

# COLLABORATIVE SCIENCE FOR ESTUARIES

WEBINAR SERIES

## Summary Points:

Dr. Dwayne Porter has been Director of the Centralized Data Management Office (CDMO) for the National Estuarine Research Reserve System (NERRS) since 1994. The CDMO is based out of the Baruch Institute for Marine and Coastal Sciences at the University of South Carolina.

Dwayne received his PhD in Geographic Information Processing from the University of South Carolina, where he is currently Professor of Environmental Health Sciences in the Arnold School of Public Health.

As a member of the NERRS Science Collaborative team, Dwayne engages reserves in the task of data management to facilitate research, collaboration, and integration. He and his team at the CDMO provide data and information management, technical support, and trainings to the NERRS and Science Collaborative-supported activities.



## Dwayne Porter

*Director*

*Centralized Data  
Management Office*

Date: February 28, 2018  
Time: 2:00-2:45pm EST



# 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



Presented by:

**Dwayne E. Porter, Melissa Ide, Jeremy Cothran, Amber Knowles, Jennifer Keese, Julia Britton,  
Dan Ramage and Marie Bundy**



NOAA NERRS Science Collaborative Webinar Series  
28 February 2018

## Summary Points:

This webinar focuses on the role of environmental monitoring and data management to support sound science for improved decision-making.

## Outline

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

## Summary Points:

This webinar covers why environmental data management is important and outlines the role it plays in the NERRS System-wide Monitoring Program (SWMP), a monitoring program conducted at all 29 reserves. It also provides a few examples in order to demonstrate the power of integrating monitoring and observing programs to support decision making and problem solving.

# 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.

## Summary Points:

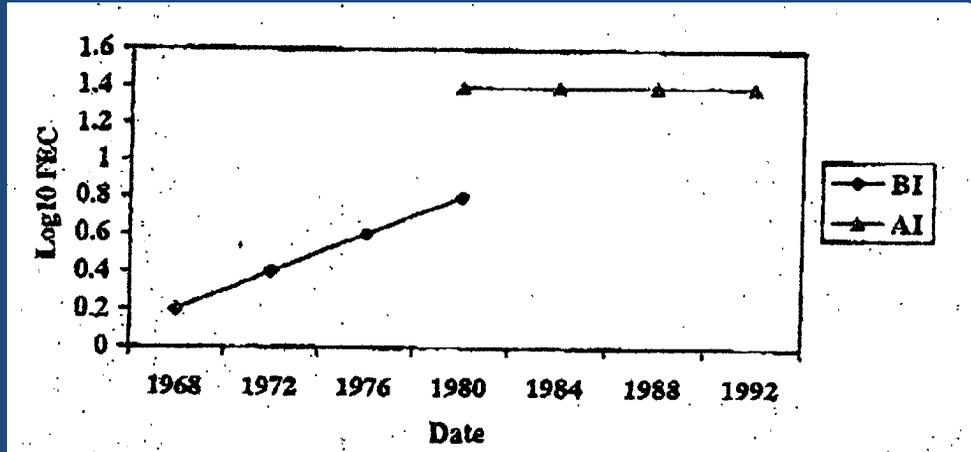
There are three reasons why NERRS do data management:

First, they are required to by an Executive Order issued 30 years ago, which requires all programs supported by the federal government to manage their data, database development, and data sharing.

Second, it makes sound financial sense. Environmental data collection and monitoring is expensive and is becoming increasingly difficult to fund as budgets become tighter. Data management helps researchers find ways to gain the greatest utility out of each and every data point they collect.

# Why do environmental data management?

## 3.) Your job may be on the line!



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01/01/2003	07:00:00	09.6	056.36	37.2	060.1	05.4	0.50	01.9	.

## Summary Points:

Third, if you do not have a sound data management program in place, there can be serious consequences that can lead to inaccurate conclusions and poor decision making. For example, these three graphs and images represent issues from poor data management and interpretation, which I will detail further on slide six.

# 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.

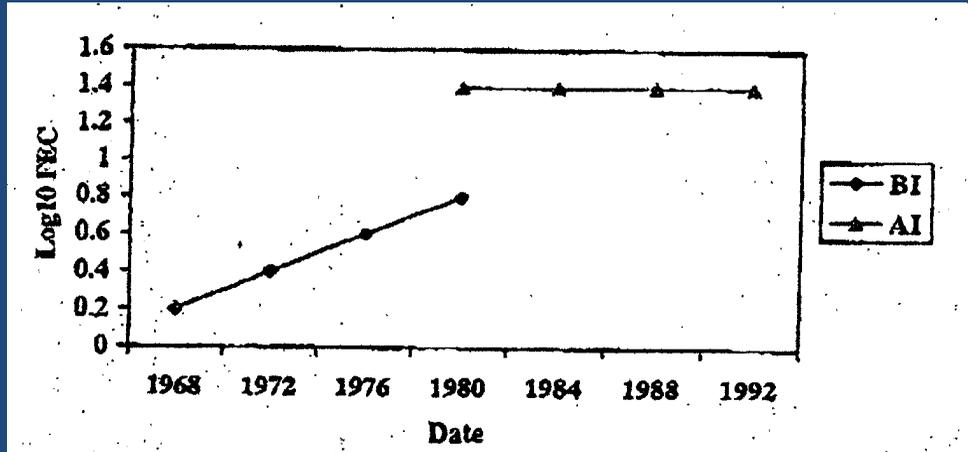
## Summary Points:

A good database management program has five components:

- *User needs assessment* - First, you need to understand the needs of those collecting and using the data and understand who the end users of the data will be. If you are not cognizant of the needs and limitations of all those involved in the project, you can develop a program that's robust but not implementable due to capacity limitations.
- *Data collection protocol* - Second, you need to identify the issue or question you want to address. You need to consider what data you need, when you are going to collect it, and how you are going to collect it. All of this needs to be documented.
- *Quality Assurance/Quality Control Procedures* - Third, you need to have robust QA/QC procedures in place. A lack of a robust and adhered to QA/QC process can result in many problems down the road.
- *Documentation and Metadata* - Fourth, it is crucial that you document everything and develop metadata for the data you are collecting. Metadata describes the data being collected. It allows for the utility of the data beyond the bounds of the initial reason why the data were collected.
- *Access and Archival* - Fifth, you need to ensure the longevity of the data via data archives and also provide ways to access the data.

# Why do environmental data management?

## 3.) Your job may be on the line!



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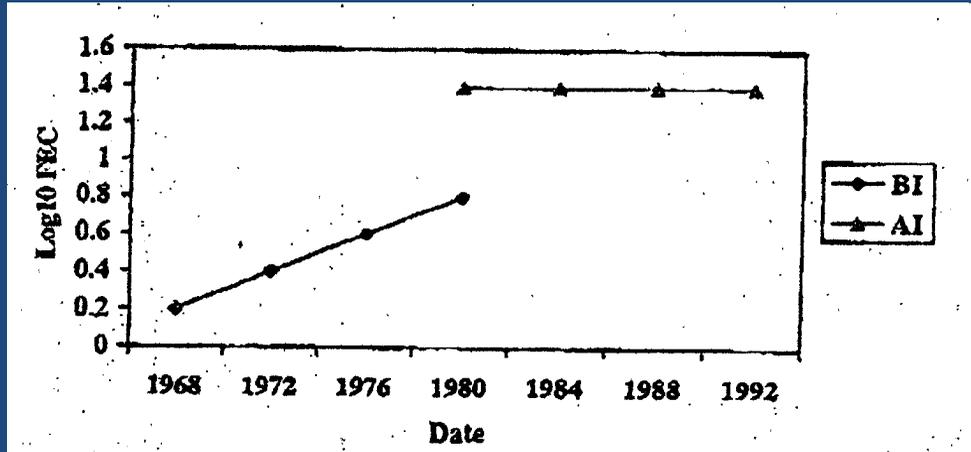
## Summary Points:

These images demonstrate issues that can occur if you do not have a strong data management program in place:

**Top Left:** We did an intervention analysis looking at the success of the implementation of a municipal wastewater treatment plant in decreasing bacterial loading in estuarine waters. We expected that once the plant came online in 1980, we would see a decrease in bacterial loading but this was not the case. If we were not intimate with our study area, we would be questioning the effectiveness of the plant. But since we were familiar with study area, we knew that at the same time the plant came online, construction of navigation jetties had just been completed nearby, decreasing the amount of fresh ocean water coming into the estuary. This decrease in flushing resulted in elevated bacterial levels, but without really understanding our study area, the data would not have told us that story.

# Why do environmental data management?

## 3.) Your job may be on the line!



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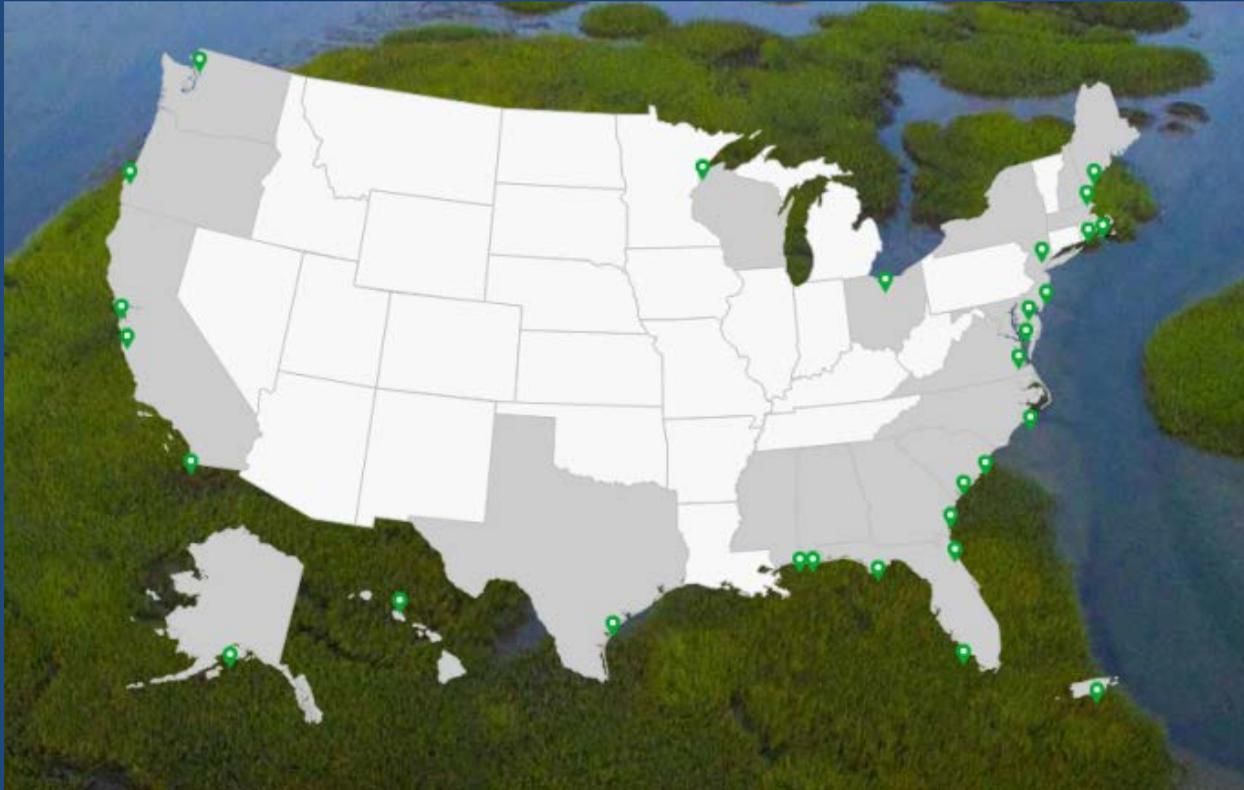


## Summary Points:

**Lower Left** - This table shows dissolved oxygen levels from late December 2002 through early January 2003. There was a significant decrease in DO around midnight on 1/1/03 and people looking at the data came up with a variety of reasons why this drop occurred. Since we knew our study area and had proper documentation of the site, we could figure out what happened, which is that community lagoon upstream of the sampling site that was flushed at midnight on New Year's Eve to symbolize the cleansing of the community. But without having this metadata describing our study site, we would likely draw false conclusions.

**Right** - This map shows three different boundaries for North Inlet-Winyah Bay NERR generated a decade ago. At the time, there was a proposed beach nourishment effort north of our study area, and decision-makers asked for the boundaries of North Inlet-Winyah Bay. NOAA, the state's Coastal Zone Management office, and the reserve all provided different boundaries, as shown here. How could the users know which one was correct? Now, we have a process in place to ensure we have an authoritative database and the ability to track data users in the event of future changes in the data.

# 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)**

## Summary Points:

The National Estuarine Research Reserve System (NERRS) is a NOAA partnership program between NOAA and a local institution, such as a state agency or university. It is a network of 29 unique research reserves protected for long-term research, management, education, and coastal stewardship. Its mission is to practice and promote stewardship of coasts and estuaries through innovative research, education, and training using a place-based system of protected areas.

In 1994, a group of NERRS Research Coordinators and others with the then Sanctuaries and Reserves Division (now part of the Office for Coastal Management) of NOAA met at North Inlet-Winyah Bay Reserve to lay the groundwork for a System-wide Monitoring Program (SWMP). The idea was to provide a consistent, standard monitoring program at each reserve for site-specific needs and cross-reserve comparison in support of addressing local, regional, and national issues.

# 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.



## Summary Points:

SWMP was established to address short-term variability and long-term change in coastal estuaries. This was at a time when reserves were focusing on nonpoint source pollution and land use change in watersheds as the key issues facing coastal estuaries. As such, the three core components of SWMP became water quality, weather, and nutrients.

SWMP introduced two important components to the reserve system:

1. Each reserve within the NERRS was required to collect data in the same way, using the same equipment.
2. It established a robust data management program, drawing upon the successes and lessons learned from the NSF's Long-Term Ecological Research (LTER) system.

# 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.

## Summary Points:

Each reserve collects water quality data at a minimum of four locations using a Yellow Springs Instrument meter. Each reserve also has at least one weather station located in or near the reserve.

# 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.



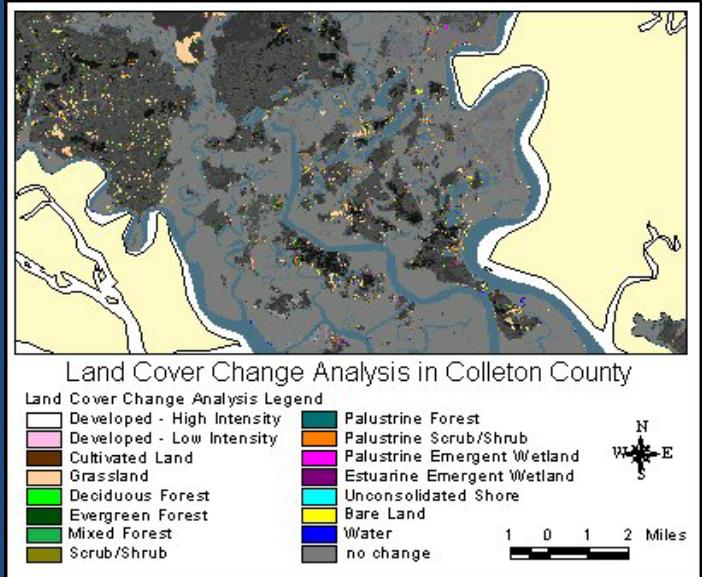
## Summary Points:

Reserves monitor nutrients on a monthly basis. Although reserves send their samples to different laboratories for analysis, they do inter-lab comparisons to address the issue of quality using multiple labs.

# Additional SWMP efforts

*Parameters Monitored*

Habitat Mapping  
 Biomonitoring  
 Sediment Elevation



## Summary Points:

Reserves also conduct habitat mapping, biomonitoring, and sediment elevation monitoring as part of SWMP. At this point in SWMP's maturation, CDMO is exploring ways to better integrate these three efforts with SWMP's core components.

# 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.

## Summary Points:

25 years ago, when we first met at North Inlet-Winyah Bay to establish CDMO, we identified what types of data we wanted to collect and how we were going to collect it. We also agreed that we were going to manage the data from a central location.

There were many discussions about whether the CDMO should be the “Central” Data Management Office or “Centralized” Data Management Office. Ultimately, we chose to go with “centralized”, since “central” implied that all data management would take place at one central office, which wasn’t the case.

We firmly believed, and still do, that those groups collecting the data are the ones best equipped to manage the data and conduct QA/QC. So the “centralized” part of CDMO reflects that the NERRS has a consistent protocol in all of the data collection that we do but that it is all managed at the local level.

# 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.

## Summary Points:

The hallmark of SWMP is its QA/QC component.

QA/QC is a three-step process at the CDMO:

1. Provisional - The data goes through an automated QA/QC process
2. Provisional Plus - The people in the field who collect the data review it
3. Authoritative Database - Data has gone through a final review by the CDMO

The majority of monitoring and observing programs in existence today stop at provisional data. Provisional Plus and Authoritative QA/QC are important steps in ensuring you bring the eyes of the data collectors onto the data. The last two steps, while time consuming, are important for ensuring credibility in the data.

In the NERRS, there are individuals located at each reserve and in the central office that are engaged in QA/QC.

# 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

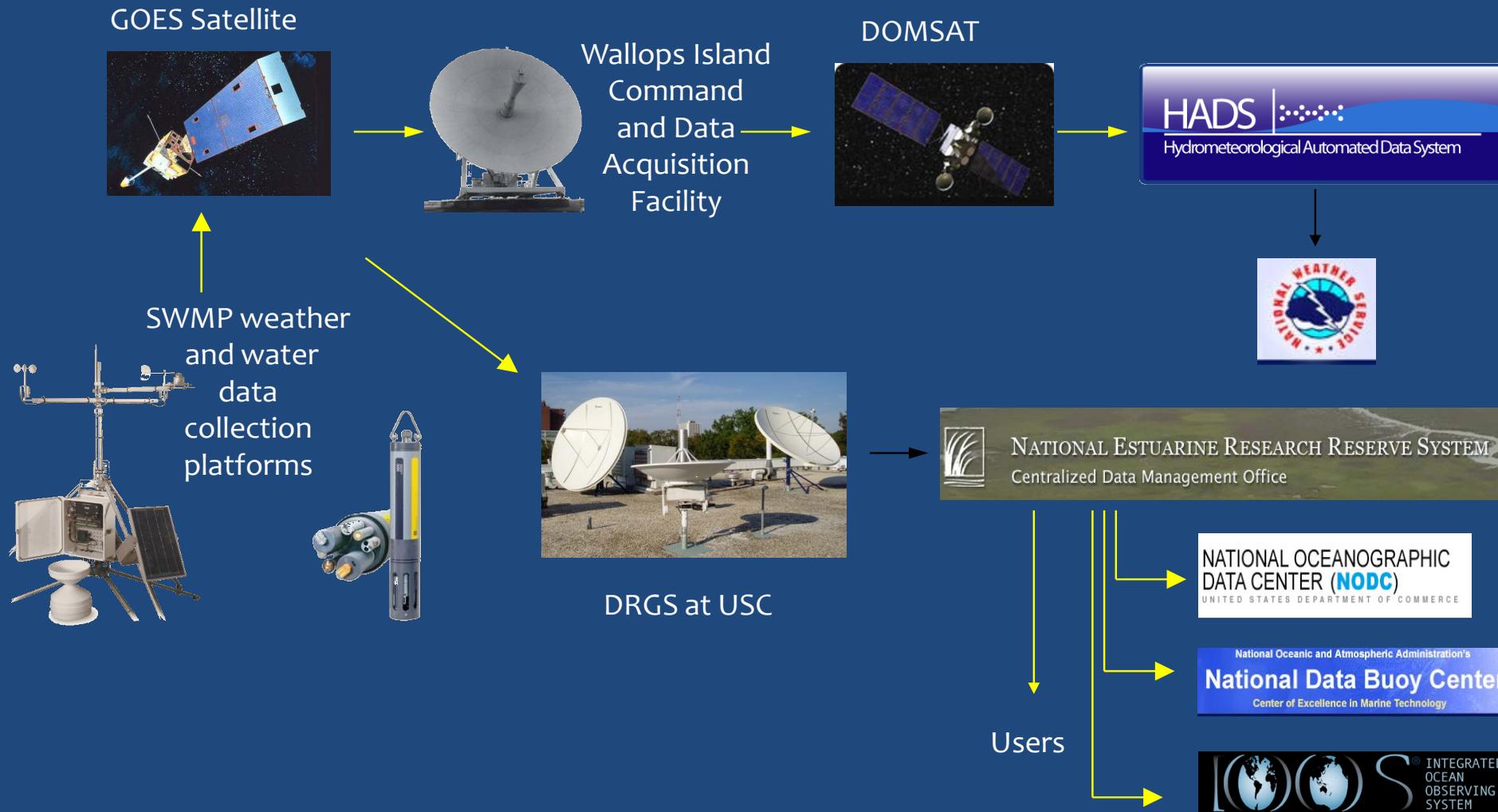
147 Nutrient datasets (119,576 records)

130 active and 17 inactive

## Summary Points:

A quick overview of what datasets we currently have in place at CDMO through SWMP.

# NERRS SWMP near-real-time data flow



## Summary Points:

Most SWMP data is now available in near real-time. CDMO uses the GOES satellite system, where the data are sent to GOES, run through its initial QA/QC, and then made available to a wide variety of audiences.

## Users of NERRS SWMP data include...

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

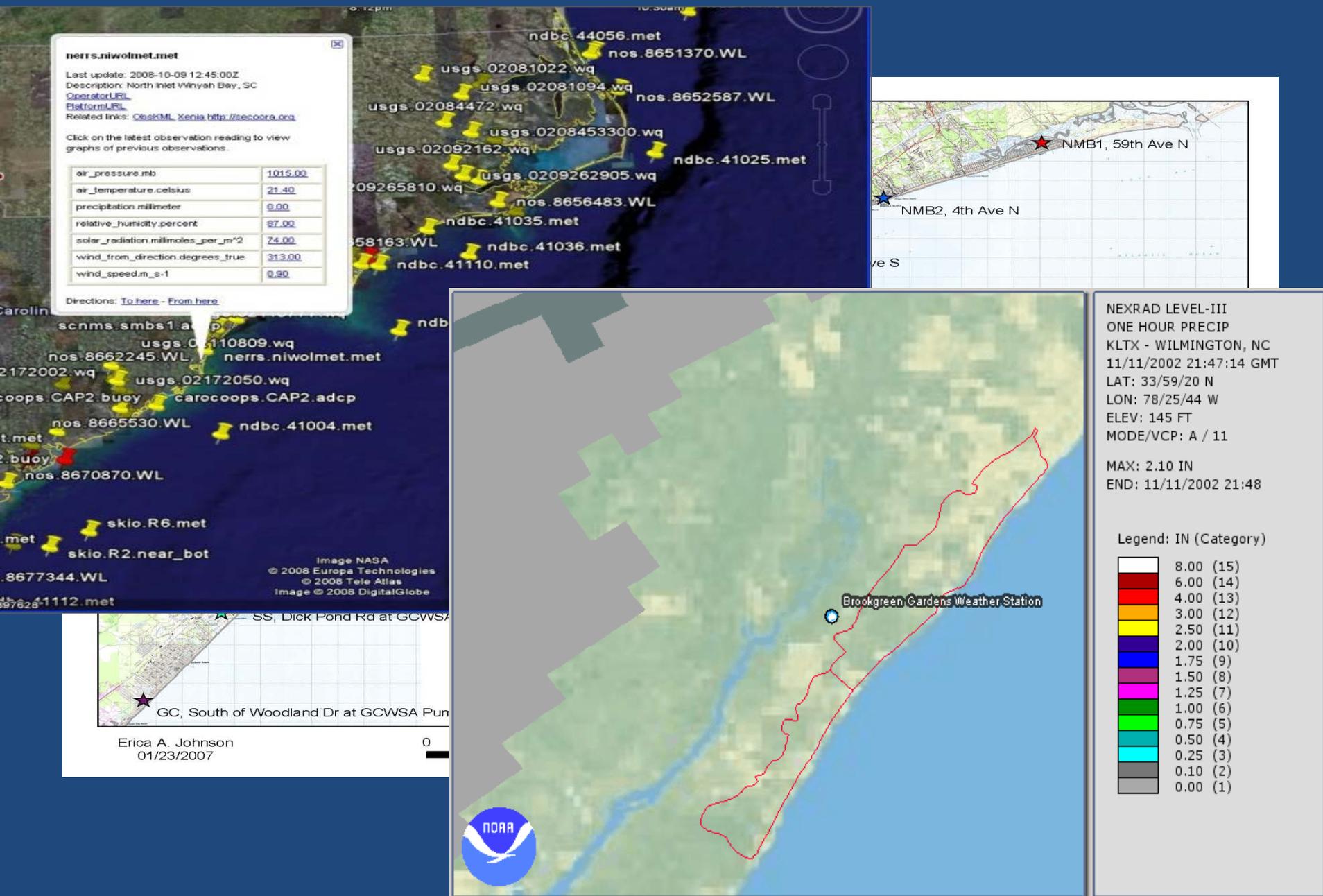
IOOS related: NANOOS, NERACOOS, SECOORA, AOOS, MARACOOS, GCOOS

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

## Summary Points:

This list shows a subset of the users and uses of SWMP data.

# The real value is in integrating observing systems!



## Summary Points:

Every monitoring program is created for a specific reason and is designed to achieve that goal or mission.

However, many societal issues that we need to address today require the use of data that cannot be collected by just one observing system.

As such, the real value of a robust data management program is that it allows for the exchange of high-quality data across programs to address larger issues.

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

## Summary Points:

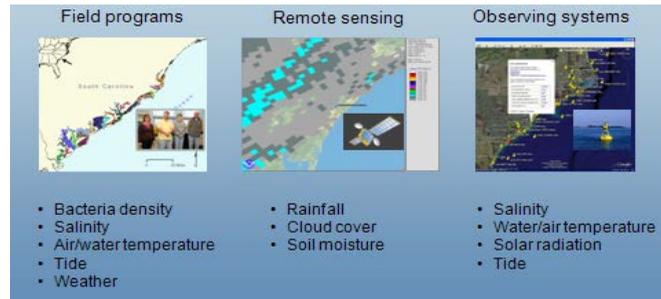
On the next few slides are examples of how integrating monitoring programs can inform decision-making.

# Beach Water Quality Assessment and Modeling Activities

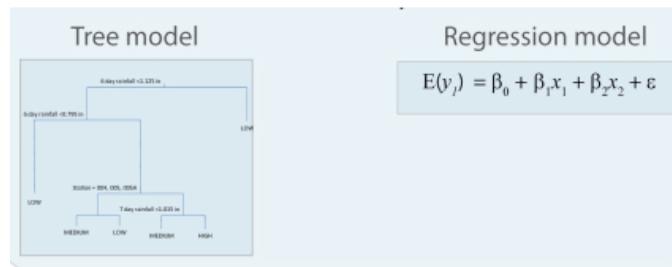
**Issue:** Exposure to beach swimming waters with elevated bacterial levels is a public health concern and one of economic vitality.

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

**Process** 1.) Data integration and fusion

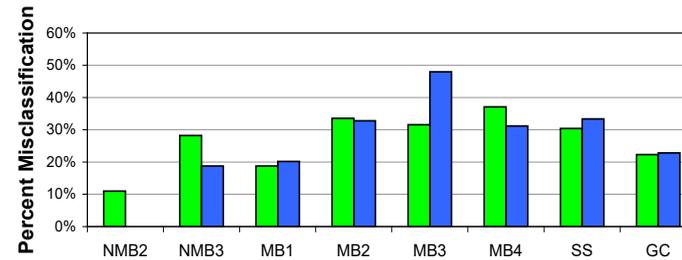


2.) Ensemble model development

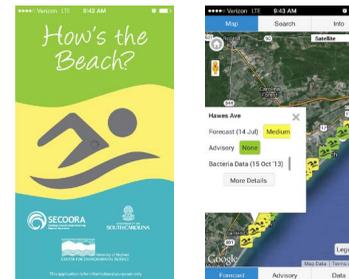


**Who is doing it:** A partnership among beach managers, tourism interests, public health officials and the general public including...

3.) Model validation



4.) Operational decision-support tool



## Summary Points:

One effort underway in the Southeast U.S. is the development of preemptive models to help authorities determine whether or not beach swim advisories should be issued. This effort involves a suite of actors, including NERRs, USGS, EPA, Southeast Regional Coastal Ocean Observing System, and state and local partners.

The ability to integrate data from each of these programs allows us to develop a decision support tool, whereby we can give an estimate of water quality at swimming beaches each morning in North Carolina, South Carolina, and Florida.

# Monitoring Water Conditions in Shellfish Harvesting Waters

## Summary Points:

**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



As a second example, one of the initial projects that came out of SWMP was working with the Pacific Northwest Shellfish Growers Association in Washington and Oregon to provide real-time data that commercial shellfish growers use to make decisions about when and where to harvest.

**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.

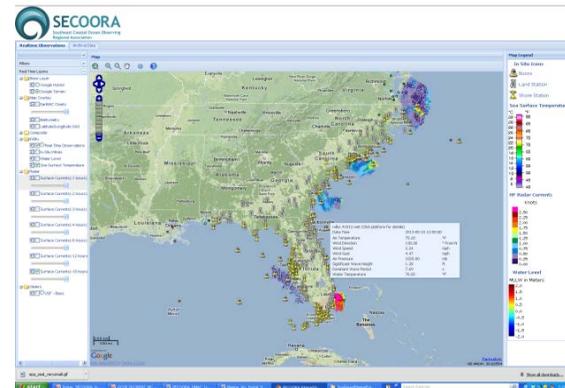
**Goal:** To provide 24/7 access to critical marine information for the commercial and recreational marine communities within the SECOORA region.

**Process:**

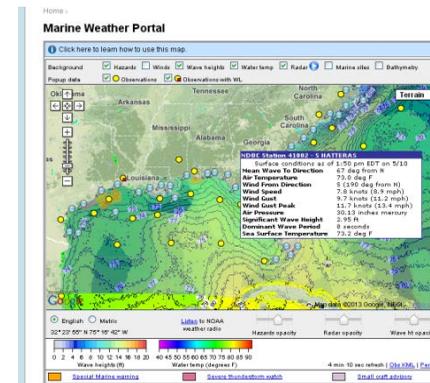
1.) Determine user needs



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

## Summary Points:

A third example is a collaboration between a number of NOAA, state, and local partners to provide access to critical marine information.

This effort started in the Southeast U.S. but has since expanded into the Gulf of Mexico. Currently, the project is looking to expand even further by partnering with the National Weather Service.



# 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.

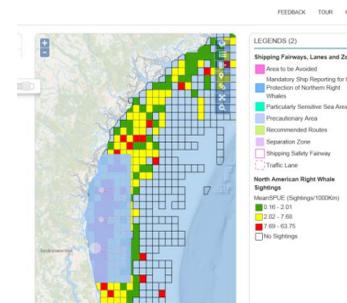
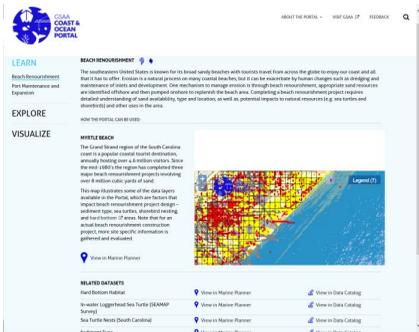
**Goal:** To provide access to regional coastal and ocean data and planning tools in support of the Governors' South Atlantic Alliance (GSAA).

**Process:**

1.) Determine user needs

2.) Data development and fusion

3.) Decision support



## Summary Points:

Most regions in the U.S. have a regional ocean planning initiative. The Southeast U.S. has faced a number of challenges in its regional marine planning efforts but an initial realization they had was that they needed access to data from a variety of sources.

The regional planning group identified sources that had robust data management programs in place, where they were assured of the quality of the data and also had access to documentation that allowed them to understand the data.

Integration of these data has allowed groups to create decision support tools that support marine spatial planning.

**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

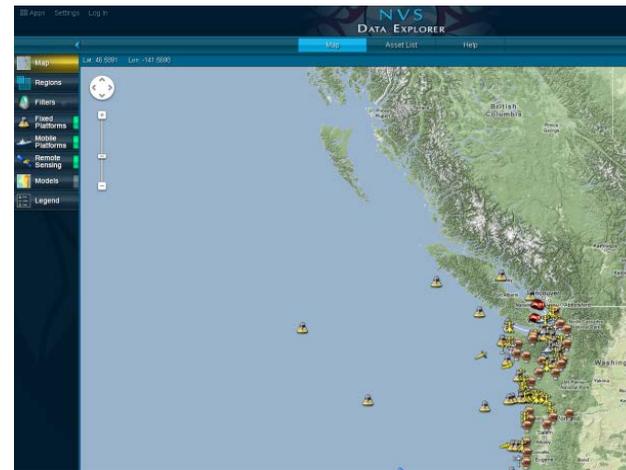
**Issue:** In support of addressing global issues such as ocean acidification, there is a need for a public information network for creating and sharing environmentally relevant data and information online.

**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.

## Summary Points:

Data integration is also done on an international scale. The Integrated Ocean Observing System (IOOS) Program Office initiated one such effort, and the NERRS SWMP was the first estuarine component of the international program.

Since SWMP had a strong data management structure in place, they were easily able to meet all expectations and requirements of this international program.

# 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...!

## Summary Points:

As you are working within your own monitoring or observing program, here are a few things to consider in thinking about maximizing the utility of your data:

- Your data needs to have relevance beyond the intended collection of the data.
- A well designed data management program is critically important.
- It's important to have a demonstrated use for data in management decisions. SWMP data, for instance, contributes to a variety of societal issues.
- Although there's never enough funding for data collection, integration gives you better bang for your buck.
- Whether you have the resources or inclination to be a 24/7 operational system, it is important to realize that once people rely upon your data, they recognize you as operational.

# For more information

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## Questions:

### **How can people access SWMP data?**

CDMO maintains a data portal in support of SWMP at [www.nerrsdata.org](http://www.nerrsdata.org). This site has a wide variety of web services and tools that allow you to export and graph data. In addition, CDMO works closely with regional associations within IOOS where SWMP data are continually transferred to IOOS Regional Associations.

### **What are some ways data management can better facilitate collaboration and integration for responsiveness to end users?**

Sound data management facilitates communication allows people to be less concerned about their loss of identity. Early on, a lot of opportunities were missed because monitoring programs were concerned about others getting credit for the work that they had done. But if you have a robust data management system in place and diligently document what you are doing, there's less concern about loss of identity and greater inclination to interact and integrate with other programs.

# For more information

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## Questions:

**What concerns would you have with data that is collected using different measures or practices due to partners' varying capabilities and resources?**

If appropriate data documentation is followed and appropriate metadata are developed and provided to end users that describe the limitations of the data, then I don't see any issues. Some of the responsibility for using the data is on the users and, too often, we decide to exclude monitoring efforts because of perceived incompatibilities between data collection efforts.

**Can you comment on the NOAA USES project with your experience as a data manager?**

NOAA USES (Urbanization of Southeastern Estuaries Study) started out as five-year, competitively funded project that was provided continued funding for 17 years, through the diligence of a former South Carolina state senator. It focused on studying the impacts of urbanization on coastal estuaries, using North Inlet-Winyah Bay NERR as a control site and an urbanized estuary approximately 30km to the north as a study site. We collected data on toxicology, water quality, land use, and other parameters. Data management played a big role in ensuring that we had enough high-quality data and that data collected for one set of uses was usable and accessible to everyone involved in the project.