

The Role of Environmental Monitoring and Data Management in Supporting Science to Inform Decision Making: Integrating Coastal and Ocean Monitoring Programs to Address Societal Needs



Dwayne E. Porter*
Arnold School of Public Health and
Baruch Institute for Marine and Coastal Research
University of South Carolina
and the
NOAA National Estuarine Research Reserve System

* And a host of others who actually do the work including:



Outline

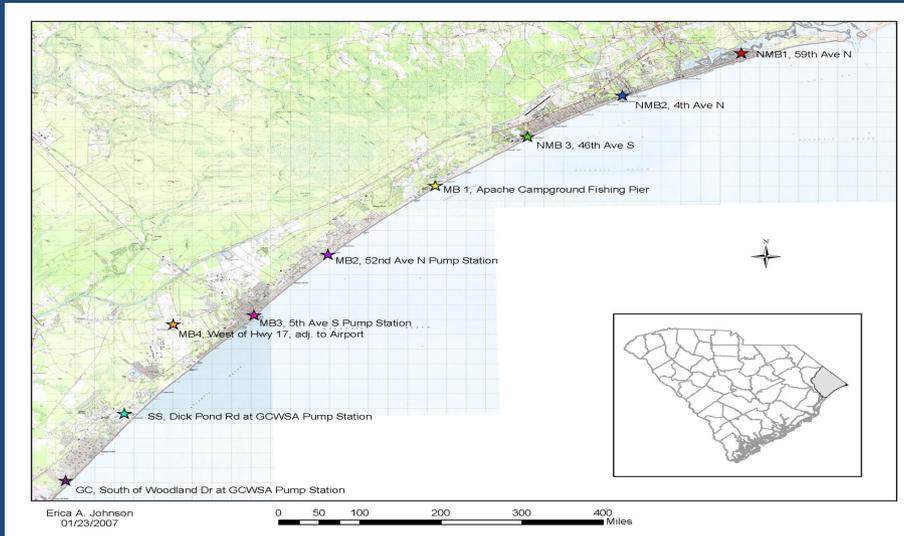
- Why do environmental data management?
- An overview of the NOAA NERRS System-wide Monitoring Program
- Examples of integrating monitoring programs and sound science to inform decision making

Objective

When we are done you (hopefully) will know the four (4) key “requirements” for realizing the full value of your monitoring data to address societal needs.

Why do environmental data management?

Observations? ... Data? ...



Underwhelming!



*Unknown and / or
overwhelming!*

Why do environmental data management?

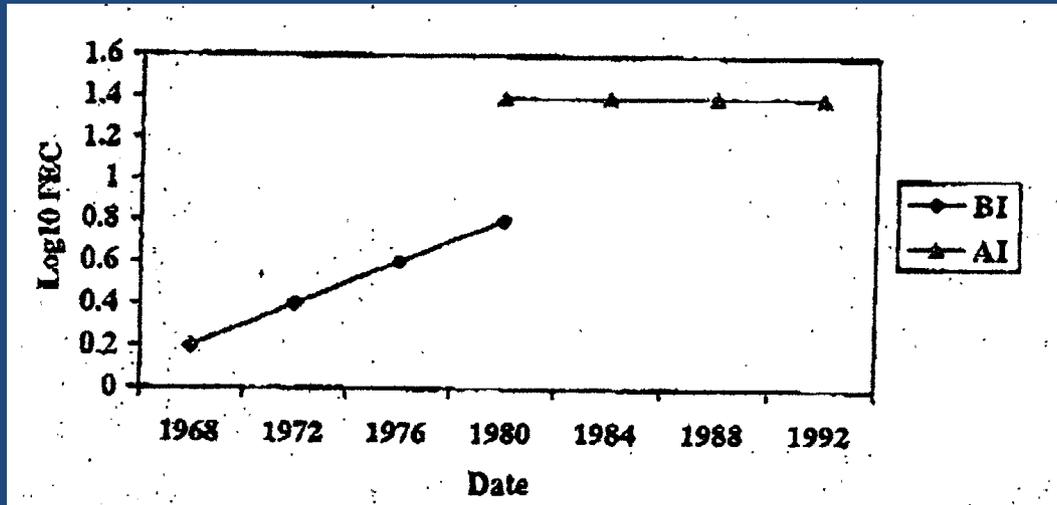
1.) Federal directives require federally funded organizations and projects to make their data and information available to the public, and to coordinate database development.

Per Executive Order, OMB Circular A-130 states in summary, as policy, that agencies shall "*...distribute information at the agency's initiative, rather than merely responding when the public requests*" (Anderson 1994).

2.) It makes sound financial and resource management sense.

Why do environmental data management?

3.) Your job may be on the line!



Date	Time	Temp	SpCond	Sal	DO	DO	Depth	pH	Turb
MM/DD/YYYY	hh:mm:ss	C	mS/cm	ppt	%	mg/L	m		NTU
01/01/2003	00:00:00	12.4	056.75	37.6	066.0	05.6	0.52	07.7	.
01/01/2003	00:30:00	13.3	056.94	37.8	068.1	05.6	0.52	07.8	.
01/01/2003	01:00:00	14.1	057.25	38.1	011.0	01.7	0.72	01.9	.
01/01/2003	01:30:00	13.3	056.86	37.8	010.3	01.3	0.68	01.7	.
01/01/2003	02:00:00	13.0	056.22	37.3	071.3	06.0	0.55	01.6	.
01/01/2003	02:30:00	12.8	055.34	36.6	063.9	05.4	0.50	01.6	.
01/01/2003	03:00:00	12.5	054.43	35.9	060.9	05.2	0.48	01.6	.
01/01/2003	03:30:00	12.3	054.51	36.0	061.3	05.2	0.49	01.6	.
01/01/2003	04:00:00	11.7	056.47	37.4	075.9	06.5	0.60	01.7	.
01/01/2003	04:30:00	11.6	056.71	37.6	081.4	07.0	0.65	01.9	.
01/01/2003	05:00:00	11.1	056.77	37.6	082.8	07.2	0.67	01.0	.
01/01/2003	05:30:00	10.5	056.43	37.3	074.6	06.6	0.61	01.0	.
01/01/2003	06:00:00	09.9	056.20	37.1	067.1	06.0	0.56	01.9	.
01/01/2003	06:30:00	09.5	056.28	37.1	063.1	05.7	0.53	01.9	.
01/01/2003	07:00:00	09.6	056.36	37.2	060.1	05.4	0.50	01.9	.

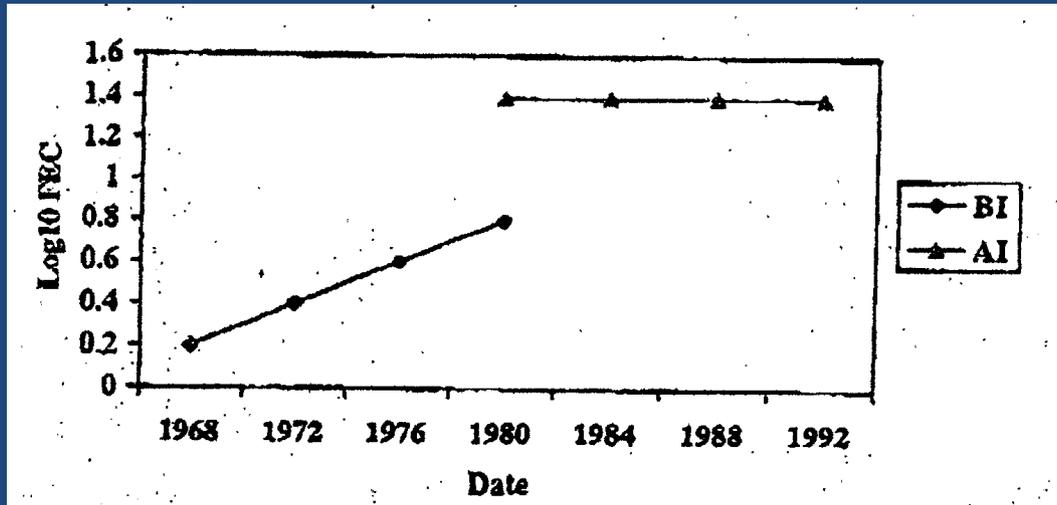
Components of the data management program

A properly implemented database management program consists of several items including hardware and software, personnel, data and documentation. More important to the overall success of maintaining a usable database is the implementation of a database management strategy. In addition to obtaining inter-administrative support, there are at least five key components for a successful implementation of a multi-participant database management strategy:

- A.) user needs assessment (UNA);
- B.) data collection protocol;
- C.) quality assurance/quality control (QA/QC) procedures;
- D.) program documentation and metadata; and
- E.) data access and archival.

Why do environmental data management?

3.) Your job may be on the line!



Date	Time	Temp	SpCond	Sal	DO	DO	Depth	pH	Turb
MM/DD/YYYY	hh:mm:ss	C	mS/cm	ppt	%	mg/L	m		NTU
01/01/2003	00:00:00	12.4	056.75	37.6	066.0	05.6	0.52	07.7	.
01/01/2003	00:30:00	13.3	056.94	37.8	068.1	05.6	0.52	07.8	.
01/01/2003	01:00:00	14.1	057.25	38.1	011.0	01.7	0.72	01.9	.
01/01/2003	01:30:00	13.3	056.86	37.8	010.3	01.3	0.68	01.7	.
01/01/2003	02:00:00	13.0	056.22	37.3	071.3	06.0	0.55	01.6	.
01/01/2003	02:30:00	12.8	055.34	36.6	063.9	05.4	0.50	01.6	.
01/01/2003	03:00:00	12.5	054.43	35.9	060.9	05.2	0.48	01.6	.
01/01/2003	03:30:00	12.3	054.51	36.0	061.3	05.2	0.49	01.6	.
01/01/2003	04:00:00	11.7	056.47	37.4	075.9	06.5	0.60	01.7	.
01/01/2003	04:30:00	11.6	056.71	37.6	081.4	07.0	0.65	01.9	.
01/01/2003	05:00:00	11.1	056.77	37.6	082.8	07.2	0.67	01.0	.
01/01/2003	05:30:00	10.5	056.43	37.3	074.6	06.6	0.61	01.0	.
01/01/2003	06:00:00	09.9	056.20	37.1	067.1	06.0	0.56	01.9	.
01/01/2003	06:30:00	09.5	056.28	37.1	063.1	05.7	0.53	01.9	.
01/01/2003	07:00:00	09.6	056.36	37.2	060.1	05.4	0.50	01.9	.

The National Estuarine Research Reserves (NERRS)



“Protected areas designated for long-term research, education and stewardship. Reserves will serve to enhance public awareness and understanding of estuarine areas, and provide suitable opportunities for public education and interpretation.”

Coastal Zone Management Act (sec. 315)

The National Estuarine Research Reserves (NERRS)



The NERRS System-wide Monitoring Program

Established in 1995, SWMP is a national coastal observing system...



- **Designed to identify and track short-term variability, and long-term changes** in representative estuarine ecosystems and coastal watersheds
- For the purpose of understanding how human activities and natural events can impact ecosystems and mankind and to support improved decision making
- SWMP data are collected using the same protocols and instrumentation at every site in every reserve across the NERRS allowing for intercomparisons (apple to apples) and consistency in data collection across the system



- **Three major components include**
 - abiotic indicators of water quality and weather
 - biological monitoring and
 - watershed, habitat, and land use mapping.

Monitoring water quality and weather

<i>Parameters Monitored</i>	
Water parameters:	Weather parameters:
Temperature	Temperature
Conductivity	Wind speed and direction
Salinity	Relative humidity
Dissolved oxygen	Barometric pressure
pH	Rainfall
Depth / Level	PAR
Turbidity	



Water quality data are collected at 15-minute intervals at 4 locations within or adjacent to a research reserve.

Weather data are collected within or adjacent to a research reserve at 5-second intervals which are used to produce 15-minute sums or averages.

Monitoring nutrients

Parameters Monitored

Nutrient parameters:

Ammonium

Nitrate

Nitrite

Ortho-phosphate

Chlorophyll a

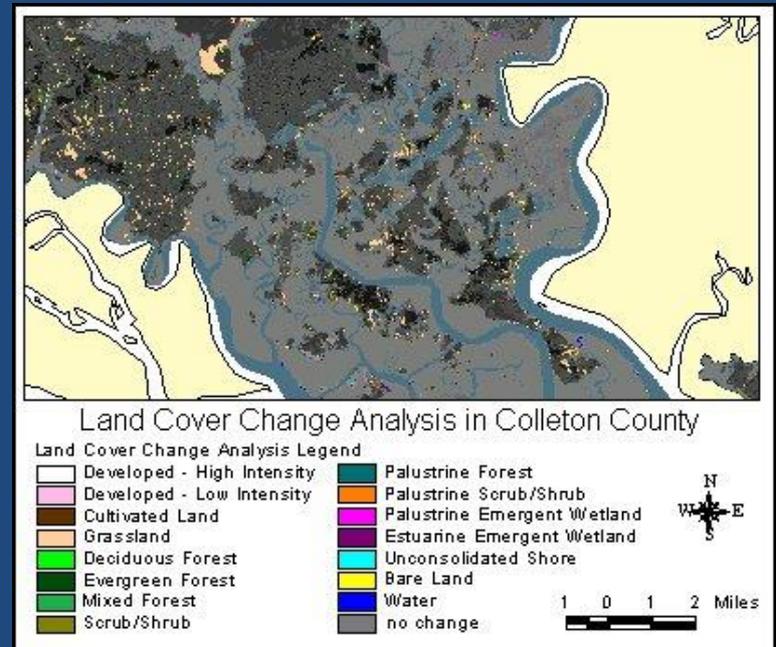
Water samples for nutrient analyses are collected monthly at each of the water quality stations. At one water quality monitoring station at each reserve, nutrient samples are collected over a 24-hour period to determine how nutrient concentrations change over a day/night cycle, and over tidal cycles.



Additional SWMP efforts

Parameters Monitored

Habitat Mapping
Biomonitoring
Sediment Elevation



NERRS SWMP data management

The **Centralized Data Management Office (CDMO)** was established in 1995 in support of the NERRS System-wide Monitoring Program (SWMP) in order to:

- develop, implement and manage the basic infrastructure and data protocol of the NERRS SWMP,

- support the assimilation and exchange of data and metadata within the NERRS framework, and

- support the ingestion of high-quality data with other local to global monitoring efforts via data push and pull services.

NERRS SWMP data management

High-quality data require rigorous QA/QC and must involve the data provider:

Provisional data have been run through the automated QA/QC process (primary review) and data values flagged as appropriate but have not been manually reviewed or edited (secondary review). Provisional data are available via the data portal and web services.

Provisional plus data have been through primary and secondary review and are awaiting final tertiary review by the CDMO. Provisional plus data are available via the data portal and web services and replace the provisional data.

Authoritative data refer to data that have gone through final tertiary review at the CDMO. Authoritative data are available via the data portal and web services and replace provisional plus data. Authoritative data are archived with the NODC.

NERRS SWMP datasets

34 Meteorological datasets (16,361,877 records)

30 active and 4 inactive

30 are reporting data via telemetry

159 Water Quality datasets (56,600,045 records)

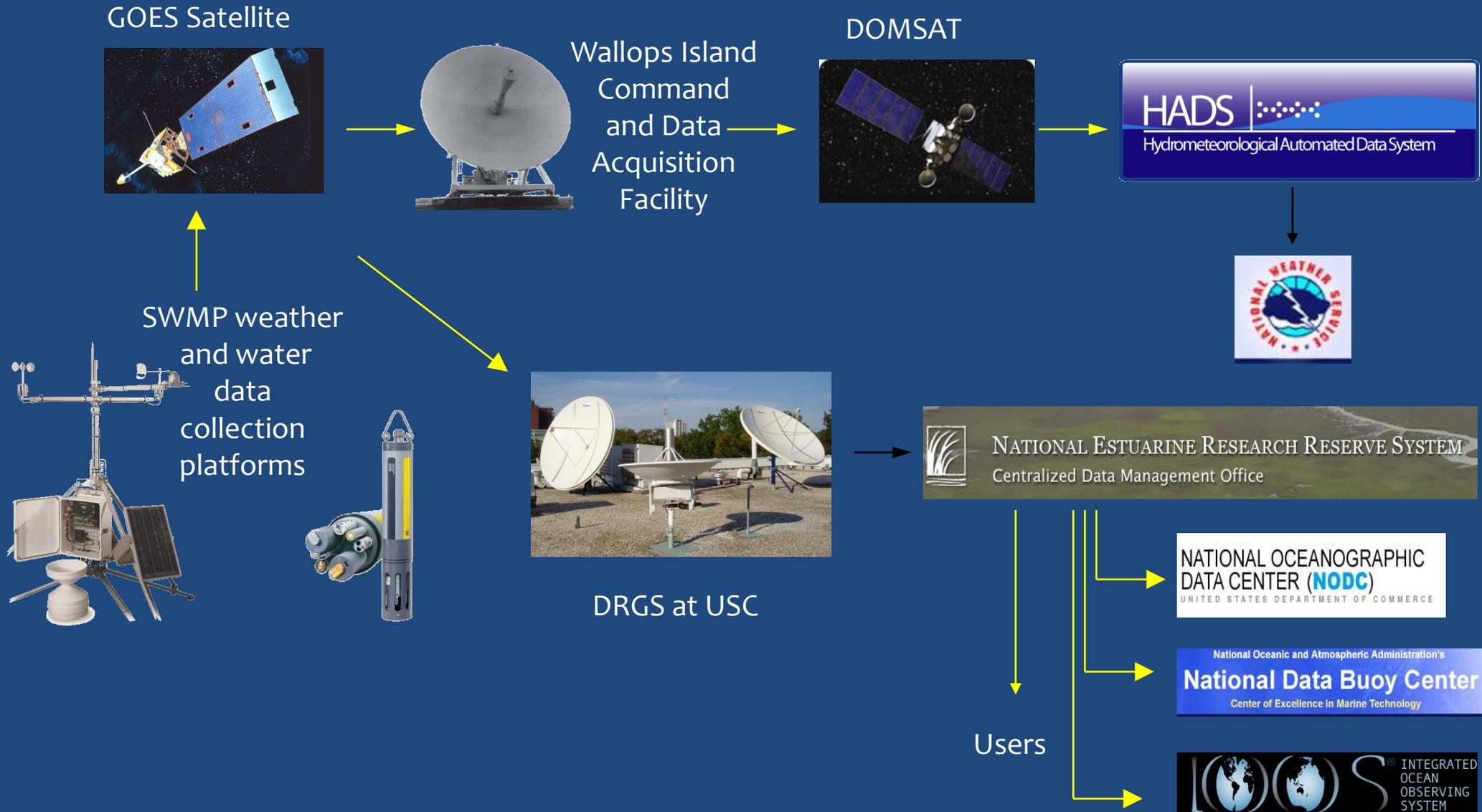
120 are active 39 inactive

60 are capable of reporting data via telemetry

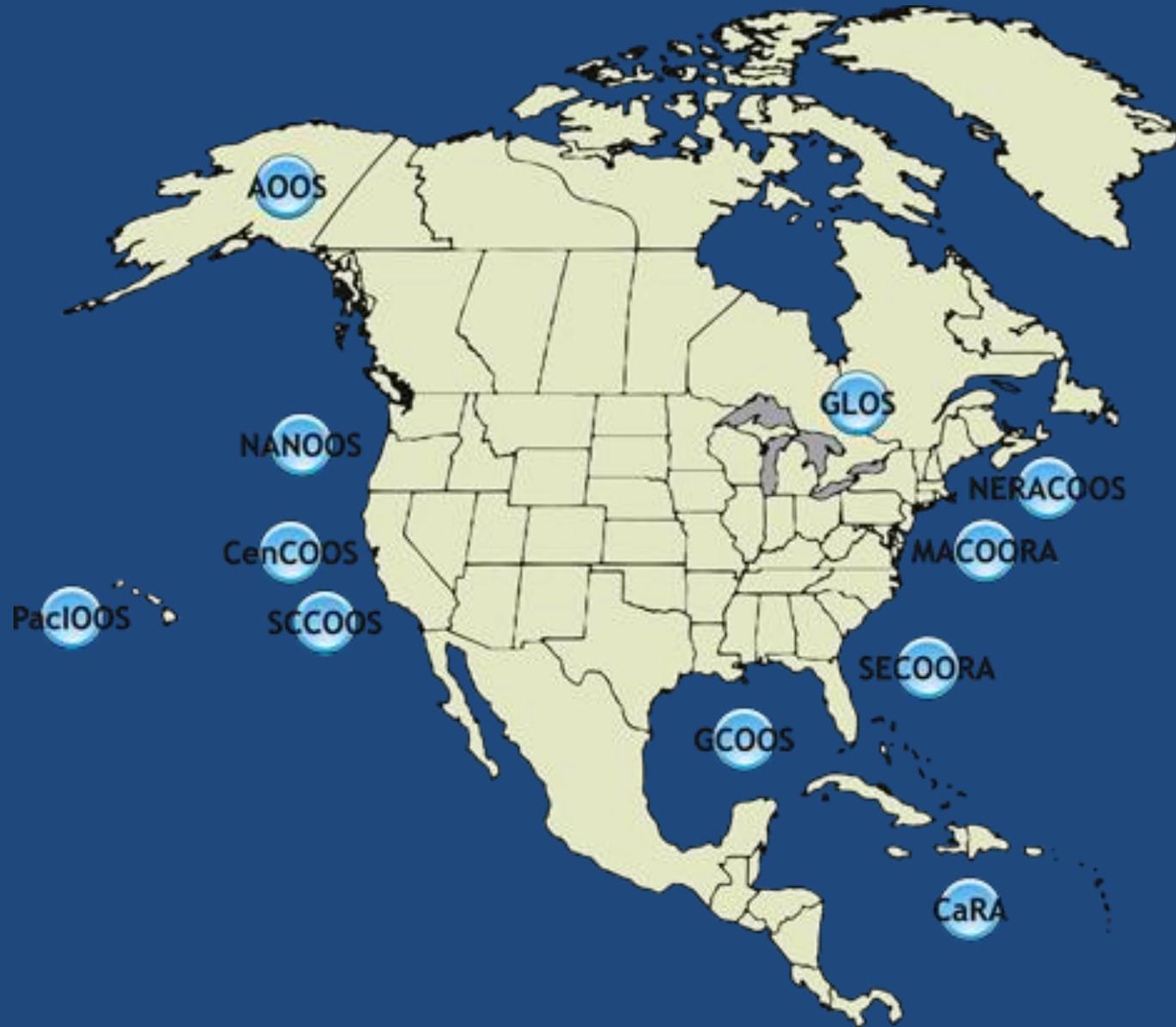
147 Nutrient datasets (119,576 records)

130 active and 17 inactive

NERRS SWMP near-real-time data flow



Integrated Ocean Observing System



www.usnfra.org and www.ioos.org

Integrated Ocean Observing System

The **Integrated Ocean Observing System** (IOOS) provides high-quality data and information on current and future states of the oceans and Great Lakes from the global scale of ocean basins to local scales of coastal ecosystems.

IOOS is a network of 11 regional coastal ocean observing systems striving to meet national and regional needs for local coastal and ocean observations, data management, and modeling.

IOOS and local RA DMAC efforts are supporting the ***data assimilation efforts*** that facilitate decision support tool development to improve safety, enhance the economy, and protect the environment.

Users of NERRS SWMP data include...

NOAA related: Oceans and Human Health Initiative, National Data Buoy Center, Data in the Classroom (www.dataintheclassroom.org), Chesapeake Bay Interpretive Buoy System (www.buoybay.org), National Coastal Data Development Center, National Ocean Service, National Weather Service Hydrometeorological Automated Data System, NWS Regional Forecast Offices

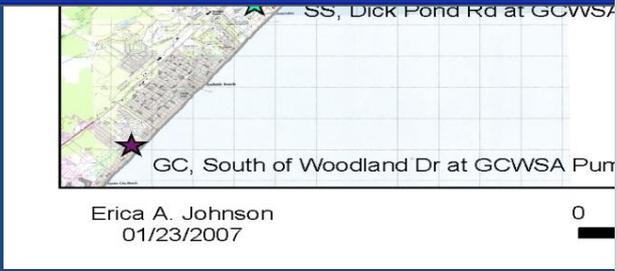
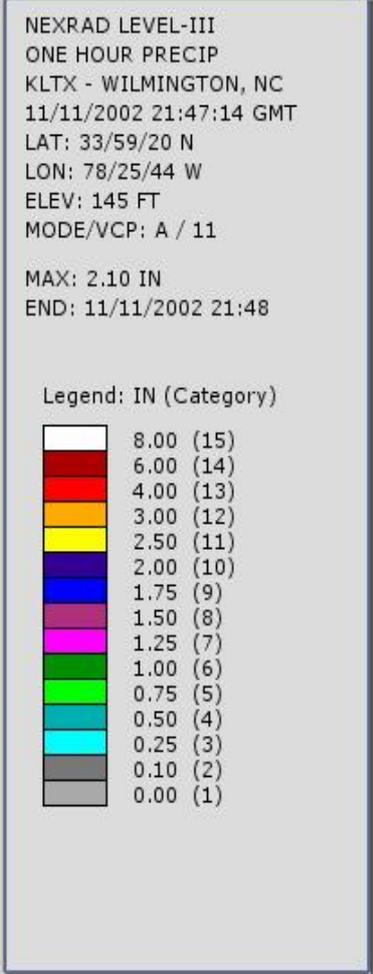
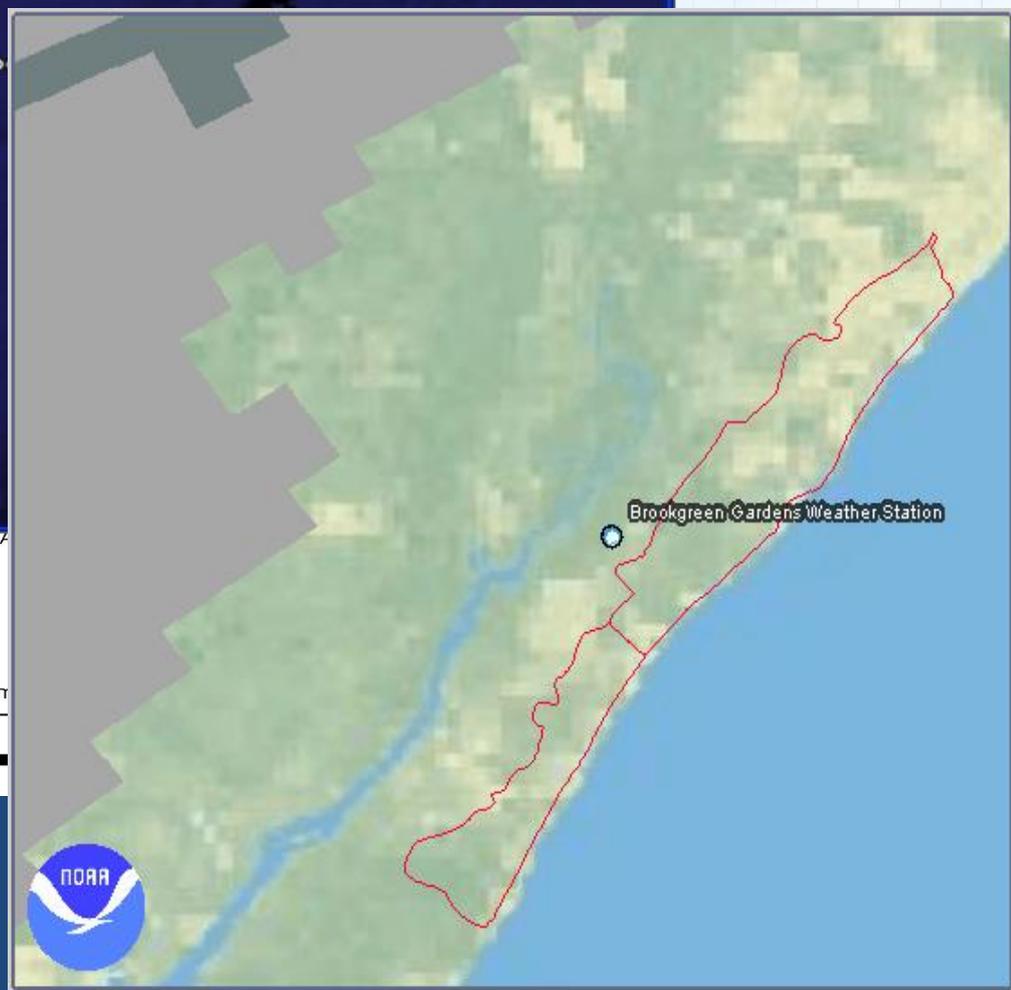
IOOS related: NANOOS, NERACOOS, SECOORA, AOOS, MARACOOS, GCOOS

Others: Estuaries.Gov, Pacific Shellfish Growers Association, San Diego State University Field Stations Program, Stockton College, Maryland DNR, Chesapeake Bay Eyes on the Bay, Georgia Forestry Commission, Georgia Coastal Ecosystems LTER, Center for Integrative Coastal Observation, Research and Education, Environmental Monitoring Sensor Intelligence Corp, SC Department of Health and Environmental Control, Smithsonian Institute, Insurance companies, Attorneys, MBARI EARTH, South Brunswick High School

Data collection, assimilation and integration

Data assimilation  Data integration

The real value is in integrating observing systems!



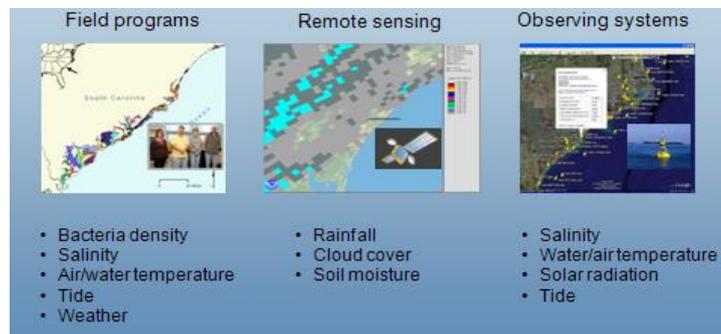
**Examples of Integrating
Monitoring Programs and Sound Science
to
Inform Decision Making**

Beach Water Quality Assessment and Modeling Activities

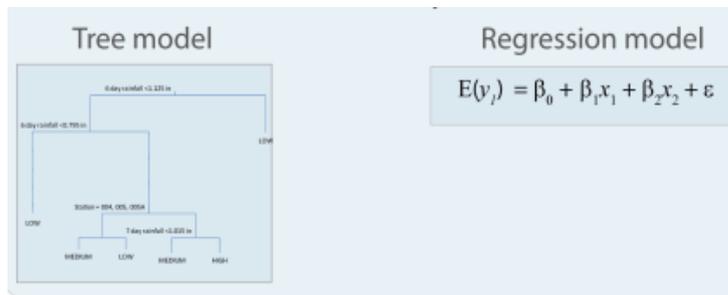
Issue: Exposure to beach swimming waters with elevated bacterial levels is a public health concern and one of economic vitality.

Goal: Develop and implement scientifically-justified, decision-support tools for accurate and defensible preemptive advisory issuance decisions.

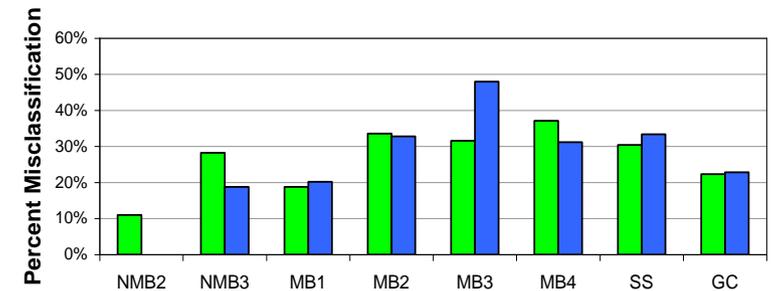
Process 1.) Data integration and fusion



2.) Ensemble model development



3.) Model validation



4.) Operational decision-support tool



Who is doing it: A partnership among beach managers, tourism interests, public health officials and the general public including...

Monitoring Water Conditions in Shellfish Harvesting Waters

Issue: Commercial shellfish growers in the Pacific Northwest depend on good water quality data in order to make informed decisions that have economic implications.

Goal: To provide critical information about water temperature, chlorophyll levels, salinity, turbidity, and dissolved oxygen so that better decisions can be made about managing mariculture operations.

Process: 1.) Data collection



2.) Data fusion



3.) Decision support



Who is doing it: A partnership between NANOOS, the KAT, PAD and SOS NERRS, Pacific Coast Shellfish Growers Association, Pacific Shellfish Institute, University of Washington and the CDMO (support from OCM and NERRA)

Supporting Safe Marine Activities

Issue: Mariners need dependable access to current and forecasted information on winds, waves and weather.

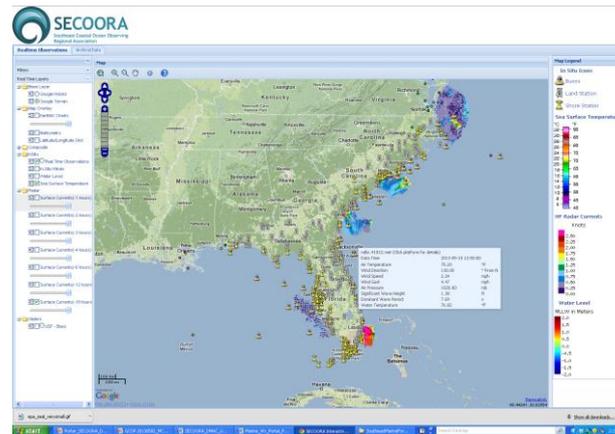
Goal: To provide 24/7 access to critical marine information for the commercial and recreational marine communities within the SECOORA region.

Process:

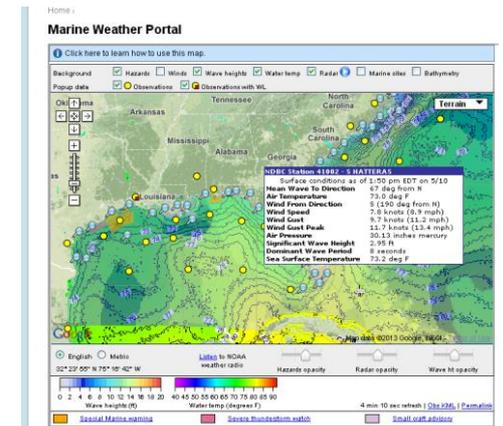
1.) Determine user needs



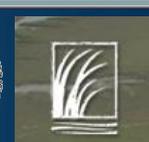
2.) Data fusion



3.) Decision support



Who is doing it: A partnership between SECOORA, UNC-W, USC, USF and the NWS Office of the CIO, NWS Eastern and Southern Region Headquarters and WFOs, NERRS and Second Creek Consulting



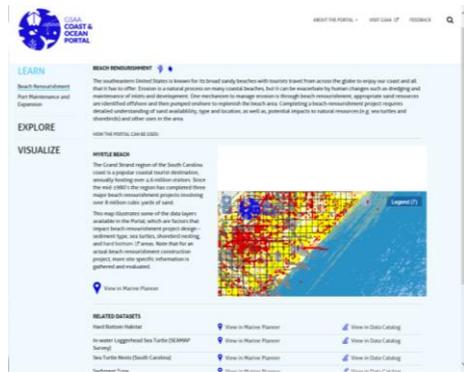
Supporting Marine Spatial Planning

Issue: Local to regional resource managers and planners needs access to spatially and temporally relevant data and to planning tools in support of healthy ecosystems, clean coastal and ocean waters, disaster planning and recovery, and working waterfronts.

Goal: To provide access to regional coastal and ocean data and planning tools in support of the Governors' South Atlantic Alliance (GSAA).

Process:

1.) Determine user needs



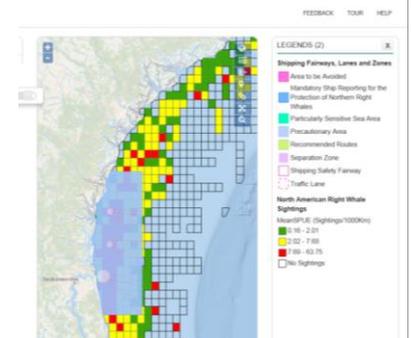
2.) Data development and fusion



- LEARN: Jurisdictions and Boundaries / 27 •
- EXPLORE: Marine Habitat / 23 •
- DATA CATALOG: Marine Species / 60 •
- VISUALIZE: Oceanographic Features / 5 •
- Ocean Uses / 27 •
- Upland Uses / 3 •



3.) Decision support



Who is doing it: A partnership involving NC, SC, GA, FL agencies and academic institutions, SECOORA, TNC, EcoTrust and NOAA.

Supporting Improved Decision Making Globally

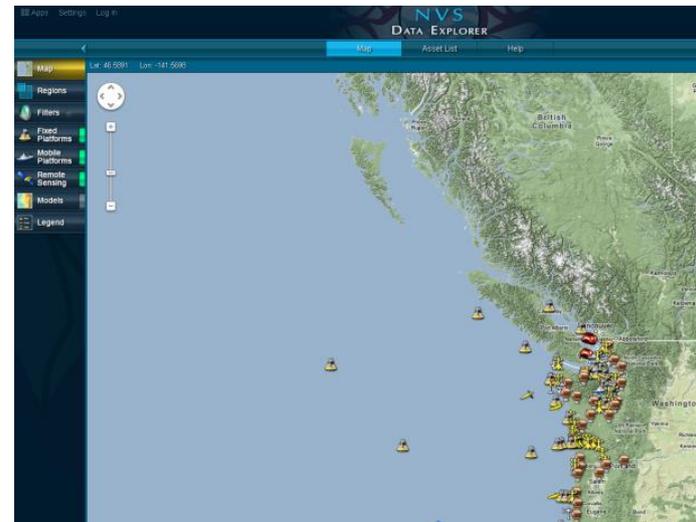
Issue: In support of addressing global issues such as ocean acidification, there is a need for a public information network for creating and sharing environmentally relevant data and information online.

Goal: To improve the global environment by sharing information and knowledge.

Process: 1.) Data assimilation



2.) Decision support



Who is doing it: IOOS Program Office, NERRS, NANOOS, SECOORA, European Environment Agency and ESRI.

To wrap things up, criteria to consider

Do the data have:

- relevance to regional information needs?
 - Yes!
- a well designed and adhered to data management program?
 - Yes.
- demonstrated use in management decisions?
 - Examples provided, and user base is growing.
- existing funding for data collection?
 - Yes ... but never enough.
- the ability for additional leveraging to assist with scale-up?
 - Absolutely!
- the backing of an operational (24/7) backbone?
 - Oh cr...!

For more information

Dwayne E. Porter

porter@sc.edu

Melissa Ide

melissa@belle.baruch.sc.edu

Marie Bundy

marie.bundy@noaa.gov



NATIONAL
ESTUARINE
RESEARCH
RESERVE
SYSTEM