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

PRE-CONSTRUCTION

FLOOD EVENT DURING CONSTRUCTION

1 MONTH AFTER CONSTRUCTION

6 YEARS POST-CONSTRUCTION
TWO-STAGE DITCHES IN TRI-STATE REGION

LAKE MICHIGAN

MICHIGAN

LAKE ERIE

OHIO

INDIANA

Legend:
- Blue: Planned Two-Stage Ditch
- Green: Installed Two-Stage Ditch

Western Lake Erie Watershed Boundary

(Click and hold on numbers in corners to see examples of two stage ditch projects)
Self-forming Stream: Market @ Morse
A “Do Nothing” Approach
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)
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 their 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.