Hypoxia Forecast Models in Coastal Waters used to Inform Nutrient Management

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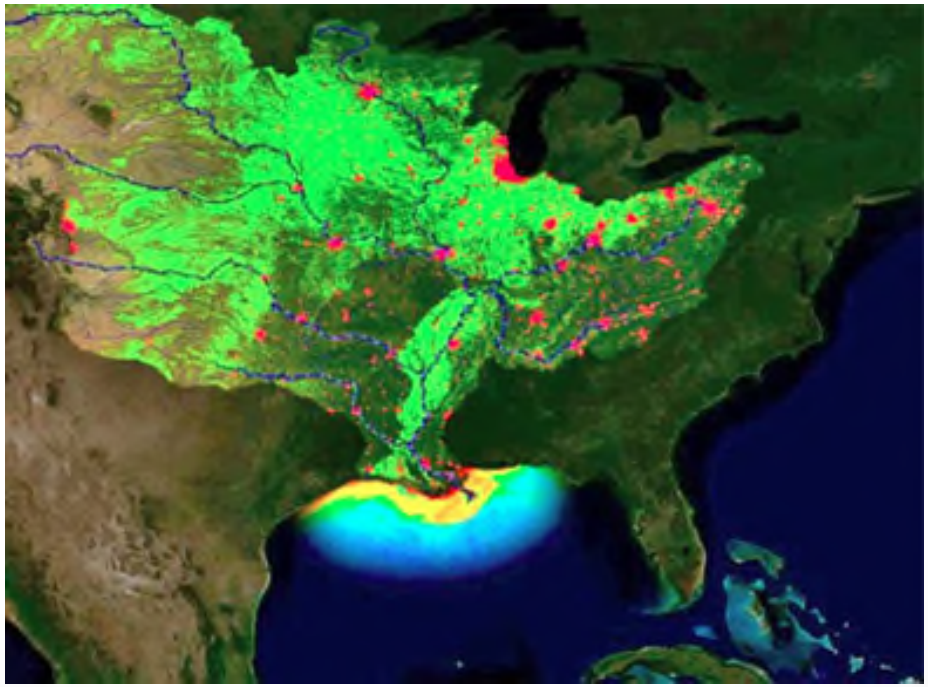
NOAA/NOS

National Centers for Coastal Ocean Science



National Monitoring Conference

29 April 2014; Cincinnati, Ohio

Nutrient Pollution Can Lead to Hypoxia

Nutrient Pollution

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Algal Blooms

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Bacterial Decay

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Oxygen Depletion (Hypoxia)

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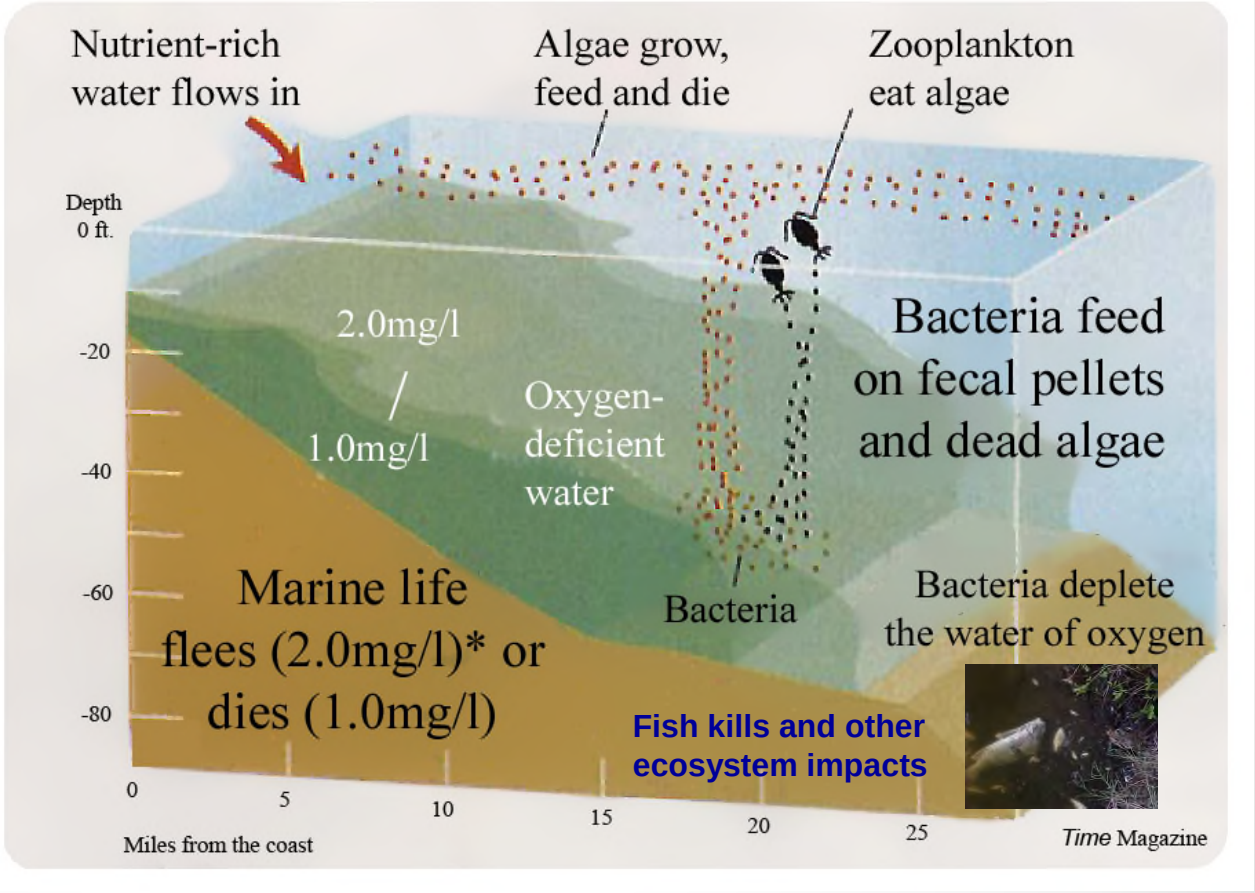


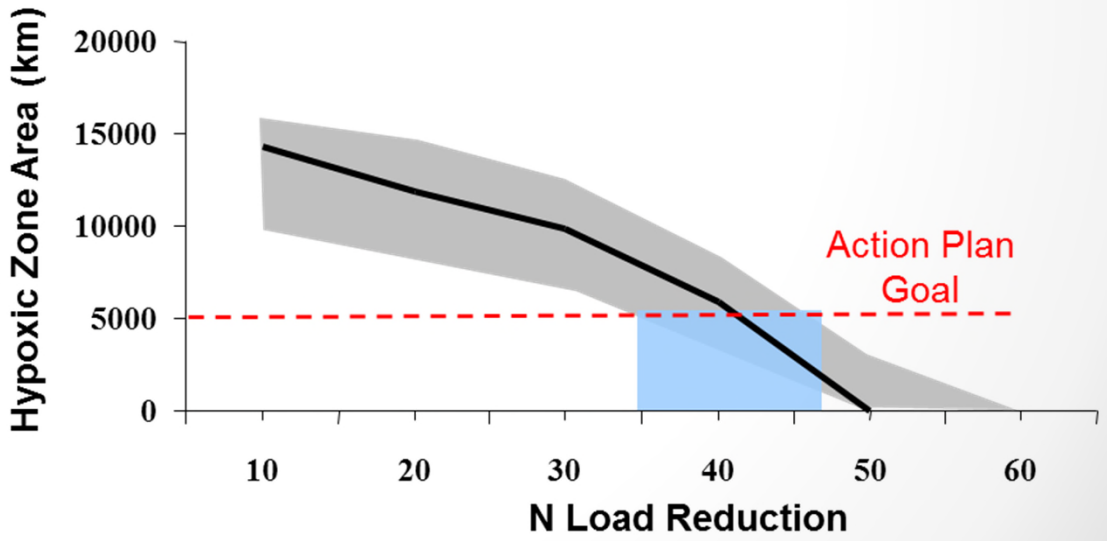
Fish and shellfish mortality, habitat loss, reproductive stress, population reductions

Scenario Forecast Models

Predictive models used to:

- **inform management goal-setting,**
- **monitor progress of management actions, and**
- **evaluate the effectiveness of alternative management scenarios**

Model ensemble suggests a 35 - 45% reduction in N loads to meet Gulf Hypoxia Action Plan Goal



Scavia et al

Legislatively Mandated Hypoxia Programs

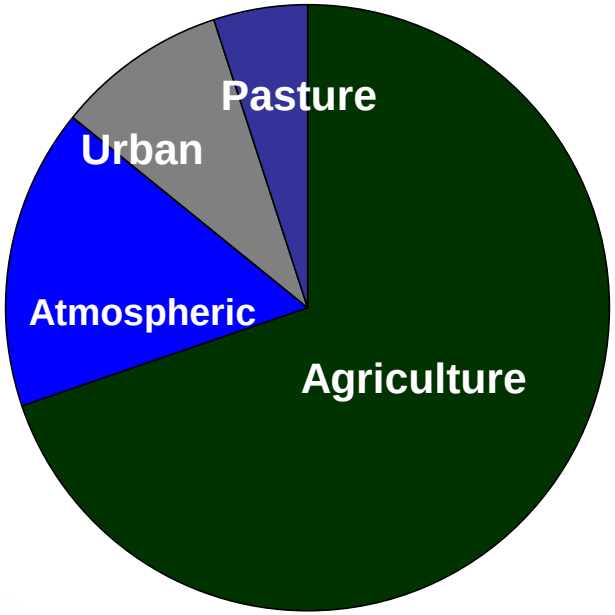
- **Coastal Hypoxia Research Program (CHRP)**
- **Northern Gulf of Mexico Ecosystems and Hypoxia Assessment Program (NGOMEX)**
  - **Develop the capability to predict hypoxia in response to anthropogenic and climatic stress, and to evaluate the ecological, economic, and social impacts;**
  - **Provide results and modeling tools to coastal managers to assess alternative strategies for preventing, controlling, or mitigating the impacts of hypoxia on coastal ecosystems.**

Sources of Nutrient Pollution Vary by Region

Gulf of Mexico

% Contribution to Nitrogen Pollution

Greatest source: Agriculture



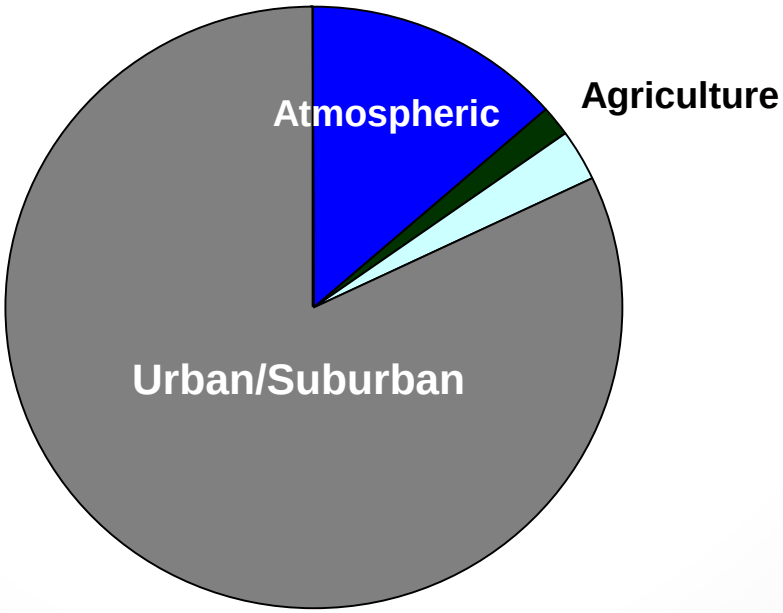
Source: Alexander et al. (2008)

Sources of Nutrient Pollution Vary by Region

Narragansett Bay

% Contribution to Nitrogen Pollution

Greatest Source: Urban areas



Source: Nixon et al. (2008), Moore et al. (2004)

Narragansett Bay

Lead PI: Dan Codiga/Candace Oviatt (URI)

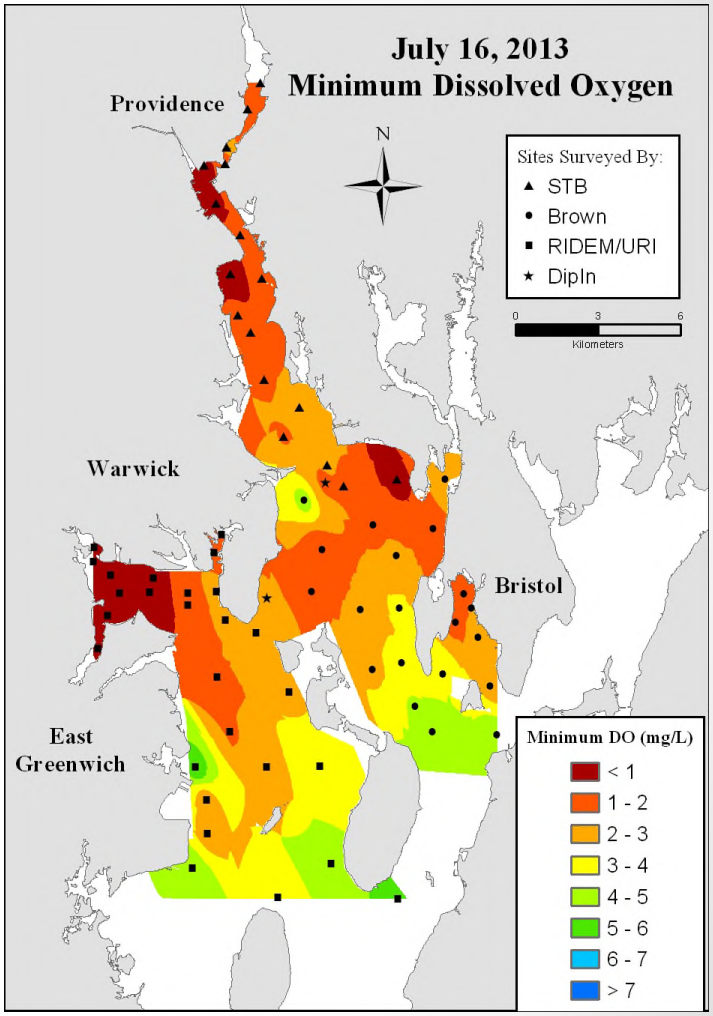
Partners: Brown U; U Conn; VIMS; RI DEM; Narr Bay Estuary Program, RI Rivers, Bays, & Watersheds Coordination Team; EPA

Models:

- **Empirical hindcast/forecast statistical**
- **ROMS Hydrodynamic**
- **Bio/Phys Ecological GEM (Gross Exchange Matrix)**
- **Ecological OBM (Officer Box Model)**

Management Need:

- **In 2003, an intensive hypoxia event in NB prompted a new state law to impose N limits on wastewater treatment facilities;**
- **Models used to evaluate effectiveness of N reductions in mitigating hypoxia and its ecological impacts, and to inform future nutrient reduction targets.**



Source: Warren Prell (Brown U)

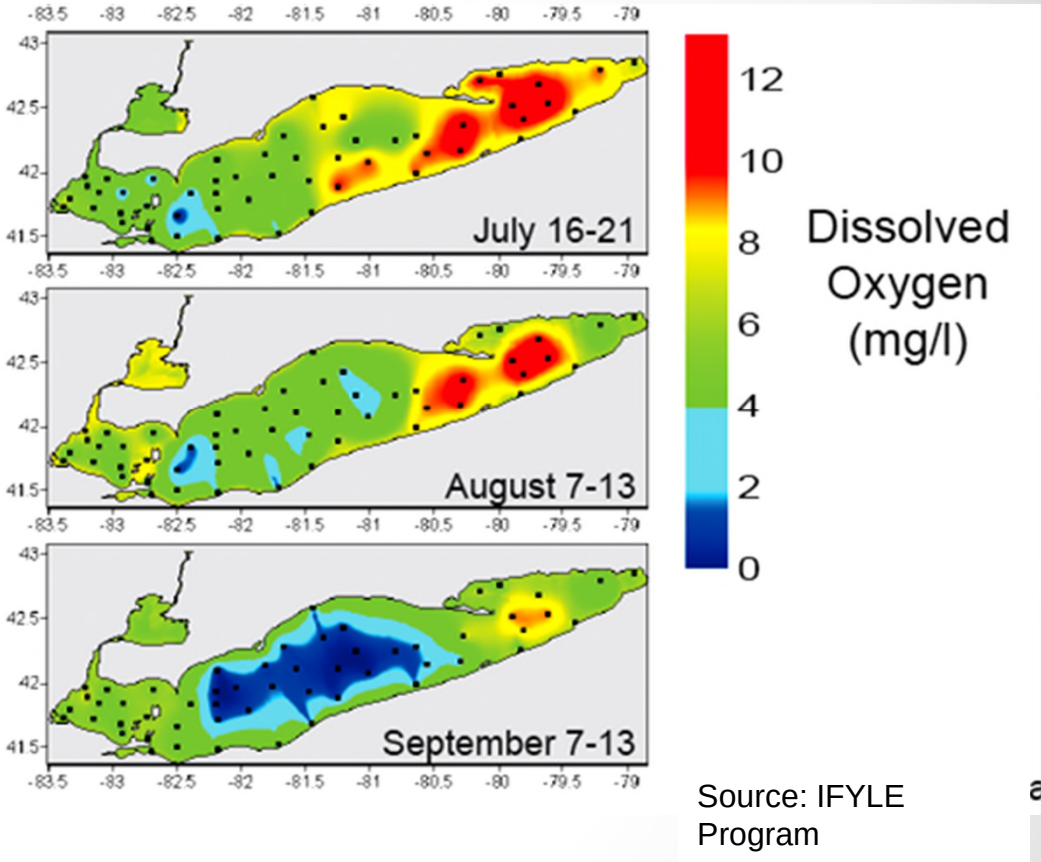
Lake Erie

Lead PI: Don Scavia (U. Mich) ECOFOR Program

Partners: Heidelberg U; NOAA; W Mich U; LimnoTech; Purdue; Ohio St; E2 Inc

Models:

- **Statistical models**
- **Hydrodynamic - SWAT (Soil & Water Assessment Tool)**
- **DLBRM (Distributed Large Basin Runoff Model)**
- **Several ecological models**



Source: IFYLE Program

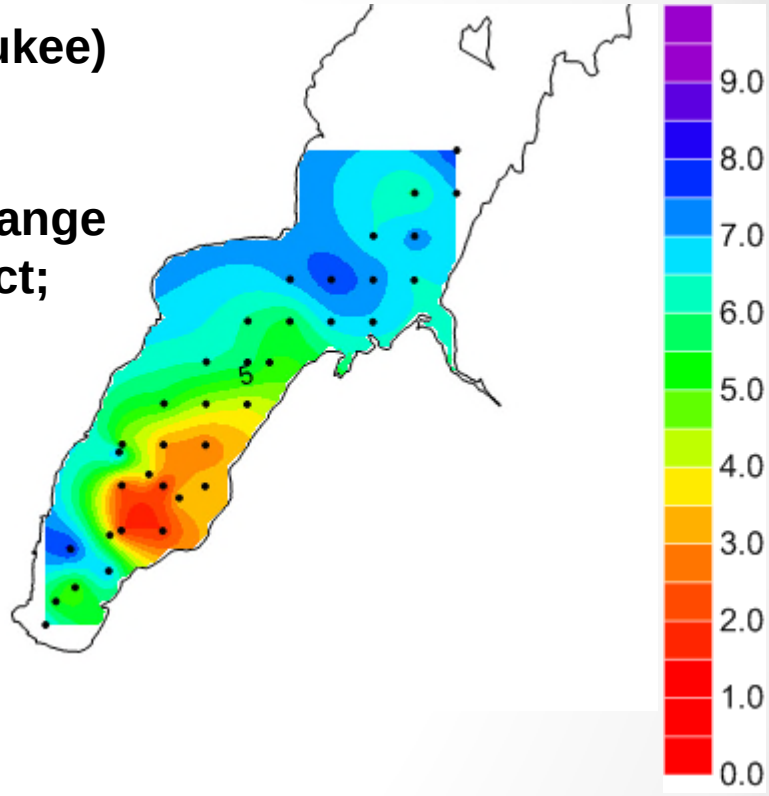
Management Need:

- **Inform regulators of phosphorus reduction targets needed for hypoxia mitigation;**
- **Model forecasts used by Lake Erie fisheries managers to guide fisheries policies in response to anticipated hypoxia impacts.**

Green Bay

Lead PI: Val Klump (U. Wisconsin – Milwaukee)

Partners: UW-Green Bay; UW-Madison Ctr Climate Res; Wisc Initiative on Climate Change Impacts; GB Metropolitan Sewerage District; WDNR; EPA; USGS



Models:

- **FVCOM Hydrodynamic coupled to biogeochemical model**
- **SWAT Watershed**
- **Downscaled global climate models**

Management Need:

- **Models assessing effectiveness of current P reduction BMPs, and providing guidance for future nutrient reduction targets taking into account watershed land use and climate change.**

Chesapeake Bay & Delaware Inland Bays

Lead PI: Mike Kemp (U. Maryland Center for Environmental Sciences

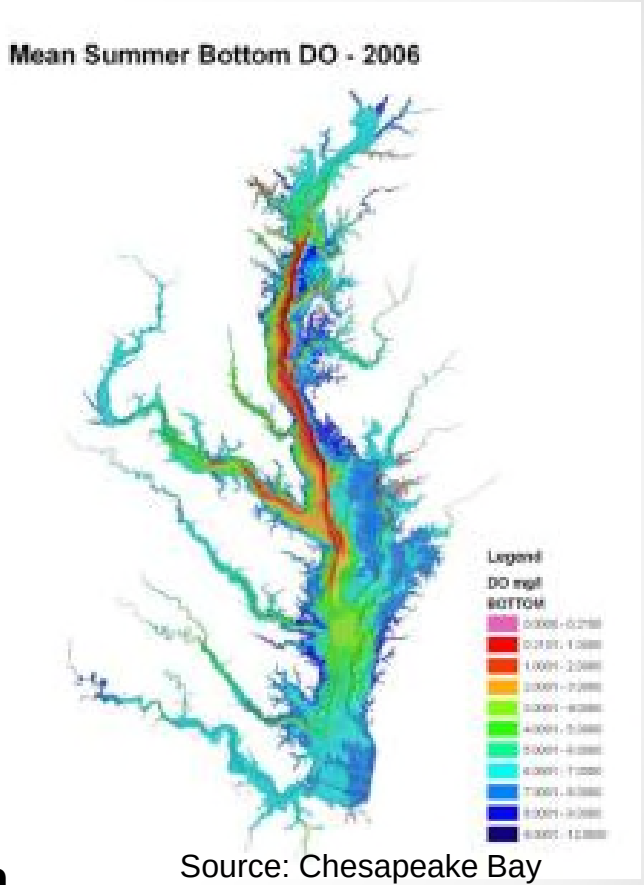
Partners: U Del; Dalhousie U

Models:

- **Multivariate regression models**
- **Statistical models**
- **ROMS hydrodynamic coupled to RCA biogeochemical model**
- **Sediment Flux Model (SFM)**
- **3D Habitat Volume Model**

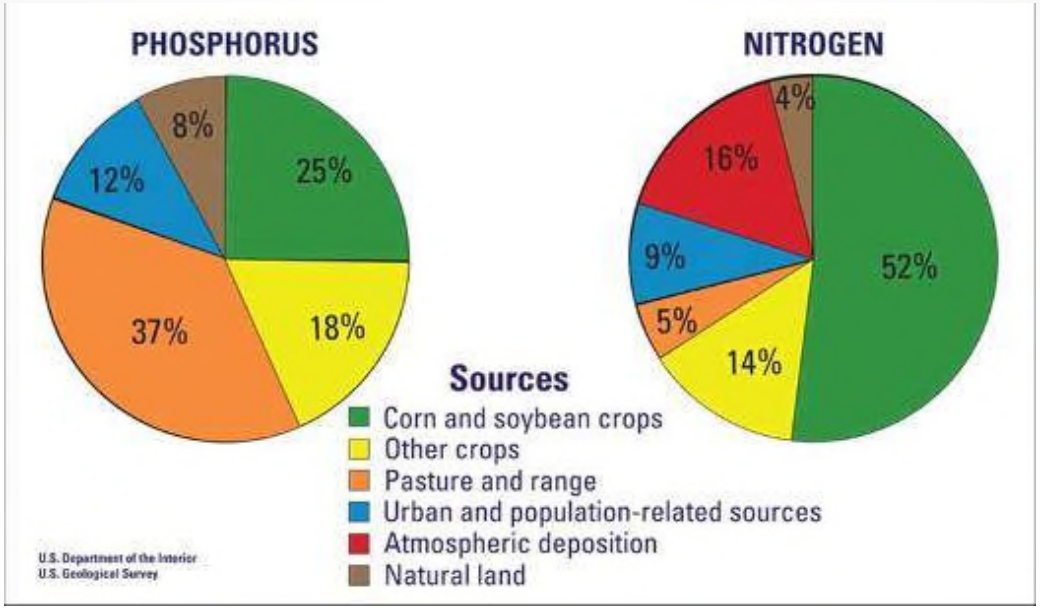
Management Need:

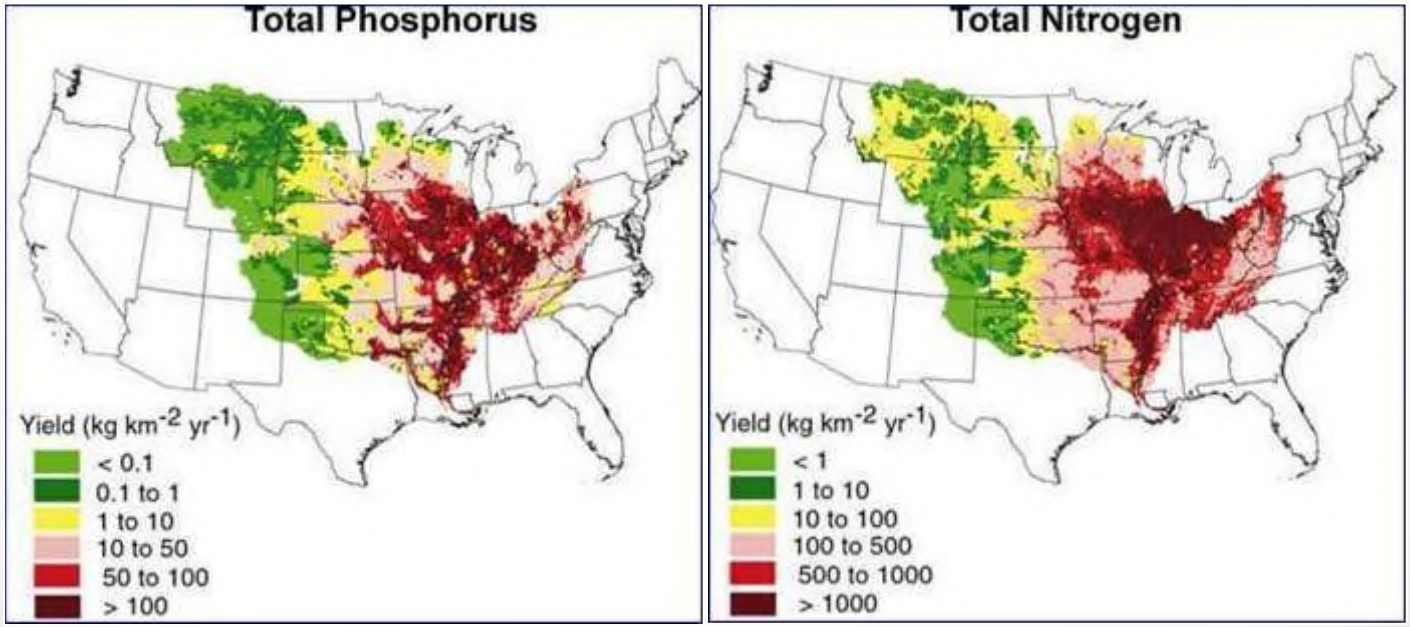
- **Determining quantitative relationship between nutrient reductions and hypoxia volume;**
- **Informing future nutrient reduction targets**



Source: Chesapeake Bay Program

Sources of Nutrients Delivered to Gulf

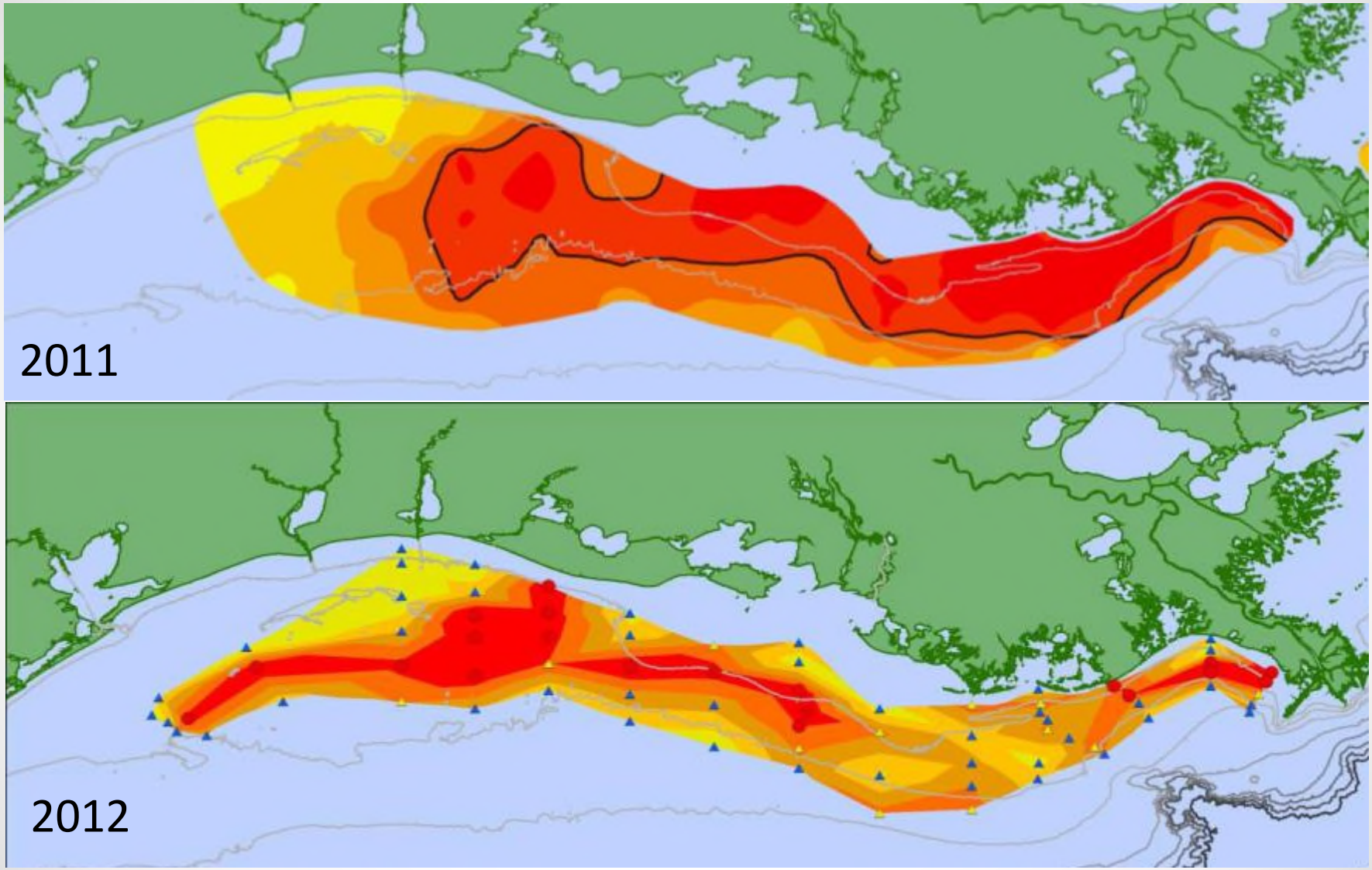




Alexander et al. 2008

http://water.usgs.gov/nawqa/sparrow/gulf_findings/

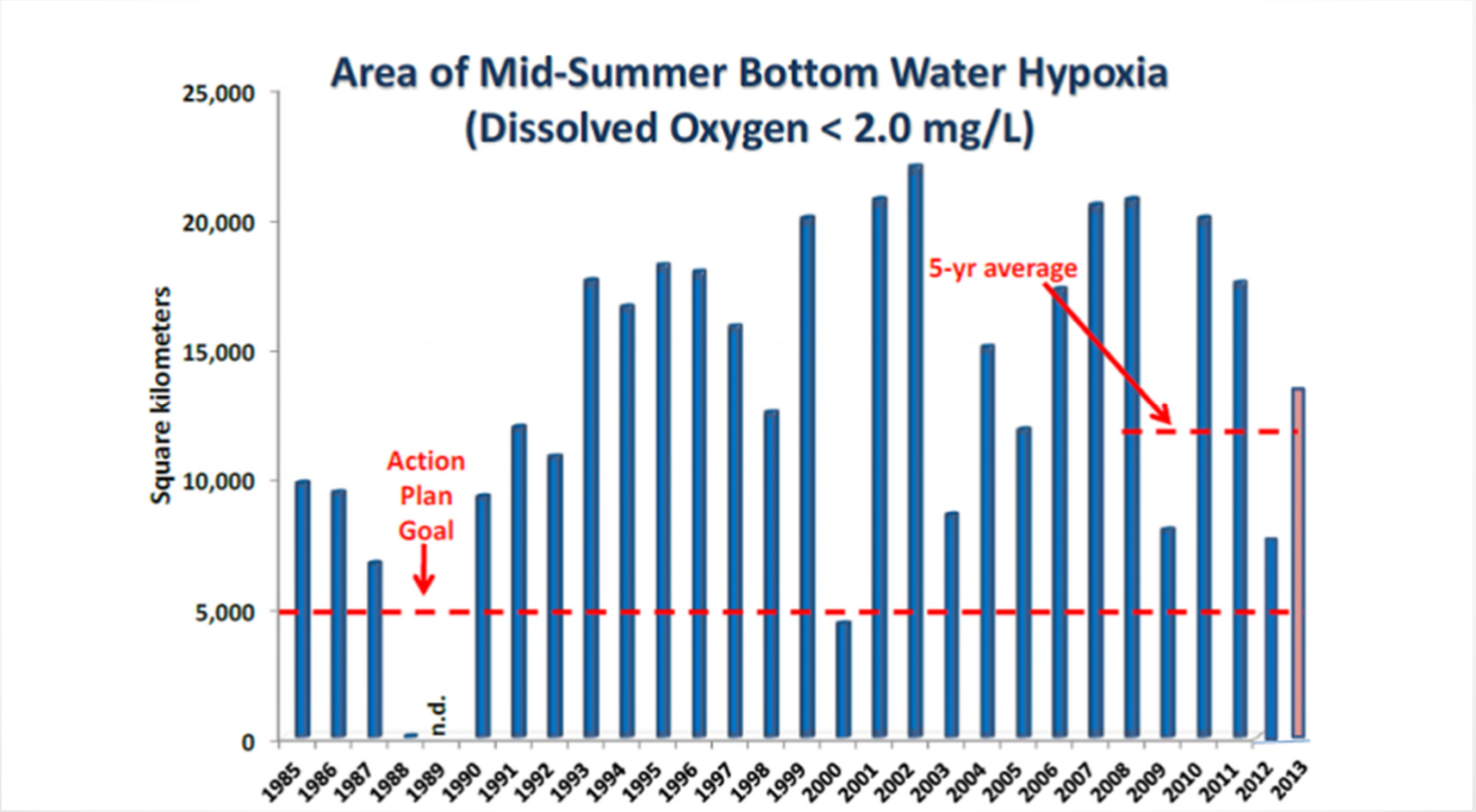
Extent of Bottom-Water Hypoxia (DO < 2 mg L^{-1}) late July 2011 and late July 2012



Data source: N.N. Rabalais, Louisiana Universities Marine Consortium, and R.E. Turner, Louisiana State University; funding from NOAA, CSCOR, NGOMEX09

Gulf Hypoxic Zone Monitoring

Maximum annual areal extent of hypoxic zone – metric to assess progress toward Hypoxia Task Force Action Plan Goal



From Nancy Rabalais (LUMCON)

Scenario Forecast Models

Lead PIs: Nancy Rabalais (LUMCON); Steve DiMarco (Texas A&M)

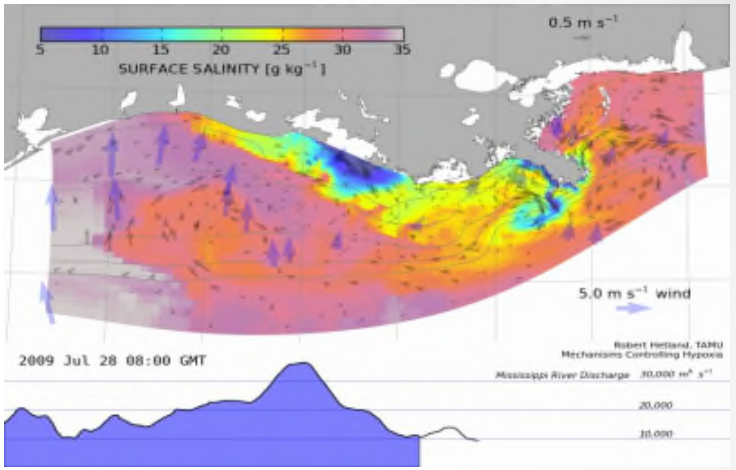
Partners: Dalhousie U; VIMS; LSU; U Mich; Coastal Carolina U

Models:

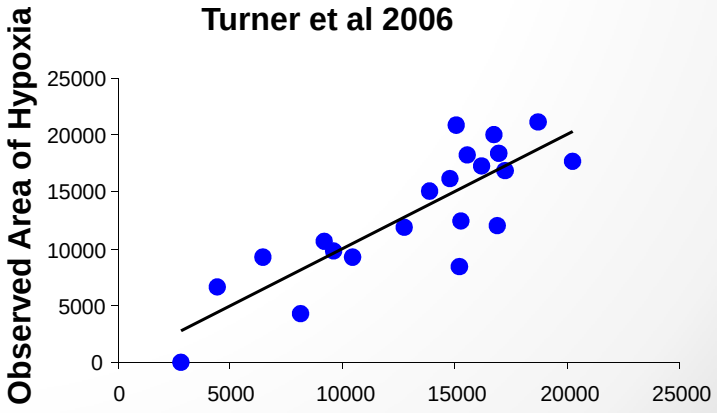
- **Statistical Regression**
- **FVCOM Hydrodynamic**
- **ROMS Hydrodynamic coupled to biogeochemical**

Management Need:

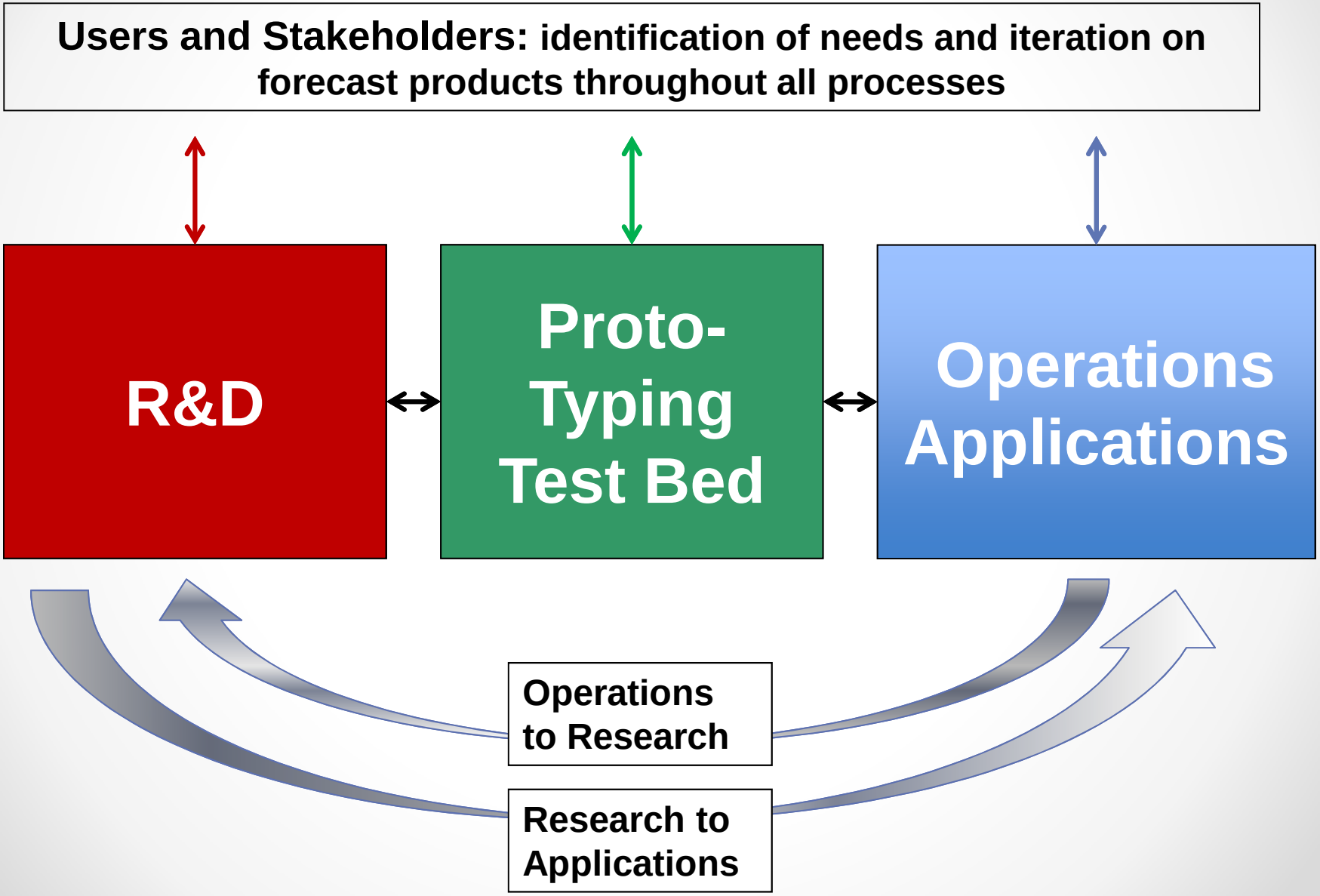
- **inform hypoxic zone and nutrient reduction goal-setting;**
- **Evaluate the effectiveness of alternative nutrient reduction scenarios to inform adaptive management strategy**



Hydrodynamic model. Source: S. DiMarco, Texas A&M



NOAA's Ecological Forecasting Roadmap



Questions

Photo credit: Nancy Rabalais (LUMCON)