potential Workshop Location and Date – TBD

Outreach and Marketing:

Members – Jesse Ausubel (Chair – Outreach), Terry Garcia (Chair – Marketing), Robert Ballard, Vera Alexander, Marcia McNutt, Bruce Gilman, Haraldur Sigurdsson
OE Primary Point of Contact – Fred Gorell

The Outreach and Marketing Subcommittee discussed the need for OE to develop an identity that resonates with multiple audiences, including but not limited to Congress, NOAA, other federal and state agencies, the science and education communities, and the general public. The subcommittee discussed potential long-term outreach strategies such as identifying 3-4 "news worthy" type items – events, people, assets, etc. – and developing a rigorous marketing plan to ensure the messages are clear, understandable, and widespread. The subcommittee could also provide guidance on and identify opportunities for building a 2-5 year marketing plan and approach focusing on major markets and public events. Finally, the subcommittee discussed identifying public and private enterprises that OE could develop partnerships with to promote the program and the excitement associated with exploration. The group did not discuss any potential workshops.

SHORT-TERM ACTIONS:

- OE will provide the OEAWG with updated vision and mission statements as they develop, especially as they relate to the merger between OE and NURP

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- OE will provide a distilled version of the PowerPoint presentations given during the meeting
 - As background for the Expedition Planning Subcommittee, OE will provide the OEAWG:
 - a summary of past proposals (funded and un-funded) including information on geographic area of interest, thematic focus, and the total amount of funding per year
 - copies of the summary reports generated from the eight regional workshops
 - copies of the OE Annual Reports
 - a copy of this year's Announcement of Opportunity
 - As background for the Outreach and Marketing subcommittee, OE will provide a PowerPoint gallery of slides that can be used to describe the OE program to multiple audiences

NEXT MEETING

The tentative date for the next OEAWG is November 8-10, 2006. Kym Murphy offered to look into having the meeting hosted at Disney's Imaginarium near Burbank CA.

Participants:

- Robert Ballard (IFE)
- Larry Mayer (UNH)
- Vera Alexander (UAF)
- Jamie Austin (UTEXAS)
- Jesse Ausubel (Rockefeller)
- Terry Garcia (NGS)
- Bruce Gilman (DMT)
- Marcia McNutt (MBARI)
- Kym Murphy (DISNEY)
- Tom Rossby (URI)
- Haraldur Sigurdsson (URI)
- Stephen Hammond (OE)
- John McDonough (OE)
- Nicolas Alvarado (OE)
- Margot Bohan (OE)
- Jeremy Potter (OE)
- Jeremy Weirich (OE)
- Catalina Martinez (OE)
- Justin Manley (OE)
- Paula Keener-Chavis (OE)
- Webb Pinner (OE)
- Tim Birdsong (OE)
- Fred Gorell (OE)
- Karen Kohanowich (NURP)
- Barbara Moore (NURP)
- Joanne Flanders (OE)
- Joyce Woodford (OE)
- Joe Flood (OE)
- Kelley Elliott (OE)
- Ivett Shields (OE)
- Cynthia Decker (SAB)

APPENDIX II

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 was 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 Mid-Atlantic 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 mid-water fauna also diverge across the boundary;
- Trenches, such as the Cayman Trough, where active venting and volcanism at higher pressures may harbor new extremeophiles;
- 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 cast of a Conductivity Temperature Depth (CTD) instrument 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 predetermined 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 are available online at: ftp://www.oarhq.noaa.gov/oe/OEAWG/OKEANOS%20Expedition%20Planning/OEAWG_Maiden_Voyage_Document_05072007.pdf

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 hullmounted 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, DVLNavigation, 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 walls 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 Aframe. 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 Jframe 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 Sidescan 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 JFrame. 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 a 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-80oC 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.

**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
May 10-11, 2007**

Appendix II

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

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.**

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.

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 Lounsbury 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 hullmounted 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

*Information about the OEAWG and its members:

http://www.sab.noaa.gov/Working_Groups/Working_Groups.htm

Proposed camera sled

6,000m ROV

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.

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, Mcdonough/Manley/Coleman timeline for delivery, etc. Why the Pacific first?

1

1:30-11:45 – 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, Washington, D.C. 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
Laurie Bradt Institute for Exploration
Janice Meagher Institute for Exploration
Sandra Witten Institute for Exploration
Max Angerholzer Lounsbery Foundation

APPENDIX III TECHNOLOGY WORKSHOP

NOAA Ocean Exploration Advisory Working Group

Summary Workshop Report

Technologies for the *Okeanos Explorer*

October 23-24, 2007 Monterey Bay Aquarium Research Institute

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* 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 a planning workshop at the National Geographic Society in Washington D.C. in May 2007, which focused on identifying targets in the Pacific for the *Okeanos Explorer* to investigate during its first two years of operation. A summary report describing that workshop is available.

On October 23-24, 2007 another OEAWG workshop was convened at the Monterey Bay Aquarium Research Institute (MBARI). This report describes that workshop, focused on technology needs for the *Okeanos Explorer*.

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. This workshop was dedicated to discussing the technology suite aboard the EX. As stated by the OEAWG the workshop objective and desired outputs were:

Objective: *The OEAWG aims to collect community input to help shape the technology investments by NOAA’s Ocean Exploration program. For example, in what areas might modest investments now in technology development or deployed systems yield high payoff*

in terms of our ability to explore the ocean with greater efficiency and increase the rate of new discoveries?

Anticipated Outputs:

- 1) Refined OE technology priorities, especially in the context of outfitting and operating the Okeanos Explorer.*
- 2) List of technology gaps for Ocean Exploration.*
- 3) Possible strategies for filling those gaps.*

These outputs will provide a foundation for the OEAWG to develop recommendations to NOAA's Science Advisory Board on ocean exploration's technology needs and priorities.

3. Workshop Process

The OEAWG organized and facilitated this workshop through a grant administered by Dr. Robert Ballard's Institute for Exploration. These funds supported the travel costs of the workshop participants. OE assisted the OEAWG in the development of the agenda based on the ongoing developments of technology for the EX, including the vessel refit, telepresence, and the ROV systems. OE offered suggestions for attendance at the workshop as did MBARI technical staff. The final invitations were issued by Marcia McNutt, who served as overall workshop chair. Approximately 35 ocean technologists as well as the OEAWG and several NOAA staff attended the workshop. Appendix I includes the list of attendees. MBARI hosted the event.

The OEAWG members served as hosts and facilitators of the workshop. Opening briefings provided attendees with a concept for an ocean exploration vision based on telepresence technology, results from the prior OEAWG workshop, status of the OE program, the EX status and capabilities, the ROV being built for EX and the ongoing technology developments and applications at MBARI. Briefing materials are available and access instructions are included in the References. The full workshop agenda is included in Appendix II.

The plenary briefings were followed by a series of breakout sessions discussing the different modes of exploration described as: 1) Underway Reconnaissance, 2) Water Column Exploration and 3) Site Exploration. Breakout sessions reported back to the main group which reconvened its discussions as a whole. This process was repeated and a final plenary session on the second day focused on the technology of telepresence and its role in science, as experienced at NASA.

4. Opening Discussions

The opening briefings served to provide background information and set the stage for following discussions. The briefings are available online (see references). In addition to this material several ideas emerged during the discussion. These are included here for

reference and consideration, not necessarily as recommendations from, or to, the OEAWG.

Maps and images – During discussion after Dr. Jamie Austin’s presentation on the prior workshop, he promoted the idea that EX, and OE, should focus on making visually compelling and scientifically meaningful maps. He suggested: “The Program needs a legacy of great images and great maps.” While some felt this was too simplistic, most agreed that it does capture the essence of exploration and serves to make the mission of the EX unique in comparison to a typical oceanographic research vessel. Related to this subject was a discussion of “rigor-osity” (a term coined at the workshop), i.e. within the context of a given expedition, how much science would be enough. Different views were shared but all agreed that the level of investigation needed to be sufficient to enable a follow on research proposal but that there was a major difference between exploration sufficient to support submission of an NSF proposal and the level of investigation required to produce rigorous, post-discovery-level journal articles. Mapping and images support both objectives, although at different levels completeness. Specifically, this discussion focused on the collection of data and samples other than maps and images. Different views were shared but all agreed that such data sets should be sufficient enough to characterize an area or phenomena in order to provide scientists valuable information for developing NSF-type proposals for future work, as well as for supporting the development of journal articles.

Managing and delivering expectations – A vigorous discussion concerned the issue of managing expectations of the oceanographic community. Dr. Austin suggested all technology deployed need to be “bulletproof” whereas, in contrast, Dr. Marcia McNutt suggested that careful attention to ensuring that users understood the intent and context of initial observations would result in satisfied users. A subsidiary point raised was the fact that transitioning new technology can represent a ten-fold increase in cost and effort as compared to the initial development. Thus, across the group it was recognized that promotion, and application of the EX and its new technologies will require careful planning and effective communications with many communities.

Community relations – The gap between traditional academic oceanography and applied NOAA exploration mission needs was apparent in various discussion points. Dr. Steve Hammond highlighted that the EX, as well as OE, must ultimately be relevant to NOAA. Dr. Austin pointed out that NOAA is not required to adhere to the academic community’s and the OEAWG’s advice and that it would be beneficial to all concerned to recognize OE and the EX as means to strengthen relations. This workshop recognized that data and data “ownership” would continue to be an issue. But, as a technology focused event there was greater concern about how the data would be managed rather than who would “own” it.

State-of-the-art versus currently existing technology – The various MBARI presentations revealed technological differences between some state-of-the-art technologies and those which will be initially deployed on the EX. It was recognized that many of the tools developed and proven at MBARI could benefit OE and the EX. The transition-cost

realities and need to manage expectations tempered the urge to envision EX having a complete suite of latest technologies when the ship becomes operational. An interesting thematic point was Dr. Jim Bellingham’s vision of “pervasive ocean presence.” While ocean observing systems are one component of this vision, underway systems are another. EX, with its telepresence capabilities, is well positioned to be on the cutting edge of this particular technology transition.

5. Breakout Sessions

NOAA staff supported the OEAWG during the workshop by taking notes and presenting some of the scheduled briefings. All breakout sessions were attended by at least one note taker and led by a member of the OEAWG. Each breakout session delivered a report to the plenary. This section provides a summary of those reports. The original slides delivered are available (see the References). This section aims to present the themes, recommendations and/or challenges identified by each breakout group. Specific technologies and tools discussed in the breakouts will be collated and discussed in a separate document designed to support ongoing technology investments for the EX as well as broader Ocean Exploration and Research needs.

5.1. Site Exploration

Site exploration can be defined as working within a defined “box” to thoroughly explore a predefined region, and to dive the ROV on specific targets of interest. This includes “mowing the lawn” using the EM-302, selecting areas of interest for investigating with the camera sled at slow speeds, and conducting full ROV operations on targets of interest to collect high-quality video and stills as well as representative samples. The majority of the items identified by this group related to upgrades and modifications to the dedicated ROV and camera platform. These will be reviewed in a separate document. Other thematic concepts introduced included:

Borrow not buy – Rather than engage in an attempt to acquire additional tools, participants suggested working with the community to borrow items (such as a still camera for the construction of photo mosaics), during initial EX operations. Such loan programs would enable more cost effective experimentation and concept development. This idea would apply equally to sub-systems on the ROV and camera platform and major EX systems like AUVs and towed platforms.

Low-cost deployable assets – Innovative use of affordable systems like drop cameras and elevators was suggested to augment the ROV and camera platform. Drop cameras were suggested as a low cost way to get very basic imagery of a site without the effort of an ROV dive. Elevators were seen as a potential approach to enable more significant sample collection without numerous ROV recoveries.

Scouting/reconnaissance – The need to develop an effective approach and tool suite for scouting was discussed. Options include a camera platform more like the IFE Argus or

an autonomous vehicle. In either case it was suggested that the “borrow not buy” approach would be wise, at least initially.

ROV needs – A long list of ROV tools was created. This list included any items already under consideration by OE as well as some new suggestions. One need cited is for a fiber-optic gyro, for optimal heading data. This item has been cost prohibitive but will be added as funds are available. The entire list and a procurement plan will be developed separate from this report.

Selling OE – It was recognized that much of the site exploration work would be primary “selling” material for OE. Sites such as vents and shipwrecks would be of public interest, likely even more so than broad area maps. Thus, this breakout session suggested technology investments that support outreach need to receive a high priority.

5.2. Underway Reconnaissance

Underway reconnaissance can be defined as using the multibeam sonar and other ship-based sensors while transiting through unknown, or poorly known, waters for the purpose of detecting an anomaly or something of interest that bears investigation using other tools and techniques. Two important systems the EX does not have currently are a low-frequency ADCP and an EK-60. Both would contribute to the water column aspect of the reconnaissance operation, and have the added benefit of providing information that could be analyzed in the context of “regional exploration,” i.e., oceanographic exploration and characterization that would complement biological or geological exploration.

As with the site exploration breakout, a series of specific tools and technologies were discussed by the underway reconnaissance group. These also will be included in the technology discussion document. Ideas and themes of broader interest included:

Aircraft – The potential role of unmanned aerial vehicles (UAVs) balloons, blimps and the like was discussed. Specific roles and requirements for such platforms were not fully developed. However, this was a novel suggestion that warrants additional consideration.

Hull Systems – A variety of vessel mounted systems were discussed. Two systems of great interest were the EK60 and ADCP. It was explained that due to budget constraints these systems cannot be acquired at the present time (and installation would not be possible until a future drydock overhaul period). However, there is a possibility that portable systems could be procured on loan, and operated through the ship’s moon pool. Another capability not yet funded but of high importance (e.g., for the purpose of establishing water column sound velocity profiles necessary for bathymetric soundings accuracy) is an XBT system. As such a system is relatively affordable it anticipated that one will be procured in the near future. Two concepts for vessel-based reconnaissance were through-hull analysis and atmospheric sensors. Both were seen as useful to broad NOAA missions and could enable new discoveries. It was also suggested that observations systems for automated bird and marine mammal observations be installed on the vessel. However, these operations, as on most NOAA ships, are ancillary and

opportunistic, and if entertained could rely on equipment provided by other NOAA programs.

Towed Systems – Various ideas were offered on the role of towed systems in underway work. The feasibility of full-speed biological sampling was discussed; exploring the possibility designing an at-speed net sampling system was also mentioned. If feasible, this was seen as a potential significant benefit for biological oceanography. Development of a towed system equipped with pumps that could feed water samples from various depths for flow-through analysis was also mentioned. A technology required for such activities would be a reliable full-speed towed undulating vehicle.

Daily stations – The idea of a regular daily sampling/survey station as an integral part of underway reconnaissance was introduced by OE. The challenge posed by the time necessary to accomplish such work was discussed. For example, utilization of a camera platform equipped with limited CTD capability and a bottom sampler, rather than the CTD rosette, was posited. This breakout felt that repeatable activity of this nature was highly desirable but options for accomplishing such stations were felt best explored by the water column breakout group. A later discussion of this topic included the statement by Dr. Larry Mayer that routine daily stations were an excellent way for the program to help establish a legacy.

5.3. Water Column Exploration

Water column exploration can be defined as investigating the water column using ship-based instruments (such as those that would be used for underway reconnaissance), as well as deployed instruments such as a CTD, the ROV camera sled, and nets. It differs from underway water column reconnaissance in that the work is done while on station. Water column exploration could be conducted on a daily basis at “Ewing Stations,” which could also include collecting sediment grabs or cores on a daily basis while the ship is in transit. Like underway reconnaissance, the information collected could be used to help determine if the ship should stop and conduct a more thorough investigation of an area of interest.

As with the other groups, a series of technologies were identified by the water column team. These will be discussed in detail in the subsequent analytical document. Interesting themes raised by this breakout included:

Technology Transition – As a dedicated vessel, the EX can be utilized in innovative ways. For example, time could be made available during each year’s field season for the support of technology testing. The proof-of-concept testing that of necessity requires sea time is critical to acceptance and use of a new technology. Such time is difficult for most technology developers to obtain, and the EX could thus provide an important new capability that would be entirely consistent with the focus of the Office of Ocean Exploration and Research (OER—the name of the new organization that includes Ocean Exploration and the National Undersea Research Program) on technology development. The availability of telepresence is also enabling to technology development. Many new

tools for use in the water column require calibration and monitoring by specialists. The hardware can often be maintained by ship technicians but during development input and consultation is always required from the person, or persons, responsible for creating the instrumentation (or its concept) inventors. Having a broadband link to shore allows these experts to provide such support without having to be on board the vessel. Providing engineering time on a regular basis would very likely enable many more innovative technologies to be applied in OE expeditions.

More Platforms – Additional platforms to enable water column exploration were identified. Towed systems that could undulate within the water column, reach significant depths and be towed at speed would be useful. AUVs were also identified as of interest, especially if they could carry new in situ sensors and collect water samples like the MBARI system described in opening presentations.

Data Bits not Samples – The breakout group recognized that the limited sample storage space onboard EX and the variable nature of its daily activities will preclude, or at least require significant modification of, many traditional biological and chemical sampling strategies. New technologies that collected digital data about the ocean (as opposed to actual pieces of it) were suggested as the best approach to additional water column exploration. The phrase “formaldehyde is obsolete” was used to describe this outlook. While the group agreed this approach made sense it also recognized that significant investments were required to deliver on the promise of such new technologies. However, this is also an area that is ripe for attracting potential inventors and investors to use the EX to test new equipment and sensors that are in development at no-cost to OE.

Protocols Required – The need for some standardization of data types and collection protocols was identified as key to methodical water column exploration. A desired effort would include collection of CTD, chlorophyll, fluorescence, nutrient, backscatter, fast repetition fluorescence, DO, pH, oxidation reduction potential, CO₂, transmissivity, and broad-frequency passive acoustics data. While this is an ambitious list it is also all feasible with current technology. Some careful planning would make it possible to equip the camera sled with instruments to collect all of this data. Proper data management techniques would result, eventually, in a robust database of water column information.

6. Concluding Discussions

The closing plenary included an interesting presentation from Dr. Kanna Rajan (a former NASA employee now with MBARI). This briefing discussed how NASA implemented science from afar. The net impact of this presentation and the associated discussion was the understanding that NOAA can learn a great deal from the NASA experience but also that the EX model has its own intricacies that will require additional consideration. This discussion was more contemplative than “decisional” and served primarily to open a new thread of consideration for OE.

Other points were made in the discussion. The following are presented for consideration not necessarily as recommendations of the participants or the OEAWG.

Abandon the water column – Thematically similar to Dr. Austin’s point in the opening session (maps and images) was the comment from Dr. Bellingham that the EX is not well suited to significant water column work. From a purely technical perspective it makes sense to apply the vessel and its tools to what they are already optimized toward, mapping and site exploration. Admittedly this would leave out a large segment of science users but it would also make the EX a focused tool more likely to succeed in its mission.

Staffing – The ongoing questions about staffing were raised. The theme during this workshop included the need to align staff with any advanced technology (vice operational) plans. Some time was also spent discussing the role of science techs and the staff ashore. While useful on the whole this discussion highlighted the need for further OE work sessions to develop the detailed plans for EX.

Gaming – The NASA experience, along with some large MBARI field programs, suggested that it would be valuable to engage in gaming sessions. These could take the form of small workshops with a science team and OE/EX staff. Together this group would consider how to execute exploration, thinking through an actual effort in a real-world site.

Equipment loans – several individual attendees indicated that they would be willing to loan equipment to EX to assist in the development of the optimal exploration protocols. These offers will be captured in the technology assessment document under development.

7. Closed Session

After the workshop officially closed the OEAWG members and NOAA staff held a closed session. This proved to be an energetic discussion with many strong views. It highlighted the challenges faced by the program but also the opportunities that the Ocean Exploration program and the EX will provide to the ocean community. The following themes were represented in the discussion.

Underway (sticks) vs. Site work (boxes) – Strong feelings were shared on the value of sites (e.g. vents, wrecks, reefs) and broad area underway work. The lack of the EK60 and 38kHz ADCP was lamented by those who felt more underway work was critical. The sticks and boxes model provided a vocabulary for the discussion but, despite this working model, those valuing sticks felt that the boxes had the run of the workshop. The practical limitations of funding closed the discussion. Upon providing the latest budget information on the EK60/ADCP procurement the sticks proponents had to admit that they would have to wait for the inclusion of these tools in the future. The proponents of boxes were adamant that the tools for that application (i.e. ROV and camera platform) needed to be enhanced as recommended in the workshop. The potential loan of equipment and low-cost solutions was discussed and understood to be a path forward. While there was some dissatisfaction in evidence, the discussion led to creative ideas. In particular, using the moon pool to install an ADCP as soon as funds became available, as opposed to

waiting for a dry-dock phase, was suggested. It is likely that completion of the 2008 EX schedule/plan will diminish this debate as the realities of fiscal and technical limitations become evident.

Distinct program, moving slowly – The need for the rollout of the EX to go slowly became very clear. The freedom to do so was also made clear. There was strong agreement amongst the OEAWG members that the “community” had low expectations and could wait while OE began the effort slowly and focused on strong execution. This discussion of community expectations also led to the reminder from OEAWG members that the OE/EX program needs to be distinctive from other efforts. The ongoing back and forth over the ROV was cited as a failure to clearly portray ocean exploration and EX as distinctive from other ocean science efforts and tools.

Communications – The need for more, and improved, communications across many audiences was discussed. The OEAWG members focused on the external communications needs, but recognized OE must also communicate better within NOAA. It was suggested that outreach to AGU (perhaps an EOS article) and similar venues would be advisable. A town hall meeting to present the capabilities of the EX was suggested by NOAA and the OEAWG, recalling the “distinct program” comment suggested such a town hall might focus on the philosophy more so than the ship. That would serve to begin the “selling” of the effort and would also serve to defuse or dilute criticism of the tools. In addition to broad outreach at community events the OEAWG recognized that additional small workshops would be of benefit. Topics of interest included data management, gaming exercises, and perhaps a focus on sticks.

OEAWG issues – The OEAWG also discussed its internal issues including the need to reinvigorate its membership and develop an effective approach for working with the SAB and NOAA.

8. Next Steps

Several suggestions were made to productively build upon this workshop. The most important step identified was to develop a robust schedule and plan for 2008. Development of scientific plans requires an understanding of what tools will be available, how they will be tested and debugged and what staffing will be available onboard. Developing this schedule is a priority for an already scheduled OE EX team work session.

It was also recommended that OE take more steps to present the plans for the EX to the oceanographic community. Such presentations could reference the OEAWG workshops and the steps OE is taking to benefit from those workshops. While no specific ideas were offered concepts such as town hall meetings at AGU/ASLO/OCEANS were discussed.

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) B. Evers and J. Manley, "A Vehicle for Science and Exploration: Bringing Offshore Industry Advances and Experience to the Oceanographic Community," *Proceedings of Oceans 2007*, MTS/IEEE, Vancouver, Canada, October 2007.

3) Materials from the workshop available online:

http://terra.gso.uri.edu:8380/plone_sandbox/oceanos-explorer/oeawg-technology-workshop-oct-2007/

usrname: oeawg

paswr: o3awg

List of Attendees for Technology Workshop

Vera Alexander	OEAWG/University of Alaska, Fairbanks
Doug Au	MBARI
Jamie Austin	OEAWG/University of Texas, Austin
Bob Ballard	OEAWG/University of Rhode Island
Jim Bellingham	MBARI
Dave Butterfield	University of Washington
Rich Camilli	Woods Hole Oceanographic Institution
Dave Caress	MBARI
Dwight Coleman	University Rhode Island
Cynthia Decker	NOAA
Brent Evers	Phoenix International
Dan Fornari	Woods Hole Oceanographic Institution
Gwyn Griffiths	National Oceanography Centre, Southampton
Steve Hammond	NOAA
Corey Jaskolski	National Geographic Society
Deb Kelley	UNOLS/University of Washington
Bill Kirkwood	MBARI
Karen Kohanowich	NOAA
Dave Lovalvo	Eastern Oceanics
Justin Manley	NOAA
Larry Mayer	OEAWG/University New Hampshire
John McDonough	NOAA
Marcia McNutt	OEAWG/MBARI
Chris Meinig	NOAA-Pacific Marine Environmental Laboratory
Ken Melville	University of California, San Diego
Luke Nachbar	NOAA
Jim Newman	Woods Hole Marine Systems, Inc.
Joe Pica	NOAA
Webb Pinner	NOAA
Jeremy Potter	NOAA
Mike Prince	UNOLS
Kanna Rajan	MBARI
Tom Rossby	OEAWG/University Rhode Island
Craig Russell	NOAA
Hans Thomas	MBARI

The Workshop Agenda

Tuesday October 23, 2007 – Pacific Forum Conference Room

9:00 – 10:30 Opening Session and Introductions

9:00 – 9:10 Welcome and introduction to the OEAWG - Dr. Marcia McNutt, MBARI

9:10 – 9:35 The Ocean Exploration Paradigm Shift - Dr. Robert Ballard, Institute for Exploration, University of Rhode Island

9:35 – 10:00 Concept of Operations for the *Okeanos Explorer*: Summary of the Results of the First Workshop - Dr. Jamie Austin, Institute for Geophysics, University of Texas, Austin

10:00 – 10:20 NOAA-OE Program Office Plans for Initial Operations of *Okeanos Explorer* – Dr. Steve Hammond, NOAA-OE Program Director

10:20 – 10:35 Break

10:35 – 12:05 MBARI Advanced Technology Concepts

10:35 – 10:55 Advanced Sensors at MBARI, Bill Kirkwood MBARI

10:55 – 11:15 Autonomous Underwater Vehicles at MBARI, Hans Thomas, MBARI

11:15 – 11:40 What is next in ocean technology, Dr. Jim Bellingham, MBARI

11:40 – 12:05 Reality Check: Current Capabilities and Limitations of the *Okeanos Explorer* and its ROV – Craig Russell and Justin Manley, NOAA-OE

12:05 – 1:00 Working Lunch – The podium will be open to any conference attendees who wish to make a pitch for a certain technology or approach, either reinforcing ideas already heard or adding to what was discussed earlier.

1:00 – 2:30: Breakout Sessions –

Group 1 – Underway reconnaissance: Ship's View
OEAWG Facilitator: Dr. Larry Mayer
NOAA Staff: Joe Pica

Group 2 – Water Column Exploration: Ocean View
OEAWG Facilitator: Dr. Marcia McNutt
NOAA Staff: Jeremy Potter

Group 3 – Site Exploration: Pacific Forum
OEAWG Facilitator: Bruce Gilman
NOAA Staff: Craig Russell

2:30 – 3:00 Break

3:00 – 4:00 Breakouts Continue -

4:00 – 5:00 Reconvene and Reporting

4:00 – 4:15: Reconvene

4:15 – 4:30: Underway Reconnaissance

4:30 – 4:45: Water Column Sampling

4:45 – 5:00: Site Exploration

5:00: Adjourn

Dinner: Small groups are encouraged to make their own dinner plans. MBARI staff will provide suggestions.

Wednesday October 24, 2007 - Pacific Forum

8:30 – 8:45: Reconvene and Review

8:45 – 10:00: Final Breakout Session

10:00 – 10:15: Break

10:15 – 11:00: Reconvene and Reporting

10:15 – 10:30: Underway Reconnaissance

10:30 – 10:45: Water Column Sampling

10:45 – 11:00: Site Exploration

11:00 – 12:00: Open Discussion: Have we achieved our aims?

12:00 – 1:00: Lunch

1:00 – 2:30: Final Discussion

1:00 – 1:30: Summary of concepts thus far

1:30 – 2:30: Open Discussion on the role of Telepresence in the technology portfolio, moderated by Kanna Rajan

2:30 Adjourn

3:00 – 5:00 OEAWG Closed Meeting – Harbor Conference Room

Example of the table of technology recommendations table that will be developed

Technology	Status	Anticipated Action	Resources Required	Priority
EX EK60	Designed not installed	Install in next major port service period	Get \$ estimate from Craig R.	High
ROV Fiber-optic Gyro	Designed not installed	Install when funding permits	~\$100k	High
Camera Platform Alternative Frame Shape	Alternative design awaits field experience with current model	Ship's force could possibly construct an alternative frame at sea	Modest personnel and materials resources	Unknown until current design is tested