The Nature Conservancy
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Two-Stage Ditches

Much of the landscape in the Wabash River basin, a large-river watershed that drains to the Gulf of Mexico, has been converted to agricultural use. With this massive landscape conversion has come altered hydrologic function and significant changes in the flow of nutrients and sediments out of these agricultural watersheds. Infrastructure of old simply can't handle the needs and demands that they are receiving today. One tool in the toolbox to combat this is the Two-Stage Ditch. Utilizing current infrastructure of drainage ditches, the Two-Stage Ditch enhances these systems to provide additional function of sediment removal, nutrient uptake, and still allows for sufficient water flows and drainage.

Issues: impaired water quality, stream bank erosion, sedimentation, turbidity, flooding

Function: "mini floodplains" or "benches" that slows down the water velocity and allows for sediment sorting and nutrient uptake to occur, reconnecting agricultural streams to floodplains.

Two-Stage Ditch performance

1. Yearly in a ½ mile segment the sediment inputs reduce by 53 tons versus a conventional ditch
2. As benches age the nutrient uptake and removal increases (a gift that keeps on giving)
3. Benches filter tile water, provide bank stability, and decreases water velocities by 50%
4. Performs the best in elevated water flows resulting in lower peak discharges in storm events
5. Reduces regular ditch maintenance frequency as a result of self cleaning/stability
6. Shows increased nutrient uptake and removal immediately after construction

Details: Flooding is the key to naturally mitigating the impacts of high flows. Properly designed Two-Stage Ditches accommodate large flows and should rarely, if ever, flood surrounding land except for extreme conditions. Two-Stage Ditches do form naturally, but generally this is when the perception is to dip them out, not always is there a drainage impact. Two-Stage Ditches do require more room than conventional ditches and they do cost more to construct. Typical bottom cleanout of conventional ditches as the result of sediment build up will cost between $1 and $1.50 per linear foot. The average Two-Stage Ditch will cost around $10-$12/linear foot. One option is immediate the other is permanent.

Challenges and Future Direction: Farmers (usually the same ones already with land in some program) are being asked to take land out of production to create them. A Two-Stage Ditch will take some ground out of production (.5 to 1 acre per ½ mile). The practice does reduce ponding in fields and limits soil loss from bank failure/erosion. It is essential to maintain highly productive agriculture land and at the same time improve water quality. Two-Stage Ditches are detailed in the NRCS Technical Manual, but not yet recognized by the Farm Service Agency (FSA) as a contracting practice. It is cost-sharable through the EQIP program (75% cost share), but will not rank out as high as other practices and therefore is not being adopted as readily. Conservation begins at the farm scale and ramps up to larger watershed areas to make improvements locally that will have impacts that reach far downstream to places like the Mississippi River and ultimately the Gulf of Mexico. When managed for water quality, ditches have the potential to make positive impacts toward improving water quality. The Nature Conservancy believes that the Two-Stage Ditch is a viable and practical conservation tool.

Two-Stage Management: Nitrogen & Sediment Dynamics in Agricultural Streams

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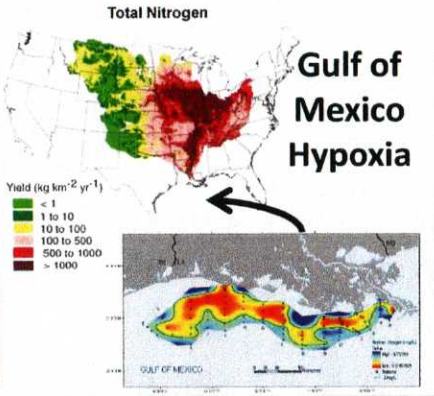
The Nature Conservancy

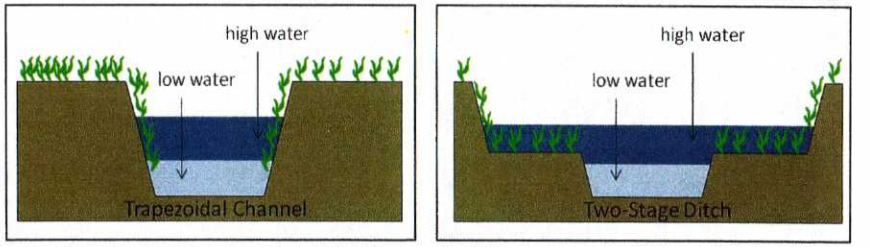
Problem of Excess

Streams in the agricultural Midwest can be a source of excess nutrients and sediments that pollute downstream ecosystems. Example: fertilizer runoff is responsible for the periodic "dead zone" in the Gulf of Mexico. Our goal is to maximize in-stream N and sediment removal before downstream export.

Can 2-stage ditch management reduce nitrogen and sediment export?



Two-Stage Restoration Strategy



During high flows, water spreads onto the floodplains, increasing the area over which N removal can occur.

N Removal via Denitrification

- Denitrification is the microbial conversion of nitrate (NO_3^-) to dinitrogen gas (N_2), and is a **permanent removal of nitrogen**
- Denitrification occurs naturally in stream sediments
- The two-stage ditch increases stream surface area, resulting in increased permanent N removal

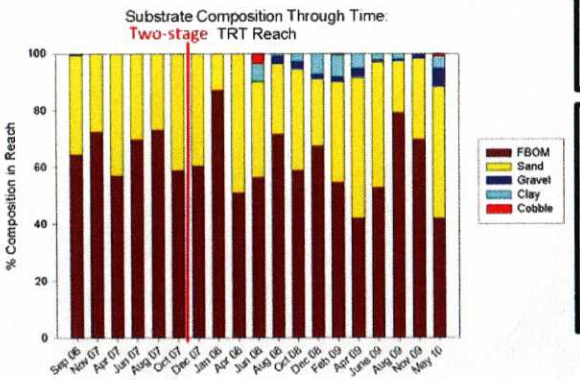
Shatto Ditch Demonstration Project

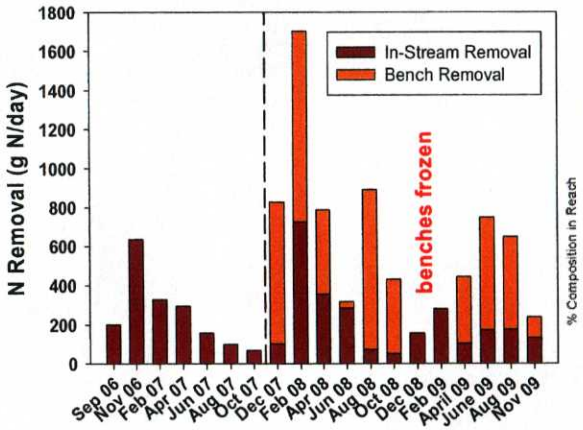
Bench Flooding

- Most N & sediment export occurs during high flows
- Flooded benches increase water residence time, which results in increased N processing and sediment removal
- Conditions are ideal for denitrification in flooded benches (high NO_3^- and C, anoxia)

Sediment Effects

- Water column turbidity decreased by 43%
- New streambed substrates are exposed





Data from Roley et al. in press, 29 July 2011

Implications for Downstream Water Quality

- Because of very high N loads, the increase in N removal translates only to 2-16% of the NO_3^- load
- In-stream management practices are most effective if coupled with watershed and landscape-level management programs
- **Both enhancing in-stream removal and reducing inputs are necessary to reduce downstream export**

Future Directions

- Study the effect of the two-stage across a range of streams and determine the change in two-stage function over time and with varying nitrate loads.
- Develop a management tool to evaluate the influence of the two-stage in different conservation scenarios.