Accelerating Watershed Conservation Planning & Implementation in Michigan's Stony Creek Subwatershed: A Bottom-Up Approach to Reducing Phosphorus Loading into Lake Erie

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Table of Contents

Table of Contents ii
Table of Figures v
List of Acronyms: vi
Executive Summary 1
Introduction 3
Algal Blooms in Lake Erie 3
HABs in Lake Erie: A Brief History 4
The Nonpoint Source Challenge 6
Recent Conservation Efforts 7
State Planning for Phosphorus Reduction 11
A Bottom-Up Approach 12
HUC-12 Planning in Stony Creek: Project Overview 13
Methods 15
Site Selection 19
Establishing a Network of Stakeholders 20
Interview Methods 21
Steering Committee Methods 22
Steering Committee and Watershed Management Plan Development 24
Field Prioritization Methods 25
RUSLE Erodibility Assessment 25
Soluble Reactive Phosphorus (SRP) Risk Assessment 26
Overall Risk and Field Prioritization 27
Findings 29
Key Theme One: Socio-cultural influences and personal attitudes factor heavily in farmer decision-making around BMP adoption 29
Personal Attitudes 30
Socio-Cultural Factors 31
Barriers and Motivators to BMP Adoption Associated with Key Finding 1 32
Key Theme Two: Simplicity and specificity of conservation programming play a large role in adoption rates of conservation practices 34
Simplicity in Conservation 34
Bottom-Up, Field-Level Planning 35

Barriers and Motivators to BMP Adoption Associated with Key Theme 2 37
Key Theme Three: Financial incentives are necessary but not alone sufficient for improving BMP adoption rates 38
Financial Incentives 38
Barriers and Motivators to BMP Adoption Associated with Key Theme 3 40
2016 Lenawee CRP Review 41
Discussion 42
Limitations to Research 42
Parallel Efforts 43
Institutional Barriers 44
Applications Outside of Stony Creek 44
Recommendations 46
1. Increase and stabilize funding and support for the Conservation District Office 46
1.1. Conduct needs-based assessment to determine a necessary increase in funds to match increased staffing level 46
1.2. Allocate a portion of current state/federal funding to locally administered conservation programs that can be streamlined and tailored to community's needs 47
2. Improve accessibility and simplicity of conservation programming 47
2.1. Provide producers with a "one-stop-shop" for conservation programs 47
2.2. Offer individualized, field-level support to farm conservation planning 48
3. Increase information and education efforts in Stony Creek concerning BMPs and producer-led events 48
3.1. Producer-led events 48
4. Enhance avenues for collaboration between producer communities, trusted organizations, and stakeholders to engage with cost-share policies 49
4.1. Financial planning and management 49
4.2. Partnership development 49
4.3. Networking events 50
5. Develop a strategic approach to attract and retain younger producers in rural farming communities 50
5.1. Establish engagement opportunities for future producers 50
5.2. Grant opportunities 50
Conclusion 51
References 53

Appendix A: Auxiliary Information 58
State of Michigan Condensed WLEB HAB Mitigation Timeline 59
Appendix B: Interview Research Documents 60
Interview Guide 60
Interview Process and Email Templates .... **Error! Bookmark not defined.**
Center for Excellence Outreach Poster & Postcards .... **Error! Bookmark not defined.**
Center for Excellence Outreach Survey 66
Center for Excellence Farm Operator Practices Survey 68
Appendix C: Field Analysis Documents 73
Appendix D: Steering Committee Documents 74
Steering Committee Charter 74
Appendix E: Literature Review Documents 83
Effective communication strategies 83
BMP evaluation 85
Effectiveness of Policy and Incentive Programs 87
Use of Models and Soil Phosphorus Testing to Reduce Phosphorus Loads 90
Harmful Algal Blooms 95
Rural community and decision making 100
Appendix F: Stony Creek Watershed Conservation Plan i

Table of Figures

Figure 1: Satellite imagery of the October 2011 Lake Erie algal bloom. Image provided by the NASA Moderate Resolution Imaging Spectroradiometer (MODIS). 4
Figure 2: Western Lake Erie Bloom severity index (SI) for 2002-2023. The SI is based on the amount of biomass over the peak 30-days. The 2023 bloom had a severity of 5.3. A severity below 3 is the goal of the Great Lakes Water Quality Agreement (GLWQA). 5
Figure 3: Stony Creek (South Branch River Raisin) is located in Lenawee County, Michigan. 14
Figure 4: Theory of Change for Agricultural Phosphorus Conservation in Stony Creek (South Branch River Raisin) HUC-12. This Theory of Change approaches the task of watershed management and community engagement with a two-pronged approach, focusing on the social 17
Figure 5: The 13 priority subwatersheds identified in Michigan's Adaptive Management Plan, with Stony Creek, Lime Creek, Niles Ditch, and S.S.LaPointe labeled. Agricultural inventory status was current as of summer 2023, with the Stony Creek inventory completed during fall 2023. 19
Figure 6: Expanded Steering Committee Candidate Search Region 24
Figure 7: Priority fields were identified as those with limited BMP implementation but with high risk of phosphorus loss through erosion and runoff, presenting greatest opportunities for phosphorus loss reductions. 25
Figure 8: Discrete findings from interviews, steering committee, and field analysis, and the three key themes drawn from the discrete findings. **Error! Bookmark not defined.**
Figure 9 2016 Lenawee CRP Review 41
Figure 10: 2016 Lenawee CRP Review: A description of the CRP audit in Lenawee County in 2016, and its impacts on local attitudes toward conservation programming **Error! Bookmark not defined.**
Figure 11:Annual CRP total payments by county 41
Figure 12: Major subwatersheds and jurisdictional boundaries of the River Raisin (River Raisin Watershed Council, 2009), 10, fig. 1-1 3
Figure 13: Stony Creek (South Branch River Raisin) sits primarily in Dover Township, MI. 4
Figure 14: Hydrologic Unit Codes (HUCs) Explained (USGS, 2023) https://nas.er.usgs.gov/hucs.aspx 5
Figure 15: Stony Creek (South Branch River Raisin) is located in Lenawee County, Michigan. 6
Figure 16: Stony Creek Relative Erosion Risk, factoring in soil type, rainfall data, and topography 15
Figure 17: Stony Creek Relative Erosion Risk by Field and Observed BMP Use 16
Figure 18: Stony Creek BMP Recommendations Visual Aid, showing the primary recommendations for Stony Creek farmers. Recommendations are differentiated between

more- and less-sloped fields, defined by EGLE standards (greater/less than 75% of the field in 3% grade). 18

List of Acronyms:

ACPF	Agricultural Conservation Planning Framework
AMP	Adaptive Management Plan
AOC	Area of Concern
BMP	Best management practices
CAFO	Certified Animal Feeding Operation
CD	Conservation District
CREP	Conservation Reserve Enhancement Program
CWA	Clean Water Act
DAP	Domestic Action Plan
DRP	Dissolved reactive phosphorus
EGLE	Michigan Department of Environment, Great Lakes, and Energy
FSA	Farm Services Administration (of the USDA)
GIS	Geospatial Information System
GLWQA	Great Lakes Water Quality Agreement
HUC-12	Hydrologic Unit Code, 12 digits long
MAEAP	Michigan Agriculture Environmental Assistance Program
MDARD	Michigan Department of Agriculture and Rural Development
MDNR	Michigan Department of Natural Resources
NPS	Nonpoint source pollution
NRCS	Natural Resources Conservation Service
QOL	Quality of Life (referring to MDARD, EGLE, and MDNR)
RUSLE	Revised Universal Soil Loss Equation
SIP	State Implementation Plan
SRP	Soluble reactive phosphorus
U-M SEAS	University of Michigan School for Environment and Sustainability
USDA	US Department of Agriculture
USGS	US Geological Survey
WASCOB	Water and sediment control basin
WCP	Watershed conservation plan
WLEB	Western Lake Erie Basin

Executive Summary

Since the mid-1990s, an increase in annual cyanobacterial harmful algal blooms (HABs) in the Western Lake Erie Basin (WLEB) has driven a focus on nonpoint source (NPS) nutrient pollution in tributary watersheds, especially in the states of Michigan, Indiana and Ohio, and in the Canadian province of Ontario (EGLE et al., 2021; Green et al., 2023; Watson et al., 2016). Attention to the issue was intensified in 2014 when a HAB in WLEB led to a drinking water crisis in Toledo, Ohio, which spurred commitments by the governments of Ohio, Michigan, and Ontario to achieve a 40% reduction of phosphorus loading into the lake by the year 2025 (Snyder et al., 2015; Steffen et al., 2017). However, these states are not currently on track to meet their reduction targets. To address NPS loading into the lake, government attention turned to the approximately 7 million acres draining directly into the WLEB, as well as the region's primary land use: agricultural production (OSU Extension, 2024). Agricultural production is associated with 70-90% of NPS phosphorus loading into WLEB (Wilson et al., 2019), which can be mitigated through the use of agricultural best management practices (BMPs) for conservation. In Michigan's 2021 Adaptive Management Plan for Lake Erie, the state identifies and prioritizes 13 subwatersheds for data collection and evaluation toward increased BMP adoption. To explore a new approach in localized conservation planning, the Michigan Department of Agriculture and Rural Development (MDARD) partnered with the University of Michigan School for Environment and Sustainability (SEAS) to research the factors contributing to producer conservation choices in a select priority subwatershed. The Stony Creek (South Branch River Raisin), a HUC-12 component of the River Raisin watershed, was chosen for this research effort.

Over a sixteen-month period, our team of five SEAS graduate students reviewed literature related to agricultural, social, biochemical, and economic aspects of WLEB algal blooms; performed informal outreach and information gathering through event participation and farm visits; conducted 12 stakeholder interviews with producers, community members, and local experts; developed an erosion risk map of the subwatershed through GIS analysis utilizing the RUSLE model; and formed a steering committee to direct the development of a Watershed Conservation Plan (WCP) for Stony Creek. Through these various research efforts and their respective results, we synthesized three Key Themes that affect BMP adoption in Stony Creek:

1. Socio-cultural influences and personal attitudes factor heavily in farmer decision-making around BMP adoption;
2. Simplicity and specificity of conservation programming play a large role in adoption rates of conservation practices; and

3. Financial incentives are necessary but not alone sufficient for improving BMP adoption rates.

Within these three themes, we identified nine cross-cutting barriers and six motivators to conservation adoption in Stony Creek. Based on these barriers and motivators, we developed five key recommendations for improving BMP adoption in Stony Creek:

1. Increase and stabilize funding and support for Lenawee Conservation District;
2. Improve accessibility and simplicity of conservation programming;
3. Improve information and education efforts in Stony Creek concerning BMPs;
4. Enhance avenues for collaboration between producer communities, trusted organizations, and stakeholders to engage with cost-share policies; and
5. Develop a strategic approach to attract and retain younger producers in rural farming communities.

Our research findings drove the completion of a Sub-Watershed Conservation Plan (WCP) for Stony Creek, guided by a steering committee of local producers and stakeholders in agricultural conservation and watershed management. In the Stony Creek WCP, we recommend precision agriculture practices (nutrient management, nutrient mass-balance calculations, and precision application of nutrients) and two suites of BMPs based on field topography. While our research findings and recommendations are specific to Stony Creek

Introduction

Algal Blooms in Lake Erie

The North American Great Lakes are vital, holding 20% of the world's fresh surface water and supporting a $6 trillion regional economy annually (Krantzberg, 2020). Lake Erie, the southernmost of the Great Lakes, has approximately twelve million people living in its watershed, includes 17 major metropolitan areas, and provides water to about eleven million of these residents (US EPA, 2023). Lake Erie is one of the most diverse ecosystems in the Great Lakes and generates over $63 billion in annual income from tourism, recreational boating, shipping, fisheries, and other industries (Watson et al., 2016).[1] Lake Erie boasts one of the most profitable freshwater fisheries in the world due to its warm, shallow waters, which facilitate growth of algae and microfauna to support robust fish populations (Briscoe, 2019). Beyond its economic value, Lake Erie is of high cultural importance to those living near its shores and within its watersheds, especially to the indigenous Anishinaabe people, who derive deep spiritual meaning from the lake (Hudson & Ziegler, 2014). However, the value and services provided by Lake Erie are now threatened by eutrophication due to agricultural runoff in tributary watersheds. Historical conversion of the watershed's native wetlands, forests, and grasslands to ever-intensifying agricultural production has facilitated decades of nonpoint source (NPS) nutrient pollution into the lake, fueling eutrophication and disrupting the region's natural, cultural, and economic value (River Raisin Watershed Council, 2009).

Accelerating eutrophication of Lake Erie in recent decades has been associated with harmful algal blooms (HABs) that now threaten the lake's ecosystem services. Algal blooms, generally, are rapidly growing colonies of algae or phytoplankton in aquatic ecosystems. While algal blooms are natural phenomena, excessive blooms are often indicative of environmental imbalances and can degrade water quality, foul shorelines, and cause hypoxic water conditions via aerobic decomposition (NOAA, 2016). Hypoxic regions, known as "dead zones," are regions within a body of water where most fish and other aquatic organisms cannot survive due to a near total depletion of dissolved oxygen. Some types of phytoplankton also produce toxins that can damage aquatic life and, when ingested, cause illness in humans and animals. When these toxin-producing organisms grow rapidly, they are commonly referred to as harmful algal blooms or HABs (Agrawal & Gopal, 2013; US EPA, 2013). The shallow waters of Western Lake Erie are highly susceptible to toxic cyanobacterial (blue-green algae) HABs of the *Microcystis* strain

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[1] Annual income generation adjusted to 2024 dollar value.

(O'Neil et al., 2012; Steffen et al., 2017). Discharges of agricultural phosphorus and nitrogen nutrients into the WLEB feed cyanobacterial colonies, which bloom into thick and expansive mats of dense organic material in the summer and fall months. Annual severity of HABs in the WLEB is variable and correlated to rainfall, particularly in the spring months (Williams & King, 2020). However, current and projected changes to meteorological patterns due to climate change (e.g., increasing rainfall and greater intensity of rainfall events in the region) are likely to have compounding effects on the presence and persistence of HABs in the WLEB (Williams & King, 2020). Warmer air and water temperatures and increased lake stratification associated with prolonged warmer seasons, as seen in recent decades, are also associated with increased frequency and intensity of harmful algal blooms.

HABs in Lake Erie: A Brief History

Figure 1: Satellite imagery of the October 2011 Lake Erie algal bloom. Image provided by the NASA Moderate Resolution Imaging Spectroradiometer (MODIS).

HABs are not a new phenomenon in Lake Erie or its western basin. By the early 1960s, nutrients (primarily phosphorus and nitrogen) from municipal wastewater and urban runoff from coastal urban centers contributed to an extreme state of eutrophication in the lake, causing Lake Erie to be known as the "dead" lake (Watson et al., 2016). Nutrient pollution was not the largest challenge to the lake's water quality at the time; the 1960s saw a series of freshwater disasters related to industrial pollution, namely river fires in northwestern Ohio, which became symbolic of water pollution issues during the heyday of the American environmental movement. 1972 saw the enactment of two important pieces of legislation: The Federal Water Pollution Control Act, known commonly as the Clean Water Act, and the Great Lake Water Quality Agreement (GLWQA). The 1972 Clean Water Act set limits on all municipal and industrial discharges from "point sources," or single identifiable sources such as pipes or ditches, into navigable waterways. The GLWQA set goals to specifically limit the amount of phosphorus loading into each of the Great Lakes to combat eutrophication. The severity of Lake Erie's degradation caused federal lawmakers to include national phosphorus discharge limits in wastewater from municipal sources in the Clean Water Act, leading to lasting changes in wastewater treatment standards and detergent product phosphorus content (Kehoe, 1996). Together, the laws catalyzed a successful national effort to clean up and regulate pollutant discharges into waterways. Point sources of nutrient pollution into Lake Erie were minimized, and the lake made a miraculous recovery over the ensuing decade thanks to its short water retention time of 2.6 years (Watson et al., 2016).

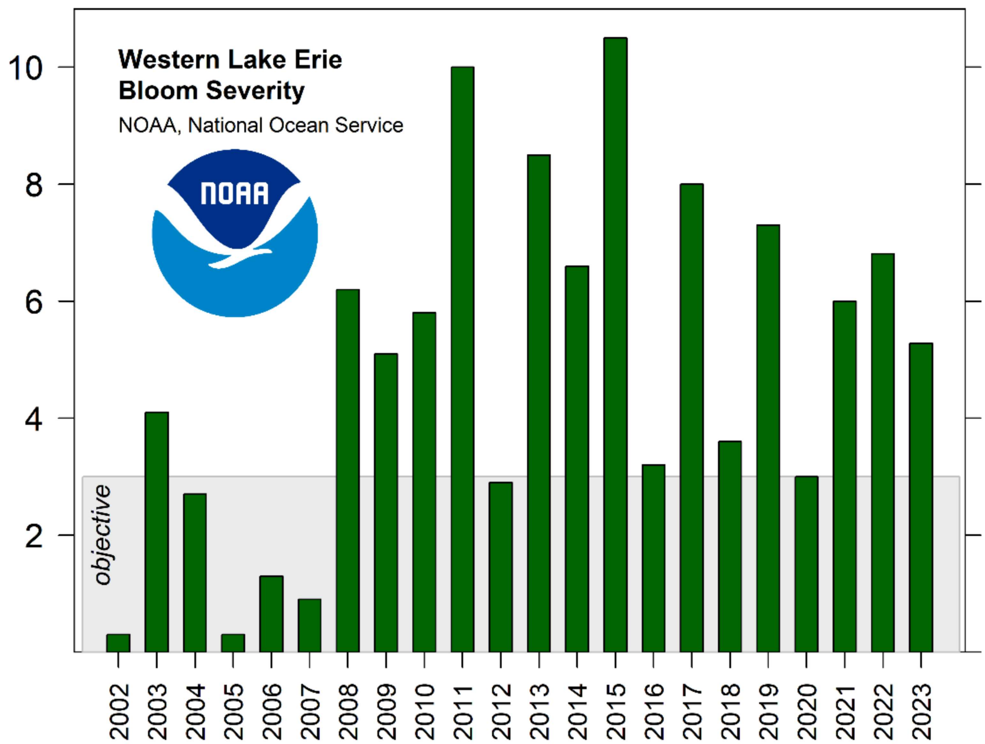

Figure 2: Western Lake Erie Bloom severity index (SI) for 2002-2023. The SI is based on the amount of biomass over the peak 30-days. The 2023 bloom had a severity of 5.3. A severity below 3 is the goal of the Great Lakes Water Quality Agreement (GLWQA).

Point-source nutrient pollution into Lake Erie was addressed in the 1970s and 1980s. Contemporary HABs are caused by ***nonpoint source pollution****, namely from* ***agricultural fertilization and tilling practices****.*

However, by the mid-1990s, Lake Erie would once again see the effects of HABs in the western basin. Intensifying agricultural use of inorganic phosphorus and nitrogen fertilizers in the Lake Erie watershed, as well as growing numbers and sizes of animal feeding operations and the resulting increase in manure spreading, led to surges of these elements reaching the lake through tributary waterways, spurring on a new era of recurring annual HABs in the WLEB (Blue, 2022; Watson et al., 2016). In 2014, one such HAB caused the city of Toledo, Ohio, to issue a "Do Not Drink" notice to over 400,000 people for three days due to toxic microcystin contamination of the city's Lake Erie water source (Carmichael & Boyer, 2016; Steffen et al., 2017). The "Toledo Water Crisis" drove the creation of the 2015 Western Basin of Lake Erie Collaborative Agreement (Collaborative Agreement) for reducing phosphorus loading into Lake Erie. This document, signed by governors of Michigan and Ohio and the premier of Ontario, commits each party to a 40% reduction of phosphorus loading into Lake Erie by 2025 (Snyder et al., 2015), a goal now pursued by Michigan's Quality of Life (QOL) departments via the state's Domestic Action Plan for Lake Erie (DAP). [2] While the Collaborative Agreement accelerated state-level planning for phosphorus reduction into the lake, the 2012 GLWQA Annex 4 had set 2016 and 2018 deadlines for establishing loading targets and state domestic action plans, respectively (Environment and Climate Change Canada, 2012). At the time of this writing, none of the signatory parties is on track to meet the 2025 goal, and the State of Michigan is in the process of developing an update to its Domestic Action Plan, which outlines the state's roadmap for achieving the phosphorus reduction goals.

The Nonpoint Source Challenge

Although the Toledo Water Crisis reinvigorated state, national, and international priorities for restoring Lake Erie's water quality, meaningful progress toward mitigating HABs in Lake Erie has not been realized. Reducing nutrient loads from nonpoint sources, specifically agricultural fields, is difficult to monitor; progress relies on voluntary action taken by producers. Limited resources further restrict progress; there is not a comprehensive water monitoring apparatus for evaluating BMP performance, and there is limited financial and

[2] Michigan QOL departments include the Department of Natural Resources (DNR); the Department of Environment, Great Lakes, and Energy (EGLE); and the Department of Agriculture and Rural Development (MDARD).

administrative support for incentivizing voluntary conservation. Additionally, observed weather variability stemming from climate change has obscured nutrient loss trends, making connections to specific agricultural practices less obvious and hampering education and outreach efforts. These combined factors have reduced the effectiveness of government initiatives aimed mitigating the primary drivers of HABs in Lake Erie: Nonpoint source nutrient pollution in the form of agricultural fertilizer runoff (Daloğlu et al., 2012; Duchemin & Hogue, 2009; Gao & Arbuckle, 2022; Scavia et al., 2014; Watson et al., 2016; Wilson et al., 2019).

Agriculture in surrounding drainage basins is estimated to be responsible for over 90% of all phosphorus currently entering Lake Erie (Wilson et al., 2019). When phosphorus fertilizer application rates exceed crop needs and soil retention capacities, excess phosphorus enters Lake Erie via agricultural ditches, drainages, and tributaries (EGLE et al., 2021; EWG, 2019). Over time, overapplication has created phosphorus accumulations in some soils that continue to leach phosphorus to waterways for years after application (EGLE et al., 2021; EWG, 2019). Additionally, conventional commodity cropping practices, including free flow drain tiling, intense tillage, and leaving fields bare during the non-growing season, contribute to particulate phosphorus loads via soil erosion. NPS phosphorus loads from agricultural fields into waterways are exceedingly difficult to monitor due to their dispersion across the landscape, but their cumulative effects are clearly seen and felt in the WLEB.

Recent Conservation Efforts

Although Clean Water Act regulations enabled the Lake Erie ecosystem to bounce back in the 1980s, the Act and its amendments are ill-suited to addressing the resurgence of HABs. With point sources of nutrient pollution now well-regulated under the Clean Water Act, nonpoint sources of nutrient pollution are the primary drivers of renewed and pervasive algal blooms in Lake Erie (Scavia et al., 2014). Phosphorus and nitrogen play important roles in cyanobacterial growth and toxicity, respectively. While recent studies indicate that nitrogen pollution may drive toxicity of Lake Erie HABs, phosphorus has been established as the primary limiting factor of HAB growth, and it has therefore been the focus of mitigation efforts. (Hellweger, Ferdi L., et al, 2022).

Table 1: Summary of common agricultural BMPs (best management practices) utilized in the Western Lake Erie Basin

Common Agricultural Best Management Practices (BMPs)	
Conservation Tillage	No-till or reduced tillage system that minimizes soil disturbance and allows crop residue to remain in the field
Constructed Wetlands	Artificial wetland ecosystem designed to provide biological treatment or filtration of agricultural runoff
Cover Crops	Plants grown as between periods of harvested crop production, providing winter cover and reducing bare soil
Drainage Water Management	System that allows for control of water flow from agricultural fields with tiled drainage, retaining water in the field and reducing intensity of discharge
Filter Strips / Riparian Buffers	An area of perennial vegetation along waterways that reduces contaminants from runoff and reduces proximity of fertilizer applications to waterways
Grassed Waterways	An in-field channel planted with perennial vegetation to reduce erosion and gully formation
Nutrient Management	Planning soil amendments to minimize fertilizer application while providing economic benefit; includes 4R management: the right source, right method, right rate, and right timing
WASCOBs	Water and Sediment Control Basin; constructed embankments designed to intercept runoff, allowing sediment to settle and water to drain through underground outlet.

> ***BMPs** are farm practices that reduce the amount of fertilizer nutrients **running off farm fields** into waterways, and they are **incentivized** to entice farmers into **reducing downstream impacts** of agricultural production. Current incentives are **not always effective**.*

Despite a lack of NPS-specific regulation, efforts have been made to reduce phosphorus loading through top-down support of agricultural best management practices (BMPs). Unlike point sources regulated by Clean Water Act and GLWQA, NPS pollution is not subject to regulation and enforcement. To drive adoption of BMPs, state and federal governments employ a variety of cost-share incentive programs. Federal conservation programs, most notably the USDA Conservation Reserve Program (CRP), have made significant investments in conservation through Farm Bill allocation. The USDA reported over $1.77 billion spent in 2023 with nearly 25 million acres enrolled nationwide in CRP (USDA FSA, 2024). Through CRP, farmers are financially incentivized to remove agricultural lands from production to reduce environmental impacts of agriculture in vulnerable ecosystems (USDA, 2006). The Environmental Quality Incentives Program (EQIP) and Conservation Stewardship Program (CSP) utilize federal funding to incentivize conservation, offering farmers technical assistance in conservation planning through local NRCS offices, along with financial support to implement plans through cost-sharing. Federal funding also supports conservation efforts with local, private partners through the Regional Conservation Partnership Program (RCPP). However, enrollment into these programs is competitive, parsing eligibility for different programs can be complex, and participation is limited by funding availability (USDA CCC & State of Michigan, 2023).

There has been robust historical participation in CRP and EQIP programs, but recent budget cuts and erosion of trust in government programs among farming communities have hindered enrollment and retention (USDA CCC & State of Michigan, 2023). While CRP and other federal programs provide critical funding to support environmental protection, programs under the Farm Bill have long incentivized maximizing agricultural yields through industrial farming methods, a goal typically at odds with conservation efforts. Increased fertilizer and pesticide applications, field expansion, and reduction of crop diversity have been leveraged to increase yields of a small number of staple commodity crops while simultaneously increasing nutrient and pesticide runoff, erosion, and loss of soil organic matter. According to USDA records, from 1985 to 2021, farmers nationwide received over $18 billion, or an average of approximately $1 million per farmer through subsidy programs nationwide, although the top non-indigenous recipient received over $18.5 million in 2023 (Devens & Hayes, 2023). This period of subsidized farm consolidation and intensification correlates to the marked worsening of eutrophication in Lake Erie and the reemergence of HABs(citation).

In the River Raisin Watershed, Michigan's largest watershed to Lake Erie and a significant source of nutrient loads to the WLEB, conservation efforts at the state level have been ongoing for decades. Growing national attention to Lake Erie HABs has spurred initiatives and funding for environmental restoration of the river (Devens & Hayes, 2023; Watson et al., 2016). The state-administered Conservation Reserve Enhancement Program (CREP) funnels federal funding to producers to incentivize adoption of approved agricultural BMPs in state-prioritized watersheds through cost-share subsidy, typically at higher rates than CRP. These BMPs are intended to reduce NPS nutrient pollution, improve water quality, and protect wildlife, and they include planting filter strips, riparian forest buffers, wetland restoration, and sediment retention control structures (USDA CCC & State of Michigan, 2023). Uniquely, Michigan offers the Michigan Agriculture Environmental Assurance Program (MAEAP), which provides technical assistance and certification of farms for utilizing sustainable practices (EGLE et al., 2021; State of Michigan, 2018). Other grant funding has enabled organizations such as the River Raisin Watershed Council to work toward conservation and remediation of the River Raisin through watershed management planning, educational programs, farmer collaboration, and rain garden initiatives (RRWC, 2023). Additionally, programs have been developed locally that contribute to community-building and education around agricultural conservation in the River Raisin Watershed including the Center for Excellence, organized through the Lenawee Conservation District, and the Farmer-Led Watershed Conservation Network (Farmer-Led Watershed Conservation, 2024).

> Federal and state BMP incentive programs often **do not meet the needs** of farmers and are deemed **more trouble than they are worth**.

Even with these programs in place, there has not been sustained, widespread adoption of practices to effectively mitigate nutrient runoff in the River Raisin (EGLE, 2022; Gao & Arbuckle, 2022). Effective conservation practices are often prohibitively expensive for initial implementation without considerable subsidy. In cases where cost-share is available, applicable, and accessible, social pressures and aversion to risk or change may still hinder adoption (Gao & Arbuckle, 2022). Farmers have shown a tendency to discontinue Best Management Practices (BMPs) once initial compensation programs end, highlighting the struggle to sustain these practices over time

(Surdoval et al., 2024). This suggests that the effectiveness of BMPs may hinge on continued financial and social incentives, pointing to a potential flaw in the design and long-term viability of these time-limited programs. Moreover, the one-size-fits-all approach of most federal programs may fail to account for the specific requirements of individual fields and farming operations. Such programs may not fully address the real complexities that farmers face, which can impact the adoption and success of BMPs (Roesch-McNally et al., 2018). Federal and state programs often do not meet the needs of the farmers they intend to support, applying a broad brush to producers with nuanced needs and unique considerations for adopting BMPs. Finally, incentive programs require participation in a dense government bureaucracy, which often dissuades farmers from seeking assistance for BMP adoption (Bressler, 2022). Given the voluntary nature of agricultural conservation activities, programs must be designed to meet the needs of farmers across multiple dimensions.

State Planning for Phosphorus Reduction

As existing conservation programs have demonstrated limited success in addressing HABs, federal, state, and provincial governments have recognized and responded to the need to reduce phosphorus inputs into Lake Erie. Annex 4 of the 2012 GLWQA set phosphorus concentration goals and annual load targets for each of the Great Lakes (Environment and Climate Change Canada, 2012). Phosphorus reduction targets were formally adopted by states via State Implementation Plans (SIPs) in 2016, followed by State Domestic Action Plans (DAPs) in 2018 (State of Michigan, 2018). (See Appendix A: Condensed WLEB HAB Mitigation Timeline.)

The State of Ohio is also addressing WLEB HABs through NPS nutrient pollution reduction, with the majority of WLEB phosphorus discharges originating in the expansive Maumee River Basin (Kast et al., 2021). Motivated by the 2014 Toledo Water Crisis, the State of Ohio greatly increased spending on programming to reduce NPS nutrient pollution. However, the more than $3 billion spent by Ohio since 2011 has had little effect in terms of HAB reduction (Matheny, 2018). Michigan met its interim goal of 20% phosphorus reduction though improvements to Detroit’s municipal waste treatment plant in 2010, which contributed to a 37% reduction in phosphorus loading from the Detroit River (Scavia et al., 2019). It should also be noted that this reduction occurred three years before the WLEB Collaborative Agreement was signed, but two years after the established 2008 baseline. In the time since, Michigan has achieved little in addressing its highest concentrations of NPS phosphorus pollution originating in the river Raisin watershed

(EGLE, 2022). Despite Michigan's efforts to incentivize farmers to take on voluntary agricultural BMPs through existing conservation programs, the state is not projected to meet the 2025 goals (Brooker, 2020). To make meaningful progress, a major shift is needed in the state's approach to agricultural conservation.

A Bottom-Up Approach

Michigan's Lake Erie DAP Team was established following the 2015 WLEB Collaborative Agreement, consisting of members from Michigan's QOL departments. The team developed the DAP and the Adaptive Management Plan (AMP) in 2018 and 2021, respectively, to outline a governmental planning, management, and implementation agenda for meeting phosphorus load reduction goals in the WLEB. Michigan's DAP team plays a critical role in achieving the 40% phosphorus reduction goal by 2025.In the interest of practical and durable conservation solutions, the DAP team and MDARD have convened a stakeholder advisory group to inform the state's approach with a focus on scaled-down conservation planning. The AMP identifies priority subwatersheds within the River Raisin watershed that present the greatest potential for reducing phosphorus runoff from farm operations based on observed agricultural practices and geographical features such as topography and farm proximity to waterways. AMP-driven subwatershed prioritization allows for more granular and goal-oriented planning and encourages a "bottom-up" approach, featuring more localized communication and conservation efforts (EGLE, MDARD, and MDNR 2021).

The "bottom-up" approach offers several advantages over generalized state-level conservation recommendations and programming. Outreach and planning can be done with greater specificity by individuals with more nuanced understanding of the land and its agricultural history. This has important implications for building trust and agency among producers, who often feel left behind by a government typically focused on densely populated urban areas. Taking stock of agricultural and geographical factors at a smaller scale allows BMP implementation to be targeted more precisely to areas of greatest risk, with specific practices matched to the individual field or to regions within fields. This can be interpreted as an efficiency and cost-saving benefit to the government and farmers, avoiding unnecessary expenditure in implementing BMPs where they aren't effective or necessary. Similarly, farmers may be more amenable to BMP implementation in light of a more specific and transparent government process.

However, there are significant economic and administrative challenges to this approach. The most obvious is the additional cost of conducting the work of subwatershed and farm field prioritization, whether in-house or by contracting with local entities. The multiplicative effect of splitting an existing administrative region into smaller, individually assessed regions implies a need for additional staff and administrative structures, a significant barrier within resource-constrained government agencies. Additionally, while we make the case that localized subwatershed management and BMP recommendations help to build trust with local producers, there is also a potential for disillusioned rural communities to view this effort as an expansion of the government's purview over their communities and livelihoods.

The potential benefits and challenges of the bottom-up approach led MDARD to initiate a test case of localized watershed management in a priority subwatershed of the River Raisin watershed. This effort is intended to put into action the goals laid out in the Michigan DAP and AMP, and to document lessons learned in subwatershed-focused community engagement and BMP-related outreach. Our team of graduate students at the University of Michigan (UM) School for Environment and Sustainability (U-M SEAS) was tasked by the MDARD WLEB Specialist with conducing this project, and to be especially concerned with:

1. Community member and farmer perceptions of BMPs,
2. Locality-specific barriers to farmer adoption of BMPs and potential solutions,
3. Metrics to adequately track uptake and effectiveness of BMPs, and
4. Community-centered subwatershed management plan with area-specific recommendations for BMPs.

HUC-12 Planning in Stony Creek: Project Overview

Our project seeks to facilitate sustained voluntary adoption of effective conservation practices by creating an effective model of grassroots planning at a HUC-12 subwatershed level. This project adopts an adaptive management approach grounded in community and stakeholder participation with the assumption that smaller scale, grassroots style planning will identify solutions that are pragmatic and amenable to local stakeholders. A granular assessment of the landscape can be used to better identify suites of tailored practices that will be most effective at both building and restoring overall soil health and reducing nutrient losses at a field level, and to identify the support and resources needed by those farmers for implementation. This approach considers the cultural and environmental complexities of conservation needs that have been overlooked by traditional "top-down" conservation planning at state and federal levels. While some research has delineated regional differences in effective conservation practices among Lake Erie tributary watersheds (Macrae et al., 2021), the process and findings outlined in this report are intended to be replicable at the subwatershed scale as part of bottom-up conservation planning in the WLEB.

The project focuses on the Stony Creek HUC-12 subwatershed of the South Branch River Raisin, one of the 5 priority subwatersheds identified in the State of Michigan's AMP. The area covers approximately 46 square miles in western Lenawee County, MI. Stony Creek is primarily rural agricultural land, with its largest population center, the Village of Clayton, reporting a population of 311 in 2020 (US Census Bureau, 2021). Stony Creek includes a mix of row crop farming (primarily corn, soy, and occasionally wheat and alfalfa) and animal feeding operations (cattle) that pose a potential risk of phosphorus runoff, making it a candidate for more focused conservation planning efforts. Farmers in Stony Creek have a history of mistrust of federal programs after a 2016 mishandling of CRP verifications in Lenawee County put over 1400 conservation contracts under review, with many farmers being removed from the program and required to return conservation payments (Huhman, 2017). (See Figure 10 for more information.) This context makes Stony Creek a priority subwatershed for community-based conservation planning, in that reestablishing trust at the community level is a crucial hurdle to implementing effective conservation measures.

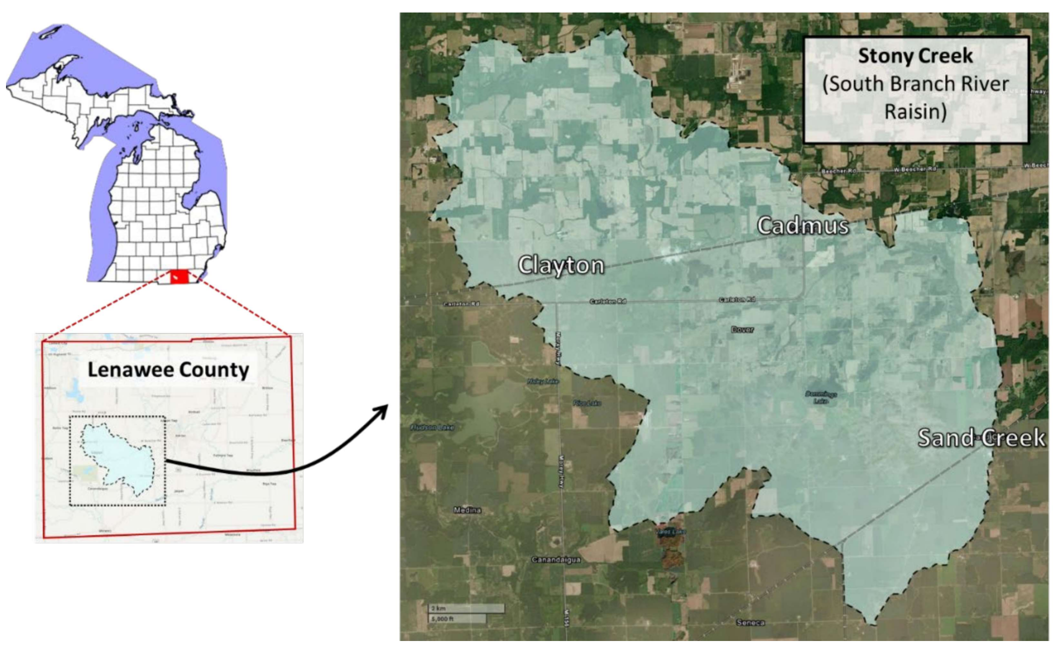

Figure 3: Stony Creek (South Branch River Raisin) is located in Lenawee County, Michigan.

Methods

The objective of the project is to leverage community engagement and technical analysis to establish a locally specific pathway to NPS phosphorus reduction in Stony Creek. More specifically, the project seeks to develop a Watershed Conservation Plan (WCP) for Stony Creek that is concise, readable, and specific to the local community and landscape. The WCP was developed through a Steering Committee of local stakeholders and informed by local interviews, analysis of geospatial data, and a literature review. Interviews provided insights into community dynamics, attitudes, and barriers to conservation. Geospatial analysis of cropland and agricultural inventories identified key areas of opportunity for recommended interventions. A literature review provided insights into current research around best management practices and efficacy of conservation policy and programs. At the core of the project is local engagement and trust building; interfacing with the community and building relationships is a critical component absent from traditional "top-down" conservation planning. Conservation planning built on trust and collaboration is necessary for facilitating effective stakeholder communication, generating buy-in, and identifying solutions that will benefit local communities through healthier soils and a robust local economy, as well as reducing nutrient loads and abating harmful algal blooms downstream.

Our Theory of Change (ToC) for this project, as shown below in Figure 3, is a two-pronged approach to achieving the project objectives. The two primary lines of effort are focused broadly on social science and technical data analysis, respectively. The social science approach includes developing relationships with local stakeholders and service providers, conducting qualitative social research in the subwatershed to identify local BMP barriers and motivators, and forming a steering committee of local stakeholders to guide the development of a locally focused Watershed Conservation Plan (see Appendix F). The technical data analysis approach includes assessing available agricultural inventory data, GIS data, and conservation program data to develop a detailed phosphorus loss risk map for Stony Creek. These two lines of effort are intertwined, as some of the technical data is obtained or contextualized through outreach and engagement efforts, and some of the social research findings play into phosphorus risk modeling. Both approaches are synthesized in our engagement with local and state agencies and in the development of the WCP. Through local distribution of the Plan, producers can better understand the barriers and motivators at play in BMP adoption in their immediate region. The plan also presents recommendations and resources for BMP cost-share programs and conservation community-building, as well as actionable metrics for tracking the uptake of BMPs throughout the area. In total, the Plan and the details of this report should assist State and local actors in achieving meaningful phosphorus effluent reductions through increased BMP adoption in pursuit of the state's reduction goals.

To meet the objectives of our project, we first selected a priority sub-watershed from among several candidates. Once we selected Stony Creek (South Branch River Raisin), we developed a network of stakeholders and potential partners internal or otherwise connected to the subwatershed. We then collected and analyzed qualitative and quantitative data through interviews, geospatial data sources, and literature reviews to inform the drafting of the watershed conservation plan (WCP) and codified recommendations to MDARD and other QOL agencies. Additionally, we assembled a steering committee of local stakeholders to guide the focus and intent of the WCP according to the needs of the local community. Lastly, we developed and finalized the WCP and a list of actionable recommendations for the State of Michigan to increase BMP adoption rates.

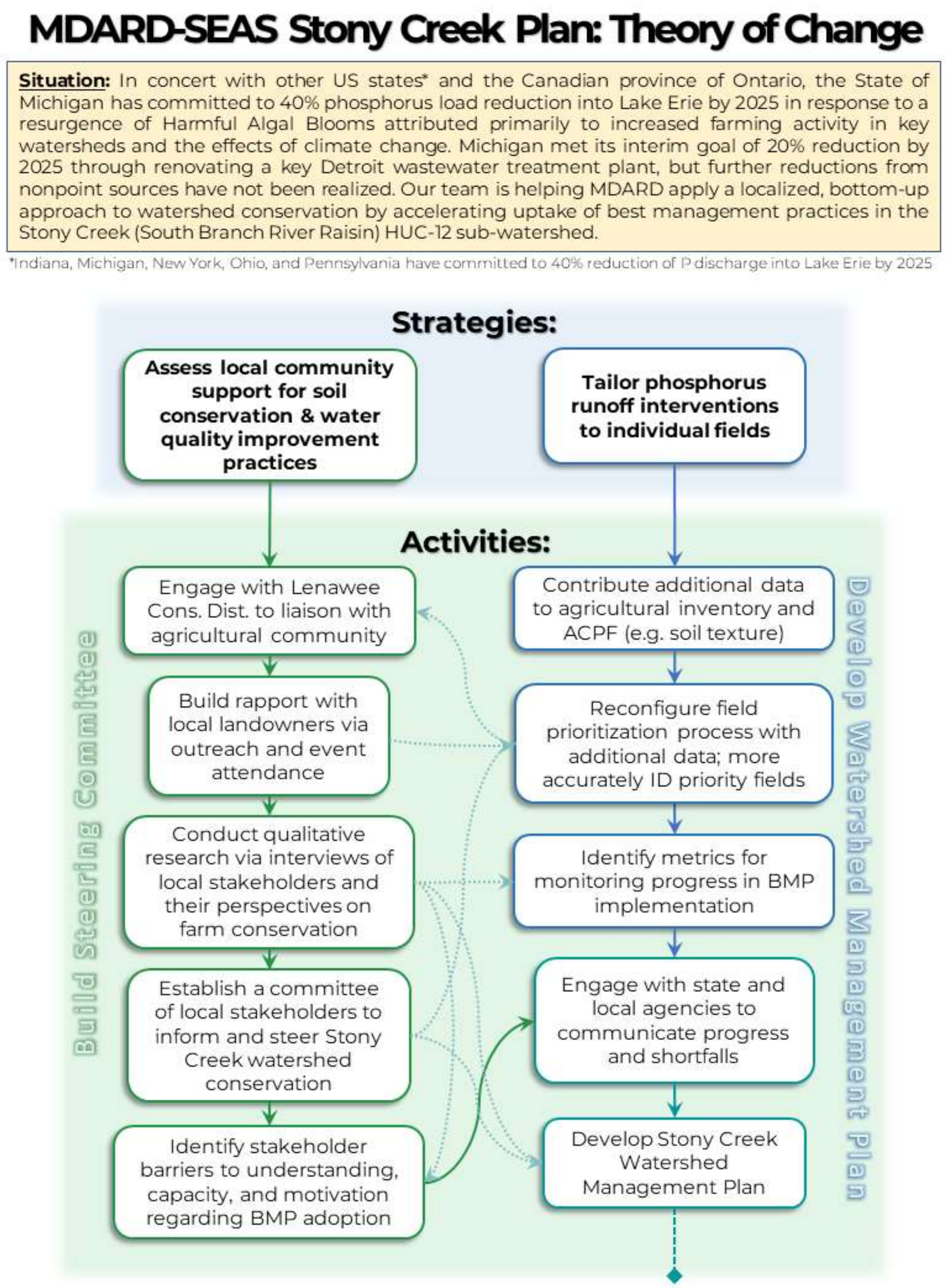

Figure 4: Theory of Change for Agricultural Phosphorus Conservation in Stony Creek (South Branch River Raisin) HUC-12. This Theory of Change approaches the task of watershed management and community engagement with a two-pronged approach, focusing on the social

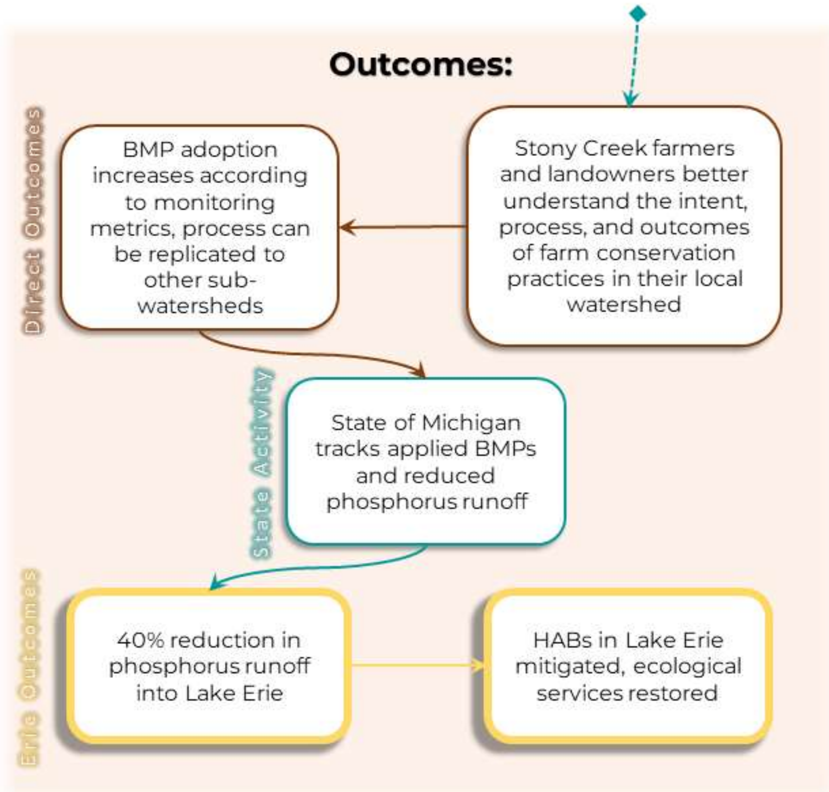

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Figure 4: Theory of Change for Agricultural Phosphorus Conservation in Stony Creek (South Branch River Raisin) HUC-12 (continued). Due to the limited nature of the project in the context of typical and enduring top-down state-level management, we have differentiated projected outcomes as direct or indirect. The Theory of Change acknowledges that while the outcomes of this project may be positive, expanded success of this model depends on many other actions by many other individuals and institutions.

Site Selection

In Michigan's portion of the Western Lake Erie Basin, 13 HUC-12 subwatersheds were identified for targeted phosphorus reduction efforts. Michigan EGLE and local conservation districts are conducting an agricultural inventory assessment to support conservation efforts with field-level geospatial and land use data in these sub-watersheds. From this data and analysis, discussed further in the AMP, four HUC-12 watersheds were prioritized based on risk of phosphorus loading to Lake Erie, completion of agricultural inventory datasets, and presence of a USGS gauge station to allow some aggregate monitoring of progress. Our team was presented with these four HUC-12 watersheds to consider for our work of "bottom-up" conservation planning (see Figure 5).

We conducted a review of the four subwatersheds to determine which was best suited for our purpose; the review is summarized in Table 1. We ultimately selected Stony Creek (South Branch River Raisin) based on several key distinctions. Stony Creek did not have a local conservation plan in place beyond the River Raisin Watershed Conservation Plan. This provided an opportunity to develop a novel community-focused plan in Stony Creek. There are several animal feeding operations within the boundaries of Stony Creek, which provided opportunities to address key sources of phosphorus loads from manure that were not present in the other sites. We also prioritized working with the Lenawee County Conservation District Office, which is relatively well-staffed, actively promotes BMPs, and is well-received by the local community.

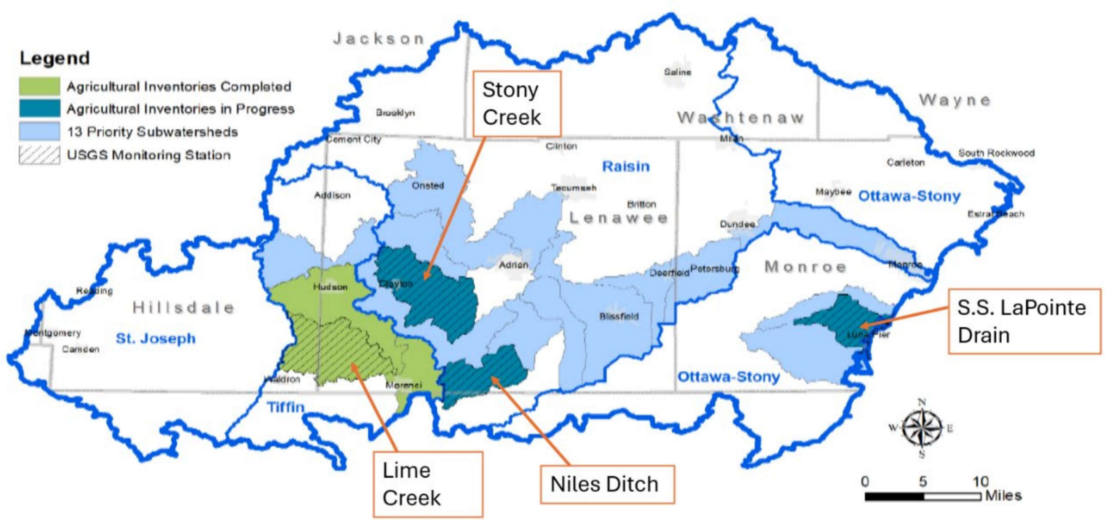

Figure 5: The 13 priority subwatersheds identified in Michigan's Adaptive Management Plan, with Stony Creek, Lime Creek, Niles Ditch, and S.S.LaPointe labeled. Agricultural inventory status was current as of summer 2023, with the Stony Creek inventory completed during fall 2023.

Table 2: Summaries of 4 HUC-12 Subwatersheds considered for this project.

	Lime Creek	Niles Ditch	S.S. LaPointe	Stony Creek
Location	Lenawee Co, Hillsdale Co, MI	Lenawee Co, MI; Fulton Co, OH	Monroe Co, MI	Lenawee Co, MI
Local Government	Medine Twp, MI Wright Twp, MI	Fairfield Twp, MI Royalton Twp, OH	Luna Pier, MI Erie Twp, MI La Salle Twp, MI	Dover Twp, MI Clayton, MI Sand Creek, MI
Agricultural Systems	Predominantly commodity row crops	Predominantly commodity row crops	Predominantly commodity row crops	Commodity row crops, dairy production
Community Structure	Rural	Rural	Rural, suburban, urban	Rural, village residential
Conservation planning	Bean Creek 319 Watershed Management Plan, 2019	River Raisin WMP, no local plan in place	LaPointe Drain 319 Watershed Management Plan, 2017	River Raisin WMP, no local plan in place

Establishing a Network of Stakeholders

Our approach to improving watershed conservation in Stony Creek was to engage with the local community in the development of a watershed conservation plan and recommendations for MDARD and other governmental institutions. By first spending time with stakeholders, we were able to establish an understanding of cultural values, economic challenges, and local politics of the community, which would then heavily inform our qualitative data collection process. From the outset we were cognizant of the challenges of this approach. As outsiders representing government and academic institutions offering solutions to a closely-knit rural community, our priority was to make connections with the local community without alienating either the team or the community members. To begin this process, we utilized connections from MDARD, Lenawee Conservation District, and University of Michigan who were trusted in the area, and who acted as our liaisons to the local community. To orient our efforts, we conducted introductory calls and farm visits with local producers and community members. Many of these initial interactions yielded additional contacts, and through this snowball process we built a network of individuals and organizations from which to draw conservation insights and recommendations.

We also utilized existing organizations' meetings to introduce ourselves and our project to the community. We attended several community events, including:

- Lenawee County Conservation District Board monthly meetings,
- Farmer Led Conservation group annual meeting and farm tour,
- Western Lake Erie Basin quarterly meeting and edge-of-field demonstration,
- Lenawee Center for Excellence annual field day, and
- Village of Clayton Town Hall monthly meetings.

Attending and participating in these events allowed our team to engage in informal, face-to-face conversations with community members representing a range of interests. These interactions and relationships were then leveraged as we began our interview process, field prioritization analysis, and Steering Committee formation within the community.

Interview Methods

To incorporate the needs and experiences of local stakeholders into the Watershed Management Plan, our team conducted interviews to gather insights from local farmers, planners, and other community members. We utilized both semi-structured and informal interviews for data collection. A less structured interview format was well-suited to the multifaceted nature of the project's process (i.e., steering committee formation, relationship building, etc.) and allowed for a range of answers and data types, giving participants more freedom to speak on topics important to them. Our semi-structured qualitative study was approved by the University of Michigan's Institutional Review Board.

Our team utilized snowball and convenience sampling in the interview process. Participants were identified by referrals from organizations such as the River Raisin Watershed Council and the Lenawee Conservation District, as well as by searching publicly available contact information for local county and village leadership and business owners. We prioritized farmers, residents, or people working in the Stony Creek sub watershed for interviews. However, when confronted with low solicitation response rates, we expanded our region to include the same demographics within roughly 15 miles of the sub watershed and to include nearby downstream communities such as Adrian, Michigan. Due to the plan's narrow focus, the research sample was not intended to be representative of a larger population, although we hypothesized that many rural communities in the American corn belt may be similar. Twelve semi-structured interviews were conducted, analyzed, and combined with many informal conversations which informed our project. Although we were unable to interview all potential categories of stakeholders in the community, we reached a saturation point in our twelve interviews where we began to hear the same themes from stakeholders, or "the point in coding when you find no new codes occur in the data” (Urquhart, 2013).

The interviews were conducted in person or via virtual video conference by one of our five team members, with an additional team member present to record and take notes. Interview audio was recorded using either a handheld voice recorder or the Zoom video conference recording feature. An interview guide was developed with a series of potential questions written to direct the conversation to topics of relevance to the Plan, including community structure and engagement, adoption of agricultural practices, and attitudes around conservation. In the guide, we tailored questions to respondents’ categorical background and area of expertise. For example, our questions for producers were different from those for business owners. The questions were open-ended and allowed room for respondents to expand on a given topic, making for a more conversational tone and atmosphere during the interview. See Appendix B for our interview guide.

Following each interview, audio data was transcribed using either Zoom, Otter.ai, or Parrot.ai. Transcripts were reviewed for accuracy and saved in a secure drive. Interview participants were each assigned a random numerical identifier for anonymization of interview data. Transcripts were then analyzed using the Dedoose software suite to identify common themes and key findings.

Steering Committee Methods

The creation and facilitation of a steering committee to inform the final watershed conservation plan was a primary objective from the project's start. The goals of establishing a steering committee were twofold: to engender community conservation participation and buy-in among the farmers, landowners, and other community members within our target subwatershed; and to develop a durable subwatershed conservation plan with representation from multiple stakeholder groups.

> Steering committee selection prioritized **producers**, **landowners**, and **residents** of the Stony Creek sub-watershed.

Steering Committee Formation

To inform the committee-forming process, we reviewed steering committee facilitation best-practices in the literature. Although the academic literature is largely concerned with steering committees in a business context, (Karlsen, 2020; Lechler & Cohen, 2009; Loch et al., 2017) we were able to draw insights from the review and from additional writings related to business management, political consensus-building, and multi-stakeholder negotiations. (Fisher et al., 2011; Stone et al., 1999) These insights included techniques for facilitating discussions among diverse stakeholders, considerations for effective committee representation, and methods for overcoming conflict and reaching consensus.[3] We drew common best practices and recommendations from among these resources to inform the committee members of the solicitation and selection process. As a result, we sought to establish a committee of five to eight members, with a majority representing conservation-practicing farm operators and a minority of other landowners, community members, and conservation experts within the geographic boundary of the subwatershed or just beyond.

We identified potential committee members via our broader outreach and interview process. Given the potential for conflicting interests and personalities among committee members, we planned to carefully consider the expertise and personalities of each potential member and how these qualities would contribute to a well-rounded and constructive group decision making process. We also initially sought to limit committee membership to those working or living within the geographic boundary of the subwatershed. However, the small geographic area was found to be too limiting for our engagement efforts, so we increased our geographic selection area to within seven miles of the subwatershed boundary to include the downstream community of Adrian, MI. We also allowed for the presence of one expert member who was not living or working within the expanded geographic area to balance the committee with a non-local perspective. These members all reviewed and approved of a committee charter, which set the rules and responsibilities of all members as well as the committee's mission and vision. A version of the charter can be found in Appendix D.

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[3] These skills and others were the subject of Professor Steven Yaffee's *Negotiation and Mediation Skills* course at the University of Michigan School for Environment and Sustainability, and the course content heavily informed our considerations in designing our own steering committee.

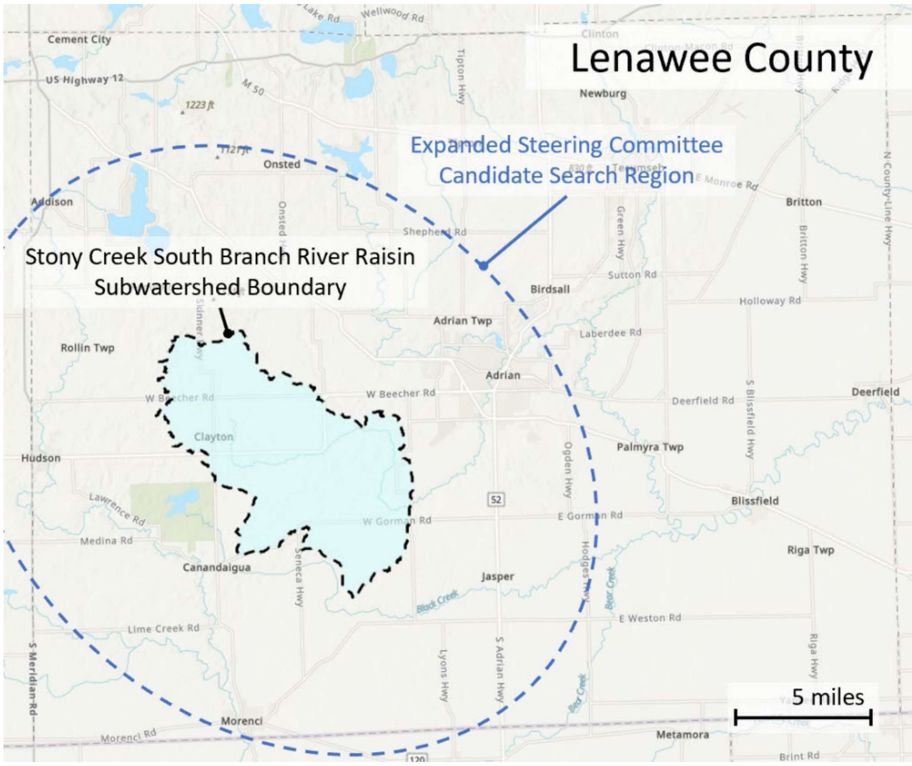

Figure 6: Expanded Steering Committee Candidate Search Region

Steering Committee and Watershed Management Plan Development

A plan outline for Stony Creek was modeled upon elements of the 2009 River Raisin Watershed Management Plan, which met state requirements for nonpoint source program funding applications through the Michigan Department of Environment, Great Lakes, and Energy (EGLE) (River Raisin Watershed Council, 2009). The steering committee first provided input on the outline with a focus on local relevance and accessibility. The committee also provided input on the content of draft sections as they were developed. Between committee meetings, the SEAS team developed draft plan sections in accordance with committee input, and updated drafts were sent to committee members for review in advance of meetings. During committee meetings, drafts of the plan were reviewed and commented upon with additional considerations and recommendations discussed for development into the plan. Once a final draft was completed and agreed upon by the committee, it was shared with the Michigan Department of Agriculture and Rural Development and the River Raisin Watershed Council, on whose website the plan was hosted.

Field Prioritization Methods

We assessed the agricultural fields in Stony Creek for the risk of phosphorus loss to identify key opportunities for intervention to reduce phosphorus loads. The field priority assessment consisted of a field-level analysis of vulnerability to phosphorus loss and an inventory of current best management practices in use. We then used this data to identify fields that pose unmitigated risk of nutrient loss and thus present areas of greatest opportunity.

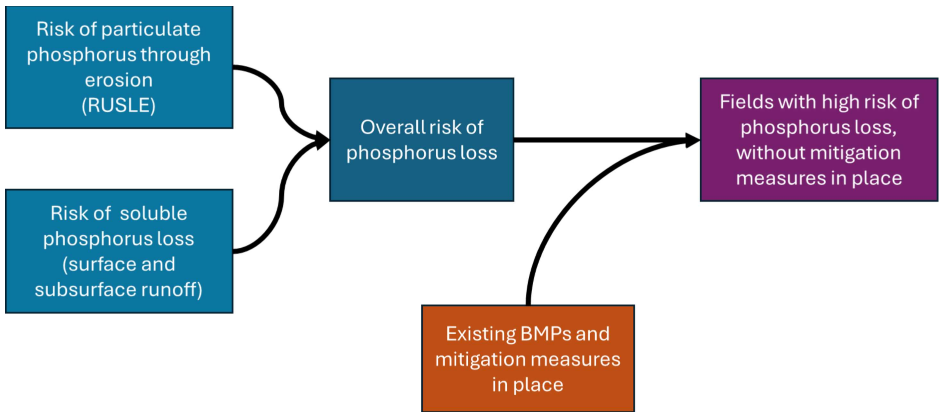

Figure 7: Priority fields were identified as those with limited BMP implementation but with high risk of phosphorus loss through erosion and runoff, presenting greatest opportunities for phosphorus loss reductions.

We used geospatial data analysis in ArcGIS Pro to conduct the risk assessment and prioritize fields. First, the Revised Universal Soil Loss Equation (RUSLE) was used to assess the risk of particulate phosphorus loss through erosion. Then, additional factors were assigned to each field to represent vulnerability to subsurface and surface loss of soluble reactive phosphorus (SRP). These factors were based on soil texture, field tiling, manure application, and distance to the nearest waterway. Finally, each of these factors were combined with the RUSLE score to give each field an overall risk score. The final risk scores were then used with BMP data to identify fields of greatest opportunity based on risk and lack of mitigating practices.

RUSLE Erodibility Assessment

The RUSLE equation is a model that predicts average annual soil loss with considerations for rainfall, landscape, management practices. Given that climate change has led to greater intensity rainfall events which can exacerbate erosion, it is critical to consider rainfall when assessing particulate nutrient loss in agricultural lands (*RUSLE - an Online Soil Erosion Assessment Tool*, n.d.). In the RUSLE equation, the average annual soil loss (A) is a function of rainfall erosivity (R), soil erodibility (K), slope length and steepness (LS), cover management (C), and conservation practice (P), where:

$$A = R * K * LS * C * P$$

For this assessment, we used raster datasets to represent each of the RUSLE factors at a field level for Stony Creek:

- *Rainfall Erosivity(R)*: Raster data was obtained from the European Soil Data Center, which uses precipitation data from a global network of weather stations and interpolates erosivity using the Gaussian Process Regression (GPR) model. The dataset provides rainfall erosivity values at 1 kilometer resolution in units of [MJ mm ha^{-1} h^{-1} yr^{-1}] (*ESDAC - European Commission*, n.d.).
- *Soil Erodibility (K)*: Soil series data was obtained from ESRI's ArcGIS Data Hub, which uses data from the USDA SSURGO database. The SSURGO data consists of data from the National Cooperative Soil Survey with soils identified by soil series type at a resolution of 30 meters. A data layer of K values was created using the erodibility factor associated with the identified soil series type (*Soil Survey Geographic Database (SSURGO)* | *Natural Resources Conservation Service*, 2023)
- *Slope Length (L) and Slope Steepness (S)*: Slope length (meters) and slope steepness (percent slope) were calculated at a 1-meter resolution from the USGS National Map digital elevation model (DEM).
- *Cover Management (C)*: Cover management factor data was derived using field management data from the Agricultural Conservation Planning Framework (ACPF) and the table of C factor values from the NRCS. The ACPF is an extensive geospatial dataset created by Michigan department of Environment, Great Lakes, and Energy (EGLE) along with the county Conservation District offices for priority sub-watersheds. This dataset includes field-level crop and tillage data, which was used to identify the corresponding C value per field using the NRCS C-factor table (*RUSLE - an Online Soil Erosion Assessment Tool*, n.d.).
- *Conservation Practice (P)*: Field slope data, along with data on terracing practices, were used to derive a P-value utilizing Karamage et al.'s study of soil erosion risk (Karamage et al., 2017).
- *Average Annual Soil Loss (A)*: Each RUSLE factor dataset, R, K, L, S, C, and P, was converted from a raster to a vector layer, with a value assigned to each field polygon using the weighted average value by area within the field. The layers were combined to a new dataset with each field having an A value based on the function of its individual RUSLE factors, R*K*L*S*C*P. These values were then adjusted to a scale of 1-100, where 1 represents zero estimated soil loss and 100 is the highest calculated value of soil loss.

Soluble Reactive Phosphorus (SRP) Risk Assessment

- *Tile Drainage Management*: Using agricultural inventory data from the ACPF database, fields were assessed for potential tile drainage based on slope.
- *Distance to Stream*: Using the ACPF data, which includes for each field the distance to the nearest water body, fields were assessed for proximity to water bodies.
- *Manure Application*: Using agricultural inventory data from the ACPF database, fields which are part of an animal feeding operation were identified for potential manure application.

Overall Risk and Field Prioritization

The assessments for estimated erosion, drainage, stream distance, and manure application were reviewed to identify fields at risk for potential particulate phosphorus loss through erosion or soluble phosphorus loss through drainage and runoff. Michigan's Agricultural Conservation Planning Framework (ACPF) contains data from 2021 and 2022 crop years on management practices in Stony Creek. The data is derived from imagery analysis and drive-by windshield surveys and includes the use of cover crops, tillage practices, buffer strips, grassed waterways, water and sediment control basins (WASCOBs), and blind inlets. To identify priority fields for intervention, fields were identified in which were not utilizing mitigation practices.

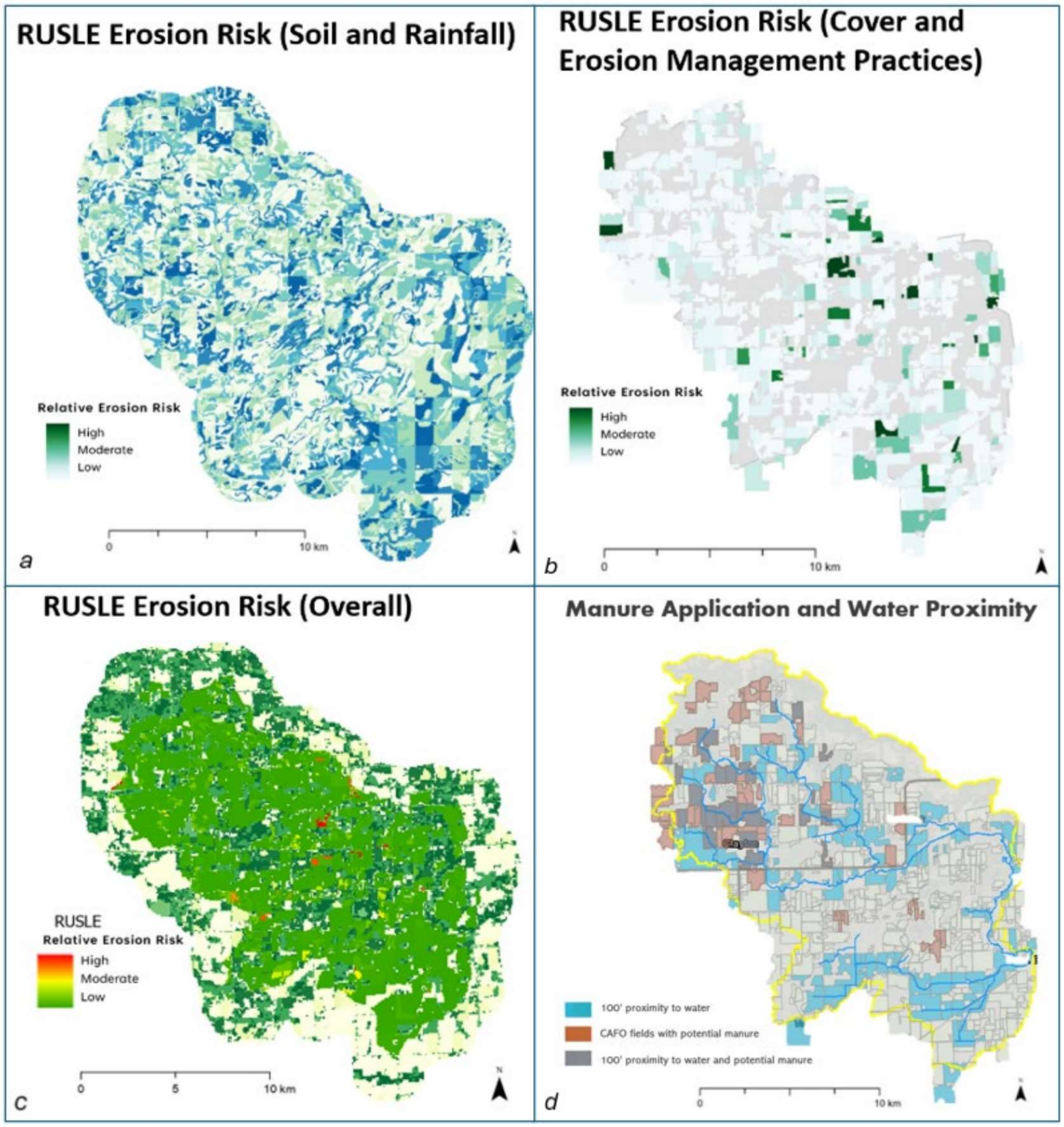

Figure 8: Mapping of phosphorus loss risk in Stony Creek based on: (a) RUSLE soil erodibility and rainfall factors; (b) RUSLE cover and erosion management factors; (c) Overall erosion risk based on RUSLE; and (d) potential manure and water body proximity.

Findings

Our findings were developed through three distinct research categories: stakeholder interview analysis (Interview Analysis), steering committee input (Steering Committee), and Stony Creek farm field analysis (Field Analysis). The three research categories produced twenty-five discrete findings between them. We analyzed the discrete findings and their contexts and organized them into three overarching themes which impact farmer BMP adoption: Socio-cultural factors, conservation program accessibility and simplicity, and financial factors. (See Appendix A for a graphical depiction of the discrete findings and the key theme analysis.) The key themes are explored in the following sections by order of importance in farmer decision-making based on the prevalence of the key theme in our research. Following the discussion of each key theme, we explore the ways in which the theme materializes as barriers and motivators in the Stony Creek context.

Key Theme One:
Socio-cultural influences and personal attitudes factor heavily in farmer decision-making around BMP adoption

Table 3: Key Theme 1 and associated discrete findings by research area.

Research Area	Finding Detail
Steering Committee	"Conservation is a mindset" - external factors may or may not influence individual choices on conservation.
	Farmers prefer conservation district programming, complexity and impersonality of state and federal programs is a deterrent.
	Farmers are weighing the costs and benefits of BMP adoption in dollars and convenience.
	Generational divides exist in BMP adoption, but younger farmers have fewer resources.
	Some people will never comply voluntarily.
	Rural areas are poorly supported or represented with funding or policy.
	State and Federal activities leave deep memories, largely negative since CRP audit.
Interview Analysis	Farmers greatly prefer Conservation Districts, especially since the CRP audit.
	BMP adoption plateaus after early adopters.
	Rural communities are averse to change.
	Generational divide hinders BMP adoption.

	Voluntary BMP adoption will stagnate without regulation and enforcement.
	Capacity of supporting agencies is limited - funding, staff, and priorities.
	Conservation practices are sometimes perceived as "less proper".
Field Analysis	High-risk fields are diverse and require different approaches.
	Several variables of field-level data are private or not collected.

Personal Attitudes

According to Steering Committee members, “Conservation is a mindset”, indicating a personal predisposition toward conservation is critical and external factors regarding BMP uptake are often elevated or minimized by farmers based on preexisting beliefs and experiences around agricultural conservation. One farmer described this clearly, “At the end of the day [implementing BMPs] is something you have to want to do.” Additionally, the interview research indicated a perception that BMP adoption rates plateau after a wave of early adopters, suggesting a link to intrinsic motivation. One interview respondent said, “We’ve reached the point where we’re not bringing more people in… we’re just not getting that last group [of farmers].” In Stony Creek and Lenawee County there is a small but active core of conservation-minded farmers. For these individuals, an intrinsic drive to protect the soil or water can often override financial or non-financial factors of adopting BMPs, though many of these farmers have been engaged in BMPs for years or decades and now see net benefits to the practice rather than cost. Conversely, others are resistant to conservation programs or practices regardless of potential financial benefits.

The bulk of funding for conservation support comes from state and federal programs, however, many farmers in Stony Creek have limited trust in these governments. Local views of “big government” are consistent with those in many rural American communities, but recent local events have further damaged trust and willingness of farmers to engage with federal and state programs. The 2016 CREP audit in Lenawee County resulted in many farmers vowing to never enroll in federal or state programs again. (See Figure 9 for additional information.) However, we found that feelings of distrust in government generally do not extend to more local agencies. Local government offices such as the County Drain Commission are seen more favorably, and there is broad trust in the county Conservation District office. One interview respondent said, “Working with the Conservation District is just a whole lot shorter and sweeter…time frame is a big advantage of working with the district [compared to federal offices].” Since most funding ultimately comes from federal programs, there must be a rebuilding of trust and leveraging of the offices that farmers are currently interested in engaging with. While some research supports the variation present in levels of trust at different scales of government (local, state, and federal) (Jensen & Piatak, 2024), as well as the role of trust in farmers’ conservation behaviors (Boyer et al., 2018); (Chang et al., 2023), there is little research combining these notions into a comprehensive study of farmer attitudes toward different scales of government in the US agricultural context. Trends in government trust cannot be generalized broadly due to the highly nuanced and complex circumstances of location-specific agricultural production. However, our qualitative research results indicate trust in government is a through-line in decision making processes in Stony Creek. Due to the county-wide occurrence of the CREP audit, we expect to find similar trends beyond Stony Creek within Lenawee County.

Socio-Cultural Factors

In Stony Creek, negative attitudes towards conservation are part of a broader social perception of proper farm management. For example, a clean, plowed field has traditionally been the ideal in the non-growing season, while leaving crop residue in fields or growing a field of mixed cover crops is considered a sign of poor management. This clean-field fallacy creates a social stigma farmers identify as a significant deterrent to BMP adoption, as supported by interview data. Farmers identified that this sometimes extends to landowners requiring renting farmers to follow conventional practices such as tillage. These ideas are also supported by the literature, where research identifies psychological factors and social norms as critical factors which influence farmers’ decisions (Espenshade et al., 2022; (Gao & Arbuckle, 2022); (Gu et al., 2023).

Effects of farmer age, on-farm generational dynamics, and landowner preferences contribute to this key finding. Farmers, and the Stony Creek community more broadly, have historically been faced with declining populations and associated reductions in government investment and economic prosperity, contributing to the general feeling of being left behind. Many younger generations are not following the farming career path like the generations before them, contributing to a phenomenon of exodus out of rural America.

“Younger” and “older” generations are somewhat arbitrary categories, as there is a wide range of ages within both categories. We heard anecdotally from one interview respondent that farmers generally continue to oversee farm operations for many years past the average retirement age, and their children, the “younger” generation, may not fully take over the farm operations until later in life, perhaps until the child’s mid-sixties. The technological advances that many BMPs require such as nutrient management, present a larger hurdle for generations that have not been exposed to such practices for extensive periods of time and the learning curve is steeper for older generations. One interview respondent stated, “How comfortable you are with adopting technology, and relying on automated systems, computers, and internet systems to be able to help you with the management of practices, particularly when you think about nutrient management and precision application, that sort of thing, there’s quite a bit of a generational divide.” Additionally, according to local farmers and stakeholders, these feelings of mistrust are held more strongly in older generations of farmers, while younger farmers may be more likely to enroll in state and federal programs and be more accepting of BMP adoption. The link between age and farmer conservation behaviors has been identified in literature. One study of farmer decision-making found that older farmers were more likely to be satisfied with their current nutrient management practices, while younger farmers more often saw room for improvement (O’Connell & Osmond, 2022), and an expansive 2022 study of climate sentiments found younger generations to be more strongly motivated by climate change (Swim et al, 2022). Another interview respondent supported this link between age and conservation behaviors with the explanation, “[BMPs] might be all well and good, but if [a farmer] looks at it and says ‘I’m going to retire in another 3-5 years, is it even worth it? I’m successful now, I’ll just be successful for another 3-5 years.’”

Barriers and Motivators to BMP Adoption Associated with Key Finding 1

Barriers to BMP Adoption	**Motivators of BMP Adoption**
Non-financial burdens	Intrinsic motivation (of some producers)
Lack of buy-in from those not intrinsically motivated to BMPs	MAEAP, Center for Excellence, and similar field days/events
Tradition/social stigma	Positive social pressures
Association of cost-share and conservation programming with government	Conservation districts are viewed more positively than state or federal offices

Generational divisions in trust, engagement, and BMP use	There are trusted local groups/actors that can be leveraged (RRWC, FLC, MSU ext., Drain Commission, Conservation District, etc.)
Risk of perceived of privacy infringement with targeted outreach	Opportunities to leverage for BMP adoption and influencing family/social connections

Personal attitudes and socio-cultural factors can present as barriers *or* motivators to decision-making around BMP adoption for farmers. For example, the presence or absence of intrinsic motivation may determine whether a farmer ultimately decides to implement BMPs on their operation. If a farmer has an intrinsic motivation or positive attitude toward the outcomes of adopting conservation practices, they are more likely to overcome obstacles such as the learning curve associated with technology, or the social pressures of maintaining a “clean field.” Conversely, a farmer that lacks personal motivation may be more easily dissuaded by barriers of technology or social pressures. Additionally, a farmer that is intrinsically motivated toward conservation practices may seek out positive social pressures by attending agricultural conservation events and interacting with other producers that are implementing conservation practices on their operations or interact with the Conservation District or other local groups that may help guide or promote BMPs. Alternatively, a farmer that lacks intrinsic motivation for conservation practices, may use less favorable interactions with state or federal programs as a reason to not attempt to engage with local groups such as the Conservation District. Finally, a farmer that is not intrinsically motivated may view their age or proximity to retirement as grounds to not implement new practices on their farm, while a farmer in a similar position that is intrinsically motivated may decide that they are more stable in their career and retiring soon, so now is the time to try something new on their farm. Our final recommendations are based in this analysis of barriers and motivators.

Key Theme Two: Simplicity and specificity of conservation programming play a large role in adoption rates of conservation practices

Table 4: Key Theme 2 and associated discrete findings by research area.

Research Area	Finding Detail
Steering Committee	Farmers prefer conservation district programming, complexity and impersonality of state and federal programs is a deterrent.
	There is no need to reinvent the wheel.
Interview Analysis	Farmers greatly prefer Conservation Districts, especially since CRP audit.
	BMP adoption plateaus after early adopters.
	Some BMPs allow for simplification of operations.
	Generational divide hinders BMP adoption.
	There is no one "silver bullet" practice to reduce phosphorus runoff.
Field Analysis	P-loss risk is variable within fields and not easily generalizable.
	High-risk fields are diverse and require different approaches.
	Mitigation approaches should vary to address soluble reactive phosphorus and particulate phosphorus individually.
	WASCOB use is generally good in Stony Creek.
	Soil test phosphorus and mass balance calculations are critical to effective management.

Simplicity in Conservation

Simplicity and streamlining in conservation programs and BMP recommendations were identified as an important counter to some of the non-financial burdens of BMP adoption. These burdens include navigating arduous online application processes to enroll in conservation programs, learning new technology-enabled equipment, and determining how to implement a specific practice effectively. One local farmer from Lenawee County shared their experience of investing significant amounts of time into applying to a cost-share program, but after several returned applications due to document formatting issues, gave up pursuing the program. This farmer was already engaged in conservation activities and was motivated to implement the conservation practices but was still deterred from pursuing funding programs. Steering committee research and interview analysis both found strong preferences among producers for Conservation District programming due to its relative simplicity and ease of access compared to similar state and federal programming. The ability to walk into the local office and work with a known, trusted staff member can help avoid time and frustration they would have to put into a more complex, online application process. Even identifying applicable support programs can be difficult if a farmer does not know where to look or if the specific requirements are complex. One farmer we interviewed explained the complexity of some state and federal programs with, "There's so many programs out there…you go down and sit at the NRCS office and pretty soon they've thrown four acronyms at you, and you don't know what any of them mean, and it's like oh, I feel like I'm in over my head here. And a lot of times [many farmers] don't continue." Again, a local, knowledgeable point of support, such as the Conservation District office, can serve as an intermediary to connect farmers with programs and is preferred to many farmers. This point is further supported by our field analysis which showed successful placement of structural BMPs, including grassed waterways and water and sediment control basins (WASCOBS), implemented as part of a streamlined program through the County Drain Commission.

Our analysis also found that the simplicity or complexity of the actual practices is pivotal in adoption. According to interviews, some BMPs are adopted primarily because of their simplifying effects on farm operations, such as fewer passes with farm equipment in the case of low- or no-till farming. One farmer we interviewed said, "[No-till farming] limits the workload quite a bit in the spring…otherwise I'd have to hire a couple more people." Steering committee members also noted well-known and established BMPs, such as no till and buffer strips, as effective means to improve soil health and water quality, indicating that a higher level of complexity of practices is not necessarily needed to address the NPS issue in Stony Creek. As one farmer stated, "There's no need to reinvent the wheel," when it comes to conservation.

Bottom-Up, Field-Level Planning

While simplicity is valued as a means to reduce barriers to BMP adoption, there is not one simple or universal solution that can address effective BMP use in an area. Solutions must be tailored to the varied environmental and social factors within a farm and can therefore be complex. Current literature also indicates that conservation BMP planning at the field level is necessary to effectively address environmental impacts. John et al. found that localized analysis allows for a deeper understanding of social and ecological factors at play in BMP adoption (2023). Local farmers indicated the importance of seeing results of their conservation efforts and of knowing that BMPs in place are appropriate to a specific field's risks. Farmers adopting BMPs with intrinsic conservation motivations must be confident that their practices will have a positive environmental impact. One farmer we spoke with discussed neighbors who had adopted the use of cover crops and filter strips years ago but became frustrated as they continued hearing about water quality issues when they see themselves and many of their peers doing the right thing. Making reductions in phosphorus losses requires field-level assessment and planning to identify specific suites of practices that are effective in addressing the field's risks and are feasible given the farm's size and financial capacity. Correctly placing BMPs is critical, as studies using SWAT modeling (USDA's Soil and Water Assessment Tool) indicate that substantial adoption of multiple conservation practices is needed to see effective change in phosphorus reductions (Scavia et al., 2017). Research also shows that field-level assessment and planning supports economic efficiency and a reduction in perceived financial burdens of BMP adoption of generalized recommendations (Pannell et al., 2014).

Tailoring and implementing field-level BMP recommendations without creating additional complexity requires competent, on-the-ground support for farmers. Individualized consultation is available through the Conservation District and, to a lesser extent, through MAEAP program verifications. Farmers expressed support for this type of on-farm support, however MAEAP verifications are limited in scope and frequency, and the limited funding and staffing capacity of the Conservation District office limits the effectiveness of Conservation District staff to adequately engage and support individual farmers.

Field analysis indicates that phosphorus loss risk is variable among fields and even within individual fields. Such risk variation is not easily mitigated with blanket prescriptions of BMPs, but often requires individualized planning. For example, no-till farming can reduce total phosphorus loss in fields at risk for erosion, however in fields at risk of soluble phosphorus loss, such as those with tile drainage, reduced tillage may be more effective, and should be paired with other practices such as cover crops and injection phosphorus application. Some fields in Stony Creek present a risk for soluble phosphorus loss through tile drainage that can be mitigated with a saturated buffer, while others experience gully erosion that requires very different solutions. In fields with accumulations of phosphorus from legacy over-applications, careful nutrient management planning is critical, and practices such as soil pH management may be needed to maximize crop uptake of soil phosphorus. In addressing these complexities to nutrient runoff, soil test phosphorus data and mass balance calculations are critical to effective mitigation by enabling dynamic and data-driven nutrient management plans at the field level.

Barriers and Motivators to BMP Adoption Associated with Key Theme 2

Barriers to BMP Adoption	**Motivators of BMP Adoption**
Conservation programs barriers to entry (interest and knowledge to identify relevant opportunities)	Conservation programs barriers to entry (interest and knowledge to identify relevant opportunities)
Historical focus on individual rather than suites of BMPs	Historical focus on individual rather than suites of BMPs
Limited understanding of and programs to address SRP	Limited understanding of and programs to address SRP
Non-financial burdens	Intrinsic motivation (in some)
Lack of buy-in from those not intrinsically motivated to BMPs	MAEAP, Center for Excellence
Tradition/social stigma	Positive social pressures

Simplicity and specificity in conservation programming can present as barriers or motivators to BMP adoption. For example, some farmers may be deterred from implementing BMPs due to the complexity of programming if they are already less motivated by the potential positive outcomes of conservation practices. On the other hand, a farmer that is more intrinsically motivated by potential conservation outcomes may overcome the barrier of complex programming in order to implement BMPs on their operation. Our final recommendations are based in this analysis of barriers and motivators.

Key Theme Three:
Financial incentives are necessary but not alone sufficient for improving BMP adoption rates

Table 5: Key Theme 3 and associated discrete findings by research area.

Research Area	Finding Detail
Steering Committee	Farmers are weighing the costs and benefits of BMP adoption in dollars and convenience.
	Generational divide in BMP adoption is real, but little support is going to younger farmers.
	Rural areas are poorly supported and face rural exodus.
	State and Federal activities leave deep memories.
Interview Analysis	Farmers greatly prefer Conservation Districts
	Motivation to adopt among early adopters is generally about hedging against risk from changing weather patterns.
	Some BMPs allow for simplification of operations.
	Generational differences in motivations and resources affect BMP uptake.
	Financial considerations are prioritized in BMP adoption.
	Capacity of supporting agencies is limited - funding, staff, and priorities.
Field Analysis	High-risk fields are diverse and require different approaches.

Financial Incentives

Financial incentives are rarely the only driver of agricultural conservation practices in Stony Creek. However, financial capacity is an important factor of BMP adoption when there is additional cost involved. This mixed role of financial support in BMP adoption is corroborated in the literature, particularly regarding commodity cropping in the US Midwest (Gao & Arbuckle, 2022; Prokopy et al., 2019; Roesch-McNally et al., 2018). The prevalence of federal- and state-funded cost-share programs demonstrate the practical role of finance in decision-making processes among farmers. Studies have also shown this to be accurate and, in support of our findings, varied depending on several factors. Pannell et al. explore the economics of conservation agriculture and find that larger farms with more resources and less uncertainty benefit the most from conservation farming (Pannell et al., 2014).

Extrapolating from Lenawee County data, the overwhelming majority of farms in Stony Creek operate as family-run small businesses, with farm fields in the subwatershed ranging from 2.5 to 392 acres (USDA, 2017). Among these farms, profit margins are reportedly slim, although economic conditions vary greatly from farm to farm. While finances play a large role in farm operations, interview analysis demonstrates that farmers in Stony Creek are weighing the costs and benefits of BMP adoption both in market terms (expenditures and revenues) and non-market terms (convenience or social stigma). One interview respondent provided insight to the complexities of costs and benefits with, “In the long term [farmers] are going to increase their yields and that’s more money in their pockets, and they’re doing the right thing environmentally. But it’s time consuming, and there’s upfront costs, there’s reduced yields in the short term.”

The capacity of farmers to bear the costs associated with BMP adoption, whether social or capital, is impacted by generational dynamics around land and capital ownership. Younger and newer farmers, although generally more motivated to implement conservation measures, are less likely to own land or have the financial capacity to pay the upfront costs of some BMPs, while older, more established farmers have more capital but may be less inclined to change practices (Bressler, 2022; Huang et al., 2019). Steering committee discussions and interview analysis indicated these factors are at play within Stony Creek. Contributing to generational issues are nationwide trends of rural exodus and the pressures faced by farmers who desire to retire, or those faced by families who are handling a deceased relative’s estate. Farmers in Stony Creek, as in much of rural America, are confronted with issues regarding farm succession and declining rural populations over the past several decades. Steering committee discussions highlighted the preference for landowners to transfer ownership to relatives, but that this is not often possible, or that it is undesired by relatives who have relocated out of the area. In Stony Creek, farmland is often sold to neighboring farmers rather than newcomers, and in many cases is then rented out, contributing to the difficulties of new farmers and their relative difficulty acquiring capital.

Financial and operational security is a strong marker of whether BMPs are seen as viable. Most farmers who are willing to adopt new BMPs need financial support or cost-sharing to do so, but programs may not offer enough to offset upfront costs or may not compensate for the perceived risk of trying a new practice. However, *positive* financial pressure is present when farmers view BMPs as methods to hedge against future risks and costs from changing weather patterns. It is also present when farmers view BMPs as cost-saving measures by reducing input costs such as fertilizer and fuel. The extent to which farmers acknowledge these costs and benefits in Stony Creek is associated with their interactions with — and preference for services and advice from —the local Lenawee Conservation District. However, distrust of government programs means that many farmers will not access available funds that could provide financial benefit. The aftermath of the 2016 CREP audit and forced disenrollment demonstrated the impact of cost-share programs and their absence. Because of this, some have a mistrust of any money received from government programs as being unreliable or a potential burden in the future. Programs offered through the local Conservation District are more trusted than through federal or state offices, but the resources offered by the Conservation District are minimally capable compared to state and federal funding streams. This is due largely to the Lenawee County Conservation District receiving minimal financial support from the state, and as a result they struggle to meet the needs of their constituent producers with limited budgets and staff.

Barriers and Motivators to BMP Adoption Associated with Key Theme 3

Barriers to BMP Adoption	**Motivators of BMP Adoption**
Limited financial capacity of newer/younger farmers	Targeted support of new/younger farmers can have greater and longer-term impacts
Limited funding of local groups (i.e. Conservation Districts)	Existing programs offering education and up-front cost support
Failure to recognize risk posed by climate change	Opportunities to leverage Conservation Districts to support field-level planning for affordable and effective BMPs

The incentive aspects of BMP adoption can present as barriers or motivators, whether financial or otherwise. For example, younger farmers who may be more motivated by the long-term positive outcomes of implementing conservation efforts on their farm may be more limited compared to older farmers in terms of financial capacity or practicable acreage. Additionally, individuals may value the non-monetary aspects of BMP adoption (time doing paperwork, energy in learning new practices, etc.) at different rates relative to the cost-share amount. However, for younger producers who are more interested in agricultural sustainability and BMP adoption, specialized financial assistance may offer the most bang-for-buck in terms of adoption rates. Our final recommendations are based in this analysis of barriers and motivators.

Figure 9: 2016 Lenawee CRP Review

2016 Lenawee CRP Review

Farmers across Lenawee County identify a county-wide, 2016 CRP audit as a pivotal moment for conservation practices in the area. Lenawee County experienced steady growth in adoption of conservation practices through the 1990s and early 2000s, with up to 9% of the county's farmland in CRP conservation (USDA, 2017; USDA FSA, 2024). In 2016, an audit held every CRP contract in Lenawee County under review, 1,425 contracts in total, with farmers' payments held for a year or more until reviews were completed (Huhman, 2016). According to Michigan Farm Bureau's *Michigan Farm News*, the impetus for the audit was partly "confusion over whether or not filter strips can be placed along drains" News" (Bednarski, 2017). Some local farmers reported the review also included measurement of CRP-funded filter strips to verify they met the 50 feet minimum width, and others reported that contracts were terminated over language that had been changed after original agreements were signed (Huhman, 2016). In March of 2017, with many contracts still under review, farmers were faced with the decision of whether to invest money in maintenance of their CRP land, as is required in their contracts, or preparing fields for crops. The review process and clarification of CRP contract language further was drawn out by ongoing vacancies of leadership positions at the USDA following the transition of presidential administrations. The review resulted in some contracts being terminated, leaving farmers held accountable for repayment of previous CRP payments, and with many other contracts ended due to farmers' uncertainty of whether their CRP land upkeep would be compensated (Huhman, 2017). According to local farmers, of those who finished their contracts, many did not, or insist they will never, enroll in the program again. This loss of CRP land in Lenawee County is evident in annual payment dollars reported by the USDA, which fell nearly 50% from the 2016 to 2018 crop year. Some of this loss can be attributed to cuts in program funding, however a comparison against surrounding counties shows a distinct drop in Lenawee relative to others in southeast Michigan (see Figure 7) (USDA FSA, 2024).

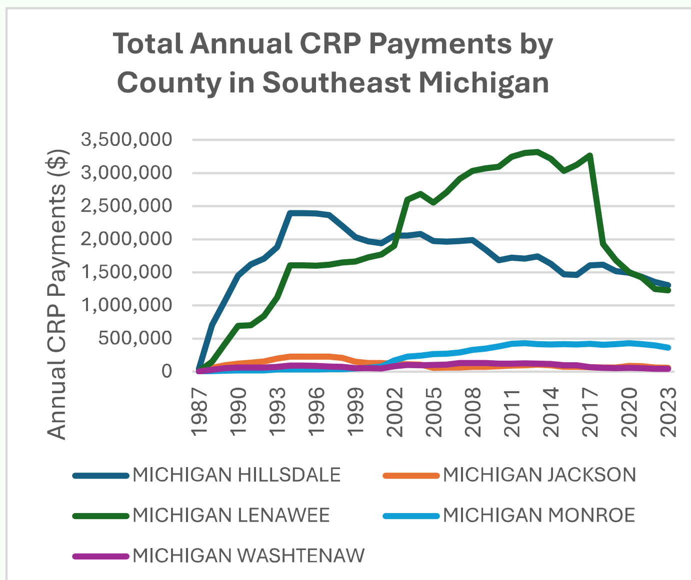

Figure 10:Annual CRP total payments by county

With this event in mind, it is important to recognize that historically there has been a willingness of Lenawee farmers to adopt BMPs. More importantly, the memory of the incident is strong with residents and poses a major hurdle to state and federal conservation efforts that must be addressed.

Discussion

Limitations to Research

We faced several limitations relating to the availability and procurement of data during our research. Our work was largely informed by semi-structured interviews and informal interactions with community members and stakeholders; while this style of information-gathering was crucial to our research and offered personal insights into the lived experience of local producers and residents, it presented some drawbacks. The small area (roughly 45 square miles) and rural demographics posed difficulties in building relationships and establishing trust with local stakeholders. As outsiders, we faced difficulty finding and establishing credibility with community liaisons, and as students we faced further challenges with credibility as well as the transience of our engagement. We were able to mitigate these challenges through continued presence and face-to-face interactions at events such as farmer field days and Conservation District meetings, and with introductions through known community connections. However, these constraints led to difficulty in identifying willing participants for interviews and steering committee membership.

Our interview research was limited by having only 12 participants, which included individuals from within and outside of the Stony Creek subwatershed. Despite the small sample size, interviews were information-rich with a minimum hour in length. Interview candidates were identified though snowball sampling, which allowed us to tap into informal networks of farmers but resulted in participants who were already engaged in agricultural conservation. While we acknowledged this selection bias early in the project design and found it unavoidable within our time constraints, it is a significant factor in the applicability of our findings. However, individuals that we interviewed and spoke with informally were largely local farmers who were well-established in the community, had been involved in conservation and agriculture for decades, and could speak to their own numerous interactions with non-conservation-minded farmers in the area.

We had difficulty and delays in identifying steering committee members who were local to the subwatershed, interested in participating in planning, and had the availability to meet. After two initial members left the committee, only three individuals participated in the development of the Stony Creek Watershed Conservation Plan. While we did not explore the reasons for the limited interest in the committee among those invited, we suspect there is a level of research fatigue among the stakeholders in this area. Both individuals who left the committee cited preexisting engagement commitments or poor experiences with previous conservation committee work. Even with a streamlined committee there was difficulty in finding common availability among the student committee coordinator, notetaker, and committee members, which limited the number of face-to-face planning meetings. The small committee size limited the breadth and depth of input the committee provided, but the input from the committee was highly consistent with interview data as well as information from informal interactions with community members.

Geospatial analysis was limited by the data available through the Agricultural Conservation Planning Framework and Agricultural Inventories collected and compiled by Lenawee Conservation District and EGLE, respectively. The assessment of phosphorus loss risk included consideration of current practices. Cover crop planting, tillage practices, and spring residue were determined visually in drive-by assessment of fields. However, the risk assessment was limited to farm- and field-level data from 2021 and 2022. Also, some fields did not have agricultural inventory data as they were not visible in the drive-by assessments, and the accuracy of data from fields which were included were not verifiable after the fact. Because of these limitations, the application of this analysis is presented as a guide and is not necessarily meant to be prescriptive.

The limited timeframe and budget of this project posed limitations to the overall depth and scope of work. Our project hinged on community engagement which, to be successful, requires connecting with community members and stakeholders and establishing relationships. This process ideally would take place over more time than our project allowed. Conservation planning and research at a broader level generally operates on larger budgets, such as current conservation planning of the nearby Wolf Creek watershed taking place over several years with contracted external support, or more extensive research efforts into BMP adoption by Dr. Jay Martin at Ohio State University operating on a multimillion-dollar budget. Given the limited timeframe of our project, our findings and recommendations should be considered in the context of longer-term, adaptive management; our recommendations are based on our findings at this time, but they may need to be adapted with new research and as new barriers and opportunities arise.

Parallel Efforts

It is important to acknowledge that our work is taking place among other parallel or overlapping efforts not directly addressed in our findings and recommendations. Some of these are also associated with Michigan's DAP plan, such as the WLEB advisory group working to advise the DAP, agricultural inventory analysis of priority subwatersheds by EGLE as a tool for conservation districts, and work by the Alliance for the Great Lakes to quantify costs of meeting phosphorus goals through BMP adoption. Other efforts include a program through Ducks Unlimited to fund wetland restoration and purchase of easements by groups such as The Nature Conservancy. A project is currently underway through the Graham Sustainability Institute's Water Center at the University of Michigan to catalogue all conservation efforts and programs in the WLEB, concluding in December 2024, which will provide a more comprehensive list of these efforts. The outcomes of these and other similar efforts should be considered in future review of our recommendations and adaptation of the Stony Creek Watershed Management Plan.

Institutional Barriers

This project considered conservation programs directly impacting growers but did not seek to address broader institutional factors. The food processing and ethanol industries continue to drive demand for commodity crops, placing pressure on producers to prioritize yields. Crop insurance and subsidy programs through the farm bill reflect this with a focus on maximizing commodity crop production. Additionally, Michigan's MAEAP, a major component of the State of Michigan's conservation programming, has had success in engaging farmers in environmental-friendly practices but does not directly address nutrient loading and water quality. Another key factor we did not address is the issue of variable funding over time. Funding decisions at state and national levels can change with government administrations, creating an inherent lack of consistency in program funding that hinders long-term planning. These are critical factors that ultimately must be considered to have positive, lasting environmental outcomes; they were not, however, in the scope of our project.

Applications Outside of Stony Creek

Our process of data collection and analysis was intended to identify factors specific to the Stony Creek subwatershed, to support watershed management planning at a smaller-scale, HUC-12 level. We were able to work with some individuals in and nearby Stony Creek to identify the relevant barriers and motivators to inform our recommendations. However, we had difficulty collecting information specific to Stony Creek, especially relating to social and community factors. While geospatial data could easily be parsed by geographic boundaries, local communities and jurisdictions do not align with watershed boundaries. Data such as conservation program enrollment or demographics is available only at the county or township level. Even in interviews, residents of Stony Creek spoke of their engagement in communities such as churches, schools, or town councils, which are not specifically bound the physical subwatershed. Our process was made easier by the fact that the Stony Creek subwatershed somewhat, although not exactly, aligns with Dover Township, and is completely within Lenawee County. The challenges in collecting HUC-12 level data could exacerbated in similar planning of other subwatersheds, such as Lime Creek and Niles Ditch of the River Raisin watershed, which span across county and state boundaries.

Because of the limitations of HUC-12-specific data and findings, many of our recommendations for Stony Creek can broadly apply for all of Lenawee County, but not necessarily for other counties. Lenawee has had a history of strong farmer engagement with the Conservation District Office and has been limited by funding in its ability to adequately staff and leverage this trust. Other counties likely have different experiences and different levels of funding. Additionally, fallout from the 2016 county-wide CRP audit stands as a unique barrier that is common across Lenawee. While our specific findings and recommendations may not be broadly applicable to the entire WLEB, the process of community-informed planning used in our project can serve as a model for identifying relevant solutions for phosphorus reductions in other counties and subwatersheds.

Recommendations

While agricultural BMP adoption is critical to reducing phosphorus loads and thus addressing Lake Erie algal blooms, many of these practices can benefit producers through improved soil health and reduced inputs and costs. By and large producers feel a deep connection with the land, a sense of responsibility to do right for the next generation, and pride in working with the land to produce food. This ethos has the potential to serve as a strong foundation for conservation and sustainable agricultural practices, given the right support and messaging. To help overcome barriers to adoption and increase participation in conservation activities, we have developed a set of recommendations derived from the identified barriers and motivators. These recommendations are intended to help promote and advance conservation agriculture and BMP adoption at the HUC-12 subwatershed level, as well as to inform actors at both the state and local level.

1. Increase and stabilize funding and support for the Conservation District Office

The Lenawee Conservation District (LCD) has a history of successful engagement and promotion of conservation programs, yet its effectiveness has been stymied by underfunding and declines in staffing. We found that the Conservation District (CD) is the preferred avenue of conservation support among farmers in Stony Creek. Therefore, a primary barrier to BMP adoption is inadequate funding and staffing for Conservation Districts. Established trust with CD offices is an enabling factor to BMP adoption, and an increase in support would further advance participation and trust.

1.1. Conduct needs-based assessment to determine a necessary increase in funds to match increased staffing level

The state and LCD should collaborate and conduct an assessment to determine a necessary increase in funds and staffing at the CD level. Compared to surrounding counties in southeast Michigan, LCD has significantly fewer technicians and specialists. Currently, LCD has three district staff members while some surrounding counties have more technicians than LCD has employees. The LCD staff, though limited in number, currently hold a wealth of experience and understanding of the surrounding community and local history. It is imperative to build up staffing in the immediate future to allow knowledge sharing and the establishment of trust with new staff. Local producers voiced their preference to work with the Conservation District office, and effective planning for conservation must identify and build on what is currently working; in this case that is resoundingly the local-level action of the conservation district office.

1.2. Allocate a portion of current state/federal funding to locally administered conservation programs that can be streamlined and tailored to community's needs

Local CD staff understand what motivates local producers and what has or has not worked in the past. Distributing funding through the CD office allows for funds to meet local needs and to streamline the process of getting support where it is most needed. For example, the LCD's current local program to reduce soil test phosphorus threshold levels for fertilizer application has provided the opportunity for producers to reduce phosphorus applications on a portion of their fields to monitor the yield impact, while being reimbursed by the conservation district for losses incurred. With additional funding the office can exercise ingenuity to find new solutions that work and meet the needs of producers.

2. Improve accessibility and simplicity of conservation programming

There are many complexities and deterrents within current conservation programming, including technical complexities of certain BMPs and the bureaucratic and arduous application processes. There are also barriers regarding the burden of time and money that factor into BMP adoption. These barriers to BMP adoption in Stony Creek should be addressed via efforts to simplify programs and grant applications. Our research shows that even when producers are familiar with different BMPs, there is a disconnect between knowledge and BMP implementation. The following additions to conservation programming would simplify the process and improve accessibility.

2.1. Provide producers with a "one-stop-shop" for conservation programs

Program complexity was identified as a key barrier to BMP adoption in Stony Creek. While funding may be available to offset costs of BMPs, difficulty in identifying funding sources, deciphering prerequisites, and navigating application processes can keep producers from accessing those funds. A single, knowledgeable conduit to those programs can simplify the process. The LCD has an established trust with local producers and can serve in that role but needs the staffing and program knowledge to do so. Not only is funding hindering the performance of CDs, but training and education sharing should improve. Standardizing the knowledge base, implementing a system for knowledge transfer, and improving training and resources will all enable CD staff to be an effective one stop shop. This could also manifest as a website or online platform offering access to details about grants, programs, contact information, and more. Specifically, this webpage could host specific links to recommended BMPs for Stony Creek producers, relevant cost-share programs, instructions for application, and FAQs. The informational webpage would complement LCDs' official website, providing an extra resource to local producers.

2.2. Offer individualized, field-level support to farm conservation planning

The diversity of soils, land histories, topography, and hydrology of a given field necessitates a field-level approach to planning the most effective suite of BMPs. Additionally, the social factors that dictate a producers' capacity or interest to adopt those practices are equally complex. One-on-one support is critical to identifying solutions that are both effective but also acceptable to the producer. Local field technicians are in a unique position to have the technical knowledge to advise on BMP uptake, local understandings of social barriers, as well as holding a level of trust that is not present with outside field support.

3. Increase information and education efforts in Stony Creek concerning BMPs and producer-led events

Information-sharing and education efforts can be key contributors to the success of BMP adoption in Stony Creek. BMPs are conceptually well-known to producers, yet BMP uptake currently lags in Stony Creek. Barriers, such as misinformation stemming from limited education, could see enhancements through greater backing and refinement of ongoing initiatives. Improved and expanded producer-led events, along with university research partnerships, were found to be motivators of BMP adoption.

3.1. Producer-led events

Producer-led events, specifically Center for Excellence and events put on by the Farmer-Led Conservation Group and Michigan Association of Conservation Districts, were found to enable BMP adoption within our research. These events enable BMP adoption because they provide producers with the opportunity to discuss conservation practices, specifically the benefits. These events are held both annually and bi-annually and consist of informational sessions and updates from producers and researchers working in agricultural conservation. There are two different approaches to increasing these events that MDARD or CDs can use: Attract more producers to these already existing events and/or increase engagement opportunities within Stony Creek on a more frequent and less formal basis. More frequent events would provide producers with the space for engagement and encourage discussion about water and soil health.

4. **Enhance avenues for collaboration between producer communities, trusted organizations, and stakeholders to engage with cost-share policies**

MDARD and the state should host events and workshops that help producers to stay informed regarding cost-share programs. Introducing opportunities for collaboration would address many barriers that were found. There were specific barriers found regarding trust between producers and government programs, and collaborating with local producers would likely lead to willingness to adopt BMPs. Not only would it be beneficial for producers to be part of decision-making regarding cost-share policies, but there are many trusted organizations that can provide useful input, including the River Rasin Watershed Council, MSU Extension, and more. These organizations were found as motivators to BMP adoption, and these organizations would provide more expertise pertaining to these policies and programs, ultimately resulting in collaborative cost-share policies.

4.1. Financial planning and management

Finances play a major role in trust and willingness to participate in BMP adoption. MDARD and the state, in collaboration with CDs, should offer financial planning and management workshops to help producers, organizations, and stakeholders understand budgeting, cost estimation, fund allocation, and financial reporting related to cost-share programs would strengthen relationships and lead to transparency. These workshops and events should be held annually to keep producers informed on decision-making regarding funding and finances.

4.2. Partnership development

MDARD and LCD should facilitate partnership development between producer communities, trusted organizations, and the state government by identifying common goals, aligning interests, and fostering mutually beneficial relationships. Encourage joint project proposals and collaboration on cost-share initiatives. This would improve trust and relationships between the important stakeholders in BMP adoption.

4.3. Networking events

Hosting networking events such as conferences, forums, listening sessions, or roundtable discussions can allow producers, organizations, and stakeholders an opportunity to connect, share experiences, and explore potential collaborations related to cost-share initiatives. Giving space for collaboration would provide opportunities for transparency and openness regarding possible cost-sharing programs. These networking events would help improve relationships and build trust between producers and the state government.

5. Develop a strategic approach to attract and retain younger producers in rural farming communities

Our findings show that the new generation of producers are more inclined to participate in agricultural conservation practices, but the transition between the aging producer population and new generation is difficult. Developing a plan to attract and retain the new generation of producers in rural communities would positively advance the transition of farming generations. A specific barrier that this plan would address is the lack of support and capacity for younger producers. Furthermore, the plan would provide an opportunity to leverage younger producers for greater long-term impacts, which was found to be a motivator to BMP adoption. The economic success of communities in and around Stony Creek can help retain populations as well as support robust markets, supporting producers in turn.

5.1. Establish engagement opportunities for future producers

The LCD and township should engage with groups such as Future Farmers of America, 4H, and the Lenawee Career Tech Agri-Tech program to promote conservation agriculture for future producers. Invest in building interest in farming careers and establish a mindset of conservation in youth to support future generations of leaders in agricultural conservation. Identify programs supporting new producers, with land acquisition and mentoring, such as the Michigan FarmLink Program currently operating in Washtenaw County.

5.2. Grant opportunities

Municipalities in and around Stony Creek should identify and apply for grants through Michigan's Office of Rural Prosperity to support local communities. One specific grant is the Rural Readiness Grant Program, which specifically provides funds to support capacity initiatives and collaborative planning. Grants like this could provide Stony Creek with assistance in planning for the future, and this would include planning a strategy to attract and retain young producers within Stony Creek.

Conclusion

The Western Lake Erie Basin has been regularly impaired by toxic algal blooms for decades, which have increased in scale and intensity over the years. Though there are many factors influencing HABs in the WLEB, agricultural runoff persists as a major source of phosphorus loading that requires action to meet the State of Michigan's goal to reduce phosphorus loading into Lake Erie by 40%. However, the voluntary and incentivized approach to BMP adoption is not on track to meet these goals in its current form.

We chose the Stony Creek sub watershed, a priority HUC-12 as defined by the State of Michigan's Adaptive Management Plan, as a case study to better understand best management practice adoption from a historic, field-specific, social, political, financial perspective and to explore new considerations for conservation planning in the WLEB. We researched farmer decision making and considerations of conservation farming through literature review, conducting stakeholder interviews, facilitating a steering committee, and analyzing field data.

- Our research resulted three major themes: Socio-cultural influences and personal attitudes factor into farmer decision-making around BMP adoption
- Simplicity and specificity of conservation programming play a large role in adoption rates of conservation practices
- Financial incentives are necessary but not alone sufficient for improving BMP adoption rates

These themes led to five major recommendations to lower barriers and leverage motivators to BMP adoption in Stony Creek.

- Increase and stabilize funding and support for the County Conservation District(s)
- Improve accessibility and simplicity of conservation programming
- Improve education and information efforts in Stony Creek, producer-led events, university initiatives and research

- Enhance avenues for collaboration between producer communities, trusted organizations, and stakeholders to engage with cost-sharing policies
- Develop a strategic approach for retaining and attracting younger farmers/new generations of producers to rural and agricultural communities in the long term

Limitations to our study include availability and access to data, time limits and credibility constraints, and selection bias in our interview participants and steering committee members. Additionally, our findings are specific to the context of the Stony Creek subwatershed. However, the process of community-based planning and research provides value and can be applied elsewhere, especially in Lenawee County and southeast Michigan.

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Appendix A: Auxiliary Information

Findings from Information Gathering & Analysis Activities: Steering Committee, Interviews, and Field Level Analysis

State of Michigan Condensed WLEB HAB Mitigation Timeline

1970s

1972: CWA and GLWQA regulate point source P discharge into WLEB

1980s

1980s: Lake Erie clears up, ecosystem services resume

1990s

Mid-1990s: Resurgence of WLEB HABs

2000s

2008: Retroactive baseline P loading year for 2015 40% reduction goals

2010s

2010: Detroit waste treatment plant significantly upgraded
2011: Worst WLEB algal bloom in recent memory
2012: GLWQA Annex 4 sets Great Lakes P loading and concentration goals
2014: Toledo toxic HAB & water crisis, ~400,000 without water for 3 days
2015: MI, OH, Ontario sign Collaborative Agreement, set reduction goals of 40% by 2025
2016: MI State Implementation Plan written toward achieving Agreement goals

2018: MI Domestic Action Plan sets path for MI QOL agencies

2020s

2021: MI Adaptive Management Plan establishes adaptive processes for P reduction efforts
2023: First annual State of the Western Lake Erie Basin conference held in Adrian, MI
2024: Stony Creek watershed management plan proof of concept complete

Appendix B: Interview Research Documents

Interview Guide

Semi-Structured Interviews with Stakeholders and Potential Steering Committee Members

Introduction

Hi, my name is [name] and I'm a master's student at University of Michigan School for Environment and Sustainability. I am working with a group of 4 other master's students, with the Michigan Department of Agriculture and Rural Development, on local, community-based conservation planning. Thank you so much for taking the time to speak with us today.

As we mentioned in our initial email(s), we are working to build a local conservation plan for the Stony Creek sub watershed of the River Raisin. Stony Creek sub-watershed covers most of Clayton Township and part of surrounding townships in Lenawee County. We are talking with folks about their experience with agricultural conservation and best management practices in the community. We would love to hear about your experiences and any thoughts or suggestions you have. We would like to use this information and, in collaboration with you and other community members, co-design a conservation plan with farmers and neighbors in the area.

Before we get started, are there any questions you have for us or our project?

Do I have your consent to record this conversation?

This recording will only be used to help with data collection and will not be shared with anyone outside of our research team without your permission. Any identifiable information from this interview will be anonymized and remain confidential unless you provide explicit consent to share.

Jump in at any time if you have any questions or concerns as we go. Feel free to skip any questions you aren't comfortable answering or stop the interview at any time.

Interview Questions

I understand that you own/manage/farm/ work with land in this area (refer to map). Is this correct?

1. Community questions (All Respondents):

a. We'd like to start off by learning a bit about the local area and community. What do you consider your local community to be? (Or: What communities do you consider yourself a part of?)
b. What do you love most about this area? What makes your local community feel like home to you? What are you most proud of?
    i. Are there any community events or activities that you participate in and look forward to?
    ii. Is there anything you would change or improve in your local community if you could?
c. Is there a time you can think of when the community came together in the past to address a local issue?
    i. (If yes:), Could you describe this?
    ii. How did this work out?
    iii. In hindsight, is there anything you think could have been done differently to address this issue?
    iv. (If not:) Why do you think this is? Is it because there hasn't been an issue that needs addressing, or are there any other reasons?
    v. Why/why not?

Role-Specific Questions (Farmers / Landowners / Business Owners / Orgs/Agencies/Local Leadership)

2. Farmers:
    a. Could you tell us a bit about your farming operation? (Follow-up questions if needed:) You farm [X crop], I believe? How many acres? How long have you been farming? (Do you own/lease/rent out land to farm?)
    b. Do you use any conservation practices in your operation (*prompt if needed:* such as nutrient management, filter strips, cover crops, or no/low till)? If yes, could you please explain a bit more what kind of conservation practices do you follow?
        i. What factors/motivations influence your use of [each practice they mention]?
        ii. What has made it difficult? What has made this easier? Do you plan to continue? Why or why not?
        iii. Have you experienced issues with nutrient loss or soil erosion in your fields? Did you take any steps to mitigate it? (*prompt if needed:* Can you describe what you did, how it worked?)

c. Do you talk with any of your neighbors or other community members about farm conservation? How do those conversations go? Do people you speak with have generally negative or generally positive feelings towards conservation measures?
d. In your experience, has the tone of these conversations or views of conservation changed over the years? Could you tell us a bit about that?
e. In taking a local (sub watershed/township level) approach to conservation planning, as we're doing with this project, who do you think is important to have a voice in local conservation planning?
f. Who do you see as the major leaders in conservation in the area (environmental and otherwise)? Do you see yourself/do others see you as a leader in the community?
g. Who are the early adopters for conservation?
h. Are you involved in any conservation efforts off your farm? Can you tell us about what you do?

3. Landowners (Non-farmers)/Business Owners:
    a. Could you tell me a bit about yourself and your [business or land use]?
        i. How long have you or your family lived in this area?
        ii. What kind of business do you own? Where is it located? Do you have many local customers?
        iii. What type of property do you own or rent? Where is it located? How is it used?
    b. What are some of the biggest challenges you face with your business? Are any of these challenges related to environmental issues? (*Prompt if needed:* issues such as water quality issues, fouled water channels, chemical odors, other conditions which might limit land use or dissuade customers from coming in.
        i. Considering local water quality in this sub watershed, are there any farm operators, local businesses, or other community members we haven't already talked about who you think have a stake in conservation efforts?
        ii. Based on your experiences with these challenges, what do you see as the highest priority environmental issues in the area/community?
        iii. Alt if answered: Have you seen or heard of other businesses in the area that face similar challenges to "x"?

iv. Are there any different challenges related to local air, soil, or water quality that affect other people or businesses in this community?

c. How do farm or land conservation measures impact you/your land/your business (e.g. agricultural practices, conservation district programs, etc.)? Are there any conservation regulations or incentives that have impacted you?
    i. Have you experienced any benefits from any conservation programs or measures?
d. Who do you see as the major leaders in conservation in the area (environmental and otherwise)? Do you see yourself/do others see you as a leader in the community?
    i. Who are the early adopters for conservation?

4. Agencies/gov officials/organizations:
    a. Could you tell us about your role and the work you do with [agency/org]?
    b. Can you tell us a bit about the work that your office/agency/org does?
    c. Can you tell us about any conservation initiatives/work your organization is doing?
        i. What conservation measures that you've worked with have been effective?
        ii. Are there any measures or initiatives you've tried that haven't been successful? Why do you think they didn't work? Could they have been improved in any way or expanded to be more successful?
        iii. What role (if any) does the issue of phosphorus runoff play in these measures?
    d. What conservation measures do you see being taken in the community?
        i. What impact have they had? How effective are they?
        ii. Do you have any ideas of how these could be improved (if they are not working) or expanded on (if they are working)?
    e. Have you heard/received any feedback from community members regarding conservation techniques/measures? Do you have a sense of what attitudes people have locally towards conservation?
        i. What factors do you think most influence these attitudes?
        ii. How have you seen attitudes change over time in your role?
        iii. Have you seen any efforts successfully shift attitudes (for or against conservation)?

5. Desired Outcome Questions
    a. There are many different reasons that farmers may take up conservation practices (e.g. limit risks to crop yields, reduce spending on irrigation or nutrient application, mitigate soil erosion and nutrient loss, and reduce farm impacts on local water quality). In your experience, are there any particular conservation practices that are especially useful in this area specifically (based on local conditions and challenges)? Any that have not received enough attention?
    b. Can you think of any barriers that make it difficult for local groups/community members to address environmental challenges such as water quality or soil erosion? Do you have any suggestions of how to overcome these barriers?
    c. [Optional question if interviewee is good potential SC member] We are ultimately trying to bring together a steering committee of local stakeholders and community members to lead conservation planning efforts for the Stony Creek sub watershed area. Would you be interested in participating in this?

Wrap-Up

Is there anything else you'd like to share that we haven't covered yet?

Do you have any additional questions for us?

Closing

Thank you for taking the time and effort to sit down and talk with us today! Before we end, do you have any other suggestions of community members, leaders, or other contacts you think we should connect with for this project?

As I mentioned before, we will be using the experiences, opinions, and insights you shared with us today to help inform us as we build a local committee to lead conservation planning in Stony Creek. We hope that this will ultimately help your and other community members' interests and needs be incorporated into future conservation efforts in the area.

As we discussed at the beginning of this conversation, any identifiable information from this interview will be made anonymous and remain confidential. Thank you so much again for talking with us today and for your contribution to this project. Your input on [topics discussed] is really helpful for us in this process. [If not interested/viable for SC]: Would you like to be looped into our projects' process in the coming months? [If interested and viable option for SC]: We will follow up with steering committee information and we really look forward to continuing this conversation with you there! [All]: Please feel free to reach out if any future questions or comments come to mind [provide our contact card/information]. Have a great rest of your day!

Center for Excellence Outreach Survey

Stony Creek Conservation Planning

Thank you for finding our interest form!
We are a team of 5 graduate students working with Michigan Department of Agriculture and Rural Development (MDARD) to build a community-driven conservation plan at the sub-watershed level. We are collaborating with individuals and groups from the Stony Creek sub-watershed in order to better understand the area, and how a watershed management plan may impact them. Involvement of community members from a range of backgrounds is critical to ensure that all voices are heard. We would like to talk with individuals about their insights and experiences with community engagement, conservation, and agricultural best practices. We will also bring together a group of individuals to form a steering committee, who will help develop and oversee the conservation planning for Stony Creek.

Stony Creek Sub-watershed Boundary

1. Would you be willing to schedule a 1 hour conversation with members of our team to share your thoughts and experiences?

   Mark only one oval.

   ◯ Yes
   ◯ No

2. If you are willing to schedule a conversation, are there any specific days or times that work best for you?

   ____
   ____
   ____
   ____
   ____

3. Would you be interested in participating in a committee to build a local watershed plan?

Mark only one oval.

- ⬭ Yes
- ⬭ No
- ⬭ Maybe

4. Would you like to receive more information about this project?

Mark only one oval.

- ⬭ Yes
- ⬭ No

5. What is the best way to contact you?

Mark only one oval.

- ⬭ Phone call
- ⬭ Text
- ⬭ Email

6. What is the best phone number to reach you?

____

7. What is your email address?

____

Center for Excellence Farm Operator Practices Survey

Farm Operator Practices Survey

Thank you for taking our survey! You will be asked eight short questions about your farming experience and practices.

Specifically, you will be asked about agricultural conservation practices, including their benefits and their barriers.

We will not ask you for any personally identifiable information (name, email address, etc.), and you can choose not to answer any of the questions on the survey.

Your responses will be used to direct important conversations in this community regarding water quality and soil health. If you would like to be a part of those conversations, please ask us about our watershed conservation efforts!

1. What do you produce in your farming operation? (Select all that apply.)

   Check all that apply.

   - ☐ Row crops (corn, soy, wheat)
   - ☐ Specialty crops (fruit, vegetable, horticulture, etc.)
   - ☐ Livestock - Dairy
   - ☐ Livestock - Beef production
   - ☐ Livestock - Chickens
   - ☐ Livestock - Pork production
   - ☐ Livestock - Other

2. What is the status of the land that you farm?

   Mark only one oval.

   - ◯ I own my farmland
   - ◯ I lease my farmland
   - ◯ I both own and lease my farmland
   - ◯ I prefer not to answer

3. Have you implemented any of the following Best Management Practices (BMPs) on your farming operation at any time over the past five years? (Select all that apply.)

Check all that apply.

- [ ] Crop rotations
- [ ] No till
- [ ] Reduced/strip till
- [ ] Buffer strips
- [ ] Cover crops
- [ ] Drainage water management
- [ ] Precision nutrient management
- [ ] Soil testing
- [ ] WASCOBs
- [ ] Grassed waterways
- [ ] Organic farming
- [ ] Land in conservation
- [ ] None of the above
- [ ] Other: ______________________

4. If you selected any practices above, please indicate which of the following motivates your choice to use BMPs. (Select all that apply.)

Check all that apply.

- [ ] Building soil health
- [ ] Reducing input costs
- [ ] Yield advantages
- [ ] Supporting local wildlife
- [ ] Improving local water quality
- [ ] N/A
- [ ] Other: ______________________

5. What do you see as the biggest barriers to implementing conservation BMPs? (Select all that apply.)

Check all that apply.

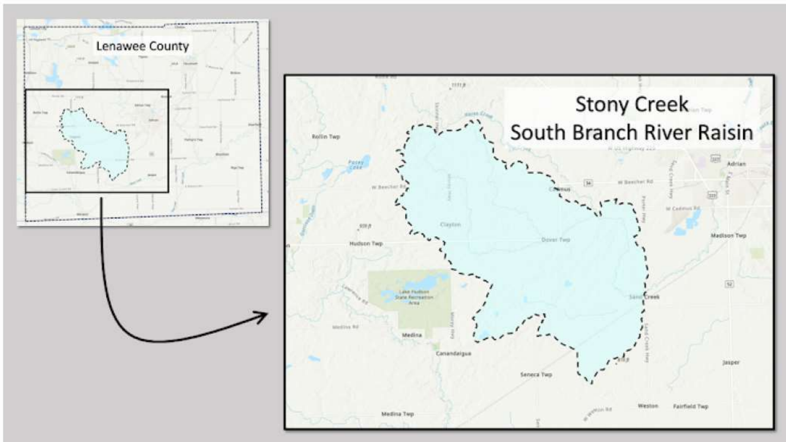
- [ ] Yield losses
- [ ] Increased costs
- [ ] Need for specialty equipment
- [ ] Availability of other resources needed for BMPs (e.g. cover crop seeds, DWM installation, etc.)
- [ ] Mistrust of incentive programs (state or federal)
- [ ] Uncertainty of what incentives/support are available
- [ ] Inadequate incentives/support available
- [ ] Long application processes for support programs
- [ ] Need for more information/trainings about conservation practices
- [ ] Other: ______________________

6. How much land do you own/farm?

Mark only one oval.

- Less than 20 acres
- 20-100 acres
- 101-500 acres
- Greater than 500 acres
- I prefer not to answer

7. Do you farm or own farmland within the Stony Creek sub-watershed of the South Branch River Raisin. (Map is shown below.)



Mark only one oval.

- Yes
- No
- I'd prefer not to answer

8. Do you apply any of the following in your fields (or have you in the past 5 years)? (Select all that apply.)

Check all that apply.

- Manure (from your farm)
- Manure (sourced from other farms)
- Nitrogen (anhydrous ammonia)
- Nitrogen (urea)
- Nitrogen (nitrates)
- Phosphorus
- Potash
- Other
- Do not use nutrient additions/Don't grow crops

That's it! Thank you for your responses!

We know surveys can be a chore. If there is anything in this survey that we can improve upon, please let us know! You can call or email us any time, or you can leave your comments in the next section.

Email: mdardproject23@umich.edu
Phone: (517) 215-3703 (Tina Waterbury)

We really appreciate your responses, and they will be used to make smart and lasting conservation decisions for everyone's benefit.

9. Please leave any feedback or questions here:

Appendix C: Field Analysis Documents

Erosion Risk Assessment Methods Using RUSLE

1. ***R-Factor***: Rainfall Erosivity
   Data Source: European Global Soil Data Center (ESDAC), 1km resolution
2. ***K-Factor***: Soil Erosivity
   Data Source: USGA gSSURGO data table
3. ***LS factor***: Slope Length/Steepness
   Data Source: USGS Digital Elevation Model, LS equation from {Citation} Mitasova & Brown, 19996
   Analysis:
   - Calculate slope and Flow accumulations from DEM layer in ArcGIS
   - Use raster algebra to calculate LS using equation: [“FlowAccum” * 10/22.1]$^{0.6}$ * [Sin(“Slope” * 0.01745)/0.09]$^{1.3}$ * [1.6]
4. ***C-Factor***: Cover Management
   Data Source: USDA Agricultural Conservation Planning Framework and USGS C-Factor Table
   C-Factor Determination Procedure:
   - Exported data for 2020 crop, 2021 crop, 2021 Fall tillage, 2022 Spring residue, using data from Agricultural Inventory windshield surveys conducted by the county conservation district office
   - Looked up C values using USDA guide cited on MSU’s Institute of Water Research site https://www.iwr.msu.edu/rusle/cfactor.htm
   - C-Values looked up manually for each combination of crops and practices, applied to each field, and C-values joined to attribute table for field data layer.
     - Used Zone 102B data
     - Used data for 150Bu corn grain and 40 Bu Soy crops (based on MI avg yields)
     - % cover data was given only as <30% and >30%. C-value data was averaged (i.e. for “<30%” data, average C values for <10, 10, and 20% cover given in table) or extrapolated a C value estimate where values were not given for >30%
     - For fields recorded as “Hay,” values for wheat were used as hay was not given
     - For fields recorded as “pasture,” alfalfa values were used

5. **P-Factor**: Erosion Support
   Data Source: Agricultural Conservation Planning Framework and P-Factor Table from (Karamage et al., 2017)

Appendix D: Steering Committee Documents

Steering Committee Charter

Stony Creek, South Branch River Raisin Watershed Conservation Planning Committee

Committee Charter

(November 1, 2023)

Document Information 3
Committee Vision 4
Committee Mission 4
Operating Guidelines 4
  Committee Composition 4
  Guidelines for Members at Large 4
  Guidelines for the Project Team Liaison 4
  Handouts for New Committee Members 5
Committee Meeting Guidelines 5
Agenda 5
Charter Approval Sign-Off 5
Glossary 7
Annex A: Sample Meeting Notes 8
Annex B: Sample Agenda 9

Document Information

Revision History:

Version	Date	Revision Summary
1.	7/11/2023	Initial draft of charter to be updated by committee
2.	11/1/2023	Updated draft #1

Document Owner:

Name	Organization
Stony Creek Watershed Conservation Planning Committee	

Reviewers:

Name	Title	Versions

Committee Vision

To build a sense of community around local land stewardship, soil health, and water quality.

Committee Mission

We believe in conservation and community. In order to improve local water quality, we will develop an actionable watershed conservation plan for the Stony Creek (South Branch River Raisin) sub-watershed. We work to create a model for lasting water quality improvements within our community by increasing agricultural BMP adoption and improving community awareness of conservation practices and benefits.

Operating Guidelines

Committee Composition

Members at large, U-M SEAS project team liaison

Guidelines for Members at Large

Committee members will:

- *treat each other members with respect at all times.*
- *work as part of a team toward fulfilling the committee's goals.*
- *read required materials in advance of meetings.*
- *attend required meetings. Members who miss 2 meetings (in person or over Zoom) may be asked to leave the committee.*
- *notify the Chair and Project Team Liaison as soon as possible in the event that a member cannot attend a meeting.*
- *respond to requests by other committee members and the Project Team Liaison in a timely manner.*

Guidelines for the Project Team Liaison

The Project Team appoints the committee Project Team Liaison. The Project Team Liaison serves as a resource to the committee. This includes several tasks, including advising the committee on committee-related issues, developing informational materials for the committee, assisting in the preparation for meetings, developing recommendations for committee consideration, and serving as a primary communications point with other members of the Project Team.

The Project Team Liaison will:

- *be familiar with all aspects of the committee's work.*
- *be familiar with state policies and procedures.*
- *maintain contact with the Chair and the committee members.*
- *provide orientation materials and information to new members.*
- *assist the Chair in preparing the meeting agendas.*
- *ensure that meeting minutes are written and distributed according to the guidelines below.*
- *draft action items or discussion items on behalf of the committee. Must send the item(s) to the Chair for approval.*

Note: Many of the Project Team Liaison's roles will be transferred to a secretary position after the project team disengages from the Committee in summer 2024.

Handouts for New Committee Members

- *The following are the standard set of handouts that should be sent to all new committee members within one week of accepting a committee position:*
    - *The committee charter with roles and active members listed*
    - *Meeting notes for the past year (beginning Fall 2024)*
    - *Miscellaneous information that is pertinent to the committee, such as a brief description of current projects.*
    - *Calendar of future meeting dates, if available.*

Committee Meeting Guidelines

The Committee will be able to conduct business with a quorum of 50% or more members present. The Committee will function according to consensus rules.

Agenda

Developing the Agenda and Meeting Structure

- *Provide complete agenda with complete meeting details in advance of the meeting:*
    - *beginning and end times;*
    - *location;*
    - *committee roster; and*
    - *last meetings' action items*
- *Committee members should agree on primary agenda items for subsequent meetings before meeting close.*
- *Indicate which agenda items are discussion items or require action and send action items out prior to the meeting.*
- *Close meeting with review of meeting accomplishments and action items.*

Charter Approval Sign-Off

This sign-off sheet is used to indicate approval of and agreement to the conditions and commitments contained in this document.

Name (print)	Signature	Date

Glossary

Term	Definition or Description

Annex A: Sample Meeting Notes

Stony Creek Sub-Watershed Conservation Planning Committee Meeting Notes

Meeting Begin and Attendance
A meeting of the Stony Creek Sub-Watershed Conservation Planning Committee was held at [Location] on [Date]. Attendees included [list attendee names]. Members not in attendance included [list names].

Previous discussion & action items:

Continuing discussion & action items:

New topics of discussion:

Action items for next meeting:

Meeting End:

Project Team Liaison	Date of approval

Annex B: Sample Agenda

Stony Creek Sub-Watershed Conservation Planning Committee Meeting Agenda

Location:	[Address or room number]
Date:	[Date]
Time:	[Time]
Attendees:	[List attendees]

Agenda items

1. [Agenda item]
2. [Agenda item]
3. [Agenda item]
4. [Agenda item]
5. [Agenda item]
6. [Agenda item]

Action items	Owner(s)	Deadline	Status
[Action item 1]	[Name(s) 1]	[Date 1]	[Status 1, such as In Progress or Complete]
[Action item 2]	[Name(s) 2]	[Date 2]	[Status 2]
[Action item 3]	[Name(s) 3]	[Date 3]	[Status 3]
[Action item 4]	[Name(s) 4]	[Date 4]	[Status 4]
[Action item 5]	[Name(s) 5]	[Date 5]	[Status 5]
[Action item 6]	[Name(s) 6]	[Date 6]	[Status 6]

Appendix E: Literature Review Documents

The results of the literature review have been summarized in a series of synthesis matrices. These charts are presented in six different categories: effective communication strategies; BMP evaluation; effectiveness of policy and incentive programs; use of models and soil phosphorus testing to reduce phosphorus loads; harmful algal blooms, and; rural community and decision making. Each matrix has been prepared by arranging the main theme and ideas under the vertical column and names of the authors in horizontal column.

Effective communication strategies

Main idea (Theme)	Espenshade et al., 2022	Osmond et al., 2015	O’Connell, Osmond, 2022	Witzling et al., 2023	Weigel et al., 2022
Behavioral pattern analysis amongst farmers using fertilizers	-The paper also discusses three primary psychological factors that determine farmers' decisions: (1) attitude, (2) social norms, and (3) perceived self-efficacy -Grow More Approach	-Significant gap and trust issues between public policy, local government, and farmer behavior -Farmers hesitant to use nitrogen at recommended rates, lack of trust on university studies -Trust issues in nutrient management decision making			
Challenges in decision making			-Lack of resources towards information making -Emphasize the		

			importance of demographics especially location in decision making		
Types of communication strategies for promoting conservation efforts				-Promoting conservation efforts through social media -Testing carried out by Facebook ads at various demographics	-Targeted information increased response rates in increasing farmer engagement by 20%

The articles used in the research significantly address the sustainability challenges facing the US agricultural society today. It is observed that three primary psychological factors determine farmers' decisions: (1) attitude, (2) social norms, and (3) perceived self-efficacy (Espenshade et al., 2022). While our project primarily deals with the applicability of phosphorous fertilizer, a significant portion also involves understanding farmer behavior towards phosphorous use. One of the major challenges when it comes to decision making has been the lack of trust amongst farmers towards the policies, local government and recommendations provided by university students (Osmond et al., 2015)**.** While our project mainly deals with application of phosphorous fertilizer, we anticipate similar challenges and trust issues with farmers towards changing behavior and accepting the policies in place for addressing non-point source pollution. The articles in the research also emphasize that location plays an important role in decision making (O’Connell, Osmond, 2022) and it’s very important that tailor made regional programmes should be given importance in order to bring significant change. In the changing scenario, social media like

Facebook especially targeted at specific demographics can increase conservation efforts (Witzling et al., 2023).

BMP evaluation

Main idea (Theme)	Lemke et al., 2011	Gonzalez, 2018	Baker et al., 2023	Barling and Moore, 1994	Bonham et al., 2006
Improvement in soil and water quality due to BMP adoption	-Whether focused outreach increase BMP adoption - Study spread over 7 years at Illinois across Mackinaw River -outreach did increase BMP adoption (grassed waterways, stream buffers, and strip tillage) within the treatment watershed -no significant changes in nitrate-nitrogen, total P, dissolved P, or hydrology				
Impact of various BMP adoption		-Comparison of no-till and crop rotation to chisel till	-Study is restricted to farmlands that are	- Role of buffer strips in managing	

		- The main results of this study found that no-till resulted in higher amounts of soil cohesion and less sediment loss when compared to chisel tillage, a different tillage practice. - till plots of land saw an average of 79% reduction in runoff when compared to chisel tillage	long-term, no-tillage, and row-crop -researchers found that this practice significantly impacted OP loading, but did not have an impact on TSS, TN, or TIP alone - Cover crops have potential to reduce the run-off	water quality and pollution -Buffer strip effective when flow is shallow -Study carried out in Australia and can be different from the environmenta l conditions in mid-western regions in US	
Cost effectivene ss					-Cost effectivene ss of buffer vs nutrient managem ent -Study conducted at two sites spatially specific (farm scenario)

					vs multi representative scenario -The result has indicated phosphorous delivery declining by .2 pound/acre in farm specific scenario

The articles primarily focus on various targeted outreach programs for BMP adoption and have indicated that despite the specific approach towards BMP approach, it really made any differences in soil and water quality (Lemke et al., 2011). This study offers valuable insights for our project, indicating that challenges may persist even after widespread BMP adoption in the Stony Creek region. Additionally other literature studies indicate that for optimal results so as to improve water and soil quality various methods like increasing cover crops, no-till, crop rotation and buffer strips can play an important role to reduce the nutrients and especially use of buffer strip to address nutrient management has been found to be effective (Barling and Moore, 1994).

Overall, the studies emphasize the importance of successful agricultural practices for improving water and soil quality. This involves combining BMPs, considering long-term impacts, and implementing practices continuously. Each study contributes valuable insights into the complexities of BMP effectiveness and offers recommendations for more robust and sustainable agricultural practices which is relevant for our project to understand what the long-term impact of adoption of BMPs in Stony Creek Region will be.

Effectiveness of Policy and Incentive Programs

Main idea (Theme)	John et al., 2023	Hampicke, 2006	Prokopy et al., 2019	Baojing et al., 2023	Gao & Arbuckle, 2022

Types of agricultural policies and its impact	-Precision agriculture amongst small scale farmers - PA is described as providing for higher farm efficiency, better yields, and better resource conservation -Generational and age-based barriers identified	- Study conducted in European agricultural area -Conservation methods on pay-performance scheme as opposed to subsidies			
Behavioural traits observed towards implementing of agricultural policies			-Quant literature review -Study categorized the following variables: Attitudes, behaviour, environmental awareness, information, farm characteristics, operator characterist		

			ics, and economic factors -Age negative factor of prediction		
Barriers to BMP adoption				-Study acknowledges the many barriers to farmer adoption of nutrient management practices, and recommends market policy solutions such as internalizing costs of nutrient pollution and granting access to financial capital for smallholders via a Nitrogen Credit System (NCS)	-Iowa's Nutrient Reduction Strategy (NRS), and makes recommendations for improving farmer BMP adoption -Examines psychological, social, and structural barriers to BMP adoption -Positive relationship between crop insurance and reducing N applications

The articles used in the research talk about adoption of specific or precision agriculture to increase the yield, especially for small scale farmers (John et al., 2023). Two of the literature studies focus on barriers that have been found especially from the farmer side while adopting the BMP's and psychological, social, and structural barriers have been found to BMP adoption (Gao & Arbuckle, 2022). One study has indicated how age is one of the biggest negative barriers while implementing any new policy and incentive program (Prokopy et al., 2019).

Use of Models and Soil Phosphorus Testing to Reduce Phosphorus Loads

Main idea (Theme)	Weaver et al. (2023)	Duncan et al. (2017)	Scavia et al. (2017)	Ni et al. (2020)	Guo et al. (2020)
Agronomic Soil Tests for DRP	- Agronomic soil tests can be indicative of dissolved reactive phosphorus (DRP) loss. - Existing soil tests, like P Buffering Index and Colwell P, showed associations with DRP values. - High Colwell P values were identified as indicators of DRP loss. - Opportunities exist to use farmers' existing soil tests to assess DRP risk and				

	guide nutrient management.				
Linking STP to P Loss		- Regression analysis used to link soil test phosphorus (STP) levels to phosphorus loss risk. - High STP indicates increased phosphorus losses with increased fertilizer applications. - STP alone not sufficient to predict dissolved reactive phosphorus (DRP) loss. - STP can be a useful tool in highlighting risk but needs integration into a holistic management plan.			

Multi-Model Assessment			- Used multiple variations of the SWAT model to assess nutrient reduction strategies. - Consistent outcomes across models, indicating potential for total phosphorus (TP) and DRP reduction. - Adoption of nutrient management practices and buffer strips showed promise in reducing phosphorus loads. - Emphasized the need for substantial adoption of multiple conservatio		

			n practices to meet reduction targets.		
DRP Loss Factors and Mechanisms				- Synthesis study analysing factors influencing DRP losses in the Lake Erie Basin. - Soil properties strongly impact DRP losses in both surface and subsurface runoff. - Management practices have varying effects on DRP losses, with impacts differing between surface and subsurface runoff. - Effects of management practices are further dependent on soil properties.	

Impact of Agricultural Phosphorus					- Examined the 2019 crop year in the Lake Erie Basin. - Higher precipitation led to fields left fallow, resulting in a 62% reduction in applied phosphorus and 29% less DRP load. - Particulate P levels consistent with expectations. - Highlights the role of fertilizer management practices in influencing DRP loads.

The synthesis of multiple studies on phosphorus management in agriculture reveals promising insights for mitigating dissolved reactive phosphorus (DRP) loss. Agronomic soil tests, such as the P Buffering Index and Colwell P, demonstrate associations with DRP values, particularly identifying high Colwell P values as indicators of DRP loss (Weaver et al. (2023). One of the studies indicates that in the 2019 crop year in the Lake Erie Basin which highlights the role of fertilizer management practices in influencing DRP loads, emphasizing the need for strategic approaches in agricultural phosphorus application to minimize environmental impact (Guo et.al).

Harmful Algal Blooms

Main idea (Theme)	Gregory J. Doucette et al	Lu, S. Roy et al	Viviana Ulloa-Jofré et al	Darcy Dugan et al	George S. Bullerjahn et al
Global solutions to regional problems: Collecting global expertise to address the problem of harmful cyanobacterial blooms	- Toledo water crisis in 2014 due to Microcystin contamination. - Global collaboration to address algal blooms in Lake Erie. - Remote sensing techniques used for sampling and model simulations. - Best management practices (BMPs) recommended for reducing dissolved reactive				

	phosphorus (DRP) concentrations. - Emphasis on nutrient management, water management, tillage management, and crop rotation. - Discussion on bloom treatment strategies and economic impacts.				
Bi national efforts and policy making		- Far-reaching impacts of Harmful Algal Blooms (HABs) on ecosystems and humans. - Algal toxins contribute to global concerns and higher mortality rates. - Need for sustained support and management at various			- Binational efforts addressing cyanobacterial blooms in the Great Lakes. - Policy aspect focusing on seven binational efforts to monitor water quality.

		levels. - Importance of modeling, prediction, and forecasting in designing monitoring and management plans. - General discussion of solutions, lacking specific exploration of costs and implemented strategies.			- Cyanobacterial blooms result from human activities, particularly agricultural runoff. - Need for coordinated efforts and collaboration with stakeholders. - Creation of steering committee involving key stakeholders for effective watershed management.
Control methods to reduce algal blooms			- Regulatory steps in different countries to address algal blooms.		

			- Categorization of control methods into physical, physiochemical, and biological. - Physical methods include water mixing enhancement strategies. - Chemical methods involve substances like copper sulfate and hydrogen peroxide. - Exploration of biological control methods used in pest control.		

Use of monitoring systems				- Global issue of Harmful Algal Blooms (HABs) in freshwater and marine ecosystems. - Regional initiatives for HAB monitoring and forecasting. - Key recommendations for a global HAB observing system. - Discussion of cases in Alaska, Pacific Northwest, and California. - Emphasis on real-time monitoring, Earth satellite data integration, and stakeholder involvement.	

The articles used in the research emphasize nutrient management, tillage management and water management from the global studies conducted all around to control algal blooms (Gregory J. Doucette et al). One of the studies also indicates that Binational efforts addressing cyanobacterial blooms in the Great Lakes should emphasize on a policy-oriented approach, outlining seven collaborative initiatives for monitoring water quality. The paper underscores that these harmful blooms, largely stemming from agricultural runoff, necessitate coordinated efforts involving stakeholders. A key recommendation involves the establishment of a steering committee comprising essential stakeholders for efficient watershed management (George S. Bullerjahn et al). As this study emphasizes the establishment of a steering committee for watershed management, it holds relevance for our project to see how a small and specific local area can benefit from the involvement of the steering committee.

Rural community and decision making

Main idea (Theme)	Jordan, Maloney, McLaughlin et al(1994)	Duram et al(1999)	Paul et al(2019)	Singh, Dorward, Osbahr et al(2016)
Agricultural Policy-Making	- NFU's diminishing influence on agricultural policy in Britain. - Policy influenced by various interest groups and a clientelist approach. - Policymaking is fragmented and competitive with flexible policy communities.			
Organic Farmers' Decision Making		- Factors influencing organic farmers' decision-making.		

		- Proactive characteristics of organic farmers. - Key characteristics: diversity, willingness to face challenges, adaptability, business-oriented approach, lack of formal agricultural education, connection to the land, non-radical environmentalist stance, ability to overcome obstacles.		
Community-Supported Agriculture (CSA)			- Economic benefits of CSA farming in the United States. - CSA farmers earn more than the national average but struggle for a living wage. - Emphasis on social, ecological, and economic benefits despite financial challenges.	

Farmer Decision-Making in Developing Countries				-Comprehensive approach to analysing smallholder farmer decision-making. - Five key questions addressing various aspects of decision-making. - Study based in Pratapgarh, India, emphasizing resource ownership, access, and social and cognitive factors.

The articles used in the research show how some of the factors like lack of formal agricultural education, connection to the land, non-radical environmentalist stance can be a hindrance to overcome obstacles (Duram et.al). One of the literature studies done ion India also focuses on five questions related to the agricultural decision making and this study may or may not be relevant as the study has been conducted in a developing nation, however it does emphasize on the social and cognitive factors which are taken into account for decision making (Singh, Dorward, Osbahr et al). There are many factors which can make it complicated especially when it comes to rural communities to make decisions.

Appendix F: Stony Creek Watershed Conservation Plan

Stony Creek (South Branch River Raisin) Watershed Conservation Plan

University of Michigan School for Environment and Sustainability
&
Michigan Department of Agriculture and Rural Development

Project Partners:

Lenawee County Conservation District
River Raisin Watershed Council
Farmer-Led Watershed Conservation
Michigan Department of Agriculture and Rural Development

With special thanks to the invaluable contributions of the
Stony Creek Community Conservation Steering Committee.

April 4th, 2024

Table of Contents

Table of Contents ii
Table of Figures iii
Executive Summary 1
Introduction 2
River Raisin Watershed & Stony Creek (South Branch River Raisin) Subwatershed 2
Challenges to Conservation 6
Economic Challenges 6
Bureaucratic Issues 7
Social/Cultural Challenges 9
Goals and Implementation Activities 9
Stony Creek Management Goals 10
Local Community Needs 11
Recommendations 12
On-Farm Practices 12
Information and Education (I&E) 18
Implementation Activities 19
Metrics and Evaluation 22
Conclusion 24

Table of Figures

Figure 1: Major subwatersheds and jurisdictional boundaries of the River Raisin (River Raisin Watershed Council, 2009), 10, fig. 1-1 3
Figure 2: Stony Creek (South Branch River Raisin) sits primarily in Dover Township, MI. 4
Figure 3: Hydrologic Unit Codes (HUCs) Explained (USGS, 2023) https://nas.er.usgs.gov/hucs.aspx 5
Figure 4: Stony Creek (South Branch River Raisin) is located in Lenawee County, Michigan. 6
Figure 5: Stony Creek Relative Erosion Risk, factoring in soil type, rainfall data, and topography 15
Figure 6: Stony Creek Relative Erosion Risk by Field and Observed BMP Use 16
Figure 7: Stony Creek BMP Recommendations Visual Aid, showing the primary recommendations for Stony Creek farmers. Recommendations are differentiated between more- and less-sloped fields, defined by EGLE standards (greater/less than 75% of the field in 3% grade) 18

Watershed Conservation Plan for Stony Creek (South Branch River Raisin)

Executive Summary

Stony Creek (South Branch River Raisin) (Stony Creek) is a HUC-12 subwatershed located primarily in Dover Township, Lenawee County, Michigan, and lies within the River Raisin Watershed. The River Raisin watershed is Michigan's primary direct drainage into the Western Lake Erie Basin (WLEB), and Stony Creek has been highlighted by the State of Michigan as a priority subwatershed for agricultural conservation efforts to reduce phosphorus loading into the lake. Agricultural Best Management Practices (BMPs) are designed to reduce the environmental impacts of farming while improving the sustainability and profitability of agricultural production. However, approaches to reducing agricultural runoff through voluntary cost-share programming and outreach efforts have not resulted in significant increases in adoption of BMPs primarily due to economic and social/cultural factors. Therefore, conservation challenges must be presented in a way that demonstrates the historical and systemic nature of current barriers and does not diminish the humanity or dignity of farmers and the choices they make to support themselves and their communities.

The overall goal of this plan is to lay a path to building conservation program participation in Stony Creek with a focus on the needs, priorities, and perspectives of the local community and agricultural stakeholders. The inputs into this plan come from interview research with local producers, field-level GIS and agricultural inventories within the subwatershed, and discussions with the Plan's steering committee of local stakeholders. This research was conducted by graduate students from the University of Michigan School for Environment and Sustainability in partnership with the Michigan Department of Agriculture and Rural Development. This plan may serve as a template for other priority subwatersheds in their community-based conservation efforts.

This plan offers recommendations for specific BMPs applicable to Stony Creek, as well as programmatic recommendations for broader engagement and progress monitoring. Precision agriculture is recommended regardless of any conditions on the land, whereas other practices are recommended based on a more- or less-sloped field binary. For fields with 75% or more in 3% grade or higher, we recommend annually successive uptake of grassed waterways, water and sediment control basins (WASCOBs), and no-till farming. For fields with less than 75% in 3% or higher, we recommend annually successive uptake of cover crops and filter strips. In addition to improving local water quality, BMPs such as precision agriculture and low/no-till contribute positively to soil health while minimizing costs associated with nutrient inputs and equipment wear and tear. All recommended

practices are supported by subsidy programs through federal, state, land grant extension, and Conservation District programming. Additionally, conservation organizations should provide consolidated conservation information in a central webpage and conduct more and smaller/less formal outreach events in the Stony Creek region. Finally, we suggest that monitoring for progress in reducing field runoff would require considerable edge-of-field water quality monitor installation, a task which is not feasible in the short term. Instead, the following metrics should be considered as surrogates for granular water quality monitoring data within the boundaries of Stony Creek: Cropland acres enrolled in MAEAP, CREP, and other conservation programs; number of farms enrolled in MAEAP, CREP, and other conservation programs; miles of grassed waterways installed; acres of cover crops; acres of no-till and low-till; acres managed via WASCOB; miles of vegetated riparian buffers (buffer strips); number of community outreach events quarterly and annually; community outreach attendance; farm conservation organizations active in Stony Creek, and; number of conservation champions active in Stony Creek.

Introduction

River Raisin Watershed & Stony Creek (South Branch River Raisin) Subwatershed

The River Raisin watershed is situated in Southeast Michigan and drains over 1,000 square miles of land into the Western Lake Erie Basin (WLEB). The watershed touches Lenawee, Monroe, Washtenaw, Jackson, and Hillsdale counties in Michigan and Fulton County in Northeastern Ohio. (See Figure 1.) Over 75% of the watershed land area is in agricultural production, a fact which underlies a number of social, economic, and ecological considerations for conservation efforts (River Raisin Watershed Council, 2009). The primary agricultural products are grain corn and soybeans, with occasional crops of wheat, hay, and corn silage (USDA, 2017a). Lenawee County, at the heart of the watershed, ranks in the top 6% of counties nationally in terms of grain sales including corn and soy (USDA, 2017b). According to the USDA, 96% of farms across the watershed's Michigan counties are family owned and operated, providing some insight into the social and cultural importance of agriculture in this area (USDA, 2017a).

As Michigan's primary direct drainage basin into the Westen Laker Erie Basin (WLEB), the River Raisin watershed has been a focus of conservation efforts over the years (State of Michigan, 2018). Due to the significant re-emergence of cyanobacterial harmful algal blooms (HABs) in the WLEB over the past three decades, a renewed interest in the source and role of phosphorus has arisen within the governments of states and provinces bordering the lake, as well as within environmental conservation NGOs and community organizations in the region. In 2015, the states of Michigan and Ohio, along with the Canadian province of Ontario, agreed to reduce their phosphorus loading into the WLEB by

40% in 2025, from a 2008 loading baseline year. In 2018, the Michigan Domestic Action Plan (DAP) team identified the Stony Creek subwatershed as a state priority for addressing nonpoint source nutrient pollution into the WLEB, along with several other subwatersheds in the River Raisin watershed. The Michigan DAP team consists of state government employees from conservation-focused departments, and it develops state-level plans to address HABs according to requirements in Annex 4 of the 2012 Great Lakes Water Quality Agreement (IJC, 2023).

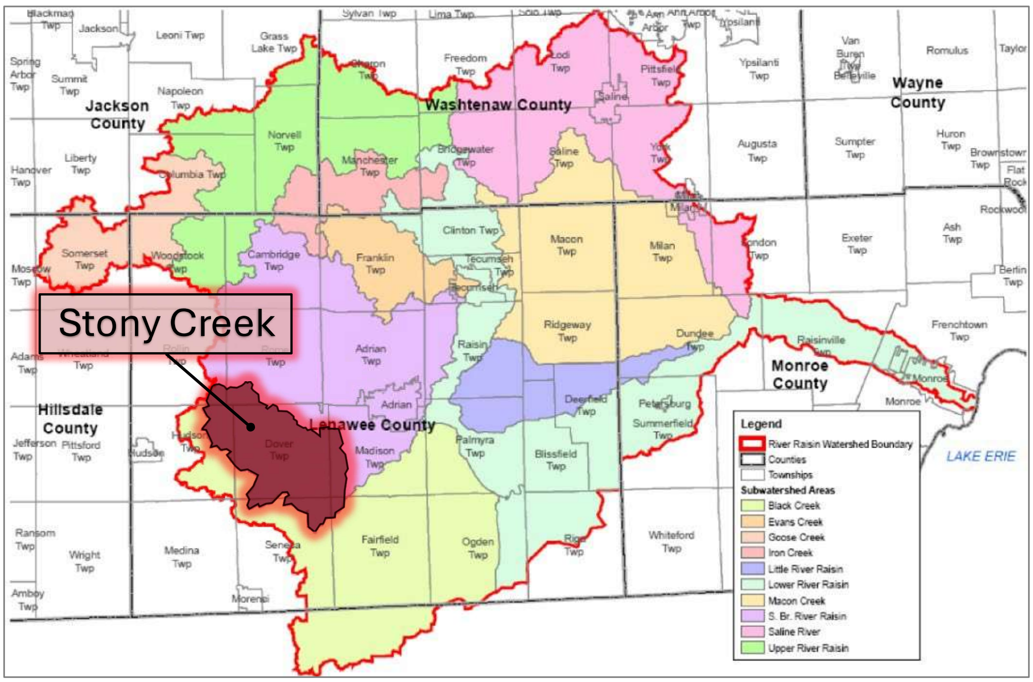


Figure 11: Major subwatersheds and jurisdictional boundaries of the River Raisin (River Raisin Watershed Council, 2009), 10, fig. 1-1. Stony Creek shown (added).

The Stony Creek (South Branch River Raisin) subwatershed (Stony Creek) is classified as a HUC-12 subwatershed (041000020202) and is located in the southwestern portion of Lenawee County, Michigan. (See *Figure 4*.) Stony Creek covers nearly 46 square miles centered over Dover Township (population 1,662) with portions of the subwatershed extending into neighboring Rome, Rollin, Hudson, Madison, Fairfield, and Seneca townships (see *Figure 2*). Stony Creek is made up mostly of rural cropland with a few towns and villages throughout. The largest of these is

Hydrologic Unit Codes (HUCs) are used by US Geological Survey (USGS) to identify watersheds throughout the US. A two-digit HUC-2 code indicates a large region, whereas a twelve-digit HUC-12 code indicates a subwatershed of approximately 30 square miles, on average. See Figure 3 for a graphical depiction of the HUC system.

the village of Clayton, with a population of 311 people in 2020 (US Census Bureau, 2021). There are 674 farm fields in the subwatershed ranging from 2.5 to 392 acres, constituting 20,734.9 total acres or 70.65% of the total land area in the subwatershed.

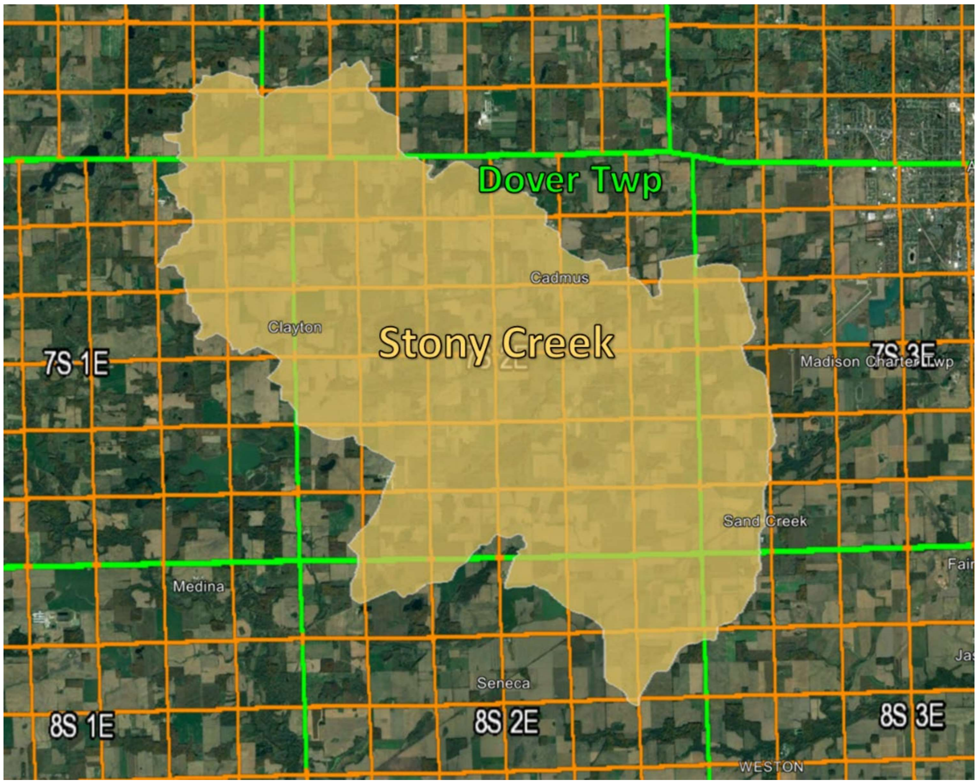


Figure 12: Stony Creek (South Branch River Raisin) sits primarily in Dover Township, MI.

Figure 13: Hydrologic Unit Codes (HUCs) Explained (USGS, 2023)
https://nas.er.usgs.gov/hucs.aspx

As a component of the greater River Raisin watershed, Stony Creek and its agricultural land use has been identified by the state of Michigan as one of 13 priority subwatersheds for Lake Erie. Subwatershed prioritization has been completed according to the state's agricultural inventory process, which identifies potential nonpoint source pollution risk via field surveys and topographical analysis (EGLE et al., 2021).This plan outlines the agricultural context and barriers to conservation, and then recommended solutions specific to Stony Creek and its immediate surroundings, utilizing inputs from research, residents, farm operators, and a local steering committee. The plan focuses on those conservation methods determined to be the most worthwhile and feasible to the local population, and which are backed by scientific research. The goal of this plan is to get to the heart of community conservation in Stony Creek, and to provide a potential roadmap for other communities to act in their own best interests while striving for a more sustainable future.

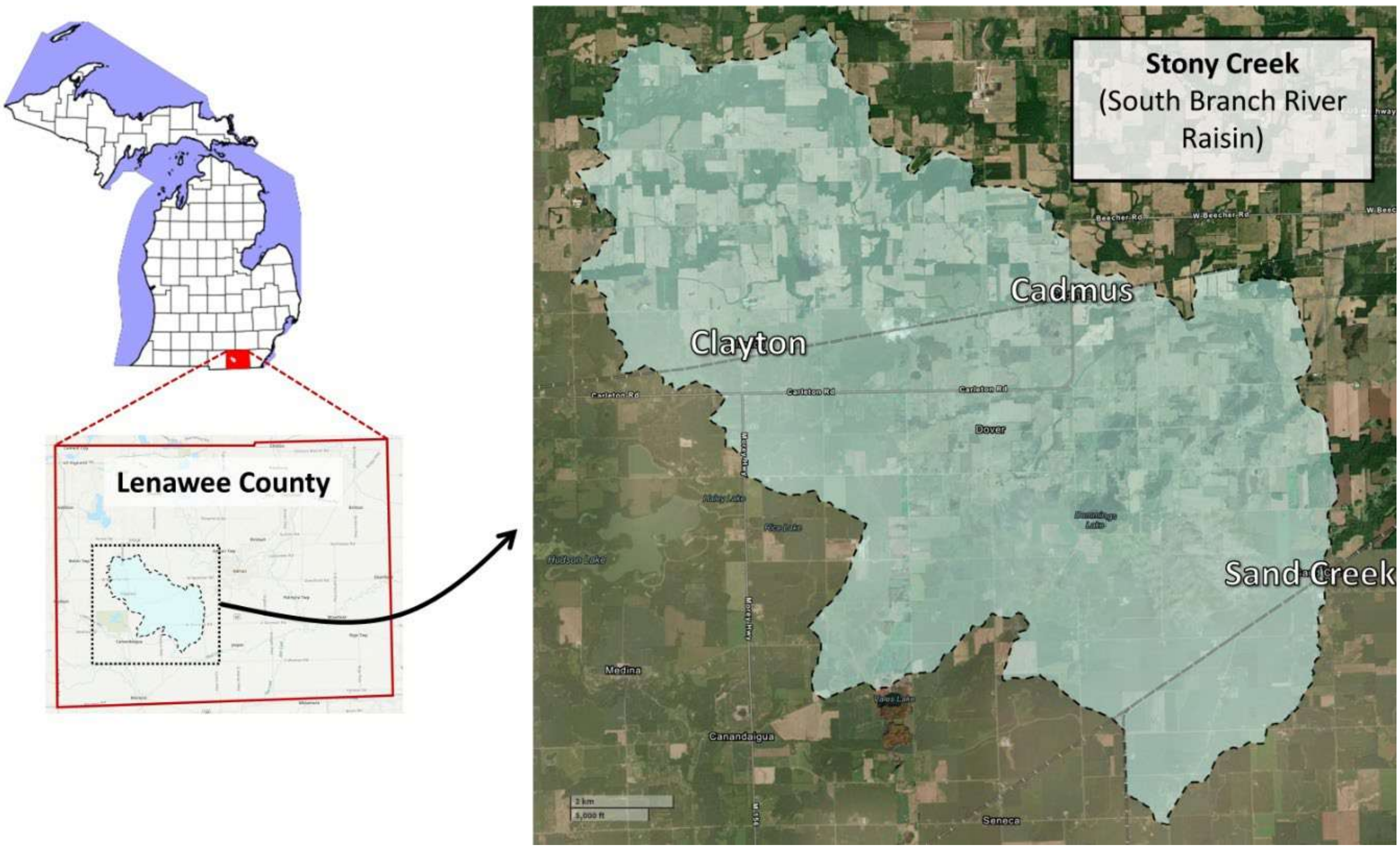


Figure 14: Stony Creek (South Branch River Raisin) is located in Lenawee County, Michigan.

Challenges to Conservation

The challenges to agricultural conservation in this subwatershed are significant and are mirrored in much of the American corn belt. These issues can be categorized primarily as economic and/or social/cultural in nature. It is critical that conservation challenges are presented in a way that recognizes the historical and systemic nature of current barriers and does not diminish the humanity or dignity of farmers and the choices they make to support themselves and their communities.

Economic Challenges

From an economic perspective, national trends of farm consolidation, increased efficiency, and yield prioritization have spurred soil and water quality degradation across the US. These trends are reinforced by federal subsidies under the Farm Bill, propping up national and global markets for corn and soy commodities. Economic incentives for maximizing soy and corn yields are deeply engrained in the US agricultural setting.

Additionally, farming technology continues to develop towards higher levels of efficiency and productivity in terms of yielded bushels per acre. GPS-enabled precision tilling, planting, fertilizing, and harvesting equipment improves yields through detailed monitoring and data logging of inputs and outputs, often shown in near-real-time (NRT) to producers operating the equipment. These technological advancements allow farmers to maximize their profits through yield increases and have increasingly become the operational standard for profitability. For those who can afford these new technologies, either outright or on credit, this trend towards high-tech equipment feeds into economic pressures to maximize yields. However, it also presents an opportunity for producers to utilize their precision equipment with a focus on sustainable practices – a necessary component of agricultural conservation discussed later in this plan. Still, the cost of advanced equipment is prohibitively high for many small-scale farmers.

The context of federal and state subsidy and yield maximization is a significant barrier to conservation due to the economic and financial realities of producers in this and other watersheds. Many farmers compete in the commodities market along such thin margins that they are unable to support the costs of conservation measures, regardless of whether they would like to be more sustainable. The general economic argument for increasing the use of agricultural best management practices (BMPs) is that, in a span of years or decades, a participating farmer will see increased profits from reductions in input costs of fuel, equipment wear-and-tear, fertilizers, and soil organic matter. These factors also contribute to soil heath improvements, bolstering long-term productivity in a more sustainable manner. While this logic is sound, the length of time needed to see the benefits of BMPs is beyond the scope of farmers who struggle to operate on a yearly or even seasonal basis.

To counter the considerable economic and financial barriers to conservation in the absence of mandates and regulation, state and federal government programs offer significant financial support to producers for improving their conservation activities. Federal grants and cost-share programs under US Department of Agriculture (USDA) National Resource Conservation Service (NRCS) number in the hundreds, and the 2024 funding cycle offers over $3 billion to producers nationwide (USDA NRCS, 2023). There are also federal funding opportunities through the US Fish and Wildlife Service (USFWS) and US Forest Service (USFS), among others. At the state level, Michigan Department of Rural Development (MDARD) set aside $13 million in their budget to support soil health and regenerative practices, and other state agencies offer several more funding avenues. However, even at these levels of national and state funding, cost-share programs are competitive, and financial resources quickly become limited or unavailable to producers.

Bureaucratic Issues

Bureaucracy is a necessary aspect of government administration, and conservation programs are no exception. Too often, the prospect of navigating a dense bureaucracy is too much for producers to take on, especially when they do not have a strong desire to adopt conservation practices. Nearly every producer who has participated in conservation subsidy programs through the state or federal government experienced the bureaucratic hassle of seeking and receiving funding. While a level of processing and accountability is required of government entities in the distribution of funds, producers can be especially sensitive to the complexity of these funding systems due to the time and energy costs to access them.

There are conservation champions in and near Stony Creek who have successfully navigated the application systems, and who make good use of subsidy funding on their operations. And yet, they are also quick to point out examples of bureaucratic hurdles that would almost certainly deter less motivated producers. There are even examples of these champions dropping out of funding application processes due to bureaucratic hangups, showing that efforts of even the most driven producers can be thwarted by the administrative structure of the state and federal government. In one case, a fatal administrative stalemate grew from a simple issue with printing compatibility regarding a project proposal map.

To make things more complicated, bureaucratic processes change according to the administrative agency which is providing the funding. Funding from federal and state sources leverages different eligibility requirements than funding from Conservation District programming. Funding programs with the most available resources often present the highest barriers to access in the form of prerequisite farm conditions or preexisting conservation practices. For example, FSA programs often set on-farm infrastructural standards, such as storage container condition, electrical standards, and proximity to buildings, which must be met for cost-share eligibility. Conservation Districts and local government units are the preferred conservation funding institutions for many producers in Stony Creek, even as they retain low levels of funding and offer relatively less conservation programming support. This preference speaks to the value that farmers place on their time and energy and is not fully represented in federal cost-share programs. Additionally, while CD programming isn't without prerequisites, they are typically not as stringent as USDA requirements, contributing to ease of adoption among producers.

Stony Creek producers often prefer to work with funding programs through the Lenawee County Conservation District (LCD). As members of affected rural communities, CD practitioners are trusted to have their friends' and neighbors' best interests at heart in pursuit of improved environmental quality. (See the last section, *Metrics and Evaluation*.)

Social/Cultural Challenges

Farming is more than a job or profession. Farmers and farm operators identify deeply with their work, and often derive their purpose and self-worth from their critical ability to raise crops and livestock. More broadly, rural Americans are proud of their history of community values, pragmatism, and self-sufficiency. Michigan is 94% rural by land mass, and yet only 18% of its population lives in rural areas – reduced from 39% in 1920 (Gardner, 2022). These factors provide important context to many of the social and cultural barriers to conservation practices here in Stony Creek, including age and family dynamics, reliance on hired farm labor, and cultural divisions between rural communities and urban centers.

Nearly 1/3 of farmers in Michigan are over the age of 65, and it’s likely that this holds true within Stony Creek (Gardner, 2022). Older producers are less likely to take on new, voluntary conservation practices for several reasons. It is easy to see how a farmer using conventional methods for decades might reject a new practice. Beyond this, conservation farming is not without risks, especially in the first few years. Older farmers may be less risk tolerant due to their decades-long experience in successful conventional farming methods. Additionally, older farmers have little incentive to “buy in” to conservation practices when they do not plan to be farming long enough to see the long-term benefits.

In addition, farm patriarchs tend to hold onto their decision-making power into old age. Often, by the time the “old dad” hands off his authority to an heir, the heir has already been farming conventionally for decades themself. In other industries or businesses, transitions of power or ownership usually occur sooner, and there is more opportunity for “the next generation” to be younger and more interested in or capable of making fundamental changes in the operation. In this way, changes to producer behavior without intervention occur more slowly than is generally acknowledged.

Aspects of farm labor practices also contribute to the slow uptake of BMPs in Stony Creek and elsewhere. Farm owners will often hire out work to be done on the farm, as has been done throughout history the world over. Due to both the shrinking rural population and age of many farm owner-operators, this labor is increasingly sourced from non-local individuals or businesses without strong ties to the local community. Whereas conservation practices serve to benefit both the ecosystem and local environmental quality, nonlocal hired help is less likely to value local water and soil conditions to the same extent as residents of the area. Considerations for runoff mitigation and the 4 Rs of farm conservation (right source, right rate, right time, right place) are not likely to factor into operational decisions by hired laborers without landowner intervention.

Goals and Implementation Activities

Stony Creek Management Goals

The goal of this plan is to provide a roadmap toward improved soil health and water quality in Stony Creek by focusing on the following objectives:

1. Acknowledge and utilize the experiences and needs of the local community;
2. Educate and inform community members of what can and should be done to improve soil health and water quality in the subwatershed;
3. Foster a sense of stewardship among producers and community members in and around the subwatershed; and
4. Provide actionable recommendations to local producers, community members, and government entities for the improvement of soil health and water quality.

To meet these objectives, this plan was written with input from local community members through a steering committee convened for this purpose. The steering committee for this plan comprised one local producer and conservation champion, one local agricultural education expert, and one watershed planning expert with extensive experience working in the Stony Creek region. The committee convened to establish on the purpose and scope of the plan, set the plan objectives and topic outline, and review draft iterations between October 2023 and April 2024, making recommendations based on each member's varied and considerable experience.

In contrast to some watershed management plans, the objectives of this plan do not include a waterway measurement or monitoring element for three reasons. First, the high number of monitoring stations needed to measure nutrient runoff from individual fields is not feasible in the short term primarily due to high cost, but also disinterest among producers in voluntary runoff monitoring and reporting. Second, edge-of-field monitoring is limited to specific metrics but can be viewed as a comprehensive indicator of soil health and water quality. Third, due to variations in nutrient and sediment runoff from fields across months and years, monitoring data would mean very little without several years of data collection. Compounding this issue is the time delay in field-level responses to BMPs, which may take 5-10 years to develop. In the current climate of voluntary action among producers, widespread field monitoring is not a reasonable goal in the short term.

However, monitoring plays an important role in producer behavior in the long term and is critical for developing a full understanding of what is working, what is not, and what systems might be altered to improve soil health and water quality. Important work is being done within Lenawee County to understand and improve conservation behaviors, and that work hinges on the availability of robust monitoring data. In the field of farm conservation research, there is a strong consensus around the importance of monitoring for informing behavior as well as for providing system-wide data, particularly for funding requirements. As such, this plan includes recommendations to participate in water monitoring efforts for long-term improvement and program effectiveness.

Additionally, “monitoring” in the general sense is necessary to understand the effectiveness of the plan in meeting its goals. In this plan, we include a list of metrics for monitoring progress of BMP adoption in Stony Creek which do not strictly depend on high-intensity water quality measurements. (See the final section, *Metrics and Evaluation*.)

Local Community Needs

Above all, local watershed conservation activities should contribute to the local community, not burden it. While there may be aspects of watershed conservation that seem costly, stewardship of the soil and water contributes to the sustainability of the largest economic driver in Stony Creek: agriculture. Agricultural BMPs contribute to the long-term sustainability of farming activity in the watershed, and therefore help to ensure the continued existence of the small towns and villages throughout Stony Creek.

Self-sufficiency, local knowledge, and pragmatism are key aspects of rural communities which are often overshadowed by policies and organizations operating from urban centers, sometimes prioritizing the knowledge and opinions of individuals without deep connections to rural America. Local communities should be embraced for their ability to contribute to practical solutions. As such, communities should be provided with a forum to participate in local planning activities, and their inputs should be weighed heavily in the final planning product. This will result in a plan which is prepared with the best insights into its specific, localized context, and plan implementation will be made more durable with the community participating throughout the process. In the context of voluntary conservation measures, deeply engaging with communities in this way is an ideal alternative to large-scale, top-down planning, which has failed to accelerate watershed stewardship where it is needed most.

Additionally, as part of the River Raisin watershed, Stony Creek is part of a long history of conservation and environmental stewardship. Since the River Raisin’s official acknowledgement in the Great Lakes Water Quality Agreement (GLWQA) of 1987, producers and community members have been consistently improving the condition of the watershed’s agricultural lands and waters (US EPA, 2019). Although recent events have focused attention on the area due to its nutrient contributions to Lake Erie, marked improvements have been made within the subwatershed, and this sentiment should preface any information and education (I&E) efforts here. Engagement practitioners should acknowledge the historical progress and the legacy of watershed stewardship within the

River Raisin watershed and convey their gratitude for the continued efforts of Stony Creek's producers and community members.

Recommendations

On-Farm Practices

Improving soil health and water quality in Stony Creek requires on-farm practices which reduce erosion, increase soil organic content, and minimize the potential for nutrient runoff. The topography varies throughout the subwatershed and is generally flatter in the southeast and hillier in the central and northwestern portions. Soil types and slopes throughout the subwatershed provide varying levels of erosion risk due to the natural landscape. In this sense, different fields will require different interventions for soil health and water quality, with one notable exception: Precision agriculture.

Precision agriculture is a system of farming which utilizes on-farm data to ensure crop yields are realized with the least amount of resource use. Primarily, the system involves closely tracking nutrient application so that fertilizers are not used where they aren't necessary, and so they're applied with the least product waste. This approach relies on regular soil testing to determine what areas in each field are saturated with legacy nutrients, and what areas require regular or increased application. Additionally, equipment is required to precisely apply nutrients below the soil surface for each plant. Recent experiments in Lenawee County have successfully shown that accounting for legacy nutrients in the field and precisely applying less nutrient has no appreciable impact on yields with significant cost savings to the producer (Graham Sustainability Institute, 2024). These and other findings were presented at the first-annual 2023 Western Lake Erie Basin Conference, held in Adrian, Michigan, where producer collaboration was highlighted as a key method toward increasing adoption of BMPs. However, producer attendance at the event was extremely low, exemplifying the engagement barrier between conservation practitioners and agricultural producers – a barrier this plan attempts to bridge.

Aside from the generalized recommendation for precision agriculture, this plan proposes a simplified three-phase BMP adoption strategy for use in Stony Creek. The strategy encourages producers and landowners to take on one practice per year for three years, and to maintain the combination of practices for a minimum of ten years to see marked improvements in soil health, water quality, and financial surplus from reduced inputs. Each practice is subsidized by a state or federal program, as shown in Table 1, with more support and information available through the Lenawee Conservation District staff. The two categories of field are generally more sloped (greater than 75% of the field in 3% grade or higher) and less sloped (less than 75% of the field in 3% grade or higher). Developed with models using satellite topography measurements and soil type data, Figure 5 shows the relative erosion risk within Stony Creek at a 30 square meter resolution. Figure 6 highlights farm fields which encompass high erosion risk areas, and which are not known to be actively using BMPs to control erosion.

Table 6: Conservation programming information for producers in Stony Creek.

	STRAND	**Soil Erosion 101, Back to Basics**
Program Administration	MSU Extension, Lenawee Conservation District	Lenawee CD
Program Website	https://www.canr.msu.edu/news/strand-cost-share-signup-is-live	https://www.lenaweeconservationdistrict.org/
Program Phone Number	517-263-7400 Ext. 5 (LCD) or 888-678-3464 (MSU Ext.)	517-263-7400 Ext. 5
Program Offerings	Cost-share for new or enhanced precision nutrient management strategies for acreage in Michigan WLEB drainage	Flat rate payments for grass waterways, erosion control structures, and WASCOBs
Program Application	See the Lenawee Conservation District at 1100 Sutton Rd, Adrian, MI 49221	See the Lenawee Conservation District at 1100 Sutton Rd, Adrian, MI 49221

	Taking Nutrient Management to Another Level	USDA NRCS Support & FSA Grants
Program Administration	Lenawee CD	USDA
Program Website	https://www.lenaweeconservationdistrict.org/	https://www.nrcs.usda.gov/getting-assistance/how-to-apply
Program Phone Number	517-263-7400 Ext. 5	517-263-7400
Program Offerings	Funding for yield monitors, hydraulic down pressure, electric drives, variable rate, GPS, nitrogen applicators, strip-till equipment, cover crops, no-till combo, and more	CRP, CSP, EQIP, RCPP (Funding for most/all conservation programs - contact your USDA service provider)
Program Application	https://uploads.documents.cimpress.io/v1/uploads/1446845d-c321-44e3-aca2-1ed2be75627a~110/original?tenant=vbu-digital	See the USDA Field Office at 1100 Sutton Rd, Adrian, MI 49221

	Michigan CREP
Program Administration	MDARD
Program Website	https://www.michigan.gov/mdard/environment/ crep
Program Phone Number	800-292-3939
Program Offerings	Additional cost-share for establishment of grasses, legumes, windbreaks, filter strips, riparian buffers, and more
Program Application	See the USDA Field Office at 1100 Sutton Rd, Adrian, MI 49221

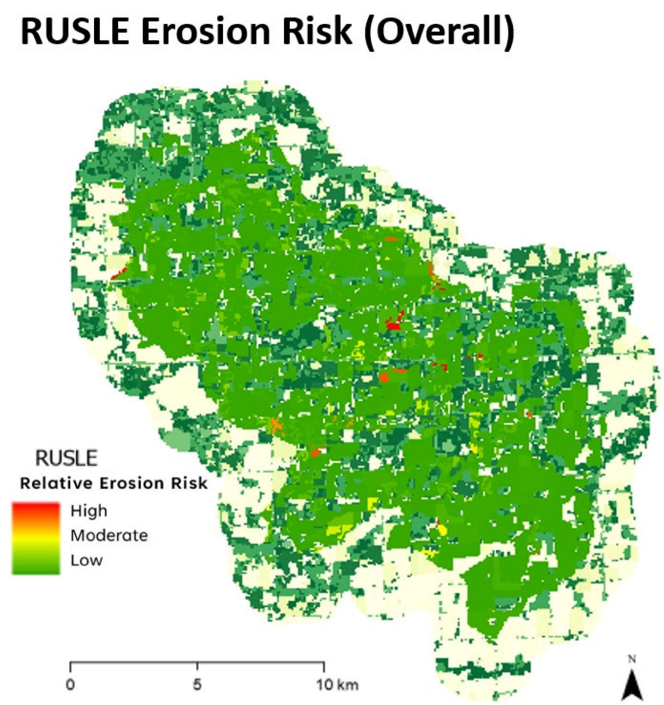


Figure 15: Stony Creek Relative Erosion Risk, factoring in soil type, rainfall data, and topography

For fields with moderate to high erosion risk according to Figures 5 and 6, three annually successive BMPs are recommended: Grassed waterways, WASCOBs, and no-till farming. Grassy waterways should be installed where natural gullies form in the landscape to trap suspended solids and prevent continued and repetitive erosion of soil. WASCOBs should be installed to impound water in a controlled manner and allow sediments to settle out either via elevated drainage or filtered drainage. No-till farming leaves maximum residue on farm fields and anchors the soil in place with the year's crop root systems, providing erosion resistance over the surface of the field.

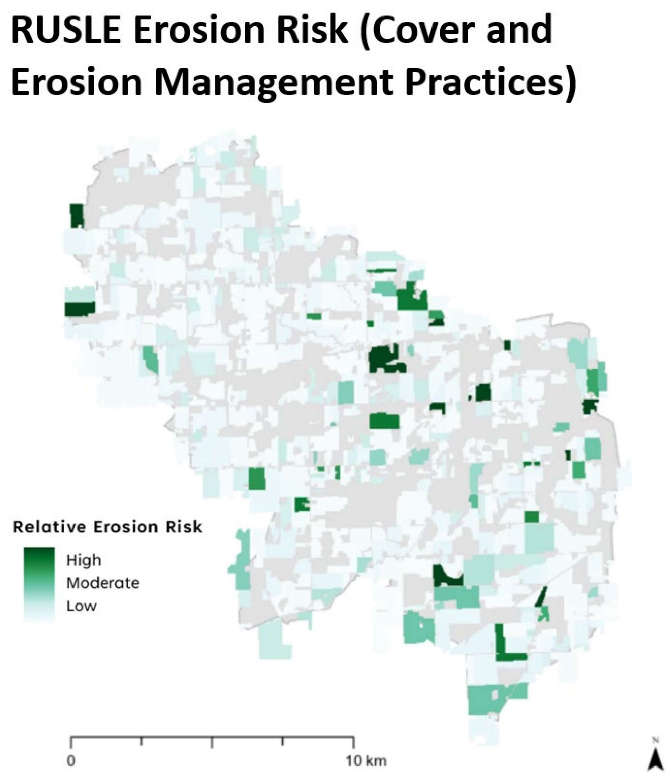


Figure 16: Stony Creek Relative Erosion Risk by Field and Observed BMP Use

For fields which fall in the low erosion risk categories in Figures 5 and 6, two alternative BMPs are recommended: Cover crops and filter strips. Like the benefits of no-till, cover crops anchor the soil and prevent erosion outside of the main growing season. Some cover crops can also be harvested and sold for a profit, but most are terminated and mulched to reincorporate biomass into the soil. See Table 1 for a comprehensive selection of cover crops applicable in Michigan and their individual pros and cons. Filter strips provide a riparian vegetation buffer between farmed row crops and drainage ditches, encouraging runoff nutrient uptake by buffer plants and improving local water quality.

Refer to Figure 7 for an agricultural BMP recommendations visual aid for Stony Creek producers.

Table 7: Selected Michigan cover crops for prevented planting with ratings for goals, advantages, and potential problems. Key: P – POOR, F FAIR, G – GOOD, VG – VERY GOOD, E – EXCELLENT, VH – VERY HIGH, H – HIGH, M – MODERATE, L – LOW, N – NONE. From Cover Crops for Prevented Planting, by D. Baas et al., 2019, MSU Extension.

			Goals						Potential Advantages								Potential Problems		
Species *	Summer Annual or Cool Season **	Winter Kill	N Scavenger	Soil Builder	Erosion Fighter	Weed Fighter	Good Grazing	Quick Growth	Subsoiler	Free P&K	Loosen Topsoil	Suppresses Nematodes	Suppresses Soil Diseases	Allelopathic	Attract Beneficials	Bears Traffic	Becomes a Weed	Attracts Harmful Insect/Nematodes	Contributes to Crop Diseases
Annual Ryegrass	SA	No	VG	VG	VG	VG	VG	VG	G	G	E	G	G	G	F	E	VH	N	L
Barley	CS	No	VG	VG	E	VG	VG	VG	G	G	VG	F	G	VG	G	G	L	M	M
Oats	SA	Yes	VG	G	VG	E	G	E	P	F	VG	P	G	VG	P	G	N	L	L
Rye	CS	No	E	E	E	E	G	E	F	VG	E	VG	VG	E	F	VG	M	L	L
Wheat	CS	No	VG	VG	VG	VG	VG	VG	G	VG	VG	F	F	F	F	G	L	M	M
Sorghum-Sudan	SA	Yes	E	E	E	VG	VG	E	E	G	G	VG	VG	E	G	G	L	L	N
Buckwheat	SA	Yes	P	G	F	E	P	E	P	E	VG	F	P	VG	E	P	VH	L	N
Radish	SA	Yes	E	VG	VG	E	G	VG	E	VG	G	VG	G	VG	F	F	L	L	N
Rapeseed	CS	No	VG	G	VG	VG	G	VG	G	F	G	VG	G	VG	G	F	M	M	N
Berseem Clover	SA	Yes	G	VG	VG	VG	E	E	VG	VG	G	F	F	G	VG	G	L	M	L
Crimson Clover	SA	Maybe	G	VG	VG	VG	G	E	F	G	G	F	G	F	VG	F	L	H	L
Red Clover	CS	No	G	VG	G	VG	E	F	VG	VG	G	F	F	G	VG	G	L	M	L
Sweetclovers	CS	No	F	E	VG	VG	F	G	E	E	E	F	F	F	VG	G	M	M	N
Winter Pea	CS	No	F	G	VG	G	VG	VG	F	F	VG	G	VG	F	VG	F	N	L	M
Hairy Vetch	CS	No	F	VG	G	G	G	F	G	G	VG	F	G	G	E	P	H	L	N

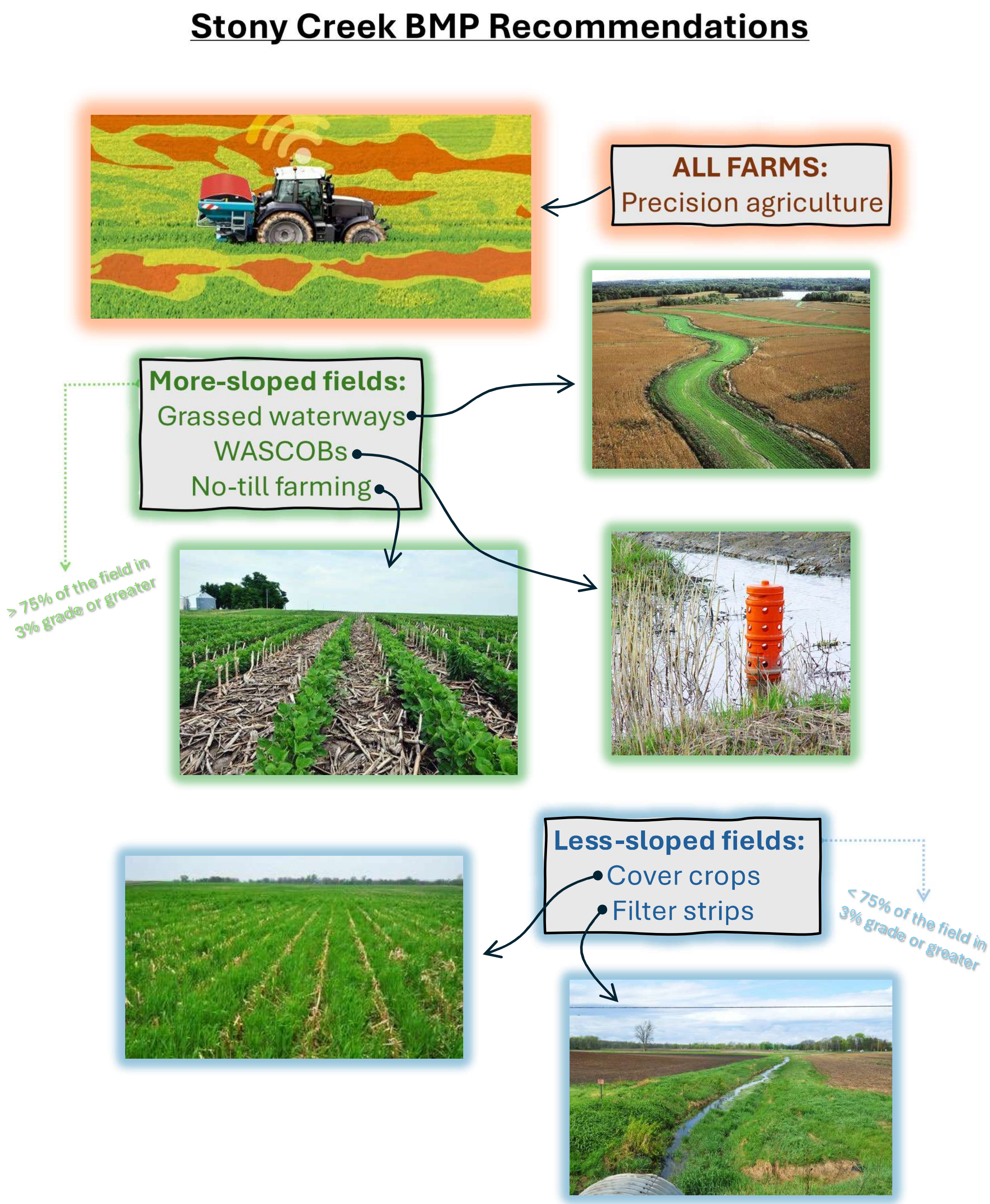


Figure 17: Stony Creek BMP Recommendations Visual Aid, showing the primary recommendations for Stony Creek farmers. Recommendations are differentiated between more- and less-sloped fields, defined by EGLE standards (greater/less than 75% of the field in 3% grade).

Information and Education (I&E)

Agricultural BMPs are familiar to producers, and yet BMP uptake lags in Stony Creek. This points to a need for more and better opportunities to bring farmers together to discuss and demonstrate the positive impacts of BMPs and the significant financial support available for conservation. Part of the information gap comes from the lack of edge-of-field monitoring, which some local producers indicate would make a difference in their conservation practice decision-making. In the absence of field-level monitoring data, there is still plenty of information which can be communicated and utilized for improved BMP uptake.

There are educational opportunities for Stony Creek producers interested in conservation farming in the form of the Center for Excellence field day and events put on by the Farmer-Led Conservation group and the Michigan Association of Conservation Districts (MACD). These events are annual or bi-annual and consist of informational sessions and updates from producers and researchers working in agricultural conservation. One approach to increasing I&E in Stony Creek is to attract more producers to these events. Event organizers should interface with local communities to develop a communication strategy to reach producers and landowners in the watershed with effective messaging and delivery methods.

A different approach is to increase engagement opportunities within Stony Creek on a more frequent and less formal basis. Quarterly events could be organized for producers, landowners, and watershed residents with informal conservation messaging to encourage community discussions around soil health and water quality. These sessions could be accompanied by pamphlets of up-to-date contact, program, and website information for conservation subsidy programs at all levels of government. This type of outreach effort could also be made at existing community events such as fairs, festivals, markets, etc. More frequent interactions embedded within the community may provide better engagement outcomes than less frequent special events.

A key aspect of both approaches is cooperation between conservation organizations' activities in Stony Creek. To maximize outreach, pool resources, and provide the most comprehensive set of information and recommendations to producers and community members, conservation organizations should coordinate their efforts as much as possible. For coordination purposes, a lead organization should be appointed to synchronize information and outreach activities on a central webpage for ease of access. Participating organizations (see Table 2) should agree to a coordination scheme, in which each organization procedurally updates the others on planned activities in and near Stony Creek.

Implementation Activities

There is no single path toward implementation of the recommendations in this plan. However, in the realm of voluntary farm conservation practices, careful outreach and engagement with producers may be the most important effort at the subwatershed level.

Active outreach is critical, whether at the individual or organizational level, and there are opportunities to bridge both levels on a more frequent basis. Table 2 lists organizations that are active in the local conservation space, and that may have an interest in coordinating outreach for sustainable farming practices. Organizing with these entities to provide quarterly or monthly opportunities for gatherings within Stony Creek would allow for more engagement with local producers. However, there is the issue of attracting producers to such events. Local advertising of events through geographically targeted social media ads, local radio station placements, notices placed in the Adrian Telegraph newspaper, and mailing notifications are all underutilized, with the latter having an outsized impact in recent Farmer-Led Conservation meeting attendance for new attendees.

These organizational outreach efforts should be paired with town halls in Clayton and Dover Township, local festivals, and other community events. Rather than catering to farmers at farmer-specific events, outreach should include engagement with the local community more broadly to normalize agricultural conservation concepts and raise the general awareness of their benefits for soil, water, and long-term sustainability. Changing community expectations about what healthy farm fields look like plays a role in the choices that farmers make within their communities, indicated by Stony Creek locals discussing the perceived “properness” of fields tilled bare after harvest.

In addition to active outreach, there is a need for locally specific conservation recommendations and information to be easily accessible and understandable in an online format. This should take the form of a single webpage, simple and easily navigable, which provides all the relevant information for Stony Creek producers and community members to become more informed and active in the conservation space. Utilizing an existing organization such as the River Raisin Watershed Council or the Farmer-Led Conservation group offers the most efficient pathway to establishment and maintenance of a one-stop-shop for local information outside of a government offering through MDARD or the Lenawee Conservation District.

The webpage should host links to recommended BMPs for Stony Creek farmers, as well as to the relevant cost-share programming at the Federal, State, and Conservation District levels, with instructions for application, “frequently asked questions” (FAQs), and other information designed to provide a first-time visitor with all the information they would need to get started on a program application. The webpage would not attempt to be a replacement for resources provided by the Lenawee Conservation District, but rather a complement to the office and an additional resource to utilize when the District is task-saturated or unable to quickly respond to inquiries.

Importantly, this plan does not call for implementation or adoption of novel technologies for phosphorus capture or runoff prevention. Rather, community engagement and educational efforts should focus on the primary BMP recommendations included in this plan, which are well known and present a lower barrier in terms of aversion to change or perceptions of risk.

Table 8 Local Agricultural Conservation Organizations and Contact Information

Organization	Role	Location	Email	Phone
Lenawee Conservation District	Local government agricultural and natural resource conservation assistance, programs hub	Adrian, MI	brooke.bollwahn@macd.org	517-263-7400 (Ext. 5)
River Raisin Watershed Council	Watershed conservation non-profit, planning and implementation grant partner	Tecumseh, MI	rrwc@lenawee.mi.us	517-264-4754
Legacy Land Conservancy	Land trust and conservation non-profit	Ann Arbor, MI	info@legacylandconservancy.org	734-302-5263
MI Farm Link	Farm succession assistance, new farmer assistance, farmland conservation organization	Washtenaw County, MI	hello@mifarmlink.org	734-302-8715
Future Farmers of America	Youth and student organization for agriculture and leadership	Lenawee County, MI	region2ffa@gmail.com	517-849-9934
Farmer-Led Watershed Conservation	Conservation farming networking and education organization (administered by RRWC)	Lenawee County, MI	rrwc@lenawee.mi.us	517-264-4754
LISD Tech Center	Career technical education, natural resources and agriscience	Adrian, MI	carley.kratz@lisd.us	517-263-2108
Michigan Association of Conservation Districts	Advocacy organization for Michigan Conservation Districts	Flint, MI	dan.moilanen@macd.org	517-331-4391
Village of Clayton	Local government body & gathering space	Clayton, MI	villageofclayton@gmail.com	
Dover Township	Local government body & gathering space	Clayton, MI		517-445-2412 517-445-2267

Metrics and Evaluation

Metrics and monitoring continue to be a crucial element of watershed planning at the state and federal levels. Metrics typically come in the form of water quality monitoring data within key waterways and, in some cases, at the edge-of-field. However, for a nuanced understanding of all conditions contributing to nutrient and sediment losses from fields, and to offer recommendations for field-level BMPs backed by sampling and measurement, much more edge-of-field monitoring would be needed in Stony Creek. However, in Stony Creek (and perhaps at the HUC-12 scale in general), resources and social will would not support a local effort to install and maintain monitoring equipment at the field edge. This arduous and expensive task can only be left to State and Federal agencies, and implementation of such a program is not guaranteed even with their resources.

Rather than emphasizing a focus on metrics related to soil and water samples for Stony Creek, this plan recommends gathering and analyzing metrics related to the quantity of the following variables:

- Cropland acres enrolled in MAEAP, CREP, and other conservation programs,
- Number of farms enrolled in MAEAP, CREP, and other conservation programs,
- Miles of grassed waterways installed,
- Acres of cover crops,
- Acres of no-till and low-till,
- Acres managed via WASCOB,
- Miles of vegetated riparian buffers (buffer strips),
- Community outreach events quarterly and annually,
- Community outreach attendance,
- Farm conservation organizations active in Stony Creek, and
- Conservation champions active in Stony Creek.

Each of the variables on the list is measurable either through data collected by government entities via conservation programming enrollment, desktop analysis of satellite imagery, or by organizational network mapping and records from community engagement events. In terms of monitoring progress and setting goals for BMP uptake, these categories of data are either more readily available and feasible for collection, or they are already available. Additionally, they represent viable proxies for strict monitoring of water quality within Stony Creek. However, while several of these metrics are easily available at the state- and national-level through the USDA Agriculture Census, there are no products which identify their values at the county or subwatershed level. For example, there are 167,800 acres of cropland enrolled in MAEAP (MDARD, 2023), constituting 2.2% of the total 7,515,740 acres of cropland in the state (USDA, 2022). Whether or not this is representative of the situation in Stony Creek is unclear, and developing subwatershed-level statistics would set up the necessary foundation for goal setting and progress evaluation. The context of this example can be extended across the following recommended metrics: Number of farms enrolled in conservation programs, miles of grassed waterways, acres of cover crops, acres of no-till and low-till, acres managed via WASCOB, and miles of vegetated riparian buffers. Submitting a Freedom of Information Act request from USDA Agricultural Research Service, National Agricultural Statistics Service (NASS) for this data in the specific Stony Creek geographic area may be required to develop these localized statistics.

The additional metrics are not likely to be housed in one central location, may not exist in a standard format, and may need to be developed from scratch in partnership with local conservation agencies and NGOs (see Table 3). Researching, maintenance, and publishing of these metrics would likely be a central role of a Stony Creek agricultural conservation entity, whether at the Conservation District, another local entity, or a new organization focused on agricultural conservation in Stony Creek.

Conclusion

Agricultural conservation for environmental improvement and long-term sustainability is a critical task facing producers in the Stony Creek (South Branch River Raisin) subwatershed. While producers here have opportunities to take up agricultural best management practices through a wide range of government-subsidized cost-share programs, the adoption rates of these practices are hindered by several factors. Economic, bureaucratic, and socio-cultural aspects of BMP adoption all present challenges to producers and weigh heavily in their choices regarding the uptake of conservation practices. These challenges can be mitigated, in part, through building more and better community-based engagement and educational efforts. Opportunities for community-centric conservation networking exist within the various organizations currently operating in and near Stony Creek (see Table 3). These organizations can be leveraged as a holistic resource for developing community conservation events at higher than annual or bi-annual frequency throughout the region. By centering the lived experiences of local producers, information and education efforts can boost perceptions and attitudes around BMPs, which are a critical marker of whether producers will overcome barriers and pursue conservation practices.

Additionally, the barriers described can be mitigated with simple and specific conservation programming, most accessed through Lenawee Conservation District but also available through USDA FSA and NRCS efforts. We recommend all producers take up precision agriculture in order to utilize their operational inputs most efficiently for cost savings and improvements to soil health and water quality. Additionally, for producers who are new to conservation practices, we recommend one of two suites of BMPs depending on whether farm fields are more- or less-sloped, with practices including cover crops, reduced tillage, WASCOBs, and others. These practices are all covered by cost-share programming, with program details listed in Table 1.

While our recommendations are specific to Stony Creek, they are simplified and by no means exhaustive. We believe the recommendations provided here are the most direct route to increasing the adoption of BMPs in this region, but there is certainly a need for creative approaches to increasing BMP adoption in the future. Conservation competitions, local conservation newsletters, conservation champions, increased involvement with local town halls – these and more could bring a fresh perspective to community conservation planning within the Stony Creek community for improved local and downstream conditions.

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