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Acoustic Metadata Management and Transparent Access to Networked Oceanographic Data Sets

Marie A. Roch
Dept. of Computer Science, San Diego State University
5500 Campanile Drive, San Diego, CA 92182-7720
Phone: (619) 594-5830 FAX: (619) 594-6746 E-mail: marie.roch@sdsu.edu

Simone Baumann-Pickering
Scripps Institution of Oceanography
University of California at San Diego
9500 Gilman Dr., La Jolla, CA 92093-0205
Phone: (858) 534-7280 FAX: (858) 534-6849 E-mail: sbaumann@ucsd.edu

Catherine L. Berchok
Alaska Fisheries Science Center, National Marine Fisheries Service
National Oceanic and Atmospheric Administration, Department of Commerce
7600 Sand Point Way N.E., Building 4
Seattle, Washington 98115-6349
Phone: (206) 526-6331 FAX: (206) 526-6615 E-mail: Catherine.Berchok@noaa.gov

John A. Hildebrand
Scripps Institution of Oceanography
University of California at San Diego
9500 Gilman Dr., La Jolla, CA 92093-0205
Phone: (858) 534-4069 FAX: (858) 534-6849 E-mail: jhildebrand@ucsd.edu

Erin M. Oleson
Pacific Islands Fisheries Science Center, National Marine Fisheries Service
National Oceanic and Atmospheric Administration, Department of Commerce
1601 Kapiolani Blvd, Ste. 1110
Honolulu, Hawaii 996814
Phone: (808) 944-2172 FAX: (808) 941-0307 E-mail: Erin.Oleson@noaa.gov

Sofie M. Van Parijs
Northeast Fisheries Science Center, National Marine Fisheries Service
National Oceanic and Atmospheric Administration, Department of Commerce
166 Water Street, Woods Hole, MA 02543
Phone: (508) 495-2119 FAX: (508) 495-2258 E-mail: sofie.vanparijs@noaa.gov

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LONG-TERM GOALS

The long-term goals of this effort are to produce software capable of organizing and archiving metadata associated with the detection of marine mammals. The software provides a workbench for researchers to integrate queries for both biological and physical data by providing mediation services to support queries that cover networked data sets in manners similar to those used for querying the acoustic data.

Archiving of non-acoustic measurements such as conductivity, temperature, and depth (CTD), as well as other modalities of observation is supported as well. The data is to be accessible from a variety of languages used by the scientific community for analysis and modeling.

OBJECTIVES

The objectives of this effort are to produce:

1. A database which can flexibly store multiple types of metadata derived from a variety of acoustic platforms, both stationary and mobile.
2. Standardization of methods to make the data repositories useful to the passive acoustic monitoring community.
3. Secure access on network platforms using industry standard security protocols.
4. Visualization primitives in selected analysis and modeling languages (e.g. Matlab, R).
5. Access methods for the above languages.
6. Primitives to query data both spatially and temporally in an efficient manner.
7. Demonstration projects to show the value of the database as a scientific workbench component.

APPROACH

1) Technical approach

The acoustic metadata database enables researchers to organize, store and most importantly query information derived from passive acoustic monitoring (PAM). Due to the large number of acquisition platforms, types of detection effort, etc., structuring these data is a complicated semi-structured task and traditional databases do not meet the needs of PAM users. By compiling a large team of PAM users who work on a global scale, we are defining data standards that are likely to meet the needs of the PAM community in general. Networking capabilities provide the ability to share data and eventually export summary data to OBIS-SEAMAP. In addition, this effort provides users with access to online physical oceanography databases using a single interface. The project also provides access methods for a variety of computer languages used for analysis by the scientific community.

2) Key Personnel

Dr. Marie A. Roch (San Diego State University) is the project manager and administrator for this project. She also takes the lead for software development.

Dr. John A Hildebrand (Scripps Institution of Oceanography (SIO)) is the project manager for the subaward to SIO.

Drs. Simone Baumann-Pickering (Scripps Institution of Oceanography), Catherine L. Berchok (NOAA Alaska Fisheries Science Center (AFSC)), Erin M. Oleson (NOAA Pacific Island Fisheries Science Center (PIFSC)), Melissa Soldevilla (NOAA Southeast Fisheries Science Center (SEFSC)), and Sofie Van Parijs (NOAA Northeast Fisheries Science Center (NEFSC)), all represent data providers who will be using the database and are integrally involved in the operational specification, requirements, and testing.

Dr. Simone Baumann-Pickering is providing the lead on habitat modeling, and Dr. Sofie Van Parijs is the project manager for NOAA as well as the lead on data standardization.

3) Work plans for the upcoming year

Plans for the coming year include advocacy for the platform, an internal workshop in Spring 2013, development of spatial-temporal query indices, implementation of the data level security model, and discussions with Ei Fujioka of Duke University on formats for OBIS-SEAMAP export. Further work is required on the mediator models to support automatic translation of queries from units to indices based on the data grid.

WORK COMPLETED

Significant progress has been made on establishing data standards over the last year. Our spring meeting focused on using the database with live data and determining how the data design could be improved from our prototype to better meet the needs of the community. To this end, a revised schema has been implemented. Naming of species has been standardized using the integrated taxonomic information system (www.itis.gov), and the ability to map back and forth between local names or abbreviations has been added. Work on call standardization is ongoing, with the mysticete suborder nearly completed and the odontocete suborder in progress. Development of a user manual is ongoing, with sections focusing on both administrative and user roles.

We now support mediator interfaces to NOAA's Environmental Research Division's Data Access Program (ERDDAP) and queries can now access a wide variety of environmental variables such as ice coverage, salinity, etc. Finally, we have developed a new data import facility. Recognizing that many people have their own tool sets, we wanted to make it as easy as possible to import data into Tethys without requiring programming knowledge. Users can write a mapping file that specifies correspondence between data fields in other formats (e.g. relational databases, spreadsheets) and Tethys will handle the import. The interface has been tested for Excel workbooks and MySQL and is being extended to other data sources such as Access, comma-separated value files, and other database providers.

RESULTS

The ability to access a wide variety of data sources significantly enhances Tethys's ability to assist researchers conducting passive acoustic monitoring studies. An illustration of this can be seen in work that analyzed beaked whale echolocation signals from high frequency acoustic recording packages (Wiggins and Hildebrand 2007) deployed at 26 different sites across the Pacific (Baumann-Pickering et al. 2012) over a four year period (Figure 1). A combination of automated and analyst detections resulted in detections from approximately eleven years of acoustic effort being incorporated into the analysis. Species labels were assigned for species whose echolocation signals have been described in the literature. Based on spectral and temporal characteristics, the remaining unknown signals were grouped into classes (see Baumann-Pickering et al. 2012 for details), and relative presence for all signal types at each deployment site was determined (Figure 2) as well as diel and lunar patterns for each of the different echolocation types. Analysis of spatial distributions of the unknown call types coupled with analysis of visual sightings and stranding records of lesser understood beaked whale species permitted hypotheses with respect to the species that might have produced each unknown call echolocation signal type.

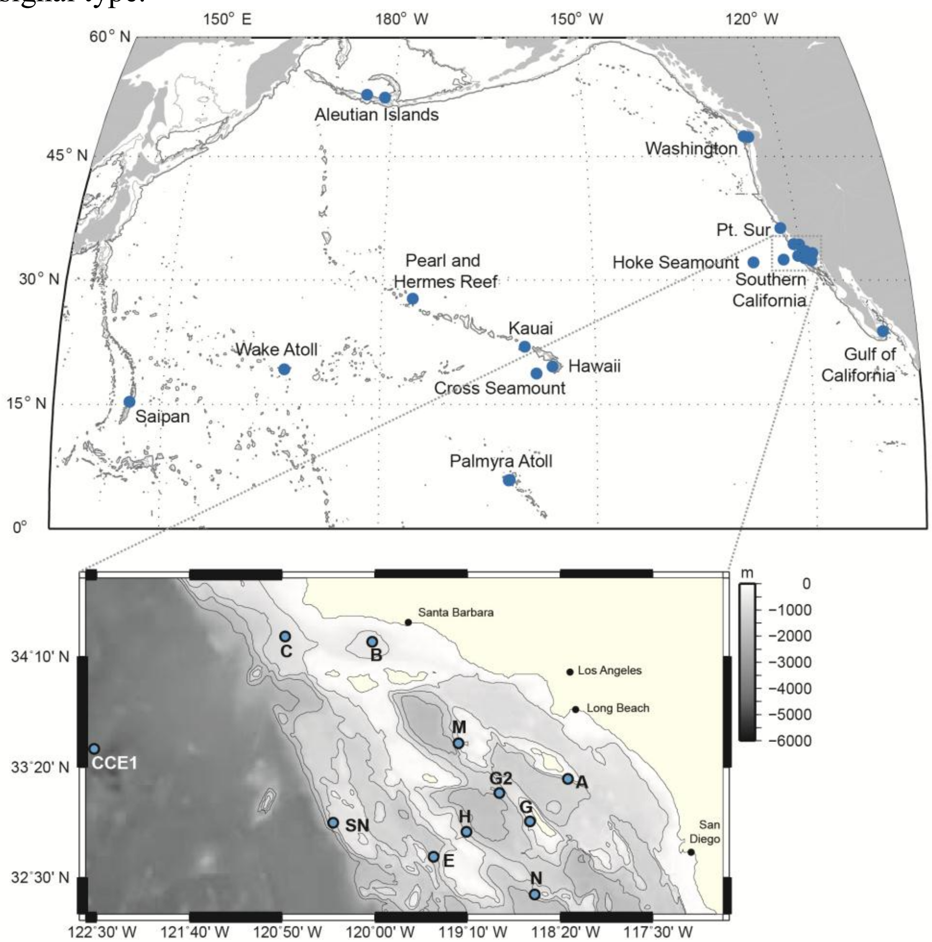

Figure 1 – HARP deployment locations in the Northern Pacific and Southern California Bight (inset). (Baumann-Pickering et al. 2012)

IMPACT/APPLICATIONS

Widespread adoption of Tethys has the potential to reduce the amount of time needed for data preparation and greatly increase productivity as demonstrated in the beaked whale study highlighted this year and the anthropogenic noise study in last year's report.

RELATED PROJECTS

ONR N0001411WX21401 – Advanced Methods for Passive Acoustic Detection, Classification, and Localization of Marine Mammals. PI Jonathan Klay, Dave Mellinger, Dave Moretti, Steve Martin and Marie Roch. Outputs from this project will be in a form that can be easily fed to the Tethys database.

N00014-12-1-0273 – Modeling of Habitat and Foraging Behavior of Beaked Whales in the Southern California Bight, PI John Hildebrand, Simone Baumann-Pickering – The work performed in this grant makes use of Tethys and has overlapping key personnel.

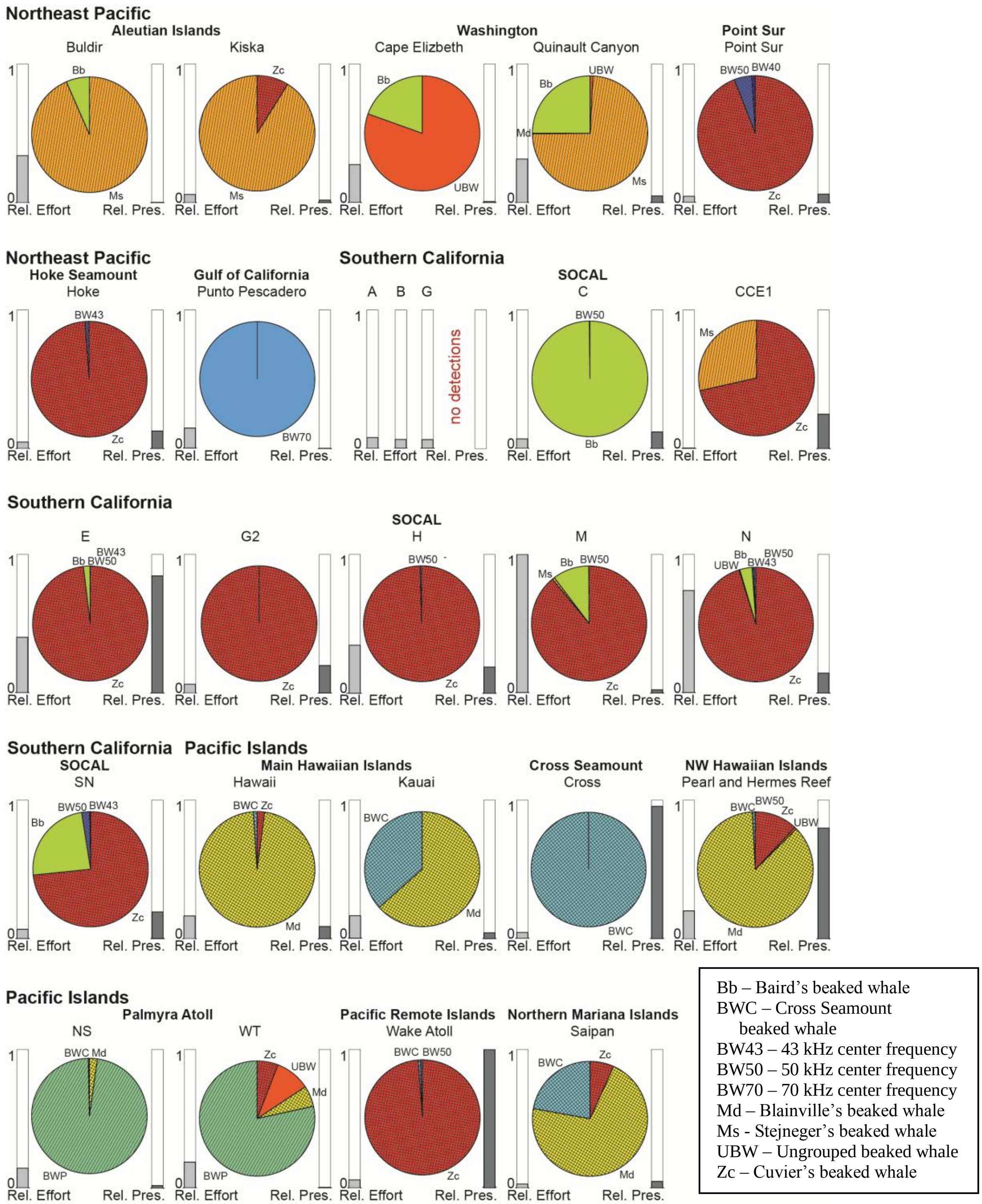

Figure 2 – Beaked whale relative composition for each species/echolocation type based on duration of acoustic encounters at HARP sites throughout the Pacific (Baumann-Pickering et al. 2012). For each chart, relative effort (left) provides a measure of the amount of acoustic effort relative to the site with the longest deployment (site M). Relative presence (right) indicates how often the animals were present relative to the site with the highest duration of acoustic encounters (Wake Atoll).

N000141210904 – Blue and fin whale habitat modeling from long-term year-round passive acoustic data from the Southern California Bight, PI John Hildebrand, Ana Širović. – The work performed in this grant makes use of Tethys and has overlapping key personnel.

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Baumann-Pickering, S., A.E. Simonis, M.A. Roch, M.A. McDonald, A. Solsona-Berga, E.M. Oleson, S.M. Wiggins, R.L. Brownell Jr, J.A. Hildebrand (**2012**) Spatio-temporal patterns of beaked whale echolocation signals in the North Pacific.Intl. Whaling Commission**,** Panamá, Panamá. SC/64/SM21, 16 pp.

Wiggins, S.M., J.A. Hildebrand **(2007**) High-frequency Acoustic Recording Package (HARP) for broad-band, long-term marine mammal monitoring, Intl. Symp. Underwater Tech., Tokyo, Japan: 551-557, doi: 10.1109/UT.2007.370760

PUBLICATIONS

Baumann-Pickering, S., A.E. Simonis, M.A. Roch, M.A. McDonald, A. Solsona-Berga, E.M. Oleson, S.M. Wiggins, R.L. Brownell Jr, J.A. Hildebrand (**2012**) Spatio-temporal patterns of beaked whale echolocation signals in the North Pacific.Intl. Whaling Commission**,** Panamá, Panamá. SC/64/SM21, 16 pp.