Managing Nutrients to the Gulf

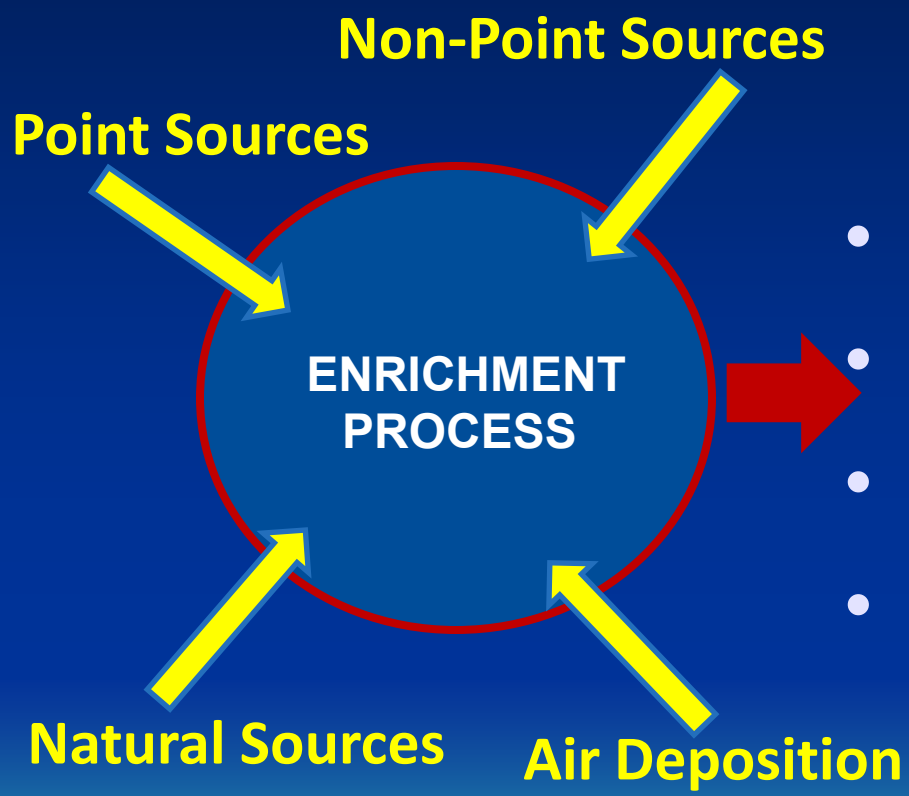
State Nutrient Reduction Strategies Workshop
Agricultural Component

June 13, 2011

Topics

- We live in a nutrient world (Swimming, Drinking Water, Aquatic Life)
- A desert in the Gulf of Mexico
- Action Plan (Goals, State Level Plans)
- What does this all mean?

We Live in a Nutrient World



- Increased primary production (algae blooms)
- Algal die-off
- Depleted oxygen
- Decreased bio-diversity
- Changed species composition
- Impaired water quality

Nutrient Basics

- Basic nutrients and nutrient cycles
- Principal ways nutrients affect designated uses
- Principal forms and measures of N, P, Chl, and Clarity
- Insights about nuisance algae

- Still a lot of science to be done

What are nutrients?

- Elements required for growth
- C, H, O, N, P, S – The Big Six Macronutrients
- 20 Other Micronutrients: B, F, Na, Mg, Si, Cl, K, Ca, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Se, Mo, Sn, I
- Of the big six, C, H, O, and S are generally readily available and rarely limit growth
- Not so for N and P

Nitrogen – What is measured

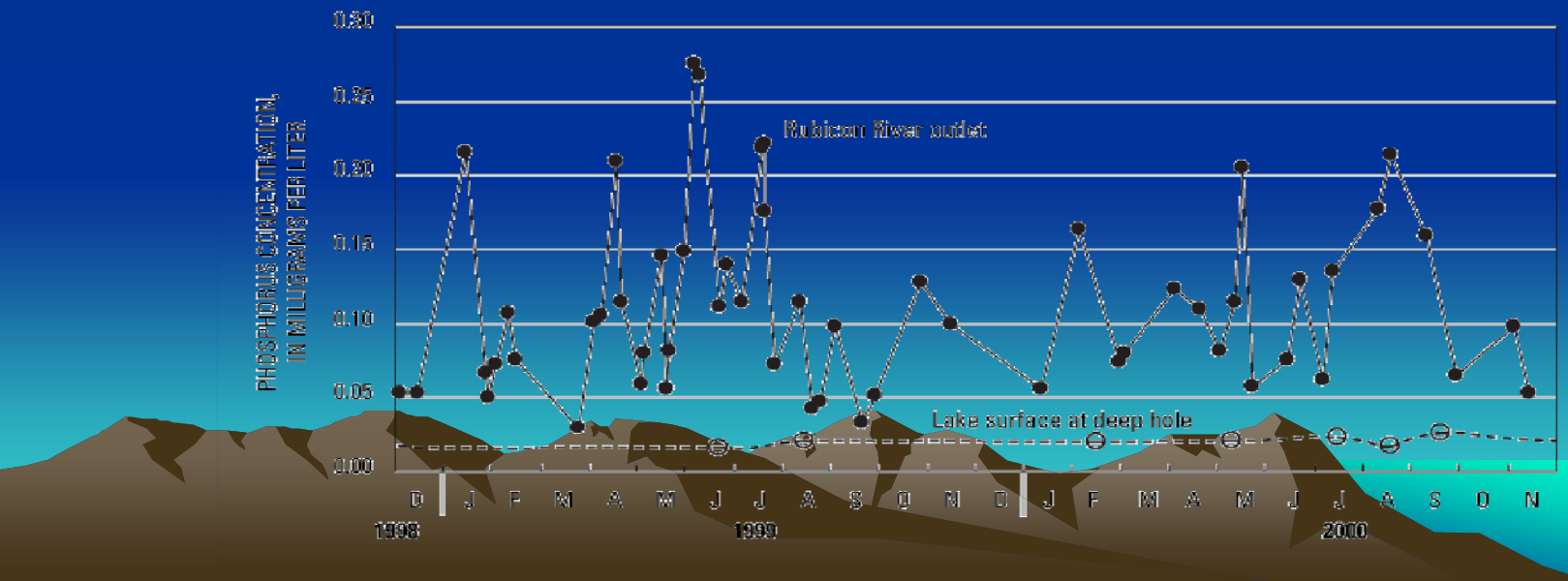
- Dissolved Forms (filtered – 0.45 μm)
  - NH_3-N (ammonia) and NH_4^+-N (ammonium)
  - NO_3/NO_2-N (nitrate/nitrite)
  - DIN = ammonia + nitrate/nitrite
  - Total Kjeldahl Nitrogen (TKN = DON-N + NH_3-N)
  - DON = TKN – (NH_3-N)
  - Total (TN) = TKN + NO_3/NO_2 (persulfate digestion)
- Total forms (unfiltered)
  - Same species as above including particulate forms
  - Particulate by subtraction

Phosphorus – what is measured

- Orthophosphate (PO_4-P) – form measured (as P)
  - Dissolved Forms (filtered – 0.45 μm)
  - Dissolved or Soluble Reactive P (SRP)
  - Dissolved Acid hydrolyzable P (condensed and some organic)
  - Total dissolved phosphorus (TP) – acid digestion
- Total forms (unfiltered) (particulate by difference)
  - Total reactive P
  - Total acid hydrolyzable P
  - Total P (TP)

Nutrient Dynamics

- N and P vary, through time and space
- Lot of this is a function of climate and supply
- Frequently independent – so limiting nutrient often changes



Limitation

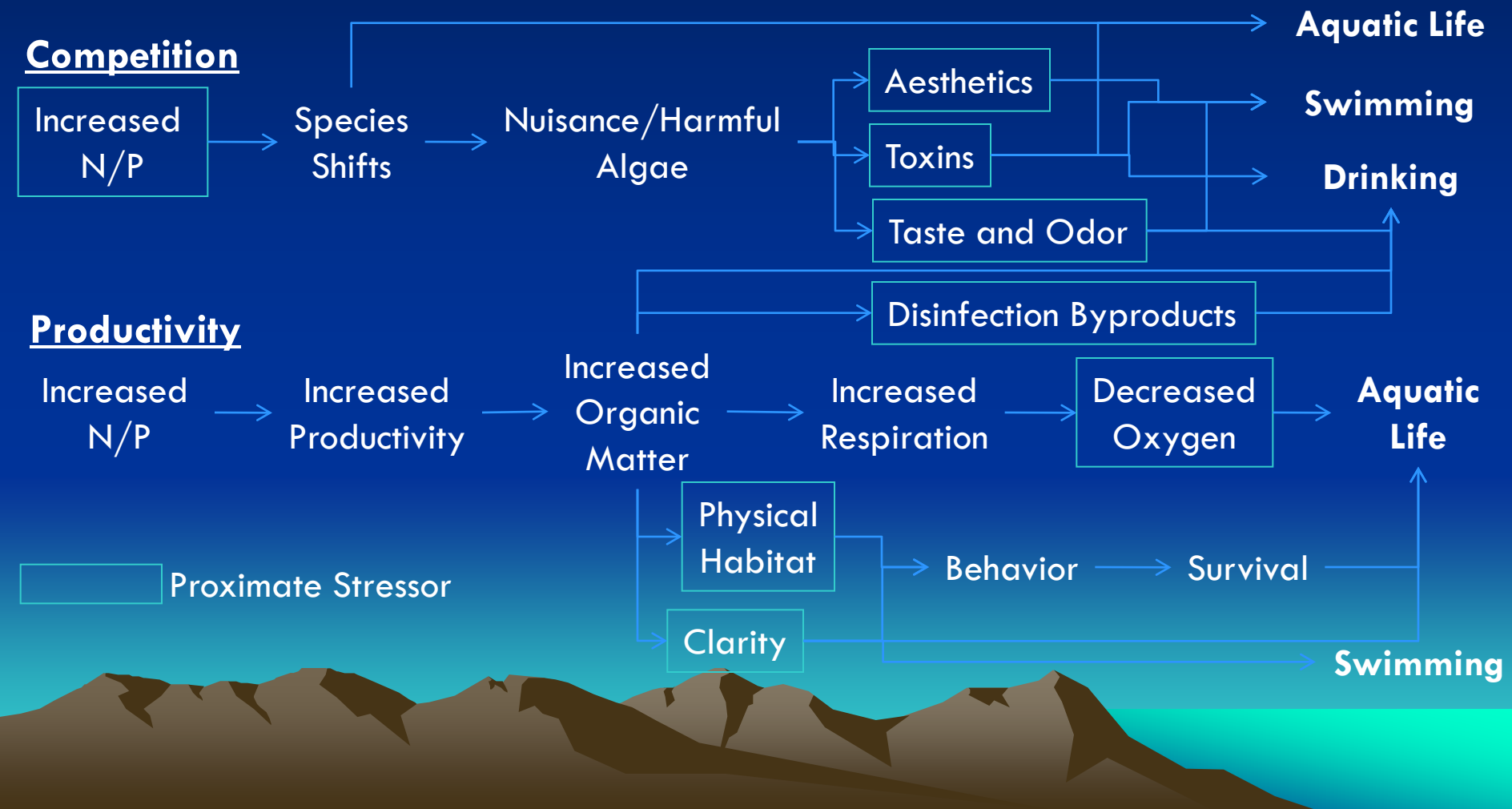
- Organisms contain nutrients in specific ratios
  - Redfield Ratio: 106:16:1 (C:N:P molar) of phytoplankton; pretty plastic
  - *Daphnia* C:P is 80:1; not so plastic
- Liebig's Law: Growth is controlled by the scarcest resource

- So, in order to build more organisms, you need to get over the limiting nutrient
  - Frequently these nutrients are N and P

A little aside – productivity, production and biomass

- Photosynthesis = primary productivity (mg C/m^2/d)
  - Gross PP = total amount fixed
  - Net PP = GPP – Respiration (algae respire too!)
  - Limited by concentration – determines growth rate
- Productivity over time = production (g C/m^2)
  - Likely limited by concentration and load
  - More N and P over time, will mean more accumulated production
- Biomass is standing stock = what is present at any one time (g C/m^2 or g Chl *a*/m^2)
  - Chlorophyll used as a surrogate of biomass – variable
    - Chl a/cell varies!
  - Biomass is related to productivity and production
  - Limited by both concentration and load

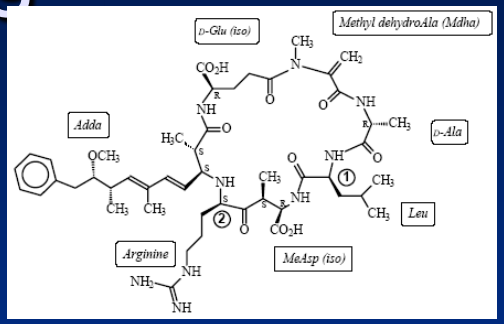
Competition-Productivity interrelationship



Nuisance Algae and Swimming

- Nuisance Algae/Plants
  - Many are poor competitors for low nutrients
  - In blooms, they look (and smell) bad
  - Decomposition and chemicals produced by senescing algae

Nuisance Algae and Swimming/Drinking



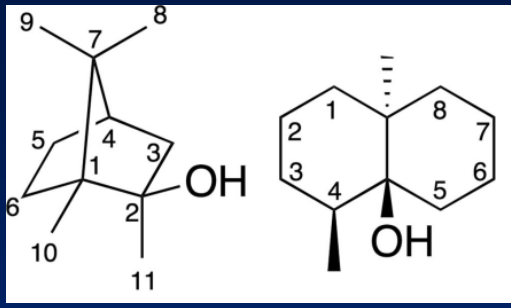
- Many produce toxins
  - Cyanotoxins (70 kinds):
    - Hepatotoxins: Microcystins, Nodularin
      - Liver damage; tumor promotion
      - *Microcystis, Anabaena, Oscillatoria, Nostoc, Anabaenopsis*
    - Neurotoxins: Anatoxins, saxitoxins
      - Block neurotransmission - paralysis
      - *Anabaena, Aphanizomenon, Microcystis, Oscillatoria,*
    - Cylindrospermopsin
      - Blocks protein synthesis –liver and kidney damage
      - *Cylindrospermopsis*
    - Lyngbyatoxin, debromoaplysiatoxin
      - Dermatitis
      - *Lyngbya*

Increased N/P → Species Shifts → Nuisance/Harmful Algae → Toxins → **Swimming** / **Drinking**

Nuisance Algae and Swimming/Drinking

- Cyanotoxins
  - Commonly detected, infrequently above threat levels
  - Most treatment facilities (US) remove from potable supply
  - Health risk to livestock, pets, and, potentially, swimmers
  - What controls toxicity? Still developing
    - Temperature
    - Light intensity
    - Nutrients
    - pH

Nuisance Algae and Drinking



- Taste and Odor
  - Several nuisance taxa can produce chemicals that create taste and odor issues for drinking water and in fish tissue – at very low concentrations
  - 2-Methylisoborneol (MIB) and geosmin
    - Produced by actinomycete fungi (*Streptomyces*) and filamentous cyanobacteria (*Oscillatoria, Phormidium, Anabaena, Pseudanabaena, Lyngbya, Aphanizomenon, Planktothrix,* etc.)
    - Wines, cheese, beets, forest etc. – earthy/musty smell

Increased N/P → Species Shifts → Nuisance/Harmful Algae → Taste and Odor → **Drinking**

Organic Matter and Drinking

- Filtration costs
  - Excess organic matter in suspension or on intake structures can increase operating costs
  - Clog intake screens, Increase coagulant demand, Shorten filter runs, Increase filter backwash water requirements

Increased N/P → Increased Productivity → Increased Organic Matter → Drinking

Organic Matter and Aquatic Life

- Respiration drives down dissolved oxygen
  - Hypoxia (<2 mg/L) and Anoxia (0 mg/L)
  - Organisms that need oxygen must either move, die, or both
    - Hypoxia/Anoxia can make other pollutants more "available" and this synergy may increase their toxicity

Increased N/P → Increased Productivity → Increased Organic Matter → Increased Respiration → Decreased Oxygen → **Aquatic Life**

National Scope of Nutrient Problem

- **14,000 Nutrient-related Impairment Listings in 49 States**
  - And This is an Underestimate . . .
- **Over 47% of Streams Have Medium to High Levels of Phosphorus and Over 53% Have Medium to High Levels of Nitrogen**
- **One Third of U.S. Estuaries Eutrophic**
- **168 Hypoxic Zones in U.S. Waters**

National Scope of Nutrient Problem

- **14,000 Nutrient-related Impairment Listings in 49 States**
  - And This is an Underestimate . . .
- **Over 47% of Streams Have Medium to High Levels of Phosphorus and Over 53% Have Medium to High Levels of Nitrogen**
- **One Third of U.S. Estuaries Eutrophic**
- **168 Hypoxic Zones in U.S. Waters**

Sources - Key Facts

- **Municipal Wastewater Treatment**
  - POTWs are among the most heavily regulated sectors in the U. S.
  - Collectively, our nation's municipal wastewater systems treat over 18 million tons of human waste
  - Of more than 16,500 municipal treatment system permits, however, only about 4% have numeric limits for nitrogen and 9.9% for phosphorus

Sources - Key Facts

- **Urban Stormwater**
  - The urban population heavily impacts coastal areas – Chesapeake Bay 31% of phosphorus load and 11% of nitrogen load from urban stormwater
  - 80% of the U.S. population live on 10% of the land
  - Stormwater sources expected to increase dramatically with increased urbanization - 50% of the urban landscape will be redeveloped by 2030 and 30% of needed built environment does not exist

National Population Growth

- **Increase in Nutrient Pollution Over Past 50 Years Reflects Doubling of U.S. Population**
- **Additional 135 Million People by 2050**
- **Nutrient Pollution Expected to Accelerate**

Year	U.S. Population
1950	152 million
2008	304 million
2050	439 million

Sources - Key Facts

- **Agricultural Livestock**
  - Livestock Production in U.S. is a $130 Billion Industry
    - 96 million cattle, 68 million pigs, and 9.4 billion chickens produce over *1 billion tons* of manure annually
  - A Substantial Portion of Agricultural Livestock Production is Largely Unregulated by the Recent CAFO Rule (Grand Lake St Marys example)
- **Agricultural Row Crops**
  - Row Crop Agriculture is a $120 Billion Industry
  - Stormwater Runoff and Irrigation Return Flows Exempt from the Clean Water Act
  - Subject to Variable Controls at the State Level

A Desert in the Gulf of Mexico

A Desert in the Gulf of Mexico

- Hypoxia observed in the Gulf since the 1950s
  - Occurs primarily during the summer
  - Varies in size each year; averaging ~16,000 sq mi
  - Potential environmental and economic impacts for the Gulf coast

A Desert in the Gulf of Mexico

- Hypoxic zone size influenced by:
  - Nutrient inputs (Human)
  - Streamflow (Human)
  - Storm conditions
  - Climate/climate change

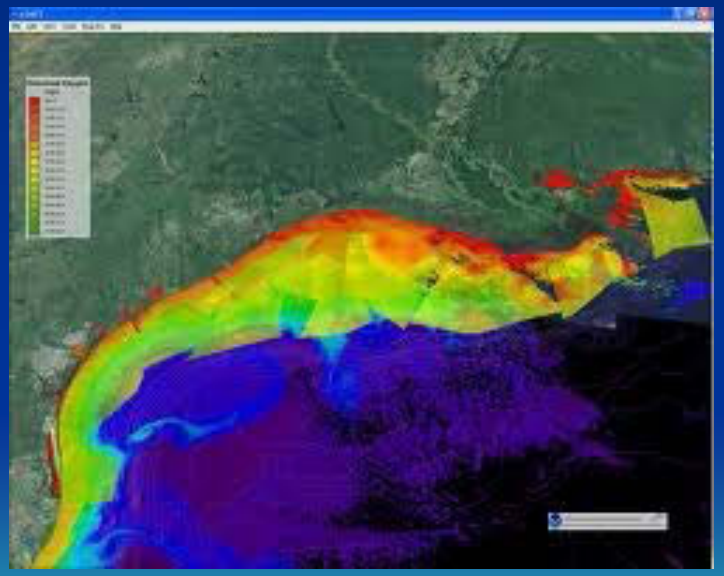
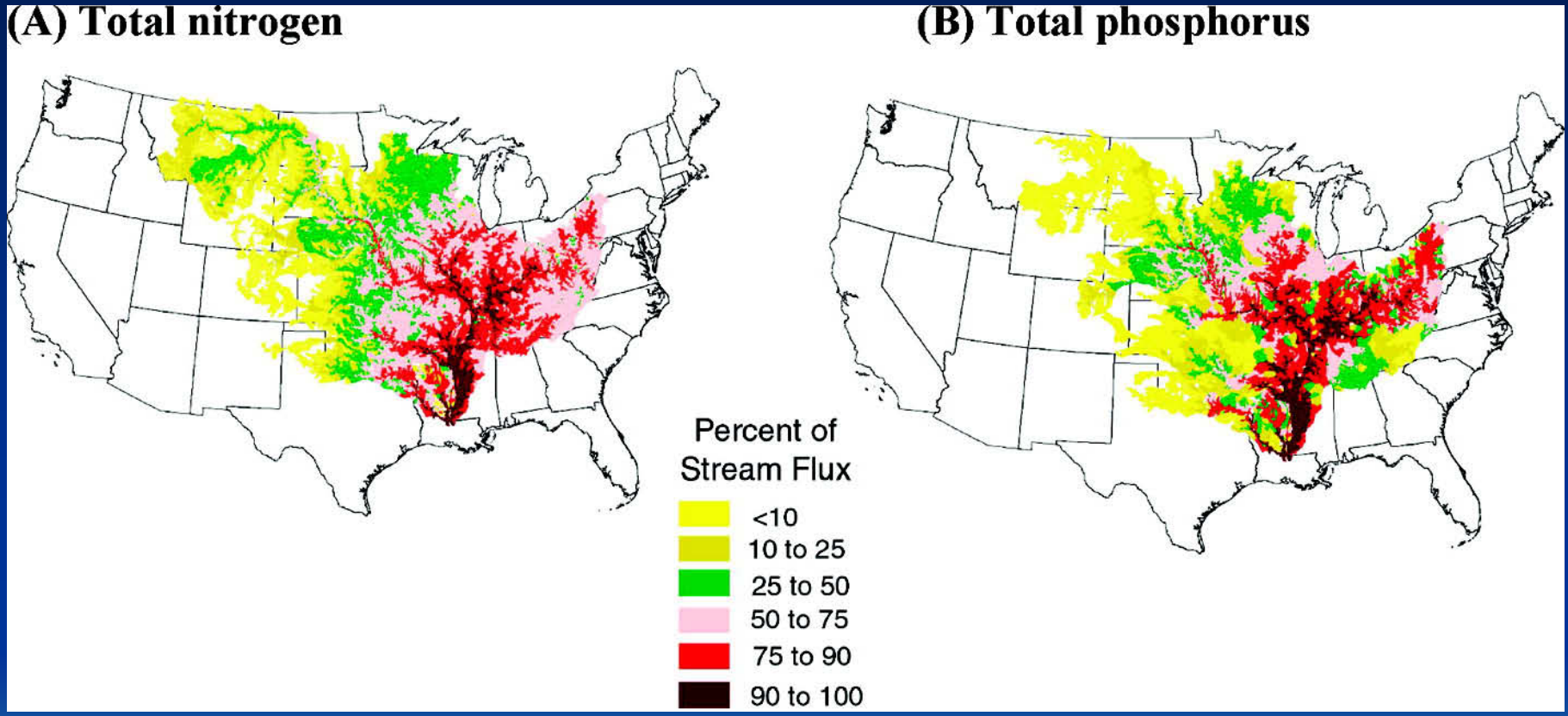


Figure 3. Percentage of stream nutrient load delivered to the Gulf of Mexico from the incremental drainage of MARB reaches: (a) total nitrogen; (b) total phosphorus. (ES&T, 2008)



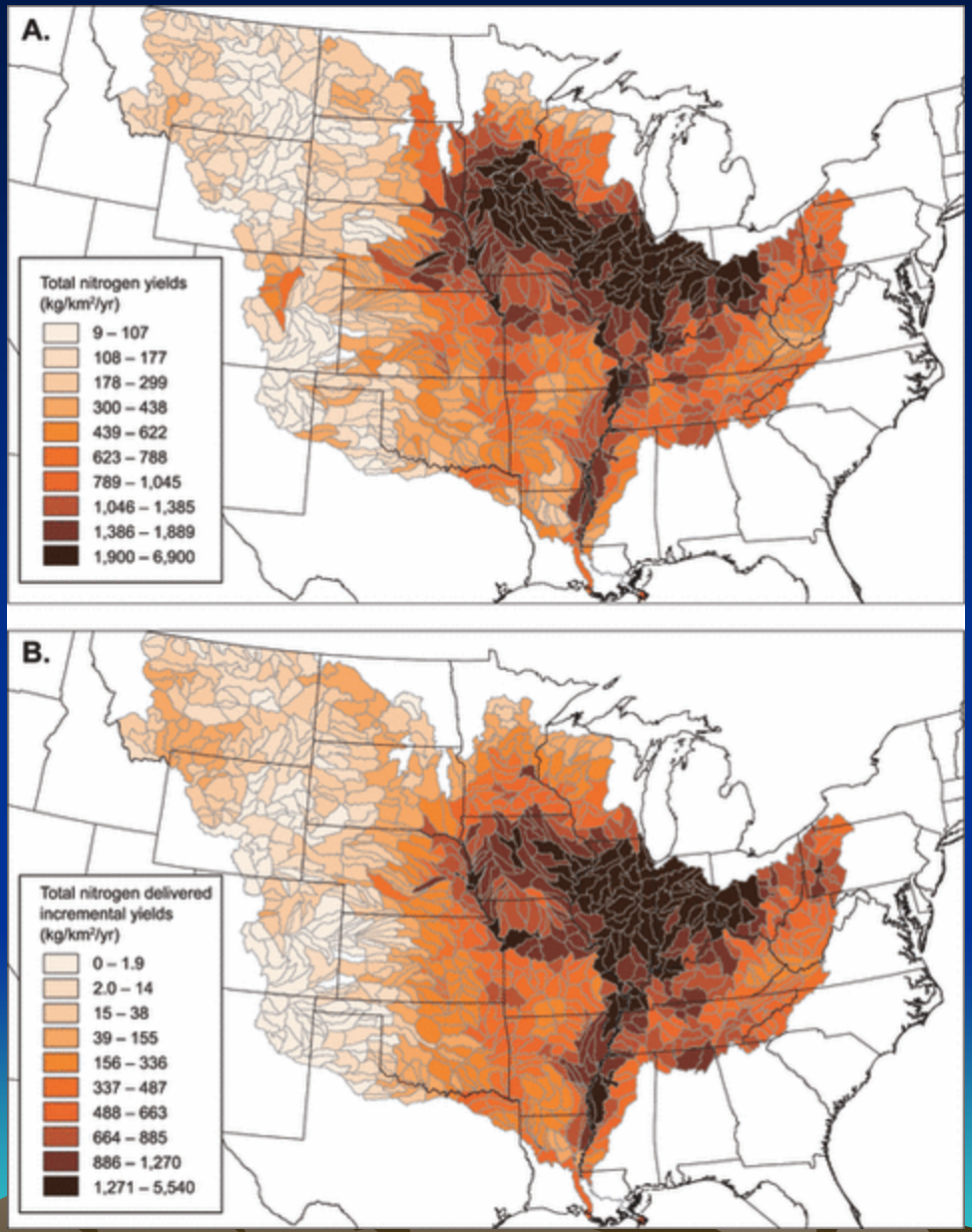


Figure 3. Distributions (deciles) of Incremental Yields (A) and Delivered Incremental Yields to the Gulf of Mexico (B) of Total Nitrogen (TN) for the HUC8 Watersheds Within the MARB for

Conditions Similar to 2002. (JAWRA, 2009)

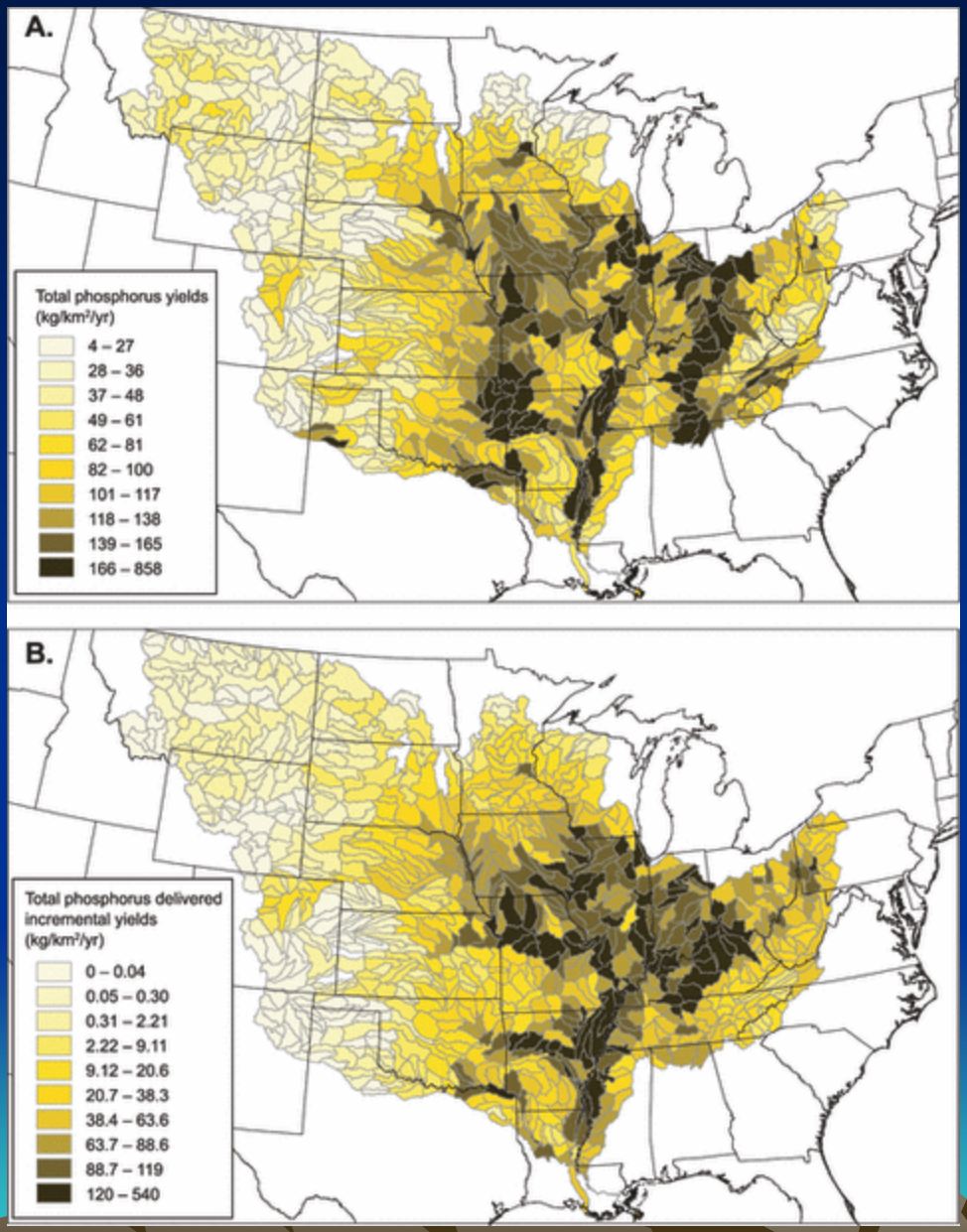


Figure 4. Distributions (deciles) of Incremental Yields (A) and Delivered Incremental Yields to the Gulf of Mexico (B) of Total Phosphorus (TP) for the HUC8 Watersheds Within the MARB for

Conditions Similar to 2002. (JAWRA, 2009)

Progress

- Nutrient loadings to the Gulf:
  - Average TN > 1.5 MM metric tons/yr (1980 to 1996); current average ~1.3 MM metric tons/yr
  - Net TN steady over past decade
  - Net TP at zero now for much of the basin
- Soil erosion is decreasing with improved agricultural practices
  - 42% decrease in soil losses between 1982 and 2003

Institutional Challenges

- **Multiple existing plans with impractical timeframes resources needs**
  - TMDLs, 9-element plan, State & Local ODNR plans, Governor's plan, RAPs
- **Segmented state leadership, authority and missions**
  - Federal-State-Local; Environmental – Agriculture– Natural Resources
- **Staggered agency engagement**
  - Start & stop syndrome –Tell us what's going on!!!
- **Incomplete data due to USDA 1619 concerns**
- **Unwillingness to "own the load"**
  - Farm lobby and the realities of drainage

What is EPA doing

- Regional framework adopted/being tracked
- Working with between Regions to ensure consistency
- Working with other Federal Agencies (in particular NRCS) to ensure nutrient efforts are a priority
- Working to bring new resources to the table

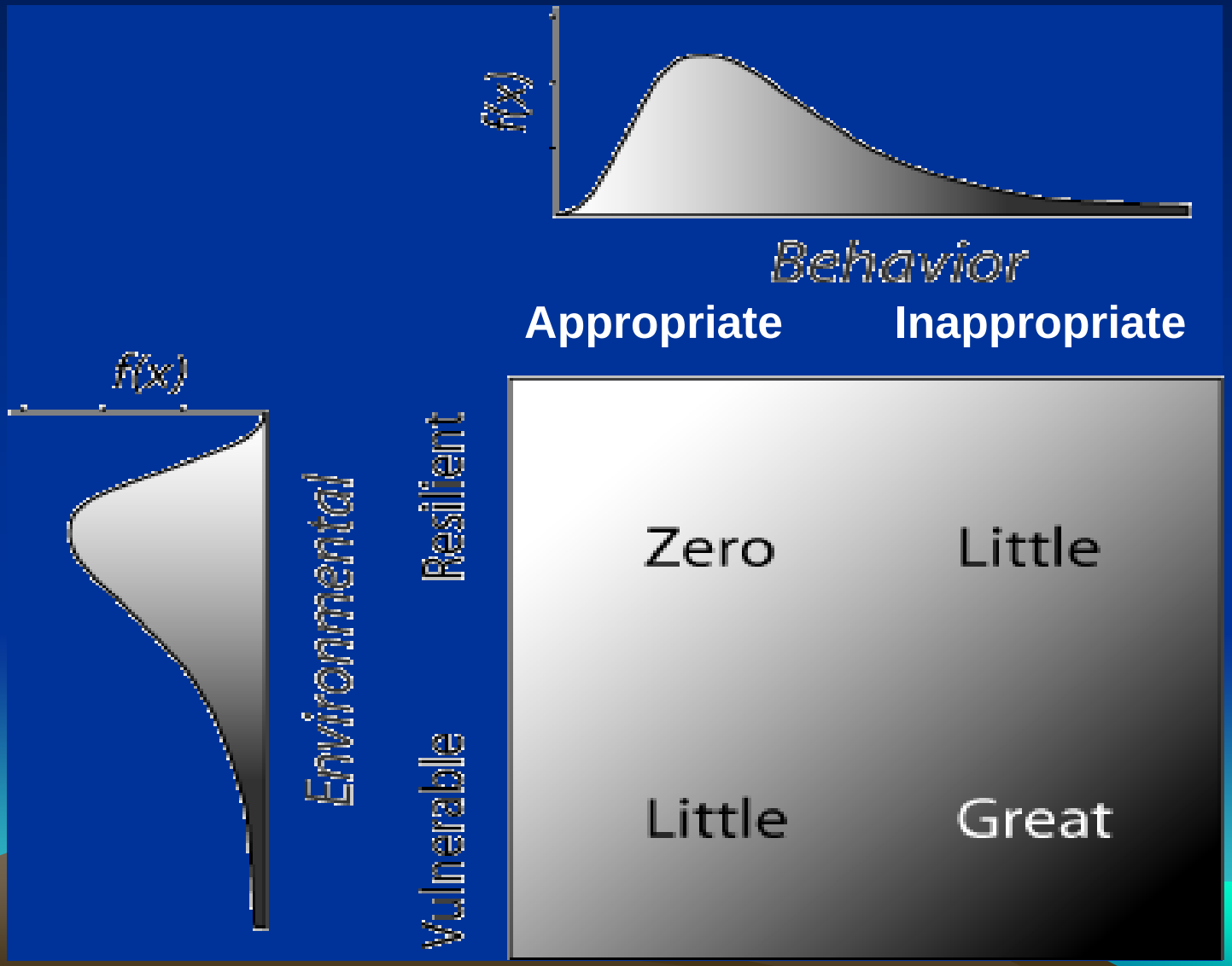
Region 5 Approach

- Work with the states to maximize existing efforts
- Enhance reporting of present efforts
- Develop and implement state level nutrient strategies
- Provide assistance to Regional, State and Local efforts to accelerate nutrient reduction efforts

What are we looking form States:

- Solving local nutrient problem first
- Need to target
- Basis of effort (geographic, sector, combination)
- Traditional water programs placing a priority on nutrients (targeting)
- What Programs (Gov't/NGO) are included
- Will we be able to tell what has been done, by who, where and the impact
- Are we preventing problems while we're fixing them
- Leadership by the private sector

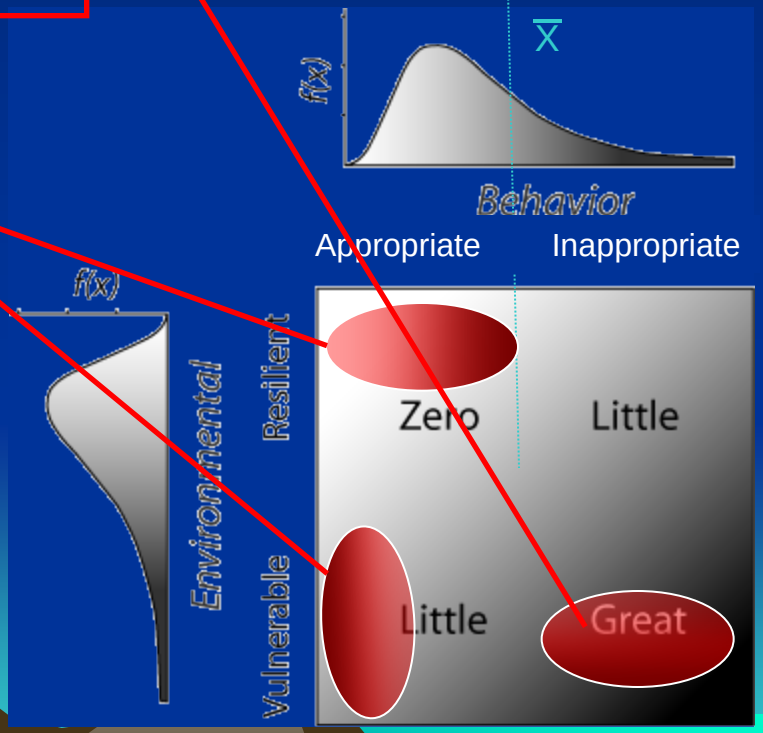
Disproportionality



What Should the Focus of our efforts?

Focus on Solving Problems

Focus on Managing Programs



What Does This All Mean?

1. Nutrient pollution is a reality; nutrient management is a must
2. While Multi-jurisdictional water bodies effort Gulf of Mexico are driving= federal involvement ; Local problems should be driving implementation
3. The problem is more than nutrients

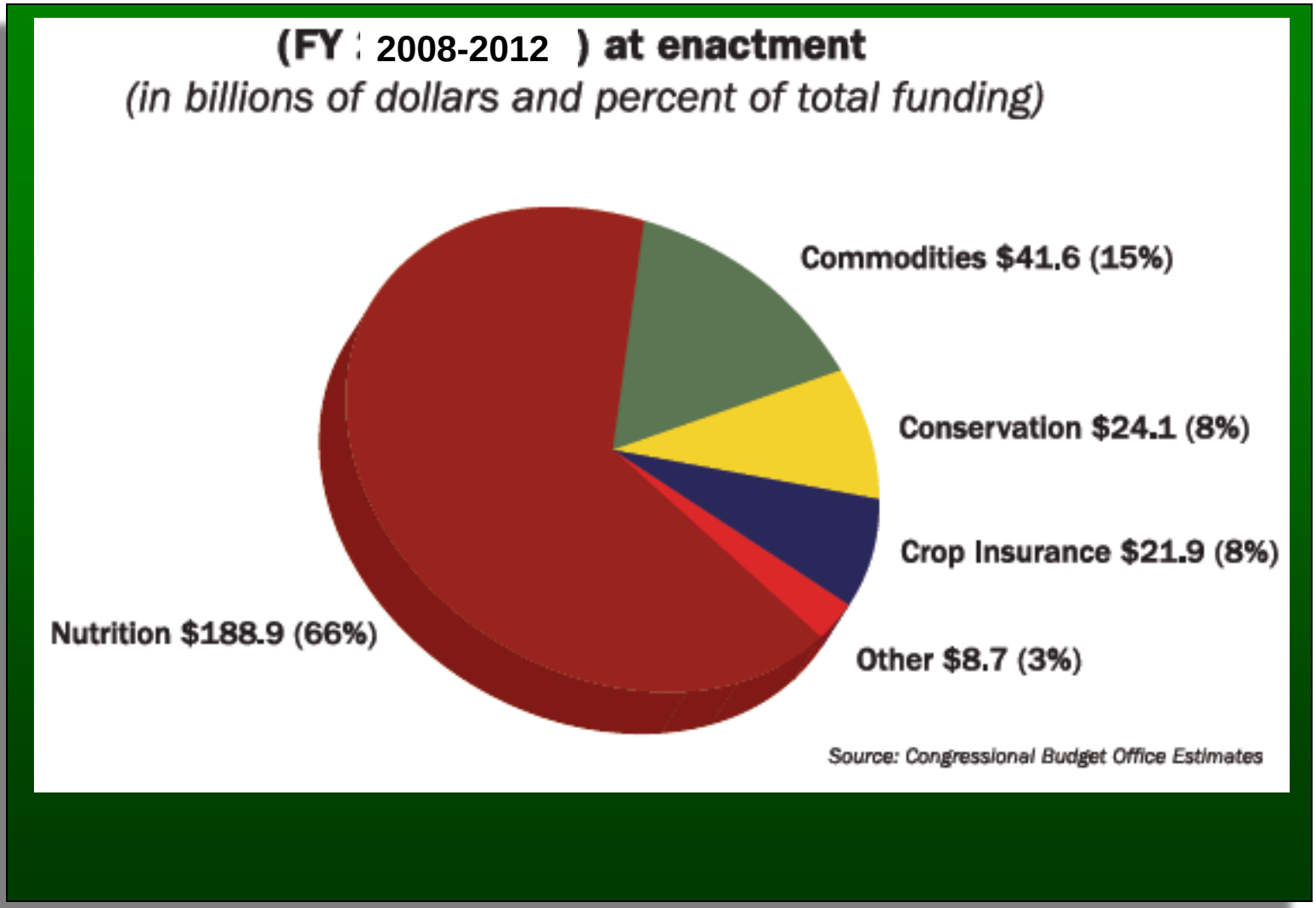
What Does This All Mean?

- Getting Started:
  - Understand your state's nutrient loading issues
  - Think outside the box
  - Pay attention to state and federal nutrient initiatives;
  - Engage state and federal regulators on nutrient issues while the plan is being developed
  - Begin to implement the plan for nutrient management

Tools and Authorities – Think outside the box

- **Incentives – voluntary agreements, corporate stewardship, trading**
- **Non-regulatory: Private industry (sustainable production, grower requirements, etc)**
- **Legislative**
- **Existing & Alternative Regulatory: point source caps, NPDES & WQS regulations, NPS performance/technology based regulations**
- **Farm bill example follows**

- **There are 3 means for delivering $ to agriculture via Farm Bill.**
- **Commodity Subsidies, Conservation Programs, Crop Insurance.**



Loan Rate	CYs 2010-12
Wheat	$2.94/bu
Corn	**$1.95/bu**
Grain sorghum	$1.95/bu
Barley	$1.95/bu
Oats	$1.39/bu
Long-grain rice	$6.50/cwt
Medium-grain rice	$6.50/cwt
Soybeans	$5.00/bu
Other oilseeds	$10.09/cwt
Upland cotton	$0.52/lb
ELS cotton	$0.7977/lb
Peanuts	$355/ton

CCP	CYs 2010-12
Wheat	$4.17/bu
Corn	**$2.63/bu**
Grain sorghum	$2.63/bu
Barley	$2.63/bu
Oats	$1.79/bu
Upland cotton	$0.7125/lb
Long-grain rice	$10.50/cwt
Medium-grain rice	$10.50/cwt
Peanuts	$495/ton
Soybeans	$6.00/bu
Other oilseeds	$12.68/cwt

	Direct Payment rate
Wheat	$0.52/bu
Corn	**$0.28/bu**
Grain sorghum	$0.35/bu
Barley	$0.24/bu
Oats	$0.024/bu
Upland cotton	$0.0667/lb
Long-grain rice	$2.35/cwt
Soybeans	$0.44/bu

- **Commodity production supports paid on floor & target prices… and at a standard rate de-coupled from production.**

The Conservation Compliance

Highly Erodible Land (HEL) Compliance, Sodbuster, Wetland Conservation (Swampbuster)

Covenant

- **Public provides financial support via USDA payments.**
- **Recipients protect soil and wetlands for the public.**

- **Penalties are reduction or loss of farm program payments for draining existing wetlands or not maintaining soil protections.**

NRCS photo

NRCS photo

United States Department of Agriculture

USDA

Federal Crop Insurance Corporation

FCIC

Risk Management Agency

RMA

- **Federal Crop Insurance is subsidized for producers and insurance companies.**
- **National average is 60% of premium is paid by subsidy, often even higher.**
- **Major commodity crops well covered; challenges exist for new, organic, or locally/regionally atypical crops.**
- **Crop Insurance exempted from compliance* in 1996 Farm Bill.**

- **Participation in Crop insurance is high across major commodities.**
- **Premiums and indemnities have been growing rapidly.**

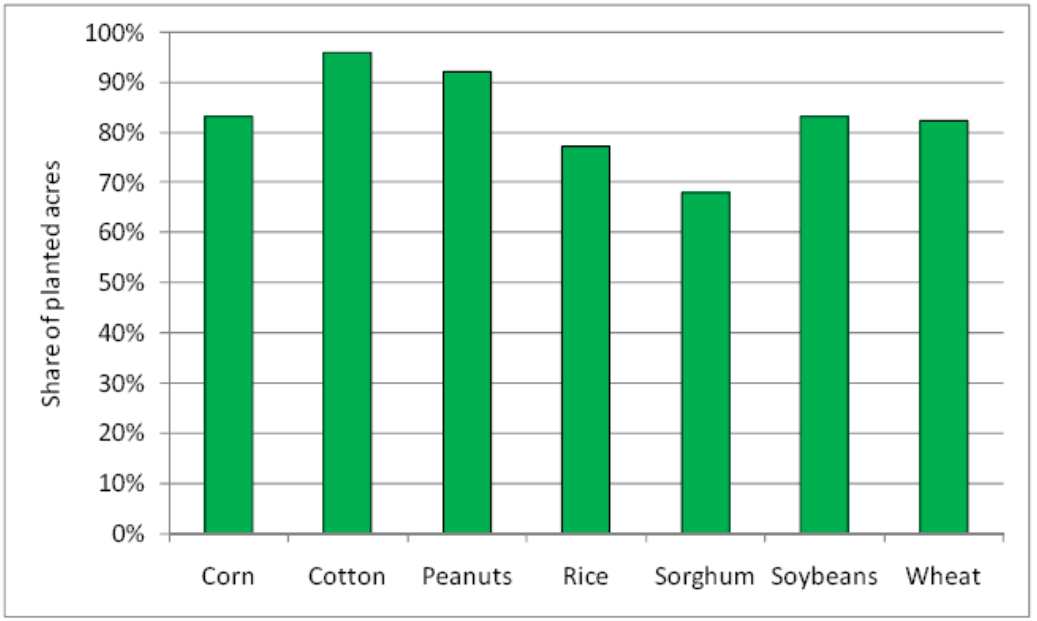


Figure 3. Crop insurance participation rates, 2009 (acres enrolled divided by planted acres)

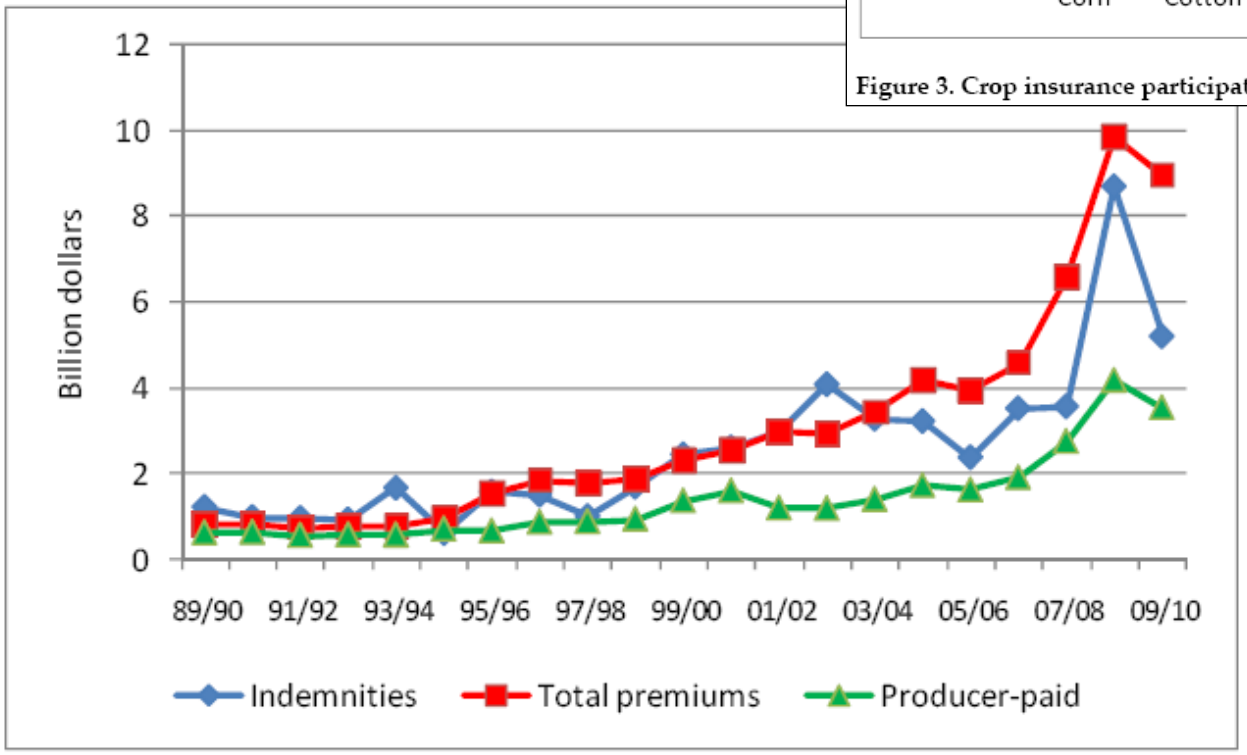


Figure 1. Crop insurance indemnities, total premiums and producer-paid premiums

Farm Bill Context:

- Commodity program crop prices are high: production subsidies largely absent, Crop Insurance is dominant.
- Federal deficits are driving budget cuts & Conservation programs are continually being cut.

Bottom line: Add nutrient mgt to conservation compliance and add conservation compliance to insurance

The message

- **All major sources of nutrients must be held accountable for their contributions to the problem.**
- **Combating the challenge of nutrient pollution will require a profound long-term change in how we implement programs, share accountability between sources, within watersheds, and across state lines.**
- **Leadership is vital to supporting and requiring a more consistent and full utilization of existing tools from state to state and source to source**
- **Build on what has worked**

What has been successful when addressing nutrients

- Local leadership is the key in changing behavior.
- Private sectors needs to be involved.
- Monitoring, planning, implementation and evaluation need to be integrated
- Planning identifies where to Target efforts
- It is an ongoing commitment

QUESTIONS?

Mail Code W-15J
77 West Jackson Blvd
Chicago, IL. 60604-3511

Telephone: 312-886-0209

email: davenport.thomas@epa.gov