

# Integrated Management and Visualization of Animal Telemetry Observations



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Name: **Dr. Hassan Moustahfid**

Institution: US IOOS®

Contact info. [Hassan.Moustahfid@noaa.gov](mailto:Hassan.Moustahfid@noaa.gov)



# 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

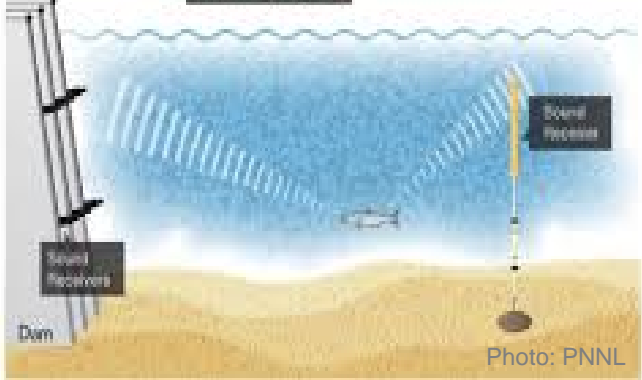
Providing Real-Time Monitoring of Animals

Improving Fisheries Management

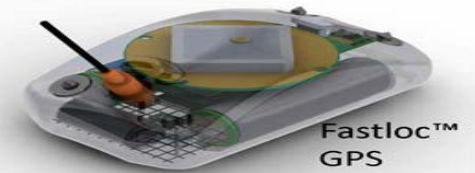
Protecting Endangered Species



# Many tag types



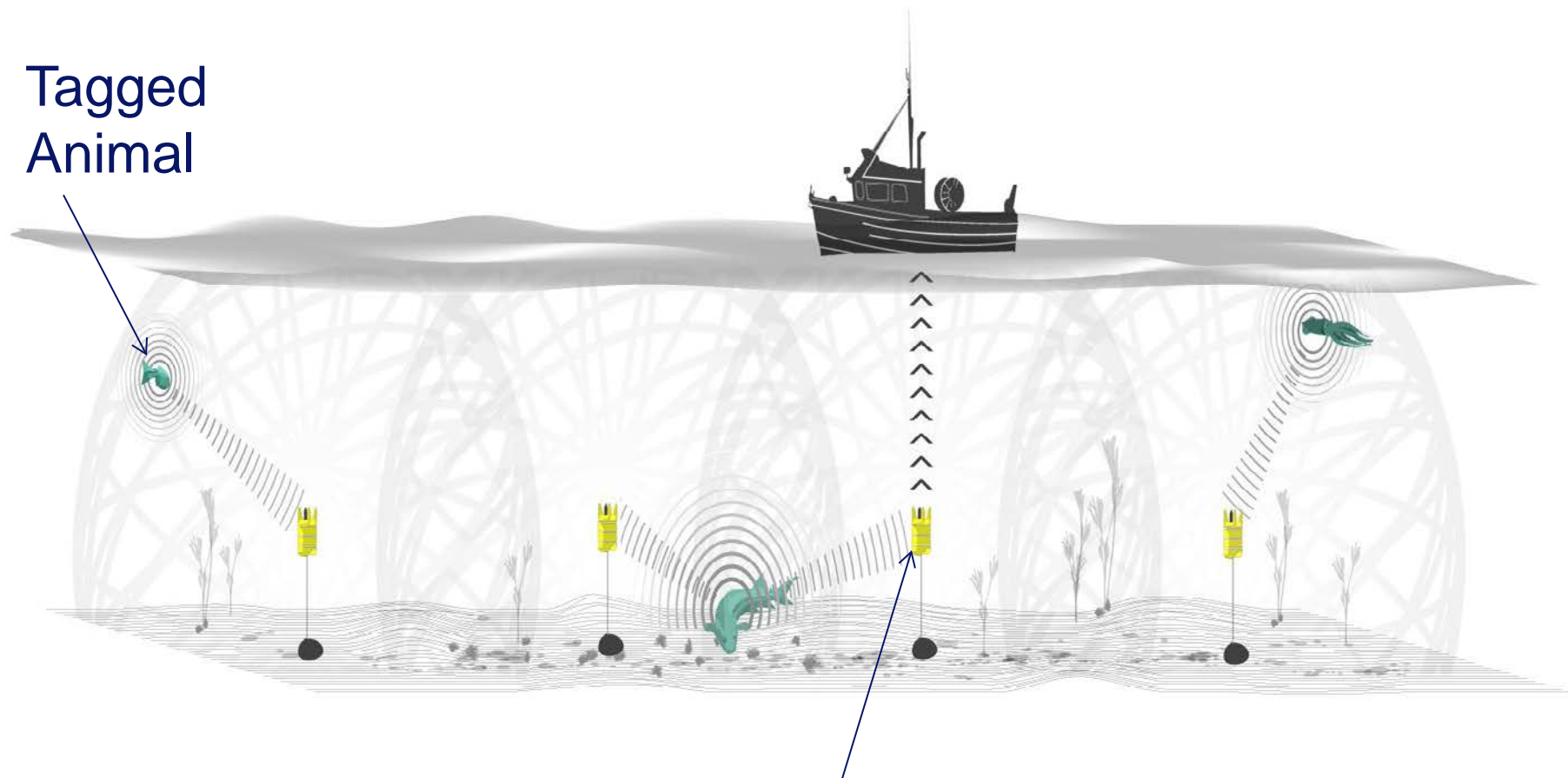
Satellite Relay Data Logger (SRDL)



Fastloc™ GPS



Tagged  
Animal



Acoustic  
Receiver



Image Credit: POST

# Challenges of Animal Telemetry Data

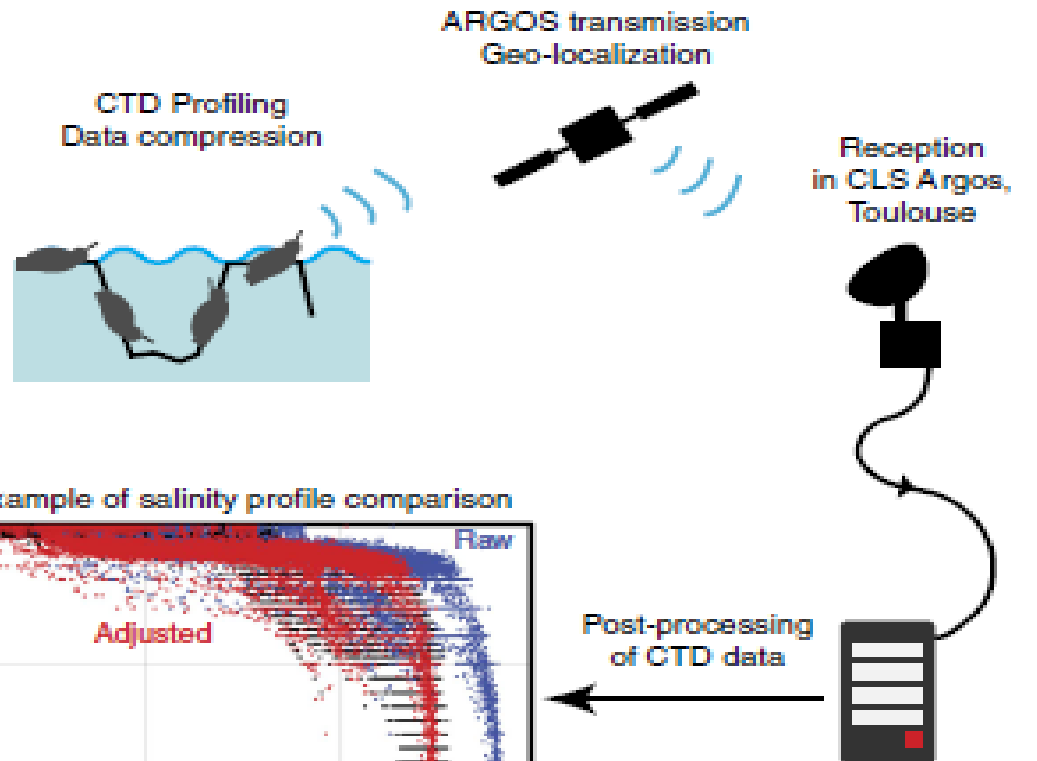
## e.g. Acoustic Telemetry Data

- 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.

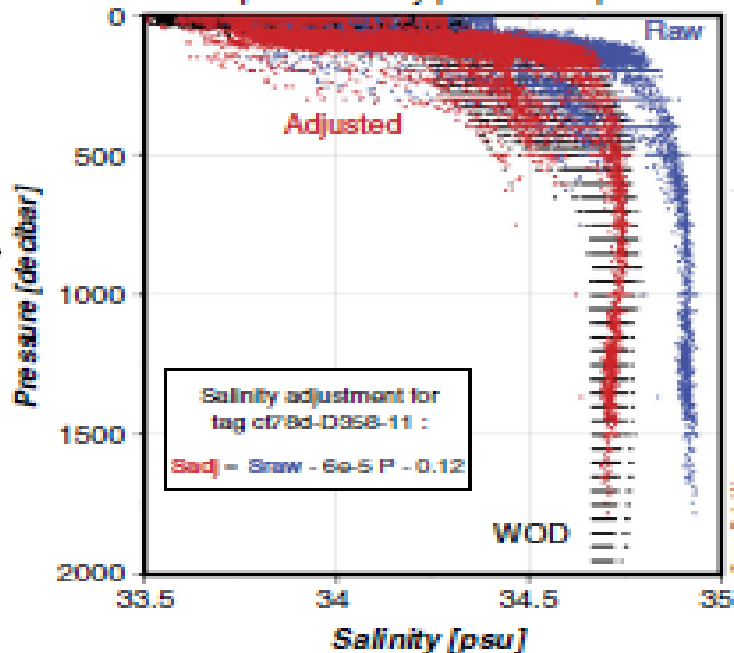


# Procedures of collecting oceanographic data (Hydrographic profiles) from CTD SRDL tags on e-seals or Sharks

Deployment on land

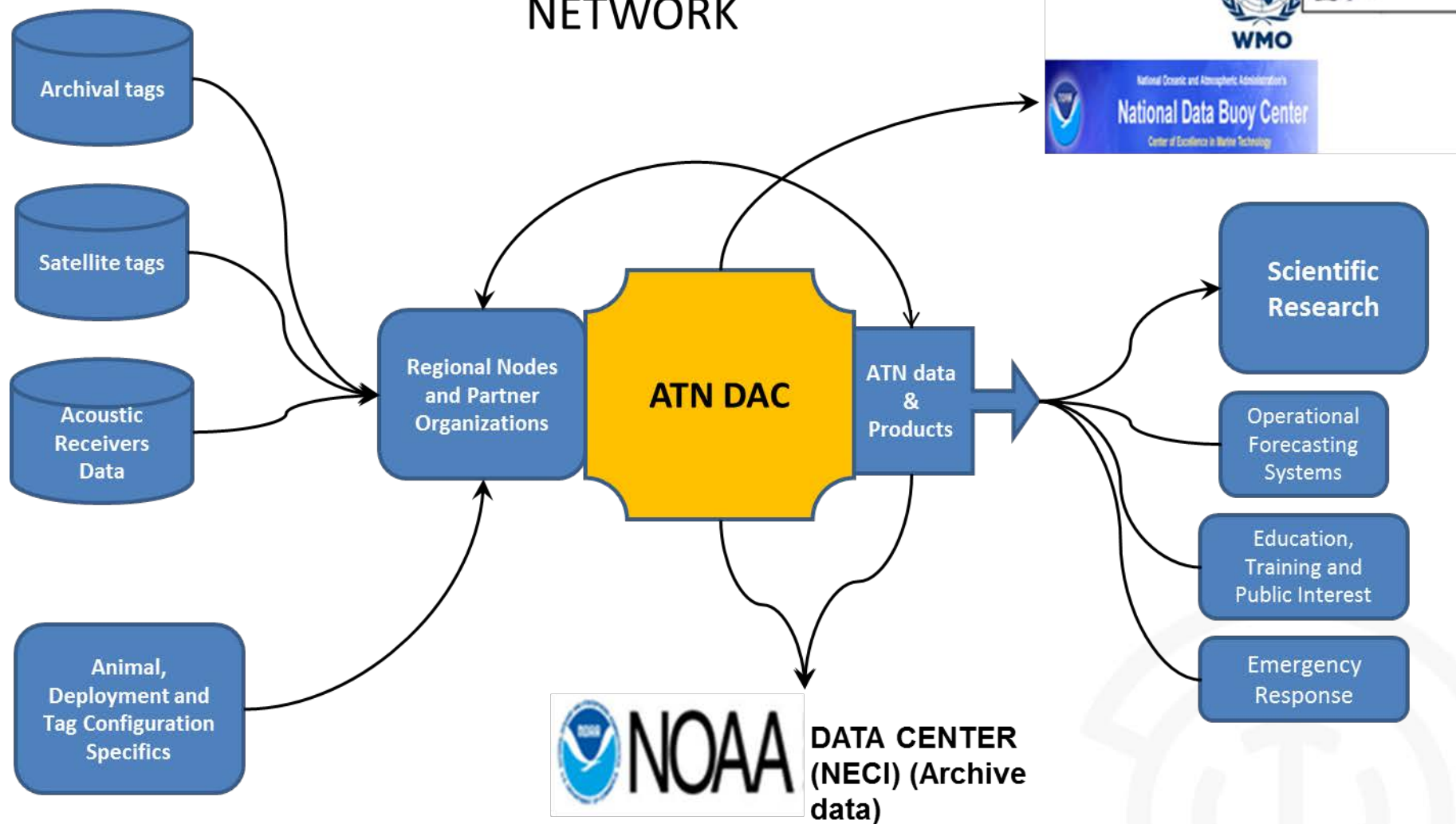


Example of salinity profile comparison



Distribution  
to ocean  
data centers

# DATA FLOW FOR ANIMAL TELEMETRY NETWORK

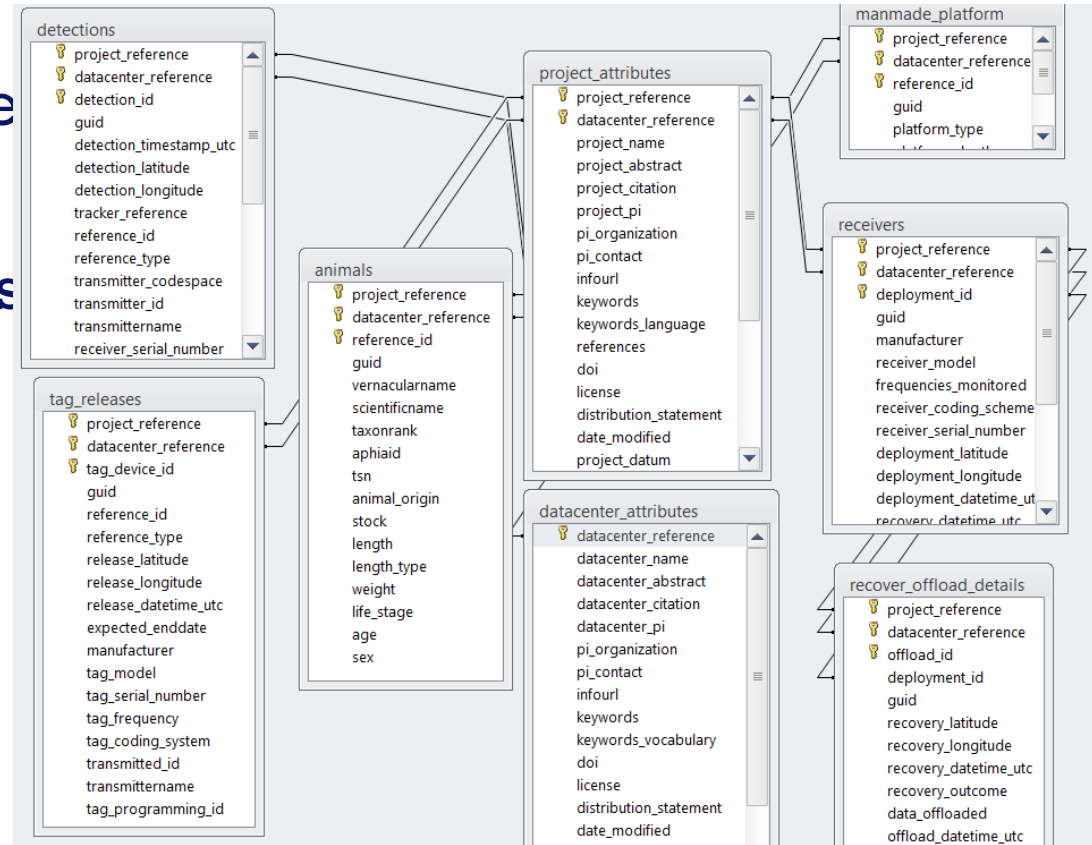




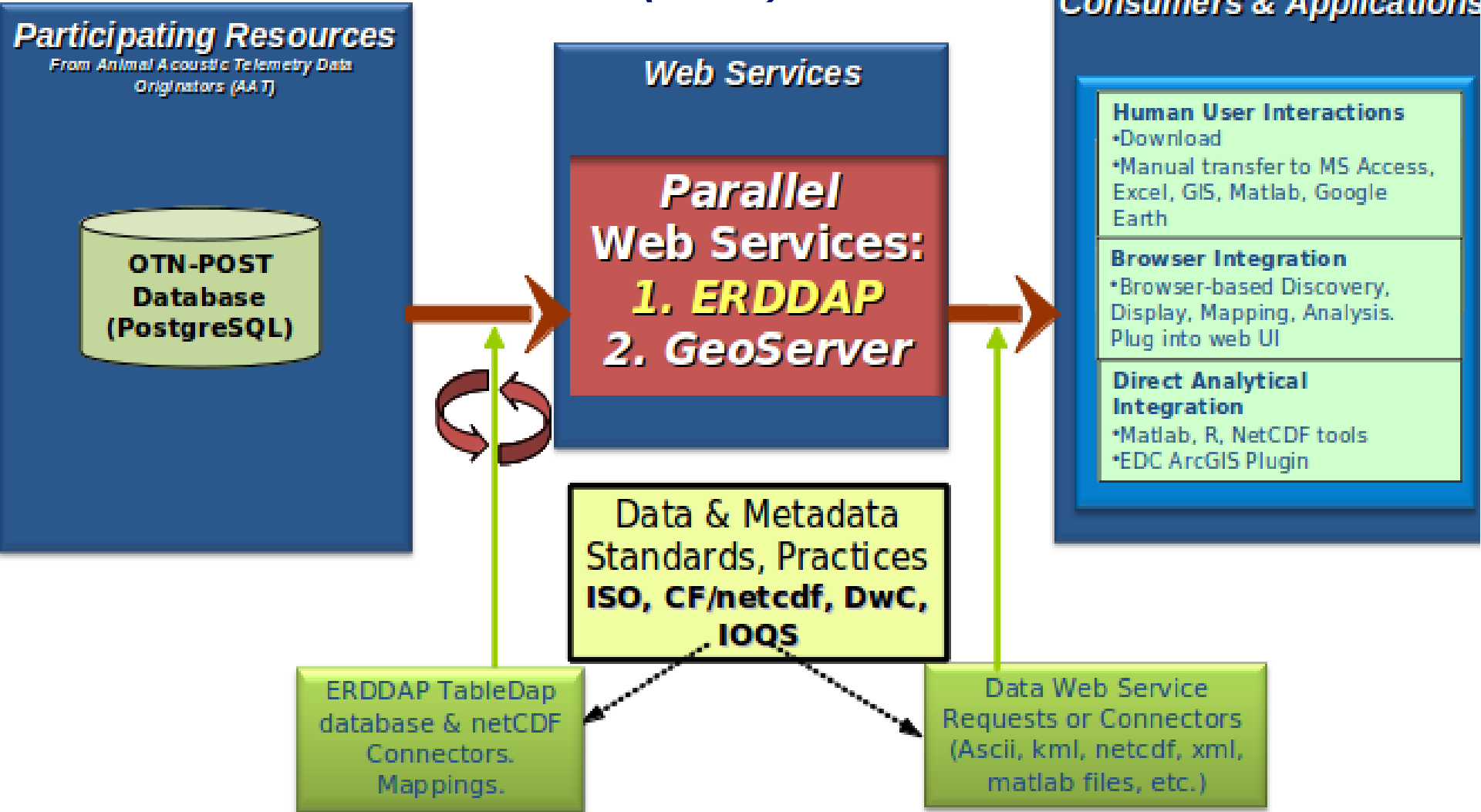
# Entity Relationship Diagram

## 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



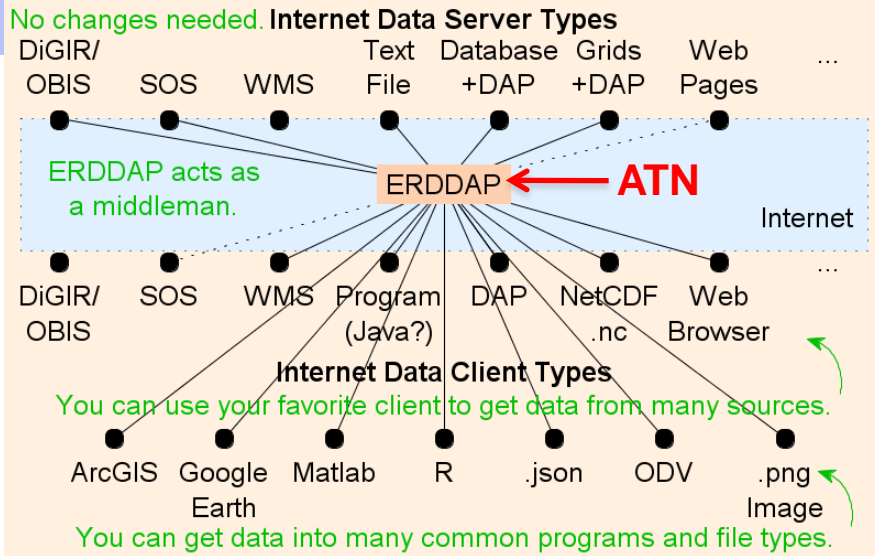
# AAT Observations System Design – Service Connections. Access to all data via ERDDAP: RDBMS > netCDF files (CDM) > ERDDAP.



# What is ERDDAP?

Solves problem of different communities using different services.

ERDDAP > tabledap > Make A Graph



ERDDAP  
Easier access to scientific data

ERDDAP > tabledap > Make A Graph

Dataset Title: OTN NEP - Detections  
Institution: OTN (Dataset ID: otnnepDetections)  
Range: longitude = -127.4927 to -123.8565°E, latitude = 42.72693 to 50.90033°N, time = 2004-05-21T11:17:56Z to 2013-04-02T02:12:30Z  
Information: Summary | License | FDGC | ISO 9115 | Metadata | Background | Subset | Data Access Form

Graph Type: markers  
X Axis: Longitude  
Y Axis: Latitude  
Color: uncertainty\_in\_latitude

Constraints #1  
time: 2013-03-27T00:00:00Z to 2013-04-03T00:00:00Z

Server-side Functions #1  
orderBy: time  
orderByMax: time

Graph Settings  
Marker Type: Filled Square  
Color: Blue  
Color Bar: Min: -127.4927, Max: -123.8565, N Sections: 2

OTN NEP - Detections  
time = 2013-03-27T00:00:00Z, time = 2013-04-03T00:00:00Z

get the data you want, in the format you want, including: csv, netCDF, kml, mat

## ERDDAP > List of All Datasets

ERDDAP  
Easier access to scientific data

ERDDAP > List of All Datasets

Pick a Dataset

Grid ID	Title	Make W	Dataset ID
505	OTN NEP - Acoustic Receivers and Stations	OTN	otnnepAcoustic
505	OTN NEP - Acoustic Tags and Animal Information	OTN	otnnepAcousticTags
505	OTN NEP - Detections	OTN	otnnepDetections
505	OTN NEP - Stations	OTN	otnnepStations
505	OTN NEP_DEF - OTN Strait of Juan de Fuca Line Acoustic Receivers and Stations	OTN	otnnepDEF
505	OTN NEP_DEF - OTN Strait of Juan de Fuca Line Detections	OTN	otnnepDEFDetections
505	OTN NEP_LIND - Lindley Tags Acoustic Tags and Animal Information	NOAA-SWIFSC	otnnepLIND
505	OTN NEP_MOOSR - Moser Tags Acoustic Tags and Animal Information	NOAA-SWIFSC	otnnepMOOSR
505	OTN NEP_P502 - OTN Canapa Pacific Society Sal... rrgnet 2 Acoustic Tags and Animal Information	USC	otnnepP502
505	OTN NEP_Q03 - OTN Queen Charlotte Strait Line Acoustic Receivers and Stations	OTN	otnnepQ03
505	OTN NEP_Q03 - OTN Queen Charlotte Strait Line Detections	OTN	otnnepQ03Detections
505	OTN NEP_VOGL - Vogler Tags Acoustic Tags and Animal Information	NPS	otnnepVOGL
505	OTN NEP_WLL - Willapa Bay, OR Acoustic Receivers and Stations	KRS	otnnepWLL
505	OTN NEP_WLL - Willapa Bay, OR Detections	KRS	otnnepWLLDetections

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

ERDDAP  
Easier access to scientific data

ERDDAP > tabledap > Data Access Form

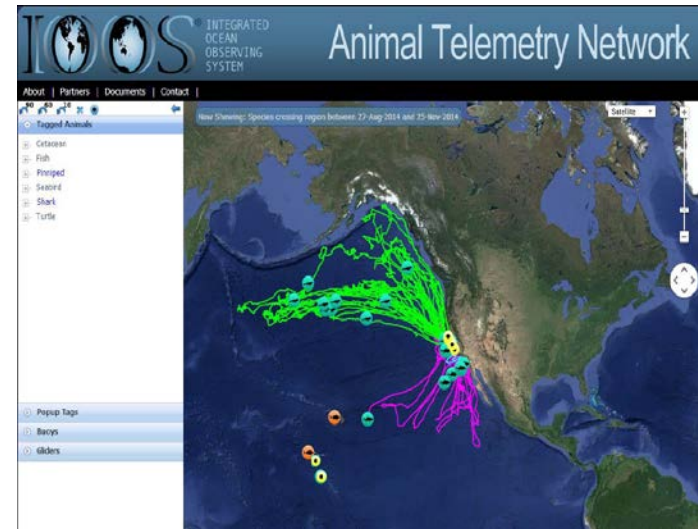
Dataset Title: OTN NEP - Detections  
Institution: OTN (Dataset ID: otnnepDetections)  
Information: Summary | License | FDGC | ISO 9115 | Metadata | Background | Subset | Make a plot

Variable #1: time  
of time (UTC) #1: 2013-03-27T00:00:00Z to 2013-04-03T00:00:00Z  
of latitude (degrees\_north) #1: 42.72693 to 50.90033  
of longitude (degrees\_west) #1: -127.4927 to -123.8565

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.  
dds - View the data's metadata via an OPeNDAP Dataset Attribute Structure (DAS).  
dds - 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.  
esriCsv - 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.  
htmlTable - 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.  
ncF - Download a NetCDF-3 CF Discrete Sampling Geometries file (Contiguous Ragged Array).  
ncFMA - 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

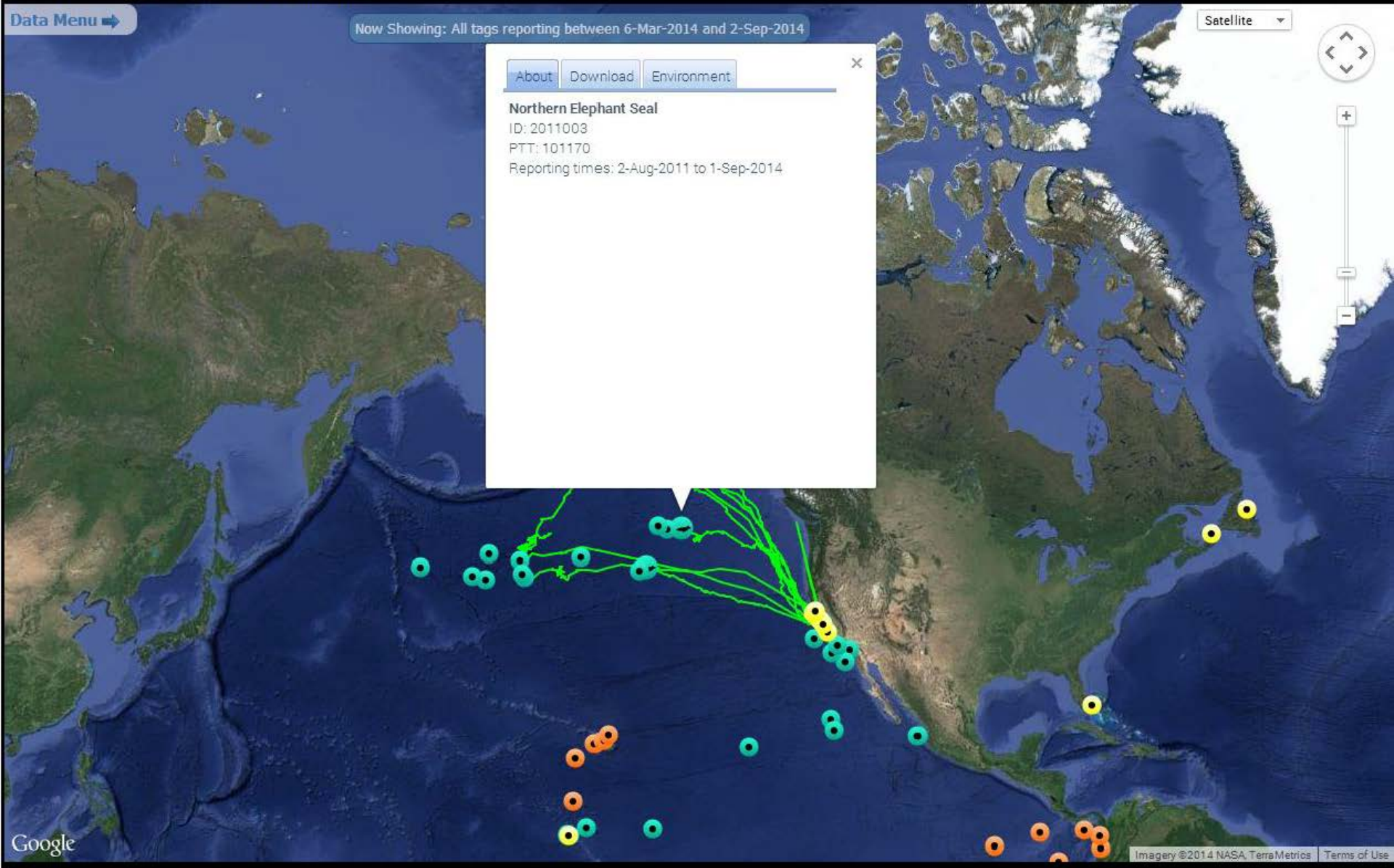
[About](#) [Download](#) [Environment](#)

### Northern Elephant Seal

ID: 2011003

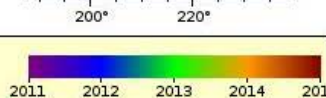
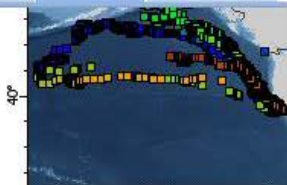
PTT: 101170

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



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

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

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

Satellite



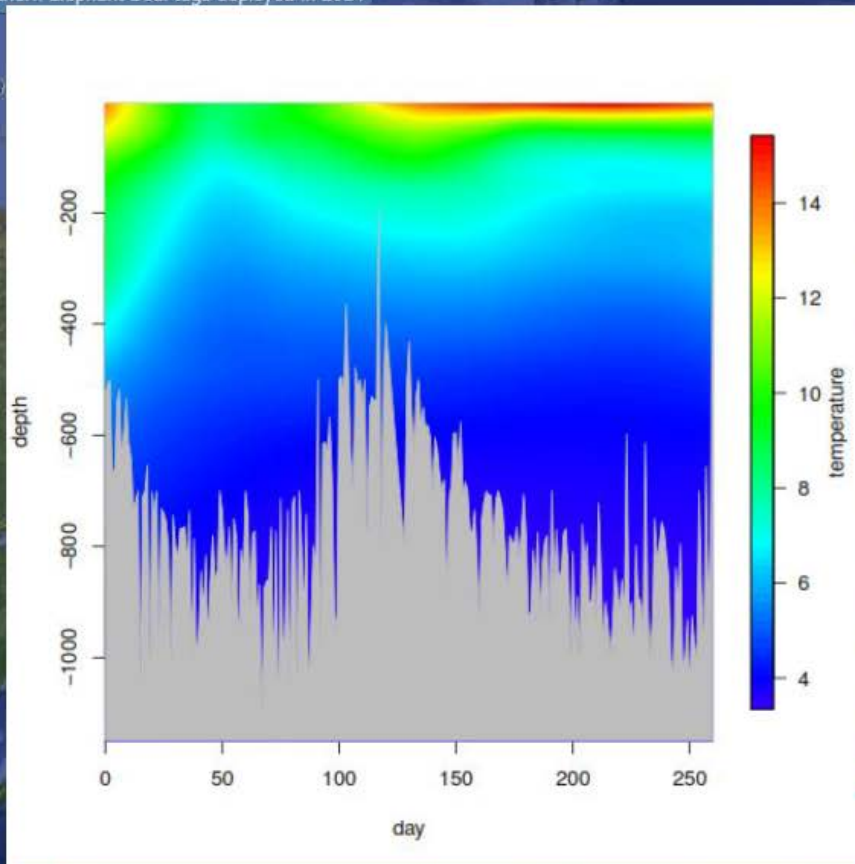
Tagged Animals

- 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:

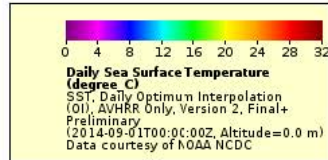
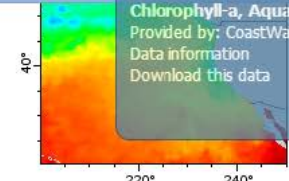
Chlorophyll-a, Aqua MODIS, NPP, Pacific Ocean (8 Day Composite)

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?



## Animal Telemetry Network

About | Partners | Documents | Contact |

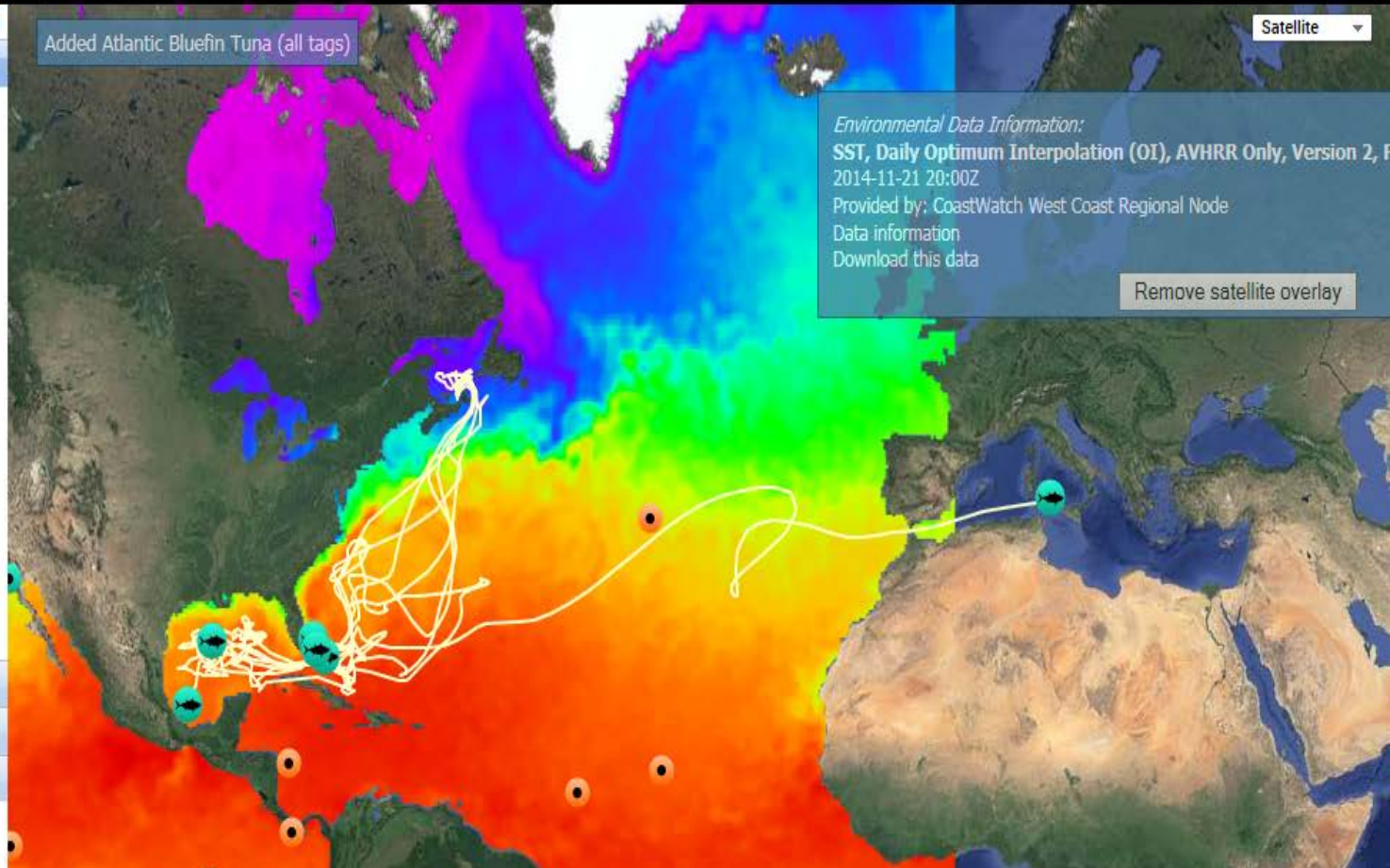
90 60 10

Tagged Animals

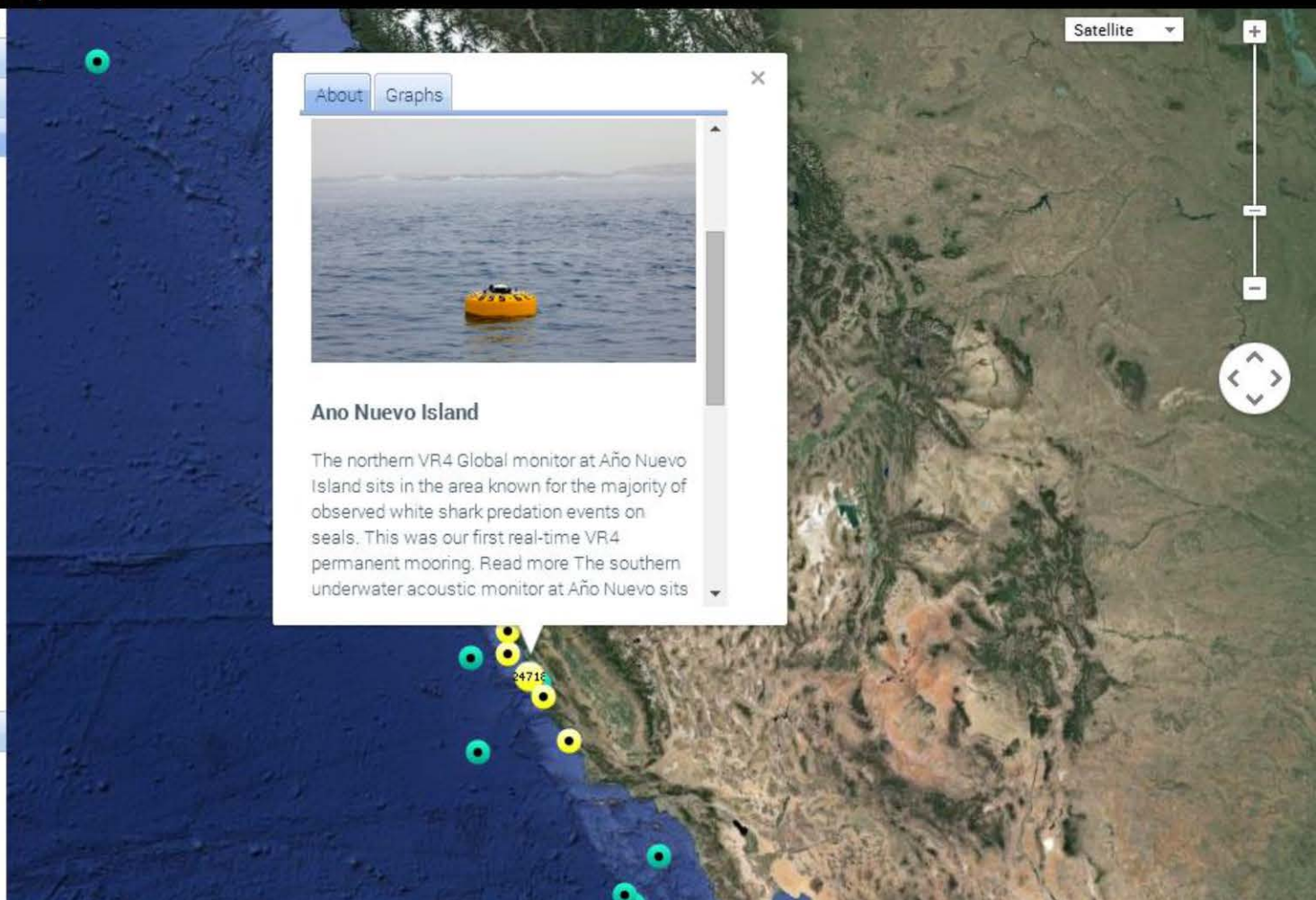
- Cetacean
- Fish
  - Atlantic Bluefin Tuna
  - Black Marlin
  - Blue Marlin
  - Pacific Bluefin Tuna
  - Striped Marlin
  - White Marlin
- Pinniped
- Seabird
- Shark
- Turtle

Popup Tags

- Buoys
- Gliders



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



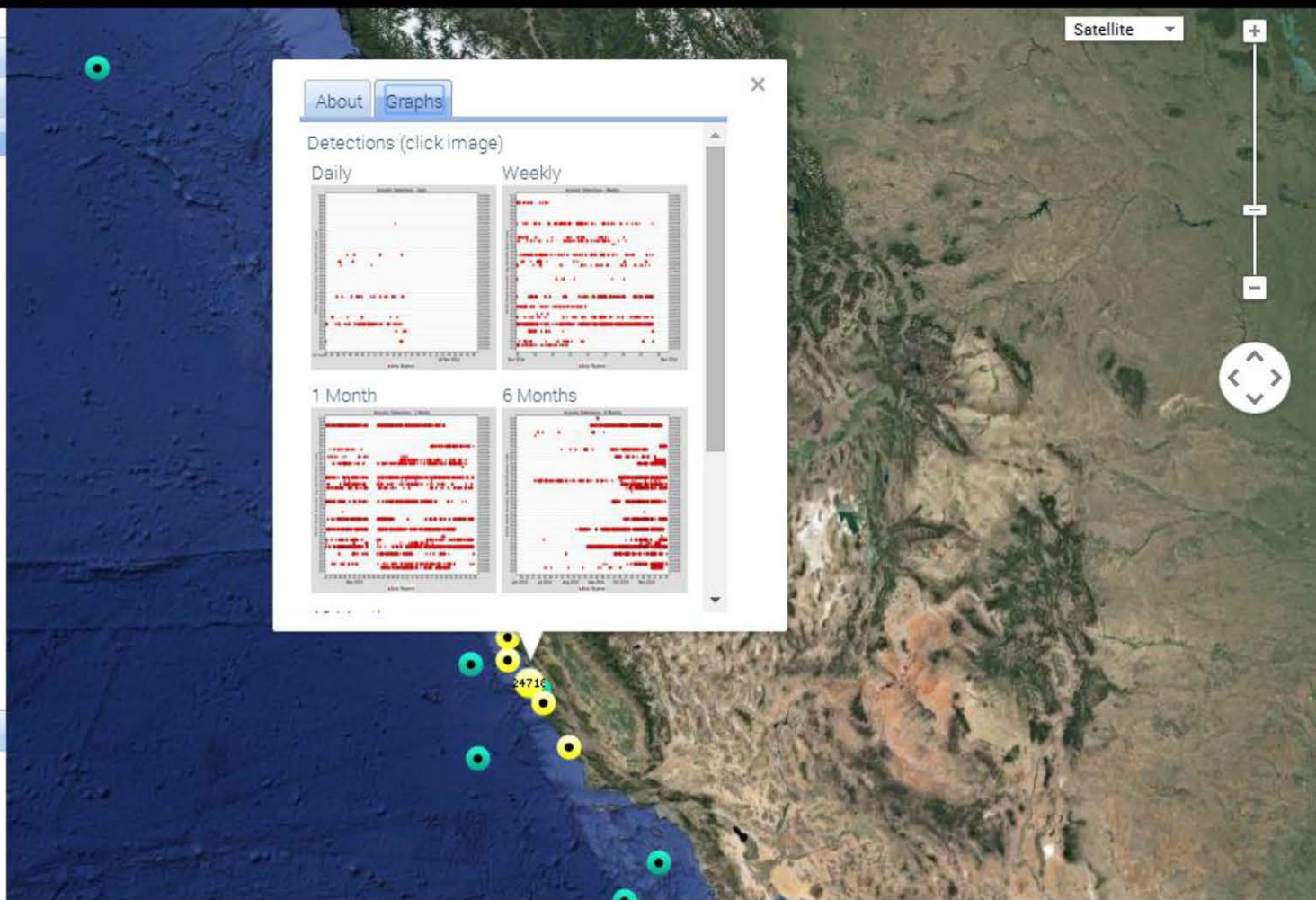
About Graphs

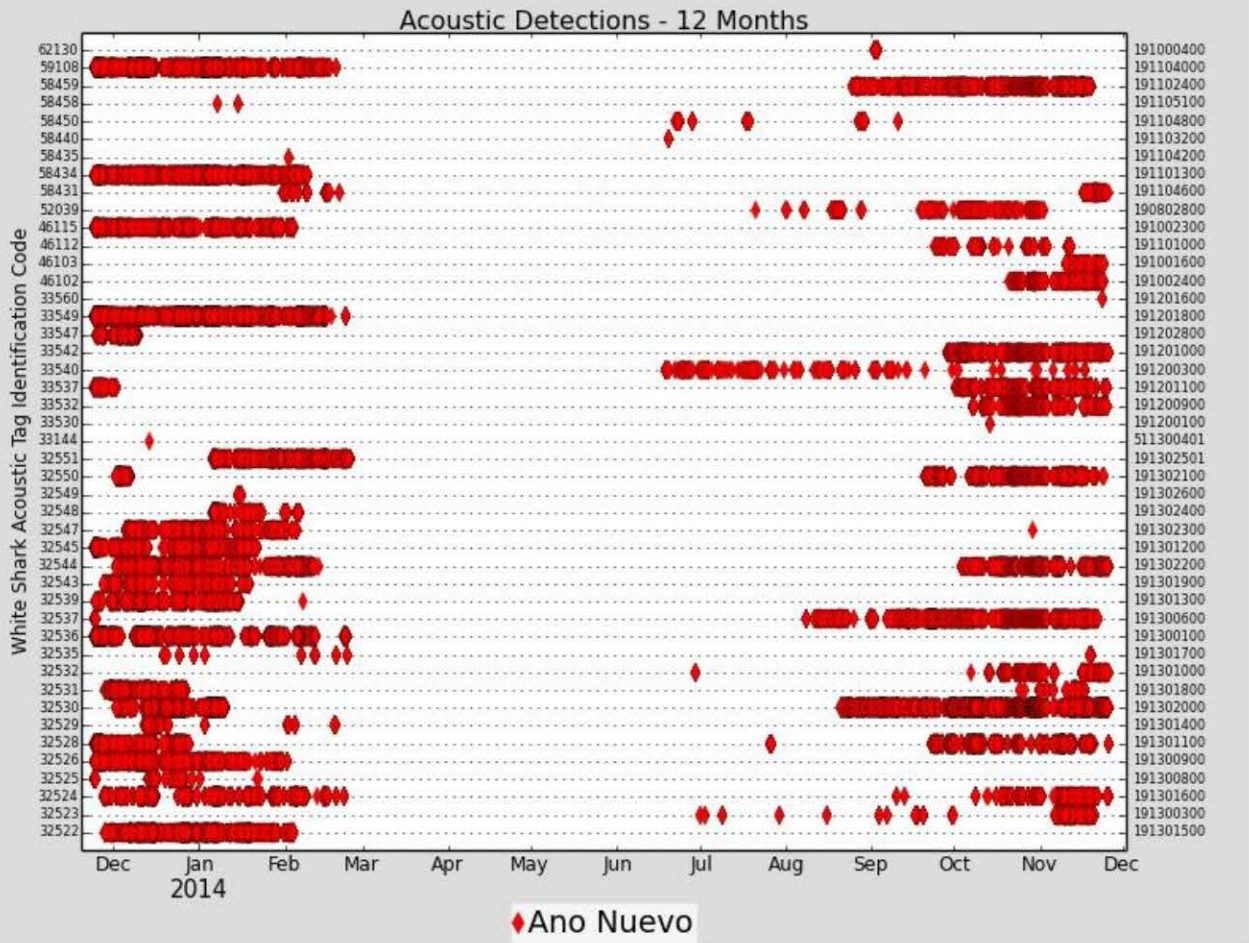


### Ano Nuevo Island

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

+

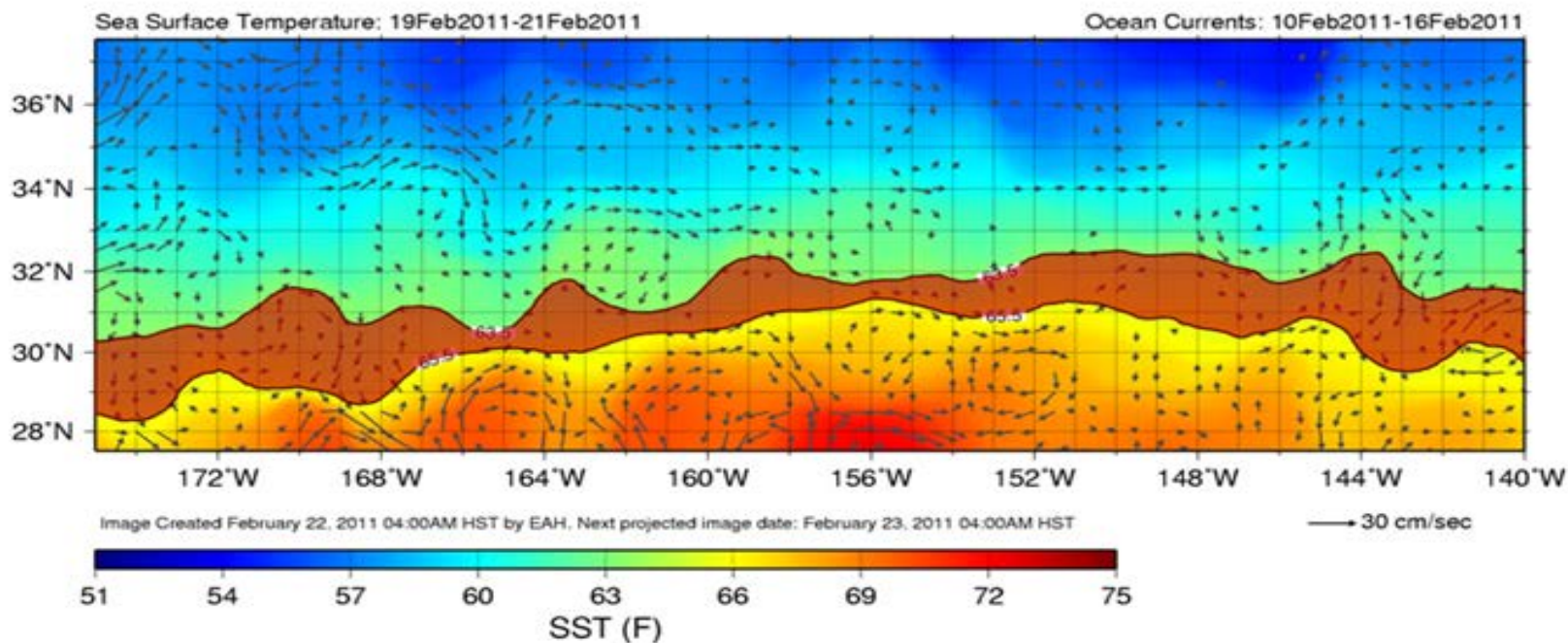
-

⬅ ➡

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

# Reduce Bycatch of Loggerhead Turtles in Hawaii in Longline Fishery

avoid fishing between solid black 63.5°F and 65.5°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)