

# Integrated Management and Visualization of Animal Telemetry Observations



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# Outline

- **Opening Remarks**
  - AT data applications
  - Complexity (different type of telemetry tags and many needs)
  - IOOS ATN Data Flow vision
- **IOOS ATN DAC**
- **Closing remarks and next steps**
- **Wrap up, Q/A**



# Benefits of AT Data

## Education and Outreach

Improving Ocean Forecasts

Defining Essential & Critical Habitats for Spatial planning

Providing Real-Time Monitoring of Animals

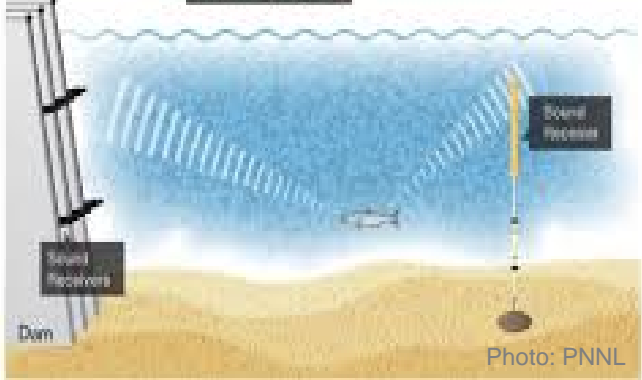
Improving Fisheries Management

Protecting Endangered Species

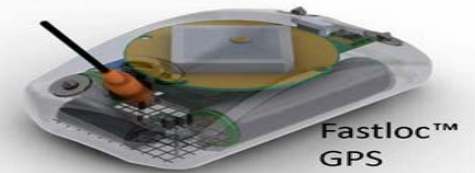




# Many tag types



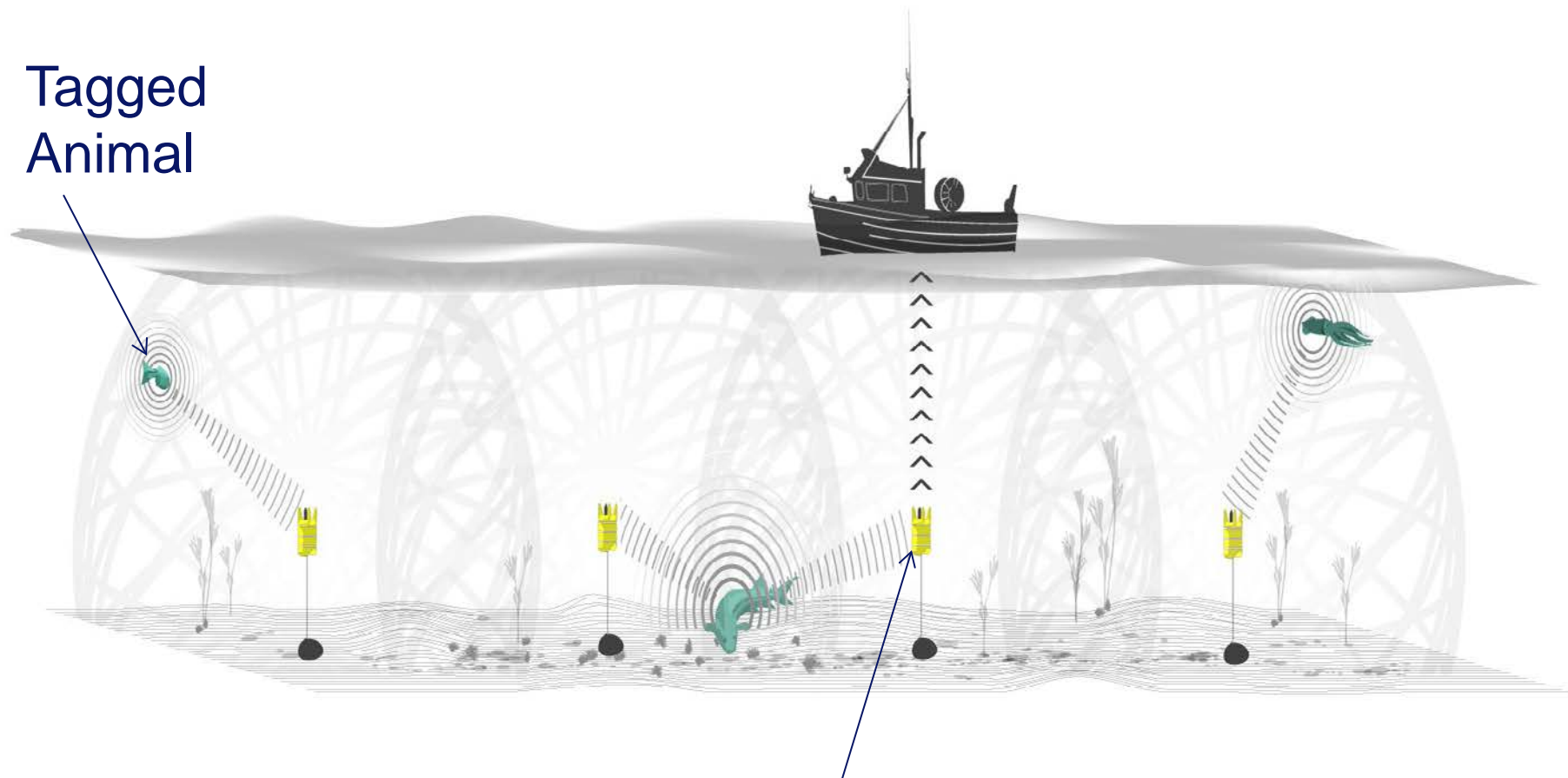
Satellite Relay Data Logger (SRDL)



Fastloc™ GPS



Tagged  
Animal



Acoustic  
Receiver



Image Credit: POST

# Challenges of Animal Telemetry Data

## e.g. Acoustic Telemetry Data

- Three interlocking parts (Receiver Metadata, Tag Metadata, and Detections) must be assembled to recreate an animal track
- Must keep track of Receiver Histories
- Metadata may be fairly complex:
  - Instrument attributes (e.g. tag and receiver programming)
  - Positions and position errors
  - Time (tracks)
  - Quality control
  - Attribution for objects served
  - Some of the receivers are carried by other large animals and Gliders.



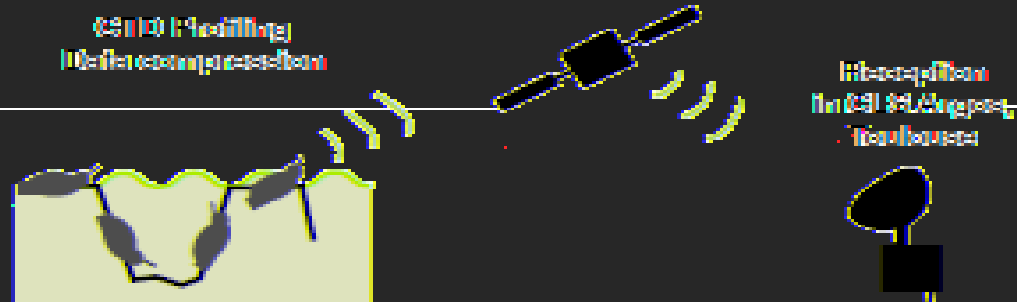


# Procedures of collecting oceanographic data (Hydrographic profiles) from CTD SRDL tags on e-seals or Sharks

Deployment on land

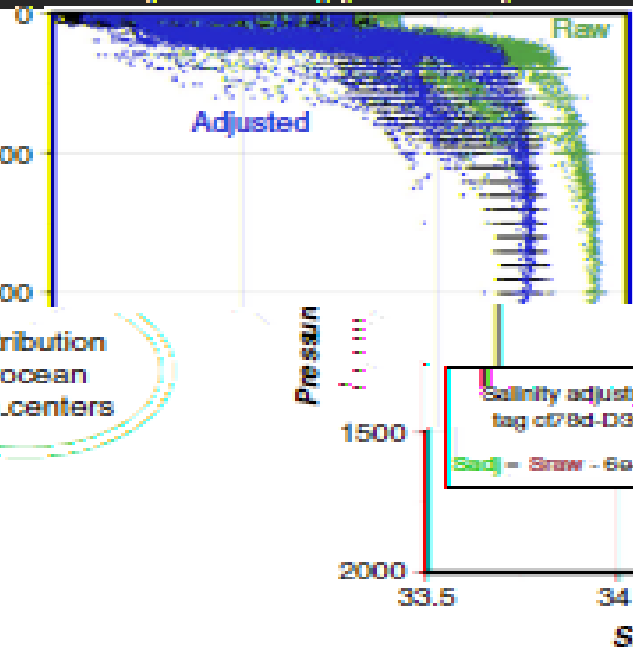


ARGOS transmission  
(Size location)



Interception  
for CTD SRDL tag post-processed  
results

Plotting the CTD SRDL tag post-processed results



Post-processing of CTD data

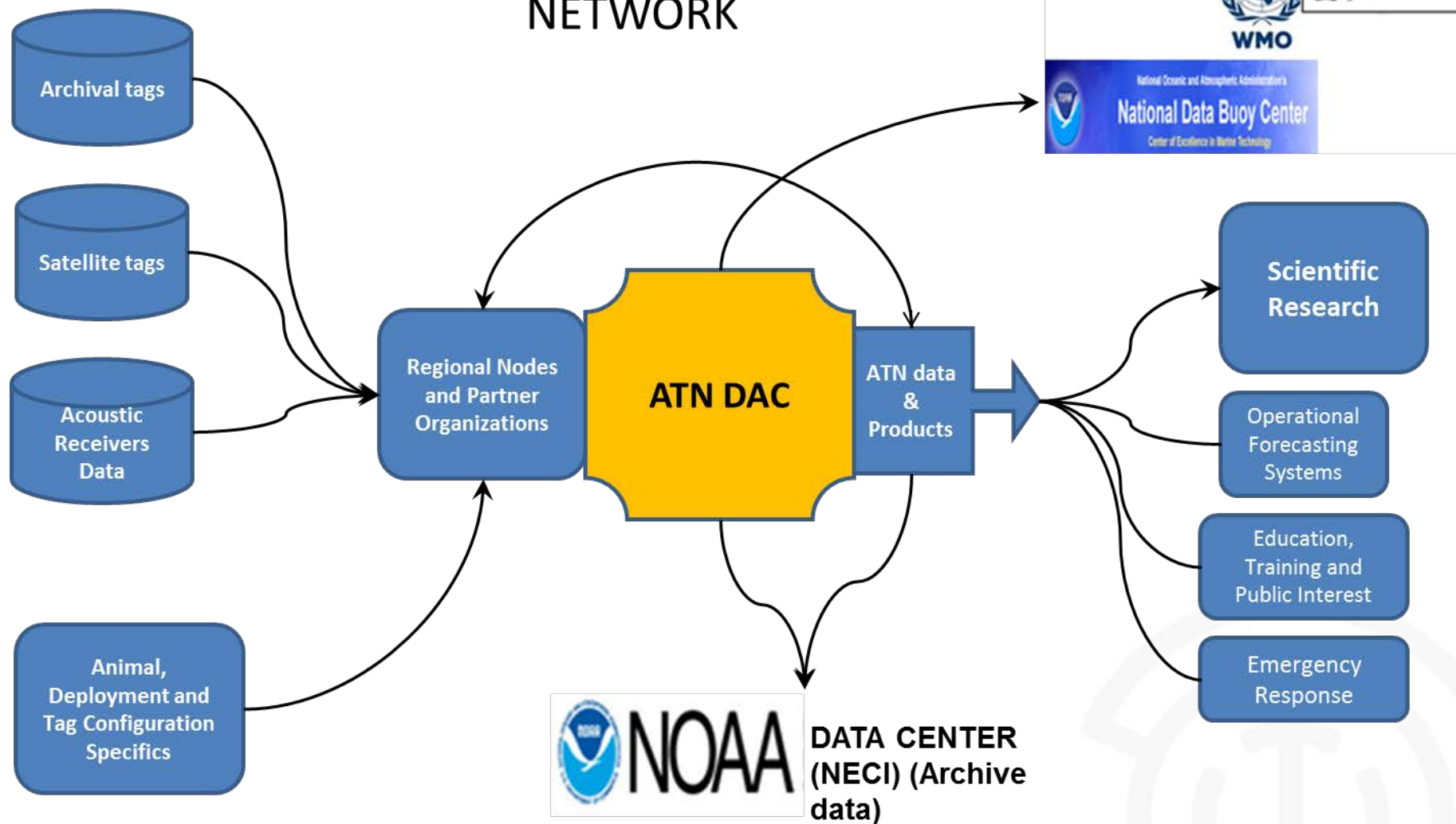


Data extraction

Storage at SMRU  
Distribution to JGS

Distribution to ocean data centers

# DATA FLOW FOR ANIMAL TELEMETRY NETWORK

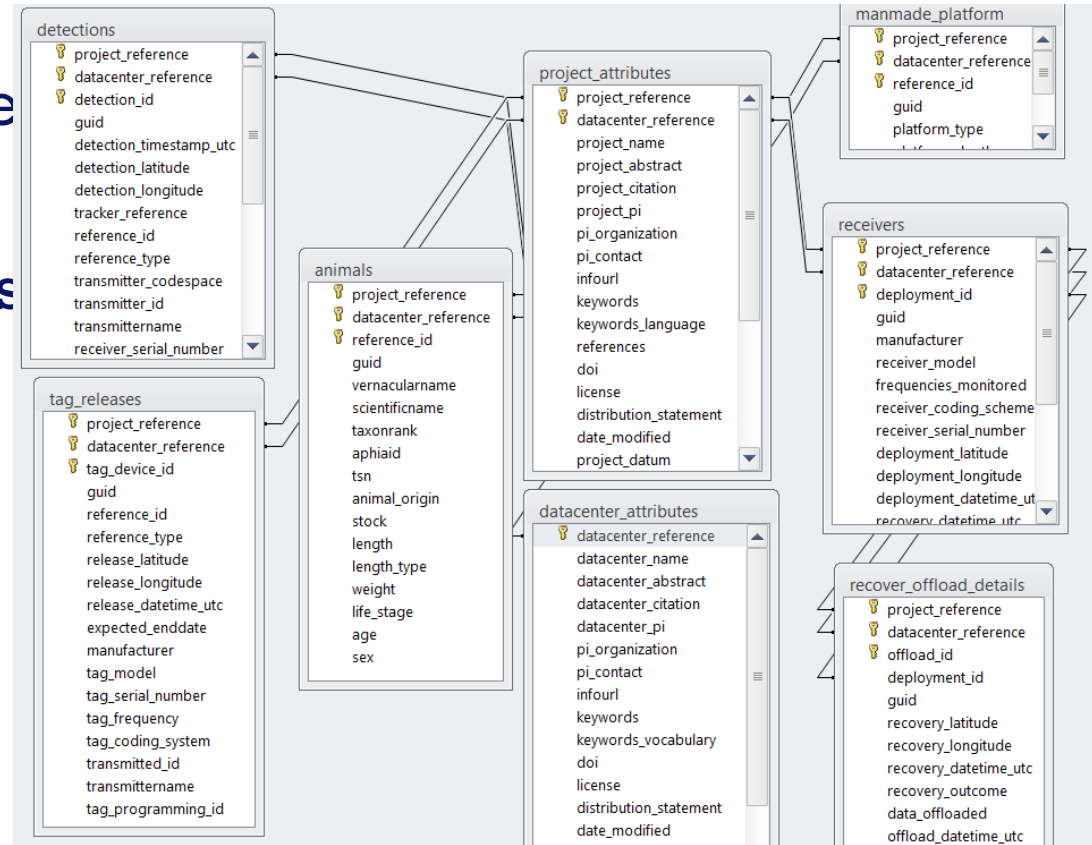




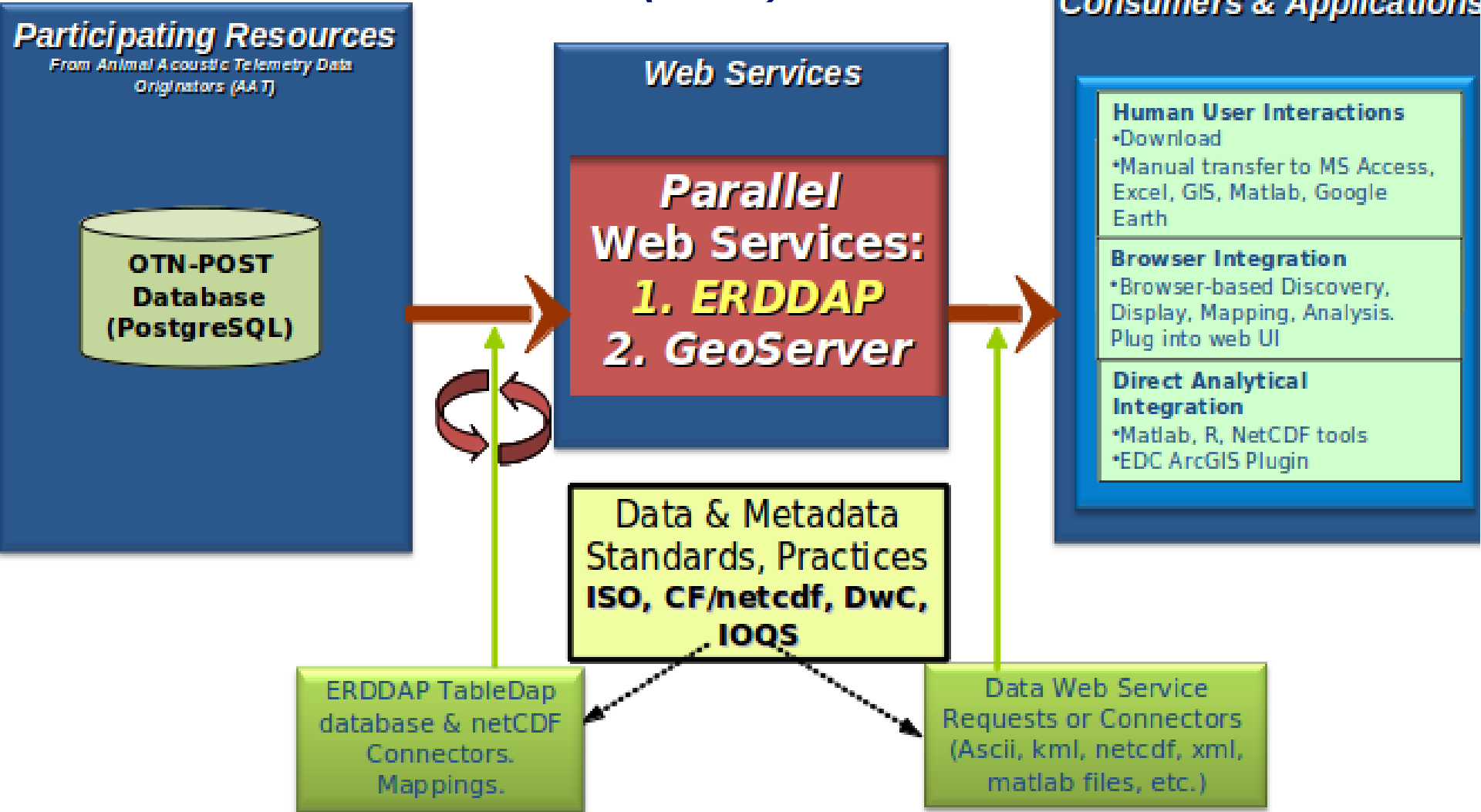
# Entity Relationship Diagram

## Metadata convention for animal acoustic telemetry data exchange

1. datacenter\_attribute
2. project\_attributes
3. manmade\_platforms
4. receivers
5. recover\_offloads
6. tag\_releases
7. animals
8. detections
9. tracks



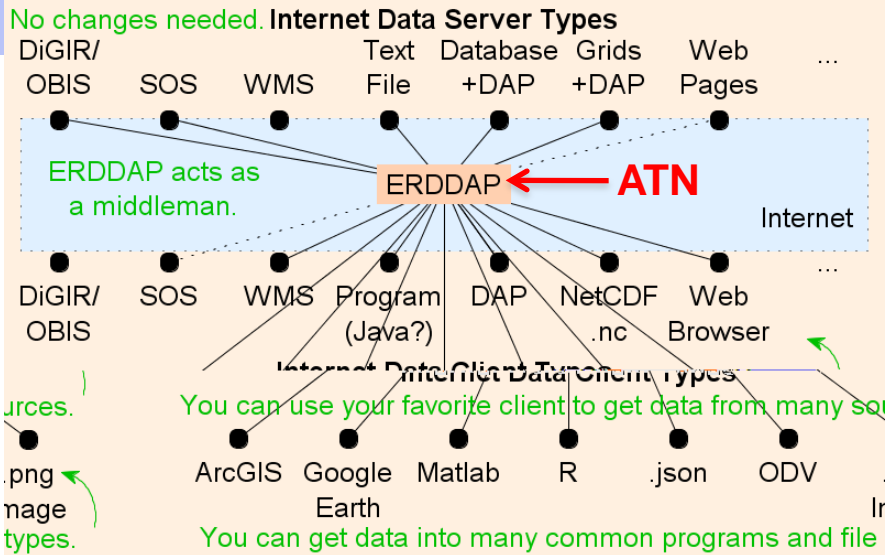
# AAT Observations System Design – Service Connections. Access to all data via ERDDAP: RDBMS > netCDF files (CDM) > ERDDAP.



# What is ERDDAP?

Solves problem of different communities using different services.

ERDDAP > tabledap > Make A Graph



## ERDDAP > List of All Datasets

**ERDDAP**  
Fastest access to scientific data

**ERDDAP > List of All Datasets**

Pick a Dataset

Grid Sub-DAP	Table Name	Make W	Title	Summary	FOGDC, ISO, Metadata	Background Info	RSS	E mail	Institution	Dataset ID
set	data	20020		OTN NEP - Acoustic Receivers and Stations					OTN	otnepAcvrs
set	data	20020		OTN NEP - Acoustic Tags and Animal Information					OTN	otnepAnTags
set	data	20020		OTN NEP - Detections					OTN	otnepDetects
set	data	20020		OTN NEP - Stations					OTN	otnepStations
set	data	20020		OTN NEP_DEF - OTN Strait of Juan de Fuca Line Acoustic Receivers and Stations					OTN	otnepJDFReceiv
set	data	20020		OTN NEP_DEF - OTN Strait of Juan de Fuca Line Detections					OTN	otnepJDFDetects
set	data	20020		OTN NEP-LIND - Lindley Tags Acoustic Tags and Animal Information					NOAA-SWFSOC	otnepLINDarTags
set	data	20020		OTN NEP-MOSCR - Moser Tags Acoustic Tags and Animal Information					NOAA-SWFSOC	otnepMOSCRarTags
set	data	20020		OTN NEP-PS22 - OTN Canada Pacific Sockeye Sal... rgep22 Acoustic Tags and Animal Information					USC	otnepPS22arTags
set	data	20020		OTN NEP-QC3 - OTN Queen Charlotte Strait Line Acoustic Receivers and Stations					OTN	otnepQC3Receiv
set	data	20020		OTN NEP-QC3 - OTN Queen Charlotte Strait Line Detections					OTN	otnepQC3Detects
set	data	20020		OTN NEP-VOGL - Voger Tags Acoustic Tags and Animal Information					NFRS	otnepVOGLarTags
set	data	20020		OTN NEP-WLL - Willapa Bay, OR Acoustic Receivers and Stations					KRS	otnepWLLReceiv
set	data	20020		OTN NEP-WLL - Willapa Bay, OR Detections					KRS	otnepWLLDetects

Also web accessible (WAF) ISO 9115-2 and FDGC .xml discovery metadata files

**ERDDAP**  
Fastest access to scientific data

**ERDDAP > tabledap > Data Access Form**

Dataset file: OTN NEP - Detections ES

Information: Summary | Location | GDC | ISO 9115-2 | Metadata | Background | Subset | Make a Graph

Variable # | Check box | Units | Optional Constraint #1 | Optional Constraint #2 | Minimum # | Maximum #

of time (UTC) # | ... | 2013-03-01T00:00:00Z | 2013-04-01T00:00:00Z

of latitude (degrees\_north) # | ... | 42.72893 | 56.90033

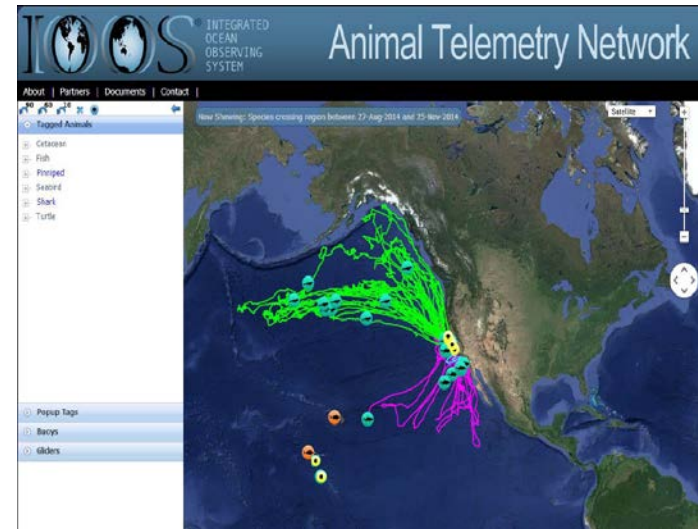
of longitude (degrees\_west) # | ... | -127.4927 | -123.6565

of detection: .asc - View OPeNDAP-style comma-separated ASCII text.  
 .csv - Download a comma-separated ASCII text table (line 1: names; line 2: units; ISO 8601 times).  
 .csvp - Download a .csv file with line 1: name (units). Times are ISO 8601 strings.  
 .das - View the data's metadata via an OPeNDAP Dataset Attribute Structure (DAS).  
 .dms - View the data's structure via an OPeNDAP Dataset Descriptor Structure (DDS).  
 .dods - OPeNDAP clients use this to download the data in the DODS binary format.  
 .esfCsv - Download a .csv file for ESRI's ArcGIS 9.x and below (separate date and time columns).  
 .fgdc - View the data's FGDC .xml metadata.  
 .geoJson - Download longitude,latitude,otherColumns data as a GeoJSON .json file.  
 .graph - View a Make A Graph web page.  
 .help - View a web page with a description of tabledap.  
 .html - View an OPeNDAP-style HTML Data Access Form.  
 .html table - View a .html web page with the data in a table. Times are ISO 8601 strings.  
 .iso19115 - View the data's ISO 19115-2/19139 .xml metadata.  
 .json - View a table-like JSON file (missing value = "null"; times are ISO 8601 strings).  
 .mat - Download a MATLAB binary file.  
 .nc - Download a flat, table-like, NetCDF-3 binary file with COARDS/CF/THREDDS metadata.  
 .ncHeader - View the header (the metadata) for the NetCDF-3 file.  
 .ncCF - Download a NetCDF-3 CF Discrete Sampling Geometries file (Contiguous Ragged Array).  
 .ncCFMA - Download a NetCDF-3 CF Discrete Sampling Geometries file (Multidimensional Array).



• <http://oceanview.pfeg.noaa.gov/ATN/>

- 48 different species ( sharks, sea turtles, seals, whales, tuna, squid and other taxa)
- Years: 2000-2015
- 7 tag types or platforms
- Real time reporting – e-seals and sharks.
- Data in GTS -- WMO code-Q9900....



Data Menu →

Now Showing: All tags reporting between 6-Mar-2014 and 2-Sep-2014

Satellite

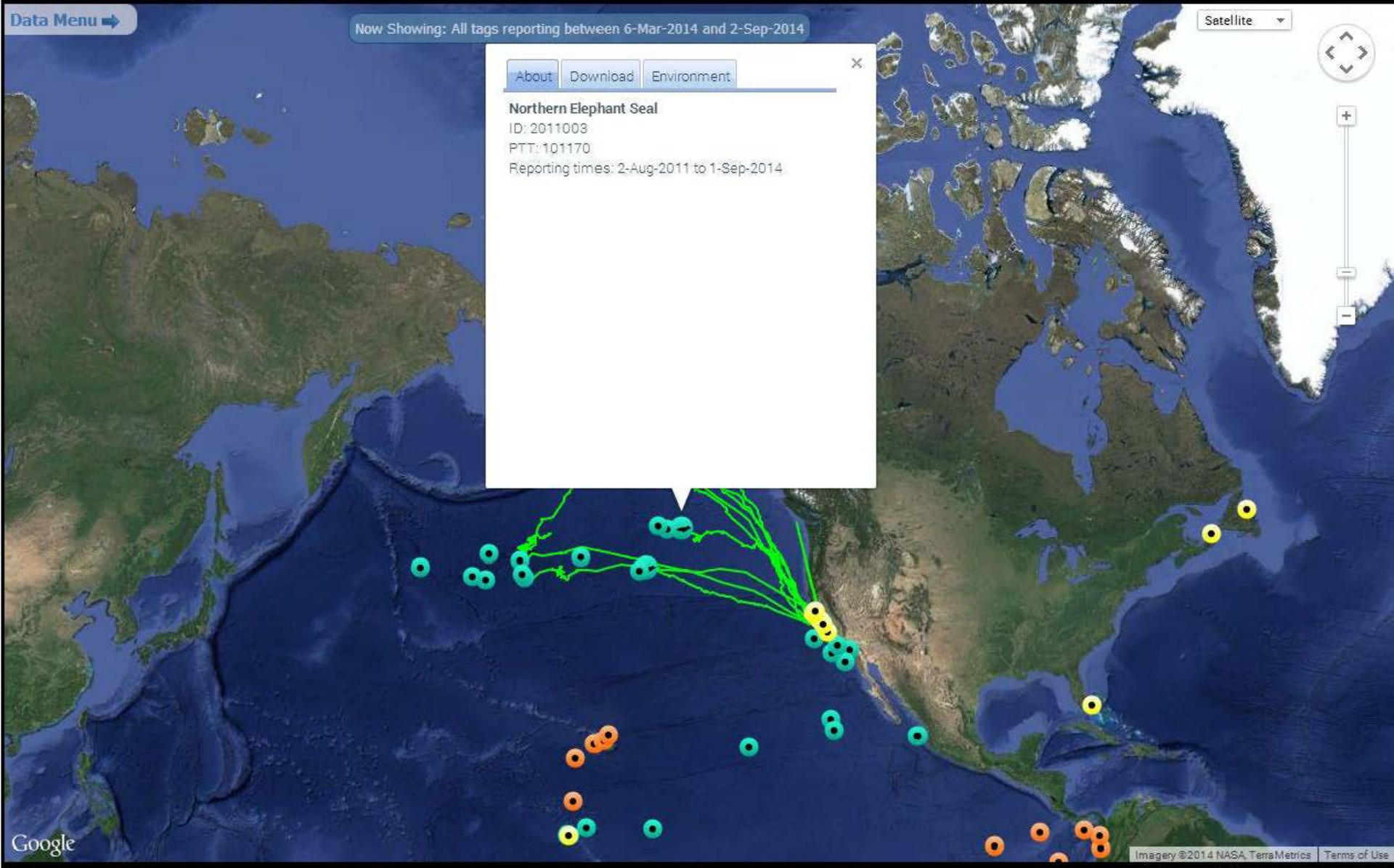
[About](#) [Download](#) [Environment](#)

### Northern Elephant Seal

ID: 2011003

PTT: 101170

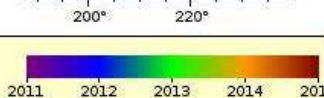
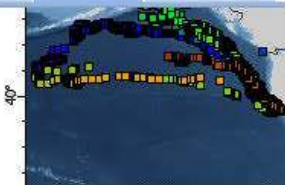
Reporting times: 2-Aug-2011 to 1-Sep-2014





Now Showing: All tags reporting between 6-Mar-2014 and 2-Sep-2014

About Download Environment



■ **Time (UTC)**  
Global Tagging of Pelagic Predators  
(GTOPP) Animal Tracking Data  
(topplD="2011003", serialNumber="101170")  
Data courtesy of GTOPP

- [View larger image](#)
- [View in ERDDAP](#)
- [Track: text popup](#)
- [Track: csv file](#)

Satellite





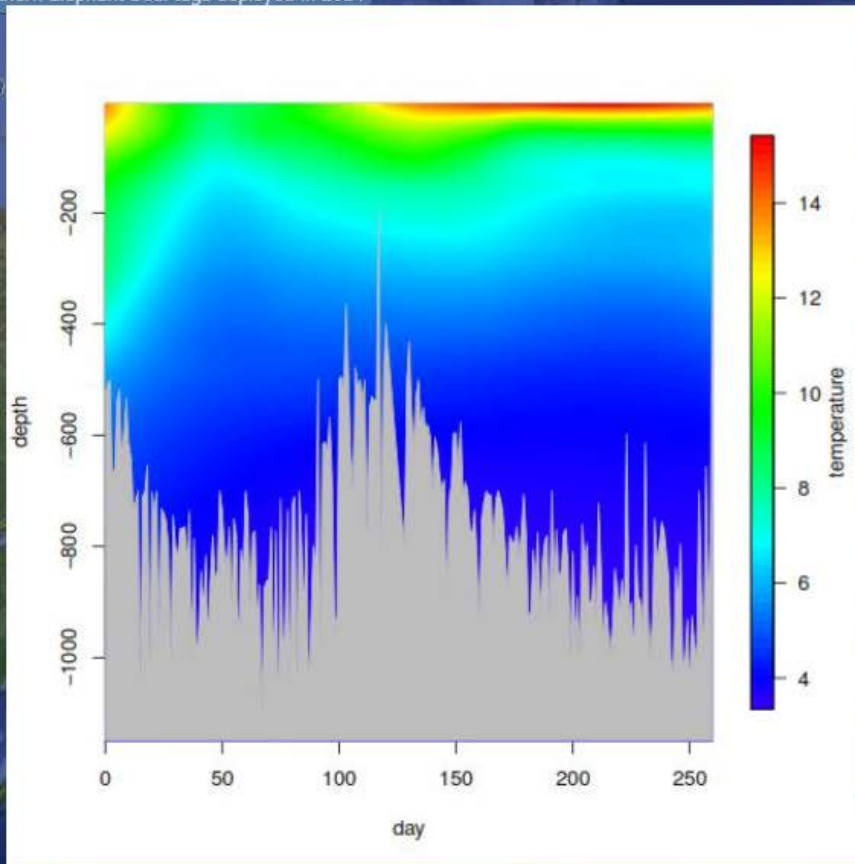
Tagged Animals

- Cetacean
- Fish
- Pinniped
  - California Sea Lion
  - Cape Fur Seal
  - Crabeater Seal
  - Galapagos Sea Lion
  - Northern Elephant Seal
    - 2002
    - 2003
    - 2004
    - 2005
    - 2006
    - 2007
    - 2008
    - 2009
    - 2010
    - 2011
    - 2014
    - Northern Fur Seal

Buoys

Gliders

Added Northern Elephant Seal tags deployed in 2014



Data Menu →

Added Northern Elephant Seal tags deployed in 2014

Satellite

About

Download

Environmental Data Information:

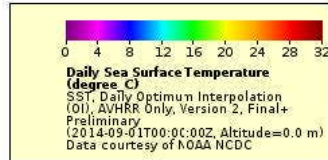
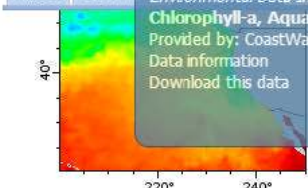
Chlorophyll-a, Aqua MODIS, NPP, Pacific Ocean (8 Day Composite)

Provided by: CoastWatch West Coast Regional Node

Data Information

Download this data

Remove satellite overlay



Show chla on map

Coming soon: show environmental data at any time

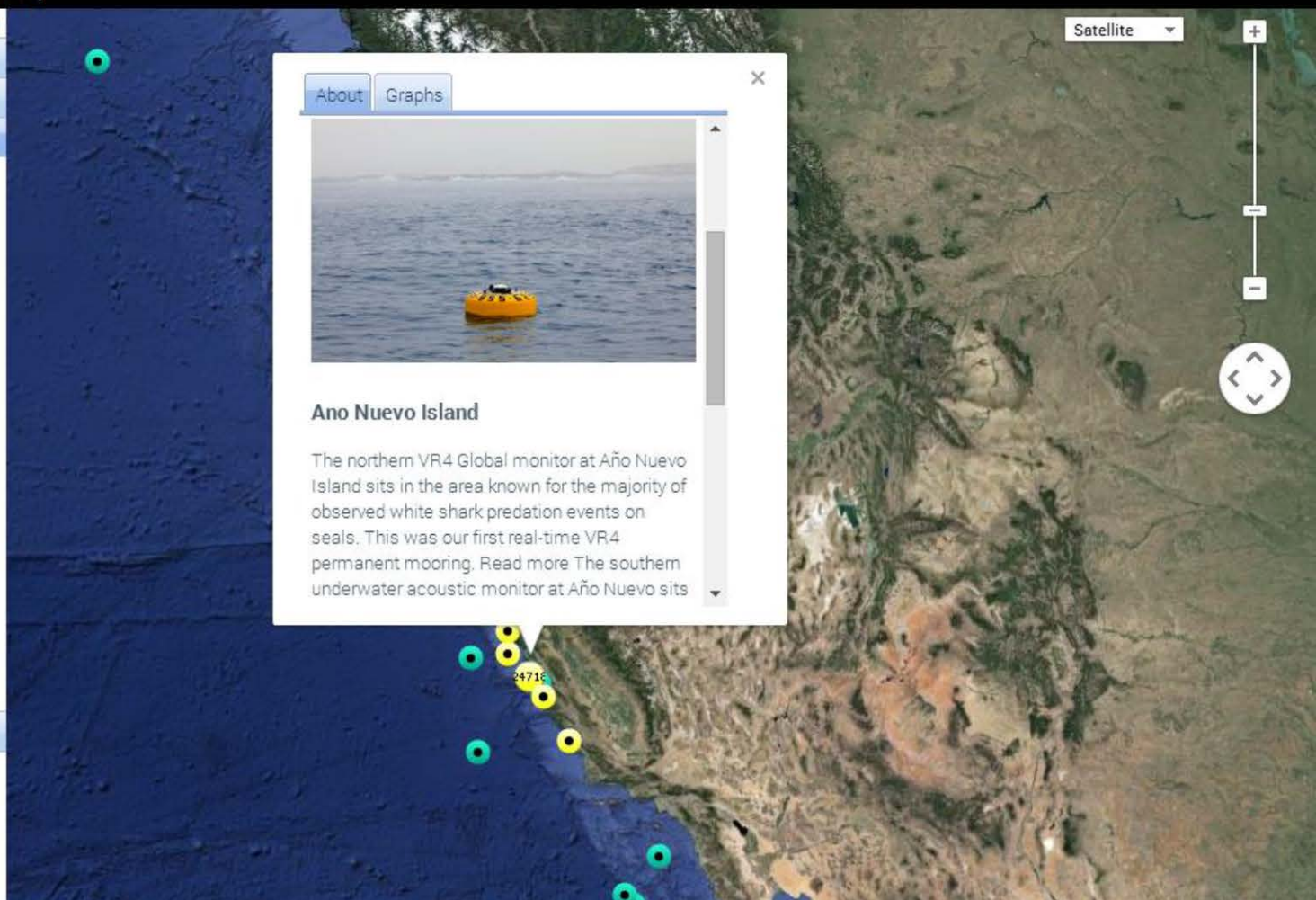


# Atlantic Bluefin Tuna: Where they go?






- ◉ Tagged Animals
- ◉ Popup Tags
- ◉ Buoys
  - + Ano Nuevo
  - + Cambria
  - + Chagos
  - + Farallones
  - + Hopkins
  - + Palmyra
  - + Tomales
- ◉ Gliders



About
Graphs
✕

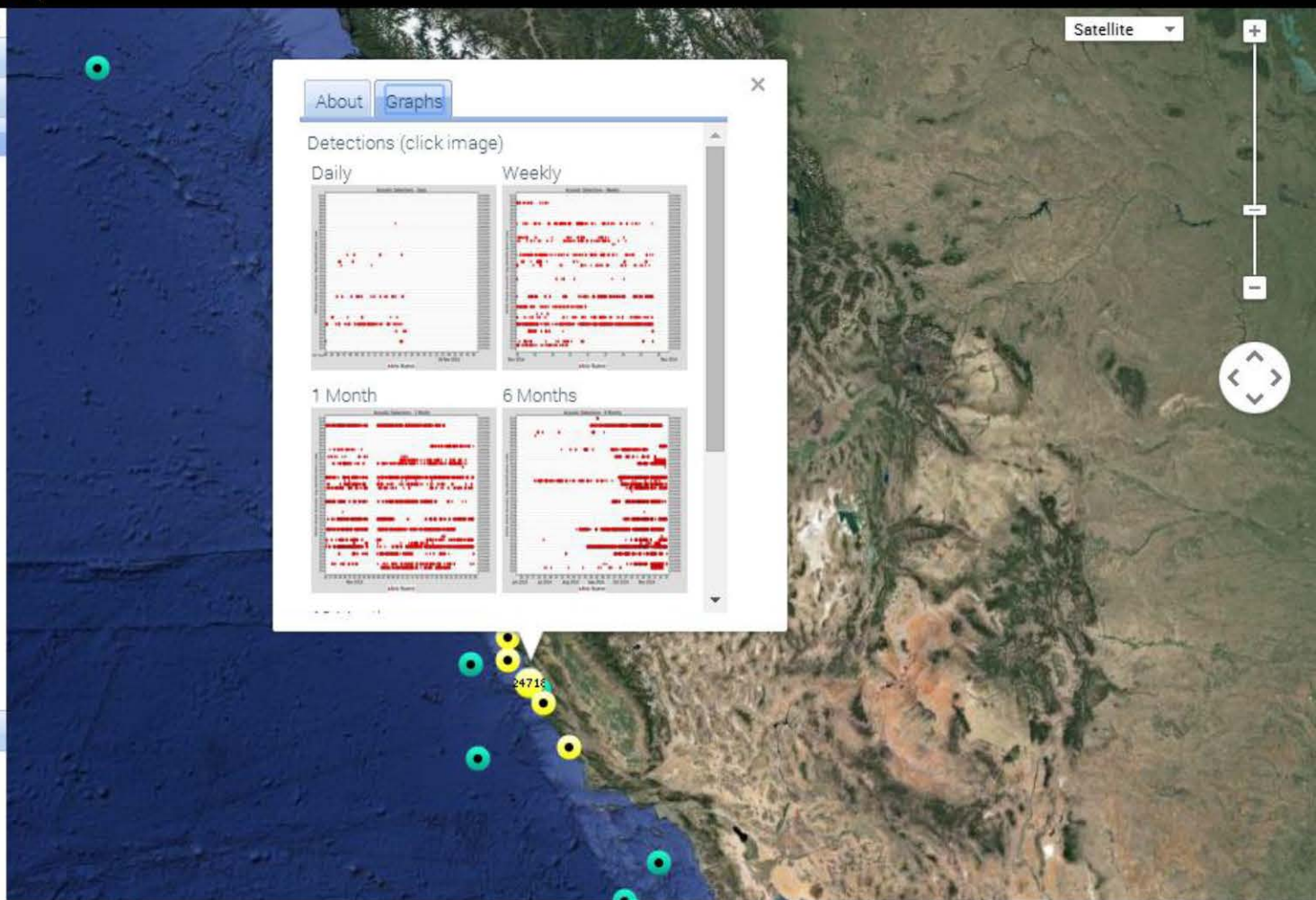


**Ano Nuevo Island**

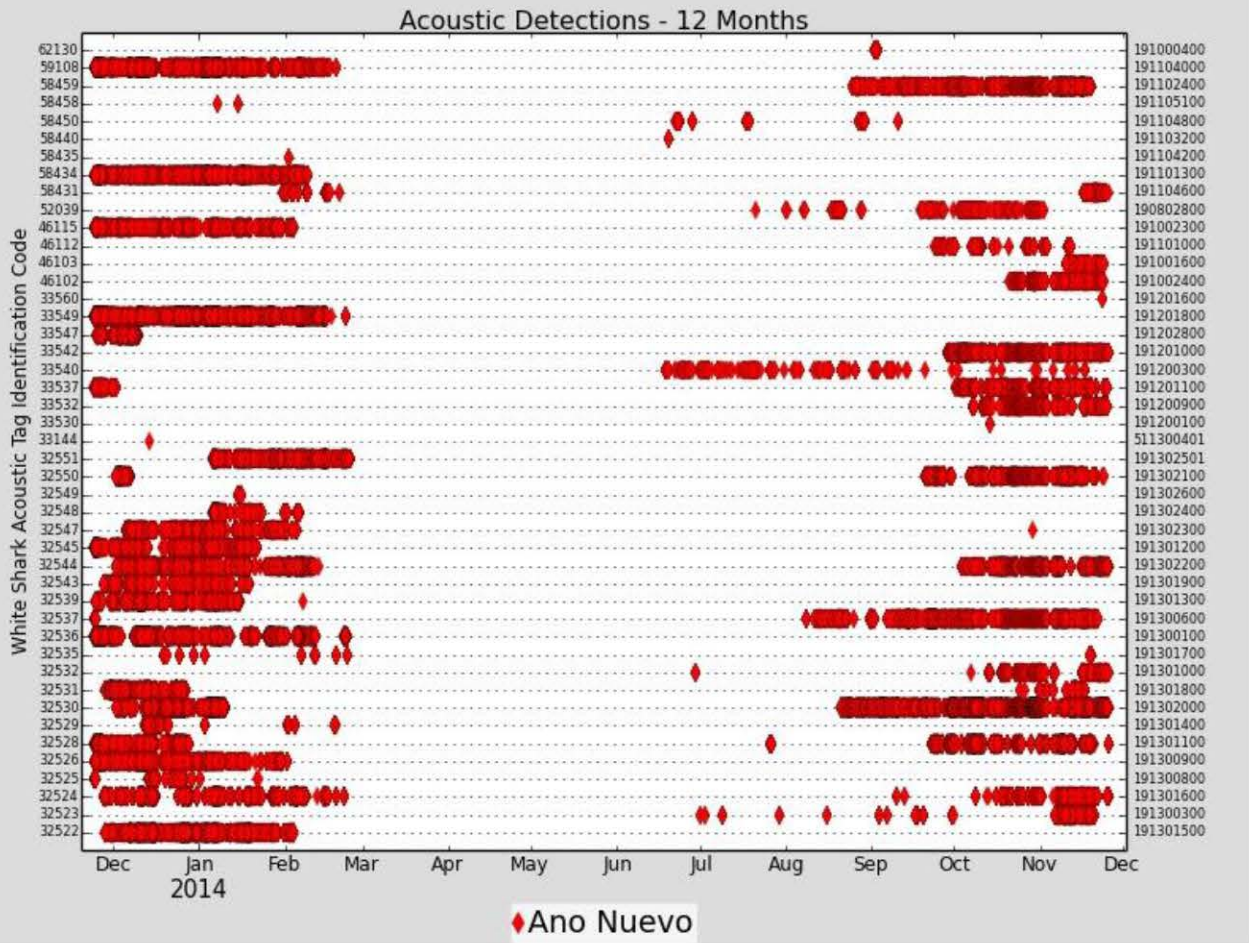
The northern VR4 Global monitor at Año Nuevo Island sits in the area known for the majority of observed white shark predation events on seals. This was our first real-time VR4 permanent mooring. Read more The southern underwater acoustic monitor at Año Nuevo sits



- Tagged Animals
- Popup Tags
- Buoys**
  - Ano Nuevo
  - Cambria
  - Chagos
  - Farallones
  - Hopkins
  - Palmyra
  - Tomales
- Gliders







(or hover mouse over image to pause)

Satellite

+

-

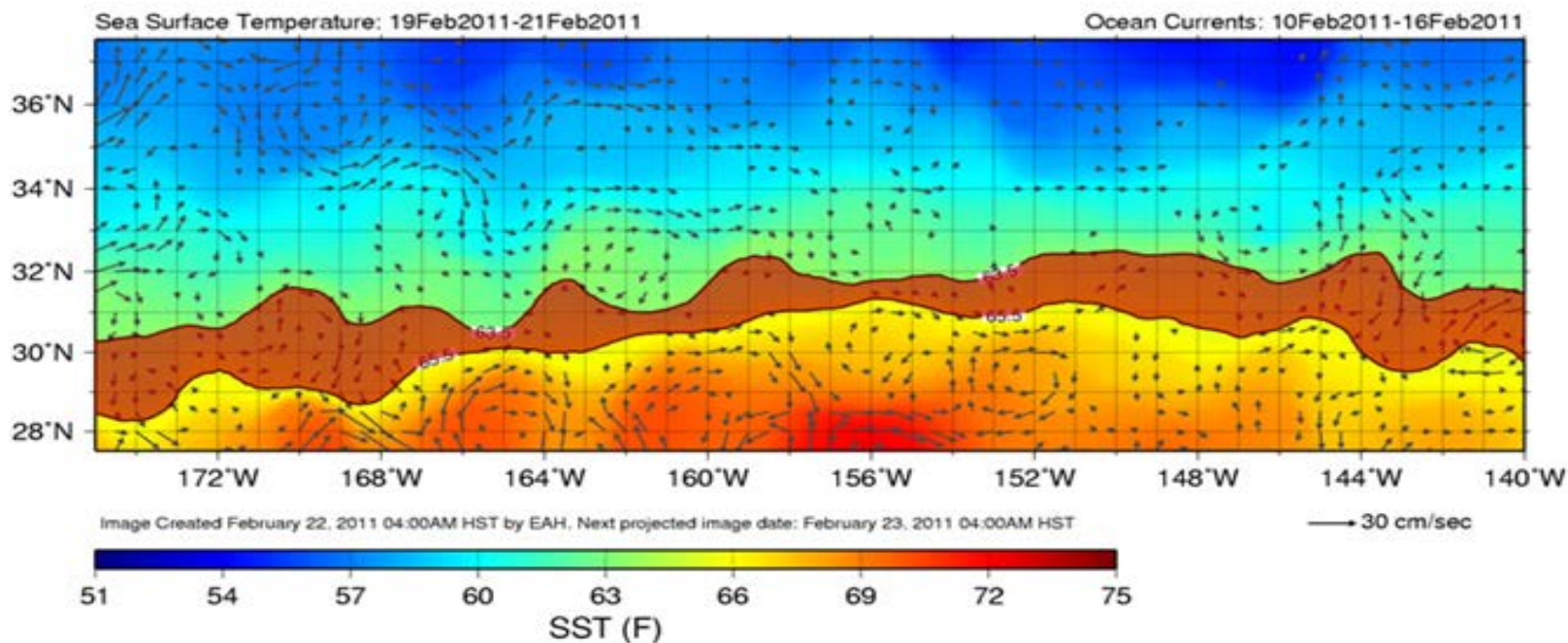
⏪ ⏩

- About | Partners | Data
- 90 60 10
- Tagged Animals
- Popup Tags
- Buoys
- Ano Nuevo
- Cambria
- Chagos
- Farallones
- Hopkins
- Palmyra
- Tomaes
- Gliders



# Reduce Bycatch of Loggerhead Turtles in Hawaii in Longline Fishery

avoid fishing between solid black  $65.5^{\circ}\text{F}$  and  $65.5^{\circ}\text{F}$  lines  
to reduce turtle interactions



PACIFIC ISLANDS FISHERIES SCIENCE CENTER  
ECOSYSTEMS AND OCEANOGRAPHY DIVISION  
2570 Dole Street, Honolulu, HI 96822  
<http://www.pifsc.noaa.gov/eod/turtlewatch.php>  
contact: [Evan.Howell@noaa.gov](mailto:Evan.Howell@noaa.gov)

Data provided by Central Pacific CoastWatch node

TURTLEWATCH



<http://sos.noaa.gov/Datasets/dataset.php?id=181#>



# Closing Remarks

## Backwards ....

Defining the specifications was hardest part. Creating and refining a specific data feed was relatively easy. The demonstration services have been implemented and appear useful.

## Forwards ...

- Continue integrating ATN data and explore ways to visualize complex data.
- Develop work plan for further collaboration to fully operationalize the system.
- Expand user base

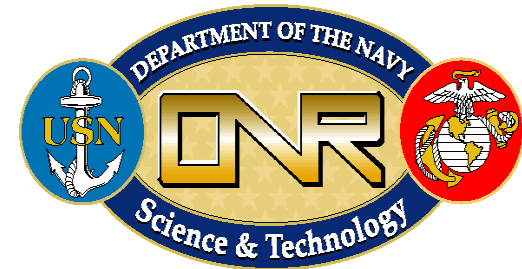
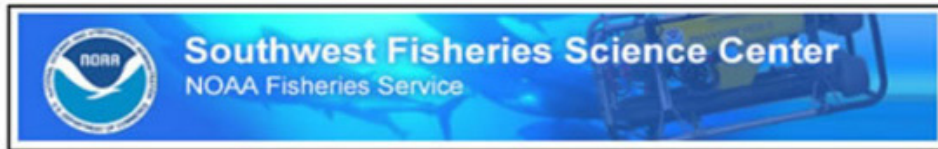
# Acknowledgment

Dr. Randall Kochevar , Stanford University, Hopkins Marine Station

Michael Weise , US NAVY/ONR

Barbara Block , Stanford University, Hopkins Marine Station

Lynn Dewitt, NOAA SWFSC





# THANK YOU

<https://code.google.com/p/ioostech/wiki/AnimalAcousticTelData>

<http://ioos.github.io/animal-telemetry/passive-acoustic/>

<http://oceanview.pfeg.noaa.gov/ATN/>

[http://www.ioos.noaa.gov/observing/animal\\_telemetry/welcome.html](http://www.ioos.noaa.gov/observing/animal_telemetry/welcome.html)