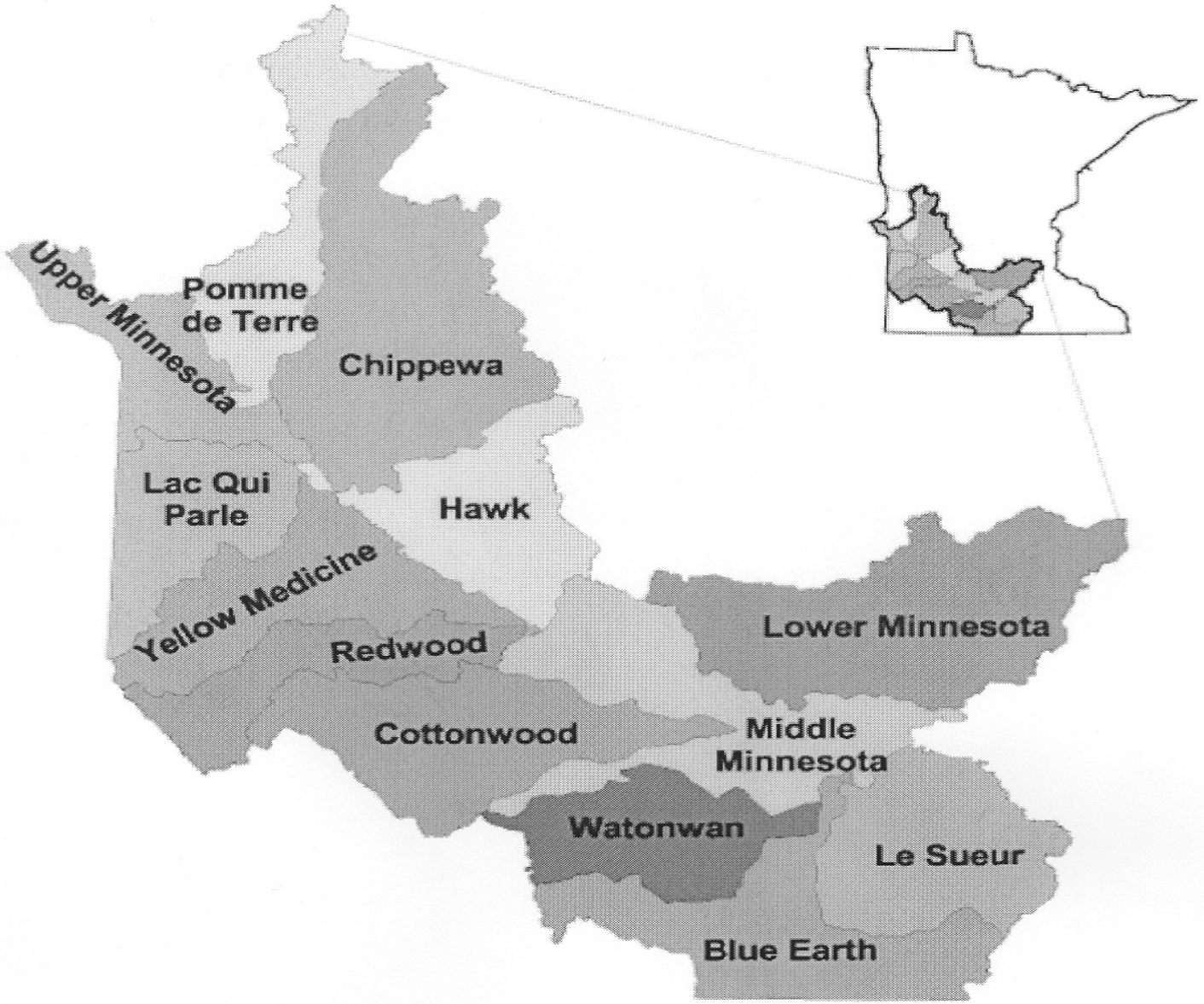
Improving Water Quality and Enhancing Hydrologic Stability of the Minnesota River through Agroforestry and other Perennial Cropping Systems.

Ken Brooks, D. Current, W. Easter,
D. Ennanaay, N. Jordan, Y. Konishi,
J. Magner, L. Meschke, C. Sheaffer,
S. White, and D. Wyse

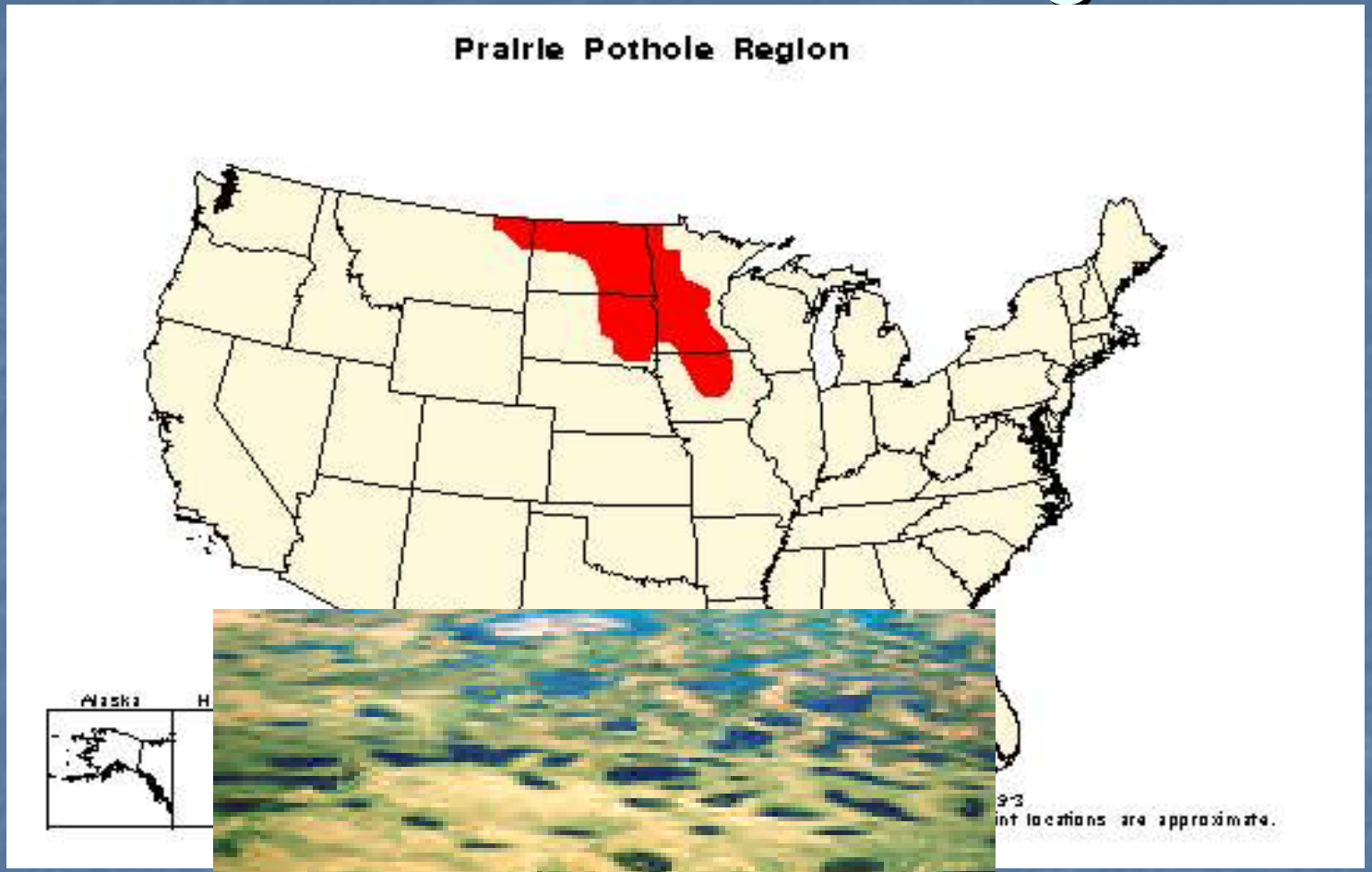
Introduction

- Intensive corn-soybean agricultural is practiced on over 20 million ha in Upper Midwest of USA
- Questions today -- Is it sustainable financially? Environmentally?
- Water quality impairment of concern – meeting TMDLs and Hypoxia in Gulf of Mexico
- Focus on the Minnesota River Basin

Map of the Minnesota River basin

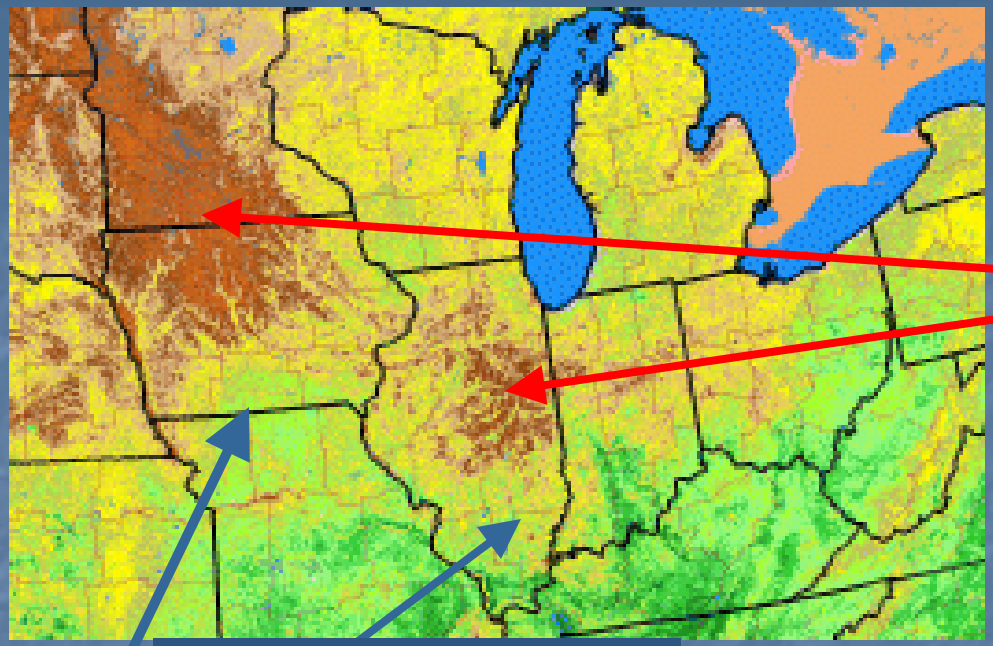


Prairie Pothole Region




Former wetlands

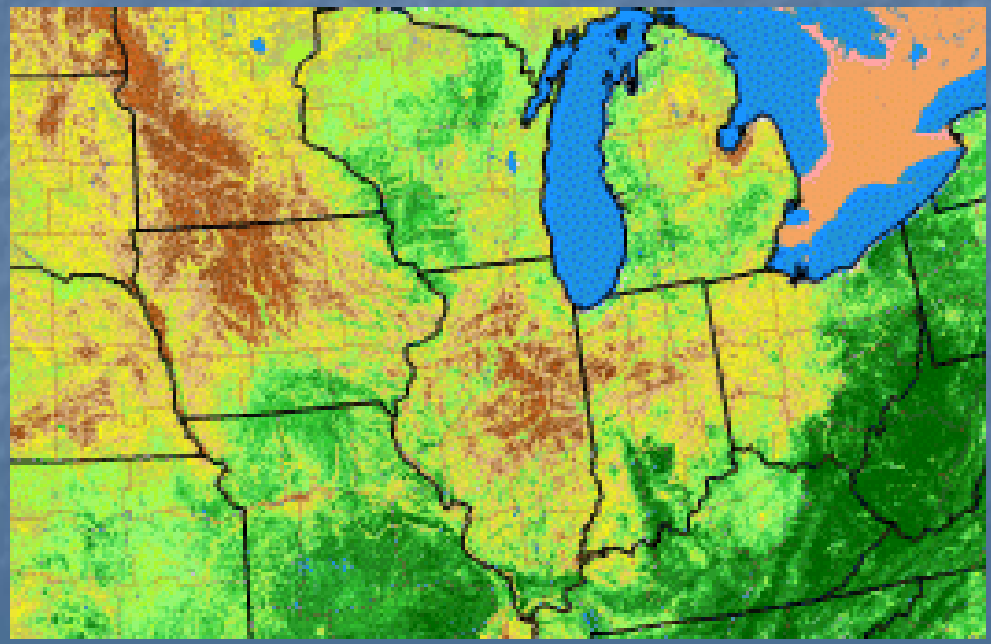
Satellite images of vegetative activity.



Areas of annual row cropping

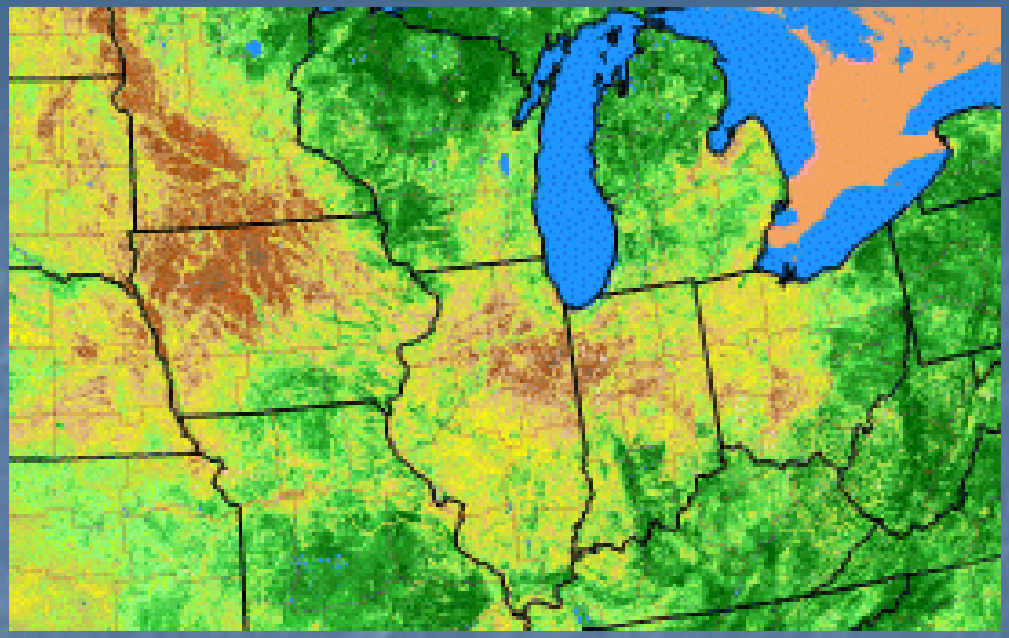
April 20 – May 3

Areas of perennial vegetation

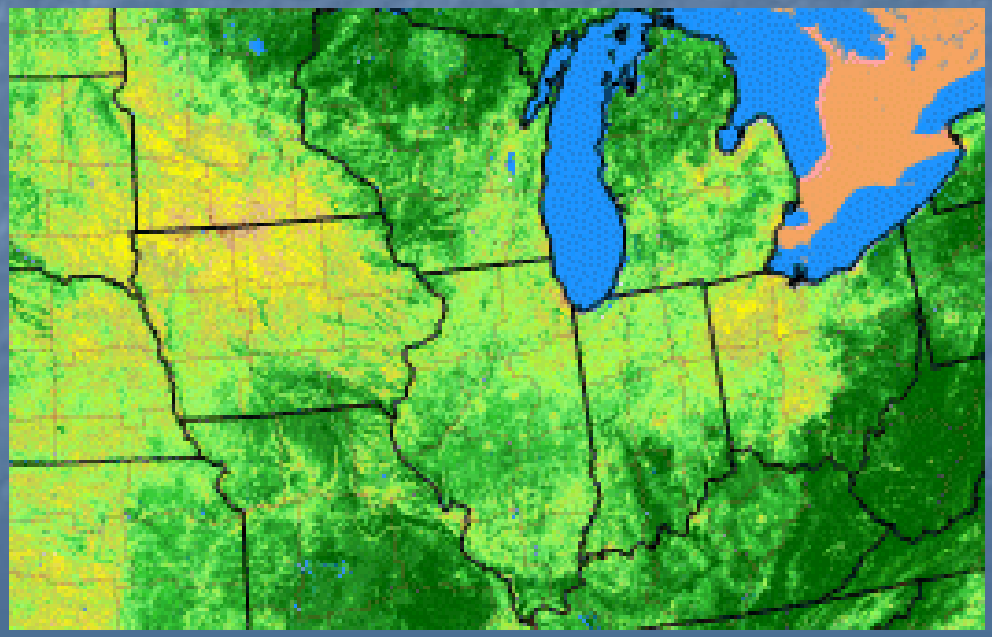


May 4 – 17

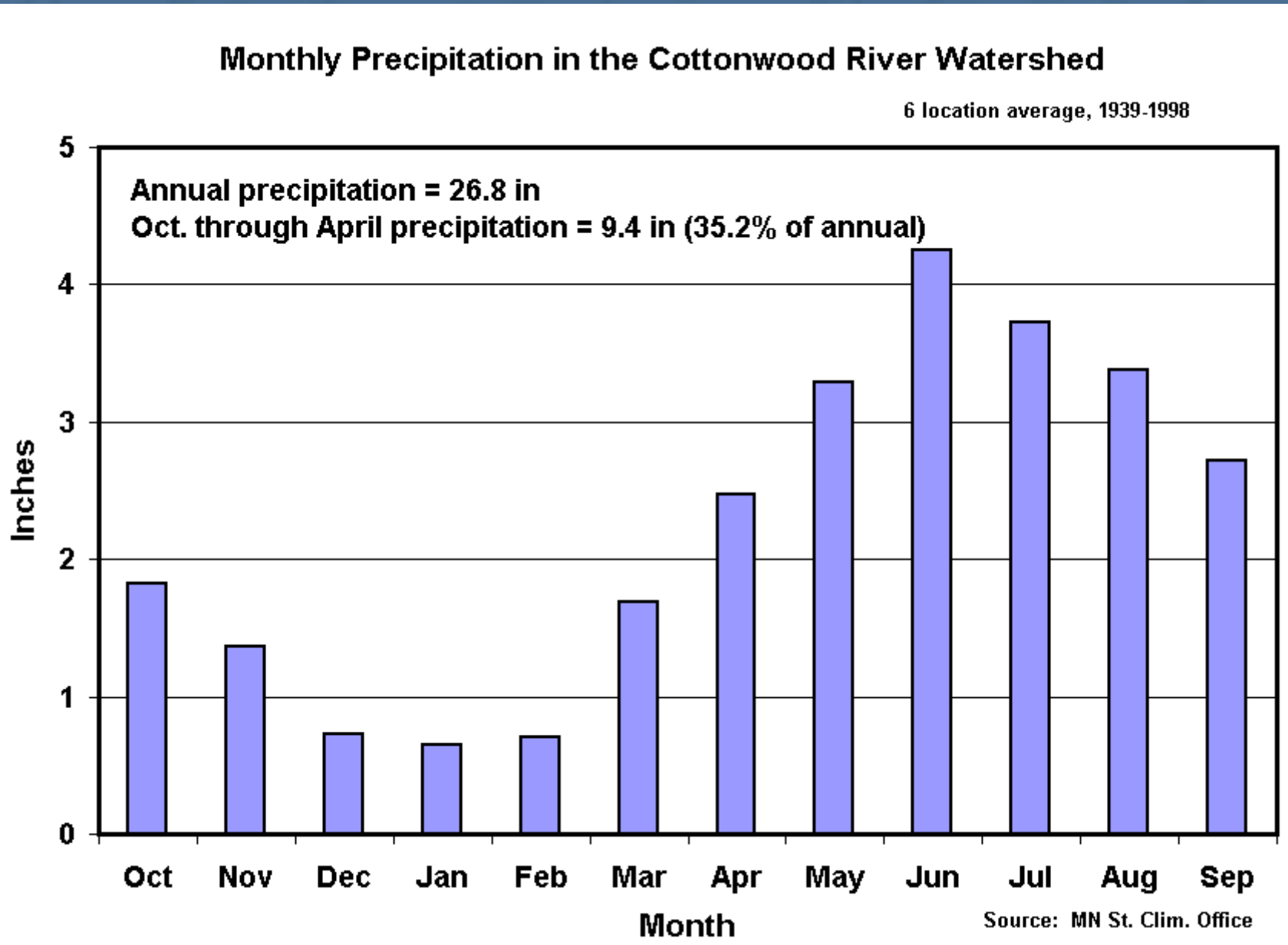
Satellite images of vegetative activity.

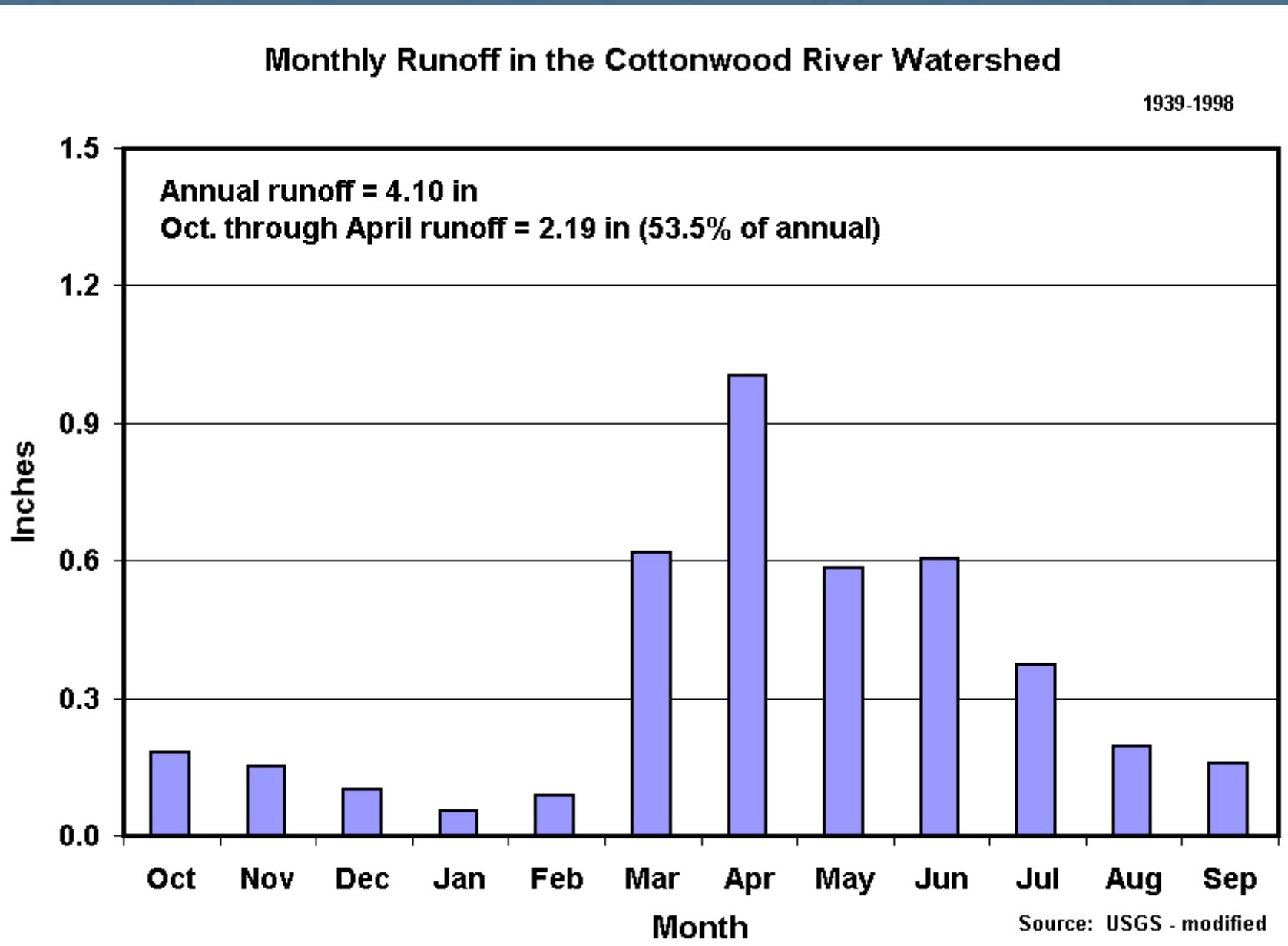


May 18 - 31



June 15 - 28

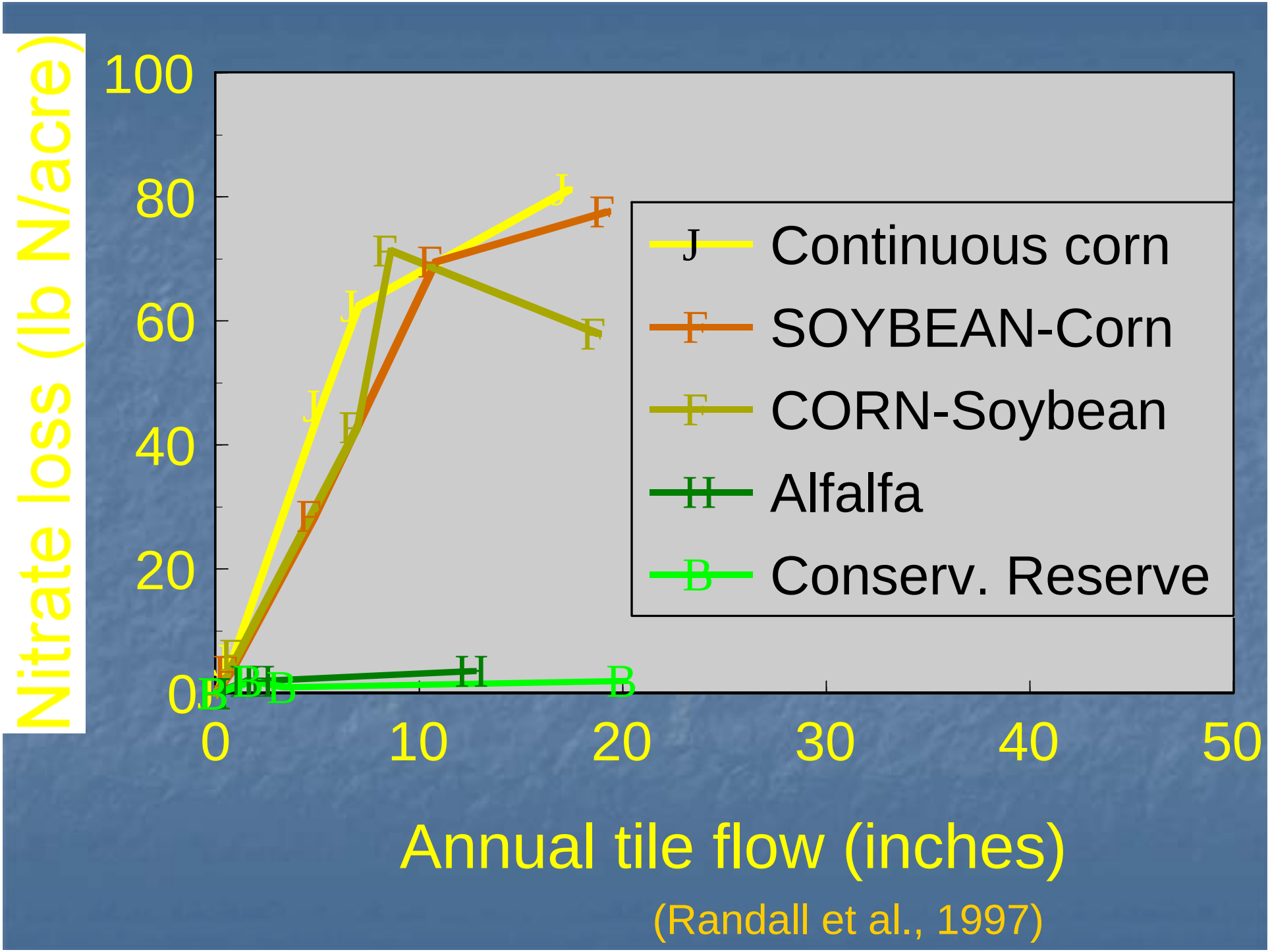

Monthly Precipitation in the Cottonwood River Watershed
6 location average, 1939-1998
Annual precipitation = 26.8 in
Oct. through April precipitation = 9.4 in (35.2% of annual)
Inches
0
1
2
3
4
5
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Month
Source: MN St. Clim. Office


Monthly Runoff in the Cottonwood River Watershed
1939-1998
Annual runoff = 4.10 in
Oct. through April runoff = 2.19 in (53.5% of annual)
Inches
1.5
1.2
0.9
0.6
0.3
0.0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Month
Source: USGS - modified

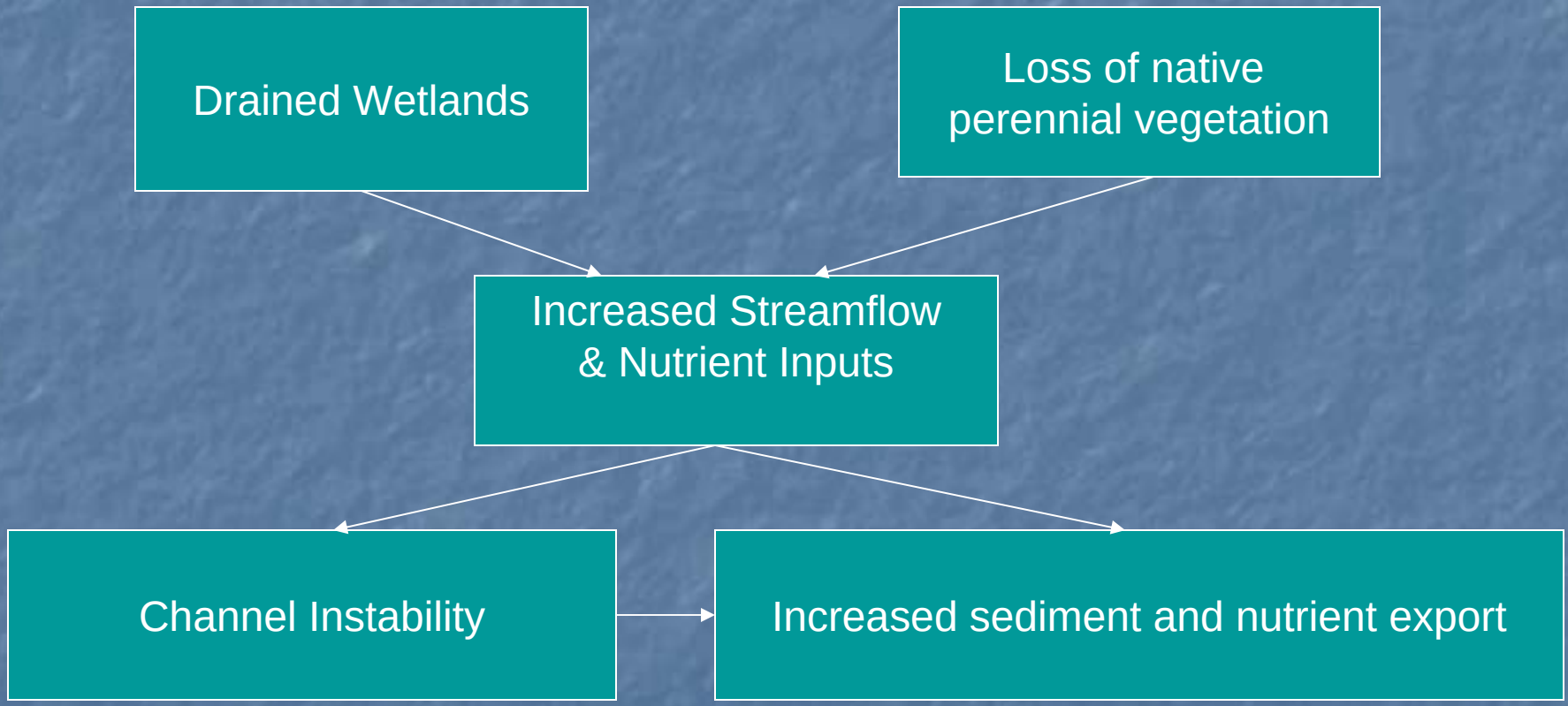
Surface Soil Erosion under Annual Cropping on Slopes

Ditching & Tile Drains to Ditches Export more nutrients & sediment downstream

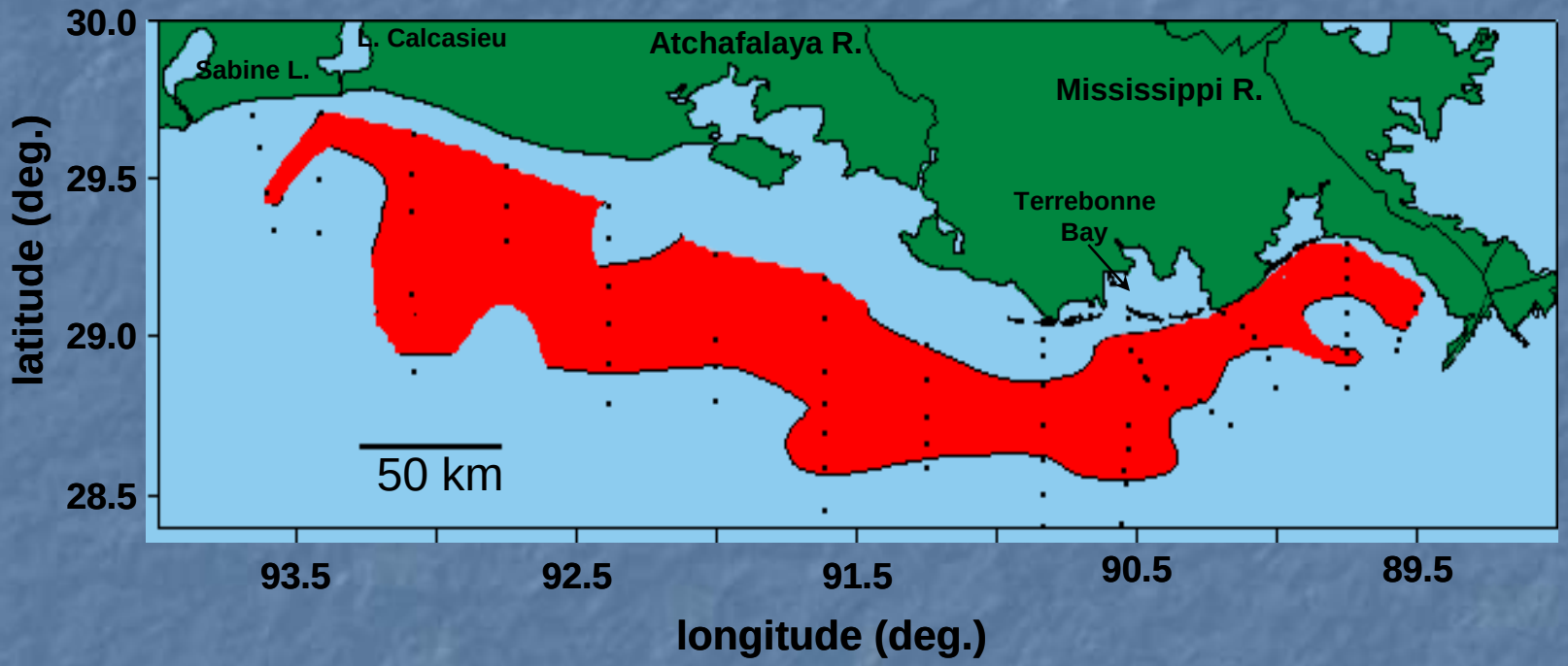
- Over 45,000 km of open ditches in Minnesota
- Ditch maintenance is costly and exports sediment
- Tiles discharge directly into ditches


Nitrate loss (lb N/acre)
100
80
60
40
20
0
0
10
20
30
40
50
Annual tile flow (inches)
(Randall et al., 1997)
J Continuous corn
F SOYBEAN-Corn
F CORN-Soybean
H Alfalfa
B Conserv. Reserve

Consequences of Expanded Agricultural Production



Hypoxia in the Gulf of Mexico



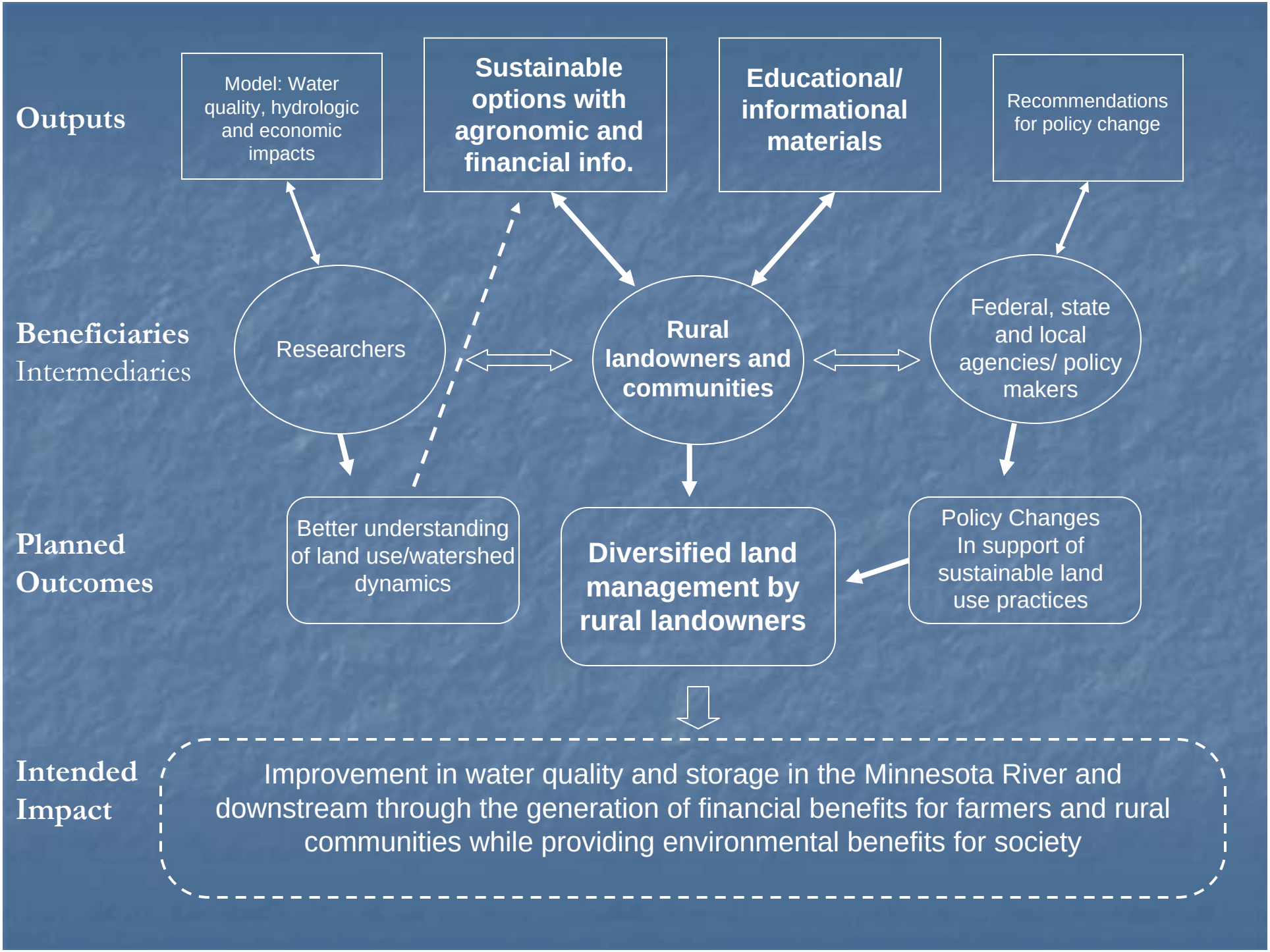
bottom dissolved oxygen less than 2.0 mg/L, July 1999

Rabalais et al. 2000

Objectives

Identify, develop and implement **alternative cropping & management strategies** that incorporate woody & other perennial cropping systems and **wetlands** to:

- **Improve** hydrologic conditions & water quality
- **Diversify & strengthen** rural economy
- Identify and advocate for **policy changes** needed to achieve widespread adoption


Outputs
Model: Water quality, hydrologic and economic impacts
Sustainable options with agronomic and financial info.
Educational/ informational materials
Recommendations for policy change
Beneficiaries
Intermediaries
Researchers
Rural landowners and communities
Federal, state and local agencies/ policy makers
Planned Outcomes
Better understanding of land use/watershed dynamics
Diversified land management by rural landowners
Policy Changes In support of sustainable land use practices
Intended Impact
Improvement in water quality and storage in the Minnesota River and downstream through the generation of financial benefits for farmers and rural communities while providing environmental benefits for society

Options with potential markets

- Bioenergy
- Seed production
- Decorative woody florals
- High value hardwoods
- Hazelnuts
- Feed-Illinois Bundleflower
- Herbs, essences, essential oil
- Cover crops

Upland Tree Crops for Bioenergy or Pulp & Lumber

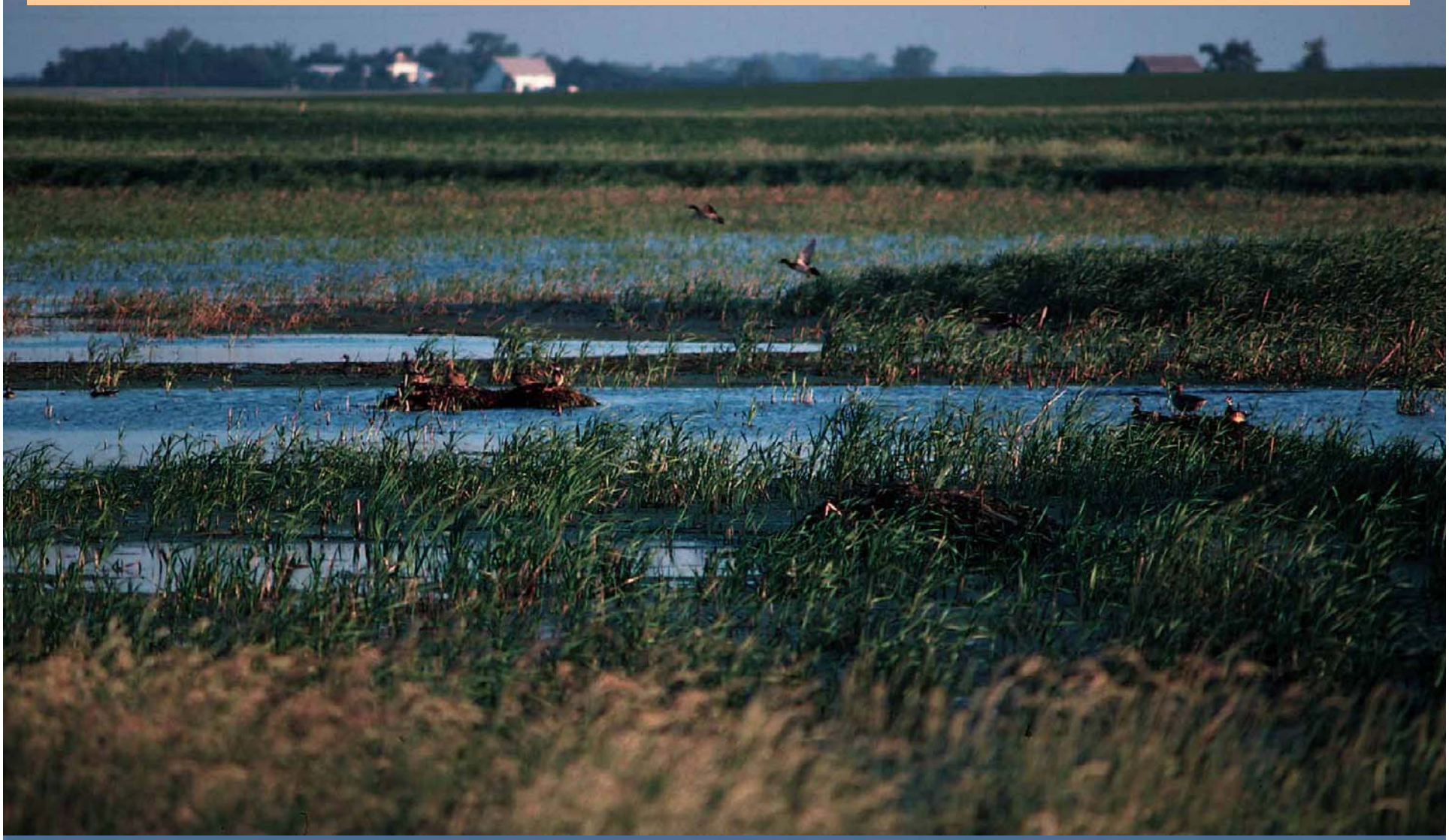
- Planting trees on agriculture land reduces water flow compared to annual crops
- Nitrogen loading is reduced compared to annual crops

Windbreaks & Living Snow Fences

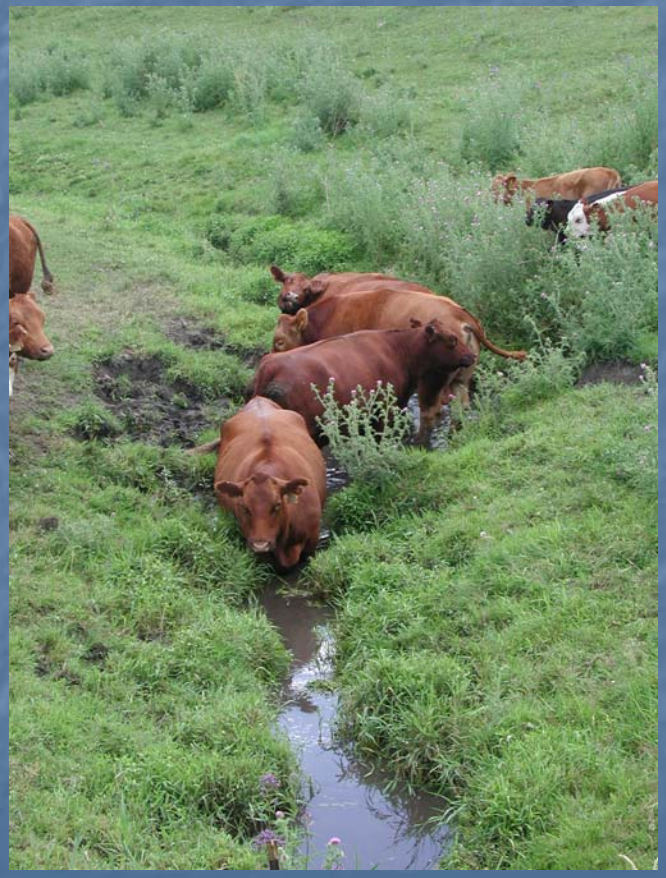
Native Perennial Legumes

- Forage
- Biomass
- Grain

Working Wetlands: Wetland Crops & Nutrient Farming Systems



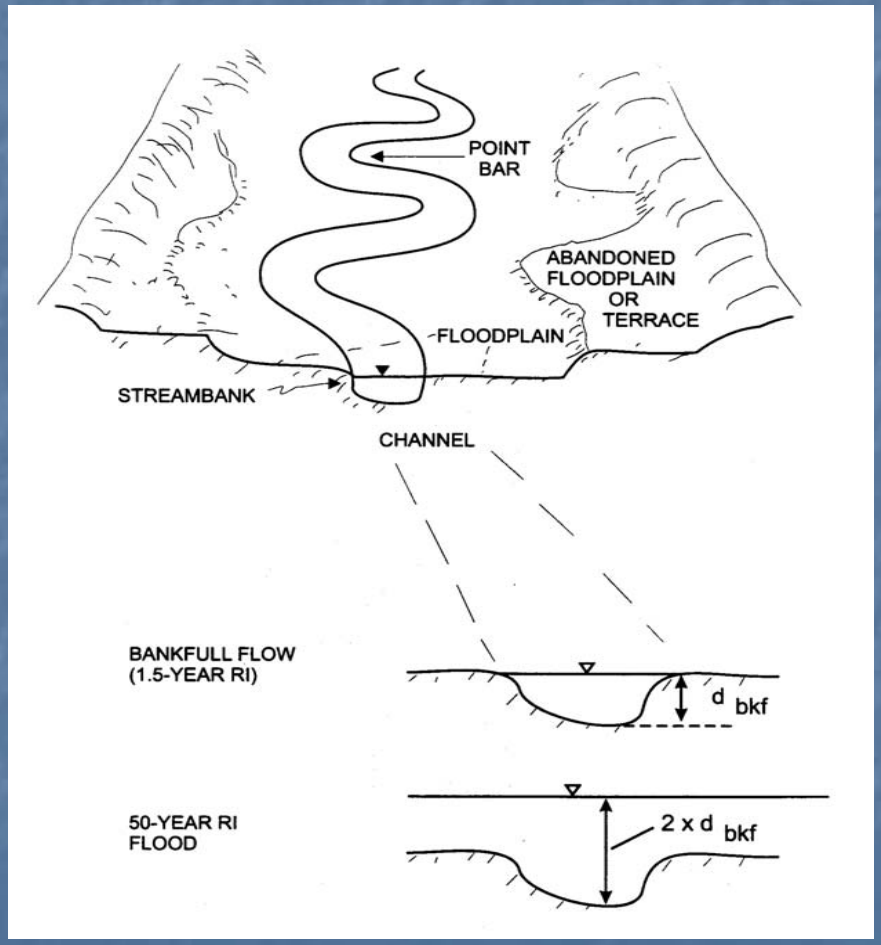
Riparian Area Management: Role of Perennial Vegetation



Developing ditches with natural channels: Improve hydrologic function

Channel Stability Benefits

- Upland management that affects water flow & sediment affects stream channel stability
- Perennial vegetation & Agroforestry in floodplains promote channel stability



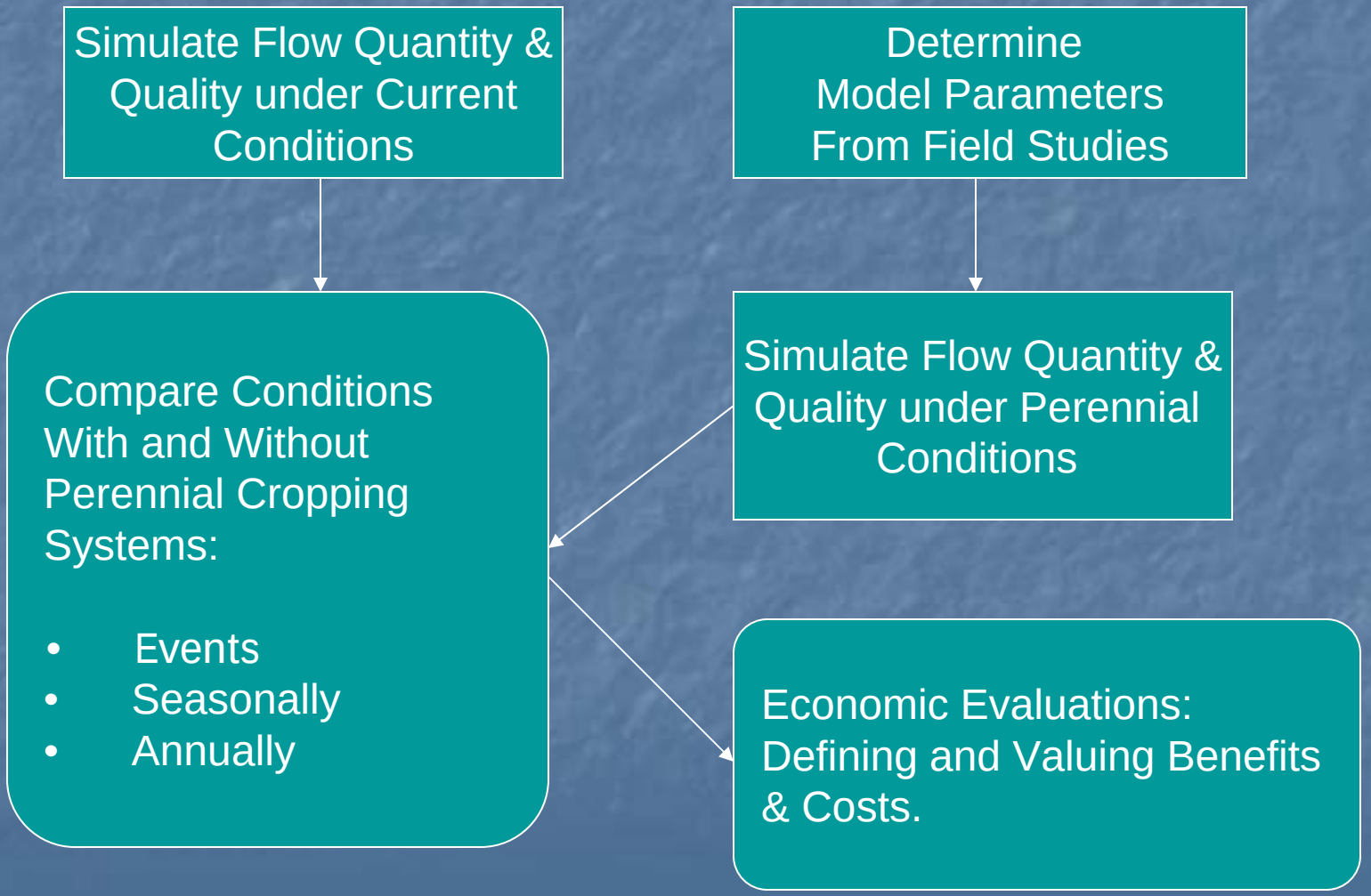
PROGRAM ACTIVITES

1. Through **learning groups** and workshops identify cropping systems of interest
2. Establish demonstration areas (4 – 8 ha)
3. Apply hydrologic and economic models to evaluate impacts – evaluate effects of scale and landscape position

Learning groups

- Four groups focused on locally identified interests;
  - **hazelnut** and **native seed production** in the Greater Blue Earth watershed
  - **decorative woody florals** and **healthy meats/Omega 3** in the Chippewa River watershed
- Members of the groups
  - farmers with a wide range of experiences,
  - regional SWCD, NRCS, MPCA, DOT and DNR staff,
  - University of Minnesota extension and research personnel,
  - non-governmental organizations concerned with water quality and diversified cropping systems such as BERBI, IATP and LSP.

HSPF Model Application



Study concentrates on benefits related to:

- Production of alternative sources of income
- Reduced flood damages,
- Reduction in sedimentation,
- Enhanced aquatic recreation, and
- Reduced water treatment costs, respectively.

Program Activities

Following economic analyses & market assessments:

- Develop educational materials for stakeholders
- Hold workshops – focusing on economic and policy implications
- Hold discussions with policy makers on implications for next Farm Bill

Future Work

- Continue development & monitoring of perennial plant materials and cropping systems
- Concentrate on determining landscape positions for plant materials that maximize production & environmental benefits
- Determine cropping systems compatible with floodplains and riparian wetlands to enhance hydrologic storage and reduce nutrient loading

Acknowledgements

- Support provided by USDA-CSREES Integrated Research, Education and Extension
- Complementary studies supported by Minnesota LCMR and Pollution Control Agency
- Assistance of Steve Morse, Regional Green Lands, Blue Waters Initiative
- Collaborative support from Donald Hey, Wetlands Initiative, Chicago, IL