Overview of Constructed Wetlands

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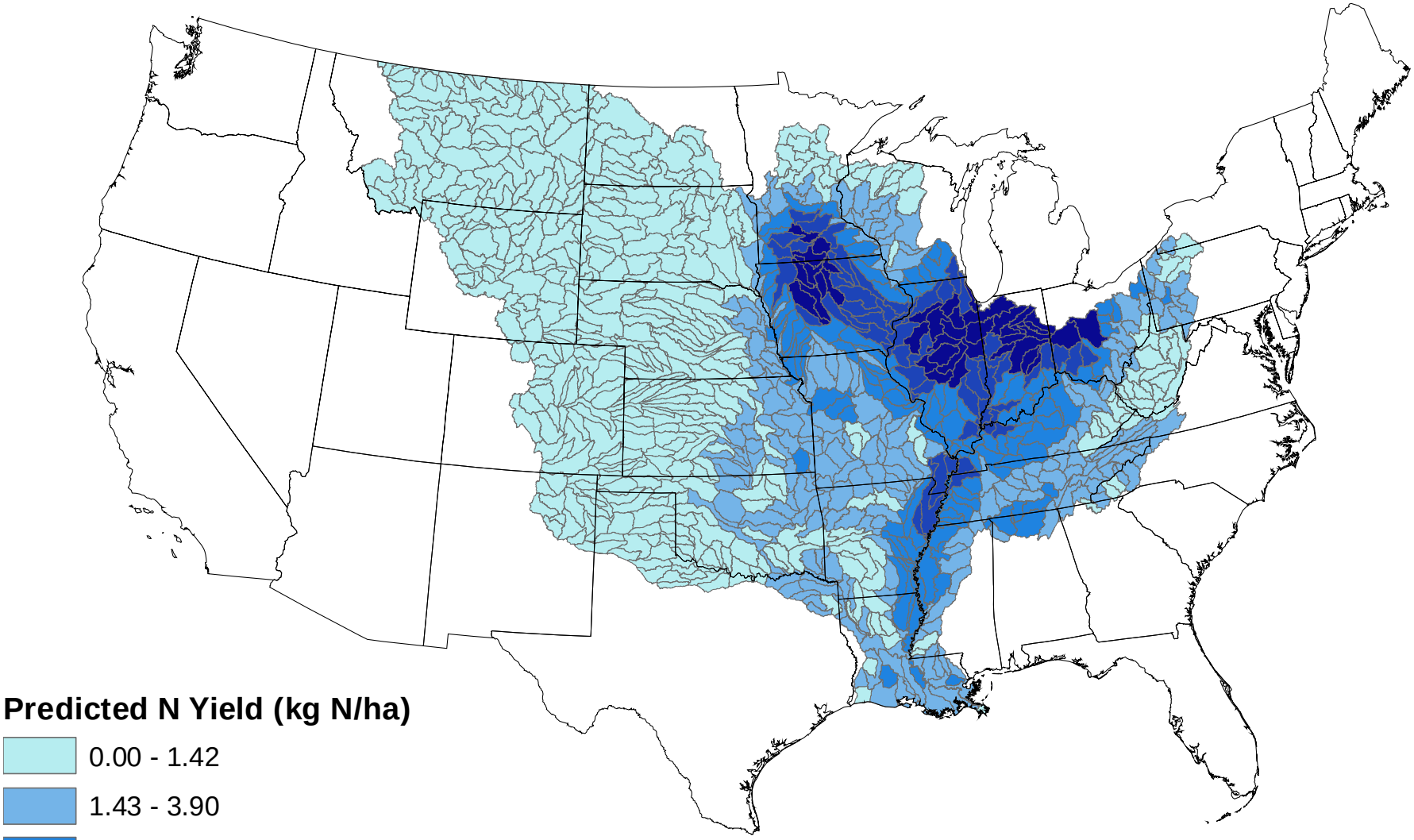
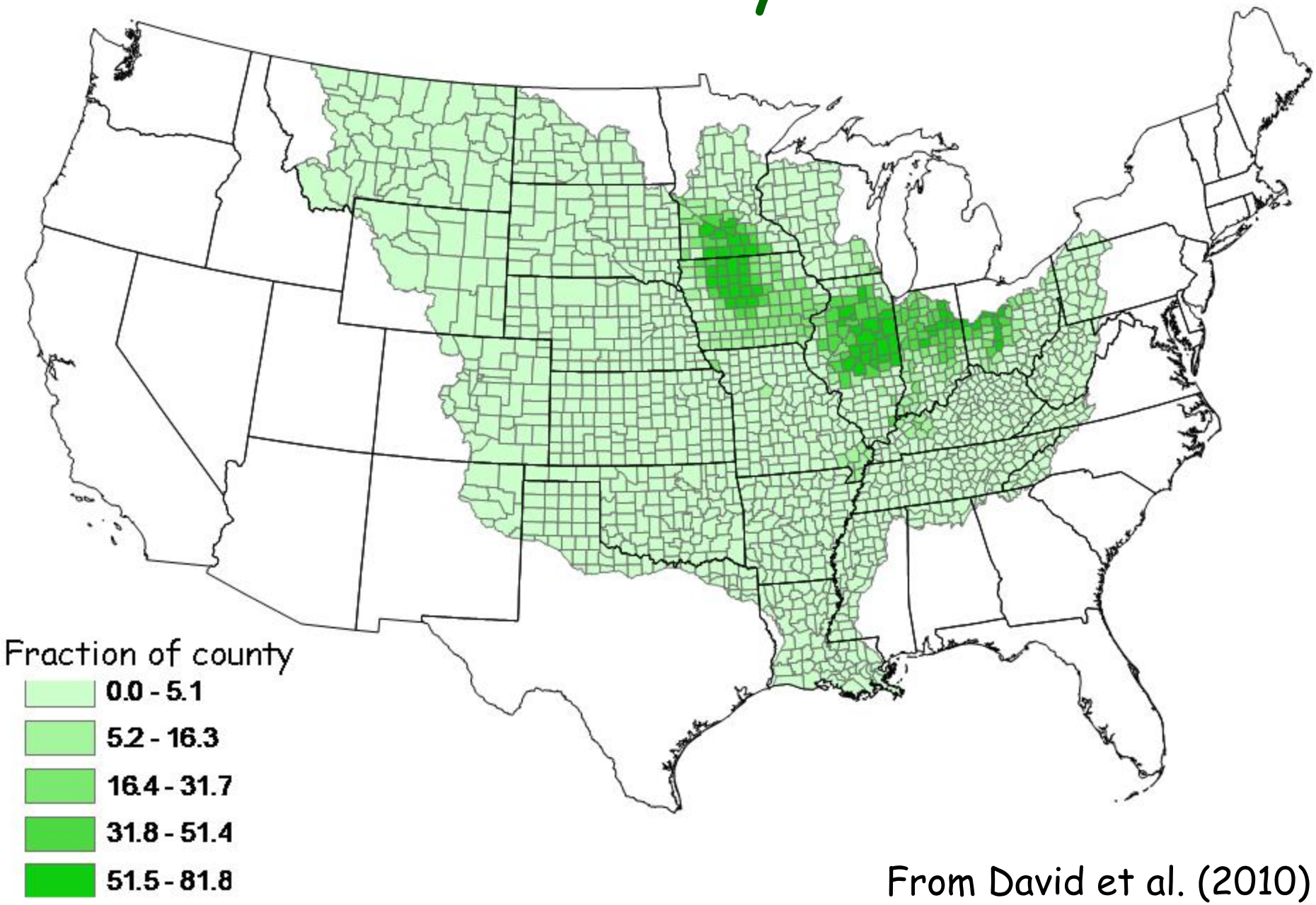
January to June Nitrate-N Yield



Adapted from David et al. (2010)

Drainage by tiles and ditches

Fraction of county tile drained



From David et al. (2010)

More tile drainage every year

What are constructed wetlands?

- intercept tile line with small constructed wetland (0.5 to several ha)
  - bulldoze berm
- tile water is retained for hours to days
- allows for nitrate removal by denitrification
- usually along side of ditch or stream
- extensive literature and experience with sewage treatment
  - less for agricultural drainage waters

Tile wetland

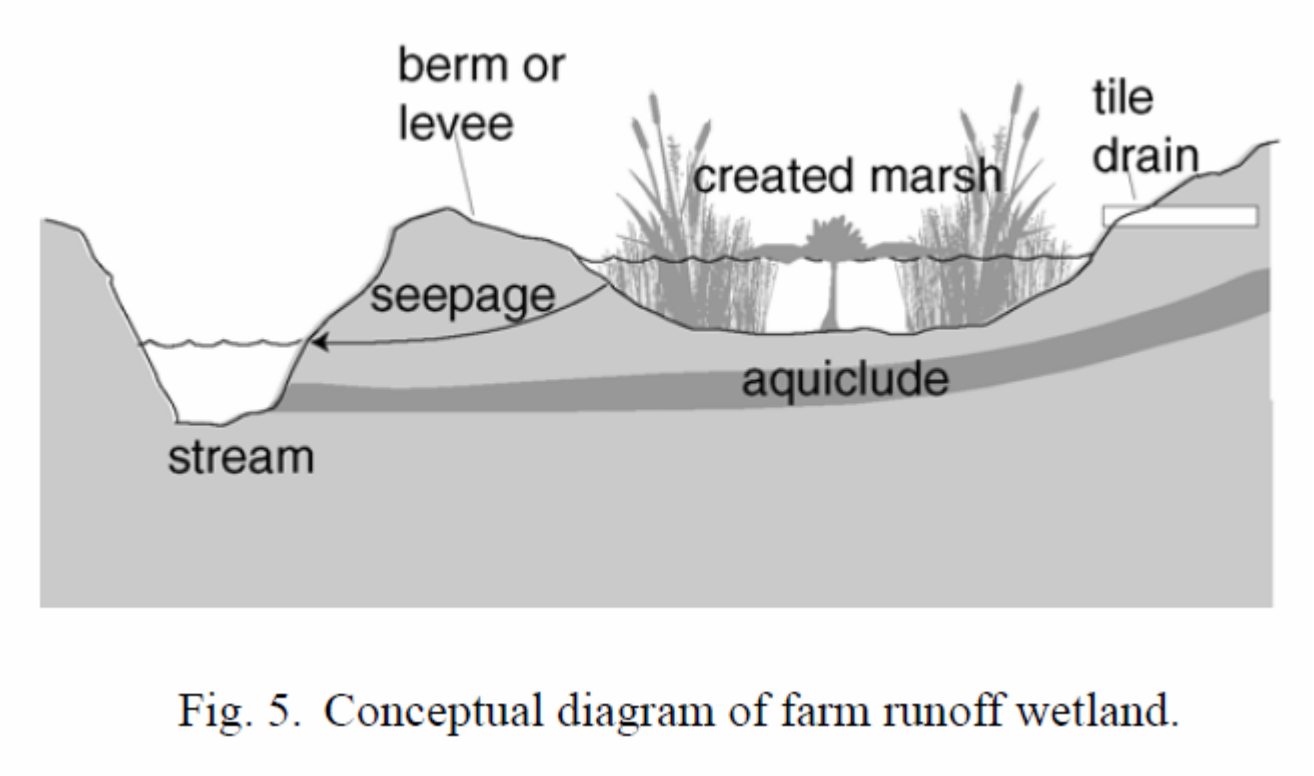
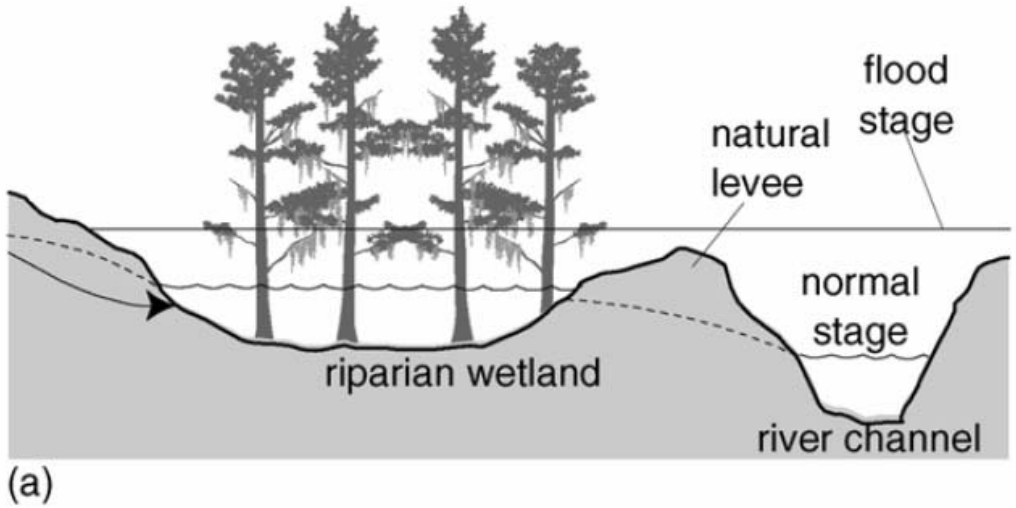


Fig. 5. Conceptual diagram of farm runoff wetland.

From Mitsch and Day (2006)

Riparian wetland



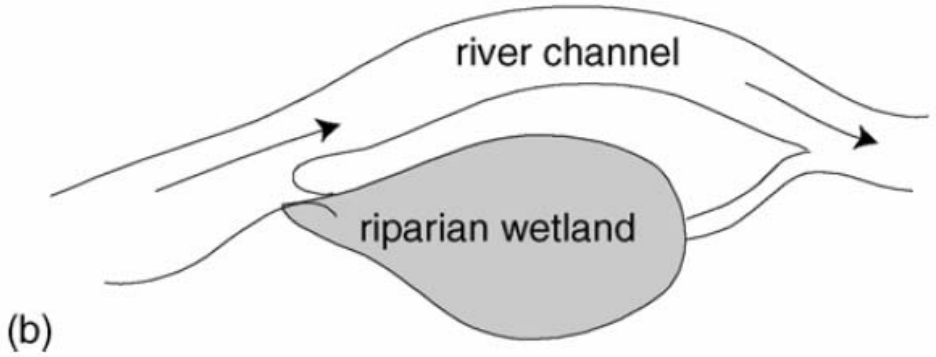


Fig. 6. Conceptual diagram of river diversion wetland: (a) plan view, (b) aerial view.

From Mitsch and Day (2006)


Wetland A
Wetland B

Illinois tile water and N inputs

- N - 30% winter, 65% spring, 5% summer & fall
- Tile A, 30-59 million L yr^{-1}
- Tile B, 13-19 million L yr^{-1}
- Tile D, 58-106 million L yr^{-1}

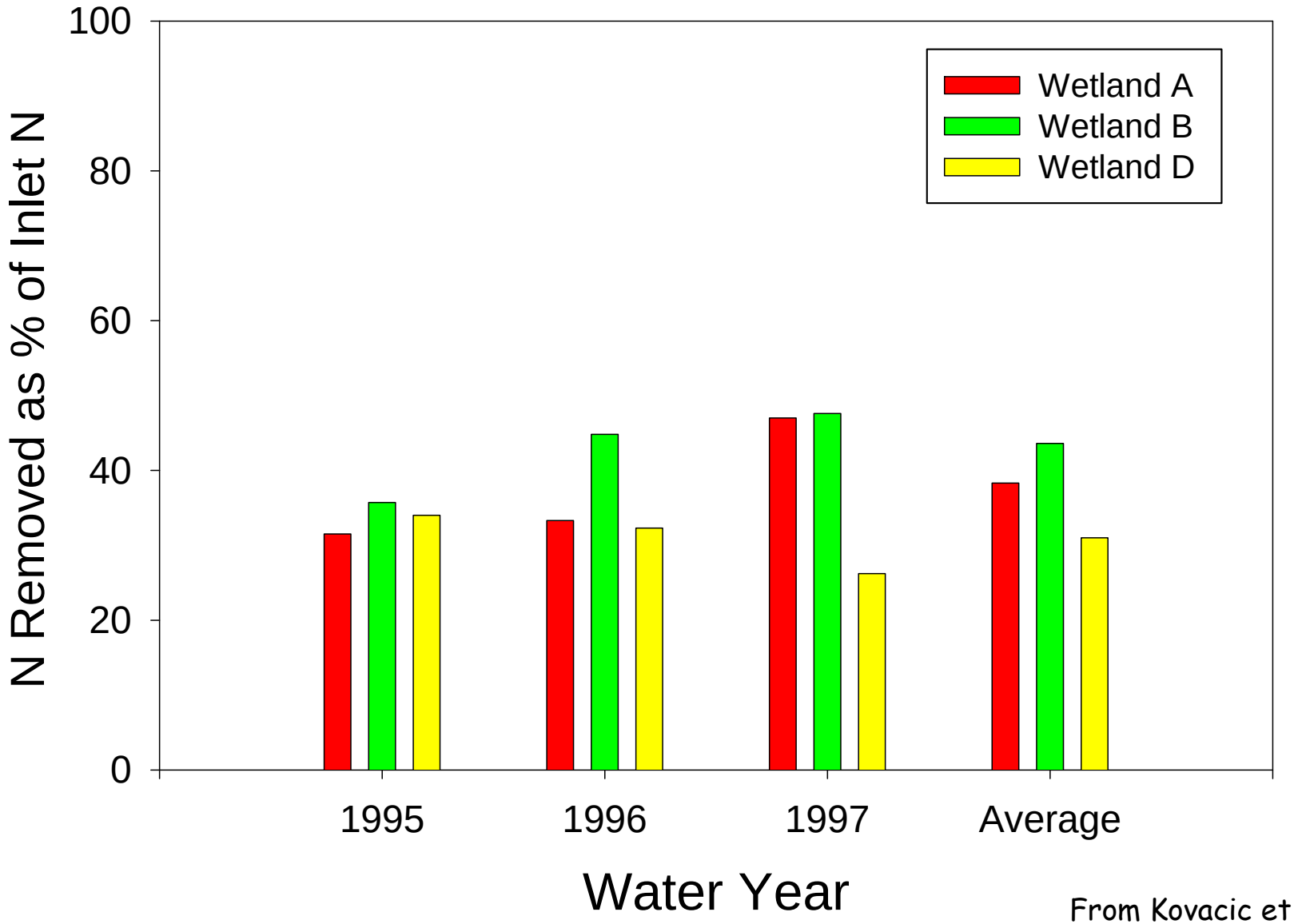
From Kovacic et al. (2000)

Illinois seasonal N removal (%)

Season	A	B	D	Overall
Fall	83	83	83-97	83-97
Winter	39-48	34-54	8-34	8-54
Spring	30-53	26-52	34-44	26-53
Summer	93-100	100	88-100	88-100

From Kovacic et al. (2000)

Illinois total N removal



From Kovacic et al. (2000)

What is the IOWA CREP?

The Iowa Conservation Reserve Enhancement Program is a state, federal, local, and private partnership that provides incentives to landowners who voluntarily establish wetlands for water quality improvement in the tile-drained regions of Iowa. The goal of the program is to reduce nitrogen loads and movement of other agricultural chemicals from croplands to streams and rivers.

In addition to improving water quality, these wetlands will provide wildlife habitat and increase recreational opportunities.

Program Benefits

Landowners enrolling in CREP will receive:

- Up to 15 years of annual rental payments from USDA for all enrolled acres paid at 150% of the average soil rental rate
- 100% cost-share for wetland restoration and buffer establishment
- A one-time, up-front incentive payment to enter into either a 30-year or perpetual easement.

Wetlands for Water Quality Improvement in Agricultural Watersheds

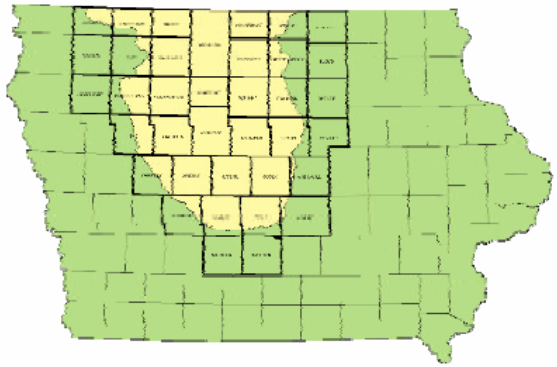
Why is the Iowa CREP important?

Public Concern has increased about the effects our agricultural systems are having on surface water quality. In particular, nitrate contamination can negatively affect human health and contribute to nutrient enrichment problems in surface waters.

Substantially reducing nitrate losses requires a combination of:

- In-field best management practices
- Off-site nitrate removal wetlands

Research at Iowa State University has demonstrated that strategically sited and designed wetlands can remove 40-90% of nitrates and over 90% of herbicides from cropland drainage waters.



Counties Eligible for the Iowa CREP

Program Sign-Up

Enrollment is on a continuous basis. Land must be in one of the 37 eligible counties in North-Central Iowa (shown above), and must meet CREP eligibility requirements. Eligible lands must be situated so that the established wetland does not impact drainage rights of upstream or downstream landowners.

Where can I get more information?

Individuals interested in the Iowa CREP may contact the Iowa Department of Agriculture and Land Stewardship-Division of Soil Conservation. Information is also available at local Farm Service Agency and Soil and Water Conservation District offices.

Participating Agencies

- Iowa Department of Agriculture and Land Stewardship
- USDA Farm Service Agency
- Soil and Water Conservation Districts
- Iowa State University
- USDA Natural Resources Conservation Service

IOWA DEPARTMENT OF AGRICULTURE AND LAND STEWARDSHIP

USDA Farm Service Agency

The Iowa Department of Agriculture & Land Stewardship is an equal opportunity provider and employer.

Iowa Department of Agriculture
and Land Stewardship
Division of Soil Conservation
515-281-6146

http://www.IowaAgriculture.gov

October 2009

IOWA Conservation Reserve Enhancement Program

Helping Landowners Protect Iowa's Natural Resources

A joint effort of the Iowa Department of Agriculture and Land Stewardship and the United States Department of Agriculture in cooperation with local Soil and Water Conservation Districts.

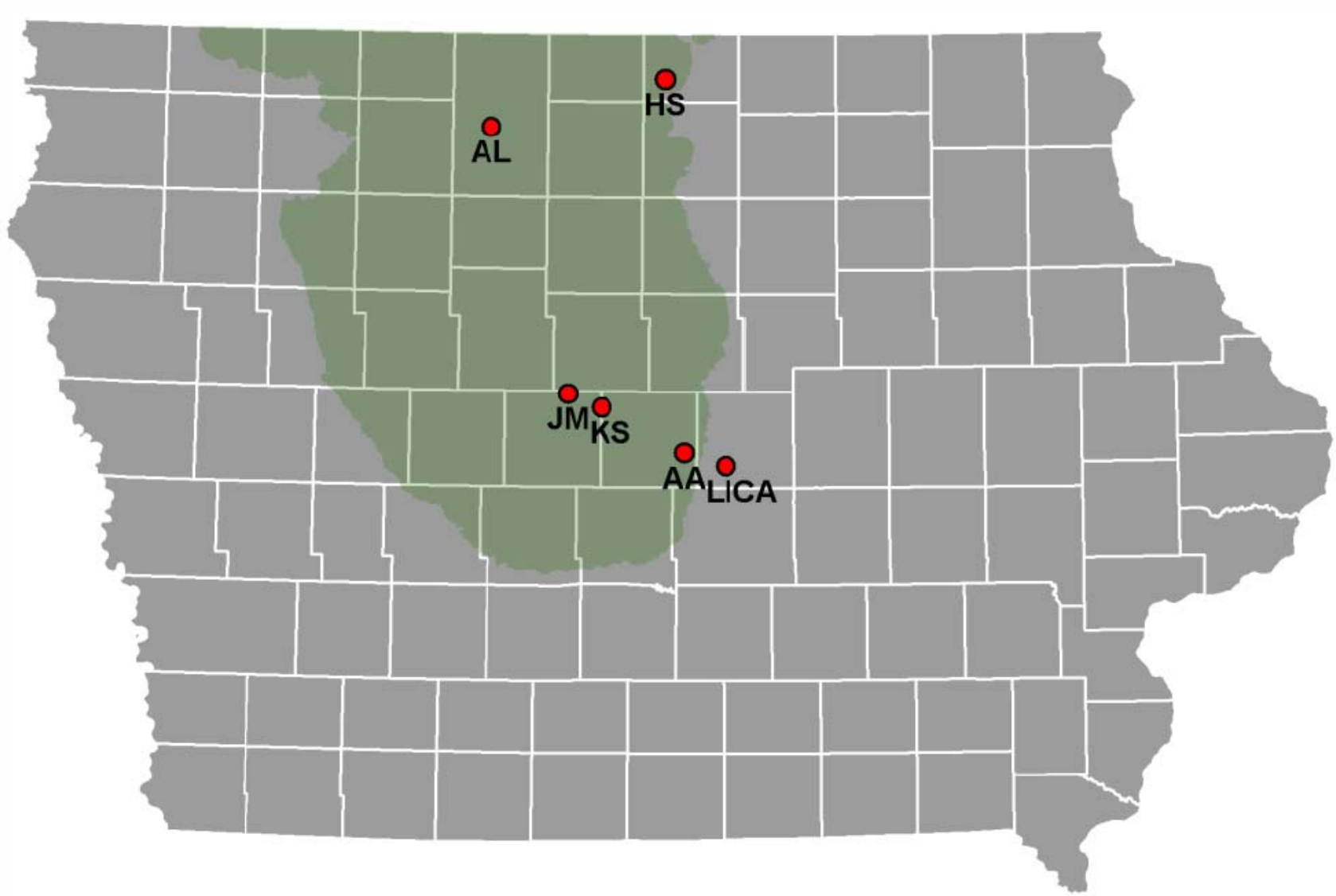
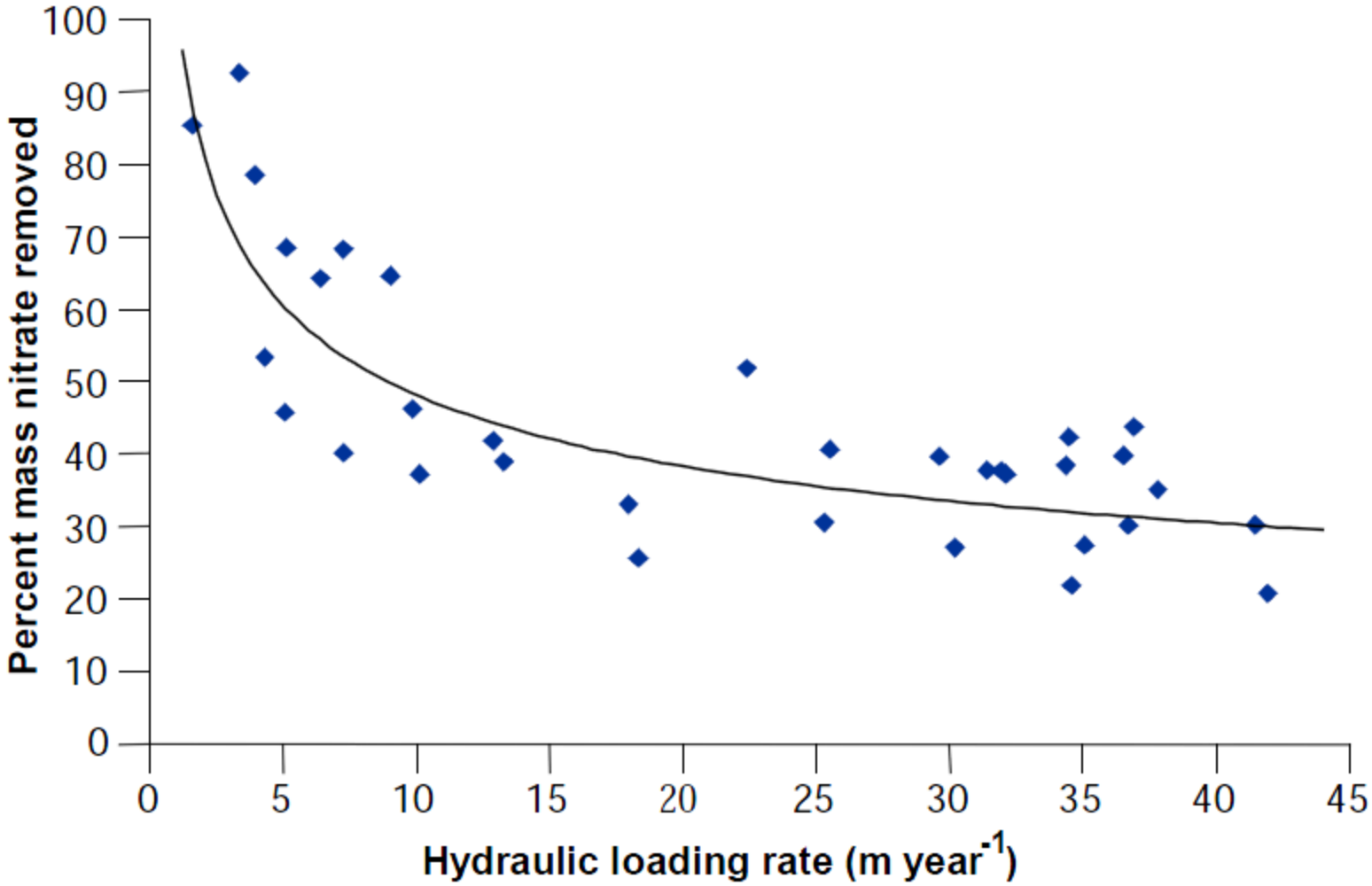


Figure 7. Wetlands monitored during 2010.

What determines effectiveness?

- hydraulic loading
  - amount of water and nitrate
  - retention time
- nitrate concentration
- carbon
- temperature
- soils and vegetation
- microbial populations

Loading controls % removal



From Crumpton et al. (2008)

Wetland to watershed areas

- 0.5 to 5% in literature
- what is watershed area?
  - just tile drained area
  - overall field
- need to standardize
- however, don't always know tile drained area
  - can vary year to year as well

Major unknowns

- overall greenhouse gas emissions
- long-term performance
- optimum wetland to watershed area
- placement limitations
- large-scale acceptance
- costs
- ????

Limitations

- cost
  - bottom line
- landscapes and land
  - can't put them everywhere
- flows
  - high winter/spring tile flow
- social barriers
  - many

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Constructed Marshes for Nitrate Removal

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Large numbers of free water surface treatment wetlands are in use for nitrate reduction. Target applications are field runoff, river and stream improvement, and enhancement of wastewater treatment plants. In total, an extensive database now exists, in many publications and operating reports. Microcosms and mesocosms are not included here because of the lack of transferability to design. A first-order areal model is appropriate, to be implemented with appropriate temperature, hydraulic efficiency, and flow pattern. Annual average rate constants at 20°C have a median of 25 m/year. Performance is better at higher water temperatures, with a modified Arrhenius temperature factor of 1.106. Measured values of the tanks-in-series (TIS) parameter average N = 4.4 TIS. Higher rate coefficients are associated with emergent soft tissue vegetation, and lower efficiencies with submergent vegetation, unvegetated open water, and forested wetlands. Carbon availability can limit denitrification at high nitrate loadings; however, wetlands produce carbon in sufficient quantities to support typical municipal and agricultural loads. Design may be for load reduction or concentration reduction, with the latter requiring larger wetlands. Significant ancillary benefits of ecological diversity and wildlife habitat are certain to accompany the project. A small negative greenhouse gas penalty, which accrues to all new wetlands, is not an important factor. Economic issues may include land cost and pumping cost. Constructed marshes are an ecologically and economically attractive method for reducing nitrate levels in surface waters.

Conclusions

- wetlands can be effective at the end of tile lines
- removal rates of nitrate variable
  - 20 to 90%
- most likely lost as N_2
- many financial and social barriers
- landscape limitations