

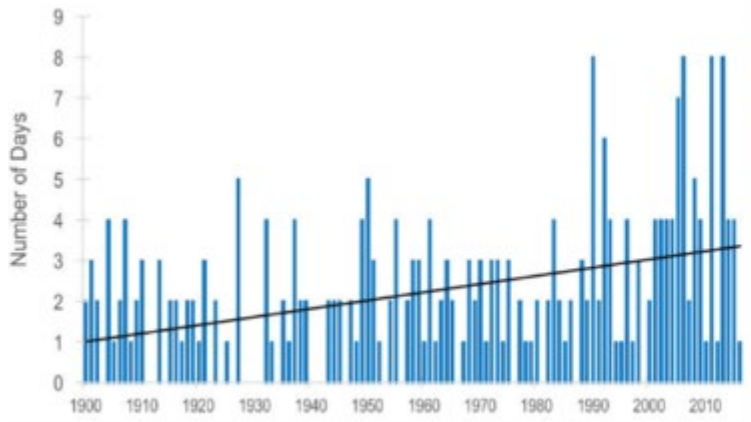
Using the two-stage ditch to meet water challenges in agricultural waterways.

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Future? By 2080, +45% increase in 100-yr storm events

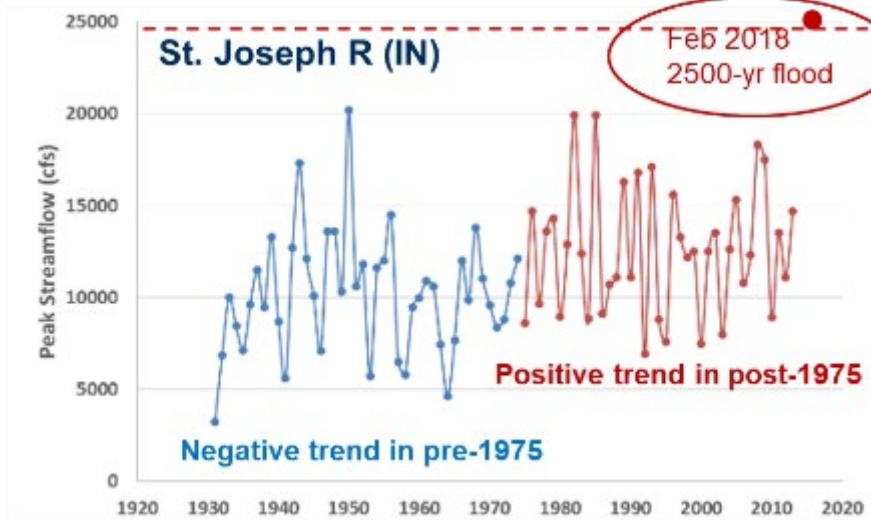
More Frequent Extreme Precipitation Events in Indiana



Widhalm et al. 2018, IN CC Impacts Assessment



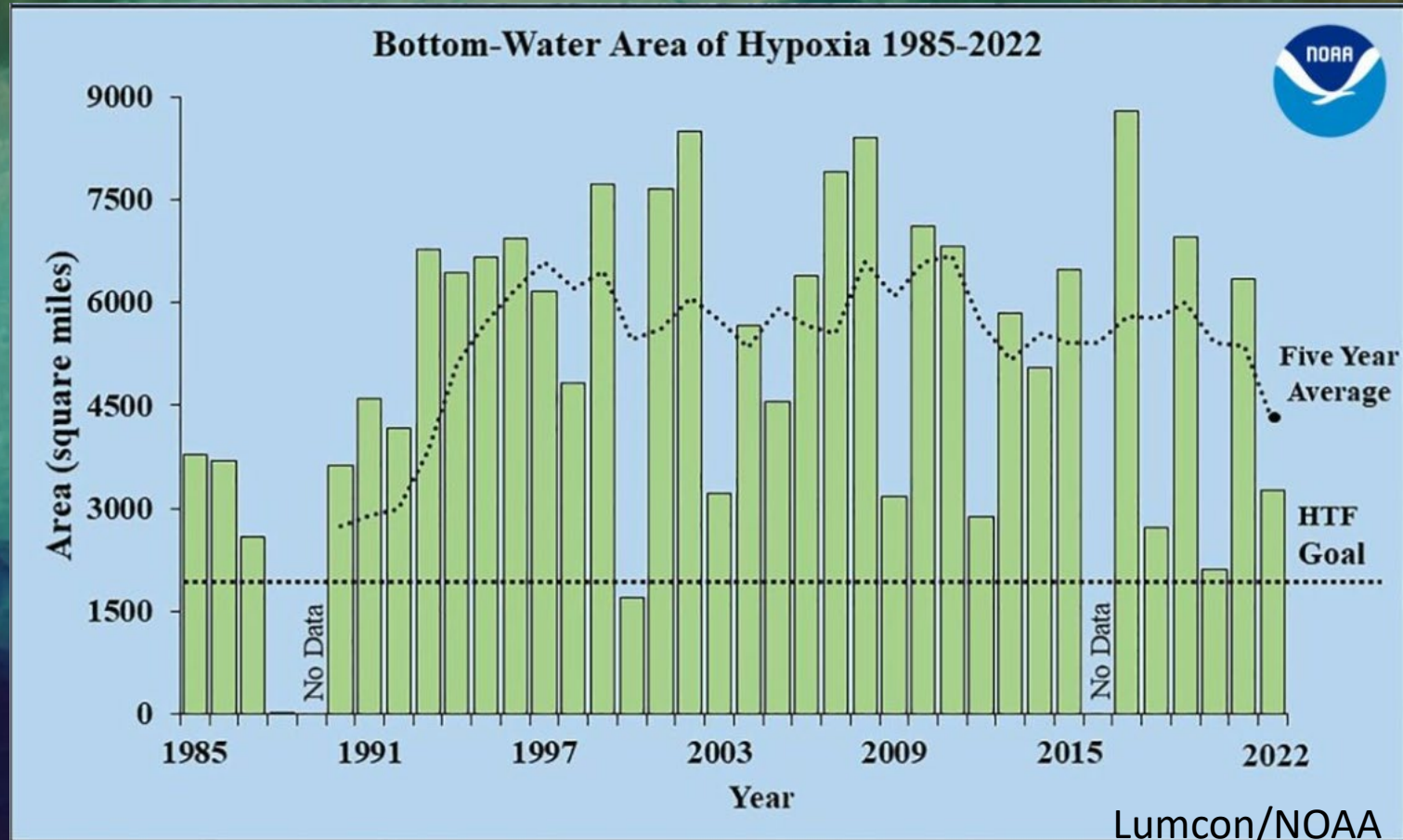
Tile Drained Field



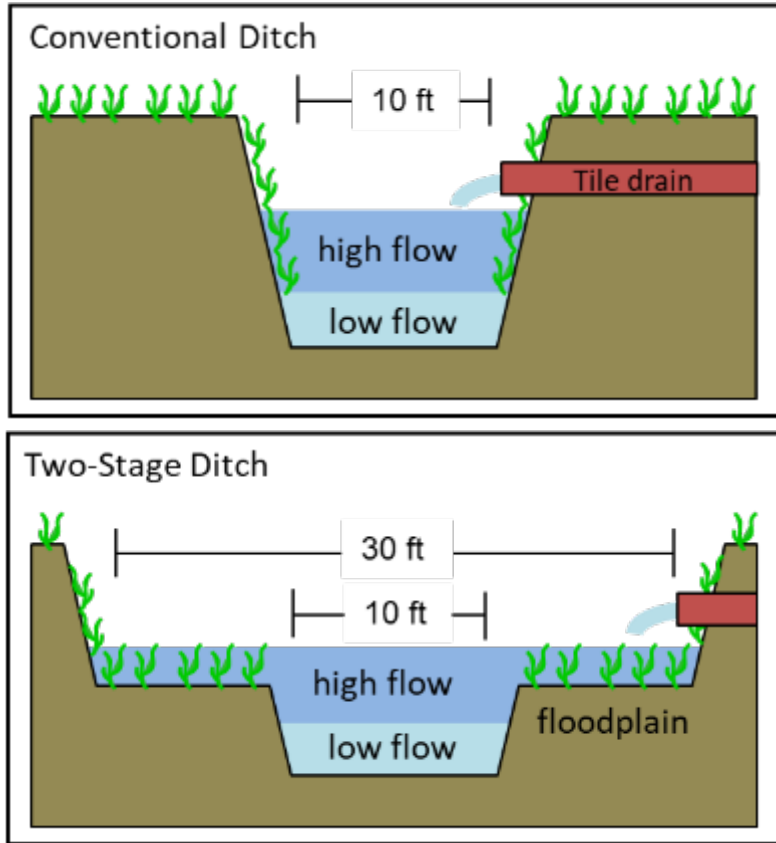
<https://www.southbendtribune.com>

Challenge: How can we maintain drainage for productive agriculture AND prevent nutrient and sediment loss to adjacent waterways during high flows?

Gulf of Mexico:
export of excess nutrients via MRB
→ algal blooms followed by hypoxia



Floodplain construction via the two-stage ditch



In addition to efficient drainage, the two-stage ditch offers co-benefits:

- Eliminates maintenance costs (no dipping)
- Reduced overbank flooding and bank failure
- **Improved water quality**

Two-stage in Shatto Ditch (IN)

total = 6.6 km (4.1 mi)

- 2007: 0.6 km (0.5 mi) two-stage floodplain only
- 2017 & 2018: +6 km (3.6 mi) floodplain construction and stream dredging to adjust grade
- **now two-stage = 75% of stream length**



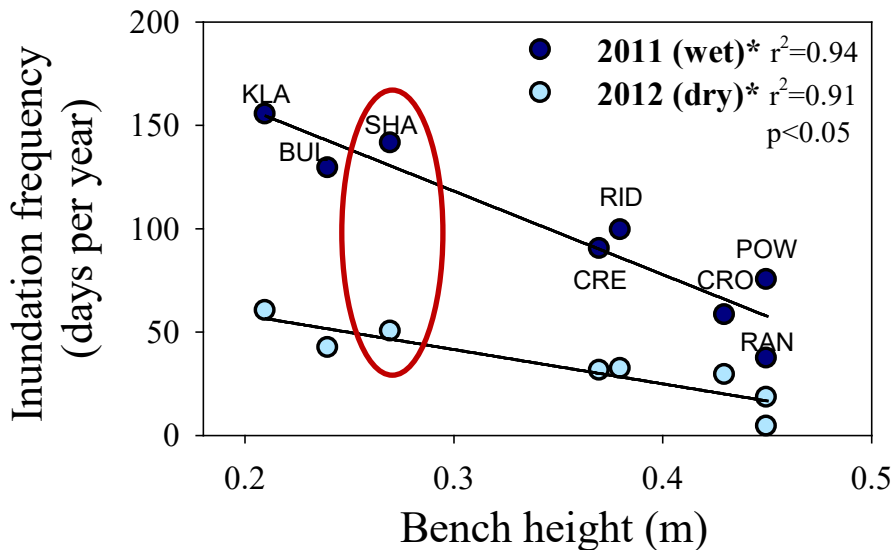
2007 Two-Stage Ditch Construction



2017 Two-Stage Ditch Construction



Two-stage floodplains slow water velocities during storms

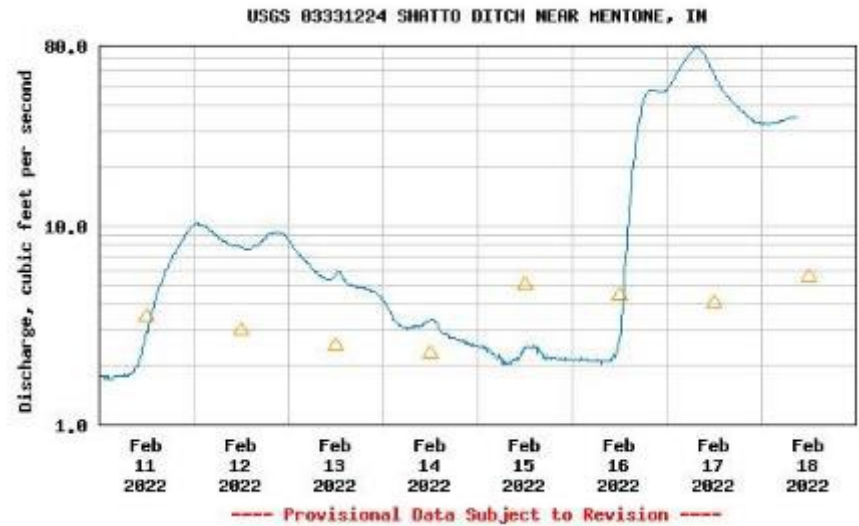


- Storm flows inundate two-stage floodplains, but duration varies among wet and dry years

Shatto Ditch (2007-present): ~10 flood events/yr with no overtopping banks

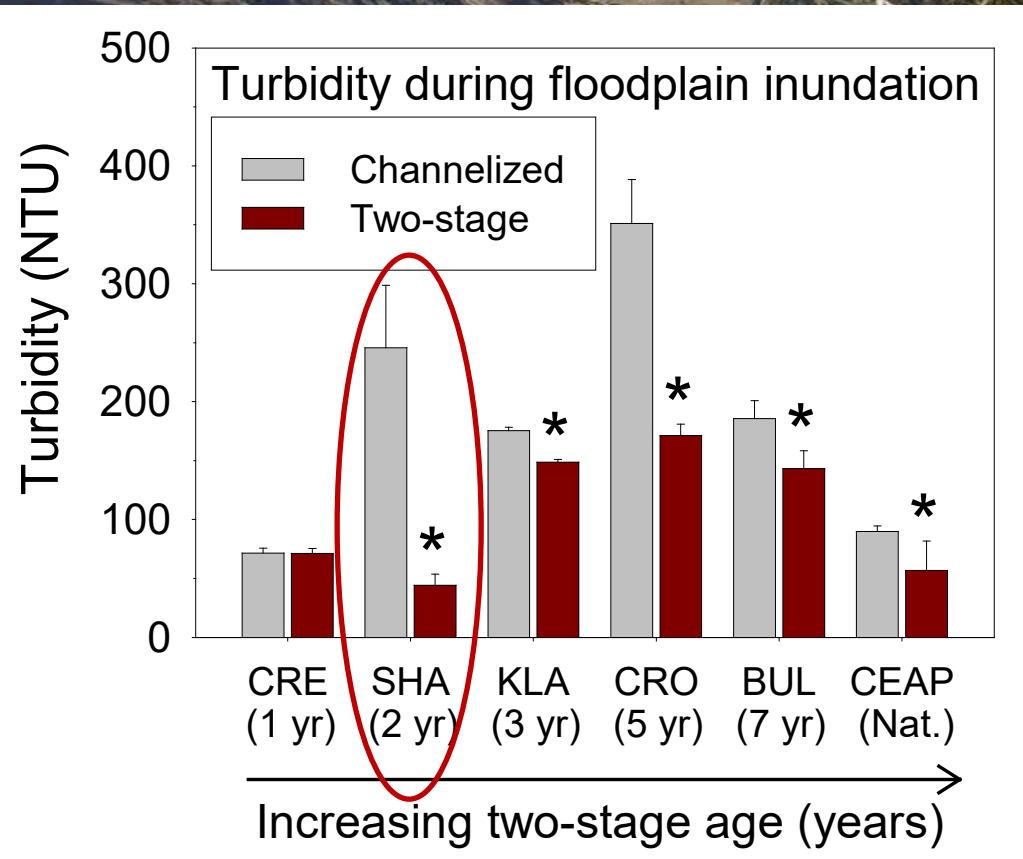


Shatto Ditch (Feb 16, 2022): Rain-on-Snow Event



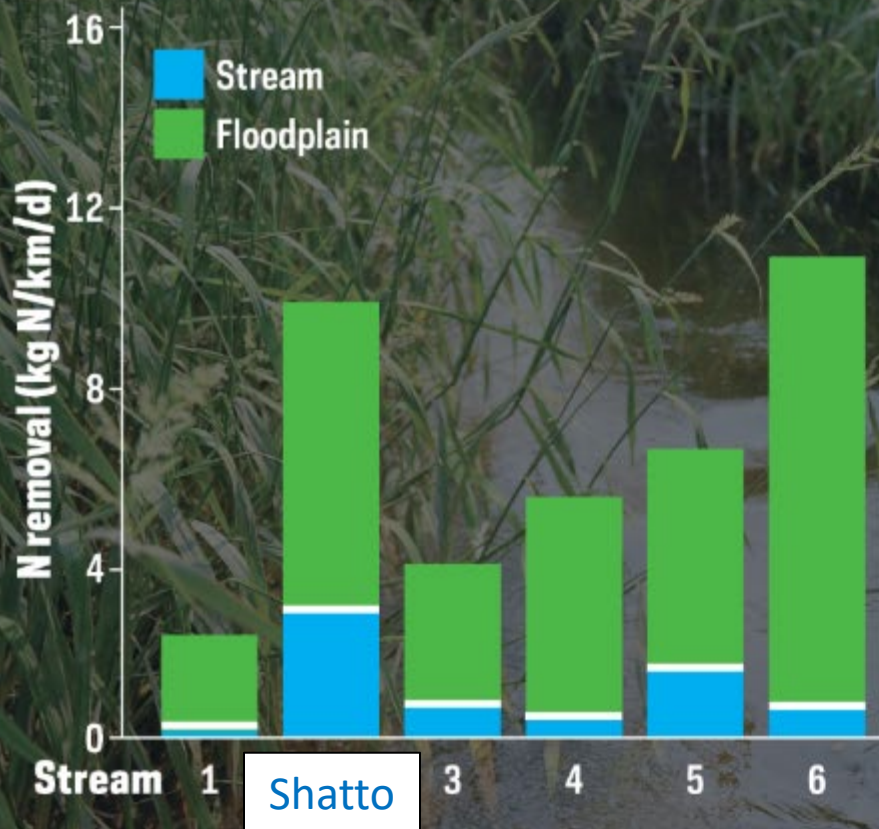
FLOODPLAINS REDUCE SEDIMENT AND P EXPORT

Davis et al. 2015 JAWRA



- Two-stage reduces water column turbidity (“cloudiness”).
- [SRP] at two-stage outlet was lower than upstream channelized reach (n=189 paired samples, p=.004).
- Mechanism: Floodplain inundation slows water during storms, promotes sediment and P retention.

Floodplains increase denitrification N removal



Floodplains ↑ N removal by **3-24** times

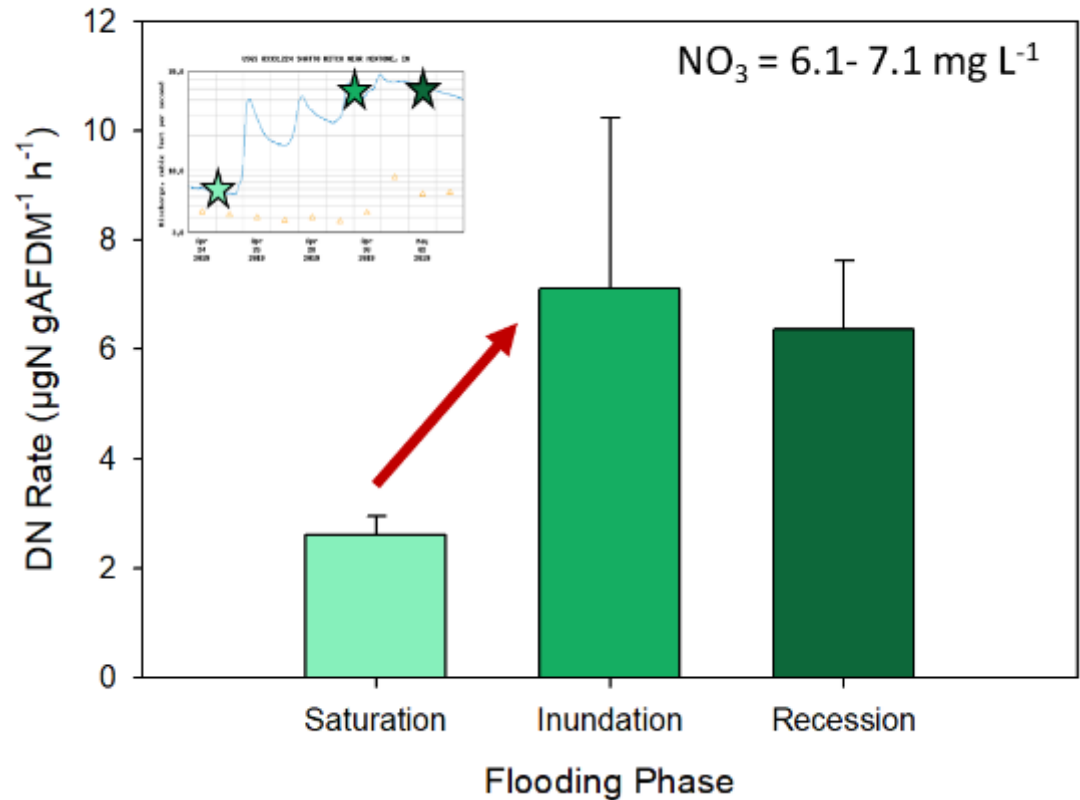
Approach: Lab assays to measure denitrification using sediments/soils.

Result: Floodplain N removal improves with time.

Mechanism: two-stage ditch enhances nutrient retention by tripling bioreactive surface area through floodplain construction.

Caveat: Six streams were all different “ages” of two-stage.....

How does floodplain denitrification vary over a storm event?



Inundation with high-nitrate stormwater stimulates denitrification in floodplain soils.

Two-stage floodplains can be used as part of a watershed's **“nutrient management toolbox”** and improves water quality while “working with” productive agricultural systems.

Best practices to maximize function on restored floodplains:

- **inundate regularly** (i.e., >12 events/yr).
- **retain tile outflows** for as long as possible.
- **vegetation is key**; “age” well over time w/ no woody vegetation.



Implementation costs: average ~\$10 per linear foot

- Possible economies of scale- typically implemented in 1 mile segments
Cost: ~52K per mile
- Indiana: NRCS EQIP incentive covers ~70% (Code 582, Open Channel)
- One-time cost: no post-construction maintenance costs for two-stage
Benefit: more stable channel design
- Lost land: 1.2 acres/side/mile = -2.4 croppable acres/mile of two-stage.





AUG 15, 2022 | NEWS RELEASE, OHIO DEPARTMENT OF AGRICULTURE

Governor DeWine Announces \$5 Million Grant Program for New H2Ohio Best Management Practice


Ohio Governor Mike DeWine and the Ohio Department of Agriculture (ODA) today announced a \$5 million grant program for a new H2Ohio Best Management Practice (BMP) – the Two-Stage Ditch. A two-stage ditch is a conservation practice that modifies the shape of a drainage ditch to create vegetation benches on each side. The vegetative benches slow water flow and reduce downstream nutrient runoff.

About H2Ohio

H2Ohio is Governor Mike DeWine's comprehensive, data-driven water quality plan to reduce harmful algal blooms, improve wastewater infrastructure, and prevent lead contamination.

[Learn More](#)

Two-stage take homes and challenges.

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- An aerial photograph showing a narrow, winding ditch or stream cutting through a vast, green, grassy field. The ditch is filled with water, reflecting the sky, and is bordered by dense, tall grasses. The surrounding landscape is flat and extends to a distant horizon under a clear sky.
- Two-stage ditch is an effective practice with **documented water quality benefits.**
 - Can be an upgrade to existing rural/agricultural infrastructure **while maintaining drainage and adding resilience to storms.**
 - To upscale, we **need to re-frame agricultural drainage** and its role in conservation and water quality improvements.
 - New NRCS Practice Standards could increase two-stage miles, but public–private partnerships w/ **incentives will be required for widespread implementation.**

thank you.

#tanklab



www.indianawatershedinitiative.com



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