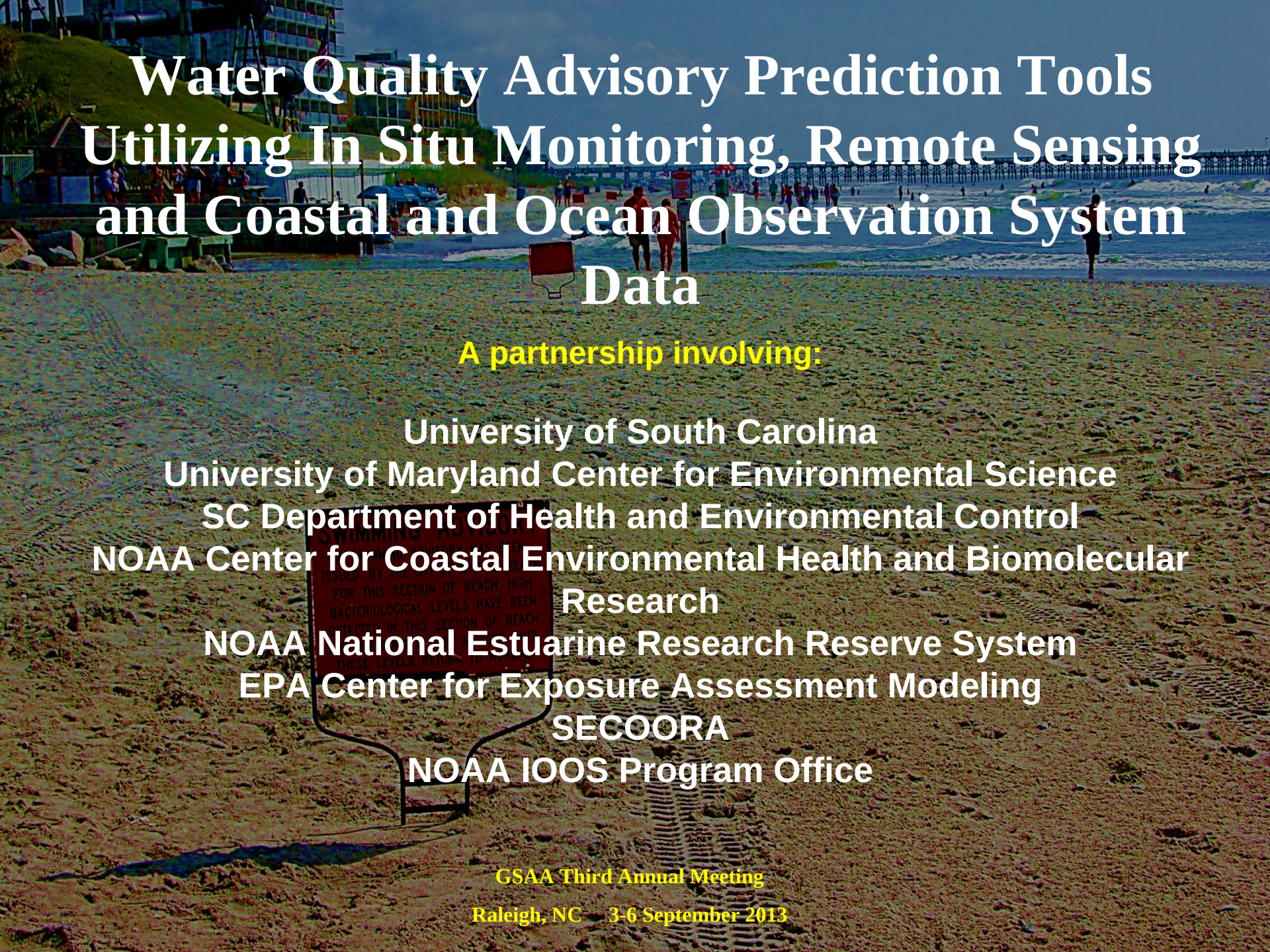


Water Quality Advisory Prediction Tools Utilizing In Situ Monitoring, Remote Sensing and Coastal and Ocean Observation System Data

A partnership involving:

University of South Carolina
University of Maryland Center for Environmental Science
SC Department of Health and Environmental Control
NOAA Center for Coastal Environmental Health and Biomolecular Research
NOAA National Estuarine Research Reserve System
EPA Center for Exposure Assessment Modeling
SECOORA
NOAA IOOS Program Office

GSAA Third Annual Meeting

Raleigh, NC 3-6 September 2013

Outline:

- Objectives as related to GSAA CCOW
- Setting the stage
- Integration of field program, remote sensing, and observing system data for improved models and forecasts
- Current activities
- Outcomes of integrative efforts

Objectives

1.Develop decision-support tools for bacteria contamination at beaches and shellfish areas *(Objs. CCOW1. Improve watershed management … and CCOW2. Enhance …impacts to …water quality …)*
2.Increase utility of observing system and remote sensing data *(Objective CCOW3. Increase data comparability …)*
3.Illustrate science-to-management application through integration of data

Setting the stage

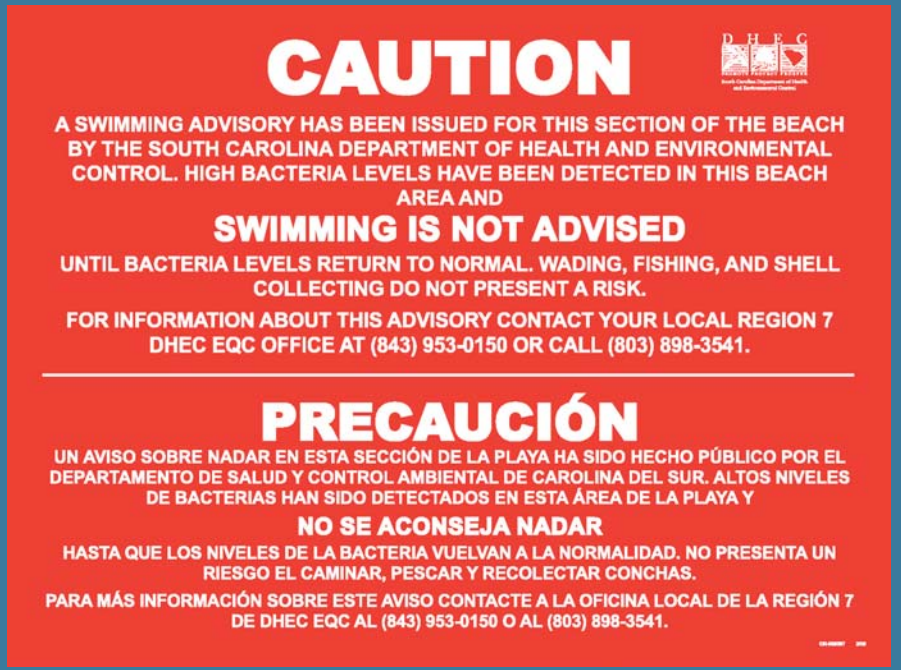
In response to water quality concerns and associated public health concerns

- State and local health agencies sample water quality at ocean swimming beaches and shellfish harvesting waters
- Results used to inform public of potential health risk

Setting the stage

Swimming advisories are issued if *Enterococcus* levels

- ≥500 MPN/100mL
  - Issue advisory
- ≥104 MPN/100mL
  - Resample

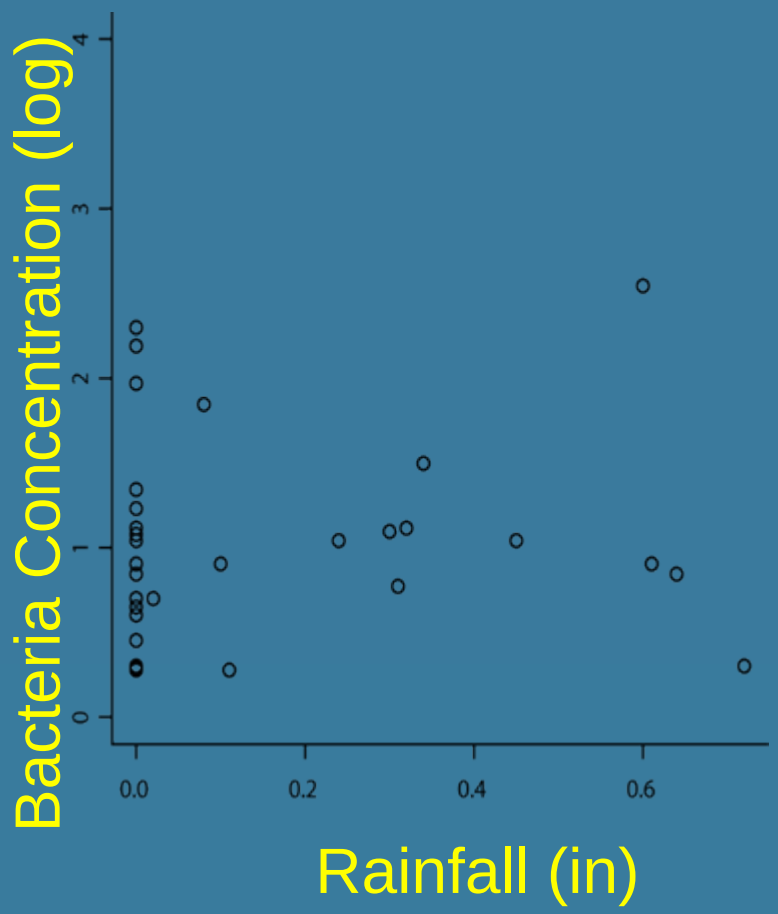


Today's advisory is based on yesterday's water quality!

Setting the stage

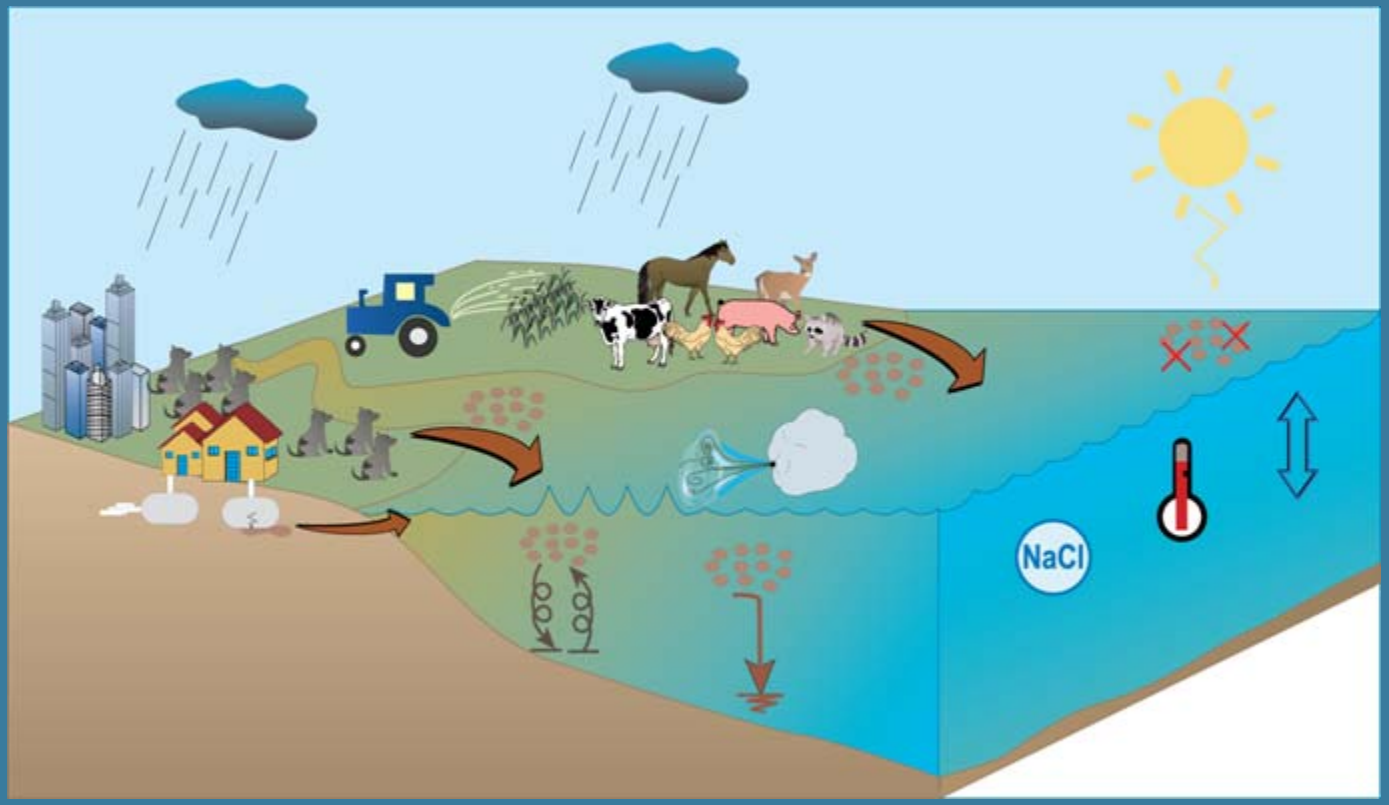
Most shellfish managers use rainfall estimates to issue temporary harvesting restrictions

- Poor correlations between concentrations and rainfall
- Rain gauges often in different watersheds



Setting the stage

Additional factors affect bacteria loading and survival



LOADING

- Precipitation
- Animal waste
- Fertilizer application
- Bacterial input
- Failed septic systems

SURVIVABILITY

- Sedimentation
- Solar inactivation
- Temperature
- Tidal flushing
- Salinity
- Wind
- Deposition/ resuspension

Setting the stage

Implications of advisories

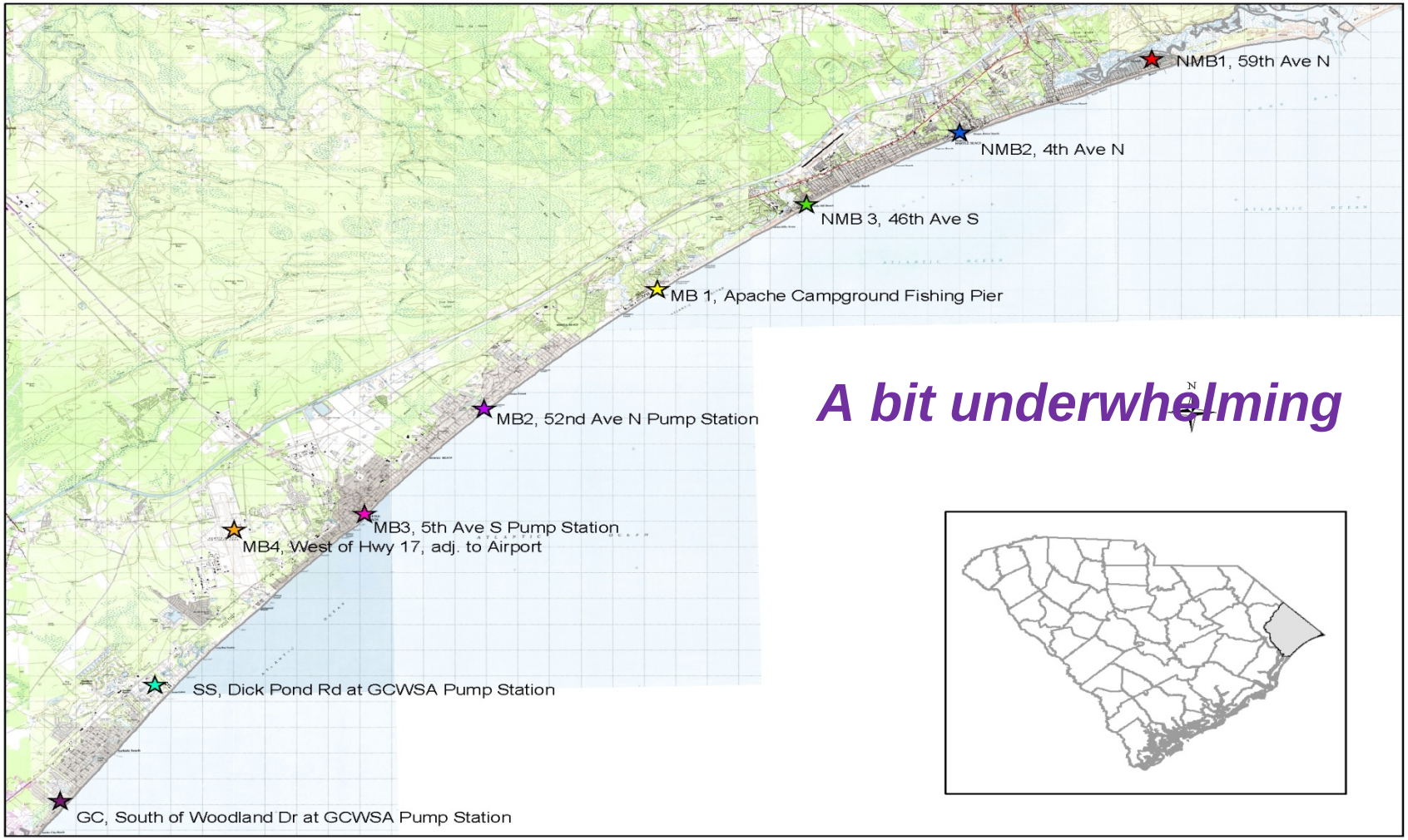
- **Error of commission**
  - Issue advisory when water quality is good
  - Poor image / revenue loss (i.e. the Chamber of Commerce is not happy)
- **Error of omission**
  - Fail to issue advisory when water quality is poor
  - Public health risk

Setting the stage

A potential improvement offered up to public health officials is that

- ***Bacteria* concentrations can be predicted with an accuracy adequate to assist decision-makers in the preemptive advisory process**

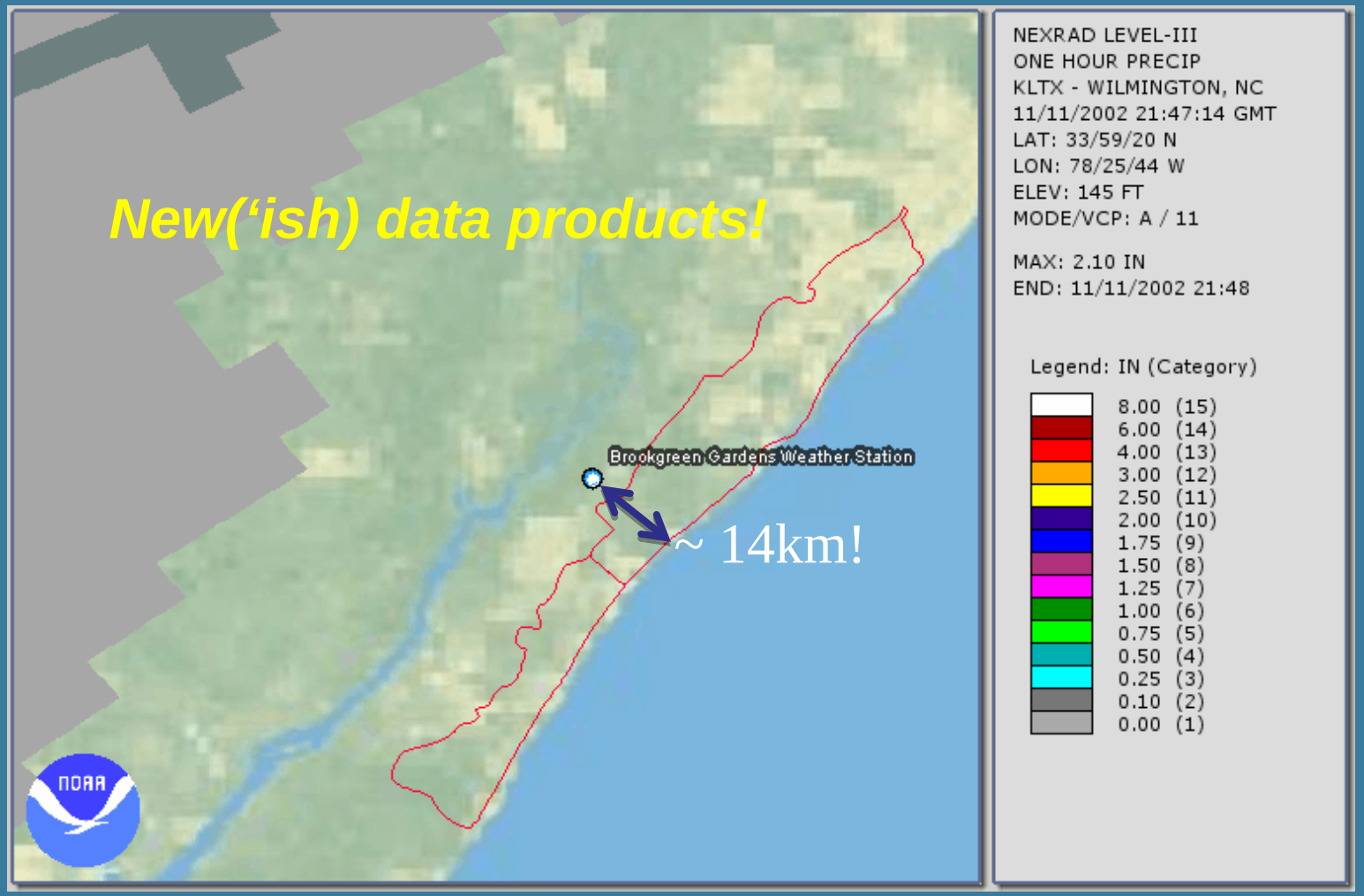
Setting the stage



A bit underwhelming

Integration of…

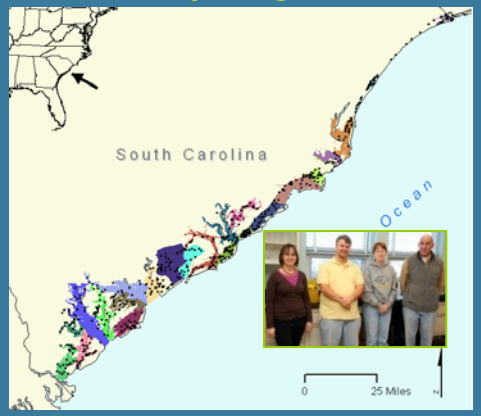
Integration of…



Integration of…

Data assimilation and integration from multiple sources including:

Field programs

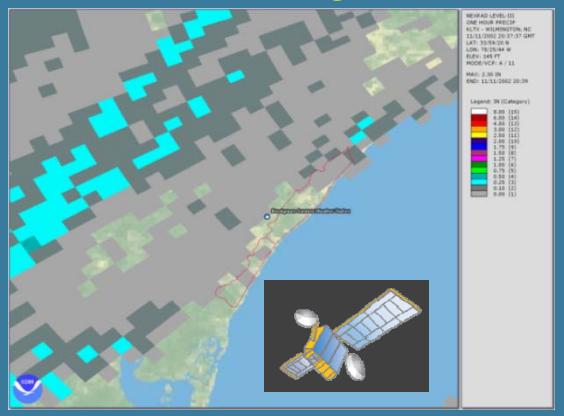


- *Bacteria density*
- *Salinity*
- *Air/water temp*
- *Tide*
- *Weather*

Observing systems

- *Rainfall*
- *Currents*
- *Salinity*
- *Wind*

Remote sensing / Models

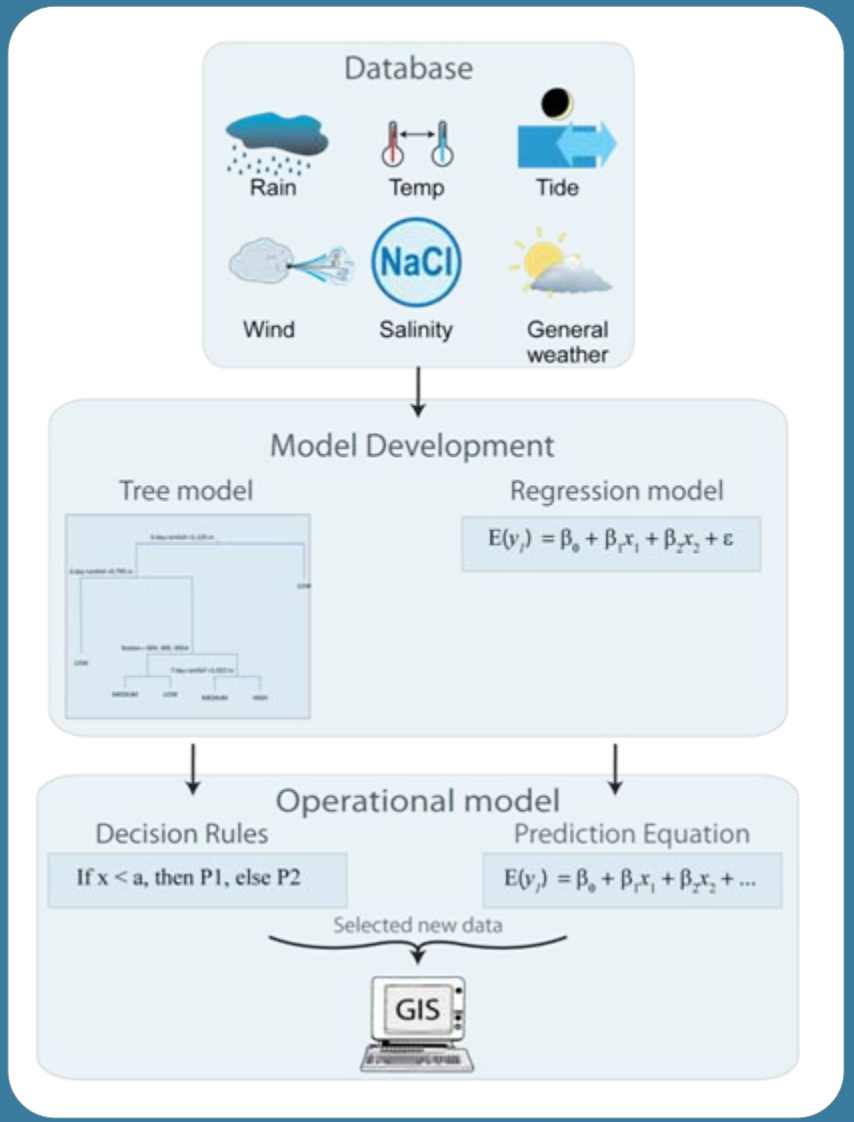


- *Salinity*
- *Air/water temp*
- *Rainfall*
- *Currents*
- *Wave activity*

Integration of…

Building on (student) efforts supported by SCDHEC, SECOORA, IOOS, NOAA and now the EPA, new models from integrated data:

- **MLR**
- **CART**
- **Ensemble models**



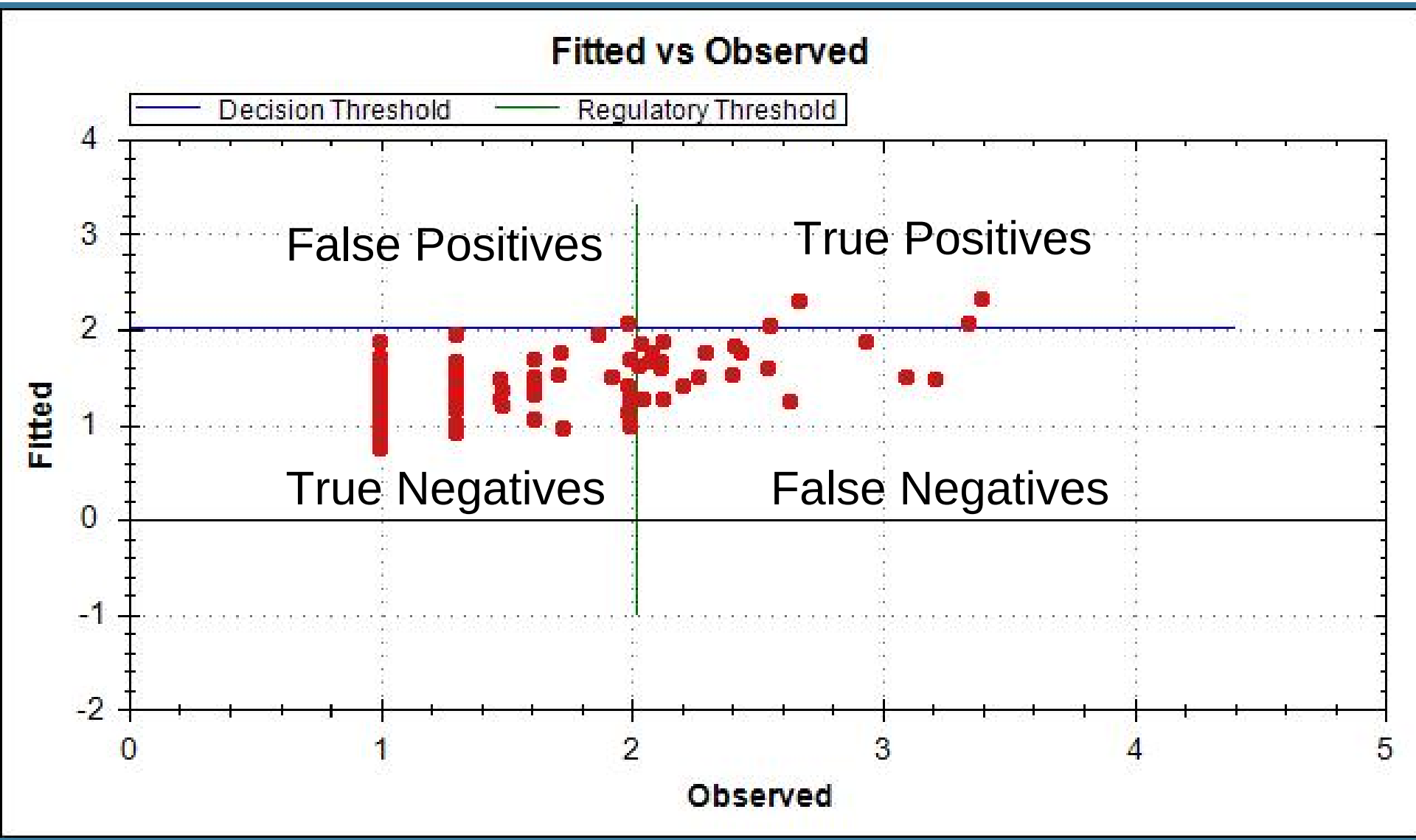
Integration of…

Model complexity is dependent upon

- **Location**
- **Availability of data**
- **Acceptable error**

Level 1	Level 2	Level 3
Cumulative Rainfall	Cumulative Rainfall	Cumulative Rainfall
Rain Intensity	Rain Intensity	Rain Intensity
Preceding Dry Days	Preceding Dry Days	Preceding Dry Days
Weather	Weather	Weather
Tidal Range	Tidal Range	Tidal Range
Lunar Phase	Lunar Phase	Lunar Phase
Station	Station	Station
	Wind Speed	Wind Speed
	Wind Direction	Wind Direction
		Current
		Salinity

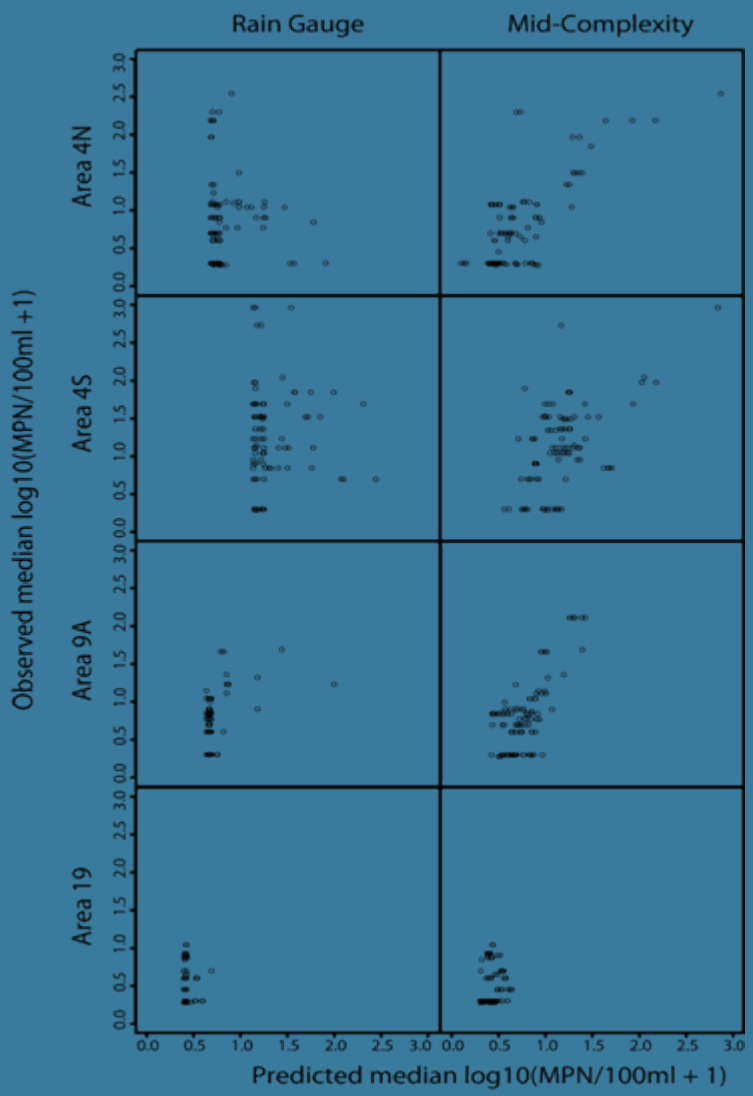
Integration of…



Integration of…

Improved predictions for management application

- Well correlated predicted and observed
- Random cross-validation



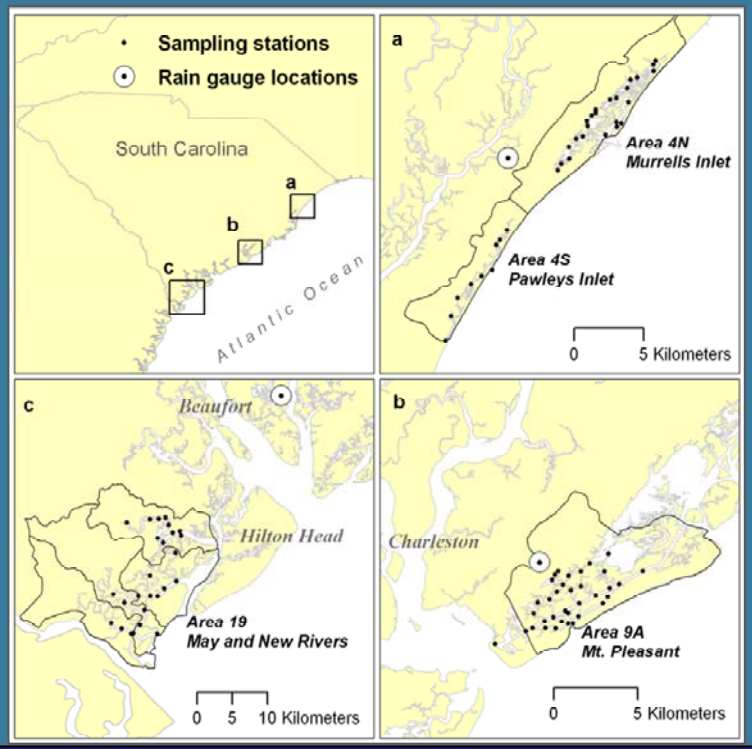
Current activities

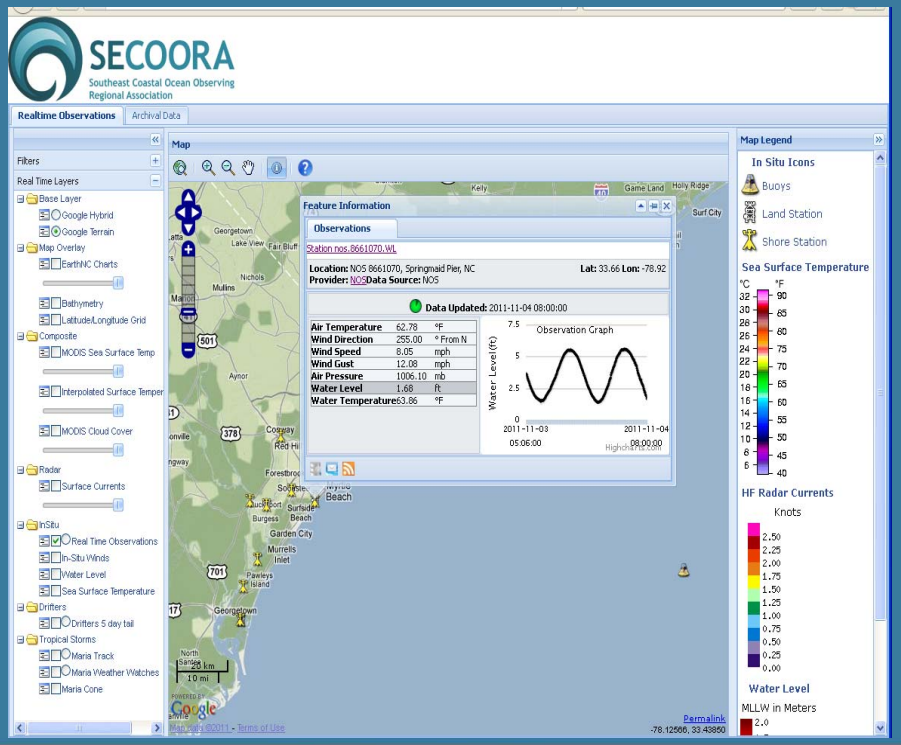
Shellfish areas

- *Not operational but could be*
- *Robust prototypes using integrated remote sensing rainfall data*

Beach applications

- *Operational and automated*
- *Updating with integrated data*
- *Development of GIS delivery*





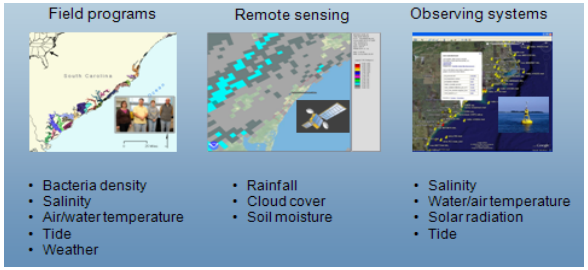
Supporting Beach Swimming Advisory Decision Making

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

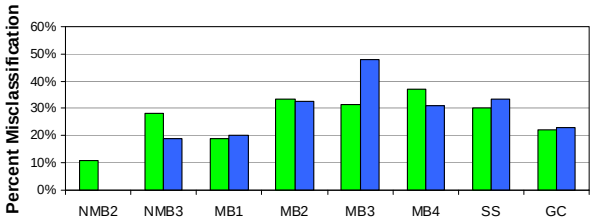
Goal: Develop and implement scientifically-justified, decision-support tools for accurate and defensible preemptive advisory issuance decisions.

Process:

1.) Data integration and fusion

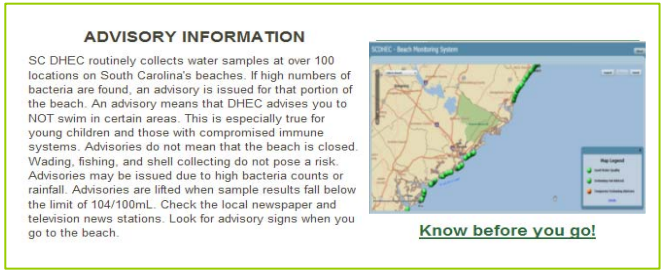


3.) Model validation



2.) Ensemble model development

4.) Operational support tool

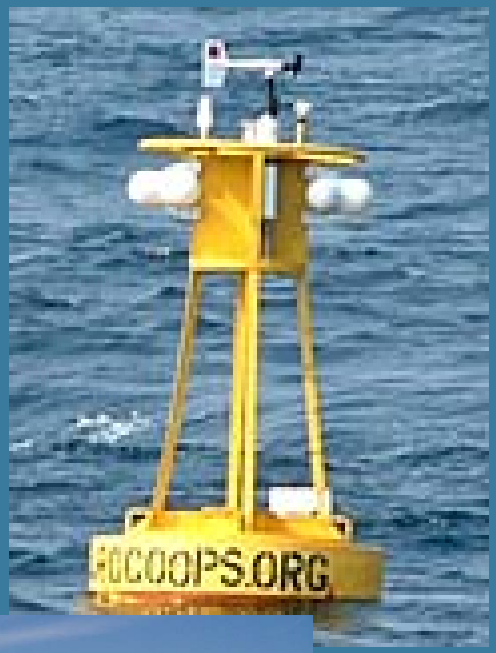


Who is doing it: A partnership among beach managers, tourism interests, public health officials and the general public including…

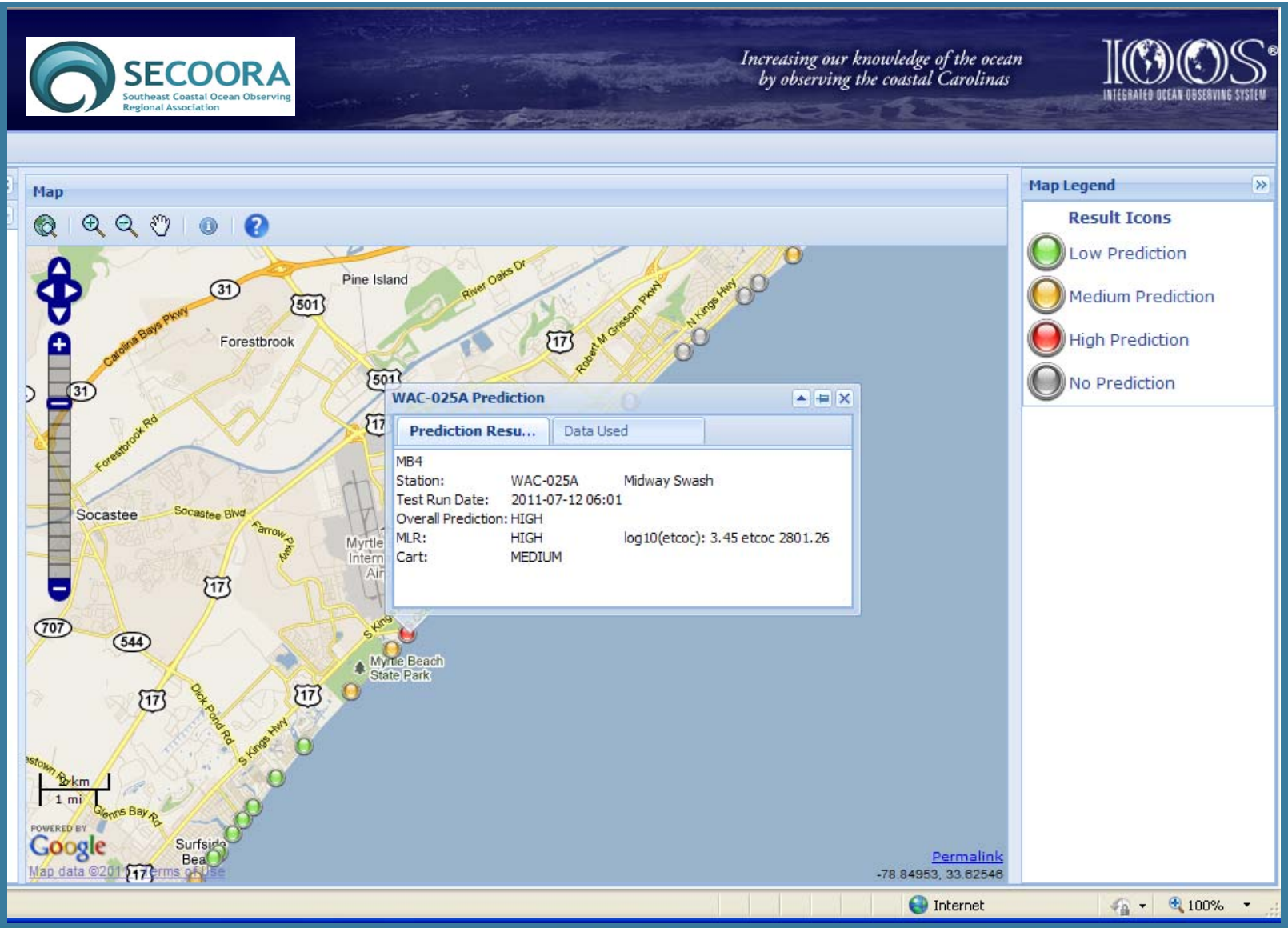
Current activities - Beach advisory modeling

Explanatory variables include

- **Meteorological**
  - Rainfall
  - Wind direction
- **Physical/Chemical**
  - Current
  - Salinity
- **Tidal Conditions**
  - Tide Range
  - Lunar Phase



Current activities - Beach advisory modeling



Monitoring Water Conditions in Shellfish Harvesting Waters

Issue: Commercial shellfish growers in the 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.

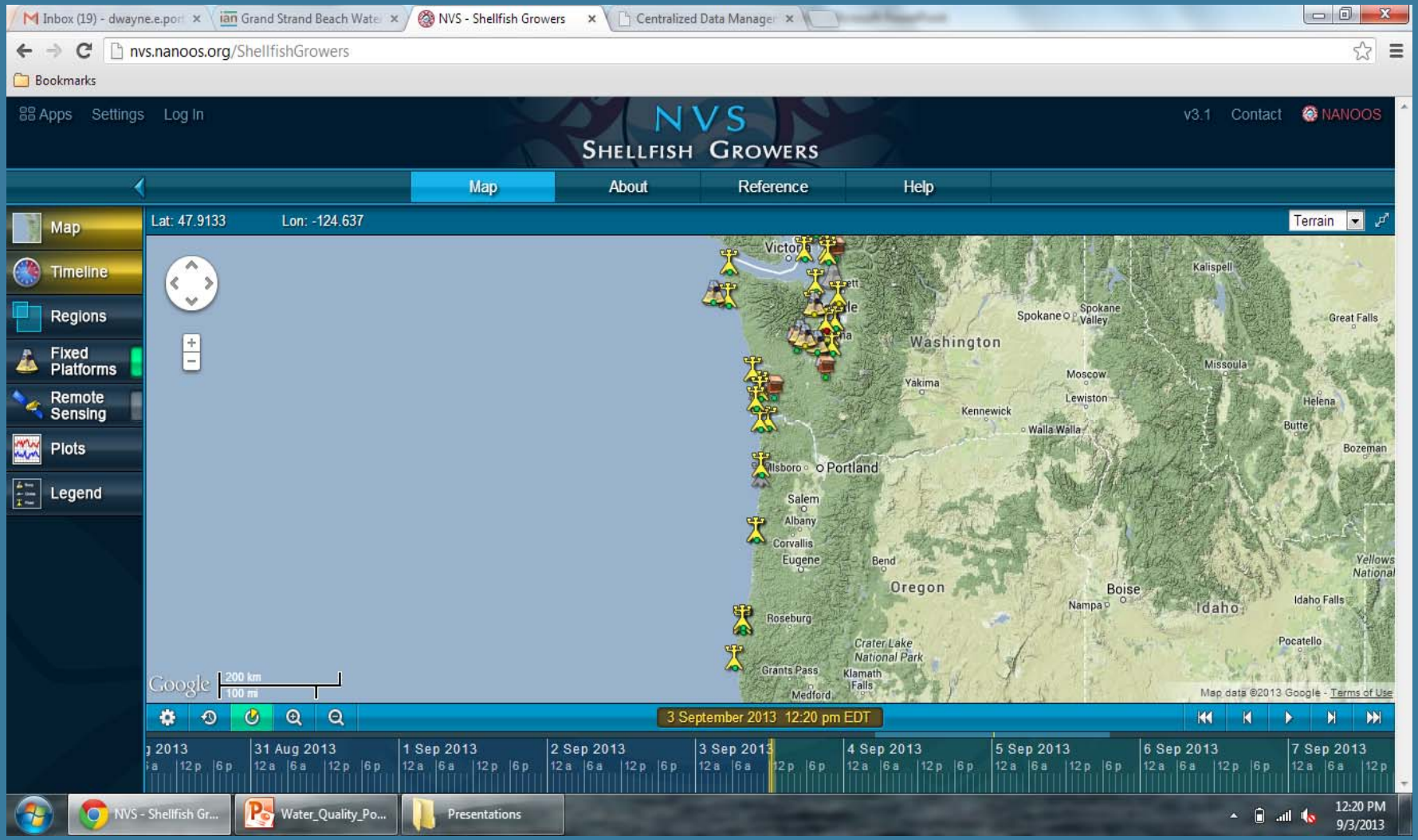
Process: 1.) Data collection

2.) Data integration and 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, CDMO, SECOORA (and support from CSC and NERRA)

Current activities - Shellfish harvest support system



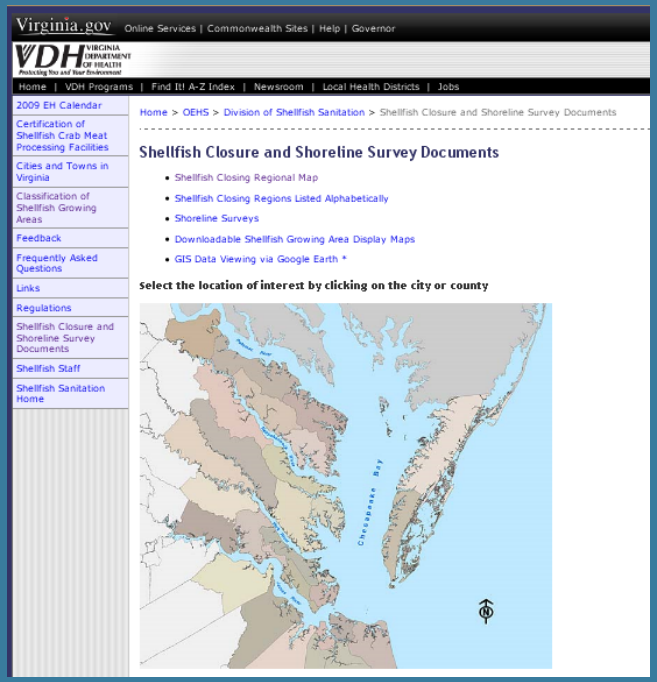
Outcomes of integrative efforts

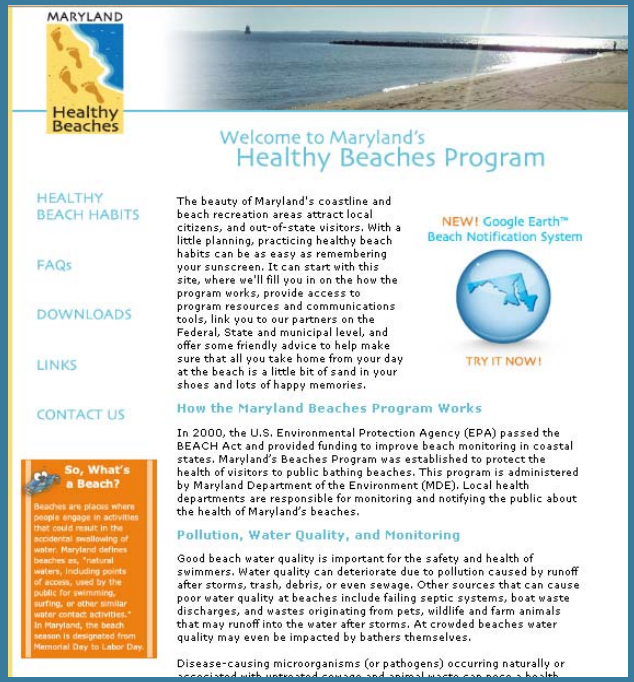
- Improving understanding of the role of technologies in addressing priority environmental and public health issues
- New observation infrastructure of additional real-time, continuous observations
- Improved knowledge of the data that exist to address GSAA management issues in the region
- Rapid access to local data for managers, researchers, and the public via the interactive website
- Development of inter-agency “rapid response” efforts addressing priority health and management issues
- Improved coordination and communication among diverse, complimentary group of coastal agencies and organizations supporting proactive efforts rather than reactive response

Outcomes of integrative efforts

Can we develop forecasts for other areas?

- Similar field program, remote sensing, and observing system data are available
- Forecast development approach is highly transferable





Acknowledgements

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- SCDHEC – Shannon Berry, Sean Torrens
- UNCW – Lynn Leonard, Jen Dorton
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