Animal telemetry network data assembly center: Phase 1

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LONG-TERM GOALS

This project is part of a broader on-going collaboration between IOOS and the animal telemetry community. IOOS and ATN participants are currently updating a 5-year strategic plan that describes this collaboration, including the phased development of a sustainable ATN Data Assembly Center (or DAC) for data collected by the growing U.S. community of marine animal taggers or biologgers. The revised strategic plan presents a broad vision for an animal telemetry network as a core component of IOOS that will:

- Facilitate the organization of local animal telemetry systems into confederated regional nodes;
- Facilitate integration of animal telemetry instruments with existing observing systems;
- Improve data standards, management, sharing capability and establish a cyber- infrastructure for archiving and displaying telemetry data;
- Serve as a focal point for the development of new sensor technology;
- Bring permanence and sustainability to a national telemetry network; and
- Expand animal telemetry outreach and education programs.

OBJECTIVES

As set forth at the onset of the project, the project goals are:

- To establish an ATN data assembly center with a data portal and visualization tools to enable public access to data/metadata from marine animal tags;
- Applying existing IOOS DMAC data standards, vocabularies and other established DMAC protocols and services; and
- Ensuring the initial version is also compatible with established international programs that distribute data from tagged marine animals including Australia's Integrated Marine Observing System (IMOS) and Canada's Ocean Telemetry Network (OTN).

The project objectives are to:

- Establish in approximately 12 months, a scalable data portal that successfully enables public access to selected data from marine animal tags (Archival, Satellite and Acoustic) and from several marine animals (Fish, Sharks, Mollusks, Marine Mammals, Turtles and Seabirds);

- Deploy this portal on an existing, dedicated, stand-alone computer server at Hopkins Marine Station in Pacific Grove with backup at Stanford University in Palo Alto, CA and the NOAA PMEL facility in Pacific Grove, CA;
- Ensure the provision of priority core functions including data storage, downloading and archiving, delivery of priority user-defined data products, and implementation of quality control improvements

APPROACH

Based on technical recommendations from two U.S. IOOS Program (IOOS) hosted national Animal Telemetry Network (ATN) workshops, and a recent successful collaboration between IOOS, the U.S. Navy and NOAA's National Weather Service on improved access to observations from tagged marine animals, IOOS, including Regional Associations, and the U.S. Navy (Naval Oceanographic Office and Office of Naval Research) have identified the need for a national and publicly accessible ATN data management capability, including the sustained delivery from anywhere in the world of real-time/near real-time marine animal telemetry data to a web-accessible portal with data visualization tools and timely data delivery to IOOS Data Management and Communications (DMAC) web services and the WMO Global Telecommunication System (GTS). This Statement of Work (SOW) describes the initial phase for establishing this capability.

Co-funded by US IOOS and the US Navy's Office of Naval Research, this project set out to establish an initial capability for public access to and use of data collected from tagged marine animals. The work was executed at Stanford University's Hopkins Marine Station by scientists and computer programmers from Stanford's Tagging of Pacific Predators (TOPP) program in collaboration with NOAA Fisheries in Southwest Fisheries Science Center Environmental Research Division (SWFSC/ERD). The project builds on substantial existing capabilities of the TOPP program and SWFSC/ERD data management and distribution tools including refinements funded by NOAA to support the Damage Assessment, Remediation and Restoration Program (DARRPA) phase of the U.S. Government's response to the Deepwater Horizon Oil Spill in the Gulf of Mexico.

The U.S. IOOS Program hosted ATN workshops in 2011 and 2012 with the nation's marine animal tagging community to identify opportunities for collaboration and to advance the concept of a national marine animal telemetry network. Subsequent reports document recommended priorities, highlighting in particular a community need to adopt standards-based protocols for data from tags. Based largely on these recommendations, IOOS has worked closely with data providers and users to describe standards for data format and content, and to promote the use existing tools for data sharing. For example, a project conducted with Stanford University and co-funded by IOOS and the Office of Naval Research (ONR) provided improved access to physical oceanographic data from elephant seal satellite tags to ocean modelers at the Naval Oceanographic Office (NAVOCEANO) and at the National Centers for Environmental Prediction in NOAA's National Weather Service. Data from 350 historic tags and two live/active tags were made accessible to NAVOCEANO modelers and 8,138 observations were successfully downloaded and assimilated.

Future phases of this work, currently being proposed, will add more data to the portal and enhanced capabilities for data access, distribution, archiving, analysis and visualization based in part on requirements defined in the first steps of this project and on user feed-back when the initial product is deployed.

WORK COMPLETED

On Wednesday, Sept. 3, the ATN DAC development team, led by Stanford University Professor Barbara Block and including Dr. Randy Kochevar (project manager, Stanford), Alan Swithenbank (database manager, Stanford) and Lynn DeWitt (information technology specialist, NOAA ERD), provided a walk-through demonstration of the project status (deemed ATN DAC beta, v. 0.9). In attendance were: Dr. Hassan Moustahfid (NOAA IOOS), Dr. Mike Wiese (ONR), Dr. Leslie Rosenfeld (MBARI, CenCOOS), Dr. Dan Costa (UC Santa Cruz) and Jennifer Patton (CenCOOS). The goals of the meeting were to review the overall project goals set forth in July, 2012 when the ATN DAC concept was first described, as well as the specific milestones and deliverables defined in the ATN Data Node Phase I Statement of Work and the ATN DAC Deliverables (April, 2014).

The ATN DAC leverages off several systems within the TOPP data product delivery network to provide data to the ATN DAC interface. The data delivery processes include direct postreSQL database queries, accessing ERDDAP servers, and extraction from automatically generated standard delimited data files. Those data are unified within the ATN DAC system then delivered to the ATN DAC interface.

In its beta form, the ATN DAC provides a clean and intuitive Google Maps-based user interface with simple, color-coded icons for various sensor types: satellite tags, implanted archival tags, pop-up satellite archival tags, acoustic receiver buoys and autonomous buoys with acoustic receivers. For each platform type, the user can display additional data (e.g., animal or glider track, acoustic detections) and metadata (platform type, date and duration of deployment) by simply clicking on the icon. An icon click also presents the user with a variety of additional options, which vary by platform. These include: display or download PDT or fluorometry data, display or download tracking data, display or download detection data, view data in ERDDAP server, etc.

RESULTS

At the time of the demonstration, the ATN DAC provided access to several thousand animal tracking datasets collected through the TOPP and GTOPP programs, as well as Atlantic bluefin tuna tagged through the Tag A Giant program and billfish tagged through the IGFA Great Marlin Race program. In all, 48 different species are represented, with deployment dates ranging from 2000-2014. In addition, the interface provides access to acoustic buoy detection data from 20 receivers located in 13 different sites – most of which are in the US and Canada, but also including Palmyra and the Chagos Archipelago. There is also a placeholder in the data structure for archival glider data, and three such datasets are being processed for display.

While the default view of the interface shows the most recent data (users can select from 10, 30 or 180 days), the interface features a pull-out “Data Menu” which allows them to view or hide datasets from all these species and platforms by clicking check-boxes arranged in a hierarchical, nested structure - similar to that used in Google Earth to activate and deactivate various data layers. For example, a user can view all the blue whale tags by clicking a single box; or they can drill down to individual deployment years (e.g., to display all the tags deployed in 2004), or even down to individual tags (tag number “2204001-2306-MatePTT”). At the individual tag level, users can also view, download or access the data through an ERDDAP server, all directly from the Data Menu (i.e., without having to locate that specific tag on the map first.)

In the time since the project launch, there have been a number of additions and refinements to the ATN DAC interface, including:

- Addition of the ability to show or hide all currently active tracks in the current view with a single click
- Addition to clear all animals from the current view
- Improved metadata displays for acoustic buoys
- Enhanced data displays for acoustic buoys

We are also currently working to improve the oceanographic profile displays on the real-time elephant seal data displays, as well as improving the handling of miniPAT tag data. We anticipate that these tasks will be completed before the end of December.

In addition to the interface improvements listed above, we are completing installation of a new primary server for the system, which includes updated hardware and software to improve overall system performance, stability and security.

We are now in the process of finalizing the statement of work for Phase 2 of this project, which will include additional improvements to system infrastructure, increased metadata in compliance with IOOS standard formats and nomenclatures, and the development of tools to allow integration of datasets from outside TOPP (e.g., MARES).

IMPACT/APPLICATIONS

Phase I of the ATN DAC development was intended primarily as a prototype, to demonstrate the capability of a system to serve data from a wide variety of platforms used in animal telemetry. We successfully accomplished this task, and we can now move forward with a more operational implementation of the system, which will include the ability to integrate external data (i.e., data from users outside of the Block Lab/TOPP program) into the ATN DAC. As we expand and refine this system, our hope and expectation is that the data it contains will gain greater use by the broader community of marine biologgers as well as biological, physical and chemical oceanographers and ocean modelers who can use the data these animals provide.

As we continue to expand and refine the ATN DAC system, one goal will be to begin to train users in how to take advantage of the functionality of the system. For example, NAVO is currently using the real-time GTS feed from the elephant seal SMRU tags to pull the data from these animals into their oceanographic models. This could also be accomplished using an ERDDAP server, which can feed real-time (or near-real time) data in a variety of formats, simply through the use of restive URLs that can be incorporated into software systems (e.g., MATLAB code) to query data in the ATN DAC. The power and flexibility of the ERDDAP server is one of the

RELATED PROJECTS

The ATN DAC project builds on a decade of work done in the Tagging of Pacific Predators (TOPP) program, for which the TOPP data management system was first developed. The software for this system was further refined and improved for the GulfTOPP system, used in the NOAA National Resources Damage Assessment process following the *Deepwater Horizon* oil spill, and many features

in the ATN DAC were first developed as part of the GulfTOPP effort. We are also using many of the data processing and management tools in collaboration with the International Game Fish Association for our IGFA Great Marlin Race project; the data from which are being incoroporated in their entirety into the ATN DAC. We are also using animal telemetry data in a variety of public education and outreach projects, including NSF-funded Ocean Tracks and Ocean Tracks: College Edition programs, the Concord Consortium's NSF-funded Common Online Data Analysis Platform (CODAP) project, and the Exploratorium's NSF-funded Living Liquid exhibit development program. In all of these cases, discussions are happening about how to either leverage or tie in to the ATN DAC to facilitate greater and more efficient data delivery to educators, students and the general public that uses these resources.

REFERENCES

(None cited)