- **Introduction to agricultural headwater streams in the Midwestern United States**

- **Current management approaches and challenges for stream restoration**

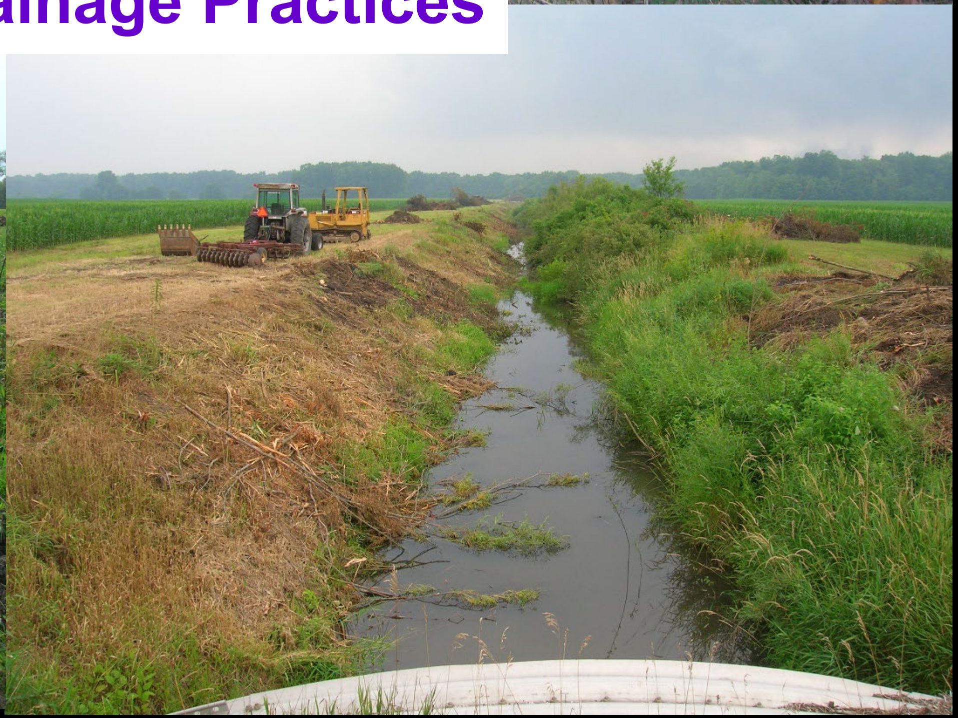
- **Examples of research findings that highlight the value of additional information on the ecological effects of restoration practices**

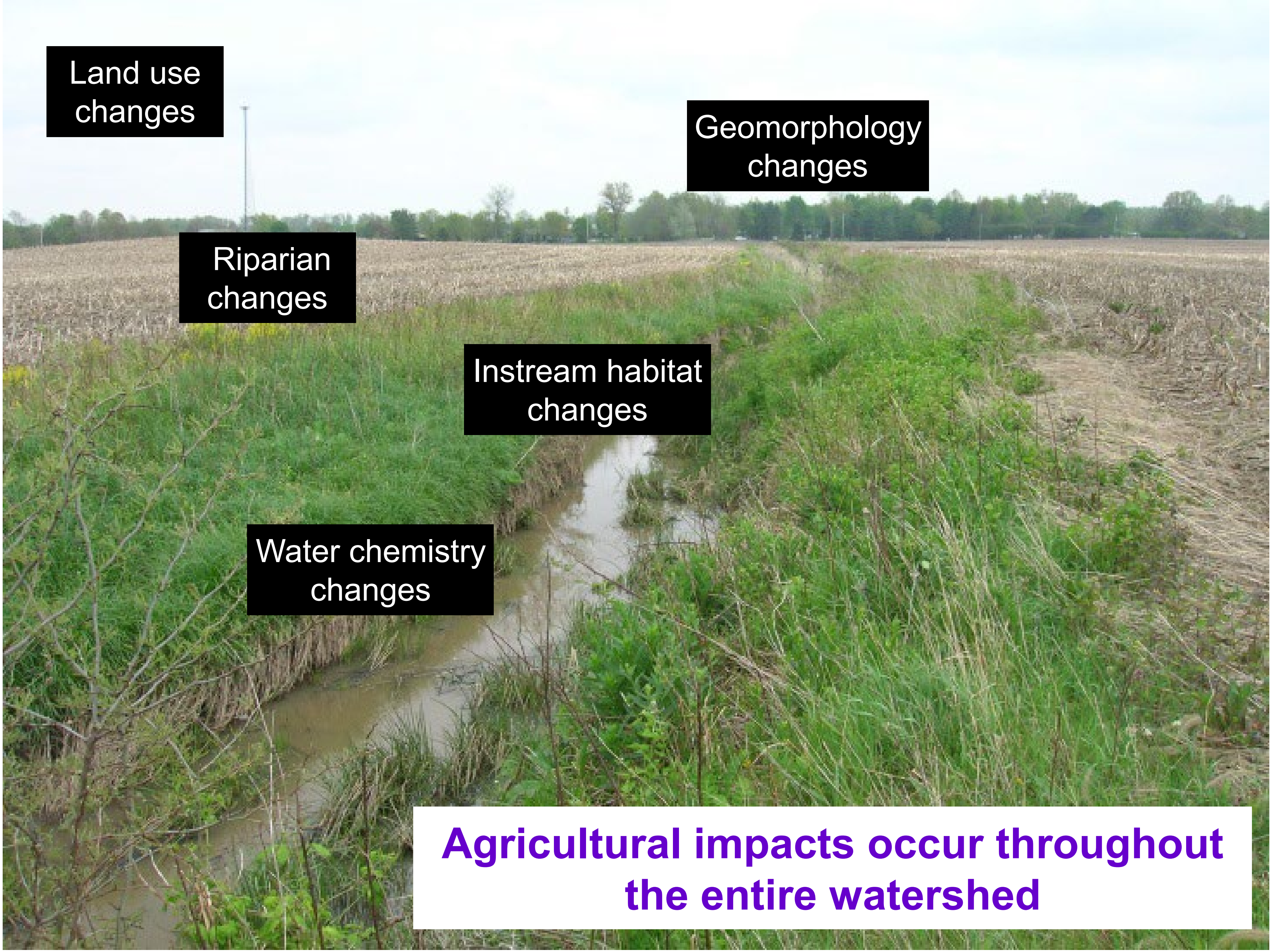



Midwest Agricultural Headwater Streams

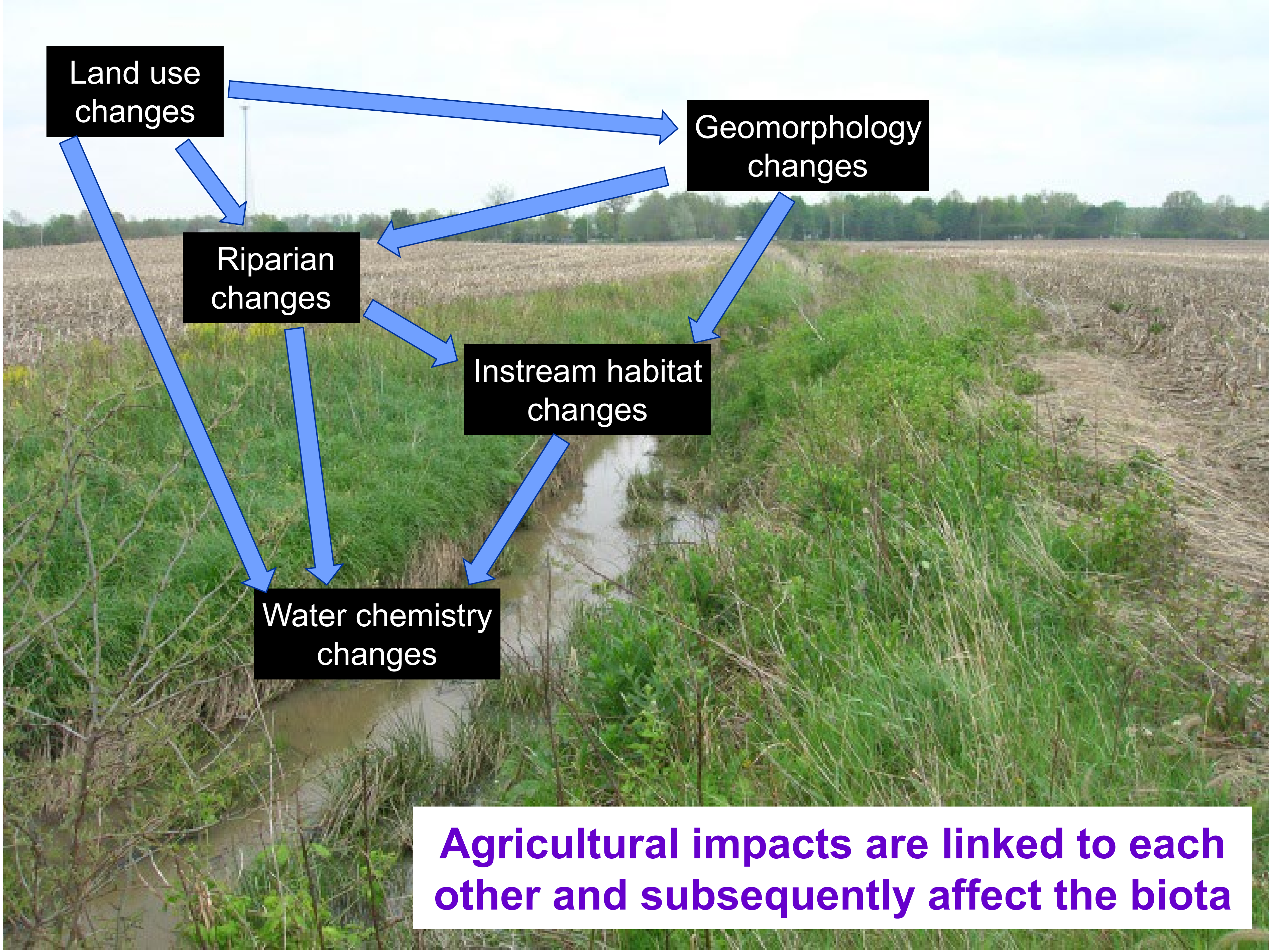
- Headwater streams are numerous - 53% of all streams in U.S. are headwater streams (U.S. EPA)
- In the Midwest – 2 stream types occur
  - **Unchannelized**
  - **Channelized (i.e., agricultural drainage ditches)** – headwater streams created or modified for agricultural drainage and they are common

Agricultural Drainage Practices





Agricultural impacts occur throughout the entire watershed


Land use changes
Geomorphology changes
Riparian changes
Instream habitat changes
Water chemistry changes
Agricultural impacts are linked to each other and subsequently affect the biota

Current Management Approaches for Channelized Agricultural Headwater Streams

- Focuses on drainage without regard to physical, chemical, or biological impacts
  - Drainage = Yield
- Federal and state conservation and restoration efforts for agricultural streams in general **focus on water chemistry** and ignore physical habitat impacts
  - Result –these efforts are **not addressing the full spectrum of agricultural impacts** and in some cases **not addressing the most important impacts**

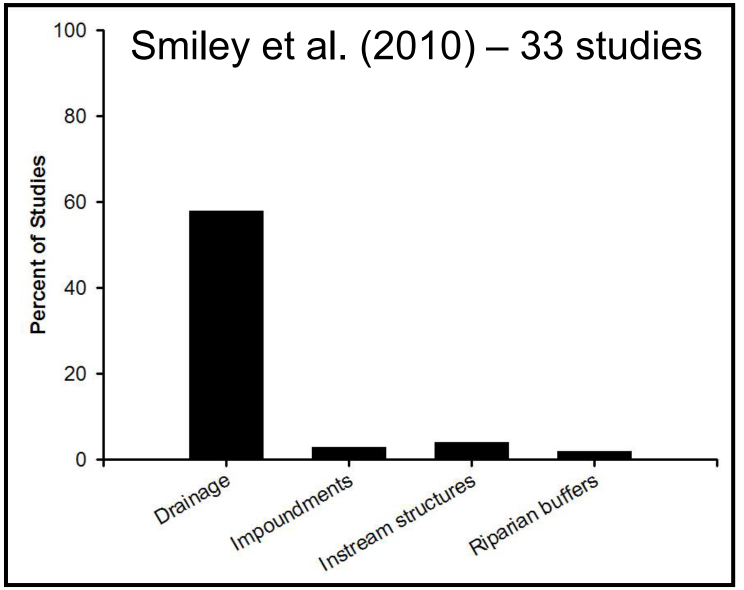
Challenges for Stream Restoration in the Midwest

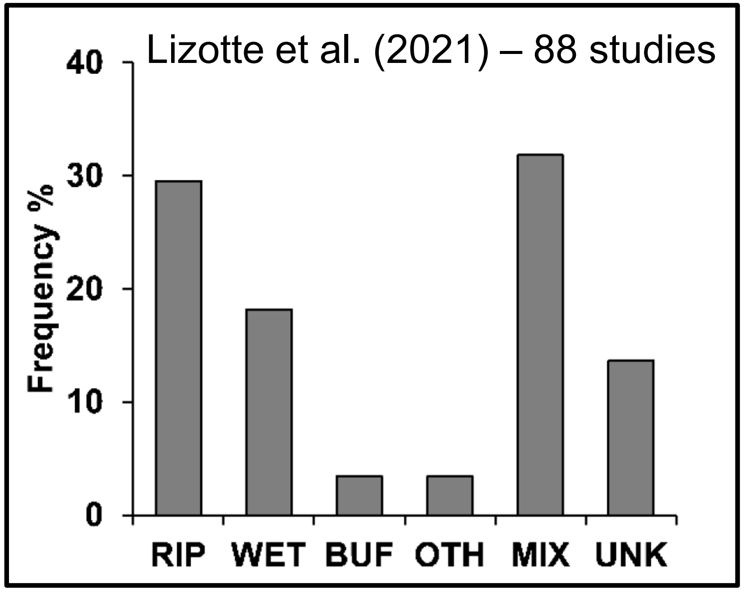
- **Hesitancy of agricultural community towards restoration**
  - Perception that restoration requires taking agricultural land out of production and/or using practices that interfere with drainage
  - Lack an understanding of the modern definition of ecological restoration that focuses on recovery and future conditions rather than reestablishing past conditions
- **Lack of agricultural community's understanding of their role in stream management**
  - Do not consider drainage ditches streams and such do not see a need to restore them
  - View their role as is watershed management, not stream management
- **Drainage laws limit the management actions that can be undertaken in drainage ditches with formal drainage contracts**

Challenges for Stream Restoration in the Midwest – Part 2

- In the Midwest U.S. only 11% of stream restoration projects evaluated (Alexander and Allen 2006)

- **Literature reviews focused on the effects of agricultural conservation practices indicate only limited information is available on the ecological impacts of conservation practices on agricultural headwater streams** (Smiley et al. 2010; Lizotte et al. 2021)
  - *Documentation that promoted practices are effective provides landowners with assurance that their investment is worthwhile*

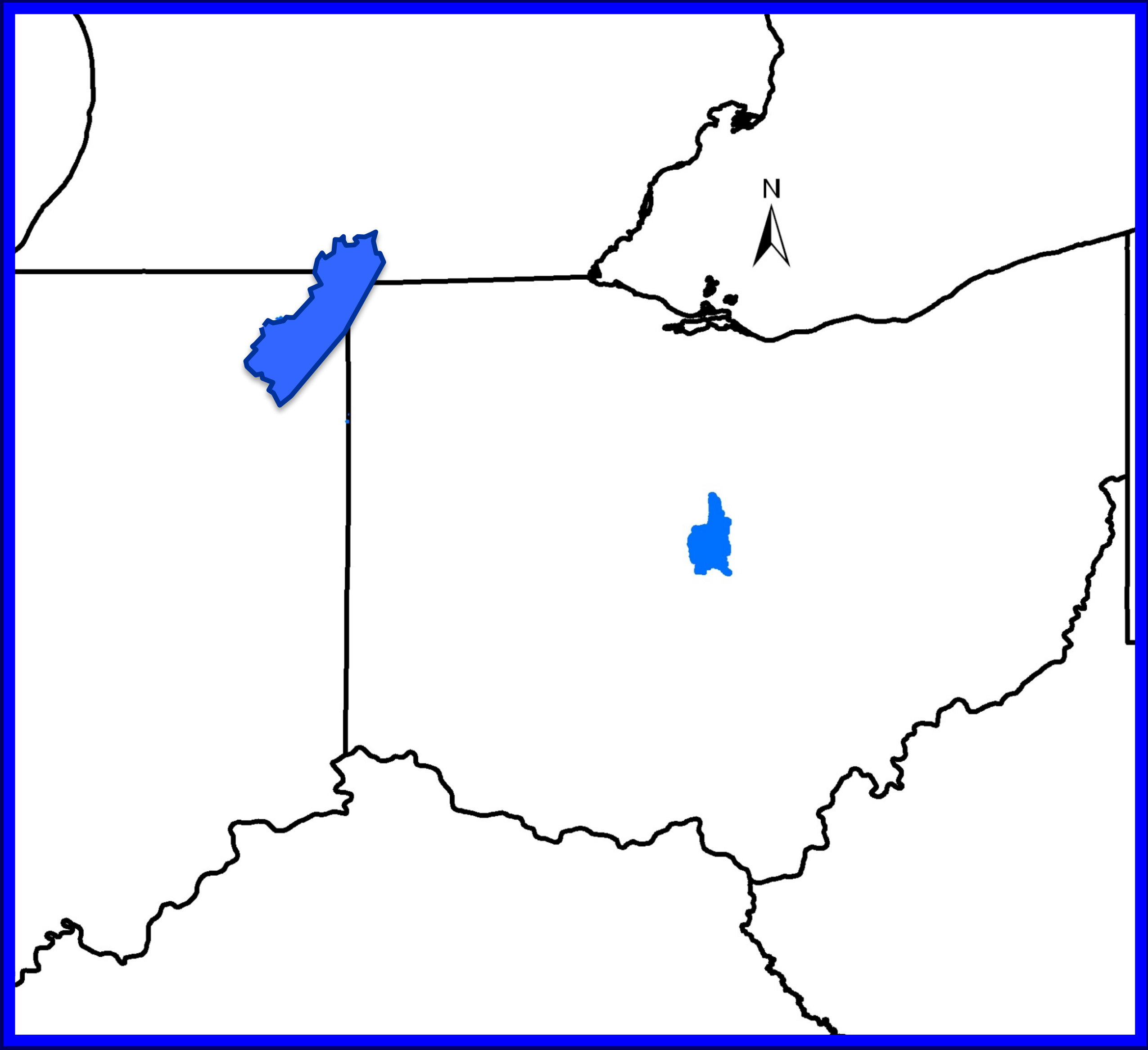




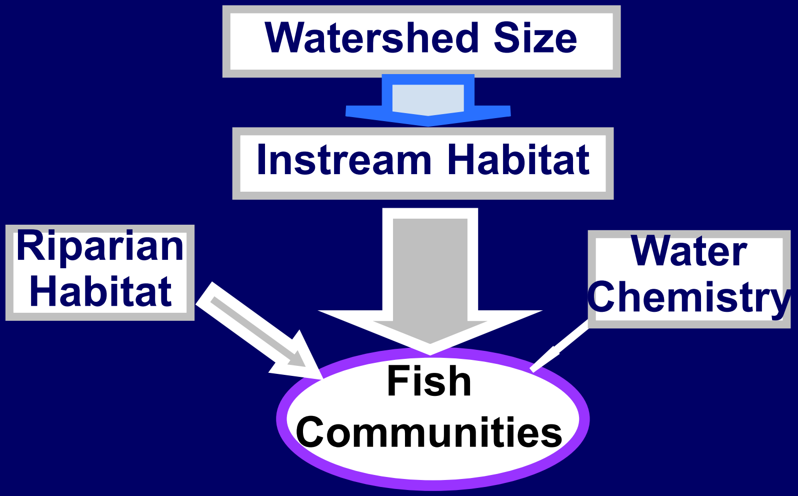
Research Examples

What factors have greatest influence on the biota in agricultural headwater streams?

- Results from series of studies conducted in St. Joseph River watershed and Upper Big Walnut Creek



Biota-Habitat Relationships in CEAP Agricultural Headwater Streams in Indiana & Ohio (2005 to 2015)



Smiley et al. 2008. Journal of Soil and Water Conservation 63: 218A-219A
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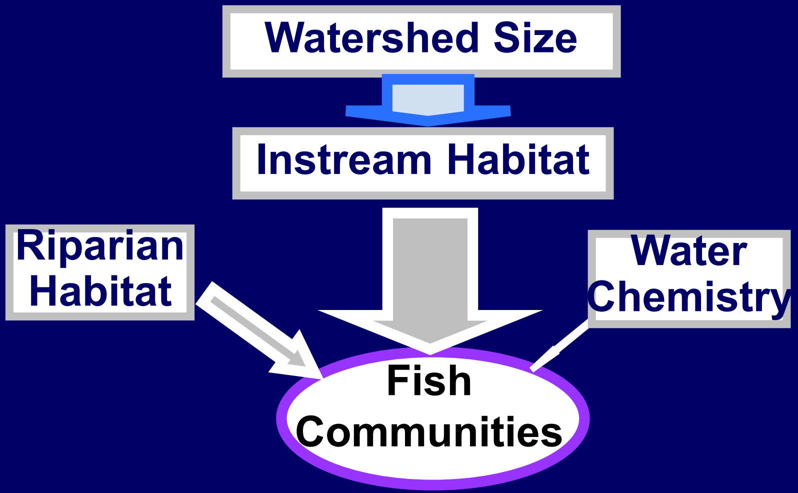

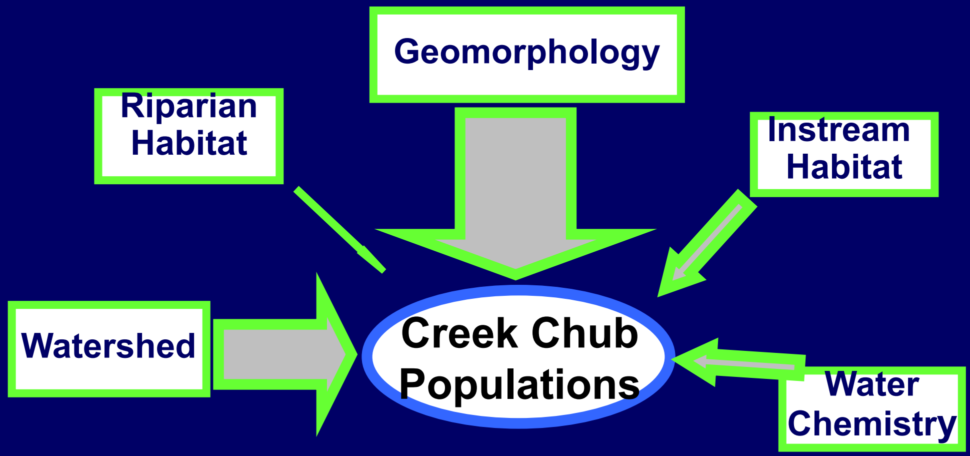

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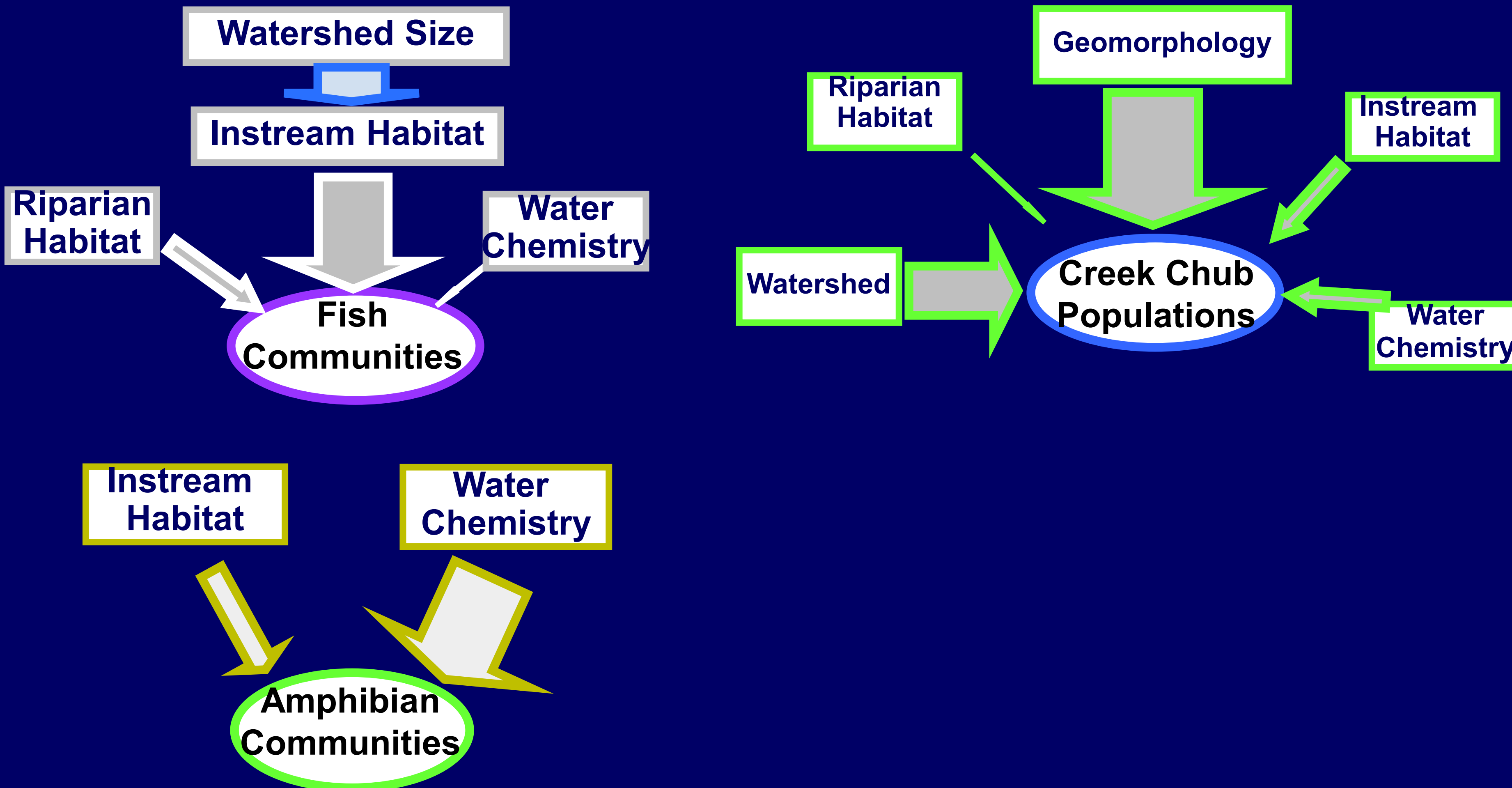

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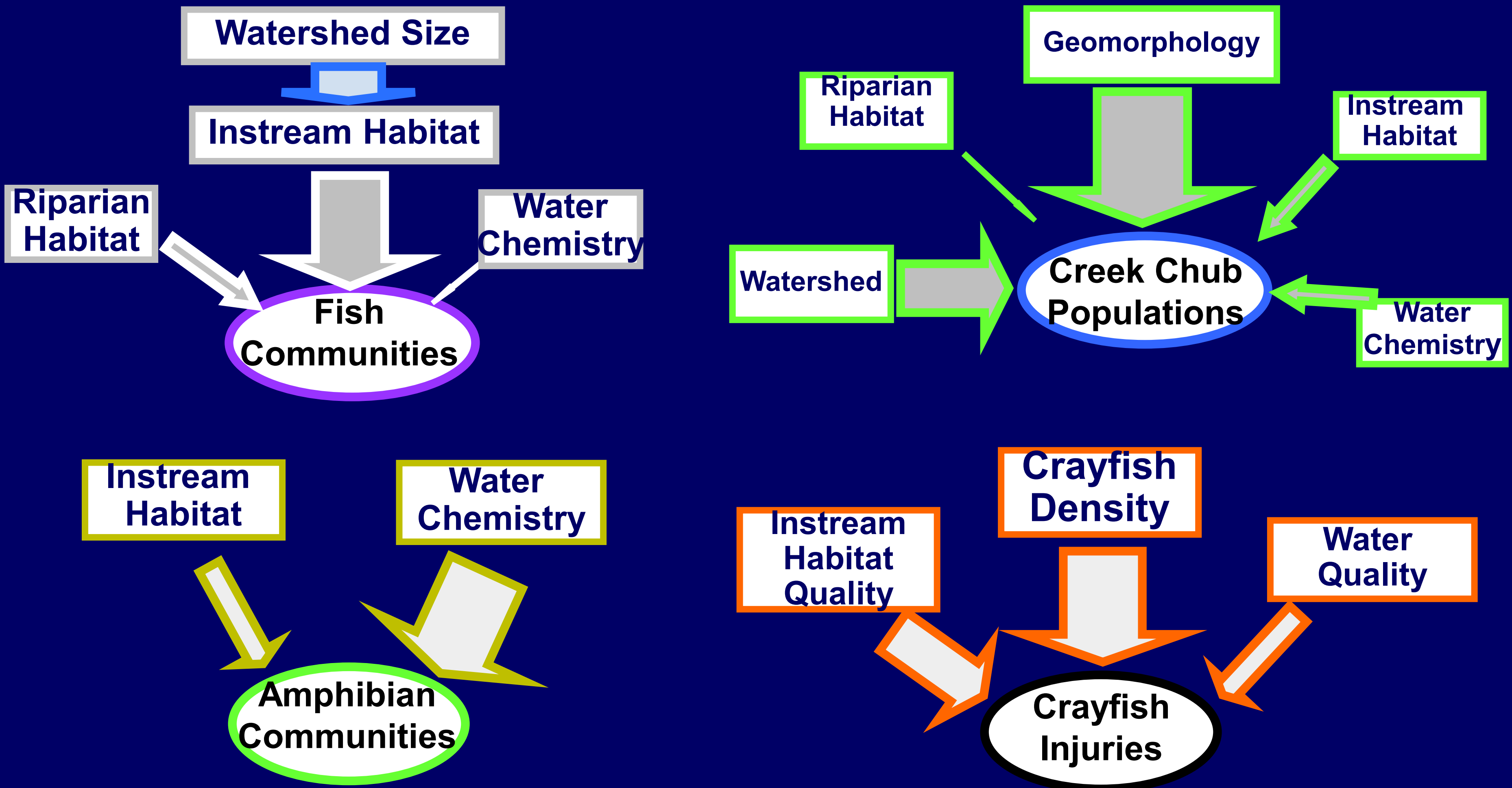

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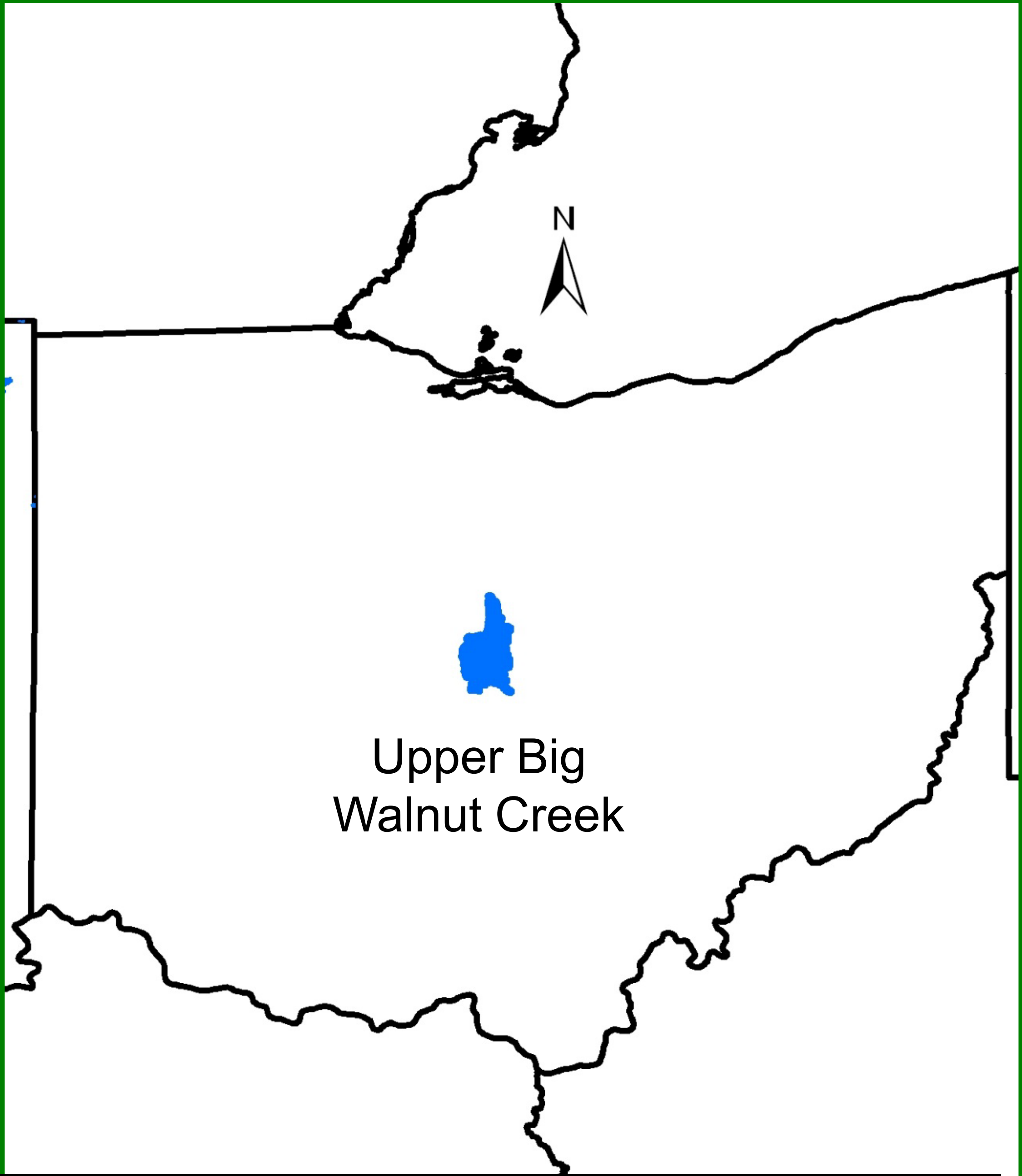
Jordan et al. 2016. Agriculture, Ecosystems, and Environment 230:87-97
Wood et al. 2020 Environmental Monitoring & Assessment 192:227

What is the long-term effect of planting grass filter strips on fishes, instream habitat and nutrient concentrations?

- 3 channelized streams with unplanted herb. riparian habitats
- 3 channelized streams with grass filter strips
- 2 unchannelized streams with forested riparian habitats
- 2006 to 2015



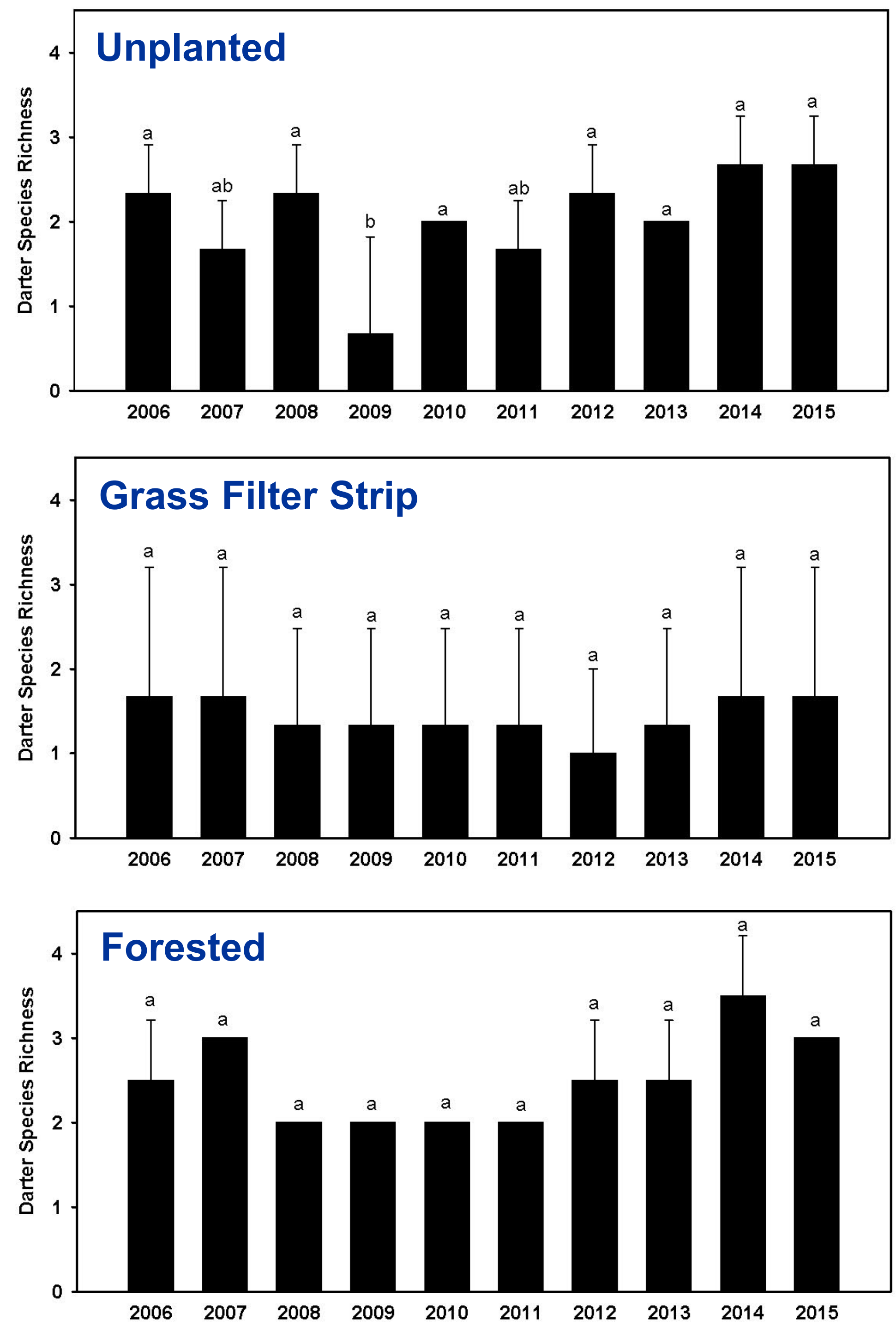
Smiley. 2024. Aquatic Conservation: Marine & Freshwater Ecosystems 34:e4137
Balcerzak et al. 2022. Journal of American Water Resources Association 58: 1497–1509

Fish Community Results (2006 - 2015)

	Riparian Habitat Type	Riparian Habitat Type x Year
Species Richness	$P > 0.05$	$P > 0.05$
Abundance	$P > 0.05$	$P > 0.05$
Darter Species Richness	$P > 0.05$	**$P = 0.046$**
Minnow Species Richness	$P > 0.05$	$P > 0.05$
Sunfish Species Richness	$P > 0.05$	$P > 0.05$
Percent Darter	$P > 0.05$	$P > 0.05$
Percent Headwater Fishes	$P > 0.05$	$P > 0.05$

Darter Species Richness Riparian Habitat Type x Year Interaction Effect

- Trends in darter richness among riparian habitat types did not differ among years
  - Instead darter richness exhibited different annual trends among riparian habitat types

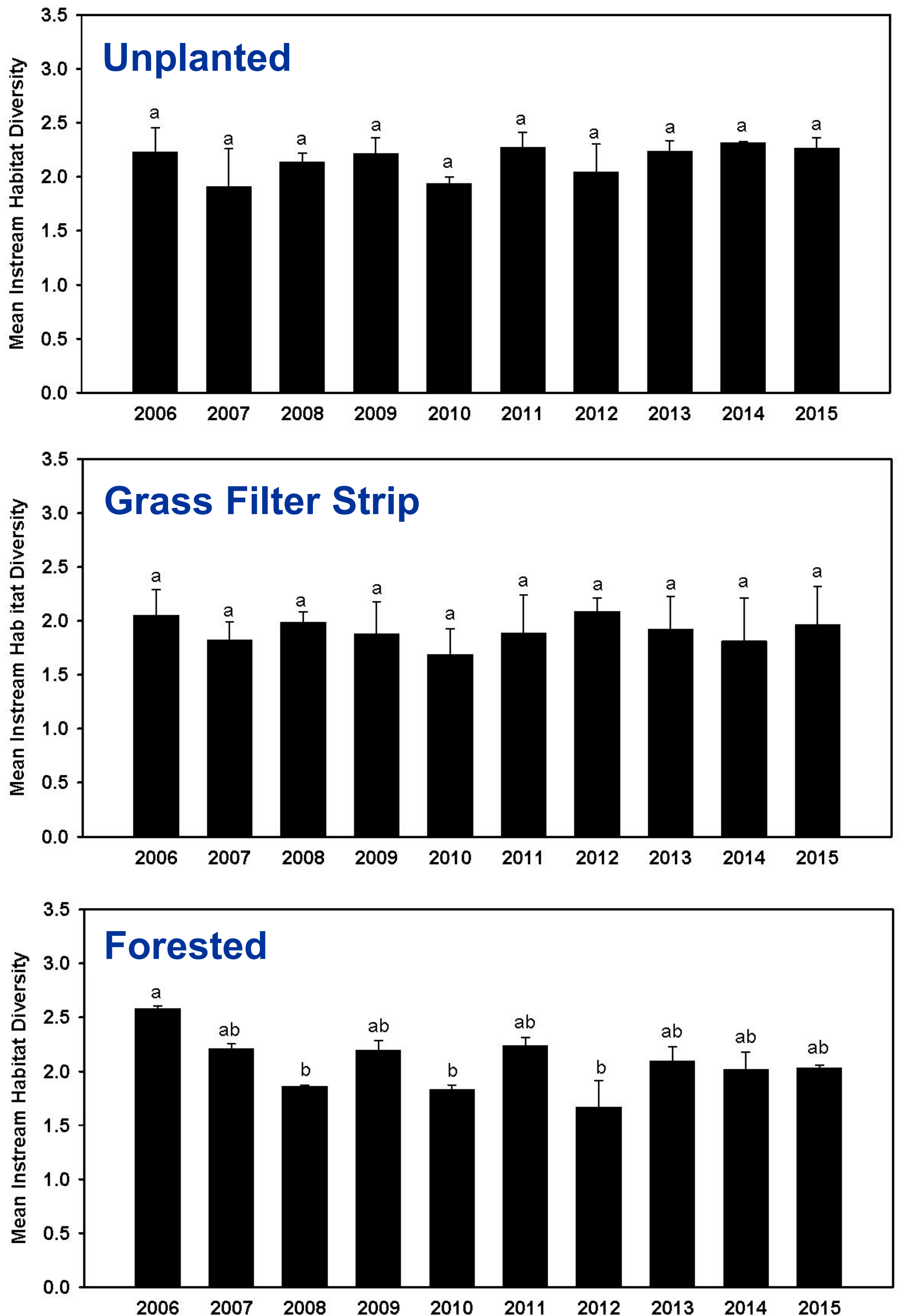


Instream Habitat Results (2006 – 2015)

	Riparian Habitat Type	Riparian Habitat Type x Year
Mean water depth	P > 0.05	**P = 0.040**
Mean water velocity	P > 0.05	**P < 0.001**
Mean wet width	P > 0.05	P > 0.05
Mean instream habitat diversity	P > 0.05	**P = 0.001**
Mean dominant grain size	P > 0.05	P > 0.05
Mean percent instream wood	P > 0.05	P > 0.05

Instream Habitat Diversity Riparian Habitat x Year Interaction Effect

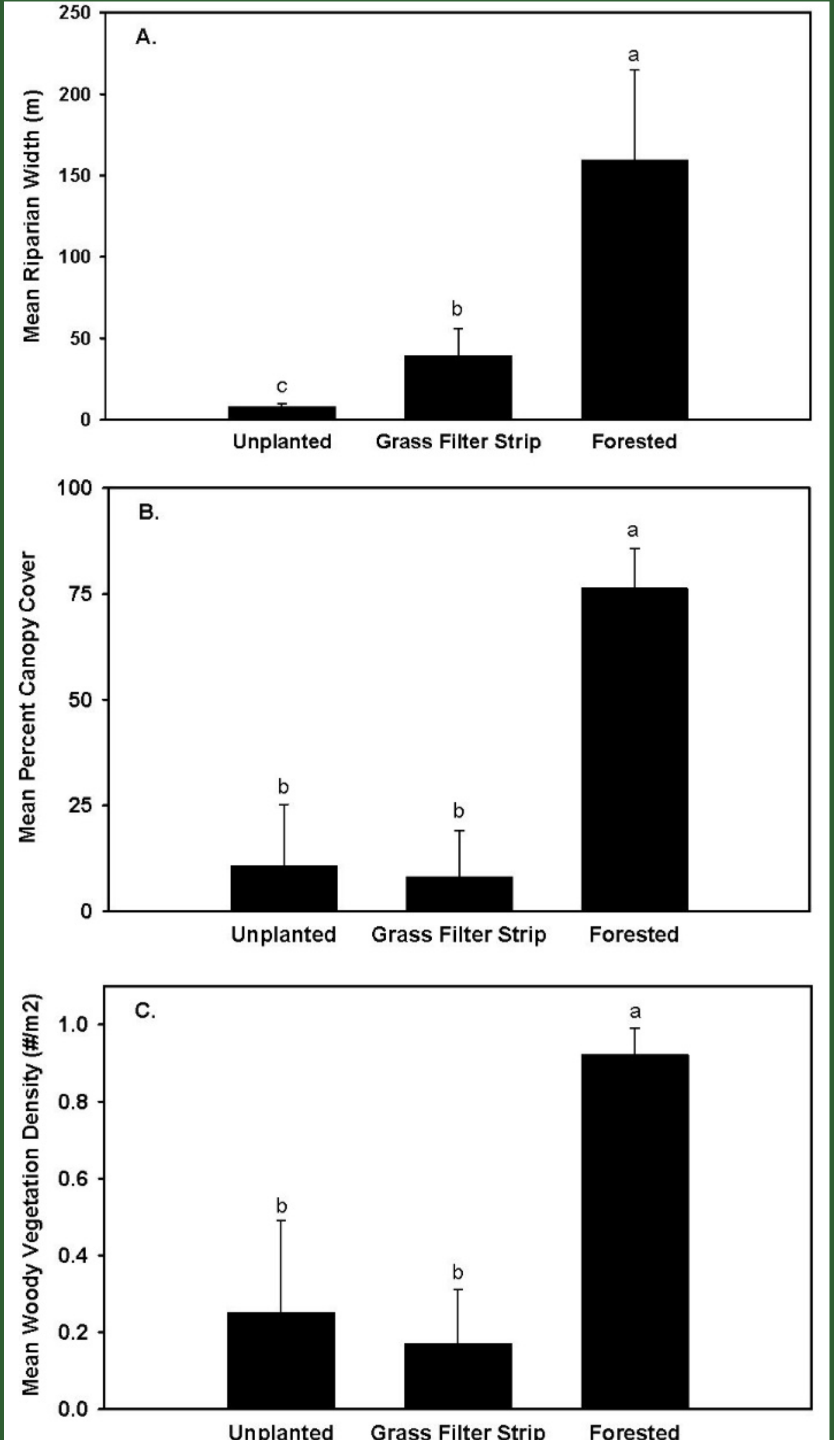
- Trends in mean instream habitat diversity among riparian habitat types did not differ among years
  - Instead this variable exhibited different annual trends among riparian habitat types
  - *Water depth and water velocity interaction effects* exhibited different patterns, but were similar in that none of the interaction effects suggested a positive effect of grass filter strips



Nutrient Results (2006 – 2015)

	Riparian Habitat Type	Riparian Habitat Type x Year
Ammonia	P > 0.05	P > 0.05
Nitrate+Nitrite	P > 0.05	P > 0.05
Total Nitrogen	P > 0.05	P > 0.05
Dissolved Reactive Phosphorus	P > 0.05	P > 0.05
Total Phosphorus	P > 0.05	P > 0.05

Riparian Habitat Results (2006 – 2015)



Conclusions

- Fish community, creek chub population structure, and crayfish injuries most strongly influenced by physical habitat variables and amphibian communities most strongly influenced by water chemistry
  - *Results highlight the taxa specific responses of the biota*

- 10 to 13 years after planting - grass filter strips simply widened the riparian habitats and did not influence fish community and population structure, instream habitat characteristics, and nitrogen and phosphorus concentrations
  - *Results highlight that grass filter strips should not be installed alone, but used as part of a treatment train (Lenhart & Smiley 2018) that implements grass filter strips in combination with watershed and instream habitat practices*

- More information on the impacts of stream restoration practices will:
  - *Increase the knowledge base for restoration science*
  - *Provide information to develop effective restoration strategies*
  - *Provide information to increase the agricultural community's buy-in of proposed restoration projects*

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