Long-Term Studies of Hypoxia in Corpus Christi Bay: The Cybercollaboratory Testbed

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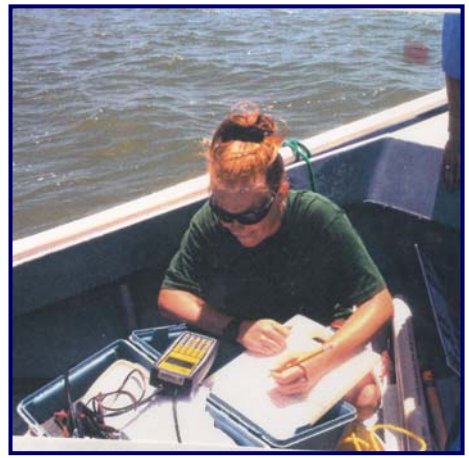
Outline

- Long-term studies
  - Hypoxia spatial, temporal distribution
  - Links to environmental conditions
- Biological effects
  - Benthic communities
  - Direct and indirect effects
- Cybercollaboratory test-bed
  - A WATERS project using CCB data
  - Hydrologic Information Systems
  - Cyberinfrastructure Implementation



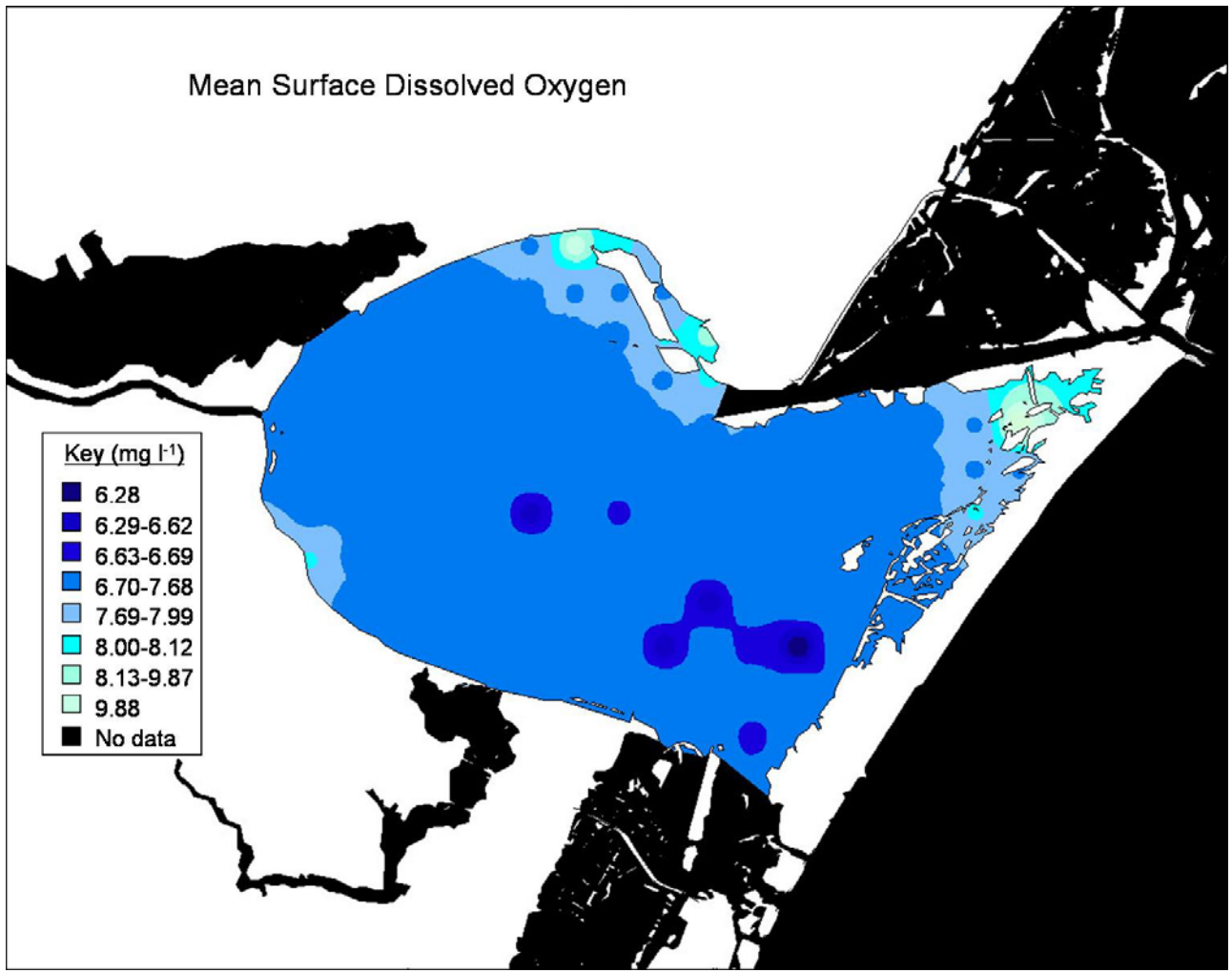
Hypoxia History

- Corpus Christi Bay is a shallow (~3.2m) enclosed bay with a level bottom. It experiences high wind speeds, temperature, and receives a low amount of fresh water inflow
- Hypoxia (low oxygen conditions) has been documented in the southeastern region of Corpus Christi Bay every summer, particularly in July, since 1988
- Hypoxia found in bottom waters, usually within 1 m from bottom
- Hypoxia appearance related to environmental conditions.
- Biological effects are moderate

Spatial Monitoring

Annual Surface DO Mean (1982-2002)

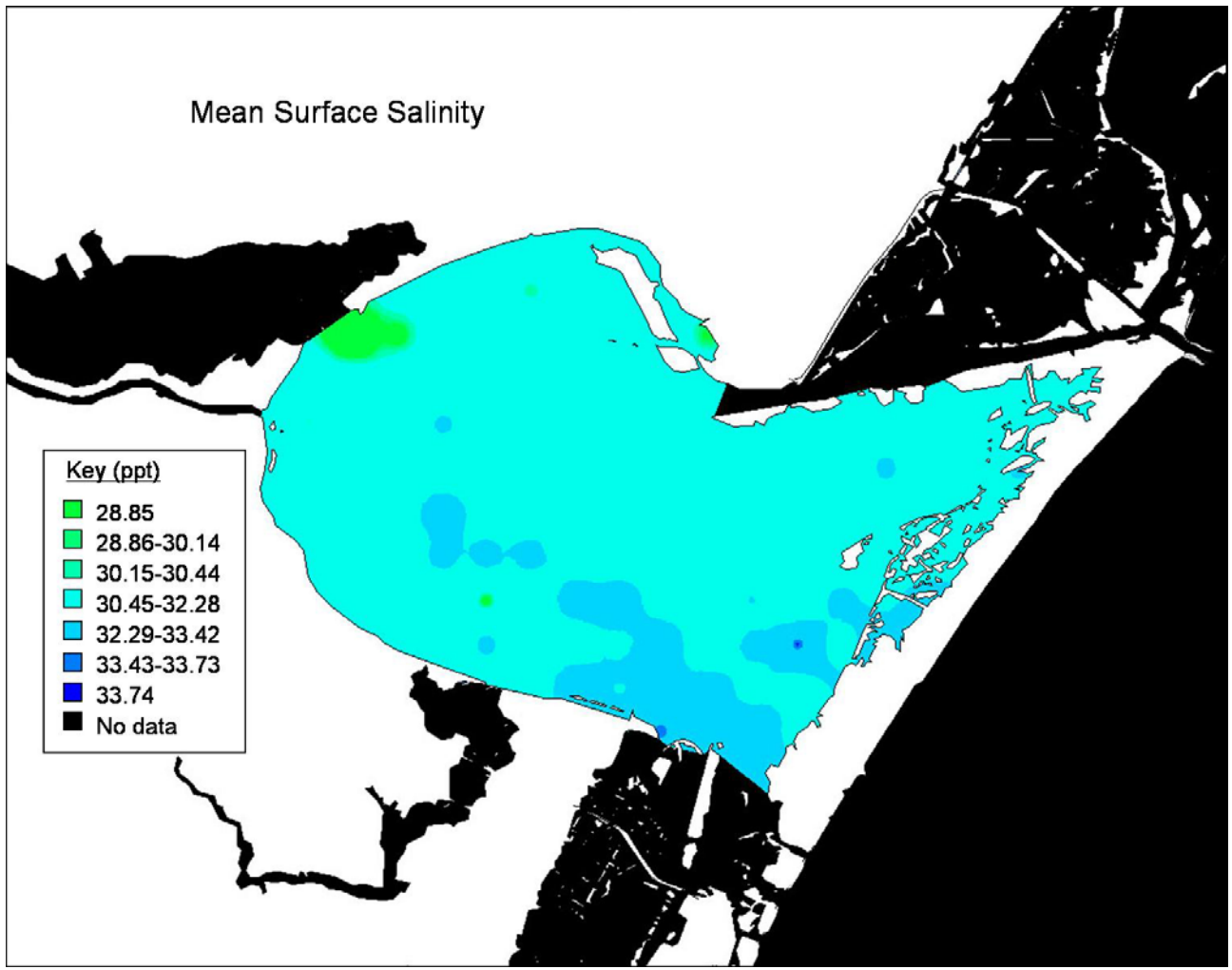
- The southeastern region of Corpus Christi Bay had the lowest average dissolved oxygen concentrations (Applebaum and Montagna, 2005)



Spatial Monitoring

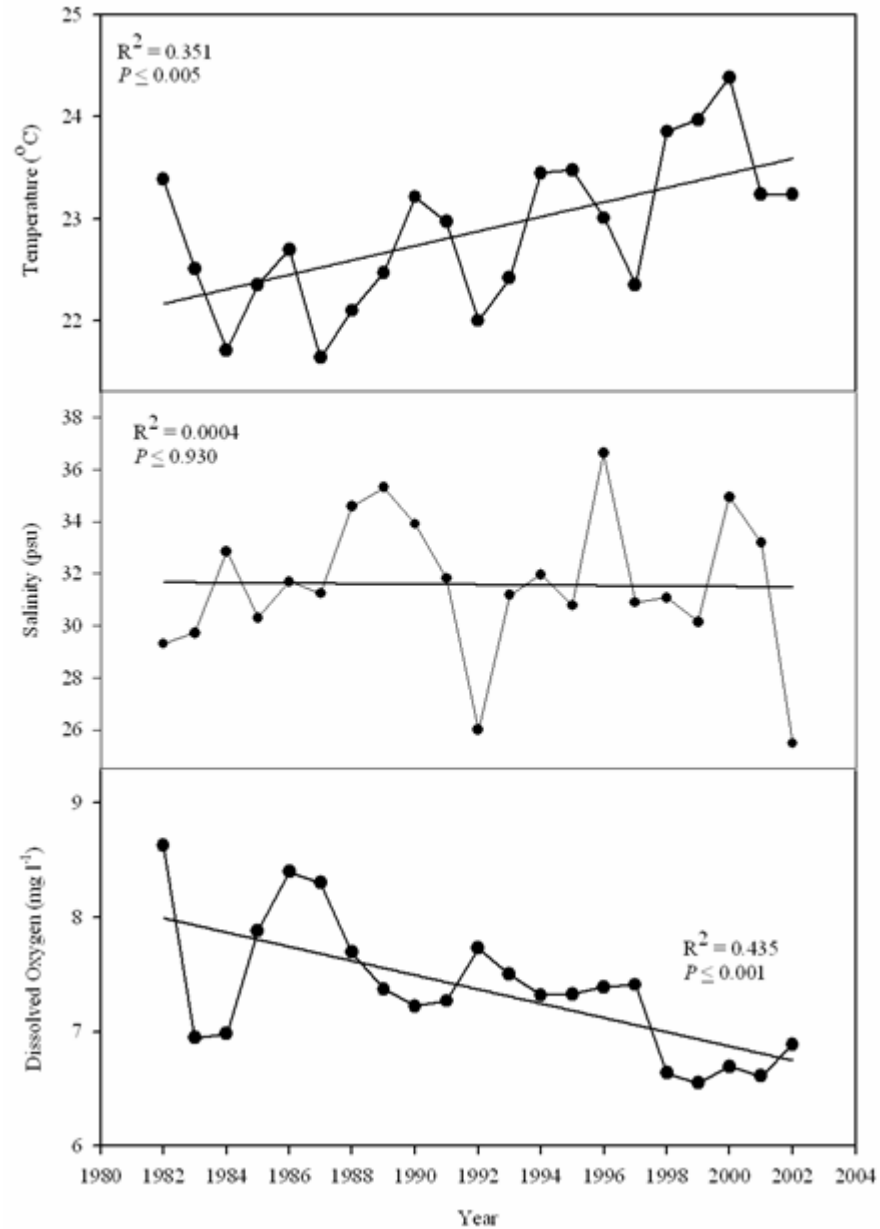
Annual Surface Salinity Mean (1982-2002)

- The southeastern region of Corpus Christi Bay also had the highest average salinity (Applebaum and Montagna, 2005)



Spatial Monitoring: Climate Change?

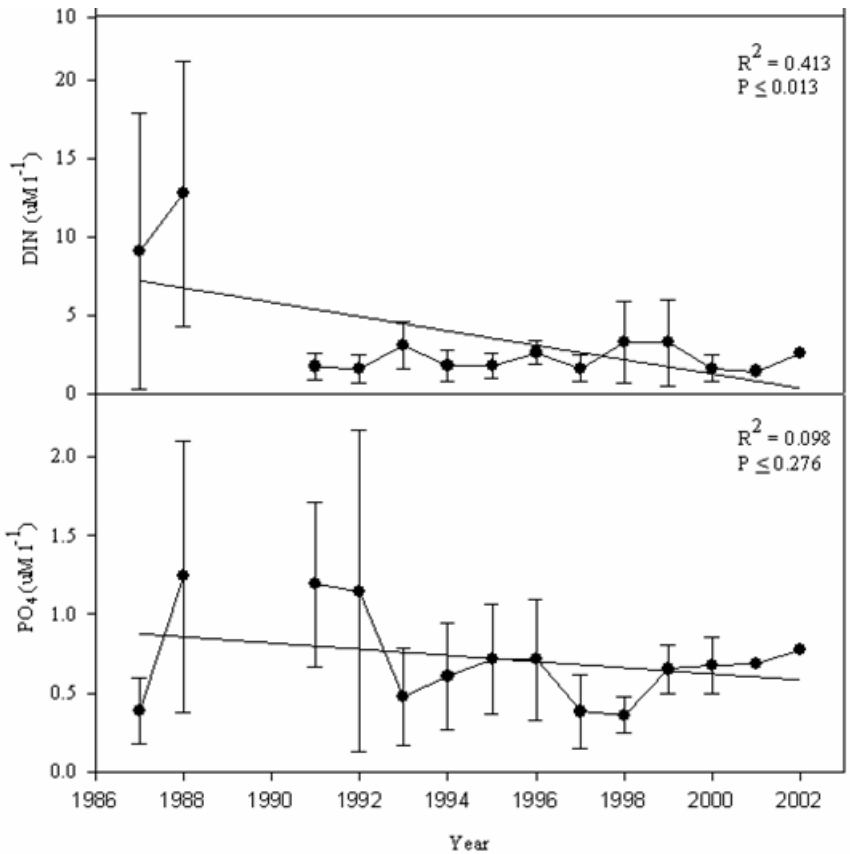
- Surface temperature increased at a rate of 0.07°C yr^{-1} from 1982 to 2002
- Surface DO decreased at a rate of 0.06 mg L^{-1} yr^{-1} from 1982 to 2002



(Applebaum and Montagna, 2005)

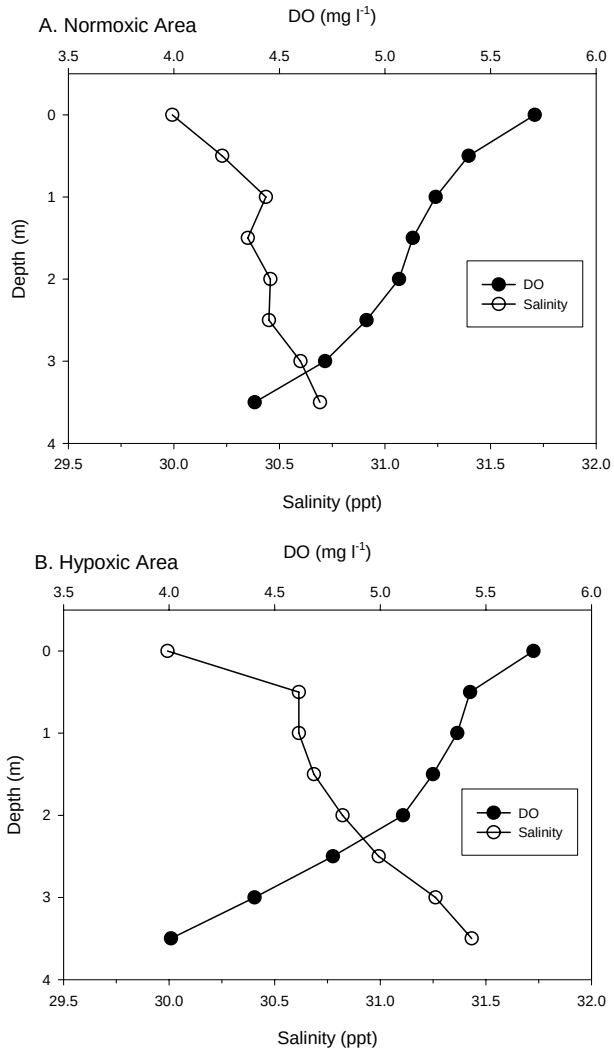
The Role of Nutrients

Nitrogen and phosphate concentrations in Corpus Christi Bay from 1987 – 2002 (Applebaum and Montagna 2005)



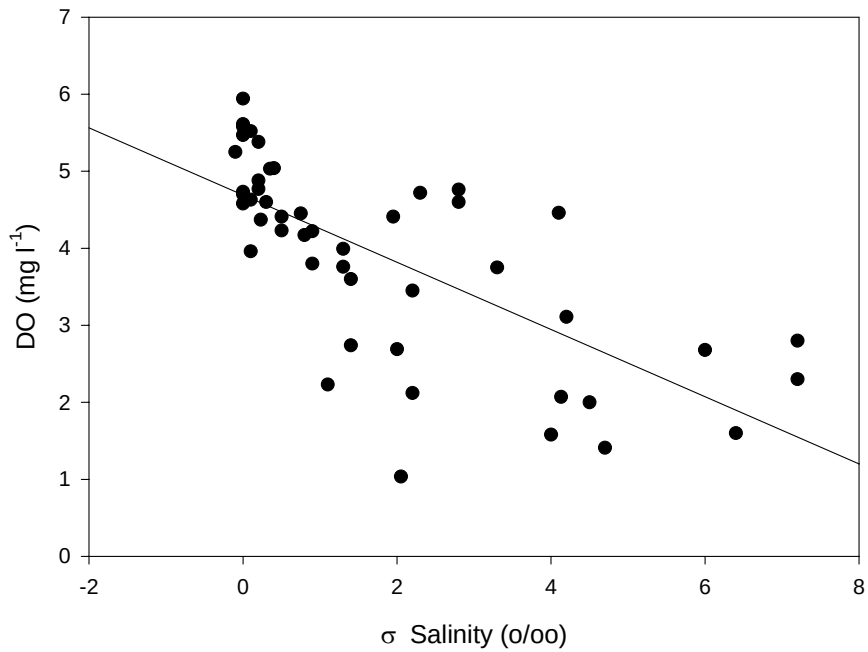
- Nitrogen and phosphate levels are low: average concentrations are 2.2 mM l^{-1}(DIN) and 0.7 mM l^{-1} (PO4).
- Regional scale phytoplankton blooms have not been observed during sampling since 1987.
- Nutrient concentrations are low because there is no direct river inflow source, negligible agriculture, and little urbanization.

Role of Salinity Stratification



Montagna and Ritter 2006

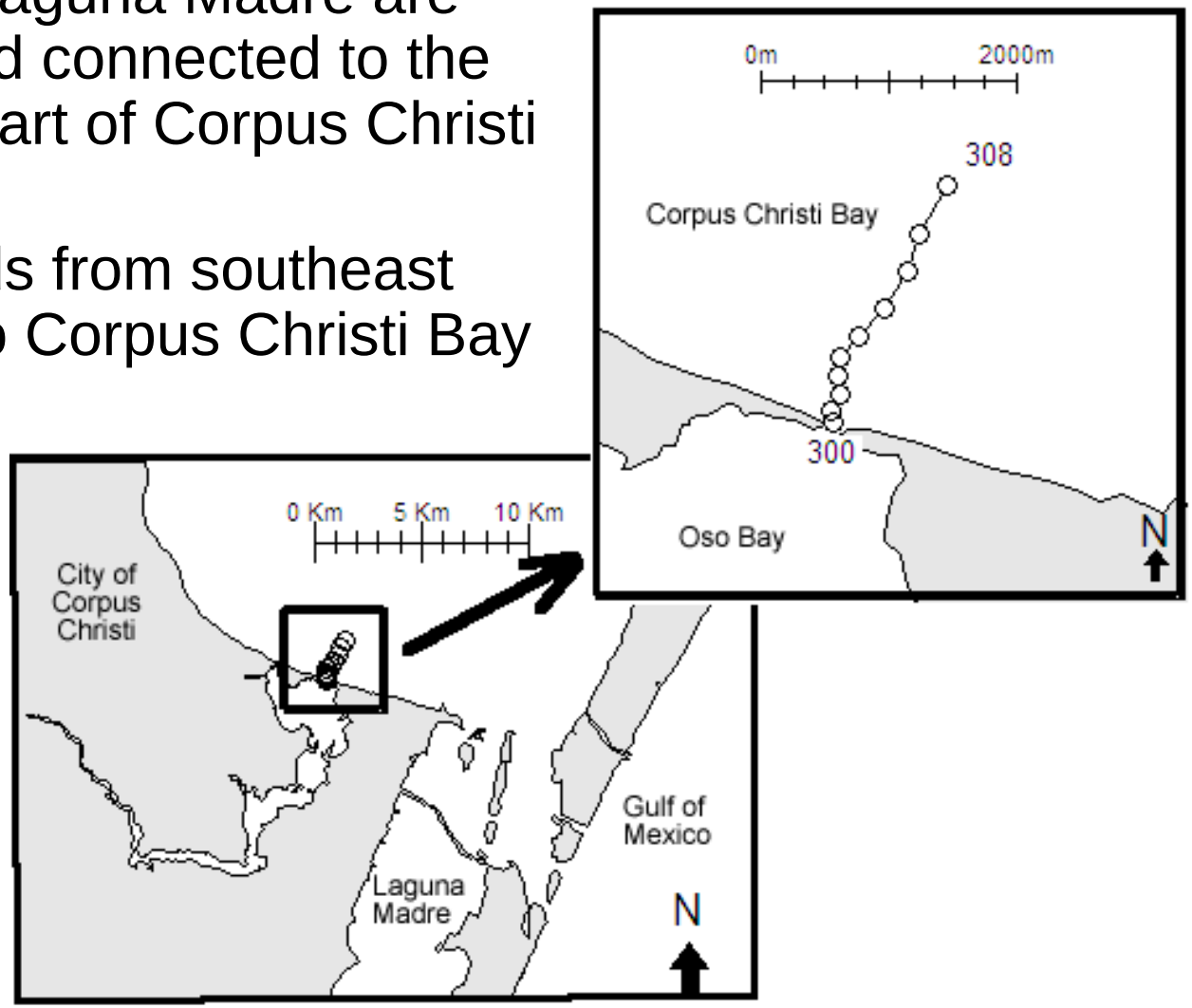
- Hypoxia in CCB occurs when salinity difference between surface and bottom water is large



Ritter and Montagna 1999

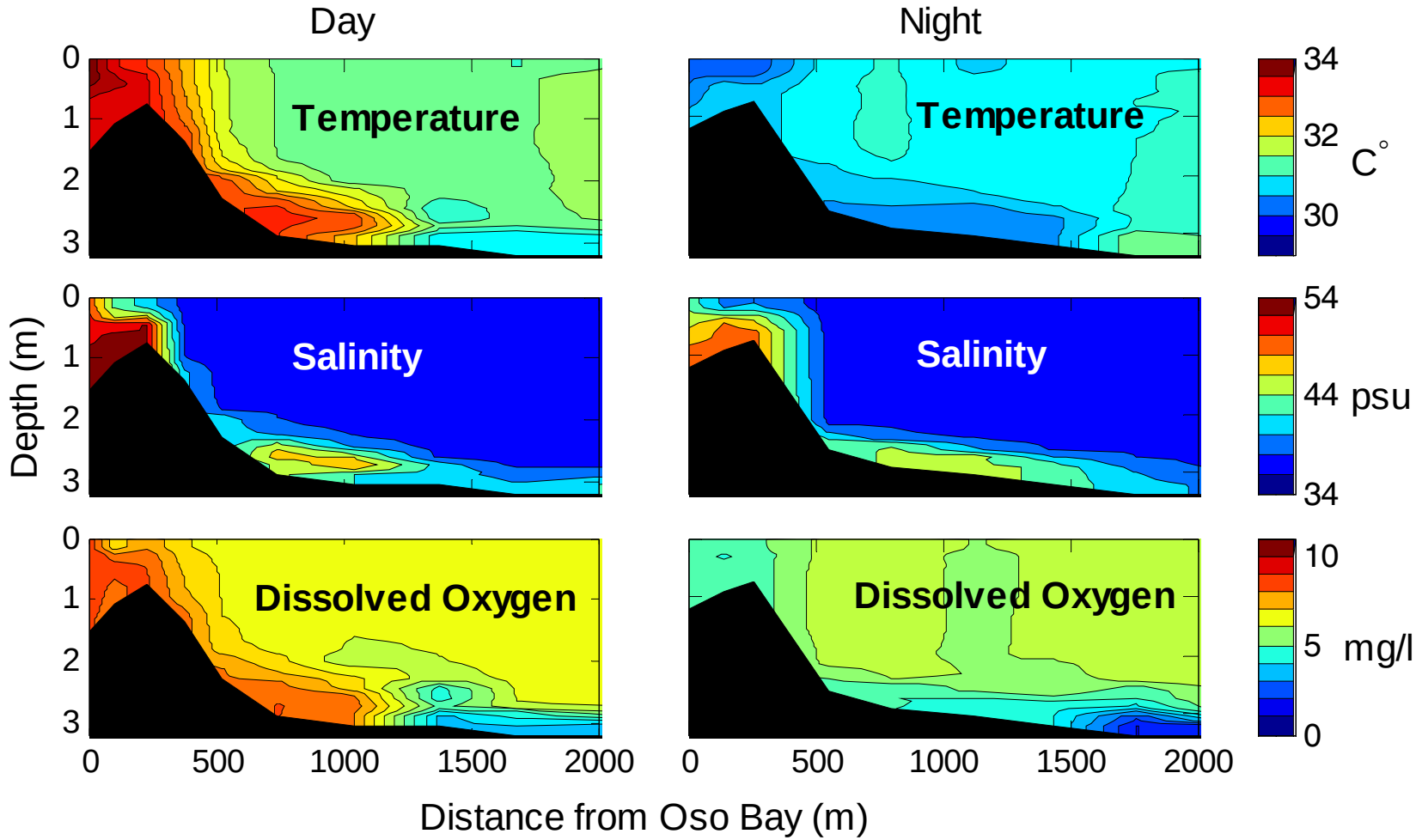
Source of High Salinity Water

- Oso Bay and Laguna Madre are hypersaline and connected to the southeastern part of Corpus Christi Bay
- Prevailing winds from southeast drive water into Corpus Christi Bay



Source: Ben Hodges

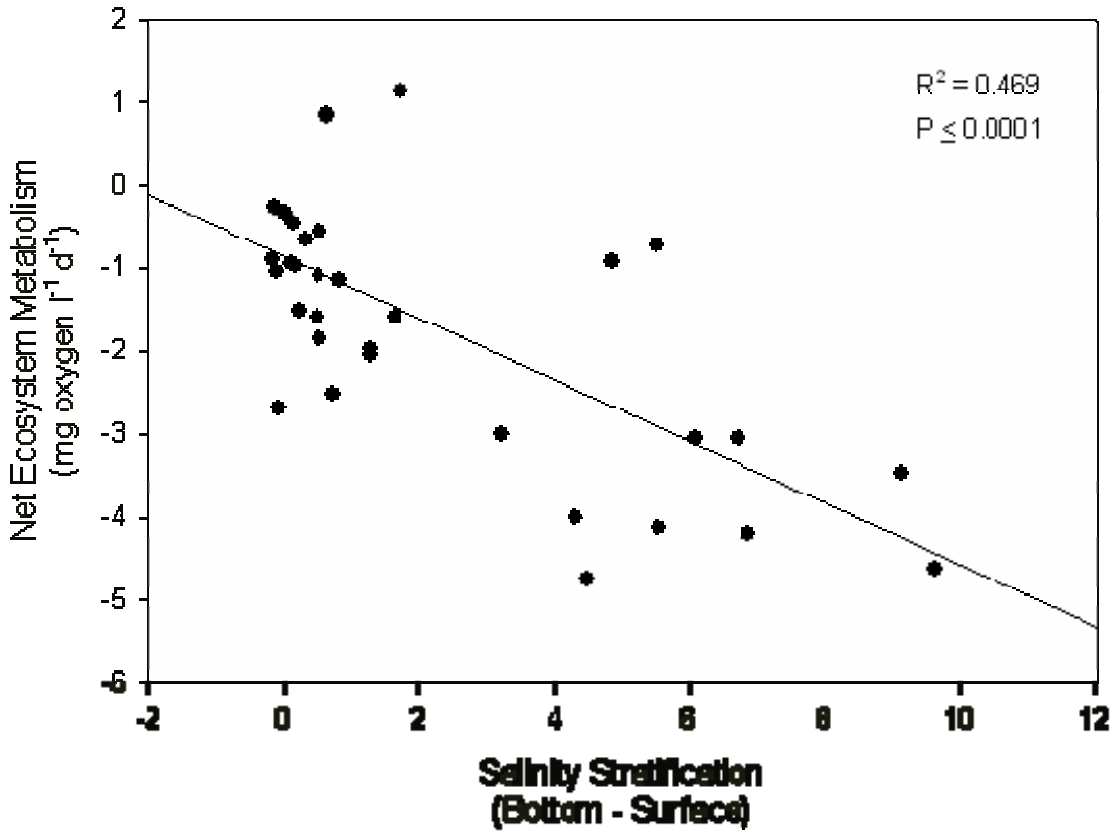
Typical Day/Night Transects of Outflow From Oso Bay Aug 22-24, 2005



Source: Ben Hodges

Effects on Net Ecosystem Metabolism

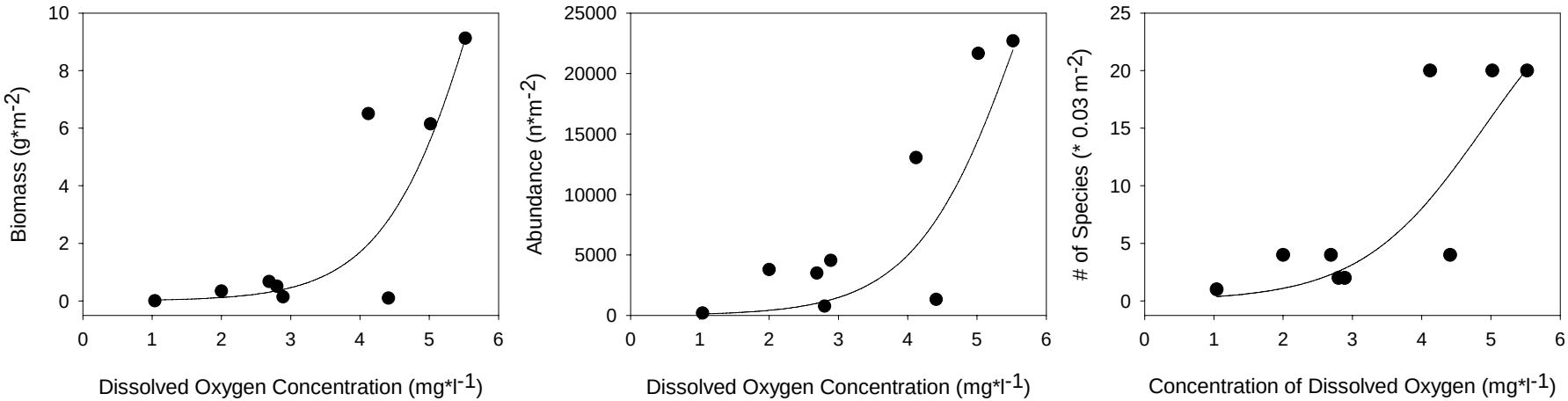
- The balance between respiration and photosynthesis (NEM) decreases with salinity stratification
- Thus, higher bottom salinities promote excess respiration



Russell and Montagna, 2006

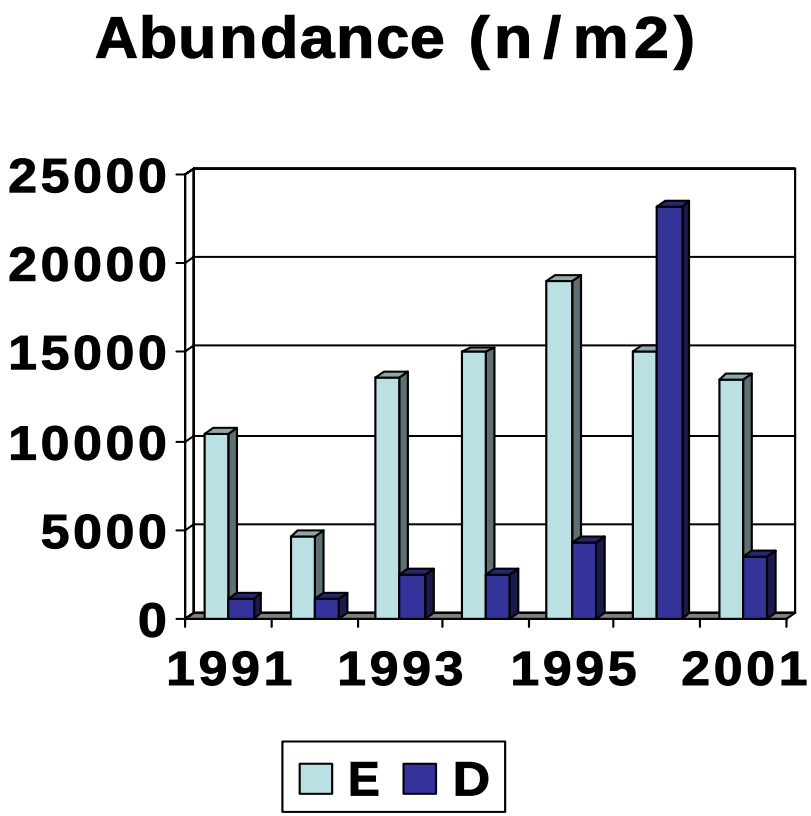
Benthic Community Effects

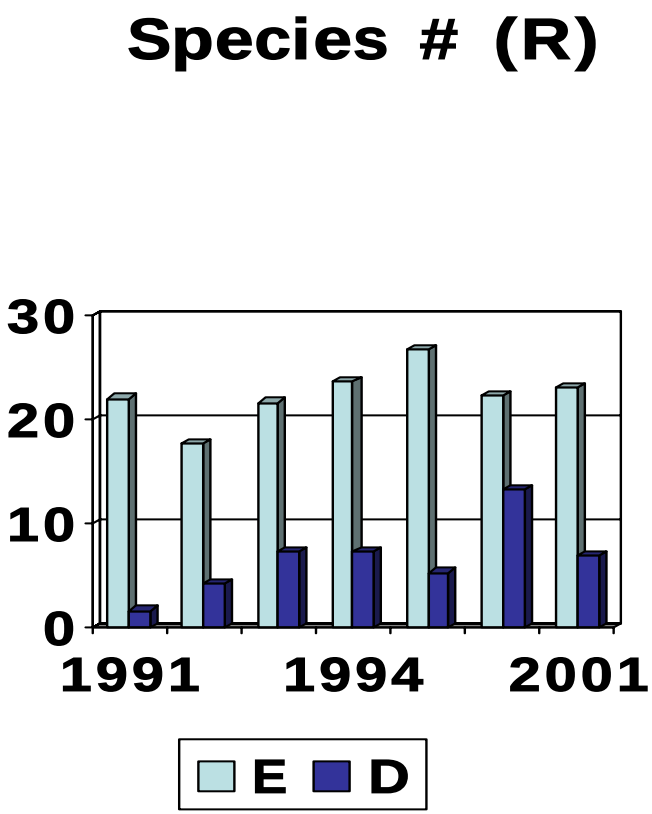
- Hypoxia effects in Corpus Christi Bay have been found at DO concentrations $\leq$ 3 mg l^{-1}
- Interaction with high salinity?
  - Effects at higher concentration when stressed by salinity.



Ritter and Montagna 1999

Long-term Spatial Effects on Benthos

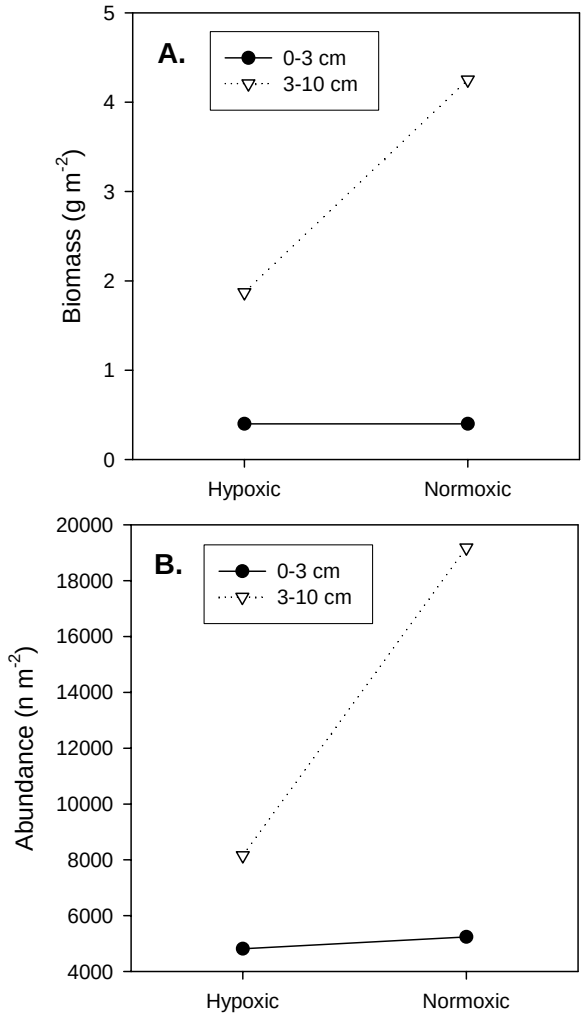




Station E=Normoxic, Station D=Hypoxic

Vertical Profiles of Benthos

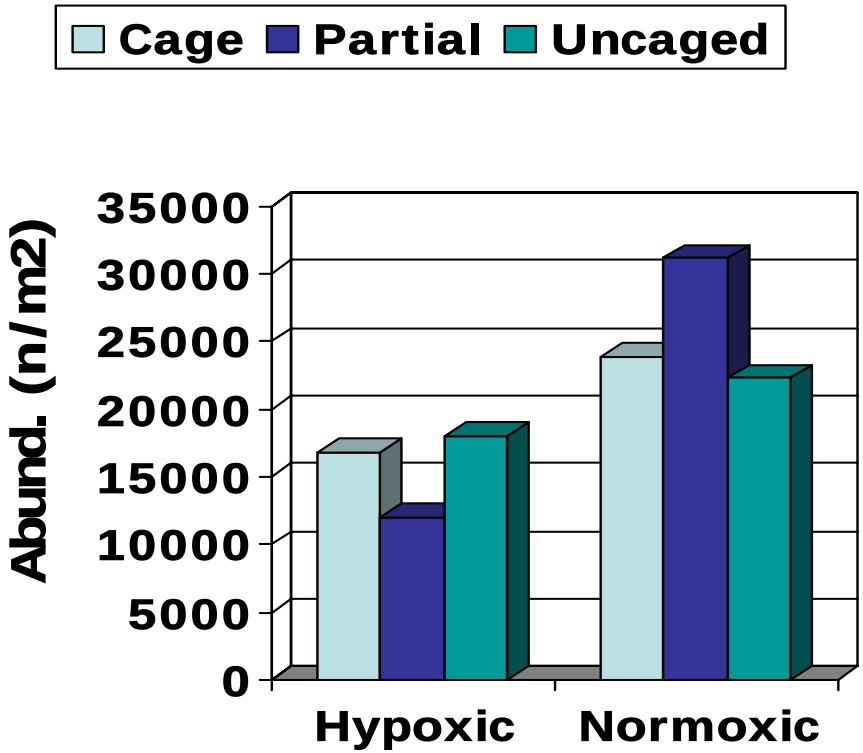
- More deeper dwelling benthos in normoxic areas.
- Loss due to loss of deeper habitats, and organisms being squeezed to the surface.

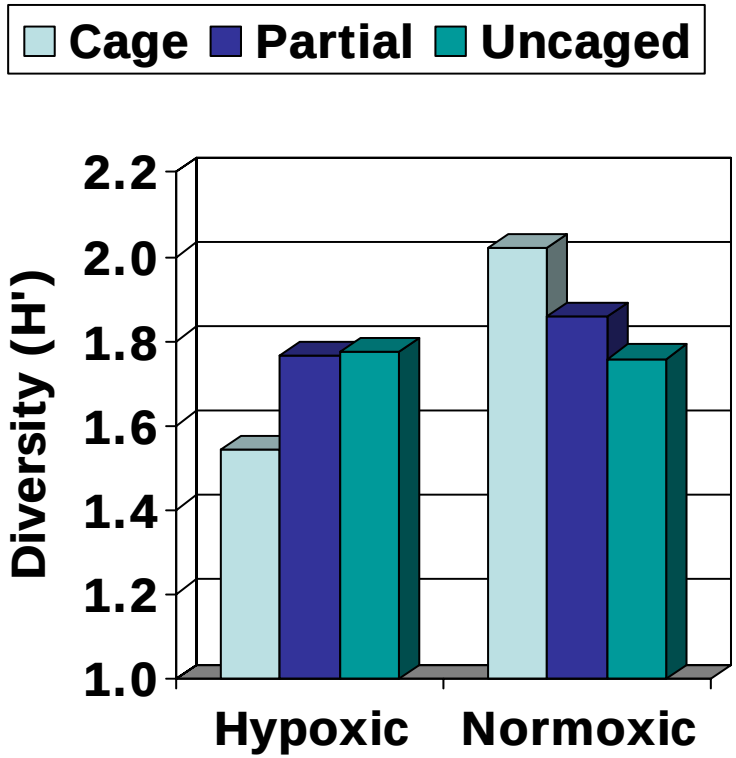


Montagna and Ritter, 2005

Effects on Predation Potential (Area*Cage Interaction)

Montagna and Ritter, 2005





- Abundance differences driven by the partial cage.
- Diversity differences driven by the cage.
- Thus, no strong evidence that predation is increased in surface at hypoxic stations.

Biological Effects Summary

- Ecosystem processes during salinity stratification likely drive the hypoxia, because respiration is stimulated and water masses are not mixing
- Reduced benthos (abundance, biomass, and diversity) in hypoxic areas
- Reduction due to loss of deeper-dwelling organisms
- Likely a direct effect, and not an indirect effect

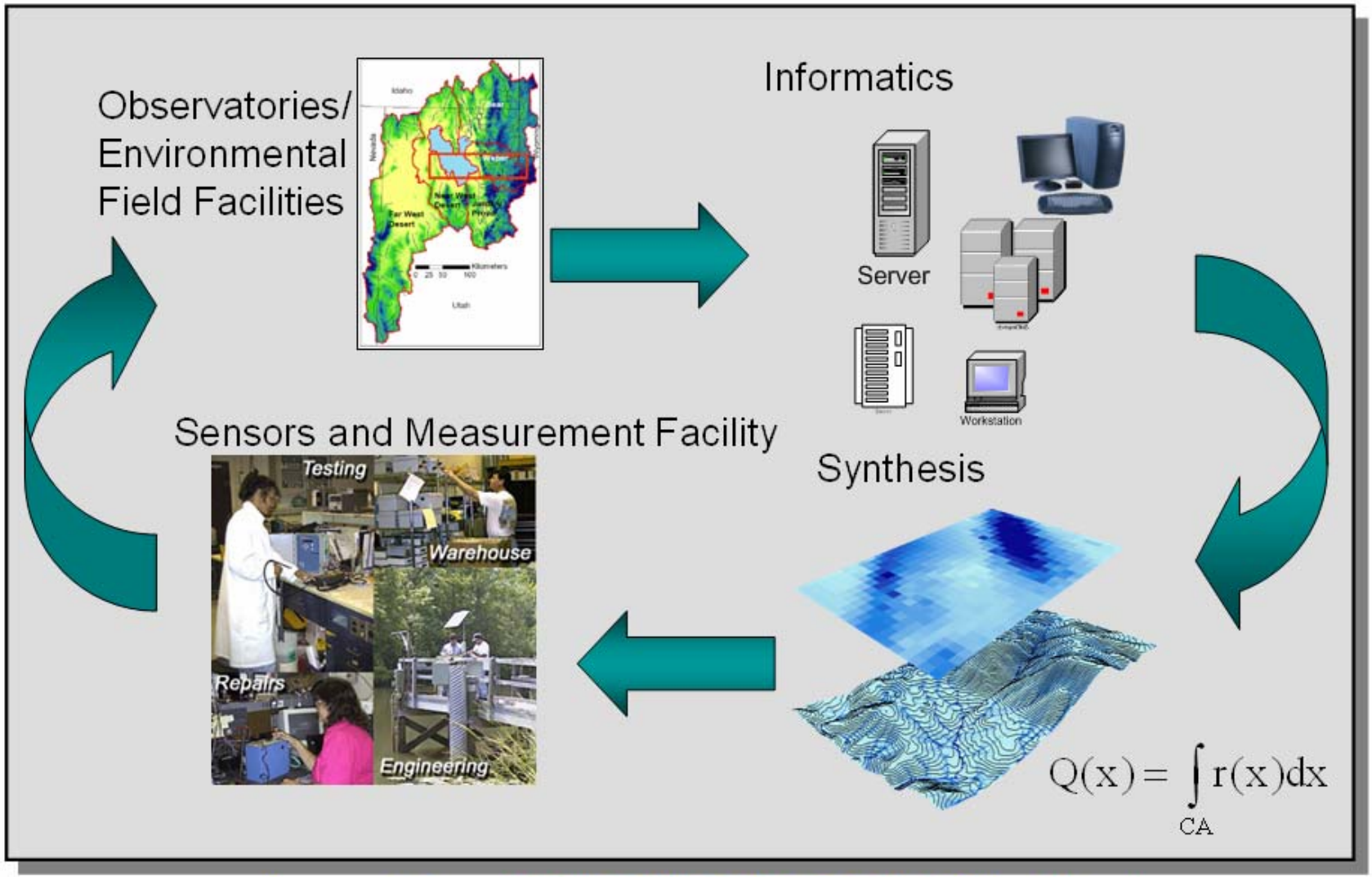
New Questions

- Can we forecast hypoxia?
- Can we predict the best time to sample?
- Are we sampling correctly?

WATERS

- WATERS (WATer and Environmental Research Systems network) is an NSF initiative to develop real-time environmental forecasting and management to:
  - Better monitor and understand large-scale, event-based environmental phenomena
    - E.g., hypoxia, flooding
  - Create and test engineered systems that better prevent and control such phenomena
    - E.g., agricultural systems, flood control systems, water cycle engineering systems
- New Corpus Christi Bay Observatory Testbed Project is demonstrating how cyberinfrastructure can enable real-time forecasting

Common Vision: WATERS Network



A combined CLEANER-CUAHSI effort

Source: David Maidment, Univ. of Texas

- A web portal to allow sharing of information and ideas across the community.
- Currently being used by CLEANER Project Office team & several observatory testbeds
- Public CI demo space shows numerous cyberinfrastructure demonstrations

http://cleaner.ncsa.uiuc.edu/cybercollab

NCSA CyberCollaboratory :: Home - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address http://cleaner.ncsa.uiuc.edu/cybercollab/c/portal/layout?p_l_id=44.1

CLEANER — CUAHSI

Welcome, Paul A Montagna!
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Community » Corpus Christi Bay Testbed — Switch Community ...

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Home

Welcome to the Corpus Christi Bay Testbed

This community serves as the starting point for a prototype Environmental Information System (EIS) that couples sensor measurements with end-to-end cyberinfrastructure to improve understanding of hypoxia in Corpus Christi Bay, Texas. Eventually this community space will blend with other sections of the CyberCollaboratory to integrate data services ingesting observed data from both national and local remote data archives/source together with an environmental modeling system for Corpus Christi Bay. Collectively these services will demonstrate the effectiveness of an EIS for supporting on-going environmental research.

Announcements

Please post new announcements by clicking on the "Add Entry" link on the right. Add Entry

Friday, August 11, 2006 *Posted by: Steve Downey at: 2:28 PM*

Try out the current tools

Welcome everyone!

This portion of the CyberCollaboratory contains tools and content specific to the Corpus Christi Bay testbed. Try out the current tools and provide your feedback here or by email Steve Downey at <downey@ncsa.uiuc.edu>.

Add Comments

NCSA Community Liaisons

Community Liaisons

Having trouble or have a question about the CyberCollaboratory? IM or email us.

Not online — Email

aol yahoo email

Personal Posts

Personal Posts For Paul

Personal Posts are messages sent to users who may not be online at the moment. Next time they visit this page, they'll receive your message.

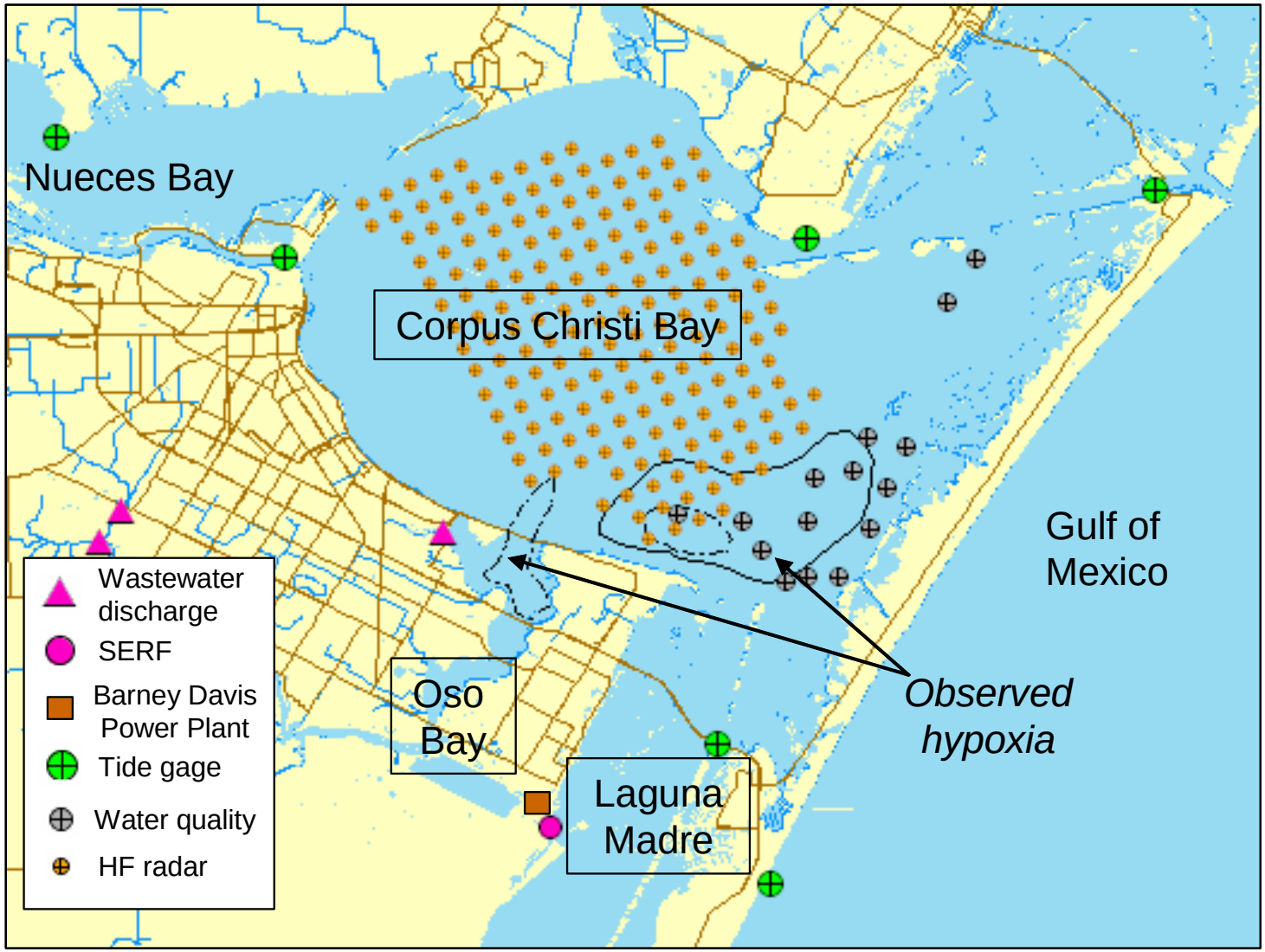
There are no personal posts for you

Send a Personal Post

About - Disclaimer - Make CLEANER my start page!

Done — Internet

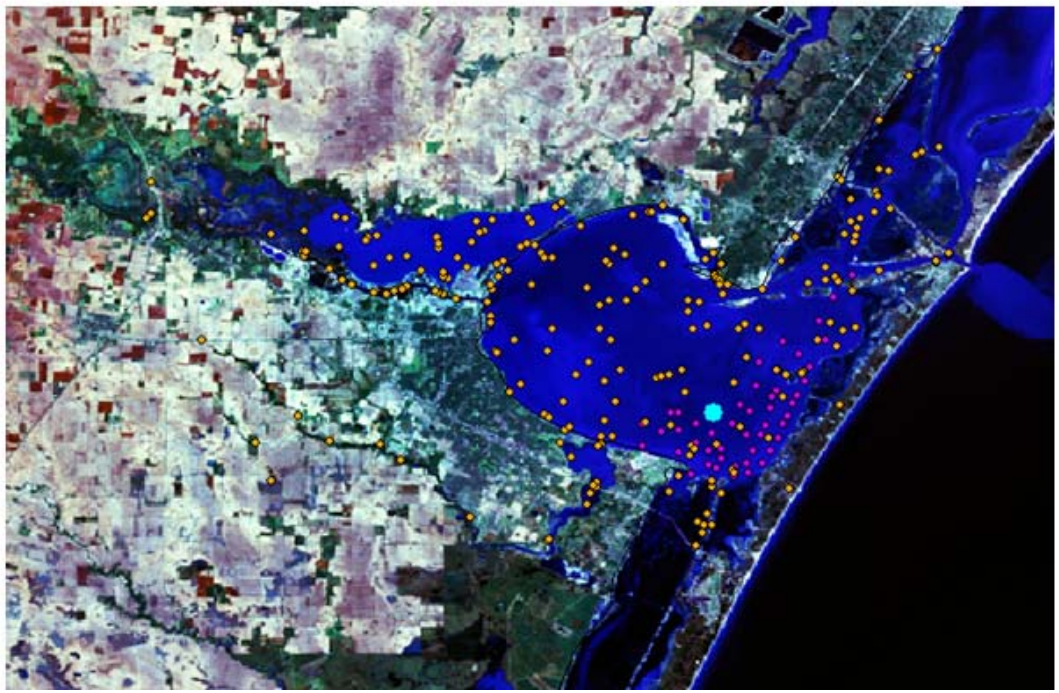
Corpus Christi Bay Test Bed



Source: David Maidment

Example: Corpus Christi Bay Environmental Info System

- Workgroup HIS implementation
- Uses ODM to store hydrology and environmental data from state agencies and academic investigators.
- Contains web-services to regional data repositories (e.g. TCOON).

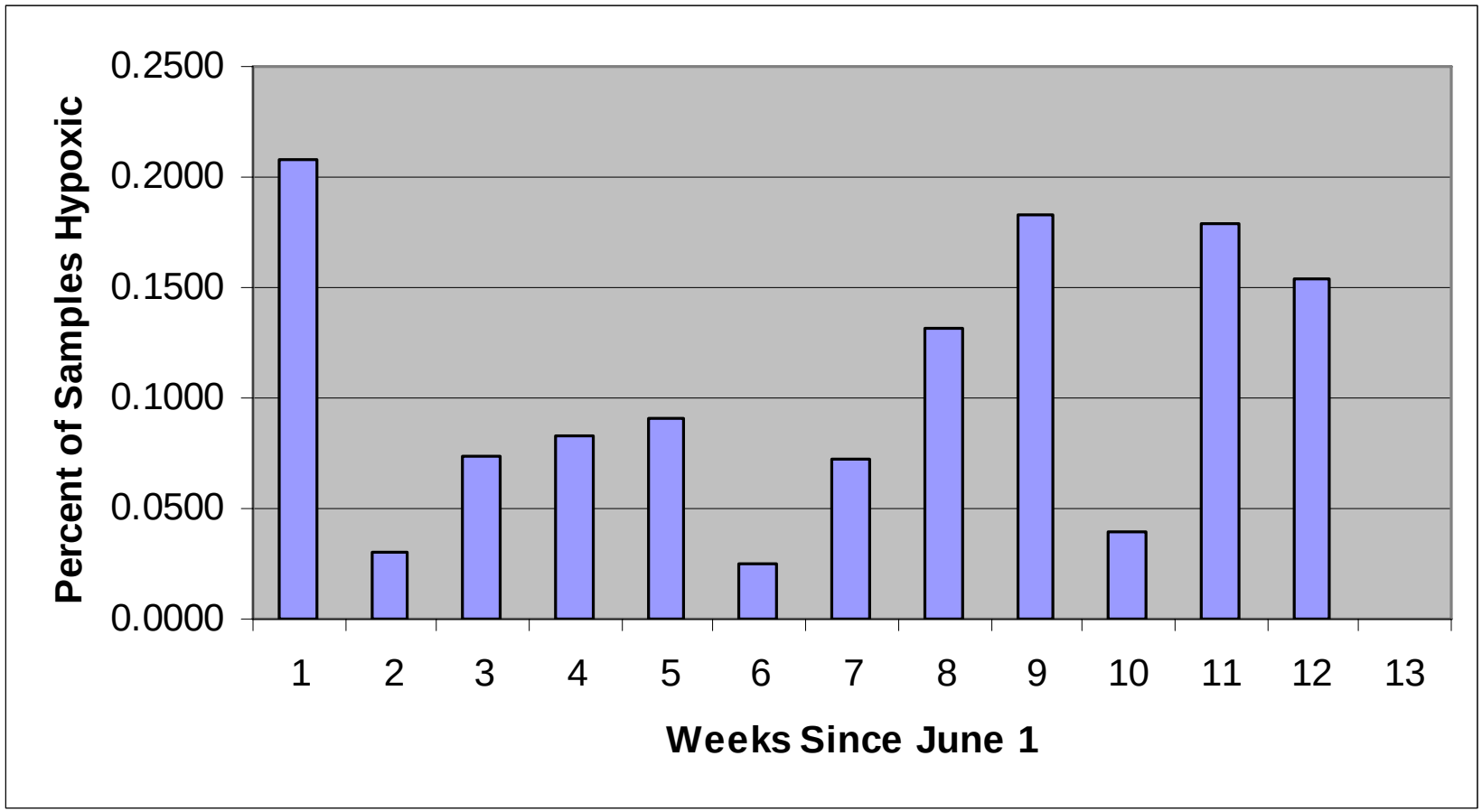


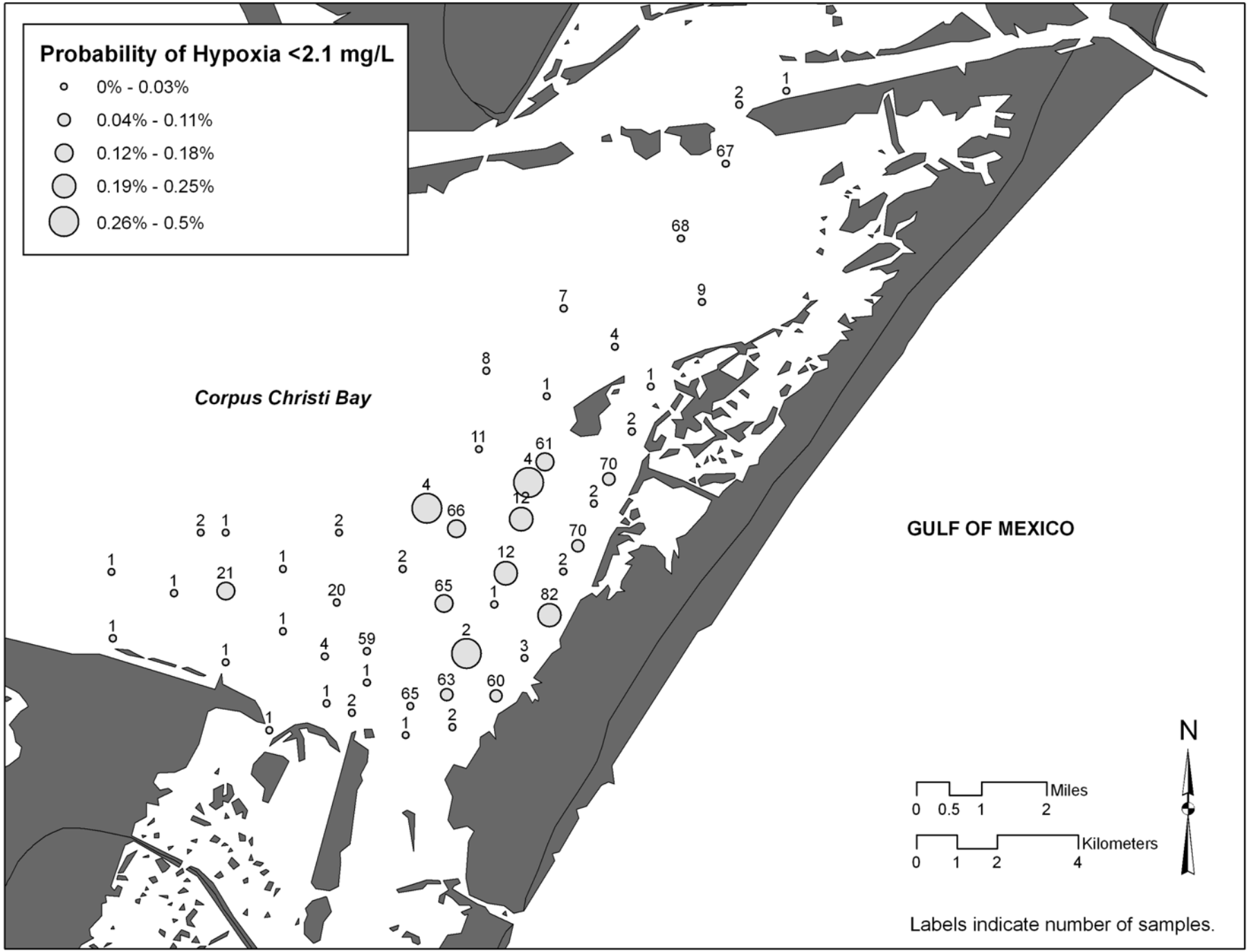
Water quality data sites in Corpus Christi Bay (maps by Tyler Jantzen)

Demo: TXHIS ODM webservice

Source: David Maidment, Univ. of Texas

Probability of Finding Hypoxia During the Summer



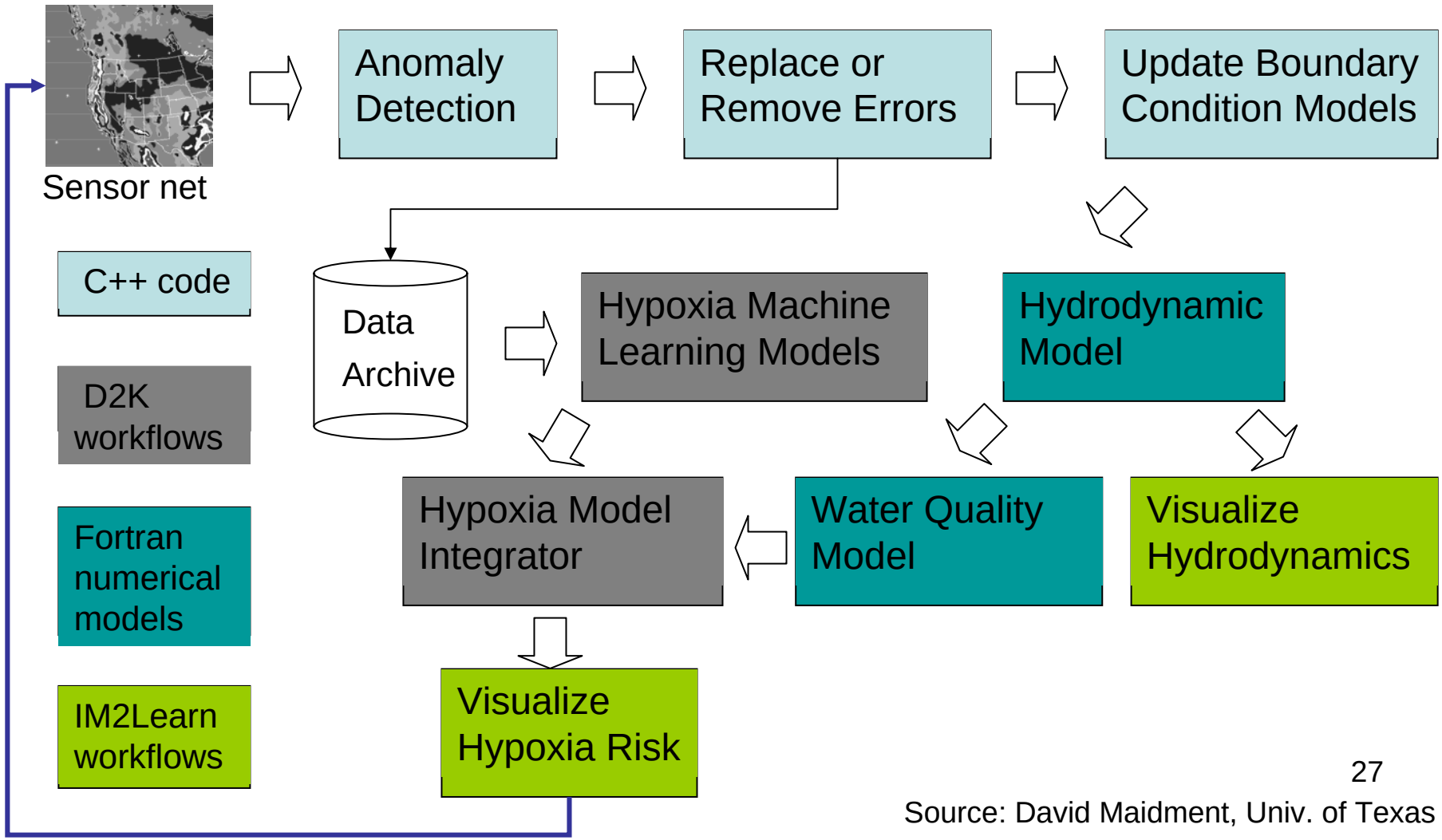

Probability of Hypoxia <2.1 mg/L
0% - 0.03%
0.04% - 0.11%
0.12% - 0.18%
0.19% - 0.25%
0.26% - 0.5%
Corpus Christi Bay
GULF OF MEXICO
N
Miles
0 0.5 1 2
Kilometers
0 1 2 4
Labels indicate number of samples.

Test Bed Preliminary Results

- Only started in June 2006
- Creating some simple models
- Creating some visualization tools
- Created much better sampling designs for 2006 summer sampling season

- In the future

Corpus Christi Bay Near-Real-Time Hypoxia Prediction Process



Source: David Maidment, Univ. of Texas

Acknowledgements

- Rick Kalke, Christopher Kalke, Kristi Jones, Larry Hyde, Terry Palmer, Sally Morehead, Laura Ryckman, and Carrol Simanek for sampling, data collection, and data management

- Funding:
  - Texas General Land Office
  - Texas Coastal Management Program
  - Coastal Bend Bay and Estuaries Program
  - Texas Commission on Environmental Quality
  - Texas Water Development Board
  - National Science Foundation (Waters Test bed)

- Historical dissolved oxygen data for Corpus Christi Bay
  - Texas Parks and Wildlife Department