INTRODUCTION

Narrative of An NSF Community-based Interoperability Network Proposal

Titled:

The Integrated Ecosystems Assessment Interoperability Initiative
Bringing Informatics to the Forefront of Science Based Decision Support
Enabling the Assessment of Climate Impacts on Large Marine Ecosystems:

Submitted by:

Network Lead Peter Fox (RPI and WHOI),
with co-conveners

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Until recently, there has been a lack of a successful method to develop, implement, and sustain informatics solutions to modern application problems, such as environmental and climate assessments, that involve very diverse and heterogeneous data and information sources, as well as multi- disciplinary organizations and people.

This paper discusses an approach directed toward applying informatics to enable regional integrated ecosystem assessments in two Large Marine Ecosystems – recognized by NOAA as California Current LME and the Northeast U.S. Continental Shelf LME. (http://www.lme.noaa.gov/)

The initiative outlined in the white paper is strongly motivated by a presidential directive to develop a policy framework for a comprehensive, ecosystem-based approach to ocean resource management that addresses conservation, economic activity, user conflict, and sustainable use.

The goal is to bring ocean informatics to the forefront as an essential tool for implementing this new national policy framework and advancing the capacity for science in support of ecosystem based management, large marine ecosystems, as well as integrated ecosystem assessments.

The objective is to enable routine, integrated ecosystem assessments and forecasts including impacts related to climate change and the capacity to address vulnerability, risks, and resiliency, and to develop an outcome based process that results in informed tradeoffs and priority setting.

Existing data will be leveraged via semantic web technologies to capture knowledge. These technologies can leverage extant vocabularies and data repositories used by the stakeholders and define the meaning of that data by providing language constructs understood by computers that closely reflect how people think and pose questions of the data. Central to the success of this initiative is the commitment to train a new generation of scientists who will learn to interact effectively with this new integrated ecosystem assessment capability

This initiative will deliver a working capability based on the paradigm of the virtual observatory (or laboratory) that integrates heterogeneous data and information collections gathered over the last 40-50 years, with application client software and presented through Web-based means that creates the appearance of all resources being local to the user. This virtual observatory will serve all in the participatory stakeholder groups.

What makes the initiative approach viable, apart from having been applied in 5 other application settings with strong success, is the important confluence of political, agency, science and technical agendas now being focused toward the implementation of ecosystems based management.

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The Integrated Ecosystem Assessment Interoperability Initiative

Enabling the Assessment of Climate Impacts on Large Marine Ecosystems: Bringing Information Science to the Forefront of Science Based Decision Support

A White Paper Outlining a New Collaborative Initiative

Network Lead Peter Fox (RPI and WHOI),
with co-conveners
Andrew Maffei (WHOI)
Jon Hare (NOAA/NMFS) and Phil Levin (NOAA/NMFS)

"The oceans, our coasts, and the Great Lakes provide jobs, food, energy resources, ecological services, recreation, and tourism opportunities, and play critical roles in our Nation's transportation, economy, and trade, as well as the global mobility of our Armed Forces and the maintenance of international peace and security. We have a stewardship responsibility to maintain healthy, resilient, and sustainable oceans, coasts, and Great Lakes resources for the benefit of this and future generations."

Quoted from President Obama's executive order establishing an Interagency Ocean Policy Task Force, June 12, 2009

EXECUTIVE SUMMARY

The impetus for this Integrated Ecosystem Assessment Interoperability Initiative is a presidential directive to develop a policy framework for a comprehensive, integrated, ecosystem-based approach to ocean resource management that addresses conservation, economic activity, user conflict, and sustainable use.

The goal is to bring information science to the forefront as an essential tool for implementing this new national policy framework and advancing the capacity for science in support of Ecosystem Based Management, Large Marine Ecosystems, and Integrated Ecosystem Assessments.

Advancing capacity for the application of science is essential to ensure the long-term preservation of resources and appropriate balance of competitive uses within the ocean. It is also critical to our country's economy, national defense, cultural, and recreational interests.

The objective is to enable routine, integrated ecosystem assessments and forecasts including impacts related to climate change and the capacity to address vulnerability, risks, and resiliency, and to develop an outcome based process that results in informed tradeoffs and priority setting.

This will be achieved through the application of an information science and semantic technology driven methodology developed by Dr. Peter Fox and collaborators at Rensselaer Polytechnic Institute to advance the capacity of an integrated assessment to provide the foundation for synthesis and quantitative analysis of natural and socio-economic ecosystem information to support ecosystem-based management.

This initiative will create the capacity to assess the impacts of changing climate on two large marine ecosystems: the northeast U.S. and the California Current. These assessments will become essential parts of the science-based decision-support tools used to develop adaptive management measures.

Activities and meetings will be organized within the framework of the Federation of Earth Science Information Partners, an 11-year-old, non-profit organization that arose from a National Research Council Decadal Survey in 1995. Central to the success of this initiative is the commitment to train a new generation of scientists who will learn to interact effectively with this new integrated ecosystem assessment capability.

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This initiative will deliver a working capability based on the paradigm of the *virtual observatory (or laboratory)* that integrates heterogeneous data and information collections gathered over the last 40-50 years, with application client software and presented through Web-based means that creates the appearance of all resources being local to the user. This virtual observatory will serve all in the participatory stakeholder groups.

Existing data will be leveraged via semantic web technologies to capture knowledge. These technologies can leverage extant vocabularies and data repositories used by the stakeholders and define the meaning of that data by providing language constructs understood by computers that closely reflect how people think and pose questions of the data.

The success of this initiative will be measured by its effect on advancing the technology *and* increasing interaction among the diverse communities that will drive its development, and use the resulting products. Application-oriented interoperability of distinct, heterogeneous data collections and the social communities that use them *together* will provide the foundation for developing new, integrated, ecosystem-based assessment protocols, which have been determined to be one of the essential science-based, decision-support tools for implementing ecosystem-based management[1].

With an important confluence of political, agency, science and technical agendas toward a coherent and managed approach to ecosystems assessment now apparent, we outline in this white paper an integrated response to the call-to-action. Fundamental and sustained progress is essential. The opportunity exists for an open and collaborative framework in which stakeholders are represented, contributors and beneficiaries are able to participate, and rich scientific data and information resources are unlocked and used in management, assessment and policy applications. Let us begin.

[1] Phillip S Levin, Michael J Fogarty, Steven A Murawski, and David Fluharty, 2009, Integrated Ecosystem Assessments: Developing the Scientific Basis for Ecosystem-Based Management of the Ocean, PLoS Biol. January; 7(1): e14. doi: 10.1371/journal.pbio.1000014.

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THE OPPORTUNITY

President Obama charged an interagency task force with crafting the first U.S. national policy to manage the country's marine resources in a sustainable manner and to develop a policy framework that "addresses conservation, economic activity, user conflict, and sustainable use of ocean, coastal, and Great Lakes resources." [0]. This framework, due at the end of 2009, represents the culmination of decades of work on various fronts.

The various facets of this work are finally converging: important federal initiatives and funding programs, non-government-organization-funded studies, advances in information science, a legacy of marine and climate change scientific research and data, and sufficient development of cyberinfrastructure and new observing programs. This convergence not only makes possible, but also mandates, pursuing integrated ecosystem-based assessment to guide ecosystem management.

The foundation for this opportunity was laid by the policy recommendations made by the Pew Ocean Commission and President Bush's Commission on Ocean Policy. Participants on the Pew Ocean Commission sought to advance conservation and stewardship of our marine resources by calling on the U.S. to adopt ecosystem-based management practices as a cornerstone of a new national ocean policy. The Packard and Moore foundations, advocating the results published in that commission's report, provided funds to continue the cause outside the framework of federal ocean policy [1].

The joint recommendations of the two commissions led to the creation of the U.S. Ocean Action Plan by presidential executive order under the Bush Administration in 2004. This plan called for a new interagency research and management agenda linking scientific research with ocean stewardship. To define and drive this agenda, the two subcommittees were established: the Joint Subcommittee on Ocean Science and Technology and the Subcommittee on Integrated Management of the Ocean. Together, the two produced the first interagency Ocean Research Priorities Plan, which identified six research themes based on 20 management-driven research priorities. This interagency plan now serves as the road map to direct federal research investments to develop the capacity to forecast key ocean and ocean-influenced processes and phenomena, provide scientific support for ecosystem-based management, and deploy an integrated ocean-observing system that could describe ocean state accurately.

Through this activity, which occurred both inside and outside of government, three important initiatives emerged:

1. An Ecosystem Based Approach to Management (EBM)
2. Advancement of the Large Marine Ecosystem concept (LME)
3. Integrated Ecosystems Assessments (IEA)

All three are now likely to become legislated management protocol in the new national ocean policy [2].

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In response to the Ocean Action Plan NOAA Marine Fisheries began focusing on advancing the practical application of ecosystem-based management via large marine ecosystems (which, in effect serve as testbeds for EBM and the application of IEA) for the 10 LMEs identified in the U.S.

Because convergence between climate and ecosystems was identified early on by the science community as an important focus, federal and state investment in climate and ecosystem research has been substantial and many important research programs have included both [3]. That investment is complemented by a new data management paradigm that provides protection, stewardship, and access to legacy data from ocean science research funded by the National Science Foundation. The Biological and Chemical Oceanography Data Management Office program sets the stage for interoperability of ocean science research data and the potential for fully integrating data toward the application of integrated ecosystem assessment.

Substantial advances in information science and equally ambitious work on cyberinfrastructure have paralleled all of this activity. The development includes the necessary networking technology; applications and modeling software as well as data collection, generation, and digital curation to support manifest integration and interoperability needs.

In short, all the necessary pieces – policy, science, data, and cyberinfrastructure exist. These components are now in concert with anticipated federal mandates for employing new management protocols, which are likely to be approved later this year. In fact, the dual track of the advances made both inside and outside of government in response to the Ocean Action Plan in terms of restructuring and planning within the government, and advancing concepts in marine conservation science and policy by non-governmental organizations make the state of readiness to move ahead even more compelling.

THE RESPONSE: ENABLING AN INTEGRATED ECOSYSTEM ASSESSMENT

To address this national need and exquisite moment of opportunity requires a focused, multi-institution collaborative effort. The intention of this initiative is to bring information science to the forefront of this activity by enabling routine integrated ecosystem assessments and forecasts. These assessments include impacts related to climate change and the capacity to address vulnerability, risks and resiliency resulting in informed decisions concerning resources and setting of priorities.

Information Science is an interdisciplinary science concerned with the analysis, collection, classification, manipulation, storage, retrieval and dissemination of information. Practitioners within the field study the application and usage of knowledge among and between people and organizations and existing systems with the aim of creating, replacing, improving or understanding information systems. Information science is often (mistakenly) considered a branch of computer science. However, it is actually a broad, interdisciplinary field incorporating not only aspects of computer science but often-diverse fields such as archival science, cognitive science, commerce, communications, law, library science, management, mathematics, philosophy, public policy and the social sciences.

Information Science focuses on understanding problems from the perspective of the stakeholders involved and then applying information and other technologies as needed. In other words, it tackles systemic problems first rather than individual pieces of technology within that system. Within Information Science, attention has been given in recent years to human–computer interaction, groupware, the semantic web, the social web, value sensitive design, iterative design processes and to the ways people generate, use and find information.

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This initiative proposes to develop and deploy an Integrated Ecosystem Assessment (IEA) system using an information science and semantic technology driven methodology developed by Dr. Peter Fox and collaborators at RPI. The intention of this initiative is to advance the capacity of an IEA to provide the foundation for synthesis and quantitative analysis of natural and socio-economic ecosystem information to support ecosystem-based management. In particular, this initiative will create the capacity to assess the impacts of changing climate on two large marine ecosystems: the northeast U.S. and the California Current. These assessments will become essential parts of the science-based decision-support tools used to develop adaptive management measures.

This initiative seeks to enhance interaction and information sharing within and among diverse data providers, analysis tool developers and user groups that constitute the broader coastal and marine ecosystem science application community. The Federation of Earth Science Information Partners, a unique consortium of more than 90 organizations dedicated to providing the most up-to-date, science-based information to researchers and decision-makers who are working to understand and address the environment, economic and social challenges facing our planet will serve as the primary forum and venue for this work.

The application of the above mentioned semantic web methodology will result in several data interoperability networks (see "Information and Influence Networks," below) to support and catalyze consensus strategies to transform environmental indicator data into decision criteria and provide required feedback to those conducting assessments, building the application tools, and collecting and disseminating data.

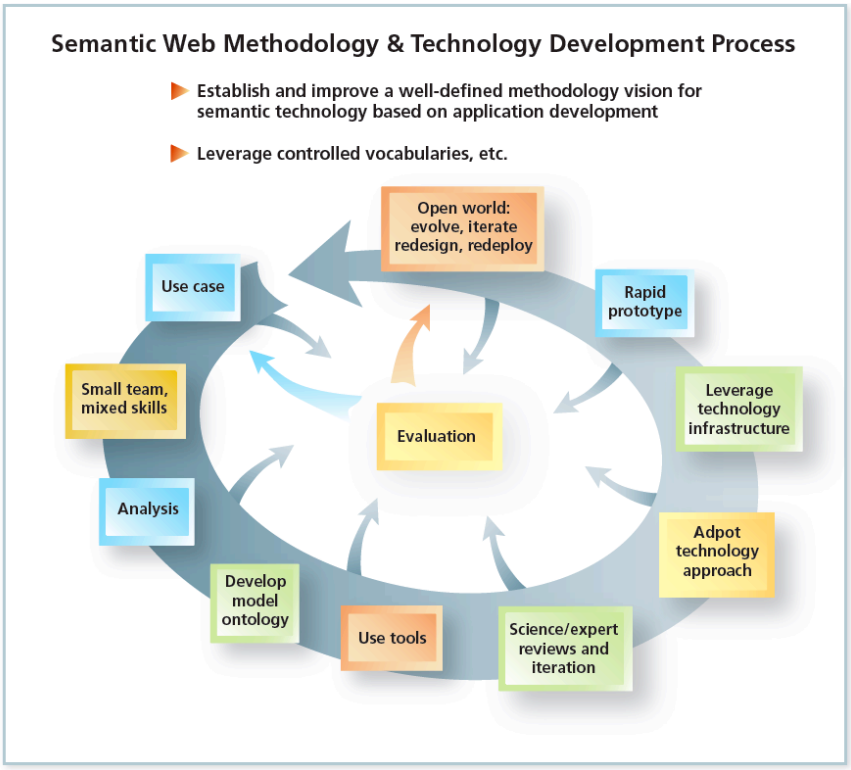


Figure 1 Semantic web methodology pathway used for collaborative data classification, integration and use.

AN ENABLING FOUNDATION FOR THIS WORK: SEMANTIC WEB TECHNOLOGY

Over many years computer science has progressed from basic machine languages to higher-level procedural languages and object-oriented languages. Each advance has introduced dramatic improvements in software capabilities that resulted in major leaps forward in fulfilling information technology requirements. Semantic technology promises yet another major advance.

To create the proposed integrated ecosystem assessment, semantic web methodology will be employed

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which has been implemented and evaluated in several natural science settings (e.g., in virtual observatories) over the past five years. These concepts as well as the implemented technical science infrastructure are changing the ways that researchers and students conduct and learn from scientific research. Their goal is to identify the right balance of observational data and simulation models, coupled with web portals and services and application client software that a researcher or any non-specialist user can use as easily -- as if all the materials were available locally on his/her computer.

Semantic technology makes it possible to transform data and information, as a raw material, into progressively more useful knowledge. While information is discrete data about a specific subject, knowledge is contextualized information linked or synthesized in way that can reveal new insights. The data and information can take various forms: text, diverse file formats, executable software models, and web pages. Limited by conventional technologies, we can face great challenges in tapping and integrating the value of the information contained in these data structures. Semantic technology however attempts to overcome these limitations by providing mechanisms to map data to a common domain model to support greater interoperability and integration of data.

Semantic technology gives us the ability to define the meaning of domain concepts all the way down to the data level by providing language constructs that more exactly reflect how we think and reason. It uses a formalistic, descriptive language based on predicate logic that a computer can understand and perform computations upon. Predicate logic is a form of deductive logic that expresses arguments in machine-friendly, unambiguous mathematical terms.

Semantic language constructs are used to encode an ontology, a sophisticated model that defines how terms and concepts are defined and related, e.g. how data inter-relates with other data. Furthermore, semantic technology provides mechanisms to load disparate data content into distributed semantically-enabled data stores that enable data integration.

However perhaps the most powerful aspect of semantic technology is its ability to apply rules and inferencing logic to data in a semantic data store. Inferencing is the ability to arrive at a conclusion based on a set of assertions and/or rules applied to data. Semantic technologies also support advanced querying to discover relationships among data that could not be detected easily using conventional technologies.

Figure 1 above depicts the semantic web methodology pathway that will be used in this initiative. [4, 5]

ORGANIZING SYSTEM REQUIREMENTS THROUGH USE CASES

Conventionally, a use case is part of a methodology to identify and organize functional requirements of a system. It consists of possible sequences of interactions among systems and users in a particular environment. It can be thought of as a collection of possible scenarios or questions being posed or tasks being performed, related to a particular goal. Use cases can be employed during several stages of software development, such as planning system requirements, validating design, testing software and even creating an outline for online help and user manuals. Most importantly when utilized as the initiating step within the semantic web methodology pictorially represented in Figure 1, use cases provide a substantial amount of semantic content, in essence defining vocabularies, terms and concepts and detail on relations. Use cases also act to engage communities of practice from the information and influence networks that are also part of this initiative.

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INTEGRATED ECOSYSTEM ASSESSMENT EXPRESSED AS A SET OF USE CASES

The integrated ecosystem assessment will begin by identifying critical management and policy questions that define the scope of information and analyses necessary to inform ecosystem management. The IEA will use quantitative analyses and modeling to integrate a range of natural science and socio-economic data to assess the condition of the ecosystem relative to identified ecosystem management goals. It provides a means of evaluating tradeoffs in management strategies among potentially competing ecosystem use sectors.

An IEA must provide an efficient, transparent means of summarizing the status of ecosystem components, screening and prioritizing potential risks, and evaluating alternative management strategies against a backdrop of environmental (e.g., climatic, oceanographic, seasonal, real–time weather) variability.

Moreover, the assessment will involve and inform a wide variety of stakeholders and agencies. It will integrate knowledge and data collected by NOAA and other regional entities including other federal agencies, states, non-governmental organizations and academic institutions using a strategic Driver-State-Impact-Response decision support framework. It will also identify critical knowledge and data gaps, which if filled, will improve the accuracy and comprehensiveness over time of approaches to ecosystem management.

SUPPORTING NOAA'S DPSIR DECISION FRAMEWORK

The result of the proposed activity will be application-level data and human information and influence networks to support implementation of NOAA's Driver-Pressure-State-Impact-Response (DPSIR) decision framework and the cyber-infrastructure technologies to ensure data and information interoperability and reuse.

The DPSIR framework for classification of indicators has been applied broadly in environmental assessments of terrestrial and aquatic ecosystems. Indicators include (led by their first letter to make up the acronym DPSIR):

- **D**rivers, both natural and anthropogenic, that result in pressures that, in turn, cause changes in the system pollution, habitat loss and degradation, and overfishing that can be mapped to
- **P**ressures, such as coastal pollution, habitat loss and degradation, and overfishing that can be mapped to specific drivers.
- **S**tate variables, indicators of the condition of the ecosystem, including physical, chemical, and biotic factors.
- **I**mpacts, or measures of the effect of change in state variables such as loss of biodiversity, decline in productivity and yield, etc., with respect to management objectives and the risks associated with exceeding or returning to a state below these targets and limits.
- **R**esponses, the actions (regulatory and otherwise) taken in response to predicted impacts.

These different classes of indicators can be mapped to management strategy and their roles in model formulation, parameterization, and validation.

DATA AND APPLICATION INTEROPERABILITY

The interoperability approach and data technologies proposed to facilitate the assessment are shown in Figure 2. Example data repositories appear at the bottom of the figure. Example software applications and tools are represented in the middle layer. Assessment methodologies (conservation, integrated ecosystem and foundation environmental assessments) lie at the top of the figure.

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Separating these three layers are two semantic mediation layers.
The lower mediation layer aims to make the data repositories interoperable [6]. This mediation layer uses an ontology that captures the concepts of research and science terminology, toolkits, data, and information sources. It also maps incoming queries from existing tools and applications to underlying data, and mediates access to various data based on roles.

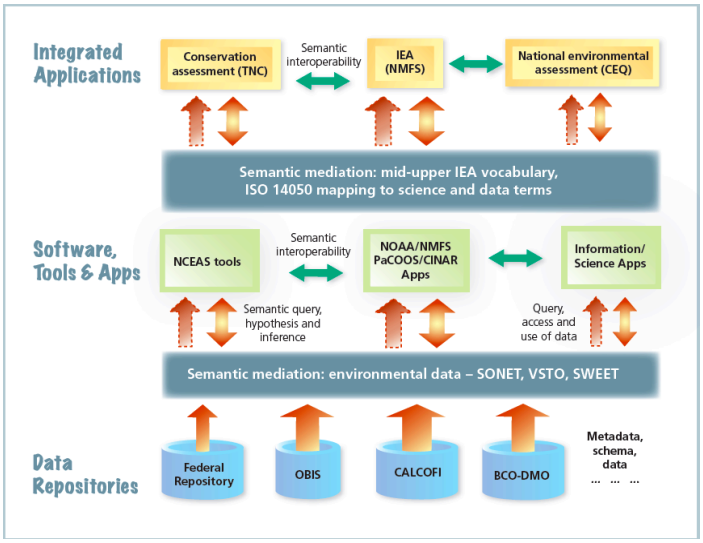


Figure 2 Interoperability approach and data technologies used to facilitate assessment.

The proposed data interoperability network will leverage the work being done on this lower mediation layer, but its focus is to create the second, higher semantic mediation layer, which will create greater interoperability among existing assessment and decision-making applications. To make this higher mediation layer work, we propose to build new controlled vocabularies and ontologies that capture the concepts of environmental assessment, policy, and conservation, and resource management toolkits, data, and information sources.

INFORMATION AND INFLUENCE NETWORKS

For the purpose of this initiative, four information and influence networks (IINs) have been identified, representing the key disciplinary domains of research, resource management, conservation, and environmental policy that make up the broader marine ecosystems science community. The relationship among these networks in influencing an IEA decision support structure is represented in a series of concentric rectangles (Figure 3).

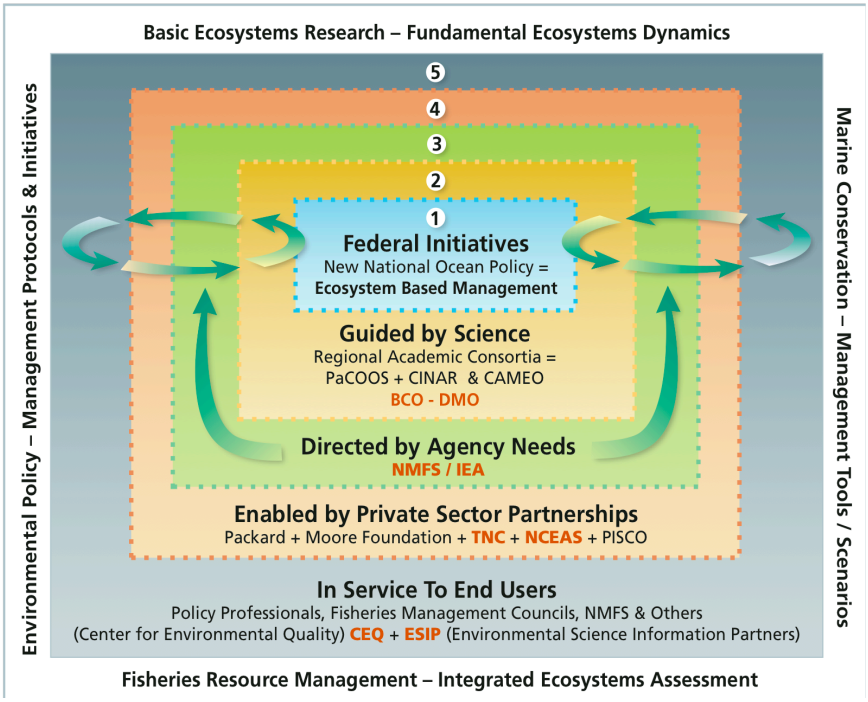


Figure 4 Relationships between integrated ecosystem assessment stakeholder communities.

With the pending federal policy of EBM serving as the nucleus (1), the next rectangle in the figure (2) consists of the academic ecosystem science research community that is advancing

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fundamental understanding of ocean and marine ecosystems' response to climate change [7], including one of the most recent marine ecosystem-based research initiatives, the Comparative Analysis of Marine Ecosystem Organization program [8].

The next rectangle (3) represents the government agency ecosystem science community that translates directives defined in legislative acts, such as the Magnuson-Stevens Fishery Conservation and Management Act, into the research and information needed to comply with those directives. This initiative directly engages the scientists within NOAA fisheries charged with implementing integrated ecosystems assessments in identifying appropriate regional stakeholders. Both developers and users of an assessment will benefit from the application of semantic technologies, which closely link research data repositories to assessments.

The next rectangle (4) represents the conservation ecosystem science community, which includes private sector partners, such as foundations and non-government organizations that share the goals of relevant federal initiatives and funding agencies and seek to develop and advance the policies and programs resulting from an IEA. This group, led by the conservation community, seeks to formalize and implement ecosystem-based management [9].

The outer rectangle (5) represents the ecosystem policy science community, including the Council on Environmental Quality and the Earth Science and Information Partners. These entities represent the "policy perimeter" that formulates (in the case of the former) or implements (in the case of the latter) new national policy initiatives. The chair of the Council on Environmental Quality serves as the principal environmental policy adviser to the President. The council coordinates federal environmental efforts and works with agencies and White House offices to develop environmental policies and initiatives. In addition, the council reports annually to the President on the state of the environment; oversees federal agency implementation of the results of the environmental impact assessment process; and acts as a referee when agencies disagree over the adequacy of such assessments.

THE PROCESS

Central to the goal of bringing information science to the forefront of enabling routine, integrated ecosystem assessments is a series of stakeholder workshops and related community capacity building activity and technology application. As such, network PI Peter Fox will establish and lead an integrated ecosystem assessment application cluster workgroup through the Earth Science Information Partners; the primary venue for executing this initiative. Meetings will be held both in field sites and in Washington, DC, at the annual ESIP winter meeting for each year of the duration of the initiative [10]. By fully engaging the information and influence networks identified above, these meetings and workshops will serve not only to articulate the use cases and advance an understanding of the detailed data interoperability needs, but also serve as forum to develop a policy consensus statement promoting a more comprehensive and sophisticated information network to advance the ocean stewardship goals of the new national ocean policy.

A more specific definition of the components of this initiative process is outlined below.

People: Perhaps the most important component to the success of this initiative is people. Leaders within the technical and scientific domain areas (as identified above and below) will be contacted individually to discuss the scope of this initiative, how they might participate, and possible funding programs to support their participation. Essential to the success of this initiative is that key representative and experts from each of the information and influence networks (identified in Figure 3) be engaged directly in consensus building activity from the very beginning to ensure development of the human capacity to advance ecosystems-based science.

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Workshops: Central to this capacity building process is the convening of a series of workshops. These workshops will be of two types. The first type will focus on administrative, management, and process issues with the identified stakeholders and data providers. The purpose of these meetings will be to gather input on the overall needed capabilities, identify participants' interests, map out a long-term strategy based on group consensus, identify and address "holes" in our thinking and planning, identify and work to gain access to all relevant data repositories, identify relevant extant cyber-infrastructure (including vocabularies/ontologies), and identify the first assessment use cases (related to the California Current and Northwest Atlantic Continental Shelf Large Marine Ecosystems) to begin organizing system requirements.

A second series of workshops will focus on technical topics, e.g., involving tool and applications developers and data specialists, to map out a long-term technical development strategy and implementation among the network participants. In these workshops, existing data sets, tools, and applications software to leverage will be identified and used as a basis for additional development and the guide implement choices for the semantic web technology. Additionally requirements with respect to data access and integration and user access/interfaces for applications tools will be gathered.

Technical Development: Much of the needed technical developments and the informatics and semantic web methods to be used are sufficiently mature and are aligned with best practices in the relevant communities. Detailed timelines and phasing of each component in Figure 1 depends on the cohesion of the network during its formative phase – in essence becoming familiar with the methodology used for the development of use cases and in the assessment of skill and knowledge among the participants. Past experience with semantically-enabled data infrastructures such as this suggest that prototype deployments are possible within the first year of activity and rapid development (ontology, software, evaluation) cycles of 3-4 months are possible. Part of the network responsibility will be to develop and sustain a detailed set of technical capabilities based on the use cases.

Operational Capability: During the development process a prototype will be deployed for testing and evaluation with the results shared with initiative participants. The goal is to develop a prototype enablement process that can be used as a national model for IEAs in all 10 U.S. federal large marine ecosystems. As the prototype moves to a more developed, tested and capable system it will be released publicly and published in a final report.

Outreach: Throughout the life of this initiative progress will be reported through publishing in peer-reviewed journals related to ocean/marine and informatics/computer science and presentations at conferences in those domains within and outside the U.S., including publishing ontologies that have been developed. After a working prototype has been developed, it will be demonstrated at conferences and other relevant venues to seek additional feedback from this wider community, which will help focus continued development. The network as a whole will also work to inform and engage the media as well as relevant organizations, agencies, research, and user groups in promoting the understanding and benefits of this new capability.

Evaluation among the User Community: Ongoing use of this system will also provide feedback to guide further development. Users are also likely to provide ideas for follow-on development to their agencies, which in turn can create programs to fund suggested work.

Long-term Maintenance and Support: For this capability to continue into perpetuity we expect that the National Marine Fisheries Service will adopt it and determine a way to support it.

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THE PEOPLE

The proposed partners for this Integrated Ecosystem Assessment Interoperability Initiative will include leaders within the technical and scientific domain areas (marine ecosystem science information and influence networks) identified below.

Federal Initiatives

Ecosystem-Based Management (EBM) http://compassonline.org/marinescience/solutions_ecosystem.asp
Large Marine Ecosystems (LME): http://www.lme.noaa.gov/
Integrated Ecosystem Assessment (IEA): http://coastalscience.noaa.gov/about/iea.html

Academic Marine Ecosystem Science Climate Research

Biological and Chemical Oceanography Data Management Office BCO-DMO: http://www.bco-dmo.org/
California Current Ecosystem Long-Term Ecological Research : http://cce.lternet.edu/
U.S. Global Ocean Ecosystem Dynamics (GLOBEC): http://www.usglobec.org/
California Cooperative Oceanic Fisheries Investigations (CalCOFI): http://www.calcofi.org/
Comparative Analysis of Marine Ecosystem Organization (CAMEO): http://cameo.noaa.gov/

Government Agency Marine Ecosystem Science

NOAA/NMFS/NEFSC: http://www.nefsc.noaa.gov/
NOAA/NMFS/NWFSC: http://www.nwfsc.noaa.gov/
CINAR: http://www.whoi.edu/page.do?pid=30715
PaCOOS: http://www.pacoos.org/

Conservation Marine Ecosystem Science

COMPASS: http://compassonline.org/marinescience/solutions_ecosystem.asp
PISCO: http://www.piscoweb.org/
NCEAS EBM Ecosystem Assessment Workgroup: http://www.nceas.ucsb.edu/ebmthree#work
The Nature Conservancy Northwest California Current Ecological Assessment (TNC CCE): http://www.marineebm.org/3123.htm
The Nature Conservancy Northwest Atlantic Marine Ecological Assessment (TNC NWA): http://www.nature.org/wherewework/northamerica/states/massachusetts/files/nam_era_faq_final.pdf

Federal Marine Ecosystem Science Policy Partners

Council on Environmental Quality (Interagency Ocean Policy Task Force): http://www.whitehouse.gov/administration/eop/ceq/initiatives/oceans/
Committee on Ocean Policy (CEQ): http://ocean.ceq.gov/about/welcome.html
Interagency Committee on Ocean Science and Resource Management Integration (CEQ): http://ocean.ceq.gov/about/icosrmi.html
Joint Subcommittee on Ocean Science and Technology (National Science and Technology Council): http://ocean.ceq.gov/about/jsost.html
Subcommittee on Integrated Management of Resources (CEQ): http://ocean.ceq.gov/about/simor.html
Ecosystems Goal Team: http://ecosystems.noaa.gov
Federation of Earth Science Information Partners: http://www.esipfed.org/

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Peter Fox, Principal Network Lead

Peter Fox, Principal Network Lead is a new recruit to the Department of Earth and Environmental Sciences at the Rensselaer Polytechnic Institute (RPI). Known as a data scientist, he leads the campus initiative to bridge the divide between scientists and the data that separate them. Fox also serves as an officer and lead of a semantic technology work group for the Federation of Earth Science Information Partners (ESIP). He is also working to develop a joint RPI/Woods Hole Oceanographic Institution ocean informatics program to initially focus on applying semantic technologies and informatics to ocean ecosystems and fisheries management.

Fox's interdisciplinary research specializes in solar-terrestrial physics and its impacts on the Earth system as a whole, computational and computer science, information technology and grid-enabled, distributed, semantic e-science data frameworks. This research applies state-of-the-art modeling techniques and Internet-based technologies including the semantic web, to large-scale distributed scientific repositories addressing all life-cycle facets of data, information, and knowledge use.

Fox is principal investigator for the Virtual Solar-Terrestrial Observatory, the Semantic e-Science Framework, the Semantically Enabled Scientific Data Integration, and the Semantic Provenance Capture in Data Ingest Systems projects currently funded by the NSF and NASA.

For Fox, this initiative signifies an enthusiastic progression toward several important goals: to apply the full capabilities of scientific data (observations and modeling) to the most pressing and challenging problems facing our planet, substantial advancement of semantic e-science [11] and informatics research and application capabilities, and educating young environmental scientists.
http://tw.rpi.edu/wiki/Peter_Fox

CONTACT:

For more information on this initiative and/or the proposed methodology please contact

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References

[0] http://www.whitehouse.gov/the_press_office/Presidential-Proclamation-National-Oceans-Month-and-Memorandum-regarding-national-policy-for-the-oceans/

[1] Projects funded included The Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO), The National Center for Ecological Analysis and Synthesis (NCEAS) Ecosystem-Based Management (EBM) system, and The Nature Conservancy Regional Ecosystem Assessments.

[2] These advances were driven by the proactive response of NOAA's National Marine Fisheries Service (NMFS) to the updated (1996) and reauthorized (2006) Magnuson-Stevens Fishery Conservation and Management Act.

[3] E.g., the California Cooperative Oceanic Fisheries Investigations, U.S. Global Ocean Ecosystems Dynamics, the California Current Ecosystems-Based Management initiative, and the Comparative Analysis of Marine Ecosystem Organization

[4] In modern Xinformatics, the development of broad semantic constructs such as SWEET (Semantic Web for Earth and Environmental Terminology, Raskin and Pan 2005) are becoming essential to mediate important vocabulary discussions among interdisciplinary communities. Several general approaches have been applied to concept and semantic development.

[5] Recently, though, an unique approach has been used by Fox and McGuiness (Benedict et al. 2007, McGuinness et al. 2007, Fox et al. 2009) to develop a series of NSF- and NASA-funded semantic data frameworks, such as the Virtual Solar-Terrestrial Observatory (VSTO; http://tw.rpi.edu/portal/VSTO), the Semantically-Enabled Science Data Integration project (Fox et al. 2006; McGuinness et al. 2007; http://tw.rpi.edu/portal/SESDI), and the Semantic Provenance Capture in Data Ingest Systems (Fox et al. 2008; http://tw.rpi.edu/portal/SPCDIS).

[6] Work is underway at NCEAS and other sites to apply existing controlled vocabularies and ontologies, such as SONET, VSTO, and SWEET, to accomplish this.

[7] Through programs such as the Global Ocean Ecosystem Dynamics (GLOBEC) initiative, California Cooperative Oceanic Fisheries Investigations (CalCOFI), the Marine Resources Monitoring, Assessment, and Prediction (MARMAP) program, the Ocean Carbon & Biogeochemistry (OCB) program, and regional consortia-based programs, such as the Pacific Coast Ocean Observing System (PaCOOS) and the newly established Cooperative Institute for the North Atlantic Region (CINAR)

[8] See http://globec.whoi.edu , http://www.calcofi.org/, http://www.dnr.sc.gov/marine/mrri/MARMAP/marmap.html, http://www.us-ocb.org/, http://www.pacoos.org/, http://www.noaanews.noaa.gov/stories2009/20090618_atlanticcoop.html

[9] Leaders in this group include programs such as the Partnership for Interdisciplinary Study of Coastal Oceans (PISCO, http://www.piscoweb.org/) and the Ecosystems Based Management Science initiative, recently established at the National Center for Ecological Analysis and Synthesis (NCEAS; http://www.nceas.ucsb.edu/ebm) at UC Santa Barbara, which is a joint project with NSF, the Moore and Packard foundations, and The Nature Conservancy.

[10] http://www.whitehouse.gov/administration/eop/ceq/, http://www.esipfed.org/

[11] Fox, P., Hendler, J. 2009, Semantic eScience: Encoding Meaning in Next-Generation Digitally Enhanced Science, in The Fourth Paradigm: Data Intensive Scientific Discovery, Eds. Tony Hey, Stewart Tansley and Kristin Tolle, Microsoft External Research, pp. 145-150.

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