PROCEEDINGS

1st Annual Implementation Conference for the Integrated Ocean Observing System (IOOS)

Arlington, Virginia
August 31 - September 2, 2004

The National Office for Integrated and Sustained Ocean Observations
Ocean.US Publication No. 8
# Table of Contents

Executive Summary 5

1. Introduction 6
   1.1 Goal 6
   1.2 Objectives 6
   1.3 Participants 7
   1.4 Procedure 7
   1.5 Conference Evaluation 7

2. A Summary of Consensus Recommendations by the Conferees (Days 1 and 2) 8
   2.1 Summary of Data Management and Communications Recommendations 8
      2.1.1 Data Management and Communications Recommendations for FY 05-06 Priority Activities 8
      2.1.2 Data Management and Communications Recommendations for FY 07 Priority Activities 9
   2.2 Regional Development Recommendations (FY 05 – 06) 11
   2.3 Priorities for Enhancing the Observing Subsystem of the National Coastal Backbone of the IOOS 11
      2.3.1 Pre-Operational and Operational Elements 12
      2.3.2 Research and Pilot Projects: Targeted Elements 12
      2.3.3 Research and Pilot Projects: End-to-End 13

3. Federal Response 15

FOOTNOTES 16

APPENDICES

Appendix I Participants 19
Appendix II Agenda 26
Appendix III Summary of Small Group Comments 29
Appendix IV DMAC Budgets 31
Appendix V Acronyms 34
Ocean.US, in collaboration with federal agencies, completed a preliminary Annual IOOS Development Plan for the initial Integrated Ocean Observing System (IOOS) in early August 2004. Recognizing that the plan must reflect both federal and common regional priorities, the First Annual IOOS Implementation Conference provided a forum for the leaders of nascent Regional Associations (RAs) to work directly with participating federal agencies to provide guidance for completing the First Annual IOOS Development Plan.

By consensus, conferees made the following recommendations:

- Continue to implement and strengthen current plans for the global ocean component of the IOOS;
- Implement immediately the plan for developing the Data Management and Communications (DMAC) subsystem of the IOOS;
- Establish and adequately fund RAs and the National Federation of Regional Associations; and
- Implement selected coastal ocean data assimilation experiments as pilot projects to facilitate coordinated development of the coastal and global components.

There was also strong agreement on the pressing need to:

- Sustain existing elements of the observing subsystem for the national backbone recommended in the preliminary IOOS Development Plan and integrate these into an interoperable system; and
- Sustain the current investment in coastal ocean observing systems.

Given the large number of options and limited time, a consensus was not achieved on a focused set of priorities for the observing subsystem of the coastal component of the IOOS. A set of high pay-off activities was recommended that, if undertaken, would enable the effective development of a fully integrated system.

Participants further identified important aspects of IOOS development that should be addressed by groups of experts before the recommendations for developing the observing subsystem in Part III of the First Annual IOOS Development Plan can be implemented. Of particular importance are provisions for the development of the infrastructure required to deploy, maintain, and replace the required platforms and sensors and for training to develop the technical work force that will be needed to operate and improve the IOOS over time. These issues will be addressed in preparation for the Second Annual IOOS Implementation Conference to be held in May 2005.

Based on input from the Conference, a draft of the First Annual IOOS Development Plan was prepared by Ocean.US. This was posted on the Ocean.US web site for a one month public comment period beginning 15 October 2004. Recommendations received during this period were used to complete the Plan, which will be transmitted to the National Ocean Research Leadership Council, subject to endorsement by the Ocean.US Executive Committee. This plan (which will be revised and updated annually following each Annual IOOS Implementation Conference) will make recommendations to be used by federal agencies in establishing their priorities for contributing to the implementation, operation, and improvement of the initial IOOS.
1. Introduction

The Integrated Ocean Observing System (IOOS) is the U.S. contribution to the Global Ocean Observing System (GOOS) and to the oceans and coasts components of the Global Earth Observation System of Systems (GEOSS). The First Annual IOOS Implementation Conference builds on a sequence of workshops and conferences initiated under the auspices of the National Oceanographic Partnership Program (NOPP) established by Congress in 1997. Reports of these activities can be found on the Ocean.US web site at [http://www.ocean.us](http://www.ocean.us).

This conference brought together representatives from coastal states, the Great Lakes, and the Caribbean with representatives from NOPP federal agencies to discuss and recommend priorities for establishing an initial Integrated Ocean Observing System (IOOS) that includes both global ocean and coastal components. Recognizing that implementation of the global component has begun, the conferees underscored the importance of continued development and strengthening of the U.S. contribution to this international effort and focused on first steps for developing the coastal component and on coordinated development of the coastal and global components.

1.1 Goal

Ocean.US, in collaboration with federal agencies (NOAA, NASA, NSF, Navy, EPA, USACE, USGS, MMS, and USCG), completed a preliminary Annual IOOS Development Plan for the initial IOOS in early August 2004. Recognizing that the plan must reflect both federal and common regional priorities, the conference was organized to provide a forum for the leaders of nascent Regional Associations (RAs) to work directly with participating federal agencies to provide guidance for finalizing the First Annual IOOS Development Plan. The final plan (which will be revised and updated annually following each Annual IOOS Implementation Conference) will make recommendations to be used by federal agencies in establishing their priorities for contributing to the implementation, operation, and improvement of the initial IOOS. A draft of the plan was posted on the Ocean.US web site for public comment on 15 October 2004. Based on this input, the plan will be revised and, subject to endorsement by the Ocean.US Executive Committee (EXCOM), transmitted to the National Ocean Research Leadership Council (NORLC).

1.2 Objectives

Conferees were asked to formulate recommendations for the following:

- Coordinated development of global and coastal components based on global requirements of the coastal component and coastal requirements of the global component;
• Implementation of a data management and communications (DMAC) subsystem that will provide rapid access to diverse data from many sources;
• Development of the national backbone for the coastal component of the IOOS; and
• Establishment of RAs for designing, implementing, operating, and improving Regional Coastal Ocean Observing Systems (RCOOSs).

The purpose of the conference was not to review the preliminary Annual IOOS Development Plan, per se. Rather, it was to initiate an annual forum for federal agencies and regional groups to collaborate in the development of the IOOS over time and to make specific recommendations for IOOS implementation using the preliminary plan to frame the discussion. Consensus on a focused set of initial priorities for IOOS implementation was the primary objective of days one and two. A meeting of federal agencies occurred on day three to formulate the federal response to recommendations from the first two days. Feedback from these sessions will be used to complete the First Annual IOOS Development Plan.

1.3 Participants

Representatives from federal agencies, nascent RAs, the NORLC Interagency Working Group, the U.S. GOOS Steering Committee, and the Ocean.US enterprise (Ocean.US staff and EXCOM) who have been involved in planning the IOOS were invited to participate in the conference (Appendix I). It was recognized from the beginning that a major effort is needed to engage a broader community of data providers and users in the process of developing a fully integrated observing system for oceans and coasts. The consensus recommendations of the conferees reflects this and makes the engagement of users from both private and public sectors from coastal regions and the Great Lakes an immediate high priority.

1.4 Procedure

The conference agenda is given in Appendix II. The first day began with an overview of the status of IOOS planning and implementation with a session to clarify outstanding questions, issues, and conference procedures (Appendix III). The day concluded with plenary sessions on establishing (1) RAs and the National Federation of Regional Associations (NFRA) and (2) an integrated approach to DMAC. The session on regional development focused on the rationale for federal investment in a regional approach, current status of RA and NFRA development, and requirements for developing a national network of RCOOSs. The DMAC session focused on key issues and opportunities for implementing the DMAC plan. An action plan for establishing IOOS DMAC “best practices” and standards development activities was developed that will ensure periodic identification and updating of key issues and priorities.

The second day began with an overview of the status and future development of the global ocean component. This was followed by a breakout session with five Working Groups (WGs):

• WG-1 formulated recommendations for coordinated development of the global and coastal components that recognize the interdependence of the two components and the goal of developing a single, seamless IOOS for oceans and coasts.
• WGs-2, -3, -4, and -5 used high priority product-categories to guide the formulation of recommendations for phased implementation of IOOS subsystems for each product category.²

Day two concluded with a discussion of recommendations and a consensus on implementation priorities (summarized in section 2). On the third day, participating federal agencies met to consider and respond to the consensus recommendations of the first two days. This led to a formal response (summarized in section 3) and to an agreement to prepare a Memorandum of Understanding on “corporate responsibilities” of the federal agencies for IOOS development.

1.5 Conference Evaluation

A statistically significant proportion of the participants submitted evaluations of the conference. Most respondents were pleased with the conference and rated it highly. There was a general comment that participants needed more time to absorb the material presented and discuss it thoroughly. Quantitative ratings of various aspects of the conference are given in Table 1. Most aspects of the conference were rated highly, and most participants indicated their expectations were met or exceeded.

Table 1. Quantitative ratings of the conference on a scale of 1 (lowest) to 5 (highest).

<table>
<thead>
<tr>
<th>TOPIC</th>
<th>AVERAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization</td>
<td>4.2</td>
</tr>
<tr>
<td>Day 1</td>
<td>4.1</td>
</tr>
<tr>
<td>Day 2</td>
<td>3.9</td>
</tr>
<tr>
<td>Day 3</td>
<td>4.0</td>
</tr>
<tr>
<td>Plenary Sessions</td>
<td>4.0</td>
</tr>
<tr>
<td>Presentations</td>
<td>4.0</td>
</tr>
<tr>
<td>Breakout Sessions</td>
<td>3.7</td>
</tr>
<tr>
<td>Conference Venue</td>
<td>4.2</td>
</tr>
<tr>
<td>Catering Services</td>
<td>4.1</td>
</tr>
<tr>
<td>Hotel Room</td>
<td>4.2</td>
</tr>
<tr>
<td>Expectations Met?</td>
<td>Yes</td>
</tr>
</tbody>
</table>
2. A Summary of Consensus Recommendations by the Confernees (Days 1 and 2)

There was strong agreement among the confernees on the following recommendations:

(1) Continue to implement and strengthen current plans for the global ocean component of the IOOS;
(2) Implement immediately the plan for developing the DMAC subsystem of the IOOS;
(3) Establish and adequately fund RAs and the NFRA; and
(4) Implement selected coastal ocean data assimilation experiments as pilot projects to facilitate coordinated development of the coastal and global components.

There was also strong agreement on the pressing need to sustain existing elements of the national backbone recommended in the preliminary IOOS Development Plan, to integrate these elements into an interoperable system, and to sustain the current investment in subregional coastal ocean observing systems. However, given the large number of options and the limited time available to work these through systematically and consistently, a consensus on a focused set of priorities for these aspects of the system did not emerge. Consequently, a summary of high pay-off activities was recommended (section 3 of this report) that, if undertaken, would enable the effective development of a fully integrated system.

Participants further identified important aspects of IOOS development that should be addressed by groups of experts before the recommendations for developing the observing subsystem in Part III of the First Annual IOOS Development Plan can be implemented. Of particular importance are provisions for the development of the infrastructure required to deploy, maintain, and replace the required platforms and sensors and for training to develop the technical work force that will be needed to operate and improve the IOOS over time. These issues will be addressed in preparation for the Second Annual IOOS Implementation Conference, to be held in May 2005.

2.1 Summary of Data Management and Communications Recommendations

Conferees endorsed the May 2004 DMAC Implementation Plan and recommended that the plan be finalized following a formal 30-day public comment period (to be announced in the Federal Register) to publicize the document more widely and to move the effort forward. By consensus, it was recommended that, once finalized, the DMAC Plan’s recommendations for data and metadata standards and best management practices should be officially adopted as the initial, formal guidance for IOOS/DMAC data providers, users, and stakeholders.

2.1.1 Data Management and Communications Recommendations for FY 05-06 Priority Activities

Conferees recommended by consensus the following priorities for immediate DMAC implementation during FY 05-06:

(1) DMAC Steering Team: Ocean.US will establish an IOOS DMAC Steering Team to coordinate and oversee the evolution of DMAC standards and to ensure that the DMAC standards process is conducted in an open and balanced manner.
(2) DMAC Expert Teams: Ocean.US will organize expert teams to address key Information Technology (IT) standards as identified in the DMAC Plan. Experts from the emerging GEOSS and relevant international data management standards activities will be invited to participate.
(3) Interagency Coordination: The Conference provided a consensus endorsement of the proposed recommendation that the EXCOM agencies establish an IOOS DMAC Implementation Oversight Working Group (IOWG). The role of the IOWG (a federal body) will be to coordinate the implementation of DMAC among the federal agencies.

These actions are critical for establishing the initial DMAC subsystem and a foundation for integrating existing and emerging IOOS data streams. Estimates of costs are summarized in Table 2.

Table 2. Estimated costs based on the May 2004 DMAC Plan. Numbers in parentheses refer to the three recommendations above. A more detailed budget is given in Appendix IV, Table A. These estimates are in addition to current investments of federal agencies in their existing DMAC-related data management activities and do not include the resources needed for hardware procurement or software implementation.

<table>
<thead>
<tr>
<th>DMAC Activity</th>
<th>FY 05</th>
<th>FY 06</th>
<th>Potential Agencies Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oversight and Coordination (1) &amp; (3)</td>
<td>$36K</td>
<td>$72K</td>
<td>All</td>
</tr>
<tr>
<td>Standards Development (2)</td>
<td>$685K</td>
<td>$954K</td>
<td>All</td>
</tr>
<tr>
<td>TOTALS</td>
<td>$721K</td>
<td>$1,026K</td>
<td></td>
</tr>
</tbody>
</table>

Outcomes of implementing these recommendations will provide a basis for determining out-year investments. Recommendations based on the May 2004 DMAC Plan include actions that should be taken by data providers immediately in order to ensure interoperability with IOOS as it evolves (Appendix IV, Table B). Cost estimates for implementation by individual agencies were not available because of the large number of systems involved and
their varying levels of maturity and compliance with DMAC guidelines. However, it is suggested (as a target goal) that agencies invest in DMAC activities approximately 10% of the amount invested in relevant observing activities.

2.1.2 Data Management and Communications Recommendations for FY 07 Priority Activities

Recommendations regarding investments for the FY 07+ timeframe were consistent with those made in the DMAC Plan. Additional recommendations provided during the breakout sessions enumerated specific, agency-focused activities that are also consistent with the DMAC Plan. These activities fall into three major categories:

- **An interoperability framework**: This area focuses on the continuation of DMAC standards oversight, coordination, and development efforts that began in FY 05-06 (section 2.1.1).
- **An interoperability infrastructure**: These investments will augment current federal program activities, and also address core DMAC infrastructure needs of the RAs. They focus on acquisition or updating of hardware, software to enable interoperability, network capacity building, expansion of data archive center capacity, standards implementation, and enhanced national systems integration.
- **Design and demonstration**: These activities include pilot projects to evaluate, test, and involve end-users in capability demonstration projects, implement new technologies, and conduct end-to-end integration of observational data across sectors, disciplines, geographic areas, and organizations.

Estimated costs associated with each of these areas are given in Table 3. Table 4 summarizes recommendations from the conference breakout sessions. They are consistent with recommendations in the DMAC Plan and will be considered as part of the DMAC planning and development process.

Table 3. A summary of estimated costs for each DMAC activity (details in Appendix IV, Table C). Estimated infrastructure costs were published in the May 2004 DMAC Plan. Note that some of these costs may also be accounted for in the RA estimates of costs for DMAC implementation provided earlier in this document. Nascent RAs are in the process of developing more specific cost estimates for their DMAC implementation (order $100-500K per region per year), which may include some duplication. Ocean.US will reconcile these estimates in the future.

<table>
<thead>
<tr>
<th>DMAC Activity</th>
<th>FY 07</th>
<th>Potential Agencies Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interoperability framework</td>
<td>$7,052K</td>
<td>All</td>
</tr>
<tr>
<td>Interoperability infrastructure</td>
<td>$6,860K</td>
<td>All</td>
</tr>
<tr>
<td>Design and demonstration</td>
<td>$3,800K</td>
<td>All</td>
</tr>
<tr>
<td>FY 07 TOTAL</td>
<td>$17,712K</td>
<td></td>
</tr>
</tbody>
</table>
Table 4. Summary of DMAC priority conference breakout session recommendations grouped by key areas addressed in the DMAC Plan; agencies affected by each recommendation are identified. Due to time constraints, projected costs and timeframes for these activities could not be developed during the conference. The DMAC Plan provided cost estimates for design and demonstration activities that are consistent with these conference recommendations, along with the other activities recommended for FY 07 (Table 3).

<table>
<thead>
<tr>
<th>DMAC Implementation Plan Needs Area</th>
<th>Representative Breakout Group Priority Recommendations</th>
<th>Potential Affected Agencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventory of current programs</td>
<td>• Inventory NOAA and EPA coastal and estuarine data sets, especially bottom, habitat and ecosystem-related, and by extension each IOOS core variable observing effort</td>
<td>• All Agencies</td>
</tr>
<tr>
<td>Data discovery</td>
<td>• Assure agency data inventories are “registered” and accessible through IOOS portal</td>
<td>• All Agencies</td>
</tr>
</tbody>
</table>
| End-to-end integration             | • Enable stream gauge observations integration  
• Enable wave observations integration  
• Interconnect High Frequency (HF) radar and fixed sensor wind and wave data | • USGS and NOAA  
• USACE, NOAA, and Navy  
• NOAA, USCG, and Navy |
| Metadata development               | • Develop Lagrangian metadata for Autonomous Underwater Vehicles (AUVs)  
• Develop imagery metadata & characterization to enable fusion and assimilation  
• Integrate species-level information (e.g., genetics, habitat, life history, etc.) | • NSF and Navy  
• NASA, NOAA, USGS, and Navy  
• NSF and NOAA |
| Semantic data model(s) development | • Develop semantic data model to enable imagery fusion with models  
• Fuse spatial and tabular nutrient data fields | • NASA, NOAA, Navy, and USGS  
• EPA and NOAA |
| Data transport                     | • Develop mechanisms for providing satellite data  
• Interconnect HF radar and fixed sensor marine wind data | • NASA, NOAA, and USGS  
• USCG, NOAA, USACE, and Navy |
| Data archival                      | • Develop climatologies of oxygen, chlorophyll, nutrients and pCO$_2$ observational data | • EPA, NOAA, and USACE |
| QA/QC                              | • Enable integration of stream gauge data into national network across all observing elements | • USGS and NOAA |

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Proceedings of the First Annual IOOS Implementation Conference
2.2 Regional Development Recommendations (FY 05 – 06)

The IOOS must evolve to meet the data and information needs of private and public sectors on state, regional, and federal levels. Thus, it is generally recognized that the IOOS must develop a hierarchy of observations, data management and analysis on global to local scales. To these ends, a national consensus has been achieved to establish (1) RAs that meet established federal criteria for governance and operations to develop RCOOSs employing IOOS design principles and (2) an NFRA to coordinate the development of RCOOSs nationwide and represent regional user needs at the federal level.

The recommendations below are considered to be of the highest priority by conferees. Recommended funding levels are given in Table 5.

Table 5. Recommended funding levels to establish RAs in eleven regions, create the NFRA, coordinate regional DMAC development with the national effort, and fund one pilot project in each region.

<table>
<thead>
<tr>
<th>Funding Category</th>
<th>FY 2005</th>
<th>FY 2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional Associations (11 regions)</td>
<td>$ 5.5 M</td>
<td>$ 5.5 M</td>
</tr>
<tr>
<td>National Federation of Regional Associations</td>
<td>$ 0.5 M</td>
<td>$ 0.5 M</td>
</tr>
<tr>
<td>Regional DMAC (11 regions)</td>
<td>$ 1.1 M</td>
<td>$ 2.2 M</td>
</tr>
<tr>
<td>Regional Pilot Projects (11 regions)</td>
<td>$ 2.0 M</td>
<td>$ 3.5 M</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$ 9.1 M</td>
<td>$11.7 M</td>
</tr>
</tbody>
</table>

- Priority 1 – Fund RAs and NFRA sufficiently
- Priority 2 – Fund necessary DMAC activities needed to support regional IOOS activities

This is the highest priority for the regional effort and should be funded preferentially over other high priority regional requests. It is critical that the RAs and the NFRA are able to initiate and complete the substantial efforts involved in meeting the criteria for RA certification, including the engagement of user groups from both private and public sectors in the design, implementation, operation, and improvement of RCOOSs. Present levels of funding ($100K per region per year) will not permit success given the extensive outreach, economic analysis, and assessments of data and information needs of user groups that must be carried out to become a certified RA. Requested funding ($500K per region per year) provides the minimum resources necessary to allow successful attainment of these objectives by FY 07.

- Priority 3 – Fund Regional Pilot Projects

Conferees recommended that funds be provided to allow all regions to initiate pilot projects in their regions ($500K per region per year). Given the diversity of needs and capabilities across regions, participants further recommended that the results from ongoing NOPP-funded socio-economic analyses (that are specific to regions and economic sectors) be used to guide their selection and design. Such pilot projects provide the mechanism to entrain private sector data users and data product suppliers, provide opportunities to showcase successes to build regional and national constituencies using the NFRA infrastructure, and provide a mechanism to begin the development of new technologies necessary to address regional RCOOS needs and share these successes throughout the RA assemblage.

2.3 Priorities for Enhancing the Observing Subsystem of the National Coastal Backbone of the IOOS

Since the initial observing subsystem is to be built using existing assets, working group recommendations for the observing subsystem focused on enhancements in FY 07 and beyond. Enhancements using existing operational capabilities are summarized in section 2.3.1, and those that require research and development are summarized in sections 2.3.2 and 2.3.3. Research and development includes recommended priorities that have already been funded, as well as priorities that may be funded in FY 05 or 06. Recommendations that called for integrating data streams from various sources (e.g., in situ and remote sensing; NOAA and USGS tide gauges) are addressed as part of the DMAC recommendations.

In one form or another, most, but not all, recommendations of the working groups are listed below. Similar or complementary recommendations were consolidated. The resulting set of recommendations are consistent with the results of the 2002 Ocean.US IOOS Workshop (Airlie House) and recommendations of nascent RAs made to Ocean.US prior to the Conference. A complete list of recommendations from the conference is available on request.
2.3.1 Pre-Operational and Operational Elements

A high priority for enhancing the initial IOOS is to begin addressing the problem of under-sampling in space-time of the core variables. The following recommendations of enhancements were made with the understanding that under sampling will remain a chronic problem but that steps must be taken to reduce the magnitude of the problem and improve the accuracy of field estimates and model predictions. As a group, the recommendations emphasize non-biogeochemical variables, underscoring the need for research to develop in situ sensing of biological and chemical variables.

Begin to address the problem of under-sampling core variables in time and space.

• Forcings

Sea surface wind and barometric pressure fields and land-based inputs are important drivers of change in coastal marine and estuarine ecosystems. Thus, increasing the density and continuity of these observations is a high priority as follows:

Winds – NOAA should increase the density of meteorological measurements of the oceans by supplementing the current National Data Buoy Center (NDBC) network with additional instrumented buoys and automated meteorological measurements on Voluntary Observing Ships (VOS).

Transports from land to sea – USGS should maintain the current stream flow and water chemistry monitoring network and increase the number of streams monitored.

• System Dynamics

Timely detection and predictions of changes in the physical environment (water column and benthos) and biologically structured habitats (sea grass beds, coral reefs, etc.) are critical to achieving the seven IOOS goals. In this context, recommendations focused on improving current observational programs as follows:

Current fields – Expand the use of cables to monitor boundary currents and associated transports of heat and water, and make use of data not usually used for this purpose, e.g., USCG Global Positioning System (GPS) equipped Self Locating Datum Marking Buoy used for search and rescue.

Waves, water level, and storm surge flooding – Increase the NDBC observing network for near shore measurements of wave spectrum, height, period, and direction; expand National Water Level Observation Network (NWLon) and increase the number of gauges reporting in real-time.

Sea ice – Maintain current Synthetic Aperture Radar (SAR) capabilities and establish in situ calibration and validation program; expand VOS Bering Sea ice edge observations; include RADARSAT Geophysical Processing System (RGPS) arctic “snapshots” in National Ice Center products.

Living marine resources – Implement adaptive sampling as part of living marine resource (LMR) surveys.

Begin to address the problem of under-sampling the core variables.

In situ observations – Instrument platforms (NDBC buoys, Physical Oceanographic Real-Time System [PORTS], International Arctic Buoy Network, additional moorings, AUVs) with oceanographic sensors (temperature, salinity, currents, dissolved oxygen, nutrients, bio-optical properties).

2.3.2 Research and Pilot Projects: Targeted Elements

Conference recommendations fall into two general categories: research and pilot projects (collectively called R&D) that target specific elements of the observing subsystem, and those that target end-to-end, product-driven development. The former are given here.

A total of 95 recommendations were received from five working groups. Most of these fall into one of the following categories: (1) waves and water level, (2) ice, (3) in situ sensors for real-time measurements of key biological and chemical variables, (4) LMR and ecosystem surveys, (5) development of remote sensing capabilities for coastal marine systems, and (6) in situ sampling.

In addition to the recommendations summarized below, one group recommended that the list of core variables be reviewed and the list updated based on new knowledge and technical capabilities. This should be done after the coastal component has been in operation for three to five years.

• Waves and water level: Surface wave fields and water level, especially nearshore, are a high priority for the IOOS.

Wave fields – Improve estimates of wave fields through development of sensors, satellite remote sensing of waves, enhanced internal wave structure measurements, vertical integration of observations, and increases in the density of in situ measurements for calibration and validation of wave models in complex (nearshore) regions and for “run-up” models.

Water level – Develop new sensor technologies, including the use of Light Detection and Ranging (LIDAR) technology to estimate water and flood water levels in nearshore environments.
• Ice: Knowledge of changing distributions, age, and condition of sea ice is important for all ship-based activities, for assessing and predicting coastal erosion, and as a habitat for many important species, including endangered and threatened species of marine mammals.

**Ice distribution, thickness, and volume** – Develop HF radar ice observations near shore and satellite-based sensors for estimating sea ice age and thickness; explore airborne and underwater long term ice thickness measuring technologies; and improve data telemetry by transitioning some International Arctic Buoy Program (IABP) buoys from ARGOS to IRIDIUM.

• **In situ** sensors for real-time measurements of key biological and chemical variables: An important objective for sustaining healthy ecosystems and LMRs is to develop the capacity to represent the state of the coastal ocean through repeated 3-dimensional representations of the distributions of dissolved $O_2$, $pCO_2$, pH (or alkalinity), and dissolved inorganic nutrients (N, P, and Si), as well as temperature, salinity, and currents.

**Sensor development** – Increase the longevity of **in situ** sensor performance by addressing biofouling, increase the density of observations by making them adaptable to a variety of platforms, and increase intercomparability by establishing reference and calibration standards.

• LMR and ecosystem surveys: Managing water quality and LMRs in an ecosystem context (ecosystem-based, adaptive management) will be enabled through timely characterizations and assessments of LMRs and the ecosystems upon which they depend. More rapid detection and timely predictions of changes in environmental parameters and LMRs depend on the creative use of existing technologies (e.g., LIDAR, acoustic sensors) and development of new technologies for the following:

**Benthic habitat mapping** – Develop functional habitat characteristics (priority on the shoreline to 30 m), and conduct repeated surveys of the distribution and condition of habitat types both nearshore (0-30 m annually) and across the U.S. Exclusive Economic Zone (five- to ten-year intervals).

**Water quality** – Monitor and assess point and non-point source pollutant inputs and their ecosystem impacts in terms of accumulations of phytoplankton biomass, depletion of dissolved oxygen, harmful algal blooms (HABs), and reductions in water clarity.

**Species diversity** – Develop and implement high resolution biological characterizations of species populations (diversity) linked to the distribution and condition of benthic habitats and changes in hydrography (modeled and observed). This should include invasive species, HABs, and pathogens, as well as LMRs.

**Stock assessments** – Improve the scope, precision and timeliness of LMR assessments, including implementing adaptive sampling for LMR surveys. Monitor the distribution and intensity of fishing effort remotely.

• Develop remote sensing capabilities for coastal marine systems: Spatially synoptic, remote measurements of core variables are particularly important in dynamic coastal waters. Developing operational capabilities for coastal systems in general and for purposes of ecosystem-based management should be a high priority.

**Satellites** – Develop new satellite missions and sensors for chlorophyll, pigment groups, and carbon proxies, and maintain current Synthetic Aperture Radar satellite (SAR) capabilities. Explore alternative high-resolution remote sensing technologies.

• **In situ** sampling: The ability to detect and predict changes below the surface and to provide data for calibrating and validating remote sensing is critically dependent on **in situ** observations.

**Glider technologies** – Use unmanned vehicles equipped with Acoustic Doppler Current Profilers (ADCPs) and conductivity, temperature, depth sensors to constrain circulation models. As sensors are developed for measuring dissolved oxygen, nutrients, phytoplankton species and biomass, and zooplankton abundance, ensure that they are compatible with gliders and other **in situ** platforms.

**Adaptive sampling** – Establish sentinel stations and areas to support model and other needs relevant to nutrients.

### 2.3.3 Research and Pilot Projects: End-to-End

Most of the recommendations for pilot projects that include all three subsystems (observations to products) fall into one of the following categories: (1) global, mesoscale nowcasts and short-range upper ocean forecasts; (2) surface current mapping, and (3) modeling.

In addition to the recommendations below, it was recommended that National Estuarine Research Reserves (NERR), National Marine Sanctuaries (NMS), National Estuarine Programs, Long-Term Ecological Research (LTER) sites, and National Association of Marine Laboratories (NAML) sites be used as test beds for pilot projects.
• Global, mesoscale nowcasts and short-range upper ocean forecasts

The vision behind IOOS is that societal and economic benefits of ocean research and observations cannot be realized without implementing a global system of observations, data telemetry, data assimilation, and modeling that will deliver regular, comprehensive information on the state of the oceans for the maximum benefit of society. The following recommendations do not cover the range of required research and development that are needed to meet the vision but, in the context of the conference, provide some insights to the issue of ice area forecasts:

Weather and climate – Improve extreme event and seasonal to interannual forecasts and continue The Observing System Research and Predictability Experiment (THORPEX) for improved weather forecasts.

Ice – Perform an operational test of the Polar Ice Prediction System (PIPS) 3.0. By 2014, transition the ice forecast product to operational status.

• Surface current mapping

Surface currents are a highly ranked core variable. Surface current maps are derived from HF radar networks in coastal waters with appropriate in situ sampling for calibration. Farther offshore, surface current mapping can be achieved through a combination of feature tracking and altimetry techniques, with calibration provided by traditional techniques such as in situ current measurements and hydrographic observations. Developing the capacity to serve surface current maps based on integrated remote and in situ data streams is a high priority for IOOS development. In this context, working groups offered the following specific recommendations:

Data transport and surface current mapping – Test delivery of real time currents and related environmental data to end users via USCG Automated Identification System (AIS).

Trajectory forecasting – Develop trajectory mapping tools to permit the use of general circulation models in search and rescue, oil spill, and HAB predictions.

Data fusion – Integrate data from different current mapping technologies.

• Modeling

The development of a fully integrated observing system will require a strong and ongoing interaction between observations and modeling. Model recommendations fall into four categories: coupled physical models, sediment transport, ice models, and biogeochemical models. Breakout groups calling for coupled physical models and biogeochemical (water quality) models recognized the need for coastal Global Ocean Data Assimilation Experiment (GODAE)-type projects in these areas and made this a high priority.

Coupled Physical Models – Utilize advanced data assimilation, including GODAE and data assimilating models, for cross-cutting pilot projects [e.g. improve hazardous materials (HAZMAT) spill response models and models of extreme water level changes] and tidal resolving models focusing on coastal regions of complex physical oceanography. Address the following aspects of coupled models: local to offshore models for winds, waves and currents; ocean models with embayment/river models; waves to storm surge models; influence of bottom type on wave propagation; wave to wind fields; and lake/atmosphere/ice circulation models for the Great Lakes (including operational evaluation of the latter). Perform an operational evaluation of the coupled ocean/atmosphere/ice model.

Sediment transport models – Enhance regional sediment transport models to quantify sediment budget predictions of coastal erosion through improved observations using both aircraft- and satellite-based LIDAR technology with hyperspectral technologies to provide new mapping products for hydrographers, coastal engineers and resource managers, scientists, and other decision makers.

Biogeochemical models – Promote continued development of the USGS continental 4-dimensional representation of flow and nutrient flux, e.g., Spatially Referenced Regressions on Watershed Attributes (SPARROW) in nationwide watersheds. Develop models that incorporate higher trophic levels (large pelagic and benthic animals). Use models (e.g., Oriented Scintillation Spectrometer Experiments [OSSEs]) to evaluate spatial and temporal sampling to optimize observing subsystem capabilities. Operationalize research models, developed through research programs such as Global Ocean Ecosystems Dynamics (GLOBEC) and Land-Ocean Interactions in the Coastal Zone (LOICZ), by implementing GODAE-type projects. Develop regional coupled physical-biogeochemical models that are supported by IOOS data.
3. Federal Response

Representatives of participating NOPP agencies considered recommendations for DMAC (section 2.1) and regional development (section 2.2) and agreed to the following declaration on day three of the conference:

“We [the federal agencies] appreciate the work done by the conference attendees to formulate a clear set of consensus priorities for FY 05-06 actions and associated recommended funding. We view the priorities in the context of both maintaining current IOOS activities (including observing systems, data systems, and product-generating/delivery systems), and integrating these activities into a national backbone consistent with the Annual IOOS Development Plan in particular and with the Interagency Working Group on Earth Observations (IWGEO) 10-year plan for GEOSS development in general.

1) We accept the stated priorities [(1) development of RAs and the NFRA, (2) DMAC, both nationally and regionally, and (3) Regional Pilot Projects]. Although each agency may reorder these three priorities to meet its own mission constraints, the interagency consensus is to accept the priorities as given.

2) Pending appropriations for FY 05-06, we cannot yet make detailed commitments.

3) To the extent our FY 05-06 budgets and flexibility allow, we will use these priorities to guide our investment strategies.

4) We are constructing an interagency funding agreement, in which we expect all the agencies to make their best effort to participate, but not all agencies will necessarily commit to each priority topic, and the bottom line may not cover the recommended funding.

5) We are committed to using recommendations for FY 07 and beyond to help guide agency-specific program development that will contribute to the establishment of both global and coastal components of the IOOS.”

The federal response to recommendations for the national backbone (section 2.3) has yet to be prepared. These recommendations were not available on day three, but were circulated to all participants within ten days of the conclusion of the conference.
For each category, conferees were asked to formulate recommendations that address development of all three subsystems (observations and data telemetry, data management and communications, and modeling) through incorporation of existing operational assets and/or through research and development to improve operational capabilities. Product categories used to guide conferees in the formulation of prioritized IOOS implementation plans for the near term (the initial system using existing assets, FY 05-06) and the longer term (enhancing the initial system, FY 07-14) are given in the table below.

<table>
<thead>
<tr>
<th>Product Category</th>
<th>Major Societal Goal Addressed</th>
<th>Examples of Potential Benefit Areas</th>
</tr>
</thead>
</table>
| Water Level and Surface Current and Wave Fields | Climate Change, Natural Hazards, Maritime Operations, National Security, Public Health Risks, Healthy Marine Ecosystems, Sustaining Living Marine Resources | • Search and rescue  
• Ship traffic and routing  
• Coastal erosion  
• Beach swimming safety forecasts  
• Beach re-nourishment planning  
• Coastal storm surge flooding  
• Fisheries habitat management  
• Aquaculture siting/permitting |
| Sea Ice Distribution, Volume and Age | Climate Change, Maritime Operations, National Security, Healthy Marine Ecosystems, Sustaining Living Marine Resources | • Maritime hazards forecasts  
• Search and rescue  
• Coastal erosion  
• Sustainable fisheries  
• Marine mammal survival |
| 3-D fields of dissolved N, Chl, O$_2$, and pCO$_2$ | Climate Change, Public Health Risks, Healthy Marine Ecosystems, Sustaining Living Marine Resources | • Global carbon budgets  
• Beach closures  
• Harmful algal blooms  
• Hypoxia/anoxia  
• Biodiversity  
• Sustainable fisheries  
• Aquaculture siting and operations |
| Spatial Extent and Condition of Essential Habitats for Living Marine Resources | Climate Change, Maritime Operations, Public Health Risks, Healthy Marine Ecosystems, Sustaining Living Marine Resources | • Critical habitat mapping  
• Biodiversity  
• Exposure to marine toxins  
• Recruitment  
• Sustainable fisheries |

These areas were chosen because they (1) are important to one or more of the seven societal goals of the IOOS; (2) can be improved in both the near-term, through more effective integration of existing observing subsystem assets, and the long-term, through the incorporation of additional existing operational capabilities and/or through research and pilot projects; (3) require both regional and global scale observations; (4) are high priorities in the preliminary draft of the *First Annual IOOS Development Plan*; and (5) encompass a broad spectrum of observing capabilities that will be needed to achieve all seven goals. These could be viewed as the seeds that will grow into the fully integrated system over time.

3. [http://dmac.ocean.us/dacsc/imp_plan.jsp](http://dmac.ocean.us/dacsc/imp_plan.jsp)

Summary of regional priorities for the operational, national backbone of the coastal component (long range (LR) HF radar and bathymetric (Bathy) – topographic (Topo) surveys of the near shore coastal zone). These capabilities are high priorities of the regions for incorporation into the operational backbone as they meet operational criteria over the next five years.

<table>
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<tr>
<th>Region</th>
<th>Data Buys</th>
<th>NWLON</th>
<th>CMAN</th>
<th>LR, HF Radar</th>
<th>NASQAN</th>
<th>Bathy-Topo, Shoreline position</th>
<th>Integrative Models</th>
<th>Remote Sensing</th>
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<td>8</td>
<td>5</td>
<td>4</td>
<td>8</td>
<td>6</td>
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</tbody>
</table>

* Additional priorities: RADARSAT ice cover, remote sensing-ground truth, Navy submarine access
* Ice capable with solar radiation sensors
* Enhance with sensors for biological and chemical variables
* Includes the Bering Sea
* Additional priorities: Status of fish stocks and ecosystems
* Additional priorities: Biological surveys, stream sampling and gauging, sea level sites, HAB identification, sensor technology
* Additional priorities: Offshore telemetry, more in situ observations (ship surveys, gliders), California Cooperative Fisheries Investigations (CALCOFI), AUVs, drifters, and floats
* Enhance to measure more variables
* Additional priorities: Buoy for nearshore transport and fate of pollutants and sediments; monitor ship traffic and offshore hazards, biological sampling, glider fleets
* Additional priorities: Wave direction, visibility, ecosystem observations, HABSOS support, sentinel stations
* Additional priorities: fleet renewal
* Additional priorities: Improve National Centers for Environmental Prediction (NCEP) forecasts; new coastal satellite
* Additional priorities: interconnected waterway sampling; flow metering, and enhanced remote sensing

Federal agencies participating in the conference and whose representatives agreed to the declaration were as follows: NOAA, Navy, NSF, NASA, USACE, USGS, MMS, USCG, and EPA.
Appendices
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APPENDIX II

Integrated Ocean Observing System (IOOS)
First Annual Implementation Conference
31 August - 2 September 2004
Holiday Inn Rosslyn, Arlington, VA

Tuesday, August 31, 2004

0730 – 0830  Continental Breakfast
0800 – 0830  Registration
0830 – 1200  Plenary I: Overview, Goals, and Procedures
  0830 – 0930  Overview of the IOOS and the preliminary Development Plan, conference goals, procedures, and deliverables (Tom Malone)
  0930 – 1030  Agency Perspectives (Ocean.US Executive Committee (EXCOM) members, five minutes each) (led by EXCOM Chair or designee)
1030 – 1035  Form small groups (three to four people) to discuss and agree on the following (Dick McCaffery):
  (1)  Overall, are you comfortable with the preliminary draft of the First Annual IOOS Development Plan?
  (2)  Do you have particular issues or concerns that you would like to have clarified? If so, what are they (maximum of two)?

  [This will be a “self organizing” activity, with each group including at least one person from a federal agency and one person from a region. Each group will be asked to report back in plenary on one to two issues. All of these will be recorded for the Conference report.]

1035 – 1045  BREAK/Registration
1045 – 1100  Small group caucuses to address questions (1) and (2) above
1100 – 1200  Brief reports from groups and panel-led discussion to clarify issues related to IOOS development and to determine if there are common themes that can be used to improve the IOOS Development Plan and, if appropriate to the topic, can be addressed in subsequent sessions (led by EXCOM Chair or designee)

1200 – 1300  LUNCH

  Working lunch for Chairs, Co-Chairs, and Rapporteurs of sessions scheduled on days one and two (Tom Malone and Dick McCaffery)

1300 – 1500  Plenary II: Regional Development

  Overview of Regional Association (RA) and Regional Coastal Ocean Observing System (RCOOS) development, including the rationale for federal investment in their establishment and sustained operation; current status of RA and National Federation of Regional Association (NFRA) development, the establishment of RCOOSs, and next steps. (David Martin, Chair NFRA Organizing Committee)

  Recommend actions needed to be eligible for certification as an RA and the process for certification with estimated costs (FY 05-06); recommend actions needed to establish the NFRA (Discussion led by Dick McCaffery)

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1 The Ocean.US Executive Committee, Director of Ocean.US, and Chair of the NFRA Organizing Committee will constitute the panel.
1500 – 1530 BREAK

1530 – 1730 Plenary III: Data Management and Communications (DMAC)

Overview of the DMAC Plan, key issues, and opportunities (including recommended next steps for developing DMAC capabilities) (Lee Dantzler and Steve Hankin)

Data management intersects almost all aspects of IOOS. Ocean.US will provide an overview of the DMAC Plan, key issues, and opportunities for moving forward, as well as planned DMAC activities. The goal of the subsequent discussion will be to help ensure that a common view of DMAC considerations is incorporated into the breakout discussions. Recommendations will be solicited from the workshop participants regarding forthcoming IOOS DMAC “best practices” and standards development activities, and to help ensure that the key issues and priorities have been identified.

1800 – 2000 RECEPTION (Vantage Point Restaurant and Lounge, Holiday Inn Rosslyn)

Wednesday, September 1, 2004

0700 – 0800 Continental Breakfast

0800 – 0900 Plenary IV: The Global Ocean-Climate Component

Review of the global plan, the status of implementation, and future developments (Chet Koblinsky)

0900 – 1000 Plenary V: Product-Driven, Prioritized, Phased Implementation

Review charge to Working Groups (WGs) and procedures for formulating a prioritized, phased implementation plan for developing an integrated system that will deliver new or improved products (Tom Malone and Dick McCaffery)

1000 – 1030 BREAK

1030 – 1200 Breakout Session

Five groups work in parallel (each group with co-Chairs from a federal agency and a regional group, and a rapporteur). One WG will work on establishing priorities for coordinated development of the global and coastal components of the IOOS.\(^2\) Four WGs will focus on product-driven implementation plans (see “Guidance for Product-Driven Working Groups”) as follows:

1. Coordinated development of the global and coastal components
2. Water Level, Surface Current, and Wave Fields
3. Distribution and Volume of Sea Ice
4. 3-Dimensional fields of dissolved inorganic nitrogen, chlorophyll-a, dissolved O\(_2\), and pCO\(_2\)
5. Spatial extent and condition of essential habitats for living marine resources (e.g., coral reefs, oyster reefs, sea grass beds, kelp beds, tidal marshes, and mangrove forests)

1200 – 1300 LUNCH

1300 – 1500 Breakout Session (continued)

1500 – 1530 BREAK

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\(^2\) Discuss the interdependencies of the global and coastal components, and formulate recommendations for coordinated development of an IOOS in which the coastal component meets requirements of the global component and vice versa (FY 05 – 14).
1530 – 1700  Plenary VI: Working Group Results

Reports from WG chairs (short-term and long-term priorities for implementation and development) followed by a comment session for the record.\(^3\) Rapporteurs deliver completed work sheets from each WG to Kristine Stump no later than 1700.

Thursday, September 2, 2004

Meeting of Federal Agencies with Ocean.US

Given recommendations from days one to two and the preliminary IOOS Development Plan, agree on the following:

1. Potential agency roles and responsibilities for IOOS implementation (for subsequent vetting by the agencies following the conference as described below); and
2. A 30-day action plan for accepting, rejecting, and prioritizing recommendations for implementing the IOOS during FY 05-06 and FY 07-14.

For the coastal component (backbone, RAs) and coordinated development of global and coastal components, the EXCOM leads the following:

1. Discuss intersections with or potential linkage of recommendations from days one and two with current and/or planned agency programs;
2. Identify major problems and inconsistencies in these recommendations; and
3. Agree on a 30-day schedule for each agency to answer the following questions for each set of recommendations in the categories of “national backbone,” RAs and global-coastal coordination:
   
   a. Is the recommendation a high, medium, or low priority for your agency to implement? If high or medium, indicate when implementation should begin (FY 05-06 or FY 07-14).
   b. In terms of the seven IOOS goals in general, should the recommendation be a high, medium, or low priority for IOOS implementation?
   c. For (a) and (b) above, should your agency be the lead agency for implementation? If interagency collaboration is needed, which agencies should be involved and how will this be accomplished?
   d. Given (a), (b), and (c) above, which recommendations (or elements thereof) is your agency willing to commit to and fund? What are your agency’s priorities, and which can be committed to in FY 05-06 or FY 07-14? What conditions must be met, and what issues must be addressed for implementation to occur?

Results of days one and two of the workshop and agency responses to these questions will be used by Ocean.US to revise the preliminary IOOS Development Plan for public comment. Based on these comments, a final, EXCOM-approved draft will be prepared for transmission to the National Ocean Research Leadership Council (NORLC).

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\(^3\) The comment period is intended to give everyone an opportunity to express a point (pro or con) for the record. This may include questions for clarification, issues of concern, statements of support, etc. The purpose is to listen, not to debate.
APPENDIX III

1st Annual IOOS Implementation Conference

Small Group Feedback

On day one of the conference, participants were asked to form small groups of three to four conferees (13 groups) to discuss and agree on the following: (1) Overall, are you comfortable with the preliminary draft of the First Annual IOOS Development Plan? (2) Do you have particular issues or concerns that you would like to have clarified? If so, what are they (maximum of two)? Each group reported back in a discussion led by the Ocean.US Executive Committee to clarify issues related to IOOS development and to determine if there are common themes that can be used to help guide preparation of the First Annual IOOS Development Plan and, if appropriate to the topic, can be addressed in subsequent sessions. Many of these comments were concerned primarily with the plan itself. A summary of all comments is given below.

Common Themes

1. Users, products, and modeling
   1.1 Put into place a system that meets a set of requirements for an end-to-end system.
   As the Development Plan currently reads, there are no metrics to determine whether or not user needs are met, and these are needed in order to justify additional resources. Performance metrics for near-term successes should be included.
   1.2 Correct the lack of specificity in identifying user groups.
   The user community is not visible enough. Engage non-traditional users. Convene a user forum to gather direct input on needs.
   1.3 Identify, via marketing and socioeconomic analysis, which user groups to engage first, given limited resources.
   1.4 Link data providers to data users for success in an end-to-end system.
   1.5 Add a section describing methods to integrate the private sector.
   The IOOS Development Plan is very top-down. Look to the data management and communications (DMAC) Plan as a model for how this recommendation could be accomplished.
   1.6 Use model requirements to drive development of observing and DMAC subsystems.
   1.7 Identify what data is being collected, what models exist, and what products are being produced by IOOS.
   It is important to identify products that will keep the observing system sustained and that will maintain the interest of the agencies. Research will also develop new products. Add a section on “Data Products,” where they are defined and examples are given.
   1.8 Be more specific in the Executive Summary.
   The Executive Summary is fairly vague and “researchy,” with no evidence that IOOS is provided for user groups. There is no discussion of data products, which are of interest to many audiences. The Executive Summary needs objectives/milestones with responsible parties and timelines; otherwise, there is no accountability.
   1.9 Link the eight climate-based elements listed in the Executive Summary to the seven societal goals.

2. Research to Operations
   2.1 The process and description of the transition from research to operations should be more developed.
   This section should include mechanisms to facilitate these transitions, especially in the modeling community. The development plan should outline when programs are in each stage.
   2.2 In the context of the transition from research to operations, identify mechanisms for connecting modeling to data collection, and link modelers to data collectors.
   2.3 Include regional guidance to federal agencies for the development of the backbone (e.g., location and density of National Data Buoy Center buoys).
   2.4 Delineate mechanisms for transfer of new technology and knowledge between regions (process and funding).
   2.5 Describe the roles of user groups other than academic and federal research communities.

3. Priorities and Timelines for Phased Implementation
   3.1 Part II needs more focused objectives and priorities.
   To set these priorities, identify specific products needed from users. Look to the global community as an example of how do accomplish this task.
   3.2 Use Research to Operations recommendations to create prioritized timelines.
4. Establishing Regional Associations (RAs)
   4.1 Facilitate more dialogue between regional groups and federal headquarters.
   4.2 Increase funding level per RA for institutionalizing and capitalizing RAs and Regional Coastal Ocean Observing Systems (RCOOSs).
       Explain how the integration of existing systems will occur with regard to funding.
   4.3 Clarify the role of RAs in DMAC.
   4.4 Ensure that the Development Plan contains accurate representation of RAs, including those that are not adjacent to the coastline of the contiguous U.S., and mechanisms for working with international groups.

5. Other
   5.1 Define “integrated” and a measure for achieving it.
   5.2 Enhance biological components.
   5.3 Strengthen remote sensing recommendations, particularly ocean color.
   5.4 Include mechanisms for interagency collaboration at state and local levels.
   5.5 Develop priorities for DMAC development.
   5.6 Address dissolved oxygen in Part II.
       Oxygen is critical to eutrophication/hypoxia issues that are affecting the nation from coast to coast. We have the technology to do this with some limitations, but these are no worse than chlorophyll. Oxygen should be specifically mentioned as a high priority for early implementation of the Development Plan.
   5.7 Evaluate the location of the existing in situ platforms to ensure that they are best located to meet IOOS needs.
### APPENDIX IV

**Table A.** Summary of DMAC priorities and cost estimates (x $1,000) for FY2005-2006, as recommended in May 2004 DMAC Plan.

<table>
<thead>
<tr>
<th>DMAC Function</th>
<th>Outcomes</th>
<th>Activities</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interoperability Framework</strong></td>
<td></td>
<td></td>
<td>FY 2005</td>
</tr>
</tbody>
</table>
| Program Management Activities | Effective system planning and coordination                              | • Engage services of software engineer to prepare documents  
• Appoint DMAC Standing Committee  
• Establish DMAC implementation strategy and oversight function                                                                                                                                                                                                                           | $36    | $72     |
| Metadata/Data Discovery       | Interim metadata standards  
Initial catalog services                                                   | • Convene community-based metadata working group                                                                                                                                                                                                                                                                                           |        |        |
|                               | Initial data discovery services                                          | • Convene community-based data discovery working group.  
• Testbed to develop distributed search capability                                                                                                                                                                                                                                                                                           | [$335+] | $271    |
| Applied R&D (enhancement) activity | Bi-directional linkages between data discovery, data transport, on-line browse |                                                                                                                                                                                                                                                                                                                                          |        |        |
| Data Archive and Access       | Framework for cooperation among Archive Centers                          | • Convene a community-based working group of archive center representatives to id IOOS partner organizations that will provide archive services.  
• Framework to inventory & assess state of marine data archives                                                                                                                                                                                                                                                                           | $235   | $335    |
|                               | IOOS Archive Centers demonstrate capability to provide DMAC data discovery and transport services | • NODC pilot projects using DMAC standards for NRT and RT data sets  
• Pilot projects to modernize access to data sets delivered in real time.                                                                                                                                                                                                                                                                                     |        |        |
| Data Transport                | Semantic data model                                                      | • Convene community-based expert working group                                                                                                                                                                                                                                                                                           |        |        |
|                               | Infrastructure component development for common standards with spatial data (GIS) and biological data provider/user communities | • Convene community-based working group with key expertise in Open GIS Consortium and OBIS                                                                                                                                                                                                                                               | $450   | $348    |
| **TOTAL**                     |                                                                          |                                                                                                                                                                                                                                                                                                                                          | $721   | $1026   |

*a. A proposal has been submitted to NSF and SURA that is likely to be funded, so this amount has been deducted from the total.*
Table B. Summary of DMAC guidance to the NOPP Agencies and RAs for FY 05-06, as recommended in the May 2004 DMAC Plan.\(^a\),\(^b\)

<table>
<thead>
<tr>
<th>DMAC Function</th>
<th>Activities</th>
<th>Cost Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interoperability framework</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Metadata/Data Discovery                     | - Create and publish FGDC compliant metadata  
- Submit metadata to GCMD and NCDDC  
- Participate in DMAC Metadata Working Group                                                                                                     |                |
| Archive and Access                         | - Ensure all irreplaceable data in current/historical holdings have permanent archive  
- Convene expert working group to determine best methods to enable national archives as “users” of IOOS generated data (see related task under core activities).  
- Make arrangements for permanent archive of all future IOOS irreplaceable data for which organization is responsible |                |
| Data Transport and On-line Data Exploration and Navigation | - Install servers to provide data access using OPeNDAP  
- Continue enterprise GIS solutions (IOOS will develop gateways).  
- Participate in DMAC Data Transport Working Group (semantic data modeling)  
- Install Live Access Server and notify DMAC.                                                                                                      |                |
| **Design and Demonstration**               |                                                                                                                                                                                                          |
| Interoperability/integration               | - Pilot projects to establish interoperability between selected IOOS observing systems, partners, and regional entities.                                                                                |                |

\(^a\) Data providers should first select an approach for managing IOOS data: either delegate responsibility to another entity (i.e., agreement with NDBC to QC and distribute mooring data in DMAC compliant manner); or manage data internally in DMAC-compliant manner.

\(^b\) Cost estimates are not available for these activities.

Table C. Summary of DMAC program initiation activities and cost estimates (x $1,000) in FY 07 (Year N) as recommended in the May 2004 DMAC Plan.

<table>
<thead>
<tr>
<th>DMAC Functions</th>
<th>Activities*</th>
<th>Cost Estimates Yr N</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interoperability framework</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Program Management Activities</td>
<td></td>
<td>$726</td>
</tr>
</tbody>
</table>
| Metadata and Data Discovery     | - Determine metadata content and format standards  
- Develop tools and procedures to support metadata providers  
- Discovery: Select/develop and maintain catalog and search capability  
- Discovery: Design discovery Portal  
- Discovery: Design and implement data location service | $2,480              |
| Data Archive and Access         | - Current archive & access assessment  
- Determine dataset priorities for all IOOS data disciplines  
- Determine IOOS dataset categorization  
- Recruit centers for IOOS Archive System and form partnerships  
- Develop archive critical metadata  
- Define IOOS archive and access data policy  
- Establish IOOS data stream developers guidelines  
- Develop Archive System data discovery interfaces  
- Receive and provide more data in real time  
- Broaden base for user services  
- Establish procedures to document the archive System Metrics  
- Procedure to resolve data retention issues  
- Write plan for archive & access security | $1,612              |
<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
</table>
| **Data Transport** | - Develop comprehensive IOOS data model(s)  
- Deliver time critical (real time) data to Data Assembly and Operation Modeling  
- Develop DMAC middleware  
- Make data available using IOOS middleware solution  
- Develop metric and implement performance monitoring  
- Implement middleware security  
- Provide guaranteed geo-temporally-referenced browse for all IOOS data  
- Aggregation of unstructured data (e.g., vector, point, sequence, profile)  
- OPeNDAP-GIS client and GIS-OPeNDAP server | $2,234 |

| Subtotal | $7,052 |

**Interoperability infrastructure**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
</table>
| Communication/Infrastructure | - Includes communications hardware at ~10 sites that contribute to essential DMAC infrastructure (i.e., archive centers and primary data assembly centers)  
- Communications lease for entire infrastructure | $1,460 |
| Servers at Centers | - Servers at ~10 sites, including hardware and software, and hardware maintenance after year of installation. | $2,400 |
| Engineering/Integration | - Coordinate and manage the total hardware, software, and infrastructure definition, design, procurement, installation, integration, and maintenance.  
- Oversee Capacity Building, the effort in providing labor and services to data providers to enable them to reach and maintain the level at which they can participate. | $3,000 |

| Subtotal | $6,860 |

**Design and Demonstration**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Discovery</td>
<td></td>
<td>$1,000</td>
</tr>
<tr>
<td>Access/Infrastructure</td>
<td></td>
<td>$500</td>
</tr>
<tr>
<td>Data Transport</td>
<td></td>
<td>$1,000</td>
</tr>
<tr>
<td>Archive</td>
<td></td>
<td>$500</td>
</tr>
<tr>
<td>Information Assurance</td>
<td></td>
<td>$500</td>
</tr>
<tr>
<td>Innovative Architectures</td>
<td></td>
<td>$300</td>
</tr>
</tbody>
</table>

**Pilot Projects (see DMAC Plan)**

| Subtotal | $3,800 |

**Total** | **$17,712**

*Note that some of these activities may be initiated in FY2005/2006, and most are multi-year.*

*This estimate supports first year implementation costs of program initiation activities.*
# APPENDIX V

## Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADCP</td>
<td>Acoustic Doppler Current Profiler</td>
</tr>
<tr>
<td>AIS</td>
<td>Automated Identification System</td>
</tr>
<tr>
<td>AUV</td>
<td>Autonomous Underwater Vehicle</td>
</tr>
<tr>
<td>DMAC</td>
<td>Data Management and Communications</td>
</tr>
<tr>
<td>EPA</td>
<td>Environmental Protection Agency</td>
</tr>
<tr>
<td>EXCOM</td>
<td>Executive Committee</td>
</tr>
<tr>
<td>FGDC</td>
<td>Federal Geographic Data Committee</td>
</tr>
<tr>
<td>FY</td>
<td>Fiscal Year</td>
</tr>
<tr>
<td>GCMD</td>
<td>Global Change Master Directory</td>
</tr>
<tr>
<td>GEOSS</td>
<td>Global Earth Observing System of Systems</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographical Information Systems</td>
</tr>
<tr>
<td>GLOBEC</td>
<td>Global Ocean Ecosystems Dynamics</td>
</tr>
<tr>
<td>GODAE</td>
<td>Global Ocean Data Assimilation Experiment</td>
</tr>
<tr>
<td>GOOS</td>
<td>Global Ocean Observing System</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
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<tr>
<td>HAB</td>
<td>Harmful Algal Bloom</td>
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<tr>
<td>HAZMAT</td>
<td>Hazardous Materials</td>
</tr>
<tr>
<td>HFR</td>
<td>High Frequency Radar</td>
</tr>
<tr>
<td>IABP</td>
<td>International Arctic Buoy Program</td>
</tr>
<tr>
<td>IOOS</td>
<td>Integrated Ocean Observing System</td>
</tr>
<tr>
<td>IOWG</td>
<td>Implementation Oversight Working Group</td>
</tr>
<tr>
<td>IWGEO</td>
<td>Interagency Working Group on Earth Observations</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>LIDAR</td>
<td>Light Detection and Ranging</td>
</tr>
<tr>
<td>LMR</td>
<td>Living Marine Resources</td>
</tr>
<tr>
<td>LOICZ</td>
<td>Land-Ocean Interactions in the Coastal Zone</td>
</tr>
<tr>
<td>LTER</td>
<td>Long-Term Ecological Research</td>
</tr>
<tr>
<td>MMS</td>
<td>Minerals Management Service</td>
</tr>
<tr>
<td>NAML</td>
<td>National Association of Marine Laboratories</td>
</tr>
<tr>
<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
</tr>
<tr>
<td>NCCDC</td>
<td>National Coastal Data Development Center</td>
</tr>
<tr>
<td>NDBC</td>
<td>National Data Buoy Center</td>
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<tr>
<td>NERR</td>
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<td>NFRA</td>
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<td>National Marine Sanctuaries</td>
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<tr>
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<tr>
<td>NODC</td>
<td>National Oceanographic Data Center</td>
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<td>NOPP</td>
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<td>National Ocean Research Leadership Council</td>
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<tr>
<td>NRT</td>
<td>Near Real-time</td>
</tr>
<tr>
<td>NSF</td>
<td>National Science Foundation</td>
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<td>NWLON</td>
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<tr>
<td>OBIS</td>
<td>Ocean Biogeographic Information System</td>
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<td>OPeNDAP</td>
<td>Open Source Project for 2 Network Data Access Protocol</td>
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<td>Polar Ice Prediction System</td>
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<td>Spatially Referenced Regressions on Watershed Attributes</td>
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