Developing the Next Generation Marine Mammal Information Center for Integrated Ocean Observing: OBIS-SEAMAP 2.0

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LONG-TERM GOALS

Our ability to mitigate adverse interactions with marine mammals and other protected marine species is dependent on direct access to high-quality data sets, ecological models and expert knowledge. The OBIS-SEAMAP program (http://seamap.env.duke.edu) is designed specifically to make such information available to the research, education and management communities. Over the past four years OBIS-SEAMAP has successfully developed a multi-function information system to provide critical data to scientists, managers and educators under the NOPP program. Our continued efforts with this renewal directly support the goals of the Census of Marine Life (CoML), the OBIS network, the International Ocean Observing System (IOOS) and the operational missions of multiple agencies and educational user communities. For example, data products developed by OBIS-SEAMAP form the fundamental data stream required for the development of marine mammal habitat models for use by the U.S. Navy and are essential for the further development of this and other advanced decision support systems.

OBJECTIVES

The central work-plan for this renewal is to conduct a strategic expansion of the OBIS-SEAMAP information system in depth, breadth, functionality and usage. The specific objectives we propose are directly targeted to support more robust analyses and management of marine mammal populations. In addition to maintaining the existing system on a growth trajectory, we plan to target five new specific focal areas:

1. Data gap analysis and prioritized expansion of the marine mammal geodatabase;
2. Inclusion of new data types (acoustics, photo-ID, 4D telemetry, model outputs and turtle nesting);
3. Expanded functionality with mapping, species profiles, metadata, and web services;
4. Seamless interoperability with IOOS/GEOSS ocean observing community; and

5. Development of new partnerships focusing on data and technology.

APPROACH AND WORK PLAN

The approach and work plan can best be described by the five focal areas listed above. Funding began this August, after the proposed May begin date. So we adjusted our timeline and have just three months of a reporting period to share. PIs Patrick Halpin and Andrew Read are overseeing all aspects of the work. Specific staff and students are further mentioned below.

The Data Gap Analysis and Targeted Data Acquisition will highlight database gaps in time, space and species. A primary question we aim to address is how well OBIS-SEAMAP data coverage represents existing records globally. We are conducting a multi-step, detailed analysis by first summarizing all dataset holdings in OBIS-SEAMAP. Initial summaries include the geographic location of all observations and effort and sightings by taxon (i.e., marine mammals, sea birds, sea turtles). Next, we will seek external assessments to ensure that we are cognizant of all existing data. We will solicit outside taxa experts to review our coverage. They will be asked to help identify additional/missing datasets and to refine data searches within geographic gaps. Within each taxa, we will further investigate observations temporally (i.e., month, season, and decade) and by platform (boat, plane, tag, shore) to identify specific geographic and temporal gaps. A comprehensive literature and online database review will inventory potential high quality datasets and contributors which have not yet been targeted. This search will focus on identified geographic, taxa and temporal gaps, as well as U.S. marine managed areas such as the National Marine Sanctuaries and exclusive economic zone (EEZ). We will then formally request contributions from key dataset contacts. A final analysis will delineate critical areas for future research, especially with respect to protection and oceanic variability. This effort is being led by Connie Kot with significant assistance from Lucie Hazen, Ben Best and Ei Fujioka. Work for this first year involves development of tools to merge datasets, analysis, literature searching and submission of a synthesis manuscript. Collection of datasets will continue throughout the life of SEAMAP.

Development of the five new data types requires domain-specific expertise working with the technical team (Ei Fujioka, Ben Best and Ben Donnelly) to implement the appropriate data structures and interfaces. For the (1) Acoustic Location Data type, PhD student Lynne Williams, who works with a CSWTR Naval acoustical monitoring project, will be advising. A dedicated acoustician will also be hired this project year. In addition, a workshop is planned for this first year. Kim Urian, as curator of the Mid-Atlantic Bottlenose Dolphin Photo-ID Catalog (MABDC), is facilitating the (2) Photo-ID Data type. A workshop of curators of other collaborative Photo-ID catalogs of different species will be held in 2008 where the prototype web-based system developed for the MABDC will be presented. In this workshop, we will engage in a dialog with these participants to determine their needs and address their concerns, particularly regarding issues of data access and intellectual property rights. In-house expertise for the (3) Advanced Telemetry Data may be filled by two post-doctoral researchers: Andre Boustany, an expert in tagging tunas through the TOPP (http://topp.org) program, and Ari Friedlander who has vast experience with marine mammal tagging, especially using the latest DTAGs from Woods Hole Oceanographic Institution (WHOI). Ben Best will be integrating (4) Model Outputs beginning with the predictive cetacean habitat models from Duke, Southwest Fisheries Science Center (SWFSC) and Geo-Marine Inc. Finally, (5) Turtle Nesting Data type is currently under extensive reviews by Karen Eckert, Scott Eckert and Wendy Dow from the Wider Caribbean Sea Turtle Conservation Network (WIDECAST) as well as partner data providers. The complete web interface will be

demonstrated at the 2008 International Sea Turtle Symposium in Loreto, Mexico in February and feedback from the Symposium will be dealt with thereafter.

Many technical innovations are additionally planned to expand the functionality of the site, including: Web Services for Dataset Extraction; Environmental Sampling; Species Attributes; Populating Metadata Clearinghouses; Access Control; Background Layers; Non-Redundant Data Harvest from Portals; and Development Environment. All of these will be led by the technical team (Ben Best, Ei Fujioka and Ben Donnelly).

New partnerships will be sought in various fields. We have already initiated and exchanged dialogue with (1) Avian Knowledge Network hosted by Cornell University (AKN, http://www.avianknowledge.net/content/) for potential data exchange between AKN and OBIS-SEAMAP, (2) Marine Wildlife Behavior Database organized by University of Rhode Island (http://mwbd.edc.uri.edu/) in anticipation of a new data type (animal behavior), and (3) Google to further innovate visualization of marine data. Now that the WIDECAST data is about to be made public, we will reinstate partnership with Status Worldwide of Turtles (SWOT), aiming for the integration of SWOT and WIDECAST data.

WORK COMPLETED

Much work has been done on the backend technical side to provide a reliable and scalable development environment. Project management software is now being used for code versioning, bug tracking, and milestone scheduling. A common LDAP database manages access control across services and machines. Redundant servers have been installed which mirror the data remotely on newly purchased mass storage, i.e., between Beaufort and Durham. Machine virtualization software (VMWare) is now being used for backup/recovery and development purposes across newly purchased servers. Software upgrades and commensurate data migration are complete (Linux Centos 5), nearly finished (PostgreSQL 8.1) or planned (Plone 3).

Additional technical aspects have furthered higher goals. Tools for database querying and display of taxa distribution maps were honed for the gap analysis. A prototype PhotoID system has been developed featuring two functions, one of which is a Dolphin Browser page that provides easy browsing of dorsal fin images organized by research site. The other is an on-line Verification Form which allows contributors to monitor the match status from other contributors (Figure 1). An online mapping feature has been developed for sea turtle nesting data. Oceanographic data (sea surface temperature, height, chlorophyll, geostrophic currents and wind) have been harvested from online archive centers and are ready to be consumed by the SEAMAP internet mapper.

As for new data acquisition, since August 1, we have acquired seven new datasets (Table 1). It should be noted that a massive subset of European Seabirds at Sea (ESAS), which easily doubles the SEAMAP data holding, was registered into the OBIS-SEAMAP database and will be published soon.

Table 1. Datasets added to OBIS-SEAMAP since August 2007, bringing the total to 209 datasets with 1.2 million records.

Dataset name	Provider	# Records	Note
Cape Cod Sea Turtle Release 2007	Connie Merigo	100	Harvested from Satellite Tracking and Analysis Tool
EPIC Caribbean Lesser Antilles Seabird Colony Atlas 2001-04	Environmental Protection in the Caribbean	126	
European Seabirds at Sea - JNCC All Trips	ESAS	1,123,101	Will be published soon. This dataset is excluded from the total figures in the text.
Harbour porpoises, white-beaked dolphins and minke whales in North Sea - Land surveys -	Caroline Weir	103	
Harbour porpoises, white-beaked dolphins and minke whales in North Sea - Vessel surveys -	Caroline Weir	71	
Ivory Gulls from Northern Greenland	GREA	5,215	Harvested from Satellite Tracking and Analysis Tool
Sangalaki Green Turtles Tracking	WWF Indonesia	78	Harvested from Satellite Tracking and Analysis Tool

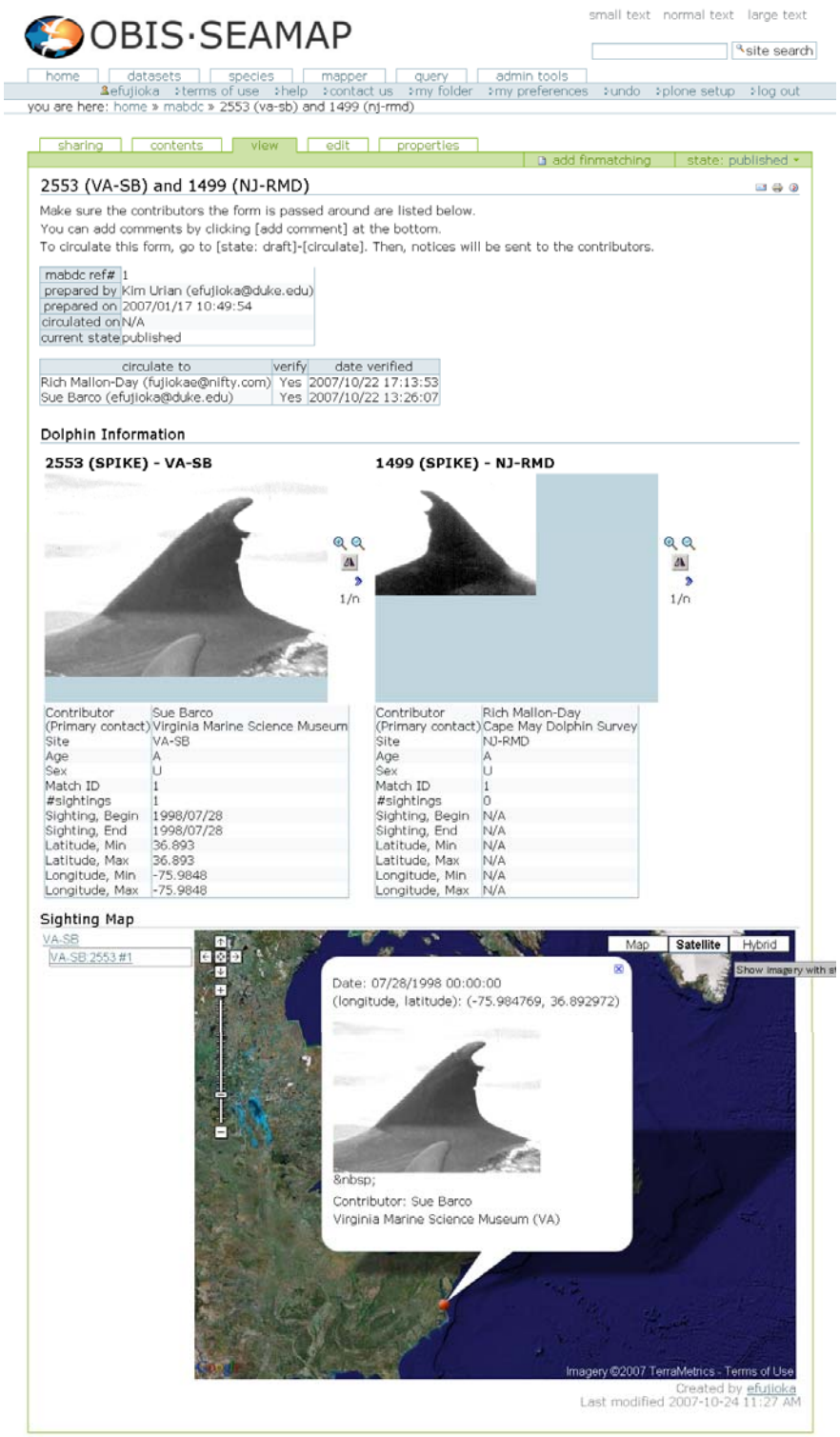

Figure 2. Photo ID Data Type. The Potential Match Form brought up by the curator is integrated with the on-line Verification Form, which is equipped with a sophisticated online workflow model. Once verified, the sighting information and images of the matched dolphin from different sites are linked in the central Photo-ID Catalog, allowing contributors to use OBIS-SEAMAP mapping tools to examine temporal and spatial movement patterns of individual dolphins that frequent multiple sites.

RESULTS

Our paper, "Application of Geospatial Web Services within a Scientific Workflow: Predictive Modeling of Marine Mammal Habitats" (Best et al, 2007), published in the October issue of Ecological Informatics, represents a project landmark. This paper details the synergy between the OBIS-SEAMAP program and a SERDP-funded marine mammal predictive habitat modeling project.

IMPACT AND APPLICATIONS

Science Education and Communication

The addition of environmental background layers to the SEAMAP site is anticipated to encourage exploration and visualization of the marine mammal, seabird, and sea turtle data. These layers will also allow SEAMAP uses to gain a better sense of the ocean environment in which marine mammals, seabirds, and sea turtles are found and will foster scientific inquiry. The addition of environmental background layers to the SEAMAP site is anticipated to have real value for exploration and visualization of marine mammal, seabird and sea turtle data.

TRANSITIONS

Science Education and Communication

While in attendance at the Census of Marine Life All Hands Meeting in Auckland, it became clear that the use of web services and scientific workflows will have great importance for synthesizing data across the Census of Marine Life field projects. From microbes to whales, we anticipate spreading these technologies across the Census with a separate project devoted to mapping and visualization.

RELATED PROJECTS

A SERDP-funded project for predictive marine mammal habitat modeling (http://serdp.env.duke.edu) is now in its last of 4 years. This project consumes the scientifically collected survey data from the OBIS-SEAMAP database. The synergy between these two projects is the subject of our recent publication (Best et al, 2007).

A new project on the Census of Marine Life Mapping & Visualization (M&V) (http://comlmaps.org) will assist individual field projects with M&V as well as promote synthesis across the Census. The technical and social lessons from SEAMAP will contribute greatly to this project's success.

PUBLICATIONS

Best, B. D., P. N. Halpin, E. Fujioka A. J. Read, S. S. Qian., L. J. Hazen, and R. Schick. 2007. Application of Geospatial Web Services within a Scientific Workflow: Predictive Modeling of Marine Mammal Habitats. Ecological Informatics. *Ecological Informatics*. 2 (3): 210-223.