Alternative approaches to drainage ditch design

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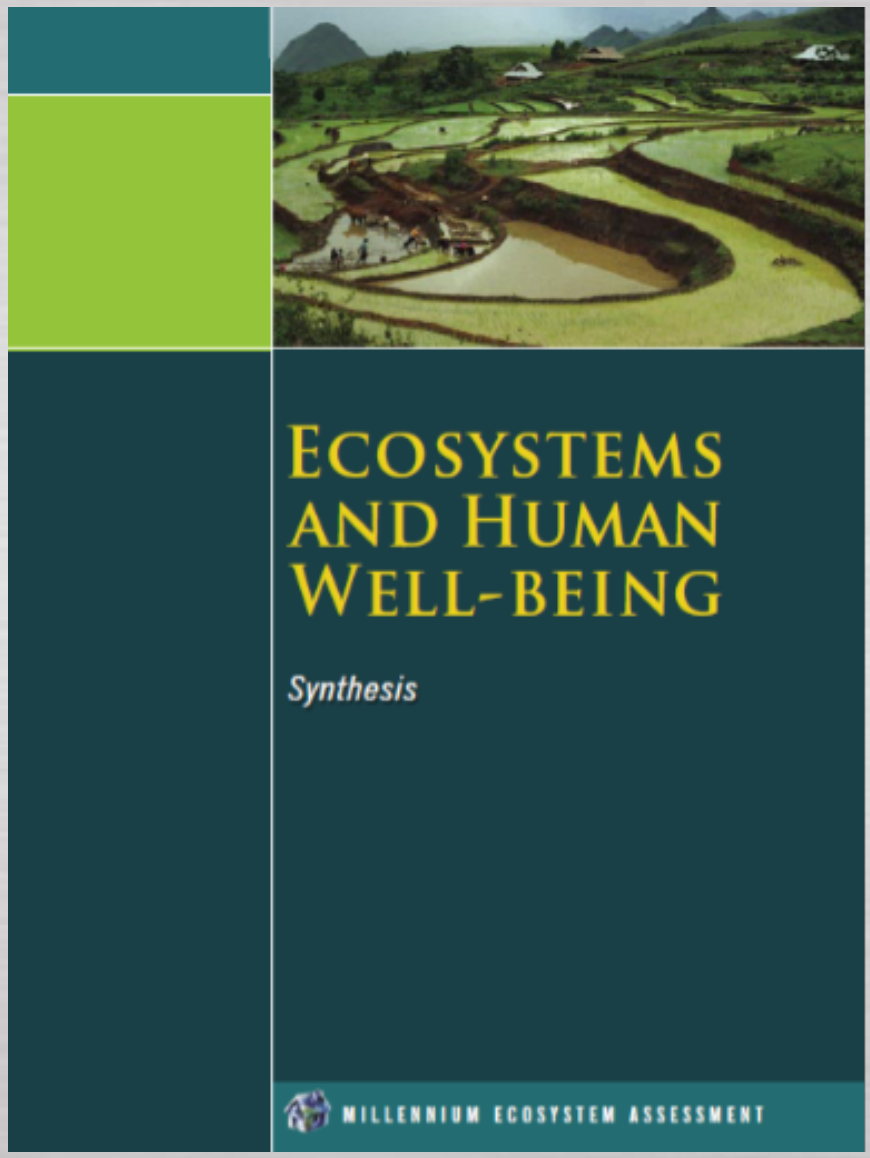
Definition: Ecosystem Services

“The benefits people obtain from ecosystems.”



Streams Prior to European Settlement

The Need for Drainage

Agricultural Ditch Design Approaches

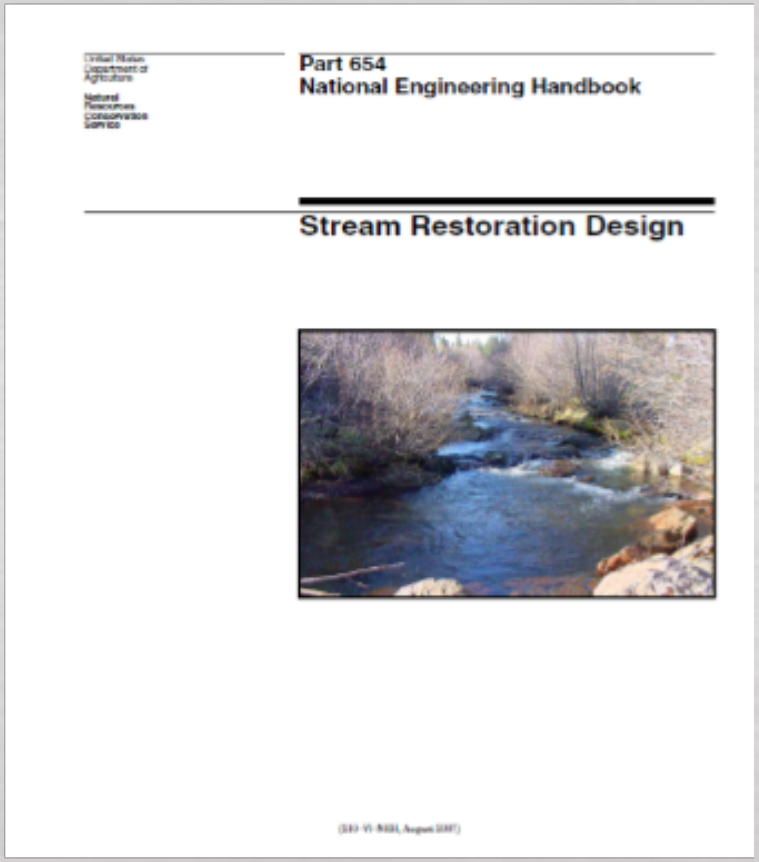
Trapezoidal Design

Two-Stage Design

Self-Forming Design

Two-Stage Ditch: Crommer Ditch

NRCS Stream Restoration Design Handbook

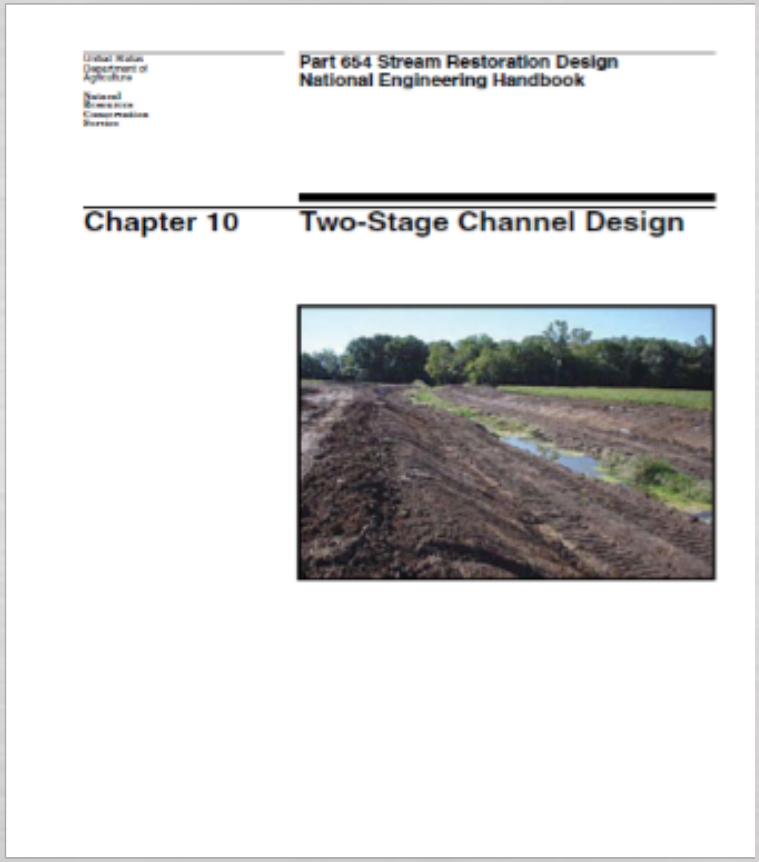

United States Department of Agriculture

Natural Resources Conservation Service

Part 654
National Engineering Handbook

Stream Restoration Design

(210-VI-NEH, August 2007)


United States Department of Agriculture

Natural Resources Conservation Service

Part 654 Stream Restoration Design
National Engineering Handbook

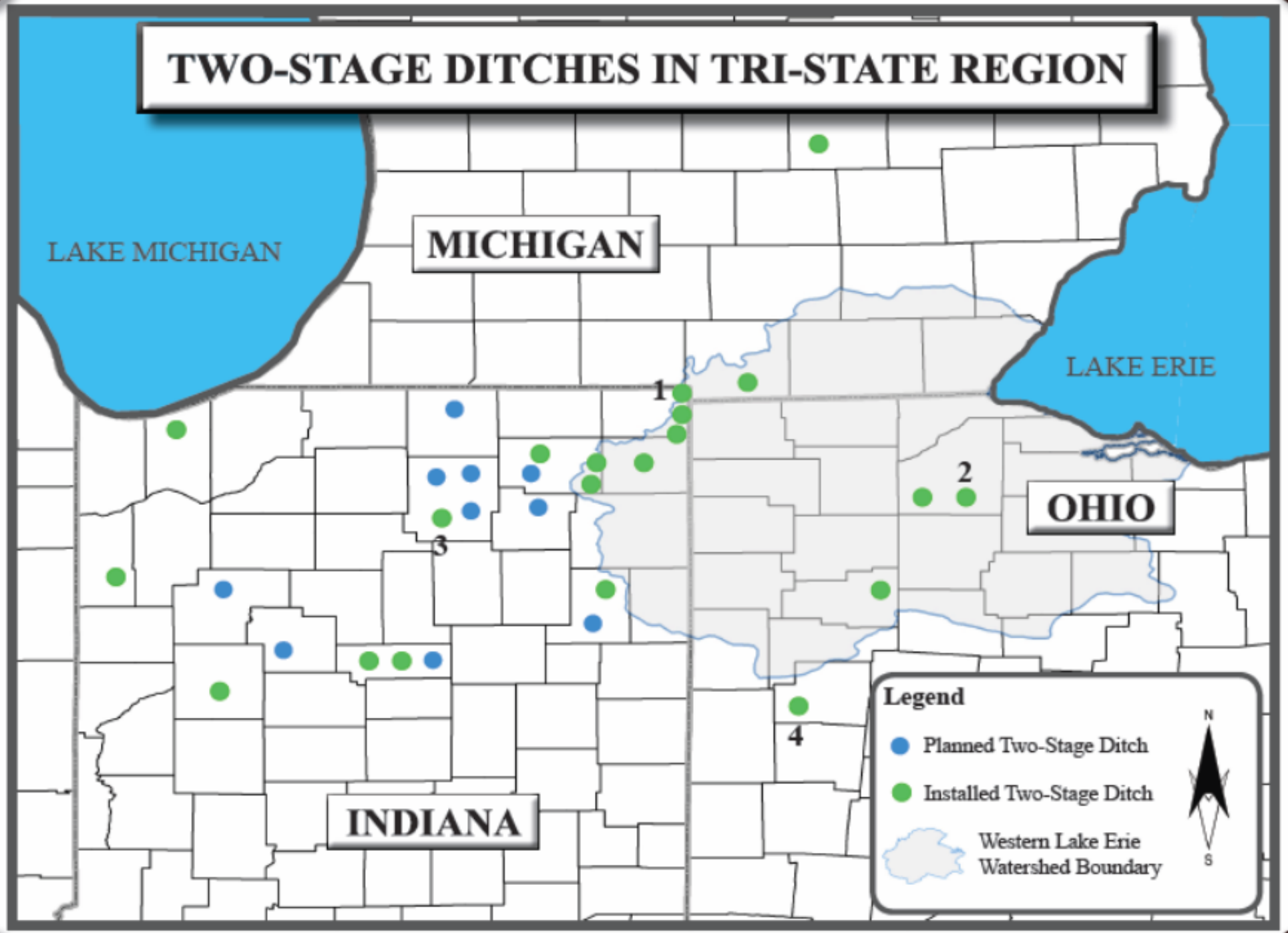
Chapter 10 Two-Stage Channel Design

http://policy.nrcs.usda.gov/viewerFS.aspx?hid=21433

1

(Click and hold on numbers in corners to see examples of two stage ditch projects)

2



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(Click and hold on numbers in corners to see examples of two stage ditch projects)

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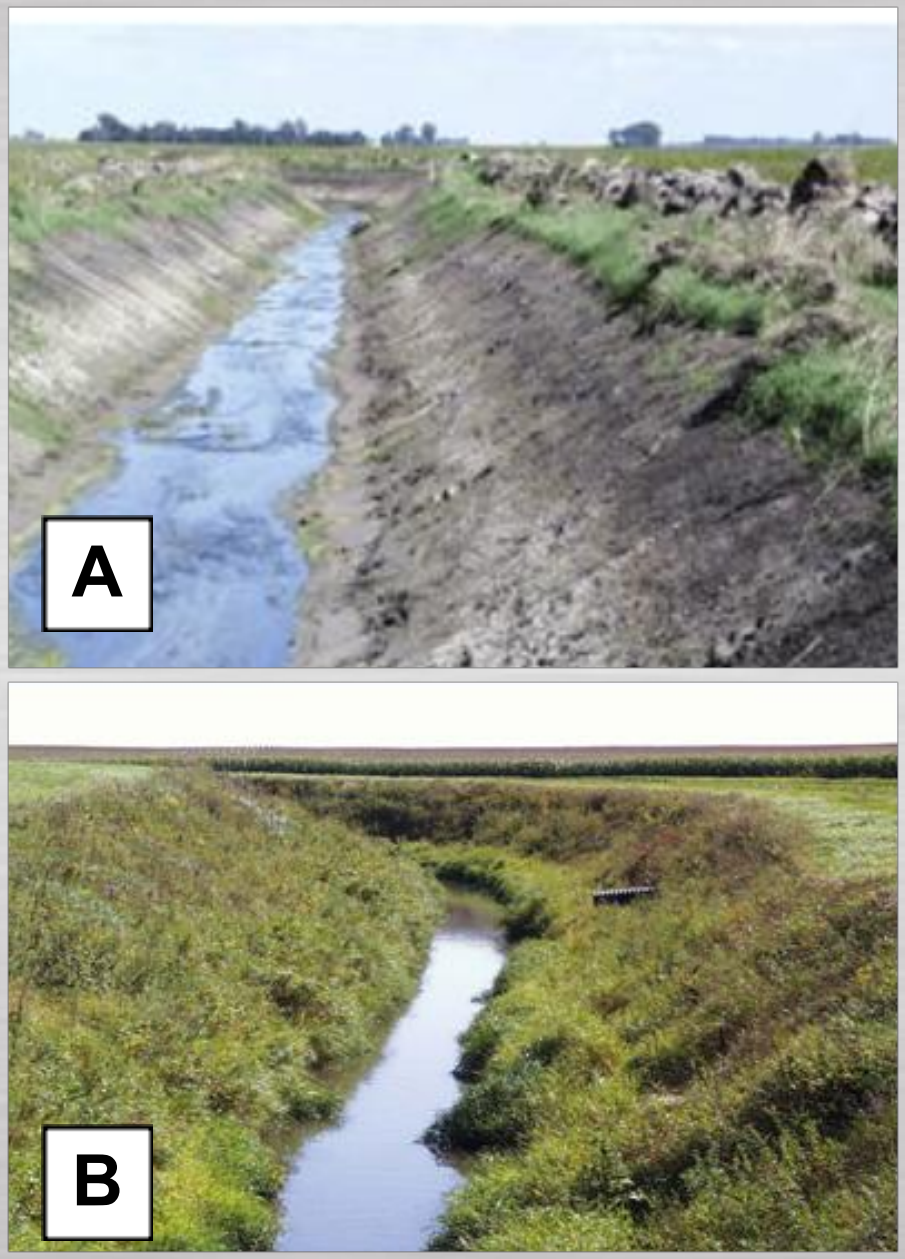
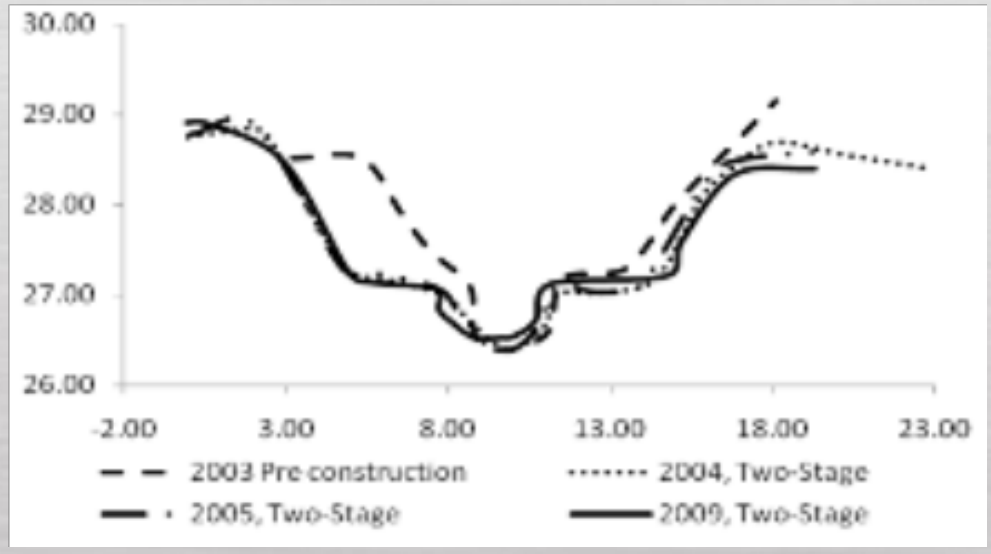
Self-forming Stream: Market @ Morse

A “Do Nothing” Approach



Document Ditch Evolution & Assess Dynamic Equilibrium



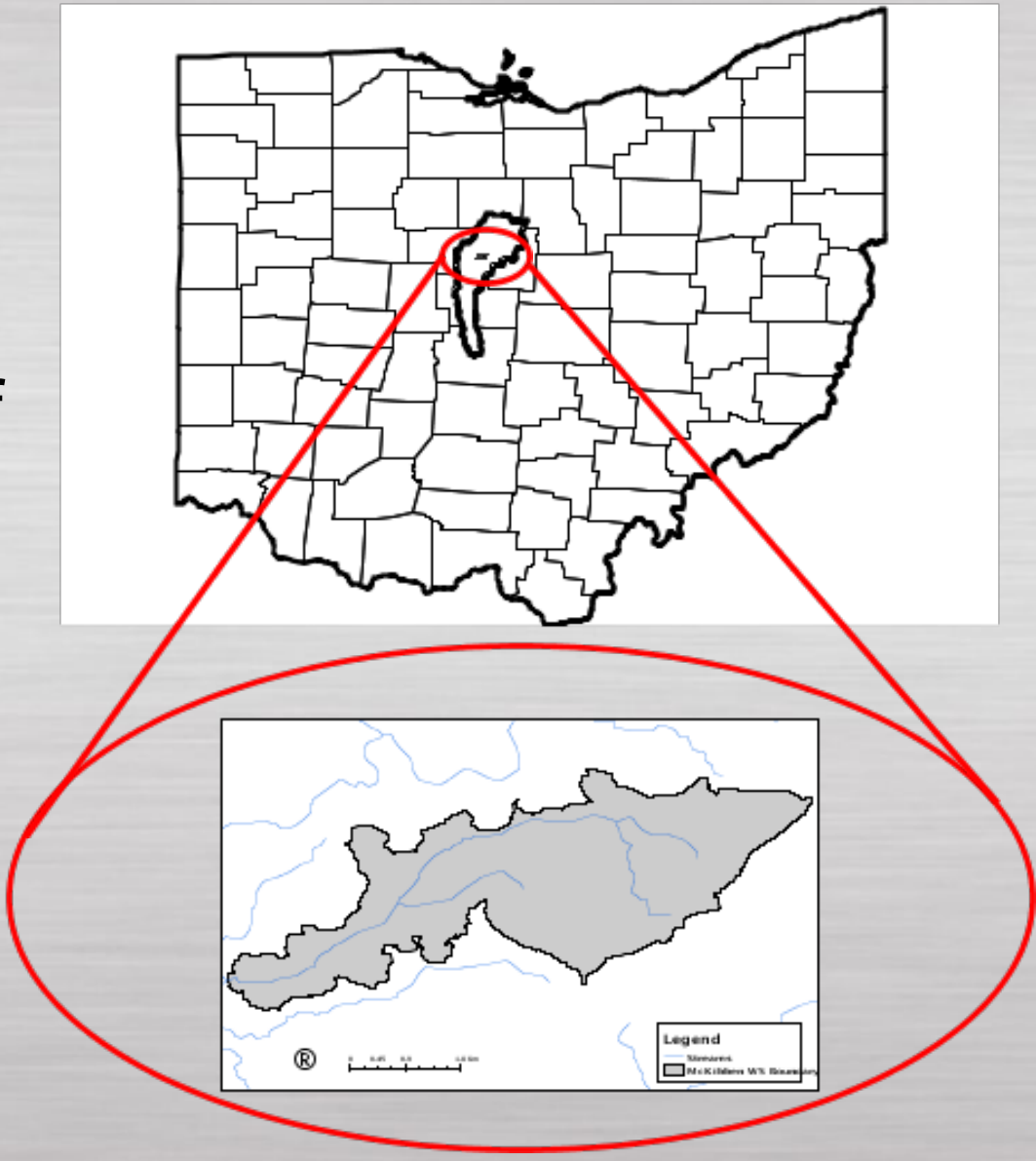
Results: Repeated surveys suggest channel form is self-sustaining.

Comparison of Ecosystem Services

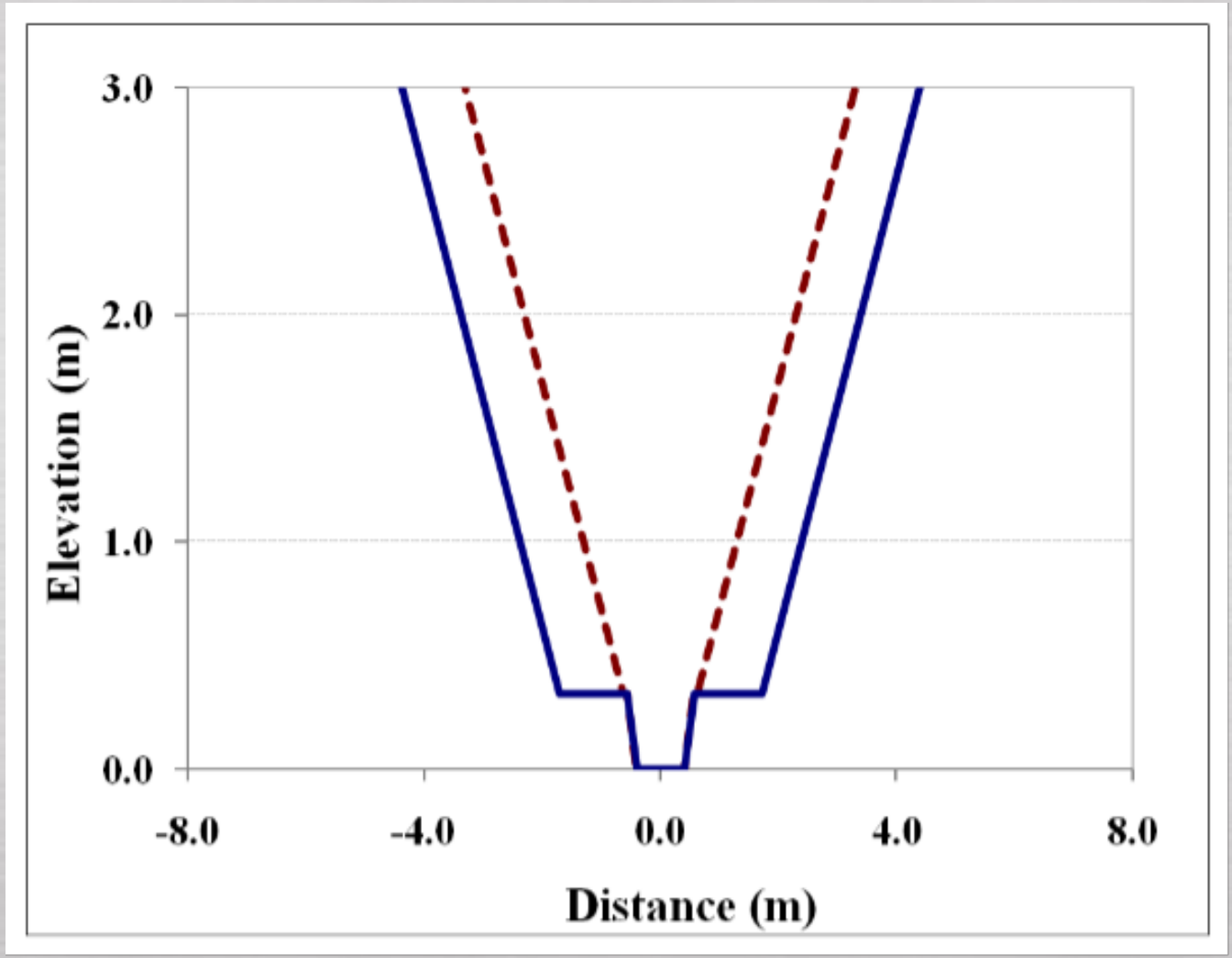
DS Flow Water Quality Habitat/
Drainage Moderation N P Sediment Biology

DS Flow Moderation: McKibben Ditch Study

- Field-scale rainfall runoff modeling – row crops, poorly drained soils, overland slope of 0.2%
- Watershed drainage area - 2.4 square miles
- Channel Slope - 0.2%
- Channel Length - 7546-feet



Flow Moderation: Trapezoidal vs. Two-Stage

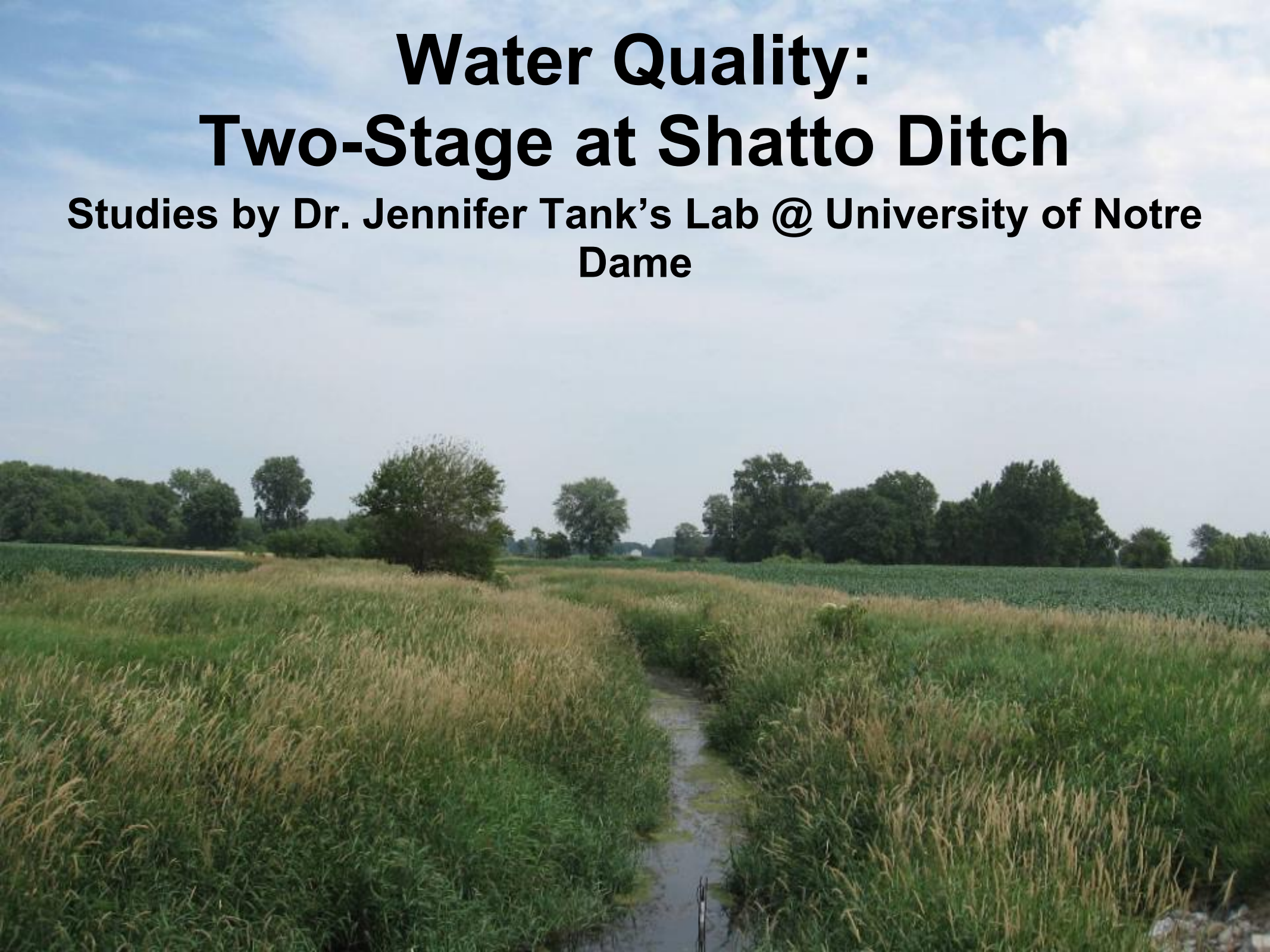


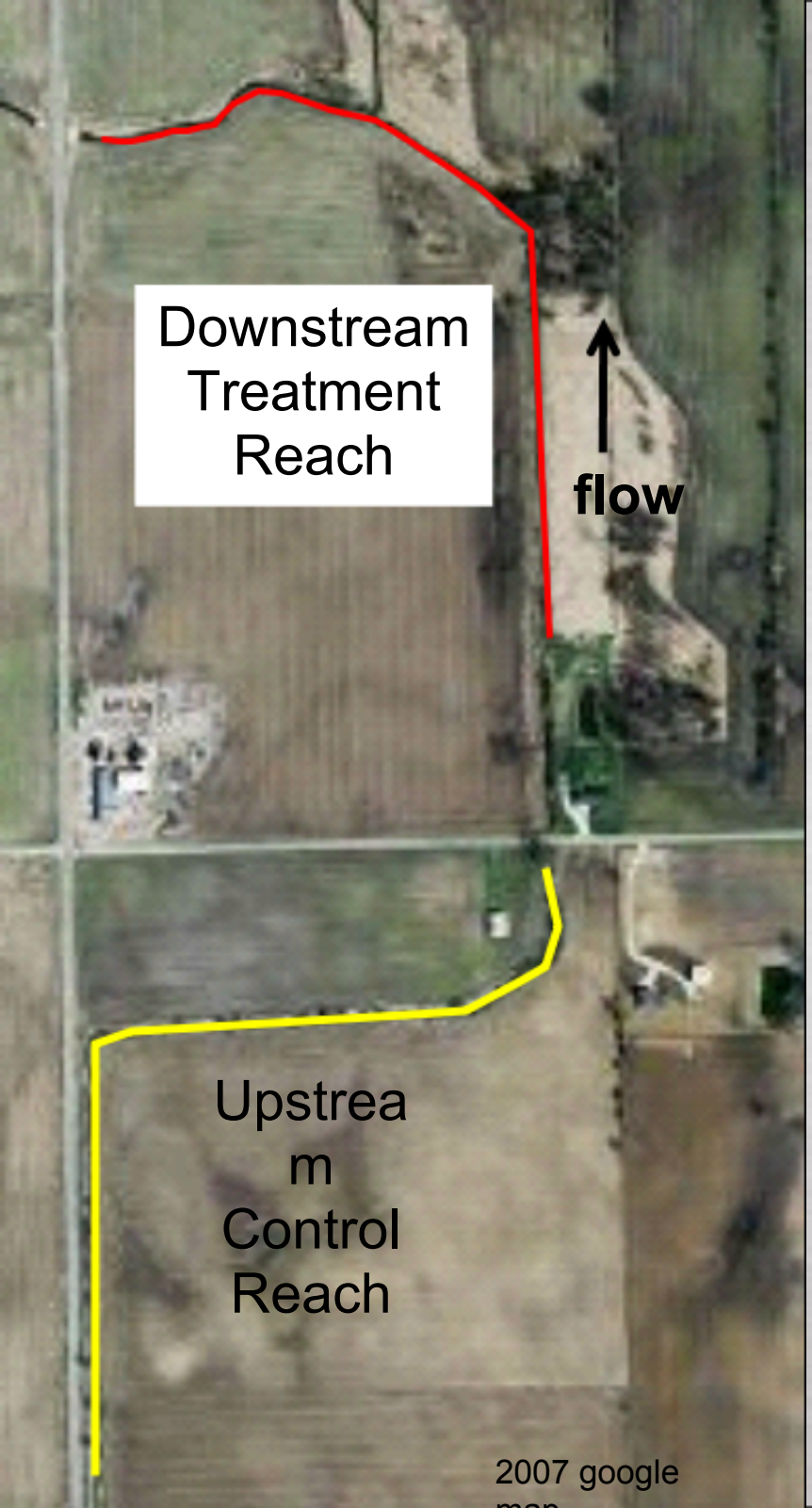
Flow Moderation: Peak Discharge & Stage Reduction

- For a typical 3-hour thunderstorm of 1, 2 or 4-inches, the peak discharge at the watershed outlet of McKibben Ditch was reduced by 6%-11% and peak stage was reduced by 10%-21%
- For a typical 24-hour frontal storm of 1, 2 or 4-inches, the peak discharge at the watershed outlet of McKibben Ditch was reduced by 2%-3% and peak stage was reduced by 5%-16%

Water Quality:
Two-Stage at Shatto Ditch

Studies by Dr. Jennifer Tank's Lab @ University of Notre Dame





Water Quality: Shatto Ditch Experimental Design

- Before After Control Impact (BACI)
- 1 year of pre-construction data collection (Sept 2006 – Nov 2007)
- ~2 years of planned post-construction data collection (Nov 2007 – Nov 2009)

Water Quality: Shatto Ditch Assimilative Capacity

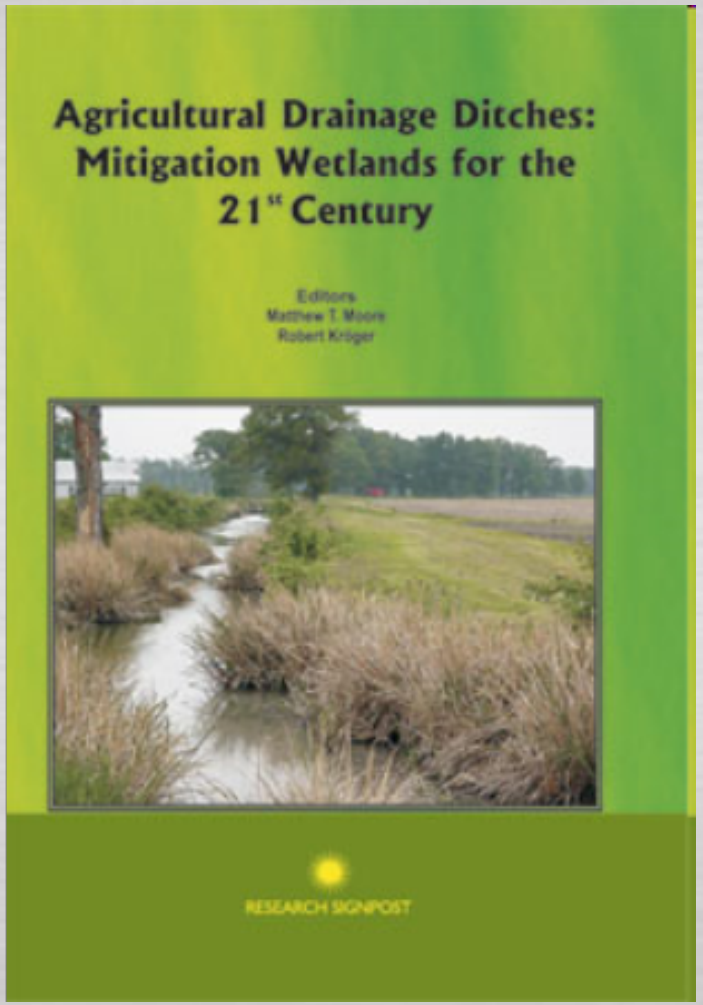
First year of data collection completed

Results for Shatto Ditch (600-meter treatment reach)

- **Event-based nitrate-N assimilation increased up to 1200% in two-stage channel**
- **Average annual nitrate-N assimilation increased (see next presentation)**
- **Total suspended sediment load decreased**
- **More benefit than vegetated buffer strip at the top of ditch**

Biological/Habitat: Conclusions from Smiley et al., 2010

- Ditches can support diverse fish communities
- Ditches are important habitat for animal and plants in agricultural watersheds
- Environmental conditions affect fish community structure
- Management practices that facilitate fish movement and creation of habitat have positive biological benefits



Article Title: Influence of physical habitat and agricultural contaminants on fishes within agricultural drainage ditches

Summary

- The practice of constructing agricultural ditches disconnects streams from there historical floodplains to facilitate drainage of the landscape for crop production
- Construction of these systems has led to a dramatic loss in many beneficial ecosystem services provided by stream systems including: flow moderation, water purification, and habitat/biology

Summary continued

- Alternative ditch construction and maintenance practices (i.e. two-stage ditch and self-forming streams) attempt to enhance the provision of ecosystem services while maintaining adequate drainage

- Enhancement of ecosystem services is accomplished through the creation of floodplain benches (two-stage) or low, frequently wetted channel bottom (self-formed streams)

Final Comments

- These alternative approaches may not be applicable or practical everywhere
- Tradeoffs need to be evaluated critically
- Approaches are one tool in the toolbox, need to be integrated with landscape practices using a watershed or systems approach
- More research is needed