A Dialogue on NOAAs Ecological Forecasting Roadmap (EFR): Gulf of Mexico

Objectives:
• Educate those with an interest in Gulf of Mexico ecological forecasting about NOAAs Ecological Forecasting; and
• Inform NOAA team leads and the GCOOS-RA about regional issues related to ecological forecasting, including information needs and gaps.
NOAA’s Ecological Forecasting Roadmap

Summary for GCOOS Regional Discussion

Allison Allen
Portfolio Manager
NOAA Ecological Forecasting Forecasting Roadmap
February 12, 2015
Webinar Objectives

- Provide background on NOAA’s Ecological Forecasting Effort
- Share information on existing ecological forecasting efforts on the Gulf Coast
- Identify potential gaps and/or emerging areas for collaboration
- Identify points of contact for various efforts as a starting point for continued discussion
What Are Ecological Forecasts?

● Ecological forecasts predict likely changes in ecosystems in response to environmental drivers and resulting impacts to people, economies and communities.

● Ecological forecasts provide early warnings of the possible effects of ecosystem changes (e.g., harmful algal blooms, hypoxia, etc.) on coastal systems and human well-being with sufficient lead time to allow for corrective or mitigative actions.
“Our job is to build an understanding of the Earth, the atmosphere, and the oceans to transform that understanding into critical environmental intelligence: timely, actionable information, developed from reliable and authoritative science, that gives us foresight about future conditions”

Dr. Kathy Sullivan
NOAA Administrator
NOAA’s Ecological Forecasting Roadmap: What we will achieve

- Strong science to enable delivery of forecasts
- Delivery of more products and services building on existing NOAA and partner capacity
- Delivery of more consistent, efficient, reliable, and national forecasts (tailored to region-specific needs)
NOAA Ecological Forecasting Roadmap: Governance and Strategy

NOAA ECOLOGICAL FORECASTING STRATEGIC GOALS FOR 2015-2019

- **CONSTITUENT PRIORITIES**
  - Identify evolving forecast priorities driven by constituency needs and requirements.

- **RESEARCH TO APPLICATIONS (R2A)**
  - Successfully transition forecasts from research to applications.

- **NOAA FORECAST PRODUCTS & SERVICES**
  - Deliver a targeted ecological forecast portfolio aligned with national, regional and local needs.

- **NATIONAL INFRASTRUCTURE**
  - Evolve NOAA’s and non-Federal infrastructure, technology, people, processes and systems to support ecological forecasting.

- **GOVERNANCE & MANAGEMENT**
  - Institutionalize ecological forecasting as a sustainable cross-NOAA Program and priority.

EF Executive Steering Committee

- EF Portfolio Manager
  - Allison Allen, (NOAA)

- Teams:
  - HAB Team
  - Hypoxia Team
  - Pathogens Team
  - Species Distribution Team
  - Infrastructure Team
Forecasts Under Development

**HAB:**
- West Florida Shelf (operational)
- Texas (operational)
- Lake Erie (demo/experimental)
- Gulf of Maine (demo/experimental)
- Puget Sound (demo/experimental)
- Washington Coast (demo/experimental)
- California (future)
- Chesapeake Bay (future)

**Hypoxia:**
- Gulf of Mexico (demo/experimental)
- Chesapeake Bay (demo/experimental)
- Puget Sound (demo/experimental)
- Great Lakes (future)

**Pathogens:**
- Chesapeake Bay (demo/experimental)
- Delaware Bay (demo/experimental)
- Tampa Bay (demo/experimental)
- Gulf of Mexico (demo/experimental)
- Pacific Northwest (future)
EFR HAB Goals

- Develop a standardized and modular data integration for analysis, production and dissemination of HAB forecasts on a national scale
- Ensure maintenance of existing operational HAB Forecasts, and improve through validation and refinement;
- Transition existing HAB forecasts from R&D and demo phases to operations;
- Build national infrastructure to support HAB forecast system, including advancing HAB detection capabilities
Status of HAB Forecasts

- Eastern Gulf of Mexico (FL): operational since 2004 (semi-weekly)
- Western Gulf of Mexico (TX): operational since 2010 (semi-weekly)
- Gulf of Maine: weekly forecasts since 2005 (transition phase)
  - seasonal since 2008 (transition phase)
- Lake Erie: weekly forecasts since 2009 (demonstration phase)
  - seasonal since 2012 (demonstration phase)
- Pacific Northwest: R&D, forecasts 2009-2012
- California: R&D
- Chesapeake Bay: R&D
- Puget Sound: R&D
- Other regions: Alaska, Caribbean
HAB National Strategy

Vision - national operational forecast network

Within 5 years:

- Operational forecasts in Gulf of Maine, Gulf of Mexico (FL, TX), Chesapeake Bay, Lake Erie, PNW, California;

- Progress towards establishing operational systems in NY (Long Island Sound), Alaska, Caribbean, other regions

- Capacity for National Forecast and Early Warning for Event Response to HABs (FEWER HABs)
Hypoxia Team Overview

- By far the most significant and pervasive pollution-related impact and threat to coastal habitats and fisheries

- Harmful Algal and Hypoxia Research and Control Act puts NOAA in charge of the only National research programs for Hypoxia
  - Monitoring/observing
  - Causes
  - Impacts

- National hypoxia report led by NOAA - more than 300 (almost 50%) coastal systems impacted and trending upward

- There is a great demand for Accurate, Accessible and Actionable (AAA) forecasts at the ecosystem scale to drive costly management decisions
Management Information Needs for Decisionmaking

Model R & D, Observations, Data Assembly

Model Operationalization

Synthesis/Analysis of Model Output for User Community

Incorporation of Model Output into Management Decisions

Response of Ecosystem

Adaptive Ecosystem Management Cycle (~5-7 yr interval)

New focal point for capturing outputs of R&D efforts; “Concept of Operations” for scenario-based forecasts a work in progress.
Gulf of Mexico Hypoxia Activities and Needs

● **Underway:**
  ● Statistical/Empirical models for long-term scenario guidance for Hypoxia Task Force and seasonal forecasts
  ● 3D time-variable deterministic models

● **Near-term Needs:**
  ● Statistical/empirical models (and obs); transition to operations starting in 2015
  ● Support for mid-summer observations moving from part of a research project to more dedicated long-term funding with partners
  ● Operational observations/monitoring
  ● Integration of coastal and hydrologic models

● **Longer-term Needs:**
  ● Revisit observation plan needs to be revisited to match model requirements
  ● More robust measurement of the hypoxic zone area metric requires more spatial and temporal resolution in observations
Pathogens Team Overview

- Vibrio guidance models and predictive tools for recreational waters and shellfish
- Region to Nation approach - Chesapeake, Delaware, Tampa Bays, and Gulf of Mexico

FY15 Activities:

- Stakeholder engagement
  - Refine and prioritize needs and work plans regionally
  - Transition to new regions (Puget Sound, Northeast Atl.)
- Transition to operations
  - Conops plan, skill assessment, user defined products
  - Chesapeake Bay Pilot
- FDA/NOAA Collaborative Activities
  - Implementation of risk assessment models (harvest and time -temp)
  - Validation and improvement where needed (observations)
- Vv in surface waters (probability of occurrence, Chesapeake and DE Bays)
- Vp in oysters (FDA risk assessment models, Gulf, Tampa, Chesapeake, DE)
- 5 previous days and 48 hr predictions
NOAA Habitat Science Needs

• Foundational Information
  • surveying, mapping, identification, monitoring trends

• Habitat Usage Information
  • connections, habitat linkages to LMR, stock assessments, species distributions

• Ecosystem Services Valuation
  • identification, social valuation, conservation and restoration planning

• Climate change effects
  • assessing, predicting impacts on habitat, resilience to climate change
Why Produce Ecoforecast for Habitat & Species Distributions?

I. Identify priority habitat restoration areas based on higher probability of success (e.g., resiliency)

II. Forecast and understand species responses to climatic changes (e.g. increased water temps; changes in salinities)

III. Forecast gain/losses in ecosystem services provided by habitat and animals (e.g., coastal protection)

IV. Forecast ecological hotspots for protected species

V. Define & evaluate survey design (e.g., adaptive sampling)
Biogeographic Assessment Framework: In Support of Offshore Planning

Data synthesis & modeling to support renewable energy planning for New York

A biogeographic assessment to support the New York Dep. of State in evaluating potential risks to vulnerable habitats and species from proposed renewable energy installations

Interaction with resource managers early, and ensuring manager satisfaction with products are keys to transition success
Infrastructure and Process Team

Operational Ecological Forecasting Framework

Environmental Forecasts
Operational (may be NOAA-owned or hybrids of NOAA and other agency forecasts)

Model Guidance
(input from R&D and Test Beds)
- Hydrodynamic
- Meteorological
- Biological
- Geochemical
- Hydrologic
- Socio-economic

Observations
Remote
In situ
Socio-economic

Data storage and access

Generation
Display, Analysis & Creation

Verification & Skill Assessment
Tools and Protocols (input from R&D and Test Beds)

Output Dissemination
Tools and Protocols (input from R&D and Test Beds)

Archive

Outreach
- Media
- Education
- Training
- Help Desk/FAQ

Value-Added Services
- Warnings & Advisories
- IEA
- Socio-Economic Implications
- Living marine resource projections

Prototype/Test Beds

Users & Stakeholders
Public & Private, Local, State & Federal Gov., NGOs, Academia

R & D

Input: Obs & Modeling

Storage Data Mgmt

Generation, QC/QA, Dissemination & Archive

Services & Products

Uses & Users
Example of Major Tasks and Accomplishments

Document requirements and components of a common national EF infrastructure

- Recommend best practices for transitioning EF products and services to operations and applications
- Evaluate and recommend Environmental Processing System(s) for ecological forecasting
- Review NOAA’s modeling plan for coverage and forecast variables
- Compile best practices for efficient and robust data management and access
- Develop skill assessment tools for operational ecological forecasts
- Develop protocol for supporting scenario-based modeling and connecting ecological forecasts to ecosystem-based management approaches
Opportunities for Collaboration

- Observations and Modeling gaps
- Transitioning mature research
- Forecast Development and Delivery
- Outreach
- Ongoing Discussion
  - Discussion of priorities and key activities
  - Identify specific areas of collaboration
  - Integrate partnership opportunities into the revised EFR Action Plan
Questions?

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EFRTeamLeads@noaa.gov
NOAA EFR & the GCOOS Build-out Plan

Stephanie Watson
Gulf of Mexico Coastal Ocean Observing System Regional Association (GCOOS-RA)
The GCOOS Build-out Plan

- 631 workshop contributors
- From 297 organizations
- 90 plans reviewed
- 50 additional contributors
- 19 elements in the BOP
- 13 subject matter expert writing teams
## Good Match

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Water Quality, Pathogens & Hypoxia Monitoring  
Current and Planned Examples

- **Current**: Integrated Water Quality Monitoring Network (IWQN) 3 workshops and pilot; beach WQ monitoring; Nutrient and Hypoxia Data Portal

- **Planned**: Further implementation of the IWQN; coastal, estuarine, and shelf monitoring from GOMA/GCOOS Gulf Monitoring Network design; Further development of Nutrient and Hypoxia Data Portal; expanded beach WQ monitoring
HAB Integrated Observing System
Current and Planned Examples

• **Current:** With GOMA - 3 HABIOS workshops and plan, HABS monitoring via Cytobot (Lisa Campbell, TAMU) & AUVs (Mote and USF)

• **Planned:** Further implementation HABIOS
Species/Living Marine Resources
Current and Planned Examples

• **Current:** Data server for Comparative Assessment of Gulf Estuarine Systems (CAGES) data, Integrated Acoustic Tagging Network for the Gulf, animation of invasive lionfish distribution expansion in the Gulf

• **Planned:** continuous data of salinity, temperature, currents, chlorophyll (estuaries to deep sea); glider network for salinity and temperature profiles and passive acoustics; aerial surveys of marine mammals; expanded plankton monitoring; mobile radar for bird monitoring, MBON
Habitats
Current and Planned Examples

- **Current:** Support for surface current monitoring (USM)

- **Planned:** Satellite imagery and LIDAR for identifying shoreline and nearshore habitats and their distributions, including mangroves, salt marsh, sea grass; sidescan sonar imagery and 3D digital elevation model data; Multi-beam bathymetry for deeper water habitats
Sea-Level Change
Current and Planned Examples

- **Current:** Texas Coastal Ocean Observation Network (including hurricane-hardened stations), COMPS, other National Water Level Observation Network (NWLON) Sites, Access via GCOOS Data Portal and other sites.

- **Planned:** fill gaps in NWLON, add precision GPS-CORS capabilities, include offshore sites, add more hurricane-hardened stations.
Wave Energy
Current and Planned Examples

- **Current:** surface currents and waves network includes:
  - HFR
  - NDBC stations
  - WAVCIS
  - and more

- **Planned:** Expanded HFR network, expanded wave monitoring/modeling
Ocean Acidification
Current and Planned Examples

- **Current**: USM/GCOOS/NOAA/Liquid Robotics Wave Glider ocean acidification experiment (2013), Flower Garden Banks National Marine Sanctuary Sentinel Studies (BOEM/Shell, FGBNMS, TAMU, others)

- **Planned**: Ecosystem modeling; expanded monitoring for impacts to corals, shellfish, and plankton; expanded use of autonomous vehicles and fixed buoys
• GCOOS BOP
  – Includes many of the NOAA EFR topics
  – Lists needs and recommendations for each topic
  – Includes estimated costs for enhancements to existing Gulf observing system
• GCOOS-RA can serve as a liaison to Gulf stakeholders to further identify NOAA EFR products and services
• Collaborative opportunities for demonstration products and services?

Stephanie.Watson@gcoos.org
Progress Toward Operational Hypoxia Forecasting
Gulf of Mexico Coastal Ocean Observing System Webinar

NGOMEX09: Integrated Ecosystem Modeling of the Causes of Hypoxia
Forecast Modeling Efforts

Gene Turner, Louisiana State University
Don Scavia, University of Michigan
Dan Obenour, University of Michigan
Mary Anne Evans, University of Michigan
Anna M. Michalak, University of Michigan
Dubravko Justić, Louisiana State University (Coupled dynamic FVCOM and Water Quality Model)
Nancy Rabalais, Louisiana Universities Marine Consortium
Bottom-Water Dissolved Oxygen < 2 mg l⁻¹
July 22 – August 1, 2015
Predicting Hypoxia in summer (nitrate-N flux in May, year)

Similar analyses with Q, PO4, TP, TN, Si, various Si:N:P ratios indicate that N, in the form of NO$_3$+NO$_2$, is the major driving factor influencing the size of hypoxia on the Louisiana shelf.
Modified from Turner et al. 2012: has the more recent data from 2000 to 2012 and a fit of 0.94, and without the 'year' term. The prediction of the 2010 was 99% of the actual observed that year.
NO\textsubscript{x} Load Model
(\textit{Turner et al. 2012})

![Graph showing the relationship between observed and predicted area for NO\textsubscript{x} load model with a 1:1 line and a data point marked for 2010.]
No evidence of oil effect

No evidence of 2010 differing from 1989-2010

Rabalais et al. unpubl. data
Geostatistical modeling framework to estimate the hypoxic extent (1985–2011). Instead of a traditional interpolation-based approach, they used a simulation-based approach that yielded more robust extent estimates and quantified uncertainty. The modeling framework also makes use of covariate information (i.e., trend variables such as depth and spatial position), to reduce estimation uncertainty. Furthermore, adjustments are made to account for observational bias resulting from the use of different sampling instruments in different years.

**N.B. for 27 years the average difference in Obenour and corrected LUMCON is 1.25%**
Scavia et al. is an adaptation of the Streeter-Phelps river model that simulates oxygen concentration downstream from point sources of organic matter loads based on mass balance equations for oxygen-consuming organic matter, in oxygen equivalents (i.e., biochemical oxygen demand, BOD), and dissolved oxygen concentration (DO). The use of Bayesian calibration allows all parameters to be represented as probability distributions, thus ensuring propagation and quantification of uncertainty.

Comparison of modeled and measured subpycnocline respiration rates. Case 3 applies different weather categories as solid black and red lines. SD reflects loading variability and model uncertainty.
Modeled ◆ and observed ■. Black is model output for ‘normal’ years, ◆ for storm years, and ◇ for windy years.
Curves of hypoxia area as a function of May TN load. Observed areas are green circles with 95% CI; blue storm years, red wind years. Best estimate curve solid black line. 95% CI for mean response for normal years is represented by dotted black lines. Forecast uncertainty dotted black lines. 95% CI for individual annual responses represented by dashed black lines, and as dashed gray lines for unknown weather. Red lines are the May TN load for 5 year running average hypoxic area, and the load required to achieve 5,000 km².
June 2014 Forecast for Mid-Summer Hypoxia Area

**Turner:**
14,785 km\(^2\). The 95% confidence interval is 12,078 and 17,378 km\(^2\).

**Scavia:**
14,000 km\(^2\). 95% credible interval, 8,000 to 20,000.

**LUMCON observed estimate:**
13,080 square kilometers, and, YES there was some ‘storminess.’

Cannot predict tropical storm or hurricanes, cannot predict “storminess” or shifts in wind direction before or during the cruise. Useful for hindcasting or building parameters into models, but not for Ecological Forecasting.

The average size for the last five years is 14,352 km\(^2\) and is three times larger than the environmental target (5,000 km\(^2\)) approved by a federal/state task force in 2001 and maintained by the same task force in 2008.
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Ecological Forecast Roadmap Webinar

Harmful Algal Blooms
Barb Kirkpatrick, EdD, RRT
GCOOS/GOMA Primer on HABs

http://gcoos.tamu.edu/documents/HabPrimer-10162013.pdf

A Primer on Gulf of Mexico HARMFUL ALGAL BLOOMS

Common questions and answers for stakeholders, decision makers, coastal managers, and the education community.
Karenia brevis blooms

- Toxic aerosols cause respiratory illness
  - People with asthma/chronic resp. illness
  - 1 hour exposure- decrease pulmonary function and increased symptoms for 3-5 days
  - Increased emergency rooms visits for resp. illness

- Blooms are patchy
  - Beach impacts very different from beach to beach and day to day
Beach Conditions Reporting System

- Daily subjective reports from 33 Florida beaches
- Began with resp. irritation and dead fish on beach
- Added rip currents, surf conditions at request of users
- Feed data to NOAA COOPS
NOAA HAB Operational Conditions Reports

- Southwest Florida
- Northwest Florida
- East Florida
- Texas
Gulf of Mexico Harmful Algal Bloom Bulletin
Region: Southwest Florida
Monday, 17 October 2011
NOAA Ocean Service
NOAA Satellite and Information Service
NOAA National Weather Service
Last bulletin: Thursday, October 13, 2011

Conditions Report
A harmful algal bloom has been identified along- and offshore Charlotte and Lee counties. Patchy moderate impacts are possible alongshore Charlotte and northern Lee counties, and patchy very low impacts are possible alongshore central Lee County today through Tuesday, with more potential for impacts Wednesday, October 18. No impacts are expected elsewhere alongshore southwest Florida today through Wednesday. Reports of dead fish have been reported from areas alongshore southern Charlotte and northern Lee counties.

Analysis
A harmful algal bloom has been identified along- and offshore Charlotte and northern Lee counties. Recent sampling results show very low to low concentrations of *Karenia brevis* 3 miles west of Placida Harbor in Charlotte County. Low to medium concentrations were measured at Stump Pass and Bird Key in Charlotte County (FWRI; 10/12). Medium to high concentrations 4.8 to 20 miles west of Boca Grande, and low to high concentrations 4.8 to 13.5 miles west of Cayo Costa were reported in northern Lee County (FWRI; 10/11). Other samples in Lee County showed background to medium concentrations of *K. brevis* at Boca Grande, Boca Grande Pass, Pejuan Point, Redfish Pass, North Captiva Island, Captiva Island, Captiva Rocks, and Captiva Shallows (FWRI; 10/12, FWRI; 10/13). The bloom currently extends approximately 20 offshore and 15 miles alongshore of Charlotte and Lee counties where the greatest abundance of *K. brevis* is offshore Lee County. *K. brevis* was not detected in samples collected the week of October 14 alongshore of Pinellas, Hillsborough, Manatee, Sarasota and Collier counties of alongshore and offshore of the Florida Keys in Monroe County (FWRI; 10/10-10/14). Widespread fish kills both alongshore and offshore have been reported in association with this bloom in Sarasota, Charlotte, and Lee counties, with the most recent reported on October 14 from the Englewood area of Charlotte County and alongshore and offshore of Boca Grande in Lee County (FWRI; 10/14).

Recent MODIS imagery is partially obscured by clouds along- and offshore the southwest Florida coast from Manatee to Monroe counties and in the Florida Keys, limiting analysis (10/14). A feature of elevated to very high chlorophyll (>20 µg/L) remains visible along- and offshore the coast from southern Sarasota to Lee counties. Elevated chlorophyll at the coast may contain *K. brevis*, but could also be due to the non-toxic algal blooms that continue to be reported in several counties in southwest Florida (FWRI; 10/11-10/13).

Variable forecasted winds today through Tuesday will reduce the potential for impacts at the coast, with more potential for impacts on Wednesday.

-Burrows, Fenstermacher
NOAA HAB Operational Conditions Reports

• “Operational”
  • 7 days a week/365/yr
  • Same process regardless of analyst
  • Resolution- currently at the county level

• Now pushed to National Weather Service as part of the ‘weather ready nation’ initiative
“Every beach, Every day”

- NASA ROSES project- Stumpf and Kirkpatrick
- Improve forecast resolution to the beach level
- 3 yr project- starting Spring 2015
- More observations!
  - Cell phone microscope to assess *Karenia* cells in a sample (Litaker)
  - Dip stick for brevetoxin under development (Litaker)
Other supported GCOOS HAB efforts

• Imaging flow cytobot- Port Aransas, TX
• Glider missions for HAB tracking
Coastal Ocean Circulation Model Applications to \textit{K. brevis} HABs and Future Biological Additions

R.H. Weisberg  
Distinguished University Professor  
Physical Oceanography  
College of Marine Science  
University of South Florida

with

J. Walsh, J. Lenes and L. Zheng

GCOOS Ecoforecasting Webinar  
2/12/15

DISCLAIMER:  
The nowcast/forecast system and other data analyses are experimental products. No warranty is made, expressed or implied, regarding accuracy or suitability for any application. All rights reserved Univ. of So. Florida, College of Mar. Sci. – Ocean Circ. Group. Copyright Univ. of So. Florida, 2015.
West Florida Coastal Ocean Model (WFCOM)

Downscaling from the deep ocean, across the continental shelf and into the estuaries by nesting FVCOM into GOM HYCOM, including eight tidal constituents

What have we learned?
The coastal ocean (defined as the continental shelf and estuaries) is driven by a combination of deep ocean and local forcing.

What does it mean?
Accurate coastal ocean circulation modeling requires the nesting of unstructured and structured grid models.

How do we use it?
A daily, automated nowcast/forecast version of WFCOM is run at USF. A previous, smaller domain version is available via thredds server, and we are transitioning to the newer version. Model results are available through the NOAA GNOME online oceanographic data server (GOODS).
WFCOM Example of Accomplishment:
Why there was no K. brevis bloom on the WFS in 2010.

- A near shore *K. brevis* bloom requires upwelling, but too much upwelling (as occurred in 2010) inhibits bloom formation because inorganic nutrients upwelled across the shelf break favor diatoms over dinoflagellates.
- On this basis we successfully predicted that there would not be a major bloom in 2013 and that there would be one in 2014.
- A conclusion is that the ocean circulation physics and the organism biology each provide necessary conditions for bloom formation, but neither alone are sufficient conditions.
**WFCOM HAB Tracking Tool**

*K. brevis* 3.5 day trajectory forecast example for 10/24-28/2014 when cells were observed near the Charlotte Harbor estuary.

**Notes:**

- Surface trajectories are less useful than bottom trajectories because *K. brevis* delivery to the beach is via the bottom.
- Forecasts are limited by observations (black lines are trajectories without observations).


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**HAB forecasted trajectories at upper water column from 10/24/2014 through 10/28/2014**

**HAB forecasted trajectories at lower water column from 10/24/2014 through 10/28/2014**

**K. brevis** Cell Category
- Present
- Very low
- Low
- Medium
- High
- Drifter
Further Downscaling of WFCOM for individual Estuaries

Additional downscaling for flows through inlets, shipping channels and other narrow constrictions in estuaries.

What have we learned?
Connectivity between shelf and estuary waters may require even higher resolution. For this we can nest an estuary specific model into WFCOM, such as the Tampa Bay, Sarasota Bay and the ICWW example shown to the right, including sub-regional enlargements.

What does it mean?
We can now model how contaminants such as spilled oil may flow within an estuary system.

How do we use it?
A Tampa Bay version (to 20 m resolution) exists, and similar versions may be established for any eastern GOM estuary. These can be automated and served on NOAA GOODS. Presently, only the lower resolution WFCOM (to 150 m in Tampa Bay and Charlotte Harbor) is served on GOODS.
Other Recent WFCOM Applications

What else have we learned?
- How *gag grouper* larvae get from offshore spawning to near shore settlement.
- Why fish lesions were found on WFS reef fish.
- Why spotted sea trout prefer spawning at a certain Tampa Bay location.

What does it mean?
- Just about anything of an ecological nature in the coastal ocean depends on the circulation.
- We can now begin to explain (and predict) *K. brevis* inter-annual variability.
- We can now begin to explain (and predict) inter-annual variability in *gag* recruitment success.

How do we use it?
- As performed above, scientifically posed questions may be addressed using a combination of coastal ocean observations and properly chosen models such as WFCOM.
- But this is not possible without sustained funding for coordinated programs of observing and modeling.
NEXT STEPS: Add Biology Tailored to *K. brevis* HABSIM Submodels

- **Biological** – phytoplankton, zooplankton, bacteria, fish
- **Chemical** – macro and micro nutrients (C, N, P, Si, Fe)
- **Atmospheric** – Saharan dust (Fe) as wet and dry deposition
- **Benthic** – benthic diatoms, regeneration of nutrients

(Lenes et al., 2012; 2013)
Currently moving HABSIM into the Generalized Biological Model of FVCOM

10 state variables have been moved and are being tested to date

Allows for ‘online’ 3-D simulations to maximize computational efficiency and to minimize error

For WFCOM we are transitioning from the original model domain for N/Fs and HAB tracking to the expanded model domain.
Recent Publication Examples


Vibrio Nowcasting for the Northern Gulf of Mexico

D. Jay Grimes

The University of Southern Mississippi
Gulf Coast Research Laboratory
Ocean Springs, MS 39564

GCOOS Webinar
February 11, 2015
What are the Health Risks from Marine Vibrios?

The “big three”

- **Vibrio cholerae**
  - Cholera
  - Wound infections
  - Gastroenteritis

- **Vibrio vulnificus**
  - Primary septicemia^a
  - Wound infections^b
  - Gastroenteritis??

- **Vibrio parahaemolyticus**
  - Gastroenteritis
  - Wound infections

(Over 118 *Vibrio* species have been described, 11 of which are human pathogens.)
RS versus \textit{in situ} SST correlated

Predicted $V_p$ vs. observed $V_p$ correlated

Mean $\log_{10} V. parahaemolyticus/g = -0.84 + 0.11 \times \text{SST}$

$r = 0.692$ for IS and $r = 0.673$ for RS

(Phillips et al., 2007, \textit{J. Food Prot.} 70:879-884, Figure 1)
Recent Maps that Include Salinity

average $\log(Vp/g) = -2.05 + 0.097T_{WATER} + 0.2SAL - 0.0055SAL^2$
Website

• Mitigation scenarios will show the effect of icing or refrigerating the oysters
  – within 5 hours
  – within 10 hours

• The current VPCP rule states that oysters intended for raw consumption must be iced or refrigerated within 5 h of harvest, June – September

• As the cooling continues, the numbers are reduced

• VVCP rules effective 2010 and will be more stringent

http://www.eol.ucar.edu/projects/ohhi/vibrio/
Pathogen Forecasting

Monitoring of Alabama’s Estuarine and Marine Waters

by State Regulatory Agencies
No actual pathogens, such as, norovirus are used for water quality monitoring.

EPA uses enterococcus as the marine indicator of fecal pollution and water quality.

FDA uses fecal coliforms as the shellfish growing area indicators of water quality.

Alternate indicators have been explored to track sources of pollution, but there are many ramifications that must be considered before regular use.
Monitoring Agencies

ADEM
Alabama Department of Environmental Management

ADPH
Alabama Department of Public Health

GEOLOGICAL SURVEY OF ALABAMA
Founded 1848
Monitoring Agencies

- Coastal Water Monitoring Program
- Alabama Nonpoint Pollution Control Program
- Coastal Alabama Recreational Waters Program (BEACH)
- EPA National Coastal Condition Assessment
Monitoring Agencies

Shellfish Growing Waters for compliance with National Shellfish Sanitation Program
Monitoring Agencies

Some monitoring and event response in estuaries for biological indicators including fecal coliforms.
Areas of Interest for Future Consideration

• Continuous / real time monitoring data with QC / QA prior to use by consumers in regulatory agencies

• More, strategically placed sensors that represent sentinel sites, such as shellfish growing areas.

• Support the development and use of computer models that will assist in predicting movement and areas of impact that pathogens/indicators may have during coastal events.
Areas of Interest for Future Consideration

• Establish baseline hydrological parameters and monitoring efforts for the prediction of pathogens, indigenous vibrios, and fecal indicators at shellfish restoration projects. Standardized methods and data reporting are essential.
  
  • Parameters of interest would be water elevation, water velocity/direction, wind speed, solar rad, air temp, water temp, pH, salinity, dissolved oxygen, and rainfall.
  • Additional parameters are chlorophyll-a, turbidity, nitrates
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Habitat

Fish and Wildlife Conservation Commission – Fish and Wildlife Research Institute

- Seagrass
  - Seagrass Integrated mapping and Monitoring (SIMM) Program

- Corals
  - Coral Reef Evaluation and Monitoring Project (CREMP)

- Coastal Habitat Projects
  - Coastal Habitats Independent Mapping and Monitoring Program (CHIMMP)
    - [http://ocean.floridamarine.org/CHIMMP/](http://ocean.floridamarine.org/CHIMMP/)

- Mangrove Forests’ Response to Sea-Level Rise and Climate Change

- Harmful Algal Blooms Reports

- Geospatial Assessment of Marine Ecosystems
  - Metadata Mapper

South Atlantic Fisheries Management Council

- [http://ocean.floridamarine.org/safmc_dashboard/](http://ocean.floridamarine.org/safmc_dashboard/) links to Managed areas, Essential Fish Habitat and SAFMC Habitat and Ecosystem Atlas projects

Gulf of Mexico Alliance

- [http://goma-projects.blueurchin.com/](http://goma-projects.blueurchin.com/) DeepWater Horizon Project Tracker (under development, sample data only)
- [http://research.gulfresearchinitiative.org/](http://research.gulfresearchinitiative.org/)
- [https://data.gulfresearchinitiative.org/](https://data.gulfresearchinitiative.org/)

NOAA