Synthesis of Water Quality Studies in Baffin Bay With a View Towards Solutions

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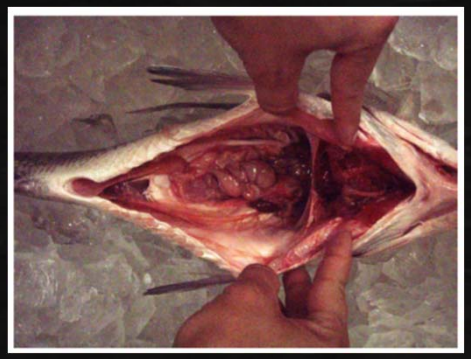
The Situation in 2012: Visual Evidence of Environmental Change in Baffin Bay

1. Brown tide blooms (1990's-present)
2. Episodic low oxygen & fish kills
3. Emaciated drum, dead clams

Widespread brown tide in Baffin Bay, Laguna Madre

Significant fish kills in Baffin Bay (2007, 2010, 2012, 2015)

Loss of *Mulinia lateralis* in Baffin Bay (???-2013)



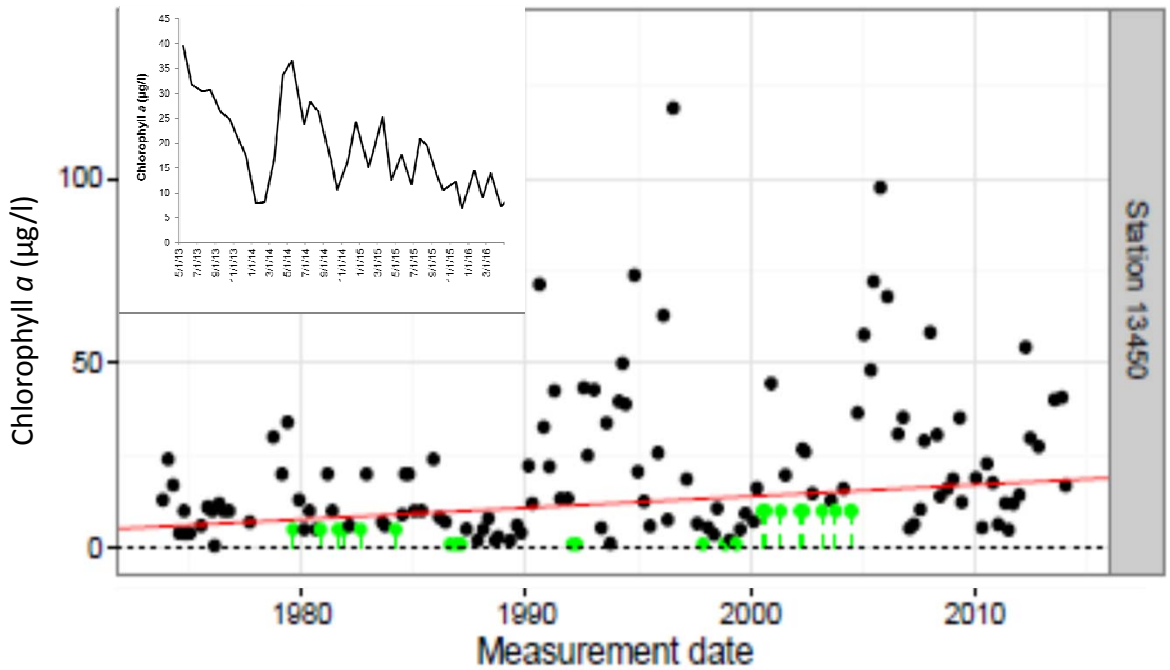
Emaciated (i.e., "jelly-flesh") Black drum in Baffin Bay (2012-2013)

Should we be concerned about the health of the Baffin Bay ecosystem?

Year-to-Year & Long-Term Trends: Chlorophyll *a*

= algal biomass; indicator of nutrient enrichment

- 2-fold increase since mid-1970's (Montagna & Palmer 2012)
  - Brown tide the primary culprit
- Year-to-year variability tied to rainfall patterns
  - Volunteer data important for fully understanding drivers of brown tide



What is driving long-term increase in chlorophyll & dense, prolonged brown tide blooms?

Potential Cause(s) of Long-term Increase in Algal Biomass

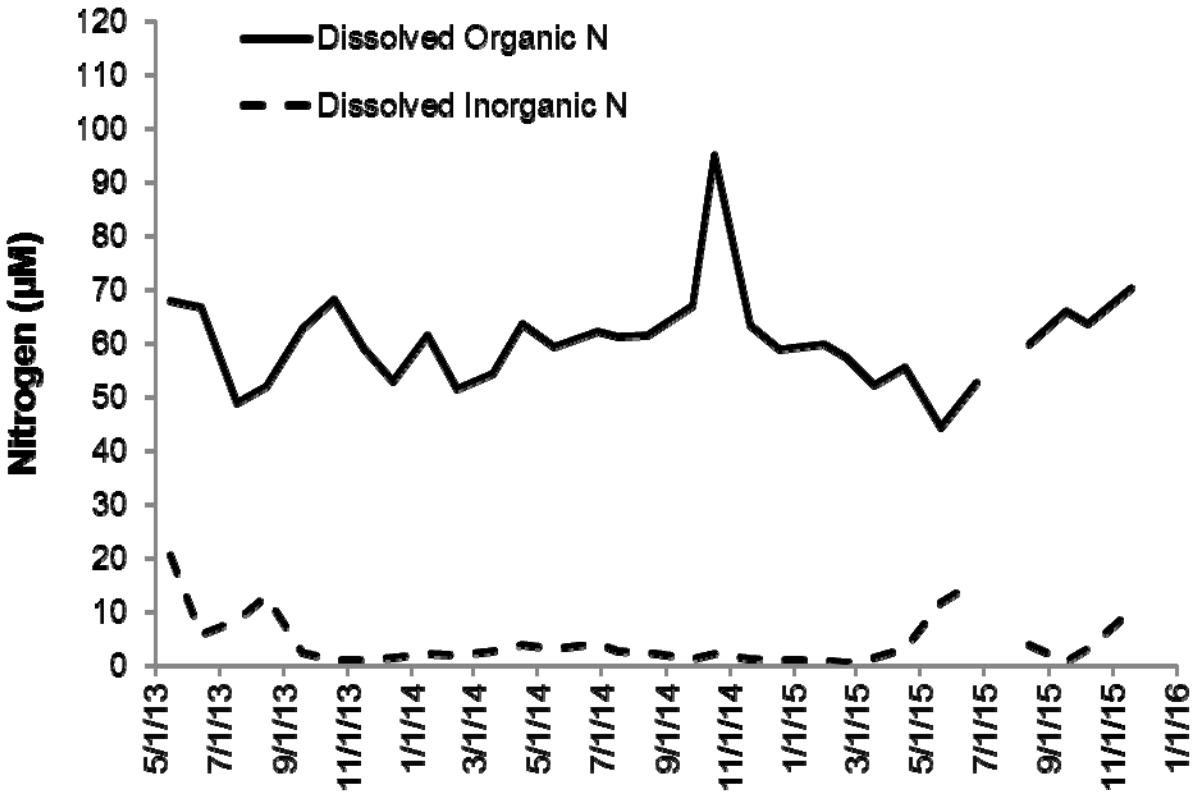
Baffin Bay is poorly flushed... Retains/recycles nutrients & sensitive to external inputs

Factors affecting algal growth:

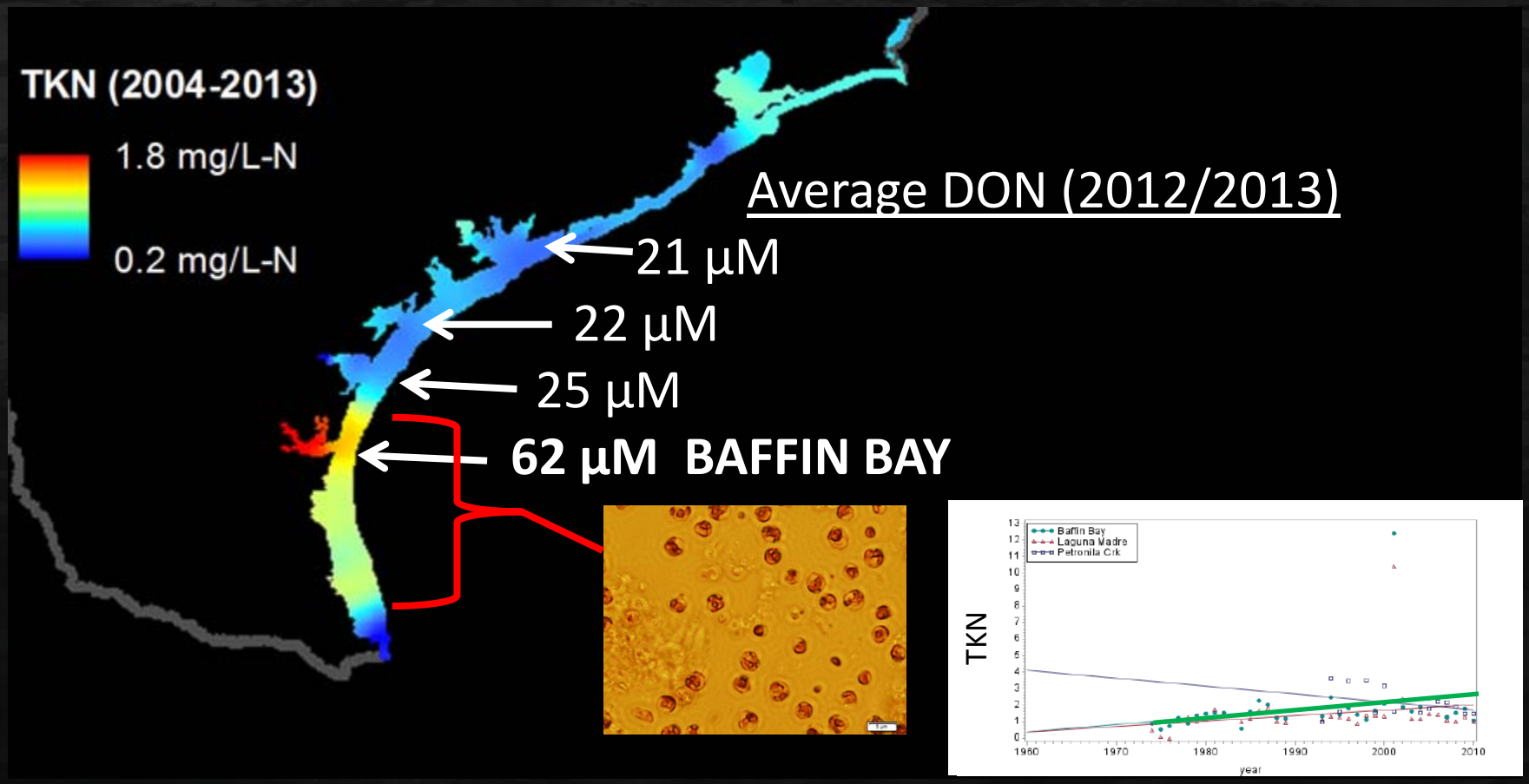
- Salinity- high salinity favors brown tide; salinity has decreased dramatically since ICW opening
- Benthic filter feeders- unknown change in population over time; die-off's in other systems have led to algal blooms
- Water temperature- enhances algal growth; increase since 1960's along much of Texas coast
- ***Nutrients (N and/or P)***- increases in several parameters since 1970's

Nitrogen in Baffin Bay

- Inorganic nitrogen generally low in surface waters
- ***Dissolved organic nitrogen conc. very high in Baffin Bay***



Brown Tide & Organic Nitrogen in Baffin Bay

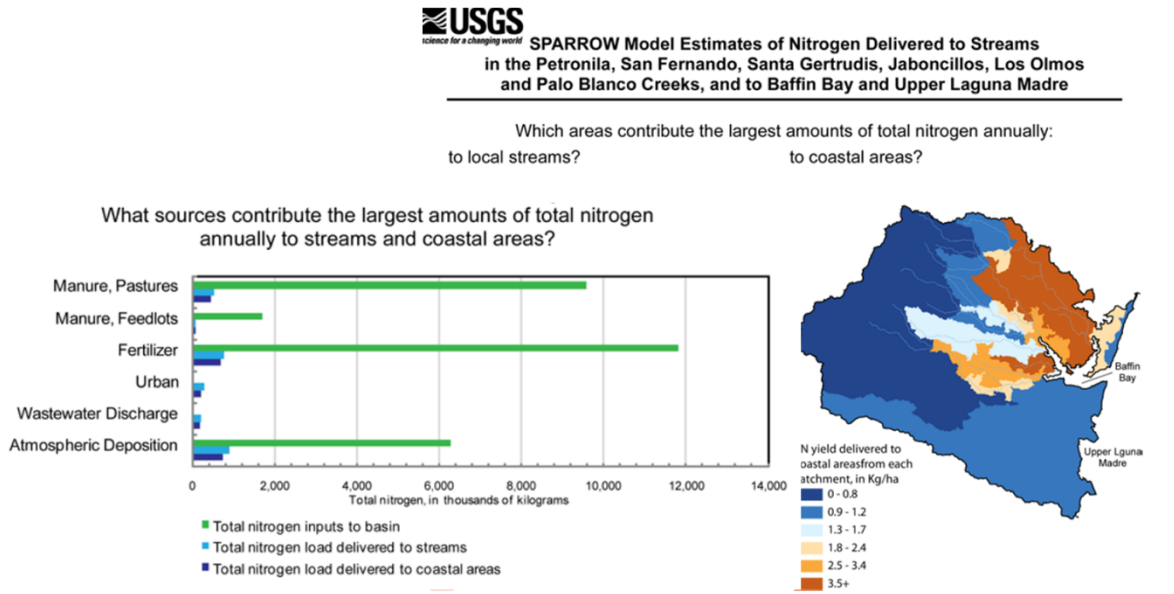


- TKN and DON 3-fold higher in BB than in other Texas bays
- High DON & brown tide linked in other systems
- TKN increased from mid-1970's to early 1990's, stabilized since (Montagna & Palmer 2012)

External Sources of Nitrogen to Baffin Bay

1. Fertilizer ≈ Atmospheric deposition
2. Manure
3. Wastewater ≈ Urban

- Likely varies depending on rainfall conditions



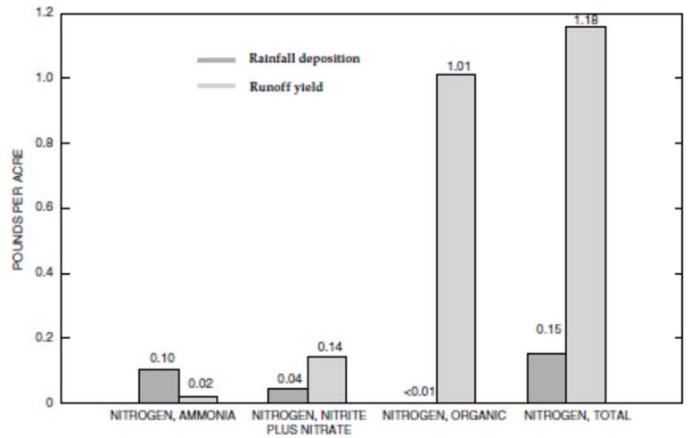
Rebich, R. A., Houston, N. A., Mize, S. V., Pearson, D. K., Ging, P. B. and Hornig, C. E. (2011), Sources and Delivery of Nutrients to the Northwestern Gulf of Mexico from Streams in the South-Central United States. Journal of the American Water Resources Association, 47: 1061–1086. doi: 10.1111/j.1752-1688.2011.00583.x

External Sources of Nitrogen to Baffin Bay

Organic nitrogen = urea-based fertilizers, animal waste & plant matter, wastewater, etc.

- USGS study – most of N from Petronilla Creek as particulate organic N; attributed to <u>crop residue</u>

- TCEQ data – very high algae levels in Petronilla Creek, increasing over time; <u>algal debris</u> flushed into bay?

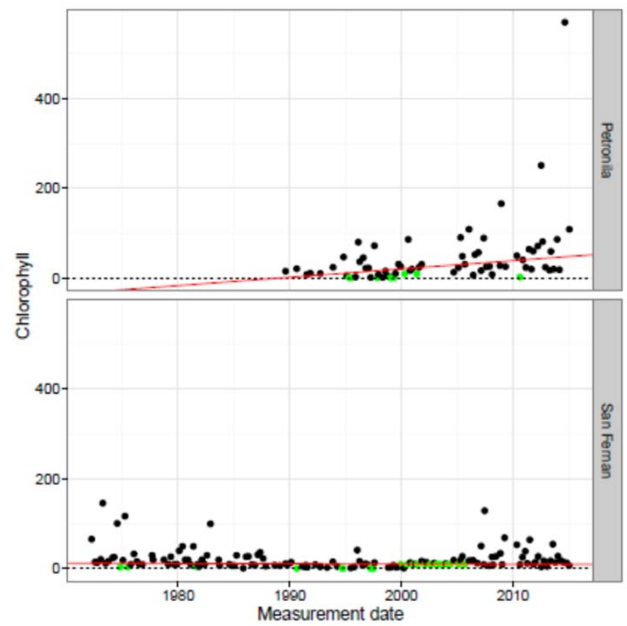


U.S. Department of the Interior
U.S. Geological Survey

Hydrologic Conditions and Water Quality in an Agricultural Area in Kleberg and Nueces Counties, Texas, 1996–98

By Darwin J. Ockerman and Brian L. Petri

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 01–4101



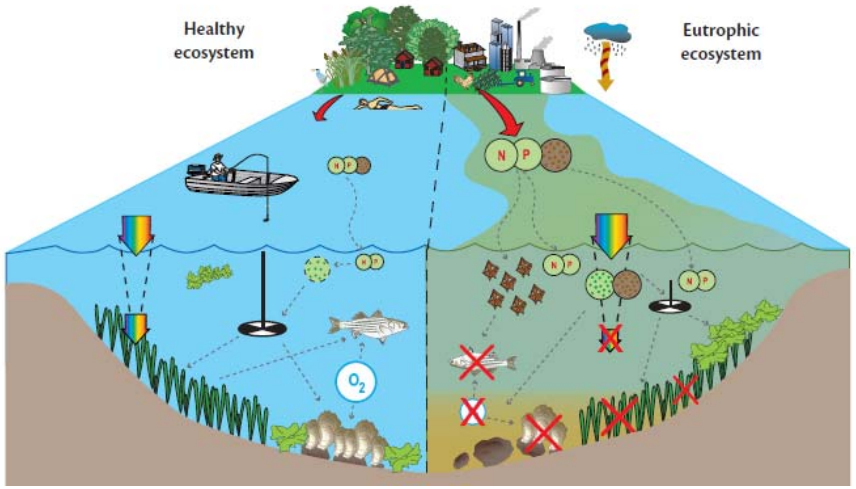
Should We Be Concerned About the Health of the Baffin Bay Ecosystem?

- Very high (AND increasing) chlorophyll & nitrogen levels in Baffin Bay

- Increasing temperature enhances algal growth, increases bacterial respiration & reduces dissolved oxygen levels

Yes, multiple indicators suggest that Baffin Bay water quality has deteriorated.

Given sensitivity of system to nutrient inputs, solutions are needed to reduce loadings to the system.



What Are The Solutions?

- Water temperature increase driven by larger climate system, beyond local capacity to resolve

- Increase flushing?
  - No major rivers or freshwater inputs
  - Previous opening of Yarborough Pass in 1940's only decreased salinity by few %
  - Chlorophyll continues to increase despite ICW opening and lower salinities than in past

- **Reduce nutrient inputs?**
  - Has been accomplished elsewhere
  - Public-private stakeholder partnership ideal, ***e.g., Tampa Bay restoration***

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