A WISCONSIN COMMUNITY REDUCES STREAM WATER PHOSPHORUS AND GROWS MOMENTUM FOR CONSERVATION AGRICULTURE

by

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TABLE OF CONTENTS

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Abstract

Agricultural phosphorus (P) runoff is the primary driver of surface water quality degradation in the United States Upper Midwest, where field-level conservation practices do not fully mitigate soil and nutrient loss from annual row crops. We evaluated steam water P concentrations in a targeted watershed experiment that increased managed grazing of perennial grassland using a Before-After-Control-Impact (BACI) analysis (before: 2017-2020, after: 2021-2025). We found that transitioning <1% of the watershed area to well-managed grazed perennial grassland resulted in a ~14% net reduction in P concentration compared to reference watersheds. Analyses of P concentrations in subcatchments using a paired watershed analysis found the pattern was strongest in specific areas, suggesting that spatially targeted interventions could have disproportionate effects on watershed-level outcomes.. Our results represent the first known demonstration of watershed-scale stream water P reduction via agricultural land use change showing that modest land use transitions toward perenniality can yield disproportionately large water quality benefits. Interviews with community actors highlighted a collaborative collective action model as the primary driver of successful project implementation that illustrates a scalable framework for system-level agricultural transformation.

Introduction

The ecological impacts of the industrialized agricultural system that dominates the United States Upper Midwest are evident in the region's degraded waterways (Motew et al., 2018; Lathrop et al., 1998; Asplund et al., 2023). Driven by nitrogen (N) and phosphorus (P) runoff from intensive farming practices, massive nutrient loading fuels a persistent hypoxic zone downstream in the Gulf of Mexico (Marshall et al., 2018; Houser & Richardson, 2010; Bian et al., 2022; Bauddh et al., 2020). More locally, impacts are evident in the “Driftless Area” of southwest Wisconsin, where the combination of intensive row-crop production and steep topography creates a high risk for soil and nutrient loss, in particular P, to surface waters (Berhe et al., 2018; Zhang et al., 2019; Rath et al., 2025) impairing their uses for recreation, biodiversity, and drinking water (Carvin et al., 2018; Diaz & Rosenberg, 2008; Mathewson et al., 2020; Lathrop & Carpenter, 2014). For affected communities, fewer days of swimming and fishing are available (Brooks et al., 2016), and tourism revenue declines (Eiswerth et al., 2008) while surface water P-remediation costs millions of dollars (Meyer & Raff, 2024). For farmers, agricultural runoff means that costly fertilizer inputs and soil resources are washed away and wasted (Powell et al., 2002).

While models suggest that top-down regulation has successfully reduced regional mass balance inputs of P at a macro-level (Raff et al., 2026), this progress has not translated to widespread surface water quality improvements. This is primarily due to the vast accumulation of “legacy P” stored within soils from decades of historical nutrient imports (Johnson et al., 2026). Mitigating ongoing loading requires agricultural frameworks that simultaneously reduce exogenous P inputs and stabilize existing in-field stores. Recent work in the Midwestern USA shows the potential for strategic plantings of native prairie strips to drastically curtail P export at the field edge (Zhou et al., 2014). Additional studies highlight the potential of alternative systems, such as well-managed grazing of perennial grassland (Vadas et al., 2015a, 2015b) or their implementation within small catchment areas (Young et al., 2023) to reduce nutrient pollution. However, the empirical scalability of alternative agricultural land uses such as well-managed grazing at the landscape scale remains a critical gap in the literature.

To achieve landscape-scale adoption of alternative systems, farmers, researchers, policy makers, and conservation organizations are increasingly looking beyond top-down regulations toward bottom-up collective action models as a way to support larger systemic transformations (Norström et al., 2020). In particular, farmer-led watershed groups are gaining attention as a bottom-up approach for watershed restoration, leveraging peer-to-peer networks to foster community buy-in and coordinate conservation across property boundaries (Prager, 2015; Alblas & van Zeben, 2023). These grassroots frameworks are considered uniquely suited to scale complex agricultural transitions because changing land use patterns requires overcoming social and economic inertia at the community level where these groups are positioned (Alblas & van Zeben, 2023).

However, the ability of these collective action models to tangibly improve water quality depends largely on whether their strategies target systemic agricultural change or merely encourage incremental interventions to the existing systems. Currently, many farmer-led initiatives focus on voluntary, incremental modifications rather than systemic changes to agricultural management. Agricultural P loss is driven by systemic imbalances that traditional conservation efforts fail to address. At the farm level, the import of exogenous feed creates P surpluses that exceed the retention capacity of soils (Waller et al., 2021; Long et al., 2018). This risk is compounded by the dominance of annual row crops that typically leave soils bare and vulnerable to erosion and leaching and lack the deep root structures necessary for soil stability and nutrient retention (Zhang et al., 2025; Sanford et al., 2021). Despite some adoption of best management practices (BMPs) like cover crops and reduced tillage, these incremental adjustments fail to address the fundamental instability of annual systems and can inadvertently increase dissolved P loads (Daryanto et al., 2017; Hanrahan et al., 2021). Consequently, “non-point source” pollution from agricultural fields remains the primary driver of water quality degradation in Wisconsin, signaling a need to move beyond incremental adjustments to annual cropping systems (Campbell et al., 2022).

While modifications to annual cropping systems have not meaningfully reduced nutrient pollution at the watershed scale, alternative farming systems have been shown to offer significant improvements. In contrast to annual cropping systems, which in the US are utilized for producing feed for beef and dairy animals, well-managed grazing of perennial grasslands is a regenerative alternative to the industrial approach to milk and meat production (Jackson, 2024). Well-managed grazing practices utilize multi-species pastures and strategic livestock rotation to actively manage both herd health and pasture vitality. Because these systems provide year-round soil cover and improved soil structure (Cates & Ruark, 2017), they offer a significant reduction in the erosion-driven transport of P compared to annual row-crop systems (Augustine et al., 2021; Wepking et al., 2022). Recent studies have found that well-managed grazing results in negligible P loss compared to row-crops (Young et al., 2023; Good et al., 2025). However, the scale of change required to meet surface water quality goals is immense; recent watershed modeling indicated that meeting regional water quality goals would require restoring ~50% of agricultural land to perennial grassland, reducing the number of animal units in the watershed by 50% (thereby reducing the nutrient imbalance), and maintaining those changes for half a century (Campbell et al., 2022).

Despite these documented ecological benefits, transitioning from the dominant industrialized annual agricultural systems to perennial grassland-based agriculture is an immense challenge. This shift is hindered by a lack of institutional support, specifically a shortage of technical experts qualified to develop grazing plans, and a scarcity of financial incentives for agricultural transitions that can compete with an industrial system that favors productivist goals over conservation (Wardropper, 2018; McDonald et al., 2018; Jackson, 2024; Jackson & Gratton, 2026). These institutional barriers create a path dependency that locks producers into annual cropping, regardless of water quality costs to society (Roesch-McNally et al., 2018). These barriers highlight the need to pilot integrated models that deliver targeted technical guidance and financial support needed to scale these systemic agricultural transitions.

In southwestern Wisconsin, a local farmer-led watershed council initiated a project to explore if increasing the amount of grazing in a watershed could improve water quality. The "Tainter Creek Grazing Project" piloted a collaborative framework among the Tainter Creek Farmer-Led Watershed Council and a consortium of organizations ranging in size, locality, and skills. By providing the professional grant management and hands-on support that individual producers often lack, the project sought to bridge the 'implementation gap' through a strategic cost-share framework supported by dedicated technical service providers (TSPs). The project emphasized significant 1:1 interactions between interested farmers and TSPs who were local experts on both the sociopolitical dynamics of the community and the intricacies of transitioning farms from annual row crop systems to grazing systems. In addition, the project eased barriers to participation by reducing administrative and technical burdens typically experienced with conservation cost-share programs. Simultaneously, the project engaged in community science water quality monitoring to evaluate whether adding and enhancing grazing practices could measurably improve stream waters of the watershed.

In this study, we addressed the Tainter Creek project's efficacy on water quality by evaluating stream water P concentrations and developing a qualitative narrative about the internal mechanisms of the community collaboration. By synthesizing empirical water quality data with the lived experiences of the farmers, technical service providers, and project coordinators, we quantified the impacts of managed grazing while identifying strategies to improve the scalability of future farmer-led conservation initiatives.

Methods

Tainter Creek Grazing Project

Established in 2016, the Tainter Creek Farmer-Led Watershed Council in southwest Wisconsin shows how collaborative frameworks can overcome barriers to grassland agriculture transitions. Supported by the Valley Stewardship Network (VSN), a local conservation non-governmental organization, and the Vernon County Land Conservation Department, the council focused primarily on land management changes to mitigate agricultural externalities, such as impaired stream water quality, while advancing other initiatives along the way. In 2018, the group secured their initial State of Wisconsin Department of Agriculture, Trade, and Consumer Protection's Producer-Led Watershed Protection Grant funding to formalize their efforts (Rushmann et al., 2019). Simultaneously, the *Pasture Project* at the Wallace Center (https://pastureproject.org/) identified the Tainter Creek watershed as a priority site for P and sediment reduction within the Upper Mississippi River Basin. Facilitated by VSN, the Pasture Project secured a federal Environmental Protection Agency (EPA) grant to reduce P and sediment runoff by 5% through the Tainter Creek Grazing Project (2019–2022). Researchers from the University of Wisconsin-Madison's *Grassland 2.0* project partnered to facilitate community conversations, modify the water quality sampling design, and build the GrazeScape™ model (https://scapetools.grasslandag.org/grazescape/) to assist with farmer-engagement and planning as well as water quality analyses to predict and assess project impact.

With the overarching goal of improving water quality in the Tainter Creek watershed, the grant proposal to the US EPA identified goals of 5% reduction in P (771 kg yr^{-1}) and sediment (852,754 kg yr^{-1}) runoff. The team worked together to identify pathways for soil stabilization and nutrient reduction. They agreed that increasing perenniality and livestock integration in the watershed could help them reach water quality goals while also supporting farmer livelihoods. TSPs partnered with UW-Madison researchers to build a spreadsheet model that used data from the USDA Web Soil Survey (Soil Survey Staff, 2019), SnapPlus (University of Wisconsin-Madison, 2019), and RUSLE2 (USDA-ARS, 2013) to estimate the scope of land use transitions that might be necessary to reach their P and sediment reduction goals. Using this spreadsheet model, they estimated that it would require either a complete conversion of ~223 ha of annual row crops to managed grazing or installation of ~1,012 ha of grazed cover crops on annual row-crop fields to achieve these goals.

The partnership designed a cost-share model to pay for either the labor or material costs required to implement new practices on farmers' land. The payments were distributed to participating farmers based on the amount of P or sediment the new practice was estimated to reduce. Funded practices included conversions from row crops to pasture systems, grazable cover crops, grazing infrastructure enhancements, and grazable prairie plantings. Conservation technical service providers worked with each farmer interested in the project to complete a whole-farm enterprise assessment to ensure that the project was a good fit within their business plans. The assessment sought to understand each farmer's capacity for hands-on management, their current practices including crop rotations and any livestock they owned, whether land was owned or rented, what their business and conservation goals were, and any perceived or real barriers they faced. Once a pool of interested landowners was identified, they were guided through the grazing planning process to determine if this was an appropriate system to implement on their land as well as whether they met the specific criteria to be eligible for cost-share. TSPs provided each farmer with a suite of maps that described the property's current land management, topography, soil type, and any areas of critical conservation concern. TSPs had conversations with each farmer about what their goals were, how proposed management changes might affect their production, input costs, and herd health in addition to potential ecological outcomes based on the computational spreadsheet model. This collaborative approach ensured that grazing enterprise plans were rooted in economic viability, practicality, and ecological outcomes. By prioritizing cost-savings and operational profitability, the project coordinators, TSPs, and producers worked to ensure the transition to managed grazing was both financially and environmentally sustainable.

Ultimately, the project distributed \$173,000 to implement conservation practices on 98 ha, with a focus on converting annual cropping systems to well-managed grazing. Through the support of VSN and Vernon County Land and Water Conservation District, 26 farms received technical assistance, and 14 formal grazing plans were established. Spreadsheet modeling estimated that these transitions could produce reductions of ~1,043 kg of P and ~1,451,496 kg of sediment at the field scale. If implemented, these proposed changes were estimated to exceed project goals by 135% and 170%, respectively, on the 98 ha where projects were implemented. While modeled estimates suggested that reductions in P loss from agricultural land were possible at the magnitude needed to meet goals, an analysis of stream water quality was needed to validate the project's efficacy.

Assessing stream water P response to land use change

We developed a grazing implementation experiment that followed a Before-After-Control-Impact (BACI) design commonly used in landscape level ecological studies. We compared the grazing implementation watershed (hereafter the "treatment") of the Tainter Creek) to two nearby "reference" watersheds. The treatment and reference watersheds were selected to be similar before the intervention occurred, were measured before the grazing implementation and then tracked following the grazing treatment application (Stewart-Oaten & Bence, 2001). Three watersheds were selected for this study that were determined to be similar in their geographical location, topography, landscape composition, and dominant agricultural practices (Table 1; Figure A1). Grazing practices in the Tainter Creek watershed were implemented beginning in 2021. The reference watersheds (Halls Branch and West Fork) differed from Tainter Creek in that they did not have a producer-led watershed group collectively managing the watershed, and there was no organized transition to managed grazing being facilitated in these watersheds (Table 1).

Table 1. HUC-12 watershed descriptions. Quantified land use areas for the Tainter Creek, Halls Branch, and West Fork HUC-12 watersheds including total area, agricultural area, and forested area, as well as presence of collective management at time of study and study group.

HUC-12 watershed name	**Watershed area (ha)**	**Agricultural area (ha)** *% of total*	**Forested area (ha)** *% of total*	**Grassland area (ha)** *% of total*	**Collective watershed management?**	**Study group**
Tainter Creek	13,612	4,534 *33 %*	5,446 *40%*	3,292 *24%*	Yes	Treatment
Halls Branch	3,383	664 *20%*	1,719 *51%*	935 *28%*	No	Reference
West Fork	11,109	3,153 *28%*	3,633 *33%*	3,836 *35%*	No	Reference

Targeted land use and land cover change

Grazing practices implemented in the Tainter Creek watershed included grazing cover crops, grazed prairie plantings, converting annual row crop systems to managed grazing, enhancing existing grazing practices by repairing flood damaged fencing and heavy use areas, and adding additional fencing and water systems for increased rotational frequency, and conversion of annual cropping systems to well-managed grazing. In the Tainter Creek watershed 98 ha (<1% of total area) received some type of grazing treatment. There were also two streambank restorations in the Tainter Creek Watershed that occurred during the timeframe of this study that were not associated with the Tainter Creek Grazing Project but may have affected stream water P. See appendix A for additional details of known land use change (Table A2).

Stream water sampling

Stream water sampling was conducted at 9 sites within the 3 study watersheds beginning in 2017 and continued at varying capacity through 2025 (Figures A1, A2; Table A1). Each of the HUC-12 watersheds have pour points flowing into the Kickapoo River (Figure A2). Sample sites within each watershed had a hierarchical spatial distribution. For instance, site 9 in the West Fork watershed was upstream of site 8 (pour point), and sites in the Tainter Creek watershed sampled areas of growing size as they were located successively downslope (sites 7 through 2). Halls Branch watershed had a single sampling site at its pour point (Site 1). Subcatchments were drawn with the watershed delineation tool in USGS StreamStats (Ries et al., 2017) and some are nested within each other (Figure 1).

In 2017 and 2018, water sampling was opportunistic and unconstrained by a rigid schedule, reflecting a volunteer and citizen-science led collection phase. Beginning in 2019 and continuing throughout the duration of the study, the protocol transitioned to a systematic, monthly fixed-frequency routine during the growing season (May-October). Under this formalized schedule, sampling events were conducted once per month and anchored to a designated weekday (typically the second, third, or fourth Wednesday of the month, depending on the institutional calendar for that year). Annual data collection intensity varied across the study timeline with sampling efforts concentrated during 2019-2022 due to increased budget and staff capacity. Importantly, sampling intensity was evenly distributed across all monitoring sites (Table A1). Local volunteers and conservation technicians collected water samples by scooping ~240 mL of stream water into a sterile sample cup, adding a small vial of sulfuric acid to the bottle to stabilize it, and sending it to the Wisconsin State Laboratory of Hygiene for analysis. The Wisconsin State Laboratory of Hygiene follows US EPA protocols to determine the concentration of total P in the sample (U.S. Environmental Protection Agency, 1993). From each stream water sample on a collection date we obtained the concentration of total P.

Daily precipitation data were obtained from the PRISM Climate Group (Daly et al., 2008). We utilized the AN91d dataset at a 4-km spatial resolution, centered on the study area (Lat: 43.4245, Lon: -90.8793). These daily values were used to calculate the cumulative 7-day rainfall for each streamwater sample. Because the study period extended into mid-2025, precipitation values for the final months were considered provisional as per PRISM quality control protocols (data retrieved 11 November 2025).

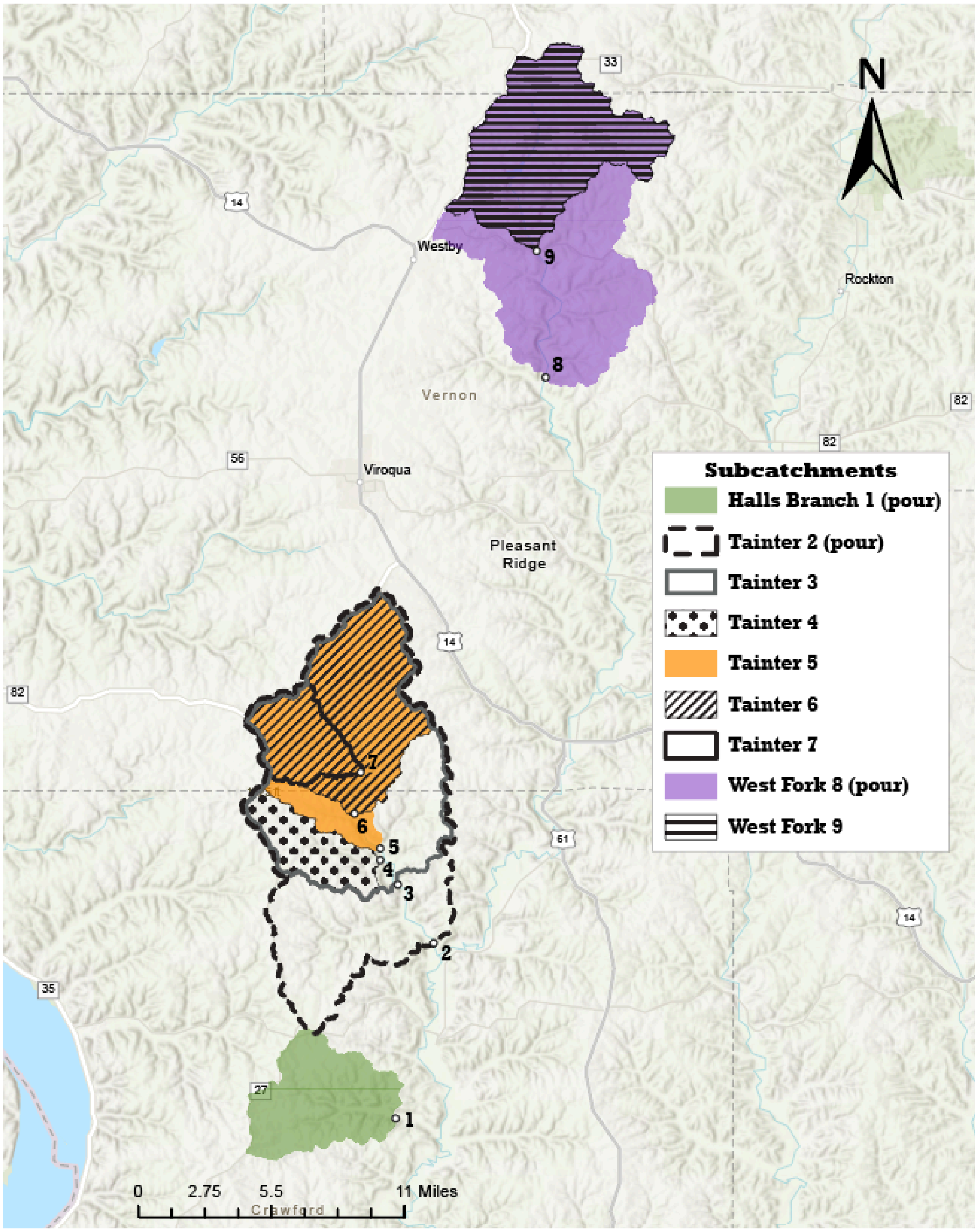

Figure 1. Nested subcatchments within HUC-12 watersheds. Pour points (Halls Branch 1, Tainter 2, and West Fork 8) represent the drainage area for their respective HUC-12 watersheds. Subcatchments 3-7 in the Tainter Creek HUC-12 watershed are nested within each other, and subcatchment 9 is nested within the West Fork HUC-12 watershed.

Data analyses

Before-After Control-Impact (BACI) analysis

We used a generalized linear mixed-effects model (GLMM) to analyze the 574 samples retained after the removal of duplicates and outliers. To align with the BACI design described above, data were categorized by Period (Calibration/Implementation), Treatment (Reference sites [1, 8, 9]/Tainter Creek sites [2-7]), and the Period x Treatment interaction to test the primary BACI hypothesis: that sites in the treatment watershed Tainter Creek would show a decrease in P the implementation period, relative to the reference watersheds.

The model also included covariates of Year and Precipitation as fixed effects, along with their respective interactions with Period, to account for shifts in temporal trends in P and hydrologic activity that could also have influenced variability in P.

The Year variable (2017-2025, continuous variable) was mean-centered to aid with model convergence and allow for the interpretation of main effects at the study's temporal midpoint. Year captures annual linear trends affecting phosphorus concentrations, allowing the model to distinguish between long-term regional declines and the specific impacts of the grazing treatment (Period term). Precipitation in the 7 days preceding sample collection (log-transformed) was used to account for changes in phosphorus concentration due to more or less rainfall before sampling.

Site ID was included as a random effect to account for repeated measurements at a specific site. We used a gamma model with a logarithmic link because phosphorus data were right skewed. Heteroscedasticity was addressed by modeling the data dispersion as a function of Period, accounting for the significantly different variance of phosphorus concentrations observed before and after implementation.

To settle on the final model structure, we conducted a multi-stage model selection process using the glmmTMB package. We first built a comprehensive candidate suite of 13 models to evaluate interactions ranging from simple additive baseline effects to highly parameterized three-way and four-way global interaction structures. These candidates were ranked via Akaike Information Criterion corrected for sample size (AICc). We then isolated a refined four-model matrix to test specific configurations of the precipitation response. By comparing both AIC | BIC alongside formal nested Likelihood Ratio tests, we confirmed that including the two-way interactions for both period x precipitation and period x year provided the most parsimonious and biologically sound fit. This structure successfully captured changes in the watershed's change in response to precipitation over time while isolating the true management signal from environmental noise.

The final model prioritized parsimonious two-way interactions to isolate three distinct environmental shifts. First, a significant two-way interaction between Period and Treatment would indicate that the implementation of grazing practices resulted in differences between the treatment and reference watersheds (the main BACI effect). Second, an interaction between Period and Precipitation was included to evaluate changes in the study region's hydrologic sensitivity (the "Rain Slope") between periods. Third, an interaction between Period and Year was included to account for potential differences in the annual linear trajectory (the "Yearly Slope"), testing whether the trends in phosphorus concentrations changed between experiment periods.

Model assumptions were examined using DHARMa-simulated residuals. We used the Durbin-Watson test to confirm the absence of temporal autocorrelation and Moran's I to confirm the absence of spatial autocorrelation; results indicated no evidence of significant temporal or spatial dependence among the residuals in the final model. Statistical significance for all tests was assessed at the α=0.10 level. This cutoff level was deemed appropriate for this landscape-level study because the risk associated with committing a Type II error (missing a true conservation signal) was considered greater than the risk of a Type I error (finding a false positive). Final significance for the BACI interaction was determined using a Likelihood Ratio Test (LRT) comparing the full model to a null model excluding the Period x Treatment interaction term.

To interpret the effects in terms of water quality outcomes, we calculated Estimated Marginal Means (EMMs) using the emmeans package in R. These values represent predicted phosphorus concentrations for each group and period while holding all other model covariates (Year and Precipitation) at their mean values. The "net reduction" attributed to the grazing intervention was derived from the back-transformed interaction coefficient, which isolates the Tainter Creek response from the regional background trends observed in the reference watersheds.

A series of sensitivity analyses were conducted to validate the structural stability of the primary model and confirm that observed trends in P concentrations were a true reflection of grazing interventions rather than artifacts of shifting sampling schemes, localized watershed differences, or confounding meteorological patterns. To address potential temporal sampling bias, we evaluated the potential effect in the change in field protocols between the early "unconstrained" sampling phase (2017-2018) and the formalized fixed-frequency sampling phase (2019-2025). The primary BACI model was re-run excluding data from the period 2017-2018 to verify. We found that removing these early data points did not alter the significance or conclusions drawn from the original model, confirming that the early “unconstrained” sampling schedule did not exert undue leverage on the model.

To rule out regional climate shifts as a confounding factor driving stream water P, we verified whether precipitation patterns significantly differed between the calibration and implementation phases. A non-parametric Wilcoxon rank-sum test with continuity correction was applied to compare actual weekly cumulative rainfall totals across periods on sampling dates. This was supplemented by a linear regression model modeling log-transformed weekly precipitation as a function of Period and Year to confirm the stability of the precipitation trends over time. Overall, we found that precipitation in the 7 day lead up to sampling dates did not statistically differ between the calibration and implementation periods.

Finally, we evaluated spatial and structural stability across our experimental controls at the individual HUC-12 watershed scale, moving beyond the aggregated treatment versus reference (combined West Fork and Halls Branch) framework. Results of this analysis showed that there was no statistically significant difference in P concentration trajectories between Halls Branch and West Fork in either the calibration phase or the implementation phase, validating the decision to group them into one reference group. A robust Filgner-Killeen test of homogeneity of variances (centered at the median) was performed alongside Levene’s test to formally assess baseline concentration volatility and dispersion patterns between the two reference streams, Halls Branch and West Fork Kickapoo. This analysis highlighted increased variability in the West Fork watershed compared to the Halls Branch watershed that merited further investigation of stream water P relationships between each of the separate watersheds through a paired watershed approach.

Overall, the results emerging from the final model presented are not likely to be influenced by confounding factors such as changes in sampling methodology or coincident changes in precipitation patterns that could have coincided with the treatment effect.

Paired Watersheds analyses

While the among-watershed HUC-12 (i.e., Tainter Creek vs. Halls Branch/West-Fork) BACI model provided a comprehensive overview of large watershed-level trends, the inherent spatial dilution of the grazing treatments (98 ha) within the large drainage area (13,612 ha) could mask localized treatment effects. We explored relationships at a spatial scale with increased treatment density through subcatchment-level pairwise comparisons. This spatially targeted paired sub-watershed analysis serves as a *post-hoc* exploration of the landscape to assess likely drivers of the results from the BACI analysis.

Within the HUC-12 Tainter Creek watershed, we identified water quality sampling locations for 5 watershed subcatchments (sites 3 through 7 moving upstream from the HUC-12 pour point Site 2) in an effort to constrain variation observed when combining data from across the entire watershed with the BACI approach (Figure 1). These comparisons were suggested by community partners involved in the data collection because they understood that some subcatchments were receiving more significant energy and effort to perennialize the land than other areas, and as a result more uptake and adoption of well-managed grazing. We then made pair-wise comparisons of Tainter subcatchments with each of 3 reference watersheds: the Halls Branch pour point (Site 1), the West Fork pour point (Site 8) and a West Fork subcatchment (Site 9). When examining pairwise scatterplots of the data, the high P concentrations of the calibration phase were clearly leveraging relationships and precluding comparisons between the two phases. Hence, we truncated the dataset to values < 0.05 ppm P to eliminate the effects of high P concentrations, allowing comparison of the calibration and treatment phases within similar conditions.

We analyzed these data by testing whether the slope in P concentrations collected on the same dates at two sampling sites differed in the calibration and implementation phases. A change in the slope between treatment and reference watershed between the calibration phase and the treatment phase would indicate evidence of a grazing treatment effect at the scale of the specific subwatershed comparison (Young et al., 2023; Jokela & Casler, 2011). We fit linear models to data from each phase and assessed whether slopes were significantly different at the α=0.1 level. To balance the exploratory nature of these subcatchment comparisons with the increased risk of Type I error inherent to multiple comparisons, we utilized a Benjamini-Hochberg (BH) correction (Benjamini & Hochberg, 1995).

Ethnographic methods

A crucial part of understanding the complex, dynamic, and highly-collaborative nature of this project was immersing ourselves in the Tainter Creek community. We attended field days, pasture walks, and other community events. Over the course of the Tainter Creek Grazing Project, we facilitated several discussions probing the challenges and opportunities provided by transitioning annual cropping systems to grass-based agriculture. We spent time getting to know the individuals involved in the project, outside in fields and inside offices, and had many informal conversations with them about their preferences, needs, values, perceptions, goals, and barriers. Our ongoing exchanges and shared time in the community allowed us to continue building the trusting relationships necessary to conduct a formal postmortem evaluation of the collaborative dynamics of the Tainter Creek Grazing Project through semi-structured interviews. Additionally, the qualitative data gathered from both informal conversations and semi-structured interviews helped strengthen our understanding of the project as a whole and guided our analysis of stream water P by providing insight on key events and social dynamics which are not obvious from water quality data in isolation.

Interview selection and recruitment

Interviewees were selected based on their involvement in the Tainter Creek Grazing project. Individuals considered for interviews were involved as either program organizers, TSPs, and farmers/land managers who received technical assistance and/or cost-share for practice implementation. All stages of the interview process were guided by International Review Board (IRB) guidelines for exempt studies. Recruitment for interviews was done via email, phone, and personal letters sent to project participants.

Conducting interviews

All interviews were conducted under IRB protocols for exempt studies. Most interviews were conducted in-person, while several were conducted over Zoom or via a phone call. The majority of interviews were done individually, though several requested to be interviewed at the same time as another participant. All interviews were recorded using a Zoom H1n Handy Recorder device and stored on a microSD card until they were transcribed. These were semi-structured interviews; a list of common interview questions can be found in the appendix. A total of 9 interviews were collected, with 10 total participants. Of these, 2 were involved in the Tainter Creek Grazing project as program organizers, 3 were technical service providers, and 5 were farmers. Interview durations ranged from approximately 30 minutes to about 3 hours.

Interview transcription and thematic analysis

Interviews were transcribed using Quirkos, a qualitative data analysis software tool. A member of the study team then reviewed all transcripts to ensure they matched the audio recording. Once transcribed, audio recordings were destroyed as per the IRB protocol. All personally identifiable information was removed from the transcript and stored separately to protect individual and organizational privacy and reputation. Once transcribed, a member of the study team reviewed the interview data, looking for common themes.

Results

BACI

During the calibration period (2017-2020), P concentrations across all study watersheds exhibited a significant regional downward trajectory (slope = -0.115, SE=0.021, $p<0.001$; Figure 2; Table A3). During the calibration phase P concentration in the treatment and reference watersheds showed little evidence of being different (Figure 2; Figure A3). The model predicted a mean P concentration of 0.034 mg/L (95% CI [0.030, 0.038]) for Tainter Creek and 0.038 mg/L (95% CI [0.032, 0.044]) for the reference sites (Ratio=1.12, SE=0.09, p=0.16; Table 2).

Following the implementation of grazing practices (2021-2025), there was strong evidence that P concentration in the Tainter Creek was different than the reference watershed, (Period x Treatment interaction: LR X^2=5.98, p=0.014; Figure A3). This difference was estimated to represent a 14% net reduction in P concentrations within Tainter Creek during the grazing intervention period, relative to the reference watersheds, after accounting for factors such as precipitation prior to sampling and regional temporal trends in P concentration. During the implementation period, the predicted mean P concentration in Tainter Creek had dropped to 0.026 mg/L (95% CI [0.024, 0.028]), relative to the reference watershed mean of 0.034 mg/L (95% CI [0.030, 0.038] Table 2; Figure A3).

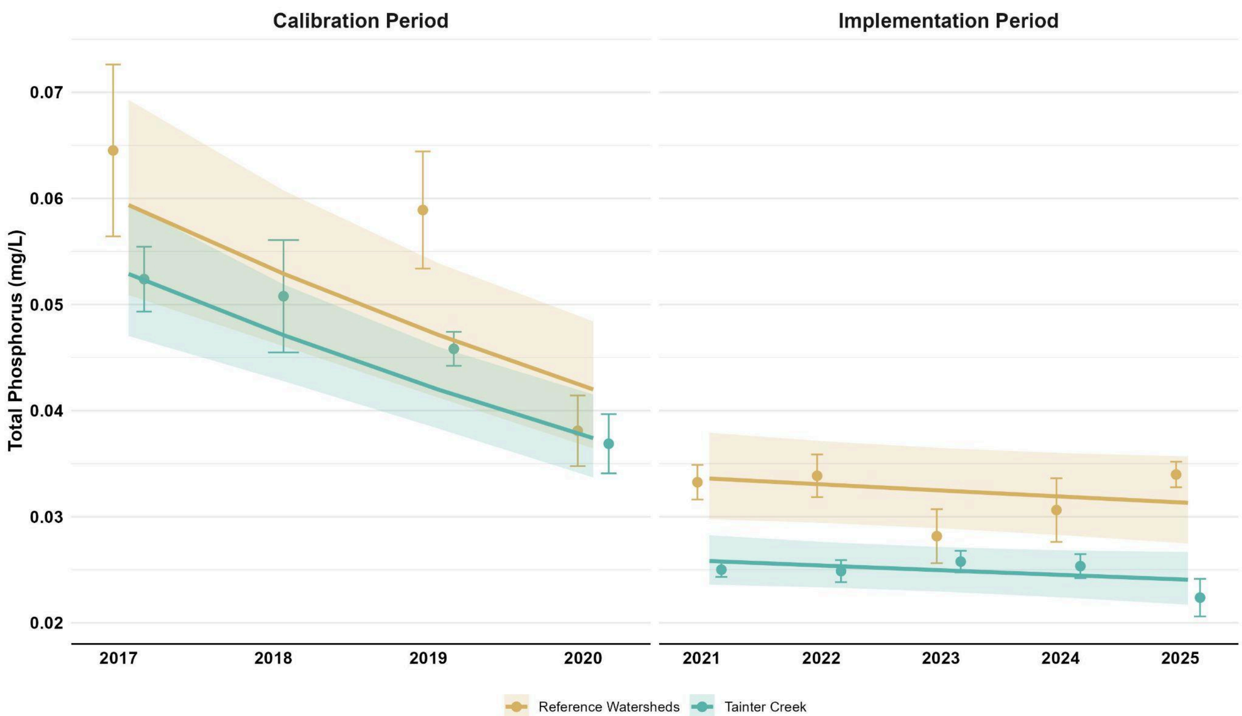

Figure 2. BACI model estimates a 14% reduction in P concentrations in Tainter Creek. Points represent the mean phosphorus concentrations per treatment group and year, based on the raw data. The error bars represent the standard errors around each mean. The trendlines represent the estimated phosphorus concentration trends in the Tainter Creek watershed and reference watersheds over the Calibration period (2017-2020) and the Implementation period (2021-2025). Ribbons around the trendlines are the 95% confidence intervals from the model. The model estimated that a 14% net reduction in phosphorus concentrations in the Tainter Creek watershed compared to the reference watersheds during the Implementation period could be attributed to the grazing treatment (p=0.014).

Table 2. Estimated Marginal Means from BACI model.

Watershed	Period	Predicted Mean P (mg/L)	95% Confidence Interval	% Change
Tainter Creek	Before	0.0336	[0.029, 0.038]	–
	After	0.0259	[0.023, 0.028]	-10.7%
Reference watersheds	Before	0.0377	[0.032, 0.044]	–
	After	0.0336	[0.029, 0.038]	-23.1%*

**Interaction effect (Net Reduction): 14.0% (p=0.014)*

Paired watersheds

The spatially targeted paired subcatchment analyses that used same day sampling to constrain variability and excluded high-concentration outliers found significant treatment effects (i.e., significantly different slopes between calibration and implementation periods, Figure 3). As P concentrations increased across all watersheds, Tainter Creek subcatchments generally had lower P concentrations when compared to the Halls Branch reference site, though several of these comparisons were marginally significant when adjusting for multiple comparisons (Table 4), in particular, Tainter 3 and Tainter 5 (Figure 3). Pairwise comparisons with the Benjamini-Hochberg correction to provide a more conservative assessment indicated significantly different slopes only for Tainter 3 and Tainter 5 subcatchments when compared to the Halls Branch pour point (Table 3).

In contrast, comparison of Tainter Creek and West Fork subcatchments indicated no significant differences in slopes for calibration and implementation phases. The lack of significance likely stemmed from the high calibration phase variability. A formal Fligner-Killeen test of homogeneity of variances confirmed a stark, statistically significant divergence in baseline concentration volatility between the two reference streams ($p<0.001$), with the unexplained residual variance of West Fork ($\sigma^2=0.00027$) being more than double that of Halls Branch ($\sigma^2=0.00012$). This high variability in West Fork may have been associated with the massive flooding of 2018 that occurred when the upstream Jersey Valley dam failed and associated sediment and nutrients made their way downstream and likely settled out in stream bottoms.

Table 3. Paired watershed comparisons of slope estimates for calibration and treatment phases for reference and treatment watersheds. Significance determined at $P<0.1$, but Benjamini-Hochberg correction applied to adjust P value for multiple comparisons allowing side by side comparison of a liberal and conservative assessment of statistical significance.

Reference	Treatment	Estimate	SE	Statistic	P value	P_{BHadj} value
Halls Branch (site 1)	**Tainter** (site 2)	-1.340	0.623	-2.150	**0.037**	0.22
1	3	-2.240	0.624	-3.580	**0.0009**	**0.008**
1	4	-0.562	0.692	-0.811	0.42	0.76
1	5	-1.840	0.482	-3.810	**0.0005**	**0.008**
1	6	-0.963	0.551	-1.750	**0.09**	0.32
1	7	-1.130	0.553	-2.030	**0.05**	0.22
West Fork (site 8)	2	-0.275	0.325	-0.848	0.40	0.76
8	3	-0.486	0.328	-1.480	0.15	0.44
8	4	-0.0543	0.265	-0.205	0.84	0.89
8	5	-0.341	0.264	-1.290	0.21	0.53
8	6	-0.109	0.266	-0.410	0.68	0.84
8	7	-0.165	0.249	-0.664	0.51	0.77
West Fork (site 9)	2	0.158	0.376	0.420	0.68	0.84
9	3	-0.005	0.415	-0.0124	0.99	0.99
9	4	-0.115	0.297	-0.387	0.70	0.84
9	5	-0.209	0.295	-0.708	0.48	0.77
9	6	-0.0693	0.302	-0.229	0.82	0.89
9	7	-0.256	0.294	-0.870	0.39	0.76

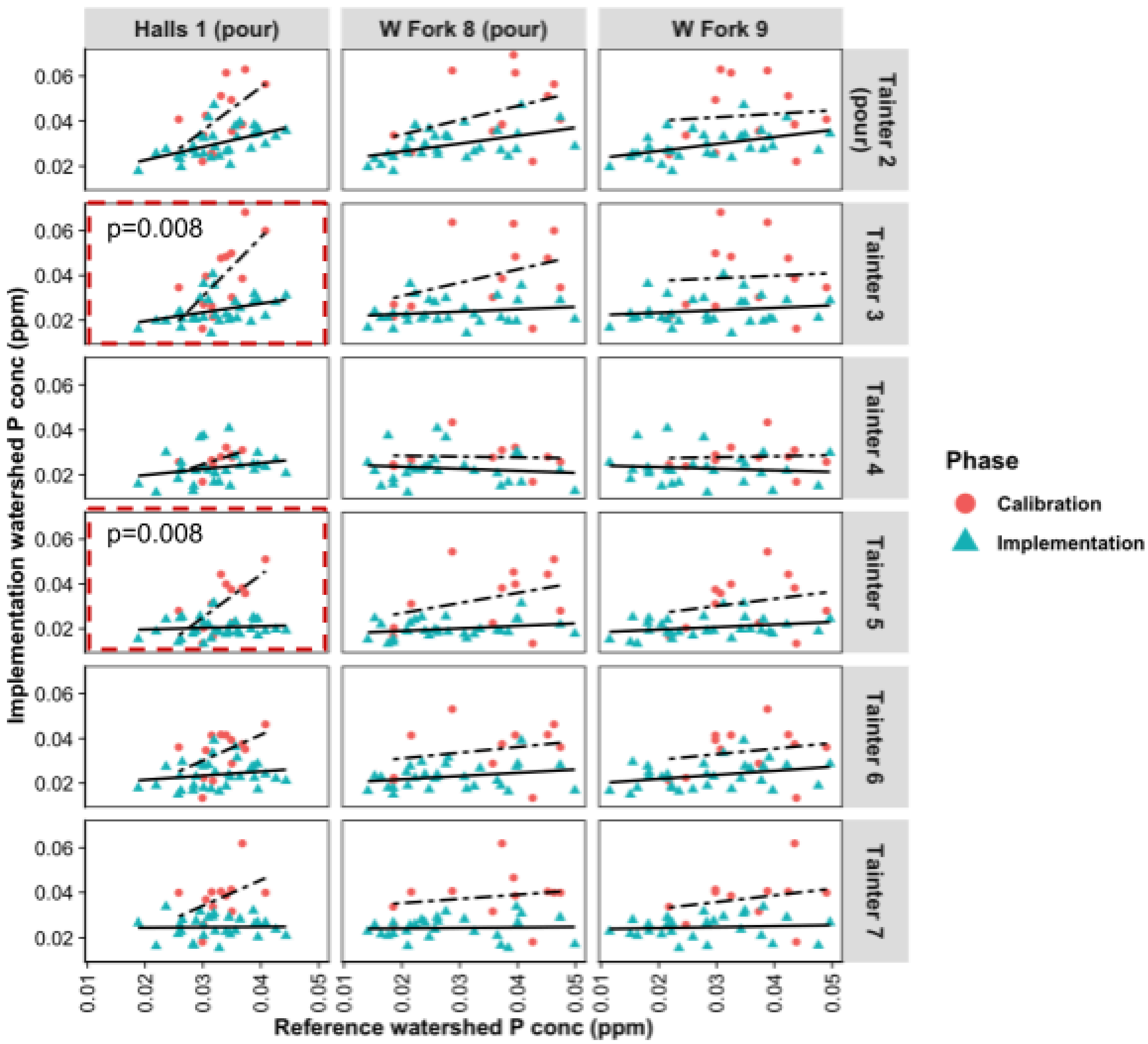

Figure 3. Scatterplots of reference and implementation watersheds by calibration and implementation phases where P concentrations >0.05 mg/L were removed to compare data within a similar range.

Discussion

Decades of watershed management relying on incremental, practice based conservation interventions have had little effect on stream water P concentrations at watershed scales. We found that changes in agricultural practices from annual cropping systems to well-managed grazing reduced stream water P concentrations at the watershed scale. This effect occurred despite a relatively small amount of agricultural change (<1% of land in the targeted watershed) and resulted in a net ~14% reduction in stream water P concentrations at the watershed level. We provide empirical evidence that focusing conservation efforts on their potential outcomes rather than applying them randomly in large amounts is key to improving surface water quality. This result was especially clear in two of the smaller subcatchments, where the density of grazing practices implemented was higher and nearby streambank restorations may have assisted in P abatement (Table A2).

The influence of subcatchment scale was clear when analyzing the *P*-values in Table 3. Although subcatchments 6 and 7 were significant at the uncorrected $p<0.1$ level, high variation during both the calibration and implementation phases introduced enough uncertainty to obscure slope differences under the conservative multiple comparison adjustment (BH_{adj}). However, subcatchment 5, which aggregates both 6 and 7, resolved this noise and displayed a strong difference in slopes that signals upland management in Tainter Creek successfully lowered P concentrations relative to the Halls Branch control. In contrast, subcatchment 4 lies outside of 5, 6, and 7, and experienced no significant change in P concentration relationship with Halls Branch; while subcatchment 4 did receive some streambank restoration, no upland grazing practices were implemented. Moving downstream, subcatchment 3 showed significant P reduction after an additional 36 ha of grazing practices were added and ~1 km of streambank restorations occurred. This P remediation effect is spatially diluted at the full HUC-12 watershed scale at site 2, where a substantial area of unchanged land drains into the system without any additional grazing practices or streambank restorations. Despite this scale-dependent dilution, the BACI analysis successfully detected these HUC-12 level differences by accounting for much of this localized variation.

This study builds on previous work that established the efficacy of well-managed grazing at the edge-of-field scale (Young et al., 2023; Rotz et al., 2009; Belflower et al., 2012), providing a mechanistic basis for this study design. However, scaling of a grazing effect on water quality to watershed scales has largely relied on simulation models to estimate landscape-level impacts (Campbell et al., 2022; Wilson et al, 2014). Our results provide evidence that targeted conservation transitions to grazing can have a measurable impact on water quality at the watershed scale.

While the efficacy of managed grazing as a nutrient conservation tool is well documented at the plot scale (Young et al., 2023; Bellflower et al., 2012), our results demonstrate that these benefits are transferable to the landscape scale. The significant P reduction in the Tainter Creek watershed is novel when considering the 5-year period of implementation. Previous studies suggested that impacts on surface water quality can take decades to realize and that these temporal horizons grow with increasing catchment size (Melland et al., 2018; Schilling & Spooner 2006). This study found significant, measurable improvements to water quality in a 5-year period, suggesting that well-managed grazing can work to improve water quality targets at a watershed scale. This suggests that the impact of perennialization is strong enough to be detected even amidst the background variability of a ~13,000-ha watershed. Part of the reason for this may be due to the finding that the signal in our smaller subcatchment analysis is stronger than at the whole watershed scale. This indicates that increasing the density of well-managed grazing practices on the landscape can have even greater impact, a finding that has been noted in previous research (Wilson et al., 2014; Carvin et al., 2018). From a scalability perspective, this signal suggests that meeting watershed goals could be best achieved by identifying areas that might be particularly vulnerable to erosion and nutrient runoff before scaling out to wider geographic areas. This density approach can help secure definitive water quality victories that can be shared to create momentum for future projects. Participants of the Tainter Creek Grazing Project shared that achieving and sharing their localized successes was key to gaining momentum for similar projects both regionally and nationally.

The Tainter Creek Grazing Project represents a strategic departure from traditional conservation spending, which has historically prioritized the widespread adoption of incremental practices with limited success (Osmond et al., 2012; Rissman & Carpenter, 2015). Current strategies that focus on field level changes rather than system transformations require more land – often upwards of 50% of the watershed (Campbell et al., 2022; Motew et al., 2019). These strategies require constant annual investment and still fail to move the needle on nutrient reduction (Hanrahan et al., 2021; Waller et al., 2021). In Wisconsin, despite 63 active Total Maximum Daily Load (TMDL) plans for nutrient reduction, no broad-scale delisting of impaired waters has occurred since the 2024 reporting cycle (WDNR, 2024). This lack of recovery is partially attributable to the limitations of attempts at buffering agricultural nutrient losses in an inherently leaky annual cropping system through incremental changes (such as cover crops), rather than affecting transformative landscape change through shifts to perennial agricultural systems. Scaling well-managed grazing practices rather than incremental BMPs is likely to have a higher impact on successful nutrient reduction at the watershed scale and therefore help reach TMDL goals more effectively.

Our study suggests that focusing conservation investment in transitioning agricultural land to well-managed perennial grazing provides a higher return on conservation efforts by addressing the fundamental nutrient imbalances among annual systems that drive P loss. Rather than paying annually for practices such as cover cropping and reduced tillage in row crop systems, funding in the Tainter Creek Grazing Project was shifted toward one-time infrastructure investments and specialized technical assistance that facilitated a permanent land transformation. The success of this model demonstrates that the implementation gap can be bridged by the elements that the Tainter Creek Grazing Project prioritized: the use of outcome based metrics, the deployment of technical experts who understand perennial systems, and a commitment to multifunctional landscapes.

Scaling through social innovation

Beyond the landscape change that was made possible through the Tainter Creek Grazing Project, their success was driven by a highly collaborative framework paired with an active farmer-led group already exploring innovative practices. This partnership successfully expanded local capacity through three critical elements. First, the project transitioned from a traditional payment-for-practice model where participants are rewarded based on the number of acres under conservation management practices, to an outcomes based model which rewarded participants based on the estimated impact that an implemented practice would have on water quality goals. Previous research has shown that payment-for-practice models often fail to overcome opportunity costs in agricultural landscapes and therefore fall short of their intended outcomes (McDonald et al., 2018). By awarding cost-share based on estimated P mitigation, the project ensured that conservation dollars favored high-impact transitions. Importantly, the outcomes identified were grounded in goals set by the Tainter Creek Farmer-led Watershed Council, who made it their mission to improve the water quality in the Tainter Creek; administrative and financial support from VSN, *Pasture Project* at the Wallace Center, and other outside organizations made the farmers' vision scalable, and expert TSPs made implementation possible. Including local actors from the onset of a project and working towards goals that all stakeholders can agree on through an adaptable process have been identified as key factors of success in co-producing sustainable outcomes and should be a focus when scaling conservation efforts (Norström et al., 2020; Davis & Ramírez-Andreotta, 2021; Conti et al., 2025).

Second, this outcome oriented approach was facilitated by specialized technical service providers (TSPs). Unlike traditional agency staff often constrained by administrative mandates (Wardropper, 2018), TSPs on the Tainter Creek Grazing Project team acted as strategic advisors who navigated the boundary between the grant's top-down goals and farmer's bottom-up realities. Crucially, they were given liberties to explore flexible options that would both support the farmer's needs and help move the project towards their greater goals of reducing P runoff. This allowed for the expert level planning required to transition producers from randomly applying incremental BMPs toward a total systemic shift (Blesh & Wolf, 2014). Tainter Creek Grazing Project participants expressed immense appreciation for the knowledge, dedication, emotional intelligence, and ingenuity of the TSPs who helped make grazing transitions possible. However, the critical reliance on this specialized human capital stands in stark contrast to broader agricultural policy trends. While recent legislative mandates have technically expanded funding allocations for climate-smart incentives, matching investments in the human infrastructure required to deploy those resources have severely lagged (Reimer et al., 2023; Rissman et al., 2023). This structural misalignment illustrates a broader institutional deficiency where federal frameworks chronically underfund conservation efforts as a whole while simultaneously neglecting the localized technical capacity and human capital imperative for supporting producers through the socio-economic risks of well-managed grazing transitions (Reimer et al., 2023; Wardropper et al., 2020). To scale the Tainter Creek model nationally, agricultural policy must treat technical expertise as social infrastructure that is equally or more important than fencing or pipelines. Scaling cannot occur through technological updates or generalized agency checklists alone; it requires building a dedicated, localized workforce. This points to an opportunity for land-grant universities and state extension networks to develop specialized grazing-TSP pipelines, translating federal climate-smart funding into localized human capital capable of derisking system-level transformations for risk averse producers.

In practice, the efficacy of these localized interventions is particularly dependent on a TSP's capacity to communicate and operationalize the inherent multifunctionality of perennial landscapes. The Tainter Creek Grazing Project leveraged multifunctionality by aligning P mitigation with a farmer's financial viability, landscape level biodiversity, and agritourism (i.e., trout stream restoration), therefore embedding conservation within the region's social and economic fabric (Reynolds et al., 2021). This transition to grassland agriculture can enhance biodiversity by creating critical corridors for grassland birds (Augustine et al., 2021) and increasing floral resources for pollinators (Mu et al., 2016). Well-managed perennial grasslands also reduce flood intensity and frequency by increasing interception, percolation, and storage (DeLonge & Basche, 2019); reduce nitrate leaching to groundwater (Jackson, 2020); and promote climate-smart soils (Rui et al., 2022; Dietz et al., 2022). This overlapping support model reduces reliance on single grant cycles and allows opportunities for increased collaboration and investment from diverse stakeholders. In the Tainter Creek Grazing Project example, having multifunctional goals brought together a team of organizations ranging from local to national, including groups focused on everything from conservation to economic viability to research. This inherent multifunctionality unlocks non-traditional pathways for scaling by stacking capital from diverse sources. Because well-managed grazing simultaneously reduces nutrient runoff, mitigates flood risk, preserves trout streams, and builds climate-smart soil, scaling frameworks can look beyond traditional state and federal agricultural budgets. Municipal water utilities looking to reduce P removal costs, insurance consortiums aiming to decrease downstream flood claims, and corporate supply chain sustainability initiatives can co-invest in the same perennial transformation projects. Leveraging these multi-sector financial opportunities represents the most viable pathway to scale the model across larger geographies without relying solely on limited public funds.

Ultimately, the Tainter Creek Grazing Project serves as a proof of concept that the gap in reaching long term ecological goals is best bridged not through more regulation, but through strategically integrated collaborations grounded in adaptive, human-centered relational dynamics. By aligning outcomes-based incentives, specialized technical guidance, and multifunctional goals, this framework offers a path away from the inefficient, practice based conservation strategy that has characterized the last half-century. While the scale of change required to restore the Mississippi River Basin remains immense, these findings provide a scalable and socially viable template for transforming industrialized agricultural landscapes into systems that are both ecologically restorative and economically resilient.

Limitations

This study was limited by a relatively short timeframe for understanding the long-term impacts of watershed scale land transformations; the 5-year monitoring (implementation) period following a 4-year calibration period likely captures only the beginning of a longer-term ecological trajectory. Large scale transformations from row crops to managed grazing require significant lead time for planning, infrastructure installation, and forage establishment. For these reasons, only a fraction of the producers who were interested in implementing grazing practices were able to do so during the Tainter Creek Grazing Project timeline. Additionally, new grassland systems take 3 to 5 years to become established and achieve maximum soil stabilization benefits (Sanford et al., 2021; Cates & Ruark, 2017; Helmers et al., 2012); it is possible that an even stronger P reduction signal may be realized once the newly implemented grazing practices become established. Furthermore, the presence of "legacy phosphorus," P stored in stream banks and soils, can mask the immediate benefits of upland conservation (Schilling & Spooner, 2006; Campbell et al., 2022). The hydrologic lag time inherent in these systems suggests that the full impact of the Tainter Creek grazing transitions may not be realized for a decade or more.

A primary technical limitation of this study was the reliance on P concentrations rather than mass loading of phosphorus. While concentration is a vital metric for localized stream health and biotic integrity, it offers only a temporal snapshot of water quality. To calculate the total annual load of P delivered from these watersheds would require continuous discharge monitoring in addition to P concentration data. Due to the high cost of monitoring stations and the specialized personnel required for their maintenance, load calculations were outside the current study's scope. Consequently, while we can confirm a reduction in the concentrations of P in the stream water at the time of sampling, we cannot yet quantify the total reduction in P mass leaving the watershed.

Finally, the ability to detect a clear treatment signal in a BACI design is often confounded by climatic and landscape variability. Every landscape is different, and each region experiences different climatic trends that impact the way P moves. The unique biophysical and cultural attributes of the Tainter Creek watershed, such as its steep geography and highly active farmer-led council, mean that the magnitude of these results may not be directly transferable to different geographies. While the direction of the impact of increased perennialization on P is well supported by the literature, the specific 14% reduction should be viewed as case and landscape specific. Future research should prioritize watershed level designs across different geographies and incorporate continuous flow monitoring to further validate the scalability of the managed grazing model and its impacts on water quality.

Conclusion

Productive agricultural landscapes and clean water are not incompatible, but the current focus on incremental changes (i.e. cover crops, reduced tillage) within annual cropping systems is insufficient to address the magnitude of water quality impairment at the landscape scale. Well managed grazing of livestock on perennial grasslands can result in significant water quality improvement, as we demonstrated with fairly limited land use/land cover conversion (<1% of target watershed) in a relatively short time frame (5 yr). Impediments to this type of transformative change are mostly socially constructed, so we need innovative sociological approaches, like the ones demonstrated here, to help bring positive ecological change to agricultural landscapes. Key elements include a shift towards focusing on outcomes rather than practices, investing in highly skilled TSPs, and leveraging multifunctional goals for widespread support. Furthermore, these elements cannot be effective in isolation; they require dynamic collaborations, targeted relationship building, and revolutionary community dialogue capable of challenging the status quo.

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Appendix A: Supplemental stream water data

BACI model R code

```
BACI_model <- glmmTMB(
  P ~ Period * Treatment +
                  Period * log(Precipitation + 1) +
                  Period * Year +
                  (1 | Site),
  dispformula = ~ Period,
  family = Gamma(link = "log")
```

Sensitivity analyses

To ensure that these conclusions were not driven by underlying spatial or temporal artifacts, a series of sensitivity analyses were performed. First, the BACI model was evaluated at the individual watershed scale rather than the aggregated treatment versus reference level. This spatial sensitivity check confirmed that there was no statistically significant difference in P concentration trajectories between Halls Branch and West Fork in the calibration phase ($p=0.49$) or the implementation phase ($p=0.15$), validating the decision to group them into one reference group. Second, the BACI model was re-estimated excluding the "unconstrained," opportunistic sampling dates from 2017-2018; removing these early data points did not alter the significance or conclusions drawn from the original model, confirming the the early sampling schedule did not exert undue leverage on the model. Finally, a non-parametric Wilcoxon rank-sum test verified that precipitation in the 7 day lead up to sampling dates did not statistically differ between the calibration and implementation periods ($W=2124.5$, $p=0.13$), which was supported by a log-linear model showing no long-term precipitation shifts across periods ($t_{119}=-1.20$, $p=0.23$). Together, these checks confirm that individual watershed anomalies, changing weather regimes, or protocol adjustments were not confounding drivers of the observed P decline in Tainter Creek.

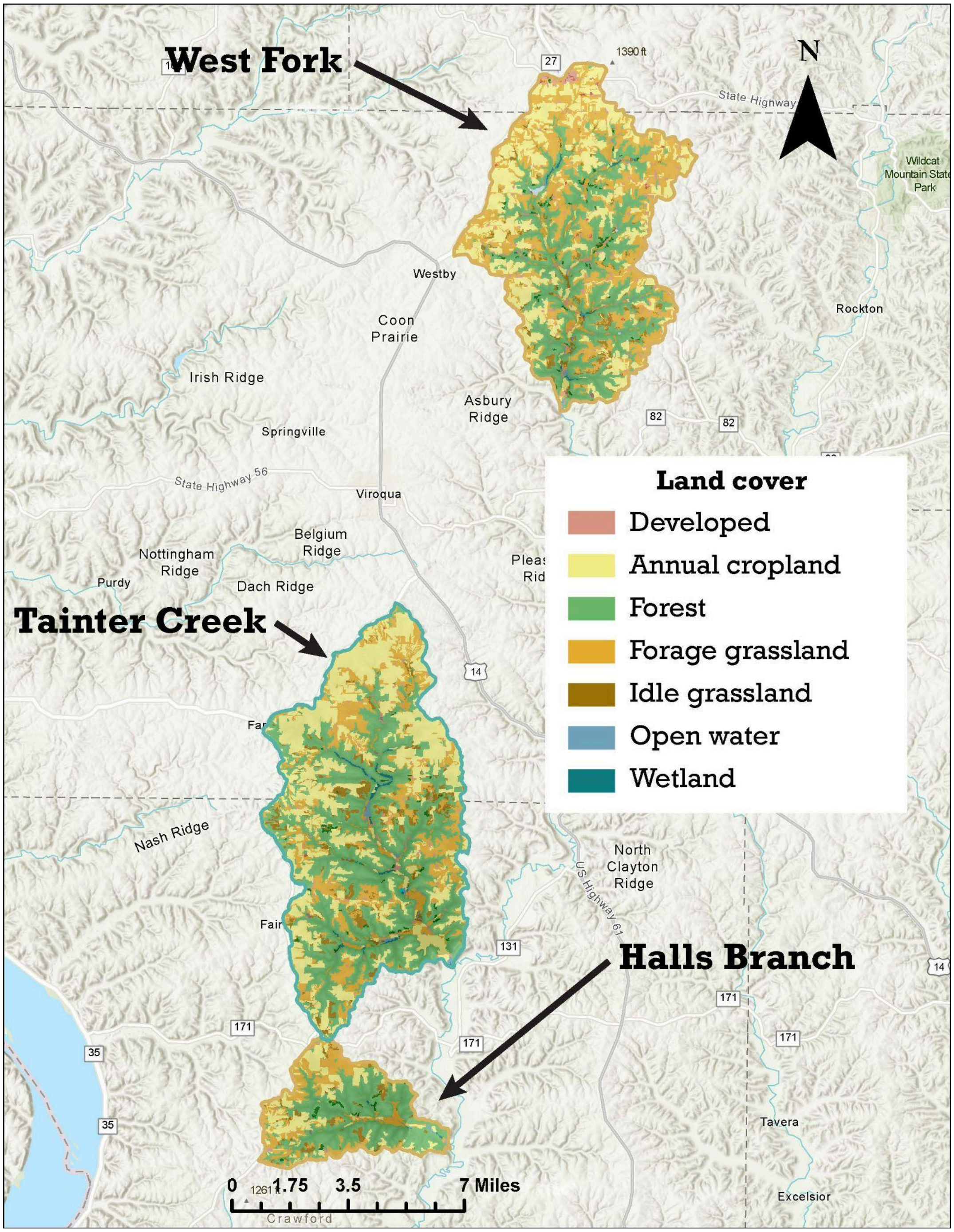

Figure A1. Land use of HUC-12 study watersheds based on Wiscland2 , class 2 designation (WDNR, 2016)

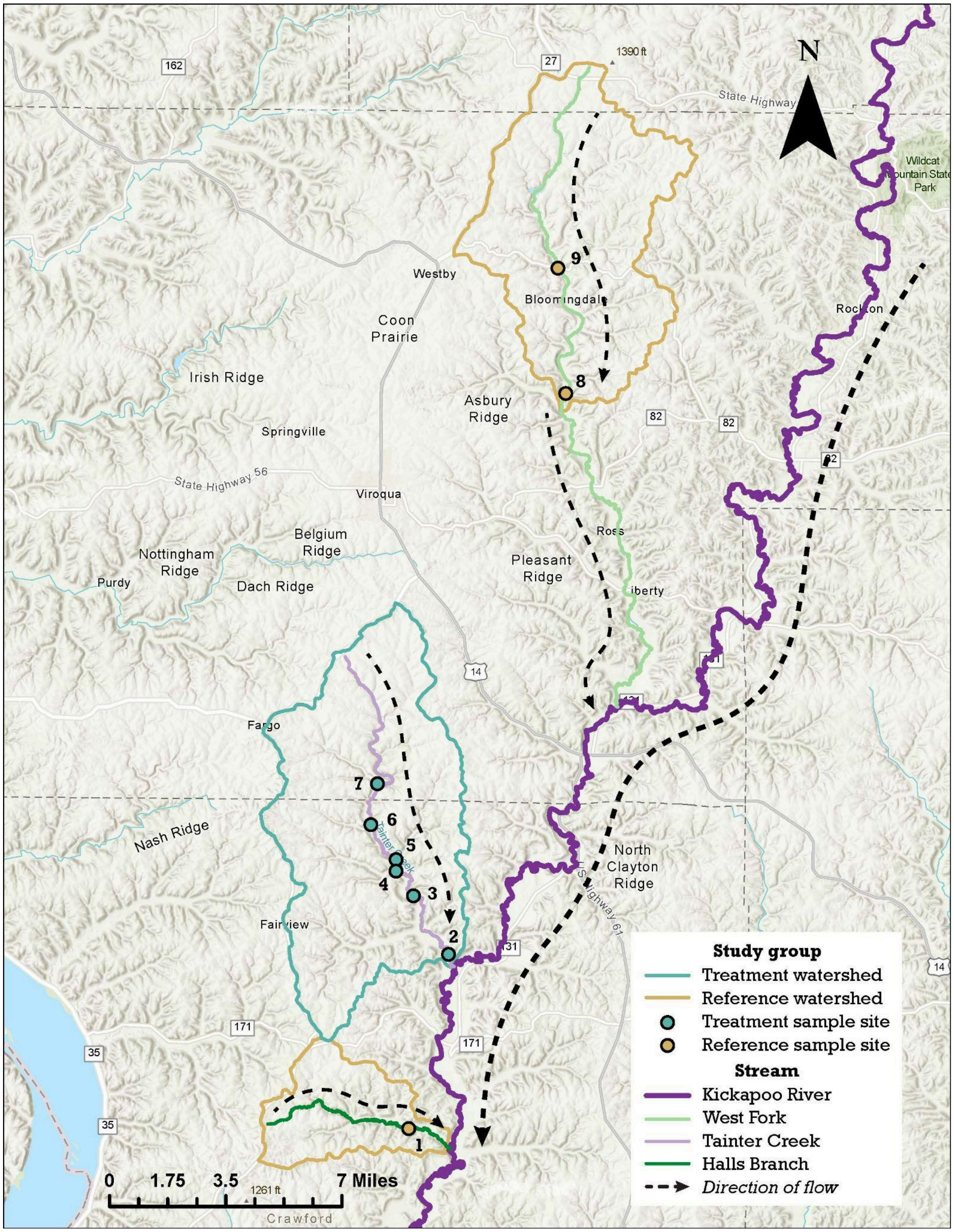

Figure A2. Hierarchy of sampling sites and stream network. This map shows the location of each sampling site along the streams included in this study. Each of the individual streams sampled flows into the Kickapoo River, and the general direction of their flow is indicated with a dashed line and arrow. Note that site 9 is upstream of site 8, and sites in the treatment watershed flow in descending order from 7 to 2.

Table A1. Streamwater sample distribution by site and year.

	Number of samples									
Site	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Site Total**
Halls 1 (pour)	6	0	9	8	13	12	6	6	3	**63**
Tainter 2 (pour)	6	6	9	7	13	11	6	6	3	**67**
Tainter 3	6	6	9	8	13	12	6	6	3	**69**
Tainter 4	0	6	9	8	13	10	5	6	0	**57**
Tainter 5	4	9	9	8	13	11	6	6	3	**69**
Tainter 6	5	6	8	8	13	11	7	6	3	**67**
Tainter 7	4	2	8	8	13	10	8	6	0	**59**
West Fork 8 (pour)	5	0	8	8	13	13	6	6	3	**62**
West Fork 9	6	0	8	7	13	12	6	6	3	**61**
Yearly Total	**42**	**35**	**77**	**70**	**117**	**102**	**56**	**54**	**21**	**574**
Period Total	**Calibration = 224**				**Implementation = 350**					

Table A2. Grazing treatment implementation and known streambank restorations. Grazing treatments were not evenly spread across Tainter Creek subcatchments, and some subcatchments had a higher density of treatment implementation. Additional project area describes the amount of land in a subcatchment that was transitioned to a grazing practice which is unique to the preceding subcatchment. Total project area includes all land within the subcatchment that was transitioned to a grazing treatment, including land in any smaller, nested subcatchments. Two streambank restoration projects occurred during the implementation period, and their relative locations and known details are included for reference.

Subcatchment	Additional project area (ha)	Total project area (ha)	Streambank restoration project details
7	6	6	-
6	57	63	-
5	0	63	-
4	0	0	~1 km of streambank restored to confluence of Conway Creek and Tainter Creek; upstream of sampling site 4
3	36	98	Streambank restoration occurred, scope unknown; upstream of sampling site 3
2	0	98	-

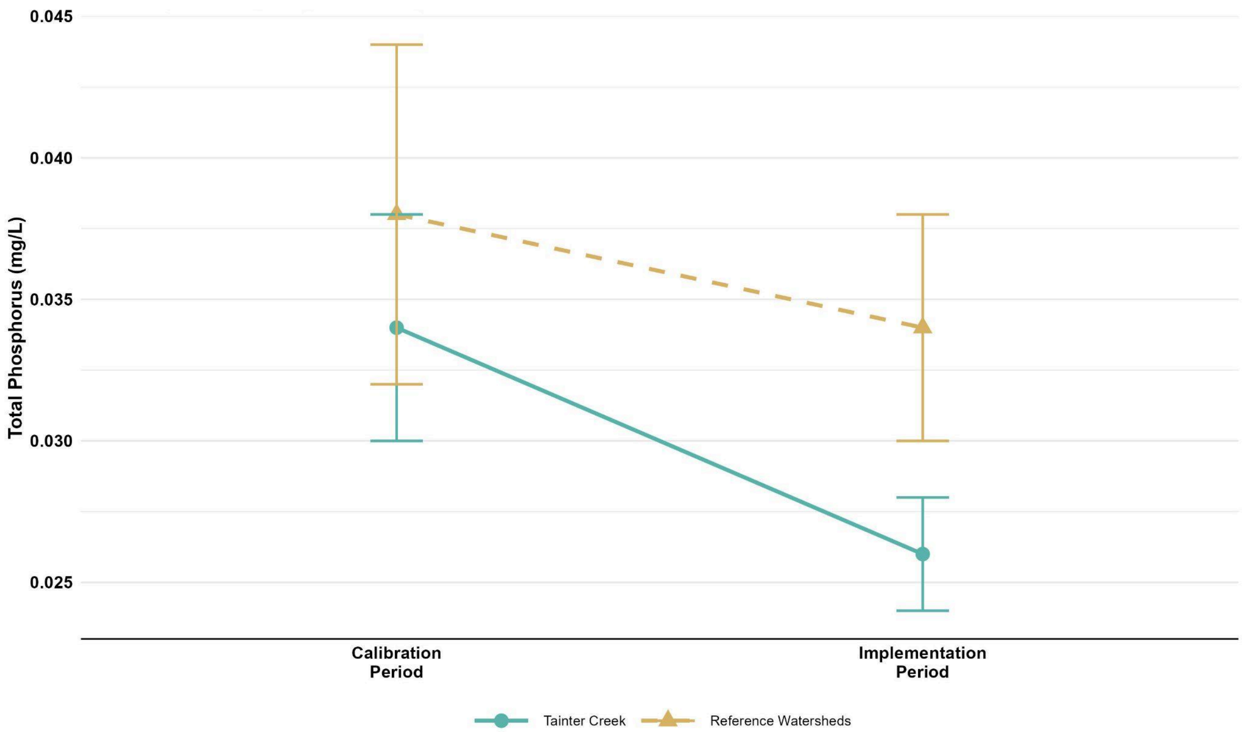

Figure A3. BACI interaction shows divergence after implementation of grazing practices in Tainter Creek. The interaction between study period and treatment group demonstrates a significant divergence in water quality trajectories (X^2=5.98, p=0.014). While both groups exhibited a regional downward trend, the implementation of grazing practices resulted in an estimated 14% net reduction in P concentrations within Tainter Creek relative to the reference watersheds. Points represent back-transformed estimated marginal means adjusted for annual temporal trends and precipitation; error bars represent 95% confidence intervals. Non-parallel slopes between the Tainter Creek and reference watersheds illustrate the treatment effect of the grazing intervention.

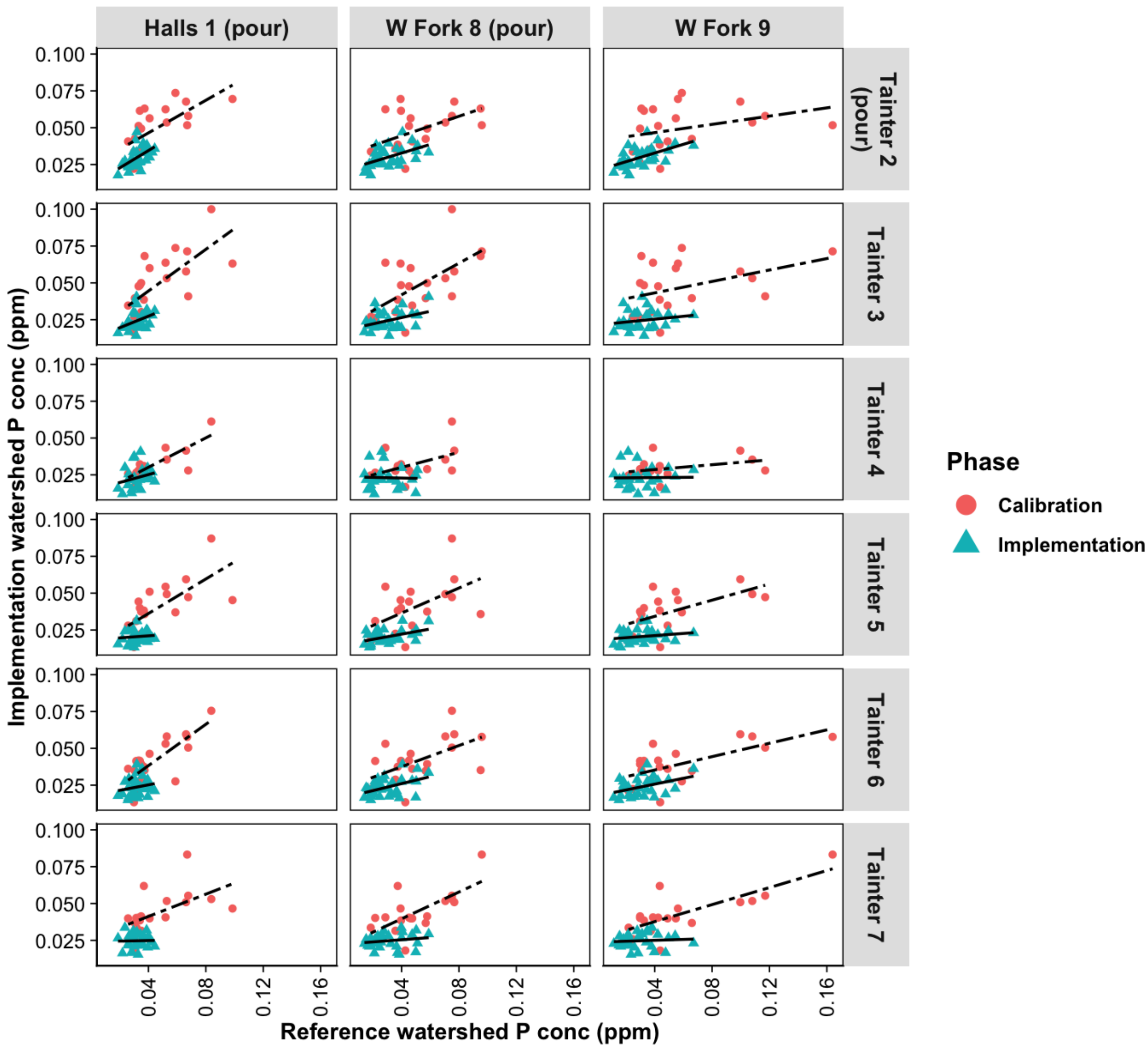

Figure A4. Scatterplots of reference and treatment watersheds by calibration and implementation phases. High P concentrations during calibration phase precluded direct comparison with implementation phase, so we eliminated data points where reference P conc was >0.05, allowing comparison during relatively low-flow conditions (see Fig. 6)

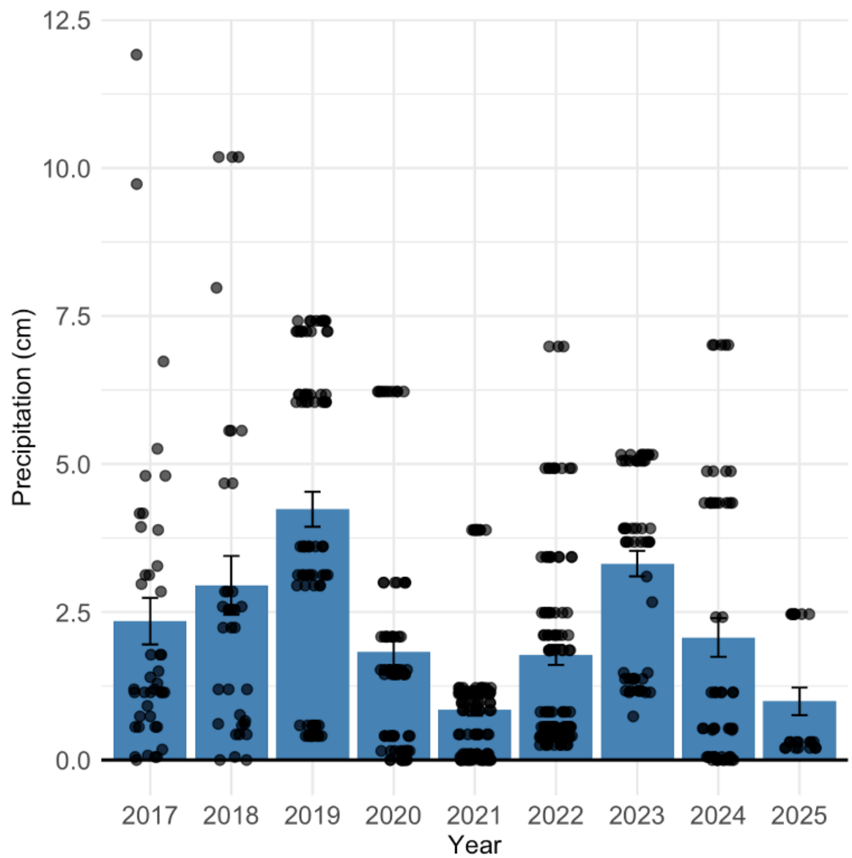

Figure A5. Precipitation in the 7-d run-up to each sampling event (PRISM Climate Group, 2024). Note the transition in 2019 to sampling all 9 sites on the same day in an effort to constrain variability related to runoff and streamflow.

Table A3. Summary of fixed effects from the GLMM

Effect	Estimate (log scale)	Std. Error	z-value	p-value
Intercept	-3.381	0.082	-41.23	< 0.001
Period (Implementation)	-0.113	0.054	-2.09	0.036
Treatment (Tainter)	-0.111	0.088	-1.26	0.207
Year (Centered)	-0.115	0.021	-5.47	< 0.001
Precipitation (log-7day)	0.524	0.051	10.27	< 0.001
Period x Treatment (BACI)	-0.151	0.061	-2.47	**0.014**
Period x Year (Yearly Slope Shift)	0.098	0.027	3.62	< 0.001
Period x Precip (Rain Slope Shift)	-0.429	0.063	-6.81	< 0.001

Table A4. GLMM model performance and diagnostics

Metric	Value / Result	Interpretation
Random Effect Variance	0.0084 (Site)	Low variation between sites
AIC / BIC	-3652.0 / -3604.1	Strong model parsimony
DHARMa Dispersion	p = 0.404	No overdispersion detected
Outlier Test	p = 0.318	No influential outliers
Durbin-Watson	p = 0.729	No temporal autocorrelation
Moran's I	p = 0.177	No spatial autocorrelation

Table A5. Summary of GLMM main results

Effect / Parameter	Value	Statistic Type	Source Output
BACI Interaction	p = 0.0144	Pr(>Chisq)	Likelihood Ratio Test (LRT)
BACI Significance	chi^2 = 6.09	Chisq	ANOVA (Type III)
Treatment Effect	-0.147	Estimate	Summary (Conditional Model)
Precipitation Response Shift	-0.429	Estimate	Summary (Conditional Model)
Annual Trend Stabilization	0.098	Estimate	Summary (Conditional Model)
Random Effect (Site)	0.0084	Variance	Summary (Random Effects)
Model Fit (Parsimony)	-3652.0	AIC	Summary / LRT

Appendix B: Qualitative assessment of collaboration dynamics

Introduction

Agriculture in the U.S. has become increasingly individualistic. Where neighbors would once gather to help each other with busy planting and harvesting seasons, borrow equipment and labor, and come together to share knowledge, they now find themselves increasingly isolated. This is in part due to the consolidation and disappearance of farms in the U.S., creating larger farms which are further apart and demand more attention from the farmer to maintain (MacDonald et al., 2020). These trends have also been bolstered by the dominant, industrialized agriculture system that is heavily supported by economic and legislative structures in the U.S. Production is incentivized and encouraged above all other metrics including but not limited to farmer wellbeing (Hopkins et al., 2025), community vitality (Strauser & Booth, 2025), biodiversity (Chaurasia et al., 2020; Rosenberg et al., 2019), soil health (Thaler et al., 2021; Sanford et al., 2012), clean water (Brown et al., 2020), and profitability (Nigatu, 2020). As a result, farmers have one of the highest suicide rates of any occupation in the U.S. (Arif et al., 2021), rural communities are struggling, and the environmental consequences of this industrialized agriculture system are tremendously negative.

The challenges which the current industrialized agriculture system in the U.S. have produced are entrenched and difficult to combat through individual action. This has been proven time and time again as private landowners work tirelessly to make environmentally friendly choices on their own land only to be discouraged by a lack of support from government subsidies and programs (Reimer et al., 2023; Wardropper et al., 2020). The Farm Bill, an important legislative package which governs federal policy on crop insurance, agricultural subsidies, nutrition assistance, and conservation, only dedicates 5% to funding conservation programs and practices (Congressional Research Service, 2024). In contrast, 19% goes toward subsidies for commodity crops and federal crop insurance backstops, which heavily favor row crops such as corn, soybeans, and small grains, while the remainder is dominated by nutrition assistance programs (Agriculture Improvement Act of 2018, 2018). Additionally, it is much easier for an individual farmer to apply to and receive assistance for growing commodity crops than it is for them to receive financial assistance to implement conservation on their agricultural land. In 2025, while federal crop insurance frameworks automatically processed and guaranteed over 1.1 million active commercial policies with near-universal approval, working-lands conservation programs like the Environmental Quality Incentives Program (EQIP) faced such severe structural underfunding that roughly 50% to 60% of all qualified farmer applications were forced into a bureaucratic backlog and left entirely unfunded (Institute for Agriculture and Trade Policy, 2025).

This lack of support for conservation on agricultural working lands is not due to disinterest from farmers in implementing conservation. When asked about their wants and goals for their land, farmers express a deep care for land stewardship (Leitschuh et al., 2022; Strauser & Stewart, 2024), and they define that being a ‘good farmer’ means in part improving environmental outcomes on their farm (Becker Steele, 2026). However, the barriers they face to make this desire a reality are immense and unsupported by the dominant agricultural system. Yet, these barriers can be lessened by collective action.

Recognizing the need for farmers to gather, share knowledge, and work towards common goals, the Farmer-led Watershed Council program was created. The idea of Farmer-led Watershed Councils is to give farmers a space to talk about their wants, needs, challenges, and opportunities, so that they might work on problems collectively. Farmer-led Watershed Councils help give agency to farmers by giving them a group identity and platform which is more widely recognized than that of an individual farmer (Reimer et al., 2023). However, even these recognized, and empowered groups face barriers to receiving grant funding to work towards their common goals. While they receive some funding from the state, this is often only enough to pay for meeting accommodations and the occasional educational event. If they want more funding to go after larger conservation projects, they have to compete with often much larger and more well-equipped organizations such as non-governmental organizations and universities. These organizations and institutions often have entire departments dedicated to grant writing, whereas for farmers, it is rarely something they have bandwidth or familiarity to prioritize

Because farmers and Farmer-led Watershed Councils often have reduced capacity to organize and apply for project funding, it can be helpful for them to team up with other organizations to reduce some of the administrative burden. In this model, the farmers bring the grounded and local knowledge of what works best on their land, and the other organization(s) provide the structure to steward the program in an effective manner. When done well, this partnership can be mutually beneficial, securing more conservation opportunities on the land while supporting farmers' goals. However, there is a delicate balance to strike between bottom-up and top-down leadership for these multi-stakeholder projects to be mutually beneficial. If power is concentrated at the top, the proposed pathways tend to be too rigid and often ignore the nuances impacting farmers and their communities. Conversely, when all agency is awarded to bottom-up actors, projects risk losing momentum or being unprepared to traverse bureaucratic processes (Conti et al., 2025).

In this evaluation, we use a case study approach to further explore how a collaborative conservation project with multiple stakeholders across a hierarchical gradient works to serve local conservation goals. The Tainter Creek Grazing project was a collaboration between the Tainter Creek Farmer-led Watershed Council, a local conservation NGO, the local county conservation agency, the state research institution, and a national conservation NGO. This unique collaboration of groups with differing goals and motivations provides an interesting opportunity to assess how agency amongst collaborators serves to move conservation forward and leave lasting impacts to the local community. Our objective is to do a retrospective evaluation of the project's goals, processes, and outcomes by conducting interviews with those involved to gain an understanding of the collaborative dynamics and provide suggestions for improved local impact on similar projects.

Methods

Interview selection and recruitment

Interviewees were selected based on their involvement in the Tainter Creek Grazing project. Individuals considered for interviews were involved as either program organizers, technical service providers, and farmers who received technical assistance and/or cost-share for practice implementation. All stages of the interview process were guided by International Review Board (IRB) guidelines for exempt studies. Recruitment for interviews was done via email, phone, and personal letters sent to project participants.

Conducting interviews

All interviews were conducted under IRB protocols for exempt studies. Most interviews were conducted in-person, while several were conducted over Zoom or via a phone call. The majority of interviews were done individually, though several requested to be interviewed at the same time as another participant. All interviews were recorded using a Zoom H1n Handy Recorder device and stored on a microSD card until they were transcribed. These were semi-structured interviews. A total of 9 interviews were collected, with 10 total participants. Of these, 2 were involved in the Tainter Creek Grazing project as program organizers, 3 were technical service providers, and 5 were farmers.

Interview transcription and thematic analysis

Interviews were transcribed using Quirkos. A member of the study team then reviewed all transcripts to ensure they matched the audio recording. Once transcribed, audio recordings were destroyed as per the IRB protocol. All personally identifiable information was removed from the transcript and stored separately to protect individual and organizational privacy and reputation. Once transcribed, a member of the study team reviewed the interview data, looking for common themes.

Preliminary Results and Discussion

Throughout the interview process, several themes emerged which were present in a majority of interviews. Participants expressed that they felt the different groups and organizations worked well together, and that each brought an important aspect to the overall functioning of the project. They felt that their individual engagement with the project was valuable in some way, with some finding intrinsic value and others tending towards valuing extrinsic rewards. Agency experienced throughout the project changed at different times, reflecting Conti et al.'s Transformation alliances pathway, where top-down actors initiate the process, define its goals, and identify grassroot participants to collaborate with, allowing local actors to have agency over on-the-ground experimentation while top-down actors legislate to ensure initial goals are met (Conti et al., 2025). Common lessons learned include a need for longer funding cycles to maintain sustained support for local actors, desire for more funding for local practice implementation versus administrative necessities, an appreciation for agency given to local actors to be able to meet their needs within the administrative boundaries, and benefit received from visibility from press. Every participant expressed a willingness to engage in a similar project and/or process in the future to help them reach their conservation goals.

Each collaborator brought their own expertise

This dynamic group of stakeholders, each with their own professional backgrounds and unique motivations, worked together to support a transition from cropland to grazing in the Tainter Creek watershed. When asked about which person or group was most important to the project, interviewees suggested that it was not one entity, but rather the collaboration of all groups which made this project successful. The national level NGO and the university were able to handle much of the administrative burden as well as providing scientific backing to the practices proposed by local stakeholders. These groups were also able to take on greater risks than state and federally funded agencies who often partner with the farmers to administer conservation projects, allowing for greater innovation and experimentation within the project bounds.

The farmers brought a deep knowledge of their land and business practices that could not have been realized without their critical participation and significant interaction with the project throughout the duration of this study, including post-project reflections resultant from this research. They are each intimately aware of the unique opportunities and barriers that exist on their own farm as well as the socio-political interactions amongst their neighbors and fellow farmers. Their guidance and input to the project facilitators allowed for a flexible process that could support many different types of farm conservation that would be more widely accepted, adopted, and maintained; this process was mutually beneficial to all stakeholders due to each member's participation throughout.

Finally, the local NGO, in partnership with county conservation staff, served as key mediators between the local and top-down actors. They were able to advocate for farmers' needs while also explaining the intricacies of the grant which needed to be maintained. It was especially important that these actors built trusting relationships with both farmers and grant administrators and were therefore able to have candid discussions about what was needed from all stakeholders. The community-driven nature of this project and familiarity between farmers and technical staff aided in the openness to participation and facilitated a more effective partnership because trust and legitimacy were already established among local actors.

Based on Chambers et al.'s framework for co-productive agility, I would describe the stakeholders as having a productive balance between control oriented versus inclusion oriented actors with a range of facilitative leadership between reframing dominant narratives and pushing for solutions (Chambers et al., 2022). While each individual within a group of stakeholders has their own identity and approach to collaboration, the groups can be classified broadly based on the archetypes found in Chambers et al., with each group exemplifying one of the four archetypes to varying degrees.

In this project, the national NGO and university tended to fall into the 'Hero' archetype, leading with predetermined ideas on what solutions would work best to reach desired outcomes (Chambers et al., 2022). This was in part influenced by the nature of grant funding and being beholden to the metrics outlined in the grant deliverables. Chambers et al. highlights that 'Hero' actors are helpful in navigating conflicting agendas to achieve change, as they find themselves in a position which is somewhat removed from the local politics and are therefore able to balance power differentials and challenge systemic issues. As previously mentioned, the national NGO and university had more influence over institutionally recognized solutions and could more readily challenge political systems.

The farmers on this project often exemplified the ‘Woodpecker’ archetype, pushing other stakeholders to rethink the dominant solutions proposed by top-down actors so that their grounded knowledge could inform a more reflexive solution landscape. The ‘Woodpecker’ actors help keep solutions rooted in the reality that they face (Chambers et al., 2022), which is crucial for implementing a project which is meant to help local farmers work towards conservation goals using their own private land. Without farmers advocating for their unique needs and pushing back against the dominant narratives, this project would not have worked for so many people and would have been implemented on fewer farms.

The local NGO in this project showed characteristics of the ‘Host’ archetype, positioning themselves as a trusted sounding board for ideas from all other actors and providing space to explore a diverse range of agendas (Chambers et al., 2022). They strove to remain apolitical among stakeholders and worked to include ideas and react to needs from both top-down and bottom-up actors. In practice, this meant organizing meeting spaces for the Farmer-led Watershed Council to discuss ideas as well as being present at meetings with the national NGO and university to understand the requirements of the grant and advocate for local needs. They were especially important for managing the range of needs of all collaborators and balancing power dynamics between groups.

The local conservation staff and technical service providers represented the ‘Genie’ archetype, acting as a strong advocate for marginalized agendas and being staunch voice pieces for farmers especially (Chambers et al., 2022). They were able to use their expertise as conservation professionals to guide the niche solutions proposed by farmers along a path that was realistic under the grant structure. These actors were key advocates for implementing changes that were both innovative and realistic.

As outlined by interviewees, having all four of these archetypes included in this highly collaborative process was what made this project successful. Had one of the groups overexerted their power or pushed a certain narrative without balancing the tensions of control versus inclusion and process versus impact, there would have been consequences for overall project success. To achieve true co-productive agility, each of these archetypes (hero, woodpecker, host, and genie) must be present and valued (Chambers et al., 2022), as they were in the Tainter Creek Grazing Project. The following quotes are examples of this highly collaborative dynamic:

> "The individuals that were involved in this really relied upon their areas of expertise and experience" - TSP 2
>
> "Simple answer is that it was a good team" - TSP 1
>
> "Understanding their expectations and goals and merging them with the producer's expectations and goals…and respecting the top down, but also respecting the bottom up" - Farmer 2

Funding and support must be extended longer than 5 years

When asked what could be done differently to better support collaborative conservation transformations, participants resounded that support must be sustained for longer periods of time. The grant that supported this project provided funding for three years (2019-2022). From a programmatic standpoint, it often takes more than a year to get organized, reach out to collaborators, find an appropriate project fit, and begin meeting to discuss potential solution pathways. Then, it is important to spend time building trust within a community, especially when combining stakeholders from local and national levels (Chambers et al., 2022; Duru et al., 2015; Charli-Joseph et al., 2023). When done respectfully, this can take years to achieve, depending on the composition and positionality of the group of collaborators. Only after sufficient trust has been built and a mutual understanding of all expectations and motivations has been established should implementation begin.

This project benefited from having local stakeholders present for all stages, including applying for the grant and identifying potential partners. Yet, even with some level of local collaboration from the onset, it was important to build trusting relationships with all actors involved, especially farmers who would potentially be taking a risk and making changes to their established business plans. For this reason, the first grazing implementation on this project began two full years into the project, and practices were being implemented on the ground even after the grant ended. Several interviewees expressed that they felt more projects could have been completed and therefore additional impact made if support from the grant was extended.

From a scientific perspective, the three-year grant period made it impossible to draw an empirical conclusion to the environmental outcomes of the project. Part of the impetus for this project was to investigate how the grazing practices implemented would affect water quality. A before-after-control-impact (BACI) study design was enforced, which requires several years of data collection prior to treatment implementation to set a baseline for comparing outcomes to. Thankfully, this project benefited from having a history of water quality measurements collected in the study region before the project began, allowing for a four year calibration period. These water quality measurements continued throughout the three-year grant period and continued for five years after practices began to be implemented. However, it is important to note that the majority of this data collection happened outside of the years that the grant was active. And, even with nine years of water quality data, other environmental variables impacting ecological outcomes can make it extremely difficult to reach scientific significance.

Beyond the actual implementation of a project, other studies show that to sustain lasting, transformative change, there must be at least five years of sustained support (Davis & Ramírez-Andreotta, 2021). Changing systems heavily entrenched in political and cultural norms, such as the dominant industrialized agricultural system, takes time and energy that is far beyond the possibilities of the current short-term grant funding structure. These processes require folks to reckon with their current values, wants, needs, and consequences, understand the current structures and systems that dominate their points of view and level of agency to change, learn to reimagine what the future could be like outside of the current dominant regime, and feel empowered to go against their established cultural norms to produce change (Charli-Joseph et al., 2023; Juri et al., 2025; Ketonen-Oksi & Vigren, 2024). This kind of process is necessary to break out of the current systems, and it takes far longer than a few years to accomplish. This was emphasized by several participants:

> "Another five years of [national-level NGO] involvement with a program like they had would have done wonders. These things don't happen in five-year periods." TSP 1
>
> "I would establish what I would perceive to be a realistic timeline for accomplishing the expectations. And I honestly don't think three years is long enough." - Farmer 2
>
> "One of the challenges with the grant was it was three years...it was impossible to do in three years" – TSP 3

There is a strong appetite for continued transformative change

Every single participant that was interviewed for this study expressed a desire to continue engaging in similar processes as the one outlined in this project to advance conservation on working agricultural lands, improve water quality and other positive ecological outcomes, and support local community resilience and prosperity. While some expressed that there were ways they would change the process slightly, they all agreed that it was a worthwhile endeavor. It is clear that they all recognized the value that this collaborative conservation project brought to their own lives as well as their community. They shared an intimate knowledge of the negative consequences of continuing along the path of the current industrialized agricultural system, and they expressed their concerns for how this would impact their communities in the future if they don't act to change it.

When asked how they would act to change the system to support the future they desired, they shared several unique insights. Some demanded that greater attention be given to supporting landscape diversity at both the farm level and the landscape level, offering greater resilience against changing market conditions while also creating opportunities for locally sustained food systems. Others shared concerns over the consolidation of farms and difficulty for new farmers to enter into agricultural endeavors. Several participants shared that they felt there has been a loss of a land ethic as landowners become further removed from their property and contract folks with little to no connection with the land to work it. Each of these concerns echoes the issues brought on by the dominant industrialized agricultural system in the U.S., and something must be done to address them if we are to have functioning agricultural landscapes in the future. The following quotes show some of the participants' interests in future conservation work:

> "I was hoping we could have spent [the money] on tracking the stream and finding out numbers and seeing what's happening to the trout populations" – Farmer 1

> "I think promoting diversity of production capacity on the landscape, um, not just corn, not just soybeans, not just dairy, not just beef, not just whatever…we need to find that here again. Otherwise, we're just going to end up with 2,000 acres [809 ha] of corn and soybeans. I mean, the dairy farms are getting gobbled up and stopping." – TSP 3

> "I think that has to be part of this new structure where you've got support and a recognition for practices that provide resilience on the farm level and on the community level. Maybe that's the focus now, and so that the funding that comes toward that would be, you know, a recognition that we want to be as resilient as possible in our community" – Program organizer 2

Recommendations

Based on the retrospective evaluation of this project through participant interviews and supported by previous studies, I offer the following recommendations for success in similar collaborative conservation projects with multiple stakeholders:

1. Strategically coalesce a group of partners with the appropriate positionalities and skills
2. Strive for project timelines which extend ten or more years
3. Set project goals which are locally motivated and challenge dominant narratives

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COLLABORATING FOR CLEAN WATER

HOW STRATEGIC PARTNERSHIPS AND A TRANSFORMATION TO MANAGED GRAZING CUT PHOSPHORUS IN TAINTER CREEK BY 14%

By: Alexis Wellman

PROJECT SUMMARY

The Tainter Creek Grazing Project was a dynamic collaboration between the Tainter Creek Farmer-led Watershed Council and several other organizations ranging from local to national, with a diverse skillset. These groups rallied around a common goal: **improving water quality in the Tainter Creek**. They worked together to explore innovative approaches to agricultral transformation that could both meaningfully improve water quality and **improve farmer's bottom lines**. With the help of highly skilled technical service providers, farmers transitioned nearly 250 acres to well-managed grazing. **This land transformation meaningfully reduced the amount of phosphorus in Tainter Creek after 5 years**. The Tainter Creek Grazing project found success through strategic collaborations and locally-driven processes.

KEYS TO SUCCESS

- Locally-driven
- Outcome focused
- Monitored outcomes
- Strategic collaborations
- Extended support
- Flexible structure
- Specialized technical service providers

LOCALLY-DRIVEN

A key piece of the Tainter Creek Grazing Project's success was the leadership of local farmers and community members. While their team included organizations at the national level, local input, goals, and initiatives were included and prioritized throughout the project's scope. This ensured that both the practices implemented and their intended outcomes were relevant and would be long-lasting due to a vested interest in and ownership over the project.

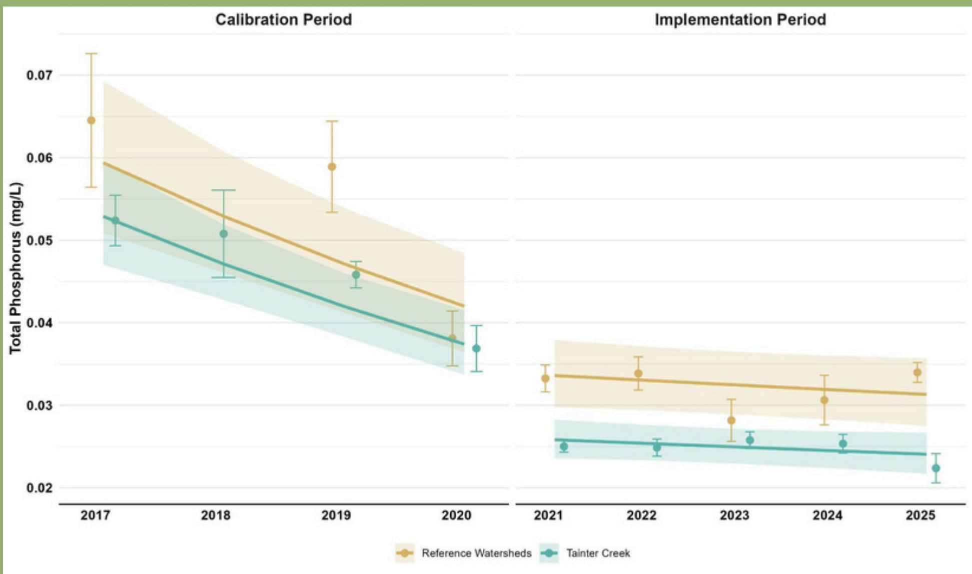
OUTCOME FOCUSED

The Tainter Creek Farmer-led Watershed Council had one specific goal that brought them together amidst differing opinions. Their clear goal of improving water quality gave them something to work towards, and it shaped the trajectory of the project. Cost-share was provided not based on the number of acres under conservation management, but rather based on the estimated amount of phosphorus and soil that would be saved due to the implemented practice. This allowed the group to prioritize actions which would lead to their ultimate goal without wasting time and resources on ineffective practices.

MONITORED OUTCOMES

Researchers and agency staff designed a study that leveraged historical stream water monitoring to set a baseline for water quality before grazing plans were implemented through the project. They continued to monitor water quality after the grazing treatment was implemented to see if the land use changes made would impact their water quality goal.

PHOSPHORUS CONCENTRATIONS 14% LOWER IN TAINTER CREEK AFTER GRAZING IMPLEMENTATION



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The Tainter Creek Grazing Project employed a strategic study design that allowed them to measure phosphorus concentrations in the Tainter Creek versus two reference watersheds, before (2017-2020) and after (2021-2025) grazing practices were implemented in the Tainter Creek watershed. Analysis of this data using a statistical model showed that the Tainter Creek watershed experienced a 14% net reduction in phosphorus compared to the reference watersheds after grazing practices were implemented.

Note: points and error bars represent raw data averages and variance, respectively. Lines and shading represent modeled trend and confidence intervals, respectively.

STRATEGIC COLLABORATIONS

The collaborating organizations on this project were different in locality, size, purpose, and most importantly, skillset. Each organization leaned into their areas of expertise to support the project's goals. Farmers brought a local, grounded perspective of what was feasible for their business and local landscape. Non-profit organizations had the administrative capacity to apply for and manage grant budgets, contracts, and support staff. Researchers helped design a study to track water quality outcomes and probed conversations that went against the status quo. Finally, technical service staff from local organizations and agencies served as the key translators and advocates for equitable, sustainable grazing transitions rooted in both economic practicality and ecological benefit.

EXTENDED SUPPORT

Successful collaborations take time to foster. Trusting relationships must be built before any decisions can be made. Additionally, land use transitions can take several years to complete. It is crucial that support extend longer than 5 years.

PROJECT PARTNERS

FLEXIBLE STRUCTURE

Through The Tainter Creek Grazing Project 26 farms received technical assistance and 10 farms implemented new grazing projects on ~250 acres. Farmers credit the project for it's unique flexibility. It allowed farmers the liberties to explore what worked for them, as long as it met key criteria. Farmers weren't bound to specific materials, specifications, or contract windows. They had the flexibility to explore innovative plans that fit their goals and business directions, with the help of specialized technical service providers

SPECIALIZED TECHNICAL SERVICE PROVIDERS

Converting from row crops to well-managed grazing is no small feat. Guiding farmers through the planning process requires expert individuals who are able to effectively communicate the range of ecological and economic impacts of a land use transition. In the Tainter Creek Grazing Project, technical service providers worked with each interested farmer to create a whole farm assessment, a suite of maps showing curernt practices and proposed projects, financial analyses showing savings from proposed grazing transition, and and a grazing plan. Each farmer was given specialized advice that was unique to them and their farm. This level of detailed planning takes dedicated technical service providers who can navigate the social, environmental, and practical nuances of conservation planning.