

RESTORATION OF CHANNELIZED AGRICULTURAL HEADWATER STREAMS

Dr. Peter C. Smiley Jr. (Rocky)
USDA ARS Soil Drainage Research Unit

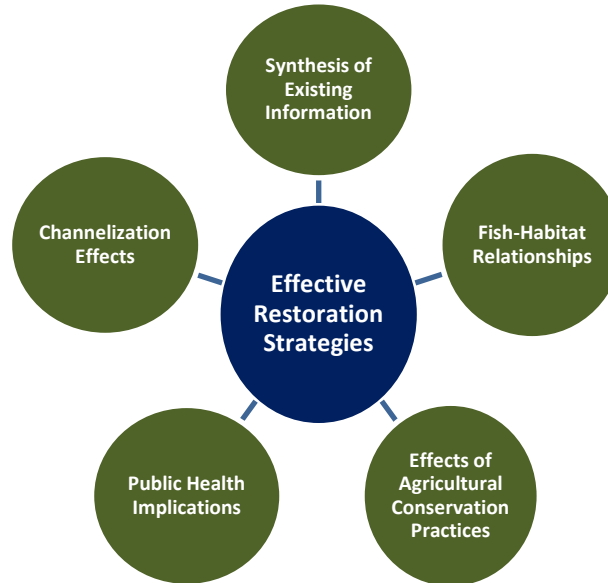


Channelized agricultural headwater streams (i.e., agricultural drainage ditches) are agricultural headwater streams that have been created or modified to facilitate agricultural drainage. These streams are managed primarily for drainage to maintain agricultural productivity. Channelized agricultural headwater streams are common across the Midwestern United States. The reduced ecological integrity (i.e., physical, chemical, and biological quality) of these streams has been frequently documented by state and federal water quality agencies.

There is a need to incorporate environmental considerations into the management of these streams. Potential solutions range from repair of actively eroding streambanks to implementation of a comprehensive watershed restoration plan. Yet, the ecological effects of potential restoration practices on the aquatic biota are unknown. Thus, the information needed to develop effective restoration strategies is lacking.

THE RESEARCH PROGRAM

Dr. Smiley has developed a multi-faceted research program focused on providing the quantitative information required for developing restoration plans that will benefit the biota and improve the physical and chemical quality within these degraded streams.



Dr. Smiley's research program involves individual and collaborative cross-location research projects conducted in Ohio and Indiana. His field research projects are hypothesis-driven field experiments that examine relationships of the aquatic biota with physical and chemical habitat conditions or evaluate how habitat changes as a result of specific practices influence the biota. Dr. Smiley's research typically focuses on fishes, but he also works with amphibians, reptiles, and aquatic macroinvertebrates.

PAST RESEARCH ACCOMPLISHMENTS

Results from headwater stream research conducted from 2005 to 2024 have resulted in 18 peer review manuscripts, two invited peer review manuscripts, two book chapters, and one technical report. These publications report the following research accomplishments:

- *Synthesized information on fish habitat relationships and the influence of conservation practices on fishes in channelized headwater streams.*
- *Quantified the relative influence of physical habitat and water chemistry on fishes, amphibians, and crayfishes in channelized headwater streams.*
- *Documented that planting grass filter strips adjacent to channelized headwater streams does not contribute to restoration of these small streams.*
- *Quantified the influence of atrazine reduction practices on pesticides and fishes within channelized headwater streams.*
- *Documented that pesticide mixtures within channelized headwater streams consisted mostly of combinations of herbicides or herbicides and fungicides.*
- *Documented public health risks posed by agricultural contaminants and potential insect disease vectors within channelized headwater streams.*
- *Determined the channelization effects on aquatic macroinvertebrate colonization within the riparian habitats of agricultural headwater streams.*
- *Determined the hydrological effects of channelization on agricultural headwater streams.*

RESULTING RESTORATION GUIDANCE

Past research results provide needed information that can be used by state agencies, federal agencies, non-profit organizations, and private consulting firms for developing restoration strategies for channelized headwater streams. Specific guidance includes:

- *The need for a watershed approach in the management and restoration of channelized headwater streams.*
- *Restoration and conservation practices that lead to improvements in physical habitat quality and water quality will benefit fishes, amphibians, and crayfishes.*
- *Grass filter strips need to be installed with other practices capable of improving physical habitat quality and water quality.*
- *Implementation of atrazine reduction practices in < 30% of the watershed will not influence pesticides or fishes in channelized headwater streams.*
- *Management of channelized agricultural headwater streams is needed to protect downstream drinking water sources.*
- *There is a need for watershed management plans that target the reduction of multiple pesticides within channelized agricultural headwater streams.*
- *Practices that lead to the development of forested riparian habitats will increase aquatic macroinvertebrate diversity within the riparian habitats of channelized headwater streams.*
- *The hydrology of channelized headwater streams needs to be modified to more closely mimic those of unchannelized headwater streams.*

CURRENT RESEARCH: 2022 – 2027

Dr. Smiley and collaborators from USDA ARS Soil Drainage Research Unit, Purdue University Fort Wayne, USDA ARS National Soil Erosion Research Laboratory, and the Ohio State University will be conducting research projects aimed at understanding the benefits of improved water quality and the quantification of the ecological effects of previously un-evaluated conservation practices. Specific research projects include:

- ***Evaluation of the ability of instream inserts to improve physical habitat diversity and fish biodiversity at the microhabitat scale.***

This project involves a before-after-control-impact design to assess the responses of instream habitat variables and fish community structure to the installation of instream inserts designed to create riffle-pool sequences within a channelized agricultural headwater stream in central Ohio.

- ***Evaluation of the ability of instream inserts to improve physical habitat diversity, improve fish community integrity, increase dissolved oxygen concentrations, and reduce nutrient concentrations at the reach scale.***

This project involves a before-after-control-impact design to assess the responses of instream habitat variables, fish community structure, dissolved oxygen, and nutrient concentrations to the installation of instream inserts designed to create riffle-pool sequences within a channelized agricultural headwater stream in central Ohio.

- ***Assessing the relationships among instream habitat diversity, nutrient concentrations, and fish community structure.*** *This project sampling channelized agricultural headwater streams ranging in instream habitat diversity from low to*

high and measuring fish community structure, nutrient concentrations to assess if drainage ditches with greater instream habitat diversity exhibit less nutrient concentrations and less within season variability of nutrient concentrations and greater fish biodiversity and abundance than ditches with less instream habitat diversity.

- ***Identification of the best environmental predictors of fish community structure in channelized agricultural headwater streams.***

This project will involve the development of predictive models of fish community structure in channelized agricultural headwater streams using data from a 14 year database of fish, instream habitat, water chemistry, riparian habitat, geomorphology, watershed characteristics, and weather data from streams in Indiana and Ohio.

Please contact me if you have questions regarding my research, are interested in receiving reprints, have consulting needs, or are interested being a collaborator.

Dr. Peter C. Smiley Jr. (Rocky)
USDA ARS Soil Drainage Research Unit
590 Woody Hayes Drive
Columbus, Ohio 43210
Email: rocky.smiley@ars.usda.gov
Webpage:

www.ars.usda.gov/pandp/people/people.htm?personid=37236