

# The Role of Midwestern Agriculture in Gulf of Mexico Hypoxia

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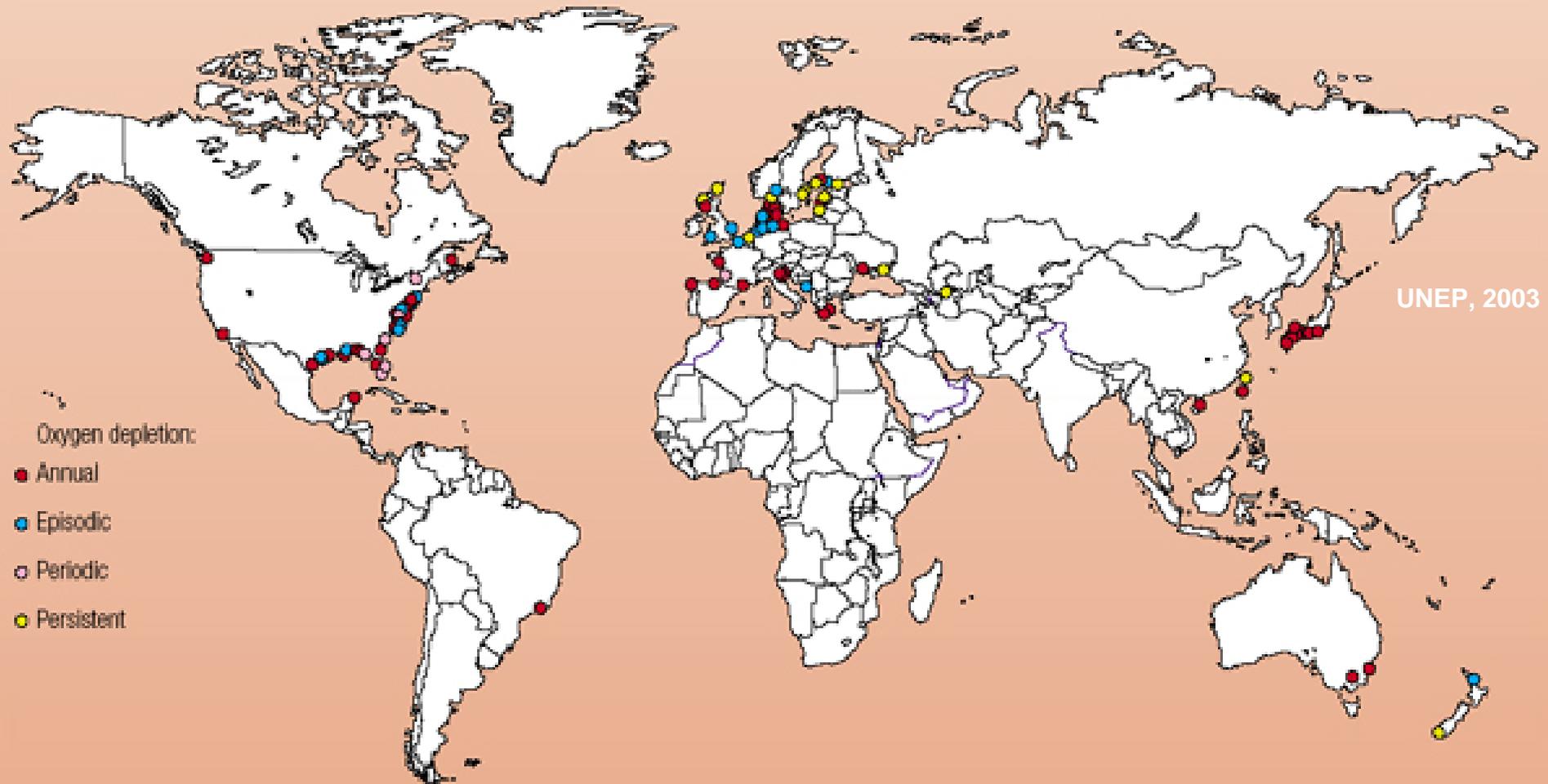


*Photo: Nancy Rabalais, Louisiana Universities Marine Consortium*

# 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



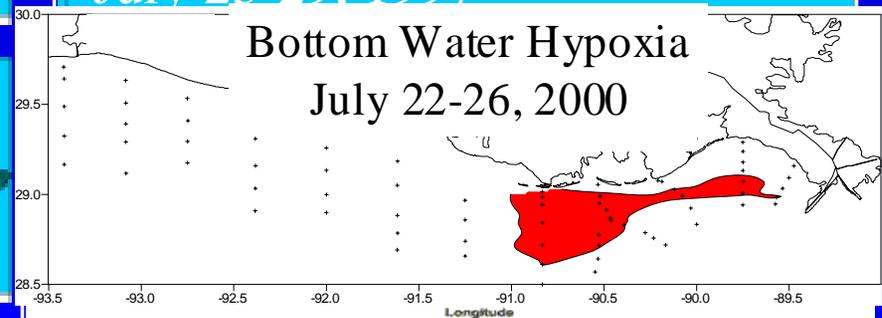
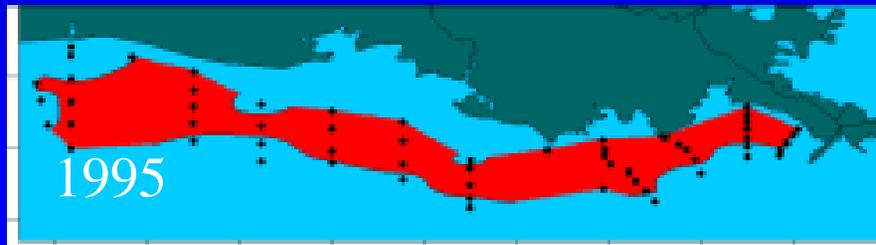
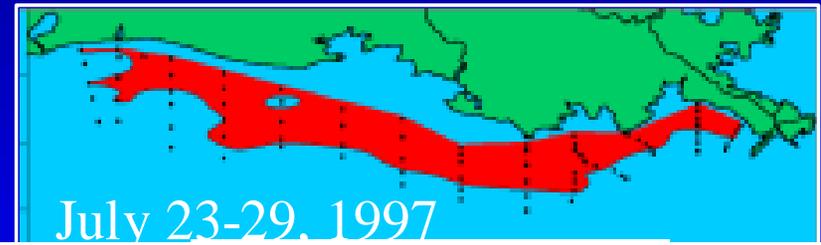
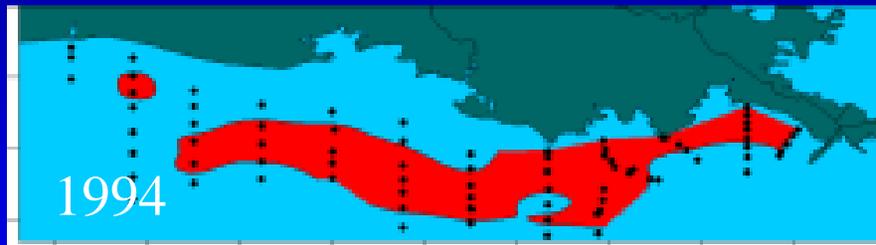
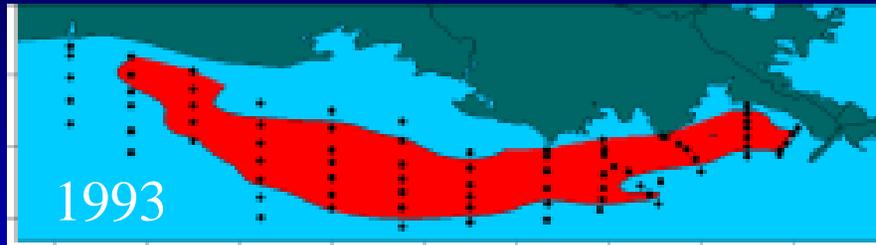
# Hypoxia in the Gulf of Mexico



- 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



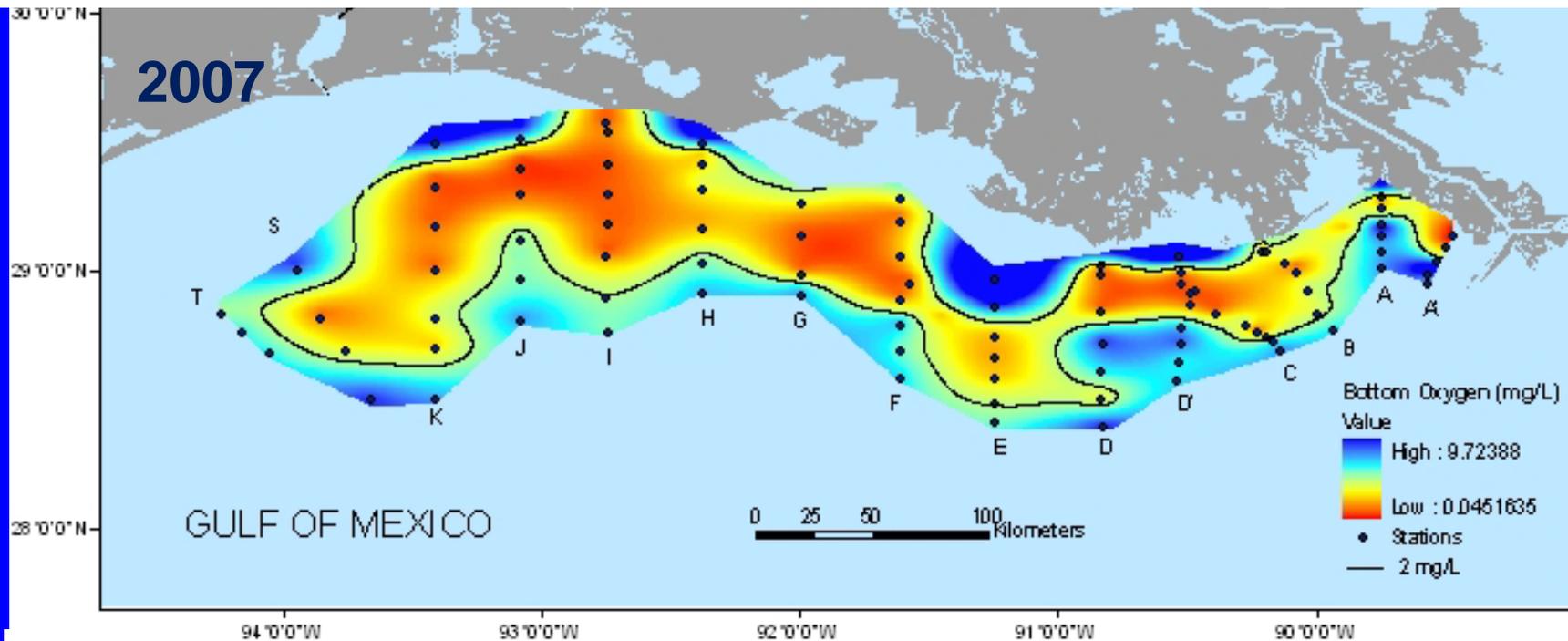
# Hypoxia in July 2004

July 21-25, 2004 - Area of Bottom Hypoxia

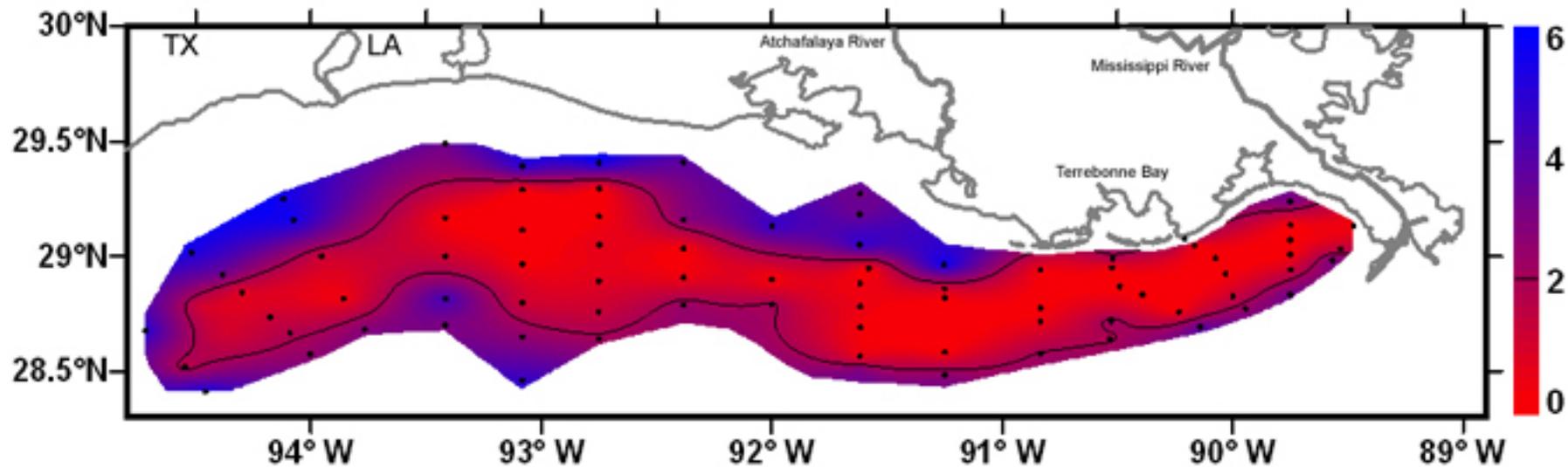


Data Source: N. Rabalais, UNHCCN

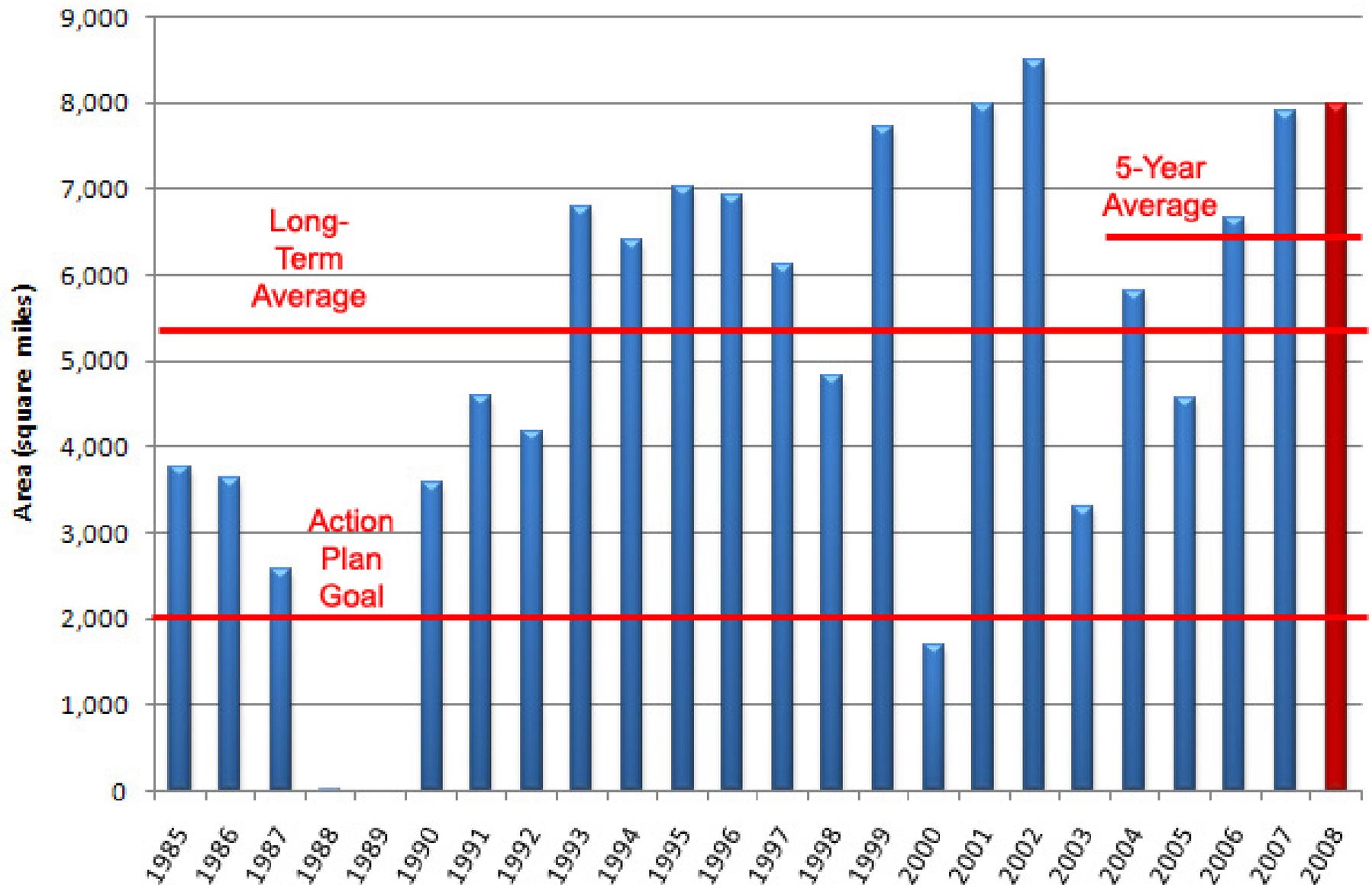
The hypoxic zone is closer than normal to the Louisiana coast this year (persistent winds from south). As a result, shrimp trawlers did not have success.



**July 21-27, 2008**

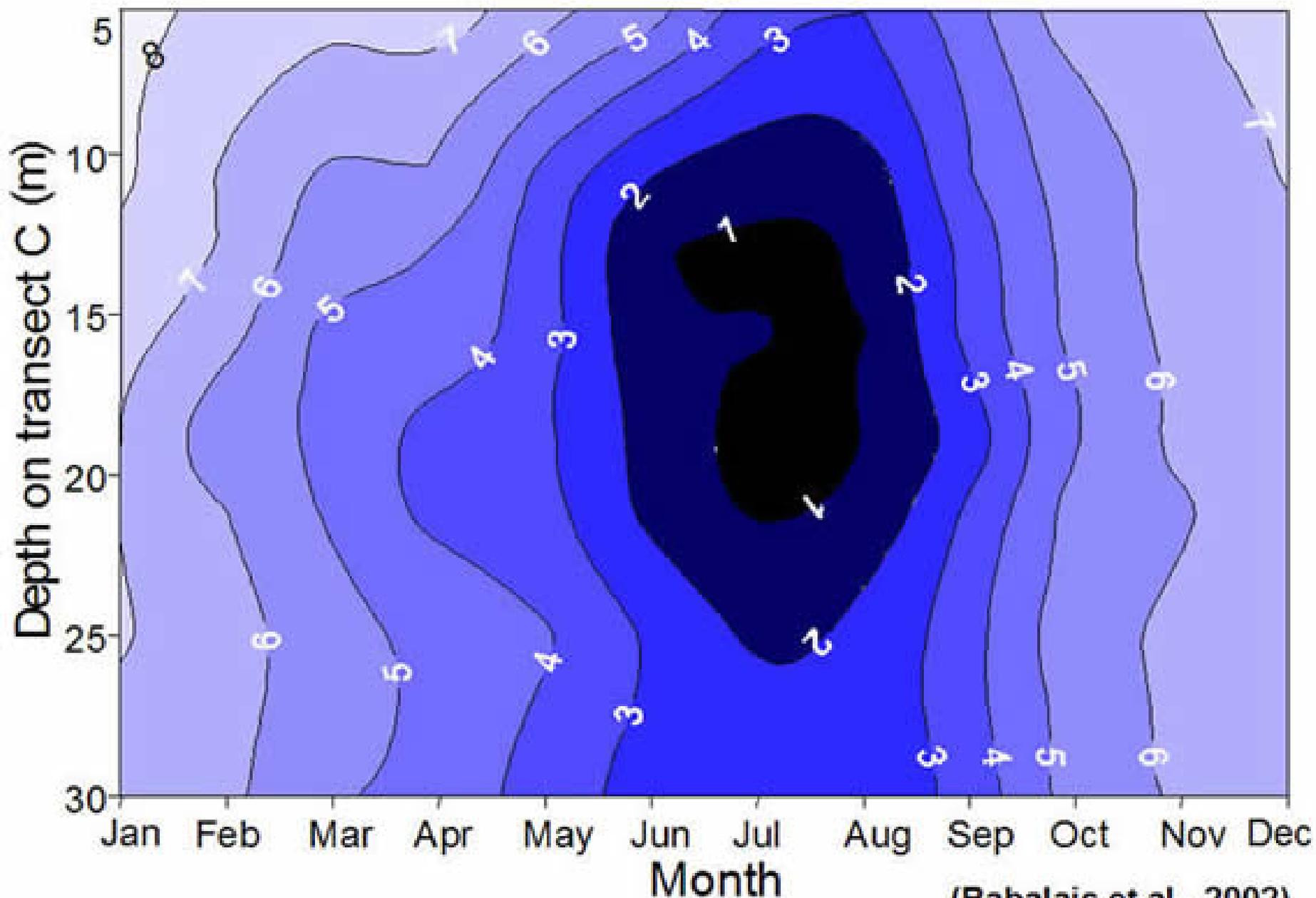


# Area of Mid-Summer Bottom Water Hypoxia (Dissolved Oxygen < 2.0 mg/L)



Source: N. Rabalais, LUMCON

## Average Monthly Bottom Dissolved Oxygen (mg/L) 1985 - 2001



(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)

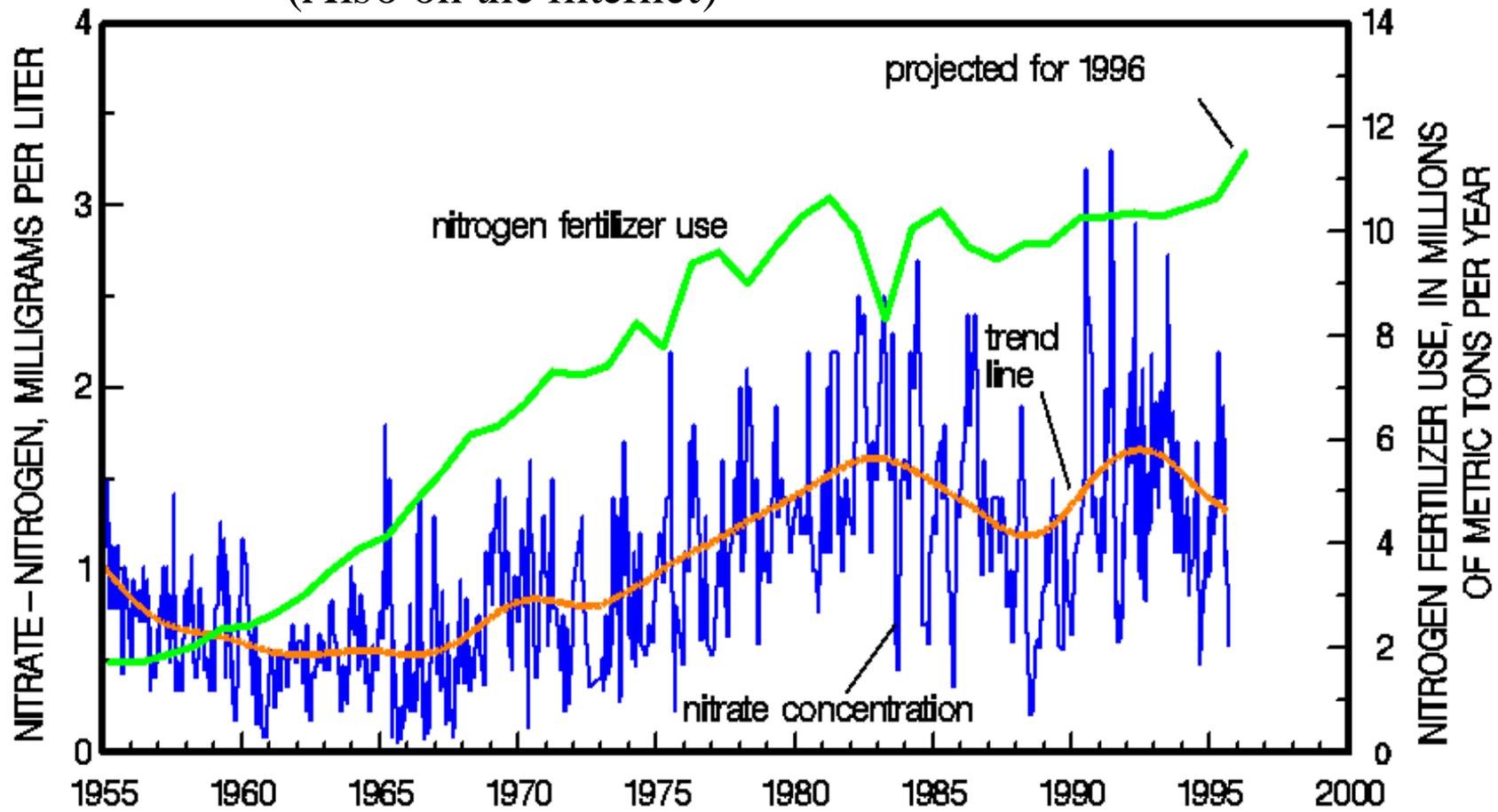


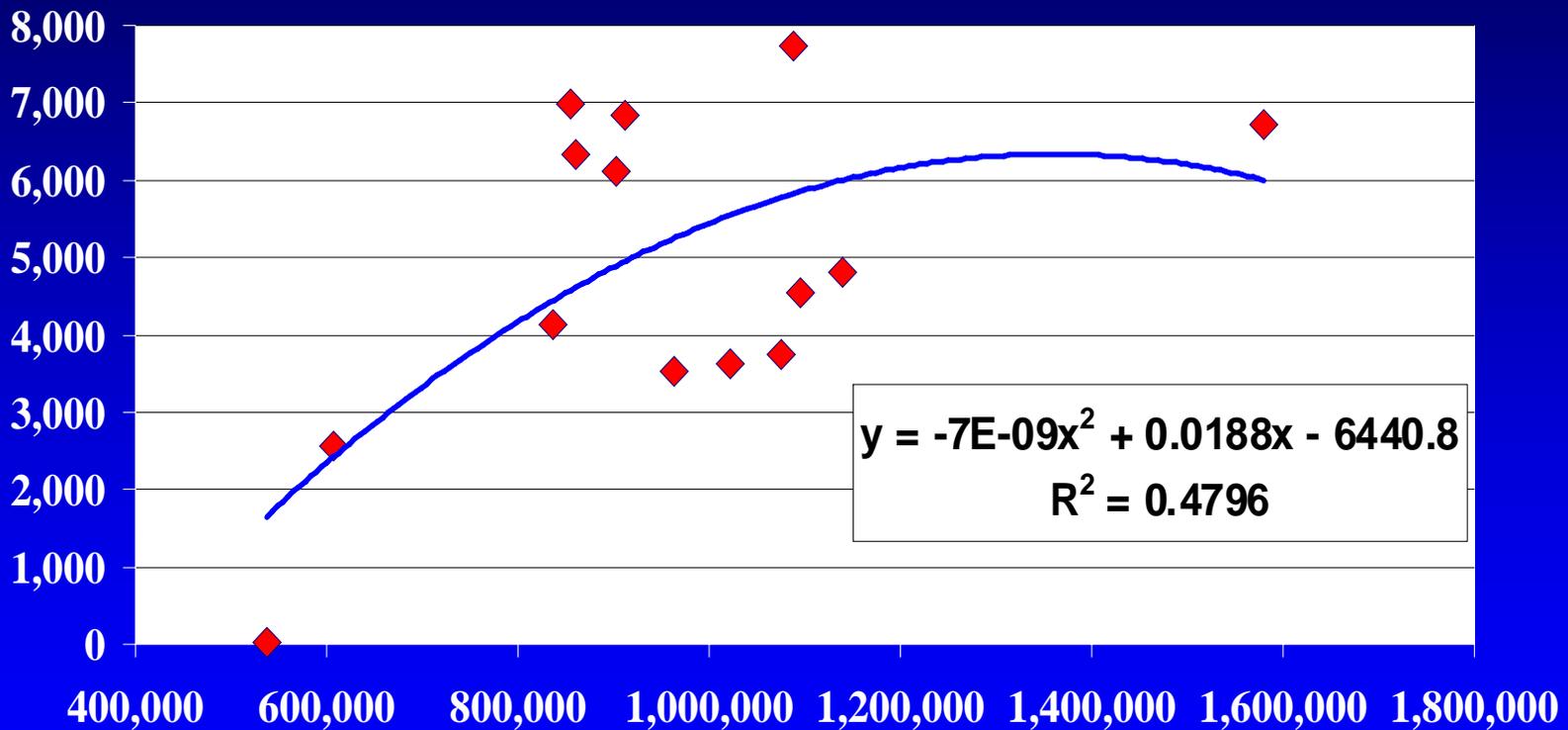
Figure 1. Estimated nitrogen fertilizer use in the United States, and nitrate concentrations in the Mississippi River at St. Francisville, LA., 1955–95.

# 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)

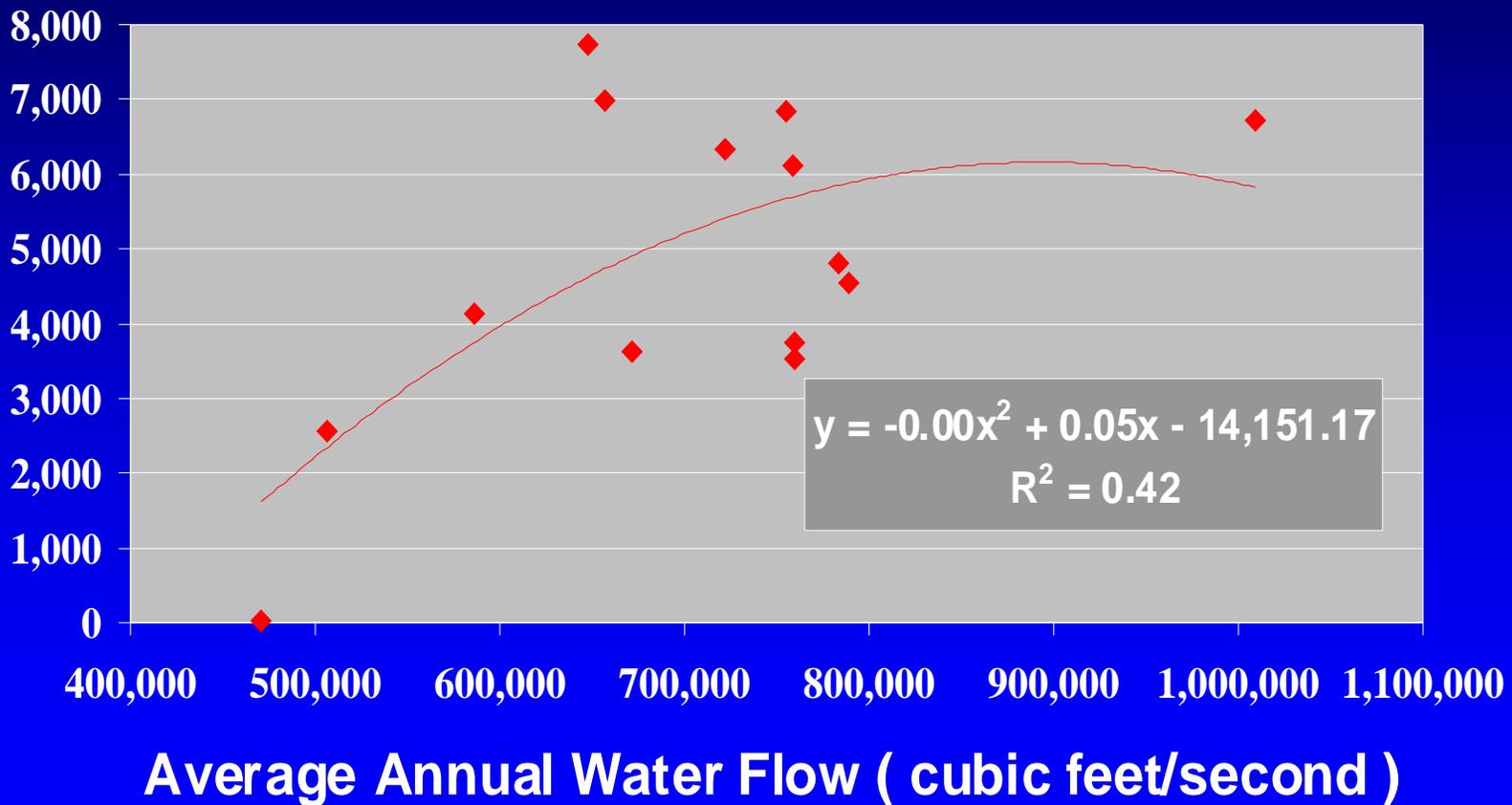
Hypoxia Area, square miles



Annual Nitrate-N Flux, metric tons

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

Hypoxia Area, square miles



# 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>

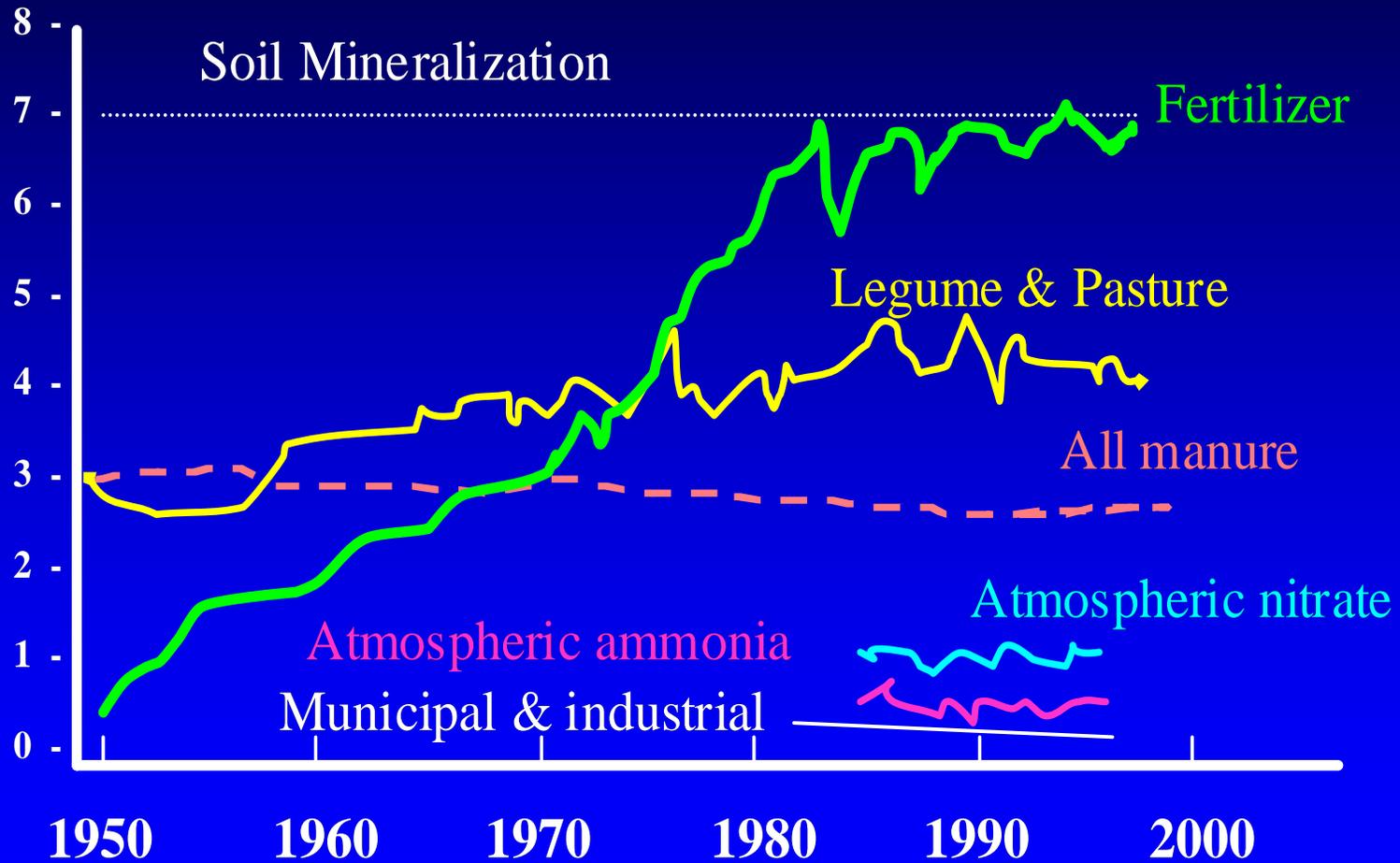
# Reducing N load by 30%

- 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

Million metric tons

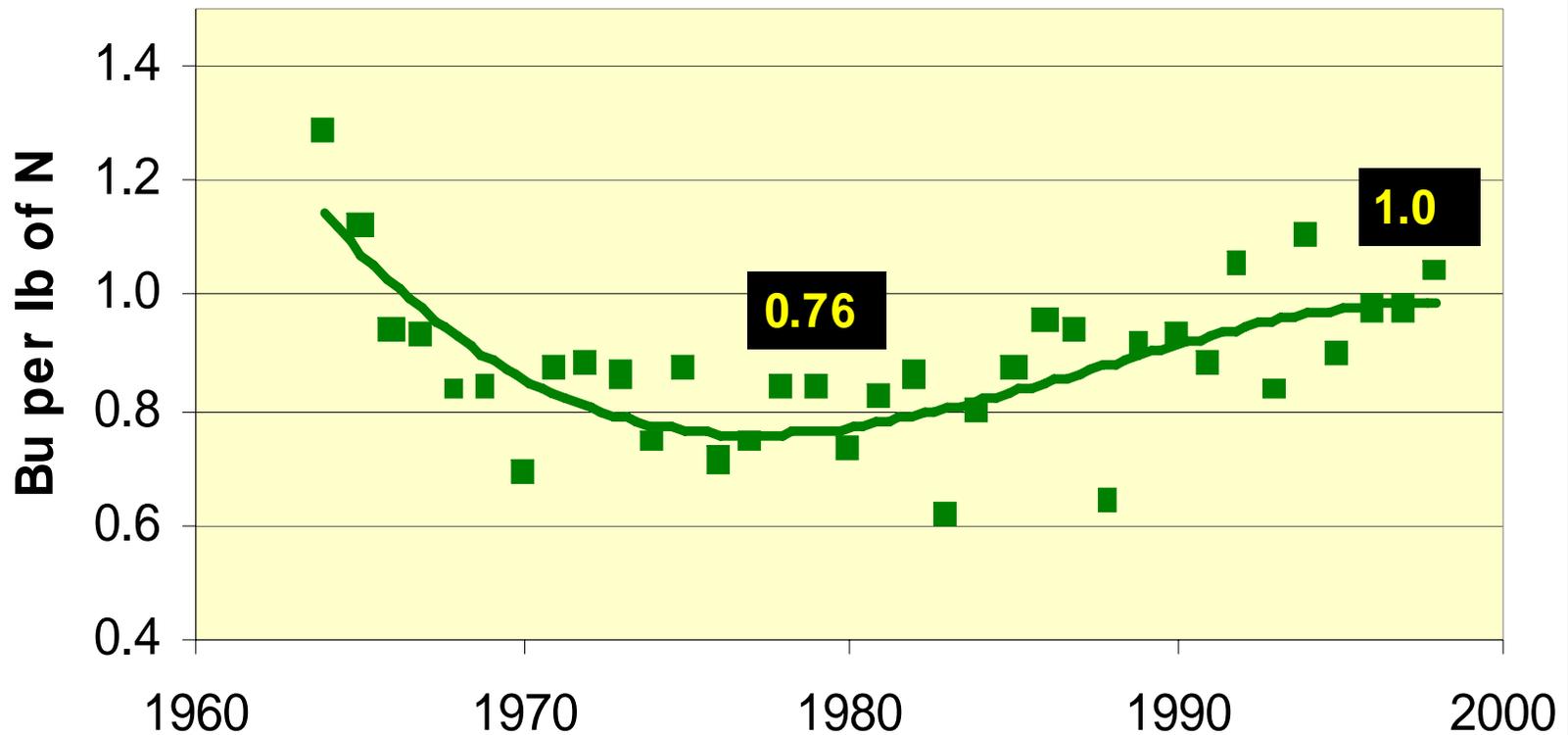


# Reducing N load by 30%

- 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

## N Fertilizer Use Efficiency for Corn

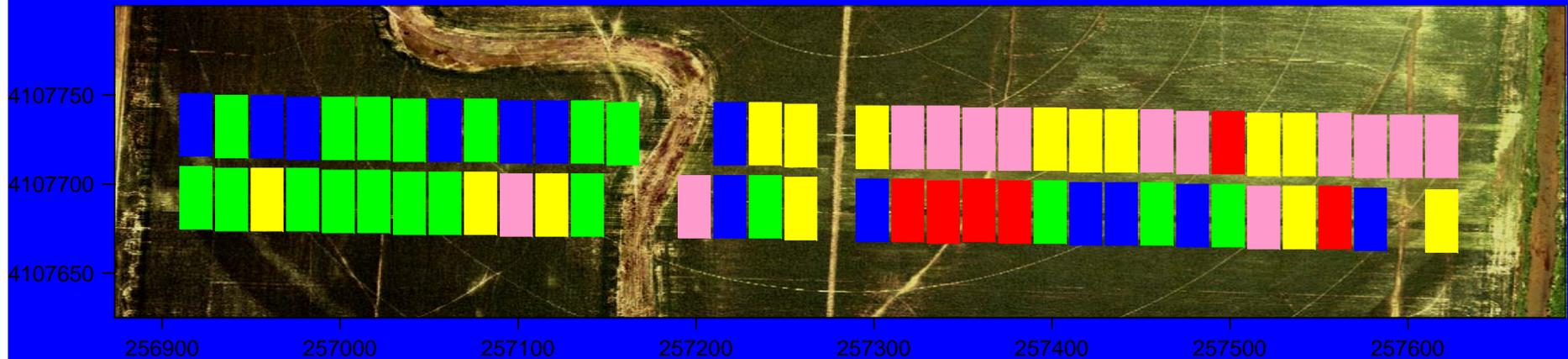


# Ways to reduce N movement to surface waters

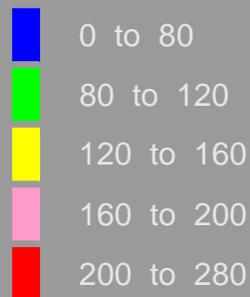
- Reduce fall N fertilizer applications
- Reduce fertilizer N over-applications
  - match rate to crop need to minimize unused N
- Reduce manure N over-applications
- Some suggest increased wetlands to remove N, but much more expensive per unit reduction

# Reducing N overapplication can be tricky

## Oran 2000 Optimal N Rates



### Optimal N rates, kg/ha



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