The Role of Midwestern Agriculture in Gulf of Mexico Hypoxia

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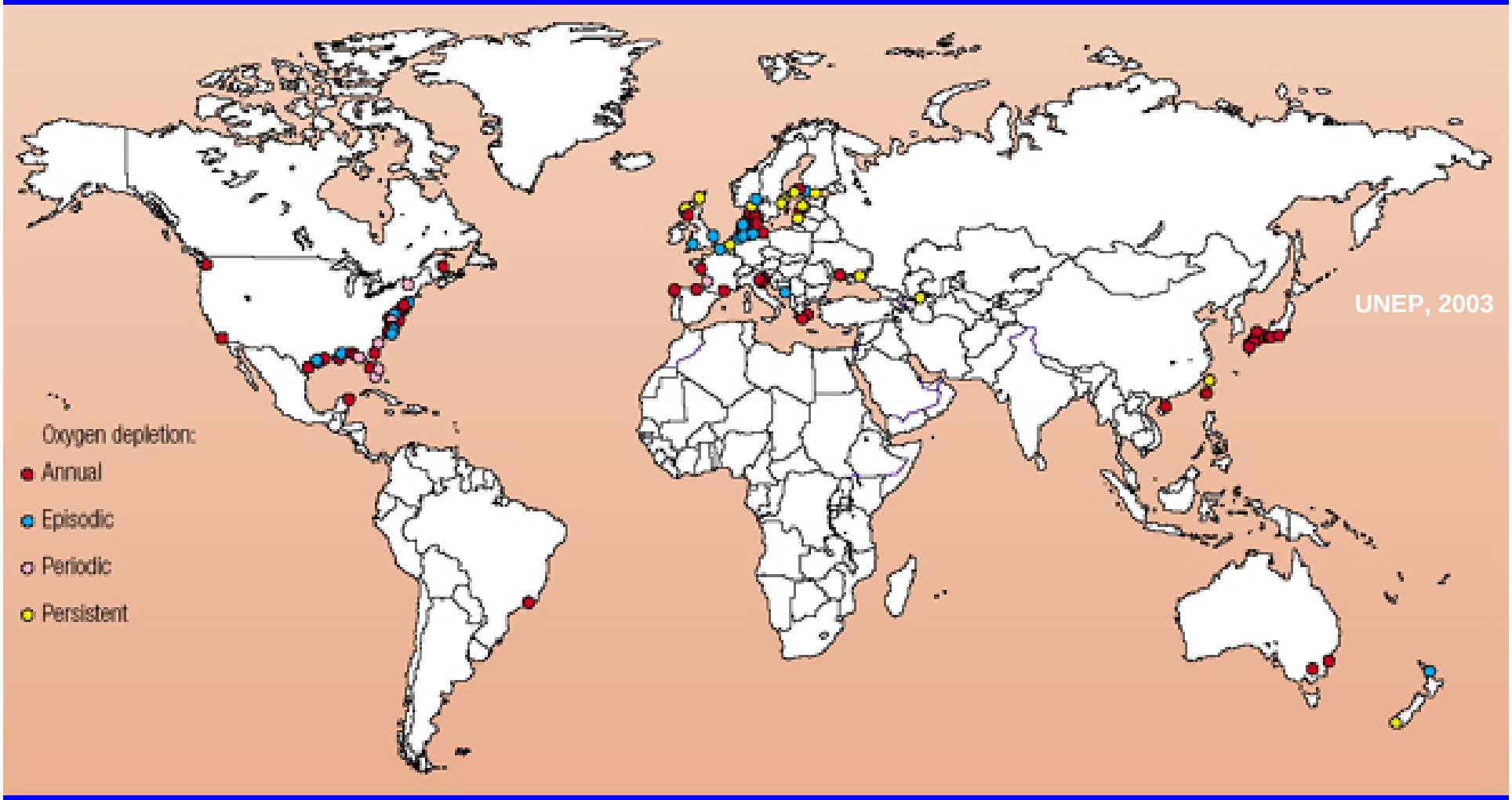
Photo: Nancy Rabalais, Louisiana Universities Marine Consortium

What is hypoxia?

- Hyp = low
- Oxia = oxygen
- Hypoxia = low oxygen
  - defined as less than 2 ppm oxygen dissolved in water
  - most aquatic organisms will die with prolonged exposure

Oxygen-Starved Coastal Zones

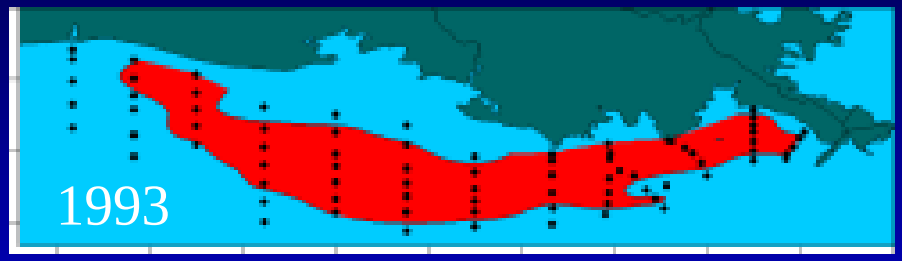


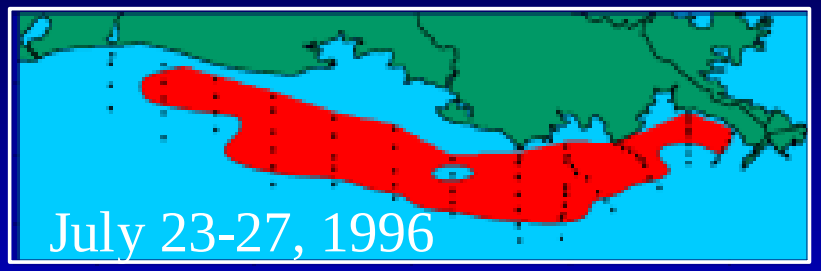
Hypoxia in the Gulf of Mexico

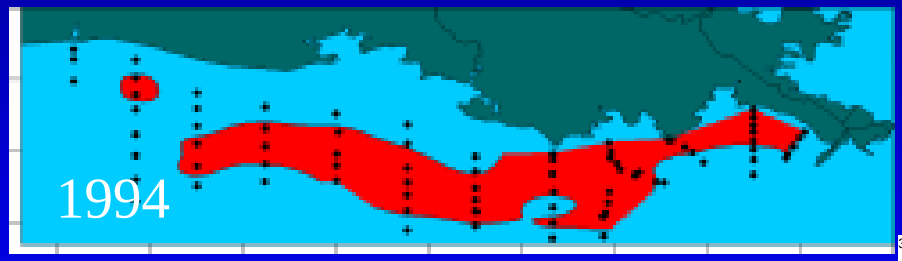
- Seasonal (appears in summer)
- Associated with phytoplankton bloom (single-celled marine plants)
- N is limiting nutrient in marine waters
  - adding N should increase phytoplankton growth
    - could increase hypoxia; depends on conditions
  - similar effect to P added to fresh water

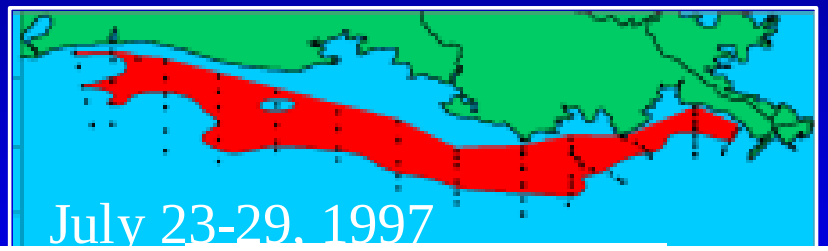
GOM Hypoxia Since 1993

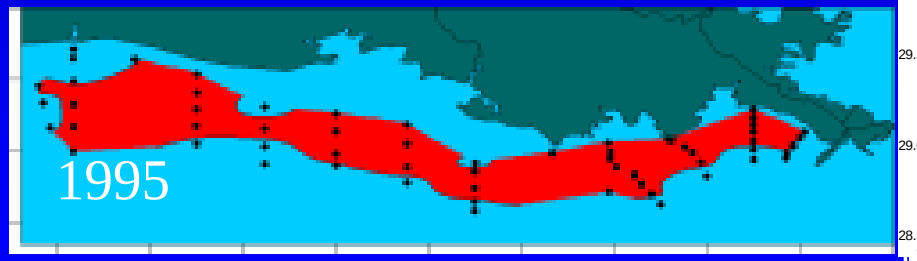
Source: Rabalais, Turner, and Wiseman

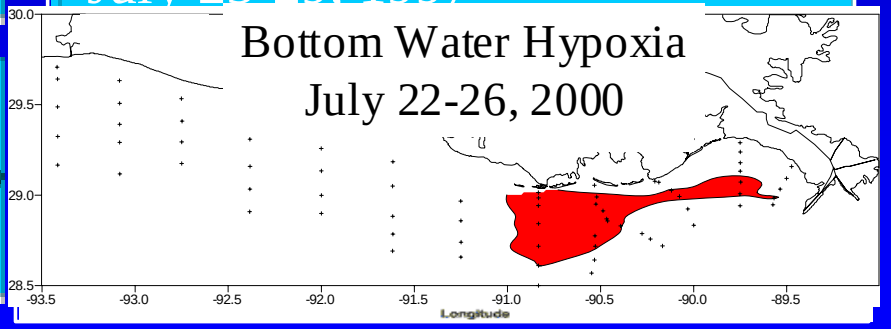




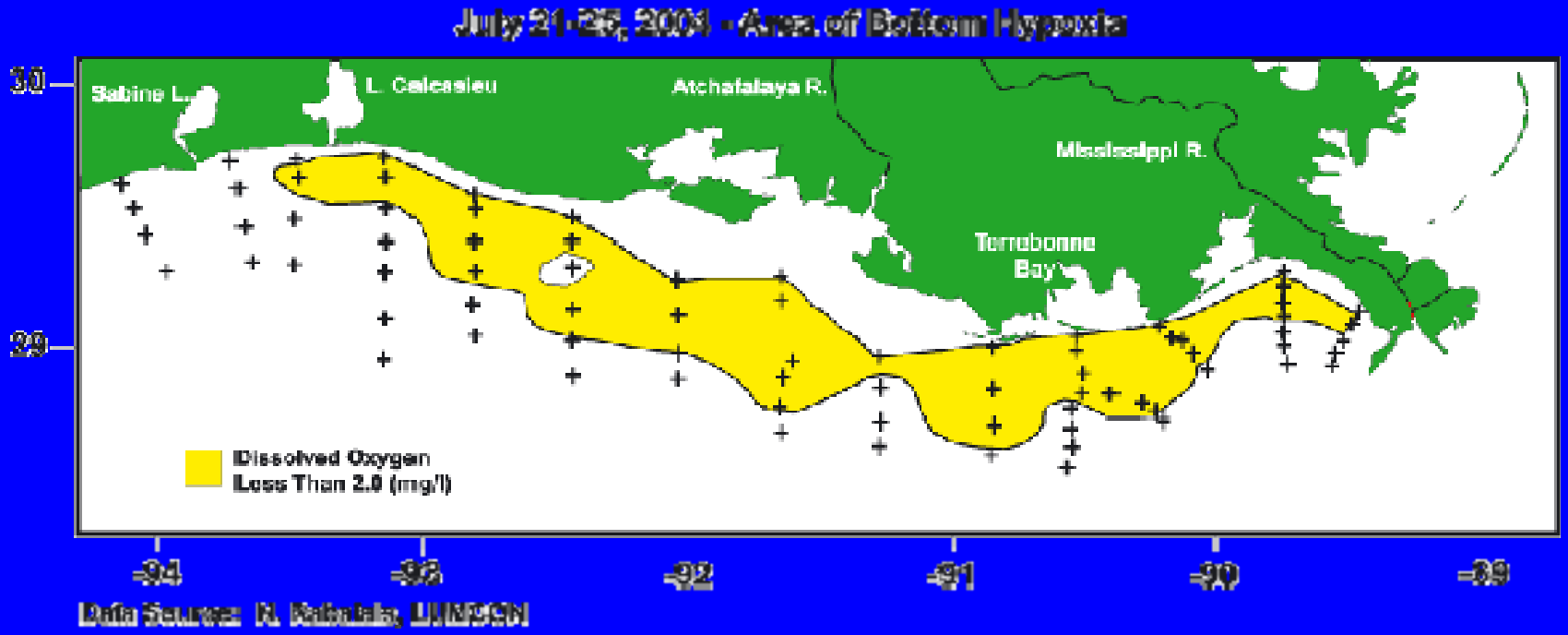




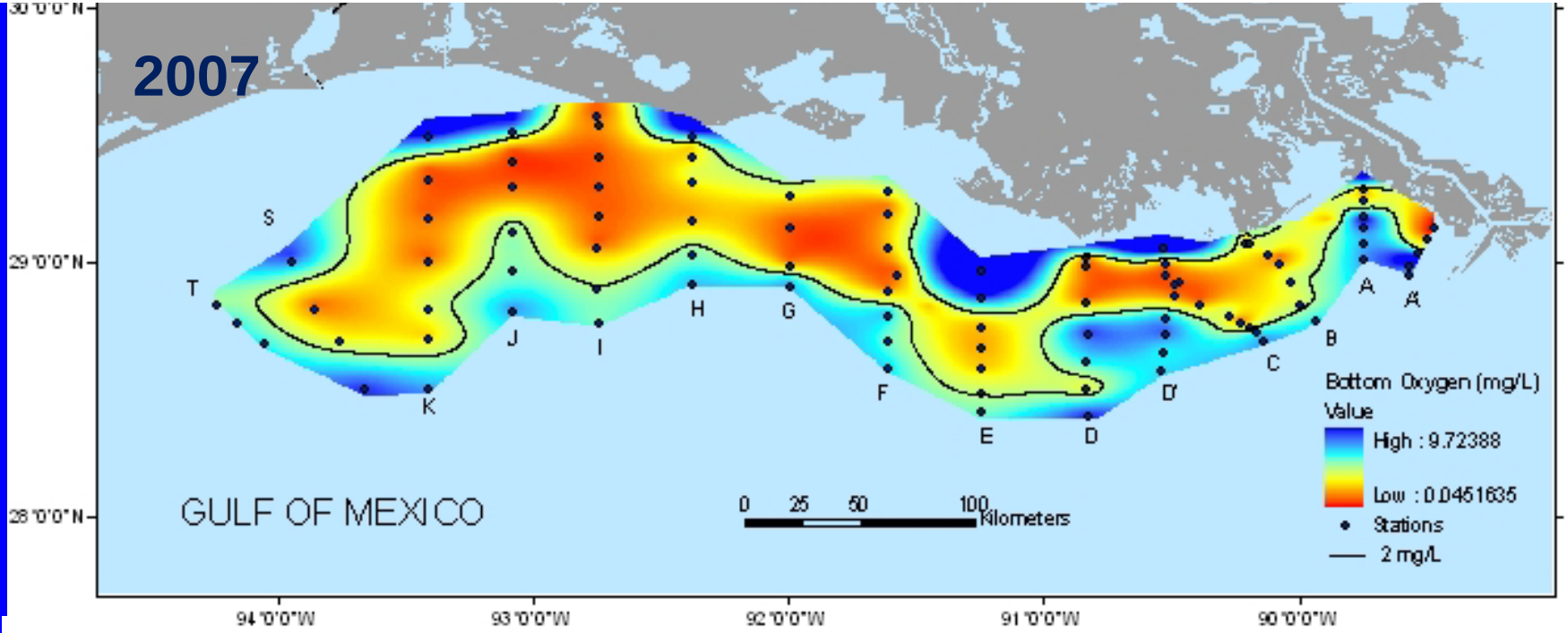


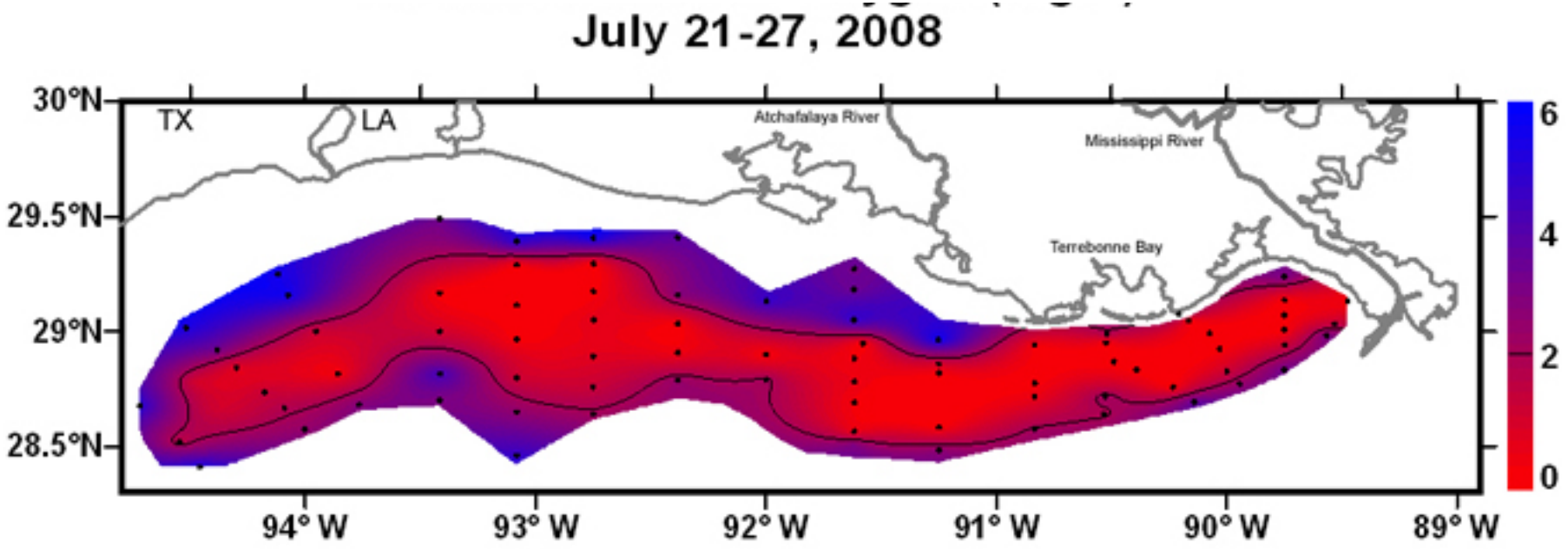


Hypoxia in July 2004



The hypoxic zone is closer than normal to the Louisiana coast this year (persistent winds from south). As a result, shrimp trawlers did not have success.

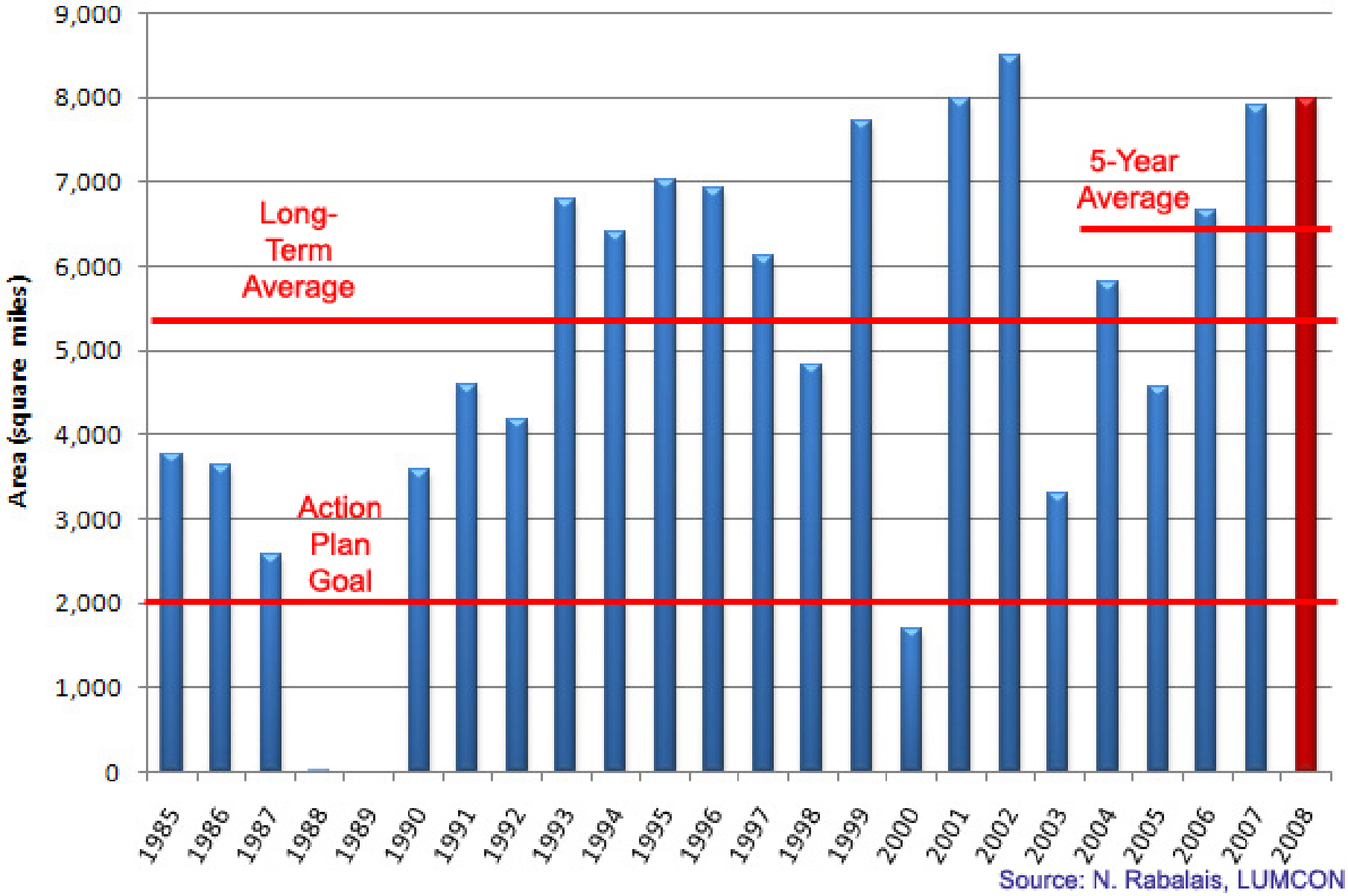


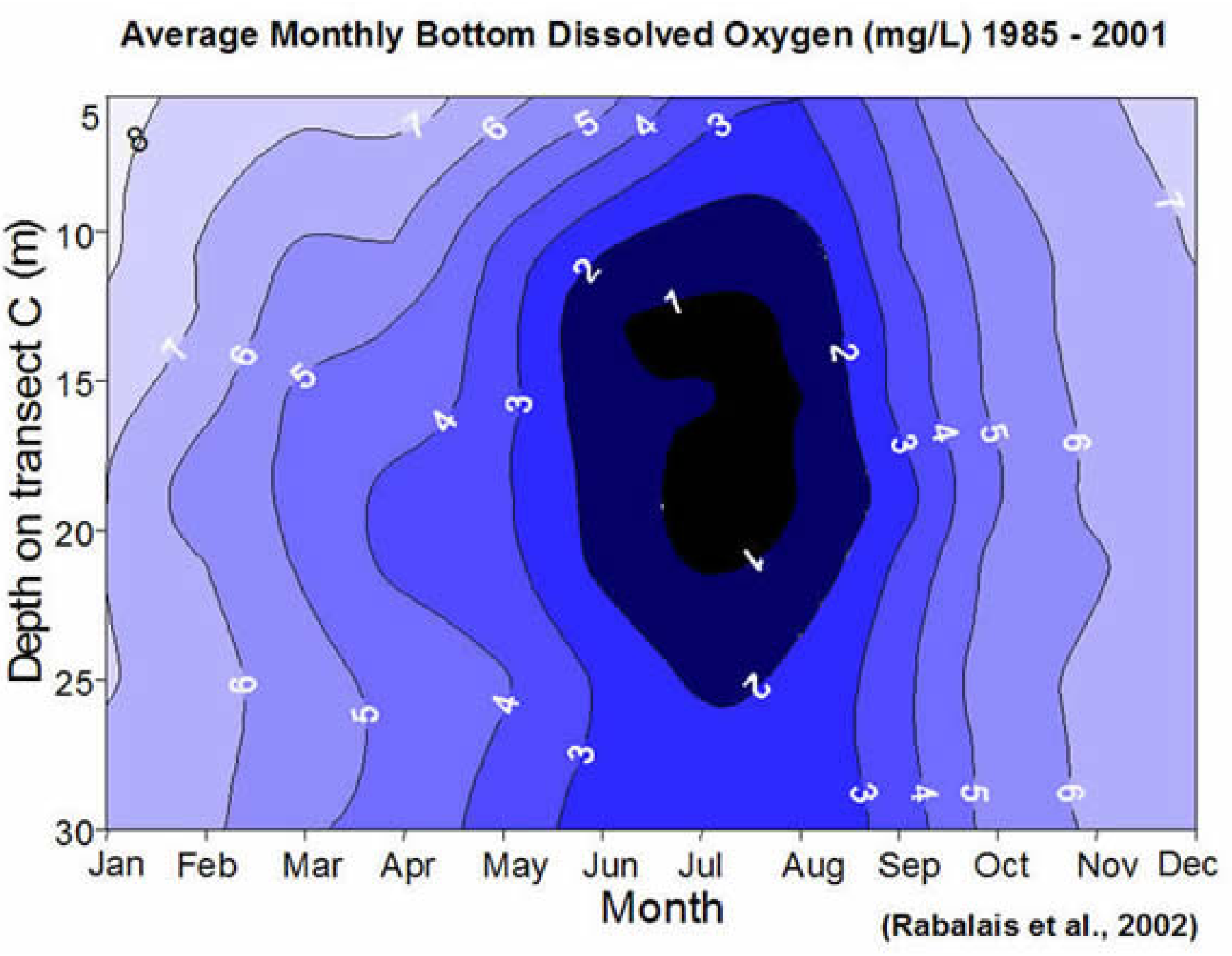


Data source: N. Rabalais, Louisiana Universities Marine Consortium

Map by B. Babin

Area of Mid-Summer Bottom Water Hypoxia (Dissolved Oxygen < 2.0 mg/L)




Average Monthly Bottom Dissolved Oxygen (mg/L) 1985 - 2001
Depth on transect C (m)
5
10
15
20
25
30
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
(Rabalais et al., 2002)

Hypoxia and N fertilizer

- N fertilizer use
  - started after World War II
  - increased until 1980
  - pretty much level since 1980
- Mississippi River N
  - increased from 1950-1980 then leveled off
- Hypoxic zone in the Gulf
  - only measured since 1985

Source: USGS. Open File Report 97-230
(Also on the internet)

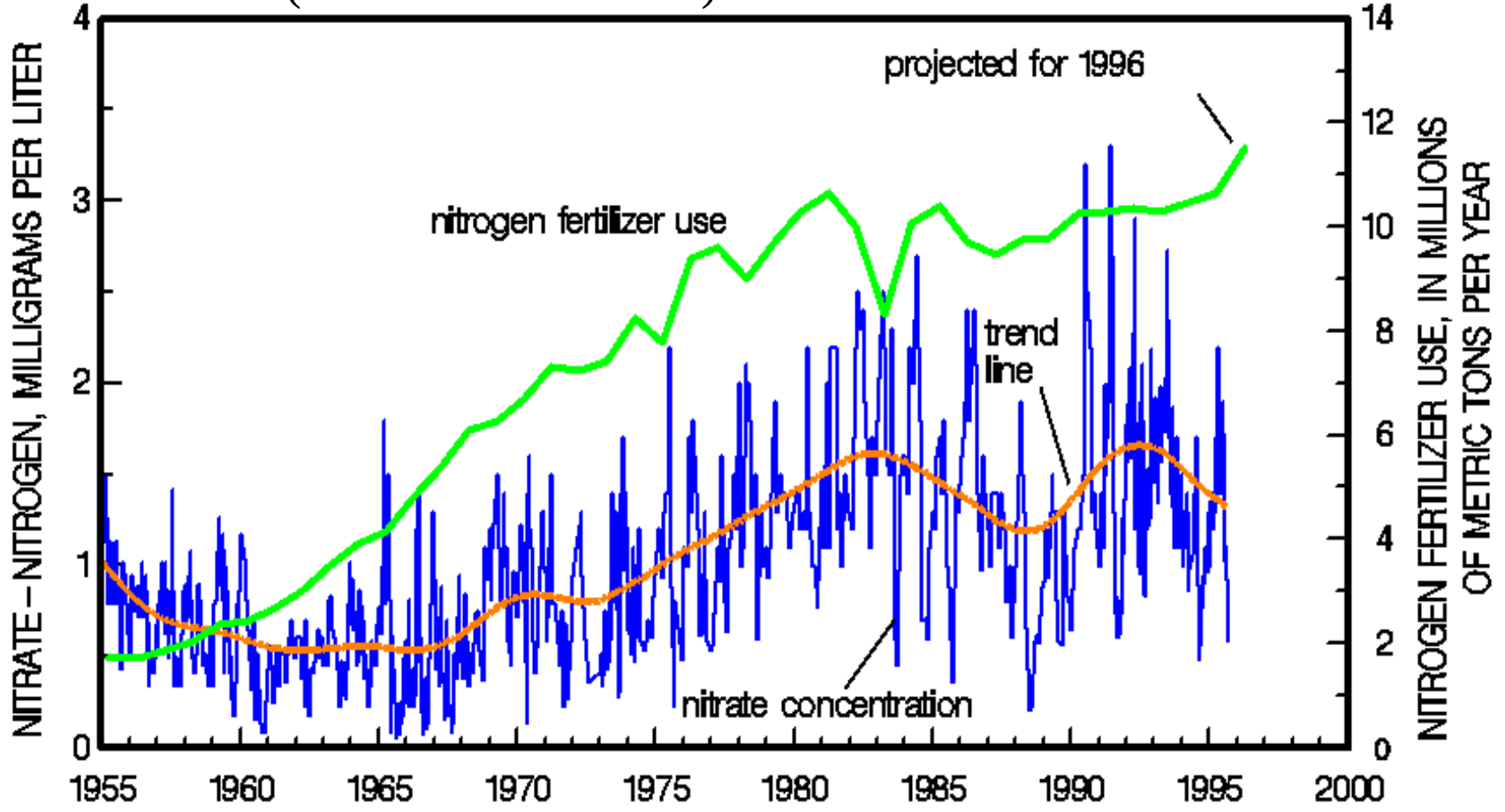
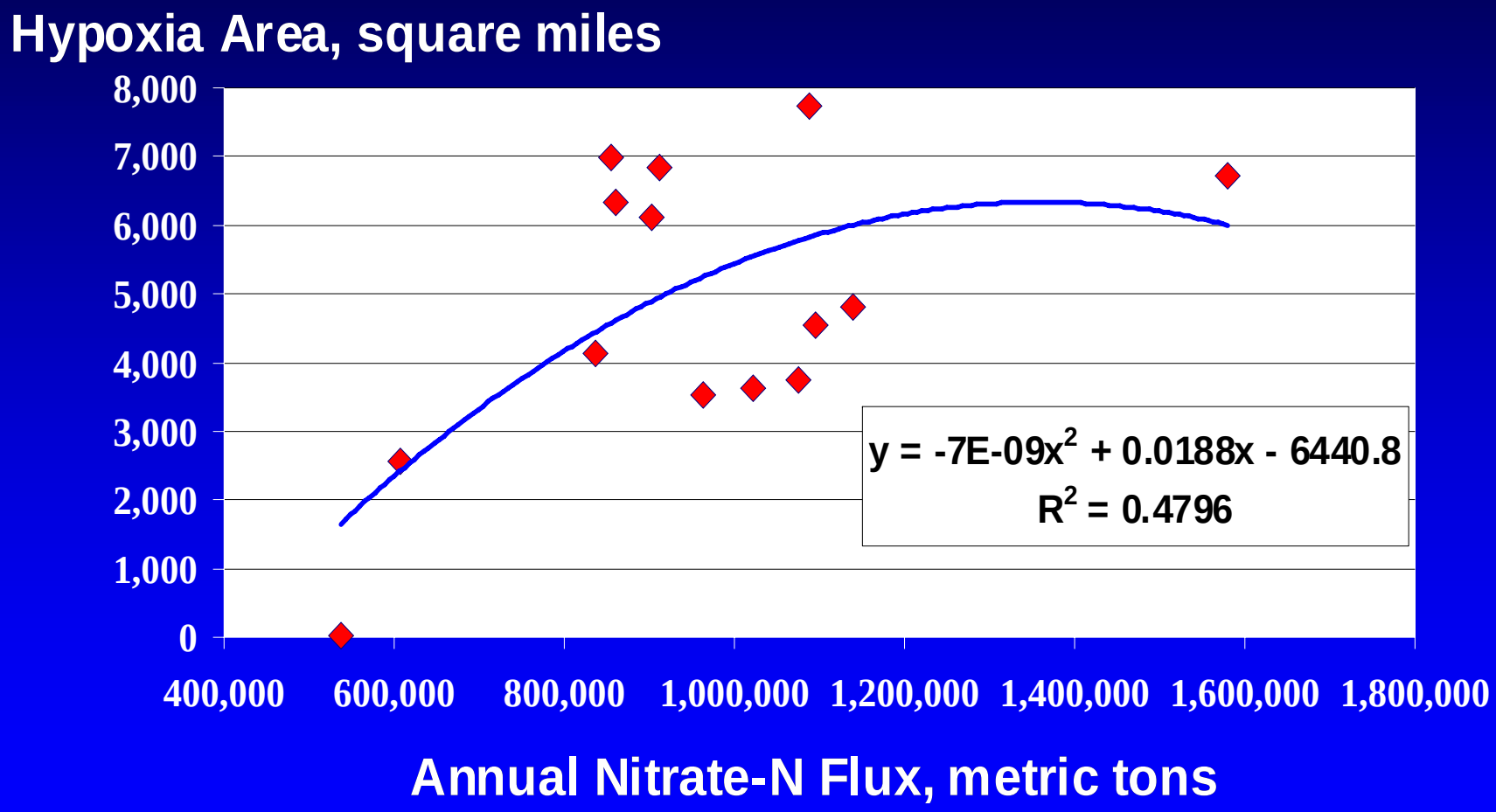


Figure 1. Estimated nitrogen fertilizer use in the Unites States, and nitrate concentrations in the Mississippi River at St. Francisville, LA., 1955–95.

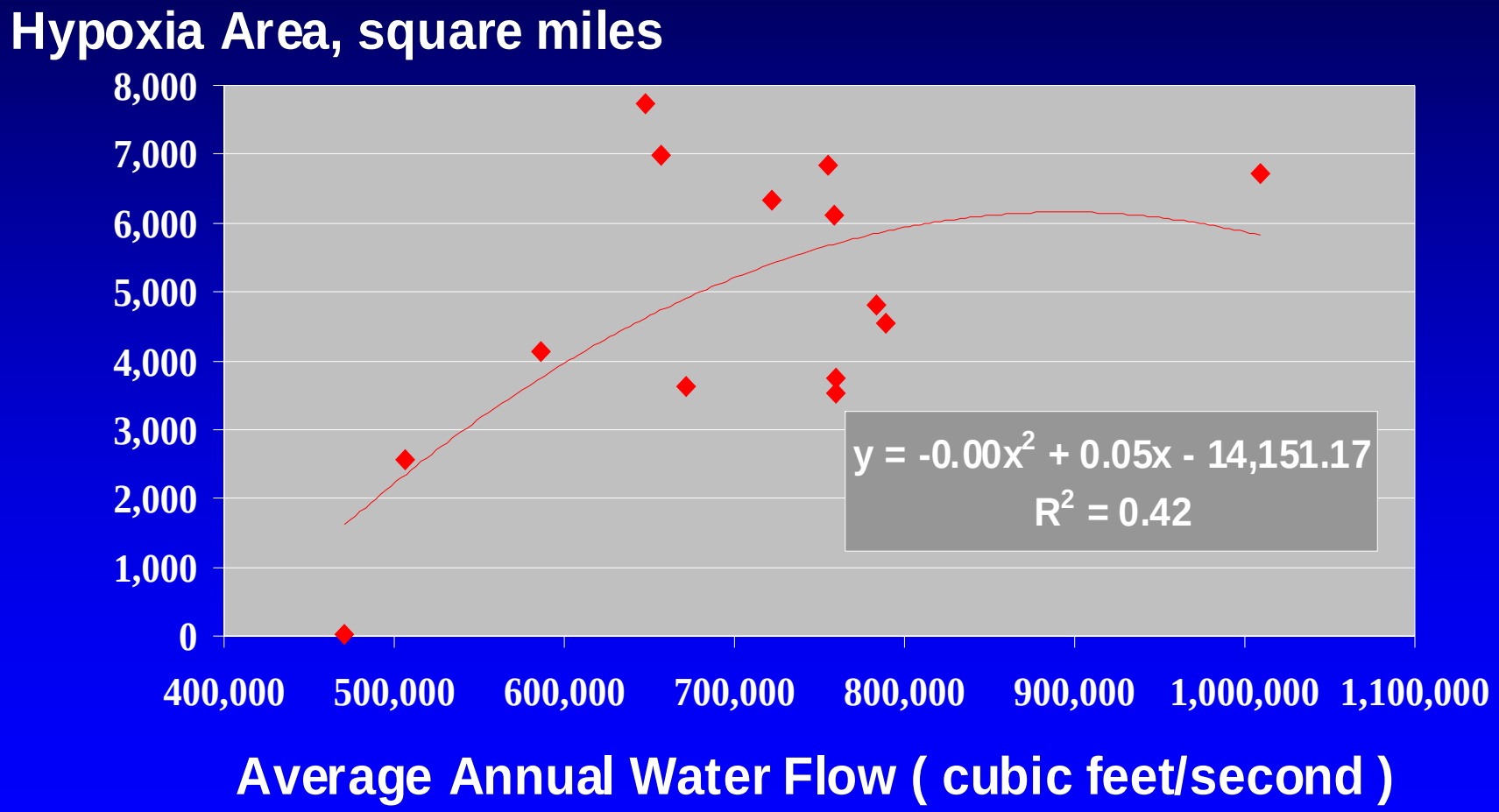
Size of the hypoxic zone

- Only measured since 1985
- Size related to N going down the river but not to N use (fairly constant)
- N going down the river related mostly to flow differences from year to year

Hypoxia Area in Gulf of Mexico & Mississippi River Nitrate-N Flux (1985-1999)



Hypoxia Area in Gulf of Mexico & Mississippi River Water Flow Rate



EPA Action Plan

- Developed by Mississippi River/Gulf of Mexico Watershed Nutrient Task Force
- Issued for public comment by EPA summer 2000
- All voluntary
- Targets:
  - *Initially:* reduce N load to Gulf by 30%
  - *Now:* reduce 5-year average size of hypoxic zone to below 5000 square kilometers
    - Use “adaptive management” (i.e. whatever works)

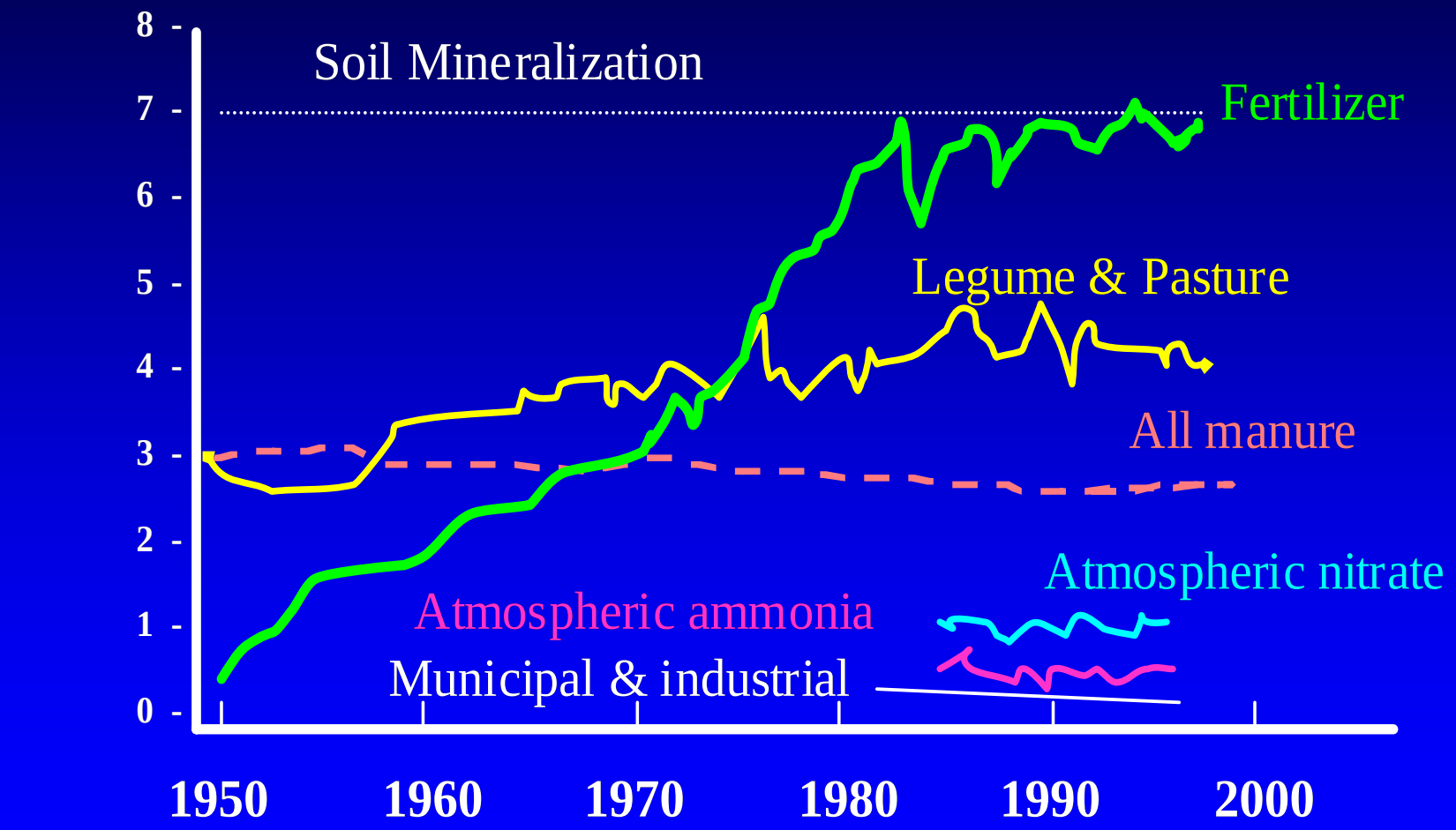
http://www.epa.gov/msbasin/actionplan.htm

Reducing N load by 30%

- Total N load to Gulf is about 1.8 million tons/year
- Increase since 1950 about 1 million tons/year
- 30% reduction = 0.5 million tons/year
- annual fertilizer N use about 7 million tons/year

Annual N Inputs to Mississippi Basin

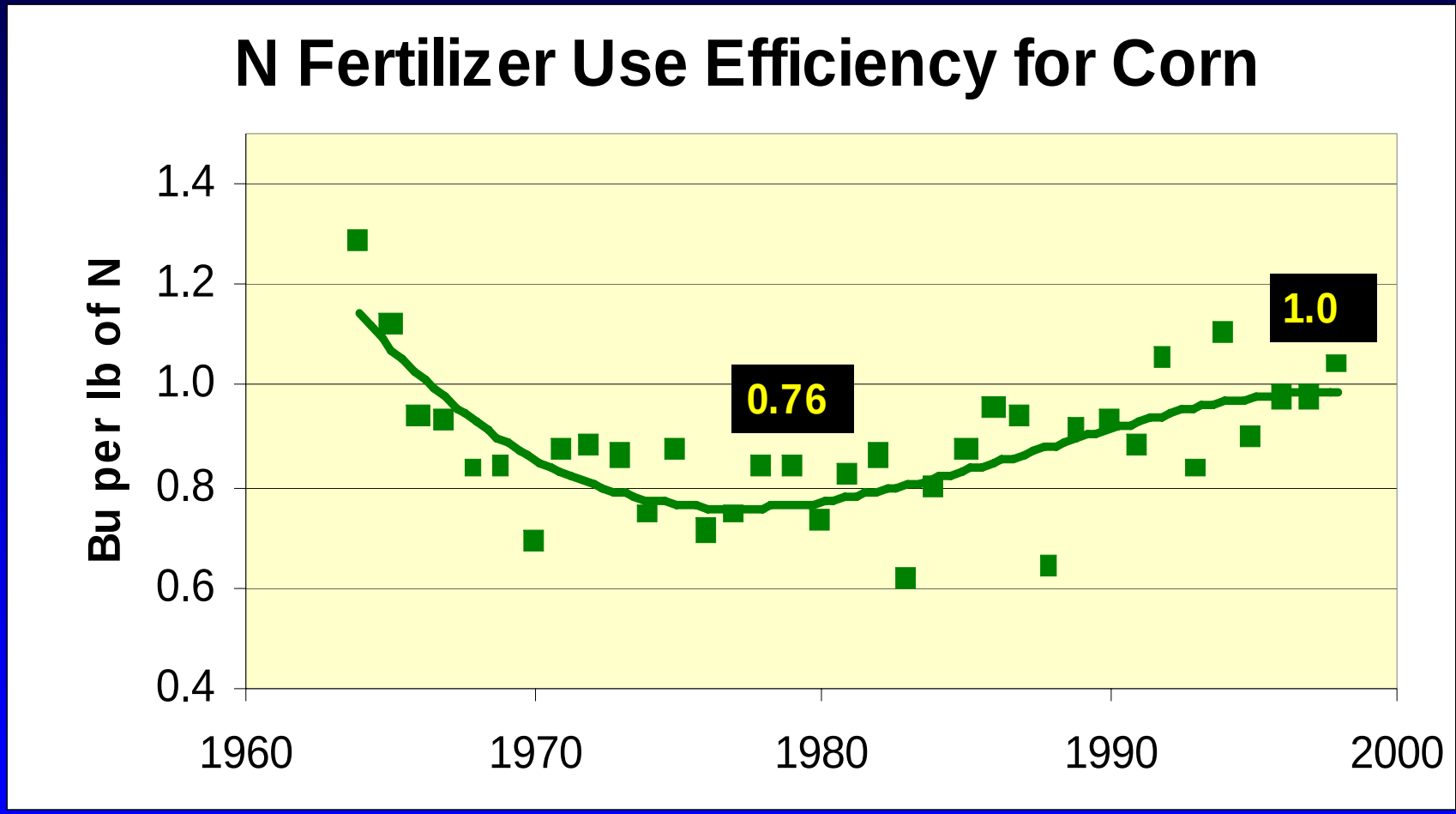
Approximated from Goolsby. USGS. 1999. CENR Report #3



Reducing N load by 30%

- Time lag between N management changes and improvement in water quality?
  - Water (and N) leaching from fields may take a long time to reach rivers
  - Lots of talk about N runoff but main losses appear to be via leaching and re-emergence in springs, seeps, etc.

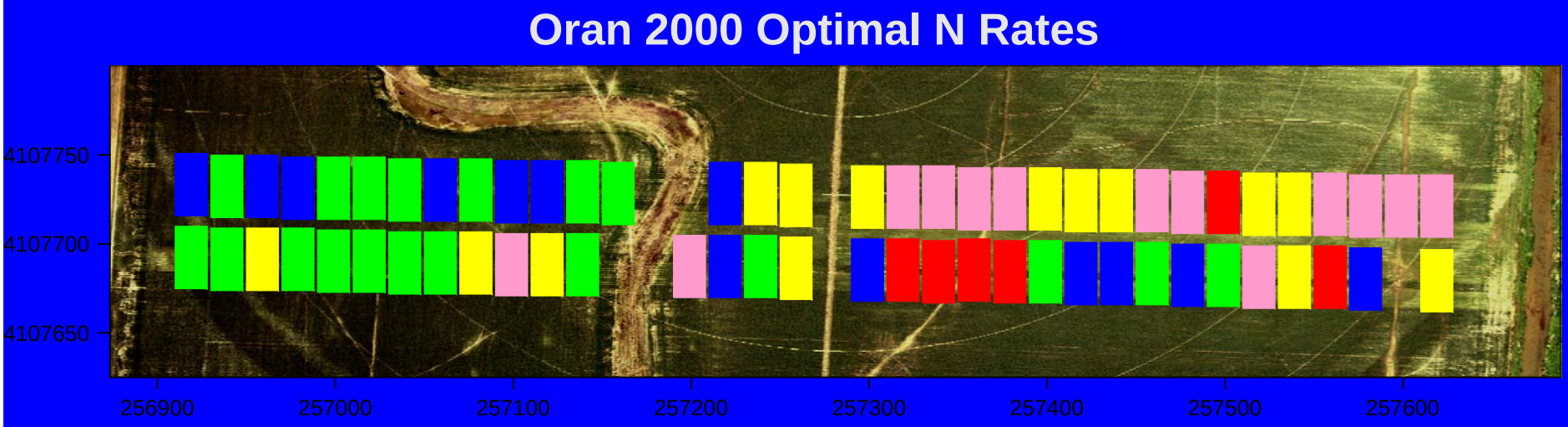
Fertilizer N Use Efficiency on Corn has Increased 32% since 1980



Ways to reduce N movement to surface waters

- Reduce fall N fertilizer applications
- Reduce fertilizer N over-applications
  - match rate to crop need to minimize unused N
- Reduce manure N over-applications
- Some suggest increased wetlands to remove N, but much more expensive per unit reduction

Reducing N overapplication can be tricky



How do you fertilize this field?

N applications based on color can meet crop needs precisely

Variable-rate sidedressing demonstrations in 2004: N rates were reduced by an average of 45 lb N/acre compared to rates used by producers in the same fields.

Hypoxia and agriculture: Summary

- Gulf hypoxic zone size varies from year to year; 2000 smallest since 1989 (drought)
- EPA has adopted an Action Plan
- They are seeking federal funding for voluntary programs to reduce N loading of the Mississippi River
- Their target is to reduce the size of the hypoxic zone to less than 5000 square kilometers (5-year average) by reducing N loading to the Gulf
- Reducing N loading:
  - Reduced fall N fertilizer applications
  - Reduced over-application of fertilizer & manure N
- There may be a time lag between adoption of effective practices and reduced N delivery to the Gulf