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

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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.
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.
The WILD display system had its own set of functional requirements:

- Provide standard GIS tools and functionality.
- 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 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.
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.
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.
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.
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 its 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 output) into a UDP broadcast stream, allowing it to be picked up and used anywhere on the ship’s network.
The WILD Logger setup form allows parameters such as platform height, communications parameters, and data storage location to be set.
The WILD Mapper settings form 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.
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.
The network of NMEA Distributors needed to merge all of the information of interest was quite complex but worked very well.
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.
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.
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.
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 its way to the area the animals were seen they dove and were picked up on the acoustic array again.
The chase progressed throughout the afternoon and into the evening.
Animals surfaced at 16:25
Following the third surfacing the towed array was shipped to allow the vessel to maneuver better.
The visual team attempts to keep the vessel in a position to maximize the ability to see the animals surfacing based on glare etc.
(Animals surfaced at 17:48)

(Tag boat at 17:52)

(Tag boat at anticipated surfacing location 17:43)
The Focal Follow was ended at 20:14 UTC due to loss of daylight.
The first year of the SOCAL-10 sea trials were very productive. Lessons learned will be incorporated into the subsquent fieldwork.
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   ▼ ONR
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▼ SOCAL-10 team
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Thank You!

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Questions?

Thank you!
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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 feed 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.

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

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