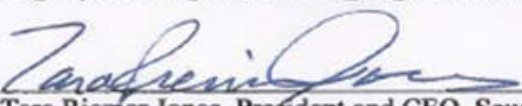
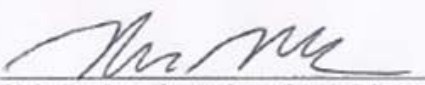


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<b>Proposal No:</b>	<b>Submitted:</b>	<b>Received:</b>
<b>Project Title:</b> Gulf of Alaska Integrated Ecosystem Research Project (GOAIERP) Data Management		
<b>Project Period:</b> April 2012 – April 2015		
<b>Name, Address, Telephone Number and Email Address of Applicant:</b>		
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<b>Total Funding Requested From NPRB: \$</b>		
<ol style="list-style-type: none"> <li>1. Axiom Consulting and Design: _____</li> <li>2. Alaska Ocean Observing System: _____</li> </ol>		
<b>Total Other Support:</b>		
<ol style="list-style-type: none"> <li>1. Axiom Consulting and Design: _____</li> <li>2. Alaska Ocean Observing System: _____</li> </ol>		
<b>Legally Binding Authorizing Signature and Affiliation:</b>		
 Tara Riemer Jones, President and CEO, Seward Association for the Advancement of Marine Science, Fiscal Agent for the Alaska Ocean Observing System		
 Rob Bochenek, Axiom Consulting and Design		

## 5 **Proposal Summary**

6 This project supplies the NPRB GOAIERP research effort with critical data management support to assist  
7 study teams in efficiently meeting their objectives and ensuring data produced or consolidated through the  
8 effort is organized, documented and available to be used by GOAIERP investigators and future research  
9 efforts. This effort coordinates and shares costs with several existing data management projects that are  
10 parallel in scope to the data management needs of the integrated program, as well as leverages the Alaska  
11 Ocean Observing System's (AOOS) cyber infrastructure and existing data management capacities. The  
12 project team proposes to support data submission, metadata generation and data transfer among study  
13 teams by creating a stand-alone GOAIERP account through the AOOS Ocean Workspace, a web-based  
14 project level data management system. Axiom data analysts and domain experts will review/audit  
15 metadata and data structure formats produced from GOAIERP project activities and advise study team  
16 members in best practices for data formats and metadata authoring. Axiom software engineers will also  
17 deploy a GOAIERP Portal interface that showcases and provides access to GOAIERP project profiles and  
18 data products produced from the integrated research program, as well as Gulf of Alaska data sets and  
19 models currently under the stewardship of AOOS. Additionally, Axiom engineers will develop a web-  
20 based tool to facilitate data discovery of GOAIERP project level data, which will include the ability to  
21 search and filter by space, time, parameter and taxonomy.

## 22 **Technical Approach**

### 23 *Project Challenges*

24 Managing oceanographic data is particularly challenging due to the variety of data collection protocols  
25 used and the vast range of oceanographic variables studied. Data may derive from automated real-time  
26 sensors, remote sensing satellite and observational platforms, field and cruise observations, model  
27 outputs, and various other sources. Variables can range from mesoscale ocean dynamics to microscale  
28 zooplankton counts. The resulting datasets are packaged and stored in advanced formats, and describe a  
29 wide spectrum of scientific observations and metrics. Due to the complexity of the data, developing data  
30 management strategies to securely organize and disseminate information is also technically challenging.  
31 Distilling the underlying information into usable products for various user groups requires a cohesive,  
32 end-to-end approach in addition to a fundamental understanding of the needs and requirements of the  
33 researchers, as well as other user groups and stakeholders.

34 Data sets resulting from research projects pose their own set of technical challenges due to the  
35 heterogeneous nature of the information produced from those efforts. From a systems level perspective,  
36 model and sensor output are much more standardized data formats and thus are easier to manage in an  
37 automated fashion than project level data resources. Project level data typically require more manual  
38 manipulation and individualized review. Generating standardized metadata is critical to ensure that the  
39 research investment is capitalized in future synthesis/research efforts in addition to reducing duplication  
40 of effort and increasing data discovery and usability.

41  
42 Authoring complete and compliant FGDC metadata often requires the use of multiple tools as well as  
43 manipulating complex XML files (FGDC Biological Profile). For example, metadata validation that is  
44 facilitated through external manual review introduces issues of latency and human error, and consumes  
45 large amounts of staff time. This model does not scale well, a factor that will become increasingly  
46 important as larger amounts of data flow into and out of the system. Additionally, researchers involved in  
47 integrated programs require additional tools beyond metadata editors, including web-based systems which  
48 allow project data to be securely organized and shared across research teams that may exist in different  
49 physical locations and organizational units. Though several tools exist for metadata creation, few of these  
50 tools are web-based and very few have any collaborative functionality or the ability to manage actual data

sets. Furthermore, integrated programs require more advanced features like versioning and tracking of dataset lineage across individuals.

In many integrated programs, data analysis and visualization of complex models and data sets can be computationally intensive, precluding data and data products from being accessible to users in a form that is informative and useful. Running these analysis and visualization operations on High Performance Computing (HPC) clusters can provide the required performance thresholds needed for visualization and analysis of complex data and models.

### *Existing Technical Capabilities of AOOS/Axiom Partnership*

The Alaska Ocean Observing System (AOOS) was established in 2004 under a Memorandum of Agreement by a consortium of partner Federal and state agencies and Alaska research institutions as the regional association for integrating coastal and ocean observing activities in Alaska's three regions: Arctic, Bering Sea/Aleutians and Gulf of Alaska. AOOS is one of 11 regional associations that make up the regional component of the national Integrated Ocean Observing System (IOOS). Axiom Consulting & Design is an ecological informatics software engineering firm that provides core data management services to AOOS and designs, implements and supports all components of the AOOS cyber infrastructure and data life cycle. Axiom successfully competed for the AOOS data management services contract in 2010 and will provide those services until at least 2014. The initial AOOS focus has been on developing the cyber infrastructure to integrate and provide access primarily to real-time, modeled, GIS and remote sensing data. Beginning in 2011 with funding from the Prince William Sound Science Center and in 2012 from the Exxon Valdez Oil Spill Trustee Council, AOOS has turned its attention to developing the tools to address the needs of the scientific research community and project-level data types. These are the same types of data being collected through the GOAIERP.

Because of its core mission and funding, AOOS (supported by Axiom) provides the following capabilities that are to be leveraged at no cost throughout this project:

- **Security and Redundancy** – AOOS operates two physically distributed, mirrored data centers (Anchorage AK and Portland OR). Each independent cluster also implements several levels of redundancy and backup. The two physical locations ensure there exist multiple redundant copies of data in addition to web application servers. Several layers of physical hardware (enterprise level firewalls) and system monitoring software (NAGIOS) are also in place to provide hardened cyber security.
- **Capacity and Performance** – High Performance Computing (HPC) has been a component of the AOOS technical strategy for the last year and a half. AOOS operates its own “cloud” of compute and storage resources that data managers can provision to specific tasks and roles. Currently, the AOOS data system has 260 processor cores available for compute capacity and approximately 150 TB of high performance clustered disk storage space. Though this may seem excessive for the needs of the GOAIERP program, Axiom engineers have demonstrated that large GIS, model and remote sensing datasets require HPC environments to be visualized and queried over web-based interfaces. Because HPC is achieved through load balancing and parallelization, these types of systems also provide the added bonus of high availability and redundancy.
- **Cyber Infrastructure Developed to National Standards** - AOOS has developed an infrastructure that meets the guidelines and specifications recommended by the national ocean observing community. The AOOS data system is built using several mature open source interoperability and data stewardship systems such as THREDDS, OGC Systems, OpenDAP, and Geoserver. Maintaining this infrastructure and a regional ocean data portal is one of the top priorities of the AOOS Board. This infrastructure includes these components: data ingestion, metadata, data aggregation assembly, data catalog and discovery, QA/QC, data access and transport, data storage and archive, and end user input and feedback.

- **Core Applications** – AOOS has been actively developing several data management systems and capacities that will be leveraged directly to support the needs of the GOAIERP program in addition to providing the core technical components for the deliverables of this project. Specifically, AOOS will be deploying a full life cycle project level data management system (Ocean Workspace) targeted towards the support of integrated research programs in February 2012. The capabilities of the Ocean Workspace are further detailed later in this proposal under the methods section. AOOS has several existing data search and visualization systems developed or in development that will be extended and customized for the needs of this project.
- **Automated Submission to NODC and DataONE Archive** – AOOS is developing several automated pathways to submit internally managed data sets to multiple national archives. Through a partnership established with IOOS, the National Ocean Data Center is developing protocols for automatic transfer and submission of data sets and metadata from IOOS Regional Associations such as AOOS. AOOS is also configuring itself to be a contributor node to the DataONE network (<http://www.dataone.org/>) as a result of its collaboration with the National Center for Ecological Analysis and Synthesis (NCEAS) to provide data management services to the Exxon Valdez Oil Spill Trustee Council’s Long Term Monitoring and Herring Research and Monitoring Programs.
- **Existing Relationships and Partnerships** – AOOS brings a deep level of institutional knowledge and existing relationships with data-providing agencies, NGOs and individuals in the Alaska region. Pertinent signatories to the AOOS MOA include Federal agencies such as NOAA, BOEM, USGS, and Coast Guard; State of Alaska Departments of Fish and Game, Natural Resources and Environmental Conservation; and research entities including the University of Alaska, NOAA’s Alaska Fisheries Science Center, US Arctic Research Program, Alaska Sea Grant, Prince William Sound Science Center, Alaska SeaLife Center, as well as NPRB. All are committed to the AOOS mission to increase information about Alaska’s oceans and coasts, and widely distribute that information to the scientific community as well as resource managers, other stakeholders and the general public. AOOS has well-established working relationships with several investigators who are part of the GOAIERP program. This background will prove indispensable when working with GOAIERP investigators to accomplish the objectives of this project.

#### *Use of AOOS Capabilities and Systems for GOAIERP Project Deliverables*

AOOS systems are developed with a strict adherence to using non-proprietary open source software. In addition, all software systems developed by AOOS are also open source. As a result, these systems are designed to be easily leveraged and packaged into new tools, which can be easily deployed in a “turnkey” fashion. AOOS proposes to build off its existing data management platform to cost effectively deploy a number of tools to support GOAIERP research efforts.

#### *Objectives*

- 1) Support data management communication, coordination and implementation for GOAIERP project.
- 2) Provide core data management oversight and services for GOAIERP project, including data ingestion, qa/qc, metadata generation, transfer and sharing of data among project PIs, and final transfer of all data to NPRB and appropriate national data archives.
- 3) Develop tools to access, query, analyze and visualize information relevant to and produced by GOAIERP PIs that meet the needs primarily of the research team, and secondarily, the needs of the larger scientific community, resource managers and the general public.

## Methods

### **Objective 1.** *Support GOAIERP data management project implementation and coordination.*

This objective addresses Objective I (Data Program Communication and Coordination) of the detailed project scope section of the RFP.

*Task 1. Develop plan for – and implement - protocols for communicating with Project Steering Committee (GABI), NPRB staff, and project PIs.* In the first two months of this project, project PIs will develop a detailed plan that describes specific mechanisms and timelines for communication with these parties. Rob Bochenek (Information Architect) and Dr. Will Koeppen (Senior Data Analyst) will function as project data managers and coordinate with the project Steering Committee (GABI) and NPRB staff in addition to attending all relevant meetings and teleconferences. These staff members will be responsible for refining the data management protocols used during this project to improve the efficiency of data submission/metadata generation and increase the future utility of GOAIERP data sets. Molly McCammon will participate in key GABI meetings and will brief the steering committee on AOOS and EVOS Long Term Monitoring/Herring Program activities that are relevant to GOAIERP undertakings. Because AOOS and NPRB are co-located, most communication with staff will be in person, with additional communication via email and use of other communication tools such as webinars, wiki pages, etc.

*Task 2. Assess general project and PI data management needs.* AOOS data management staff will work with GOAIERP investigators to assess in more detail the types of data collected during sampling efforts, assess Standard Operating Procedures (SOPs) for data collection and gauge the general data management needs of PIs that may be particular to this project. This assessment is critical to prioritize the data management needs and types of tools needed by researchers to increase their abilities to manage their data in an automated, standard fashion. A meeting between AOOS data management staff and NPRB/GABI representatives is scheduled early in the project to better understand program needs, scope activities and customize data management strategies. Due to the non-sequential GOAIERP field seasons (2011 and 2013) followed by a year of synthesis, data management activities must be effectively scheduled to address program needs. Though investigators propose a draft schedule in this proposal under the Timeline and Milestones section, this may be modified based upon review and input from NPRB and GABI staff.

*Task 3. Track general data and metadata submission.* Mr. Bochenek and Dr. Koeppen will ensure data submission and metadata generation by investigators is on schedule with NPRB GOAIERP program requirements. This will be accomplished through periodic audits of datasets and metadata submitted through the GOAIERP Workspace following the various field seasons and secondary analysis and synthesis activities. AOOS data management staff will work with GABI and NPRB staff to develop specific timeframes for these activities. Datasets utilized by the retrospective analysis activities will need to be ingested on a case by case basis prioritized by directives supplied by GABI and NPRB staff.

### **Objective 2.** *Provide core data management oversight and services for GOAIERP project, including data ingestion, qa/qc, metadata generation, transfer and sharing of data among project PIs, and final transfer of all data to NPRB and archiving with appropriate national data archives.*

This objective addresses Objective II (Fundamental Data and Metadata Management) of the detailed project scope section of the RFP.

*Task 1. Complete development of the GOAIERP Workspace as the project's primary tool for data ingestion and sharing and metadata generation.* The AOOS data management group is currently developing a web-based platform – called the AOOS Ocean Workspace - that can be used for researchers

to manage project profiles, organize project data and files, author metadata, and facilitate transfer of data and information among PIs. System development is currently supported with funding from AOOS and the Prince William Sound Science Center in addition to funding provided by the Exxon Valdez Oil Spill Trustee Council (EVOSTC)-funded Long Term Monitoring and Herring Research and Monitoring Programs that are coming online in February 2012. The user interface provides PIs with tools to generate complete metadata profiles that comply with national standards, post project files/data and track versions of files and modifications across GOAIERP team members. Initially, this system will focus on authoring FGDC metadata formats but will expand in the future to support metadata files and interfaces for the ISO 19115 standard.

The software development phase of this application was initiated in March 2011 with a planned release date of February 1<sup>st</sup>, 2012. The workspace is powered by several scalable open source technologies (PostgreSQL, MongoDB, Java, Hibernate, HTML 5, and Elasticsearch). AOOS proposes to deploy a specific instance of this platform (GOAIERP Workspace) to support GOAIERP. This platform will provide GOAIERP investigators and project managers with a transparent view of data collection and metadata authoring progress in addition to providing a framework for data integration. It is envisioned that this platform will function as the primary vehicle to facilitate data transfer, metadata generation and archiving for the entire GOAIERP data management lifecycle. This platform will be available for immediate use at the start of this project (April 1<sup>st</sup>, 2012).

AOOS data management staff will review datasets and provide feedback to researchers regarding best practices. The focus of this activity is to enable the researcher to structure their data in a useful way independently, but in some cases, data managers will manipulate or restructure datasets based on the needs of the synthesis program and data managers' experience with effective data structures. The GOAIERP workspace will be enabled to store any type of digital file (netCDF, excel, images, MS Access, .hex, .txt, .zip, Shapefiles, etc.) and to track versioning of individual files. If researchers refine and modify their files, the Workspace will capture and store each independent version in addition to tracking the lineage of modifications across individuals. As of this writing the Workspace has the following capabilities:

***Secure user and project profiles*** – GOAIERP project participants will have a password protected and dedicated Workspace portal for the GOAIERP Research Program Group that will provide a single access point for all relevant parties (GABI, NPRB and Investigators) to access GOAIERP project profiles and data. Transfer of data and information will occur over SSL encryption for all interactions with the workspace. Each GOAIERP investigator will have a GOAIERP Workspace login and personal profile. The workspace is already enabled to utilize the Google applications authentication system. If users are already logged into their Google applications account (Gmail, Google Documents, etc.) they can launch the workspace without the need to re-authenticate. All users will be members of the GOAIERP Research Program Group and will have read access to the entire repository of GOAIERP data, files and metadata across all projects managed in the group. Permissions to edit, add or delete information from a project must be explicitly enacted by a user who has admin privileges over the project (AOOS DM staff or individual project PIs).

***Metadata Authoring*** – The GOAIERP Workspace will provide investigators with interfaces to author FGDC compliant metadata including the biological profile extension. Additionally, this tool can automatically validate metadata files and alert the researcher to portions that are lacking required detail. AOOS engineers have developed an integrated FGDC biological profile extension editor that allows users to search the 1.5 million taxonomic holdings of the [Integrated Taxonomic Information System \(ITIS\)](#) and easily generate the biological profile component of the FGDC metadata record. Most importantly, the GOAIERP Workspace operates as a cloud based service and is accessed through a web browser interface, allowing researchers to move between computers during the metadata generation process in addition to



allowing authorized GOAIERP team members and administrators to simultaneously review and edit metadata in real time.

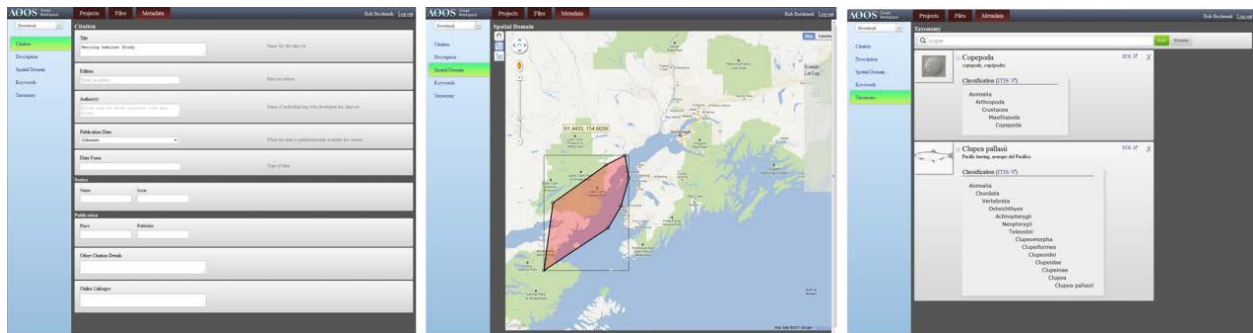


Figure 1. Screen captures of the workspace (metadata creation). The left capture shows the interface for users to author core FGDC metadata fields. The middle capture displays a tool which allows researchers to define the spatial extent of the project. The right capture displays the FGDC Biological Profile tool which allows users to search the ITIS database by common or scientific name and select relevant taxa. The interface then provides the user with several validation resources that allow the user to view where the selected taxa sit in the ITIS tree in addition to a verification image if that taxa is registered in the Encyclopedia of Life. Finally, the workspace packages all these components into a FGDC compliant metadata record.

**Advanced and Secure File Management** –A core functionality of the AOOS Ocean Workspace will be the ability to manage and share project level digital resources. The workspace is to function not only as a repository of finalized data but also as a working platform for sharing preliminary datasets and other digital resources among researchers and study teams. Users of the GOAIERP Workspace will be provided with tools that allow them to bulk upload files, organize those documents into folders or collections and then associate those files with predefined and user defined context tags.

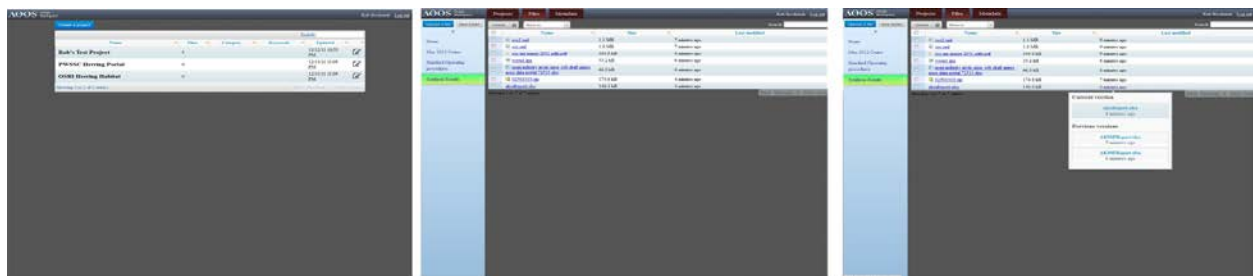


Figure 2. Screen captures of the Workspace file management system. The left capture shows a list of projects to which the hypothetical user has access rights. The middle capture displays the interface a PI would use to organize independent files into collections or folders. The right capture displays the versioning capabilities of the Workspace. If a file is uploaded with the same name into the same folder, the Workspace assumes that this file is a new version of the old file and begins to track individual versions of the file.

**Task 2. Refine GOAIERP Workspace based on project PI and NPRB staff feedback.** Throughout the project, AOOS data management staff will engage GOAIERP PIs, NPRB staff and GABI members to refine and extend the capabilities of the GOAIERP Workspace. The Workspace will follow an annual release cycle with major functional improvements being packaged in each emerging version.

**Task 3. QA/QC.** Data managers will review and verify that data sets submitted and metadata created by investigators conform to NPRB and GOAIERP data policy requirements. Data managers will work

directly with PIs through the GOAIERP workspace to edit metadata profiles in addition to modify data structures for data sets if required. These manipulations will most likely be driven by the needs of synthesis activities in addition to conforming to general practices regarding data structure optimization (data flattening, consistent units, explicit data types, non-concatenation of values within fields, etc.).

*Task 4. Prepare data and products for final transfer to NPRB.* At the end of the project, all data collected and organized through this effort and software applications developed to support the data management component of GOAIERP will be transferred to the NPRB office. AOOS data management staff will coordinate with NPRB staff and GABI members to coordinate this transfer as the GOAIERP effort comes to a close in year 3 in order to ensure a seamless transition. Following the conclusion of the project, AOOS will be able to provide public access to the GOAIERP data through the main AOOS Ocean Portal according to a mutually agreed upon timeframe.

*Task 5. Arrange for transfer of data to appropriate national data archives.* AOOS is expected to establish automated submission to several national data archiving centers (NODC and DataONE) during the timeline of this project for use by other projects in addition to the GOAIERP. If the automated transfer function is not completed by the conclusion of this project, data managers will package NPRB finalized datasets and metadata and submit these resources manually in the format required by the archives.

**Objective 3.** *Develop data discovery tools to access, query, analyze and visualize information relevant to and produced by GOAIERP PIs that meet the needs primarily of the research team, and secondarily, the needs of the larger scientific community, resource managers and the general public.*

This objective addresses Objective III (Data Discovery Development) of the detailed project scope section of the RFP.

Working with NPRB, GABI and GOAIERP outreach staff, AOOS will develop two independent tools for visualizing and querying data sets relevant to or produced by GOAIERP project activities. Both of these systems will leverage the substantial work already undertaken (and planned) by AOOS data management staff.

*Task 1. Develop the GOAIERP Data Discovery Search Tool as a search interface for filtering and discovering GOAIERP project information and data sets.* AOOS engineers will utilize the metadata and other contextual information that has been entered or created in the GOAIERP Workspace account to develop a series of search indexes utilizing a highly scalable technology called Elastic Search. Elastic Search is a Java-based distributed indexing scheme that allows entire collections of documents, databases, and flat files to be indexed via several dimensions. When implemented, collections of information can be searched rapidly by spatial queries, time, text patterns, parameter and taxonomy. An intuitive user interface will also be created which facilitates data discovery and access to information, metadata and data. AOOS is planning on deployment of their core search tool in early summer of 2012. The GOAIERP specific instance of this tool is slated to be released in August 2012.

*Task 2. Develop the GOAIERP Portal to provide an integrated visualization platform for spatially enabled GOAIERP project/program data superimposed with existing and future GOA data collected outside of the GOAIERP project and absorbed by the AOOS data system.* GOAIERP project descriptions, sampling activities, data sets and other products will be showcased via this interface while being coupled with models, sensor feeds and GIS datasets already under

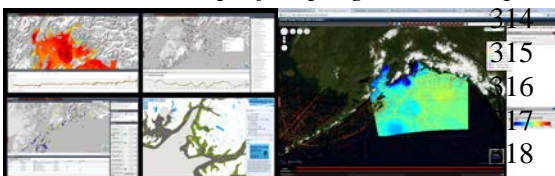


Figure 3. AOOS Data Portal.



the stewardship of AOOS (<http://data.aoot.org>). These resources and efforts are detailed more fully in the Coordination and Collaboration with Other Efforts section of this proposal. Figure 3 (on the left) provides screen captures of existing AOOS data portals that provide access to data management systems that manage sensors, models, remote sensing and GIS data layers. The AOOS Ocean Portal (AOP) provides a framework to rapidly deploy tools that are specific to regions, themes, management issues and emergency response and planning applications. The AOP is powered by geoserver, postgres, java services and several other systems running on a clustered data center with user interface tools written in flex. The AOP: Gulf of Alaska portal currently provides access to regional models, GIS datasets and sensor streams. Investigators plan to expand upon the AOP: Gulf of Alaska Portal to develop a stand-alone GOAIERP Portal that will showcase GOAIERP project efforts, data sets, models and other information. The GOAIERP Portal will be functioning at the beginning of this project (April 1<sup>st</sup>, 2012) but will not include GOAIERP specific data layers. GOAIERP project spatial footprints, project data and data sets utilized by the retrospective analysis activity will be added for the June 1<sup>st</sup>, 2012 release of this system.

### ***Partnerships and Ongoing Work which Contributes to the Objectives of this Proposal***

AOOS brings a significant amount of leveraged resources, infrastructure, regional marine Gulf of Alaska data management projects and partnerships to this proposed effort. The data management effort for the GOAIERP could not be accomplished for the budgeted amount by a team without these leveraged resources, even with the increase in funding approved for the second RFP. In particular, the following resources are leveraged:

1. Exxon Valdez Oil Spill Trustee Council – (\$1m over 5 years) for data management services to support Long Term Monitoring and Herring Research and Monitoring Programs. AOOS has been selected to provide core data management services for these two long-term (20 years expected in five-year increments) programs based in the oil-spill affected region of the Gulf of Alaska. The data management strategy to be utilized in the EVOS research projects parallels the strategy described in this proposal. As a result, aspects of both projects will greatly benefit from each other. For example, software development tasks for both the Ocean Workspace and discovery tools (GOAIERP Ocean Portal and GOAIERP Data Discovery Search Tool) will be coordinated across programs so that continuing development activities can simultaneously benefit both programs and resulting deliverables.
2. AOOS – (\$500k to AOOS DM per year for 5 years) for Alaska oceanographic data management effort. Supports open source, standards based data system that serves up and archives real-time sensor feeds, models & remote sensing applications, GIS data layers, and historical datasets. Data system developed on interoperability concepts and meets NOAA Integrated Ocean Observing System standards and protocols for streaming data feeds to national data assimilation sensors. A Data Management Committee chaired by Dr. Phil Mundy, Director of NOAA's Auke Bay Laboratory in Juneau, provides ongoing advice, prioritization and direction to the team at Axiom Consulting & Design. The AOOS board is made up of federal and state agencies, and major marine research institutions in the state that have committed to data sharing. The AOOS board has committed to supporting a statewide data system as a top priority.
3. PWSSC – PWSSC Data Management Project (\$60K to AOOS DM). Project involves the creation of a prototype data management system for use by PWSSC staff to manage, track, document via metadata and visualize oceanographic and biological data being collected at the center. Project will use a stack of open source technologies and protocols with the overall goal of creating a packaged solution for research organizations to better manage and document their data resources. This project is functioning as the pilot application for the AOOS project level data management system (AOOS Ocean Workspace).
4. NOAA High Performance Compute Incubator Program (\$95K to AOOS). Exploratory research to better understand effective approaches to serving out large complex model datasets to end users

and providing tools to visualize and mine these resources through web interfaces. Project will focus on the NPRB BSIERP Ecosystem Model (Al Herman) as a test case. The resulting capacities and understanding developed from this effort will be directly applicable to GOAIERP modeling output.

5. Northern Forum/USFWS Seabird Data System – (\$50K annually). Project involves the creation and population of a series of new seabird metric databases (diet and productivity) and integrating these new databases with legacy seabird databases (species distribution and abundance at seabird colonies, pelagic species distribution and abundance, USGS seabird monitoring databases and NPRB's North Pacific Seabird Diet Database). Modern spatially explicit, web based data entry interfaces have and continue to be developed to assist researchers existing in distributed agencies to contribute their historic and current seabird metric data into standard data structures. Project will result in vastly increasing the amount and quality of seabird species distribution, diet and other seabird data available for use in retrospective analysis and management. Though data includes areas around all of Alaska, most available data is located in GOA.
6. AOOS – (~\$200K to ADF&G). A 3-year funded partnership with ADF&G Division of Commercial Fisheries to develop data sharing and transfer to make commercial fisheries data more accessible, and to allow ADF&G researchers greater access to oceanographic data.
7. Cook Inlet Regional Citizens Advisory Council (\$27K). Contract with Axiom to develop a data management system for their oceanographic and contaminants data in Cook Inlet and incorporate into an ERMA (Emergency Response Management Application) type product.
8. AOOS – collaborator with Alaska Data Integration Working Group – an initiative with the Alaska Climate Change Executive Roundtable to develop protocols for serving up project data to increase data sharing among federal and state agencies.

## **Deliverables**

### ***GOAIERP Workspace - April 1<sup>st</sup>, 2012***

The GOAIERP Workspace will provide a web-based platform for PIs to post, share and discover data sets and rapidly author metadata. The system will be enabled with security authentication in order to limit access to GOAIERP investigators, project managers and administrators. The system will also provide PIs with tools to generate metadata profiles that comply with national standards. This system will be supported and cultivated throughout the project with several major modifications and upgrades planned. The expansion of the capabilities of the GOAIERP Workspace will be driven by feedback and input from GOAIERP team investigators, NPRB staff and GABI members.

### ***GOAIERP Portal - June 1<sup>st</sup>, 2012***

The GOAIERP Portal will be developed by building upon the [AOOS Ocean Portal: Gulf of Alaska](#), to deploy a data integration and visualization tool that will highlight GOAIERP projects and data products in addition to providing access to a large array of ancillary GOA data sets that are under the stewardship of AOOS. This portal will have a geospatial/mapping centric user interface that allows users to overlay a variety of data layers (Models, GIS, Sensor and GOAIERP project sampling data) simultaneously. Users of the portal will be able to access detailed GOAIERP project information coupled with regional models, sensor feeds and other GIS data sets. The tool will assist GOAIERP researchers, resource managers and the general public to access relevant GOA datasets. This tool will undergo several annual redevelopment cycles based upon user feedback.

### ***GOAIERP Data Discovery Search Tool - August 1<sup>st</sup>, 2012***

A second user interface/search tool will be deployed in August, which provides users with a more contemporary tabular style interface to GOAIERP project level data. This interface will allow users to query project profiles and metadata by time, parameter, species and spatial location. Significant work has

already been undertaken by AOOS data management staff to design and develop this system as a component of the core AOOS data system. The GOAIERP Data Discovery Search tool would build off of and extend this system which already under active development. This tool will undergo several annual redevelopment cycles based upon user feedback.

#### ***GOAIERP Data/System Transfer to NPRB and National Archives- April 1<sup>st</sup>, 2015***

The ultimate goal of this project is to provide services to assist in the organization, documentation and structuring of data collected and made available via GOAIERP activities so that it can be transferred efficiently to NPRB and made available for future use by researchers and other user groups. This will include an entire replica of the GOAIERP data archive and any software developed to support the GOAIERP project. Additionally, a replicate copy of finalized data will be submitted (automatically or manually) to NODC and DataONE national archive centers by the close of the project.

#### **Timeline and Milestones**

FY12 2nd Quarter	(Jan 2012 – March 2012)
January	Staff attend Alaska Marine Science Symposium
March	Rob Bochenek and Will Koeppen attend GOAIERP planning meeting
FY12 3rd Quarter	(April 2012 – June 2012)
April	Project authorized to begin
April	Release AOOS Ocean Workspace (Project DM System)
April	Meet with NPRB staff and GABI (project kickoff and scoping activities)
April	Set up user profiles, projects and permissions for PIs in GOAIERP Workspace
April	Begin transfer of 2011 field season datasets into GOAIERP Workspace
May	With input from NPRB/GABI, isolate ingestion tasks for retrospective data sets
June	Release Version 1 AOOS Ocean Portal: GOAIERP Portal
June	Audit complete for 2011 field season data sets and metadata
FY12 4th Quarter	(July 2012 – Sept 2012)
July	Initiate ingestion of retrospective data sets
August	Submit annual report to NPRB
August	Release GOAIERP Data Discovery Search Tool
FY13 1st Quarter	(October 2012 - December 2012)
November	Rob Bochenek and Will Koeppen attend GOAIERP planning meeting
November	Assess need for revisions to GOAIERP Workspace for 2013 field/cruise season
FY13 2nd Quarter	(Jan 2013 – March 2013)
January	Annual Alaska Marine Science Symposium
January	Release updated GOAIERP Workspace based upon user feedback
FY13 3rd Quarter	(April 2013 – June 2013)
May	Participate in annual PI meeting
June	Submit FY14 work plan for review
June	Release updated Ocean Portal: GOAIERP Portal (V2) based upon user feedback
June	Complete integration of salvaged retrospective data into AOOS DM System
FY13 4th Quarter	(July 2013 – Sept 2013)
August	Submit annual report to NPRB

465	August	Begin transfer of 2013 field season datasets into GOAIERP Workspace
466	August	Release GOAIERP Data Discover Search Tool (V2)
467		
468	FY14 1st Quarter	(October 2013 to December 2013)
469	November	Coordination meeting with GOAIERP Synthesis Team
470	December	Audit complete for 2013 field season data sets and metadata
471		
472	FY14 2nd Quarter	(Jan 2014 – March 2014)
473	January	Annual Alaska Marine Science Symposium
474	January	Release updated Ocean Portal: GOAIERP Portal (V3) based upon user feedback
475	February	Rob Bochenek and Will Koeppen attend GOAIERP planning/synthesis meeting
476	March	Prepare for absorption of secondary GOAIERP data products into DM system
477		
478	FY14 3rd Quarter	(April 2014 – June 2014)
479	June	Release updated Ocean Portal: GOAIERP Portal (Final Version) based upon user feedback
480		
481		
482	FY14 4th Quarter	(July 2014 – Sept 2014)
483	August	Submit annual report
484	August	Meet with NPRB and GABI to schedule and coordinate project close out (data and application transfer)
485		
486	August	Release GOAIERP Data Discovery Search Tool (Final Version)
487		
488	FY15 1st Quarter	(October 2014 to December 2014)
489	December	Rob Bochenek and Will Koeppen attend GOAIERP planning meeting
490		
491	FY15 2nd Quarter	(Jan 2015 – March 2015)
492	Jan	Start integration of secondary data products produced from synthesis activity
493	February	Audit secondary data products and metadata from synthesis activity
494	March	Initiate GOAIERP data and software application transfer to NPRB
495	March	Initiate/validate data transfer to AOOS and national archives
496		
497	FY15 3rd Quarter	(April 2015 – June 2015)
498	April	GOAIERP data and software application transfer to NPRB complete
499	April	Data transfer to archives complete
500		

## 501 **Management Approach and Personnel Qualifications**

### 502 **Molly McCammon – Executive Director, AOOS**

503 McCammon will function as the project’s administrative lead and ensure that all budget information and  
 504 project reports are submitted in a timely fashion and all deliverables are submitted consistent with the  
 505 final project contract. She will also participate in key GABI meetings and brief both the steering  
 506 committee and NPRB on GOAIERP relevant activities occurring in AOOS and the EVOS LTM/Herring  
 507 programs. McCammon has served as Executive Director of AOOS since 2003. Prior to that, she served as  
 508 Executive Director of the Exxon Valdez Oil Spill Trustee Council for 10 years.

### 510 **Rob Bochenek – Information Architect, Axiom**

511 Bochenek will function as technical lead, provide project management expertise and oversee all aspects of  
 512 the AOOS data management system. He will also supervise all staff in the AOOS data management  
 513 group. His extensive background in developing marine data management systems and the creation of user

interface tools will be key in reaching the objectives of this project. Bochenek graduated from the University of Michigan in 2000 with a Bachelor of Science Engineering in Aerospace Engineering and Bachelor of Science in Mathematics. He has been involved in data management for large scale federal and state scientific research efforts for the last 10 years. He started Axiom Consulting & Design to focus on broader multi-agency efforts to manage scientific data via an end-to-end systems approach.

#### **Will Koeppen – Senior Data Analyst, Axiom**

Dr. Koeppen will be responsible for core data management activities including review of data and metadata and interfacing with GOAIERP parties (GABI, PIs and NPRB staff) to refine and enforce data management protocols for the GOAIERP program. He has a Masters in Earth and planetary science from Washington University in St. Louis and a PhD in geology and geophysics from the University of Hawaii. He recently participated in several multi-week research cruises in which he provided data management stewardship over seismic reflection/refraction data and ocean acoustics in addition to deploying buoys, etc. in the mid-Pacific between Hawaii and Guam. His past research efforts encompassed georeferencing diverse datasets of varying scales, processing and quality control, statistical analyses, interpretation, and report writing for peer-reviewed publication. The data analyst will coordinate with GOAIERP researchers and work with the data sets they produce and assist with metadata generation/review activities. The data analyst will also lead the effort to isolate, prioritize and collate data sets deemed of potential value by PIs, GABI members or synthesis researchers. This position will also be tasked with integrating collated data sets into the GOAIERP Workspace to make these sets openly available to GOAIERP researchers.

#### **Shane StClair – Senior Data Analyst, Axiom**

Shane StClair will provide data management expertise in support of Dr. Koeppen and provide additional programming/database support for the software tools developed through this project. StClair will also facilitate the transfer of systems to NPRB at the end of this project. StClair has an extensive background in developing sophisticated biological and physical data management systems. He earned a Bachelor of Science degree in the biological sciences from the University of Alaska, Anchorage in 2002. He worked for the Alaska Department of Fish & Game from 2002 – 2006, participating in a large scale database management system project that involved data rescue, quality control, database design and functional programming for salmon data in the Arctic-Yukon-Kuskokwim region. From 2006 - 2008 he worked as a web application developer for the Exxon Valdez Oil Spill Trustee Council. StClair joined Axiom Consulting in 2008 as a software engineer and has been the lead developer on projects involving data management, geospatial visualization, and interoperability systems. His skill set includes knowledge of a variety of programming languages (Java, ColdFusion, Flex/Actionscript, JavaScript/jQuery, T-SQL, PSQL, HTML/CSS) and database platforms (SQL Server, Oracle, MySQL, Postgres/PostGIS), object oriented programming techniques, and a commitment to clean, maintainable code.

#### **Ross Martin –Software Engineer, Axiom**

Ross Martin will support and cultivate the GOAIERP Workspace and assist in administrating the cyber infrastructure which powers GOAIERP data management systems. Additionally, Martin will be the primary developer of the GOAIERP Data Discovery Search Tool. He received a double major at the University of Alaska Anchorage in Management and Management Information Systems and has been developing software professionally since 2006. Among his other projects, Martin has worked on applications for the Department of Defense and developed solutions for the financial industry that service thousands of users. He is experienced with building modern web applications and takes a keen interest in designing user interfaces for usability.



**Molly (Mary Elizabeth) McCammon**

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1007 West Third Avenue, Suite 100, Anchorage, Alaska 99501

**PROFESSIONAL EXPERIENCE**

**July 2003 – Present**

**Alaska Ocean Observing System (AOOS).** Executive Director.

***Responsibilities***

- Develop the Alaska regional component of the national Integrated Ocean Observation System (IOOS).
- Represent Alaska interests in National Federation of Regional Associations (NFRA) and further development of national IOOS.
- Work with Alaska members to establish an integrated system of ocean observations for Alaska to meet the needs of a wide variety of users, including mariners and fishermen, scientists, resource managers, search and rescue and coastal security operations, and educators.

**Other current projects**

**Co-PI for COSEE Alaska**, funded by NSF

**Lead PI, Regional Ocean Partnership planning tools project**, funded by NOAA

**Lead PI, Long Term Monitoring Program**, funded by Exxon Valdez Oil Spill Trustee Council

**1993 - 2003**

***Exxon Valdez Oil Spill Trustee Council.*** Executive Director.

***Responsibilities***

- Implement policies and direction of six-member, joint federal-state Trustee Council which is required to have unanimity for all decisions.
- Administer programs funded by \$900 million trust fund established by settlement of government claims against Exxon Corporation following 1989 oil spill, including annual work plans ranging in size from \$6 million - \$25 million a year.

***Major Accomplishments***

- Developed oil spill restoration program that is now viewed as an international model.
- Guided planning and successful review by National Academy of Sciences of ground-breaking long-term environmental monitoring program (Gulf Ecosystem Monitoring – GEM).
- Negotiated and implemented one of largest habitat acquisition programs in the nation and sustained it over nearly a decade of scrutiny by public officials and others.

### **Recent Professional Activities**

- 2011 – present, writing team, Alaska Regional Climate Assessment
- 2005 – Nov. 2011, national chair, National Federation of Regional Associations (NFRA) of Coastal and Ocean Observing; present – Executive Committee; 2003- present, Alaska representative to NFRA.
- 2006 – present, recently appointed member and past member 2006-2009 of national Ocean Research and Resources Advisory Panel; co-chair, ocean observing sub-panel.
- 2008 – present, member, National Academy of Sciences Polar Research Board.
- 2004 - present, Board member representing city of Anchorage and past President, Cook Inlet Regional Citizens' Advisory Council.
- 2004 – present, Alaska Sea Grant Program, Advisory Group member.
- 2005 – present, Fellow, Cooperative Institute for Alaska Research, University of Alaska Fairbanks.
- 2004 – 2006, member, National Research Council Committee to Establish an Arctic Observing Network.
- 2003 - 2010, Board member, Prince William Sound Science Center.

### **Past Experience 1984 – 1993**

Ten years experience in Alaska public policy, specializing in natural resources, fisheries, and Alaska Native issues, working for Alaska Governor Bill Sheffield, the Alaska Department of Fish and Game, Chief of Staff for Senate Finance Chairman John Binkley, and Senate Fisheries Committee aide.

### **Past Experience 1973 – 1984**

Reporter/writer for various news media and organizations.

### **Other**

1975 – 1984. Homesteaded in the western Brooks Range. Co-owner and operator, recreational guiding service.

### **Education**

B.A. in Journalism, University of California, Berkeley, 1973. Phi Beta Kappa.

**Rob Bochenek**  
rob@axiomalaska.com  
Work Telephone: (907) 230-0304  
523 West Eighth Avenue, Suite 202, Anchorage, Alaska 99501

## **PROFESSIONAL EXPERIENCE**

### **July 2006– Present**

**Axiom Consulting & Design, LLC** Information Architect.

#### ***Responsibilities***

- Provide information process assessment, data management/analysis and visualization services for wide variety scientific information. Software, database design and deployment services specializing in multi-tiered applications utilizing a wide array of available technologies custom fit to the project and client requirements. Clients include Federal, State and private entities.
- Development of data management systems, data portal user interfaces and data storage frameworks which communicate information with other data systems via interoperability protocols.
- Supervise four technical staff.

### **2003 - 2006**

**Exxon Valdez Oil Spill Trustee Council.** Data Systems Manager.

#### ***Responsibilities***

- Primary lead on development of EVOSTC data management policies dictating metadata, storage and utilization of biological, physical and economic data.
- Administrator/Primary Developer of all Exxon Valdez Oil Spill Trustee Council (EVOS) databases, network servers and data driven web applications.
- Developed, tested and deployed a 3-tiered intranet/extranet system to track project information, data and other deliverables. The information system was developed using SQL Server, Java, Cold Fusion, and Transaction SQL. Geospatial database functionality implemented through utilization of PostgreSQL database with PostGIS OGC compliant packages.
- Supervised an analyst programmer, responsible for budgets and advocating GEM Data Management agenda in various technical and user groups.
- Planned, deployed and installed a Windows 2003 network domain that included two file servers, database server, primary and backup domain controller, backup system, web server and firewall device. Configuration of all network services.

## **2001 - 2002**

***Alaska Department of Fish & Game*** Analyst Programmer

### ***Responsibilities***

- Created the division's first data system that was accessible through a dynamic data driven web application (intranet). Five Departmental databases (Escapement, Anadromous Waters Catalogue, Permits, and nominations) were consolidated into a SQL Server Database. This system provided a common portal to the databases that previously were accessed through distributed MS Access Databases. The centralization of data solved the Division's dilemma concerning dataset bifurcations. The middle and presentation tier were written in Java, transactional SQL and Cold Fusion. Access to this system was provided on a statewide scale.
- Restructured the Habitat Permit database by up-scaling the system from MS Access to SQL Server. Data structures were reorganized through normalization and relational table structures were modified to allow proficient indexing. Data was QA/QC'd. Access to the database was provided through the Division's intranet site.
- Provided technical documentation and presentations detailing the functionality of the intranet system to divisional employees.

### **Recent Professional Activities**

- 2007 – 2010 Member of the Alaskan Ocean Observing System Data Management and Technical Committee

### **Education**

B.S.E in Aerospace Engineering, University of Michigan, Ann Arbor, 2001.

B.S. in Physics, University of Michigan, Ann Arbor, 2001.

B.S. in Mathematics, University of Michigan, Ann Arbor, 2001.

# **William C. Koeppen, Ph. D.**

Earth and Ecological Science Institute  
1 University Place  
Orono, ME 04473

william.koeppen@gmail.com

## ***Education***

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Ph.D., Geology and Geophysics, University of Hawai‘i at Manoa, Honolulu, HI, 2008.  
Dissertation title: “Understanding the composition and evolution of the Martian surface using thermal infrared laboratory analyses and remote sensing.”

A. M., Earth and Planetary Science, Washington University, St. Louis, MO, 2003.

B. S., Magna Cum Laude, Geology/Physics, Juniata College, Huntingdon, PA, 2001.

## ***Employment***

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Director/Founder. Earth and Ecological Science Institute. Orono, ME, USA. (July 2009 – present)

Consultant. Technical Research Associates, Manoa Innovation Center, Honolulu, HI, USA. (October 2008 – present)

Postdoctoral Fellow. Hawai‘i Institute for Geophysics and Planetology, University of Hawaii. Honolulu, HI, USA. (May 2008 – June 2010)

Graduate Research Assistant. Hawai‘i Institute for Geophysics and Planetology, University of Hawaii. Honolulu, HI, USA. (June 2003 – April 2008)

Graduate Research Assistant. Earth and Planetary Science Department, Washington University, St. Louis, MO, USA. (June 2001 – May 2003)

Research Intern. Jet Propulsion Laboratory, Pasadena, CA, USA. (June – August 2000)

Assistant Field Geologist. Department of Geology, Juniata College, Huntingdon, PA, USA. (June – August 1999)

Field Station Assistant. Raystown Field Station, Juniata College, Huntingdon, PA, USA. (January 1997 – May 2001)



## ***Teaching Experience***

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Evolution of the Earth (1 of 2 TAs), Washington University, Spring 2003.  
Land Dynamics and the Environment (TA), Washington University, Fall 2002.  
Historical Geology (TA), Juniata College, Spring 2001.

## ***Honors and Awards***

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Best Paper, Oral Presentation, Tester's Memorial Symposium, 2006.

McDonnell Fellowship for the Space Sciences, Washington University, 2001-2003.

NASA Planetary Geology and Geophysics Undergraduate Research Program (PGGURP) internship. Jet Propulsion Laboratory, 2000.

National Security Education Program Boren Scholarship (for study abroad in India), Institute for International Education, 1999-2000.

Geological Society of America Undergraduate Student Research Grant, Northeastern Section, 1999.

## ***Professional Service & Organizations***

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Referee for: *Journal of Geophysical Research*, *Chemie der Erde*, *American Mineralogist*, *Polar Science*, *Geophysical Research Letters*

Session Chair (Martian Mineralogy), Lunar and Planetary Science Conference, 2006.

Member, American Geophysical Union (2001 – present).

Member, Geological Society of America (intermittent).

## ***University Service***

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Judge, 2008 Tester Memorial Symposium  
Workshop Presenter, SOEST Open House, October 2007 and 2009.  
Organizational committee, 2007 Tester Memorial Symposium.  
Workshop Presenter, Lacy Veach Day of Discovery, October 2006.  
Member, Department of Geology and Geophysics Graduate Studies Committee, 2004-2006.  
Judge, University of Hawaii Undergraduate Research Symposium, 2003-2006.

## ***Publications***

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### **Refereed Research Articles**

**Koeppen, W. C.**, E. Pilger, and R. Wright (2011), Time series analysis of low resolution thermal infrared satellite data for detecting thermal anomalies: a hybrid approach., *Bull. Volc.*, 73(5), 577-593, doi: 10.1007/s00445-010-0427-y.

**Koeppen, W. C.** and V. E. Hamilton (2008), Global distribution, composition, and abundance of olivine on the surface of Mars from thermal infrared data, *J. Geophys. Res.*, 113, E05001, doi: 10.1029/2007JE002984.

**Koeppen, W. C.** and V. E. Hamilton (2005), Discrimination of glass and phyllosilicate minerals in thermal infrared data, *J. Geophys. Res.*, E08006, doi:10.1029/2005JE002474.

Arvidson, R. E., F. P. Seelos IV, K. S. Deal, N. O. Snider, J. M. Kieniewicz, **W. C. Koeppen**, B. M. Hynek, M. T. Mellon, and J. B. Garvin (2003). Mantled and Exhumed Terrains in Terra Meridiani, Mars, *J. Geophys. Res.*, 108(E12), 8073, doi:10.1029/2002JE001982.

### **Journal Articles in Preparation**

**Koeppen, W.C.**, M. Patrick, T. Orr, J. Sutton, and R. Wright (in prep), The partitioning of Kilauea's lava between the surface and tube systems from satellite-based radiance and SO<sub>2</sub> measurements, *to be submitted to Bull. Volc.*

### **Recent Conference Presentations**

V. E. Hamilton, M. L. McDowell, and **W. C. Koeppen** (2010) Correlations between olivine abundance and thermal inertia: Implications for global weathering and/or alteration on Mars, *Lunar Planet. Sci. XLI*, Abstract #2239.

**Koeppen, W. C.**, R. Wright, E. Pilger (2009), MODVOLC2: A hybrid time series analysis for detecting thermal anomalies applied to thermal infrared satellite data, *Eos Trans. AGU*, 90(52), Fall Meet. Suppl., Abstract V24B-07.

Osterloo, M. M., V. E. Hamilton, F. S. Anderson, and **W. C. Koeppen** (2009), THEMIS detections of Forsterite-Fayalite Compositions within Terra Tyrrhena, *Lunar Planet. Sci. XL*, Abstract #1405.

**Koeppen, W. C.** and R. Wright (2008), Shaken But Not Erupted: Correlating MODIS Thermal Radiance Data With Seismic Activity Over Kilauea Volcano From 2000 To 2008, *Eos, Trans. AGU*, 89 (52), Fall Meet. Suppl., Abstract V51D-2074.

**Koeppen, W. C.**, and V. E. Hamilton (2007), Spatial and compositional variations of olivine in Terra Tyrrhena, *Eos, Trans. AGU*, 88 (52), Fall Meet. Suppl., Abstract P13D-1553.

- Hamilton, V. E., and **W. C. Koeppen** (2007), Global mineral maps of Mars: Examination of compositional variation within solid solution series, *Eos, Trans. AGU*, 88 (52), Fall Meet. Suppl., Abstract P13D-1549.
- Koeppen, W. C.**, and V. E. Hamilton (2007), Geologic setting of the olivine-bearing materials in Terra Tyrrhena, *Lunar Planet. Sci. XXXVIII*, Abstract #1134.
- Koeppen, W. C.** and V. E. Hamilton (2006), The distribution and composition of olivine on Mars, *Lunar Planet. Sci.*, XXXVII, Abstract #1964.
- Koeppen, W. C.** and V. E. Hamilton (2005), The global distribution of olivine on Mars: Forsterite to fayalite, Meteoritical Society Meeting, Abstract #5144, Gatlinburg.
- Koeppen, W. C.** , V. E. Hamilton (2004). Volcanism and/or Aqueous Alteration on Mars: Constraints on Distinguishing Glass and Phyllosilicate in the Thermal Infrared. *Lunar Planet. Sci.*, XXXV, Abstract #1457.
- Koeppen, W. C.** , V. E. Hamilton (2003). Glass and Phyllosilicate Obfuscation (and Clarification) on Mars. *Eos. Trans. AGU* 84 (46), Fall Meet. Suppl., Abstract P21B-0055.
- Koeppen, W. C.** F. P. Seelos IV., R. E. Arvidson, P.R. Christensen (2003). Terrain Distributions in Meridiani Planum and Probability of Sampling by the Mars Exploration Rover. *Lunar Planet. Sci.*, XXXIV.
- Koeppen, W. C.**, R. E. Arvidson, F. P. Seelos IV (2002). Hematite and Etched Terrain Distribution in Terra Meridiani, Mars. *Eos. Trans. AGU* 83 (47), Fall Meet. Suppl., #P72A-0492.
- Koeppen, W. C.**, Lehmann, D.F., Albright, A.L., Neese, M., and Jones, N. (2001) Comparison of red sandstone clasts in the Bald Eagle Formation to the overlying red Juniata Sandstone, Abstracts with Programs, *Geological Society of America*.

## ***Professional References***

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**Dr. Robert Wright** (postdoctoral sponsor), wright@higp.hawaii.edu, +00-1.808.956-9194  
**\*Dr. Victoria Hamilton** (academic advisor), hamilton@boulder.swri.edu, +00-1.720.240.0115  
**Dr. Michael Winter** (TRA supervisor), mikewinter@pacificspectral.com, +00-1.808.783.8457  
**Dr. Matthew Patrick** (HVO collaborator), mpatrick@usgs.gov, +00-1.808.345.0485

\*Please note that the references listed are in different time zones. Dr. Wright, Dr. Winter, and Dr. Patrick reside in Hawaii (GMT -10) and Dr. Hamilton resides in Colorado (GMT -6). Though you may contact them by phone, e-mail would be most convenient.

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## **PROFESSIONAL EXPERIENCE**

### **March 2008 – Present**

**Axiom Consulting & Design, LLC – Senior Software Engineer**

#### ***Responsibilities***

- Develop and maintain dynamic web based data entry and reporting systems for multiple clients. Utilized technologies include Java, ColdFusion, Microsoft SQL Server, PostgreSQL, Adobe Flex, Javascript, jQuery, Google Maps, OpenLayers, and Geoserver. Development process includes rapid development and deployment cycles with constant feedback from users.
- Developed prototype geospatial data portal using jQuery, Google Maps, ColdFusion and Geoserver. Prototype provides a proof of concept that disparate datasets can be simultaneously visualized on a map and filtered by common dimensions such as time.
- Develop specialized tools and software products as needed.
- Explore new developments in available technology and advise information architect on new products which can help achieve technical goals.
- Provide technical expertise to lead information architect and assist with project planning and strategy development.
- Assist other programmers with technical problems and strategy development.
- Assist in network and data center management.

### **September 2006 – February 2008**

**Exxon Valdez Oil Spill Trustee Council (EVOSTC) – Analyst/Programmer III**  
Anchorage, Alaska

#### ***Responsibilities***

- Maintained and developed the EVOSTC website. Added dynamic event management system, geospatial project description functionality, dynamic meeting audio and transcript management system, and document security system. Enhanced many aspects of existing project management system including dynamic project budget reporting system, automated email reminder system, automated system backups, and enhanced project search capabilities. Transformed website from a large number static pages to a manageable number of dynamic database driven pages.
- Digitized paper project reports, important publications, and audio recordings of meetings for publication on the website.

- Assisted data manager with network and database management tasks.
- Provided technical support to staff and meetings.

### **June 2002 – September 2006**

**Alaska Department of Fish & Game, Commercial Fisheries Division** – Research Analyst II  
Anchorage, Alaska

#### ***Responsibilities***

- Maintained and developed the Arctic-Yukon-Kuskokwim management area's dynamic website, developed tools to empower staff to publish news releases and reports, and assisted staff with document production.
- Developed a web based salmon scale inventory and management system, including dynamic filtering and scale check-out functionality.
- Aggregated, error checked, and standardized large quantities of salmon biological data into a Microsoft SQL Server database. Aggregation tasks involved scanning or hand keying archaic data sheets dating back to the 1960's. Developed web services to provide access to aggregated data.
- Assisted data management team in designing and populating a database management system housing salmon data. Data housed by the project included project metadata, escapement, aerial survey, and biometric datasets.
- Performed annual post-season herring fishery data analysis and forecast. Produced chart based and tabular outputs for managers to use in summary reports.
- Assisted commercial fisheries staff with various technical tasks as needed, including network management, document production, instrument programming and data analysis.

#### **Recent Professional Activities**

- October 2009 – Participated in the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) Web Portals Workshop in Portland, Oregon.
- June 2009 – Presented prototype data portal at the Copper River Strategy Group meeting in Gakona, Alaska.

#### **Education**

B.S. in Biological Sciences, University of Alaska Anchorage, 2002.

#### **Publications**

Brannian, L. K., S. Darr, H. A. Moore, and S. StClair. 2004. Scope of work for the AYK salmon database management system. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A04-29, Anchorage.



Brannian, L. K., S. Darr, H. A. Krenz, S. StClair, and C. Lawn. 2005. Development of the Arctic-Yukon-Kuskokwim salmon database management system through June 30, 2005. Alaska Department of Fish and Game, Special Publication No. 05-10, Anchorage.

Brannian, L.K., S. Darr, H. A. Moore, and S. StClair. 2005. Development of the Arctic-Yukon-Kuskokwim salmon database management system through 2004. Alaska Department of Fish and Game, Special Publication No. 05-04, Anchorage.

Brannian, L. K., K. R. Kamletz, H. A. Krenz, S. StClair, and C. Lawn. 2006. Development of the Arctic-Yukon-Kuskokwim salmon database management system through June 30, 2006. Alaska Department of Fish and Game, Special Publication No. 06-21, Anchorage.

Estensen J. L., S. St Clair. 2003. Pacific herring stocks and fisheries in the Arctic-Yukon-Kuskokwim region of the Bering Sea, Alaska, 2003 and outlook for 2004. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-37, Anchorage.

Hamner, H. H., S. Karpovich, S. StClair. 2003. Development Of A Shared AYK Salmon Database. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-23, Anchorage.

Hamner, H. H., S. Karpovich, S. St. Clair. 2003. Norton Sound salmon information database file inventory and problem review. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-01, Anchorage.

Hamner, H. H., S. St Clair, and H. Moore. 2004. An inventory of age, sex and length data for Norton Sound, Kotzebue, and Kuskokwim chum salmon. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A04-06, Anchorage.

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## **PROFESSIONAL EXPERIENCE**

### **April 2011 – Present**

**Axiom Consulting & Design, LLC** – Software Engineer

#### ***Responsibilities***

- Designed RESTful web application for creating geospatial metadata in accordance with commonly-used standards. Application leverages numerous modern technologies, including in-memory caches, Google Maps API, Backbone.js, and a stateless server design to allow for high availability and increased scalability.
- Created single-sign on solution using Facebook/LinkedIn OAuth services to facilitate rapid user adoption.
- Developed web-based HTML5 file storage application to provide online replication and access of data using PostgreSQL and OpenStack Swift.
- Implemented real-time system monitoring & notification system to assist in delivery of high-availability applications.
- Provided responsive client management and technical support.

### **January 2008 - May 2010**

**Alaska USA Federal Credit Union** – Programmer/Analyst III  
Anchorage, Alaska

#### ***Responsibilities***

- Deployed card activation/PIN change system, completing department's highest priority project for the year. Designed public web UI, and developed cross-system interfaces for communications with card management system, web banking system, internal core system, and phone-based IVR system.
- Developed member-facing anti-fraud positive pay application, fulfilling immediate requirement for large-scale customer acquisition. Introduced use of aspect-oriented programming framework, rich web controls, JQuery library and associated plugins.
- Created real-time activity monitoring web application for internal fraud department, eliminating developer workload for ad-hoc threat reports and expediting rapid response to security threats.
- Facilitated executive-level approval for advanced banking application redesigns through use of working prototype web interfaces utilizing AJAX for rich user experiences.

- Ensured smooth deployment of large-scale system upgrade to double operational capacity. Provided immediate break-fix support. Proposed and developed system monitoring interfaces to assist in peak-load planning and real-time troubleshooting.

### **June 2006 – September 2008**

**NorthWest Data Solutions** – Software Engineer  
Anchorage, Alaska

#### ***Responsibilities***

- Developed AJAX-powered web pages for a Department of Defense J2EE project using Struts, Hibernate, and the Dojo Javascript Toolkit.
- Developed standardized unit testing structure to increase code quality
- Mentored colleagues and assisted in application and data structure design
- Streamlined .NET project for Alaska Yellow Pages, decreasing user interface load time and enhancing usability.

### **May 2005 – August 2005**

**ConocoPhillips** – Summer Professional  
Anchorage, Alaska

#### ***Responsibilities***

- Developed web-service architecture for producing reports
- Created .NET web application to assist in tracking oil rig resources

### **Education**

B.S. in Management & Management Information Systems, University of Alaska Anchorage, 2006.

Scott Pegau  
Oil Spill Recovery Institute  
Cordova, AK



December 13, 2011

Re: AOOS Proposal to provide data management services for GOAIERP

I am writing in support of the Alaska Ocean Observing System's proposal to provide the data management services for NPRB's Gulf of Alaska Integrated Ecosystem Research Program (GOAIERP).

I serve as the Research Program Manager for the Oil Spill Recovery Institute based in Cordova. I am also the lead Principal Investigator for the Long-Term Herring Research Program recently funded by the Exxon Valdez Oil Spill Trustee Council (EVOSTC). This program focuses on the physical and biological parameters affecting the health and status of the PWS herring population, and is tightly linked with another EVOSTC program – the Long-Term Monitoring Program. Both of these programs are anticipated to be 20 years in length, funded in 5-year increments. AOOS was selected by the EVOSTC to provide data management services for these programs, and will also be collaborating with the National Center for Ecological Analysis and Synthesis, based at the University of California Santa Barbara, to prepare historic EVOSTC data for several major synthesis initiatives.

Having AOOS provide data services for the GOAIERP as well as the two long-term EVOSTC programs would be very beneficial since there is so much overlap in both the geographic region and the goals of the three programs in understanding environmental changes in the Gulf of Alaska marine ecosystem and its biological resources. Many of the same historic data sets will be critical to all three programs. Since typically, no program provides adequate funding for data management, it would help all of us to have the same data management group working for all three programs.

I have had four years of experience with the AOOS data team of Axiom Design. They are hard-working, creative, and very responsive to scientists' needs. I think they would do a good job for NPRB.

Sincerely,

W. Scott Pegau, PhD  
Research Program Manager  
OSRI



**UNITED STATES DEPARTMENT OF COMMERCE**  
**National Oceanic and Atmospheric Administration**  
**National Ocean Service**

National Centers for Coastal Ocean Science  
Center for Coastal Fisheries and Habitat Research  
Kasitsna Bay Laboratory  
2181 Kachemak Drive, Homer, AK 99603

December 13, 2011

Ms. Danielle Dickson, Program Manager  
North Pacific Research Board  
1007 West 3rd Avenue, Suite 100  
Anchorage, Alaska 99501

Dear Ms. *Danielle* Dickson:

I am writing in support of the Alaska Ocean Observing System (AOOS) proposal to provide data management services for the NPRB Gulf of Alaska Integrated Ecosystem Research Program (GOAIERP).

I serve as the Science Team Lead for a long term monitoring program recently funded by the Exxon Valdez Oil Spill Trustee Council (EVOSTC). This multidisciplinary program is a 20 year effort, funded in 5 year increments. It focuses on changes in pelagic and benthic ecosystems since the 1989 oil spill, and the influence of environmental conditions on those changes. It is tightly linked with another EVOSTC program - the Long-Term Herring Research and Monitoring Program. AOOS was selected by the EVOSTC to provide data management services for both of these programs. I am excited to have them do so because of the AOOS mandate and commitment to maintain an Alaska ocean data portal and repository.

Having AOOS provide data services for the GOAIERP as well as the two long-term EVOSTC programs would be beneficial, since the three programs overlap both in geographic region and in a goal to understand impacts of environmental changes in the Gulf of Alaska marine ecosystem. Synthesis of information from all three programs would be particularly facilitated by having the same organization provide data management and delivery services.

I have also worked with AOOS and Axiom on a Cook Inlet modeling workgroup and other projects and believe that they are highly qualified and understand the needs of working scientists. Please contact me at 907-235-4004 if you need any additional information.

Sincerely,

Kris Holderied, Director





Alaska Ocean Observing System  
1007 W. Third Avenue, Suite 100  
Anchorage, AK 99501  
907.644.6703 – phone  
907.644.6780 – fax  
[www.aoot.org](http://www.aoot.org)

March 27, 2012

Cynthia, Executive Director  
North Pacific Research Board  
1007 W Third Ave., Suite 100  
Anchorage, AK 99501

Dear Cynthia:

In a letter from you dated February 16, 2012 that we received March 13, you requested additional information on three items (system architecture, quality assurance/quality control, and security) pertaining to the AOOS proposal to supply data management services to the Gulf of Alaska Integrated Ecosystem Research Program (GOAIERP). Our response is attached. Please let me know if this is sufficient, or if you would like additional detail.

Sincerely,

Molly McCammon  
Executive Director

Cc: Danielle Dickson, NPRB  
Francis Wiese, NPRB  
Rob Bochenek, Axiom Consulting

## **Issue 1: System Architecture**

Our response is divided into two sections: a description of the system architecture of the overarching AOOS data system, and a description of the system architecture of the Ocean Workspace, the primary project data management system to be used for the GOAIERP project.

### **A. AOOS Data System**

The architectural strategy for the AOOS data system involves implementing an end-to-end technological solution which allows data and information to be channeled and distilled into user-friendly products while simultaneously enabling the underlying data to be assimilated and used by external information systems and national archive centers. The AOOS data system has been developed to emerging national and international technological advances and standards for interoperable systems that provide the greatest accessibility and usability for ocean data and information products.

The following diagram (Figure 1, Data knowledge pyramid) details the four logical technical tiers of our approach. At the base (Tier 1) of the pyramid lie the source data produced by researchers, instruments, models and remote sensing platforms which are stored as files or loaded within geospatial databases. Externally developed, open source interoperability protocols and systems (Tier 2), such as 52 North SOS, Web Map Services (WMS), Web Coverage Services (WCS) and Sensor Observation Services (SOS), are then implemented and connected to these underlying data sources. The asset catalogue (Tier 3) connects to internal interoperability systems in addition to known external sources of interoperable data and populates a database describing the dimensional characteristics (space, time, measured parameter and taxonomy) of each data resource. Web services developed by Axiom provides the connections to expose descriptive information contained in the asset catalogue database so that applications can integrate, visualize, query data sets across domains and data types. The final technical level (Tier 4) is composed of the web-based applications and tools which provide users access to data and products. Users sit at the top of the pyramid with all underlying systems working together to create a powerful and intuitive user experience. The intended result is the facilitation of rapid data discovery, improved data access, understanding, and the development of knowledge about the physical and biological environment.

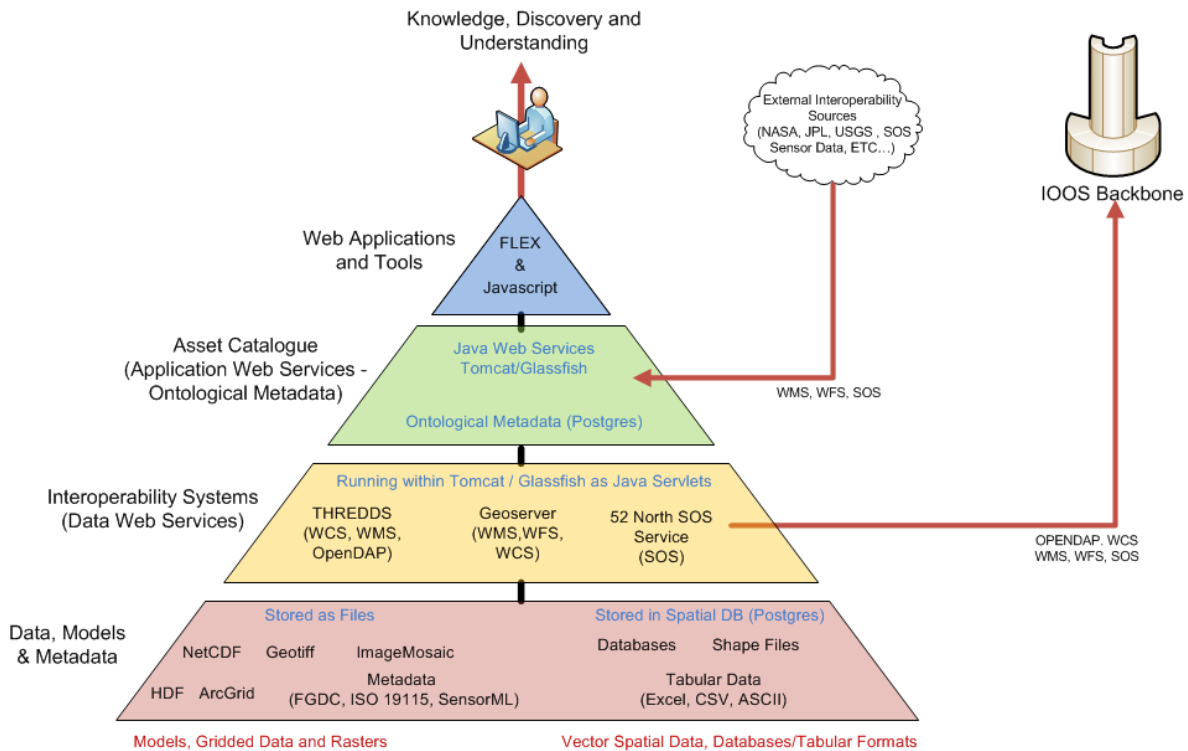


Figure 1. Data knowledge pyramid detailing the flow of data through logical technology tiers so that it can be consumed by users to enable discovery and understanding about the ocean environment.

Technical detail for the individual tiers is described below.

- Tier 1 (Data, Models and Metadata)** – At the base of the proposed data management framework are the datasets, metadata and model outputs that provide the foundation for applications and user tools. These resources can be stored either in native formats or spatially enabled databases. The decision to choose one method over the other is dictated by the requirements of the interoperability system which will be serving the data. Data which has a tabular or vector form (Shapefiles, databases, Excel spreadsheets, comma separated values (CSV) text files, etc.) will be loaded into a PostgreSQL database and spatially indexed. Geoserver, an open source geospatial data server, will then connect to the PostgreSQL database and serve the data via WFS and WMS protocols. Imagery, raster and model data will be stored in a file server in their native file formats. THREDDs and/or ncWMS will be used to serve NetCDF and HDF files which may contain two, three, four or higher dimensional gridded datasets. Geoserver will be utilized to serve GeoTIFF, ArcGrid, ImageMosaic and other two dimensional imagery/raster data.
- Tier 2 (Interoperability Systems)** – Various interoperability servers (Geoserver, THREDDs, ncWMS, 52 North SOS, etc.) will be implemented on top of source data. By design, these servers will expose a powerful set of interfaces for other



computing systems and humans to extract, query and visualize the underlying source data. These systems will facilitate all aspects of data delivery to users in addition to providing the muscle for the machine-to-machine data transfer to national IOOS systems as required. Because these systems have been developed using the Java programming language, they run within a servlet container such as Tomcat or Glassfish.

- **Tier 3 (Asset Catalogue, Ontological Metadata and Services)** – The asset catalogue provides a description of known internal and external available data resources, access protocols for these resources (interoperability services, raw file download, etc.) and directives on how to ultimately use these data resources in applications. Because documentation and access methods vary widely between data sources, a system that catalogs data sources and reconciles these inconsistencies must be implemented if the data are to be used in an efficient manner.

In addition to managing information about data availability and access methods, the asset catalogue will also contain an ontology (i.e., a description of relationships between data sets) that maps source data descriptions and metadata to a common set of internally stored terms with strict definitions. This mapping allows users to easily locate related sets of information without having explicit knowledge of the internal naming conventions of each data-providing agency. The development of an internal ontology will also enable future endeavors to connect the asset catalogue to global ontologies in the semantic web. The following dimensions are to be stored in the database for mapping the heterogeneous characteristics of source data to common metrics:

- **Source** – Service URLs and methods of interaction for these services.
- **Data formats and return types** – Data format returned by the service and how data can be equated between various formats.
- **Space (x, y, z)** – Spatial dimensions of dataset (1D, 2D, 3D). Upper and lower spatial bounds (bounding box or cube)
- **Time (t)** – For data resources with a time component: document time span, whether time corresponds to a single moment or if it is representative of a time period. If data is in discrete periods, document individual available periods.
- **Taxonomy** – Taxonomic data mapped to International Taxonomic Information System (ITIS) codes.
- **Parameter** – Parameter(s) and units in the data resource and how they map to internally defined universal terms. For example: Datasets SST, AVHRR, and Sea Surface all contain parameters that map to internal universal term Sea Surface Temperature.

Web services written in the Java programming language will be developed to connect to the asset catalogue and provide applications with access to the underlying descriptions of all known data sources. Because the asset catalogue

contains a structured ontological definition of data sources and maps all known data sources to a common definition, applications can be developed which connect users to vast arrays of data through simple but powerful interfaces. The following is a list of example functionality that is possible utilizing this methodology:

- Users can load multiple data layers (potentially existing in different physical locations and being served by different systems) onto a single web based map. Users can also filter all layers simultaneously by time or request spatial and temporal subsamples of data that can be pulled from multiple sources and automatically packaged into a single download.
- All real time sensor feeds can be accessed and visualized on a single uniform user interface by parameter even though the sources of the sensor feeds may exist in a wide array of formats and service protocols.
- Users can query the asset catalogue to discover which data is available for an area, time period, parameter and species.
- **Tier 4 (User Applications)** – Users interface with web based applications that bring together combinations of underlying data and allow users to make discoveries, improve understanding, and develop knowledge through visualization and data access. These types of applications would most likely be interactive map based data portals. Applications will also be developed which provide specific targeted functionality. These focused applications could include marine spatial planning tools, emergency response applications and educational/outreach portals. All developed tools are designed to meet user needs and thus require user input into their initial design and periodic feedback to direct functional improvements for future design iterations.

## **B. Ocean Workspace**

The Ocean Workspace is a web-based data management and scientific collaboration tool especially designed by AOOS based on our experience with other scientific collaboration tools. It uses several open source technologies, some of which are clustered software systems that can horizontally scale for improved performance and redundancy. The Ocean Workspace is composed of the following technology stacks:

- Database Systems - Postgres 9 (<http://www.postgres.org/>) is used for storage of schema-based data representations and spatial data (postgres extended with postGIS). Data is replicated across two physical database servers for redundancy, high availability and performance.
- Object Storage and Schema-less data representations – MongoDB (<http://www.mongodb.org/>) is used as a persistent NoSQL storage and query system for file objects, tabular data (flat structures) and hierarchically structured data (generally XML). MongoDB allows horizontal scaling through ‘sharding’ and redundancy and security through ‘replication’. Interacting and querying data from a MongoDB instance is much like interacting with a database except it is much more flexible and scalable and includes a hadoop style map to reduce

processing. AOOS/Axiom operates a mongoDB instance that is composed of 15 data storage nodes that include five sharded data representations, which include three redundant replicates of each shard. There are other server components for MongoDB but these are not persistent data stores and include routing and mongo DB Servers.

- Web Services – Web services are developed using Java and integrated into a web application framework called Play (<http://www.playframework.org/>) which provides a stateless architecture for Java and Scala development. The RESTful (stateless) components of Play! allow services to be horizontally scaled across application nodes for load balancing.
- User interface – Includes several enterprise Java Script and HTML 5 libraries and integrates with several server side modules wrapped into the Play! Framework.

## **Issue 2: QA/QC of Data and Metadata**

The AOOS/Axiom data management team plans to apply several forms of QA/QC procedures to both data and metadata. This being said, GOAIERP PIs are also expected to apply internal QA/QC procedures during data collection and analysis. Additionally, many data issues may not become apparent until synthesis activities commence, thus requiring a certain level of QA/QC to be undertaken by researchers performing those synthesis activities.

Specifically, AOOS data management staff will audit data and metadata as it is submitted to the Ocean Workspace system and, provide feedback to PIs regarding best practices for data structure and alert PIs to missing metadata fields. Metadata will be verified for syntactic completeness by using various metadata verification tools (<http://geology.usgs.gov/tools/metadata/>) employed within the Ocean Workspace environment. Data management staff will review the semantic content of metadata to ensure that it accurately describes the corresponding project and data files. An additional focus of this effort is to develop visualization tools within the Ocean Workspace for the most prevalent data formats, which can serve as one of the most effective and automatic methods for QA/QC of data files.

## **Issue 3: Security**

The AOOS Ocean Workspace is a secured web portal that allows access only to explicitly authorized individuals. It is distinctly different from the public-facing AOOS portal available at [www.aos.org](http://www.aos.org). Data posted to the GOAIERP instance of the Ocean Workspace will only be available to those parties who are members of the GOAIERP effort. This will include GOAIERP researchers, relevant NPRB staff, and AOOS/Axiom data management staff. All transfer of data and information through the Workspace will occur over https/ssl encrypted channels. Additionally, data files submitted to the Workspace are stored on at least three different physical servers in Anchorage for redundancy and disaster recovery. AOOS data management staff members are implementing geo-replication of data and services between the clusters existing in Anchorage with a mirror site in Portland, Oregon by June 2012 for even further redundancy and security.