Technical Document 3242
November 2010

Software Tools for Visual and Acoustic Real-Time Tracking of Marine Mammals: Whale Identification and Logging Display (WILD)

Angela D'Amico
Chsitopher Kyburg
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Approved for public release; distribution is unlimited.

SSC Pacific
San Diego, CA 92152-5001

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ADMINISTRATIVE INFORMATION

This report was prepared for the Office of Naval Research by the Advanced Concepts Branch (Code 5653) of the Maritime Surveillance Division (Code 565), SSC Pacific.

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Under authority of
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Software Tools for Visual and Acoustic Real Time Tracking of Marine Mammals - WILD

Angela D'Amico,
Christopher Kyburg,
Rowena Carlson

SPAWAR Systems Center Pacific
San Diego, California

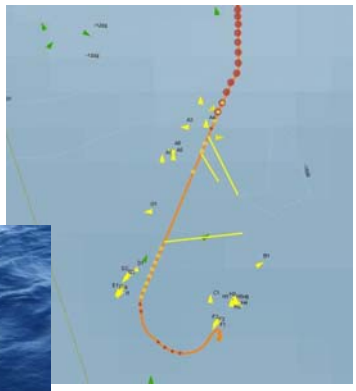


photo taken as part of research permitted under NMFS permit 14241

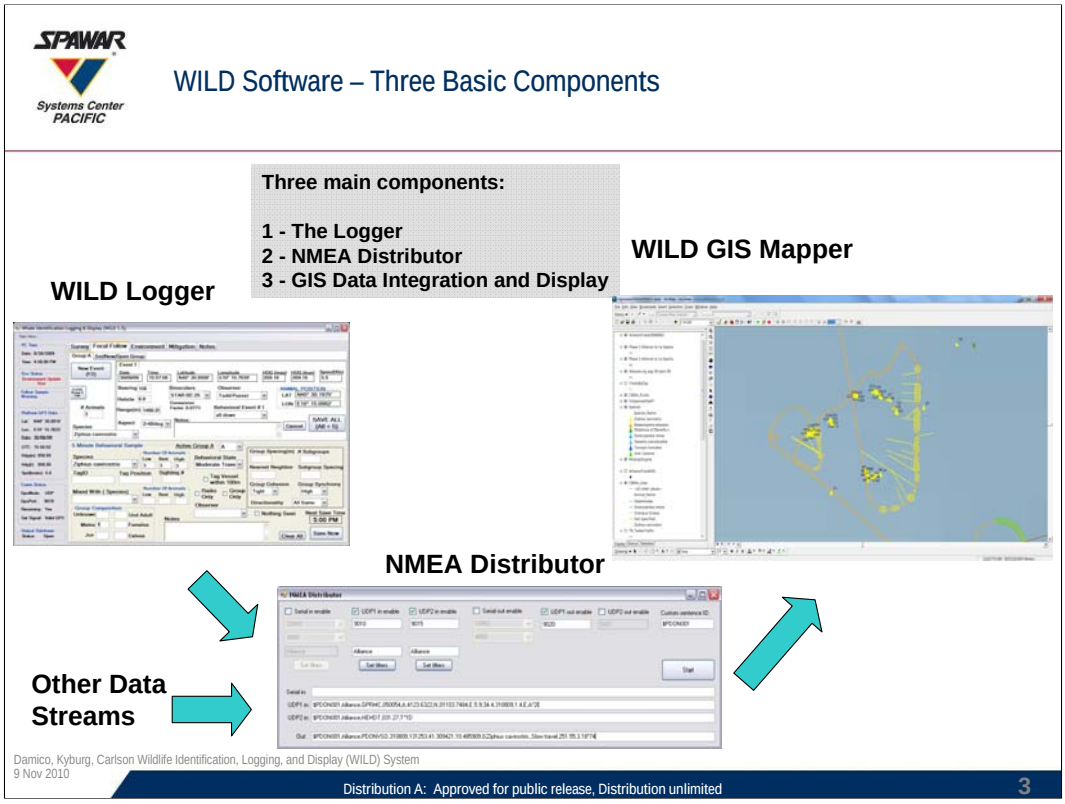
9 November 2010

Wildlife Identification, Logging and Display (WILD) - Introduction

- WILD Functional Requirements
- NMEA – a short side trip
- Wildlife Identification Logging and Display (WILD) Software
  - Used for MED 09 and SOCAL-10 Sea Trials, Pinniped Surveys, San Diego Bay

This talk will cover:

- the Functional Requirements that defined WILD
- a discussion of the National Marine Electronics Association 0183 standard and how it is used in WILD.
- a detailed description of the components of the WILD software and how they are deployed
- and finally an example of what you would see on the display as a Focal Follow unfolded.



The WILD software is composed of three components:

- The Logger: This is used by the Visual Observers to record sightings of Animals, their behaviors, and environmental conditions.

- The NMEA Distributor: This component acts as the communications manager on the ship's network. It merges data streams from the Logger and all other instruments into a single feed which can be used anywhere on the ship's network.

-The Mapper: This is the display component of WILD. It operates within the ArcGIS Geographic Information System software suite. It extends the functionality of the standard ArcGIS environment to allow real time mapping of acoustic and visual animal observations as well as vessel locations etc.

-More on all three components later.

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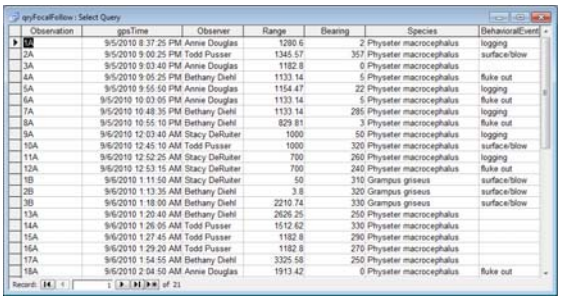
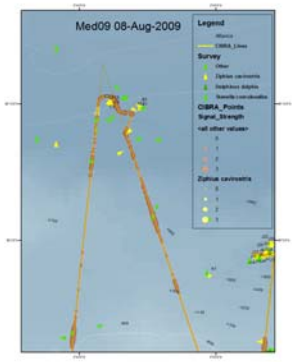
WILD Logger – Functional Requirements

Support Three Operational Modes

- 'Standard' Marine Mammal Survey Support
- Focal Follow / Tagging Support
- Mitigation Support





- Data Stored Locally
- Send Animal Location to GIS
- Operate with Ship's Navigation Data
- Operate with 'Stand Alone' Navigation Data

The Functional Requirements of the system defined how each of the three components were to operate.

The Logger needed to support three operational modes:

- Survey mode, used for systematic marine mammal surveys used to gather data for density calculations
- Focal Follow mode: This mode is used in support of tagging observations
- Mitigation mode, used for post controlled exposure behavioral observations

In addition to the three operational modes the Logger is required to:

- Store all observation and environment data locally
- Broadcast visual animal observations over the ship's network
- Be able to use the ship's navigation system for positional data or use 'stand alone' navigation data.

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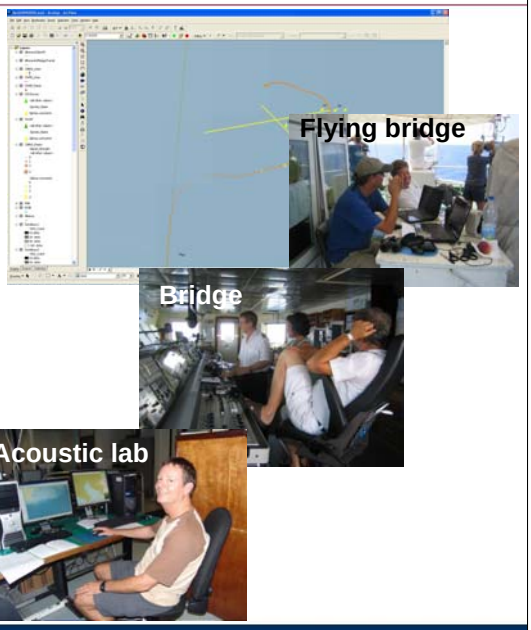
WILD Mapper Functional Requirements

Provide a "tactical display system"

- User interface
  - Allow each user to customize view
  - Provide each user with 'standard' GIS tools
  - Allow other loggers to be integrated
  - Integrate all vessels and observations – Real Time
- Data Management and networking
  - Display at multiple locations on vessel – Real Time
  - Easy integration of new sensors
  - Save all observations locally
- Display Base Map data
  - Bathymetry (raster and vector contours)
  - Raster nautical charts
  - Planned survey track lines
  - Marine sanctuary boundaries
  - OPAREA boundaries



The WILD display system had it's own set of functional requirements:

- Provide standard GIS tools and functionality.

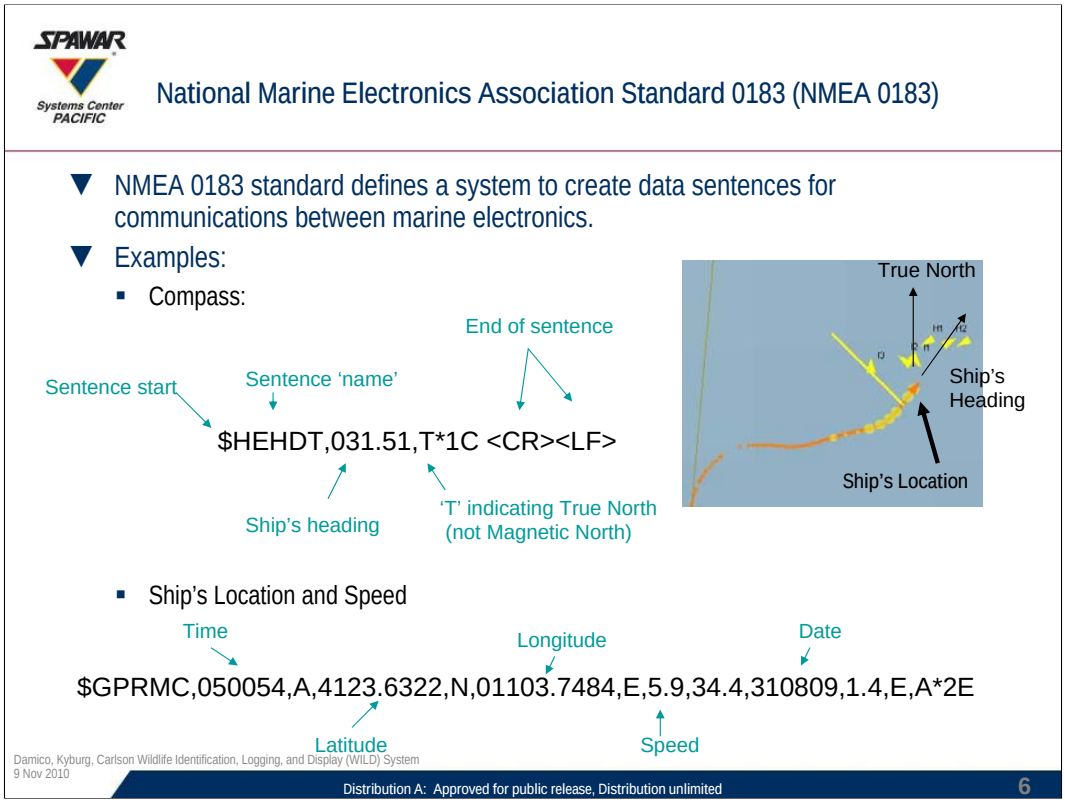
-in real time.

-Display all observations and ship's positions integrated in multiple locations of the ship in real time.

-Allow users to manipulate their displays as desired.

-Save data locally

-Display base map data such as bathymetry, land, Survey track lines etc.



In order for the Logger and other instruments to be able to transmit data to the Mapper a communications strategy was needed.

The National Marine Electronics Association created a standard for communicating data between electronic devices tailored to the marine environment known as NMEA 0183.

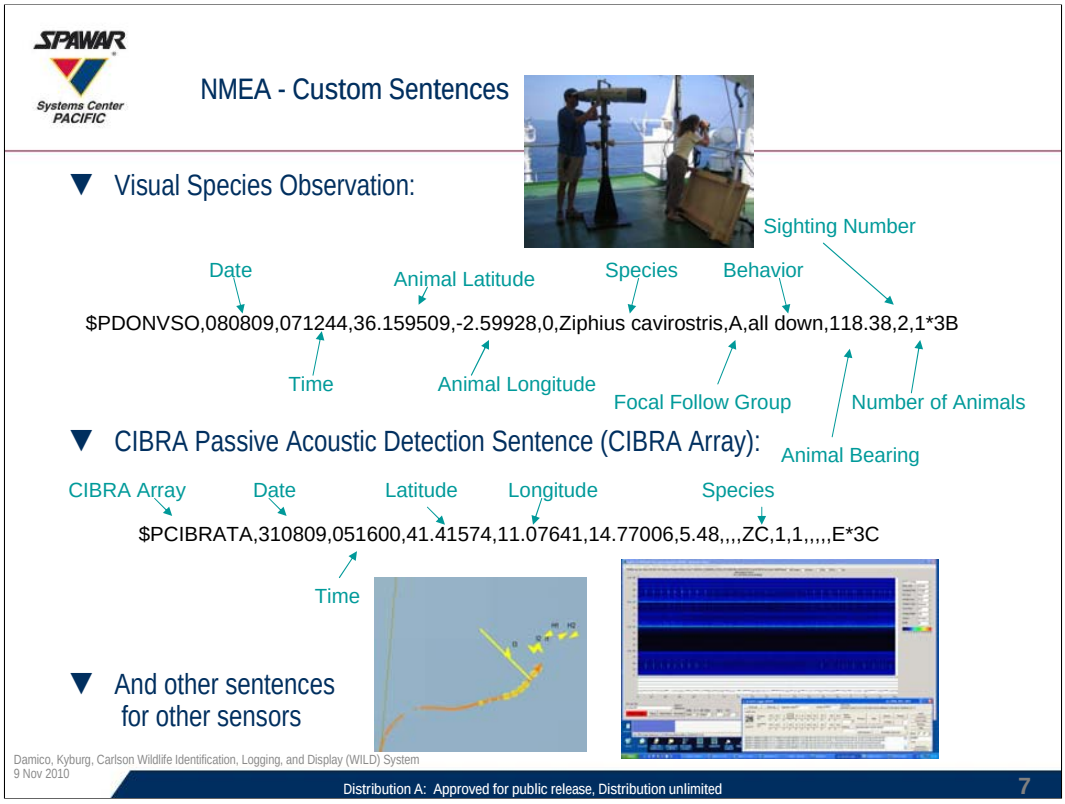
The standard allows equipment manufacturers to define data sentences for their instruments and broadcast them across a ship's network.

Two examples of these sentences are shown here.

The first is a bearing sentence produced by an electronic compass.

The second is a location sentence which has become a standard output of GPS instruments.

The instruments broadcast their respective sentences at between one and ten second intervals.



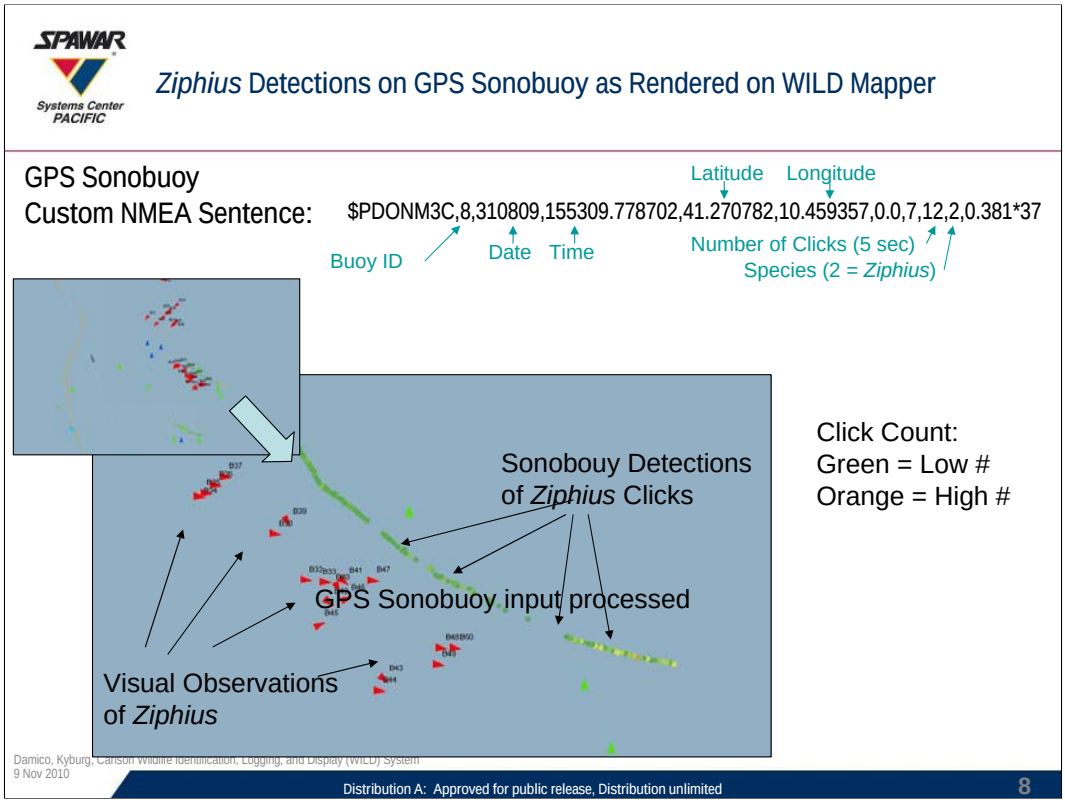
The NMEA 0183 standard was adopted for use in WILD and custom sentences were defined in accordance with the standard, and several are shown here.

The first is a Visual Species Observation sentence. All necessary data to plot the animal observation are provided in this sentence.

The second sentence is a used for passive acoustic detections using the CIBRA array created and operated by Gianni Pavan. Similarly the sentence provides all of the data required to plot the observation on the WILD Mapper.

The yellow triangles are how visual animal observations are rendered.

The yellow circles and lines are how acoustic animal vocalizations and bearings from the CIBRA array are rendered.



This is another example of a custom NMEA Acoustic sentence.

In this case it was designed to communicate GPS Sonobuoy detections.

All of the elements needed to render the observation in a meaningful way are included in the sentence

This shows how the Sonobuoy acoustic detections are plotted on the WILD Mapper display. The animal location is not determined so the detection is represented as a colored dot at the location of the buoy at the time of detection.

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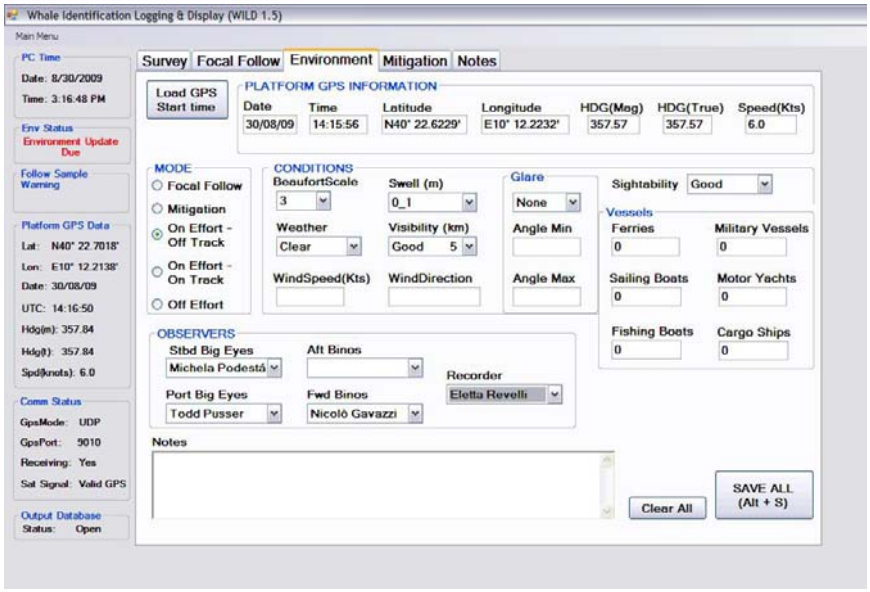
WILD Logger - Environmental Observations Form



Automatic display of ship status

Pull-down menus of standard observation information

Text boxes for input of other parameters

Now let's take a closer look at the Three components of the WILD software system starting with the logger.

The Logger is comprised of a set of sub-forms for the various functions it performs:

The current position, heading and speed of the ship is continually displayed on the left side of the Logger display.

The Environmental form shown here is used to record sea state, weather, sightability and other relevant data such as vessels in the area and who is functioning in the various roles of the Visual Observer team.

By default this information is prompted for every 30 minutes.

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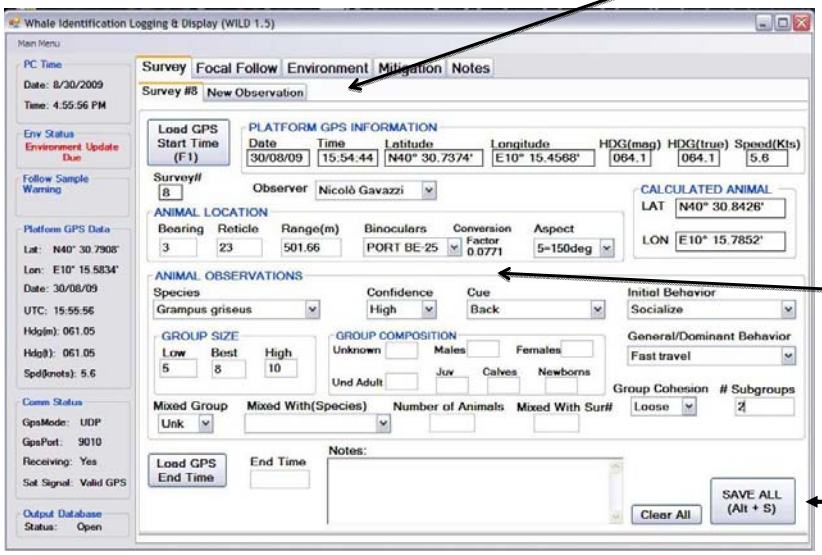
WILD - Survey Mode Observations Form

Survey Mode is along planned survey track

Multiple observation pages can be active



Animal position Is automatically calculated from ship heading, ship position, observation angle and observation Range.

Binocular menu Includes 25x150 Bigeyes, 7x50 binoculars, and the naked eye.

Latitude and longitude of the animal is automatically sent to the GIS display as soon as “SAVE ALL” button is pushed.

The WILD Logger’s Survey form is shown here.

When an animal is seen an observation record is started by pressing the “Load GPS Start Time” button

At a minimum, the species name, the bearing to the animal, the distance or reticle and the best guess of the number of animals are required. Other information may optionally be entered.

When the “Save All” button is pressed, the information is saved to the local database, and the Visual Species Observation sentence is generated and broadcast across the ship’s network.

Note that multiple observations can be open at the same time.

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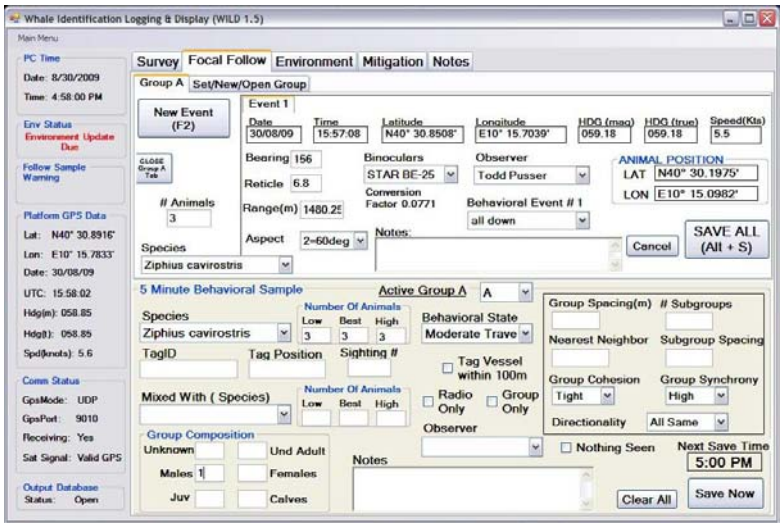
WILD – Focal Follow Mode Observations Form

Focal Follow Mode generally involved deviation from the planned survey track to follow a selected animal or group of animals



Specialized input format for Focal Follow mode

5 minute behavior form

This is the WILD Logger's Focal Follow Observation Form.

The form is very similar to the Survey form with the following differences:

A group identifier and observation number are assigned to a series of observations of one or more animals. This allows the observations to be seen as one or more series of observations of an individual or group through time.

The Lower part of the form is used to record behavior periodically in order to help document changes in group behavior.

Note that observations of multiple groups can be worked on at the same time.

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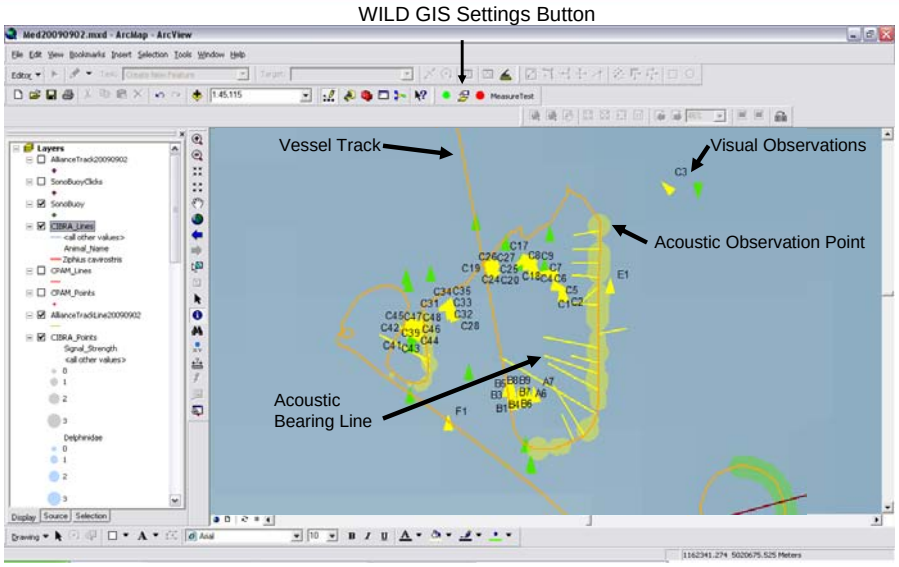
WILD Mapper - Display



This is the WILD Mapper display.

When operating the Mapper ‘listens’ on the network for NMEA sentences and renders objects on the map as they are detected.

The orange line is the ship’s track, the triangles represent visual observations, and the circles and lines represent acoustic observations. Both visual and acoustic observations are color coded to represent the species observed.

This is the NMEA distributor.

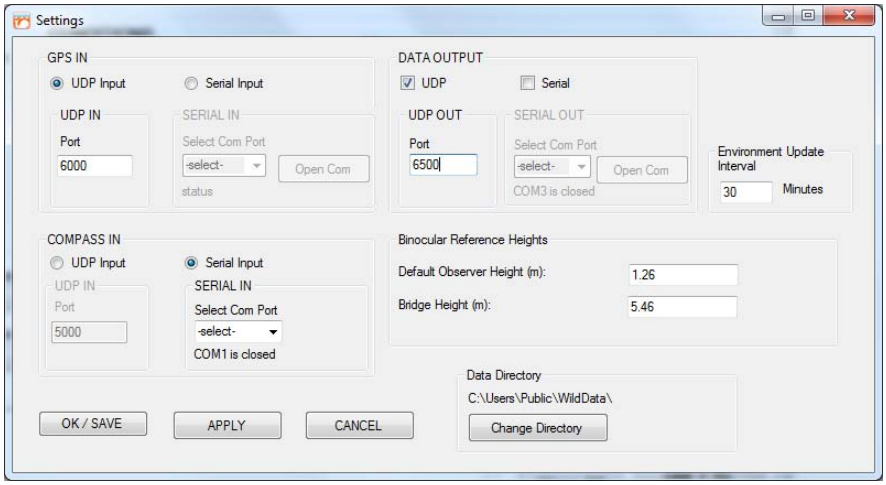
It is the communications building block of the WILD system.

In it's simplest form it accepts two data streams and merges them into one.

Multiple distributors and be used to merge any number of instruments into one data stream

It is also used to convert a serial signal (which is what most instruments ouput) into a UDP broadcast stream, allowing it to be picked up and used anywhere on the ship's network.

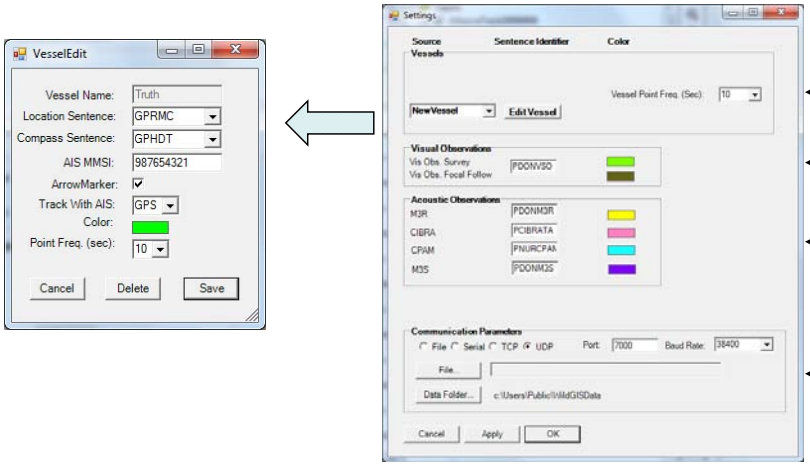
WILD – Settings Form



The WILD Logger setup form allows parameters such as platform height, communications parameters, and data storage location to be set.

WILD Mapper - Setup forms

- Vessel Locations can be from GPS or AIS



Vessel Settings

Visual Observation Settings

Acoustic Observation Settings

Communications Settings

The WILD Mapper settings forma allows similar information to be set for the Mapper in addition to managing the project vessel list and parameters.

WILD GIS Software Components

Initializer: checks to see if a Geodatabase exists for the current date. If not, creates one from the seed GDB (enables 24 hour operation, unattended).

Renderer: Sets display parameters and updates the display.

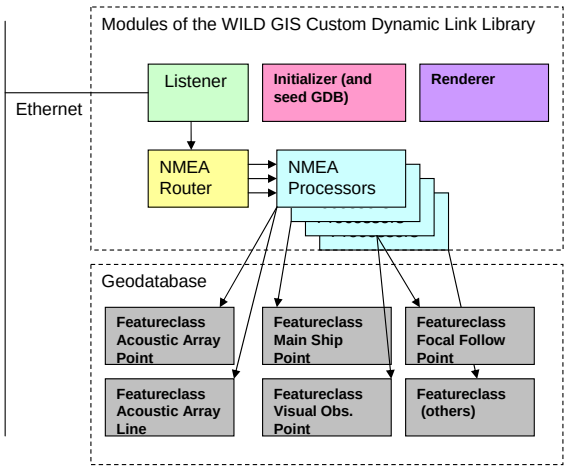
Step 1. DLL Receives signals broadcast over the ship's network by the NMEA distributors.

Step 2. UDP Listener captures NMEA sentences and checks compliance with 0183 standard.

Step 3. NMEA Router passes sentences to the correct NMEA Processor based on the sentence identifier.

Step 4. NMEA Processor extracts latitude, longitude and all other attribute data from the sentence and creates the feature. The feature class is then updated in the Geodatabase.

Step 5. WILD GIS display is then updated with the newly received data point or line.



This is a schematic of the NMEA Mapper's objects.

The listener sends valid NMEA sentences to the Router.

The Router determines what type of sentence it has from the sentence name and routes the sentence to the correct NMEA processor.

The Processor creates the feature in the correct feature class and stores it in the Geodatabase.

Periodically the renderer refreshes the map with the new feature(s).

The initializer will create a new Geodatabase when the application is started if one does not already exist.

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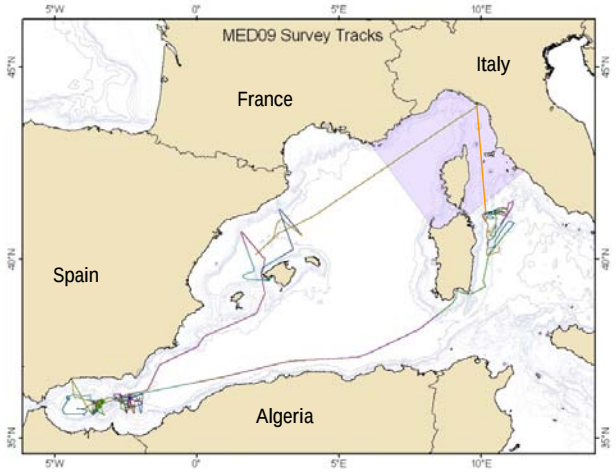
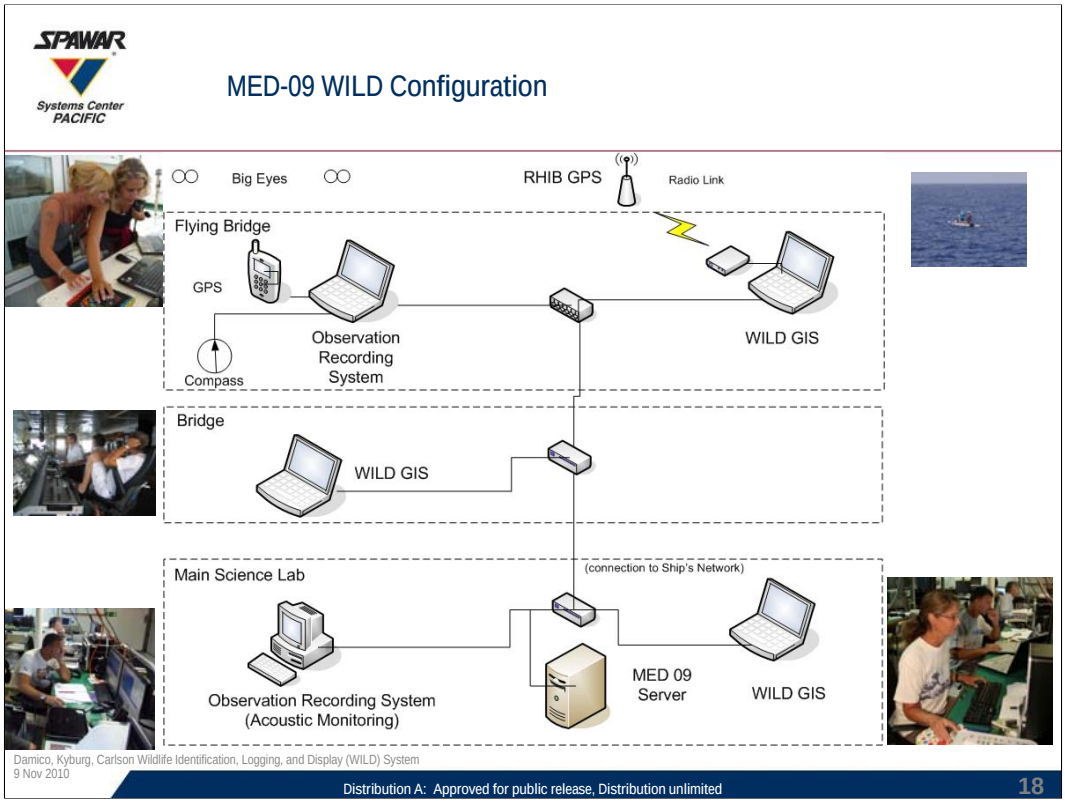
WILD System Configuration Aboard NR/V Alliance MED 09



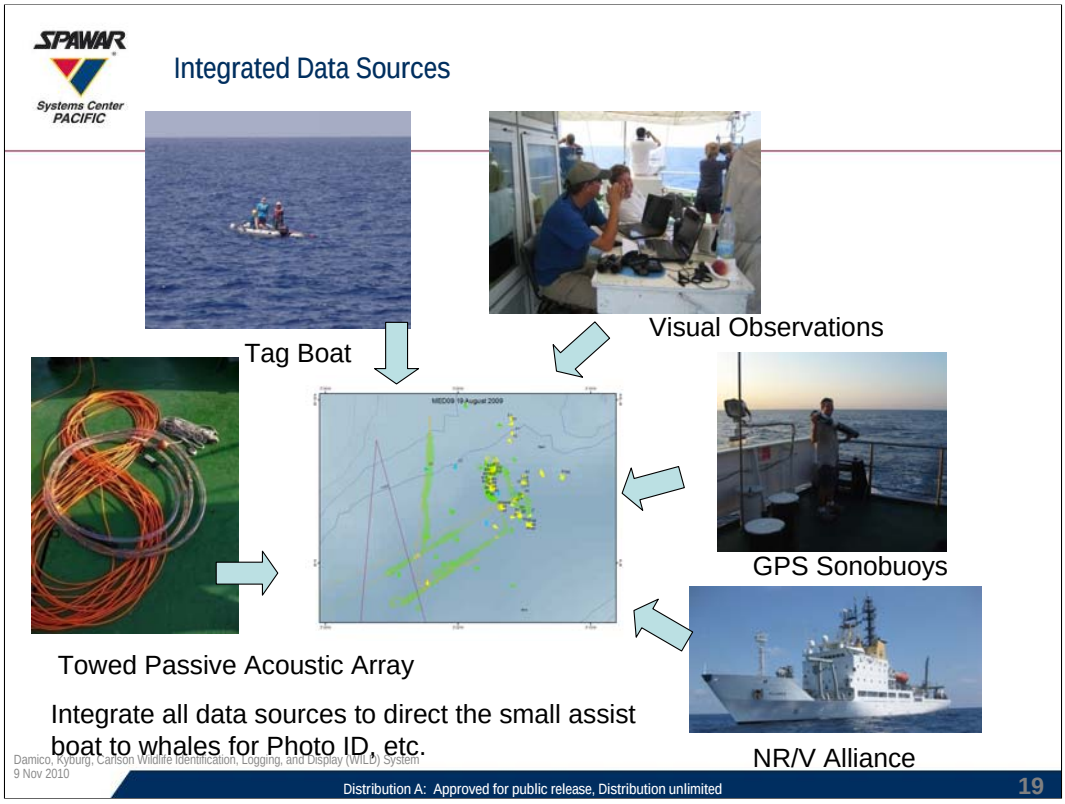
The objective of MED 09 was the detection of beaked whales and pilot whales in the western Mediterranean to evaluate abundance and dive behavior. See http://med09-expedition.blogspot.com/

The MED-09 cruise involved multiple acoustic detection systems and visual operations in a sophisticated network.



The system involved three WILD displays one in the acoustic lab, one on the bridge, and a third on the flying bridge.

On the NR/V Alliance either the acoustic or visual teams requested the ship to modify its location based on whether the animals were on the surface of at depth vocalizing so detections would be optimized.



A variety of data was integrated into the WILD Mapper aboard the Alliance including Tag boat location, visual observations acoustic detections form sonobuoys, the main Research platform Alliance, and acoustic detections from the CIBRA array.

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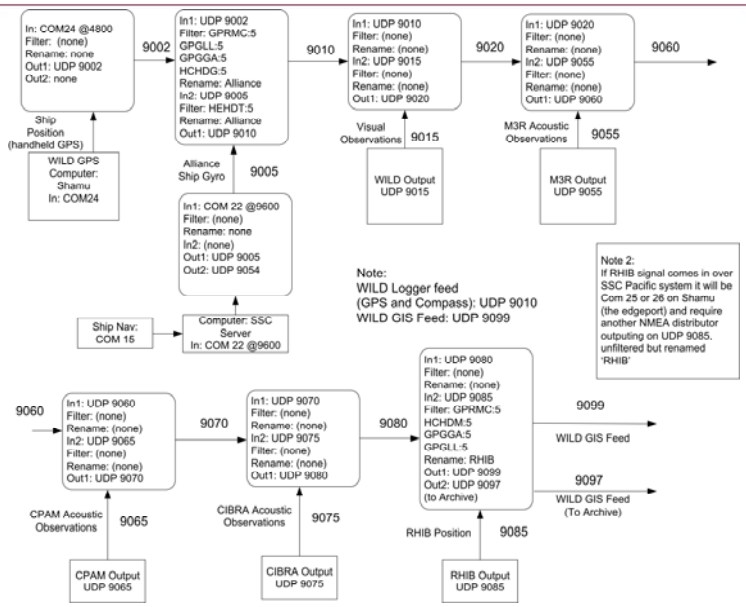
NMEA Distributor setup aboard NR/V Alliance



The network of NMEA Distributors needed to merge all of the information of interest was quite complex but worked very well

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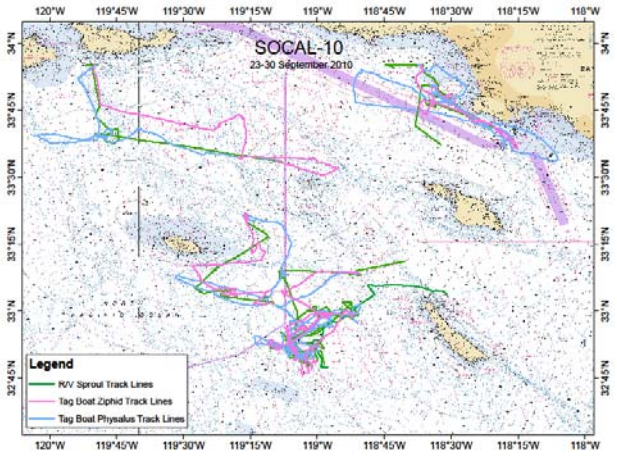
WILD System Configuration Aboard Truth and R/V Sproul SOCAL-10



The objective of SOCAL-10 was to contribute to understanding of marine mammal behavior and changes in behavior as a function of sound exposure for various species. See http://sea.typepad.com

The WILD system used in SOCAL-10 was much simpler, as visual observations were the primary detection method.

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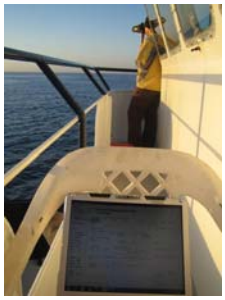
SOCAL-10 WILD Stand Alone Configuration (R/V Sproul)

GPS Heading Sensor



WILD Logger Station

AIS Reciever, WiFi Router

WILD Mapper GIS Station

Several of the changes from the MED-09 to the SOCAL-10 system include use of a GPS compass, use of WiFi in the ship's network, and IAS transponders to track the tag boats.

MED 09 Daily Summary Example

Species: *Ziphius cavirostris*

Group identifier: J

Location: 36° 10'N; 2° 38'W

Duration: 4:49 (1525 to 2014)

Group composition: 4 animals (3 adults, possibly female; 1 juv.)

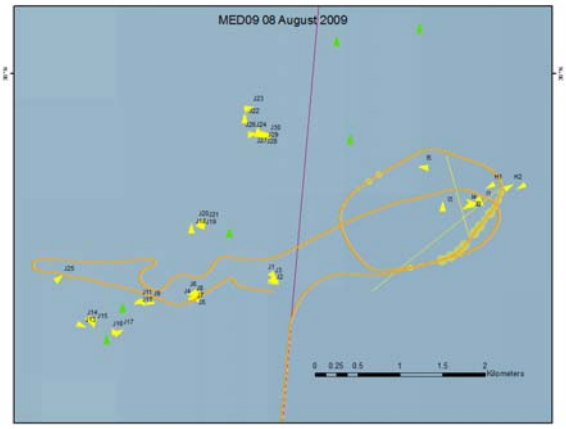
Number shallow dives: 5

Avg. shallow dive time: 20.6 min

Avg. distance between dives: 648 m

What ended follow: SUNSET

Comments: Good follow and on animals with good tracking, just ran out of light



The following set of slides give you an idea of what the WILD display looks like through a typical Focal Follow tagging attempt.

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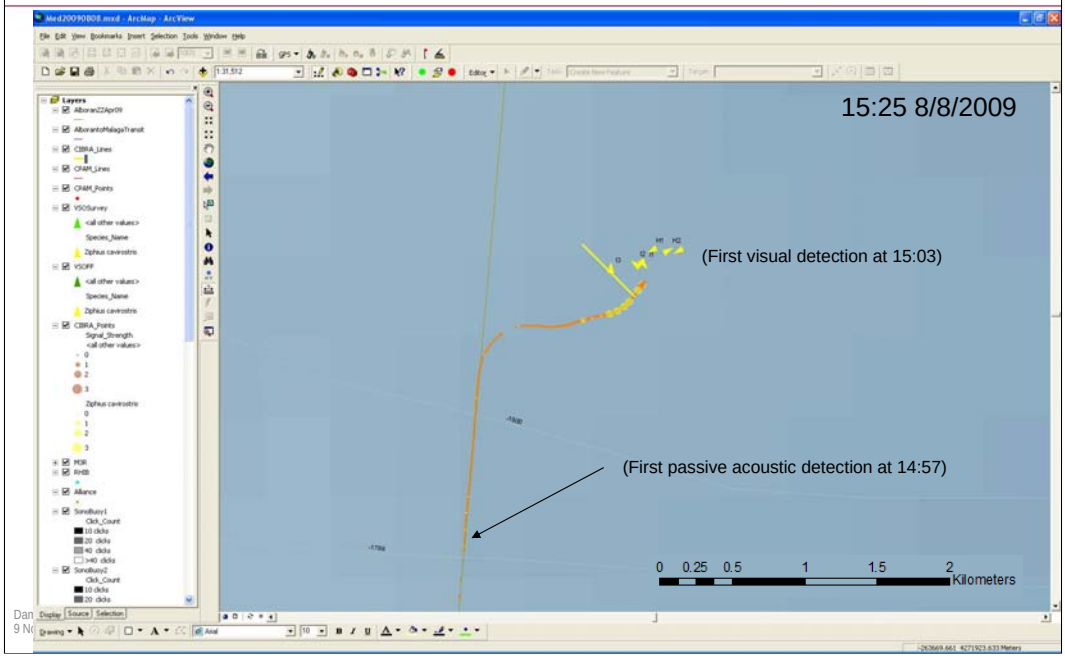
MED 09 Data File Playback: 08-Aug-2009



Beaked whales were initially detected on the passive acoustic towed array and the decision was made to change from Survey mode to Focal Follow mode and attempt to locate the animals.

The animals were seen and the Alliance headed in the direction of the observations. As the ship makes it's way to the area the animals were seen they dove and were picked up on the acoustic array again.

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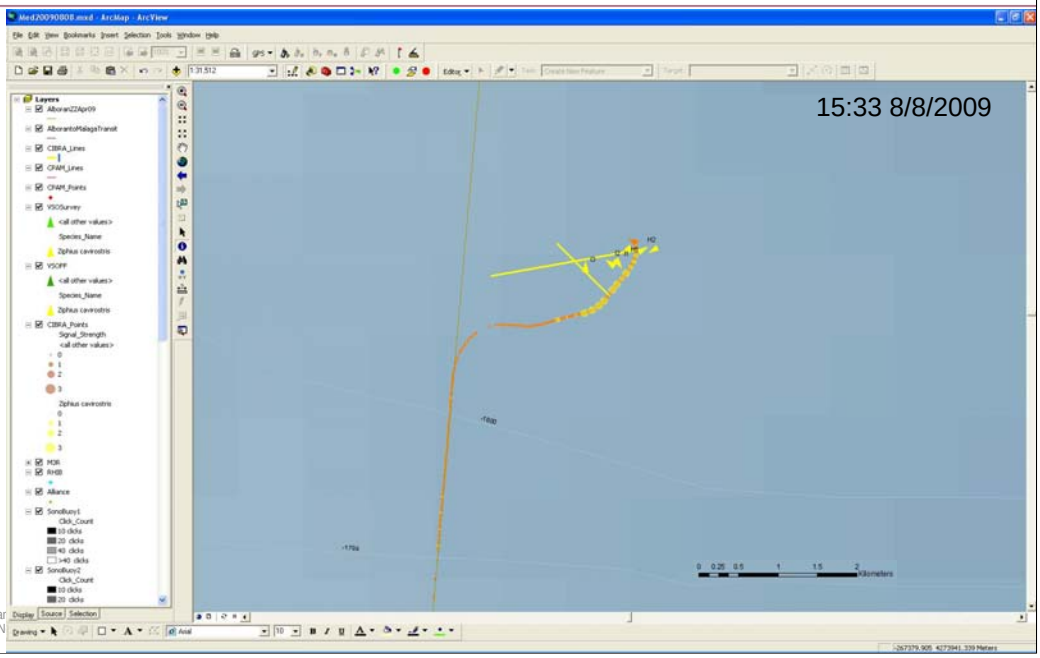
MED 09 Data File Playback: 08-Aug-2009



The chase progressed throughout the afternoon and into the evening.

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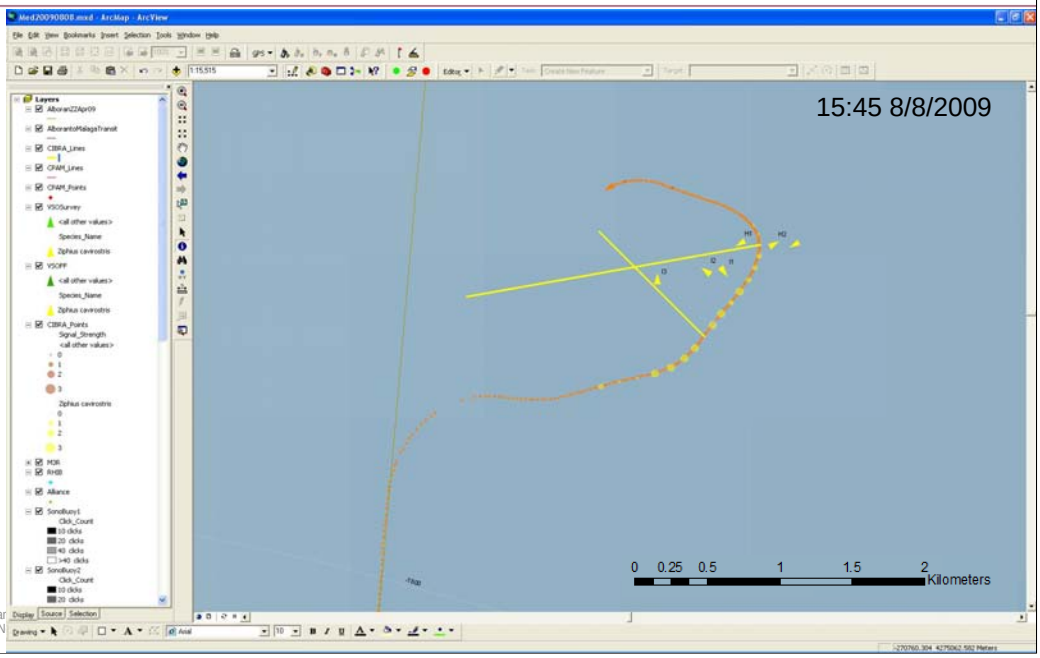
MED 09 Data File Playback: 08-Aug-2009



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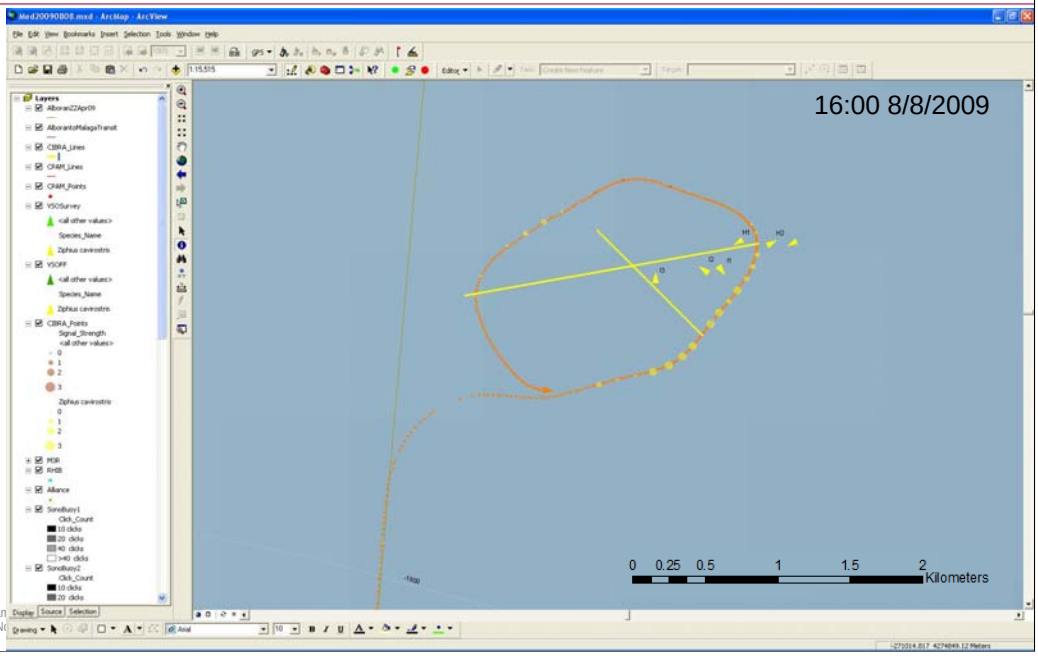

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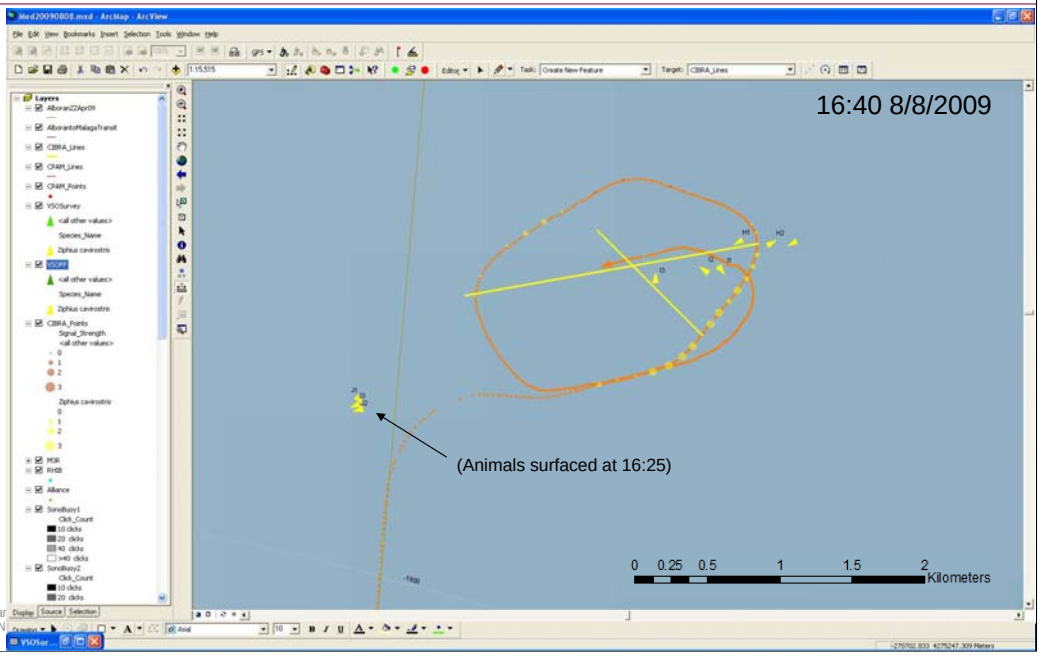
MED 09 Data File Playback: 08-Aug-2009



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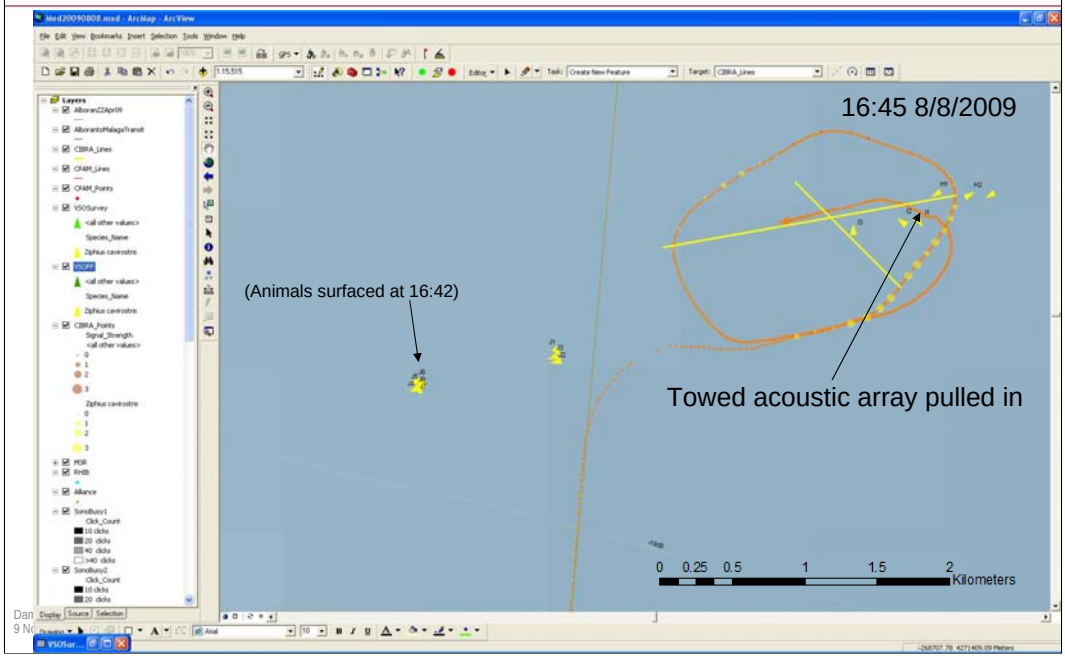
MED 09 Data File Playback: 08-Aug-2009



Following the third surfacing the towed array was shipped to allow the vessel to maneuver better.

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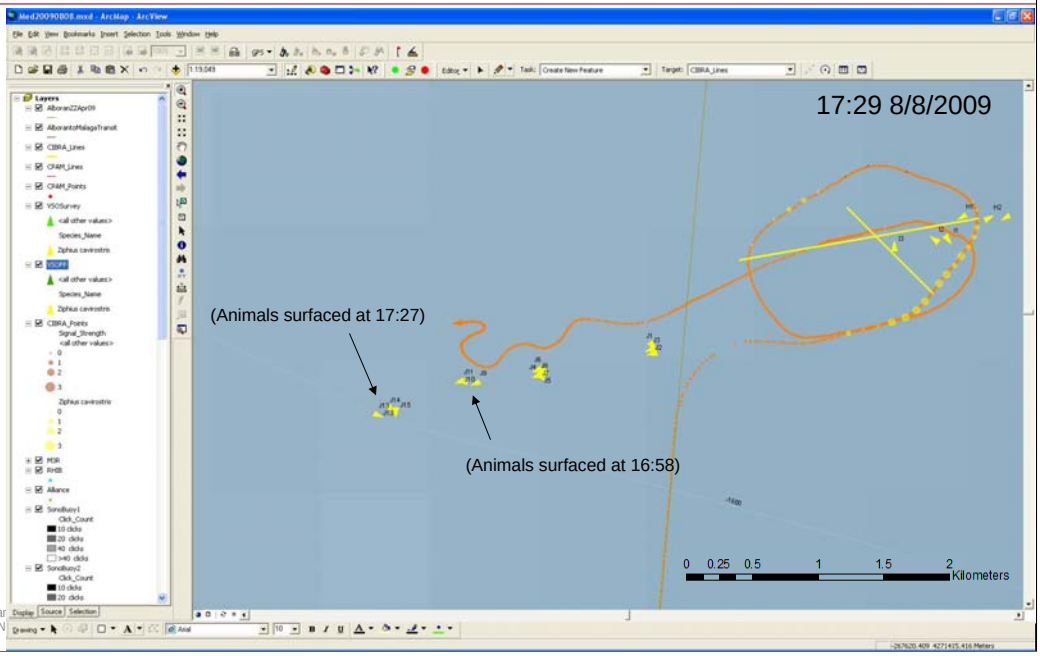
MED 09 Data File Playback: 08-Aug-2009



The visual team attempts to keep the vessel in a position to maximize the ability to see the animals surfacing based on glare etc.

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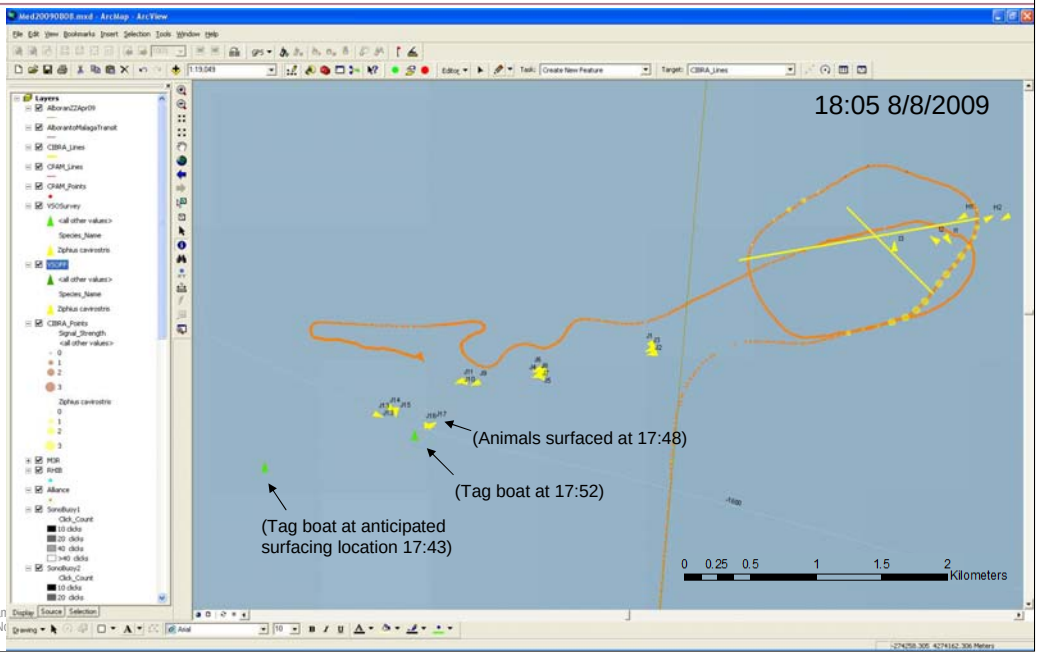
MED 09 Data File Playback: 08-Aug-2009



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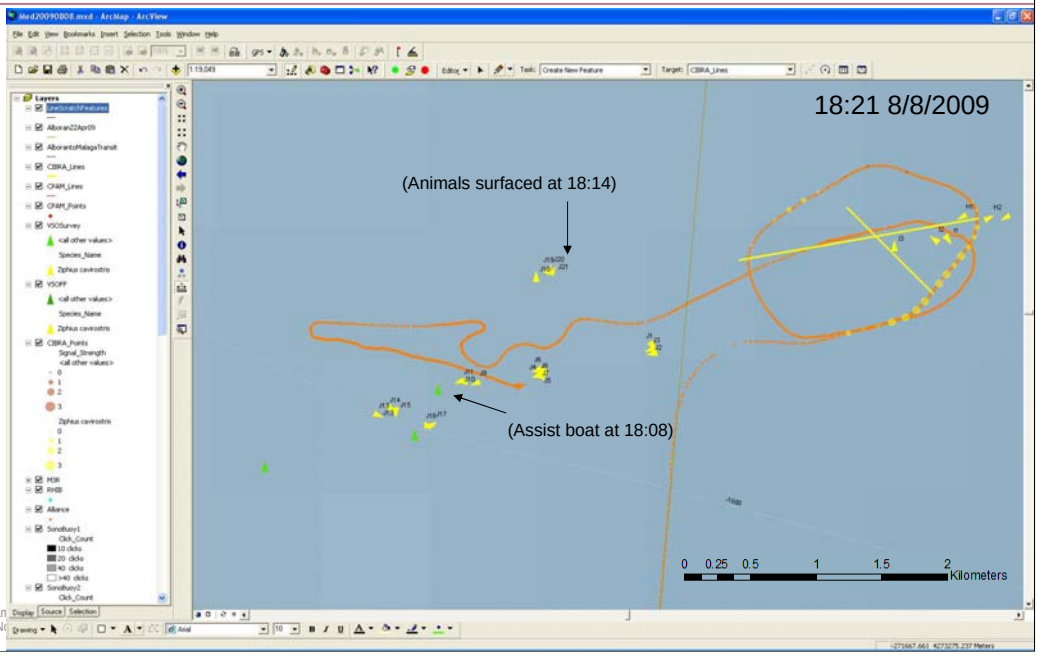
MED 09 Data File Playback: 08-Aug-2009



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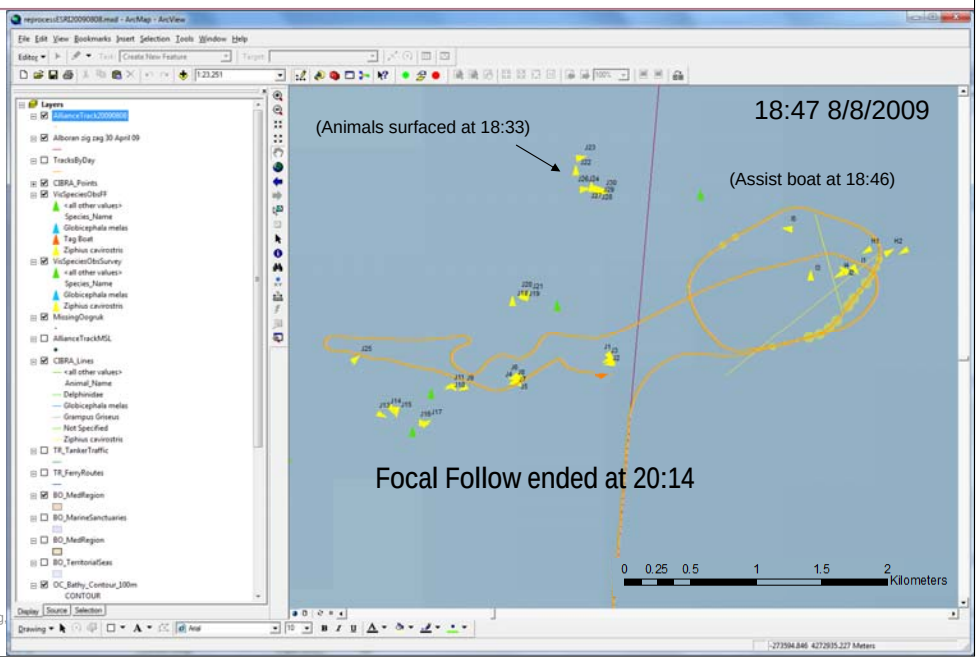
MED 09 Data File Playback: 08-Aug-2009

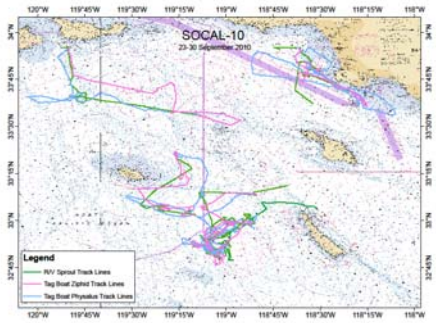


Damico, Kyburg,
9 Nov 2010

The Focal Follow was ended at 20:14 UTC due to loss of daylight.

SOCAL-10

- SOCAL 10 Sea Trials
  - Used AIS transponders instead of radio link for small boat tracking.
  - Small vessel vs 'conventional' Research vessel
- Cursory Results:
  - 26 playbacks
    - 18 blue whale
    - 5 fin whale
    - 2 sperm whale
    - 1 beaked whale
  - 3 control



The first year of the SOCAL-10 sea trials were very productive. Lessons learned will be incorporated into the subsiquent fieldwork.

Acknowledgments

- MED 09 and SOCAL–10 Sponsors
  - ONR
  - CNO N45
- MED09 team
  - Alnitak Marine Environment, Bluwest, CIBRA, Delfini Metropolitani, IFREMER, SECAC, Museo Natural History Milano, NURC, NUWC, Politech Milano, AMBAR, SEA, SSC Pacific, WHOI
- SOCAL-10 team
  - WHOI, SSC Pacific, Cascadia Research Collective, SEA Inc., Duke University, NUWC, SWMFS Southwest, Scripps, Applied Physical Sciences, U.C. Santa Cruz

The team wants to thank the participants and sponsors.

Thank You!

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Questions?

Thank you!

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-01-0188

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1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
January 2010	Final	January 2010-November 2010

4. TITLE AND SUBTITLE

Software Tools for Visual and Acoustic
Real -Time Tracking of Marine Mammal :
Whale Identification and Logging Display (WILD)

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHORS

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5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

SSC Pacific
San Diego, CA 92152–5001

8. PERFORMING ORGANIZATION REPORT NUMBER

TD 3242

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Office of Naval Research
875 N. Randolph Street, Suite 1425
Arlington, VA 22203-1995

10. SPONSOR/MONITOR'S ACRONYM(S)
ONR

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

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14. ABSTRACT

This technical document covers the functional requirements that define Wildlife Identification, Logging and Display (WILD), National Marine Electronics Association (NMEA) 0183 standard and how it is used in WILD, components of the WILD software and how they are deployed, and what is seen on the display as a Focal Follow unfolded. The WILD software is composed of three components. The first component is the Logger. The Logger is used by the visual observers to record sightings of animals, their behaviors, and environmental conditions. The second component is the NMEA Distributor. The NMEA Distributor acts as the communications manager on the ships network. It merges data streams from the Logger and all other instruments into a single feel that can be used anywhere on the ship's network. The third component is the Mapper. The Mapper is the display components of WILD. It operates within the ArcGIS Geographic Information System software suite. It extends the functionality of the standard ArcGIS environment to allow real-time mapping of acoustic and visual observations as well as vessel locations, etc.

15. SUBJECT TERMS

Mission Area:
National Marine Electronics Association Focal Follow WILD Logger
WILD Mapper Security NMEA Distributor G15 Software

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Angela D'Amico
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