Harmful Algal Blooms in the Gulf of Mexico: Impacts on Fisheries

Michael Wetz
Outline

Gulf of Mexico HABs

*Karenia* (=GOMEX “red tide”) blooms

1) Background/Toxins

2) Bloom history

3) Ecology

Summary
Harmful Algal Blooms

• Harmful algal bloom (HAB) = proliferation of a toxic or nuisance algal species that negatively affects natural resources or humans

• Several taxonomic groups contain HAB species

• Each has unique life cycles, nutrient requirements, motility, toxins

• \(\leq 100\) HAB species currently documented

Why Do We Care About HABs?

- Losses (public health, commercial fishery, recreation/tourism, management) due to HABs equal ~$50 million/year in year 2000 dollars (Anderson et al., 2000)

- Can be an indicator of degrading ecosystem health in some circumstances
Mode of action on humans/fisheries

- **Ingestion of toxin-containing fish/shellfish:** *Gambierdiscus, Dinophysis, Pyrodinium bahamense, Pseudo-nitzschia sp.*
- **Ecosystem “disruption”:** *Aureoumbra lagunensis, Pyrodinium bahamense*
- **Direct toxin production:** *Karenia sp.*
Gambierdiscus toxicus
- Epiphytic dinoflagellate (attaches to structures in GOMEX)
- Tropical-subtropical regions
- Causes ciguatera poisoning
- Toxin accumulates in fish & transferred to humans when consumed

Pyrodinium bahamense
- Bioluminescent dinoflagellate
- Tropical-subtropical regions
- Blooms common in Florida estuaries, occasionally Texas
- Some strains produce toxins that bioaccumulate & cause paralytic shellfish poisoning

Pseudo-nitzschia sp.
- Common coastal diatom
- Several species produce domoic acid, which bioaccumulates
- Can cause amnesic shellfish poisoning
- Has caused bird & marine mammal mortalities on U.S. West Coast; domoic acid found in Alabama coastal fish during recent bloom

From: Mertens et al, 2015, Harmful Algae 41: 1-24
**Pyrodinium bahamense**

- Blooms in Florida estuaries have led to low dissolved oxygen conditions & fish kills
- 2010 bloom in Baffin Bay, Texas, coincided with low dissolved oxygen conditions & large fish kill

**Aureoumbra lagunensis**

- “Brown tide”
- Forms widespread, prolonged (years) blooms in Laguna Madre-Baffin Bay of Texas since 1990; more recently in Indian River Lagoon (FL), Guantanamo Bay
- Causes severe decline in light penetration, seagrass die-off
- May negatively affect food web due to poor nutritional attributes

From: Mertens et al, 2015, Harmful Algae 41: 1-24

From: Mike Weeks, Texas Parks & Wildlife; http://tpwd.texas.gov/landwater/water/enviro nconcerns/hab/brown_tide/overflight.phtml
Karenia Brevis (GOMEX “Red Tide”)

- Dinoflagellate found in subtropical-tropical regions
- Produces a powerful toxin (brevetoxin) that can bioaccumulate & become aerosolized
- Brevetoxin causes respiratory irritation in humans, mass mortalities of fish, marine mammals & sea birds (Landsberg, 2002; Flewelling et al., 2005)

From: www.earthmagazine.org
History of *Karenia* Blooms in the GOMEX

- *Karenia* blooms w/ concomitant fish kills/human health implications documented as far back as 1850s in western GOMEX
- Impacts noted throughout Gulf of Mexico; majority of blooms occur on West Florida Shelf, followed by Texas coast

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A historical assessment of *Karenia brevis* in the western Gulf of Mexico
Hugo A. Magaña\(^{a, b}\), Cindy Contreras\(^{b}\), Tracy A. Villareal\(^{b, c}\)
Karenia Bloom Dynamics

Will Desertification of N. Africa (Due to Climate & Land Use Change) Lead to Increased Dust Transport & Red Tide Frequency/Intensity?

- On West Florida Shelf, blooms initiate in bottom waters that get transported inshore, brought to surface.
- Texas blooms start at surface on shelf, transported towards coast when winds shift.
- Annual cycle of Saharan dust deposition provides nutrients for Trichodesmium (N₂ fixer) that eventually dies & releases Nitrogen to fuel Karenia growth.
- Physical aggregation important for bloom magnitude.

(Courtesy of: Dr. Jason Lenes, USF)
Multiple sources of nutrients have been implicated to support *Karenia* blooms in the eastern GOM. Do anthropogenic nutrients support continued *Karenia* growth once blooms reach bays/estuaries?
Mainly localized examples of anthropogenic nutrient-driven HABs

Population growth & watershed land use change will increase pressure on GOMEX coastal ecosystems over coming decades
Late 2015 *Karenia* Bloom – Northern Gulf of Mexico

- Early indications that bloom coincided with warmer than average waters
- Suggestion that bloom initiation driven by anomalous winds that pushed seed stock to NW along west Florida Shelf

Red tide algae strikes Coast, poses health concerns, officials say
Progress in Understanding Bloom Formation

- Major progress over past decade in terms of understanding drivers of bloom formation, bloom forecasting/prediction
- Involves satellites, gliders & other autonomous vehicles, integrated modeling approaches
GOMEX affected by (more-or-less) natural HABs & localized examples of HABs that may be anthropogenically-influenced

*Growth & land use pressures will require careful attention to effects on water quality & coastal ecosystem health in GOMEX*

Significant progress (investment) in observational technologies & modeling have greatly increased ability to predict & understand HAB formation in the GOMEX

**What’s natural, what’s not? Continued investment needed...**
“Citizen Scientist” Water Quality & Brown Tide Sampling in Baffin Bay (TX)

- Intensive sampling program established in 2013
- Working with recreational & commercial fishermen, guides, B&B owners
- Data allowing us to make major progress in understanding Brown Tide blooms, effects on ecosystem health

• Opportunities abound throughout Gulf...

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• Dr. Jason Lenes (USF Marine Science)