

# Sargasso Sea **COVERAGE** Mapping Workshop Report

20–22 March 2016, Key West, Florida

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## SUMMARY

The COVERAGE-Sargasso Sea Workshop was held 21-22 March, 2016 at the NOAA Eco-Discovery Center, Key West, Florida. The workshop involved expert presentations on COVERAGE and issues of heightened relevance for the Sargasso Sea region followed by a series of focused group discussions with the objective of developing consensus recommendations on priorities for the future advancement of COVERAGE-Sargasso Sea application. The 36 participants included members of the scientific community as well as the Sargasso Sea Commission and representatives of the 6 governments that signed the Hamilton Declaration on Collaboration for the Conservation of the Sargasso Sea in 2014. The specific objectives of the workshop were to expose the COVERAGE-Sargasso Sea pilot project to peer review and comment; to examine the utility of COVERAGE to illuminate the relationship between ocean conditions and uses of the Sargasso Sea; and identify the high-priority applications for COVERAGE to enable “use cases” for future implementation. The Workshop started with a demonstration by the JPL team of the prototype NASA COVERAGE-Sargasso Sea product and with presentations from the researchers present of the work they are doing relevant to this project. After breakout sessions the Commission/government representatives group developed a list of *desiderata* for the project and the science group prepared a detailed list of technical recommendations. The plenary then developed a set of Overall Recommendations. These identify three issues of priority concern – “Ships and Sargassum,” “Organisms and their Environment” and “Fishing and the Environment,” together with a number of additional detailed recommendations and follow up items.

## I. COVERAGE & Workshop Objectives

### Background on COVERAGE

COVERAGE was initiated in a CEOS Strategic Implementation Team meeting in Pasadena in 2013 with the longer term aim of fusing ocean data into a single product, available in near-real-time, including climatologies, and allowing for the inclusion of emerging in situ data sets (e.g. ship tracking, animal tagging, etc.). The intent is to build a project that brings together 4 CEOS Ocean Constellations, enables broad international participation, facilitates broad use of ocean satellite data, and utilizes emerging data management and cloud capabilities. The Sargasso Sea was identified as a NASA pilot project to ensure that the development is user-driven and effective. This resulted in a prototype application for the Sargasso Sea Commission (SSC), that was presented publicly during the NASA supported COVERAGE-Sargasso workshop. Beyond the Sargasso Sea, the aim is to present COVERAGE to the CEOS SIT with plans for CEOS (global) engagement, real-time implementation, based on a priority-set of use cases. A spinoff would be a global product with near-real-time capabilities.

### COVERAGE-SARGASSO Workshop

The COVERAGE-Sargasso workshop was held between March 21-22, 2016 and hosted at the NOAA Eco-Discovery Center, Keys, Florida. It involved the participation of 6 SSC Commission members and the Secretariat, international Government participation (including UK, USA, Bermuda, BVI, Bahamas, Azores, Monaco), and 22 invited scientists and engineers from diverse agencies including NASA, NOAA, and from academia. A detailed list of workshop participants with affiliations is given in appendix 2. The workshop was organized and led by Dr David Freestone (SSC Executive Secretary) and Dr Eric Lindstrom (NASA Physical Oceanography Program Manager).

The specific objectives of the workshop were to:

- Expose the COVERAGE pilot project to peer review and comment.
- Examine utility of COVERAGE to illuminate the relationship between ocean conditions and uses of the Sargasso Sea.
- Identify the high-priority applications for COVERAGE to enable “use cases” for future implementation.

## II. Meeting Format & Process

The structure of the COVERAGE-Sargasso workshop was as follows. Specifics of the workshop agenda are provided in Appendix 1.

- Introduction and demo of prototype COVERAGE application
- Series of scientific presentations during plenary focused on monitoring and ecology of the Sargasso Sea
- Parallel breakout session of the scientific group and the Sargasso Sea Commission and government representatives.
- Joint plenary sessions synthesizing findings and recommendations of both groups

### III. Outcomes & Recommendations

#### 1. Potential COVERAGE-SS uses and priorities identified by the Commission.

Following on from the breakout session of the Commissioners and government representatives, and based on group presentations and discussions during day 1 of the workshop, the follow set of general themes and priority uses for COVERAGE-Sargasso were highlighted by the SSC:

- Communication to and improved understanding by public and policymakers (eg. characterization of functional aspects of SS):
  - Goals of the SSC inform the scientific directions for COVERAGE and its usage
  - End goal is to have scientific information made available and be able to explain it to the public stakeholders and other interest groups
  - Communicating potential emerging ecosystem threats? (e.g. *Sargassum* early warning systems)
  - Conveying the Sargasso Sea's connection to wider climate system (e.g. SS salinity affecting Midwest flooding)
  - Identification of knowledge and information gaps, and research needs
  - Provide visual synopses of potential economic impacts (eg. *Sargassum* inundation on tourism)
- Improved Understanding of the SS ecosystem:
  - Monitoring the physical characteristics and health of the Sargasso Sea
  - Explore unknown interactions and large scale temporal data sets
  - Value of historical data
  - Ocean health indicators; vulnerability index (e.g. human uses, climate change)
  - Resolving connectivity within the SS and beyond
  - Information to help identify research needs and data gaps
  - Allow some functional differentiation of regions/biomes within the Sargasso sea
  - Improved understanding of animal migration routes, habitat utilization (e.g. spawning areas)
- Providing evidence for protective measures (management focus)
  - Fishing & Food Security
    - Design protective measures and better understand the impacts of fishing
    - Provide a robust and accurate data set for fishing monitoring
    - Understanding of ocean dynamics to minimize by-catch
    - Fishery-*Sargassum* and Fishery-protected species interactions
    - Identification of essential habitat, including spawning area and migratory routes
  - Shipping
    - Uses of the Sargasso Sea for shipping by size class and vessel type class.
    - Understanding the impacts of ballast and grey water, invasive species, etc.
    - Impact of shipping on *Sargassum*, protected species and essential habitat
  - Marine Pollutants & Debris
    - Potential identification of marine debris concentrations, including plastics
    - Potential impacts of future deep sea mining activity, including increased turbidity plumes near possible mining sites.

## 2. Scientific Working Group Process & Recommendations

In a separate session, the science working group held extensive discussions on a range of issues central to the further development of COVERAGE-SS, from tool functionality, to data content, to application focus. The individual members of the working group were then tasked with developing specific recommendations for COVERAGE-SS (see appendix 4 for full details). Then in plenary, both groups discussed the Commission's findings and developed a common set of recommendations described further below. A pilot application for the Sargasso Sea is to be further developed in line with Commission and science working group recommendations. The intent is then to present this to CEOS at their next meeting in September 2016 for comment and potential support for expanding the COVERAGE initiative globally, to include also data from other international space agencies.

### Extensions of the current COVERAGE-SS prototype:

- Data connectivity improvement including:
  - Definition of interfaces and automated pipelines to larger scale data repositories such as OBIS, BCO-DMO, SEA, ICE (Integrated Conservation & Environment physical oceanography dataset), *Sargassum* imagery from USF, etc.
  - Capability to upload or connect to individual provider datasets of relevance
- The following particular categories of data were identified as being of particular interest and priority:  
Biological:
  - Important Species Datasets relevant the Sargasso Sea : OBIS, OTN, IOOS-ATN, Billfish Foundation, Miami Data Lab NIX
  - Seabird database/datasets: Birdlife International, OBIS SeaMap etc.
  - Sea turtle datasets from OBIS SeaMap, Seaturtle.org
  - Marine mammals: limited datasets available, TOPP (B. Block)
- Fisheries data: ICCAT CPUE and electronic/conventional tagging datasets. FAO catch data.
- EEZ, RFMO, and FAO region GIS data layers (shapefiles)
- AIS data: Ship tracking data to identify Shipping Industry Traffic interactions. Issues of AIS data access, cost and volume were identified.
- CLIMATOLOGIES: integration of climatological data layers from the World Oceans Atlas: Turbidity, PAR, sea level, productivity, temperature, salinity, mixed layer depth, nutrients, oxygen
- Sub-surface Data : mixed-layer depth, GRACE data for water mass exchange
- Altimetry, Surface Winds, significant wave height from satellite data and models

### Use Cases/Key Applications that could be useful for the future of the SSC work

- Commercial Fishing: Real-time data critical for determining quota's met/closures decisions, management decision-making needs (e.g. critical wave height for fishing operations)

Communication needs: to convey science data, findings and synopses to non-experts

- Scientists to Managers communications: e.g. MPAs, Coral bleaching/FKNMS BLEACHWATCH Early Warning System application case study
- Public outreach and Education:

Marine Spatial Ecology:

- Identifying patterns of species distributions in relation to environmental factors in space and time.
- Sargasso Sea Frontal Boundaries and biomes: effects of eddies and convergences on species (eg. eel spawning in frontal zones)

Climate Change and Teleconnections:

- Identification of climate trends as affect also the biological resources within the Sargasso Sea, including Ocean Acidification and shallowing of the oxygen minimum layer
- Apparent linkages between Sargasso salinity and rainfall patterns in adjacent areas (eg. continental Midwest).

### 3. Overall Recommendations

In the joint plenary session participants identified 3 key priority areas driving further development of COVERAGE-SS:

#### **“Ships and Sargassum”**

- Key concerns:
  - How do ships and *Sargassum* impact one another?
  - Why do we have extreme events/beaching involving *Sargassum*?
  - Can the human interaction with *Sargassum* be managed?
  - What is relationship with ship routing, marine mammals and wind?
- Data needs: AIS, *Sargassum* mats/imagery, mammal distributions, wind fields.

#### **“Organisms and their Environment”**

- Key concerns:
  - What is the relationship between animal track/behavior and environmental data such T, S, fronts, and currents? (Eg. Eels/Spawning)
- Data Needs: animal tagging data, altimetry, temperature, salinity, T-fronts.

#### **“Fishing and the Environment”**

- Key concerns:
  - what is the relationship between fish catch and by-catch and temperature, wind and waves?
- Data Needs: ICCAT data, temperature, winds, waves.

Additional recommendations and action items for advancing COVERAGE-SS:

- SS Commissioners and other interested participants to undertake “hands-on” trial of COVERAGE-SS tool and provide feedback. An initial timeframe of summer 2016 was identified pending NASA approval, but there is significant interest and value in undertaking this sooner.
- To facilitate the longer term sustainability of COVERAGE-SS, it was suggested that the SSC consider hiring a data manager/analyst to help grow and mature COVERAGE-SS. Given concerns expressed on arranging the necessary funding resources to achieve this, the possibility of a shared/collaborative position was suggested.
- Inclusion of additional datasets into the COVERAGE-SS system (eg. WOA layers)
- Participants thought that special attention should be given to the Gulf Stream - a vital driver of the ecosystem - and to Eddies, which contain water masses originating in different ocean basins.
- Participants felt that OBIS is ideally situated to function as a clearinghouse for a range of individual biological datasets identified during the workshop for inclusion into COVERAGE-SS. The SSC-secretariat will approach OBIS on this issue.
- The need for automated pipelines and technical interfaces between identified data sources, such as OBIS for biological data and NASA remote sensing data to COVERAGE-SS, were emphasized. JPL will investigate feasibility.



## Appendix 1. Workshop Agenda

Sunday, March 20 2016	
	Optional Conch Train Charter Trip for one hour tour departs Albury Court Inn <i>TBD</i>
6.15 pm	Shuttles will depart the Albury Court Inn and the Chelsea House for the reception and dinner at the Florida Keys Eco-Discovery Center; if you miss the shuttle, taxi fares should run about \$3.50.
6.30–9.30 pm	<b>Welcome Reception and Buffet Dinner</b> <i>Florida Keys Eco-Discovery Center</i>
9.45 pm	Shuttle will return participants to their hotels.
Monday, March 21 2016	
8.30 am	Shuttle will depart Chelsea House and Albury Court Inn
8.30-9.00 am	<b>Morning Registration</b> <i>Florida Keys Eco-Discovery Center</i>
9.00-10.00 am	<b>Plenary Session: Welcome and Orientation</b> <i>Florida Keys Eco-Discovery Center Theatre</i>  Dr. David Freestone, SSC, and Dr. Eric Lindstrom, NASA <ul style="list-style-type: none"> <li>• Overview of the project</li> <li>• Specific goals for the workshop</li> </ul> <b>Demonstration of the Sargasso Sea COVERAGE Mapping Project</b> Dr. Jorge Vazquez and Dr. Vardis Tsontos, JPL <ul style="list-style-type: none"> <li>• Pilot Mapping Project Demonstration</li> <li>• Discussion of aims and goals of Project: to examine the data products and identify potential new data sets, improvements in the utility of the tool, and potential next steps for the project.</li> </ul>
10.15 – 12.00	<b>Plenary Session</b> <i>Florida Keys Eco-Discovery Center</i>  Participant Presentations and Interactive Discussion <ul style="list-style-type: none"> <li>• <i>Sargassum</i> Mapping</li> <li>• Larger Data Sets</li> <li>• Other Relevant Data Sets</li> </ul> Identification of key issues/themes and functionality of approach for users
12.00 – 1.00	<b>Plenary Working Lunch</b> <i>Florida Keys Eco-Discovery Center</i> <i>Conference Room</i>
1.00-1.30 pm	Informal Break
1:30–3.00 pm	<b>Breakout Session #1</b>

	<p><b>Data and Marine Experts Group</b> <i>Florida Keys Eco-Discovery Center Conference Room</i></p> <ul style="list-style-type: none"> <li>• Improving the inputs (what kind of data is out there and how to get it)</li> <li>• Feasibility of locating additional real-time data that would be compatible with the project and opportunities to develop this capability</li> <li>• User feedback on utility (what would experts find most useful)</li> </ul>	<p><b>Joint Meeting of the Signatories and Sargasso Sea Commission</b> <i>Florida Keys Eco-Discovery Center Theatre</i></p> <p>Please see Separate Agenda in Folder</p> <ul style="list-style-type: none"> <li>• Introductions and updates</li> <li>• Current Issues</li> </ul>
3 – 3.15 pm	Coffee Break	

3.15 – 5 pm	<b>Breakout Session #2</b>	
	<p><b>Data and Marine Experts Group</b> <i>Florida Keys Eco-Discovery Center Conference Room</i></p> <ul style="list-style-type: none"> <li>• Distribution and management of data beyond just the visualization: formatting, inter-operability, and metadata issues addressed.</li> <li>• Applicability for international issues and entities</li> </ul>	<p><b>Joint Meeting of the Signatories and Sargasso Sea Commission</b> <i>Florida Keys Eco-Discovery Center Theatre</i></p> <ul style="list-style-type: none"> <li>• 2016-2018 Biennium Strategy Discussion</li> </ul>

**Tuesday, March 22 2016**

8.30 am Shuttle will depart hotels to take participants to the Eco-Discovery Center.

9 - 10.30 am	<b>Breakout Session #3</b>	
	<p><b>Data and Marine Experts Group</b> <i>Florida Keys Eco-Discovery Center Conference Room</i></p> <ul style="list-style-type: none"> <li>• Feasibility and opportunity</li> </ul>	<p><b>Sargasso Sea Commission Meeting (Signatories Welcome)</b> <i>NOAA Administration Office Conference Room</i></p>

	<p>to coordinate with other international agencies</p> <ul style="list-style-type: none"> <li>Options for improving the mapping tool to maximize current and future utility</li> <li>Additional information or data needed to maximize usefulness</li> </ul>	<ul style="list-style-type: none"> <li>Strategy for 2016-2018</li> <li>Development of Commission Work Plan</li> </ul>
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10.30 – 10.45 Coffee Break

10.45 am -12.15	<p><b>Plenary Session</b> <i>Florida Keys Eco-Discovery Center Conference Room</i></p> <ul style="list-style-type: none"> <li>Identifying additional resources or contacts for improvement</li> <li>Refining and identifying the best “new features” for branding this product</li> <li>Usefulness of additional capabilities and defining added value of suggested capabilities</li> <li>Identifying potential for this project – management of areas with shifting or undefined boundaries; ability to monitor impacts on movement of migratory species or vector data (ships; <i>Sargassum</i>)</li> <li>Feedback on the prototype platform</li> </ul>	
12.15–1.45 pm	<p><b>Breakout Session #4 and Working Lunch</b></p>	
	<p><b>Data and Marine Expert Group</b> <i>Florida Keys Eco-Discovery Center Conference Room</i></p> <ul style="list-style-type: none"> <li>Summarizing workshop key points and takeaways</li> <li>Develop strategic plan for next steps at the global level for CEOS</li> </ul>	<p><b>Sargasso Sea Commission and Signatories Group</b> <i>NOAA Administrative Building Conference Room</i></p> <ul style="list-style-type: none"> <li>Identify areas of importance/future use of independent Sargasso Sea COVERAGE project</li> <li>Develop Strategic plan for next steps for Sargasso Sea COVERAGE project</li> <li>Finalize SSC work programme</li> <li>Future prospects</li> </ul>

1.45- 2.30 pm	<b>Plenary Session: Summary and Wrap-up</b>	
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**Wednesday, March 23 2016**

9.30-2 pm	Small group finalizes workshop report	JPL Team
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## Appendix 2. List of Participants

Dr. Linda Amaral-Zettler	Associate Professor, Marine Biological Laboratory	<a href="mailto:amaral@mbl.edu">amaral@mbl.edu</a>
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## Appendix 3. List of Presentation & PDFs

Workshop presentations made are listed in the table below. All presentation PDFs are available online via the Sargasso Sea Commission Website (<http://www.sargassoseacommission.org/>)

<b>Presenter</b>	<b>Session</b>	<b>Presentation File Name</b>
D. Freestone & E. Lindstrom	Intro	WELCOME TO THE COVERAGE WORKSHOP.pdf
J. Vazquez & V. Tsontos	Intro	TSONTOS_CoverageDemoIntro.pdf
A Siuda	Plenary	SIUDA_SSC_NASA Meeting_Key West_21Mar2016.pdf
M. Roffer	Plenary	ROFFER_Sargasso Sea.pdf
J. Roberts	Plenary	ROBERTS_20160321_Sargasso_Sea_Key_West_Roberts_Halpin.pdf
P. Provoost	Plenary	PROVOOST_presentation pieter.pdf
C. Hu	Plenary	HU_Sargassum_Watch_System_201603.pdf
L. Gramer	Plenary	GRAMER_Better Living Through Physics- Sargasso Sea 2016 March.pdf
J. Franks	Plenary	FRANKS_Sargasso Sea COVERAGE Mapping Workshop 2016.pdf
M. Castongay	Plenary	CASTONGAY_Anguille Key West.pdf
F. Platt	Breakout	PLATT_Vizualization Tools.pdf
E. Lindstrom	Breakout	LINDSTROM_Tuesday AM examples.pdf

## Appendix 4. Poll of Desired Coverage Capabilities

The following is a representative list of suggested capabilities for the COVERAGE by workshop participants:

### Data Manager

- Extension of web-app visualization capability to handle vertically resolved data
- Data access interfaces and pipelines for Coverage: should facilitated automated assimilation of data from identified data providers
- Prioritize targeting of potential data providers with an existing capacity to serve high value data collections for Coverage (eg. IOOS, OBIS, BCO-DMO, WOA). Leveraging of those established communities for promotion of COVERAGE could be an important added benefit.
- Use of climatologies to calculate anomalies. One possible mechanism is building into COVERAGE the capability to subtract one layer from another and create a difference map.
- Longer term sustainability of COVERAGE within the Sargasso Commission will like require a capacity building component
- Thematic targeting and organization of data for COVERAGE according to priority application area(s) identified by the Sargasso stakeholders

### Scientist

- Have an interactive, animation capable product that combines the leading NASA satellite derived products including sst, ocean color, current velocity, winds and waves, thermocline depth and temperature differential
- Doing basic math functions including velocity calculations, residence times in particular conditions and simple statistics such as correlation, variance and standard deviation;
- Includes the World Atlas for such items as dissolved oxygen;
- Can input personal data;
- Has the capability to add personal tools/widgets via a User community.

### Scientist

- Data science: Integrating diverse data sources, coupling models, and visualizing information
- Physical modeling: Oceanic and atmospheric forcing, and physical-chemical properties and fluxes

- Genes to ecosystems: Biodiversity dynamics, evolutionary processes, and ecological interactions
- Social-ecological systems: Coupling past, present, and future ecosystems to human activities
- Simulations, synthesis, and service: Use-oriented avatar as a platform for data exploration, scenario-based planning, and education

#### Scientist

- Community approach to integrating data feeds, products, and applications to deliver to managers - direct involvement of information producers in the presentation of their information
- Integrating field validation into datasets and products, and the tool - enhancing NGO and governmental buy-in, and improving usefulness of information presented
- Integrating presentation of data error estimates and product uncertainty estimates into tool
- People dedicated to working between management/policy users (Commission, signatory nations) and scientists - critical to making use cases more useful for both, and to continuity of the tool
- Direct links to metadata for all data and products presented - in some standardized format

#### Scientist

- High seas surface salinity in real time (~day instead of months), Coastal salinity and Salinity anomaly from monthly climatology
- Precipitation (and anomaly from climatology)
- Mixed layer depth (and anomaly from climatology)
- Winds
- Humidity

#### Scientist

- Capability to upload datasets oneself
- Capability to contour vector lines with data rather than simply positions
- Capability to download layered images for inclusion in reports
  - Policy managers are not going to see out the raw data products to reproduce figure
- If #1 is possible, perhaps only inputs from larger scale databases



### As Non-expert user

- Are animals being affected by climate change?
- What was the water temperature and salinity last year where I fished? Does it look like it will be similar this year?
- What were the currents like last year where I fished? Does it look like it will be similar this year?
- How does chlorophyll change with temperature?
- Is the sea temperature rising? How does sea temperature change with carbon dioxide?

### Developer

- visualization of higher-level derived products (e.g., misery maps, mosquito probabilities)
- event-based notification
- access to provenance
- simplified interface/limit controls
- ability to easily add data to system (and define events)

### STEM workforce development practitioner

As a <user role>, I want <the features desired>, so that <acceptance criteria>

I want

- 1] Data science highlighted as a vital career path within NASA
- 2] Sunset aging or unsupported NASA data websites
- 3] A 3 tier front end functionality:
- 4] User friendly GUI that is built & maintained & regularly updated/improved by a major private sector web contractor while NASA operates the back end data repository
- 5] YouTube instructional videos in a help tab for all users so that anyone can quickly understand how to operate the COVERAGE application

To Do:

- 1] A career that has high visibility, good advancement prospects, and consistent management support [without it data collection goes nowhere and loses vital user support]
- 2] the frustration level of users accustomed to well curated web-sites causes them to abandon a data search that times out too early or is too difficult
- 3] a web front end that contains:

- Operator level [short time horizon, local AOI, high data processing]
- Manager [ medium time horizon, regional or biome AOI, moderate data processing]
- Researcher [long time horizon, regional or global AOI, little to no data processing, raw satellite & original observation data]

4] make dealing with NASA data a positive experience for all users, and not just resigned to a punishing experience for all but the most experienced researchers

5] we value the time of all users and expedite their understanding of the COVERAGE application, because no one has patience with outdated communication methods

So that:

1] NASA can more easily recruit and retain interested and capable students early for a data scientist career

2] the user does not have to plow through the chaff of orphaned, dead or moribund sites that are not updated or having the most relevant data. Historic data should be archived.

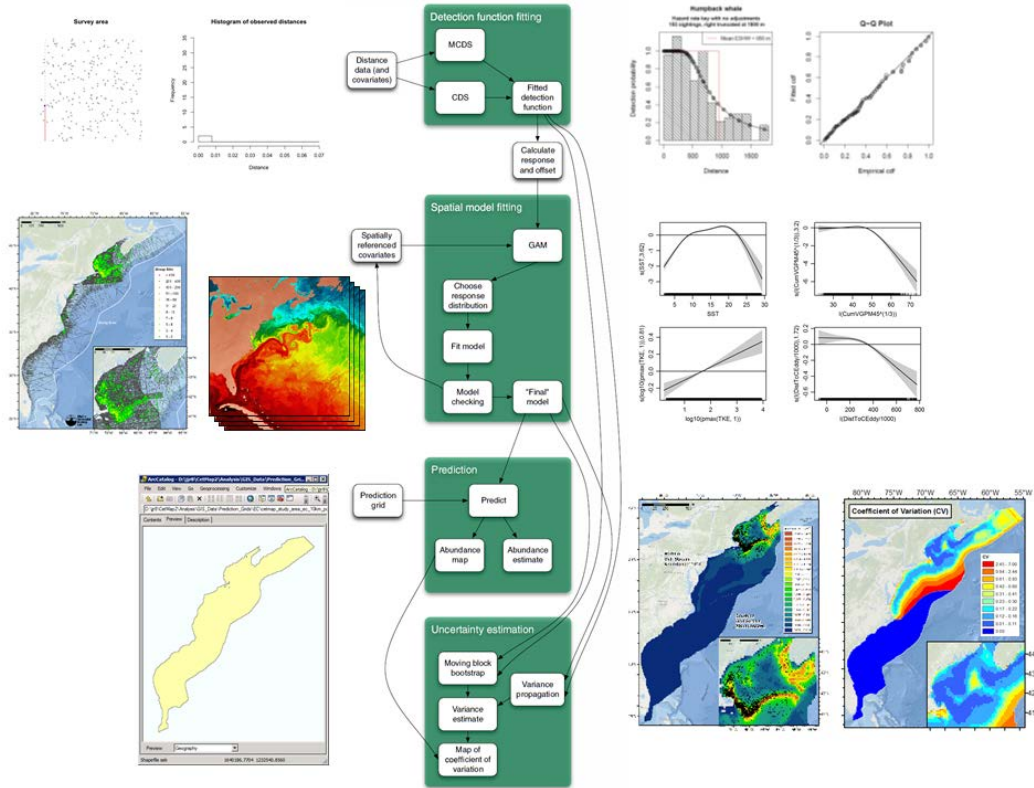
3] different user interests and capabilities are recognized and enhanced by user experience design and user acceptance testing

4] The private sector strengths of rapid innovation and market awareness and the rigor and long-term focus of the scientific community can complement and not hinder each other

5] Remote sensing is not age-diverse --young people need to see near age peers doing remote sensing to that they can identify with the people doing this research

Scientist (Spatial Ecologist)

1. Upload my marine animal observations, usually points or lines. I want to do this before submitting to OBIS; I don't want to submit my data to OBIS until after I publish it.
2. Alternatively, I sometimes want to pull data from OBIS. Usually I am aggregating datasets submitted by multiple researchers to see if the aggregate reveals something new.
3. The website overlays my data on imagery of my choice. For time series data, it animates the two. I can export images as PNG/JPEG and animations as MP4.
4. After I identified oceanographic data of interest, the website samples it and lets me download a table giving these data as covariates for my animal data.
5. Sometime later, I want to download the images so I can predict a model on them to produce an animal surface.



**Scientist**

- Prioritize data providers.
- Vertical (subsurface)
- Sustainability won't from NASA. Using and maintaing it from Sargasso Sea Commission.
- Thematic Use Cases.
- Interactive animation. Combine ocean data. Ability to do some calculations.
- Capability to add personal tools and widgets.
- Physical modeling
- Ecosystems
- Social, Economic impacts

### **Kind of data that the Sargasso Sea Commission could add**

- Mechanism for field validation response. Error and uncertainty.
- Do we expose uncertainty as a layer? Discussion. Is it valuable for the data managers. Managers making decisions based on the science. a
- Asking questions. Animals effected by climate change in the environment. Difference between this year and next. Relationship between chlorophyll and temperature.
- Event notification, if and when go to near real time data stream.
- Near real time thermal front
- Real time surface salinity maps
- Thermal front short term forecast.
- Chlorophyll-a maps daily
- Sargassum maps daily
- Indices of water mass exchanges between GS and local.
- Gulf Stream
- Eddy identifier.
- Near real time Sargasso Sea.
- Climatology
- Fish abundance species distribution
- Retrospective
- Frontal density
- Temperature frontal locations
- Eddy size and location.
- Area where adding uncertainties could be very useful.
- Vector lines and tracks.
- Upload your own data set.
- Marine spatial intelligence scenario.
- Salinity real time
- Climatology
- Mixed layer depth.
- Atmospheric variables
- Humidity
- Precipitation
- Layer political and economic boundaries.