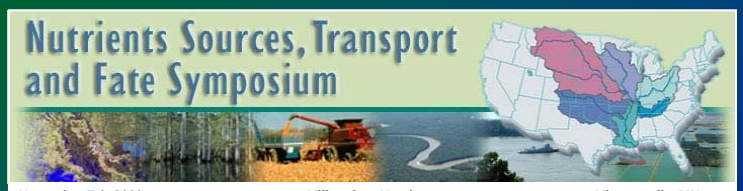
Summary of Symposium Science Findings, Gaps, and Research Needs



November 7-9, 2009 *Millennium Hotel* *Minneapolis, MN*

http://www.tetratech-ffx.com/nutrient_fate_symposium/agenda.htm

Sponsored as part of the Reassessment of the Action Plan for Reducing, Mitigating and Controlling Hypoxia in the Northern Gulf of Mexico (2001)

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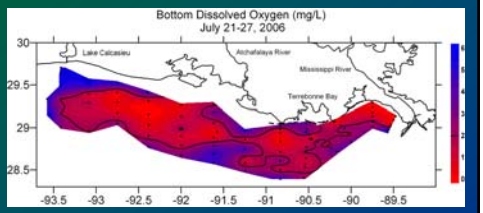
Outline

- Science Understanding/Gaps and Research Needs for:
  - Gulf Hypoxia
  - Nutrient Sources
  - Nutrient Processing, Transport, and Fate
- General Summary

Gulf Hypoxia

Understanding



Hypoxia measured 1970-now during the wettest period since 1900

Spring NO3 flux explains about 70-80% of hypoxia

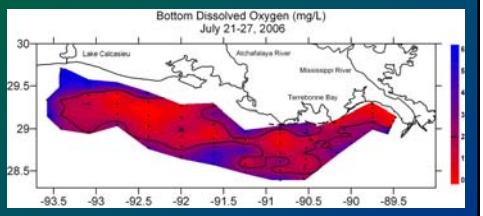
Increased N flux has altered the N/P ratios- P can be limiting in low salinity near-coastal waters, but as salinity increases, N becomes limiting

Local respiration can cause hypoxia in 1-3 weeks

Changes in distributaries could influence sediment and nutrient loads, or even increase hypoxia

Recovery of Gulf lags changes in flux, but reduction will eventually reduce hypoxia

Gulf Hypoxia



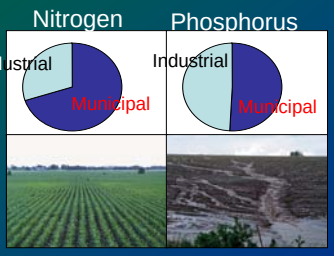
Gaps and Research Needs

Use a N reduction strategy or a dual N/P strategy to control hypoxia

Comparison of current (wet period) hypoxia size to historical size and size during average precip

Nutrient Sources

Understanding



Crops varied about 8% the last 100 years; fertilizer use increased several 100% and soybeans increased 300% since 1970s

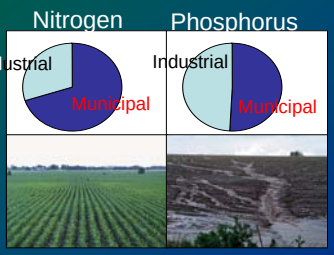
"Developed" land has increased greatly since 1982 at the expense of crop/pasture land, increasing runoff and possibly municipal point sources

Agriculture is the main contributor of nutrients, but there are different sources of N compared to P (tile drainage, livestock waste)

N and P contributions from multiple sources/locations suggest range of management approaches needed for desired reductions

Nutrient Sources

Gaps and Research Needs



Location of sub-surface drainage (NRI lost ability after 1997 due to switch to photo-interpretation), info on practices on Federal lands

Better PS data needed, including regular effluent monitoring for TN and TP, and wet weather sampling for flux estimation- lack of PS data introduces flux and model uncertainties

Effects of crop changes made to increase ethanol production need to be simulated and compared to current fluxes and potential for meeting desired nutrient reductions

Nutrient Processing, Transport, and Fate

Understanding- Flow

Decadal averages of flow increase since 1800s; step increase ~1970

From 1950-90s, 13% increase in precip, shift of 10-20 days earlier in planting date, shift in peak N flux from Mar/Apr to May/June

Less runoff in some basins now than in the 1930s

Comparison of 1980-96 average flow to average 5-year windows from 1996-2005 shows:

Annual flow decreased ~ 9.5% through 2005

Spring flow decreased ~ 11%

Flow explains ~ 70% of NO3 flux variability

Nutrient Processing, Transport, and Fate

Understanding- Nutrient Flux

Both annual and spring fluxes decreased 2000-05 for TN, NO3, PO4; TP increased; unknown statistical sig

Comparison of 1980-96 to 1996-2005 shows that flow, TN, and TP increased in Ohio; NO3 increased in Ohio and Upper Miss; unknown statistical sig

Up to 10% of eroded soils can travel downriver- important source of anoxia in GOM along with high OC deltaic sediments

SPARROW predictions of annual flux have R2/SE= 0.89/47% for N, 0.74/65% for P

Major flux error is uncertainty from sampling freq and flow coverage- need frequent long-term WQ data, need WQ data from multiple years to account for GW contribution in trend analyses

Nutrient Processing, Transport, and Fate

Understanding- Stream Processes

Miss mostly P, C limited, SiO2 enriched- buildup of P in soils may reach a threshold and increase P release to streams

PO4 moves conservatively in streams with little uptake or retention- in WI study, uptake of PO4 was not measurable for 1-3 km

P temporarily deposited in streams can be biologically available later, in oxic or anoxic conditions; in MN ~50% of P was soluble, ~30% loosely bound to seds and biologically available; particulate P can be higher at low than high flow (chlorophyll and algae)

In a Miss R study above the Atchafalaya diversion, ~10% TN lost through denit- residence time significant factor

Nutrient Processing, Transport, and Fate

Understanding- Riparian/Wetland Processes

Denit highest in riparian zones of streams < than 3rd order, still significant in streams of 3rd-5th order

TP, chl generally higher and TN, NO3 lower in backwaters than the main channel; as flow increases, differences decrease

More than 2500 km2 of new backwater areas needed to increase average denit rate to >5% in the upper Miss region

Long-term wetland NO3 retention may stay high, but P retention diminishes with time

Nutrient Processing, Transport, and Fate

Understanding- Nutrient Management

Nutrient mgmt (appls, methods, timing) ~ 20% N decrease from tile areas

Mgmt in OH, IN, IL, IA, and MN can reduce annual NO3 loads ~ 30-50%

Stream buffers ineffective if tiles bypass; water retention w/ tile control can reduce N flux up to 80%, depending on climate/tile configuration; buffers remove up to 75% of P in small WI streams

Land use changes, offsite wetlands, perennial crop changes may be needed to get a 30-45% overall N reduction

High sources of N need treated; promotion of the wrong practices needs to be avoided, economics must be considered

Nutrient Processing, Transport, and Fate

Gaps and Research Needs

Evaluate flows and fluxes as decadal or 5-yr trends (precip and river flux demonstrate decadal trend)

Set goal for spring N flux with/instead of annual fluxes

Capacity, efficiency, and sustainability of using backwaters and wetlands to reduce nutrients

Effects of coastal restoration diversions and/or crop changes for ethanol on nutrient fluxes

Nutrient Processing, Transport, and Fate

Gaps and Research Needs

Role of P in hypoxia, and how much of P is bioavailable

Build lag times into models estimating flux and trends- Miss R contains water mixtures that can be anywhere from recent to 50 years old, and NANI shows 2-5 yr lags

Improve tile drainage in models

Consider effects of high nutrients on chlorophyll, fish. Algal, and macroinvertebrate communities in addition to fluxes

General Summary

Main hypoxia drivers from rivers are flow and associated NO3 flux

Most NO3 travels conservatively except for lower order streams, floodplains, retention by reservoirs, diversions, wetlands

Wetlands diversion/treatment offers some promise, but large scale/long-term performance not clear

Limited opportunities for significant reduction of N compared to total flux; numerous small reductions add up, but are easily overwhelmed by climate, crop/fertilizer change

General Summary

Debate about the role of P and the amount of bioavailable P in streams

High source areas (including tiled areas) need treatment, but still may not be able to accomplish desired reduction enough without cropping changes

Potential large changes in cropping for ethanol production and diversion changes for coastal restoration may increase hypoxia without concurrent, focused efforts to reduce nutrient sources

Increased WQ monitoring (frequency/spatial coverage) and improved models may firm up quantitative, but sources of hypoxia generally understood. Challenge is economical and acceptable implementation of successful nutrient controls– with measured improvement!