Water Quality: Corn vs. Switchgrass (and Economics too)

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cenusa bioenergy

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Topics

- Introduction to Water Quality Problems from Agriculture
  - local rivers and streams
  - Downstream, Gulf of Mexico “dead zone”
- Contribution of corn production to problem
- Potential for switch grass and (other 2nd generation bioenergy crops) to alleviate
- Are second generation biofuels the answer?

Water Quality: Lakes

- Lakes, Reservoirs, Ponds:
  - 42% assessed, 65% inadequate water quality to support uses
  - Over 11 million acres are “impaired”
  - Agriculture third highest source of impairment

The diverse aquatic vegetation found in the Littoral Zone of freshwater lakes and ponds.

A cyanobacteria bloom in a Midwestern lake.

Nutrients cause a large algae bloom in this Iowa creek.

Photo courtesy Iowa DNR

Water Quality: Rivers & Streams

Photos courtesy Iowa DNR

- Rivers and Streams:
  - 26% assessed, 50% inadequate water quality to support designated uses
  - Nearly ½ million stream miles are "impaired"
  - Agriculture leading source of impairment (identified as cause of 22% unknown second highest)

Time trend

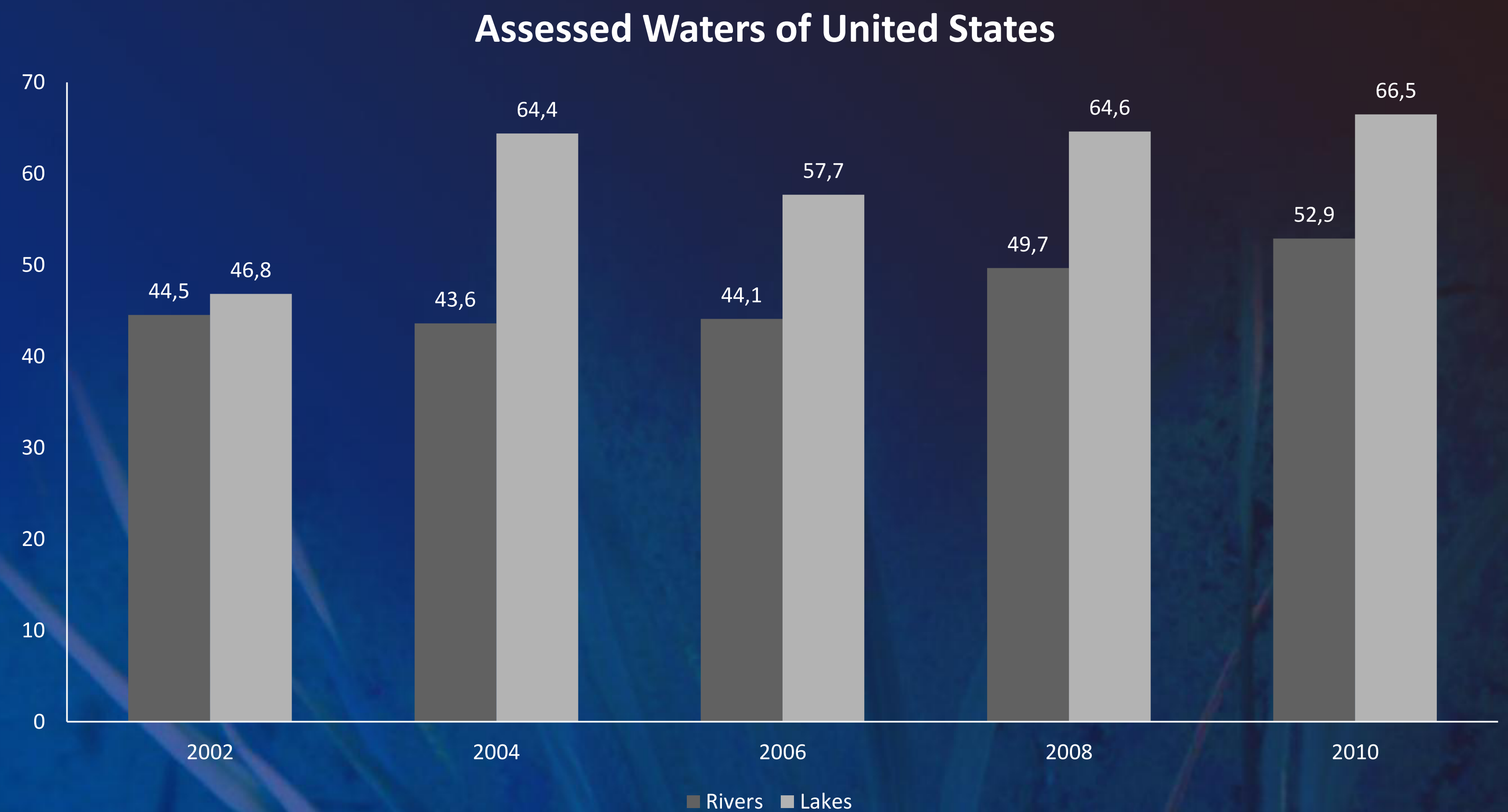
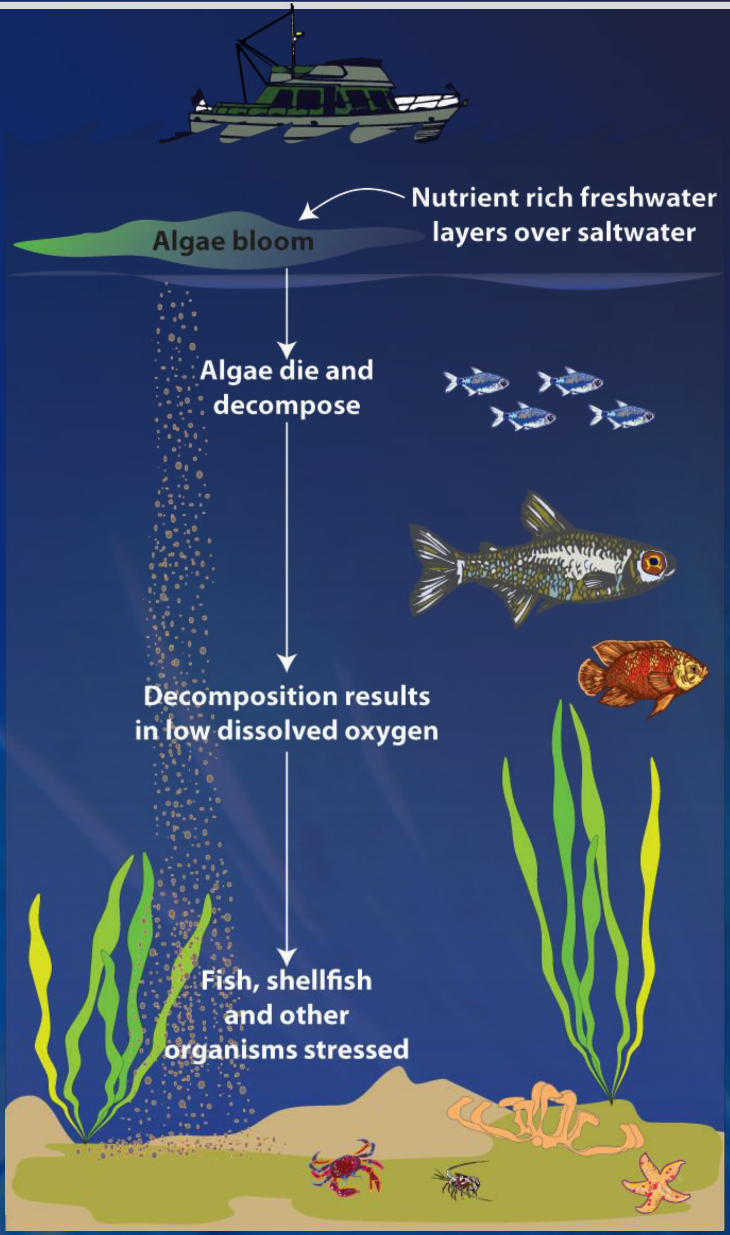


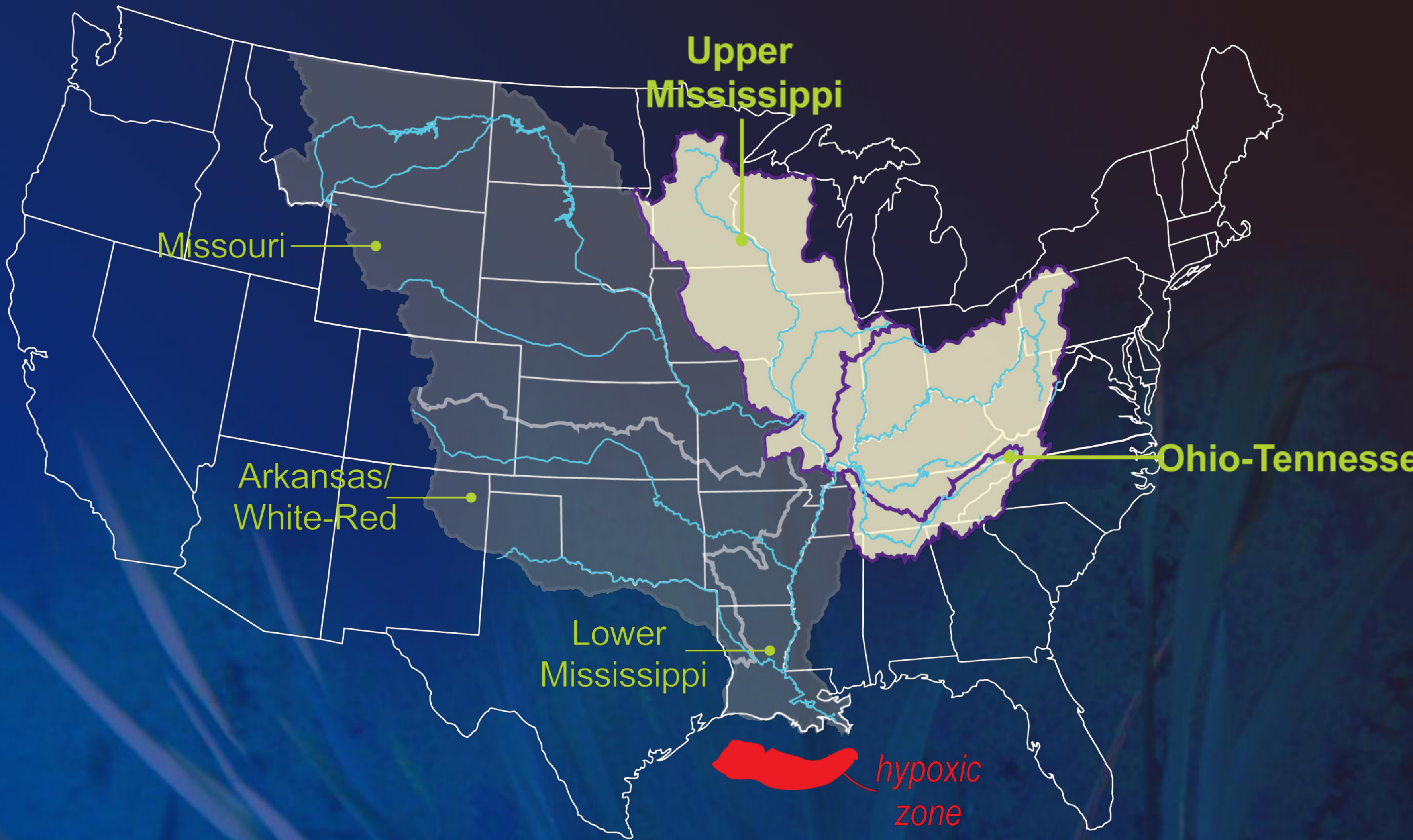
Figure 1. US waters assessed as impaired
Source: EPA National Summary of Assessed Waters Report

Hypoxia = Dead Zone



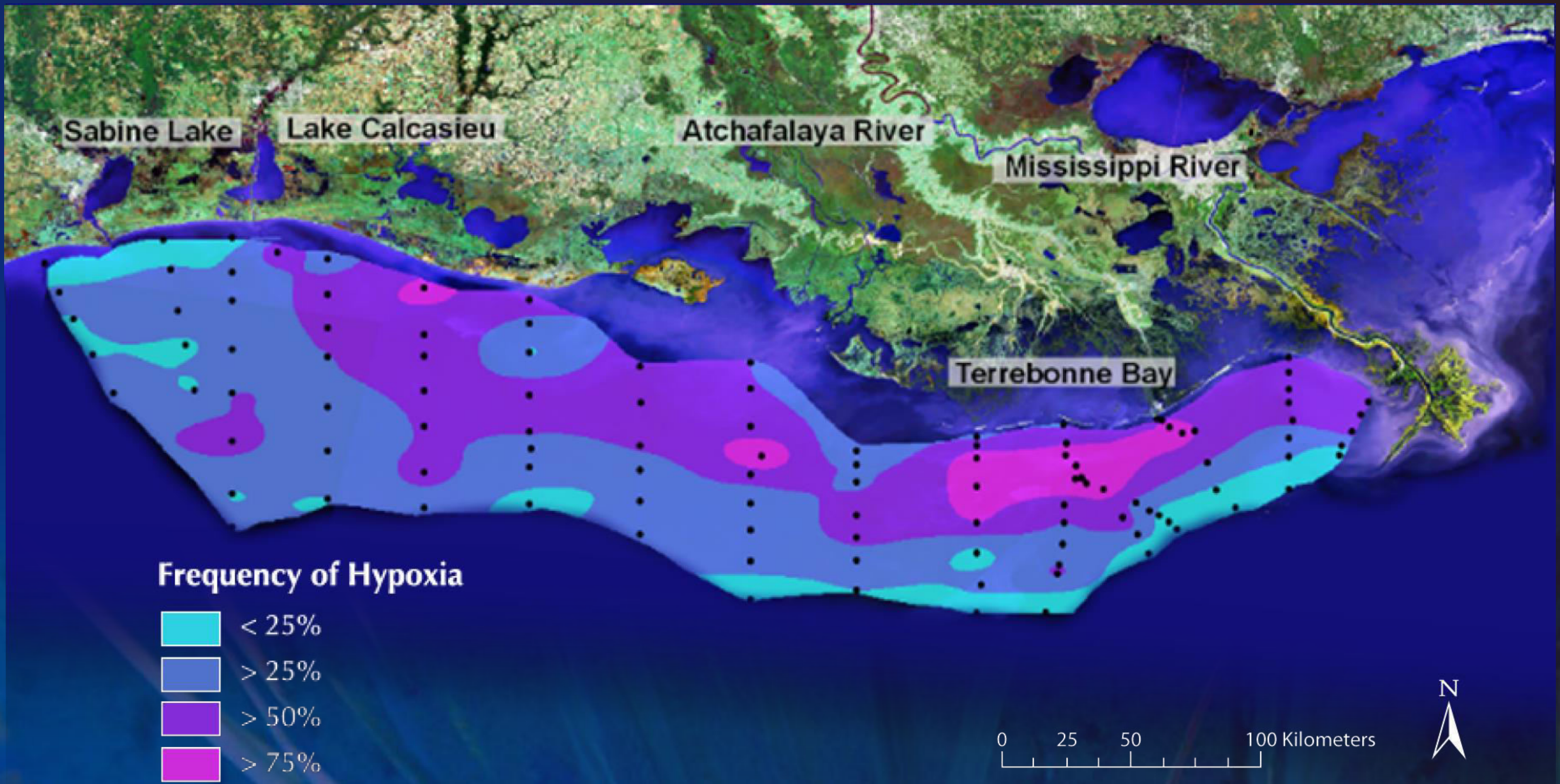
- Depleted oxygen creates zones incapable of supporting most life
- Caused by excess nutrients (nitrogen and phosphorus)
- Over 400 worldwide
- Stressed marine and estuarine systems, mass mortality and dramatic changes in the structure of marine communities (Diaz and Rosenberg, 1995).

Mississippi River Basin and its Major Subbasins



Combined, the Upper Mississippi and Ohio-Tennessee contribute about 80% of Nitrogen and 70% of Phosphorus to Gulf, main source is agriculture (EPA SAB, 2007)

Frequency and Size: 1985-Present



www.gulfhypoxia.net

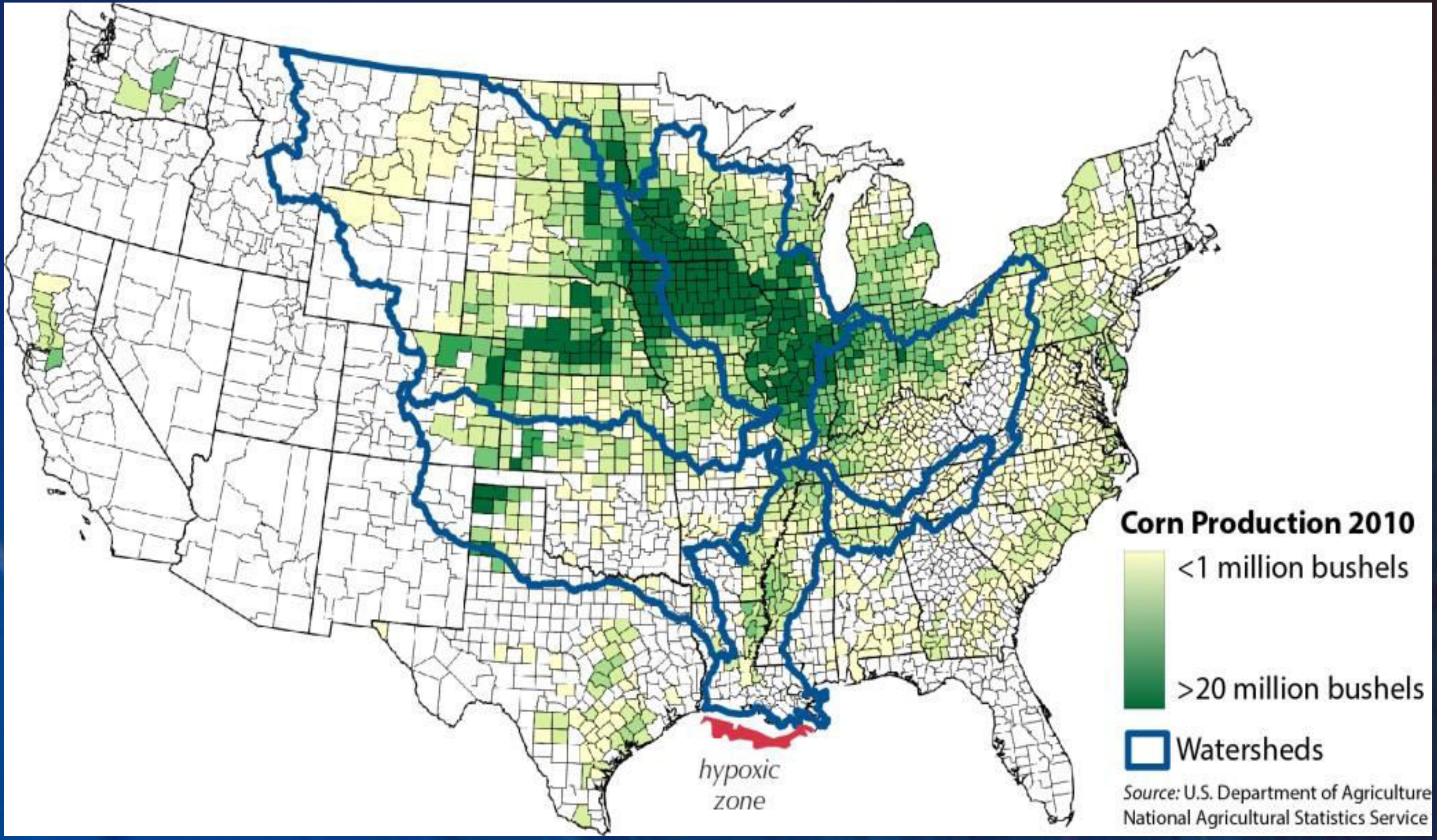
Corn

Corn

Corn is “leaky”:

- heavy nitrogen fertilization required for high productivity, lots runs off to streams and rivers
- Phosphorus, sediment erode into streams and rivers, land is bare over half year

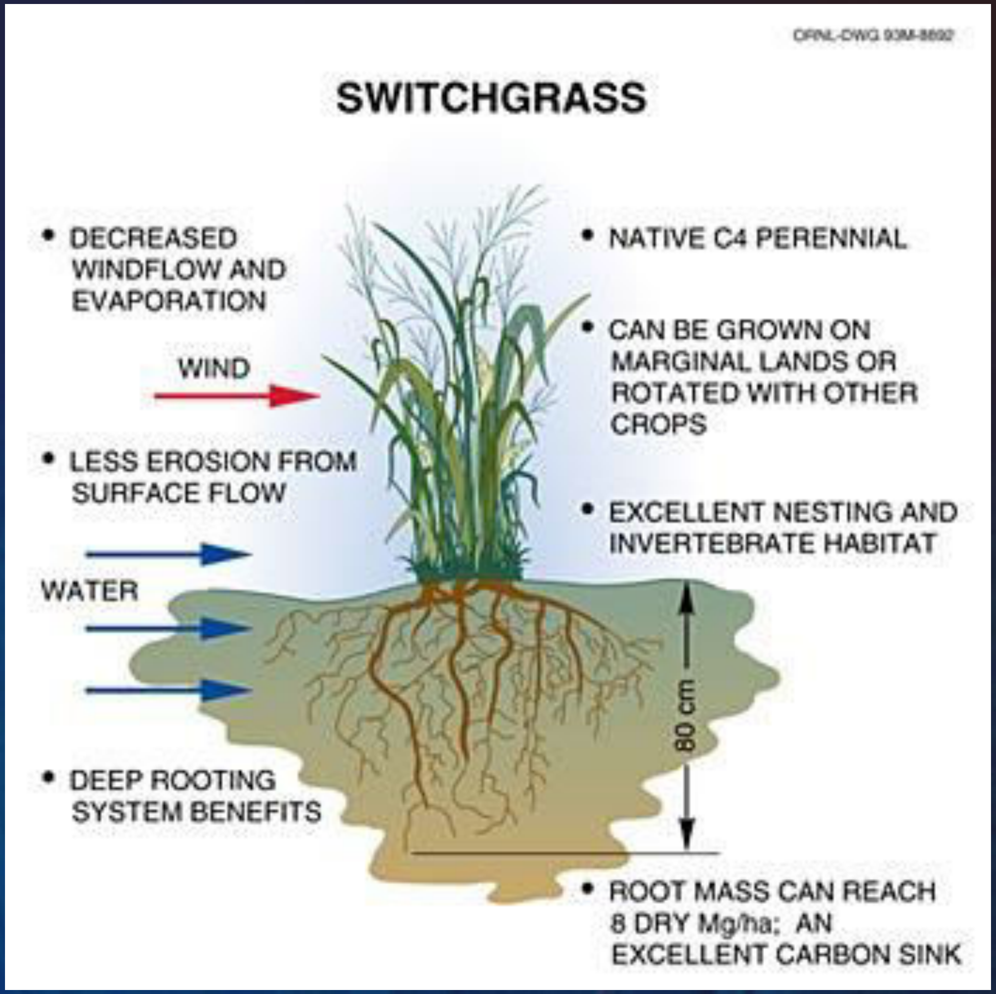
Major watersheds in Mississippi River Basin and Corn Production



Nutrient Pollution: Economics

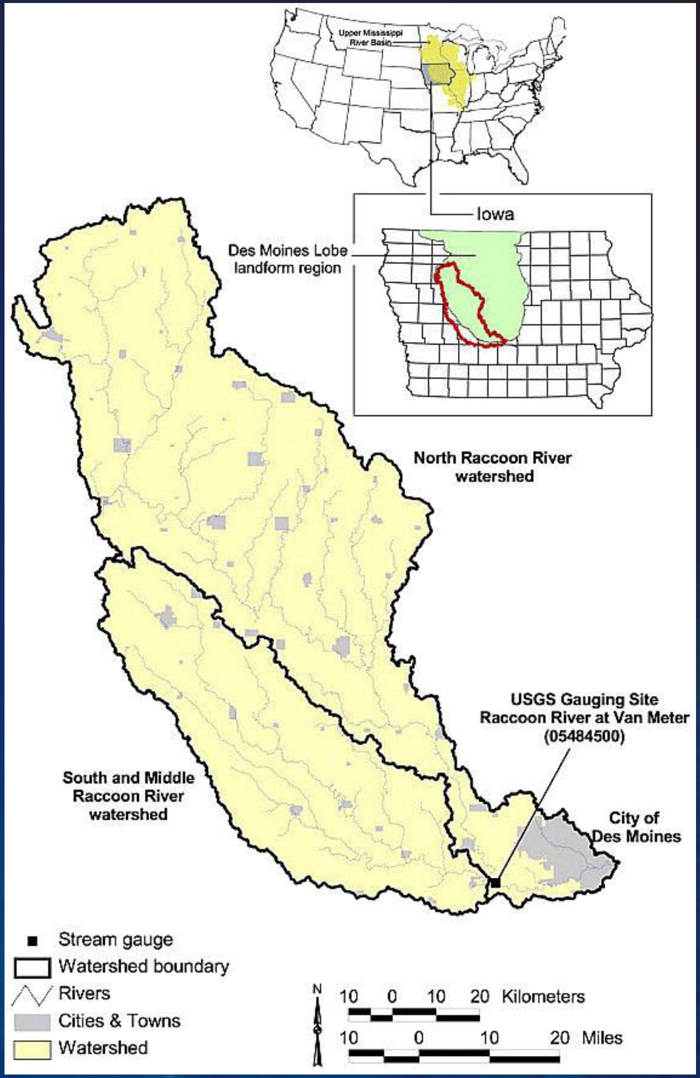
- Nutrient pollution is an "externality"
- This externality is un-priced (and unregulated)
- Many techniques to reduce the externality:
  - Change in farming practices: fertilizer timing and amount, cover crops, tillage, crop choice, etc.
  - Change in land use off farm: wetlands, stream buffers, bioreactors, tile drain management, etc.
- These are costly, no reason to adopt
- To achieve 40-50% target reductions in nutrients, experts indicate will need widespread adoption of multiple practices

Switchgrass is not nearly so leaky



http://idahofarmbureau.blogspot.com/2008/04/ethanol-update.html

Raccoon River Watershed



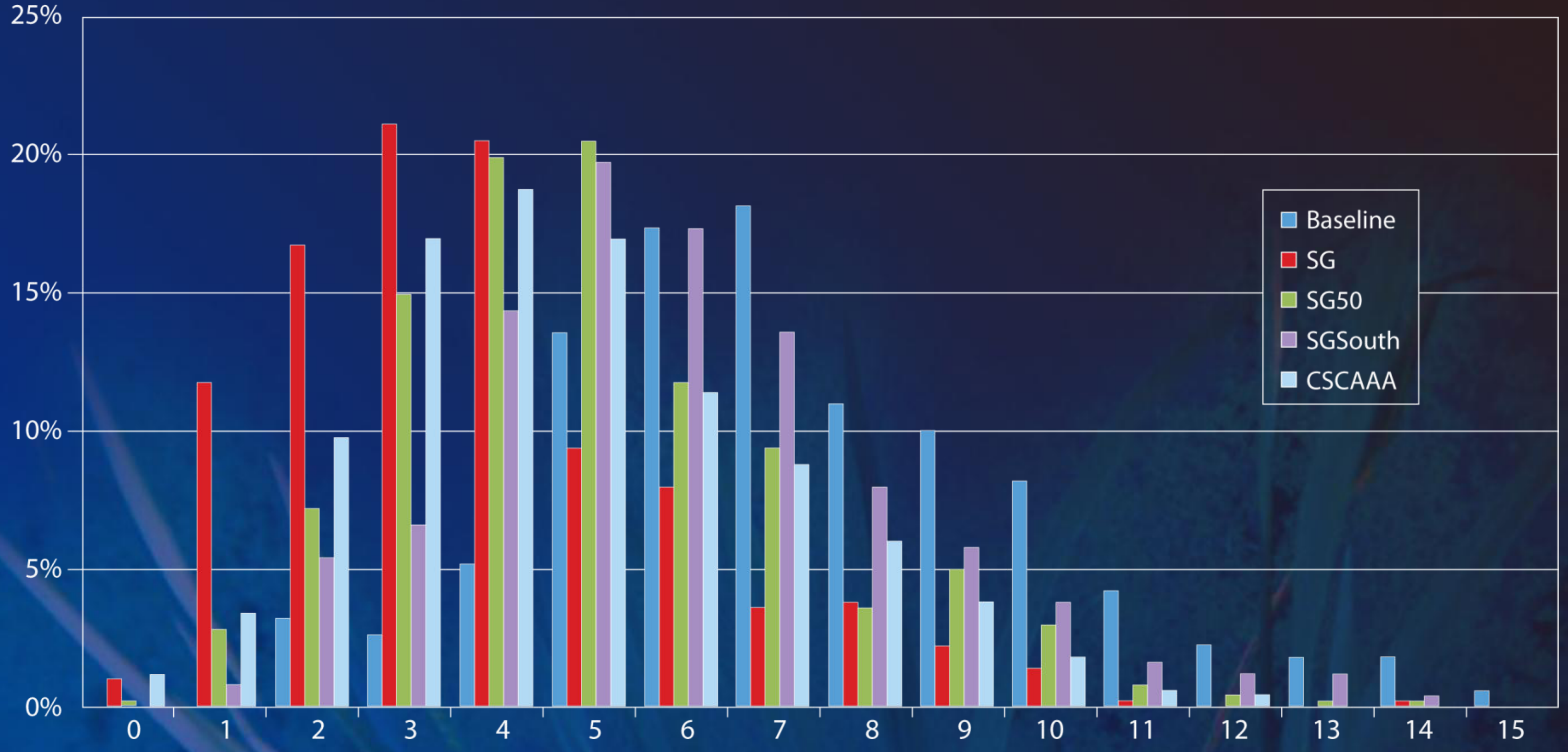
Schilling, et al. Water Resources Research
Volume 44, Issue 7, 19 NOV 2008 DOI: 10.1029/2007WR006644 http://onlinelibrary.wiley.com/doi/10.1029/2007WR006644/full#wrcr11620-fig-0001

Annual Export of Nonpoint Source Pollutants from Raccoon River Watershed under Alternative Modeled Land Use Scenarios

Scenario		Nitrogen Change	Phosphorus Change	Sediment Change
Baseline	76% corn/soybean, 17% grassland, 4% forest	-	-	-
Corn Expansion	1. Retired cropland (2% increase)	4%	5%	7%
	2. All current grassland (18% increase)	33%	33%	44%
	3. Convert all grassland and soybean (96%) corn	55%	28%	38%
Switchgrass (fertilized)	1. 25% of most erodible land converted	-3%	-51%	-63%
	2. 50% conversion	-5%	-71%	-79%
	3. 100% conversion	-11%	-97%	-98%

From Table 4: “Schilling K., M. Jha, Y-K Zhang, P. Gassman, and c. Wolter. “Impact of Land Use and Land Cover change on the Water Balance of large Agricultural Watershed: Historical Effects and Future Directions ,”Water Resources Research 44(2008)

Probability of Flood Events over 19 years under Five Land Use Scenarios



Kling, Gassman Schilling, Wolters, Jha, and Campbell. The Potential for Agricultural Land Use Changes in the Raccoon River Basin to Reduce Flood Risk: A Policy Brief for the Iowa Flood Center, 2011

Is switchgrass the answer?

What's the question?

- How do we use our land to produce the most valuable mix of food, fuel, and environmental services possible?

- Do we achieve this by restricting growth of switchgrass on "marginal" land and growing corn on most productive land?

Market will put SG where it is more profitable than other options:

1. Maybe this will be true only on "marginal" land
2. But maybe it will be true for all land located near a refinery
3. Maybe corn and stover will be most profitable (once cellulosic technology works, corn becomes even harder crop to beat).
4. Maybe SG profitable only with subsidies: is that the best use tax $? Subsidize poor for higher food prices? Invest in C sequestration? Etc
5. Will probably need policy intervention

Should SG go on marginal land?

- What if it costs less (used less energy) to produce biofuels with SG on all land quality near a refinery rather than spread out?
- What if putting SG on productive land in key locations provides great water quality improvement at low cost?
- What if we can get more food, fuel, and good water quality with corn and carefully placed wetlands ? Are GHG benefits enough to offset this?

Tradeoffs cannot be avoided[1]

- With fixed amount of land, both high and low quality land should be used to produce highest valued outputs
- Those highest valued outputs are likely to change over time
- SG has some good enviro features, but doesn't feed people and tech isn't there yet
- Corn produces high value crop, but hard on environment (water and GHG)

[1] They don't call it the dismal science for nothing ☹

A few take home points

- Water quality is a big problem, row crop agriculture (corn and soybeans) are big cause
- Failure to price or regulate the externality has expected results (too much)
- 2nd Generation biofuels have lots of potential, but much still unknown; fertilization? Field performance?
- Tradeoffs between alternative products coming from fixed land are inevitable

A few take home points

- Well functioning markets do a great job of allocating resources to their highest value, BUT not when unpriced externalities exist = GHG and water pollution
- Externalities need to be priced (or equivalently capped or regulated) to correct
- Best not to identify best specific approach, but to create clear incentives to market to achieve outcomes

Thanks for your attention

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