Hypoxia in a Hypersaline, Lagoonal South Texas Estuary (Baffin Bay)

Michael Wetz
Emily Cira
Kenneth Hayes
Lily Walker
Xinpeng Hu
Hongjie Wang
Baffin Bay & Upper Laguna Madre: Jewel of the Texas coast

- World-renowned fishing; black drum, trout, red drum
- Major contributor to economy of Texas Coastal Bend through fishing, tourism
Evidence of Declining Ecosystem Health in Baffin Bay

1. Brown tide outbreaks & seagrass die-off (1990’s-present)
2. Episodic hypoxia & fish kills
3. Altered food web affecting fisheries?
4. Long term increase in chlorophyll, TKN, temperature, salinity
Baffin Bay: Eutrophication Without a River or People?

• Baffin Bay in semi-arid region of Texas coast
  – No major river source; frequently hypersaline
• > 40% agricultural land cover; Largest city is Kingsville (26,000)
• Few studies have examined hypoxia or eutrophication of semiarid/arid estuaries
  – ~ equal to the number of riverine systems worldwide

What drives dissolved oxygen dynamics in Baffin Bay?
Baffin Bay Water Quality Studies

- Monthly volunteer water quality monitoring study
  - Exceptionally high chlorophyll & organic matter (C&N) in Baffin Bay;
  - Organic C & N 2-3 fold higher than other Texas estuaries
  - See Cira et al. talk tomorrow, Water Quality Improvements and Impacts session, 3PM, Jackson room

- Sensor-based study to characterize Dissolved Oxygen dynamics
Dissolved Oxygen: Interannual & Seasonal Variability

- Strong interannual variability in precipitation, salinity;
  2013-2014 = drought
  2015-2016 = “wet” years

- D.O. lower in winter 2016 than prior winters
  - Temp ~5-7°C warmer in 2016

- Strong seasonal variability in D.O.; temperature dependent

- Hypoxia occasionally observed in both tributaries & main channel
Several periods of hypoxia/anoxia in 2015 (upper left figure)
- Hypoxia in mid-June 2015 coincident w/ sharp increase in salinity; likely due to across-channel winds triggering upwelling of saline bottom water
- Also preceded by phytoplankton bloom (bottom figures)
• ~5 consecutive days of hypoxia in late September 2015
• Mainly in bottom waters but also affected surface for 1-2 days (upper left figure)
• Preceded by several small rain events; also coincided with a period of light winds (lower left figure)
Summary: Dissolved Oxygen in Baffin Bay

- Episodic hypoxia important in this system
- Interannual variability noteworthy

- Drivers of low D.O.:
  - Biological (i.e., high organic matter content)
  - Physical (wind speed, stratification) components

- System is poised to rapidly become hypoxic

<table>
<thead>
<tr>
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<th>Site 3 2015</th>
<th>Site 3 2016</th>
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<tbody>
<tr>
<td>% days D.O. 2-3 mg/l</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>% days D.O. &lt;2 mg/l</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td># days sampled</td>
<td>184</td>
<td>278</td>
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Where is the Organic Matter Coming From?

- Isotopic signature of resired carbon shows interannual variability of C source fueling respiration
- “Wet” years = seagrass or marsh
- “Transition” years = phytoplankton
- “Drought” years = terrestrial (old) carbon
The “Bigger Picture”

• Despite lack of major river & low population in watershed, strong evidence of water quality degradation
  • Increasing nutrient, chlorophyll levels
  • Temperature increase since 1960s enhances algal growth, bacterial respiration & reduces D.O. content of water
• Baffin Bay is a “sensitive” ecosystem due to poor flushing

**Ultimate goal**

Science-based understanding of water quality dynamics ------> Stakeholder-driven efforts to **protect & restore Baffin Bay water quality & ecosystem health**
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