The Nature Conservancy

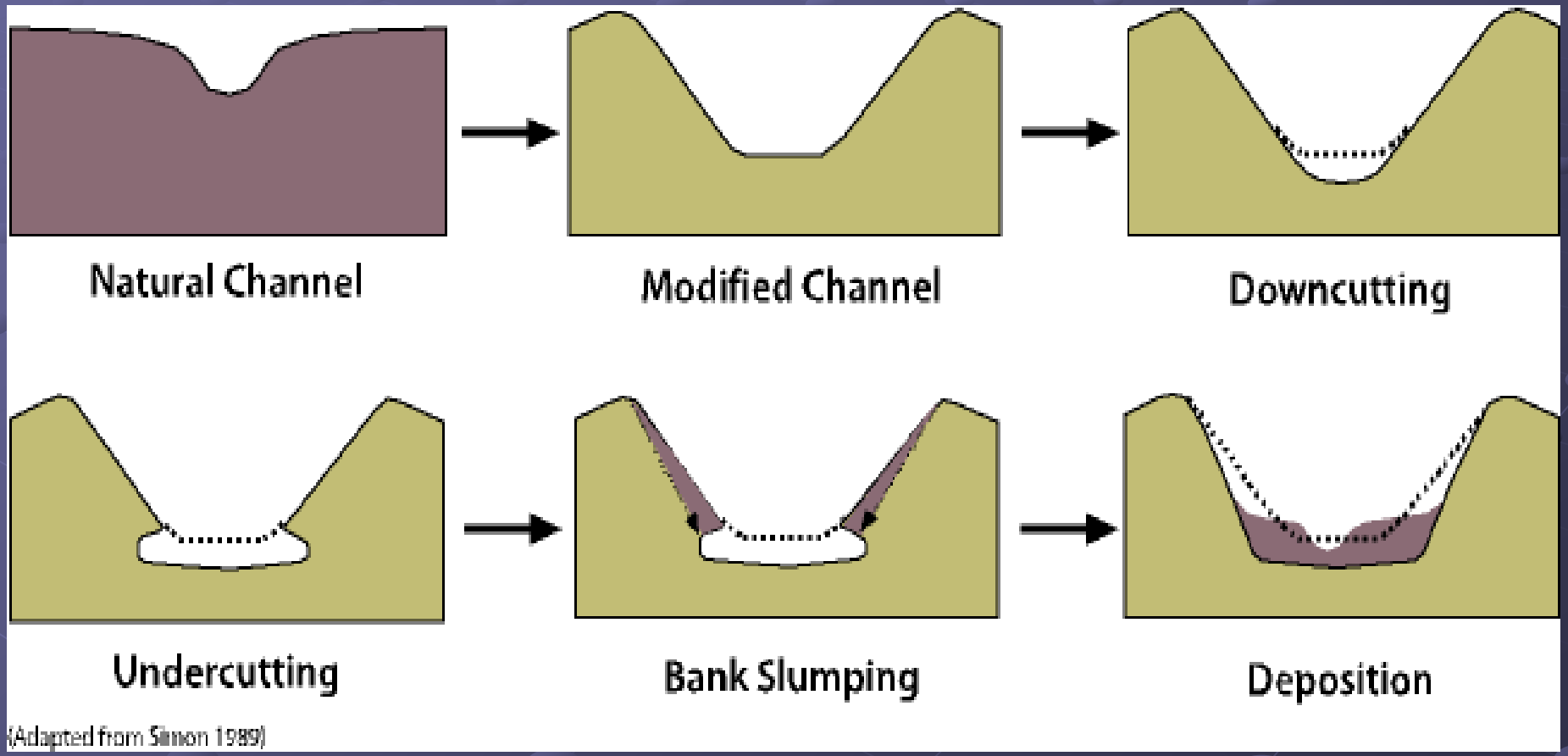
SAVING THE LAST GREAT PLACES ON EARTH

Two-Stage Ditch Design

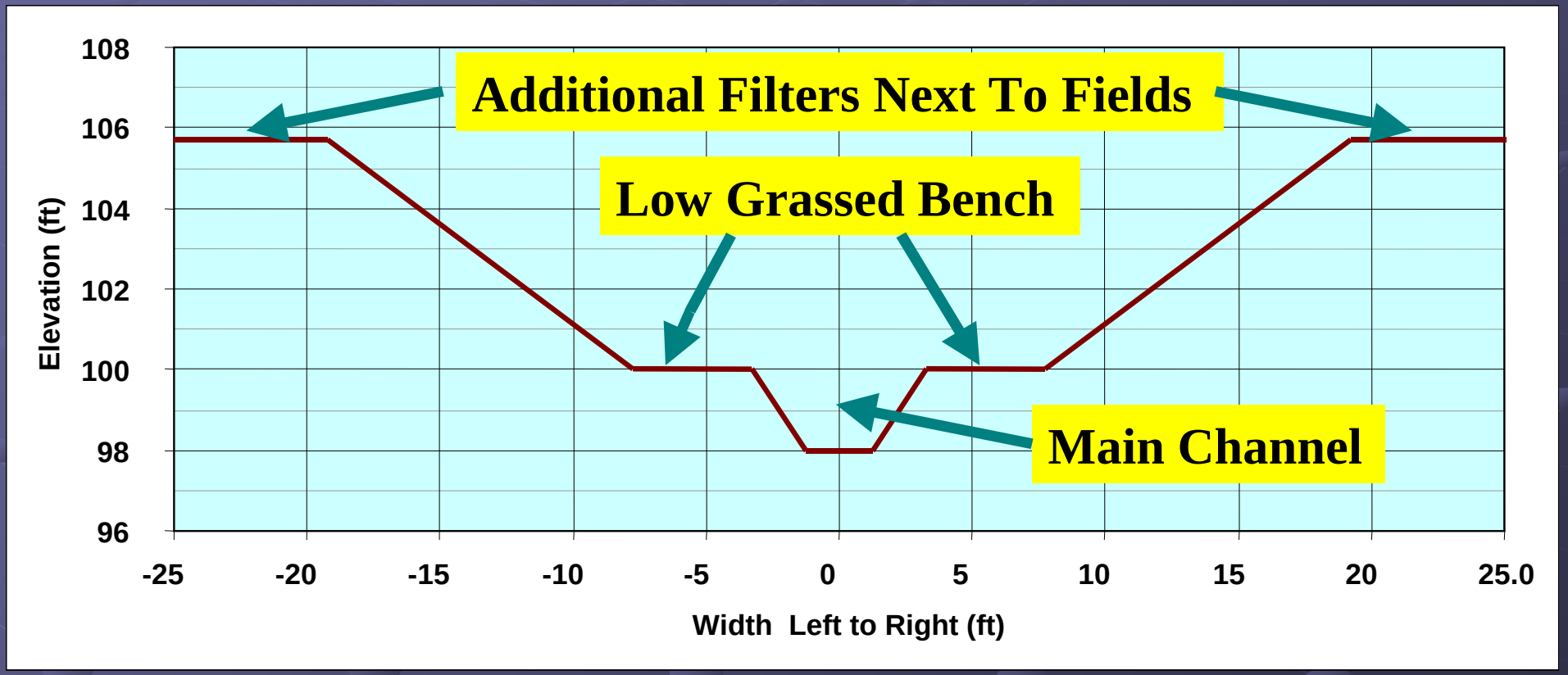
Helping Nature Improve the Function of Agricultural Drainage Ditches

Is there something better?

Channel Evolution



Two-Stage Ditch Design




CAT
CAT

The Two-Stage Ditch and Sediment Dynamics

The Laboratory of Dr. Jennifer Tank, University of Notre Dame

1 Problem of Excess Sediment

Agricultural activities can enhance the delivery of sediment to adjacent aquatic systems. Although sediment is a natural component of streams and rivers, it can be harmful when present in excess. Potential negative effects include burial of fish eggs, depletion of oxygen, and elevated stream water temperatures.

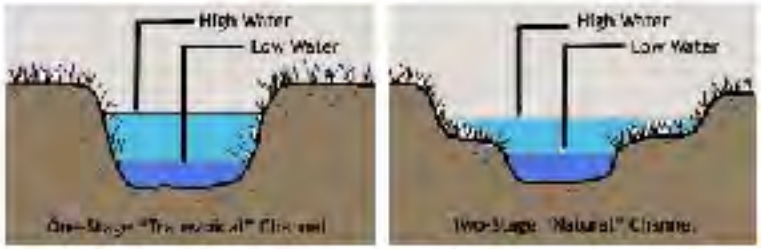
Can two-stage management influence sediment transport and deposition?

← Turbidity probe

2 What We Measure

- Continuous water column turbidity
- Continuous discharge measurements
- Total suspended solids (TSS) via grab samples
- Bimonthly transects of stream bed % cover
- Organic matter content in sediment cores

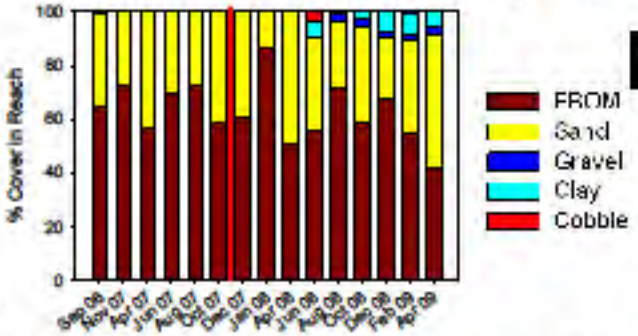
4 Two-Stage Management Strategy



"Bench" flooding slows average water velocity, promoting sediment deposition.

Graphic: Andy Ward, The Ohio State University

New Streambed Substrates Exposed



5 Effects of Two-Stage Management on Sediment Dynamics

- From December '07 to April '09, **water column turbidity decreased by 65%** in the two-stage reach
- In the streambed, the dominant sediment type did not change (e.g., FBOM and sand), but some new substrates were exposed (e.g., gravel and clay)
- Therefore, we can demonstrate *water column* effects on sediment dynamics, but significant changes in *stream bed* composition are not yet detectable

6 Implication of Two-Stage Management for Water Quality?

- The decrease in water column turbidity may have positive effects on stream biota (e.g., fish)
- Changes in streambed habitat are not yet apparent, but this may be a long-term change only detected by continued monitoring

3

Hydrolab data sondes | Ultrasonic water level loggers | Water level capacitance meters | Soil and sediment cores | Dominant streambed substrates

Contacts:
Sarah Roley, sroley@nd.edu
Mia Stephen, stephen.2@nd.edu
(574) 631-3638

The Two-Stage Ditch and Nitrogen Dynamics

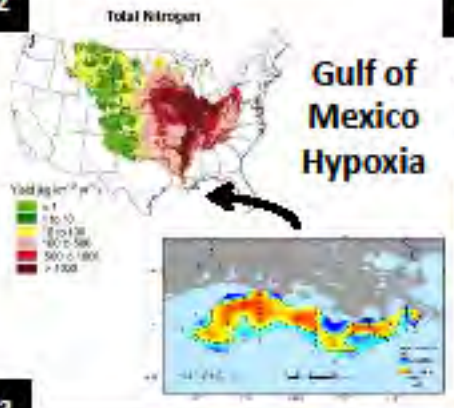
The Laboratory of Dr. Jennifer Tank, University of Notre Dame

1 Problem of Excess Nitrogen

Agricultural activities can be a source of excess nutrients that upon entering waterways can negatively influence downstream ecosystems. For example, nitrogen (N) from fertilizer runoff has contributed to fishery declines due to low oxygen conditions in the Gulf of Mexico.

Can 2-stage ditches function to reduce N export?

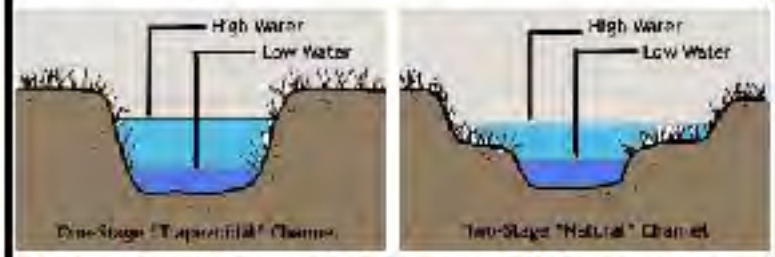
2 Gulf of Mexico Hypoxia



3 N Removal via Denitrification

- Denitrification is the microbial conversion of nitrate (NO_3^-) to dinitrogen gas (N_2), and represents a **permanent removal of nitrogen** from streams
- Denitrification requires NO_3^-, carbon (C), and anoxic (low oxygen) conditions
- Creating floodplains enhances microbial denitrification by increasing bioreactive surface area for N removal

4 Two-Stage Management Strategy



In-stream "benches" support biological removal of N from stream water.

Graphic: Andy Ward, The Ohio State University

5 Shatto Ditch Demonstration Project

6 Bench Flooding

- Most N export occurs during high stream flows
- Flooded benches increase water residence time during high flow
- Increased water residence time results in increased biological N processing potential
- Flooded bench conditions are ideal for microbial denitrification (high NO_3^- and C, and anoxic soils)

7 Benches Promote Denitrification

- As a result of bench placement, benches intercept *tile drainage* whenever tiles are flowing
- Benches also receive periodic inputs of NO_3^- via *stream flow* during floods
- Because benches are closer to the water table, soil conditions are anoxic, which promotes denitrification

8 For example, N removal increased by ~500% as a result of two-stage construction in December 2007

Area (m^2)	Before	After
bench	756 →	3780
stream	1502	1502
% bench to stream	50%	252%
N removed via DN (g N/day)	142	708

9 Implication of Two-Stage Management for Downstream Water Quality?

- Despite the 500% increase in N removal, this is *only* 5-15% of the stream NO_3^- load (below detection?)
- Stream channel management practices will only be effective if coupled with landscape management practices to reduce N inputs and stream NO_3^- loads
- **Both enhancing in-stream N removal and reducing N inputs are necessary to reduce N loads to downstream ecosystems**

Potential Benefits of 2-Stage Drainage Channel Modifications

- Decreased bank erosion and sedimentation, resulting in a reduced need for drain maintenance
- Decreased suspended solids and fluctuations in dissolved oxygen
- Processing and capture of nitrogen and phosphorus
- Restore pool and riffle habitats
- Continue to provide the required drainage capacity for agricultural production

Implementing Two Stage beyond a Demonstration

Key Steps:

- OSU worked with USDA to draft language for National NRCS Engineering Manual.
- IN STC a venue to share the performance data from NDU/OSU on initial demonstration sites.
- Combination of Eng. Manual (allowed NRCS to C/S) and performance data helped convince STC to make it a cost-sharable practice within EQIP.
- CCPI – tool to conduct technology transfer with NRCS staff – teach the technical staff.

- Progress as of 2010.

Barriers/Challenges

- Cost $9.00/ft on average for 2-stage; conventional cleanout - <$2.00/ft. (payoff takes place over a few decades)
- Extra land – 1 acre/.5 mi.
- Compatibility with FSA – CRP Filter Strips
- Technology Transfer
- Change fatigue

Resource Needs

- Initial funding at local level to help with the transition and installation.
- Broader acceptance by landowners – outreach and education.
- Technology transfer – “digging a better ditch”
- Boots on the ground.


Ohio


Illinois


South Africa


Mississippi


Ohio


Minnesota


Ohio


Michigan


Ohio