Researching the Effectiveness of Agricultural Programs in GLRI Priority Watersheds

REAP FINAL REPORT

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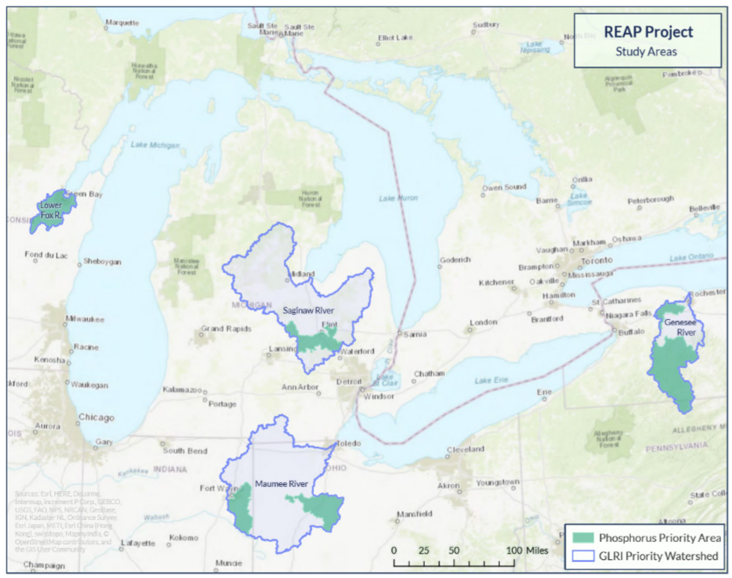
Executive Summary

Project Background

Approximately $96 million was invested between FY2010-2016 in agricultural incentives and other activities aimed at improving nearshore water quality in four priority watersheds (Maumee, Lower Fox, Saginaw, and Genesee) through Focus Area 3 of the Great Lakes Restoration Initiative (GLRI). While most other evaluations of agricultural conservation programs focus on environmental outcomes, Researching the Effectiveness of Agricultural Programs (REAP) investigated whether investments have resulted in long-term changes in voluntary on-farm decision-making that improve water quality outcomes. The REAP team included GLC staff, researchers from The Ohio State University (OSU), Michigan State University Institute of Water Research (MSU IWR), AMP Insights, and a U.S. EPA Region 5 representative. From November 2017, through December 2019, the REAP team completed empirical analyses of primary[1] and secondary[2] data sources to investigate physical, social, and economic outcomes of GLRI Focus Area 3 investments. In addition, REAP included a review of GLRI-supported models and decision-support tools. Conclusions have been synthesized to better understand obstacles and opportunities for increased engagement with farmers that will lead to sustainable change in conservation-minded behaviors among farmers in the four priority watersheds and, ultimately, improved water quality within the Great Lakes Basin.



REAP study area including boundaries for the four GLRI Focus Area 3 Priority Watersheds, and the NRCS Phosphorus Priority sub watersheds

GLRI Programmatic Strengths and Opportunities to Improve Investment Outcomes

The REAP team used primary qualitative and quantitative data from surveys, interview, and focus groups to assess GLRI's key programmatic strengths and likely drivers of farmer behavior. GLRI has several unique qualities that stand apart from other traditional agricultural incentive programs such as the U.S. Department of Agriculture Natural Resource Conservation Service's (NRCS) Environmental Quality Incentive Program (EQIP) and leave it well-poised to make investments that result in sustainable, voluntary changes in on-farm behavior that contribute to improvements in water quality. However, the majority of Focus Area 3 funding between FY2010-2016 (between approximately 60-80%[3]) was allocated

[1] "New" data from interviews, surveys, and focus groups completed by the REAP team.

[2] "Previously existing" data (e.g. Census of Agriculture, U.S. Census Bureau, programmatic data for GLRI investments).

[3] 83% of funding was allocated to projects with the primary purpose of implementing practices. At least 58% went directly to incentive payments. Specific information about how the remaining 25% was allocated within projects was not available, but it can be said with certainty that a portion was also allocated toward practice implementation.

directly toward support of traditional Farm Bill programming or other projects focused on conservation practice (practice) implementation that closely resembles EQIP. While EQIP is highly effective at implementing practices, and the REAP analysis builds from the premise that practice implementation improves water quality, this outcome in isolation does not speak to the goal of influencing on-farm decision-making in ways that are likely to be sustained if/when funding for agricultural incentives is no longer available. Findings suggest that some GLRI Focus Area 3 investments included in this investigation did capitalize on GLRI's unique strengths; however, GLRI's potential to make investments that will directly bolster the sustainability of changes in farmer behavior leading to improved environmental outcomes is underutilized.

GLRI's strengths include flexibility and support of innovative approaches, a reputation among farmers as having a personalized or grassroots feel, leeway to invest directly in outreach and education, relative simplicity and minimal paperwork for program enrollees, and its ability to expand local capacity for implementing conservation. Making an annual profit, managing soil health on individual farms, and cementing a personal legacy by passing a farm on to the next generation in better condition than when it was acquired ranked as the top concerns for priority watershed farmers. Messages related to nutrient loss (from personal farmland and the watershed in general) ranked as the lowest concerns. Through NRCS's Conservation Technical Assistance, GLRI funding has been used for demonstration farms and associated outreach events which facilitate peer-to-peer information exchange. This is important given REAP's finding that farmers prefer to receive information from peers or through personal interactions with local conservation district staff. However, based on available secondary data, only 2% of total funding was allocated toward projects with the direct goal of capacity building and outreach. Approximately 15% of GLRI Focus Area 3 funding was allocated toward monitoring, research, and decision-support tool development efforts that are potentially powerful tools for spreading awareness among farmers about the on-farm benefits of conservation.

These strengths contrast with traditional incentive programs that exclusively focus on practice installation and have strict requirements for what, how, and when practices can be implemented. Many farmers prefer not to engage with traditional federal programs due to an aversion to paperwork and contracts that include land management restrictions with a "regulatory" feel or the perception that practice standards are too generic to meet their farms' unique needs. Skepticism and lack of knowledge about practice efficacy and benefits in terms of financial and operational benefits were also identified as common barriers to voluntarily engaging in conservation. In general, farmers who own large farms, are more educated, and have greater belief in practice efficacy are more likely to engage in voluntary conservation than those working smaller farms or rented land, and who have less education and belief in practice efficacy. GLRI has the unique ability to invest in programs that are designed to overcome these barriers and engage with farmers who have been historically unwilling or unable to participate in more traditional conservation programs.

Assessment of Physical and Economic Outcomes[4]

Significant data gaps about how and/or where some GLRI Focus Area 3 funds were invested and associated outcomes limited the REAP team's ability to produce comprehensive empirical results. Data challenges included lack of access to federal interagency agreements, competing versions of priority watershed boundaries, and inconsistencies in the style and detail of project outcome reporting. Some GLRI-funded projects did not set explicit goals and therefore did not have clear criteria for evaluating success. Several basic questions could not be answered without significant caveats, including the total number of farmers

[4] Summary one-pagers of priority watershed profiles, GLRI-specific data analysis, economic analysis, and focus group outcomes are included as Appendix A of the full REAP Final Report.

enrolled in GLRI Focus Area 3 programs, first time versus repeat enrollees, total acreage placed in conservation, number of jobs created, complete practice implementation tallies at the HUC12 scale, details about the types of activities (or project elements) and how funding was allocated to support those within individual projects, and the amount of funds leveraged through cost-share agreements. The data limitations encountered during this investigation point to substantial opportunities to improve the tracking of GLRI investment activities and associated outcomes so that a comprehensive and empirically based evaluation can be completed in the future.

The data that were collected for specific GLRI investments and made available to the REAP team point to a rubric for success that is focused on physical outcomes. This rubric understates the importance of social and economic indicators of success and inadvertently penalizes innovative projects whose short-term physical outcomes are unlikely to match those of traditional conservation practice investments utilizing well-established methods. Such innovative projects would be more appropriately judged based on outcomes such as their ability to enroll new farmers, sway the opinions of conservation detractors, transfer lessons learned to future investments, and demonstrate scalability of new ideas and methods that have been piloted on a small scale. In general, the focus on collection of physical outcome data misses an opportunity to lend empirical support to pervasive anecdotal accounts of GLRI Focus Area 3's greatest strengths and success stories.

Despite these limitations, a robust analysis of physical and economic outcomes was completed using available secondary and proxy economic data. An economic impact analysis using the U.S. Bureau of Economic Analysis' Regional Input-Output Modeling System concluded that $96 million in GLRI Focus Area 3 investments had an estimated economic impact of nearly $149 million, or an output multiplier of approximately 1.5 times the original investment. This analysis also estimated that between 135 and 210 jobs were created and retained as a result of these investments. Profiles highlighting key physical and demographic differences between the priority watersheds were constructed as a reference tool for future investment decisions. In terms of practice implementation, GLRI-supported EQIP was by far the leading program and the majority of contracts (52%) across all GLRI Focus Area 3 programs for practices were signed within NRCS's Phosphorus Priority Area HUC12 sub-watersheds. Based on Census of Agriculture data, the number of acres with cover crops increased and the reported usage of fertilizer have decreased in the priority watersheds (with the exception of in the Lower Fox) since the inception of GLRI in 2010. While these changes in on-farm behavior correlate with GLRI's focus (based on number of contracts signed) on cover crops and nutrient management, REAP was unable to determine a causal link between GLRI and these outcomes due to the unknown influence of non-GLRI incentive programs and voluntary conservation outside of government incentive programs.

Recommendations

Based on the conclusions of REAP's multi-faceted analysis, the following recommendations have been crafted in support of improving the effectiveness of future GLRI Focus Area 3 investments:

1. Increase federal interagency coordination to harmonize priority watershed boundaries and standardize data collection and tracking methods.
2. Expand and standardize data tracking that includes project elements in addition to conservation practice implementation and that can support empirical analyses related to social and economic investment outcomes.

3. Align reporting requirements with crop cycles and other time-bound elements while allowing greater flexibility within multi-year contracts with farmers to alleviate the risk of deviating from conservation plans due to weather or other unanticipated factors.
4. Increase multi-year investments supporting direct outreach (i.e., in-person public and private meetings and individual interactions) and traditional capacity building (i.e., additional personnel to increase implementation of traditional practices) at the state and local level in order to accommodate the timelines required for building both localized expertise in implementing conservation and personal relationships that drive program enrollment at the community and individual farm-scale.
5. Increase investments supporting *innovative* capacity building, such as new or emerging conservation technology and innovative approaches for expanding outreach to farmers, as well as continuing investment in the implementation of proven conservation methods and the bundling or stacking of proven practices to increase efficacy.
6. Refine outreach strategies to frame the benefits of conservation around primary farmer concerns including profits and soil health. Leverage personal relationships at the farm level between farmers and county conservation district staff to better understand individuals' viewpoints about the primary drivers of profitability on their farm.
7. Invest in research that arms all stakeholders with data on the economic benefits of conservation practice adoption that can be used as an outreach and engagement tool to garner wider program participation and general support for voluntary conservation.
8. Increase outreach that targets landlords, farmers working rented land, and farm management companies who operate within the Great Lakes Basin. This could include offering financial incentives to landlords with lease agreements that include conservation requirements, augmenting incentives payments to increase financial benefits to farmers of implementing conservation practices on rented land, or allowing for the sale of cover crops to create an additional financial incentive for off-season conservation.
9. Invest in the purchase of conservation-oriented farming equipment for community use. Require equipment purchase grantees to devise outreach strategies that target large and mid-sized farms that may want to test out new equipment before purchasing it, as well as farmers working small farms that are open to using new conservation-oriented equipment but face barriers to purchasing it on their own.
10. Increase efforts to leverage information gleaned from multiple GLRI-funded tools, models, and monitoring efforts to bolster farmer confidence in conservation. This includes efforts to socialize GLRI-funded project managers and local technicians to existing resources, as well as strive to create tools that are more accessible/usable for farmers and specifically oriented towards helping them identify conservation practices that address their needs and align with their motivations.

Project Overview

Background

Approximately $96 million was invested between FY2010-2016 in agricultural incentives and other activities intended to influence on-farm decision-making and improve water quality in four priority watersheds (Maumee, Lower Fox, Saginaw, and Genesee) through Focus Area 3 of the Great Lakes Restoration Initiative (GLRI) (Figure 1). While many evaluations of agricultural conservation programs focus on environmental outcomes, this project, known as Researching the Effectiveness of Agricultural Programs (REAP), investigated whether investments result in long-term changes in voluntary on-farm decision-making that improve water quality outcomes. REAP began with the premise that implementing conservation practices (practice) yields water quality benefits and sought to better understand if and how investments can be tailored so that the resulting environmental benefits and conservation-oriented culture at the farm-scale will persist if/when incentive programs are no longer available.

From November 2017, through December 2019, the REAP team completed empirical analyses of primary[5] and secondary[6] data sources to investigate physical, social, and economic outcomes of GLRI Focus Area 3 investments. In addition, a review of GLRI-supported models and decision-support tools was carried out. Stand-alone reports were completed for each of these tasks[7]. Key findings from each of those sub-task reports have been synthesized herein to better understand obstacles and opportunities for enhanced engagement with farmers that will lead to sustainable changes in on-farm decision-making and water quality improvements.

Figure 1: REAP study area including boundaries for the four GLRI Focus Area 3 Priority Watersheds, and the NRCS Phosphorus Priority sub watersheds

[5] "New" data from interviews, surveys, and focus groups completed by the REAP team.
[6] "Previously existing" data (e.g. Census of Agriculture, U.S. Census Bureau, programmatic data for GLRI investments).
[7] Each of the seven stand-alone sub-reports are included as Appendices D-J.

Organization of GLRI Focus Area 3 Investment Data

REAP identified 34 unique GLRI Focus Area 3-funded projects and programs (investments[8]) in priority watersheds between FY2010-2016 (Appendix C). Relevant data was culled from all available documents related to these 34 investments including proposals, progress reports, final reports, and other relevant supporting materials provided by participating federal agencies and PIs. Data was organized in a master database and further categorized based on eight "project elements" that were collaboratively identified and agreed upon by the Advisory Council. Collectively, these elements describe the spectrum of activities, features, and objectives within the 34 investments. Each investment was evaluated based on available documentation and marked as containing or not containing each of the eight elements. Every investment is associated with one or several elements.

Table 1: Eight "project elements" identified by the REAP Advisory Council and PMT to collectively describe the types of activities funded through GLRI Focus Area 3 investments

	Project Element	**Description**
1	Conservation Practice Installation	*Providing incentives to offset costs of practices to benefit water quality*
2	Direct Outreach to Farmers	*In-person public and private meetings and individual interactions*
3	Indirect Outreach to Farmers	*Mailers, press releases, fact sheets, newsletters, websites*
4	Traditional Capacity Building	*Helping existing agencies/programs increase implementation of widely-adopted traditional practices (e.g., through additional personnel)*
5	Innovative Capacity Building	*Help expand the use of innovative tools, methods, and practices that are not readily supported by other major agricultural programs*
6	Edge of Field Monitoring & Research	*Measuring nutrient runoff leaving fields before it enters waterways*
7	Other Monitoring & Research	*Measures nutrients in-stream and in open water*
8	Decision Support Tool Development & Application	*Includes the development and usage of models and databases created to improve on-farm decision making and assist with strategic water quality investments.*

Investments were also placed into one of three categories based on how funding flows between the U.S. EPA and the PI (most commonly a state, federal, or local agency).

Table 2: Three categories of investment pathways that describe the flow of money between U.S. EPA and principal investigator

	Type of Agreement	**Description**
1	Direct Grant	*U.S. EPA awards a grant to the recipient(s) who directly implement the project as a grantee or through a cooperative agreement with U.S. EPA.*
2	Indirect Grant	*U.S. EPA awards a grant to a recipient (e.g., state agencies) who does not directly implement the project but distributes funding to sub-grantee implementer(s) (e.g., county conservation districts).*
3	Interagency Agreement	*U.S. EPA passes funding to a federal partner agency to support investments that are relevant to GLRI goals. The funds may be utilized directly by the federal agency or awarded to sub-grantees.*

[8] "Investment" is used throughout this report to capture GLRI funding in Focus Area 3 through a variety of mechanisms, including grants, cooperative agreements, and interagency agreements (Table 2).

Project Team and Advisory Council

The Great Lakes Commission (GLC) was the principal investigator (PI) for REAP under a GLRI cooperative agreement with the U.S. EPA. The REAP team included GLC staff, researchers from The Ohio State University (OSU), Michigan State University Institute of Water Research (MSU IWR), AMP Insights, and a U.S. EPA Region 5 representative (Appendix B). The creation of watershed profiles, economic analysis, and GLRI programmatic data analyses were led by AMP Insights; surveys, interviews, and focus groups were led by OSU researchers; and the review of GLRI-supported models and tools was led by MSU IWR. All tasks were coordinated and overseen by GLC staff via biweekly REAP team webinar meetings and approximately two in-person all-day meetings per year.

REAP was also informed by an Advisory Council (Appendix B) that included 42 professionals from federal, state, and local agencies, NGOs, the private sector, and academia, collectively representing all four priority watersheds. The Advisory Council convened five times during the project: three all-day in-person meetings in November 2017, 2018, and 2019, and two webinars in May 2018 and July 2019. The Advisory Council also provided iterative feedback and guidance on sub-tasks and deliverables through emails and phone conversations over the course of the project.

Distribution of GLRI Focus Area 3 Investments

The Maumee is the largest of the priority watersheds by area, has the most counties overlapping with its boundary (26), and received the largest p ($44 million). The Genesee watershed, which ranks 3rd in both area and number of counties (10), received the smallest portion of funding ($8 million). The Genesee was first designated as a GLRI "priority watershed" in approximately 2015[9], so it has not been a GLRI Focus Area 3 target for investment as long as the other three watersheds.

Table 3: Distribution of GLRI Focus Area 3 investments by priority watershed

GLRI Focus Area 3 Priority Watershed (State)	Total Investment FY2010-2016 (in millions)
Maumee (OH, IN, MI)	$44
Lower Fox (WI)	$24.3
Saginaw (MI)	$19.5
Genesee (NY, PA)	$8
All Priority Watersheds	**$95.8**

[9] Genesee is first listed as a Focus Area 3 priority watershed in GLRI Action Plan III which describes GLRI activities, goals, and priorities for FY2020-2024. It is not listed as a priority watershed in GLRI Action Plans I or II, which cover FY2010-2019. Based on available information, U.S. EPA has regarded Genesee as the fourth priority watershed since sometime between late 2014 and mid-2016.

Most funding ($65 million) was invested through interagency agreements with four other federal agencies, of which over $54 million went to the U.S. Department of Agriculture's Natural Resource Conservation Service (NRCS). Remaining funds were distributed between 16 direct grants ($17 million) and 14 indirect grants ($14 million). Interagency agreements were not made available to the REAP team, so some details of how and where those funds were invested could not be evaluated.

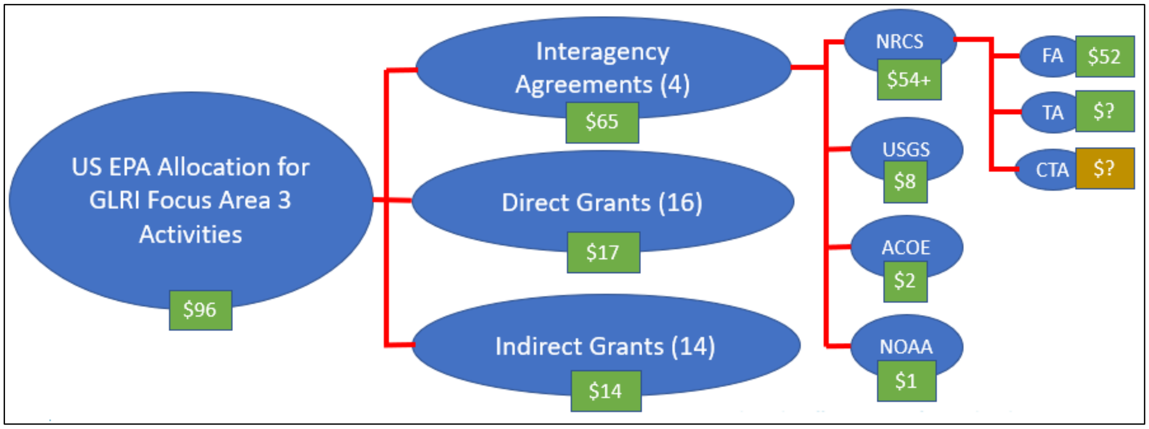


Figure 2: Breakdown of money flow of GLRI Focus Area 3 investments in priority watersheds by type of grant or agreement (rounded to the nearest million dollars).

Table 4: Distribution of GLRI Focus Area 3 investments by award recipient

Recipient	Total Award FY2010-2016
USDA-NRCS	$54,531,287
Ohio EPA	$8,140,179
USGS	$8,025,503
Ohio DNR	$5,940,000
Fox-Wolf Watershed Al.	$4,677,392
USACOE	$1,962,700
EGLE (Formerly MDEQ)	$1,845,740
MDARD	$1,802,866
NEW Water (Green Bay)	$1,686,699
16 Additional Recipients	$7,196,405
Total Investment	**$95,808,771**

The importance of this data gap came into focus when investigating GLRI expenditures using three standard NRCS investment categories: Financial Assistance (FA); Technical Assistance (TA); and Conservation Technical Assistance (CTA). FA and TA are used to promote agricultural production and environmental quality as compatible goals, optimize environmental benefits, and help farmers and ranchers meet federal, state, tribal, and local environmental regulations. The largest expenditures go to

FA, which are direct conservation incentive payments to farmers. Since this data was tracked based on the HUC12 watershed where the contract was signed, REAP was able to determine exactly how much FA funding was allocated to each priority watershed.

CTA program funds have been used to assist individuals and groups of decision-makers, communities, conservation districts and other units of state and local government, tribes, and other federal agencies, with voluntarily conservation, maintenance, and improvement of natural resources. This includes cooperative agreements supporting enhanced program delivery, and many activities similar to those categorized as TA and FA. However, CTA investments have also included innovative projects such as demonstration farm networks that are specifically geared toward outreach and education and peer-to-peer interaction to promote the benefits of on-farm conservation. Specific data concerning how and where TA and CTA investments were distributed was not available. A pervasive challenge in completing this assessment was the lack of reporting about financial allocations and outcomes within specific investments related to project elements other than practice implementation.

A pervasive challenge in completing this assessment was the lack of reporting about financial allocations and outcomes within specific investments related to project elements other than practice implementation

NRCS's CTA investments are a prime example of how GLRI is used to invest directly in activities that can bring about the sustainable changes in farmer behavior that GLRI seeks. These include the support of innovative practices, capacity expansion at the state and local level leading to increased personal interactions, and outreach and education. However, information about the geographies, total dollar amounts, and project elements associated with specific CTA investments was not available for inclusion within the REAP analysis at the level of detail required.[10] The successful outcomes of CTA investments such as demonstration farms were supported by multiple investigative methods, but remain primarily anecdotal, as limited data availability concerning their social impacts prohibited a robust empirical analysis.[11]

Table 5: Distribution of GLRI Focus Area 3 investments by project element (elements 2-5 & 6-8 from Table 1 have been condensed)

Project Element	Funding Allocation (in millions)	% of Total Investments
Conservation Practice Implementation	$79.3	83%
Monitoring, Research & Tool Development	$14.4	15%
Capacity Building & Outreach	$2.1	2%
Total	**$95.8**	**100%**

[10] The REAP team would like to thank Martin Lowenfish, Edwin Martinez, Matt Otto, and other NRCS staff who expended significant effort gathering CTA-related data and helping the team understand the nuances of GLRI-NRCS investments in Focus Area 3 activities.

[11] See Appendix F which includes a preliminary and limited evaluation of the impacts on farmers who attended field day events at the Blanchard Valley Demonstration Farm.

Data concerning how funding was distributed between multiple project elements within individual investments was limited[12], but sufficient data was available to determine both the primary purpose of individual investments as well as the complete breakdown of which elements the 34 investments did or did not include. With this limited available data, REAP discerned that 83% of funding was allocated to projects with the primary purpose of implementing practices. This includes supplements to Farm Bill programs or funding other investments focused on practice implementation that closely resemble EQIP. Available data indicates that at least 58% of total GLRI Focus Area 3 investments went directly to conservation incentive payments for farmers. Information about how the remaining 25% was allocated between the eight project elements within specific investments was not available; however, most projects with this primary purpose also included other project elements including outreach and capacity expansion. With one exception,[13] investments were made in each of the eight project elements in all priority watersheds. Only 2% of total funding was allocated toward projects with the primary purpose of capacity building and outreach, and 15% was allocated directly for investments in monitoring, research, and tool development.

Evaluation of GLRI Focus Area 3 Investment Outcomes and Efficacy Based on Multiple Measures of Success

Data gaps about how and/or where some GLRI Focus Area 3 funds were invested and associated outcomes limited the REAP team's ability to produce comprehensive empirical results. Despite these limitations, analyses of physical and economic investment outcomes were completed using the available GLRI-specific data, relevant public data sets, and proxy economic data.[14] Social outcomes were determined based on survey data[15], focus groups with GLRI-project and program enrollees in priority watersheds, and interviews with PIs and managers of GLRI investments.[16]

Physical Outcomes

In total, 106 different types of practices were implemented using GLRI Focus Area 3 incentives. The number and type used vary by watershed; however, the REAP team worked with NRCS to ensure that all practices included in the analysis meet the threshold of improving water quality upon implementation. The greatest and least amount of different practice types were implemented in the Maumee and Genesee watersheds, respectively. The greatest and least amount of conservation incentive contracts were also signed in these two respective watersheds. The majority of practices were installed through GLRI-funded EQIP. Although outcome data (practice installation tallies and HUC12 locations) were not available for several direct and indirect sub-grantee projects, the number of contracts signed through EQIP topped all individual direct and indirect investments with available outcome data by several thousand. While EQIP is highly effective at implementing practices, and the REAP project builds from the premise that practice

[12] For example, proposals, workplans, and outcome reports made available to the REAP PMT could be used to identify that an investment was primarily geared toward practice implementation and also included outreach and education components; however, there was no way to determine what percent of the funding went toward fulfilling those individual components of the overall work plan.
[13] No investments categorized as "innovative capacity building" were made in the Genesee watershed.
[14] See Appendix H and Appendix I for the full physical and economic investment outcome reports.
[15] See Appendix E and Appendix F for full new survey report and previous survey report, respectively.
[16] See Appendix D for full report on REAP interviews and focus groups.

implementation improves water quality, this outcome in isolation does not speak to the goal of influencing on-farm decision-making in ways that are likely to persist if/when funding for agricultural incentives are no longer available.

Table 6: Implementation details of GLRI Focus Area 3's top conservation practices

Conservation Practice	Implementation Details[17]
Cover Crops (NRCS Practice #340)	• 2,138 contracts signed • 25% of all contracts • 345,000-acres • $11.5 million in payments or 12% of total GLRI Focus Area 3 investment
Nutrient Management (NRCS Practice #590)	• 1,176 contracts signed • 14% of all contracts • 308,000-acres • $7.5 million in payments or 8% of total GLRI Focus Area 3 investment

Cover crops and nutrient management were the most popular practices across all priority watersheds in terms of the frequency of contracts signed. Based on Census of Agriculture data, the number of acres with cover crops increased and the reported usage of fertilizer decreased (with the exception of Lower Fox) in the priority watersheds since the inception of GLRI in 2010. While these changes in on-farm behavior correlate with GLRI Focus Area 3's goals for implementing cover crops and nutrient management, the unknown influence of non-GLRI incentive programs and voluntary conservation outside of programs precludes the determination of a causal link between GLRI Focus Area 3 investments and these outcomes.

Cover crops were also the number one practice in terms of dollars allocated to conservation payments, with nutrient management ranked third. The practice that was supported with the second highest level of funding was waste storage facilities (NRCS Practice #313). In terms of contracts, 124 (1.5% of all contracts) were signed for a total obligation of nearly $9 million (~9.5% of total GLRI Focus Area 3 investment), with an average payment of $72,350 per contract.

Most contracts for practices (at least 52%) were signed within one of the NRCS Phosphorus Priority Area sub-watersheds (PPAs). Since PPAs are defined by HUC12 watershed boundaries and some practice implementation data was not reported to this level of specificity, determinations could not be made for a portion of contracts in three priority watersheds (marked as blank in Figure 3 below). This gap did not exist for the Lower Fox watershed, where PPA and priority watershed boundaries are identical.

[17] Metadata for contracts that distinguishes unique farmer participants or unique acres of land was not available. As a result, acreage that was improved with multiple practices in a single year, or acreage under contract across multiple years (returning participants) are double-counted in the dataset.

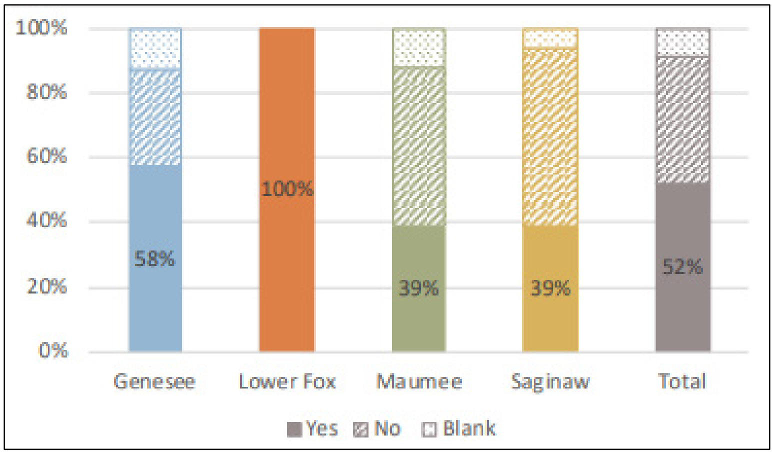


Figure 3: Percentage of contracts signed within NRCS PPAs by priority watershed

Contracts were signed in 52 out of 63 total counties whose boundaries partially overlap with one of the priority watersheds. Brown County, Wisconsin, (Lower Fox watershed), De Kalb County, Indiana, (Maumee watershed), and Defiance County, Ohio, (Maumee watershed), were the top counties for contracts signed, with Brown County significantly exceeding the number of contracts signed in other counties (Figure 4).

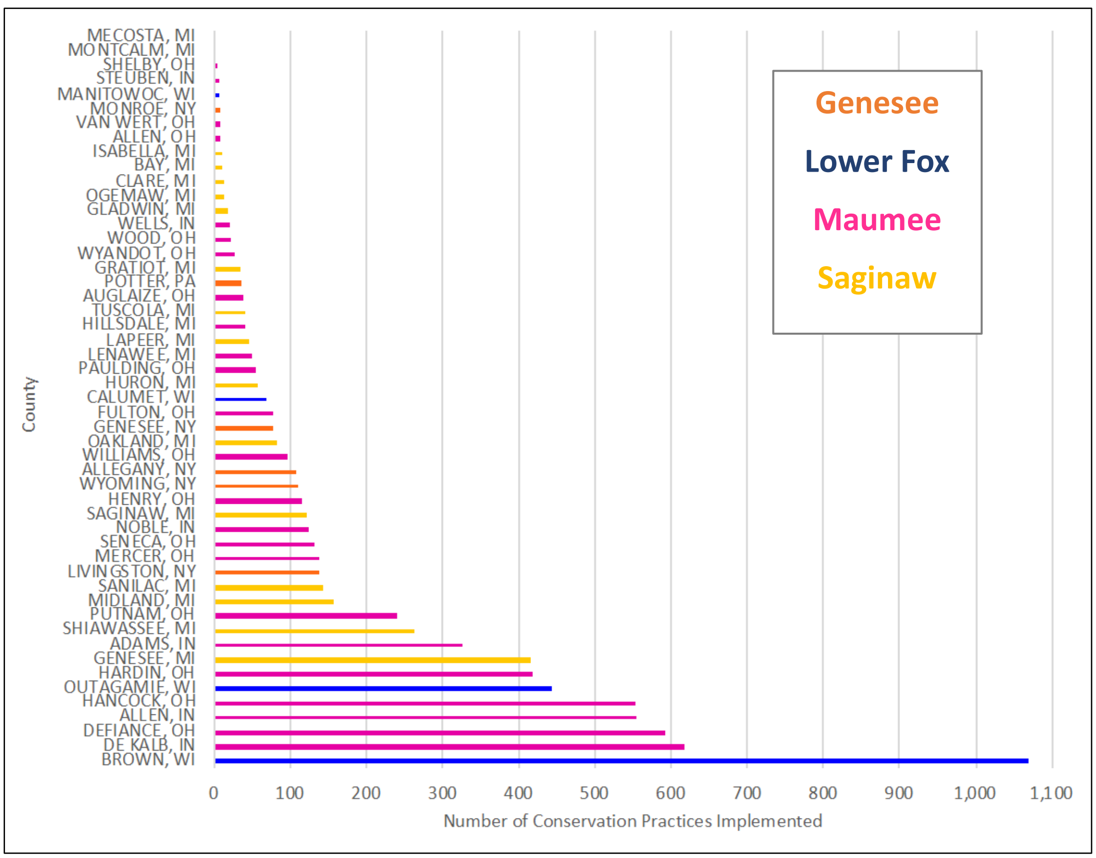


Figure 4: Distribution of practice implementation contracts signed by county and state, color-coded by priority watershed

Economic Outcomes

Due to data limitations concerning economic reporting and outcome data related to specific GLRI investments, a proxy method known as the Regional Input-Output Modeling System (RIMS II) was used to determine the economic impacts in priority watersheds. This method can be used to investigate the interrelationships between a specific industry (in this case the agricultural conservation "industry") and the multiplier effect of investments in one industry across a broader economy. Results of this type of analysis are typically expressed as multipliers that represent the additional economic impact above the direct contributions of the industry being considered. This analysis was also used to estimate the number of jobs created and retained as a result of GLRI Focus Area 3 investments.

For the REAP analysis, direct economic contributions of GLRI investments were total funds spent within each watershed. These investments then supported: a) indirect impacts - the purchase of supplies and services to support implementation of conservation practices (e.g., purchase of plants for a vegetative buffer or hedgerow planting); and b) induced impacts - personal spending by farmers receiving GLRI funding as well as any employees of industries providing supplies and services (e.g., purchase of groceries). Two data sources were used for this analysis – the Master Project Database compiled by the REAP PMT and RIMS II multipliers purchased from the U.S. Bureau of Economic Analysis. Impacts of practice installation and the impacts of the other seven project elements (referred to as "Non-CP Funds and Impacts" in Figure 5 below) were parsed out as required by this analytical method, and the results were aggregated.

GLRI Focus Area 3 investments of $95.8 million between FY2010-2016 had an estimated economic impact, measured in terms of total output, of between $142 and $149 million, or an overall output multiplier of 1.48 to 1.55 times the original investment. A conservative estimate for job creation ranges from 135 to 210 full and part-time jobs created and retained as a result of GLRI Focus Area 3 investments during that same period.

Economic Impacts and Job Growth

$95.8 million in GLRI investments leveraged nearly $149 million in total economic impact, approximately 1.5 times the original investment

Up to 210 full and part time jobs created and retained

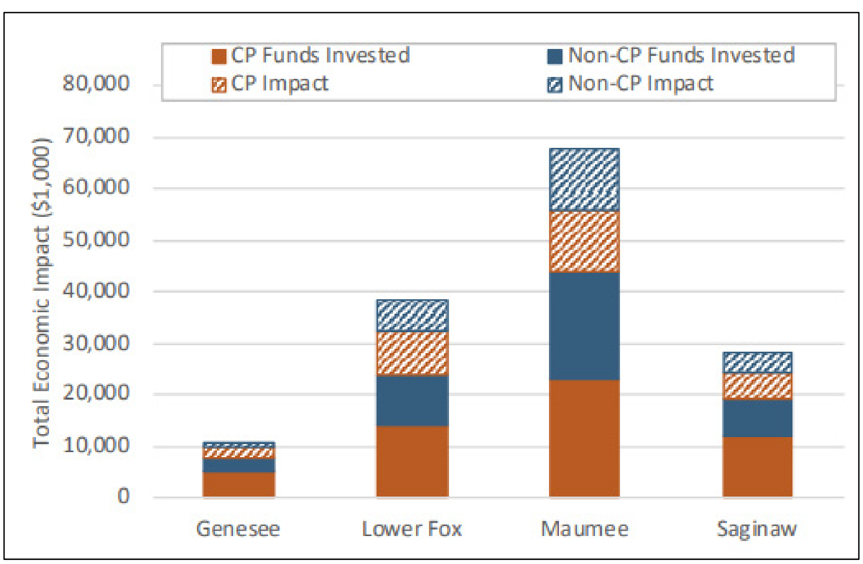


Figure 5: Estimated total economic impacts of GLRI Focus Area 3 investments by priority watershed

Social Outcomes

Farmers who participated in REAP focus groups were nearly unanimous in their support for the current structure of GLRI, suggesting that it is broadly perceived as an effective program as-is. Several people indicated that GLRI payments covered up-front costs which allowed them to integrate the practices into their operation. Once integrated, they reported many of the practices either paid for themselves or required very little cost to maintain. Many of these farmers stated that they have continued to implement practices initially installed through GLRI without incentive payments or intend to do so going forward. This contrasted with survey data where respondents indicated that for both buffer strips and cover crops, they were slightly unlikely to implement them in the future without incentive payments. While many PIs and managers who were interviewed believe that GLRI investments have resulted in lasting cultural changes, the response was not unanimous. Other program managers were optimistic, but expressed a "wait and see" approach, cautioning that cultural advances could be lost without continued GLRI investment. A third segment of interviewees indicated that they do not see evidence of lasting cultural change.

Information gleaned from farmers through both the survey and focus groups identified a low-awareness of the presence of GLRI in priority watersheds. Between 15-22% of survey respondents in each priority watershed indicated that they were "unsure" if they had participated in a GLRI-funded project or program. Focus group invitees specifically selected because they had received GLRI-backed incentive payments were asked if they had received GLRI funds. Nearly a third of farmers responded either "no" or "maybe", and when asked if they had ever heard of GLRI; several farmers responded "no". In addition, several of the barriers and other program structures or features that farmers spoke at length about not liking were tied to Farm Bill program restrictions that are not inherently connected to GLRI investments.

This lack of awareness is not surprising considering that the majority of GLRI-supported incentive payments were distributed through EQIP (a Farm Bill program, as opposed to investments uniquely associated with GLRI). The nuance of the specific funding stream that a local district uses to implement a program would be largely unimportant to an individual farmer primarily concerned with improving their operation. In addition, this may be a consequence of the widely-reported "grassroots" and "localized" perception of GLRI among farmers obscuring the fact that it is a federal program. While the lack of awareness of GLRI's presence could be inconsequential to overall programmatic goals, a widespread failure to recognize the difference between GLRI and traditional agricultural conservation programs means that GLRI's unique strengths and opportunities for innovation could be better marketed to potential program participants and members of Congress.

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Obstacles that Must be Addressed by Current Voluntary Approaches to Improve Water Quality

Policy-Level Obstacles

Significant data gaps about how and/or where some GLRI Focus Area 3 funds were invested and associated outcomes currently limit possibilities for completing a comprehensive, empirical, socio-economic investigation of the efficacy of GLRI Focus Area 3 investments. In addition, some work plans and/or proposals for individual investments did not set explicit goals and therefore did not have clear criteria for evaluating their degree of success. Other specific obstacles for evaluating program-wide effectiveness include competing versions of priority watershed boundaries at different state and federal agencies, a convoluted naming system for unique investments in GLRI's public-facing master database, and inconsistencies in the style and details of outcome reporting. Several basic questions could not be answered without significant caveats, including the total number of farmers enrolled in GLRI Focus Area 3 programs, first time versus repeat enrollees, total new acreage placed in conservation and total acres on which existing conservation was perpetuated, number of jobs created, complete practice implementation tallies down to the HUC12 scale, details of how funding was allocated to various elements within individual projects, and the amount of funds leveraged through cost-share agreements, in-kind contributions, and synergies with other non-GLRI programs. The data limitations encountered during this investigation point to substantial opportunities to improve the tracking of investment activities and associated outcomes so that a comprehensive and empirically-based evaluation can be completed in the future.

The data that was collected for specific investments points to a rubric for success that is focused on physical outcomes. This aligns with the finding that the vast majority of funding (83%) went to investments with the primary purpose of practice implementation. This investment focus and related outcome reporting understates the importance of social and economic impacts as indicators of success. It also inadvertently penalizes innovative projects whose short-term physical outcomes are unlikely to match those of traditional investments utilizing well-established methods. Such innovative projects would be more appropriately judged based on outcomes such as their ability to enroll new farmers, sway the opinions of conservation detractors, support sustainable long-term change in on-farm decision-making, and demonstrate scalability of new ideas and methods that have been piloted on a small scale. In general, the focus on collection of physical outcome data misses an opportunity to lend empirical support to pervasive anecdotal accounts of GLRI Focus Area 3's greatest strengths and success stories.

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Community and Farm-Level Obstacles

Survey data from priority watershed farmers indicates that many farmers prefer not to engage with traditional federal programs due to an aversion to paperwork and contracts that include land management restrictions, or the feeling that they are too generic to meet their farms' unique needs. Some farmers indicated that current payment structures were insufficient to entice their participation. Skepticism and lack of knowledge about practice efficacy and financial benefits were also identified as common barriers to voluntarily engaging in conservation. In general farmers who operate relatively small farms, are older, less educated, more production-minded, and more concerned with their personal operation than the watershed as a whole are less likely to participate in voluntary conservation programs. Other major constraints included a belief that the government and not individual farmers are responsible for protecting water quality. Conversely, being younger, more educated and more conservation-minded, operating a larger farm, believing that the benefits of conservation are certain, that the practices are effective, that farmers are responsible for water quality, and being concerned about watershed-level issues increased the chances that a farmer will be motivated to engage in conservation.

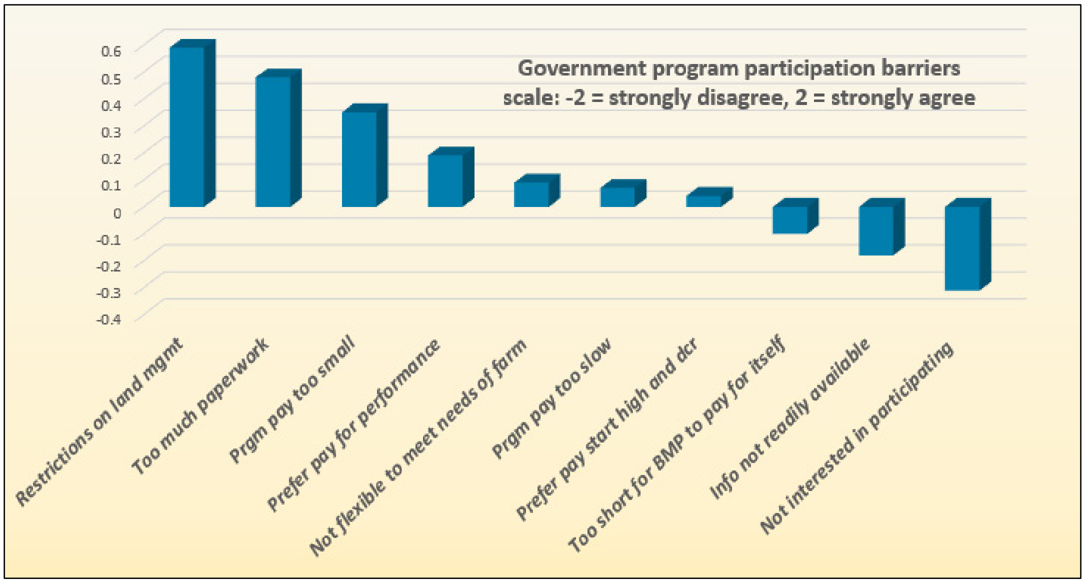


Figure 6: Ranking of top barriers to program participation based on a survey of farmers in the four priority watersheds

In terms of cover crops specifically (GLRI Focus Area 3's top practices), challenges with access to equipment, the time it takes to manage, uncertainty in the weather, and the lack of an immediate economic return were consistently cited as the highest perceived obstacles across all priority watersheds. However, it should be noted that the majority of obstacles identified by farmers were also rated on average as not limiting their ability to use cover crops, or only limiting it a little bit.

Three additional noteworthy obstacles related to contract timing and land tenure were identified by priority watershed farmers during focus groups. One participant suggested that "having the resources [available] when you need them" was an obstacle, because "everything is so timely [in this business]." Other participants across multiple focus group agreed: when resources (e.g., machinery, supplies, personnel) are unavailable under shifting conditions (e.g. changes in weather or economic conditions), it presents an obstacle. Another participant suggested difficulties in "making the adjustment [from year-to-year] of where a particular cover crop may go and how soon it can get seeded," because economic factors drive crop rotations, and "you don't know three years out, or five years out, what it might be, and it might change." Allowing for seasonal adjustments within multi-year contracts with farmers could help overcome this obstacle. In addition, farmers noted that the current incentive structures do not provide sufficient benefits to garner participation from landlords or farmers who work on rented land. This is significant considering Census of Agriculture data indicates that across the priority watersheds the percentage of operations utilizing some rented land ranges between 29-35%, and the acreage that is worked exclusively by tenant farmers ranges between 4-7%. Between 2007 and 2017, both of these percentages increased across all priority watersheds, pointing to a significant and growing population of farmers in GLRI Focus Area 3 priority watersheds who are unlikely to engage in the status quo of voluntary conservation programs.

By tailoring outreach to speak to the primary concerns of farmers, directly supporting local capacity expansion, innovative techniques, and education, and taking advantage of GLRI's flexibility compared to more rigid Farm Bill programs, GLRI has the unique potential to overcome these barriers and engage farmers who have been historically unwilling or unable to participate in voluntary conservation.

Successful Approaches for Motivating Farmers to Engage in Voluntary Conservation and Improve Water Quality

GLRI has several unique qualities that stand apart from other traditional agricultural incentive programs and leave it well-poised to make investments resulting in sustainable changes in farmer behavior. Strengths of GLRI include its flexibility and support of innovative methods, a reputation among farmers as having a personalized or grassroots feel, leeway to invest directly in outreach and education, relative simplicity and minimal paperwork for program enrollees, and its ability to expand local capacity for implementing conservation. These strengths contrast with traditional programs that exclusively focus on practices and have strict requirements for what, how, and when they can be implemented.

Through NRCS's Conservation Technical Assistance, GLRI funding has been used for demonstration farms and associated outreach events that facilitate peer-to-peer information exchange. This is important given REAP's finding that farmers prefer to receive information from peers or through personal interactions with local conservation district staff. This conclusion, based on farmer focus groups and survey data, was also supported by information gleaned from interviews with GLRI Focus Area 3 PIs and managers who reported that GLRI investments create lasting cultural changes in cases where local staff are available to spend significant time with "boots on the ground" to assist individual farmers and the project timeframe is long enough that farmers begin to realize the economic benefits of conservation.

GLRI's Unique Qualities and Key Strengths

Flexibility

Support of innovative methods

Reputation for personalized or "grassroots" programming

Leeway to invest directly in outreach and education

Minimal paperwork for program enrollees

Ability to expand local capacity for implementing conservation

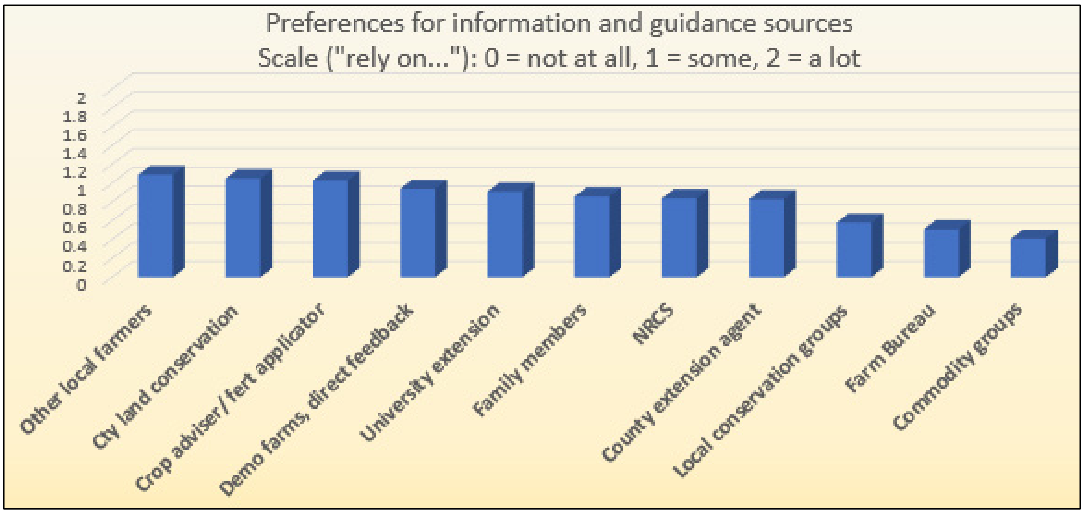


Figure 7: Ranking of preferred sources of information based on a survey of farmers in the four priority watersheds

Survey data about top concerns of farmers provides insight into how outreach and education can be tailored to achieve the widest possible engagement. Making an annual profit, managing soil health on individual farms, and cementing a personal legacy by passing a farm on to the next generation in better condition than when it was acquired ranked as the top concerns. Notably, messages related to nutrient loss (from personal farmland and the watershed in general) ranked as the lowest concerns for priority watershed farmers.

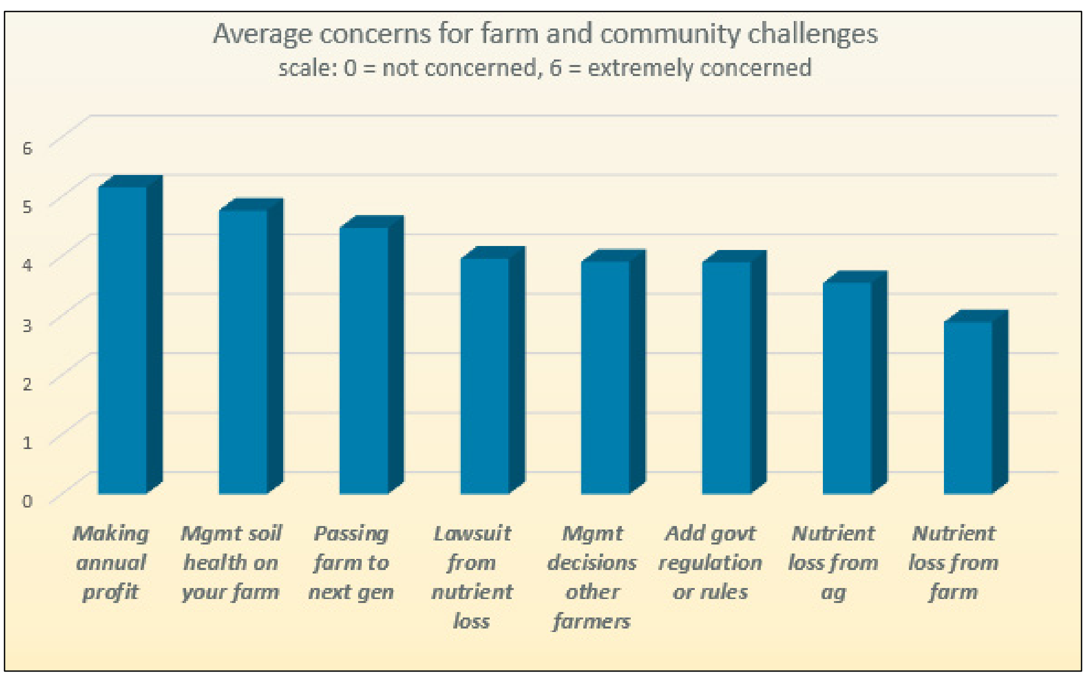


Figure 8: Ranking of top farmer concerns based on a survey of farmers in the four priority watersheds

Some GLRI Focus Area 3 investments included in this investigation did capitalize on GLRI's unique strengths; however, GLRI's potential to make investments that will directly bolster the sustainability of environmental outcomes is currently underutilized. The 15% of GLRI Focus Area 3 funding that was allocated toward monitoring, research, and tool development along with the 2% that was allocated directly toward capacity building and outreach has the potential to spread awareness among farmers about the on-farm benefits of conservation, and in turn solicit wider participation in voluntary conservation. By contrast, the 83% of funding invested for the primary purpose of practice implementation proved to be successful for achieving that outcome in isolation with no clear evidence that traditional program participants are likely to continue to implement conservation practices without incentives, or that these investments are likely to achieve wider engagement beyond the usual early adopters who are most likely to engage in voluntary conservation programs under any circumstances.

It should also be noted that the successful approaches summarized herein are based purely on survey data from farmers within the priority watersheds (but not necessarily participating in GLRI) and anecdotal accounts from GLRI participants obtained through focus groups and interviews. The lack of socio-economic outcome data that could theoretically be used to discern connections between project and program design and social outcomes such as levels of participation and instances of continuing conservation by former GLRI-program participants does not allow for further empirical or quantitative support for these lessons learned. Improved data collection methods that help determine whether a small portion of farmers are engaging in multiple acts of conservation (e.g. 30% of the population is doing many things) or a larger portion of the population are taking fewer individual actions (e.g. 60% of the population is doing at least one thing) would support future analysis and recommendations for improved engagement and enrollment.

Recommendations for Adapting Current GLRI Focus Area 3 Investment Strategies to Increase Future Effectiveness

Based on the conclusions of REAP's multi-faceted analysis, the following recommendations have been crafted in support of improving the effectiveness of future GLRI Focus Area 3 investments:

1. Increase federal interagency coordination to harmonize priority watershed boundaries and standardize data collection and tracking methods.
2. Expand and standardize data tracking that includes project elements in addition to conservation practice implementation and that can support empirical analyses related to social and economic investment outcomes.
3. Align reporting requirements with crop cycles and other time-bound elements while allowing greater flexibility within multi-year contracts with farmers to alleviate the risk of deviating from conservation plans due to weather or other unanticipated factors.
4. Increase multi-year investments supporting direct outreach (i.e., in-person public and private meetings and individual interactions) and traditional capacity building (i.e., additional

personnel to increase implementation of traditional conservation practices) at the state and local level in order to accommodate the timelines required for building both localized expertise in implementing conservation and personal relationships that drive program enrollment at the community and individual farm-scale.

5. Increase investments supporting *innovative* capacity building, such as new or emerging conservation technology and innovative approaches for expanding outreach to farmers, as well as continuing investment in the implementation of proven conservation methods and the bundling or stacking of proven practices to increase efficacy.

6. Refine outreach strategies to frame the benefits of conservation around primary farmer concerns including profits and soil health. Leverage personal relationships at the farm level between farmers and county conservation district staff to better understand individuals' viewpoints about the primary drivers of profitability on their farm.

7. Invest in research that arms all stakeholders with data on the economic benefits of conservation practice adoption that can be used as an outreach and engagement tool to garner wider program participation and general support for voluntary conservation.

8. Increase outreach that targets landlords, farmers working rented land, and farm management companies who operate within the Great Lakes Basin. This could include offering financial incentives to landlords with lease agreements that include conservation requirements, augmenting incentives payments to increase financial benefits to farmers of implementing conservation practices on rented land or allowing for the sale of cover crops to create an additional financial incentive for off-season conservation.

9. Invest in the purchase of conservation-oriented farming equipment for community use. Require equipment purchase grantees to devise outreach strategies that target large and mid-sized farms that may want to test out new equipment before purchasing it, as well as farmers working small farms that are open to using new conservation-oriented equipment but face barriers to purchasing it on their own.

10. Increase efforts to leverage information gleaned from multiple GLRI-funded tools, models, and monitoring efforts to bolster farmer confidence in conservation. This includes efforts to socialize GLRI-funded project managers and local technicians to existing resources, as well as strive to create tools that are more accessible/usable for farmers and specifically oriented towards helping them identify conservation practices that address their needs and align with their motivations.

Appendix A

Summary One-Pagers of Watershed Profiles, GLRI-specific Data Analysis, Economic Analysis, and Focus Group Outcomes

Great Lakes Commission des Grands Lacs

REAP Researching the Effectiveness of Agricultural Programs

GLRI FA3 Priority Watershed Profile

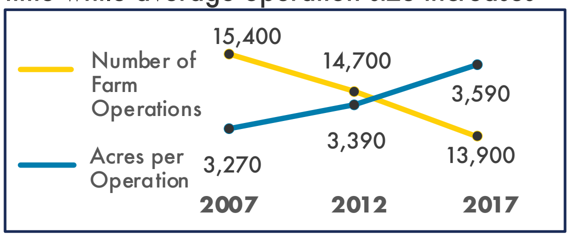
Maumee Watershed

Watershed size	4,208,100 acres
Drains to	Lake Erie
No. of counties	26
Acres agricultural land	3,086,100
% Agricultural land	73

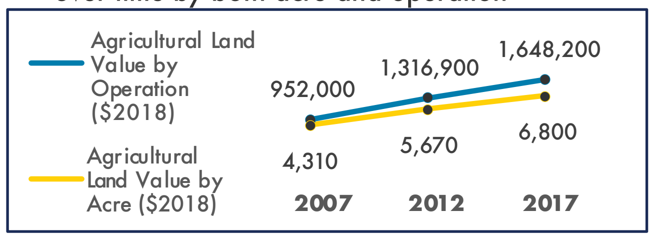
Total producers	22,300
Average age	57
Average yrs farming	27
% Female	28

Highlights

*Number of farm operations decreasing over time while average operation size increases



*Agricultural land value has been increasing over time by both acre and operation



*The majority of acres in agriculture are operated by part-owners, who farm on land they both own and rent, a trend that has increased over time, while acres operated by full owners, who farm their own land, and tenants, who farm only rented land, have decreased and remained static, respectively

Tenure by Acre (%)

	2017	Change since 2007
Full owners	20	-2
Part owners	73	2
Tenant	7	0

Share of Sales by Type

	Millions ($)	%
Crops	1,494	57
Livestock	1,116	43

Fertilizer Use by Acres 2007-2017: ↓ 6%

*Land use practices, aligned with soil conservation and best management practices for mitigating negative impacts on water quality - identified as Conservation Practices by REAP - have increased over time

Land Use Practices (% of Cropland)

		2017	Change since 2012
Conservation Practices	Cover crops	8	5
Conservation Practices	Conservation till	73	4
Conservation Practices	Conservation easements	2	1
Traditional Practices	Intensive till	20	-4

Top Crops in Acres

Soybeans	1,672,100
Corn	978,100
Grass/pasture	307,800
Winter wheat	172,300
Alfalfa	56,900

Farms That (%):

Have internet access	75
Are family farms	88

Estimates on this fact sheet are based on normalized Census of Agriculture county level data to accurately represent the footprint of the watershed

*For more information, please visit: glc.org/work/REAP/products

REAP Researching the Effectiveness of Agricultural Programs

Great Lakes RESTORATION

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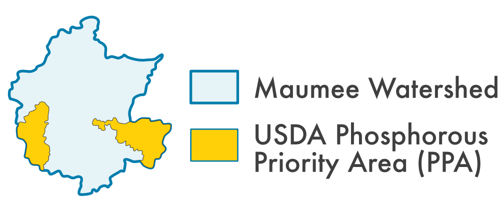
GLRI FA3 Investments and Outcomes (FY 2010-2016)

Maumee Watershed

GLRI Funded Projects	Total Investment
24	$43,998,900

Highlights



39%

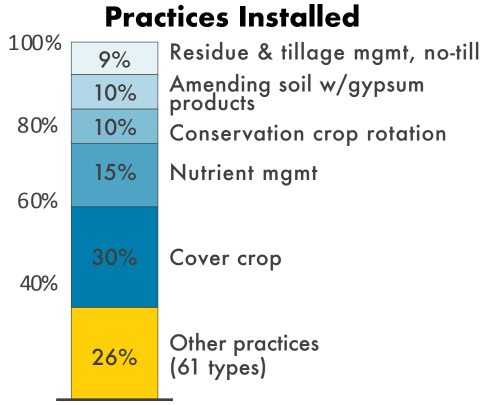
of incentive payments obligated within USDA NRCS PPA boundaries

Locations of Practice Implementation	
In PPAs	39%
Outside PPAs	49%
Unknown	12%

Top Five Counties by Number of Incentive Contracts Signed

Conservation Practice Implementation

Practices Installed



66

Practice Types Implemented

Practice Type[1]	Acres[2]
Cover crop	183,400
Nutrient mgmt	148,800
Residue & tillage mgmt, no-till	67,900
Conservation crop rotation	44,900

Practice Type	$1000s	Funding (%)
Cover crop	$6,750	29
Nutrient mgmt	$4,330	19
Conservation crop rotation	$2,740	12
Residue & tillage mgmt, no-till	$1,560	7

Practice Type	Acres	Cost/Acre[3]
Integrated pest mgmt	18,600	$7
Soil testing	37,100	$9
Conservation tillage	7,310	$15
Equipment modification	5,770	$16
Residue & tillage mgmt, reduced till	25,400	$19

1 Practices implemented may overlap in space such that the addition of the acreage would not accurately sum to total practice coverage

2 Acres may differ between tables as not all contracts reported costs

3 Costs reflect GLRI investments per acre only and do not include farmer cost-share

*For more information, please visit: glc.org/work/REAP/products

Researching the Effectiveness of Agricultural Programs

Great Lakes Restoration

Great Lakes Commission des Grands Lacs

Economic Analysis of GLRI FA3 Investments (FY 2010-2016)

Maumee Watershed

GLRI Focus Area 3 Funding FY 2010-2016

Total ($)	Payments for Conservation Practices	% Funding as Payments for Conservation Practices
$43,998,900	$23,137,800	53

Methods

- **Direct Impact**: GLRI investments increase regional economic activity and employment
- **Multiplier* Effect**: Direct impacts, in turn, increase demand for goods and services from industries supporting or supported by those receiving direct spending and spending by individuals employed by jobs created
- **Total Impact**: Sum of direct impacts and multiplier effect

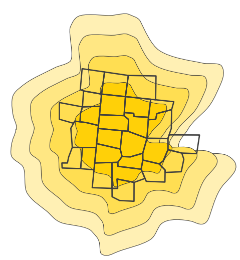
* Input-output modeling is a method commonly used to examine the interrelationships of economic sectors and describe the multiplier effect of changes in one sector across a broader economy

*Multipliers were obtained from the Regional Input-Output Modeling System (RIMS II) managed by the U.S. Bureau of Economic Analysis

Highlights

1.5

Investment to Output Multiplier

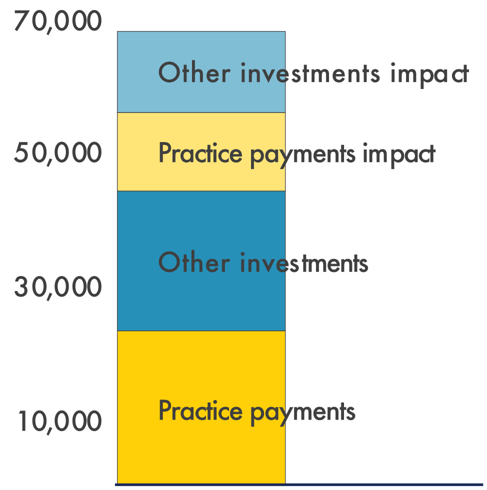


	Direct Impact	Total Output	Jobs Created
Total payments to practices	$23,137,600	$35,104,200	39
Other investments	$20,733,800	$32,720,000	46
Total GLRI FA3 impact*	$43,871,400	$67,824,200	85

*Values for Total GLRI FA3 Impact do not sum to total watershed funding as some funding was allocated to multiple watersheds and could not be parsed at the finer scale required for this analysis

Payments for conservation practices could be linked to a particular industry; however, this was not possible for other investments, so results were calculated for three scenarios. Estimates included here are an average of the results from these three scenarios.

Total Economic Impact ($1,000)



$67,824,200

Total output from GLRI FA3 investments in the watershed

*For more information, please visit: glc.org/work/REAP/products

REAP Researching the Effectiveness of Agricultural Programs

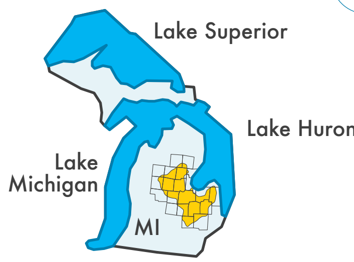
Great Lakes RESTORATION

Great Lakes Commission des Grands Lacs

GLRI FA3 Priority Watershed Profile

Saginaw Watershed

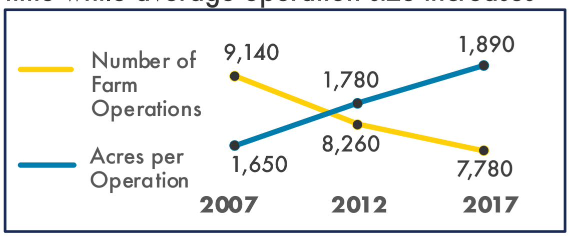
Watershed size	3,988,800 acres
Drains to	Lake Huron
No. of counties	22
Acres agricultural land	1,496,800
% Agricultural land	38



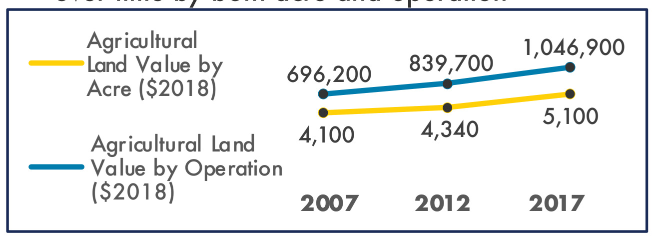
Total producers	12,900
Average age	58
Average yrs farming	26
% Female	34

Highlights

*Number of farm operations decreasing over time while average operation size increases



*Agricultural land value has been increasing over time by both acre and operation



*The majority of acres in agriculture are operated by part-owners, who farm on land they both own and rent, a trend that has increased over time, while acres operated by full owners, who farm their own land, and tenants, who farm only rented land, have decreased and remained relatively static, respectively

Tenure by Acre (%)

	2017	Change since 2007
Full owners	23	-4
Part owners	72	5
Tenant	5	-1

Share of Sales by Type

	Millions ($)	%
Crops	668	63
Livestock	396	37

*Land use practices, aligned with soil conservation and best management practices for mitigating negative impacts on water quality - identified as Conservation Practices by REAP - have increased over time

Fertilizer Use by Acres 2007-2017:

↓ 6%

Land Use Practices (% of Cropland)

		2017	Change since 2012
Conservation Practices	Cover crops	7	3
	Conservation till	47	7
	Conservation easements	1	1
Traditional Practices	Intensive till	38	-6

Top Crops in Acres

Soybeans	576,000
Corn	435,100
Grass/pasture	300,200
Alfalfa	150,900
Winter wheat	111,800

Farms That (%):

Have internet access	77
Are family farms	91

Estimates on this fact sheet are based on normalized Census of Agriculture county-level data to accurately represent the footprint of the watershed

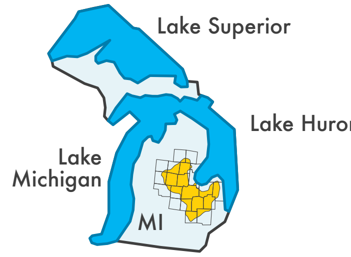
*For more information, please visit: glc.org/work/REAP/products

REAP Researching the Effectiveness of Agricultural Programs

Great Lakes RESTORATION

Great Lakes Commission des Grands Lacs

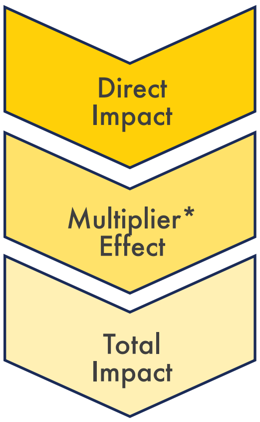
Economic Analysis of GLRI FA3 Investments (FY 2010-2016) Saginaw Watershed



GLRI Focus Area 3 Funding FY 2010-2016

Total ($)	Payments for Conservation Practices	% Funding as Payments for Conservation Practices
$19,495,400	$12,134,900	62

Methods



GLRI investments increase regional economic activity and employment

Direct impacts, in turn, increase demand for goods and services from industries supporting or supported by those receiving direct spending and spending by individuals employed by jobs created

Sum of direct impacts and multiplier effect

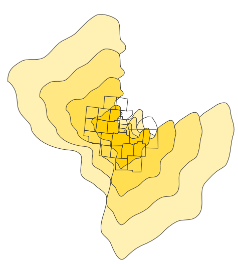
*Input-output modeling is a method commonly used to examine the interrelationships of economic sectors and describe the multiplier effect of changes in one sector across a broader economy

Highlights

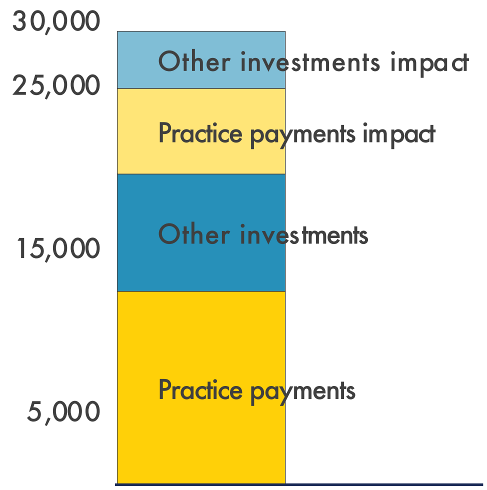
*Multipliers were obtained from the Regional Input-Output Modeling System (RIMS II) managed by the U.S. Bureau of Economic Analysis

1.5

Investment to Output Multiplier



Total Economic Impact ($1,000)



	Direct Impact	Total Output	Jobs Created
Total payments to practices	$12,134,900	$17,369,400	17
Other investments	$7,233,200	$10,786,100	16
Total GLRI FA3 impact	$19,368,100	$28,155,500	33

*Values for Total GLRI FA3 Impact do not sum to total watershed funding as some funding was allocated to multiple watersheds and could not be parsed at the finer scale required for this analysis

Payments for conservation practices could be linked to a particular industry; however, this was not possible for other investments, so results were calculated for three scenarios. Estimates included here are an average of the results from these three scenarios.

$28,155,500

Total output from GLRI FA3 investments in the watershed

*For more information, please visit: glc.org/work/REAP/products

Researching the Effectiveness of Agricultural Programs

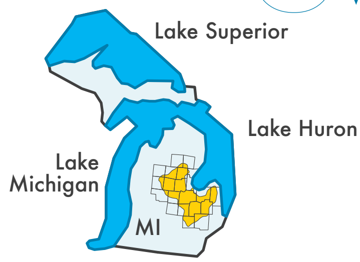
Great Lakes Restoration

Great Lakes Commission des Grands Lacs

GLRI FA3 Investments and Outcomes (FY 2010-2016)

Saginaw Watershed

GLRI Funded Projects	Total Investment
16	$19,495,400



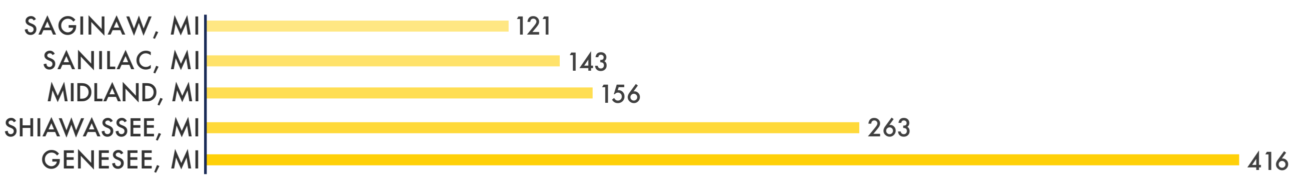
Highlights

39%

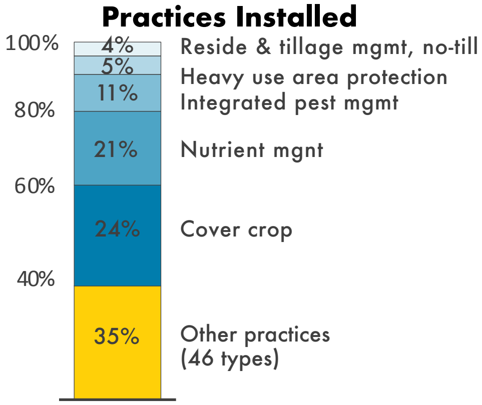
of incentive payments obligated within USDA NRCS PPA boundaries

Locations of Practice Implementation	
In PPAs	39%
Outside PPAs	55%
Unknown	6%

Top Five Counties by Number of Incentive Contracts Signed



Conservation Practice Implementation



51

Practice Types Implemented

Practice Type[1]	Acres[2]
Nutrient mgmt	118,800
Cover crop	95,700
Integrated pest mgmt	75,800
Residue & tillage mgmt, no-till	32,900

Practice Type	Acres	Cost/Acre[3]
Conservation crop rotation	4,310	$4
Residue & tillage mgmt, no-till	19,500	$12
Upland wildlife habitat mgmt	4,030	$15
Integrated pest mgmt	75,800	$16
Residue & tillage mgmt, reduced-till	8,180	$16

Practice Type	$1000s	Funding (%)
Nutrient mgmt	$2,770	23
Cover crop	$2,350	19
Agrichemical handling facility	$2,090	17
Integrated pest mgmt	$1,200	10

1 Practices implemented may overlap in space such that the addition of the acreage would not accurately sum to total practice coverage

2 Acres may differ between tables as not all contracts reported costs

3 Costs reflect GLRI investments per acre only and do not include farmer cost-share

*For more information, please visit: glc.org/work/REAP/products

Researching the Effectiveness of Agricultural Programs

Great Lakes RESTORATION

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GLRI FA3 Priority Watershed Profile

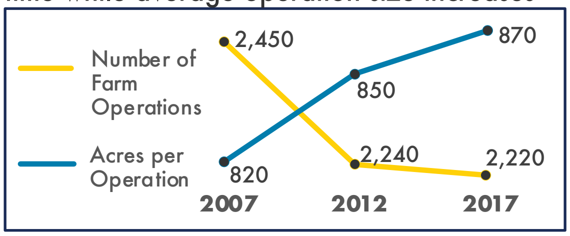
Genesee Watershed

Watershed size	1,596,200 acres
Drains to	Lake Ontario
No. of counties	10
Acres agricultural land	478,000
% Agricultural land	30

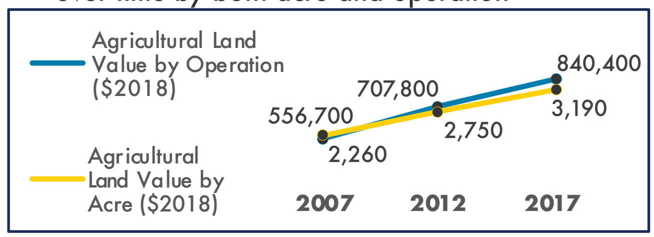
Total producers	3,900
Average age	57
Average yrs farming	26
% Female	36

Highlights

*Number of farm operations decreasing over time while average operation size increases



*Agricultural land value has been increasing over time by both acre and operation



*The majority of acres in agriculture are operated by part-owners, who farm on land they both own and rent, a trend that has increased over time, while acres operated by full owners, who farm their own land, and tenants, who farm only rented land, have decreased and remained relatively static, respectively

Tenure by Acre (%)

	2017	Change since 2007
Full owners	26	-6
Part owners	70	5
Tenant	4	1

Share of Sales by Type

	Millions ($)	%
Crops	173	30
Livestock	396	70

Fertilizer Use by Acres 2007-2017:

↓ 5%

*Land use practices, aligned with soil conservation and best management practices for mitigating negative impacts on water quality - identified as Conservation Practices by REAP - have increased over time

Land Use Practices (% of Cropland)

		2017	Change since 2012
Conservation Practices	Cover crops	10	1
	Conservation till	39	6
	Conservation easements	1	-1
Traditional Practices	Intensive till	20	-9

Top Crops in Acres

Corn	161,100
Grass/pasture	146,300
Alfalfa	100,900
Soybeans	33,400
Winter wheat	30,800

Farms That (%):

Have internet access	75
Are family farms	90

Estimates on this fact sheet are based on normalized Census of Agriculture county-level data to accurately represent the footprint of the watershed

*For more information, please visit: glc.org/work/REAP/products

Researching the Effectiveness of Agricultural Programs
Great Lakes Restoration
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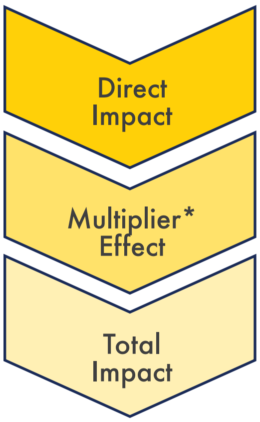
Economic Analysis of GLRI FA3 Investments (FY 2010-2016) Genesee Watershed

GLRI Focus Area 3 Funding FY 2010-2016

Total ($)	Payments for Conservation Practices	% Funding as Payments for Conservation Practices
$7,993,700	$5,475,500	68

Methods



Direct Impact: GLRI investments increase regional economic activity and employment

Multiplier* Effect: Direct impacts, in turn, increase demand for goods and services from industries supporting or supported by those receiving direct spending and spending by individuals employed by jobs created

Total Impact: Sum of direct impacts and multiplier effect

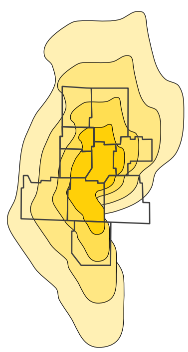
*Input-output modeling is a method commonly used to examine the interrelationships of economic sectors and describe the multiplier effect of changes in one sector across a broader economy

Highlights

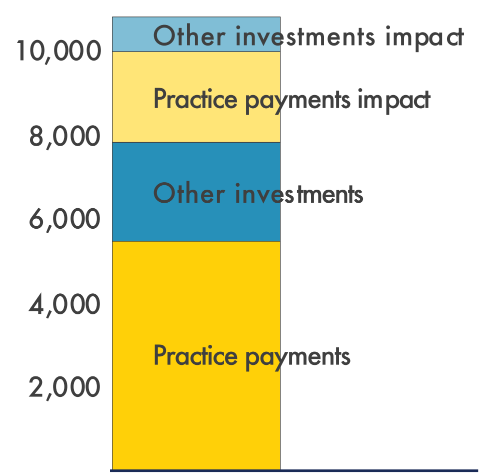
*Multipliers were obtained from the Regional Input-Output Modeling System (RIMS II) managed by the U.S. Bureau of Economic Analysis

1.4

Investment to Output Multiplier



Total Economic Impact ($1,000)



	Direct Impact	Total Output	Jobs Created
Total payments to practices	$5,475,500	$7,649,900	7
Other investments	$2,390,900	$3,234,800	5
Total GLRI FA3 impact	$7,866,400	$10,884,800	12

Payments for conservation practices could be linked to a particular industry; however, this was not possible for other investments, so results were calculated for three scenarios. Estimates included here are an average of the results from these three scenarios.

$10,884,800

Total output from GLRI FA3 investments in the watershed

*For more information, please visit: glc.org/work/REAP/products

Researching the Effectiveness of Agricultural Programs

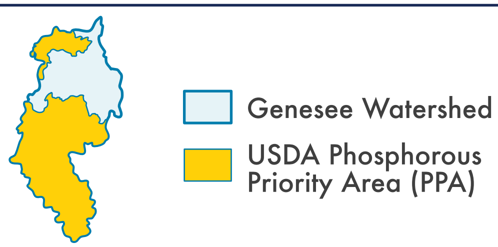
Great Lakes RESTORATION

Great Lakes Commission des Grands Lacs

GLRI FA3 Investments and Outcomes (FY 2010-2016) Genesee Watershed

GLRI Funded Projects	Total Investment
6	$7,993,700

Highlights



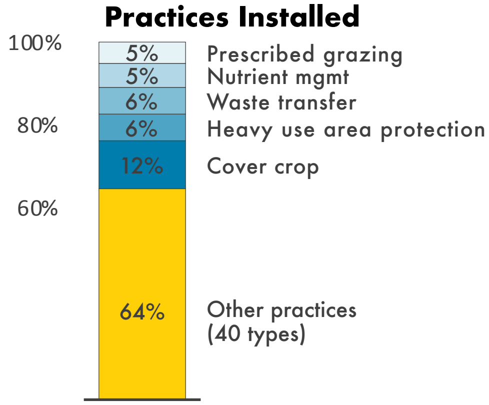
58%

of incentive payments obligated within USDA NRCS PPA boundaries

Locations of Practice Implementation	
In PPAs	58%
Outside PPAs	29%
Unknown	13%

Top Five Counties by Number of Incentive Contracts Signed

Conservation Practice Implementation



44

Practice Types Implemented

Practice Type[1]	Acres[2]
Nutrient mgmt	12,100
Cover crop	7,600
Residue & tillage mgmt, no-till	4,700
Prescribed grazing	1,600

Practice Type	Acres	Cost/Acre[3]
Nutrient mgmt	10,280	$8
Prescribed grazing	1,580	$24
Lined waterway or outlet	1,360	$28
Residue & tillage mgmt, no-till	4,710	$31
Cover crop	7,625	$62

Practice Type	$1000s	Funding (%)
Waste storage facility	$2,030	37
Heavy use area protection	$805	15
Cover crop	$480	9
Roof and covers	$410	8

1 Practices implemented may overlap in space such that the addition of the acreage would not accurately sum to total practice coverage

2 Acres may differ between tables as not all contracts reported costs

3 Costs reflect GLRI investments per acre only and do not include farmer cost-share

*For more information, please visit: glc.org/work/REAP/products

REAP Researching the Effectiveness of Agricultural Programs

Great Lakes RESTORATION

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GLRI FA3 Priority Watershed Profile

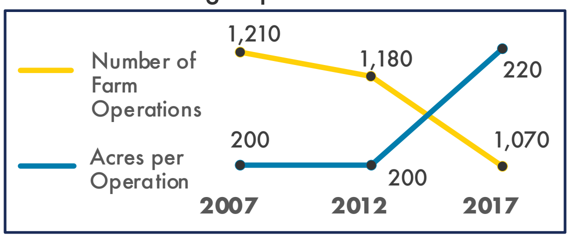
Lower Fox Watershed

Watershed size	414,400 acres
Drains to	Lake Michigan
No. of counties	5
Acres agricultural land	197,100
% Agricultural land	48

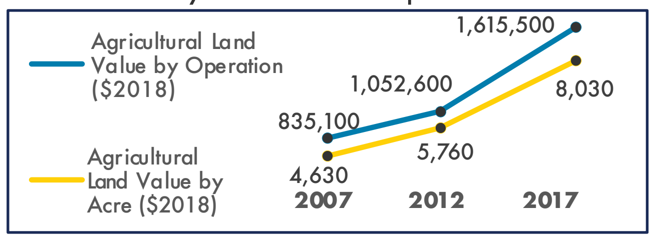
Total producers	1,850
Average age	56
Average yrs farming	26
% Female	34

Highlights

*Number of farm operations decreasing over time while average operation size increases



*Agricultural land value has been increasing over time by both acre and operation



*The majority of acres in agriculture are operated by part-owners, who farm on land they both own and rent, a trend that has increased over time, while acres operated by full owners, who farm their own land, and tenants, who farm only rented land, have decreased and remained static, respectively

Tenure by Acre (%)

	2017	Change since 2007
Full owners	18	-6
Part owners	78	6
Tenant	4	0

Share of Sales by Type

	Millions ($)	%
Crops	57	20
Livestock	229	80

*Land use practices, aligned with soil conservation and best management practices for mitigating negative impacts on water quality - identified as Conservation Practices by REAP - have increased over time

Land Use Practices (% of Cropland)

		2017	Change since 2012
Conservation Practices	Cover crops	8	3
	Conservation till	41	7
	Conservation easements	2	1
Traditional Practices	Intensive till	32	-3

Top Crops in Acres

Corn	70,100
Alfalfa	53,400
Grass/pasture	40,800
Soybeans	34,700
Winter wheat	7,240

Farms That (%):

Have internet access	79
Are family farms	89

Estimates on this fact sheet are based on normalized Census of Agriculture county level data to accurately represent the footprint of the watershed

*For more information, please visit: glc.org/work/REAP/products

Researching the Effectiveness of Agricultural Programs

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Economic Analysis of GLRI FA3 Investments (FY 2010-2016)

Lower Fox Watershed

GLRI Focus Area 3 Funding FY 2010-2016		
Total ($)	Payments for Conservation Practices	% Funding as Payments for Conservation Practices
$24,320,800	$14,061,700	58

Methods

Direct Impact — GLRI investments increase regional economic activity and employment

Multiplier* Effect — Direct impacts, in turn, increase demand for goods and services from industries supporting or supported by those receiving direct spending and spending by individuals employed by jobs created

Total Impact — Sum of direct impacts and multiplier effect

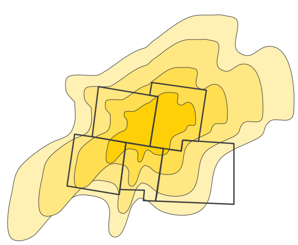
* Input-output modeling is a method commonly used to examine the interrelationships of economic sectors and describe the multiplier effect of changes in one sector across a broader economy

*Multipliers were obtained from the Regional Input-Output Modeling System (RIMS II) managed by the U.S. Bureau of Economic Analysis

Highlights

1.6

Investment to Output Multiplier

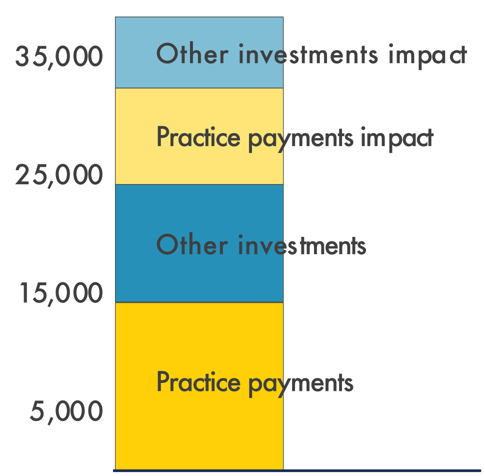


	Direct Impact	Total Output	Jobs Created
Total payments to practices	$14,061,700	$22,199,700	22
Other investments	$10,131,900	$16,216,600	21
Total GLRI FA3 impact*	$24,193,600	$38,416,300	43

*Values for Total GLRI FA3 Impact do not sum to total watershed funding as some funding was allocated to multiple watersheds and could not be parsed at the finer scale required for this analysis

Payments for conservation practices could be linked to a particular industry; however, this was not possible for other investments, so results were calculated for three scenarios. Estimates included here are an average of the results from these three scenarios

Total Economic Impact ($1,000)



$38,416,300

Total output from GLRI FA3 investments in the watershed

*For more information, please visit: glc.org/work/REAP/products

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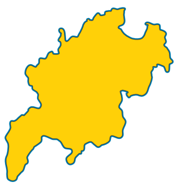
GLRI FA3 Investments and Outcomes (FY 2010-2016)

Lower Fox Watershed

GLRI Funded Projects	Total Investment
13	$24,320,800

Highlights



Lower Fox Watershed

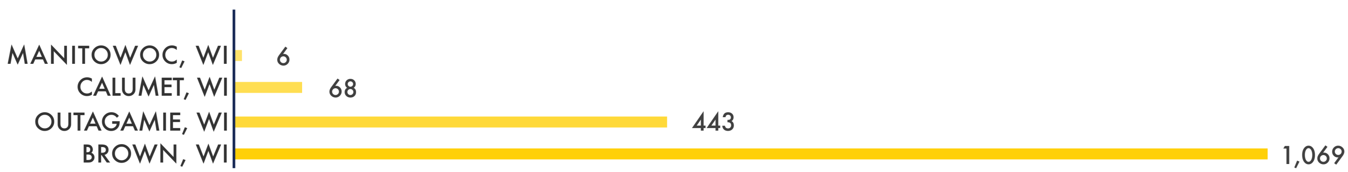
USDA Phosphorous Priority Area (PPA)

100%

of incentive payments obligated within USDA NRCS PPA boundaries

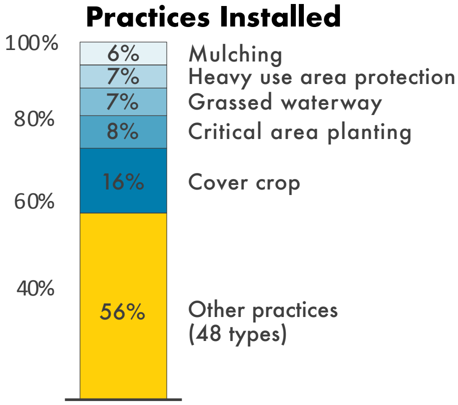
Locations of Practice Implementation	
In PPAs	100%
Outside PPAs	0%
Unknown	0%

Top 4 Counties by Number of Incentive Contracts Signed



Conservation Practice Implementation

Practices Installed



53

Practice Types Implemented

Practice Type[1]	Acres[2]
Cover crop	58,800
Integrated pest mgmt	43,800
Nutrient mgmt	28,700
Residue & tillage mgmt, no-till	7,100

Practice Type	Acres	Cost/Acre[3]
Upland wildlife habitat mgmt	210	$3
Residue & tillage mgmt, no-till	7,120	$11
Conservation crop rotation	550	$11
Nutrient mgmt	28,700	$12
Residue & tillage mgmt, reduced till	190	$12

Practice Type	$1000s	Funding (%)
Waste storage facility	$4,470	31
Cover crop	$1,890	13
Heavy use area protection	$1,410	10
Waste transfer	$760	5

1 Practices implemented may overlap in space such that the addition of the acreage would not accurately sum to total practice coverage

2 Acres may differ between tables as not all contracts reported costs

3 Costs reflect GLRI investments per acre only and do not include farmer cost-share

*For more information, please visit: glc.org/work/REAP/products

Researching the Effectiveness of Agricultural Programs

Great Lakes RESTORATION

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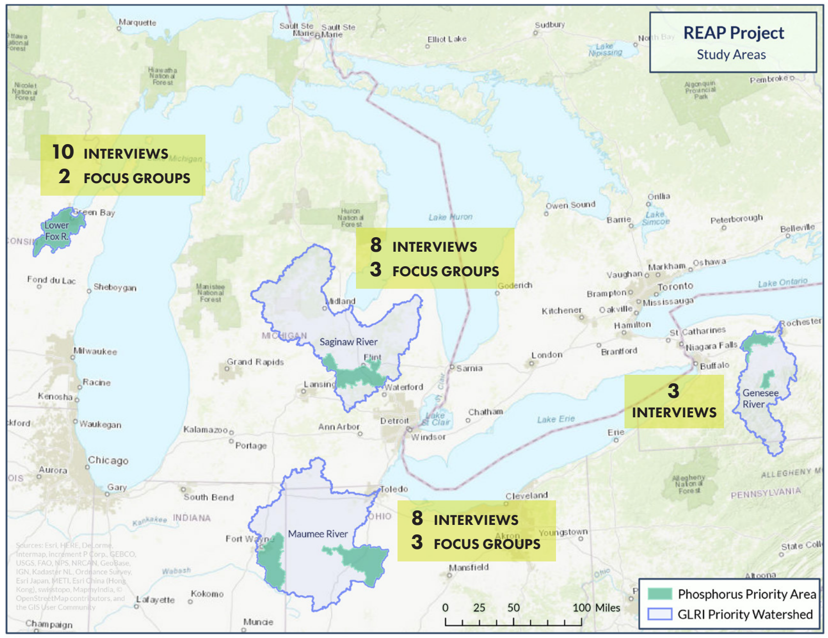
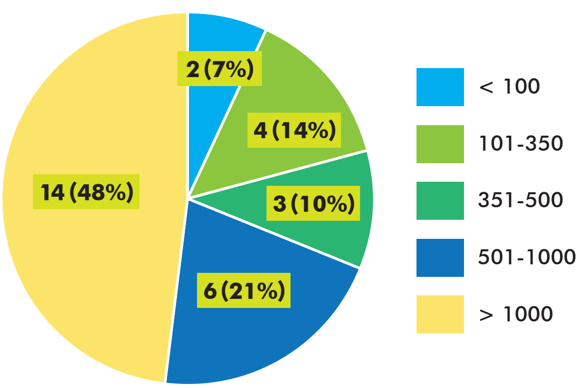
Summary of Interviews and Focus Groups to Evaluate the Effectiveness of GLRI Focus Area 3



Who

29 interviews were conducted with managers of GLRI Focus Area 3 projects and programs, and 8 focus groups were convened with farmers from priority watersheds who had received conservation incentives through GLRI.

Size of Agricultural Operations of Focus Group Participants (Acres)



What

Questions covered a variety of themes, with a focus on why farmers participate in conservation and incentive-based programs; how program participation changes practices and attitudes about practices in the watershed; how GLRI investments impacted participants; and how to improve future GLRI investments.

Key finding

Participating farmers and managers are largely satisfied with GLRI projects and programs, but request even more flexibility in program requirements and timelines and continued investments for success to be maintained.

> *I'd just like to say thanks for the program. Any time somebody's putting funds out there that we can grab onto that we can make fit, we appreciate it. And I'm surprised more farmers don't get on the programs.*

> *I think it's one of the better programs I've ever run across… you're actually getting educated. It seems like we're learning something. It's interesting.*

For more information, please visit:
glc.org/work/REAP/products

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Reported strengths

- “Flexibility” and the local, “grassroots” feel are GLRI’s primary strengths
- The “boots on the ground” approach is critical to farmer participation and lasting cultural change
- GLRI allows for experimentation with novel or innovative concepts and targeting participants that other incentive programs cannot
- Most participants report being better off as a result of participating in GLRI
- Most participants felt that participation in GLRI increased their knowledge of agricultural conservation practices and made them feel like their efforts were important
- Conservation practices are often implemented or maintained after the incentives stop

> *“The GLRI funds have provided opportunities for more kind of grassroots solutions that will fit and work for those local producers and localized watershed and natural resource concerns.”*

> *“(GLRI) allows you to think outside the box and come up with innovative ideas to address environmental outcomes that we need to in those specific regions.”*

Aspects to retain

> *“The best salespeople for this program have been the enrollees themselves. Nothing sells this program like a satisfied farmer participant…he has a good experience, he starts talking to his neighbors about it. And that has been by far the greatest outreach mechanism.”*

> *“If you get in front of the…right producer that has a good reputation in the community, and someone that people know they do things right on their farm, and you get the attention of them and they spread the word. I think I’ve had more people sign up through referrals than anything else.”*

- The localized, grassroots, and flexible nature of the program
- Incentivizing innovation and creativity (e.g., pilot programs, equipment rentals)
- Emphasis on local-level problem-solving
- Clear parameters for program participation
- Current payment methods and paperwork structures
- Support for interpersonal outreach methods (e.g., field days, demonstration farms, one-on-one education in the field with farmers)

Aspects to improve

- Increase funds for staffing at the local (program manager) level, in order to increase time available for on-farm interaction with farmers and avoid “bottlenecking” of resources.
- Offer longer contracts, but not if it would add hurdles for farmers and local program managers.
- Expand pay-for-performance options that cover farmers’ basic costs in the event of poor performance, and account for local factors (weather, topography, etc.).
- Include allowances for year-to-year adjustments for certain practices (e.g., cover crops) to account for uncertainty in crop rotations.
- Increase field days and demonstration farm visits with small groups of farmers.
- Consider approving five- to seven-year pilot projects, especially with influential farmers.
- Consider funding research to track farmers’ behaviors and perceptions post-GLRI funding.
- Improve administrative efficiency by standardizing guidelines for oversight and granting periods, and allowing for mid-project adjustments.

> *“To have lasting cultural impacts, you need to have the right people and enough people, boots on the ground, to build the relationships to help make the changes. Without those, we’re going to be putting money out for conservation that’s going to stop when the money stops.”*

Appendix B

Project Team and Advisory Council Rosters

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Researching the Effectiveness of Agricultural Programs

Great Lakes Commission des Grands Lacs

REAP Researching the Effectiveness of Agricultural Programs

REAP Project Team Roster

Great Lakes Commission

Victoria Pebbles
Program Director

Nicole Zacharda
Program Manager

Daniel Gold
Senior Water Quality Specialist

The Ohio State University

Robyn Wilson
Associate Professor of Risk Analysis and Decision Science

Adam Fix
Visiting Scholar & PhD Candidate

Callia Tellez
Undergraduate Research Assistant

US EPA Region 5

Santina Wortman
Great Lakes National Program Office

AMP Insights

Sarah Kruse
Director

Tess Gardner
Research Associate

Michigan State University Institute of Water Research

Jeremiah Asher
Assistant Director

Laura Young
Research and Outreach Associate

REAP Advisory Council Roster

Genesee Watershed

Ben Schmidt, *Assistant State Conservationist*
U.S. Department of Agriculture, Natural Resources Conservation Service - New York State Office

Victor DiGiacomo, *Associate Environmental Analyst*
NYS Department of Agriculture and Markets | NYS Soil and Water Conservation Committee

Molly Cassatt, *District Manager*
Livingston County Soil and Water Conservation District

Lower Fox Watershed

Gregory Baneck, *Director*
&
Sarah Francart, *Watershed Planner/ GIS Specialist*
Outagamie County Land Conservation Department

Chad Cook, *Natural Resources Educator*
University of Wisconsin Extension

Kendra Axness, *Water Resources Management Specialist*
Wisconsin Department of Natural Resources

Bill Hafs, *Director of Environmental Programs*
&
Jeff Smudde, *Watershed Programs Manager*
NEW Water

Mike Mushinski, *County Conservationist*
Brown County Land & Conservation Department

Tony Reali, *County Conservationist*
Calumet County Land and Conservation District

Mark Jenks, *Nutrient Management Specialist*
&
Sara Walling, *Chief of the Nutrient Management and Water Quality Section*
Wisconsin Department of Agriculture, Trade and Consumer Protection

Jessica Shultz, *Executive Director*
Fox-Wolf Watershed Alliance

Matt Otto, *Resource Conservationist*
&
Tom Krapf, *Assistant State Conservationist*
U.S. Department of Agriculture, Natural Resources Conservation Service – Wisconsin State Office

Saginaw Watershed

Joe Kelpinski, *Program Manager*
&
James Johnson, *Director of the Environmental Stewardship Division*
Michigan Department of Agriculture and Rural Development

Brian Schorr, *Soil Conservation and Watershed Technician*
Genesee Conservation District

Julie Spencer, *District Administrator*
Gratiot Conservation District

Mary Fales, *Program Director, Saginaw Bay*
&
Ben Wickerham, *Saginaw Bay Conservation Innovation Assistant*
The Nature Conservancy

Maumee Watershed (OH)

Greg Labarge, *Associate Professor*
Ohio State University Extension

Chad Carroll
District Technician/Urban Coordinator
Hancock County Soil and Water Conservation District

Logan Haake, *Precision Ag Manager*
Legacy Farmers Cooperative

Russell Gibson, *Manager of the Surface Water Improvement Section*
&
Rick Wilson, *Environmental Specialist*
Ohio Environmental Protection Agency

Kevin King, *Research Leader and Supervisory Research Soil Scientist*
U.S. Department of Agriculture, Agricultural Research Service

Matt Lane, *Administrator of the Agricultural Pollution Abatement Program*
Ohio Department of Agriculture

Aaron Heilers, *Project Manager*
Blanchard Demo Farms

Maumee Watershed (IN)

Greg Lake, *Administrator*
Allen County Soil and Water Conservation District

Jennifer Thum, *District Support Specialist*
&
Jordan Seger, *Director of the Division of Soil Conservation*
Indiana State Department of Agriculture

Multiple Priority Watersheds

Elizabeth Lillard, *Agriculture Program Specialist*
&
Jessica Espenshade, *Agricultural Program Coordinator*
National Wildlife Federation

Edwin Martinez, *Conservation Initiative Coordinator (GLRI)*
&
Mari-Vaughn Johnson, *Agronomist, CEAP Team*
U.S. Department of Agriculture, Natural Resources Conservation Service

Steve Buan
Hydrologist-in-Charge
&
Dustin Goering, *Hydrologist*
U.S. National Oceanic and Atmospheric Administration

Jeff Frey, *Deputy Director Indiana-Kentucky Water Science Center*
&
Mike McHale, *Supervisory Research Hydrologist*
&
Dale Robertson, *Research Hydrologist*
USGS Wisconsin Water Science Center
U.S. Geological Survey

Appendix C

34 GLRI Focus Area 3 Investments in Priority Watersheds Between FY2010-2016

Great Lakes Commission des Grands Lacs

Researching the Effectiveness of Agricultural Programs

Projects, Programs, and Interagency Agreements FY2010-2016 Included In REAP Analysis	Unique ID	Principal Investigator
Accelerating Outcome-Based Ag Conservation in Saginaw Bay	**EPA00E01448-0**	The Nature Conservancy
Alternative Ditches to Reduce Nutrients in the Upper Blanchard	**GL 00E01143**	The Nature Conservancy - Indiana
Baird Creek Riparian Protection	**EPA00E00441-0**	Brown County Land and Conservation District
Binational Stakeholder Engagement for Nutrients in the Lake Erie Basin	**EPA 00E00995-0**	International Joint Commission
Cover Crops and Conservation Tillage Reduce NPS Pollution	**GL00E00413-0**	Conservation Technology Information Center
Erosion Reduction in the Swartz Creek Watershed	**GL00E00858**	Mchigan Department of Agriculture and Rural Development
Expanded Maumee Tributary Monitoring To Measure Success Of	**EPA00E01405-0**	Ohio Environmental Protection Agency
Improving Water Quality in NE Lake Ontario Basin	**GL97220600-0**	Finger Lakes Regional Tourism Development Corp
Improving Water Quality Restoration Partnerships in Michigan's Shiawassee and Flint River Watersheds	**GL-00E01128-0**	Michigan State University, Planning and Zoning Center
Increasing Nutrient Management Plan Expertise in Blanchard Watershed	**GL-00E01145-0**	The Ohio State University Office of Sponsored Programs
Kawkawlin River - Targeted Phosphorus and E. coli Reduction	**GL00E01124**	Michigan Department of Environmental Quality
Locating and Targeting High-Impact Farm Fields to Reduce Phosphorus Discharges	**GL-00E01155-0**	Michigan State University Institute of Water Research
Maumee River Sediment and Nutrient Reduction Initiative	**GL 00E01449**	Ohio Environmental Protection Agency- Division of Surface Water
NOAA Nutrient Runoff Risk Advisory Forecast Tool	**NOAA-IA**	National Oceanic and Atmospheric Administration
Nonpoint pollution abatement	**BIA0157**	Oneida Tribe of Indians of Wisconsin Env. Health & Safety Division
Phosphorus Reduction: Variable Rate Technology Program	**GL00E00566**	Ohio Environmental Protection Agency
Plum & Kankapot Creeks Riparian Protection (2)	**GL00E00860**	Outagamie County Land Conservation Department
Powell Creek Nutrient Reduction Project	**GL00E01131-0**	Ohio Environmental Protection Agency
Sediment Reduction in the Sebewaing River Watershed	**EPA00E00859-0**	Michigan Department of Agriculture
Silver Creek Sediment and Nutrient Reduction & Habitat Restoration	**GL-00E01450**	Green Bay Metropolitan Sewerage District, NEW Water
Soil Health Agronomic Assistance & BMPs for Farmers in the Western Lake Erie Basin	**GL00E01408-0**	Indiana State Department of Agriculture
Supplement Michigan's targeted Response to Repair WLEB Health	**GL-0-00E01403**	Mchigan Department of Agriculture and Rural Development
Supplementing Michigan's Targeted Response to Repair WLEB through new Approaches	**GL 00E01423**	Mchigan Department of Agriculture and Rural Development
Supporting Ohio Clean Lakes Initiative: Impaired Watershed Restoration	**GL00E01404-0**	Ohio Department of Natural Resources
Targeted Phosphorus Reduction in the Pigeon River Watershed	**GL00E00857**	Michigan Department of Environmental Quality
Targeting Hard to Reach Reductions - Additonal Streambank Protection in the Plum & Kankapot Creek Subwatersheds	**GL 00E01906**	Fox-Wolf Watershed Alliance
Targeting Outcome-Based Sediment Reduction in the Lower Fox Watershed	**GL 00E01451**	Fox-Wolf Watershed Alliance
Watershed Improvements in Lye Creek in the Upper Blanchard Watershed	**GL00E01020-0**	Ohio Environmental Protection Agency
Great Lakes Sediment and Nutrient Control Program	**NRCS-IA-(GLSNRP)**	USDA Natural Resources Conservation Service

Accelerating Farmer Adoption of Variable Rate Technology	**EPA00E01909-0**	IPM Institute of North America Inc
Best Management Practices in the Maumee River Basin	**GL00E00577-0**	Purdue University
Great Lakes Tributary Model	**ACOE-IA**	US Army Core of Engineers
Forecast/Nowcast, Edge of Field Monitoring, Evaluating P Reduction, & Study of Nutrient Runoff Impacts	**USGS-IA**	Dept. of Interior-U.S. Geological Survey
Supplementing Farm Bill Ag Conservation Programs	**NRCS-IA-(EQIP)**	USDA Natural Resources Conservation Service

Appendix D

Interviews with GLRI Program Managers & Focus Groups with Priority Watershed Farmers

Great Lakes Commission des Grands Lacs

Researching the Effectiveness of Agricultural Programs

Researching the Effectiveness of Agricultural Programs: **Analysis of Interviews and Focus Groups with Farmers and Program Managers**

January 31, 2019

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I. Objectives

The agricultural community of the Great Lakes Basin has received over $100 million from the U.S. Environmental Protection Agency's Great Lakes Restoration Initiative (GLRI) for projects and programs that fall within the GLRI's Focus Area 3: "Nonpoint Source Pollution Impacts on Nearshore Health." These investments are intended to increase the adoption of agricultural conservation practices, influence on-farm decision making in the short and long term, and ultimately improve water quality. This research project evaluates the effectiveness of these investments in terms of their ability to increase the adoption of conservation practices, create lasting cultural changes among farmers, and expand the capacity of local agencies and organizations to administer programs and projects that advance GLRI Focus Area 3 goals in priority watersheds.

This exploratory project collected qualitative data via focus groups with farmers and in-depth interviews with program managers of institutions that have received GLRI funding for projects and programs that support Focus Area 3 objectives. Data collection focused on sub-themes that inform the research questions, including: 1) how farmers make decisions about the adoption of conservation practices; 2) why farmers participate in conservation and incentive-based programs; 3) what leads to additional farmers participating in these programs; 4) how program participation changes practices and attitudes about adoption of practices in the watershed; 5) how GLRI investments impacted participating institutions; and 6) how GLRI investments could be improved from the perspective of participating institutions and farmers.

The data has been collected in order to evaluate the effectiveness of GLRI Focus Area 3 investments within four GLRI priority watersheds. This written document summarizes the research team's analysis and provides reflections on ways to improve future investments in terms of both the ways that institutions distribute and utilize GLRI funds and engage with on-farm decision makers.

This research constitutes one portion of a larger, U.S. Environmental Protection Agency funded research project (EPA-R5-GL2016-AIP: "Researching Effectiveness of Agricultural Programs"). Therefore, the output of this research will eventually be incorporated into a larger report.

II. Background and Rationale

Preliminary analyses of GLRI Focus Area 3 investments in priority watersheds indicate that most of the funding is used to incentivize the implementation of conservation practices on farm-level operations, with a focus on cover crops and more precise nutrient management (Great Lakes Restoration Initiative, 2018). Other investments have focused on outreach and education, traditional and innovative conservation program expansion, water quality monitoring and research, and the creation of models and decision support tools. While the EPA's reporting requirements attempt to assess the immediate impacts of these investments (e.g. acres put in to conservation, farmers enrolled in programs, or pounds of phosphorus and sediment load reduced), a data gap exists when attempting to assess whether these immediate results lead to long-term cultural changes among communities of farmers and/or programmatic improvements among the institutions that serve them. Prior literature on farmer adoption of conservation practices indicates that financial incentives, producer attitudes towards various types of environmental institutions (e.g. private, federal to local government, and NGOs), and beliefs concerning the efficacy and return on investment of conservation practices all influence on-farm decision making (Prokopy, et al. 2008; Burnett, et al. 2018; Wilson, et al. 2018). Building on a growing body of literature on conservation institutions (e.g. Ostrom, et al. 1994; Ostrom, 2009) this report takes a closer look at how different institutions and individuals respond specifically to GLRI Focus Area 3 funding in priority watersheds in both the short and long-term. We accomplish this by engaging a subset of representatives of organizations that were direct recipients of GLRI funding from the EPA, those who received GLRI funding as a sub-recipient below a primary recipient, and individual farmers who ultimately received funding to implement conservation practices.

III. Results

A. Pre-focus group survey

Of the 41 focus group participants, 38 opted to complete a brief (five question) pre-focus group survey. These surveys collected demographic data, the size of their farm operations, and whether or not they are aware of GLRI. These questions help us to better understand the relationship between these factors and farmer decision-making about conservation incentives and practices.

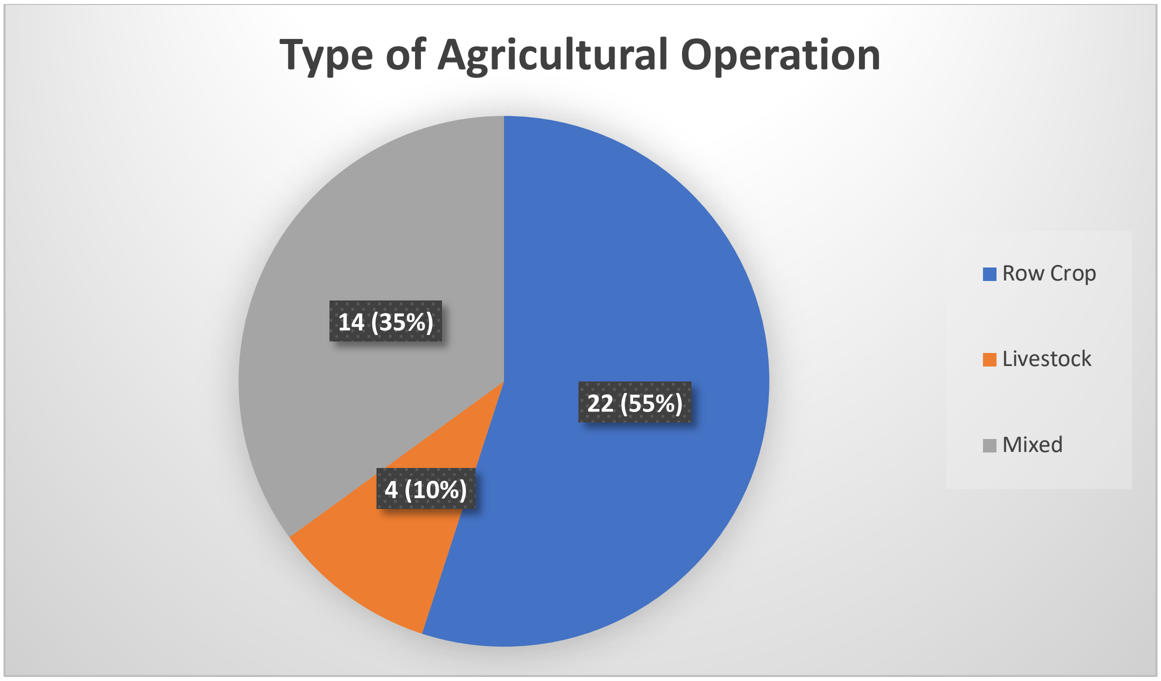

Figure 1: Type of Agricultural Operation

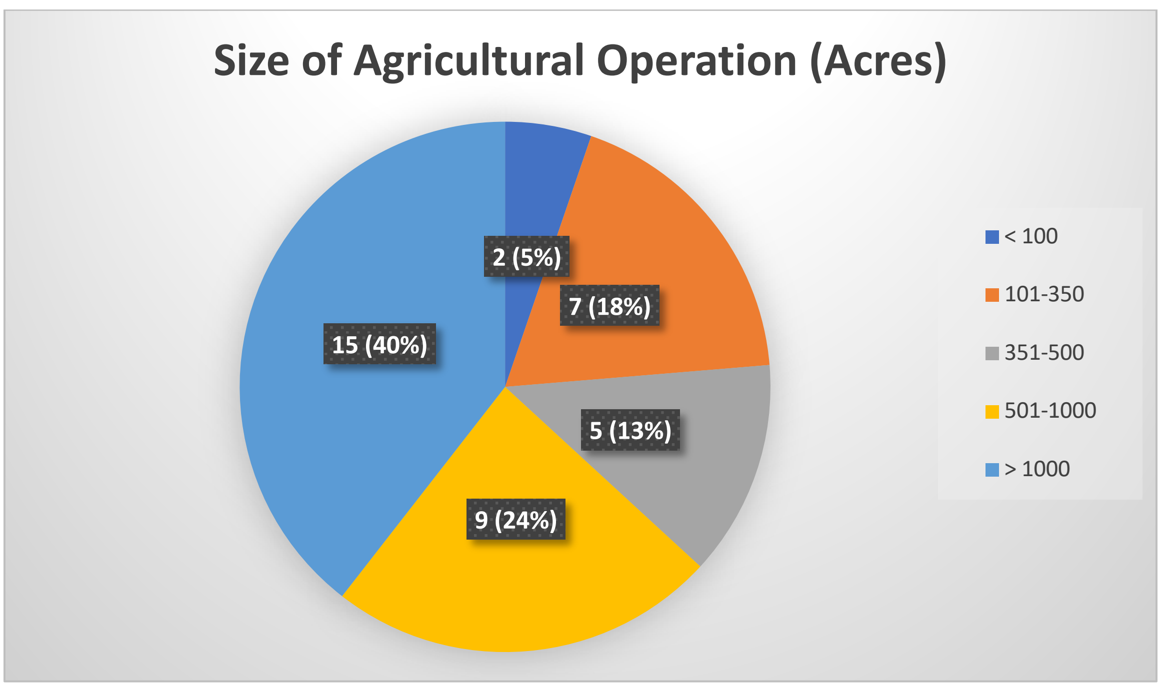

Figure 2: Size of Agricultural Operation (Acres)

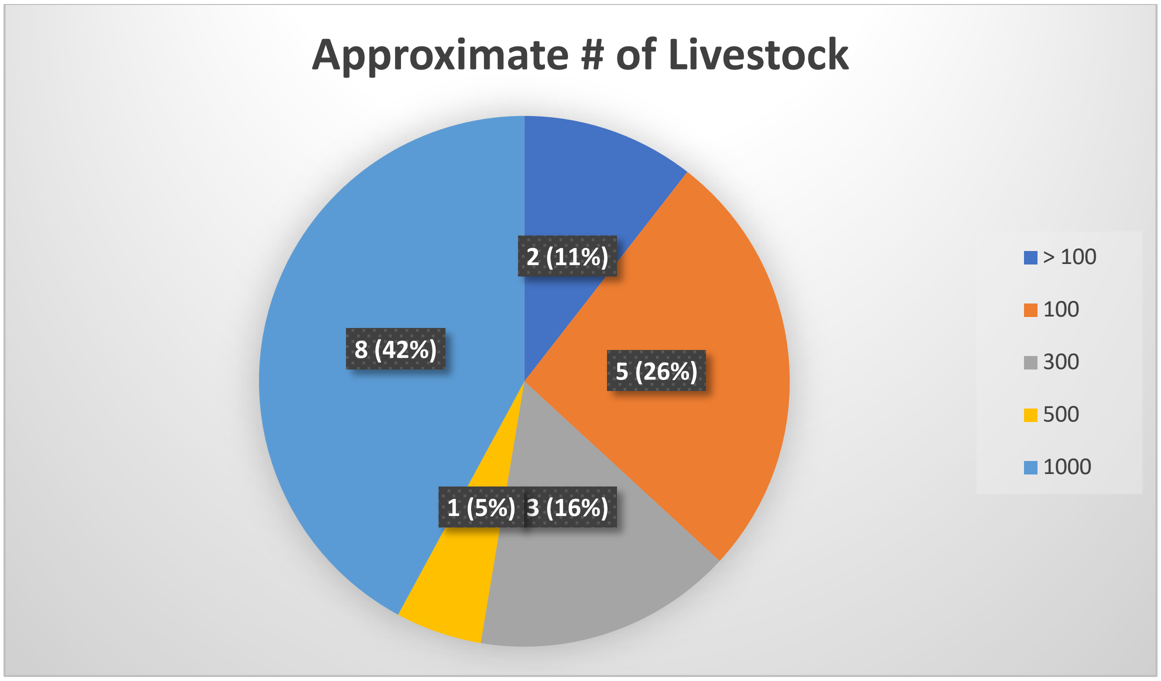

Figure 3: Approximate Number of Livestock (If Applicable)

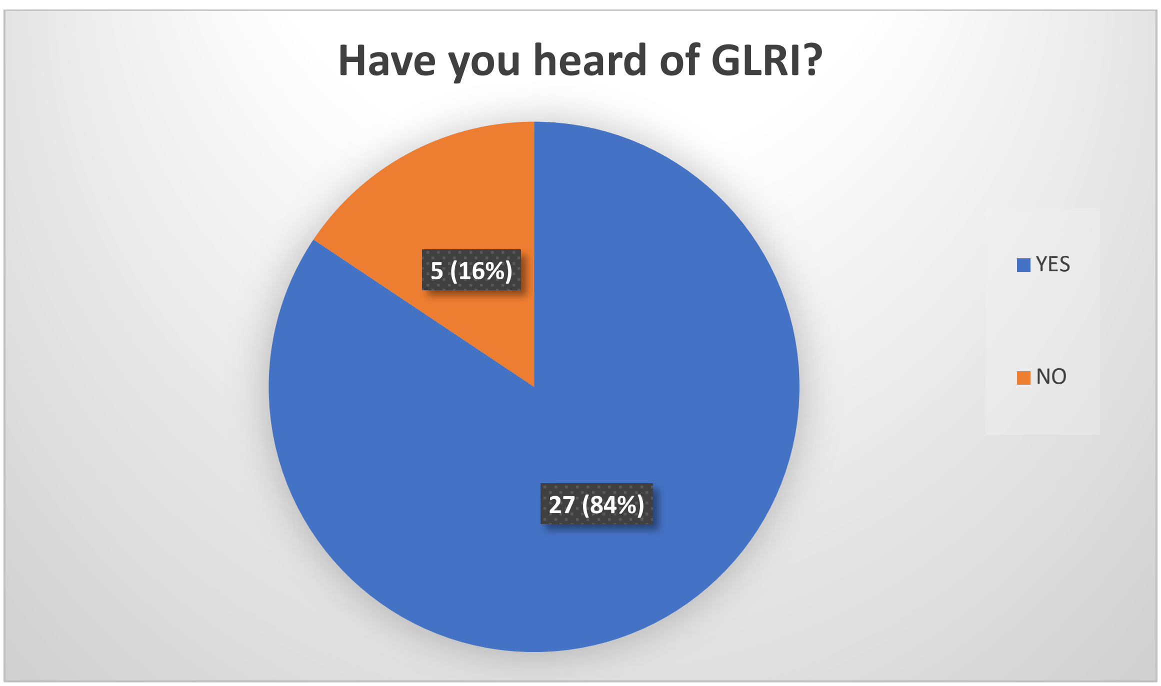

Figure 4: Awareness of GLRI

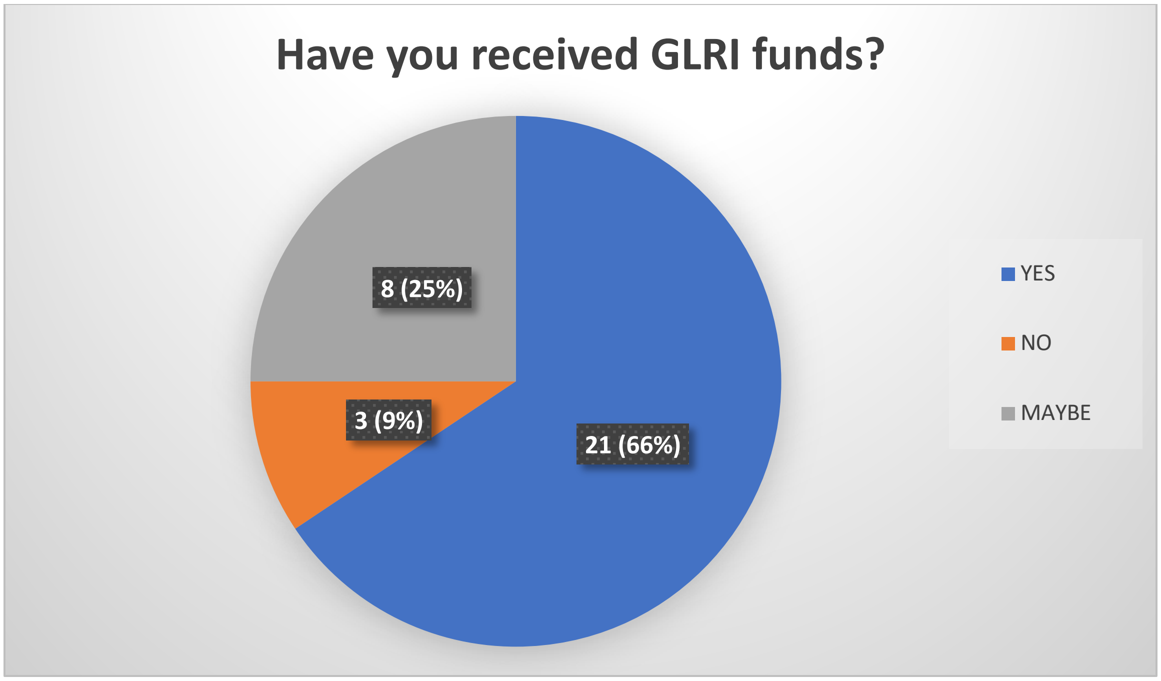

Figure 5: Awareness of Receiving GLRI Funds

B. Focus groups

We conducted eight focus groups with a total of 41 participants in three of the priority watersheds (two focus groups in the Lower Fox, with a total of 13 participants; three in the Maumee, with a total of 17 participants; and three in the Saginaw, with a total of 11 participants).

1. RELATIONSHIP WITH GRANTING ORGANIZATION/OUTREACH

What has your experience been like in working with the organization administering GLRI funds?

The vast majority of focus group participants reported a positive working relationship with the organization administering GLRI funds (all participants received GLRI incentives via their County Soil and Water Conservation District (SWCD) office). The major positive traits associated with the SCWD offices were that they were helpful, flexible, and prompt. While no negative sentiments were expressed in the sessions, some participants noted that their local SWCD offices were understaffed, and therefore felt that additional staffing would help prevent a bottleneck effect.

Example quotes:

> They have the level of experience, and that's huge. Time is everything in this business, or in any business, for that matter, and if you don't have to sit down and do calculations and wonder if they're right or wrong or just exactly what, that's a big deal. And when you're receiving grant money it has to be done right, and if it isn't done right you just forfeited everything that you've done. And if you've got someone to guide you through all those processes and make sure that you are doing things right, then that leads to a really good outcome.

> You know, more agronomists, stuff like that on the support would help somebody support some idea. It has been good, but a lot of times you never have enough. But I think one of the things that we kind of struggle with, okay, hey, does this practice work and what was the return on investment on this practice. And there's not enough people, there's not enough, you know?

What kinds of outreach were conducted by this organization?

What did you think of it? Why was it effective/ineffective? How could it be improved/done differently?

The majority of participants heard about GLRI in one of three ways: either 1. an on-farm visit from a SWCD staff member; 2. a visit to the local SWCD office for a separate purpose, which led to conversation about GLRI; or 3. word of mouth from other farmers. Smaller numbers of participants commented that they heard about GLRI via mailed notices and/or newsletters or local meetings. Field days/demo farms were discussed as effective alternatives to meetings, especially when participants had the ability to converse in small groups. Texting and email were also mentioned as effective forms of communication for some farmers (specifically in the Lower Fox watershed, where there is a highly-organized texting list in place).

Farmers consider individualized on-farm visits to be the most effective form of outreach and relationship-building. On-farm visits help to create and maintain positive working relationships between program managers and farmers. Regardless, it is clear that adequate staffing on the local-level is a key determinant of success for GLRI projects.

Example Quote:

> I think with us, I mean, we had some knowledge of it, but I think some of these younger agronomists, they actually physically stopped one day and started talking about this, and there was funding for it. Like I said, rebuilding some of the waterways and the buffers. And, well, that sounds pretty good, and jumped on that.

RECOMMENDATIONS RELATED TO RELATIONSHIP WITH GRANTING ORGANIZATION/OUTREACH:

1. Ensure adequate funding for local-level staff in order to maintain or increase on-farm visits.
2. Maintain or increase opportunities for field days/demo farm visits with small groups of farmers.

2. EFFICACY OF INCENTIVES

What would make this organization's use of GLRI funds more effective? Less effective?

If you could design a perfect payment program, what would it look like?

Focus group participants were near-unanimous in their support for the current structure of GLRI, suggesting that it is broadly perceived as an effective program as-is. Participants agreed that the level of local control allowed for positive relationship-building and also allowed for flexibility. Many participants expressed a fear of bureaucracy and hoped that GLRI would continue to avoid becoming overly bureaucratic. Individual participants reported that GLRI could be improved with: increased staffing at the local level, a decreased paperwork burden (although many also felt that the paperwork was reasonable), and/or making the program more responsive to local or watershed-specific factors, such as weather or topography.

Participants floated different, and sometimes contradictory, ideas for improving payment structures. For example, one focus group coalesced around the idea of a “step-wise” payment structure, where participants would receive increased incentives for each year they participated. Meanwhile, another focus group discussed the merits of a payment structure that provided larger up-front payments and then incrementally decreased payments year-by-year. Yet another focus group noted that, in addition to the GLRI incentive, allowing for a harvest of cover crops (e.g., winter wheat or alfalfa) would make the practice worthwhile.

Participants also debated the pay-for-performance model. Some suggested that it would help motivate farmers to try more and/or novel conservation practices. Others countered that the uncertainty would be worrisome, because they could lose money if they pay to implement the practice up front, but the practice failed due to uncontrollable factors like weather.

Multiple participants noted the importance of the non-farmer landowner in terms of conservation practices, and one participant advocated for non-farmer landowners to receive a portion of the incentive payments. Many participants noted that rental contracts are competitive, that they are negotiated yearly, and that non-farmer landowners will rent to the farmers that can produce the highest yield. Therefore, farmers will not adopt conservation practices that may affect their ability to compete for rental land. If GLRI incentives were to make up the difference by compensating non-farmer landowners directly, then more farmers would adopt the practices without fear of losing their rental contract.

The larger takeaway from these conversations is that participants were open to multiple payment structures, as long as they seemed to make sense for each individual's operation. This plays to GLRI's strengths, as it can be adapted to meet local conservation needs. Therefore, providing farmers with multiple options (for types of conservation practices as well as payment structures) leads to increased probability of effectiveness.

Example quotes:

On GLRI as being effective as-is:

> I'd just like to say thanks for the program. Any time somebody's putting funds out there that we can grab onto that we can make fit, we appreciate it. And I'm surprised more farmers don't get on the programs. Because some guys are just so scared to look at it, I guess, I don't know. But it has been a plus for me.

> I think it's one of the better programs I've ever run across. For years they always, you know, the government set aside programs or they'd come in with runoff from your barns and stuff, really there was no education there, it was just do it. But now you're actually getting educated. It seems like we're learning something. It's interesting.

On pay-for-performance:

> Pay the farmer for what he does. I know it's a little harder. It's just easier to throw a lump sum at somebody. But if you try to put a little thought into it and break it down that way, I think you would get, if you're looking for results, you'd get more results because they're going to try different things the more you pay them for doing more.

> But performance-wise, there's got to be, like now, if you put all these cover crops on and then we have a fall like we might have, when you found there's no cover crop left or no inter seed left, but yet we stuck all this money in it, so I don't know

> how you could justify… You just have to buy it, but you didn't get the results, but yet I'd like to have [less uncertainty].

On the current program structure:

> But you don't want them to get too big, either. I love the way it is now working with our watershed people. It's very personable, one-on-one, working together. If it gets too big and the pot gets too large, then it becomes a bureaucracy and then it's the rules are the rules are the rules kind of mentality. I think the smaller, the more local control you can have over it the better off the [environment] is.

On non-farmer landowner payments:

> So many landowners now are top dollar, that's all they care about. So if these cover crop type of programs and stuff take two, three years to do it—and I'll be the first to admit that there is a yield hit going to you with no till and cover crop, at least during the first three to four years, for sure. If you're going out there competing against farm ground, it's ROI, return on investment. And the money goes to the farmer, but they're…the non-farm public doesn't know. They're just all about the dollars and cents.

On allowing harvesting of cover crops:

> Participant 1: Okay, they want cover crops really bad, and cover crops are defined by crop that you do not harvest. You know how good a cover crop winter wheat is? Unbelievably good because it stays there. The other thing we're trying to accomplish is the removal of phosphate. A cover crop don't remove much phosphate, but a wheat crop really removes a lot of phosphate. If you go in there and you remove the grain and then you take straw, part of the straw, I'm telling you, you took a lot of phosphate off that ground. So I think we're a little bit wrong on that. I don't know that you've got to pay for a guy to plant winter wheat. But if you're going to pay somebody to plant a cover crop, well then why couldn't you just pay the same amount to plant winter wheat? Today winter wheat's price isn't quite so bad. Well, a year ago when it was four bucks, that's kind of a painful crop to have out. But if you can harvest it, that's a better deal. And it's good environmentally. Everything's good about that. But they've whacked that off and you aren't supposed to harvest. I think that's a mistake.
> Participant 2: And you could put alfalfa in that same category.

RECOMMENDATIONS RELATED TO EFFICACY OF INCENTIVES:

3. Retain the emphasis on local control of projects in order to continue positive relationship-building, avoid bureaucratization/remain nimble, and encourage robust participation.

4. Emphasize multiple practices and multiple payment structures:

a. Utilize payment structures with larger up-front payments with yearly decreases for practices with higher up-front costs. Once conservation practices have been adopted, they often remain in place even beyond the incentive period, especially if the maintenance costs are minimal.

b. Utilize payment structures that include yearly increases for practices that may require longer tenures before farmer benefits can be realized, such as cover crops or no till.

c. In addition to programs that incentivize farmers through either the widespread pay-for-practice model or the less prevalent pay-for-performance model, add programs that are a mix of these two systems. These programs should: 1. establish a floor to cover farmers' basic costs in the event of poor performance, and 2. account for local factors (weather, topography, etc.).

d. Consider payment structures that include payments to non-farmer landowners. This would increase the likelihood that farmers using conservation practices could compete for rental contracts with conventional farmers. It would also raise awareness of conservation practices among non-farmer landowners.

e. Consider allowing a harvest of cover crops such as winter wheat and alfalfa.

3. EFFECT ON OPERATION

How has the money you received from (a given project X) changed your operation?

Generally, participants did not feel that their operations have changed drastically as a result of GLRI incentives. One self-described "beginning farmer" noted that GLRI funds helped him stay afloat and learn better practices, both in terms of conservation and overall yield. Most felt that they had adopted and maintained practices that were relatively unobtrusive.

Which conservation practices did you choose to install? Why?

Participants reported a range of practices, including no till/partial till, trapping practices, cover crops, etc. Generally, participants indicated that they chose the practice(s) that their local SWCD official recommended based on their particular operation. Participants used this question as an opportunity to discuss the pros and cons of the practices they had tried. For example, the Flint (Saginaw) focus group discussed the merits of no till, and felt that no till vs. conventional till was a harsh dichotomy, and that there should be room for a "minimum till" or "reduced till." Meanwhile, one of the Lower Fox focus groups discussed buffer strips, recommending a change in the size requirements from NRCS-EQIP's standard 35' requirement to a flexible size requirement dependent on local factors.

Example quotes:

On GLRI incentives helping a beginning farmer:

> Well, for us, as a new farmer, it helped us to stay in business. It really has... But also I think we've learned a few things... we learn different programs. We tried with till, integrated pest management, cover crop, basic nutrient management, enhanced nutrient management, and we had a drainage project. That's separate, but those things got us to get in the fields more, to check our crops, and for weeds, and learn... So from the standpoint of a new farmer it's helpful in those ways, a lot of ways, really.

On allowing for a minimum till incentive:

> Participant 1: We worked on something no till, but we've been struggling on that because of weather. I love no till, and we can do good on it, but our weather has been so off the last two years we've mudded corps out terrible. How do you no till through—
> Participant 2: Through the ruts.
> Participant 3: I mean, it's so damp.
> Participant 2: Through the deep ruts.
> Participant 1: The no till program, I would really like to see little changes in it because it's not working with our weather today. We need to be able to... like a 'minimum till' would help a ton.

On allowing for different/smaller size requirements for buffer strips depending on each farm's characteristics:

> Participant 1: I've been thinking about putting more of them in by ourselves and just make them smaller, not necessarily 35 feet for every buffer you're going to do.
> Participant 2: Couldn't agree more.
> Participant 3: Yeah.
> Participant 1: Thirty-five feet, I mean, we get some of these fields, half the field is buffer by the time you're done. And it's kind of a pain to work around with equipment and…
> Facilitator: So reducing the size would be a good thing.
> Participant 1: For some of them, yes.
> Facilitator: And when you say some of them, what's the…?
> Participant 1: Some of the concentrated flow areas. There's some that absolutely need to be 35 feet and there's some other ones that you just watch after a heavy rain I don't think need to be as big.
> Facilitator: Okay.
> Participant 4: Or in a field, yeah, where there's not that much grade, the water's not moving.
> Participant 5: Every field has a different story because it depends on how much is coming from upstream or to it type of thing, so it's…I agree 100%.

What kinds of impacts have you noticed from these changes? Are these impacts different from your expectations? How so?

Participants were generally split between those who noticed no/minimal changes, and those who noticed positive changes. Among those who were enthusiastic about the changes, participants expressed either an overt concern for environmental stewardship or a desire to "change the negative narrative" around the environmental impacts of farming.

Example quotes:

On the efficacy of buffer strips:

> We can see it starting to work with all these torrential rains, too. I mean, the buffer strips. And we don't have as much stuff washed out. It was ten inches and we had mud all over the place.

On uncertainty regarding efficacy:

> It's kind of something you can't see. I mean, obviously the exercise was to keep sediment from flowing into the river. Well, neither one of us stands out in the rain watching, but so far…how do you know? I mean, it's got to be helping. If you sifted all that water through grass instead of bare dirt.

On the efficacy of a two stage ditch:

> We got that two stage ditch installed in 2014, and before that period I would have been ashamed to take anybody on that farm just because of the damage that was happening in the ditch. It's a mindset around everybody and all of us that get it off my land as quick as possible. And what it really is, is somebody's got to slow it down somewhere. And that ditch gave us the ability to slow it down a little bit... I mean, we're all draining more than we were 50 years ago. And you have so much water coming in there so fast. And the stream was just destroying itself, destroying the banks, and so much sediment was lost. I mean, the contribution down to the lake, I can't imagine how many tons we donated there. But with this ditch that we put in there, it slowed that water down. Maybe it was running ten mile an hour before and we got it down to three or four mile an hour now. I mean, I don't know for sure what that would be, but it's something similar to that, just slowing it down in those high flow situations. It's a lot easier to control it when it's like that. So that was huge, very huge.

On how no till has changed one operation:

> I may not have jumped into it without the payment. The payment definitely encouraged me to do it. The no till, I no tilled. It worked good for me for years. And it hasn't…the past couple years it's like [the others in the Flint focus group] say, the weather, the ruts, you can't get to it. But no till did start failing me. My crops were going downhill. And now that I've started working the ground again,

> and like I say, I give the cover crop a lot of credit. My crops have really changed since doing that.

Do you feel you are better or worse off as a result of participating in this program? Why?

The answers here ranged from neutral to much better off. There were no respondents who felt worse off as a result of their participation in GLRI.

- Maumee: All participants answered that they are better off as a result of participating in GLRI (n=17).
- Saginaw: Both Ithaca participants answered in the neutral (n=2). All Flint and Frankenmuth participants responded in the affirmative (n=9).
- Lower Fox: All participants answered that they are better off as a result of participating in GLRI (n=13).

Example quotes:

Ithaca participant:

> I guess from my side we're no worse off. We learned a few things [about environmental impacts].

Lower Fox participants:

> Facilitator: ...Do you feel you're better or worse off as a result of participating in this program?
> Participant 1: Much better.
> Facilitator: Much better?
> Participant 2: A lot better.
> Facilitator: Across the board? [Participants nod]
> Participant 3: More enjoyable. Diversification.
> Participant 4: Keeps us sort of open mind, you know, with the different ideas, different practices.

Did you continue these conservation practices after the incentive stopped? Why/why not?

Generally, participants reported that they did continue the conservation practices after the incentive stopped. Many participants indicated that GLRI payments covered up-front costs which allowed them to integrate the practices into their operation. Once integrated, they said, many of the practices either paid for themselves or required very little cost to maintain.

Example quotes:

> If the program has performed and proved of benefit, it's going to stay in place. If it hasn't performed and hasn't proved of benefit, then it probably would not be continued on. But most of the programs, I feel, have been of benefit to the general operation of a farm, and so they're probably going to stay in place.
>
> Participant 1: I plan to [continue]. I'll chase the money. Why not? But I've been doing more on my own. The last filter strip I put in, I put it in myself. Didn't make it quite as big, but maybe we should have.
> Participant 2: That's a good point what he just said. We've done several projects on our own now. It goes back to we learned. You guys helped us a lot.

RECOMMENDATIONS RELATED TO EFFECT ON OPERATION:

5. Maintain flexibility to allow farmers to experiment with different conservation practices, which empowers farmers to learn and take ownership of their conservation outcomes, encourages participation, and leads to better long-term outcomes (i.e., continued implementation and maintenance of conservation practices beyond incentive period).
6. Avoid tethering GLRI funds to other programs' standards (i.e., NRCS-EQIP's universal 35' buffer strip requirements), since this type of arrangement is incompatible with GLRI's greatest strengths (e.g., flexibility, creativity, local problem solving).

4. PERCEPTIONS OF AGRICULTURAL CONSERVATION

Did participating in this particular program change the way you view Agricultural conservation practices? How so?

Some participants reported an initial hesitation in participating in GLRI programs, due to uncertainty around the costs and benefits. A large majority of focus group participants felt that participation in GLRI projects increased their knowledge of agricultural conservation practices and made them feel like their efforts were important. Some participants expressed that they felt like better stewards of the land.

Example quotes:

On the impact of GLRI on conservation behaviors:

> [The GLRI program] probably makes us realize the importance of having [agricultural conservation practices]. There's a really good reason to implement a lot of this stuff.
>
> [The GLRI program] makes you think about the importance of these kind of practices and keeping the water from just gushing off our land. Also it shows me that there is an understanding, a broad understanding that there is a problem out there, especially in filling up our lake with phosphorus and that sort of thing, and we as farmers need to do something about helping that situation. And I think that's been a learning thing for me.

On establishing a comfort level:

> Participant: Okay, so I come in a little bit leery... There was a little bit of hesitancy to say this is really what I want to do very bad, you know.
> Facilitator: Okay. But how does it seem now?
> Participant: Oh, there's definitely a comfort in it that I'm not as scared of it as I was to start with.

On learning and becoming "better stewards of the land":

> Facilitator: Did participating in this program change the way you view agricultural conservation practices?
> Participant 1: Definitely.
> Facilitator: And how so?
> Participant 1: That there is other ways to do it, and, you know, it was all chemicals, chemicals, chemicals.
> Participant 2: Made us better stewards of the land.
> Participant 3: Yeah.
> Participant 1: Like in here, you work with the land, it works with you.

How did your participation affect your likelihood to partake in future conservation activities?

Across the board, focus group participants reported that their participation in GLRI projects increased the likelihood that they would partake in future conservation activities, both on their own ("...But I've been doing more on my own. The last filter strip I put in, I put it in myself") and through continued participation in incentive programs.

RECOMMENDATION RELATED TO PERCEPTIONS OF AGRICULTURAL CONSERVATION:

7. Respondents indicate that past participation increases their likelihood to partake in future conservation activities. Therefore, in order to increase adoption of agricultural conservation behaviors, GLRI projects and programs should continue to enroll farmers at the same or higher levels.

5. OVERLAP WITH OTHER INCENTIVE PROGRAMS

What's the difference between this particular program and any other incentive program you've participated in? Is it similar/better/worse than other programs?

Many participants were unaware of the difference between GLRI and other conservation programs, such as the Farm Bill's Conservation Title programs traditionally administered by NRCS under pay-for-practices models, such as the Environmental Quality Incentives Program (EQIP). As one participant said, "You sign up at the same offices. You get everything at the same place. Where's the money coming from, who's offering it… It doesn't really matter."

However, once we confirmed GLRI projects with participants to make sure they had the information they needed to answer questions, participants began to describe the ways that GLRI worked better than other programs. For example, one participant said, "They're more at our level. They come out there as an equal and say 'let's try this,' not 'I'm in charge.'"

In the Maumee, an extended conversation on GLRI vs. NRCS-EQIP was particularly important (in this example, the participants use "NRCS" or "EQIP" interchangeably. They are all referring to NRCS-EQIP):

> Participant 1: I think we see a difference here with this Great Lakes thing than we do with the NRCS. NRCS is like pulling teeth. Great Lakes has not been difficult at all. Either you're in or out. And you make that choice. I think that's distinctive for us. We're in a lot of EQIP contracts which have just been like a nightmare almost. We're getting through it, but the GLRI is very good. Very easy.
> Participant 2: It's a piece of cake compared to that other.
> Facilitator: Could you talk a little bit more about that distinction between NRCS and GLRI?
> Participant 1: Well, I see it as mostly bureaucracy... the state NRCS business is just too many people have to touch too much stuff. I mean, this shouldn't be that tough. It goes from our engineer, who knows what it takes to make this legitimate, to the state engineer that should say yes, that's correct. How much more do you have to have? We don't have to touch it every…everybody in the state don't have to touch this thing. Way too many people. No, there's not way too many people, there's not enough people to do the way too much job.
> Participant 2: There's too many stipulations in the process.
> Participant 3: Too many hoops.

> Participant 1: And the GLRI is just very simple. You plant cover crops within this date, the right cover crops, you get paid.
> Participant 2: I mean, the other thing I think I see is that in the Great Lakes thing the rules are well defined and you either make it or you don't. Trying to figure out the rules on the NRCS thing is like waking up in the middle of the night and not knowing where you're at. They seem to be changing. Nobody has the authority to make a decision and live with it. That's where the frustration, I think, comes from.
> Participant 3: And even people in this office that work for the NRCS are frustrated within themselves because you'll ask a question and they say, well, I don't know about that, I've got to find out.
> Participant 2: And that's in contrast with what we're saying from Great Lakes, is it's defined, it's here, you know what it is. The rules aren't changing daily.

Participants also mentioned that the speed of GLRI payments was a positive, particularly in comparison to NRCS. In addition, some focus group participants liked that GLRI required less paperwork than NRCS. On the other hand, participants expressed understanding that since NRCS contracts were longer, more paperwork was necessary. Some expressed a desire for GLRI programs to offer longer (e.g., 15 year) contracts in line with NRCS. However, they also worried that having longer contracts would make GLRI less nimble and more bureaucratic.

RECOMMENDATION RELATED TO OVERLAP WITH OTHER INCENTIVE PROGRAMS:

8. GLRI's strengths are different from other programs (e.g., the Farm Bill's Conservation Title programs traditionally administered by NRCS under pay-for-practices models, such as the Environmental Quality Incentives Program (EQIP)). Participants report that GLRI offers clear parameters for program participation, quick payment, and less paperwork than other programs. Therefore, GLRI offers an effective complement to other incentive programs. However, GLRI is miscast when used as supplemental funds for other programs (e.g., when adopting other programs' structures and requirements instead of maintaining its own). GLRI can and should bolster its unique position by ensuring its funds are used in accordance with its strengths.

6. OBSTACLES

What if any aspects of the program you participated in presented key obstacles for you?

Most participants expressed a general level of satisfaction with GLRI, but two particular obstacles arose during focus groups. One participant suggested that “having the resources [available] when you need them” was an obstacle, because “everything is so timely [in this business].” Other participants across multiple focus group agreed: when resources (e.g., machinery, supplies, personnel) are unable to respond quickly to shifting conditions, it presents an obstacle.

Another participant suggested difficulties in “making the adjustment [from year-to-year] of where a particular cover crop may go and how soon it can get seeded,” because economic factors drive crop rotations, and “you don’t know three years out, or five years out, what it might be, and it might change.” Allowing for seasonal adjustments could help with this obstacle.

> And there’s not enough [staff], there’s not enough, you know? They always talk about it on the harvesting part of it, and they don’t have time.
>
> I think the only way you can make it maybe a little better is if... you know, if you put a little more input into it, maybe you get a little bit more out of it. But it’s been good.
>
> To get a good established cover crop it’s a timing thing for us, and it’s a difficult one to thread the needle on.

RECOMMENDATIONS RELATED TO OBSTACLES:

9. Increase funds for staffing at the local (program manager) level, in order to increase time available for on-farm interaction with farmers and avoid “bottlenecking” of resources.

10. Include allowances for year-to-year adjustments for certain practices (e.g., cover crops) to account for uncertainty in crop rotations.

C. Interviews

We conducted 29 interviews with program managers. This includes interviews with 10 individuals in the Lower Fox watershed; eight individuals in the Saginaw watershed; eight individuals in the Maumee watershed; and three individuals in the Genesee watershed. In some cases, we interviewed multiple people who had worked on the same project; we have adjusted these data so that they do not over-represent duplicate answers.

1. EFFECT ON ORGANIZATIONAL CAPACITY

Did receiving a GLRI grant expand or improve your organization's ability to:

a. Engage with producers in your jurisdiction? How so?

Most (n=20) respondents who answered this question answered **yes**. The **yes** answers were grouped into three categories (see Table 1).

The most popular reason related to the increased capacity to build individual relationships. This means that GLRI funding led to an increase in individualized interaction with farmers (or SWCD staff, in the case of Indirect grants). Program managers in this category felt that the GLRI grant allowed them to "build community," "build relationships," and make "connections" with farmers.

A smaller group of program managers responded **yes** because the GLRI grant allowed for creative solutions. Simply put, these program managers were able to implement novel programs that allowed them to engage with a new and different audience of farmers. Another small group of program managers responded **yes** because the GLRI grant created a buzz with farmers. They felt that farmers were excited about GLRI funding and therefore were eager to engage.

Table 1. Increased engagement with producers via GLRI funding

ANSWER	REASONING
YES – increased capacity to build individual relationships	• building community and finding partners over multiple GLRI projects over multiple years • working together with farmers • adds to credibility • increased capacity for building relationships • funded individualized outreach • the funding keeps staff consistent and reduces turnover which helps build relationships with farmers • connection with farmers is closer because of GLRI funding • allows me time to meet in person with famers across multiple counties • allows us to build relationships • increased ability to engage with SWCD staff (Indirect grant) • funding for staff • made outreach possible • funded outreach • the planning meetings, phone calls, and visits increased contact with farmers who wouldn't usually come to the office • allowed one-on-one technical assistance for farmers • allowed us to work with new producers, especially through soil sampling

YES – allowed for creative solutions	• creative solutions • trying new things • funding the creation of demo farms • creating educational materials • allows us to engage farmers outside of NRCS-EQIP
YES – created a buzz with farmers	• created a buzz with farmers and they wanted to participate • GLRI projects are flashy and farmers are interested • the dollars piqued their interest
MAYBE	• there is an appetite [among farmers] for pay-for-performance, but that funding is not specific to GLRI
NO	• GLRI allowed us to address a larger number of issues overall, but it was just another tool in the toolbox

Did receiving a GLRI grant expand or improve your organization's ability to:

b. Advance initiatives aimed at changing on-farm decision making at the field level? How so?

Most (n=13) respondents who answered this question answered **yes**. Two responded **maybe**. These answers (shown in Table 2) largely repeated the same points from the previous question (Table 1). Again, the major reason for **yes** answers was related to increased capacity to build individual relationships, but program managers also cited allowing for creative solutions and creating a buzz as important factors. One potentially important insight came from a **maybe** respondent, who felt that it was easier to work on changing decision making through their private funding sources, which allowed them to focus on behavioral outcomes without attaching tangible environmental outcomes to the work.

Table 2. Advancing initiatives to change on-farm decision making

ANSWER	REASONING
YES – increased capacity to build individual relationships	• staff available to build relationships • allows for direct interaction with farmers • building one-on-one relationships with farmers • via hands on, one-on-one interaction with farmers • via interaction with SWCD staff (Indirect grant) • targeting individual farms based on GLWMS • without it, our ability to administer conservation would be hindered
YES – allowed for creative solutions	• funding field days and demo farms • through demo farms and farmer roundtables • being more in control of funds to work with farmers who we already had a relationship with • another tool in our toolbox
YES – created a buzz with farmers	• the farmers are already interested, and GLRI allows it become reality • reaches early adopters, which leads to word-of-mouth spread
MAYBE	• to be determined • other private funding sources allow us to do more behavior change work without clear tangible environmental outcomes

Did receiving a GLRI grant expand or improve your organization's ability to:

c. Start a new program or expand an existing one? How so?

Most (n=18) respondents who answered this question answered **yes**. Three answered **no**. Here, the **yes** answers were split into four categories (Table 3), with most answers falling within the first two: that GLRI increased their capacity via staff availability, or that GLRI had funded small/pilot projects which subsequently turned into larger projects (e.g., pay-for-performance pilots, demo farms). A smaller number of **yes** answers pointed to expanded technical capacity (e.g., GIS, soil sampling, monitoring) or the addition of a fleet of rental equipment (e.g., interseeder) that was made available to farmers in their jurisdiction.

Table 3. Starting a new program or expanding an existing one through GLRI

ANSWER	REASONING
YES – Increased capacity via staff availability	• staff availability increased capacity for existing programs • staff availability has expanded one-on-one visits and selling of the conservation practices • we became a bridge to support our local partners on the ground (Indirect grant) • expanded outreach and project capabilities across the board • expanded outreach
YES – Small/pilot projects have led to larger projects	• allowed us to refine our framework • demonstrating capability on smaller projects has allowed us to plan more and bigger projects • funded pilot pay-for-performance program • funded trial of experimental pay structure • funded pilot projects that demonstrated capacity and are now expanding • funded a variety of new projects • funded the creation of demo farms • funded demo farms and farmer roundtables
YES – Expanded technical capacity	• expanded drainage management program • funded the continuation of monitoring (baseline, edge-of-field) • expanded GIS capabilities • expanded soil sampling capabilities

YES – Added rental equipment	• added a new fleet of rental equipment (e.g., interseeder) • bought rental equipment
NO	• allowed us to do more work overall but didn't change the programs

Did receiving a GLRI grant expand or improve your organization's ability to:

d. Hire additional employees? How many?

A majority (n=11) of respondents who answered this question answered **yes**. The rest (n=8) answered **no**. The details of their answers are included in Table 4.

Table 4. Hiring additional employees through GLRI

ANSWER	**GLRI-SUPPORTED ADDITIONS (BY PROJECT)**
YES	• One FT position • ½ of one new hire and one subcontractor • Two FT positions • One temporary/PT subcontractor (engineer) • Three temporary/FT positions • One FT position and ½ of one temporary/PT position • Six FT positions and two PT positions • One FT position and one temporary/PT position • One FT position and two graduate students • One PT position • One PT position
NO	• seven responded with simple "no" answers • One responded that they supported ½ of one existing staff position with GLRI funds

Did receiving a GLRI grant expand or improve your organization's ability to:

e. Access tools and resources that expand your work flow efficiency? How so?

Respondents were split between **no** (n=9) and **yes** (n=7), with one **maybe**.

Table 5. GLRI impact on tool and resource access

ANSWER	COMMENTS
YES	• Great Lakes Watershed Management System (x3) • Increased GIS capability (x2) • HIT and various EPA tools • Networking more with USGS edge-of-field • USDA Agricultural Conservation Planning Framework (ACPF) • Through increased partnerships
NO	• Most respondents in this category continued using the same tools and resources that they had used prior to GLRI funding • One responded that GLRI slowed them down because GLRI asked for a double measurement
MAYBE	• Through GLRI we are possibly more effective in creating nutrient management plans

RECOMMENDATIONS RELATED TO THE EFFECT ON ORGANIZATIONAL CAPACITY:

11. Focus on facilitating the building of individual relationships at the field level through adequate staffing.
12. Continue to fund innovative pilot projects and equipment rental programs, which create a buzz amongst farmers.
13. Encourage flexibility in tool and resource use and provide trainings to help program managers learn how to use them efficiently.

2. CULTURAL IMPACTS

In your experience, have GLRI investments resulted in lasting cultural changes among participating institutions and producers?

While many program managers believe that GLRI investments have resulted in lasting cultural changes, the response was not unanimous. Program managers reported that GLRI investments created lasting cultural changes in cases where: local staff were available to spend significant time with "boots on the ground" to assist the farmer; and the project timeframe was long enough that the farmer began to realize the economic benefit of the practice (or, at a minimum, not have to worry about a possible economic risk). Other program managers are optimistic, but express a "wait and see" approach, cautioning that cultural advances could be lost without continued GLRI investment. A third segment of program managers do not see evidence of lasting cultural change.

Example quotes:

> Yes. The GLRI funds have provided opportunities for more kind of grassroots solutions that will fit and work for those local producers and that localized watershed and natural resource concerns.
>
> Yeah, yeah, for sure, especially with the producers. There's always people that are just in it for the money. They come in asking for a program and they just want to make a few bucks where they can. But I've had a number of people, especially the ones that have applied to GLRI, where years one and two they're just kind of sort of interested in it, but after year three, and then even after their contract ends they're still contacting us because the practices that they were doing really started to work, they started to see the benefit, so they're absolutely continuing to do them and actually improve upon them even after they're not receiving funds for them anymore.
>
> Where there is lasting cultural change the reason it's happening is because that individual is working with someone with the boots on the ground to support them and collaborate with them.
>
> So among producers I would say it's starting to make a lasting change: I don't think we're there yet, but I think the momentum is headed in that direction.
>
> From a cultural standpoint, GLRI has done a lot. But I think it also it tenuous, based upon GLRI's existence.
>
> It's tough to say because we don't have a strong metric to figure that out with. And probably, some sort of longitudinal assessment would need to be done.
>
> No. While it was a brilliant effort, it was a great idea, I feel like there were a lot of challenges and barriers that kept us from scaling this and making it a long-term effect and impact to farmers in the environmental outcome.

More specifically, once the GLRI money ran out:

a. Did producers continue to implement or maintain the conservation practices after the GLRI payments stopped? Why or why not?

Most program managers were optimistic about farmers' continued implementation or maintenance of conservation practices beyond the GLRI payment period. Still, many were cautious, recognizing that this could change quickly.

Example quotes:

> Yes, because it gives them an opportunity to try things with reduced risk to their business, and be involved in the decision-making of what that looks like for their farm. And that if we do our jobs well and make something that fits [for] them from the beginning, it's more likely to be something that they retain long-term.
>
> Oh, yes. ...[One particular farmer] has got personal interest. He stepped forward and wanted to do this project because he wanted to protect his land. He was also interested in his own life, to demonstrate to his peers that you could do this kind of thing, which is pretty forward thinking on his part.
>
> Yes. In regards to continuing the projects, yes. Because of the existence of those other sources of funding, like I mentioned, a lot of the farms do also continue with those best management practices on their own once they realize how to do things.
>
> Some of them, but not all of them. I'll tell you that right upfront. Some of them did... others, no. ... if they see any kind of a risk associated with that or if they perceive it as not being as cost effective as their previous method, then they tend to want to migrate back to that previous method.
>
> Some of them are just like bought in, like they're in it, they believe in it, they're going to do it no matter what. Other ones are like… they're not ready to take the risk financially.

b. Did participation in the GLRI project/program lead to a change in producer's attitudes about Ag conservation to improve water quality (increase or decrease confidence and acceptance towards such practices)? Why or why not?

Again, while answers leaned towards the optimistic, with many program managers noticing a change in farmer attitudes about agricultural conservation to improve water quality, not all program managers were willing to attribute attitude those changes to GLRI. Most program managers reported that a suite of factors had led to changed attitudes, of which GLRI constituted one factor. In some cases, the farmers who participated in GLRI projects were identified by local staff as being “conservation-minded” or “early adopters” prior to GLRI funding.

Example quotes:

> I wouldn’t say a change. I mean, the farmers we spoke with were somewhat in tune with what was going on already.
>
> [It’s] just now gaining traction. I think folks are starting to understand it. ...So has it caught on yet? I don’t know. We have hope.
>
> Yes and no. I think that all of the conservation partners want to bring the tool box of resources to the producer. And the producer doesn’t always need to know which acronym of funding is behind it. They just need to know that it makes sense for their farm and for conservation. ...As far as making behavior change, each incremental change has a ripple effect to the neighboring acres, for considering to try these BMPs.
>
> I know specifically the farmers I worked with in that GLRI had a conversation mindset anyway, so I didn’t have to do any hard conversion from a farm that might not have been conservation-oriented to one that may be. So, I would say that they were happy with the projects.
>
> With a lot of them, yes, their attitudes did improve, they increased.
>
> We’re seeing attitudes change, we’re seeing more farmers show up for the discussion to learn about what’s happening.
>
> I think it did change people’s attitude about it. You’re not just talking about a financial benefit, not just talking about oh, we’re keeping sediment out of the streams and helping fish. You’re talking about the difference between looking down into your ditch and seeing mud or seeing clear water. So yeah, I think that made a huge difference in people’s attitudes.
>
> A lot of it comes back on the staffing in making sure that we go back out and communicate. We can’t expect them to continue with their project if we’re not out there going back and following up with them and communicating with them.

c. Did your organization’s expanded capacity endure? Why or why not?

In some cases, program managers reported that the increased access to tools and resources helped their expanded capacity endure. For others, losing GLRI funding meant a loss of staff. It is clear that at the conservation district level, enduring expanded capacity is most closely tied to staffing levels, which are precarious and uncertain.

Example quotes:

> A lot of it. Right now, I think that we will be sustainable, except for we may lose [one staff person].
>
> Yes – due to increased access to tools and resources.
>
> Prior to when I started working here, we were about to possibly close the doors, and it was absolutely the start of GLRI and the technician funding that came with that, and adding phosphorus priority watersheds here that would be the first two solid grants that we got that kind of kept the doors open. And then that has allowed us to kind of build from there and get into other programs and other grants and things like that.

What would make GLRI-funded projects and programs more effective at engaging producers and creating lasting cultural impacts related to Ag conservation for water quality?

Again, program managers were concerned that building long-term relationships with farmers would be impossible without a commitment to funding "boots on the ground." This would mean a long-term commitment to funding staff and technical assistance in order to make the transition less "scary" for farmers. Supporting "innovative" farmers, and then using those successes as pilots to convince other farmers to try conservation practices, takes time and energy— perhaps five to seven years before the benefits become apparent.

Example quotes:

> I think it really does need to have a bit of a cradle to grave approach. …We've got to have staying power, longevity for them. We need to have education and outreach about those, and just to keep monitoring them to show how they're working.
>
> One is understanding that in order to have lasting cultural impacts, you need to have the right people and enough people, boots on the ground, to build the relationships to help make the changes. Without those, we're going to be putting money out for conservation that's going to stop when the money stops. I feel really strongly about that.
>
> If we can provide the tools to not make these changes quite so scary for producers, because you hear producers use that word, "scary". And I get it, if that was my living, that it would be scary to make a complete change. So, providing more tools to farmers to let them try out, I think would be great.
>
> if they could have a long-term likelihood of funding they would probably be more invested, I'll say, emotionally. Their thinking, their mindset would be more invested in—it would become a habit at that point. And then over a couple of years' time they probably would figure out ways to make it so that it was very, very profitable if they didn't have the funding. But it takes more than a year or two to make it a habit and to find those systems and put systems in place that are going to make long-term differences.
>
> It's being able to have that close relationship, on a fairly regularly basis, that I think builds the trust and the likelihood that the farmers are going to both be receptive and to have it more persistent—become part of the way they want to run their operation, [as] opposed to just doing it for a short-term project purpose. So yeah, that sort of boots-on-the-ground concept.
>
> It feels like there's been a strong emphasis on implementation of practices and not enough emphasis on staff and technical assistance.
>
> Having a group of farmers who are willing to do innovative things and share, share, share, share, share about it, and share the benefits and share the challenges and share the failures, is the way to make lasting change.

RECOMMENDATIONS ON CULTURAL IMPACTS:

14. Encourage lasting cultural change through a commitment to an individualized "boots on the ground" approach.

15. Implement five- to seven-year pilot projects, especially with innovative and influential farmers.

16. Fund longitudinal research to track farmers' conservation behaviors and perceptions post-GLRI funding.

3. OVERLAP WITH OTHER INCENTIVE PROGRAMS

What if anything distinguishes GLRI from other incentive programs?

"Flexibility" was the most frequently cited positive trait mentioned by program managers in response to this question. Because GLRI allows for a flexible approach, program managers and farmers were able to experiment with novel or innovative concepts. This lends the program a "grassroots" feel. By contrast, other incentive programs were viewed as "strict," "top-down," or "overly regulatory." The ability to fund staffing, equipment, outreach, and cost-sharing, was seen as a positive. These traits help GLRI build a sense of ownership among participating farmers and institutions, as they work together to problem-solve and deliver creative solutions.

Another distinguishing factor, according to multiple program managers, is GLRI's more localized approach. This allowed participants to target specific areas, and also to feel more confident in their chances of securing funding.

Example quotes:

> They welcome innovative ideas. ... why I really like GLRI is that it allows you to think outside the box and come up with innovative ideas to address environmental outcomes that we need to in those specific regions.

> The flexibility, especially when it comes to equipment. There is no cost-sharing or equipment funding that comes out of any other government program, as far as I know.
>
> The GLRI has allowed people that have got passion for certain things to come together. ... The producers are a lot more open to it. We've got a lot of different eyes looking at things.
>
> GLRI gave more flexibility for the kind of practices that could be cost shared, and the amount that could be provided to a producer. I think that sort of a flexibility both on the practices and the cost sharing that was possible, was great and I think allowed some more creativity to try to make improvements to water quality.
>
> The ability to have enough staff people out talking to the farmers. And two, the flexibility of the practices that can be funded. Those two things, I think, are the biggest.
>
> I would say the flexibility, the creativity, and the ability to really localize and target what's needed. And to try something on.
>
> It reduced competition enough that where there were people that had maybe applied in the past and couldn't get in because it was so competitive and there wasn't enough money available, those people were kind of turned off previously. So now being able to go to them and say there's a reasonable likelihood that if you come and apply and work with us on this that we can get you funded and get you in, that side of things has absolutely helped.
>
> The amount of dollars that are available in a smaller geographic area. And the fact that the competition for those dollars is greatly reduced, so the change of a producer going through all the paperwork that's associated with the signup, planning and on and on and on to him seems to be more worthwhile to get the chance of being successful at getting access to those resources and getting the practice installed is greatly increased over getting those statewide programs.

Does GLRI reach people that NRCS-EQIP does not? How so?

Program managers generally agree that GLRI does reach people that NRCS-EQIP does not, because: it allows for innovative practices; it represents less "red tape;" it seems more attainable than other funding programs; it allows for better targeting of potential participants; and/or it feels less regulatory/governmental.

Example quotes:

> I think it does because it's allowing us to do some of those different and innovative practices. I think that's really the strength, that it's allowing us that.
>
> I think that the timelines, and some of the red tape, that does come into play with the NRCS grants can be a barrier. I understand why those things are there. They need to be there. But for producers, sometimes those timing delays don't work for their operation. And so GLRI funds can usually be decided and distributed to producers with a quicker turnaround, depending on who the subgrantee is.
>
> It probably reaches producers that otherwise wouldn't participate or otherwise wouldn't know what's going on or would say that they're not going to waste their time. And that's kind of the attitude they had towards like a regular EQIP. It's a waste of time. I'm not going to get funded.
>
> I can't speak for all of them. But I do think that whether it's NRCS or County Land Conservation Departments that don't have the proper staffing, we're seeing farmers that come in the door to sign up for practice, those are the farmers that get the payments and get the funding for practices. That's not the way that the GLRI dollars that we're using work. The GLRI dollars that we're using, we go out and we target the farms that really need to be targeted.
>
> If it's funneled through a soil and water district…Soil and water districts reach people that NRCS don't always reach. Because we're a subdivision, we're a little bit of a less level of government. So, if we're able to be the boots on the ground people with farmers, sometimes we do work with more conservative farmers that aren't fully bought in to, say, Federal Farm Bill programs.

What kinds of outreach were associated with the GLRI grants, and what did you think of it? Why was it effective/ineffective? How could it be improved/done differently?

Program managers report a suite of different approaches to outreach, each specific to their own unique region. One program manager noted that GLRI has changed their outreach approach from a regulatory perspective to a "focus on solutions and positive change." Many program managers reported that their greatest outreach successes came as a result of personal interaction: visits to demo farms, training days, field days, and one-on-one education in the field with farmers, were all cited as successful approaches. Word-of-mouth between farmers was noted as being an especially effective form of outreach. Other traditional approaches (e.g., newsletters, direct mail, email, newspaper advertisements, agricultural journal advertisements, social media, websites) were also mentioned, but with less enthusiasm.

Example quotes:

> I think in the past, we focused on the bad, pointing out the problems in regulation. It seems like when GLRI came around, we started to focus on solutions and positive change. So, that funding source provided a huge change here locally for the whole process of opportunities and change.
>
> The best salespeople for this program have been the enrollees themselves. Nothing sells this program like a satisfied farmer participant. So we get him enrolled, he has a good experience, he starts talking to his neighbors about it. And that has been by far the greatest outreach mechanism.
>
> If you get in front of the right person and the right producer that has a good reputation in the community, and someone that people know they do things right on their farm, and you get the attention of them and they spread the word. I think I've had more people sign up through referrals than anything else.

RECOMMENDATIONS ON OVERLAP WITH OTHER INCENTIVE PROGRAM:

17. The strength of GLRI is that it feels like a localized, grassroots, and flexible program. Maintain those characteristics and build upon them by incentivizing innovation and creativity.

18. By contrast, other incentive programs feel regulatory and strict. Distinguish GLRI by providing positive reinforcement instead of punishment.

19. Emphasize interpersonal outreach methods: field days, demonstration farms, training days, and one-on-one education in the field with farmers, all of which encourage word-of-mouth outreach between farmers.

4. OBSTACLES

What if any aspects of the GLRI funding process presented obstacles for your organization or the producers that you were engaged with?

Without question, administrative burden is the primary obstacle identified by program managers. This obstacle was expressed in multiple ways, including: uncertainty/inconsistency with distribution of requests for proposals; long timelines between project applications and acceptance, which can lead to farmers losing interest; a cumbersome amount of project reporting requirements that varies based on the particular program administrator; burdensome QAPP process; EPA staff turnover leading to lost efficiency; and the advance requirement for food and travel expense.

Program managers described these obstacles by using words like “rigid,” “onerous,” “burdensome,” “inconsistent,” “cumbersome all the way down to the producer,” “throws up more obstacles than [it] removes,” “tied down,” and “complex.”

However, this was not a universal experience. Some program managers did not mention administrative burdens as an obstacle. Others described the process in very positive terms, as “easy,” “simple,” and “straightforward.” This indicates an inconsistency: some program managers are being burdened with more administrative hurdles than others.

Example quotes:

> The administrative burden is overwhelming on our end. ...I don’t think this is necessarily indicative of all GLRI. It may be just our particular program administrator. Everybody has a different grant administrator. Maybe it’s just a

> function of this one we have. But the reporting requirements are very burdensome.
>
> The administration of a federal contract is rather onerous and does require some time and investment to not only realize that you're going to be spending a good about of time administering the grant, not only actually doing the work you said you were going to do.
>
> I think the timing of the grant, just getting all the grant paperwork organized at the beginning, was a bit of an obstacle. Just not knowing when the start date would be, and all of that. And it just taking a lot longer than any of us probably anticipated.
>
> I think I should emphasize the roadblocks that are oftentimes put up by the agency hierarchy. Rather than being supportive and finding ways to help field office staff navigate around obstacles that they run into, they seem to throw up more obstacles than they remove. And it's hurt us.
>
> We're not very flexible on letting the farmers try different things. If they have an idea, they saw something, they want to make a change, we can't just snap our fingers and do that... So, that's been very frustrating to the farmers specifically. They feel like their hands are tied.
>
> We haven't gotten the sense that we've been able to be flexible to make changes on the fly when a producer has an idea that may be new, unique, may not have a standard out there, but it's something that they believe in and they want to try. To have that flexibility and freedom to be able to do that and not be tied down to the system of, "Well, we don't have protocols in place to do that, so we can't do it."
>
> GLRI funding, in my mind, has been very user friendly. The way that the reimbursements are made, it's a really easy process. It's very quick. ...The reporting requirements, we've had some rough times working through workplan change requests with EPA, but overall, it's been a very positive experience.

Do you believe your projects' targeted activities were successful? Why or why not?

Do you believe the program's goal was achieved? Why or why not?

Most program managers feel as though their projects and programs have been largely successful. Many felt that an increased grant length would increase their certainty of success. In some cases, the conservation practices being installed under GLRI are going against decades of tradition. In other cases, project success is difficult to measure in a limited time frame. Therefore, while most felt reasonably comfortable labeling their projects and programs as successful, they also cautioned that the success could be negated if GLRI were to end. Similarly, many believe that the success of GLRI would be enhanced by allowing for longer-term projects.

Example quotes:

> We all understand that a five-year pilot program is really too short to fully determine success, in terms of final water quality. But we've seen that we have moved the needle and improved water quality, and that's had some really good, positive impact that I believe we will continue to see.
>
> We tried new things. We weren't picky. We didn't make them… If they wanted to do it one way because they knew that that was the way they could sell it, fine. We weren't going to bootstrap them to anything. So I think we did just fine.
>
> Let's just say we've worked with – including cover crops – 200 producers over the last couple of years. Nobody has ever complained. Well, people have called to say, "Have you heard from my payment?" But it's never been negative...
>
> I would argue that GLRI funds is helping us to turn the corner. We've got a lot of young people here working with the GLRI funding. Just on this demo project, there's a lot of young people that are really getting involved and you can see they're excited about it. So I think part of that is infectious in the countryside with producers. I think they're doing the right thing now. People are proud of the products they're purchasing. We need to change that culture, and the funding, I would argue, is helping that.

What would make GLRI funded projects and programs more effective? Less effective?

Removing administrative burdens and administrative inconsistency would help relieve the pressure on program managers, which would allow them more time for program implementation (e.g., outreach, on-farm visits and relationship building, creating educational materials, providing technical assistance, organizing field days and demonstration farm visits, etc.). Program managers urged GLRI administrators to "[trust] the people at the local level."

Accordingly, many program managers recommended additional funding availability for staffing at the local level.

GLRI could also ease burdens on local program managers by facilitating networking between grantees. Some program managers expressed a desire to learn more about the successes and failures of other projects, in order to build collective capacity.

Finally, many program managers expressed support for the continuation of GLRI. Despite the obstacles, they felt that GLRI projects and programs were making an impact in their watersheds.

Example quotes:

On the continuation of GLRI funds:

> I can sum it up for you, Adam. Keep the funding coming from [GLRI]. Keep letting districts apply. We focus on the conservation practices based off phosphorus reduction. We've done models. Grass waterways show the most soil savings, as do filter strips, erosion control structures, water control structures. I would say keep the funding coming.
>
> If there was three times the amount of projects and three times the amount of money we probably could have done a lot more... But I think we did alright with what we had.

On the length of grant cycles:

> Long-term commitment of proper funding. And it's as clear as that as far as I'm concerned.
>
> Let's say if it's a HUC12 type project, minimum of five years is what should be funded. And then just kind of reiterating what I said before about GLRI being able to maintain or even expand its flexibility and what kind of projects it funds.
>
> The length of these things is really important. ...the longer we can commit resources and staff and resources to the issue, the more success we have.
>
> We found the larger five-year grant to be so much more valuable for implementation. So, I would say if I had a recommendation to how the GLRI

> dollars got spent, would be to do more, longer, larger grants, even if that means less grant cycles.

On building program-level capacity:

> Networking the successes and failures of the project themselves. You know, kind of like I think that's important with the BMPs in a community. Because you talk to each other and you find out what works and doesn't work. I would like to see that more among the grantees, as a potential way to build all of our capacity.

On funding staff at the local level:

> So being able to fund positions at the field office level, critical. Critical to being successful. Having a long-term employee so they can build rapport with producers is very important. Being able to get the answers that they seek from the field office when they call is really important.
>
> Having the staff there makes it more effective, absolutely.

RECOMMENDATIONS ON OBSTACLES:

20. Improve administrative efficiency by: standardizing reporting guidelines; standardizing granting periods (with sufficient notice to allow potential grantees to prepare applications without compromising regular duties); allowing for mid-project adjustments; and ensuring that EPA administrators are consistent across regions.

21. Consider additional emphasis on longer (five- to seven-year) projects.

22. Continue emphasis on local-level problem-solving.

5. ENROLLMENT

How many producers did your program enroll?

Table 6. Number of producers enrolled

Watershed	**Number of producers enrolled (by project)**
Maumee	• 98 • 75 • 90 • 1 (demo farm) • 3 (demo farms) • 2 (one restoration project, one pilot) • 100
Saginaw	• 60 • 21 producers, 40 contracts (some producers on multiple contracts) • 100 • 15
Genesee	• 4 (restoration projects) • 4 • 35 over seven counties
Lower Fox	• 200 over two counties (Brown & Outagamie) • 10 producers on 2,200 acres of crop land • 7

	• N/A (outreach project via demo farms, grazing programs)

Table 6 shows that there is a wide range of enrollment numbers. Traditional enrollment programs (i.e., pay-for-practice programs including cover crops, no till, and/or trapping practices) tended toward larger enrollment numbers (75-100 producers enrolled in Maumee; 35 in Genesee; 60-100 in Saginaw; 200 in Lower Fox). Novel programs, such as pay for performance in Saginaw and a restoration pilot project in Lower Fox, tended towards smaller enrollment numbers but instead emphasized number of practices implemented (i.e., 21 producers but 40 contracts) or acres treated (i.e., 10 producers but 2,200 acres of crop land). Programs that did not include a traditional enrollment component reported smaller enrollment numbers. For example, one program manager in Genesee reported working with four producers on restoration projects such as fuel tank containment facilities and covered barnyards, while multiple program managers in Maumee and Lower Fox were involved with GLRI-funded demo farms.

Did your program enrollment reach your desired capacity?

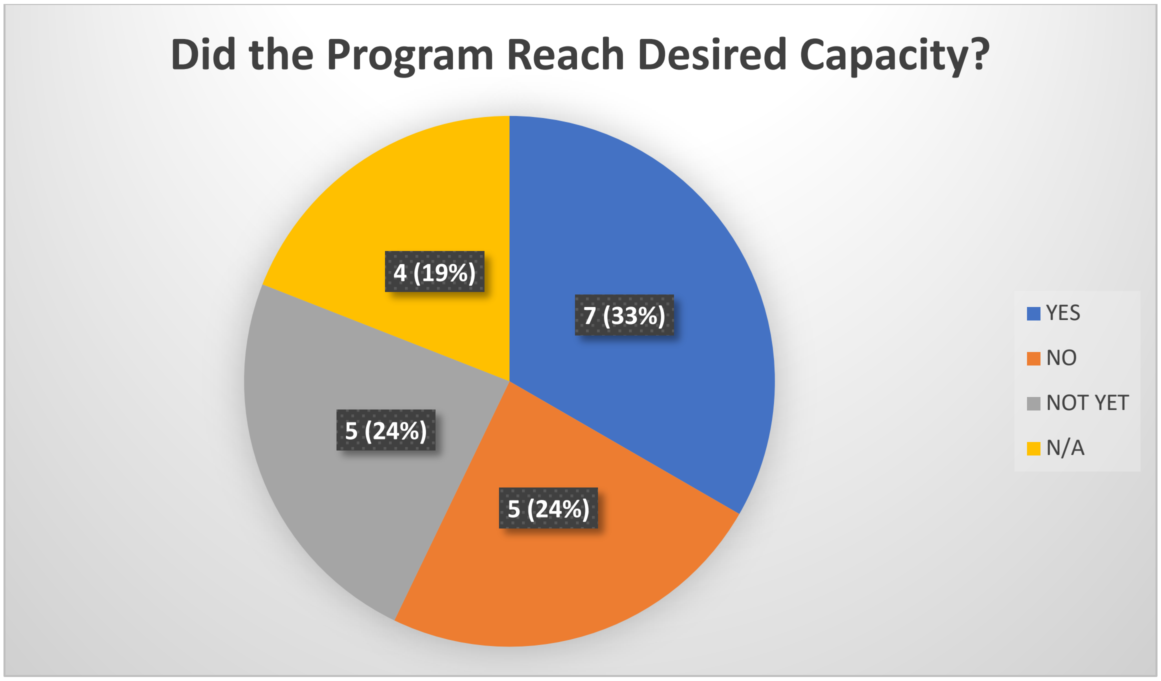

Figure 6. Did the Program Reach Desired Capacity?

Figure 6 shows that seven program managers reported reaching desired capacity; five reported not reaching desired capacity; five reported "not yet," meaning an ongoing enrollment period; and four reported that their programs did not include an enrollment element (e.g., infrastructure improvements, constructed wetlands, etc.).

If Yes: What made your program attractive to producers?

Table 7. Reasons for enrollment success

Reason	Description	Number of respondents
Ease of access	Quick turnaround/payments; easy to participate; minimal paperwork, flexibility	5
Individualized programs	Small/intimate program, meaning lots of individualized	3

	attention; Boots on the ground outreach/working with farmers	
Impact of demo farms	Impact of demo farms	2
Performance reimbursement	The economic utilization of nutrients; phosphorous performance reimbursement	2
Other (misc.)	Longer time frame than other EPA programs; State/other programs don't provide these incentives; No match component; Providing funding for soil sampling	4

If No: What was the barrier to enrolling your target number of producers (from your perspective & producers')?

Table 8. Barriers to enrollment

Barrier	**Description**	**Number of Respondents**
Insufficient economic incentive	Pay-for-performance rate was too low; Cost share dollar amount did not offset risk of participation; Commodity prices were down meaning farmers were less focused on	4

	conservation efforts; Fear of taking land out of production	
Lack of funding	Not enough staff/time to recruit; Project funding cuts; Ran out of funding; Difficulty finding time to explain novel approaches	4
Resistance to change	Farmer not interested in a change; Fear of the practice	2
Other (misc.)	Finding good locations; Delays due to increased administrative burdens; One project learned they needed to offer more than just cover crops in order to attract participants	3

As Tables 7 and 8 show, GLRI enrollment is optimized when the program is easy to access, individualized, and conducting personalized outreach. Conversely, GLRI enrollment targets were not met when funding levels either 1) did not offset farmers' fear of the risk associated with conservation practices, and/or 2) did not include funding for adequate staffing for recruitment.

RECOMMENDATIONS ON ENROLLMENT:

23. Provide funding for follow-up studies to optimize incentive amounts for novel practices, such as pay-for-performance, and gain a better understanding of how well current pay-for-practice incentives assuage farmers' fears of risk associated with conservation practices.
24. Ensure that future projects budget appropriately for recruitment purposes.

6. DECISION SUPPORT TOOLS AND MONITORING DATA

Did you use any models, decision support tools, or monitoring data from USGS, NOAA, or ACOE programs to target producers to enroll in your program, or to estimate the environmental benefits of your efforts?

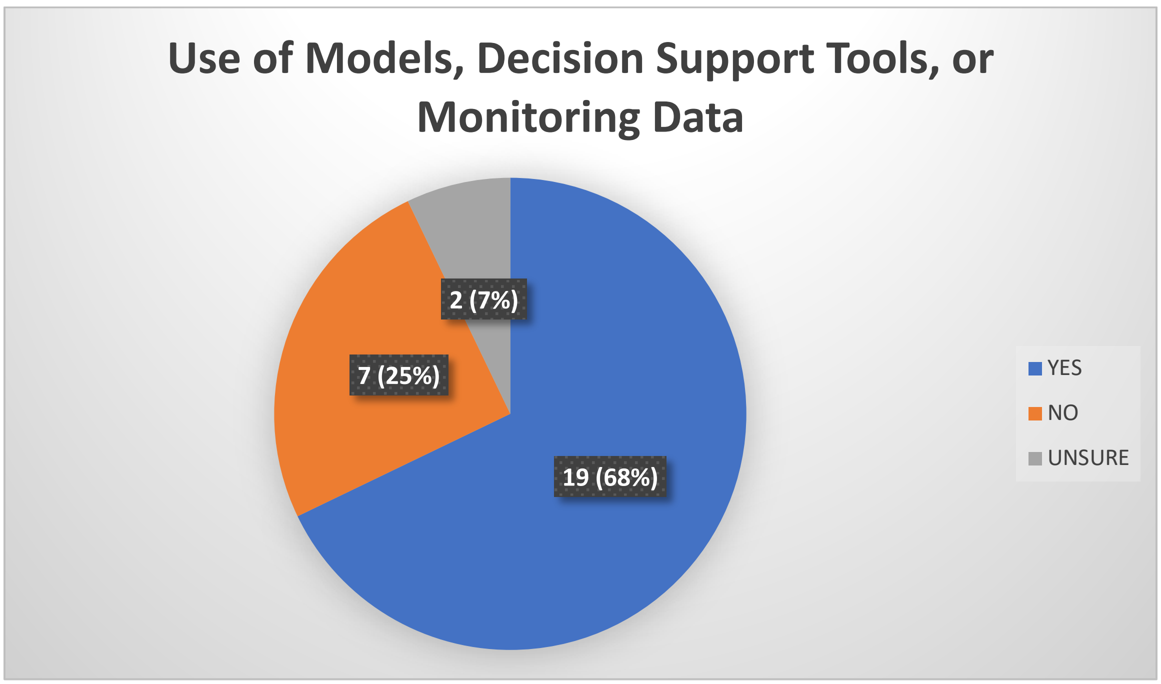

Figure 7. Use of Models, Decision Support Tools, or Monitoring Data

If Yes, what were they?

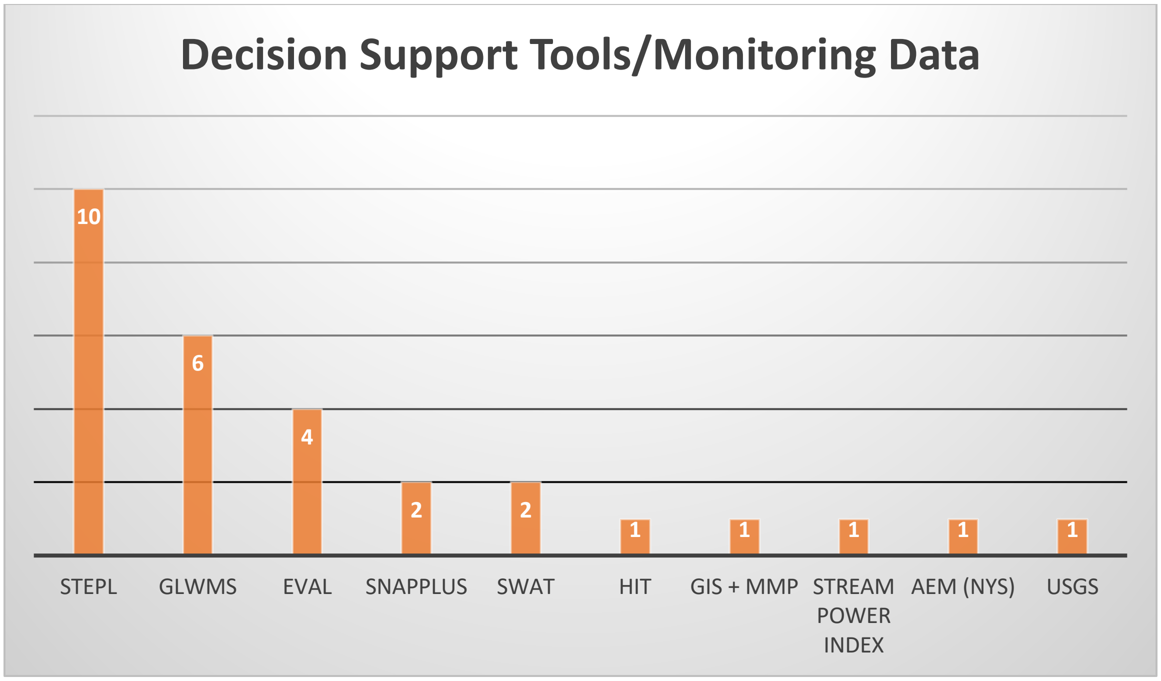

Figure 8. Decision Support Tools/Monitoring Data

Did the use of these resources have an impact on your ability to recruit producers?

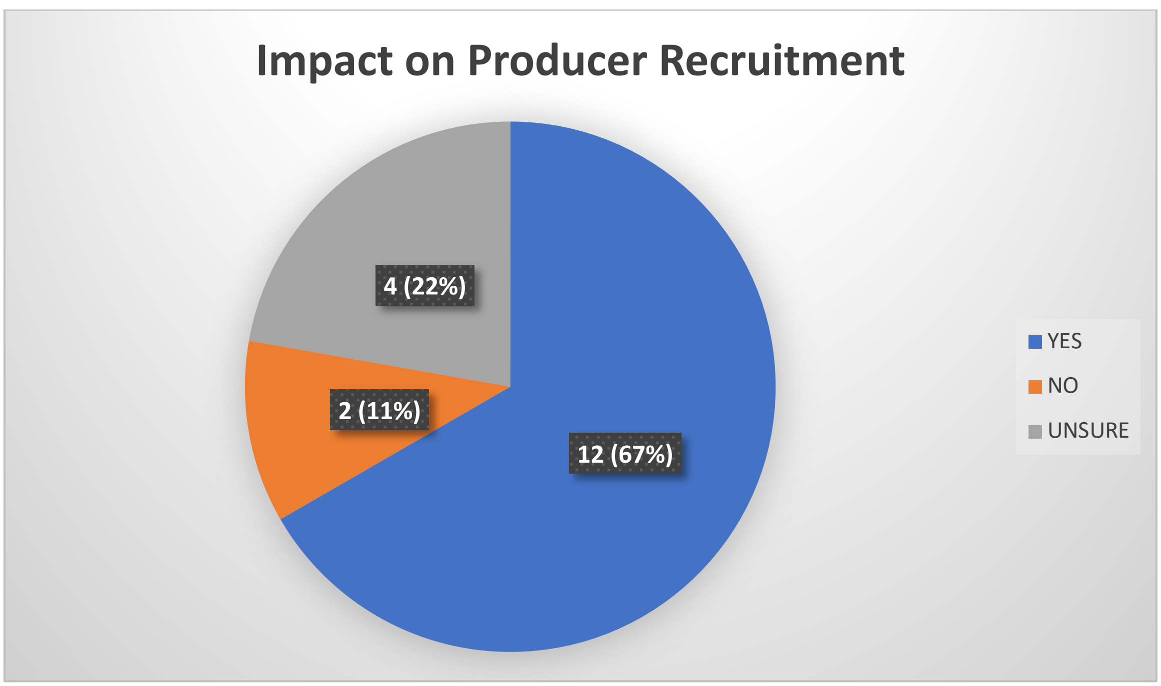

Figure 9. Impact on Producer Recruitment

Did the use of these resources increase your (or your enrollees) confidence in the efficacy of agricultural conservation efforts administered by your program?

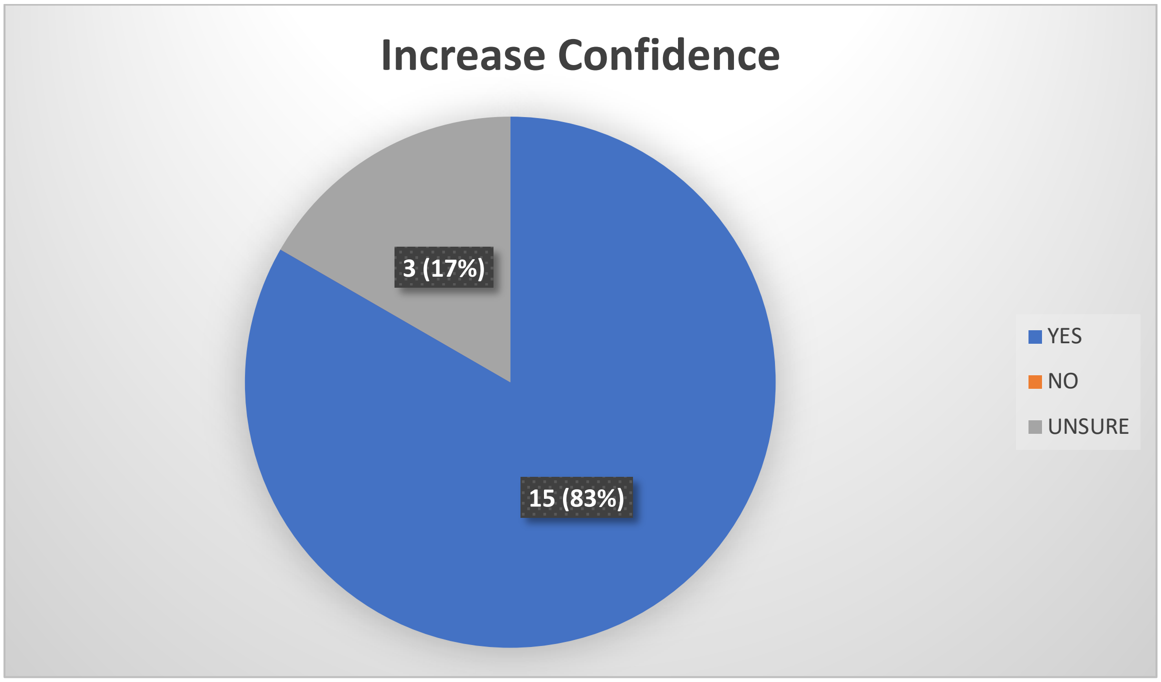

Figure 10. Increase Confidence

IV. Conclusions, Limitations, and Next Steps

This report presents 24 targeted recommendations on ways to improve future GLRI investments in terms of both the ways that institutions distribute and utilize GLRI funds and engage with on-farm decision makers. These recommendations are the result of an inductive content analysis of transcripts from 29 in-depth interviews with program managers (e.g., individuals that managed GLRI grants targeted at agricultural runoff reduction between 2010 and 2016) in the four GLRI priority watersheds: Maumee, Saginaw, Lower Fox, and Genesee; and eight focus groups with 41 farmers in three of the GLRI priority watersheds: Maumee, Saginaw, and Lower Fox. The bullet points that follow represent the major themes that emerged from the primary data:

Focus Groups with Farmers:

- Participating farmers are largely satisfied with GLRI projects and programs
- Most farmers approved of the structure of GLRI and felt that they were better off as a result of participating
- Farmer participation was most effectively encouraged via the "boots on the ground" approach by local conservation district personnel
- Farmers often continued to implement or maintain conservation practices after the incentives stopped, especially after installing trapping structures
- Farmers requested more flexibility in program requirements and timelines
- Some farmers were intrigued by pay-for-performance concepts
- Some farmers felt that non-farmer landowners should be included in incentive payment structures, because it would encourage them to rent to farmers engaging in conservation practices
- Though farmers did not always notice positive project impacts on their operation, they also did not report any significant negative impacts

Interviews with Program Managers:

- Program managers overwhelmingly favored increasing the amount of staff funding available
- Program managers overwhelmingly felt that *flexibility* was GLRI's primary strength

- Because GLRI allows for a flexible approach, program managers and farmers were able to experiment with novel or innovative concepts, which lends the program a "grassroots" or participatory feel
- Compared to GLRI, other incentive programs feel "strict" or "regulatory"
- Because of its localized, "boots on the ground" approach, GLRI is able to target participants that other incentive programs cannot
- Program managers generally felt that their programs had been successful, though they cautioned that the success would not be maintained without continued GLRI investment
- Program managers reported varying levels of administrative burden, which indicates inconsistency in oversight

The limitations of this study include: low participation in Genesee (3 program managers, 0 farmers); and lack of control over farmer sample (farmers who participated in focus group sessions were recruited by their program manager). The strengths include: ideal sample sizes in the Maumee, Lower Fox, and Saginaw; the collection of primary data leading to new knowledge; and that it informs upcoming survey research which will address the limitations of this study.

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Appendix A: Procedures

A. Research Design

This qualitative research follows a grounded theory design for data collection and analysis (Glazer & Strauss, 1967; Strauss & Corbin, 1998; Charmaz, 2000). The purpose of grounded theory is to find and explain meaning in social interactions. To do so, researchers study the ways that humans interpret their world through symbols (including language). This approach lends itself particularly well to research involving *how* and *why* questions, including the primary research question and sub-questions involved in this study, because it sets out to collect "deep," "rich," "profound" data (Charmaz, 2006). In this study, we collect data via a series of in-depth, semi-structured interviews and focus groups. We then analyze data using a multi-stage coding process (open coding, axial coding, memo writing).

B. Sample

This study primarily uses expert sampling, which is a type of purposive sampling in which knowledge is gained from individuals with a particular type of expertise (Lavrakas, 2008). Experts have been selected using the following inclusion criteria:

1. Individuals who are members of one of the following populations:
   A. "Program managers" are administrators that have: i. received GLRI funding either directly from the EPA (primary recipient) or as a sub-recipient from a primary recipient (e.g. reporting to the primary recipient, not directly to the EPA) on behalf of an institution (e.g., environmental and agricultural agencies, conservation

organizations, watershed initiatives, coops, etc.), and ii. subsequently managed that GLRI -funded project.

B. "<u>Farmers</u>" are individuals that manage farm operations that are participating in GLRI programs and/or receiving GLRI funding indirectly via "Program managers."

AND

2. Individuals who are located in and/or have administered programs within one of the four GLRI "priority watersheds":

   A. The Lower Fox watershed in Wisconsin;

   B. The Maumee watershed in Ohio/Indiana/Michigan;

   C. The Genesee watershed in New York/Pennsylvania; or

   D. The Saginaw watershed in Michigan.

AND

3. Individuals who are adults (18+).

The exclusion criterion is: 1. Any potential participants who cannot describe their connection to GLRI funding.

For the "Program managers" sample group, the sampling frame was constructed from the publicly-available list of GLRI grantees in the four watersheds between 2010 and 2016. We used this sampling frame to recruit participants from these groups for one-on-one, in-depth interviews. We followed a two-step recruitment process: First, we sent an email recruitment to each potential participant on our sampling frame. If we did not receive a reply, we followed up with an additional email or phone call (see Appendix B: Recruitment Script).

There is no publicly-available list of individual farm operators who have indirectly received GLRI incentives or participated in GLRI programs (“Farmers”). Therefore, we used snowball sampling for recruitment of this group. Once we contacted, screened, and recruited “Program managers,” we then asked those participants to recommend other participants who fit the criteria of “Farmers.” We then used these recommendations to contact, screen, and recruit farmers to participate in focus groups. Often, this process was conducted on our behalf via program managers, who forwarded our recruitment materials on to individuals who met the inclusion criteria for the “Farmers” group.

Using a grounded theory methodology means that there is not a strict guideline that should be used to generate an exact sample size. Instead, the researcher iteratively reviews the data as it is collected and looks for the attainment of saturation (Thomson, 2011). Saturation, in this case, means that at a certain point in the data collection process, the researcher notices that relevant new knowledge is no longer being generated by data collection. Therefore, following grounded theory means allowing for flexibility in sample size (Thomson, 2011). During the research design process, we provided an estimate of the number of interviews and focus groups that we believed would allow us to attain saturation: 5-10 interviews per watershed (n=20-40); and eight focus groups, each with 5-7 participants (n=40-56). These numbers are consistent with Thomson’s (2011) meta-analysis of sample size in grounded theory research and Greenbaum’s (2000) analysis of focus group size.

C. Measurement / Instrumentation

Research following a grounded theory design does not test variables, but rather collects and analyzes participant responses in a process that allows “concepts” or “categories” to emerge inductively. Therefore, data collection should utilize the research instruments that are best suited to collecting "rich" data that speak to *how* and *why* phenomena occur (Charmaz, 2006). In this study, we use two instruments that are well-suited for this type of research: 1. in-depth, semi-structured interviews, and 2. focus groups.

1. In-depth, semi-structured interviews have been administered to participants from the "Program managers" group.
    a. Justification: These interviews give participants the opportunity to share their personal experiences as managers and administrators of GLRI focus area 3 programs. As each interviewee will represent a unique program and/or organization, one-on-one interviews are an appropriate method to collect targeted and precise data relating to each individual context (Charmaz, 2006). These interviews allow us to look for common themes across a variety of individualized programs in different geographic locations.

2. In addition to understanding how GLRI incentives are managed and administered, we are also interested in farmer perceptions of GLRI incentives and how that impacts their decision making about conservation practices. To that end, we have facilitated focus groups with participants from the "Farmers" group.
    a. Justification: Focus groups give participants the opportunity to engage in a structured discourse with both the researcher and their peers during data collection. Since we are engaging with a relatively large sample of farmers (n=41), focus groups allow us to collect detailed data about *how* and *why* the phenomena of interest occur without being as resource-intensive as individual interviews (Greenbaum, 2000). In addition, this instrument allows new knowledge

to emerge from discussions *between* participants. While the "Farmers" group is not homogenous, we believe that intra-participant discourse highlights the commonalities and differences that exist within this group. For these reasons, we have chosen to conduct focus groups with this group.

D. Detailed Study Procedures

1. Methods for study data collection:

We administered 29 in-depth, semi-structured interviews with "Program managers" in all four research locations (the Genesee, Lower Fox, Saginaw, and Maumee watersheds). Adam Fix administered and audio recorded all interviews. These interviews were conducted either in-person (n=2) or on the telephone (n=27), at a mutually-agreed upon time (and location, if meeting in-person). The interviews were semi-structured. Therefore, a general list of questions was prepared by the researchers, but questions were omitted and/or unscripted follow-up questions were included as appropriate (see Appendix C: Interview Questions). The duration of each interview varied between individuals, depending on their willingness and availability to discuss their experiences. The interviews ranged from 21 minutes to 68 minutes, with an average length of approximately 45 minutes.

We conducted eight focus groups with participants from the "Farmers" group across three priority watersheds (Saginaw, Lower Fox, and Maumee). The focus groups were also semi-structured (see Appendix D: Focus Group Questions), and ranged in time depending on the participants' willingness to discuss their experiences. Focus groups ranged from 40 to 92 minutes, with an average length of approximately an hour and 15 minutes.

We initially chose to conduct one focus group in the Genesee watershed, and two focus groups in each of the remaining watersheds: Lower Fox, Saginaw, and Maumee (for a total of seven focus groups). We made this choice because the number of GLRI grants that have been disbursed in the Genesee watershed is significantly less than in the other three watersheds. However, due to difficulties with recruitment in the Genesee watershed (n=3 Program managers), we were not able to conduct a focus group there. Because participation is voluntary, and our sample population is small, holding a focus group in the Genesee watershed was not possible.

Following best practices in focus group research (Greenbaum, 2000), we recruited 4-7 participants ("Farmers") for seven of the eight focus groups. One of the eight sessions (held in the Saginaw watershed) yielded only two participants. For this reason, we scheduled an additional (third) session in that watershed, held on December 5, 2018, in Frankenmuth, MI. Due to geographical considerations, we also scheduled an additional (third) session in the Maumee watershed (December 4, 2018, in Findlay, OH). Since the first two sessions in the Maumee watershed covered northern and central portions of the watershed, adding a third session ensured that farmers from the southern part of the watershed were represented in the study.

Adam Fix facilitated all focus groups in-person, at a mutually-agreed upon time and location. In addition, one research assistant (Laura Young from Michigan State University) was present at each focus group session. Young assisted with logistical issues, acted as a note-taker during sessions, and contributed questions and input throughout the process.

All interviews and focus groups were audio recorded using at two devices: 1. a Tascam DR-100mkII audio recorder, and 2. an iPad using the "Smart Record" application. In addition, Young took contemporaneous notes, and Fix wrote field notes (including brief reflections, impressions, and other details) about each session.

In addition, Fix and Young administered a brief survey to each focus group participant at the beginning of each focus group session. These surveys collected demographic data, the size of their farm operations, and whether or not they have received GLRI funds before (See Appendix F: Pre-Focus Group Survey). These questions help us to better understand the relationship between these factors and farmer decision-making about conservation incentives and practices.

2. <u>Timeline for data collection and analysis:</u>

Subject recruitment for both interviews and focus groups began in July 2018. Data collection via interviews began in July 2018 and concluded in December 2018. Data collection via focus groups began in August 2018 and concluded in December 2018. Data analysis began in October 2018 and concluded in January 2019.

E. Reliability and Validity

Reliability and validity are core concepts in quantitative research. In the qualitative paradigm, reliability and validity are often conceptualized as trustworthiness and rigor (Golafshani, 2003, p. 604). As such, achieving reliability and validity means eliminating bias and increasing the researcher's ability to truthfully represent a social phenomenon. This study uses methodological triangulation (Carter, et al., 2014) to insure credibility/internal validity, eliminate bias, and increase the researcher's ability to interpret events truthfully. Methodological triangulation is the practice of using two or more methods to cross-check the study's findings. In this case, we are using two methods (in-depth interviews and focus groups) to achieve credibility through triangulation. From this research paradigm, triangulation is "a validity procedure where researchers search for convergence among multiple and different sources of information to form themes or categories in a study" (Creswell and Miller, 2000, p. 126).

In this study, even though program managers and producers are seen as different groups, both groups are sharing information on the same theme: the effectiveness of GLRI agricultural conservation incentives for water quality in priority watersheds. Therefore, triangulation is occurring across groups in service of the emergent themes (via "multiple and different sources of information").

In addition, the use of grounded theory adds to the trustworthiness and rigor (reliability and validity) of the study, because no information is pre-determined. Instead, all codes, themes, memos, and subsequent findings are taken directly from the data. Codes are aggregated via a systematic multi-stage analysis both within and across groups. During this stage, data that are not repeated (supported) by multiple sources are discounted or discarded. This process further increases trustworthiness and rigor.

F. Data Analysis

Using a grounded theory approach, data has been analyzed with a multi-stage coding process following Glaser & Strauss (1967) and Strauss & Corbin (1998). First, each interview and focus group audio recording was transcribed by an approved vendor; in this case, Transcription Professionals (www.transprof.com). After transcription was completed, the researchers began an open coding process, using Atlas.ti qualitative data analysis and research software. Open coding involves systematic interpretation of the content of participants' discourse. This is an iterative process, involving multiple stages of reading and assigning codes to the text, as well as sorting and refining codes. After open coding, we conducted a second round of coding using hierarchical axial coding, during which conceptual relationships emerged based on trends or patterns. Following open and axial coding, the next stage of analysis is memo-writing. Memos serve as succinct descriptions of themes. They are intended to be clear summaries, but they also allow the researcher to begin to integrate the emergent themes into an analytic narrative and produce recommendations.

G. Output

This written document is an initial output that summarizes the research team's analysis of the support structure for farmer decision making and assessment of the impact of GLRI investments on that support structure.

This research constitutes one portion of a larger, U.S. Environmental Protection Agency funded research project ("Researching Effectiveness of Agricultural Programs", USEPA Cooperative Agreement with the Great Lakes Commission: GL00E02209). Therefore, the output of this research will eventually be incorporated into a larger report. These results will be shared via a project website, webinar, in-person meetings, and publications in academic journals.

Appendix B: Recruitment Script

Researching Effectiveness of Agricultural Programs

Recruitment script (email/telephone)

Group 2: Farmers

Subject: Request to participate in research about your involvement with GLRI

Hello,

My name is Adam Fix, and I am a researcher at The Ohio State University. I am contacting you to request your participation in a research study about the U.S. Environmental Protection Agency's Great Lakes Restoration Initiative (GLRI). This study investigates the long-term cultural impacts that past GLRI investments have had on producers' on-farm decision making.

I am asking you to participate in a focus group regarding your personal experience with GLRI projects. Examples of questions I may ask include: "What has your experience been like in working with the organization administering GLRI funds?" and "Did participating in this particular program change the way you view Agricultural conservation practices? How so?" Each focus group will take approximately one-and-a-half hours of your time. We will conduct the focus groups at [LOCATION] on [DATE] at [TIME]. I would like to record the focus group in an audio format.

Participation is voluntary, and you can withdraw any time if you change your mind. There are no known risks to participation. You will receive compensation in the form of a $75 USD Visa gift card. Refreshments (snacks and beverages) will be served. This study has been sponsored by a grant from the U.S. Environmental Protection Agency (EPA-R5-GL2016-AIP: "Researching Effectiveness of Agricultural Programs").

If you would like to participate, please contact Laura Young at [EMAIL] or [PHONE].

Group 2: Farmers follow-up email #1

Subject: RE: Request to participate in research about your involvement with GLRI

Thanks for agreeing to participate in a focus group on [day] at [time]. The focus group will be conducted [at X location]. Again, my name is Adam Fix, and I will be facilitating the focus group.

If for some reason you're unable to make it, please contact me at 716-510-2554 or fix.46@osu. I'll send an email the night before with a reminder.

Thank you very much, [name]. I'm looking forward to the focus group at [location] on [day/time].

Group 2: Farmers follow-up email #2

Subject: RE: Request to participate in research about your involvement with GLRI

Thanks for agreeing to participate in the focus group tomorrow at [location/time]. This is just a reminder.

If for some reason you're unable to make it, please contact me at 716-510-2554 or fix.46@osu.

See you tomorrow!

Appendix C: Interview Questions

RESEARCHING EFFECTIVENESS OF AGRICULTURAL PROGRAMS:

PRIORITY IN-DEPTH INTERVIEW QUESTIONS

Did receiving a GLRI grant expand or improve your organization's ability to:

a. Engage with producers in your jurisdiction? How so?

b. Advance initiatives aimed at changing on-farm decision making at the field level? How so?

c. Start a new program or expand an existing one? How so?

d. Hire additional employees? How many?

e. Access tools and resources that expand your work flow efficiency? How so?

In your experience, have GLRI investments resulted in lasting cultural changes among participating institutions and producers?

More specifically, once the GLRI money ran out:

a. Did producers continue to implement or maintain the conservation practices after the GLRI payments stopped? Why or why not?

b. Did participation in the GLRI project/program lead to a change in producer's attitudes about Ag conservation to improve water quality (increase or decrease confidence and acceptance towards such practices)? Why or why not?

c. Did your organization's expanded capacity endure? Why or why not?

What would make GLRI-funded projects and programs more effective at engaging producers and creating lasting cultural impacts related to Ag conservation for water quality?

What if anything distinguishes GLRI from other incentive programs?

Does GLRI reach people that NRCS (EQIP) does not? How so?

What kinds of outreach were associated with the GLRI grants, and what did you think of it? Why was it effective/ineffective? How could it be improved/done differently?

What if any aspects of the GLRI funding process presented obstacles for your organization or the producers that you were engaged with?

Do you believe your projects' targeted activities were successful? Why or why not?

Do you believe the program's goal was achieved? Why or why not?

What would make GLRI funded projects and programs more effective? Less effective?

RESEARCHING EFFECTIVENESS OF AGRICULTURAL PROGRAMS: PRIORITY SURVEY-TYPE QUESTIONS

How many producers did your program enroll?

Did your program enrollment reach your desired capacity? **(Y/N)**

If Yes: What made your program attractive to producers?

If No: What was the barrier to enrolling your target number of producers (from your perspective & producers?)

Did you use any models, decision support tools, or monitoring data from USGS, NOAA, or ACOE programs to target producers to enroll in your program, or to estimate the environmental benefits of your efforts? **(Y/N)**

If Yes:

What were they? (describe) Did the use of these resources have an impact on your ability to recruit producers? **(Y/N)**

Did the use of these resources increase your (or your enrollees) confidence in the efficacy of agricultural conservation efforts administered by your program? **(Y/N)**

OPTIONAL SURVEY-TYPE QUESTIONS

How large is your organization? **(#)** (Not relevant for some interviewees, e.g., state employees)

Where was your project work conducted? **(Locations)** (Only if we are unsure)

How many acres did your projects cover? **(Locations)** (Only if we are unsure)

Appendix D: Focus Group Questions

FOCUS GROUP QUESTIONS

What has your experience been like in working with the organization administering GLRI funds?

What kinds of outreach were conducted by this organization?

What did you think of it? Why was it effective/ineffective? How could it be improved/done differently?

What would make this organization's use of GLRI funds more effective? Less effective?

If you could design a perfect payment program, what would it look like?

How has the money you received from (a given project *X*) changed your operation?

Which conservation practices did you choose to install? Why?

What kinds of impacts have you noticed from these changes?

Are these impacts different from your expectations? How so?

Do you feel you are better or worse off as a result of participating in this program? Why?

Did you continue these conservation practices after the incentive stopped? Why/why not?

Did participating in this particular program change the way you view Agricultural conservation practices? How so?

How did your participation affect your view of the programs' effectiveness at improving water quality?

How did your participation affect your likelihood to partake in future conservation activities?

What's the difference between this particular program and any other incentive program you've participated in? Is it similar/better/worse than other programs?

What if any aspects of the program you participated in presented key obstacles for you?

Appendix E

Table 6. List of focus group sessions

Watershed	Location	Date	# of Participants
Saginaw	Ithaca, MI	August 13, 2018	2
Saginaw	Flint, MI	August 14, 2018	5
Saginaw	Frankenmuth, MI	December 5, 2018	4
Lower Fox	Kimberly, WI	September 5, 2018	6
Lower Fox	Kimberly, WI	September 6, 2018	7
Maumee	Wauseon, OH	September 12, 2018	5
Maumee	Wauseon, OH	September 12, 2018	7
Maumee	Findlay, OH	December 4, 2018	5

Appendix F: Pre-Focus Group Survey

RESEARCHING EFFECTIVENESS OF AGRICULTURAL PROGRAMS:

PRE-FOCUS GROUP SURVEY

1. Please tell us about your agricultural operation:
    a. Row crop
    b. Livestock
    c. Mixed row crop and livestock
    d. Other (please list) e.g. fruit, vegetables, etc.

2. If acres, approximately how many acres is your agricultural operation?
    a. < 100 acres
    b. 101-350 acres
    c. 351-500 acres
    d. 501-1000 acres
    e. > 1000 acres

3. If livestock, approximately how many animal units do you have?
    a. 100
    b. 300
    c. 500
    d. 1000

4. Have you heard of the Great Lakes Restoration Initiative (GLRI)?

A. YES

B. NO

5. Have you received GLRI funds?

A. YES

B. NO

C. MAYBE

Appendix E

New Survey Report: Conservation Engagement in Four Priority Watersheds

Great Lakes Commission des Grands Lacs

Researching the Effectiveness of Agricultural Programs

Researching the Effectiveness of Agricultural Programs: An Analysis of Conservation Engagement in Four Great Lakes Watersheds

Task 4c: 2020 Survey Report

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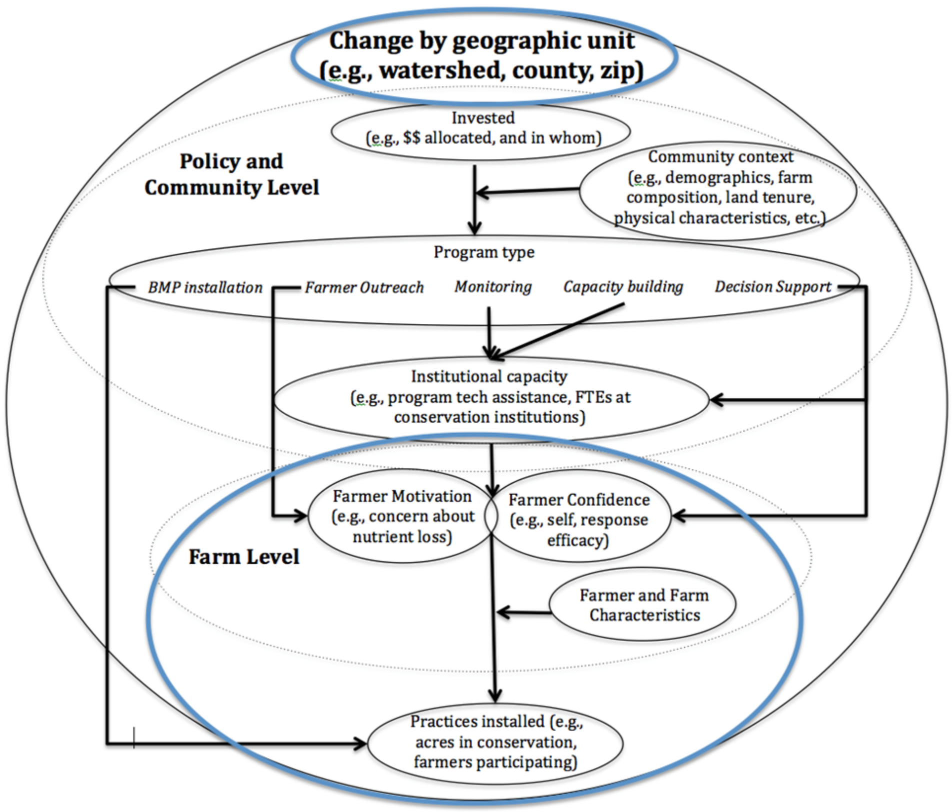
Executive Summary

Overview

Agricultural producers in the Great Lakes Basin have received over $100 million from the Great Lakes Restoration Initiative for agricultural conservation practices intended to influence on-farm decision making and improve water quality. The data presented in this report is one component of a GLRI-funded project using socio-economic analytics to evaluate the effectiveness of those federal incentives. The project uses multiple indicators of success to better understand obstacles and opportunities for enhancing on-farm decision-making to improve water quality (see Fig. 1).

Figure 1. REAP Conceptual model highlighting the components of this analysis (blue circles)



The goal of the analyses presented here are to build on the preliminary analysis included in the report, *Researching the Effectiveness of Agricultural Program: Evaluating Survey Data in the Maumee and Saginaw* Watersheds, in which existing survey data was insufficient to make comprehensive comparisons between four EPA priority watersheds. A new survey instrument was developed in 2018 and administered in winter 2019 to identify ways to improve future GLRI investments so that they better account for the needs of the local farming populations, and their unique motivations and constraints (see Appendix A for the full survey).

The results summarized here identify ways to improve future conservation program investments that better account for the needs of the local farming populations, and their unique motivations and constraints. With this data we aimed to answer three specific research questions, a summary of the answer to each question is included below:

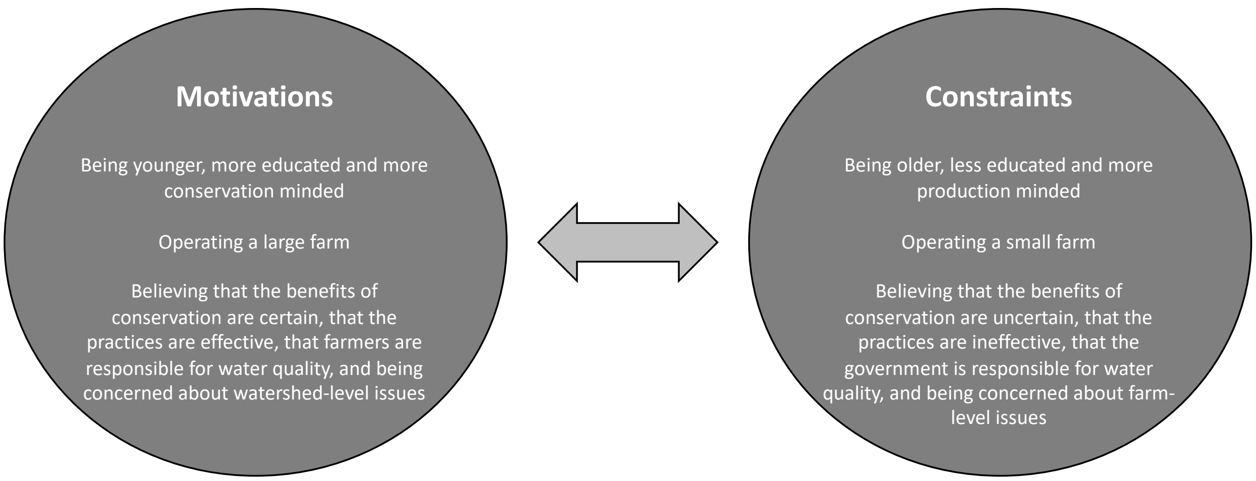
(1) *How do the priority watersheds differ in their farm and farmer characteristics, beliefs, and conservation adoption?* The priority watersheds are fairly similar in a lot of ways with high adoption rates, a strong conservation identity, a strong sense of responsibility for water quality, and an interest in doing more to engage in conservation. They also shared similar demographics in terms of age, education and experience. However, key differences emerge that can be taken into account when determining what types of investments will be the most impactful in each particular watershed (see Table 1).

Table 1. Summary of priority watershed differences

Genesee farmers report the highest cover crop use, the lowest perceived barriers, and greatest belief in cover crop effectiveness. They are also the least unsure about future program participation and have bigger farms on average but a greater commitment to engaging in conservation despite challenges. Perhaps because adoption rates are so high, Genesee farmers tend to report fairly low concern about nutrient loss from agriculture and future regulation.	**Maumee farmers** report the greatest level of concern about a variety of challenges that impede participation in conservation and are the most likely to believe that agriculture is not the main driver of water quality issues. For cover crops, they report being limited by a variety of barriers and have generally lower belief in effectiveness. The Maumee has a lot of small farms and farmers relying on off-farm income, with less diverse rotations, more reliance on fertilizer applicators for guidance, and higher participation in programs.
Lower Fox farmers report being the most informed about conservation, have the highest GLRI participation rates, and are most likely to believe that their quality of life depends on a healthy watershed. Similar to the Genesee, Lower Fox farmers are less concerned than Saginaw and Maumee farmers about nutrient loss from agriculture and future regulation.	**Saginaw farmers** have less rented land on average and are the most unsure about future government program participation despite being the least concerned about program barriers. The Saginaw watershed has a lot of small farms and farmers relying on off-farm income, with less diverse rotations, more reliance on crop advisors for guidance and higher participation in programs.

(2) *What socio-psychological factors are driving adoption of recommended practices?* Several clear drivers of conservation practice implementation emerge. Several are related to farmer characteristics such as being more conservation minded, younger, and more educated. Others are related to beliefs that farmers hold (regardless of age, education, etc), including belief in the benefits and effectiveness of the proposed practices, and feeling a sense of personal responsibility and concern for the watershed. The figure below demonstrates what factors tend to increase motivation to engage in conservation (on the left) versus what tends to decrease motivation (on the right) (Fig. 2).

Figure 2. A summary of the key motivations and constraints explaining why individuals do or do not use cover crops and buffers

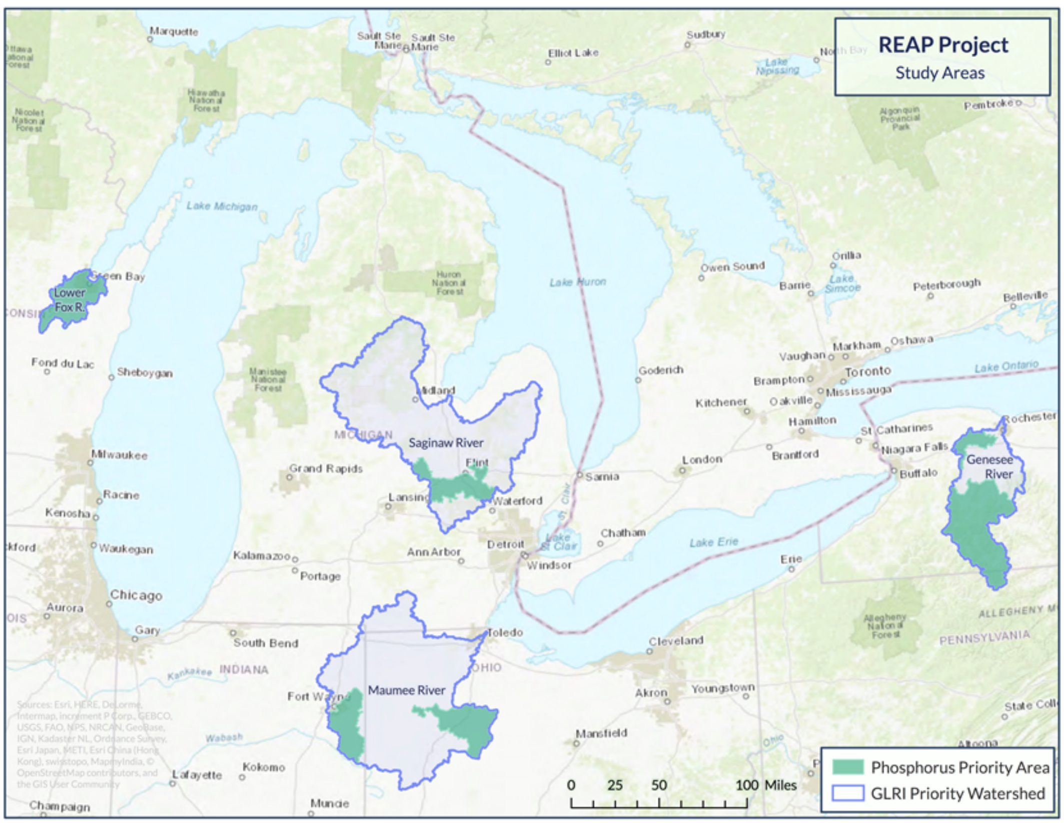


(3) *What is the impact of GLRI programs on key drivers of adoption (e.g., risk perception, confidence, etc.?)* Comparisons between GLRI and other sources is difficult as 20% of farmers who answered the question about GLRI participation were unsure if they participated in a GLRI-funded project or program. GLRI appears to be similar in impact to other federal funded programs (such as NRCS programs funded through the Farm Bill). However, GLRI participants did perceive cost barriers as slightly lower than participants in other government programs. While there is no clear evidence that GLRI participants hold any specific beliefs more strongly than participants in other federal programs (i.e., responsibility, practice effectiveness, concern about nutrient loss, etc), there is evidence that these beliefs are greatest among those participating in both GLRI *and* other government programs. Put another way, GLRI participants may be the most conscientious and concerned about nutrient loss, and therefore seeking out multiple opportunities to participate in conservation.

Survey Instrument and Methodology

In early 2019, a survey was sent to 3500 farmers in the Saginaw watershed in Michigan; the Maumee watershed in Ohio, Indiana, and Michigan; the Lower Fox watershed in Wisconsin; and the Genesee watershed in New York (Fig. 2). The sample of farmers was stratified by county to represent even numbers in all counties intersecting the four priority watersheds. The mixed mode survey was delivered via the mail with an option to complete it online. The mailed implementation process used the Tailored Design Method (Dillman, 2000). A total of 616 responses were used out of 2830 valid possible respondents with an adjusted response rate of 22% and 9% adjusted rejection rate. 40% of responses were from farmers in the Maumee watershed, followed by 25% in the Genesee and 24% in the Lower Fox. Only 11% of responses came from farmers in the Saginaw watershed. For more information on the analyses in this report[1], and the limitations of the data[2], see the executive summary endnotes.

Figure 3. The Four EPA Priority Watersheds



Key Findings

Section 1: Priority Watershed Comparisons

- **Farmers in the GLRI priority watersheds (here on out, GLRI farmers) are older than national averages.** The average farmer is 60 years old with 35 years of experience. This is important when considering that younger farmers are more conservation oriented, but most farm decision makers are older. One-third of farmers are also unsure of their succession plan, indicating that there is uncertainty regarding the future of the farm after they retire. The majority of GLRI farmers have net farm income under $50K, receive off-farm income, and operate on less than 250 acres (with farms trending larger in the Genesee and smaller in the Saginaw).
- **The majority of GLRI farmers manage some rented land.** Managing rented land is less common in the Saginaw (45% rent some land vs. 60-70% in the other priority watersheds). While conservation decisions are made primarily by the operator, 20 to 40% report making decisions with their landlord (most commonly in the Maumee). While most farmers rent from a family member or friend, the confidence in their ability to rent that land varies, with farmers in the Lower Fox being the least confident and farmers in the Maumee and Saginaw being the most confident.
- **Conservation practices are widespread but variable across the watersheds.** Farmers in the Saginaw and Lower Fox report the greatest use of conventional tillage, farmers in the Genesee report the greatest use of conservation tillage, and Maumee farmers report the greatest use of no-till. Most famers indicate the use of a crop rotation (e.g., corn/soy), but more diverse rotations are most common in the Genesee and Lower Fox (e.g., corn/soy with forage). The Lower Fox had the highest proportion of farmers with a nutrient management plan compared to the other watersheds (~70% versus 45%), while full implementation of the plan varies from a low of 65% in the Maumee and Saginaw, to 80+% in the Genesee and Lower Fox.
- **GLRI farmers are most concerned about making a profit.** Other top concerns include managing soil health and passing on the farm to the next generation. Overall, farmers in the Maumee report greater concern about a number of issues including passing on their farm, the management decisions of others, government regulation, lawsuits, and nutrient loss from agriculture in general and from their own farm. Farmers in the Genesee consistently have the lowest levels of concern about the issues identified above.
- **GLRI farmers are not convinced that agriculture is the main driver of algal blooms.** While overall GLRI farmers believe that agriculture is not the main driver, this belief was found to be strongest among farmers in the Maumee.

- **GLRI farmers are generally well informed about conservation practices.** However, farmers in the Saginaw report being generally less informed about conservation practices, particularly in comparison to those in the Lower Fox.
- **GLRI farmers believe it is more their responsibility than the government to protect the watershed**. This points to the challenge of fully engaging farmers in government programs, as GLRI farmers tend to be willing to change their practices but do not believe it is the government's responsibility to protect water quality (perhaps reflecting a general dislike for government intervention in private decisions).
- **GLRI farmers believe they know what to do and that conservation practices can "work".** However, there is considerable variability in these responses. For example, farmers in the Saginaw strongly believe that widespread adoption of cover crops can improve water quality, while farmers in the Genesee strongly believe in the on-farm benefits of cover crops, but less so in the water quality benefits. These beliefs are critical, as believing less in the benefits of the practices has a negative impact on adoption. GLRI farmers also believe that the practices needed are unique to each farm, pointing to the need to move away from "one size fits all" approaches to conservation.
- **GLRI farmers share a strong conservation identity.** GLRI farmers share similar levels of conservation and production identities, with conservation identities typically being stronger than production identities. Farmers believed the most important trait of a good farmer is leaving the land in better condition than when they received it, followed by minimizing soil erosion and maintaining organic matter. Given these results, differences in adoption between watersheds are unlikely to be a result of differences in conservationist identity or a commitment to "land stewardship" because these sentiments are pervasive and uniform.
- **GLRI farmers share a similar high reliance on other farmers and local conservation districts.** GLRI farmers didn't generally indicate a need for more information, but they did report a reliance on local "boots on the ground" and one-on-one feedback from other local farmers, conservation districts, crop advisors, and fertilizer applicators. They rely the least on commodity groups, Farm Bureau, and local conservation groups. Farmers in the Maumee rely more on fertilizer applicators, family members, and Farm Bureau than farmers in the other priority watersheds, while farmers in the Lower Fox rely more on crop advisors than everyone else. Preferred sources of information include conservation districts, demo farms, University Extension, other farmers, and direct on-farm feedback.
- **Cover crop use is higher in the GLRI watersheds than the rest of the Great Lakes[1].** The majority of GLRI farmers also plan to continue cover crops but are unlikely to do so without

[1] Recent USDA estimates estimate that cover crops are planted on less than 5% of the total acreage in the corn belt and the Lake states (see https://www.usda.gov/oce/oeep/USDA_Conservation_Trends.pdf), while our survey data indicates that 55% of GLRI farmers are using cover crops on at least 50% of their acreage (or ~25% of the total acreage described in the survey).

incentives. Adoption is higher in the Genesee compared to the other priority watersheds, but even in the Genesee only a minority have implemented cover crops on the majority of their acres. Farmers rated most cover crop implementation barriers as only limiting their ability a little bit. However, the specific importance of each barrier varied for each watershed, with Maumee farmers generally perceiving most barriers as more limiting than farmers in the Genesee. Challenges with uncertainty in the weather, access to equipment, the time it takes to manage, and the lack of an immediate economic return were consistently some of the highest perceived barriers across all watersheds.

- **Vegetated buffer use is high among GLRI farmers.** The majority of GLRI farmers plan to continue the same amount of buffer use, but they are unlikely to do so without incentives and the majority in each watershed have less than 50% of their acres draining into a buffer. The biggest perceived barriers to buffer use include losing land, weather uncertainty, lack of an economic return, and program restrictions. The importance of different barriers to buffer use varies less by watershed compared to cover crops. However, similarly to cover crops, the majority of barriers that farmers rated were, on average, rated as not limiting their ability to use buffers or only limiting it a little bit.

- **Future government program participation is uncertain:** 15-20% of farmers in each priority watershed are unsure if they participate in GLRI-funded programs, which indicates a need for greater awareness of the source of incentive payments for farmers receiving federal assistance. In addition, 15-20% will not participate in government programs in the future, and 40% are unsure, indicating farmers are not convinced that current programs are the solution. Paperwork and management restrictions are perceived as the biggest barriers to program participation, while information availability and program length are the smallest barriers. Generally, farmers in the Saginaw perceive the barriers as less problematic than farmers in the other priority watersheds. In particular, they are less concerned about restrictions on how land in programs is managed, payment size, and program length.

Section 2: Comparisons of information sources, perceived barriers, and key beliefs by farm size, practice adoption and program participation

- **Reliance on different sources for guidance is similar across all farm size categories.** Overall, farmers rely least on local conservation groups, Farm Bureau, and commodity groups, but reliance on direct feedback of practice effectiveness (i.e., edge of field measures of nutrient loss) and NRCS increases with farm size. This trend based on farm size could be more about having more access to these types of sources as opposed to just relying on them more. Farmers over the age of 80 consistently rely on each source of guidance less than younger farmers and are particularly less likely to rely on direct feedback on practice effectiveness but more likely to rely on county extension agents. Farmers under the age of 40 are most likely to rely on family as a source of guidance.

- **GLRI farmers generally believe that payments associated with government programs are too small, rather than too slow**. Farmers enrolled in government programs in general (not GLRI specifically) were less likely to think that program payments were too slow, while on average, those not participating in programs believed that payments were to slow. This may point to a misconception that farmers hold about payment speed before enrolling in a program. Perceived cost barriers are similar across different farm size categories.
- **Concern about soil health and farm succession is high regardless of practice use and program participation.** However, overall concern about soil health is lower for those not using cover crops (and slightly lower for those not using buffers), indicating that concern about soil health is a likely driver of cover crop use. Also, a greater proportion of participants in government programs indicate high levels of concern about soil health and farm succession compared to farmers who do not participate in government programs. There is no evidence that participants in GLRI programs are more concerned about these issues than participants in other government conservation programs, although the greatest proportion of individuals with high concern for soil health were those participating in both GLRI and other government programs.
- **Beliefs about personal responsibility for watershed health, degree of conservation knowledge, and one's action having an impact are greater among those already engaged in conservation.** This pattern could mean that holding such beliefs leads to adoption, or that having used a practice changes one's beliefs (the latter being particularly true for knowledge, which one could imagine increases with experience). While there is no clear evidence that GLRI participants hold these beliefs more strongly than participants in other programs, these beliefs are greatest among those participating in both GLRI *and* other government programs. Concern about nutrient loss from agriculture in general may be a greater driver for participation in programs in general while concern about one's *own* farm may drive participation in GLRI. In summary, GLRI participants may be the most conscientious and concerned about nutrient loss, and therefore seeking multiple opportunities to participate in conservation programs.
- **Vegetative buffer and cover crop use is strongly associated with higher levels of knowledge, greater exposure to the practice on a similar farm, less uncertainty of the benefits, and beliefs about effectiveness.** In particular, farmers using cover crops and buffers are much more likely to report not being limited at all, and much less likely to report being limited some or a lot by these three barriers. Farmers using these practices are also more likely to believe that they can reduce nutrient loss and improve water quality. Farmers with larger operations are more likely to perceive their use of cover crops as limited by the weather, while smaller operations are more limited by knowledge. Similarly, those with smaller operations (compared to larger operations) feel more limited by knowledge, equipment access and seeing the practice elsewhere for buffers.

- **Farmers with smaller operations report having less ability to implement conservation practices and less access to programs.** These limitations have to do with a lack of knowledge, access to equipment, and not seeing the practice on a farm like theirs. Conversely, larger farms reportedly perceive uncertainty in the weather and time as more significant barriers when implementing cover crops. Lack of knowledge applies to both cover crop and buffer use for smaller farms, while a lack of equipment and demonstrations are a bigger challenge for buffers. Interest in government programs also increases with farm size. While interest is greater on larger farms, these farms (the biggest farms in particular) report being more limited by restrictions on how land in programs is managed and a lack of flexibility to meet their own farming needs.

- **The percent of cover crop and vegetative buffer use increases as the percentage of rented acres decreases**. The majority of cover crop and vegetative buffer users fall in the category of less than 25% rented acres. Less than ten percent of those who rent 75-100% of their acres are currently using cover crops or vegetative buffers. This reveals a gap in engagement or flexibility for renters to adopt cover crops and vegetative buffers.

- **Sole decision-making authority is highest for those in the 40-60 year old age range, and lowest for both those under 40 and over 80.** A greater tendency for those under 40 to be making decisions in consultation with their landlord, and those on the largest farms (greater than 1500 acres) to be making decisions in consultation with a landlord was also reported.

Section 3: Explaining cover crop and buffer use and program participation

- **Interest in program participation increases among farmers who are younger, more educated, and believe more in practice effectiveness.** Several barriers decreased the odds of an interested farmer participating in government conservation programs. These were related to program structure (i.e., information access, flexibility, restrictions), and not related to payment structure. Smaller farms were unlikely to participate in programs unless they reported extremely high interest, pointing to the fact that programs may not be catering to smaller farms.

- **Specific practice use is driven largely by a belief that the benefits are certain and the practice is effective.** Cover crop use is also greater among younger farmers and on larger farms, while buffers are more common on larger farms. Beliefs about the benefits and effectiveness of both practices are greatest for those who strongly identify as a conservationist. Farmers with strong conservation identities are more likely to be female, younger, with less generations farming and livestock. However, identities don't vary by watershed or farm size. For cover crops, those with more formal education and a greater sense of responsibility for downstream water quality perceive practices as more effective. Larger farms are also more certain about the benefits of cover crops. For buffers, those who believe the government should protect downstream water quality are more uncertain about the benefits. Those who feel a greater sense of personal responsibility for overall watershed health and who believe their on-farm actions have an impact on water quality believe more in buffer effectiveness.

Summary and Recommendations

The following recommendations are designed to increase the impact of government investments in conservation as well as increase future adoption of conservation practices. These recommendations might be useful to individuals across the public and private sector who are engaging farmers in conservation programs. The key findings are called out in italics below, followed by recommendations that build on them.

- *To address the fact that the majority of GLRI farms are small and small farms* face *greater barriers to conservation program participation compared to larger farms, including limited access to equipment,* GLRI investments should support the purchase of conservation-oriented farming equipment for community use. Future efforts could also work to build interest in government programs, as strong interest overcomes small farm size. Interest can be built by increasing access to information and program flexibility, decreasing program restrictions, giving voice to younger farmers who may not hold decision-making power, and measuring and communicating the benefits of conservation use more clearly. Existing programs should also increase efforts to target younger farmers and larger farms as interest in conservation and related incentive programs is already high among these groups.
- *To address the reality that the majority of farmers manage rented land and a plurality make conservation decisions with their landlords*, future efforts should work to engage landowners and increase the number of written leases with conservation requirements. Large-scale success in conservation will require thinking more critically about how to support conservation on rented land.
- *To increase the critical beliefs around practice benefits and effectiveness*, future efforts should focus on demonstration opportunities and increasing understanding about practices and their benefits, particularly those related to soil health and economic returns. The knowledge gap is greater around believing that practices will work versus knowing what to do. Decreasing this gap is likely to lead to greater practice adoption.
- *To accommodate the belief that each farm is unique and overcome the perception that agriculture is not the main driver of water quality challenges,* future efforts should find ways to tailor recommendations to each individual farm through personalized technical support (increased funding for more "boots on the ground"). Increased use of decision support tools can also allow for personalized recommendations to be scaled up without increasing technical support personnel. Future outreach should also provide evidence of agriculture's impact on water quality, while highlighting the actions that have been taken to address other drivers of water quality impairment (e.g. septic systems, urban stormwater). Recognizing the collaborative efforts across urban and rural landscapes should decrease resistance based on this belief.

- *To address farmers primary concerns*, frame the need for conservation around issues of profit and soil health (not nutrient loss per se). Future engagement should focus on how conservation can alleviate the most pressing concerns. For example, demonstrate how recommended conservation practices can improve soil health, reduce the money spent on inputs, and prevent soil erosion. Increasing concern about soil health may also drive participation in programs and practice adoption. Maumee farmers are particularly concerned about regulation and lawsuits, so future investments in that watershed should explore options for protecting farmers from lawsuits and/or regulatory penalties given active conservation.
- *To leverage the fact that farmers rely on other farmers for guidance and want more direct feedback and demonstrations*, future funding should focus on direct outreach and engagement as well as highlighting successes on a variety of farms. Conservation professionals should look for local champions and fund demonstration events in critical counties so that other farmers can explain and demonstrate the benefits of conservation. These peer-to-peer learning opportunities need to be to set up on properties of multiple sizes and for different types of farmers to better to represent the entire diversity of the agricultural community (not just the conservation-minded individuals). Outreach professionals should consider that larger farm categories may have more resources to seek guidance, and that older farmers are least likely to seek guidance from intermediaries or direct feedback.
- *To leverage farmers' strong conservation identity*, future engagement should promote how conservation allows farmers to leave the land in better condition than when they began managing it. People tend to engage in more conservation when thinking about their legacy; future outreach can highlight that farmers are the backbone of America, and that improving the land is critical to leaving a lasting legacy. Generally, there is a need to continue to promote a culture of conservation as conservation-minded farmers have greater confidence in recommended practices and higher levels of practice adoption, yet may have less experience and be the younger operator in a farm partnership.
- *To promote greater cover crop and buffer use*, future investments should include contracts for the installation of cover crops across multiple years to allow on-farm (economic) benefits to be realized, while finding ways to increase acres in cover crops on farms already using the practice. Cover crop knowledge was also highest in locations where adoption rates were higher, pointing to the importance of trialing the practice to address knowledge gaps. As a result, future programs should promote experimenting with cover crops at a small scale, using a single species, perhaps with a more experienced farm partner as a sounding board to help new users gain experience (particularly important in the Maumee). For buffers, future programs should decrease restrictions on how that land is managed (this is less of an issue in the Saginaw), while finding ways to increase acres draining through a buffer on farms where buffers already exist.

- *To increase participation in government programs*, programs need to be more flexible, with less paperwork and restrictions. Increasing a sense of personal responsibility, concern about soil health, and the belief that on-farm actions impact the entire watershed may increase participation in programs (as well as adoption of conservation practices in general). To address the fact that many are unsure about participating in government programs and reluctant to give responsibility to the government, future efforts should identify ways to empower farmers to engage in conservation without government assistance.

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[1] We conducted the statistical analyses included in this report using the Statistical Program for the Social Sciences (SPSS). To compare how priority watersheds differ by a variety of metrics, we analyzed frequency distributions, measures of central tendency (mean, medium, mode) and valid percentages. We derived the valid percentages from case-by-case deletion of missing data for each variable analyzed. To address the comparative analyses explored in Section 2, we used cross tabulations and means tables to identify how average perceptions or behaviors differed by farm size, practice adoption, program participation, etc. To address the correlational analyses explored in Section 3, we used a linear regression model to determine what type of farmer in terms of beliefs and characteristics is interested in government-funded programs. Then, we used a moderated regression model to explore the effect of farm size and program participation barriers on the positive relationship between interest and program participation. Finally, we ran a mediated regression model to analyze the direct effect of characteristics like farm size and age on cover crop and vegetative buffer adoption, and the indirect effect through beliefs about practice effectiveness.

[2] While we designed to sample to target equal respondents in each watershed, the number of respondents varied across each watershed, with a very low number of responses from the Saginaw. We explored this possible non-response bias in a follow-up study to assess if there were differences in the populations being represented by this data based on location and relative response rate. We sent a follow-up survey to a random 500 non-respondents split evenly between watersheds. One month later, we sent a second wave of the surveys to a predetermined 125 respondents, split between watersheds. If a subject chosen to receive a reminder survey had already responded, we removed them from the mailing list. Of 47 returned surveys, 23 were responses, 6 were undeliverable, and 18 were no longer farming/deceased/not able to respond.

The follow-up survey consisted of a condensed version of the original survey (Appendix B). We conducted two types of analyses to determine if participants in the original study were systematically different in some way from those who did not participate. The first analysis compared the 23 non-respondents with the first 250 respondents from the original data collection. The second analysis compared the first 250 respondents to the last 80 respondents from the original data collection (where late responders serve as a proxy for non-responders). We ran a series of binary logistic and multinomial regressions for each variable to determine if a significant difference existed between groups. The significant differences are bulleted below. **Findings suggest there is no clear non-response bias due to mixed results and the fact that most measures did not differ between groups.**

- Respondents (versus non-respondents) are more likely to have a nutrient management plan for their farm, less likely to think a good farmer minimized nutrient runoff, and more likely to think agriculture is not the main driver of algal blooms.
- We found no differences between respondents and non-respondents on the following items: perceived responsibility, response-efficacy, willingness to change practices, extent of feeling informed, availability of government programs, extent of restrictions on how land in programs is managed, current cover crop and vegetative buffer use, livestock management, size of farm

operation, proportion acres rented, years farmed, off-farm income, participation in GLRI program, and participation in other government-funded programs for conservation.

Section 1: Priority Watershed Comparison

Farmer concern for the farm and community

To investigate how levels of concern for the farm and community may differ by watershed, respondents were asked to circle a number between 0 (not concerned) and 6 (extremely concerned). Table 2 displays the average level of concern for each item by watershed, loosely ordered from most to least concerning. Across all items, **the highest concern in each watershed was for making an annual profit**. Generally, **farmers were the most concerned about making an annual profit, managing soil health on their farm, and passing their farms on to the next generation.** They also had higher concern about the impacts of agricultural nutrient loss on the watershed compared to nutrient loss on their own farm.

An ANOVA with post hoc tests determined whether differences in concern between watersheds existed. Items where concern is statistically different between two or more watersheds are bolded. In cases where the differences extend beyond two watersheds, the mean or means that are different from the others are indicated with an asterisk. **Overall, farmers in the Maumee have statistically higher concern for many issues.** Maumee farmers have higher concern for passing their farm on compared to the Lower Fox; management decisions of other farmers compared to the Genesee; government regulation compared to the Saginaw and Genesee; lawsuits compared to the Saginaw and Genesee; nutrient loss from agriculture compared to the Genesee; and nutrient loss from one's farm compared to the Saginaw and Genesee. Farmers in the Genesee often report the lowest levels of concern across the board, while farmers in the Lower Fox (similar to the Maumee) report greater concern about nutrient loss from agriculture and one's own farm compared to the Genesee, and Saginaw in some cases.

Table 2. Average level of concern for farm and community challenges (scale: 0 = not concerned, 6 = extremely concerned)

	Genesee N~154	**Lower Fox** N~144	**Maumee** N~ 237	**Saginaw** N~ 65
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Making annual profit	5.18 (1.35)	5.33 (1.01)	5.20 (1.21)	4.91 (1.45)
Managing soil health on your farm	4.84 (1.32)	4.77 (1.28)	4.94 (1.15)	4.54 (1.40)
Passing your farm on to the next generation	4.57 (1.85)	**4.18** (1.96)	**4.81** (1.64)	4.36 (1.76)
Management decisions of other farmers in your community	**3.73** (1.53)	4.01 (1.46)	**4.15** (1.47)	3.75 (1.61)
Additional government regulation or rules related to ag nutrient loss	**3.69** (1.88)	4.14 (1.63)	**4.27*** (1.76)	**3.49** (1.87)
Lawsuit filed against farmers because of nutrient loss	**3.67** (1.97)	4.13 (1.83)	**4.45*** (1.79)	**3.57** (1.94)
Nutrient loss from agriculture negatively impacting watershed	**3.18** (1.78)	**3.79*** (1.75)	**3.78*** (1.73)	3.45 (1.82)
Nutrient loss from your farm negatively impacting watershed	**2.16** (1.85)	**3.35*** (1.82)	**3.48*** (1.83)	**2.55** (2.00)

Farmer beliefs about nutrient management and conservation practices

Farmers were asked to indicate their level of agreement with statements representing beliefs about perceived responsibility for water quality, response efficacy (i.e., effectiveness of conservation practices), willingness to change, and awareness of water quality issues and conservation practices. Responses were recorded on a scale where strongly disagree = -2, disagree = -1, neither disagree nor agree = 0, agree = 1, and strongly agree = 2. Table 3 displays the average response and standard deviation for the belief items, loosely ordered from strongest agreement to strongest disagreement.

Overall, **farmers believe it is their responsibility help protect the watershed and disagree or only slightly agree that it is the responsibility of the government to protect the watershed.** On average, farmers in all watersheds would be willing to change their current practices to improve water quality, while all farmers agree to some extent that they know what steps to take to reduce nutrient loss on their farm. An ANOVA with post hoc tests determined whether differences in beliefs between watersheds existed. Items where concern is statistically different between two or more watersheds are bolded. In cases where the differences extend beyond two watersheds, the mean or means that are different from the others are indicated with an asterisk. Farmers in the Maumee are more convinced that agriculture is not the main driver of algal blooms compared to everyone else. Farmers in the Lower Fox are more likely to report being better informed about practices compared to farmers in the Saginaw, and farmers in the Lower Fox are more likely to believe that their quality of life depends on a healthy watershed compared to those in the Genesee.

Table 3. Average beliefs regarding farmer responsibility, knowledge, etc. (scale: -2 = strongly disagree, 2 = strongly agree)

	Genesee N~ 154	**Lower Fox** N~ 145	**Maumee** N~ 240	**Saginaw** N~ 67
	Mean (SD)	Mean (SD)	Mean(SD)	Mean (SD)
It is the responsibility of farmers to help protect watershed	.86 (.80)	.77 (.80)	.79 (.86)	1.04 (.68)
Agriculture is not the main driver of algal blooms in watershed	**.45** (.87)	**.37** (.87)	**.72*** (1.00)	**.09** (.89)
I think I am better informed about conservation practices than most farmers	.37 (.93)	**.49** (.93)	.37 (.82)	**.13** (.95)
The quality of life in my community depends on healthy watershed	**.04** (1.04)	**.37** (1.04)	.16 (1.01)	.30 (1.06)
It is the responsibility of the government to protect watershed	.06 (.98)	-.01 (.98)	-.05 (1.05)	.22 (.93)
I am not willing to change my current practices to improve water quality	-.51 (1.01)	-.48 (1.01)	-.45 (1.08)	-.74 (.87)
I am unsure of what steps to take to reduce nutrient loss on my farm	-.52 (1.01)	-.51 (1.01)	-.32 (.97)	-.55 (.86)

Table 4 continues the list of beliefs, with greater focus on farmer beliefs in the effectiveness of several specific practices typically funded by GLRI. Responses were again recorded on a scale from strongly disagree = -2 to strongly agree = 2 (where neither disagree nor agree = 0). Table 4 displays the average response and standard deviation for the belief items, loosely ordered from strongest agreement to strongest disagreement.

Farmers across all watersheds agreed that practices that benefit water quality also benefit their farm and that cover crops/buffers can reduce nutrient loss on their farm. Farmers across all watersheds also agreed that widespread adoption of such practices can improve water quality in the watershed (i.e., high response efficacy). Farmers in each watershed also agreed that the practices needed to reduce nutrient loss are unique to each farm.

An ANOVA with post hoc tests determined whether differences in beliefs between watersheds existed. Items where concern is statistically different between two or more watersheds are bolded. In cases where the differences extend beyond two watersheds, the mean or means that are different from the others are indicated with an asterisk. Farmers in the Saginaw believe more than farmers in the Maumee that the widespread adoption of cover crops can improve water quality. Farmers in the Genesee agree more than farmers in the Maumee that cover crops can reduce nutrient loss on their farm but disagree more than Maumee and Lower Fox farmers that their actions on their farm can have measurable impact on the watershed.

Table 4. Beliefs about practice efficacy (scale: -2 = strongly disagree, 2 = strongly agree)

	Genesee N~ 154	**Lower Fox** N~ 145	**Maumee** N~ 240	**Saginaw** N~ 67
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Practices that benefit water quality also benefit my farm	1.02 (.87)	.93 (.84)	.84 (.87)	.85 (.76)
The practices needed to reduce nutrient loss are unique to each farm	.88 (.82)	.90 (.77)	.90 (.71)	.75 (.84)
Widespread adoption of grass buffers can improve water quality in watershed	.82 (.76)	.67 (.96)	.80 (.91)	.97 (.88)
Widespread adoption of cover crops can improve water quality in watershed	.79 (.72)	.66 (.85)	**.59** (.92)	**.91** (.69)
My actions on my farm have a measurable impact on the watershed	**-.34*** (1.17)	**.10** (1.10)	**.16** (1.12)	.07 (1.26)
Grass buffers can reduce nutrient loss on my farm	.61 (.96)	.57 (.88)	.61 (1.01)	.66 (1.00)
Cover crops can reduce nutrient loss on my farm	**.93** (1.14)	.70 (1.07)	**.62** (1.16)	.94 (.96)

Cover crop use and perceived barriers to implementation

Farmers in the Genesee have the highest adoption rate of cover crops (Table 5). On average, **farmers in the Genesee and Saginaw have implemented cover crops for longer than farmers in the Lower Fox and Maumee** (Table 6).

Table 5. Percentage of respondents currently using cover crops

	Genesee N=153	**Lower Fox** N=144	**Maumee** N=242	**Saginaw** N=67
Currently using cover crops	68.6%	54.9%	45.0%	52.2%

Table 6. Average years of cover crop implementation

	Genesee N=91	**Lower Fox** N=67	**Maumee** N=100	**Saginaw** N=30
Years using cover crops	15.6	8.4	8.6	14.4

In terms of coverage by acres (Table 7), **farmers in the Lower Fox have the lowest coverage on average. Approximately 1/3 of farmers in the Genesee, Maumee, and Saginaw report greater than 50% of their acreage in cover crops**. In terms of future intentions (Table 8), the majority of farmers plan to "do the same", while no farmers in the Genesee and Saginaw indicated that they would "do less". The Lower Fox had the highest proportion of farmers who plan to "do more" in the future.

Table 7. Percent of respondents in each category of acres in cover crops

% total farm acres	**Genesee** N=107	**Lower Fox** N=81	**Maumee** N=122	**Saginaw** N=38
0-25%	24.3%	48.1%	37.7%	36.8%
25-50%	39.3%	28.4%	23.0%	23.7%
50-75%	19.6%	12.3%	17.2%	18.4%
75-100%	16.8%	11.1%	22.1%	21.1%

Table 8. Future cover crop intentions

Plans for using cover crops next year	**Genesee** N=152	**Lower Fox** N=141	**Maumee** N=236	**Saginaw** N=66
Do less	-	3.5%	1.7%	-
Do the same	74.3%	59.6%	72.9%	68.2%
Do more	25.7%	36.9%	25.4%	31.8%

Table 9 displays the average response for the question, "how likely are you to use cover crops in the future without incentives?" Responses were scaled from 1-4 including where 1 = will not use, 2 = unlikely to use, 3 = likely to use, and 4 = will definitely use. With average values less than three in each watershed, farmers are slightly unlikely to use cover crops in the future without incentives.

Table 9. Likelihood of future cover crop use without incentives (scale: 1 = will not use, 4 = definitely will use)

	Genesee N=153	**Lower Fox** N=141	**Maumee** N=237	**Saginaw** N=67
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Likelihood of future use without incentives	2.99 (.75)	2.65 (.80)	2.57 (.80)	2.79 (.77)

Respondents were asked to indicate how much the following barriers limited their ability to implement cover crops (Table 10). Barriers to implementation were listed on a scale where 0 = not at all, 1 = a little, 2 = some, and 3 = a lot, with the barriers loosely listed from biggest to smallest in the table below. **Challenges with access to equipment, the time it takes to manage, uncertainty in the weather, and the lack of an immediate economic return were consistently some of the highest perceived barriers across all watersheds. However, the majority of barriers that farmers rated were, on average, rated as not limiting their ability to use cover crops, or only limiting it a little bit.**

An ANOVA with post hoc tests determined whether differences in barriers between watersheds existed. Items where concern is statistically different between two or more watersheds are bolded. In cases where the differences extend beyond two watersheds, the mean or means that are different from the others are indicated with an asterisk. Across the board, **farmers in the Maumee perceive barriers to cover crop implementation as more limiting than farmers in the Genesee.** Time, technical assistance, and rented ground barriers are higher among farmers in the Maumee compared to those in the Genesee. The contract duration barrier is higher for

Maumee farmers than for Genesee and Saginaw farmers. The lack of demonstration barriers is higher for farmers in the Maumee and Saginaw. The restriction and changes of daily operation barriers are higher for farmers in the Maumee and Lower Fox compared to those in the Genesee. Uncertainty in the weather is a stronger barrier for farmers in the Maumee and Lower Fox compared to Saginaw farmers. The lack of immediate economic return is a stronger barrier for both farmers in the Maumee and Lower Fox compared to those in the Genesee and Saginaw. Uncertainty about benefits is perceived as more of a barrier for farmers in all watersheds compared to Genesee.

Table 10. Cover crop implementation barriers (scale: 0 = not at all, 3 = a lot)

	Genesee N~ 149	**Lower Fox** N~ 141	**Maumee** N~ 233	**Saginaw** N~ 65
The following barriers limit my ability to implement CCs	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Uncertainty in the weather	1.51 (1.05)	**1.66*** (1.11)	**1.63*** (1.08)	**1.12** (1.03)
Lack of right equipment	1.12 (1.05)	1.39 (1.14)	1.30 (1.09)	1.00 (1.07)
Too time consuming to manage	**.93** (.91)	1.06 (.91)	**1.22*** (.93)	1.00 (.91)
Lack of an immediate economic return	**.87** (.91)	**1.32*** (1.04)	**1.56*** (1.01)	**.91** (.92)
Too many restrictions associated with using the practice (e.g., not being able to harvest CCs)	**.68*** (.94)	**1.17** (1.08)	**1.20** (1.11)	.89 (1.02)
The contracts providing incentives are too short	**.73** (.94)	.98 (1.03)	**1.17*** (1.02)	**.79** (.99)
Requires too many changes in my daily operation	**.57*** (.81)	**.91** (.87)	**1.06** (.93)	.88 (.97)
Uncertainty about the benefits of this practice for my farm	**.44*** (.74)	**.87** (.89)	**1.06** (.99)	**.79** (.85)
Lack of knowledge about practice*	**.58** (.85)	.84 (.81)	**.97*** (.93)	.83 (.90)
Lack of technical assistance*	**.49** (.74)	.72 (.86)	**.73*** (.90)	.60 (.83)

Table 10. Continued	**Genesee** Mean (SD)	**Lower Fox** Mean (SD)	**Maumee** Mean (SD)	**Saginaw** Mean (SD)
Not being able to see demonstration on farm like mine*	**.41*** (.73)	.61 (.85)	**.68** (.92)	**.75** (1.03)
Not wanting to use the practice on rented ground*	**.37** (.78)	.63 (.85)	**.82*** (1.00)	.68 (.95)

Vegetative buffer use and perceived barriers to implementation

Table 11 displays the percentage of respondents currently using vegetative buffers on their farm. Farmers in the Lower Fox and Maumee have higher adoption rates than those in the Saginaw and Genesee. On average, **farmers across all four watersheds have used vegetative buffers longer than cover crops, with each average around 20 years** (Table 12).

Table 11. Percentage of respondents currently using vegetative buffers

	Genesee N=153	**Lower Fox** N=139	**Maumee** N=236	**Saginaw** N=67
Currently using vegetative buffers	52.3%	60.4%	59.3%	50.7%

Table 12. Average years of vegetative buffer implementation

	Genesee N=65	**Lower Fox** N=74	**Maumee** N=123	**Saginaw** N=28
Years of buffer use	23.3	20.2	17.72	21.75

Table 13 displays the percentage of farmers reporting different levels of acres draining into or across a vegetative buffer. Approximately 38% of farmers in the Saginaw had more than 50% of their acres draining into or across a vegetative buffer, while only 23% of farmers in the Maumee reported more than 50% of their acreage draining into a buffer. In terms of future intentions (Table 14), more farmers in the Lower Fox and Maumee indicated they would “do less” for future vegetative buffer implementation than farmers in the Saginaw and Genesee. As seen with cover crops, **the majority of farmers would “do the same” with future vegetative buffer implementation**. Lower Fox had the highest proportion of farmers planning to “do more” vegetative buffers next year.

Table 13. Percent respondents in each category of acreage draining into vegetative buffers

% total farm acres	**Genesee** N=98	**Lower Fox** N=94	**Maumee** N=159	**Saginaw** N=37
0-25%	52.0%	38.3%	47.2%	40.5%
25-50%	21.4%	29.8%	29.6%	21.6%
50-75%	9.2%	21.3%	14.5%	27.0%
75-100%	17.3%	10.6%	8.8%	10.8%

Table 14. Future vegetative buffer intentions

Plans for using buffers next year	**Genesee** N=56	**Lower Fox** N=42	**Maumee** N=84	**Saginaw** N=30
Do less	3.6%	7.1%	8.3%	3.3%
Do the same	66.1%	57.1%	66.7%	76.7%
Do more	30.4%	35.7%	25.0%	20.0%

Table 15 displays the average response for the question, "how likely are you to use vegetative buffers in the future without incentives?" Responses were scaled where 1 = will not use, 2= unlikely to use, 3 = likely to use, and 4 = will definitely use. With average values less than three in each watershed, **farmers are slightly unlikely to use vegetative buffers in the future without incentives.**

Table 15. Likelihood of future vegetative buffer use without incentives

	Genesee N=150	**Lower Fox** N=138	**Maumee** N=228	**Saginaw** N=67
Likelihood of future use without incentives	2.75	2.60	2.50	2.43

Farmers were asked to how much the following factors limited their ability to implement vegetative buffers (Table 16). Barriers to implementation were measured on a scale where 0 = not at all, 1 = a little, 2 = some, and 3 = a lot, with the barriers loosely listed from biggest to smallest in the table below. **Across all watersheds, the highest perceived barriers included not wanting to lose land for production, uncertainty in the weather, lack of an immediate economic return, and too many restrictions (e.g., buffers too wide). However, similar to cover**

crops, the majority of barriers that farmers rated were, on average, rated as not limiting their ability to use buffers, or only limiting it a little bit.

An ANOVA with post hoc tests determined whether differences in barriers between watersheds existed. Items where concern is statistically different between two or more watersheds are bolded. **Compared to cover crop barriers, perceptions of vegetative buffer barriers vary less by watershed.** Uncertainty in the weather is a greater barrier for farmers in the Lower Fox compared to those in the Maumee. The barrier of installing the practice on rented ground is stronger for farmers in the Maumee than for Genesee farmers.

Table 16. Vegetative buffers implementation barriers (scale: 0 = not at all, 3 = a lot)

	Genesee N~ 147	**Lower Fox** N~ 134	**Maumee** N~ 244	**Saginaw** N~ 63
The following barriers limit my ability to implement VBs	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Not wanting to lose land for production	1.11 (1.13)	1.41 (1.10)	1.25 (1.16)	1.22 (1.13)
Too many restrictions (e.g., buffers too wide)	1.11 (1.03)	1.40 (1.06)	1.19 (1.10)	1.00 (.98)
Uncertainty in the weather	.93 (1.07)	**1.20** (1.11)	**.86** (1.05)	.79 (.99)
Lack of an immediate economic return	.92 (1.03)	1.20 (1.11)	1.13 (1.10)	.95 (.93)
The contracts providing incentives are too short	.88 (1.02)	.98 (1.01)	.93 (1.08)	.94 (1.04)
Too time consuming to manage	.84 (.84)	.92 (.85)	.89 (.97)	.84 (.89)
Lack of right equipment	.93 (1.10)	.87 (1.01)	.80 (1.01)	.71 (1.01)
Uncertainty about benefits of this practice for my farm	.76 (.95)	.82 (.90)	.83 (1.06)	.84 (.94)
Not wanting to use the practice on rented ground	**.58** (.92)	.86 (1.01)	**.89** (1.09)	.77 (1.02)

Table 16. Continued	**Genesee** Mean (SD)	**Lower Fox** Mean (SD)	**Maumee** Mean (SD)	**Saginaw** Mean (SD)
Lack of knowledge about practice	.75 (1.00)	.60 (.80)	.71 (1.01)	.83 (.95)
Requires too many changes in my daily operation	.64 (.80)	.69 (.83)	.65 (.91)	.66 (.86)
Lack of technical assistance	.58 (.78)	.56 (.79)	.60 (.92)	.81 (.96)
Not being able to see demonstration on farm like mine	.57 (.90)	.49 (.74)	.57 (.93)	.72 (.97)

Farmer identity and guidance source preference

The following items (Table 17) were adapted to represent how farmers may identify themselves as "productivist" or "conservationist" in their role as a farmer (Arbuckle, 2013; McGuire et al., 2015). The first six items relate to farmers who are conservationist-oriented, while the latter five items are associated with productivist-oriented farmers. Respondents were asked to indicate on a scale of 0-4 how important each item is to their definition of a good farmer, where 0 = not at all important, 1= slightly important, 2= somewhat important, 3= important, and 4= very important. The items are listed below in loose order from most to least important to their identity as a farmer.

On average, **farmers across all watersheds rank conservationist-oriented prompts with higher importance than the productivist-oriented prompts**. Among the productivist-oriented items, farmers across all watersheds identified more with having the highest yields per acre and highest profit per acre, when compared to getting their crops planted first or having the most up-to-date equipment. **The strongest sentiment among conservationist-oriented items was that a good farmer minimizes soil erosion.**

An ANOVA with post hoc tests determined whether differences in beliefs of what makes a good farmer existed between watersheds. Items where a statement is statistically different between two or more watersheds are in bold. **Across all statements regarding what makes a good farmer, perceptions were similar among watersheds** with one exception: farmers in the Saginaw believe it is more important than farmers in the Lower Fox that a good farmer has the most up to date equipment (productionist item).

Table 17. Farmer identity (scale: 0 = not at all important, 4 = very important)

	Genesee N~ 153	**Lower Fox** N~ 143	**Maumee** N~ 240	**Saginaw** N~ 66
A good farmer is one who…	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
minimizes soil erosion	3.17 (.80)	3.07 (.81)	3.09 (.91)	3.10 (.92)
maintains or increases soil organic matter	3.11 (.89)	2.88 (.94)	2.87 (1.02)	3.17 (.82)
manages for both profitability and minimization of environmental impact	3.08 (.81)	2.87 (.84)	2.94 (.94)	3.06 (.80)
minimizes nutrient runoff	2.86 (.98)	2.98 (.90)	2.90 (1.03)	3.01 (.90)
thinks beyond own farm to health of watershed	2.75 (.98)	2.82 (.92)	2.72 (1.05)	3.04 (1.07)
considers the health of waterways	2.67 (.96)	2.67 (.99)	2.67 (.99)	2.86 (.99)
has the highest profit per acre	2.41 (1.15)	2.35 (1.22)	2.38 (1.25)	2.29 (1.31)
has the highest yields per acre	1.97 (1.22)	1.83 (1.26)	2.10 (1.20)	2.17 (1.07)
uses latest seed and chemical technology	1.76 (1.14)	1.90 (1.23)	1.92 (1.25)	2.20 (1.23)
gets their crops planted first	1.14 (1.06)	.95 (1.13)	.97 (1.11)	1.18 (1.18)
has the most up to date equipment	.92 (1.00)	**.73** (.92)	.91 (1.11)	**1.23** (1.04)

The following items measured on the same 0 to 4 importance scale were not part of the original farmer identity scale but were added for this project to provide additional insight to the farmer decision making process (Table 18). The bolded items indicate which item responses are statistically different between watersheds. Farmers believed the most important trait of a good farmer is leaving the land in better condition, this was rated even higher than the top two items in the original identity scale (minimizing soil erosion and maintaining organic matter). Compared to those in the Maumee, Genesee farmers believe it is more important that a good farmer is one who adopts conservation practices despite challenges.

Table 18. Additional items included to capture what is important to farmer identities (scale: 0 = not at all important, 4 = very important)

	Genesee N~ 153	**Lower Fox** N~ 143	**Maumee** N~ 238	**Saginaw** N~ 67
A good farmer is one who…	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Leaves the land in a better condition than when they received it	3.35 (.77)	3.22 (.82)	3.30 (.83)	3.42 (.76)
Adopts conservation practices despite challenges	**2.74** (.86)	2.51 (.99)	**2.45** (1.06)	2.72 (.93)
Shares information about conservation with other farmers	2.52 (1.06)	2.48 (1.12)	2.46 (1.09)	2.64 (1.01)

Farmers were asked how much they rely on a list of sources for information when introducing and managing new conservation practices on their farm (Table 19). The level of reliance was measured on a scale where 0 = not at all, 1 = some, and 2 = a lot. The items are listed loosely in the table below from most relied upon to least relied upon.

Farmers across all watersheds rely the least on commodity groups, Farm Bureau, and local conservation groups – but share a similar high reliance on other farmers and local conservation districts. An ANOVA with post hoc tests determined whether differences in reliance between watersheds existed. Items where concern is statistically different between two or more watersheds are bolded. In cases where the differences extend beyond two watersheds, the mean or means that are different from the others are indicated with an asterisk. Farmers in the Maumee rely more on fertilizer applicators than those in the Genesee, and more on family members and Farm Bureau than those in the Lower Fox. However, Lower Fox farmers rely more on their crop advisor than farmers in all other watersheds.

Additionally, farmers were asked to indicate if they would like to receive more information from any of the following sources. **Few indicated that they wanted more info, but when they did there was interest in more information from county land conservation districts (N=37), demonstration farms (N=32), university extension (N=30,) direct feedback on their farm (N=29), and other local farmers (N=28).**

Table 19. Preferences for information and guidance sources (scale: 0 = not at all, 2 = a lot)

	Genesee N~ 148	**Lower Fox** N~ 141	**Maumee** N~ 232	**Saginaw** N~ 64
When adopting new conservation practices, how much do you rely on guidance from…	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Other local farmers	1.13 (.58)	1.07 (.54)	1.14 (.57)	1.03 (.64)
Your crop adviser/ consultant*	**1.01** (.81)	**1.27*** (.75)	**1.03** (.77)	**.83** (.79)
County land conservation districts	.99 (.68)	1.02 (.61)	1.12 (.68)	1.05 (.67)
Direct feedback e.g., edge of field	1.01 (.76)	.89 (.73)	1.05 (.68)	.88 (.75)
Your fertilizer applicator or retailer*	**.82** (.71)	1.01 (.69)	**1.20** (.70)	1.00 (.76)
Demonstration farms, field days, etc.	.85 (.60)	.96 (.60)	.96 (.64)	.89 (.69)
Family members*	.88 (.72)	**.71** (.61)	**.95** (.72)	.89 (.76)
University extension	.85 (.72)	.90 (.58)	.95 (.64)	.94 (.77)
Your county extension agent	.77 (.71)	.86 (.64)	.92 (.73)	.77 (.72)
NRCS	.83 (.73)	.90 (.75)	.88 (.75)	.75 (.74)
Local conservation groups	.48 (.62)	.66 (.66)	.61 (.64)	.58 (.56)
Farm Bureau*	.48 (.63)	**.42** (.58)	**.60** (.69)	.52 (.64)
Commodity groups	.35 (.57)	.43 (.53)	.44 (.60)	.42 (.64)

Government program participation and perceived barriers to participation

Table 20 identifies the percentage of farmers in each watershed who participate in or are unsure if they are participating in GLRI-funded programs. **About 15-20% of farmers in each watershed are unsure if they participate in GLRI-funded programs.** Farmers in the Genesee have the lowest GLRI participation rate, while farmers in the Lower Fox have the highest participation rate. Lower Fox farmers also had the highest percentage of farmers who were "unsure" about GLRI participation.

Table 20. Participating in GLRI Programs

Have you participated in GLRI-funded programs	**Genesee** N=153	**Lower Fox** N=142	**Maumee** N=237	**Saginaw** N=67
Yes	7.2%	17.6%	12.7%	9.0%
Unsure	15.0%	21.8%	17.3%	17.9%

Additionally, farmers were asked about their participation status in any government-funded program for conservation (e.g., CRP, EQIP, and CSP) (Table 21). **While participation rates are higher for programs in general than GLRI specifically, only one-third of farmers are enrolled in a government-funded program. T**he Maumee has the greatest amount of farmers enrolled in programs.

Table 21. Participation in government funded programs in general

Enrolled in any government-funded programs	**Genesee** N=150	**Lower Fox** N=133	**Maumee** N=228	**Saginaw** N=65
Yes	26.7%	29.3%	34.6%	16.9%

Table 22 displays the percentage of farmers in each watershed who would, would not or are unsure about their plans to enroll in programs in the future. **Less than 20% of farmers in each watershed indicated they would not participate in the future. However, emphasis should be placed on the observation that over 40% of farmers are unsure if they would participate in government-funded programs in the future.**

Table 22. Future intended participation in government funded programs

Continue to participate in government-funded programs in the future	**Genesee** N=150	**Lower Fox** N=133	**Maumee** N=228	**Saginaw** N=65
No	17.8%	13.5%	15.5%	18.6%
Yes	41.5%	39.7%	41.8%	27.1%
Unsure	40.7%	46.8%	42.7%	54.2%

Regardless of current or future program participation status, respondents were asked to what extent they agreed or disagreed with several statements about barriers to participation in government-incentive programs (Table 23). Responses were scaled from -2 strongly disagree to 2 strongly agree (where 0 = neither disagree nor agree), and the items are listed in the table below loosely from strongest agreement to strongest disagreement. **Farmers across all watersheds indicate some interest in program participation, while the greatest barriers are that there is too much paperwork required to participate and there are too many restrictions on how land in programs is managed. Farmers also report being more constrained by payment amounts than payment timeframe, structure, etc. Information availability and program length are relatively smaller barriers to most farmers.**

An ANOVA with post hoc tests was used to determine whether differences in barriers between watersheds existed. Items where concern is statistically different between two or more watersheds are bolded. In cases where the differences extend beyond two watersheds, the mean or means that are different from the others are indicated with an asterisk. **Generally, farmers in the Saginaw often perceive the barriers as less problematic than farmers in the other watersheds.** Specifically, restrictions on how land in programs is managed is more of a barrier for farmers in the Maumee and Genesee than those in the Saginaw. Payment size is more of a barrier for farmers in the Maumee than the Saginaw, and program length is more of a barrier for farmers in the Genesee than the Saginaw.

Table 23. Barriers to participation in government funded incentive programs (scale: -2 = strongly disagree, 2 = strongly agree)

	Genesee N=149	**Lower Fox** N=138	**Maumee** N=234	**Saginaw** N=63
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
There are too many restrictions on how land in programs is managed	**.62** (.91)	.57 (.85)	**.68** (.92)	**.26*** (.90)
There is too much paperwork required to participate	.55 (.91)	.41 (.87)	.52 (.91)	.32 (1.02)
The program payments are too small	.26 (.88)	.41 (.84)	**.43** (.87)	**.11** (.77)
I would prefer if payments were based on actual reductions in nutrient loss (e.g., pay for performance)	.15 (.88)	.25 (.79)	.19 (.81)	.16 (.68)
Program payments are too slow	.13 (.81)	.07 (.80)	.10 (.81)	-.14 (.80)
Programs are not flexible to meet the specific needs of my farm	.22 (.87)	.05 (.90)	.05 (.91)	-.02 (.92)
I would prefer if payments were higher to start but decreased over time	.11 (.76)	.10 (.83)	-.01 (.82)	-.11 (.70)
Information about government programs is not readily available	-.07 (.95)	-.26 (.90)	-.19 (.90)	-.21 (.90)
Programs are not long enough to allow the practice to start paying for itself	**-.01** (.73)	-.10 (.69)	-.12 (.75)	**-.30** (.53)
I am not interested in participating in government programs	-.35 (1.10)	-.24 (1.07)	-.34 (1.09)	-.22 (1.10)

Sample Demographics

The majority of farmers across all watersheds were identified as male, with the greatest proportion of females in the Genesee (Table 24). **The average farmer is about 60 years old** with average ages of 58, 59, 60, and 61 in the Genesee, Lower Fox, Maumee, and Saginaw, respectively.

Table 24. Gender

	Genesee N=152	**Lower Fox** N=143	**Maumee** N=242	**Saginaw** N=66
Male	85.5%	99.3%	94.6%	93.9%
Female	14.5%	.7%	5.4%	6.1%

Average educational attainment was scaled where 1 = some high school no diploma; 2 = high school degree or equivalent; 3 = some college, 4 = no degree; 5 = associates or bachelor's degree; and 6 = graduate or professional degree (Table 25). ***On average, farmers across each watershed have some college, but no degree, with farmers in the Lower Fox and Maumee having slightly less average educational attainment.***

Table 25. Education level

	Genesee N= 147	**Lower Fox** N= 142	**Maumee** N= 238	**Saginaw** N=63
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Education level	3.35 (1.18)	2.92 (1.02)	3.01 (1.15)	3.35 (1.21)

In terms of farming experience, **the average farmer has about 35 years of farming experience** (Table 26). In each watershed, about 50% of farmers identified as third-generation farmers. In addition, farmers were asked to describe their plans for retirement from options including: be operated by someone related to me, be operated by someone who is not related to me, be converted into non-farm use or have its development rights sold, be donated to a farmland preservation program, or unsure. **About half of farmers in each watershed indicated they would pass their farm on to a family member while approximately one-third or greater of farmers were unsure of their retirement plan.**

Table 26. Experience farming

	Genesee N=149	Lower Fox N=139	Maumee N=236	Saginaw N=64
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Years farmed	36.34 (16.19)	36.47 (14.65)	36.37 (16.09	35.23 (19.75)

Table 27 displays the percentage of farms in each net farm income bin and Table 28 displays percentage of farmers in each annual off-farm gross household income bin. A greater proportion of farmers in the Saginaw had net income levels below $50,000 than farmer in all of the other watersheds. The low sample size in the Saginaw should be taken into account when considering this. Table 29 displays the percentage of households who receive off farm income. **The Maumee and Saginaw which on average had lower median farm incomes, had higher percentages of farmers that received off-farm income.**

Table 27. Net farm income

	Genesee N= 146	Lower Fox N=131	Maumee N=222	Saginaw N = 61
< $50,000	48.6%	43.5%	54.5%	72.1%
$50,000 -$99,999	17.8%	23.7%	17.6%	14.8%
$100,000-$249,999	12.3%	14.5%	16.7%	9.8%
$250,000-$499,999	9.6%	10.7%	4.5%	1.6%
> $500,000	11.6%	7.6%	6.8%	1.6%

Table 28. Annual off-farm gross household income

	Genesee N= 103	Lower Fox N=90	Maumee N=184	Saginaw N = 59
< $10,000	7.8%	7.8%	5.4%	3.4%
$10,000 -$49,999	37.9%	38.9%	33.7%	33.9%
$50,000-$99,999	36.9%	34.4%	39.7%	42.4%
> $100,000	17.5%	18.9%	21.2%	20.3%

Table 29. Off-farm income

	Genesee		Lower Fox		Maumee		Saginaw	
	N	%	N	%	N	%	N	%
Off-farm income from farmer	124	60.5%	106	58.5%	192	78.6%	61	79.1%
Off-farm income from farmer spouse	131	64.9%	106	68.9%	185	76.8%	61	54.1%

Table 30 breaks down the farm size into four categories roughly based on USDA estimates for a small to medium to large family farm, and large non-family farm. **The majority of GLRI farms are also under 250 acres, with farms trending larger in the Genesee and smaller in the Saginaw.** The highest proportion of less than 250 acre farms was in the Saginaw, while the Genesee had the greatest proportion of farms 750 to 1500 acres. Table 31 displays the average proportion of rented acres per farm in each watershed, with the **lowest rented acreage in the Saginaw (16%) and the highest in the Lower Fox and Maumee (30%).**

Table 30. Farm size category

	Genesee N= 149	Lower Fox N=137	Maumee N=220	Saginaw N = 61
< 250 acres	36.9	46.0	48.6	73.8
250-750 acres	27.5	33.6	27.7	16.4
750-1500 acres	15.4	14.6	15.0	6.6
> 1500 acres	20.1	5.8	8.6	3.3

Table 31. Average proportion of acres rented per farm

	Genesee N= 155	Lower Fox N=141	Maumee N=239	Saginaw N= 67
% acres rented	24.4% (.18)	30.2% (.30)	30.0% (.31)	16.2% (.25)

Table 32 displays the median percent of planted acres in each tillage type this past year. Farmers in the Saginaw and Lower Fox report the greatest use of conventional tillage, while farmers in the Genesee report the greatest use of conservation tillage and Maumee farmers the greatest percent of no-till.

Table 32. Tillage type

	Genesee N= 155	**Lower Fox** N= 145	**Maumee** N= 245	**Saginaw** N=67
% planted acres for tillage type	Median	Median	Median	Median
Conventional (30% residue or less)	30%	50%	40%	50%
Conservation (30-90% residue)	50%	40%	30%	25%
No-till (90% residue or more)	23%	25%	50%	29%

The majority of famers in the Genesee, Lower Fox, Maumee and Saginaw have land in some rotation (approximately 80 to 90%) (Table 33). **More diverse rotations are more common in the Genesee and Lower Fox (i.e., other, with forage)**, than in the Maumee and Saginaw where the strong majority are corn/bean and corn/beans/wheat.

Table 33. Rotation type

Rotation Type	**Genesee** N=119	**Lower Fox** N=126	**Maumee** N=209	**Saginaw** N=53
Corn/beans	12.6%	27.0%	43.5%	34.0%
Corns/beans/wheat	30.3%	32.5%	44.0%	37.7%
Other with forage	33.6%	30.2%	7.2%	9.4%
Other	23.5%	10.3%	5.3%	18.9%

Table 34 displays the percentage of farmers with a current nutrient management plan for their farm. **The Lower Fox had the highest proportion of farmers with a nutrient management plan compared to the other watersheds (~70% versus 45%).** Approximately 80% of farmers in the Lower Fox indicated implementation on most (75-100%) of their farm, a number similar to implementation in the Genesee. Only 60-65% of farmers with a plan in the Maumee and Saginaw indicated they implemented their plan on most of their land.

Table 34. Percent of farmers with a plan and the acres on which they have it implemented

	Genesee N=148	**Lower Fox** N=141	**Maumee** N=233	**Saginaw** N=64
Current nutrient management plan	45.9%	68.8%	45.9%	45.3%
% farmers with plan implemented on "most (75-100%)" of their farm	80.9%	81.1%	61.5%	65.5%

In terms of rented acreage, approximately 67% of farmers in the Lower Fox managed at least some rented land, with about 60% of farmers in the Genesee and Maumee and 45% of farmers in the Saginaw. In terms of responsibility for conservation decisions, the majority of farmers make conservation decisions alone (Table 35). Farmers in the Maumee reported more frequently than other farmers that they with their landlord are primarily responsible for conservation decisions. On average, farmers across all watersheds have rented their largest plot of land for about 20 years.

Table 35. Responsibility for conservation decisions

Primarily responsible for conservation decisions	**Genesee** N=85	**Lower Fox** N=91	**Maumee** N=143	**Saginaw** N=29
Me alone	70.6%	71.4%	58.0%	62.1%
Me with landlord	24.7%	22.0%	37.1%	31.0%
Landlord alone	1.2%	5.5%	2.8%	3.4%
Other	3.5%	1.1%	2.1%	3.4%

Approximately 35% to 55% of farmers who rent some portion of their land have a formal written lease agreement (Table 36). The Genesee had the lowest percentage of conservation requirements included on the lease (31%), while the Saginaw had the highest (53%). Farmers also indicated how long they would be confident in their ability to keep renting their largest plot of land (Table 37). **Land tenure was most uncertain in the Lower Fox where the majority of farmers indicated they expected to rent their largest plot of land for less than five years, while the majority in the Lower Fox reported at least 3 years or more, and the majority in the Maumee and Saginaw reported more than five years.** Across all watersheds, the majority of farmers in the Genesee (60%), Lower Fox (60%), Maumee 75%), and Saginaw (72%) consider their landlord a friend or family member.

Table 36. Percent of farmers with written lease agreements and conservation requirements

	Genesee		Lower Fox		Maumee		Saginaw	
	N	%	N	%	N	%	N	%
Formal written lease agreement	102	54.9%	111	47.7%	165	35.2%	37	45.9%
Conservation requirement on lease	58	31.0%	55	47.3%	64	45.3%	15	53.3%

Table 37. Years confident in ability to keep renting largest plot

	Genesee N=94	Lower Fox N=99	Maumee N=152	Saginaw N=32
2 years or less	13.8%	21.2%	12.5%	9.4%
3-5 years	33.0%	40.4%	26.3%	31.3%
More than 5 years	53.2%	38.4%	61.2%	59.4%

Section 2: Cross Tabulations and Specific Comparisons

Farmer guidance sources varying by farm size and age

Farmers were asked to identify how much they relied on a list of sources for information when introducing and managing new conservation practices on their farm. Cross tabulations were performed to examine possible relationships between sources of guidance and farm and farmer characteristics such as farm size and age. The following tables contain farm size categories based on USDA averages of small family farms, medium family farms, large family farms, and industrial farms. The categories for farmer age are based on those under the 25th percentile, 26-50th percentile, 51-75th percentile, and greater than 75th percentile. The tables are displayed as heat maps where low percentages appear as yellow and high percentages appear as green.

Overall, reliance on guidance source is similar across all farm size categories (Table 38). **Farmers rely least on local conservation groups, Farm Bureau, and commodity groups. Reliance on direct feedback of practice effectiveness and NRCS increases with farm size.** This could reflect more about information access rather than reliance for large farms.

Farmers over the age of 80 consistently rely on each source of guidance less than younger farmers (Table 39). Farmers over the age of 80 are particularly less likely to rely on direct feedback on practice effectiveness than younger farmers. Although, a higher percentage of farmers over the age of 80 rely on county extension agents. **Farmers under the age of 40 are most likely to rely on family as a source of guidance than farmers in older age groups.**

Across all farm sizes and age groups, a high majority of farmers rely on other local farmers for guidance when introducing and managing new conservation practices on their farm. Interventions must support these existing social connections, particularly for younger farmers who more often rely on family as a source of guidance. Outreach professionals should consider that larger farm categories may have more resources to seek guidance, and that older farmers are least likely to seek guidance from intermediaries or direct feedback.

Table 38. Farmer guidance source by farm size

Guidance Source	**<250 Acres** N=272	**250-750 acres** N=158	**750-1500 acres** N=82	**>2500 acres** N=59
Other Local Farmers	87%	90%	88%	91%
County Land Conservation Districts	77%	84%	81%	85%
Demonstration Farms	71%	80%	81%	89%
Local Conservation Groups	53%	51%	44%	49%
Direct Feedback on Practice Effectiveness	65%	70%	86%	94%
University Extension	70%	77%	69%	83%
Your Crop-Adviser/Consultant	64%	77%	78%	88%
Your County Extension Agent	65%	79%	50%	66%
Farm Bureau	40%	48%	37%	51%
Your fertilizer applicator or retailer	74%	75%	77%	79%
NRCS	56%	68%	67%	81%
Family Members	68%	67%	54%	79%
Commodity Groups	32%	41%	32%	44%

Table 39. Farmer guidance source by farmer age

Guidance Source	**<40 years** N=58	**40-60 years** N=214	**60-80 years** N=298	**>80 years** N=27
Other Local Farmers	90%	92%	88%	69%
County Land Conservation Districts	75%	80%	86%	62%
Demonstration Farms	82%	71%	80%	69%
Local Conservation Groups	43%	49%	55%	56%
Direct Feedback on Practice Effectiveness	84%	73%	73%	56%
University Extension	70%	75%	76%	73%
Your Crop-Adviser/Consultant	77%	74%	72%	64%
Your County Extension Agent	68%	63%	69%	77%
Farm Bureau	47%	39%	47%	44%
Your fertilizer applicator or retailer	79%	76%	76%	70%
NRCS	59%	63%	70%	48%
Family Members	86%	64%	67%	56%
Commodity Groups	43%	36%	36%	48%

Cost barriers by program participation and farm size

The following tables seek to address if cost barriers associated with program participation differ between those participating in no program, GLRI programs, government-funded programs, and both GLRI and government funded programs (Table 40). Perceived cost barriers are also compared by farm size to examine if there is a difference in how large and small farms perceive cost challenges (Table 41). Cost barriers were taken from a bank of barriers associated with general incentive program participation. The respondents answered the prompts on a scale where -1 = strongly disagree, 1 = disagree, 0 = neither disagree nor agree, 1 = agree and 2 = strongly agree. ANOVAs with post hoc tests were performed to assess if there were significant difference in the perception of cost barriers by participation and farm size categories.

Respondents generally believe payments associated with government programs to be too small, more than they believe them to be too slow (Table 40). Farmers participating in general government programs, not GLRI specifically, were less likely to think that program payments were too slow while on average, those not participating in programs believed that payments were to slow. This may point to a misconception that farmers hold before enrolling in a program. There were no significant differences in perceived cost barriers between farm size categories.

Table 40. Program cost barriers and program participation (scale: -2 = strongly disagree, 2 = strongly agree)

	No program participation N=381	**GLRI program participation N=27**	**Govt. program participation N=131**	**Both GLRI and govt. program participation N=38**
	Mean (std. dev)	Mean (std. dev)	Mean (std. dev)	Mean (std. dev)
Government-funded program payments are too small	.31 (.81)	.41 (1.08)	.44 (.92)	.32 (.93)
Government-funded program payments are too slow	**.16 (.74)**	-.11 (.97)	**-.08[1] (.95)**	-.13 (.84)

[1] Value is significantly different than value for "no program participation"

Table 41. Program cost barriers and farm size (scale: -2 = strongly disagree, 2 = strongly agree)

	<250 acres N=258	**250-750 acres N= 152**	**750-1500 acres N=82**	**>1500 acres N=59**
	Mean (std. dev)	Mean (std. dev)	Mean (std. dev)	Mean (std. dev)
Government-funded program payments are too small	.30 (.81)	.34 (.86)	.39 (.99)	.47 (.92)
Government-funded program payments are too slow	.07 (.79)	.07 (.81)	.12 (.91)	.07 (.76)

Farmer concerns for managing soil health and passing farm on to next generation, related to practice adoption and program participation

The following tables compare level of concern about soil health (Table 42) and farm succession (Table 43) with conservation use and program participation. For analysis, the concern scale was condensed to low, medium, and high concern. The strong majority of cover crop and buffer adopters had high levels of concern for both soil health and farm succession, as did those not using these two practices. However, overall concern about soil health is lower for those not using cover crops (and a bit lower for those not using buffers), indicating that concern about soil health may be a driver of conservation adoption, in particular cover crop use.

A similar pattern can be observed for concern and program participation, where concern is high for both issues among all categories of participation. However, a greater proportion of participants in government programs indicate high levels of concern about soil health and farm succession than do participants not in government programs. There is no evidence that participants in GLRI programs are more concerned about these issues than participants in other programs, although the greatest proportion of individuals with high concern for soil health were those participating in both GLRI and other government programs.

Table 42. Cover crop and vegetative buffer use and farmer concerns

		Cover crop use		Vegetative buffer use	
		Yes N = 327	No N = 274	Yes N= 255	No N = 336
Concern for managing soil health on your farm	Low concern	1%	4%	0.3%	5%
	Medium concern	24%	37%	30%	30%
	High concern	75%	60%	70%	65%
Concern for passing your farm on to the next generation	Low concern	8%	14%	8%	15%
	Medium concern	24%	24%	24%	25%
	High concern	68%	62%	68%	61%

Table 43. Program participation and farmer concerns (scale: 0 = not at all concerned, 6 = extremely concerned)

		No program participation N=381	**GLRI program participation** N=27	**Govt. program participation** N=131	**Both GLRI and govt. program participation** N=38
Concern for managing soil health on your farm	Low concern	2.9%	-	1.6%	-
	Medium concern	34.0%	25.9%	25.8%	10.5%
	High concern	63.1%	74.1%	72.7%	89.5%
Concern for passing your farm on to the next generation	Low concern	13.4%	3.7%	7.0%	5.3%
	Medium concern	25.9%	29.6%	18.8%	21.1%
	High concern	60.7%	66.7%	74.2%	73.7%

Examining the connection between understanding and action

To address the connection between understanding and action, we examine beliefs regarding farmer responsibility, practice efficacy, knowledge and concern for nutrient loss by practice adoption and program participation. While literature shows that farmers who believe in the off-farm benefits of conservation practices are more likely to adopt the practice and participate in government programs (Reimer, Thompson, & Prokopy, 2012; Yeboah, Lupi, & Kaplowitz, 2015), environmental awareness in terms of cause and consequence is a weak predictor of whether or not a farmer will engage in conservation (Baumgart-Getz, Prokopy, & Floress, 2012; Prokopy, Floress, Klotthor-Weinkauf, & Baumgart-Getz, 2008).

Farmers who perceive a personal responsibility to help protect their watershed are more likely to be cover crop and buffer users than not (Table 44). This trend is repeated for farmers who believe that actions on their farm have a measurable impact on the watershed and that they are more informed than most about conservation. In general, this indicates that these beliefs may be important drivers of conservation practices, albeit there are other factors at play.

Table 44. Cover crop and vegetative buffer use by responsibility, efficacy, and knowledge

		Cover crop adopters		**Vegetative buffer adopters**	
		Yes N= 328	No N= 277	Yes N= 337	No N=255
It is the responsibility of farmers to help protect watershed	Disagree	5%	7%	3%	9%
	Neither disagree/ agree	17%	27%	18%	25%
	Agree	79%	66%	79%	66%
My actions on my farm have measurable impact on the watershed	Disagree	33%	37%	31%	40%
	Neither disagree/agree	23%	32%	24%	29%
	Agree	44%	32%	44%	31%
I think I am better informed about conservation practices than most farmers	Disagree	9%	15%	11%	12%
	Neither disagree/agree	44%	56%	46%	55%
	Agree	47%	29%	44%	33%

Regardless of program participation status, the majority of farmers believe it is the responsibility of farmers to help protect the watershed (Table 45). However, agreement about responsibility is highest with program participation. Believing that one's actions have a measurable impact and being more informed than most is also more likely among those participating in programs. For example, only 30% of those not participating in programs thought their actions had an impact, while 50 to 55% participating in programs held that belief.

While there is no clear evidence that GLRI participants hold these beliefs more strongly than participants in other programs, there is evidence that these beliefs are greatest among those participating in both GLRI and other government programs. With this data we cannot say that this is a result of participation, in fact, it may be that having these beliefs to begin with drives participation in multiple programs.

Table 45. Program participation and responsibility, efficacy, and knowledge beliefs

		No program participation N=381	**GLRI program participation** N=27	**Govt. program participation** N=131	**Both GLRI and govt. program participation** N=38
It is the responsibility of farmers to help protect watershed	Disagree	6.9%	3.7%	3.9%	-
	Neither disagree/ agree	23.9%	18.5%	16.3%	13.2%
	Agree	69.2%	77.8%	79.8%	86.8%
My actions on my farm have measurable impact on watershed	Disagree	40.4%	25.9%	27.9%	21.1%
	Neither disagree/agree	28.5%	18.5%	20.9%	23.7%
	Agree	31.1%	55.6%	51.2%	55.3%
I think I am better informed about conservation practices than most farmers	Disagree	13.0%	11.1%	7.8%	5.3%
	Neither disagree/ agree	51.9%	48.1%	48.8%	28.9%
	Agree	35.1%	40.7%	43.4%	65.8%

The percent of individuals with high concern about nutrient loss on their own farm was greater among those using both conservation practices (Table 46) and participating in both GLRI or GLRI and other government programs (Table 47). Trends were similar for concern about agriculture in general, although not as pronounced for GLRI versus other government programs. Specifically, both forms of concern are higher for GLRI participants, while concern about ag in general may be more of a driver for general programs (as opposed to concern about one's own farm which may drive participation GLRI). Put another way, GLRI participants may be the most conscientious and concerned about nutrient loss, and therefore seeking out additional opportunities to participate in conservation.

Table 46. Cover crop adoption and concern for nutrient loss impacting the watershed

		Cover crop users		Vegetative buffer users	
		Yes N= 323	No N = 273	Yes N= 334	No N= 252
Concern for nutrient loss from your farm negatively impacting watershed	Low concern	26%	29%	21%	35%
	Medium concern	43%	48%	47%	43%
	High concern	32%	23%	32%	21%
Concern for nutrient loss from agriculture negatively impacting watershed	Low concern	13%	17%	10%	21%
	Medium concern	47%	52%	50%	49%
	High concern	40%	31%	40%	30%

Table 47. Program participation and concern for nutrient loss impacting the watershed

		No program participation N=381	**GLRI program participation** N=27	**Govt. program participation** N=131	**Both GLRI and govt. program participation** N=38
Nutrient loss from your farm negatively impacting watershed	Low concern	36.2%	14.8%	13.4%	2.6%
	Medium concern	42.2%	40.7%	58.3%	42.1%
	High concern	21.6%	44.4%	28.3%	55.3%
Nutrient loss from agriculture negatively impacting watershed	Low concern	20.8%	3.7%	7.1%	-
	Medium concern	48.6%	48.1%	55.1%	42.1%
	High concern	30.5%	48.1%	37.8%	57.9%

Evaluating need for more effective communication of practices to farmers

We examined barriers associated with knowledge and understanding of practices by cover crop and vegetative buffer use (Table 48). Vegetative buffer and cover crop use is strongly associated with higher levels of knowledge, greater exposure to the practice on a similar farm and less uncertainty of the benefits. In particular, farmers using cover crops and buffers are much more likely to report not being limited at all, and much less likely to report being limited a some or a lot by these three barriers. The results suggest that conservation staff should be increasing demonstration opportunities for future cover crop and vegetative buffer users and increasing understanding about practices and their benefits.

Table 48. Cover crop adoption and practice understanding and awareness barriers

		Cover crop use		**Vegetative buffer use**	
	Barriers limit ability to implement	Yes N= 326	No N= 269	Yes N= 337	No N= 242
Lack of knowledge about the practice	Not at all	53%	38%	70%	38%
	A little	30%	28%	19%	26%
	Some	14%	29%	10%	20%
	A lot	2%	6%	1%	15%
Not being able to see a demonstration of the practice on a farm like mine	Not at all	72%	50%	78%	46%
	A little	21%	21%	17%	26%
	Some	6%	21%	5%	16%
	A lot	1%	4%	1%	5%
Uncertainty about the benefits of this practice on my farm	Not at all	60%	33%	67%	29%
	A little	29%	27%	20%	31%
	Some	9%	30%	10%	24%
	A lot	3%	9%	3%	16%

Exploring the relationship between practice-specific efficacy and practice use

As mentioned previously, literature supports the belief that increased belief in the effectiveness of conservation practices increased the likelihood of adoption. Comparing these beliefs for the farm and the watershed indicates that cover crop and buffers users are much more likely to belief that these practices can reduce nutrient loss and improve water quality (Table 49). This supports the finding that efficacy may influence adoption, and that conservation professionals should target increasing the perception of practice effectiveness among farmers.

Table 49. Perceived practice-specific efficacy and practice use

		Cover crop use		**Vegetative buffer use**	
		Yes N= 326	No N=276	Yes N= 335	No N= 254
Cover crops/buffers can reduce nutrient loss on my farm	Disagree	14%	16%	9%	18%
	Neither disagree/agree	10%	30%	21%	36%
	Agree	78%	54%	69%	47%
Widespread adoption of cover crops/buffers can improve water quality in watershed	Disagree	4%	10%	7%	8%
	Neither disagree/agree	18%	39%	18%	26%
	Agree	78%	51%	76%	67%

Barriers to practice implementation and program participation by farm size

When addressing barriers to implementation and participation, outreach professionals may need to consider that barriers are not equally experienced across operations of different sizes and capacities. For practice adoption, respondents were asked how much several barriers limit their ability to implement cover crop and vegetative buffers. Barriers were scaled from 1 = not at all to 4 = a lot. For program participation, barriers were framed as statements and responses were scaled from -2 = strongly disagree to 2 = strongly agree with each statement. The tables are organized by the strongest to lowest perceived barrier, by the smallest farm size category. An ANOVA with post hoc tests determined whether the differences in perceived barriers differ by farm size. Bolded statements indicate that there was a significant difference ($p= \leq .05$) among the mean response between one or more farm size categories. If the differences were between three of more categories, the mean response that was different from others has an asterisk.

For conservation practice use, smaller farms (compared to larger farms) report a lack of knowledge as a greater barrier for both cover crops and buffers (Tables 50 and 51), while they also find access to equipment and not seeing the practice on a farm like theirs bigger barriers for buffers (Table 51). This finding is intuitive in that larger farms are more likely to have the resources and capacity to purchase equipment and seek assistance on implementing new practices. However, larger farms report greater barriers associated with uncertainty in the weather and time when it comes to implementing cover crops (Table 50). This is again intuitive given the amount of acreage they have to cover with this practice, and the challenge of doing so under increasingly short windows of opportunity.

For program participation, larger farms (the biggest farms in particular) report being more limited by restrictions on how land in programs is managed and a lack of flexibility to meet their own farming needs (Table 52). Interestingly, their interest in programs is significantly higher than the smallest farms, and generally speaking, interest in programs increases with farm size. While many of the barriers measured pose a similar challenge (or lack thereof) across farm sizes, there are a few barriers that vary and could be more carefully addressed in program design to encourage a broad range of participation.

Table 50. Cover crop barriers and farm size (scale: 1 = not a barrier, 4 = strong barrier)

How barriers limit ability to implement cover crops	**<250 acres** N=~ 261		**250-750 acres** N=~151		**750-1500 acres** N=~81		**>1500 acres** N=59	
	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev
Uncertainty in the weather	**1.36***	1.09	**1.72**	1.09	**1.8**	0.91	**1.86**	1.01
Lack of the right equipment	1.34	1.14	1.19	1.02	1.11	1.08	1.12	1.04
The lack of an immediate economic return	1.23	1.07	1.26	0.96	1.31	0.96	1.29	1.1
Too many restrictions associated with using the practice	1.08	1.11	0.99	1.05	1.01	1.02	1	1.08
Too time consuming to manage	**1.01**	0.94	**1.08**	0.92	**1.32***	0.85	1.1	0.92
The contracts providing incentives are too short	0.99	1.05	0.93	0.95	1.04	1.05	0.95	1.04
Lack of knowledge about the practice	**0.95**	0.95	0.74	0.81	0.78	0.87	**0.54**	0.84
Requires too many changes in my daily operation	0.88	0.97	0.79	0.8	0.88	0.81	0.97	0.98
Uncertainty about the benefits of this practice for my farm	0.86	0.97	0.77	0.86	0.86	0.86	0.63	0.95
No demonstration of the practice on a farm like mine	0.69	0.99	0.54	0.76	0.53	0.78	0.5	0.73
Lack of technical assistance	0.69	0.89	0.61	0.83	0.69	0.9	0.51	0.73
Not wanting to use the practice on rented ground	0.59	0.95	0.73	0.91	0.64	0.86	0.58	0.89

Table 51. Vegetative buffer barriers and farm size (scale: 1 = not a barrier, 4 = strong barrier)

How barriers limit ability to implement vegetative buffers	**<250 acres** N= ~248		**250-750 acres** N= ~150		**750-1500 acres** N= ~81		**>1500 acres** N= 58	
	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev
Not wanting to lose land for production	1.19	1.15	1.28	1.16	1.36	1.08	1.4	1.12
Too many restrictions associated with using the practice	1.14	1.06	1.16	1.07	1.42	0.99	1.47	1.13
The lack of an immediate economic return	1.08	1.09	1.05	1.1	1.19	0.98	1.1	1.09
Lack of the right equipment	**0.97**	1.12	0.76	0.98	0.83	0.97	**0.53**	0.8
Uncertainty in the weather	0.93	1.08	1.03	1.09	1.01	1	0.93	1.11
The contracts providing incentives are too short	0.93	1.07	0.84	0.95	1.01	0.99	1.16	1.25
Too time consuming to manage	0.9	0.91	0.79	0.92	0.91	0.86	0.9	0.81
Uncertainty about benefits of this practice for my farm	0.89	1	0.78	0.99	0.79	0.96	0.67	0.98
Lack of knowledge about the practice	**0.81**	0.97	0.75	1.01	0.62	0.89	**0.4**	0.75
Lack of technical assistance	0.68	0.89	0.55	0.83	0.55	0.79	0.5	0.8
Not wanting to use the practice on rented ground	0.67	1.01	0.82	1.03	0.99	0.98	0.98	1.1
Requires too many changes in my daily operation	0.65	0.88	0.67	0.86	0.6	0.77	0.74	0.83
No demonstration of the practice on a farm like mine	**0.64**	0.94	**0.61**	0.89	0.45	0.76	**0.26***	0.69

Table 52. Program barriers and farm size (scale: 1 = not a barrier, 4 = strong barrier)

Government-funded program barriers	**<250 acres** N= ~258		**250-750 acres** N= ~152		**750-1500 acres** N= ~82		**>1500 acres** N= 59	
	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev
Too many restrictions on how land in programs is managed	**0.46**	0.93	**0.45**	0.86	**0.44**	1.02	**0.64***	0.91
The program payments are too small	0.3	0.81	0.34	0.86	0.39	0.99	0.47	0.92
I would prefer payments based on actual reductions in nutrient loss	0.2	0.78	0.15	0.84	0.21	0.87	0.26	0.85
Programs are not flexible to specific needs of farm	**0.08**	0.9	**0.03**	0.94	**0.01**	0.85	**0.41***	1
The program payments are too slow	0.07	0.8	0.07	0.81	0.12	0.91	0.07	0.76
Too much paperwork required	-0.01	0.75	0.08	0.82	0.07	0.92	0.17	0.79
Practices are not long enough to start paying for itself	-0.07	0.65	-0.22	0.69	-0.07	0.77	0	0.94
Information about programs is not readily available	-0.15	0.91	-0.23	0.91	-0.21	0.97	-0.19	0.94
I am not interested in participating in programs	**-0.15**	1.11	-0.32	1.07	-0.6	0.98	**-0.71**	1.04

Cover crop and buffer use by proportion of total farm acres rented

The percent of cover crop and vegetative buffer use increases as the percentage of rented acres decreases (Table 53). The majority of cover crop and vegetative buffer users fall in the category of less than 25% rented acres. Less than ten percent of those who rent 75-100% of their acres are currently using cover crops or vegetative buffers. This reveals a gap in engagement or flexibility for renters to adopt cover crops and vegetative buffers.

Table 53. Cover crop adoption and proportion of acres rented

Percentage rented acres	**Currently using cover crops** N=332	**Currently using vegetative buffers** N=342
<25%	49.5%	51.3%
25-50%	23.1%	21.2%
50-75%	18.8%	19.1%
75-100%	8.5%	8.4%

Decision making of renters by age group and farm size

For those with rented acreage, we compared their decision making authority with their age (Table 54) and farm size (Table 55). We see that sole decision making authority is highest for those in the 40-60 year old age range, and lowest for both those under 40 and over 80. We also see a greater tendency for those under 40 to be making decisions in consultation with their landlord (Table 54). In terms of farm size, we see a greater tendency for those on the largest farms (greater than 1500 acres) to be making decisions in consultation with a landlord (perhaps representing the reality that they rent much more land on average).

Table 54. Decision making by renters and age

Decision making	**<40 years** N=58	**40-60 years** N=214	**60-80 years** N=298	**>80 years** N=27
Me alone	52.8%	70.9%	63.0%	53.8%
Me with landlord	44.4%	23.4%	31.8%	30.8%
Landlord alone	2.8%	2.8%	3.9%	-
Other	-	2.8%	1.3%	15.4%

Table 55. Decision making by renters and farm size

Decision making	**<250 acres** N=272	**250-750 acres** N=158	**750-1500 acres** N=82	**>1500 acres** N=59
Me alone	70.7%	64.5%	72.6%	56.6%
Me with landlord	24.2%	27.3%	25.8%	37.7%
Landlord alone	4.0%	3.6%	1.6%	1.9%
Other	1.0%	4.5%	-	3.8%

Section 3: Exploring cover crop and vegetative buffer adoption and government program participation

Who is interested in government programs?

To investigate interest, we used a linear regression to compare how several variables impact the likelihood of a farmer being interested in government incentive programs. The dependent variable, stated interest, was measured on a scale of -2 strongly disagree (strong disinterest) to 2 strongly agree (strong interest). Table 56 displays the statistically significant predictors of program interest. The direction of the arrow signifies the effect the predictor had on program interest. For example, as education level increases, the likelihood of a farmer being interested in a program increases. **Specifically, interest in participation increases among younger farmers, more educated farmers, and those with greater response efficacy (stronger belief that practices are beneficial).**

Table 56. Predicting program interest

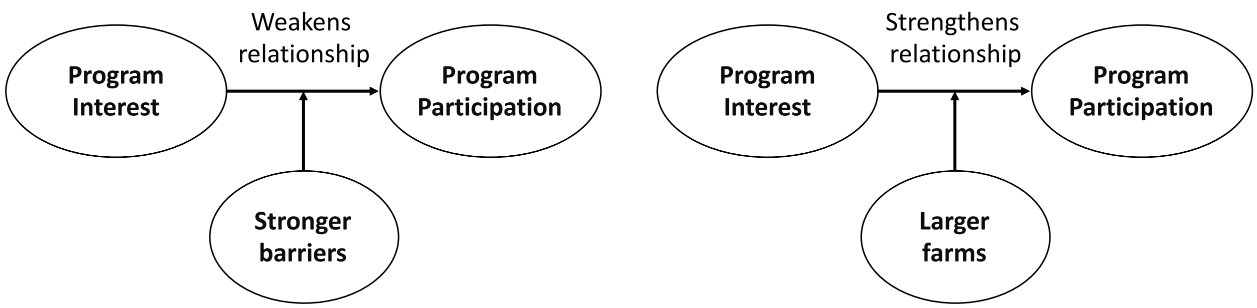
	Effect on Interest	Sig.
Farm Size	↑	.054
Age	↓	.032
Education	↑	.018
Broad response efficacy	↑	.008
Cover crops response efficacy	↑	.029
Grass buffers response efficacy	↑	.000

[1]Variables tested but not significant: CC/VB adoption, farm-level/watershed-level concern, conservationist/productivist identity, responsibility, practice knowledge

Why isn't everyone who is interested participating?

After determining the farm and farmer characteristics that influence interest in government programs, we explored what stops this interest from translating to program participation. Figure 4 shows the conceptual model in which program barriers and farm size are proposed to decrease the positive relationship between program interest and participation. In other words, farmers who hold high interest are expected to be likely to participate in programs. However, increasing program barriers and decreasing farm size could negatively impact this relationship.

Figure 4. Program barriers and farm characteristics moderating the relationship between program interest and participation



The barriers displayed in bold significantly weaken the relationship between program interest and participation (Table 57). Specifically, **the barriers that lessened the odds of interest influencing participation were related to program structure (i.e., information access, flexibility, restrictions), and not related to payment structure.**

When farm size was applied as a moderator to the relationship between program interest and current participation, we found that **large farms were more likely to participate in programs even when program interest was low, and small farms only have a high likelihood of participation when interest is high.** *For scatter plot depicting analysis, see Appendix B.*

Table 57. Barriers that significantly weaken the relationship between program interest and participation in bold

Barriers
Information about government programs is not readily available
Programs are not flexible to meet the specific needs of my farm
There are too many restrictions on how land in programs is managed
Programs are not long enough to allow the practice to start paying for itself
The program payments are too small
The program payments are too slow
I would prefer if payments were based on actual reductions in nutrient loss
I would prefer if payments were higher to start but decreased over time
There is too much paperwork required to participate

How do farm and farmer characteristics change thinking that impacts adoption?

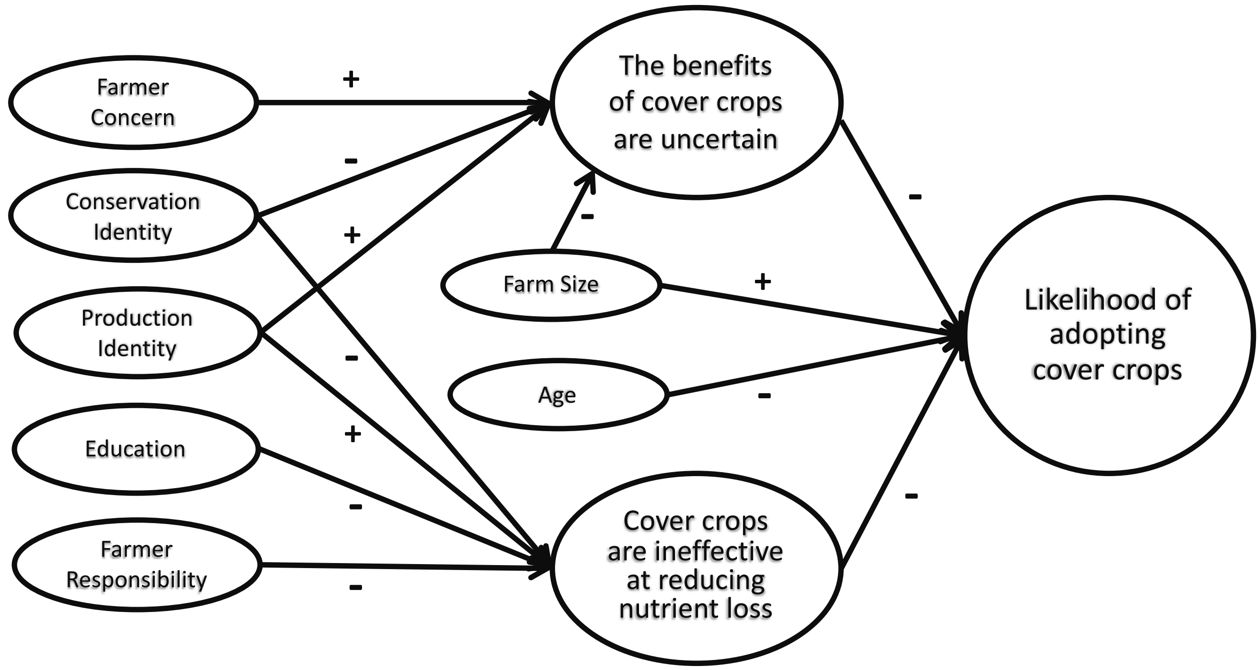
To investigate how farm and farmer characteristics might impact adoption of conservation practices, we conducted a series of mediated regression analyses. We use these analyses to identify the extent to which differences in farm and farmer characteristics barriers impact adoption by changing how farmers think about different conservation practices. Specifically, we investigated how farm and farmer characteristics may directly increase or decrease adoption, but also how they may impact adoption by changing farmer's uncertainty about the benefits of the practices on their farm and their perception of the ineffectiveness of the practice at reducing nutrient loss on their farm. The mediation analyses allow us to identify the extent to which different farm and farmer characteristics impact adoption in three ways:

1) by changing perceptions of the ineffectiveness of the practice
2) by changing the amount of uncertainty about the benefits of the practice
3) through some other process that we did not directly measure, meaning that the characteristic has a direct impact on adoption.

The results of these analyses suggest that for cover crop adoption (see Fig. 5), there are several characteristics that only indirectly impact adoption by changing perceptions about the benefits and the ineffectiveness of cover crops. Only two characteristics directly impact adoption. Specifically:

- **Younger farmers and larger farms are more likely to adopt**, not because of differences in perceived uncertainty or effectiveness, but due to other factors we didn't measure.
- **Larger farms are less uncertain about the benefits of cover crops.**
- **Farmers with stronger productivist identities show more uncertainty about the benefits of cover crops and greater perceptions of ineffectiveness (and subsequently lower adoption)**
- **Farmers with stronger conservationist identities show less uncertainty about the benefits of cover crops and lower perceptions of ineffectiveness (and subsequently greater adoption)**
- **Farmers with more formal education and those who perceive a greater responsibility for the health of the lake, show lower perceptions of ineffectiveness (and subsequently higher adoption).**

Figure 5. Mediated regression predicting cover crop adoption from farm and farmer characteristics through uncertainty and effectiveness beliefs where a "positive" arrow indicates that as one variable goes up the other does too, and a "negative" arrow indicates t



*Having more rented acreage, higher watershed-level concern, perceiving that the government is responsible for lake health, greater self-efficacy or confidence in one's ability to implement cover crops, and greater beliefs that the practices needed to manage every farm are unique were included in the analysis, but were not significant predictors of uncertainty, ineffectiveness, or adoption

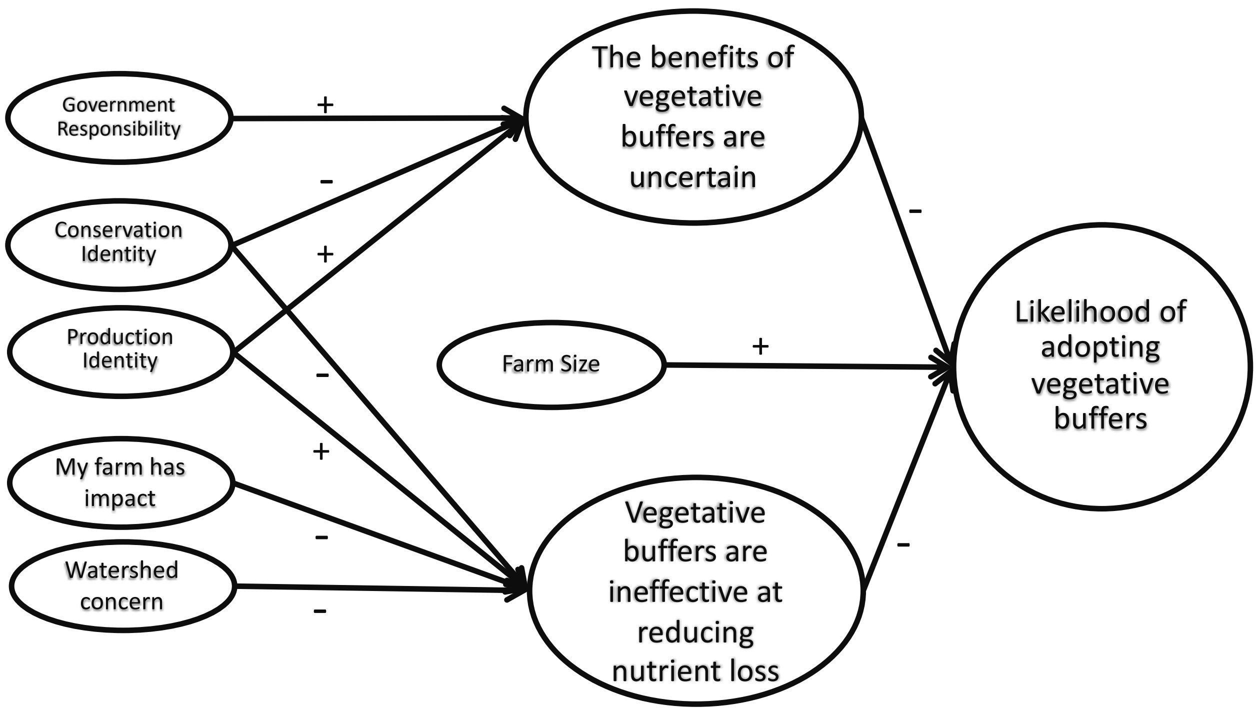
The results of these analyses suggest that for vegetative buffer adoption (see Fig. 6), there are again several characteristics that only indirectly impact adoption by changing perceptions about the benefits and the ineffectiveness of cover crops. Only one characteristic directly impacts adoption. Specifically:

For adoption:

- Similar to cover crops, **larger farms are more likely to adopt vegetative buffers**, not because of differences in perceived uncertainty or effectiveness, but due to other factors we didn't measure.
- **Similar to cover crops, farmers with stronger productivist identities show more uncertainty about the benefits of cover crops and greater perceptions of ineffectiveness (and subsequently lower adoption)**

- **Similar to cover crops, farmers with stronger conservationist identities show less uncertainty about the benefits of cover crops and lower perceptions of ineffectiveness (and subsequently greater adoption)**
- **Those who believe it's the government's responsibility to protect the lake are more uncertain about the benefits (and subsequently less likely to adopt)**
- **Farmers who are more concerned about the watershed and those who believe their actions have an impact are less likely to consider buffers to be ineffective (and subsequently less likely to adopt).**

Figure 6. Mediated regression predicting vegetative buffer adoption from farm and farmer characteristics through uncertainty and effectiveness beliefs where a "positive" arrow indicates that as one variable goes up the other does too, and a "negative" arrow indicates that as one variable goes up the other goes down.



* Being older or more educated, having more rented acreage, higher farm-level concern, greater perceived personal responsibility, and stronger beliefs that the practices needed to manage every farm are unique were factors included in the analysis, but they were not significant predictors of uncertainty, ineffectiveness, or adoption

Appendix A. Survey

Researching the Effectiveness of Agricultural Programs

A study conducted by:

In cooperation with:

Specific advisory partner logos based on particular watershed

Please respond to each question with the answer you believe is most representative of you and your farm. There are no wrong or right answers; we are only interested in your opinion. Please note that you do not have to answer an item that you feel is too personal or sensitive.

1. Did you operate a farm in 2018?

☐ Yes ☐ No

2. Do you plan to operate a farm in 2019?

☐ Yes ☐ No

If your answer is NO to either question 1 or 2, please return the survey without completing it in the enclosed envelope. Postage is paid by the survey project. Otherwise, please continue…

3. Please circle the number that best represents how concerned you are about the following issues.

	Not at all concerned →						**Extremely concerned**
a. Nutrient loss on your farm	0	1	2	3	4	5	6
b. Nutrient loss from your farm negatively impacting [insert your Lake]	0	1	2	3	4	5	6
c. Nutrient loss from agriculture negatively impacting [insert your Lake]	0	1	2	3	4	5	6
d. Additional government regulation or rules related to ag nutrient loss	0	1	2	3	4	5	6
e. A lawsuit filed against farmers because of nutrient loss to [insert your Lake]	0	1	2	3	4	5	6
f. Soil health on your farm	0	1	2	3	4	5	6
g. The management decisions of other farmers in your community	0	1	2	3	4	5	6
h. Your ability to make an annual profit as a farmer	0	1	2	3	4	5	6
i. Your ability to pass on your farm to the next generation	0	1	2	3	4	5	6

4. Please indicate your level of agreement or disagreement with the statements below by circling the number that best represents your opinion.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
a. It is the responsibility of farmers to help protect [insert your Lake].	-2	-1	0	1	2
c. My actions on my farm have no measurable impact on [insert your Lake].	-2	-1	0	1	2
e. I am not willing to change my current practices to improve water quality.	-2	-1	0	1	2
f. The quality of life in my community depends on good water quality in [insert your Lake].	-2	-1	0	1	2
g. It is the responsibility of the government to protect [insert your Lake].	-2	-1	0	1	2
h. Agriculture is not the main driver of algal blooms in [insert your Lake].	-2	-1	0	1	2
i. Practices that benefit water quality also benefit my farm.	-2	-1	0	1	2
j. I am unsure of what steps to take to reduce nutrient loss on my farm.	-2	-1	0	1	2
k. I think I am better informed about conservation practices than most farmers.	-2	-1	0	1	2
l. Widespread adoption of cover crops can improve water quality in [insert your Lake].	-2	-1	0	1	2
m. Cover crops cannot reduce nutrient loss on my farm.	-2	-1	0	1	2
l. Widespread adoption of grass buffers can improve water quality in [insert your Lake].	-2	-1	0	1	2
m. Grass buffers cannot reduce nutrient loss on my farm.	-2	-1	0	1	2
n. The practices needed to reduce nutrient loss are unique to each farm.	-2	-1	0	1	2

The following questions will ask about specific adoption and management of two well-known conservation practices. We will begin with cover crops.

1. Are you currently using cover crops on your farm?

☐ No (skip to question 3) ☐ Yes → For how many years? _____________

2. On what percent of your total farm acres do you currently use cover crops?

☐ A few (0-25%) ☐ Some (25-50%) ☐ A lot (50-75%) ☐ Most (75-100%)

3. How likely are you to use cover crops on your farm next year?

☐ Will not use ☐ Unlikely to use ☐ Likely to use ☐ Will definitely use

4. How likely are you to use cover crops in the future without incentives?

☐ Will not use ☐ Unlikely to use ☐ Likely to use ☐ Will definitely use

5. How much do the following factors limit your ability to implement cover crops?

	Not at all	A little	Some	A lot
a. Lack of information/knowledge	0	1	2	4
b. Too time consuming to manage	0	1	2	3
d. Lack of equipment	0	1	2	3
e. Not being able to see a demonstration of the practice on a farm like mine	0	1	2	3
f. The amount of rental acreage I farm	0	1	2	3
g. Lack of technical assistance	0	1	2	3
h. Unsure about the benefits of this practice for my farm	0	1	2	3
i. Not being able to harvest the cover crop	0	1	2	3
j. Uncertainty in the weather	0	1	2	3
k. The lack of an immediate economic return	0	1	2	3
l. Too many operational changes required	0	1	2	3
m. The restrictions associated with using the practice (e.g., can't harvest cover crops)	0	1	2	3
n. The government contracts are too short	0	1	2	3

6. How will the adoption of cover crops impact the net costs of production on your farm? Please consider net costs of production over both the short and the long-term:

	Net costs of production	Strongly decrease	Slightly decrease	Neither decrease nor increase	Slightly increase	Strongly increase
Short term (0-5 years)	Labor and time	-2	-1	0	1	2
	Fuel and equipment	-2	-1	0	1	2
	Fertilizer and chemicals	-2	-1	0	1	2
	Seeds	-2	-1	0	1	2
Long term (6 -10 years + beyond)	Labor and time	-2	-1	0	1	2
	Fuel and equipment	-2	-1	0	1	2
	Fertilizer and chemicals	-2	-1	0	1	2
	Seeds	-2	-1	0	1	2

7. Now, consider how the adoption of cover crops might impact the following benefits on the land you farm. Please consider the benefits of adoption in the following time frames:

	Benefit of Adoption	Strongly decrease	Slightly decrease	Neither decrease nor increase	Slightly increase	Strongly increase
Short term (0-5 years)	Soil structure and health	-2	-1	0	1	2
	Yield resiliency	-2	-1	0	1	2
	Profit-per-acre	-2	-1	0	1	2
Long term (6-10 years + beyond)	Soil structure and health	-2	-1	0	1	2
	Yield resiliency	-2	-1	0	1	2
	Profit-per-acre	-2	-1	0	1	2

Now, we would like you to answer those same questions for vegetative buffers on your farm (e.g., grassed waterways, filter strips, etc).

8. Do you currently have any vegetative buffers on your farm?

☐ No (skip to question 9) ☐ Yes → For how many years? _____________

9. Along what percent of your total farm acres do you have vegetative buffers?

☐ A few (0-25%) ☐ Some (25-50%) ☐ A lot (50-75%) ☐ Most (75-100%)

10. How likely are you to add planted buffers to your farm next year?

☐ Will not add ☐ Unlikely to add ☐ Likely to add ☐ Will definitely add

10. How likely are you to add planted buffers in the future without incentives?

☐ Will not add ☐ Unlikely to add ☐ Likely to add ☐ Will definitely add

11. How much do the following factors limit your ability to implement vegetative buffers?

	Not at all	A little	Some	A lot
a. Lack of information/knowledge	0	1	2	4
b. Too time consuming to manage	0	1	2	3
d. Lack of equipment	0	1	2	3
e. Not being able to see a demonstration of the practice on a farm like mine	0	1	2	3
f. The amount of rental acreage I farm	0	1	2	3
g. Lack of technical assistance	0	1	2	3
h. Unsure about the benefits of this practice for my farm	0	1	2	3
i. Loss of land for commodity production	0	1	2	3
j. Uncertainty in the weather	0	1	2	3
k. The lack of an immediate economic return	0	1	2	3
l. Too many operational changes required	0	1	2	3
m. Too many restrictions associated with using the practice (e.g., buffers too wide)	0	1	2	3
n. The government contracts are too short	0	1	2	3

1. People have different opinions about what makes a "good farmer." Please circle the number that best represents how important each of the following items is to your definition of a good farmer.

A good farmer is one who…	Not important at all	Slightly important	Somewhat important	Important	Very important
a. …has the highest yields per acre	0	1	2	3	4
b. …gets their crops planted first	0	1	2	3	4
c. ...considers the health of waterways that run through or along their land to be their responsibility	0	1	2	3	4
d. …minimizes soil erosion	0	1	2	3	4
e. …has the highest profit per acre	0	1	2	3	4
f. …has the most up-to-date equipment	0	1	2	3	4
g. …minimizes nutrient runoff into waterways	0	1	2	3	4
h. …uses the latest seed and chemical technology	0	1	2	3	4
i. …thinks beyond their own farm to the social and ecological health of their watershed	0	1	2	3	4
j. …maintains or increases soil organic matter	0	1	2	3	4
k. …manages for both profitability and minimization of environmental impact	0	1	2	3	4
l. …adopts conservation practices despite challenges	0	1	2	3	4
m. …challenges the belief that agriculture causes water quality issues	0	1	2	3	4
o. …leaves the land in a better condition than when they received it	0	1	2	3	4

2. How much do you rely on the following sources for information when introducing and managing new conservation practices on your farm. Please *circle the number* that best represents to what extent you currently rely on these sources for guidance, *and check the box* in the last column if you would like more information and/or guidance from these sources.

When adopting new conservation practices, how much do you rely on guidance from…	Not at all	Some	A lot	Would like to see more!
a. Other local farmers	0	1	2	☐
b. County land conservation districts	0	1	2	☐
c. Demonstration farms, field days, etc.	0	1	2	☐
d. Local conservation groups (e.g., The Nature Conservancy)	0	1	2	☐
e. Direct feedback on practice effectiveness on your farm (e.g., edge of field monitoring)	0	1	2	☐
f. University extension	0	1	2	☐
g. Your crop adviser/ consultant	0	1	2	☐
h. Your county Extension agent	0	1	2	☐
i. Farm Bureau	0	1	2	☐
j. Your fertilizer applicator or retailer	0	1	2	☐
k. Natural Resources Conservation Service (NRCS)	0	1	2	☐
l. Family members	0	1	2	☐
m. Commodity groups	0	1	2	☐
n. Other (fill-in): ______________________	0	1	2	☐
o. Other (fill-in): ______________________	0	1	2	☐

1. Are you currently enrolled in any government-funded incentive programs for conservation?

- ☐ No (Skip to 3)
- ☐ Yes → From what source/program (list all that apply):

  ____

2. How likely are you to continue the funded conservation practices once incentives have stopped?

☐ Will not continue ☐ Unlikely to continue ☐ Likely to continue ☐ Will definitely continue

2. Whether or not you participate in government incentive programs, *please indicate to what extent you agree or disagree with the following statements.*

	Strongly Disagree	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**
a. Information about incentive programs is readily available.	-2	-1	0	1	2
h. Programs are flexible to meet the specific needs of my farm.	-2	-1	0	1	2
i. I am not interested in participating in incentive programs.	-2	-1	0	1	2
j. Programs are long enough to allow the practice to start paying for itself.	-2	-1	0	1	2
k. The payment structures of existing programs are fair.	-2	-1	0	1	2
l. The program payments are too slow.	-2	-1	0	1	2
n. I would prefer if incentives were based on actual reductions in nutrient loss (e.g., pay for performance).	-2	-1	0	1	2
o. I would prefer if payments were higher to start but decreased over time.	-2	-1	0	1	2
p. There is too much paperwork required to participate.	-2	-1	0	1	2
q. There are too many restrictions on how land in programs is managed.	-2	-1	0	1	2

This last section tells us a bit more about you and your farm so that we can understand how the effectiveness of conservation programs and practices may vary by different farms. Please note that you do not have to answer an item that you feel is too personal or sensitive.

1. Are you: ☐ Male ☐ Female

2. What is your age? ______ years

3. How much formal education have you completed?

☐ Some high school, no diploma
☐ High school degree or equivalent
☐ Some college, no degree
☐ Associate's or bachelor's degree
☐ Graduate or professional degree

4. How many years have you been farming?
____ years

5. How many generations has your family been farming some portion of your current operations?

☐ I am a first generation farmer
☐ I am a second generation farmer
☐ I am a third generation farmer or more

6. When you retire, your farm will: *(Check the one that best fits your situation)*

☐ Be operated by someone related to me
☐ Be operated by someone who is not related to me
☐ Be converted into non-farm use or have its development rights sold
☐ Be donated to a farmland preservation program
☐ Uncertain

7. This past year, what was your **total farm operation's** annual net income?

☐ Less than $50,000
☐ $50,000 - $99,000
☐ $100,000 - $249,999
☐ $500,000 or greater

8. Do you or your spouse receive off-farm income? (Check all that apply)

☐ Me
☐ My spouse
☐ No off-farm income

9. If you or your spouse receives off-farm income, what was your annual gross household income from off-farm sources this past year?

☐ Less than $10,000
☐ $10,000 - $49,999
☐ $50,000 - $99,999
☐ $100,000 or more

10. How large is your **total farm operation**? For total acres, include cropland, woodland, pasture, wasteland, land in farmsteads, and land in government programs. Under planted acres, include any on which a crop was planted for harvest, including hay, this past year.

	Owned	Rented
Total Acres	a. ______	d. ________
Planted Acres	b. ______	e. ________
# of Fields	c. ______	f. ________

11. Did you raise any livestock or poultry on your farm in 2018?

- ☐ No *(If no, please skip Question 12)*
- ☐ Yes→ Roughly how many of each did you raise or manage in 2018? *(Please fill in the number below)*

_______ Dairy cows

_______ Beef cows

_______ Calves, heifers, feeders

_______ Swine (1 time capacity)

_______ Poultry (1 time capacity)

12. Across your **total farm operation**, what % of your planted acreage was in each type of tillage this past year? *(Please fill in a number for each)*

______% Conventional (30% residue or less)

______% Conservation (30-90% residue)

______% No-till (90% residue or more)

13. Do you currently have a nutrient management plan for your farm?

- ☐ No (Skip to Question 14)
- ☐ Yes → On what percent of your total farm acres do you implement your nutrient management plan?
  - ☐ A few (0-25%)
  - ☐ Some (25-50%)
  - ☐ A lot (50-75%)
  - ☐ Most (75-100%)

14. Do you rent any of the land that you actively manage?

- ☐ No (Skip to Question 18)
- ☐ Yes → Who is primarily responsible for conservation decisions on land you rent?
  - ☐ Me alone
  - ☐ Me with landlord
  - ☐ Landlord alone
  - ☐ Other ___________________

→ How long have you rented this land? ______ years

15. In general, do you have a formally written lease agreement with your landlord/ tenant?

- ☐ No
- ☐ Yes → Do any of your leases contain conservation requirements?
  - ☐ No
  - ☐ Yes

16. For how many more years are you confident if your ability to keep renting this land?

- ☐ 2 years or less
- ☐ 3-5 years
- ☐ More than 5 years

17. In general, is your landlord/ tenant a member of your local community?

- ☐ No
- ☐ Yes
- ☐ Not sure

18. What is the name of the county and township in which your main farming operation resides?

County ___________________

Township ___________________

Zipcode ___________________

Thank you for taking our survey. The return postage has already been paid, so simply fold the survey and place it in the postage-paid envelope, and put it in your mailbox.

If you have any other feedback regarding federal incentive programs please leave it here! ***In particular, we would be interested in knowing what conservation practices you would like to do that are currently not supported by government programs.***

Appendix B. Non-response follow-up survey

1. Did you operate a farm in 2018?

☐ Yes ☐ No

2. Are you operating a farm in 2019?

☐ Yes ☐ N

3. Please indicate your level of agreement or disagreement with the statements below by circling the number that best represents your opinion.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
a. It is the responsibility of farmers to help protect Lake Ontario.	-2	-1	0	1	2
b. My actions on my farm have no measurable impact on Lake Ontario.	-2	-1	0	1	2
c. I am not willing to change my current practices to improve water quality	-2	-1	0	1	2
d. I think I am better informed about conservation practices than most farmers.	-2	-1	0	1	2
e. Agriculture is not the main driver of algal blooms in Lake Ontario.	-2	-1	0	1	2
f. Information about government programs is readily available.	-2	-1	0	1	2
g. There are too many restrictions on how land in programs is managed.	-2	-1	0	1	2

4. People have different opinions about what makes a "good farmer." Please circle the number that best represents how important each of the following items is to your definition of a good farmer.

A good farmer is one who…	Not important at all	Slightly important	Somewhat important	Important	Very important
d. …minimizes soil erosion	0	1	2	3	4
g. …minimizes nutrient runoff into waterways	0	1	2	3	4

5. Are you currently using cover crops on your farm?

☐ No ☐ Yes

6. Do you currently have any vegetative buffers on your farm?

☐ No ☐ Yes

7. Do you currently raise any livestock of poultry on your farm?

☐ No ☐ Yes

8. Do you currently have a nutrient management plan for you farm?

☐ No ☐ Yes

9. What is the size of your total farm operation?

☐ Less than 250 acres
☐ 250 to 749 acres
☐ 750 to 1500 acres
☐ Greater than 1500 acres

10. What percent of your total farm operation is rented?

☐ 0-25% ☐ 25-50% ☐ 50-75% ☐ 75-100%

11. How many years have you been farming?

_______ years

12. Do you or your spouse receive off-farm income?

☐ No ☐ Yes

13. Have you participated in any Great Lakes Restoration Initiative (GLRI) funded programs?

☐ No ☐ Yes ☐ Unsure

14. Are you currently enrolled in any other government-funded programs for conservation?

☐ No ☐ Yes

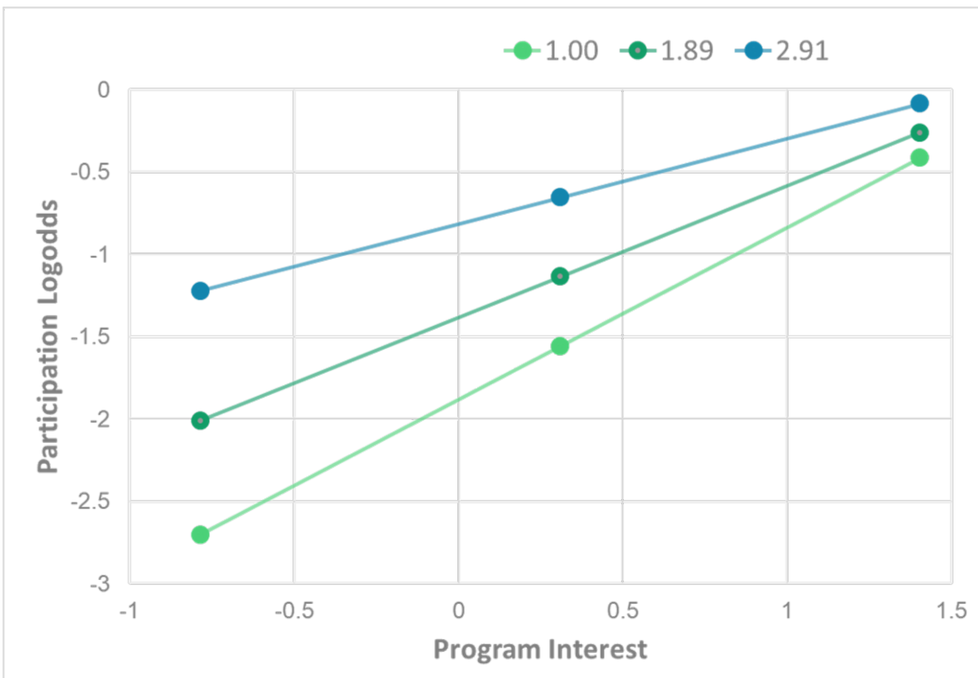
15. What is the name of the county where your main farming operation is located?

County ___________________

Appendix C. Farm Size Moderator Scatter Plot

Figure 11 displays a scatter plot depicting program farm size as a moderator between program interest and the odds of participating in a government program. Each line represents the average farm size bin (1= <250 acres, 2 = 250-750 acres, 3= 750-1500 acres, 4 = >1500 acres) and one standard deviation above and below. At a level of low program interest, larger farms (blue line) have higher odds of participating in government programs. Moving left to right along program interest shows that for a small farmer, interest has to be very high to be likely to participate in government programs (i.e., high interest can overcome being a small farm).

Figure 7. Program interest and participation by farm size



Appendix F

Previous Survey Report: Existing Survey Data in Maumee & Saginaw Watersheds

Great Lakes Commission
des Grands Lacs

REAP
Researching the Effectiveness of Agricultural Programs

Researching the Effectiveness of Agricultural Programs: Evaluating Survey Data in the Maumee and Saginaw Watersheds

Task 4a: Aggregating Existing Farmer Survey Data

2018

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Executive Summary

Key Findings

The objective of the data analysis presented here was to compare farmer adoption of conservation practices between two GLRI priority watersheds using existing survey data. The results of the analysis are meant to identify ways to improve future investments that better account for the needs of the local farming populations, and the unique motivations and constraints.[1] Our results are limited to two priority watersheds, Saginaw and Maumee, due to data availability and comparability. With this data we aimed to answer three specific research questions:

(1) How do priority watersheds differ in their farm characteristics, beliefs, and conservation adoption?

(2) What socio-psychological factors are driving adoption of recommended practices?

(3) What is the impact of GLRI programs on key drivers of adoption?

How do the priority watersheds differ?

- Concerning the characteristics of the participants in our analysis, a majority of farmers are male with less than 10% female respondents in both watersheds. On average, Maumee farmers are slightly younger than Saginaw farmers (57 vs 63, respectively), while the majority of famers in both watersheds have some college education, but no degree. More respondents in the Maumee watershed identified as multi-generation farmers with their farm being previously owned and/or operated by a family member (88% vs. 75%, respectively).
- In terms of motivations, Maumee farmers have higher perceptions of risk related to local water quality but farmers in both watersheds “agree” that it is their personal responsibility to protect water quality. Both sets of respondents also possess the same level of moderately high perceived confidence that recommended best management practices protect water quality.
- In terms of barriers, Maumee farmers perceived the barriers to cover crop use as greater than those in the Saginaw, although on average farmers in both watersheds believe that barriers to cover crops limit their ability a little. In terms of general cost and time barriers related to BMPs, cost barriers are perceived are more problematic in both watersheds compared to time barriers.
- In terms of BMP adoption, approximately twice as many Saginaw farmers were using cover crops compared to Maumee farmers (51% vs. 26%, respectively). In terms of reduced tillage, more farmers in the Saginaw have adopted this practice compared to the Maumee (59% vs. 42% respectively). However, a much higher percentage of Saginaw farmers are enrolled in farmer

[1] The analysis informed the following *REAP project output*: future directions to support water quality improvements in agricultural watersheds, and the following *project outcome*: increased knowledge of current obstacles that must be addressed by current voluntary approaches.

incentive programs including EQUIP, CRP, and CSP (65% compared to 26% in the Maumee), despite the relatively higher use of nutrient trapping practices in the Maumee (using filter strips, saturated buffers, grass waterways). Maumee farmers also had higher adoption rates of right time (i.e., avoiding application before rain event, choosing spring over fall or winter) and right rate (i.e., application rates based on soil testing) practices. This may be due to the level of outreach done by the 4R Nutrient Stewardship Program in the Maumee watershed.

What factors drive adoption?

Our analyses indicate that the following factors explain adoption of the BMPs that are often the focus of GLRI investments.

- RIGHT TIME: The individuals *more likely to be applying fertilizers at the right time* were those who were younger, more educated, more concerned about water quality, perceived greater responsibility for water quality, and with more farming experience (for the Maumee only).
- COVER CROPS: The individuals *more likely to be using cover crops* were those with more education, who were already using reduced tillage and who were less concerned about cover crop barriers (i.e., issues related to the time required to implement cover crops, the cost, lack of equipment, uncertain long-term payback). This held true for both watersheds with the exception of education that was only significant for the Saginaw.
- RIGHT RATE: The individuals *more likely to be applying fertilizer at rates informed by soil tests* were younger farmers already using reduced tillage. For the Saginaw, right rate practices also increased with greater confidence in BMPs, while in the Maumee, right rate practices decreased with greater concern about cost-related barriers.
- REDUCED TILLAGE: The individuals *more likely to be using reduced tillage* were older farmers, while in the Maumee reduced tillage was also more common among those with higher water quality risk perception. Farmers in the Saginaw were also less likely to use reduced tillage as their perception of cost barriers increased.
- NUTRIENT TRAPPING: The individuals *more likely to have installed nutrient trapping practices (e.g., filter strips)* were those participating in incentive-based programs, while in the Saginaw nutrient trapping practices were more common among those that were confident that recommended management practices protected water quality.

What is the impact of GLRI programs?

Overall, we find evidence from two specific GLRI projects, that GLRI investments in farmer engagement and outreach do increase farmer knowledge about recommended practices, as well as confidence in some cases (for cover crops and no-till in particular). However, such events did not increase concern about the issues in general, and there is some evidence that outreach events are more meaningful for the non-farming public as a means of increasing their understanding of the issues and the role of agriculture. Despite these short-term positive impacts on farmer knowledge and beliefs, we do not see evidence that future intentions to use recommended practices increase as a result of participating in GLRI programming. The one exception to this is for cover crops, where these programs do seem to increase positive intentions. However, the best predictor of future use of a practice is past use.

Recommendations

- Future GLRI investments should recognize that each priority watershed is different, and the needs of the farming population will vary, as will the type of practices that are needed to decrease nutrient loss and improve water quality.
- Younger and more educated farmers have a tendency to be using a suite of recommended practices more often, indicating that older farmers with less education are in greater need of education and assistance.
- Applying fertilizer at the right time, both within and between seasons, is the one set of recommended practices that seems dependent on concern about water quality and feeling personally responsible for water quality issues. This would be an appropriate focus for future outreach, education and engagement through GLRI.
- Confidence in the recommended practices as a feasible and effective solution to nutrient loss and water quality issues is critical to promoting adoption, this could be a key focus of GLRI funding in the future (demonstrating effectiveness through demonstration farms and support for trial adoption of practices).
- Incentive based programs seem to be critical for nutrient trapping practices, which makes sense given the collective benefit nature of such approaches.
- Current outreach and engagement through the GLRI may be having a short-term impact on farmer beliefs and knowledge, but there is less evidence that it is leading to long-term change.
- There is evidence that concerns about the costs associated with recommended practices is a significant barrier, point to the need for well-designed incentive programs where the cost is prohibitive, as well as education to correct misperceptions about costs over time.

Introduction

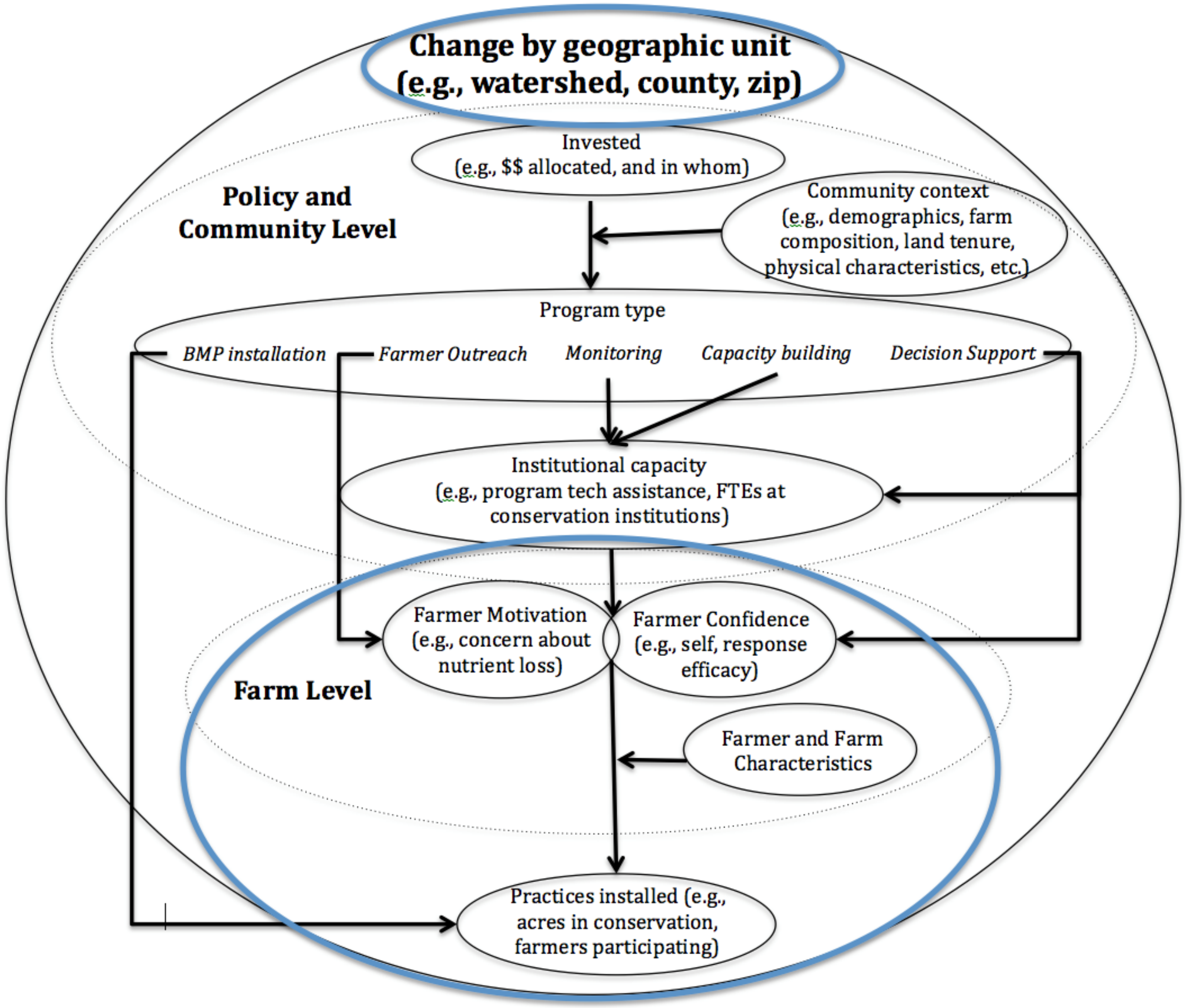
Project Background

Researching the Effectiveness of Agricultural Programs

Agricultural producers in the Great Lakes Basin have received over $100 million from the Great Lakes Restoration Initiative for agricultural conservation practices intended to influence on-farm decision making and improve water quality. The data presented in this report is one component of a GLRI-funded project using socio-economic analytics to evaluate the effectiveness of those federal (and selected state) incentives, using multiple indicators of success to better understand obstacles and opportunities for enhancing on-farm decision-making to improve water quality (see Fig. 1). The goal of the analysis presented here is to compare farmer adoption of conservation practices between two priority watersheds using existing survey data. The hope is that such an analysis can identify ways to improve future GLRI investments that better account for the needs of the local farming populations, and the unique motivations and constraints. A follow-up survey in four priority watersheds will further quantify these findings.

Specifically, the analysis addresses *why* changes in adoption occur through a set of correlational analyses, and *what* tangible benefits may result from GLRI investments at the farm level through a case study analysis of a pre-post survey data for two particular GLRI projects. The expected outcomes include: (1) an assessment of current knowledge, beliefs, intentions etc. at the farm level, and (2) an assessment of differences between the Saginaw and Maumee watersheds. These outcomes are reflected in Fig. 1, which demonstrates where this particular analysis (i.e., Task 4a) fits into the broader project. Specifically, in this task we are considering how farmer motivations, such as risk perception related to local water quality and confidence in BMPs, may influence BMP adoption at the farm level. We are also interested in how adoption may be influenced by other characteristics of the farm or farmer (e.g., farm size and farmer education), and how these relationships vary at different spatial scales (between priority watersheds and within priority watersheds by county or sub-watershed) (see Fig. 1).

Figure 1. REAP conceptual model highlighting the components of the analysis in Task 4a (blue circles)



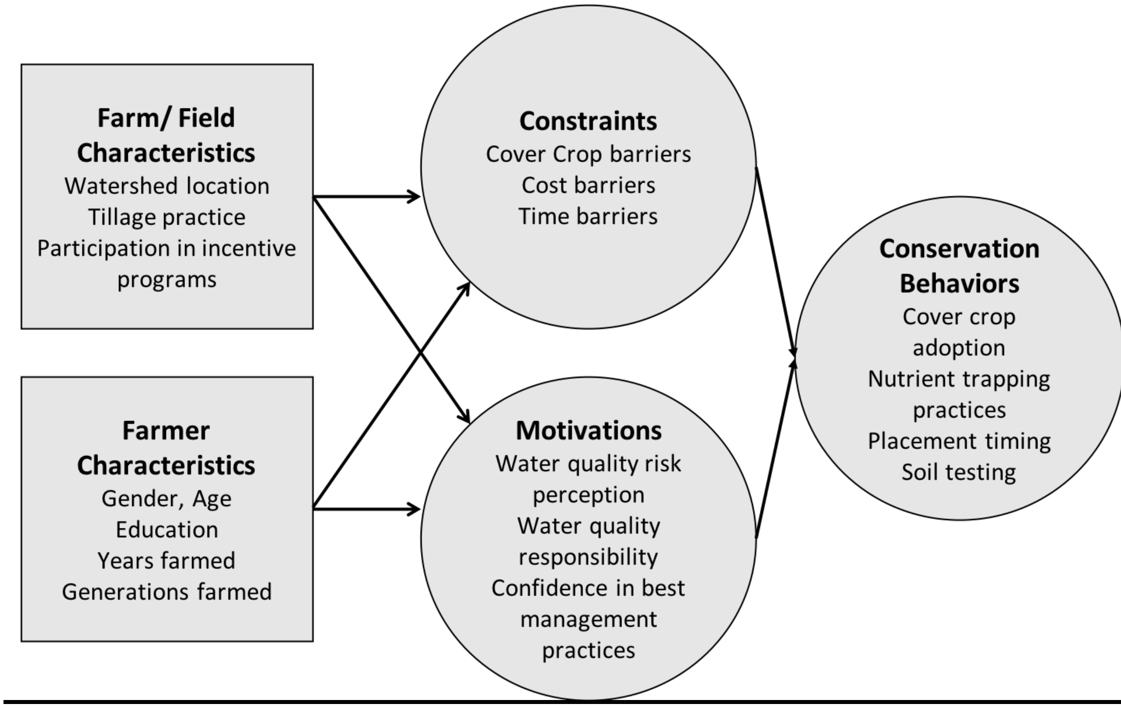
Using the existing survey data that we collected and aggregated for the Saginaw and Maumee watersheds (see Fig. 2), this analysis serves to answer 3 specific research questions:

(1) How do priority watersheds differ in their farm and farmer characteristics, beliefs, and conservation adoption?

(2) What socio-psychological factors are driving adoption of recommended practices?

(3) What is the impact of GLRI programs on key drivers of adoption?

Figure 2. Overlapping existing data in the Saginaw and Maumee Watershed



Methodology

Step 1: Identify existing survey instruments

Initially, a total of twenty-three survey instruments were identified that could be used to investigate farmer and farm characteristics, farmer motivation, confidence and practice adoption across the Saginaw, Maumee, and Lower Fox watersheds. No prior surveys were located for the Genessee watershed. Of the three surveys located in the Lower Fox, two were determined to have duplicate data so one was removed from consideration. Six of the Saginaw watershed surveys originated from the Social Indicators Database Management and Analysis system (SIDMA). Two of such survey instruments from Genesee County and South Branch Flint River were unobtainable. An additional four SIDMA surveys were taken out of consideration because they were not included in the priority watersheds (e.g., western Lake Erie basin but not Maumee). Two surveys were unable to be geolocated in terms of watershed but were suspected they included respondents in the Maumee and/or Saginaw watersheds One of such surveys instruments however, was unobtainable. From the six survey instruments identified in the Maumee watershed, one was unobtainable and one was taken out of consideration because recent data was still being processed. As a result, the following survey instruments were collected for further consideration (see Table 1).

Table 1. Initial survey instruments

Watershed	Survey Instrument	Institutions
Lower Fox	Brown and Outagamie Counties' Land and Water Conservation Department Questionnaire	Alliance for the Great Lakes
	View on Lower Fox and Green Bay Water Resources: Responses from Dairy Farmers	University of Wisconsin
Saginaw	Your View on Local Water Resources	Purdue University, MABA, IWR/ Michigan State University
	Sediment Reduction in the Sebewaing Watershed 2012	Social Indicators Database Management and Analysis systems
	Sediment Reduction in the Sebewaing Watershed 2015	Social Indicators Database Management and Analysis systems
	Sediment Reduction in the Swartz Creek Watershed 2012	Social Indicators Database Management and Analysis systems
	Sediment Reduction in the Swartz Creek Watershed 2015	Social Indicators Database Management and Analysis systems
Maumee	2014 Nutrient Management in the Maumee Watershed	Ohio State University, Purdue University, Michigan State University
	2012 Farmer BMP Survey	Ohio State University
	Blanchard River Demonstration Network Farm Evaluation Survey	Ohio State University, USDA, OFB
	2016 4R Nutrient Stewardship in the WLEB	Ohio State University, TNC, USDA, IPNI
Saginaw/ Maumee	Crop Management and Stewardship Practices	Michigan State University

Step 2: Combine survey instruments, grouping variables and identifying overlap

We began by creating a database listing all survey instruments and specific survey questions included in each instrument. The database was examined and sorted to identify "groupings" of questions that we determined addressed the same type of variable (e.g., identifying all questions that sought to measure the variable "water quality risk perception"). Variable "groups" were then created that represented the variable that several survey instrument questions were aiming to measure.

An early version of the database identified the following potential variable groups (each variable group contained several survey instruments with various prompts and scales of measurement):

Watershed familiarity, familiarity of agricultural and environmental issues, social connections, social trust, water quality knowledge, water quality control, nutrient loss control, water quality risk perception, nutrient loss risk perception, BMP efficacy, 4R awareness, management/ economic concern, legal concern, prioritization of conservation, farmer identity, risk attitude, location, farming experience, generations farming, off-farm job, income, acreage, livestock, and current practices on farm/field.

Survey instruments were then further analyzed to see what could be feasibly grouped into the same category. Emerging patterns were noted and recorded such as the observation that across multiple surveys, questions regarding the use of grassed waterways, filter strips, and riparian buffers could be combined into a measure of "nutrient trapping" practices. The variable groups were then examined to see where they overlapped in terms of survey and watershed. For a variable group to be identified as overlapping, it needed to exist in at least one survey dataset per watershed. A new database was then created with the following shorter list of overlapping variable groups:

Specific practices (4Rs, crop rotation, livestock practices etc), use of crop advisor, barriers to specific practices, broad barriers (cost, time, knowledge), social connections, social trust, information frequency, farmer conservation identity, field and farm acreage, program participation, demographics, risk perception, efficacy, and income

We then identified where overlap occurred on a watershed level, meaning that the variable group exists in at least one of the survey datasets per watershed. Variables where overlap occurred in all three watersheds was highlighted and presented in a similar manner to Table 2.

Table 2. Variable overlap in Lower Fox, Saginaw, and Maumee Watersheds

Variables	Lower Fox	Saginaw	Maumee
Gender	X	X	X
Age	X	X	X
Education level	X	X	X
Location of farm	X	X	X
Nutrient trapping practice	X	X	X
Drainage water management	X	X	X
Tillage practice	X	X	X
Cover crops practice	X	X	X
Nutrient management plan	X	X	X
Future intention of nutrient soil trapping	X	X	X
Future intention of cover crops	X	X	X
Barriers to broad management practices	X	X	X
Information source preference	X	X	X
Water quality risk perception	X	X	X
Water quality responsibility	X	X	X
Water quality control	X	X	X
Acreage of specific crop/ use	X	X	X
Livestock on farm	X	X	X
Decision making on farm	X	X	X
Family-owned farm	X	X	X

Step 3: Request data on specific variables from researchers

With this initial refined list of potential overlap, we were able to request the raw data from researchers. Two options were given to either 1) share their entire dataset or 2) provide for us only the specific survey instrument questions we identified as potentially overlapping and needed for analysis. A document was created listing each of the specific survey instrument questions needed from each survey to inform what data to ask for from each survey owner. Researchers were given the opportunity to send datasets from early April to the end of July. Multiple reminder emails were sent to researchers who had not yet replied, or replied and had not yet sent data, including a final email sent in July that stated we would be accepting datasets until the end of the month. Table 3. displays the final list of surveys for which we received data.

Table 3. List of surveys received in data request

Watershed	Survey Instrument	Institutions
Lower Fox	Brown and Outagamie Counties' Land and Water Conservation Dept Questionnaire	Alliance for the Great Lakes
Saginaw	Your View on Local Water Resources	Purdue University, MABA, IWR/ Michigan State University
	Sediment Reduction in the Sebewaing Watershed 2012*	Social Indicators Database Management and Analysis systems
	Sediment Reduction in the Swartz Creek Watershed 2012*	Social Indicators Database Management and Analysis systems
Maumee	2014 Nutrient Management in the Maumee Watershed	Ohio State University, Purdue University, Michigan State University
	2012 Farmer BMP Survey	Ohio State University
	Blanchard River Demonstration Network Farm Evaluation Survey	Ohio State University, USDA, OFB
	2016 4R Nutrient Stewardship in the WLEB	Ohio State University, TNC, USDA, IPNI

*Note: Sebewaing 2015 and Swartz 2015 were removed from analysis due to too small of sample size

Step 4: Combine variable-specific data into database for analysis

Because only one Lower Fox survey was received variable overlap between the three watersheds narrowed, as the one Lower Fox survey did not have as much comparable data. Thus, the focus then shifted to comparing the Saginaw and Maumee Watershed. This increased overlap in a few cases in which variables overlapped for Saginaw and Maumee watersheds but not the Lower Fox. A final database was created with the combined raw data of overlapping variables for each survey included in the analysis.

While details on specific-variable recoding is included in the statistical analysis section of the report, broadly speaking, final variable overlap was based on whether or not survey instrument questions were 1) clearly intending to measure the same concept, and 2) the scales used for measurement could be accurately transformed and/or combined while retaining the meaning and integrity of the data. Through this process, the inclusion of certain questions and instruments shifted due to discovering that they could not be accurately combined into one shared scale. The final overlap of variables by surveys is displayed in Table 4. Information on which specific instruments informed each variable, and how each question was recoded is included in the analysis and results section of the report. For the remainder of the report, the following survey codes will be used to refer to the original source of the data:

Survey Name	**Survey Code**
Sediment Reduction in the Sebewaing Watershed 2012	1
Sediment Reduction in the Swartz Creek Watershed 2012	2
Your View on Local Water Resources	3
2016 4R Nutrient Stewardship in the WLEB	4
2014 Nutrient Management in the Maumee Watershed	5
2012 Farmer BMP Survey	6

Table 4. Overlap of existing variables by survey and watershed

Variable	Survey 1	Survey 2	Survey 3	Survey 4	Survey 5	Survey 6
Gender	X	X	X	X	X	X
Age	X	X	X	X	X	X
Education	X	X	X	X	X	X
Years farmed	X	X		X	X	
Generation farmer	X	X				X
Reduced tillage	X	X	X	X	X	X
Water quality risk perception	X	X	X	X	X	
Water Quality Responsibility	X	X	X	X		
Confidence in practices	X	X	X		X	X
Cover crop barriers	X	X	X	X		
Cost barriers	X	X	X	X		
Time barriers	X	X	X	X		
Cover crop adoption	X	X	X	X	X	X
Right rate adoption	X	X	X	X	X	X
Right time adoption	X	X			X	X
Nutrient trapping adoption	X	X	X			X
Program Participation			X		X	X

Survey Instruments and Methodology

Surveys 1 & 2

Scientists across the Midwest developed the Social Indicators Data Management and Analysis (SIDMA) instrument to measure the social outcomes of water projects as indictors of environmental progress (Prokopy et al., 2009). The system includes core and supplemental indicators along with the process of how to collect and use such indicators. Surveys 1, 2 and 3 utilized for the survey instrument and methodology. We are awaiting more details on the project-specific details for survey 1 and 2.

Survey 3

The "Your Views on Local Water Resources: Saginaw Bay Watershed" survey was distributed to farmers in the Saginaw Bay watershed by the Natural Resource Social Science Lab at Purdue University (Eanes et al,. 2017a) The survey was released as part of a multi-phased, five-year study evaluating the effectiveness and impact of the Saginaw Bay Regional Conservation Program. The population targeted included agricultural producers and non-farming landowners of the Saginaw Bay (only those who identified as agricultural producers were used for the purpose of this analysis). A Freedom of Information Act request for names and addresses of individuals, businesses, and organizations resulted in a sampling frame of those who previously received funding from the Farm Bill. Geocoding six priority sub-watersheds, removing duplicate names and addresses, and a random selection led to a final sample size of 3,000 potential participants randomly divided into two lists of 1,500. Following a five-wave protocol, survey distribution started with two versions of an advance letter. One letter included a $2 inventive sent of 1,500 potential respondents while the other letter included no incentive. The letters contained a website address with a unique access code and a statement of an incoming paper survey for those who wished to not take the survey online. A total of 1,459 responses were recorded with a response rate of 49.5% including refusals (Eanes et al., 2017b).

Survey 4

The "4R Nutrient Management in the Western Lake Erie Basin" survey from The Ohio State University's College of Food, Agriculture, and Environmental Sciences served to study farmers perception around recommended nutrient management practices, the extent to which current research and education was impacting farmers, and to what extent retailer certification was influencing farmer decision making. The survey specifically investigated farmers' perceived barriers to adopting practices on their fields. Survey questions centered on perceived nutrient run-off in their area, perceived efficacy of recommended practices, characteristics of their farm, current management and nutrient application practices, farmer demographics, and a choice experiment examining how farmers make decisions to hire

Nutrient Service Providers. A sample of 3,272 names and mailing addresses for farmers in the Maumee Watershed was obtained from Farm Market ID (http://www.farmmarketid.com). This sample was divided and stratified by farm size with a final sample similar to census data for farms over 50 acres. The implementation process used the Tailored Design Method (Dillman, 2000) Of the 2,574 farmers contacted, 748 responses were used with an adjusted response rate of 29.1% (Prokup et al., 2017)

Survey 5

The "Farmers, Phosphorus and Water Quality" survey was conducted by The Ohio State University's College of Food, Agriculture, and Environmental Sciences School of Environment and Natural Resources. The survey served to investigate farmer decision-making to understand the prevalence of Best Management Practices in the Maumee Watershed, identify the reasoning behind farmers adopting certain BMPs, and investigate their motivation or willingness to adopt additional practices on their farm. The sample included corn and soybean farmers of the Maumee watershed and was purchased from Farm Market ID. The survey administration followed Dillman's Tailored Design (Dillman, 2000). The final round of cover letters included an incentive. Of the 2000 farmers initially targeted, 701 were used for potential analysis with those who did not operate a farm sorted out. The final response was 652 surveys (Wilson et al., 2013).

Survey 6

The "Farmers, Phosphorus and Water Quality: Part II" survey served to better understand the prevalence of various Best Management Practices in the Maumee Watershed, identity why farmers adopt specific BMPS, and identify the motivation behind farmer willingness to adopt additional practices. Of the approximately 12,000 addresses of corn and soybean farmers identified in the Maumee watershed by a private sampling firm, a random sample of 2500 for each of three survey versions was taken. This survey was conducted by researchers from The Ohio State University College of Food, Agricultural and Environmental Sciences and College of Arts and Sciences. The survey included questions over field-specific management practices relating to fields of particular crop productivity. Survey administration followed the Dillman's Tailored Design method (Dillman, 2000). Of the 75000 potential respondents, 3,234 were included in the potential analysis with an adjusted response rate of 43.12%. However, after those no longer farming were removed along with responses with insufficient questions answered, 2,764 were used in analysis (Burnett et al., 2015).

Analysis

The statistical analysis included in this report was created using the Statistical Program for the Social Sciences. To answer the first research question of how priority watersheds differ, we analyzed frequency distributions, measures of central tendency (mean, medium, mode) and valid percentages. The valid percentages were derived from a case-by-case deletion of missing data from each variable analyzed. The resulting data, respective to each watershed, was tested using a T-Test or Mann-Whitney U Test to determine whether or not these characteristics examined differed statistically between watershed. To examine the second research question of what socio-psychological factors are driving adoption of recommended practices, a binary logistic model was used to estimate the likelihood of adoption given a set of predictor variables (the characteristics examined in the first research question). To examine the third research question, about the impact of specific GLRI programs on farmer beliefs and rates of adoption, we used a series of pre-post test analysis (paired samples t-tests) to assess a change in beliefs or intentions following participation in a GLRI program. We also used correlational analyses to assess the extent to which particular changes in beliefs covaried with future intentions (e.g., does an increase in knowledge about cover crops positively correlate with an increase in future intentions to use cover crops?)

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Research Question 1: How do the watersheds differ?

The first research question we set out to answer was the following: how do the priority watersheds differ in their farm and farmer characteristics, beliefs, and conservation adoption? In the following sections we summarize the descriptive results from our analysis comparing the Saginaw and Maumee watersheds using the aggregated data described previously.

Farm and Farmer Characteristics

Gender & Age

Across all surveys, farmers were prompted to identify their gender as "male" or "female". To create a consistent code, gender data in survey 4 and 5 was recoded from [0-male, 1-female] to [1-male, 2-female]. Gender and age data is displayed in Table 5. The majority respondents in Saginaw and Maumee were male (91.4% and 97.1%). In both watersheds, less than 10% of respondents were female (8.6%, 2.9%). For Saginaw, the average age was 62.6 ranging from 28-97. On average, Maumee respondents were slightly younger with a mean age of 57.4 ranging from 18-86. In both watersheds, the most frequent age was 60. The demographics for gender and age was statistically different between the Saginaw and Maumee watershed, where the Saginaw had older farmers and more women ($z= -8.326$, $p=.000$[2] and $t= 9.659$, $p=.000$[3] respectively).[4]

Table 5. Respondent gender and age

	Saginaw				Maumee			
Farmer Demographics	***N***	***Valid %***	***Mean***	***Std. Deviation***	***N***	***Valid%***	***Mean***	***Std. Deviation***
Male	1042	91.4	-	-	4024	97.1	-	-
Female	1042	8.6	-	-	4024	2.9	-	-
Age	944	-	62.6	13.4	3987	-	57.4	12.5

Education & Farming Experience

All surveys shared corresponding measures of education level coded on the same 1-6 categorical scale. Table 6. summarizes the distribution of education level across respondents in the Saginaw and Maumee watershed. For both watersheds, the category most often selected was a high school degree or

[2] Based on an independent samples Mann-Whitney U Test
[3] Based on an independent samples T-Test
[4] When reporting all significance level for T-Test and M-W U Test, it was considered whether or not equal variances were assumed

equivalent. On average however, farmers in the Saginaw and Maumee have an education level of "some college", with the majority reporting some college or less education. Although both groups of respondents have the same average level of education, Saginaw respondents are slightly more educated with a mean response of 3.14 compared to 3.04 for Maumee, reflecting the greater proportion of individuals with some college versus just a high school degree in the Saginaw relative to the Maumee (z= -2.983, p= .003)[5]. Farming experience was determined by self-reported years farmed. This value did not differ significantly between the watersheds with an average 35 years farmed for Saginaw and 38 for Maumee (t= -1.332, p= .183).[6]

Table 6. Respondent's highest level of education (Saginaw n= 1025, Maumee n= 3989)

Watershed	Saginaw	Maumee
Education Completed	***Valid %***	***Valid %***
Some high school	3.4	1.7
High school degree or equivalent	38.2	48.7
Some college, no degree	24.6	18.6
Associate's degree	14.4	11.2
Bachelor's degree	13.8	14.2
Graduate or professional degree	5.6	5.6

Generation Farmer

The variable generation farmer is used to describe whether or not a farmer owns/ operates farmland previously own/operated by family members. For surveys 1 and 2 in the Saginaw watershed, this question was phrased, "did any family member own and operate this farm before you did" with the options "no" or "yes". For surveys 5 and 6 in the Maumee watershed, the question was phrased, "how many generations has your family been farming some portion of your current operation" with options to checkmark whether or not the respondent was a first, second, or third generation farmer. Data from both phrasings of the question was recoded to simply answer whether or not the respondent was a multi-generation farmer. The recoded data on whether or not the respondent was a multi-generation farmer was given the value of [0- no, 1- yes]. On average, respondents in both watersheds were multi-generation

[5] Based on an independent samples Mann-Whitney U Test
[6] Based on an independent samples T-Test

farmers. Table 7 shows the percentage of farmers who identified as multi-generation farmers. More respondents in the Maumee watershed reported being multi-generation farmers (z= -4.250, p= .000).[7]

Table 7. Percentage of multi-generation farmers by watershed

Watershed	N	Label	Valid Percent
Saginaw	111*	Not multi-generation farmer	25.2
		Multi-generation farmer	74.8
Maumee	3283	Not multi-generation farmer	11.8
		Multi-generation farmer	88.2

*Small sample size due to variable only being represented in surveys 1 & 2

Current Reduced Tillage

We define reduced tillage as any form of tillage that leaves greater than 30% of the crop residue on the soil surface (e.g., conservation tillage, no-till, strip tillage, ridge tillage, etc). Varying measures of tillage practice across all six surveys were consolidated to represent a categorical variable of [0- Conventional tillage, 1- Reduced tillage] practice on farm. For surveys 1 and 2, only a measure of experience with "no-till" was measured. Because the practice of no-till is included in the category of reduced tillage, we proceeded to include this question in the combined variable of reduced tillage for Saginaw. The concept of no-till was presented as "planting seeds into narrow tilled strips in soil previously untilled by full-width inversion implements to reduce soil erosion" The respondent was asked to report familiarity with practice on a scale of 1-4 with [1- Never heard of it, 2- Somewhat familiar with it, 3- Know how to use it, not currently using it, 4- Currently using it, 9- Not relevant]. The "not relevant" option was coded out as we wanted to measure tillage-use among farmers whom it applied to as best as possible. Options 1-3 were coded as [0- conventional tillage] and option 4 was coded [1- reduced tillage].

Survey 3 measured reduced tillage through the prompt, "reduced-tillage: (e.g., no-till, strip-till, ridge-till). Reduced tillage is a practice that leaves crop residue from the previous year on the fields, while limiting soil distributing activities to only those necessary to place nutrients, condition residue and plant crops." Respondents were asked to select an option that best described their experience with reduced tillage including [1- Not relevant, 2- Never heard of it and not willing to try it, 3- Never heard of it, but might be willing to try it, 4- Heard of it and not willing to try it, 5- Heard of it and might be willing to try it, 6- Used it in the past and not willing to try it again, 7- Used it in the past and might be willing to try it

[7] Based on an independent samples Mann-Whitney U Test

again, 8- Currently use it] As in surveys 1 and 2, "not relevant" was coded out. Options 2-7 were used as indicators that farmer was not using reduced tillage practice and recoded as [0- conventional tillage] and option 8 was recoded as [1- reduced tillage].

Surveys 4 and 5 had the exact same question measuring reduced tillage practice. This question was phrased, "What type of tillage was last used in this field based on crop residue after planting?" Options included [1-Conventional (<30% residue), 2- Conservation (30-90% residue), 3- No-till (>90% residue)] To measure those practicing reduced tillage, option 1 was coded as [0- conventional tillage] while 2 and 3 were [1- reduced tillage]. The option existed to use a different phrasing of the question in survey 5, which stated, "across your total farm operation, what % of your planted acreage was in each type of tillage this past year?" However, the question in survey 5 that was identical to the tillage question in survey 4 was used to keep consistency when possible.

Survey 6 gave respondents the opportunity to circle a number indicating how often they engaged in "No-till (90% or more post-planting residue)" and "Conservation tillage (30-90% post-planting residue). The response options included [0- Never, 1- Sometimes, 2- Always]. This frequency measure was recoded to inform the [no, yes] usage variable by determining that [1- Sometimes, 2- Always] represented a [1- reduced tillage] as *sometimes* still indicates engagement.

As seen in Table 8, farmers in the Saginaw watershed had more adoption of reduced tillage (z= -9.912, p= .000).[8]

Table 8. Percentage of farmers who practice reduced-tillage by watershed

Label	Watershed	N	Valid Percent
Practice some form of reduced tillage	Saginaw	782	59.1%
	Maumee	3901	42.2%

Motivations

Water Quality Risk Perception

Across surveys 1-5, survey questions or items were chosen that were intended to measure farmer water quality risk perception (e.g., measures of concern, problem severity, and perception of pollutants, sources, consequences and quality of local water bodies and Lake Erie). Table 9. displays the scope of prompts merged under the water quality risk perception. An attempt was made to remain as objective as possible when measuring risk perception and avoid prompts such as, "How concerned are you about your

[8] Based on an independent samples Mann-Whitney U Test

farm contributing to algal blooms in lake Erie?" (Survey 4), as a question like this brings into consideration whether or not the farmer believes their farm is contributing to water quality risks. It would not be valid to compare this question against the questions in surveys 1-3 that are not specific to the consideration of one's farm.

Surveys 1-3 used the same response scale which included [1- not a problem, 2- slight problem, 3- moderate problem, 4- severe problem, 5- don't know] option [5- don't know] was coded out and not included in the scaled measure of risk perception. Survey 4 prompted the respondent to circle a number that best represented how concerned they were on a level from [0- not at all concerned, to 6- extremely concerned]. This question was recoded to match the 4-option scale from surveys 1-3 because it was more logical to condense a 6-point scale to a 4-point scale than to stretch the 4-point scale. [0- not at all concerned] was recoded to represent a [1- no water quality risk perception], [1,2] on the concern scale was recoded to represent [2- slight water quality risk perception], [3,4] on the concern scale was recoded to represent [3- moderate water quality risk perception], and [5,6] on the concern scale was recoded to represent [4- severe water quality risk perception].

Survey 5 included three types of questions with three separate scales. The first question asked the respondent to rate overall water quality locally and in Lake Erie. This was coded on a scale of [-3- very bad, 0- neither good nor bad, 3- very good]. [-3- very bad] was recoded as [4- severe water quality risk perception], [-2, -1] rating was recoded as [3- moderate water quality risk perception], [0, 1, 2] rating was recoded as [2- slight water quality risk perception] and [3-very good] was recoded as [1- no water quality risk perception]. The next question was similar to the concern question in Survey 4 with an identical scale of [0- not at all concerned, to 6- extremely concerned]. The only difference was the specification of concern in western Lake Erie as opposed to Lake Erie in survey 4. This question was recoded in the same manner as in survey 4. The final question was an indication of how serious respondents felt the negative consequences of nutrient loss would be in western Lake Erie. This question included a scale of [0- not at all serious, 1- slightly serious, 3-serious, 4- moderately serious, 5- extremely serious]. [0- not at all serious] was recoded to [0- no water quality risk perception], [1, slightly serious] was recoded to [2- slight water quality risk perception], [3- serious, 4- moderately serious] was recoded to [3- moderate water quality risk perception], and [5- extremely serious] was recoded to [4- severe water quality risk perception].

Table 10. illustrates the average level of water quality risk perception. Overall, respondents in the Maumee watershed possess higher water quality risk perception than respondents in the Saginaw (z= -9.912, p= .000).[9] For Saginaw farmers, the most frequent response indicated "slight water quality risk

[9] Based on an independent samples Mann-Whitney U Test

perception" while the most frequent response for the Maumee watershed indicated "moderate water quality risk perception".

Table 9. Measures of water quality risk perception in surveys 1-5

Survey			Water Quality Measure
Saginaw	How much of a problem are the following…	1	water impairments in your area? (sedimentation in the water, nitrogen, phosphorus)
			sources in your area? (soil erosion from farm fields, soil erosion from shorelines/ streambanks, excessive use of lawn fertilizers etc. *3 more sources listed)*
			issues in your area? (loss of desirable fish species, reduced beauty of lakes or streams, reduced quality of water recreation activities, excessive aquatic plants or algae)
		2	water impairments in your area? (sedimentation in the water, nitrogen, phosphorus)
			sources in your area? (soil erosion from farm fields, soil erosion from shorelines/ streambanks, excessive use of lawn fertilizers etc. *4 more sources listed)*
			issues in your area? (loss of desirable fish species, reduced beauty of lakes or streams, reduced quality of water recreation activities, excessive aquatic plants or algae)
		3	pollutants in the Saginaw Bay watershed? (sedimentation, nitrogen, phosphorus, bacteria, muck)
			sources in the Saginaw Bay watershed? (discharges from industry into streams and lakes, discharges from wastewater, soil erosion from farm fields, etc. *10 more sources)*
			issues in the Saginaw bay watershed? (contaminated drinking water, contaminated fish, loss of desirable fish species, etc. *7 more issues)*
Maumee		4	Please circle the number that best represents how concerned you are about the following issues: the negative impacts of nutrient loss on Lake Erie
			How would you rate the overall quality of the water in the rivers, streams, and lakes the water in lake Erie How would you rate the overall quality of the water in Lake Erie?
		5	Please circle the number that indicates how serious you feel the negative consequences of nutrient loss in western lake Erie are to (you and your family, your local community, communities on and around lake Erie, plants and animals in local streams, plants and animals in Lake Erie)

Table 10. Average water quality risk perception

Watershed	N	Mean	Std. Deviation
Saginaw	925	2.4	.65
Maumee	3530	2.8	.64

Water Quality Responsibility

Surveys 1, 2, and 3 contained the exact wording, "it is my personal responsibility to help protect water quality" and were measured on a scale of [1- strongly disagree, 2- disagree, 3- agree nor disagree, 4- agree, 5- strongly agree]. Survey 4 asked, "it is my personal responsibility to help protect local water quality" and was measured on a scale of [-2- strongly disagree, -1- disagree, 0- neither disagree nor agree, 1- agree, 2- strongly agree]. This scale was recoded to match the 1-5 scale of surveys 1, 2, and 3. As seen in Table 11., the majority of respondents in both Saginaw and Maumee agree that, "it is my personal responsibility to help protect water quality". There was so significant difference in perceived water quality responsibility between watersheds (t= .856, p= .392).[10]

Table 11. Distribution of farmers agreeing with personal responsibility to protect water quality

Survey	N	Strongly disagree (%)	Disagree (%)	Agree nor disagree (%)	Agree (%)	Strongly Agree (%)
Saginaw	985	.7%	.5%	8.7%	60.9%	29.1%
Maumee	2768	.1%	.9%	8.3%	64.9%	25.8%

Confidence in Best Management Practices

Surveys 1-3 measured confidence in best management practices with the same prompt and scale of, "Using recommended management practices on farms improves water quality" [1- strongly disagree, 2- disagree, 3- neither agree nor disagree, 4- agree, 5- strongly agree]. Survey 4 asked, "To what extent can the widespread adoption of these practices improve water quality in western lake Erie". Such best management practices included "avoiding broadcasting when the forecast predicts a 50% or more chance of at least 1 inch of total rainfall in the next 12 hours", "avoiding surface application of phosphorus on frozen ground", "incorporating broadcast fertilizer (via tillage)", "subsurface placement of fertilizer (via banding or in-furrow with seed)", "determining rates based on regular soil testing once within the rotation (or every three years" and "incorporating winter wheat or cereal rye cover into rotation". These prompts were coded on a scale of [0- not at all, 1- a little, 2- somewhat, 3- a good deal, 4- to a great extent] and

[10] Based on an independent samples T-Test

recoded to represent a 1-5 scale matching the confidence measures of surveys 1-3. It was determined that "not at all" was synonymous with "strongly disagree (that adoption of practices improve water quality)" and the labels were adjusted accordingly to now fit a 1-5 scale of agreement with the prompt statement. The six best management practices were then combined and calculated to find the average confidence level across all management practices. Survey 6 measured confidence with the question, "to what extent do you agree or disagree that nutrient management practices (like filter strips and cover crops) improve water quality". The scale spanned [-2- strongly disagree, -1- disagree, 0- neither disagree nor agree, 1- agree, 2- strongly agree]. Because this scale was already a 5-point scale, the numbers were recoded to range from [-2-2] to [1-5].

Table 12. displays the average level of confidence that best management practices improve water quality. On average, farmers in both the Saginaw and Maumee agree that using best management practices improve water quality. There is no significant difference between confidence in BMPs between farmers in each watershed (t= .891, p= .373).[11]

Table 12. Confidence that best management practices improve water quality

Watershed	N	Mean	Std. Deviation
Saginaw	986	4.0 (Agree)	.74
Maumee	1334	4.0 (Agree)	.85

[11] Based on an independent samples T-Test

Constraints

Cover Crop Barriers

Questions were identified in surveys 1-4 that specifically identified barriers to adopting cover crops. While each dataset varied on the specific prompt, all barriers relating to cover crop adoption was consolidated to represent a broad sense of the level of perceived barriers existing to cover crop adoption in each watershed. Table 13 illustrates the range of barriers included in the overall cover crop adoption barrier variable. Questions for surveys 1, 2, and 3 were coded to answer how much the following factors limited one's ability to implement cover crops by [1- not at all, 2- a little, 3- some, 4- a lot, 5- don't know]. Option 5 was coded out as it did not support the measure for level of perceived barriers. The scale from surveys 1-3 was used as the final scale that survey 4 was recoded to match. Survey 4 asked to what extent the respondent agreed or disagreed with each statement scaled [-2- strongly disagree, -1- disagree, 0- neutral, 1- agree, 2- strongly agree]. [-2 strongly disagree] was recoded to [1- limit your ability not at all], [-1 disagree, 0- neutral] was recoded to [2- limit your ability a little], [1- agree] was recoded to [3- limit your ability some] and [2- strongly agree] was recoded to [4- limit your ability a lot]

The average perceived barriers to cover crop adoption are low in both watersheds (i.e., barriers limit your ability a little), but greater in the Maumee (t= -6.978, p=.000).[12]

[12] Based on an independent samples T-Test

Table 13. Specific barriers to cover crop adoption

Watershed	Survey	Barrier to Cover Crop Adoption
Saginaw	1 & 2	Don't know how to do it
		Time required
		Cost
		The features of my property make it difficult
		Insufficient proof or water quality benefit
		Desire to keep things the way they are
		Hard to use with my farming system
		Lack of Equipment
	3	Don't know how to do it
		Time required
		Cost
		Hard to use with farming operation
		Lack of equipment/ technology
		My agronomist/ crop advisor has never mentioned this practice
		My agronomist/ crop advisor suggest not doing this practice
Maumee	4	The profit margins for winter wheat are too small
		Establishing winter cover crops is too difficult due to uncertain planting window
		The risks of winter cover crops interfering with spring planting are too great
		The near term cost of cover crops is too great for the uncertain long-term payback

Table 14. Average perception of level at which barriers limit cover crop adoption

Watershed	N	Mean*	Std. Deviation
Saginaw	700	2.2	.84
Maumee	729	2.5	.57

*[1- not at all, 2- a little, 3- some, 4- a lot, 5- don't know]

Cost and Time Barriers

The method behind choosing and recoding data to represent cost and time barriers was replicate to that of cover crop barriers resulting in a prompt and scale of "how much the following factors limited one's ability to implement cover crops" [1- not at all, 2- a little, 3- some, 4- a lot]. Instead of choosing a wide range of barriers associated with cover crop practices, the cost and time barriers associated with a wide range of practices were combined to create a variable of broad cost barriers to implement recommended practices.

For survey 1, the cost variables associated with residue retention, cover crops, and filter strips were chosen along with two cost prompts included in a measure of broad barriers to change management practices. These two cost prompts read, "personal out of pocket expense" and "lack of government funds". Survey 2 contained identical variables and prompts with the exception of adding one more cost variable for soil tests. Survey 3 included cost barriers associated with cover crops, reduced tillage, and nutrient management plans. Survey 4 included cost barriers associated with nutrient placement, soil tests, and cover crops.

For survey 1, time barriers associated with no-till, residue retention, cover crops, and filter strips were consolidated to create the broad barrier of time to engage in adoption. Survey 2 time barriers came from soil tests, no-till, cover crops, and filter strips. Survey 3 included time barriers connected to cover crops, reduced tillage, and nutrient management plans. Survey 4 had time barriers associated with alternatives to broadcasting.

As seen in Table 15., on average, cost barriers are perceived as slightly higher than time barriers in both the Saginaw and Maumee watersheds. Cost and time barriers were similar among watersheds, but farmers in the Maumee perceived the barriers as slightly higher. The difference in cost and time barriers were significantly different between the two watersheds (t= -3.701, p=.000 and -6.511, p= .000, respectively).[13]

[13] Based on an independent samples T-Test

Table 15. Average perception of the degree to which cost and time barriers limit practice adoption

Barrier	Watershed	N	Mean	Std. Deviation
Cost Barrier	Saginaw	911	2.3	.94
	Maumee	729	2.4	.46
Time Barrier	Saginaw	895	2.1	.94
	Maumee	727	2.3	.64

*[1- not at all, 2- a little, 3- some, 4- a lot, 5- don't know]

Practices

Cover Crop Adoption

Current cover crop adoption was measured across all surveys in the form of [0- no cover crop, 1- yes cover crop]. Surveys 1 and 2 included a measure for current cover crop adoption in the question "how familiar are you with this (cover crop) practice?". Options ranged from [1- never heard of it, 2- somewhat familiar with it, 3- know how to use it; not using it, 4- currently using in, 9- not relevant]. Option 9 was coded out, while options [1-3] were coded as [0- no cover crop] and option [4] was coded as [1- yes cover crop].

Survey 3 measured cover crop adoption through the prompt, "Cover crops are planted for erosion production, soil improvement, and water quality improvement." Respondents were asked to select an option that best described their experience with cover crops including [1- Not relevant, 2- Never heard of it and not willing to try it, 3- Never heard of it, but might be willing to try it, 4- Heard of it and not willing to try it, 5- Heard of it and might be willing to try it, 6- Used it in the past and not willing to try it again, 7- Used it in the past and might be willing to try it again, 8- Currently use it]. As in the surveys 1 and 2, [1- Not relevant] was coded out. Options 2-7 were used as indicators that the farmer was not using crops and recoded as [0- No cover crop] and option 8 was recoded as [1- Yes cover crop].

Survey 4 asked, "was a cover crop planted on this field after the 2015 harvest?" on a [0- No, 1- Yes] scale. There was an option to use the prompt, "in the last three years I have used cover crop/ have not used cover crop" however, a time scale of three years gave a less accurate depiction of current cover crop practice. Survey 5 had a similar prompt and scale to survey 4 with a slight change of wording, "was a cover crop planted on this field after the most recent crop". These questions from surveys 4 and 5 gave the most accurate depiction of current cover crop adoption as possible.

Survey 6 asked whether respondents planted cover crops after row crop harvest never, sometimes, or always. Sometimes and always were chosen to represent the [1- Yes cover crop]. This was the result of a decision that *sometimes* still implied adoption.

As seen in Table 16., 51% of Saginaw farmers reported having adopted cover crops while only 26.2% of Maumee farmers reported using cover crops. The adoption rate of cover crops in the Saginaw is statistically different to that of the Maumee (z= -13.827, p= .000)[14]

Table 16. Percentage of farmers reporting current cover crop use on their farm

Watershed	N	Value	Valid %
Saginaw	760	No cover crop use	48.8
		Yes cover crop use	51.2
Maumee	4199	No cover crop use	73.8
		Yes cover crop use	26.2

Right Time Practices

We define the "right time" as choosing to be precise in the timing of fertilizer application, whether that is considering the best timing within (e.g., avoiding application before a rain event) or between seasons (e.g., choosing spring over fall or winter). As with cover crop adoption, current right time practices were coded into two categories [0- No right time] and [1- Yes right time]. For each survey, the right time variable included any or all of the practices that fall under the broad 4R "Right Time" management category (https://www.nutrientstewardship.com/4rs/). For surveys 1, 2, and 6, these practices included, "avoid fall application of manure or nitrogen fertilizer." Survey 4 similarly contained "avoiding fall/winter application of phosphorus" and also included "avoiding winter or frozen ground surface application of phosphorus" and "delaying broadcasting when the forecast predicts a 50% or more chance of at least 1 inch of total rainfall in the next 12 hours".

Table 17. displays the percentage of right time adopters vs. non-adopters in the Saginaw and Maumee watersheds. Maumee farmers have a higher adoption rate at 58.5% than Saginaw farmers with an adoption rate of 50.5% (z= -1.510, p= .131).[15] The strong presence of 4R Nutrient Stewardship in the Maumee watershed supports this trend of higher right time adoption rate as "Right Time" is included in the 4-Rs of right source, right time, right rate, and right place, a campaign that is very prevalent in the western Lake Erie basin (https://www.nutrientstewardship.com/4rs/).

[14] Based on an independent samples Mann-Whitney U Test
[15] Based on an independent samples Mann-Whitney U Test

Table 17. Percentage of farmers adopting right time practices

Watershed	N	Value	Valid %
Saginaw	91*	No right time use	49.5
		Yes right time use	50.5
Maumee	3459	No right time use	41.5
		Yes right time use	58.5

*Small sample size due to variable only being represented in surveys 1 & 2

Right Rate Practices

We define "right rate" practices as an attempt to determine application rates based on soil testing. Expanding the same methodology to calculate cover crop and right time adoption, right rate adoption was identified through the combination of any/all variables associated with 4R right rate adoption. Survey 1 included the practice, "conduct regular soil tests for pH, phosphorus, and nitrogen and potassium". Survey 1 along with survey 2 included, "follow university recommendations for fertilizer rates". Survey 3 contained the practices, "variable rate application of phosphorus" and "regular soil testing." Similarly, the measure for right rate adoption in survey 4 read, "do you use soil testing to inform your nutrient management decisions?" Survey 5 had the most practices listed including, "do you use soil testing on this field to inform your nutrient management decisions?", "grid soil sampling for variable rate application", "determining rates based on regular soil testing once within the rotation (or every three years), and "following soil test trends to maintain the agronomic range for phosphorus in the soil". Survey 6 included, "regular soil testing", "grid (zone) sampling or variable rate fertilizer application", and "one-year of fertilizer per year on a corn crop".

Table 18. contains the percentage of farmers adopting right rate practices. Out of all the practices included in this analysis, right rate practices have the highest adoption rate in both the Saginaw and Maumee. Maumee has a higher percentage adoption of right rate practices than the Saginaw, which further aligns with the high presence of 4R Nutrient Stewardship programs in the Maumee Watershed (z= -11.749, p= .000).[16]

[16] Based on an independent samples Mann-Whitney U Test

Table 18. Percentage of farmers adopting right rate practices

Watershed	N	Value	Valid %
Saginaw	950	No right rate use	28.0
		Yes right rate use	72.0
Maumee	4222	No right rate use	12.7
		Yes right rate use	87.3

Trapping Practices

We define trapping practices as any practice meant to provide a collective benefit to water quality by trapping the soil and water that may leave the field during rain events (e.g., filter strips, saturated buffers, grass waterways, etc). Adoption of nutrient trapping practices appeared in surveys 1, 2, 3, and 6. Surveys 1 and 2 included filter strips. In addition to filter strips survey 1 included residue retention practices. Survey 3 included grass/tree riparian buffers or filter strips, saturated buffers, grassed waterways, winder breaker/shelterbelt establishment, conservation cover, treatment wetland, and grade stabilization structures. Survey 6 included grass waterways, filter strips, and lagoon/wastewater system.

As with right rate and right time practices, nutrient trapping practices have a higher adoption rate in the Maumee watershed as compared to the Saginaw (z= -5.069, p= .000).[17] Table 19. demonstrates the percent adoption of nutrient trapping practices, showing that nutrient trapping practices are used more often than right time practices, but less often than right rate practices in both watersheds.

Table 19. Percentage of farmers adopting nutrient trapping practices

Watershed	N	Value	Valid %
Saginaw	956	No nutrient trapping use	31.1
		Yes nutrient trapping use	68.9
Maumee	680	No nutrient trapping use	19.9
		Yes nutrient trapping use	80.1

[17] Based on an independent samples Mann-Whitney U Test

Program Participation

Incentive-based program participation was included in surveys 3, 5, and 6 and was coded on a basis of [0- no participation] and [1- yes participation]. Overall participation in any program was calculated, with the most common programs being CSP, CRP, and EQUIP. Any other program or participation in an "other" option was also included. As seen in Table 20. describing overall program participation, farmers in the Saginaw watershed indicate a much higher rate of program participation (z= -21.629, p= .000).[18]

Table 20. Overall program participation

Watershed	N	Value	Valid %
Saginaw	838	No program participation	34.7
		Yes program participation	65.3
Maumee	3508	No program participation	74.0
		Yes program participation	26.0

[18] Based on an independent samples Mann-Whitney U Test

Second Research Question: What factors explain adoption?

To answer the second research question, “What socio-psychological factors are driving adoption of recommended practices”, we examined the extent to which the variables that overlapped between data sets could explain adoption rates of recommended practices. Specifically, we were able to investigate predictors to current right time, right rate, reduced tillage, cover crops, and nutrient trapping practices. Regression analysis was used to analyze the relationship between adoption of a particular practice (the dependent variable) and one or more predictors (the independent variables). Because the dependent variables were categorical on the basis of [0- no adoption, 1- yes adoption], logistic regression was chosen as the best statistical technique to answer the research question. We ran two regressions for each management practice to compare how the predictors of adoption may vary between the two priority watersheds.

In order to determine which variables would be chosen to test predictive impact on practice adoption, we had to consider the available overlap of independent and dependent variables at a survey level. Table 4 can once more be used as a visual to examine the existence of variables by survey. Binary logistic regression treats missing data with “listwise deletion”. When listwise deletion occurs, only cases that do not contain any missing data for any of the chosen analysis will be included in the test. Therefore, we could not calculate the predictive potential of a wide range of independent variables at a watershed level due to the fact that there were no surveys that possessed all of the listed variables. As a result, the methodology for choosing how many independent variables from which survey to explain adoption rates was based on which combination of surveys could be used to explain adoption of recommended practices with the most available factors. Table 21 displays the surveys and variables used to predict each adopted practice. The most inclusive combination of surveys and independent variables was used to test influence on the dependent practice variables.

Table 21. Independent and dependent predictor variables and survey data used in analysis

Dependent variable	Survey	Independent variable
Right time adoption	1, 2, 5	Gender, Age, Education, Water quality risk perception, Water quality responsibility, Years farmed, Generations farmed
Cover crop adoption	1, 2, 3, 4	Gender, Age, Education, Reduced tillage, Water quality risk perception, Confidence, Cover crop barriers
Right rate adoption	1, 2, 3, 4	Gender, Age, Education, Reduced tillage, Water quality risk perception, Confidence, Cost barriers, Time barriers
Reduced tillage adoption	1, 2, 3, 4	Gender, Age, Education, Water quality risk perception, Confidence, Cost barriers, Time barriers
Nutrient trapping adoption	3, 5	Gender, Age, Education, Confidence, Program participation

Right Time Adoption

The model for applying fertilizer at the "right time" included eight independent variables (gender, age, water quality risk perception, water quality responsibility, years farmed, generation farmer, education). Education was recoded into three categories [1- some high school, 2- high school degree, 3- higher education].

For the Saginaw watershed, the model was not significant ($p > .05$); as a result these results will not be presented. However, the model including all predictors was statistically significant for the Maumee watershed (chi-square (8, N= 2517) = 143.0, $p < .000$), indicating the model could distinguish between respondents who adopted and did not adopt right time practices. The entire model explained between 5.5% (Cox and Snell R square) and 7.4% (Nagelkerke R squared) of the variance in adoption and correctly classified 62.7% of cases. As displayed in Table 22, five of the independent variables made a unique statistically significant contribution to the model (age, education, water quality risk perception, water quality responsibility, years farmed). The odds ratio of .97 inversely indicates that as age increases, the odds of adopting right time practices decreases by 1.03. For education, the odds ratio of 2.14 indicates that compared to having some high school education, those with continued education past high school increase their odds of adopting right time practices by 2.14. The odds ratio for water quality risk perception suggests that each point increase of perceived water quality risk increases the odds of adopting right time practices by 1.70. For each point increase in perceived water quality responsibility, odds of adopting right time practices increase by 1.28. Finally, increasing the number of years farmed increases the odds of adopting right time practices by 1.01. Overall, these results indicate that the likelihood of applying fertilizer at the right time to minimize nutrient loss increases with an education beyond high school, concern about water quality, perceived responsibility for water quality, farming experience, while it decreases with age.

Table 22. Predicting likelihood of adopting "right time" practices in the Maumee

Independent Variable	*B*	S.E	Wald	*df*	*p*	Odds Ratio	95% C.I for Odds Ratio	
							Lower	Upper
Gender	-.33	.31	1.16	1	.28	.72	.39	1.31
Age	-.027	.005	23.58	1	.00	.97	.96	.98
Water quality risk perception	.531	.09	35.43	1	.00	1.70	1.43	2.03
Water quality responsibility	.24	.08	10.70	1	.00	1.28	1.10	1.48
Years farmed	.01	.01	7.73	1	.01	1.01	1.00	1.02
Generation farmer	-.05	.14	.01	1	.73	.953	.73	1.25
HS degree	.27	.33	.70	1	.40	1.32	.69	2.49
Higher education	.76	.33	5.37	1	.02	2.14	1.12	4.07

Cover Crop Adoption

The model explaining cover crop adoption included seven independent variables (gender, age, education, reduced tillage, water quality risk perception, practice confidence, and cover crop barriers). Education was recoded into three categories [1- some high school, 2- high school degree, 3- higher education].

For respondents in the Saginaw Watershed, the model including all predictors was statistically significant (chi-squared (8, N= 517) = 33.51, $p < .000$), indicating the model could distinguish between respondents who adopted and did not adopt cover crops. The entire model explained between 6.3% (Cox and Snell R square) and 8.4% (Nagelkerke R squared) of the variance in adoption and correctly classified 71.5% of cases. As displayed in Table 23, only three of the independent variables made a unique statistically significant contribution to the model (education, reduced tillage, and cover crop barriers). The odds ratio of .72 inversely indicates that for each point increase on the scale of perceived cover crop barriers, the odds of adopting cover crops decreases by 1.39. As compared with some high school education, a higher education degree increased the odds of adopting cover crops by 8.99. Almost significant but slightly above a *p* value of .05 at .06, having a high school degree compared to some high school education increased the odds of adopting cover crops by 7.41. With an odds ratio of 1.50, if a farmer had currently adopted reduced tillage practices, their odds of adopting cover crops increased by 1.5. Overall, this indicates that cover crop use is more likely among those with more education, and those who are already using reduced tillage practices. Adoption is lower among those who perceived the barriers to cover crop use as greater.

The model for the Maumee watershed including all predictors was statistically significant (chi-squared (8, N= 649) = 79.55, $p < .000$), indicating the model could distinguish between respondents who adopted and did not adopt cover crops. The entire model explained between 11.5% (Cox and Snell R square) and 16.5% (Nagelkerke R squared) of the variance in adoption and correctly classified 74.1% of cases. As displayed in Table 24, only two of the independent variables made a unique statistically significant contribution to the model (reduced tillage and cover crop barriers). Farmers already engaging in reduced tillage were twice as likely to use cover crops, increasing odds by a ratio of 1.84. While a one-unit increase in perceived barriers decreased the odds of adopting cover crops by 4.08. Overall, this indicates that as seen in the Saginaw, those using reduced tillage practice are more likely to adopt cover crops and adoption is lower among those who perceive the barriers to cover crop use as greater.

Table 23. Predicting likelihood of adopting cover crop practice in the Saginaw

Independent Variable	*B*	S.E	Wald	*df*	*p*	Odds Ratio	95% C.I for Odds Ratio Lower	95% C.I for Odds Ratio Upper
Gender	-.91	.61	2.22	1	.14	.41	.12	1.33
Age	-.01	.01	1.44	1	.23	.99	.98	.1.00
HS degree	2.00	1.07	3.50	1	.06	7.42	.91	60.47
Higher education	2.20	1.07	4.24	1	.04	8.99	1.11	72.72
Reduced tillage	.37	.19	3.93	1	.05	1.45	1.00	2.09
Water quality risk perception	-.28	.16	3.09	1	.08	.76	.55	1.03
Broad Efficacy	.11	.14	.65	1	.42	1.12	.85	1.47
Cover Crop Barriers	-.329	.11	8.32	1	.00	.72	.58	.90

Table 24. Predicting likelihood of adopting cover crop practice in the Saginaw

Independent Variable	*B*	S.E	Wald	*df*	*p*	Odds Ratio	95% C.I for Odds Ratio Lower	95% C.I for Odds Ratio Upper
Gender	.75	.61	1.51	1	.22	2.11	.64	6.97
Age	-.01	.01	1.14	1	.29	.99	.98	1.00
HS degree	20.18	22834.91	.00	1	1.00	581329406	.00	-
Higher education	20.49	22834.91	.00	1	.99	793749863	.00	-
Reduced tillage	.61	.24	6.42	1	.01	1.84	1.15	2.95
Water quality risk perception	.08	.13	.32	1	.58	1.08	.83	1.40
Broad Efficacy	-.05	.13	.17	1	.68	.95	.73	1.22
Cover Crop Barriers	-1.41	.20	47.45	1	.00	.25	.17	.37

Right Rate

The model for the use of soil tests to inform fertilizer application rates included eight independent variables (gender, age, education, reduced tillage, water quality risk perception, practice confidence, cost barriers, time barriers). Education was recoded into three categories [1- some high school, 2- high school degree, 3- higher education].

Overall, the model for the Saginaw watershed including all predictors was statistically significant (chi-squared (9, N= 584) = 59.69, p < .000), indicating the model could distinguish between respondents who adopted and did not adopt right rate practices. The entire model explained between 9.7% (Cox and Snell R square) and 15.3% (Nagelkerke R squared) of the variance in adoption and correctly classified 80.5% of cases. As displayed in Table 25, five of the independent variables made a unique statistically significant contribution to the model (gender, age, reduced tillage, water quality risk perception, confidence in practices). The odds ratio of .18 inversely indicates that being a female farmer compared to a male farmer decreases the odds of adopting right rate practices by 5.55.[19] The odds ratio of age was .978 inversely indicating that as age increases, the odds of adopting right rate practices decreases by 1.02. Farmers practicing reduced tillage were 1.85 times more likely to be using right rate practices compared to those using conventional tillage. Despite was intuition might suggest, water quality risk perception was inversely related to adoption of right rate practices. Each point increase of water quality risk perception halved the odds of adopting right rate practices. The odds ratio of practice confidence implied that increasing confidence in the efficacy of suggested management practices by one additional point on our scale increased the odds of adopting right rate practices by 1.38. Overall, these results indicate that the likelihood of using right rate practices increases among male farmers (versus female), and those who have confidence in BMPs and are already using reduced tillage practices. Inversely, the likelihood of using right rate practices decreases with age, and concern about local water quality.

The model for the Maumee watershed including all predictors was statistically significant (chi-squared (9, N= 642) = 19.51, p < .021), indicating the model could distinguish between respondents who adopted and did not adopt right rate practices. The entire model explained between 3.0% (Cox and Snell R square) and 6.2% (Nagelkerke R squared) of the variance in adoption and correctly classified 89.7% of cases. As displayed in Table 26., two of the independent variables made a unique statistically significant contribution to the model (age, reduced tillage) with one variable (cost barriers) having a nearly significant contribution (p= .057). The inverse odds ratio for age suggests that as age increases, odds of adopting right rate practices decrease by 1.03. Farmers who already implement reduce tillage double their

[19] Due to very few female respondents (n=28) analysis of gender differences is not included in suggestions

odds of adopting right rate practices. As perceived cost barriers increase, the odds ratio of .55 display that the odds of adopting right rate practices are halved. Overall, farmers who practiced reduced tillage were more likely to adopt right rate practices. Older farmers and those with high perceived cost barriers decreased their odds of adopting right rate practices.

Table 25. Predicting likelihood of adopting right rate practices in the Saginaw

Independent Variable	*B*	S.E	Wald	*df*	*p*	Odds Ratio	95% C.I for Odds Ratio	
							Lower	Upper
Gender	-1.70	.44	14.67	1	.00	.18	.08	.44
Age	-.02	.01	6.19	1	.01	.98	.96	1.0
HS degree	.44	.67	.43	1	.51	1.55	.42	5.70
Higher education	.20	.65	.09	1	.76	1.22	.34	4.39
Reduced tillage	.62	.23	7.35	1	.01	1.85	1.19	2.88
WQ risk	-.66	.19	12.49	1	.00	.52	.36	.74
Practice Confidence	.32	.16	4.32	1	.04	1.38	1.02	1.87
Cost Barriers	.05	.16	.11	1	.74	1.01	.77	1.45

Table 26. Predicting likelihood of adopting right rate practices in the Maumee

Independent Variable	*B*	S.E	Wald	*df*	*p*	Odds Ratio	95% C.I for Odds Ratio	
							Lower	Upper
Gender	-1.05	.71	2.17	1	.14	.35	.09	.20
Age	-.03	.01	5.56	1	.02	.97	.95	.20
HS degree	1.42	1.28	1.22	1	.27	4.12	.33	50.99
Higher education	1.43	1.28	1.24	1	.27	4.18	.34	51.76
Reduced tillage	.77	.29	7.14	1	.01	2.15	1.23	3.77
WQ risk perception	.04	.17	.06	1	.81	1.04	.74	1.47
Practice confidence	.03	.16	.04	1	.85	1.03	.75	1.42
Cost barriers	-.59	.31	3.63	1	.06	.55	.30	1.02
Time barriers	.37	.23	2.63	1	.11	1.45	.93	2.28

Reduced Tillage

The model explaining reduced tillage practices included seven independent variables (gender, age, education, water quality risk perception, practice confidence, cost barriers, time barriers). Education was recoded into three categories [1- some high school, 2- high school degree, 3- higher education].

For respondents in the Saginaw watershed, the model including all predictors was statistically significant (chi-squared (8, N= 598) = 37.13, p < .000), indicating the model could distinguish between respondents who adopted and did not adopt right rate practices. The entire model explained between 6.0% (Cox and Snell R square) and 8.2% (Nagelkerke R squared) of the variance in adoption and correctly classified 64.2% of cases. As displayed in Table 27, only two of the independent variables made a unique statistically significant contribution to the model (age, cost barriers). Contrary to the relationship between age and right rate adoption, the odds ratio of 1.02 indicates that as age increases, the odds of adopting reduced tillage slightly increases by 1.02. Cost barriers produced an odds ratio of .72, which inversely interprets as the odds of adopting reduced tillage decreasing by 1.4 as cost barriers increase by a point. Overall, these results indicate that the likelihood of having reduced tillage practices in place is greater among older farmers, and those who are concerned about cost-related barriers to general BMP use.

The model for the Maumee watershed including all predictors was statistically significant (chi-squared (8, N= 648) = 15.84, p < .045), indicating the model could distinguish between respondents who adopted and did not adopt right rate practices. The entire model explained between 2.4% (Cox and Snell

R square) and 3.7% (Nagelkerke R squared) of the variance in adoption and correctly classified 77.2% of cases. As displayed in Table 28, only two of the independent variables made a unique statistically significant contribution to the model (age, water quality risk perception). As seen in the Saginaw, as farmer age increases, the odds of adopting reduced tillage increases by 1.02. The odds ratio of 1.32 interprets as the odds of adopting reduced tillage increasing by 1.32 as water quality risk perception increases a point on the scale. Overall, older farmers in the Maumee as in the Saginaw have a greater likelihood of implementing reduced tillage. Farmers with higher water quality risk perception increase the probability of implementing reduced tillage.

Table 27. Predicting likelihood of adopting reduced tillage practice in the Saginaw

Independent Variable	***B***	**S.E**	**Wald**	***df***	***p***	**Odds Ratio**	**95% C.I for Odds Ratio**	
Gender	-.34	.43	.65	1	.42	.71	.31	1.64
Age	.02	.01	10.25	1	.00	1.02	1.01	1.04
High school education	-.18	.60	.09	1	.77	.84	.26	2.74
Higher education	.06	.60	.01	1	.92	1.06	.33	3.44
Water quality risk perception	-.17	.15	1.30	1	.26	.85	.63	1.13
Practice confidence	.06	.13	.23	1	.63	1.06	.83	1.37
Cost Barriers	-.33	.13	6.92	1	.01	.72	.56	.92
Time Barriers	-.19	.12	2.30	1	.13	.83	.65	1.06

Table 28. Predicting likelihood of adopting reduced tillage practice in the Maumee

Independent Variable	*B*	S.E	Wald	*df*	*p*	Odds Ratio	95% C.I for Odds Ratio	
Gender	-.30	.69	.19	1	.66	.74	.19	2.84
Age	.02	.01	8.55	1	.00	1.02	1.01	1.04
High school education	-20.04	22987.34	.00	1	1.0	.00	.00	-
Higher education	-19.90	22987.34	.00	1	1.0	.00	.00	-
Water quality risk perception	.28	.13	4.87	1	.03	1.32	1.03	1.69
Practice confidence	.027	.12	.05	1	.82	1.03	.81	1.30
Cost Barriers	-.01	.22	.00	1	.98	.09	.64	1.54
Time Barriers	-.08	.16	.25	1	.62	.93	.68	1.26

Nutrient Trapping

The model for nutrient trapping practices included five independent variables (gender, age, education, practice confidence, program participation). Education was recoded into three categories [1- some high school, 2- high school degree, 3- higher education].

Overall, the model for the Saginaw watershed including all predictors was statistically significant (chi-squared (6, N= 693) = 173.49, p < .000), indicating the model could distinguish between respondents who adopted and did not adopt right rate practices. The entire model explained between 22.1% (Cox and Snell R square) and 31.0% (Nagelkerke R squared) of the variance in adoption and correctly classified 76.3% of cases. This model had the strongest explanation of variance. As displayed in Table 29., three of the independent variables (education, practice confidence, program participation) made a unique statistically significant contribution to the model. Farmers with an education level greater than high school compared to those with some high school experience increased odds of adopting nutrient trapping practices by 3.25. With each point increase in confidence in the positive impact of suggested practices on water quality, the odds of adopting nutrient trapping practices increases by one and a half. Program participation was the strongest predictor of nutrient trapping adoption and had an odds ratio of 8.68. Participating in a program such as CRP, CSP, and EQUIP increased the odds of adopting nutrient trapping practices by almost 9 times. Overall, these results indicate that trapping related practices are more likely among those who enroll in conservation-based incentive programs, and those who believe in the effectiveness of BMPs at improving water quality.

The model for the Maumee watershed including all predictors was statistically significant (chi-squared (6, N= 576) = 70.57, p < .000), indicating the model could distinguish between respondents who adopted and did not adopt right rate practices. The entire model explained between 11.5% (Cox and Snell R square) and 18.2% (Nagelkerke R squared) of the variance in adoption and correctly classified 80.6% of cases. This model had the strongest explanation of variance. As displayed in Table 30., only two of the independent variables made a unique statistically significant contribution to the model (gender, program participation). Male farmers as compared to female farmers inversely increase odds of adopting nutrient trapping practices by three times.[20] Participating in programs such as CRP, CSP, and EQUIP increased the odds of adopting nutrient trapping practices by 5.66. Overall, male farmers as compared to women and those who participated in conservation-based incentive programs are more likely to engage in nutrient trapping related practices.

Table 29. Predicting likelihood of adopting reduced nutrient trapping in the Saginaw

Independent Variable	***B***	**S.E**	**Wald**	***df***	***p***	**Odds Ratio**	**95% C.I for Odds Ratio**	
Gender	-.34	.36	.85	1	.36	.72	.35	1.46
Age	-.01	.01	1.85	1	.17	.99	.98	1.00
HS degree	1.00	.61	2.69	1	.10	2.72	.82	8.99
Higher education	1.18	.61	3.75	1	.05	3.25	.99	10.73
Practice confidence	.42	.13	10.61	1	.00	1.52	1.18	1.95
Program participation	2.16	.19	128.03	1	.00	8.68	5.97	12.61

[20] Due to very few female respondents (n=29) analysis of gender differences is not included in suggestions

Table 30. Predicting likelihood of adopting reduced nutrient trapping in the Saginaw

Independent Variable	*B*	S.E	Wald	*df*	*p*	Odds Ratio	95% C.I for Odds Ratio	
Gender	-1.13	.43	6.80	1	.01	.32	.14	.76
Age	.00	.01	.24	1	.62	1.00	.99	1.02
High school degree	.40	.67	.36	1	.55	1.50	.40	5.59
Higher education	.62	.68	.83	1	.36	1.86	.49	7.08
Practice confidence	.11	.15	.46	1	.50	1.11	.82	1.50
Program participation	1.73	.25	46.76	1	.00	5.66	3.44	9.30

Third Research Question: What is the specific impact of GLRI?

To answer the third research question, "what is the impact of GLRI programs on key drivers of adoption (e.g., risk perception, confidence, etc.)", data were analyzed from the Blanchard Valley Demonstration Farms in which farmers completed a survey before and after a field demonstration event. We also analyzed data from another GLRI project conducted in the Sebewaing Watershed (Sediment Reduction in the Sebewaing River Watershed). In this project, participants completed a survey at the beginning of the project (2012) and again at the end of the project (2015). The pre and post-test data for these two GLRI projects were evaluated as a case study to identify the impact of specific GLRI programs on key drivers of adoption at a farm level. The key drivers included in the demonstration farm data included knowledge, concern, confidence (self-efficacy) and satisfaction with current management. We assessed any changes in these drivers after attending the tour or participating in the program (paired samples t-tests), and we also assessed the correlations between these changes for the BVDF tours and future intentions to adopt conservation practices.

Survey Instrument and Methodology

Pre- and post surveys were conducted as a means of evaluating the Blanchard Valley Demonstration Farm Tour, partially funded by the GLRI in partnership with USDA NRCS and the Ohio Farm Bureau. In this survey, the goal was to help the Blanchard Valley Demonstration Farm network determine if their educational objectives were being met. Their objectives included increasing knowledge and behavioral intentions around monitoring phosphorus levels in the soil, improving soil health through cover crops and no-till, placing fertilizer beneath the surface of the soil to decrease nutrient loss, and modifying how and where water flows in and around fields. A set of survey questions was created by researchers at The Ohio State University to focus on these four objectives, specifically assessing potential changes in knowledge about these four practices, confidence in one's ability to implement them, and current behavior and future intentions. Post-test surveys were completed immediately after the tour ended. There were 48 surveys completed from the Blanchard Valley Demonstration Farm Tours, which occurred between the spring and fall of 2017. Participants were those who opted in to attending the farm tour, with a version of the survey for farmers and one for non-farmers (e.g., county commissioners, FFA students, the media, etc).

Pre- and post surveys were conducted as a means of evaluating the Sebewaing Watershed project. The details on the survey population, participants, and administration are provided earlier in the report (see page 18).

Key Findings

Overall, the results indicate that attending the BVDF demonstration farmer tour did have a significant impact on several of the measures of interest among the farmer attendees (see Table 31). Specifically, farmers reported higher levels of knowledge across all the categories of interest (e.g., soil testing, cover crops, subsurface placement, modifying water flows, and knowing what steps to take) (in the range of moderate to well informed, $p < .05$). However, attending the event did not increase levels of concern about nutrient loss, soil health, or water quality ($p > .05$). However, farmers concern was already pretty high, in the range of moderately to very concerned. In terms of confidence, farmers indicated increased confidence in their ability to implement cover crops as a result of attending ($p < .05$), but their confidence for the other practice categories did not increase ($p > .05$). Overall, confidence was mid-range indicating there is room to improve confidence further.

Table 31. Evaluation of the impact of attending the Blanchard Valley Demonstration Farm tour using a pre-post analysis of change in farmer knowledge about conservation practices, concern about the problems, confidence in their ability to implement practices, and satisfaction with current management on his/her farm

Category	Variable	Pre-test (n=42)	Post-Test (n=42)	Different?*
Knowledge[1]	Soil test informed rates	3.14	3.83	Yes
	Cover crops/ no-till	3.48	3.76	Yes
	Sub-surface placement	3.35	3.83	Yes
	Modifying water flows	3.25	3.78	Yes
	About what steps to take	.978	.587	Yes
Concern[2]	Nutrient loss on farm	3.45	3.52	No
	Soil health on farm	3.81	3.62	No
	Water quality lake Erie	3.67	3.76	No
Confidence[3] (…in my ability to use)	Soil informed rates	.24	.32	No
	Cover crops/ no-till	.18	.38	Yes
	Sub-surface placement	.37	.61	No
	Modifying water flows	.44	.85	No
Satisfaction[3]	With current management	.53	.82	No

[1]On a scale from 1 (not at all informed) to 5 (extremely well informed)
[2]On a scale from 1 (not at all concerned) to 5 (extremely concerned)
[3]On a scale from -2 (strongly disagree) to 2 (strongly agree), where 0 (neither disagree nor agree)
*Based on a paired samples t-test with $p < .05$

In terms of the non-farmer attendees, those attending the tour indicated that their knowledge about conservation practices and the steps agriculture was taking to address nutrient loss was relatively high (they were "moderately informed") (Table 32). However, knowledge did increase (participants reported being "very well informed" after the tour, $p < .05$). Participants were already very concerned about nutrient loss, soil health and water quality, and only water quality concern increased as a result of attending the tour ($p < .05$). Finally, in terms of beliefs about agriculture, participants started out largely neutral on each issue (indicating neither agreement nor disagreement). However, participants reported stronger agreement with several statements after attending the tour, namely that 1) agriculture was taking responsibility, 2) nutrient loss can be reduced, 3) water quality issues can be solved, 4) there is no silver bullet that works for every farm, and 5) they know what steps farmers need to take to reduce nutrient loss and improve soil health ($p < .05$).

Table 32. Evaluation of the impact of attending the Blanchard Valley Demonstration Farm tour on non-farmers using a pre-post analysis of change in knowledge about conservation practices, concern about the problems, and assorted beliefs about agriculture

Category	Variable	Pre-test (n=~130)	Post-Test (n=~130)	Different?*
Knowledge[1]	Soil test informed rates	2.53	3.91	Yes
	Cover crops/ no-till	2.97	3.80	Yes
	Sub-surface placement	2.79	4.05	Yes
	Modifying water flows	2.71	4.03	Yes
	The steps ag is taking	2.79	4.21	Yes
Concern[2]	Nutrient loss on farm	3.62	3.76	No
	Soil health on farm	3.71	3.89	No
	Water quality lake Erie	3.76	4.00	Yes
Beliefs about Agriculture[3]	Ag is taking responsibility	.85	1.43	Yes
	Water issues can be solved	.71	1.28	Yes
	Nutrient loss can be reduced	1.09	1.52	Yes
	There is no silver bullet practice	1.11	1.54	Yes
	There is a silver bullet practice	-.63	-.63	No
	It is difficult to grow food & protect envt	-.33	-.10	No
	The costs of action outweigh benefits	-.51	-.49	No
	I know what is needed to reduce nutrient loss	-.05	.95	Yes
	I know what is needed to improve soil health	.02	.97	Yes

[1]On a scale from 1 (not at all informed) to 5 (extremely well informed)
[2]On a scale from 1 (not at all concerned) to 5 (extremely concerned)
[3]On a scale from -2 (strongly disagree) to 2 (strongly agree), where 0 (neither disagree nor agree)
*Based on a paired samples t-test with $p < .05$

The results for the Sebewaing project also indicate positive changes (Table 33). Specifically, participants in the project reported an increase in their belief that 1) using recommended practices improves water quality, 2) quality of life in their community depends on good water quality, and 3) water quality impacts are problematic ($p < .05$). Finally, they reported less overall concern about two common barriers to using no-till, specifically the time it takes and knowing how to do it ($p < .05$).

Table 33. Evaluation of the impact of participating in the Sebewaing GLRI Watershed Project on farmers using a pre-post analysis of their change in beliefs from the beginning to end of the project

Variable		2012 pre-test (n=~90)	2015 post-test (n=~60)	Different?*
[1]Using recommended practices improves water quality.[1]		4.16	4.37	Yes
The quality of life in my community depends on good water quality in local streams, rivers, lakes.[2]		4.02	4.25	Yes
How much of a problem is reduced…[3]	…beauty of lakes or streams	2.60	3.65	Yes
	…quality of water recreation activities	2.90	3.85	Yes
	…excessive aquatic plants or algae	3.56	4.51	Yes
No-till barriers[4]	Don't know how to do it	4.17	3.39	Yes
	Time required	4.11	3.35	Yes

[1]On a scale from 1 (strongly disagree) to 5 (strongly agree)
[2]On a scale from 1 (strongly disagree) to 5 (strongly agree)
[3]On a scale from 1 (not a problem) to 4 (severe problem)
[4]On a scale from 1 (not at all) to 4 (a lot)
*Based on a paired samples t-test with p <.05

Overall, when looking at the future intentions of the farmer attendees at the BVDF event, we do not see much evidence that attending the event would increase the intentions of those not using the practices (Table 34). For example, those farmers who attended that were already using each practice were significantly more likely to report an intention to continue using it, than those who would be classified as potential new adopters (p > .05). The only exception to this was for blind inlets, where the future intentions of the two groups did not differ, but that may be a function of there being very few individuals already using this practice. The hope would be that such an event would be an equalizer, where perhaps the future intentions of the two groups would be similar.

Table 34. Future intentions of management practices by those already vs. not using the practice

Practice	Already Using it		Not Using it		Mean Different?*
	%	Future intentions (mean)	%	Future intentions (mean)	
Subsurface placement (injection/banding)	35	4.25	65	3.04	Yes
Grid sampling and VRT	39	4.57	61	3.45	Yes
Cover Crops (not winter wheat)	57	4.3	43	3.00	Yes
Drainage Mgmt Structures	33	4.10	67	2.88	Yes
P Filter Beds	0	N/A	100	2.71	N/A
Blind Inlets	6	3.50	94	2.81	No

*Based on an independent samples t-test comparing future intentions by those already using vs not using the practice
Note: Intentions measured on a scale from 1 (will never use it), 2 (am unlikely to use it), 3 (am unsure if I will use it), 4 (I am likely to use it), and 5 (will definitely use it)

Finally, we looked at the future intentions to use each recommended practice as a function of one's change in beliefs after attending the event (Table 35). Specifically, we calculated the change in one's perceived ability to use a particular practice, one's overall concern about nutrients and water quality, and one's knowledge about the particular practice. We then looked at correlations between these change variables as well as the farmer's age, owned and rented acres, prior use of the practice, and whether or not the BVDF made them think differently about the issues. Unfortunately, we do not see much evidence that the event is increasing one's intention to use any particular practice. Specifically, we find that some practices are more likely among larger farms (e.g., subsurface placement, grid sampling, drainage water management and blind inlets). The changes in knowledge, confidence, concern and satisfaction did not correlate with future intention for any of the practices, with a few exceptions. Participants' intentions to use cover crops were greater among those who reported a greater change in knowledge about cover crops and greater overall concern about the problems ($p < .05$). Farmers who reported being less satisfied with their current practices also reported greater intentions to use cover crops, as well as drainage water management and P filter beds ($p < .05$). Having already used the practice in the past had the highest correlations with future intentions, indicating that past experience was a better predictor of future intentions than having attended the BVDF tour and experienced a change in beliefs.

Table 35. Correlations between a variety of variables in the BVDF survey and future intentions to adopt a particular practice (significant correlations in bold)

	Subsurface Placement	**Grid Sampling**	**Cover Crops**	**Drainage Water Mgmt**	**P Filters**	**Blind inlets**
Age	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
Owned acres	**.430**	**.355**	*NS*	**.385**	**.397**	**.398**
Rented acres	**.448**	**.483**	*NS*	.400	*NS*	**.409**
∆ Knowledge	*NS*	*NS*	**.453**	*NS*	*NS*	*NS*
∆ Confidence	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
∆ Concern	*NS*	*NS*	**.508**	*NS*	*NS*	*NS*
∆ Satisfaction	*NS*	*NS*	**.463**	**.437**	**.354**	*NS*
∆ Knowing steps to take	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
Tour made me think different	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
Prior use of the practice	**.612**	**.564**	**.611**	**.594**	*No results*	*NS*

Note: NS indicates there was no significant relationship between the two variables; all numbers indicate the correlation value between the two variables for significant relationships

Appendix G

Priority Watershed Profiles: Physical, Demographic, Economic, and Farm Characteristics

Great Lakes Commission
des Grands Lacs

REAP
Researching the Effectiveness of Agricultural Programs

Priority Watershed Profiles: Physical, Demographic, Economic, & Farm Characteristics

FINAL

September 2019

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AMP Insights

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ACRONYMS

CP	Conservation Practice
CRP	Conservation Reserve Program
CSP	Conservation Stewardship Program
CTA	Conservation Technical Assistance
DEMs	Digital Elevation Models
EQIP	Environmental Quality Incentives Program
EWG	Environmental Working Group
GLC	Great Lakes Commission
GLRI	Great Lakes Restoration Initiative
gSSURGO	Gridded Soil Survey Geographic
NASS	National Agricultural Statistics Service
NCSS	National Cooperative Soil Survey
NLCD	National Land Cover Database
NRCS	Natural Resources Conservation Service
REAP	Researching Effectiveness of Agricultural Programs
US	United States
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WHIP	Wildlife Habitat Incentives Program

1. Introduction

Watershed profiles were developed for four REAP priority watersheds—the Genesee Watershed, the Lower Fox Watershed, the Maumee Watershed and the Saginaw Watershed (hereafter referred to as Genesee, Lower Fox, Maumee and Saginaw). These profiles are meant to serve as the starting point for assessing whether key characteristics (see Appendix A for a full list) of priority watersheds impact the behavioral, socio-cultural, and/or economic outcomes of Great Lakes Restoration Initiative (GLRI) investments. In addition, characteristics are examined both within and between watersheds in order to (a) determine whether changes have occurred since the beginning of GLRI investments in 2010 and; (b) draw comparisons between key characteristics in the different watersheds.

As part of the profiles, baseline geospatial and economic analyses were conducted for both (a) relevant watershed characteristics (e.g., land use, value of agricultural production, etc.); and (b) GLRI project data (see Section 8).

This document is organized such that general information on how data were analyzed is described in Section 2. The remainder of the document provides detailed information on key watershed characteristics related to physical, demographic, farm, and farmer aspects of each watershed as well as summary outputs from the baseline geospatial and economic analyses. Findings are organized by characteristic, as opposed to watershed, in order to allow for easy comparison between watersheds.

2. Data Availability and Manipulation

Although the scale of the watershed profiles and accompanying baseline analyses is the watershed, the majority of data necessary to describe the identified watershed characteristics were only available at the county level. It was therefore necessary to develop a weighting schema to normalize county-level data to accurately represent the footprints of priority watersheds as all four encompass portions of multiple counties.

Two different weighting schemes were used to address two types of data:

1. For raw values (e.g., total subsidies, acres operated, etc.), data were weighted by the percentage of county area in the watershed.
2. For values already in a mean or median format (e.g., average income, median age, etc.), data were weighted by the percentage of watershed area covered by the county.

In total, the four watersheds cover portions of 63 counties. Given the large amount of data required to represent this number of counties, the decision was made to only include counties that (a) had more than 1% of their area located within the associated watershed (59 counties); or (b) represented more than 1% of the total area of the associated watershed (50 counties). Please see Appendix A for more details on this.

The time frame considered in this analysis was 2007-2017. These years frame the period in which GLRI investments were distributed (2010-2016) and incorporate baseline economic and social data from a period prior to the investments by allowing for data from three Census of Agriculture surveys (i.e., 2007, 2012, 2017) to be included in the analysis. Although the Census of Agriculture surveys were a primary source of economic and social data for these profiles and analyses, other sources were used which did not adhere to the five-year cycle of the Census of Agriculture, creating some variability, but adhering to the general time frame of 2007-2017. In cases where data were available on an annual basis (as opposed to the five-year Census of Agriculture cycle), results are presented annually.

3. Physical Characteristics

This section describes the physical characteristics of each watershed that pertain to the analysis of GLRI funding distribution and subsequent socio-economic outcomes. The characteristics that were determined to be applicable and available for this level of analysis include the watershed area and enclosed counties, watershed location relative to the nearest Great Lake, the elevation and slope profile of the watersheds, and a general soil profile of the watersheds.

3.1 Watershed Area and Location Profile

The size of four priority watersheds varies, with the Lower Fox being substantially smaller than the other three watersheds in terms of area (see Table 1). The size of the watersheds also directly correlates with the number of counties that comprise each watershed. A complete list of counties in each watershed is available in Appendix A.

Table 1. Priority Watershed Area Profile

Watershed	Area (Acres)	Counties (#)
Genesee	1,596,168	10
Lower Fox	414,394	5
Maumee	4,208,092	26
Saginaw	3,988,803	22

Although each of the watersheds drain to a Great Lake, this fact may be more or less apparent to the residents of the watershed. One of the factors that may contribute to residents' knowledge of the interconnectedness of their watershed with the Great Lakes is the watersheds' proximity to a Great Lake. This proximity was assessed by measuring the distance from the center point of each of the four priority watersheds to a point on the shoreline measured at the mouth of a significant river for the watershed (see Table 2).

Table 2. Priority Watershed Proximity to Nearest Great Lake

Watershed	Great Lake Receiving Drainage	River Mouth	Distance (miles)
Genesee	Lake Ontario	Genesee River	48
Lower Fox	Lake Michigan	Fox River	14
Maumee	Lake Erie	Maumee River	60
Saginaw	Lake Huron	Saginaw River	19

3.2 Watershed Topography Profile

Elevation can impact land suitability for crops, and subsequently applicable conservation practices, and provides information on slope as a partial proxy for runoff potential. Given that the regions in which the four priority watersheds lie are not particularly mountainous, the elevation profiles of the watersheds are most useful for the derivation of the watershed slope profiles. Digital Elevation Models (DEMs) sourced from the United States Geological Survey (USGS) and National Map were used to evaluate priority watershed elevation (see Table 3) and slope profiles (see Table 4). Overall, the Lower Fox, Maumee, and Saginaw are comparable in elevation, whereas the Genesee has more variable elevation with a greater range and higher standard deviation. This is further reflected in the watershed slope profiles in that the Genesee displays greater slope variability and a higher mean slope than the other watersheds. With the exception of the Genesee, slopes are relatively low to moderate in the watersheds (please see Appendix B for slope graphics of the four watersheds).

Table 3. Priority Watershed Elevation Profiles

Watershed	Mean Elevation (m)	Maximum Elevation (m)	Minimum Elevation (m)	Standard Deviation (m)
Genesee	414.54	776.33	74.45	164.60
Lower Fox	225.78	303.86	167.18	25.58
Maumee	246.33	371.87	164.90	31.03
Saginaw	242.48	443.16	175.07	41.54

Table 4. Priority Watershed Slope Profiles

Watershed	Mean Slope (degrees)	Maximum Slope (degrees)	Minimum Slope (degrees)	Standard Deviation (degrees)
Genesee	4.84	63.22	0.00	5.14
Lower Fox	1.54	65.14	0.00	2.44
Maumee	1.13	75.27	0.00	1.75
Saginaw	1.55	39.01	0.00	2.25

3.3 Watershed Soil Profiles

In addition to slope, a primary determinant of runoff is soil type and soil drainage characteristics. Soil data were sourced from the Gridded Soil Survey Geographic (gSSURGO) Database maintained by the National Cooperative Soil Survey (NCSS) partnership. The gSSURGO also categorizes all watershed land area, regardless of current land use, into categories of farmland quality by soil condition. There are seven designations that are used to describe the farmland potential of lands across the four watersheds:

1. All areas are prime farmland: "Land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. It could be cultivated land, pastureland, forestland, or other land, but it is not urban or built-up land or water areas. The soil quality, growing season, and moisture supply are those needed for the soil to economically produce sustained high yields of crops when proper management, including water management, and acceptable farming methods are applied (USDA NRCS n.d.)."
2. Farmland of statewide importance: "[Land that is defined and delineated] by the appropriate State agencies. Generally, this land includes areas of soils that nearly meet the requirements for prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods. Some areas may produce as high a yield as prime farmland if conditions are favorable (USDA NRCS n.d.)."
3. Farmland of local importance: "[Land that is defined and delineated] by the appropriate local agencies. Farmland of local importance may include tracts of land that have been designated for agriculture by local ordinance (USDA NRCS n.d.)."
4. Prime farmland if drained.
5. Prime farmland if protected from flooding or not frequently flooded during the growing season.

6. Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season.
7. Not prime farmland.

Watershed profiles of soil types demonstrate how varied the substrate is throughout the watershed and provide indication of the farmland quality across the watershed.

3.3.1 Genesee Watershed

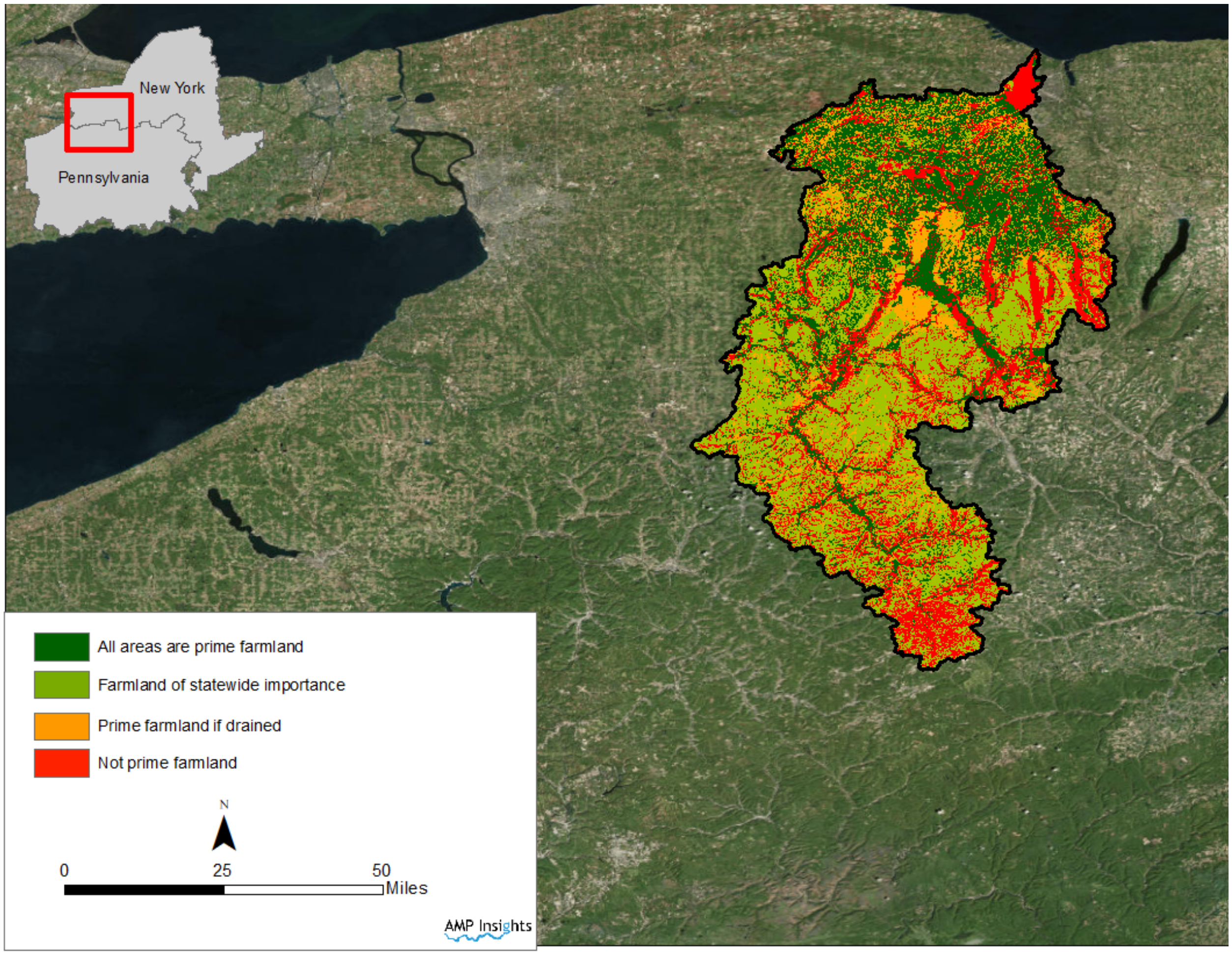
The Genesee is an area that has been glaciated resulting in loamy till deposits, silty and glayey glacial lake deposit and sandy glaciofluvial deposits (USDA NRCS 2009a, 2009b). Overall, the soil in the Genesee Watershed is well to moderately drained with variable potential for surface runoff (USDA NRCS 2009a, 2009b; National Cooperative Soil Survey (NCSS) partnership 2018). Please see Appendix B for more specific information on soil types in the Genesee.

A majority of the land in the Genesee is categorized as farmland of statewide importance followed by prime farmland. About a quarter of the land is not prime farmland and a small percentage of the watershed is considered prime farmland after alteration (see Table 5 and Figure 1).

Table 5. Genesee Watershed Farmland Quality

Farmland	Area (Acres)	Watershed Cover (%)
Farmland of statewide importance	600,880	37.64%
All areas are prime farmland	422,923	26.49%
Not prime farmland	393,719	24.66%
Prime farmland if drained	178,798	11.20%

Figure 1. Genesee Watershed Farmland Quality



3.3.2 Lower Fox Watershed

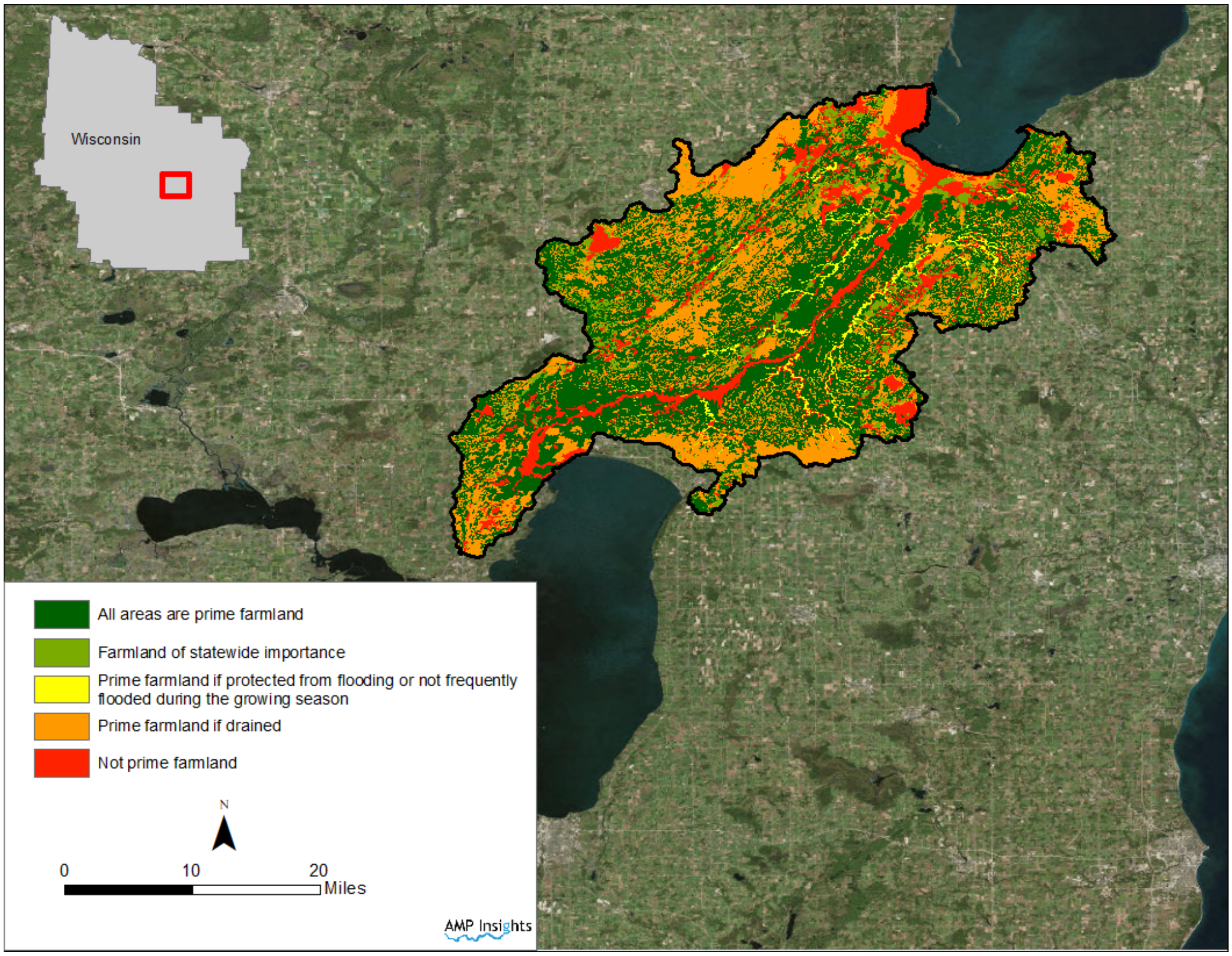
Similar to the Genesee, the soil in the Lower Fox was also primarily formed through the processes following glaciation resulting in sands, clays, and windblown silts. The soils have slow to moderately slow permeability with variable drainage. Erosion in the watershed is cited as a concern (USDA NRCS 2008c; National Cooperative Soil Survey (NCSS) partnership 2018). Please see Appendix B for more specific information on soil types in the Lower Fox.

Nearly half of the land in the Lower Fox is considered to be prime farmland with only a small percentage of the watershed considered not to be prime farmland even after alteration (see Table 6 and Figure 2).

Table 6. Lower Fox Watershed Farmland Quality

Farmland	Area (Acres)	Watershed Cover (%)
All areas are prime farmland	199,965	48.23%
Prime farmland if drained	117,746	28.40%
Not prime farmland	55,311	13.34%
Farmland of statewide importance	32,090	7.74%
Prime farmland if protected from flooding or not frequently flooded during growing season	9,521	2.30%

Figure 2. Lower Fox Watershed Farmland Quality



3.3.3 Maumee Watershed

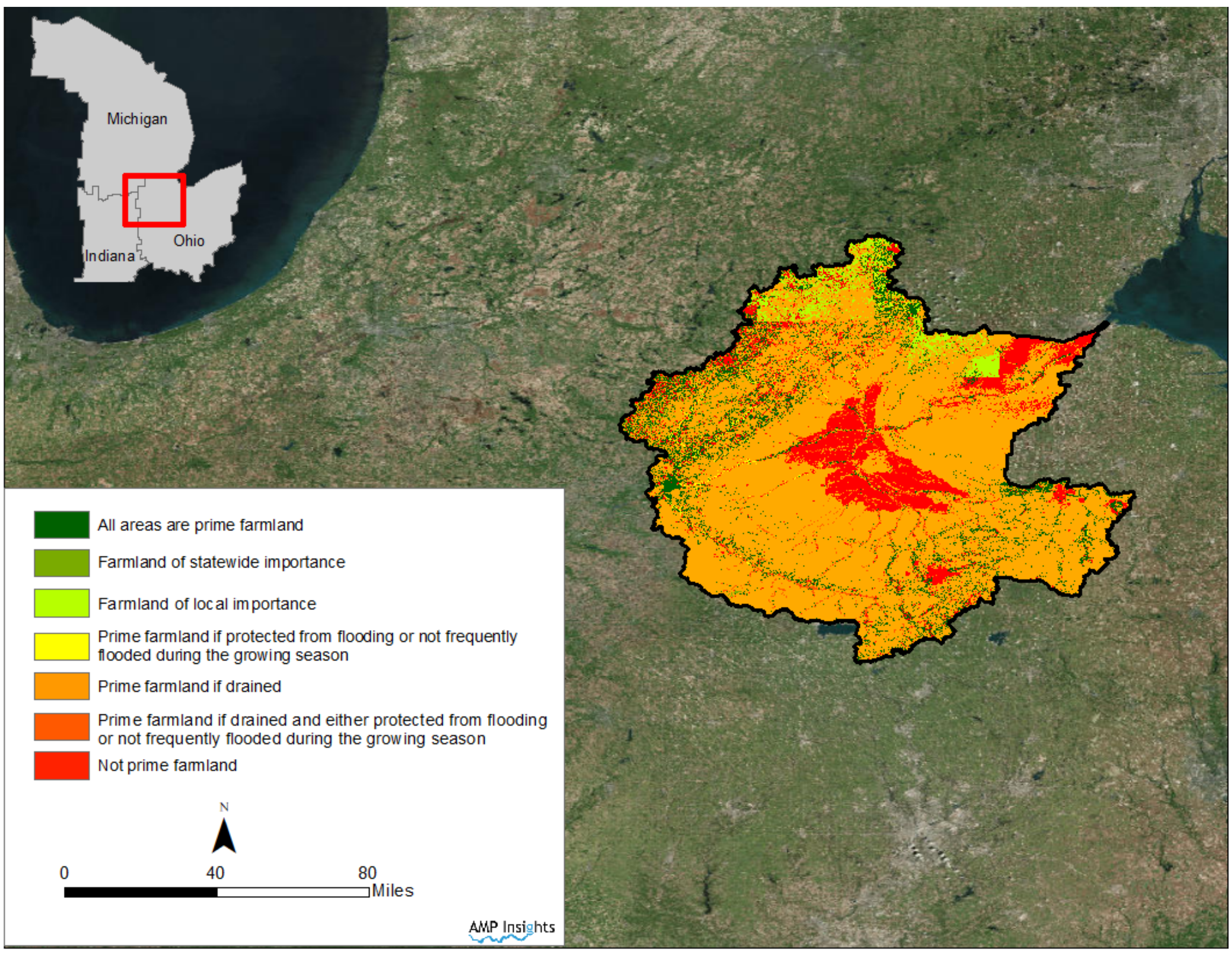
Glacial activity formed much of the soil structure in the Maumee, resulting in areas of sandy deposits and large coverage by loamy soils. These soils tend to be poorly to very poorly drained. A large portion of the watershed was wetland prior to settlement and has been artificially drained. As a result, the primary concerns for soil management in the watershed have to do with soil wetness and erosion (National Cooperative Soil Survey (NCSS) partnership 2018; USDA NRCS 2009d, n.d., 2009c, 2008b).

As indicated by the post-European settlement artificial draining of lands in the Maumee, the majority of the watershed is considered prime farmland if drained, whereas less than 10% of the watershed is considered prime farmland without alteration (see Table 7 and Figure 3).

Table 7. Maumee Watershed Farmland Quality

Farmland	Area (Acres)	Watershed Cover (%)
Prime farmland if drained	2,974,318	70.68%
Not prime farmland	548,013	13.02%
All areas are prime farmland	412,180	9.79%
Farmland of local importance	140,572	3.34%
Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season	91,519	2.17%
Prime farmland if protected from flooding or not frequently flooded during the growing season	26,360	0.63%
Farmland of statewide importance	15,143	0.36%

Figure 3. Maumee Watershed Farmland Quality



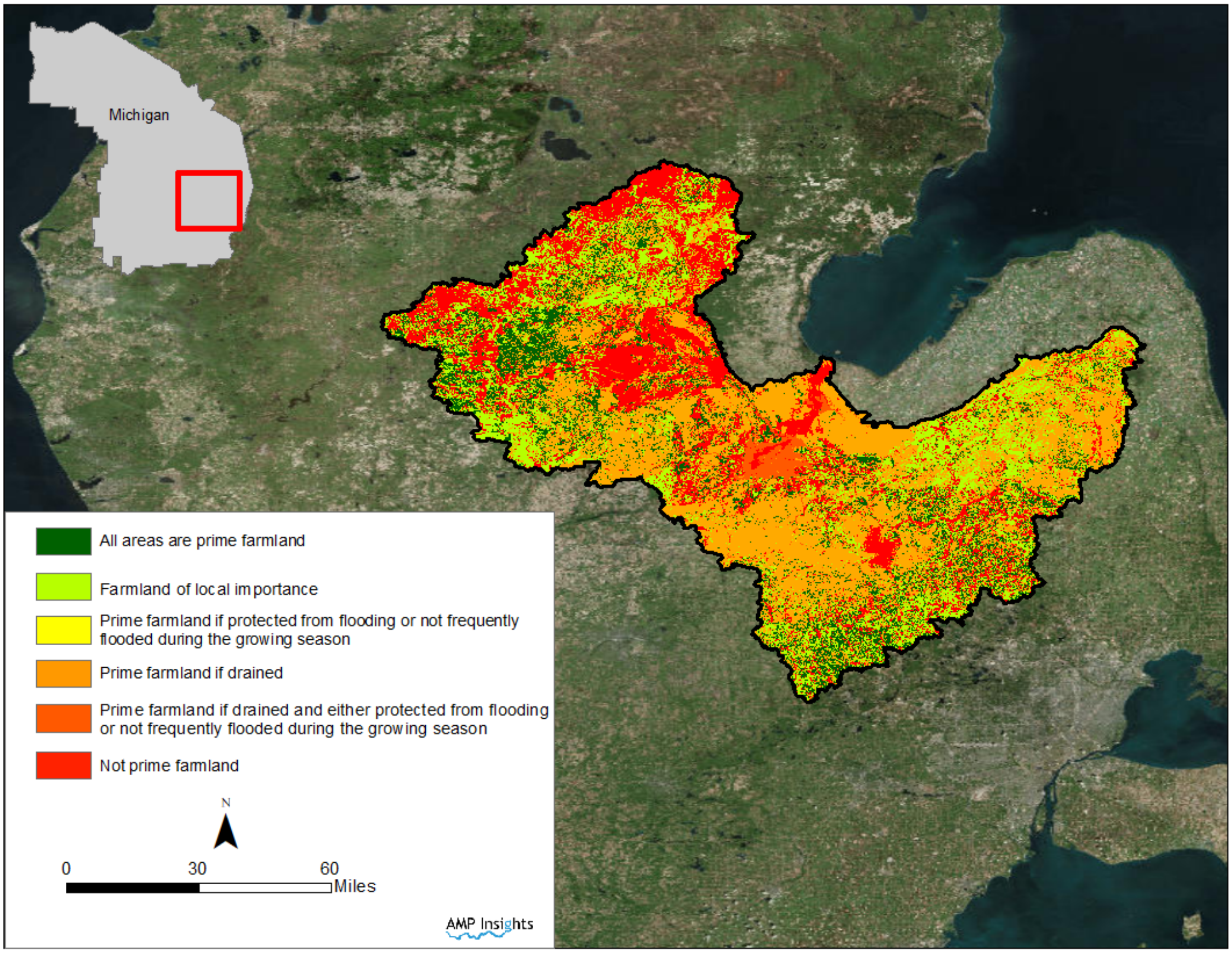
3.3.4 Saginaw Watershed

A majority of the soils in the Saginaw are loams, sandy loams, and loamy sands. Overall, much of the Saginaw soil has a tendency towards hydric soils and soils that have poor drainage (USDA NRCS 2008a; National Cooperative Soil Survey (NCSS) partnership 2018). As a result, the land in the watershed that would be prime farmland if it were drained comprises the largest category of the farmland designations (see Table 8 and Figure 4).

Table 8. Saginaw Watershed Farmland Quality

Farmland	Area (Acres)	Watershed Cover (%)
Prime farmland if drained	1,400,016	35.10%
Not prime farmland	972,944	24.39%
Farmland of local importance	933,472	23.40%
All areas are prime farmland	571,208	14.32%
Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season	108,102	2.71%
Prime farmland if protected from flooding or not frequently flooded during the growing season	2,909	0.07%
Unassigned farmland quality	337	0.01%

Figure 4. Saginaw Watershed Farmland Quality



4. Demographic Characteristics

Demographic characteristics described in this section focus on the overall population of the watershed. As such, it is not clear that these characteristics would influence behavioral, socio-cultural, and/or economic outcomes of GLRI investments to the same degree that demographic characteristics specific to farmers in the watershed may. At a minimum, however, they provide context on broader trends within the four priority watersheds.

Note that data for all demographic characteristics were obtained at the county level, then weighted and aggregated (as described in Section 2) in order to create watershed level estimates.

4.1 Population

County-level population data were obtained from the US Census Bureau (2017b, 2019a). As can be seen in Table 9, population varies substantially across the watersheds as does how each population has changed from 2007-2017. The Lower Fox has the smallest population, not surprising given that it also has the smallest land area, but it also had the greatest percentage change in population since 2007. Two watersheds (i.e., Lower Fox and Maumee) experienced population growth, while the overall populations of the Genesee and Saginaw decreased.

Table 9. Population Estimates

Watershed	Population Estimate (1000s)											Change (%)
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
Genesee	310	311	311	311	311	311	311	310	309	308	307	-1.0%
Lower Fox	208	209	211	212	214	216	217	219	220	221	223	7.5%
Maumee	1,015	1,015	1,015	1,015	1,016	1,015	1,016	1,016	1,017	1,018	1,020	0.5%
Saginaw	1,342	1,333	1,325	1,321	1,319	1,315	1,312	1,309	1,305	1,304	1,304	-2.8%

As mentioned previously, land area also varies substantially between the watersheds. Table 10 compares, by watershed, the percentage of total land area and total population of all four watersheds to provide an indication of population density that cannot be directly computed without making an assumption about population distribution in the counties (partial and full) that make up the four watersheds. Lower Fox and Saginaw represent a larger proportion of total population relative to their size, suggesting they are somewhat more densely populated relative to the other two watersheds.

Table 10. Comparison of Population and Land Area

Watershed	% of Area	% of 2017 Population
Genesee	15.6%	10.8%
Lower Fox	4.1%	7.8%
Maumee	41.2%	35.7%
Saginaw	39.1%	45.7%

4.2 Median Age

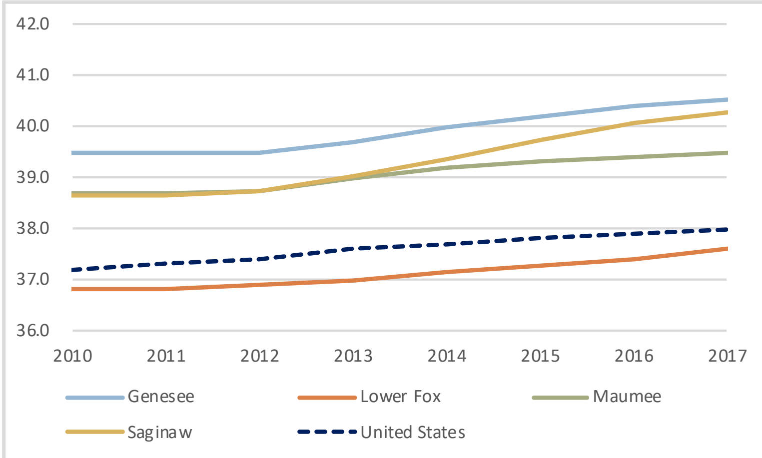
Data on median age were obtained from the US Census Bureau (2019). Note that estimates were only available from 2010-2017. Median age varied substantially between the watersheds, with the Lower Fox and Saginaw having the lowest and highest median age, respectively (see Table 11).

Table 11. Median Age

Watershed	2010	2011	2012	2013	2014	2015	2016	2017	Change (%)
Genesee	39.5	39.5	39.5	39.7	40.0	40.2	40.4	40.5	2.7%
Lower Fox	36.8	36.8	36.9	37.0	37.1	37.3	37.4	37.6	2.2%
Maumee	38.7	38.7	38.7	39.0	39.2	39.3	39.4	39.5	2.0%
Saginaw	38.6	38.6	38.7	39.0	39.4	39.7	40.1	40.3	4.2%
United States	37.2	37.3	37.4	37.6	37.7	37.8	37.9	38.0	2.2%

The median age for the United States was also included as a point of comparison. Three of the four watersheds (i.e., Genesee, Maumee and Saginaw) have a median age higher than that of the nation (see Figure 5). The median age for all four watersheds and the United States increased from 2010-2017; however, the percentage change in median age in the Saginaw watershed was almost double that of the other watersheds and the United States more broadly. As noted in Section 4.1, the total population of the Saginaw also decreased over the time frame considered, suggesting an outmigration of youth from the watershed.

Figure 5. Median Age



4.3 Median Household Income

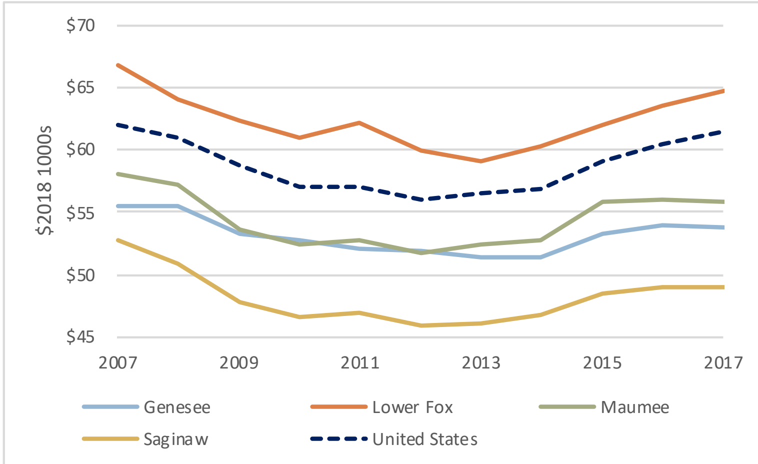
County-level data on median household income were downloaded from the US Census Bureau (2019b). Results are presented in constant 2018 dollars. The Lower Fox had the highest median income and was the only watershed with a median income higher than that of the United States across the time frame considered (see Table 12). In contrast, the Saginaw consistently had the lowest median household income across the time frame considered, and in 2017 was approximately 20% below that of the nation as a whole. In addition to having the lowest median income, the Saginaw also had greatest rate of change, with median income decreasing 7% over the last 11 years.

Table 12. Median Household Income

Watershed	Median Income ($2018 1000s)											Mean	Change (%)
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017		
Genesee	$ 55	$ 55	$ 53	$ 53	$ 52	$ 52	$ 51	$ 51	$ 53	$ 54	$ 54	$ 53	-2.9%
Lower Fox	$ 67	$ 64	$ 62	$ 61	$ 62	$ 60	$ 59	$ 60	$ 62	$ 64	$ 65	$ 62	-3.1%
Maumee	$ 58	$ 57	$ 54	$ 52	$ 53	$ 52	$ 52	$ 53	$ 56	$ 56	$ 56	$ 54	-4.0%
Saginaw	$ 53	$ 51	$ 48	$ 47	$ 47	$ 46	$ 46	$ 47	$ 48	$ 49	$ 49	$ 48	-7.0%
United States	$ 62	$ 61	$ 59	$ 57	$ 57	$ 56	$ 56	$ 57	$ 59	$ 60	$ 62	$ 59	-0.6%

With respect to changes over time, median household income in all four watersheds decreased from 2007-2017 and at a rate higher than that of the nation (see Figure 6), although it is worth noting that, across the time frame considered, median household income in all four watersheds was lowest during the years 2001-2013.

Figure 6. Median Household Income



4.4 Poverty Rate

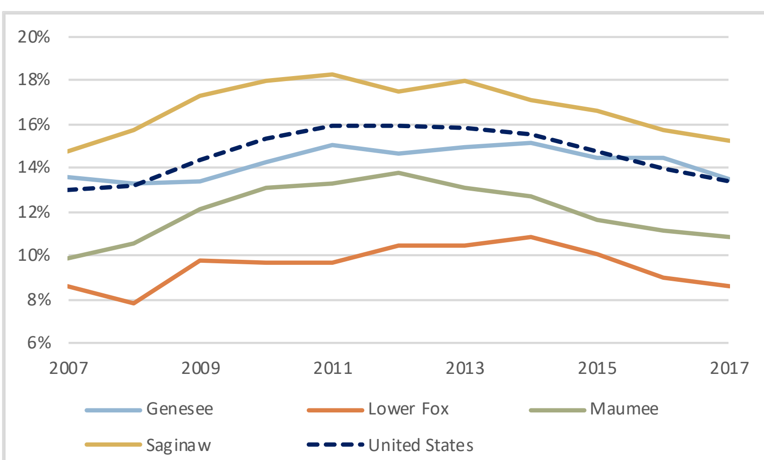
Poverty data were obtained from the US Census Bureau (2019b). As seen in Table 13, the watershed with the lowest average poverty rate from 2007-2017 was the Lower Fox (9.5%). In addition to the Lower Fox, the Maumee (12.0%) and Genesee (14.2%) averages were below the national average of 14.6%.

Table 13. Poverty Rate

Watershed	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Mean	Change (%)
Genesee	13.6%	13.3%	13.4%	14.3%	15.1%	14.6%	14.9%	15.1%	14.4%	14.4%	13.5%	14.2%	-0.1%
Lower Fox	8.6%	7.8%	9.7%	9.6%	9.7%	10.5%	10.5%	10.9%	10.0%	9.0%	8.6%	9.5%	0.0%
Maumee	9.9%	10.5%	12.1%	13.1%	13.2%	13.8%	13.1%	12.7%	11.6%	11.2%	10.9%	12.0%	1.0%
Saginaw	14.8%	15.7%	17.2%	17.9%	18.2%	17.5%	17.9%	17.1%	16.6%	15.7%	15.2%	16.7%	0.4%
United States	13.0%	13.2%	14.3%	15.3%	15.9%	15.9%	15.8%	15.5%	14.7%	14.0%	13.4%	14.6%	0.4%

As seen in Figure 7, regardless of starting value, all four watersheds followed a similar general trend across the time frame considered—increasing from 2007 to around 2011/12 and then decreasing.

Figure 7. Poverty Rate



4.5 Unemployment Rate

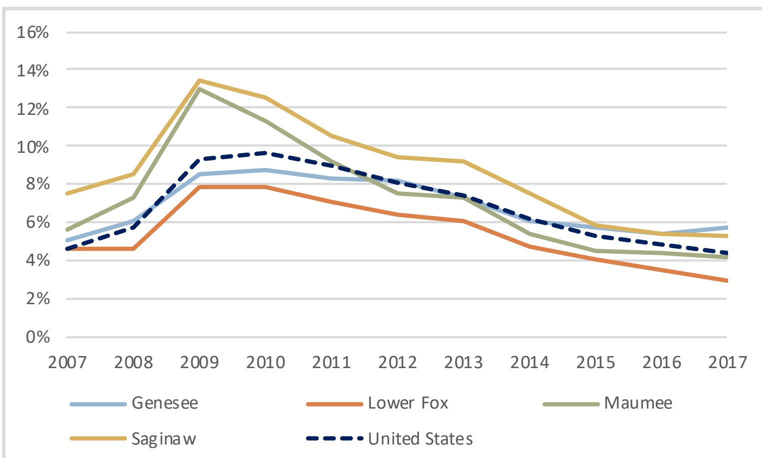
Unemployment data were obtained from the Table 13. The Lower Fox and Saginaw had the lowest (5.4%) and highest (8.7%) average unemployment rates, respectively (see Table 14). The only watershed where the unemployment rate increased from 2007-2017 was the Genesee, where the unemployment rate increased by a negligible 0.6%. Unemployment decreased in the other three watersheds, both as a percentage and relative to the national unemployment rate.

Table 14. Unemployment Rate

Watershed	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Mean	Change (%)
Genesee	5.1%	6.0%	8.5%	8.7%	8.3%	8.2%	7.4%	6.1%	5.7%	5.5%	5.7%	6.8%	0.6%
Lower Fox	4.6%	4.6%	7.9%	7.9%	7.1%	6.4%	6.1%	4.8%	4.0%	3.5%	2.9%	5.4%	-1.7%
Maumee	5.6%	7.3%	13.0%	11.3%	9.2%	7.5%	7.3%	5.4%	4.5%	4.4%	4.2%	7.2%	-1.4%
Saginaw	7.5%	8.5%	13.4%	12.6%	10.5%	9.4%	9.2%	7.5%	5.8%	5.5%	5.3%	8.7%	-2.2%
United States	4.6%	5.8%	9.3%	9.6%	9.0%	8.1%	7.4%	6.2%	5.3%	4.9%	4.4%	6.8%	-0.2%

Again, as with the poverty rate, regardless of the starting value, all four watersheds have followed a similar trend over the last 11 years—increasing from 2007-2009/10 and decreasing thereafter (see Figure 8).

Figure 8. Unemployment Rate



5. Farm Characteristics

This section describes farm-level characteristics of each watershed that pertain to the analysis of GLRI funding distributions and subsequent socio-economic outcomes. Note that the majority of farm-level data were obtained at the county level, then weighted and aggregated (as described in Section 2) in order to create watershed level estimates. The exception being land use and land cover, for which data were available in a spatial raster dataset that allowed data to be collected by the actual watershed boundaries.

5.1 Land Use

Land use in a watershed could be indicative of the area's social and economic dynamics in regards to a region's prominent industries, development, population density, and access to recreation and the environment. Land use in the four priority watersheds was explored using the National Land Cover Database (NLCD) generated by the Multi-Resolution Land Characteristics Consortium—a partnership of federal agencies. The NLCD is updated every five years. Therefore, the 2011 dataset was used to establish a baseline of land use for the watersheds at the beginning of the GLRI fund distributions (beginning in 2010). The 2016 dataset was then used to assess change over the course of the GLRI investment period.

Land use in 2011 for the four priority watersheds was varied, however, in the Lower Fox, Maumee, and Saginaw, cultivated crops represented the largest category of land use (see Figure 10, Figure 11, and Figure 12). In the Maumee, cultivated crops actually represented the majority of land use at approximately 72% of the watershed area. On the other hand, the two largest categories of land use in the Genesee were deciduous forest and hay/pasture, with cultivated crops as the third largest category (see Figure 9). Deciduous forest and hay/pasture represented significant land uses for the Lower Fox, Maumee, and Saginaw as well.

From 2011 to 2016, Maumee experienced the least amount of change in land use with only a 6.0% absolute change across the fifteen categories of land use tracked. Conversely, the other three watersheds experienced between 28.3% and 35.5% absolute change across the land use categories, with the Lower Fox experiencing the greatest amount of change. Across all four watersheds, from 2011-2016, the land in cultivated crops increased, while land in hay/pasture decreased (Table 15).

Figure 9. Land Use in the Genesee Watershed 2011

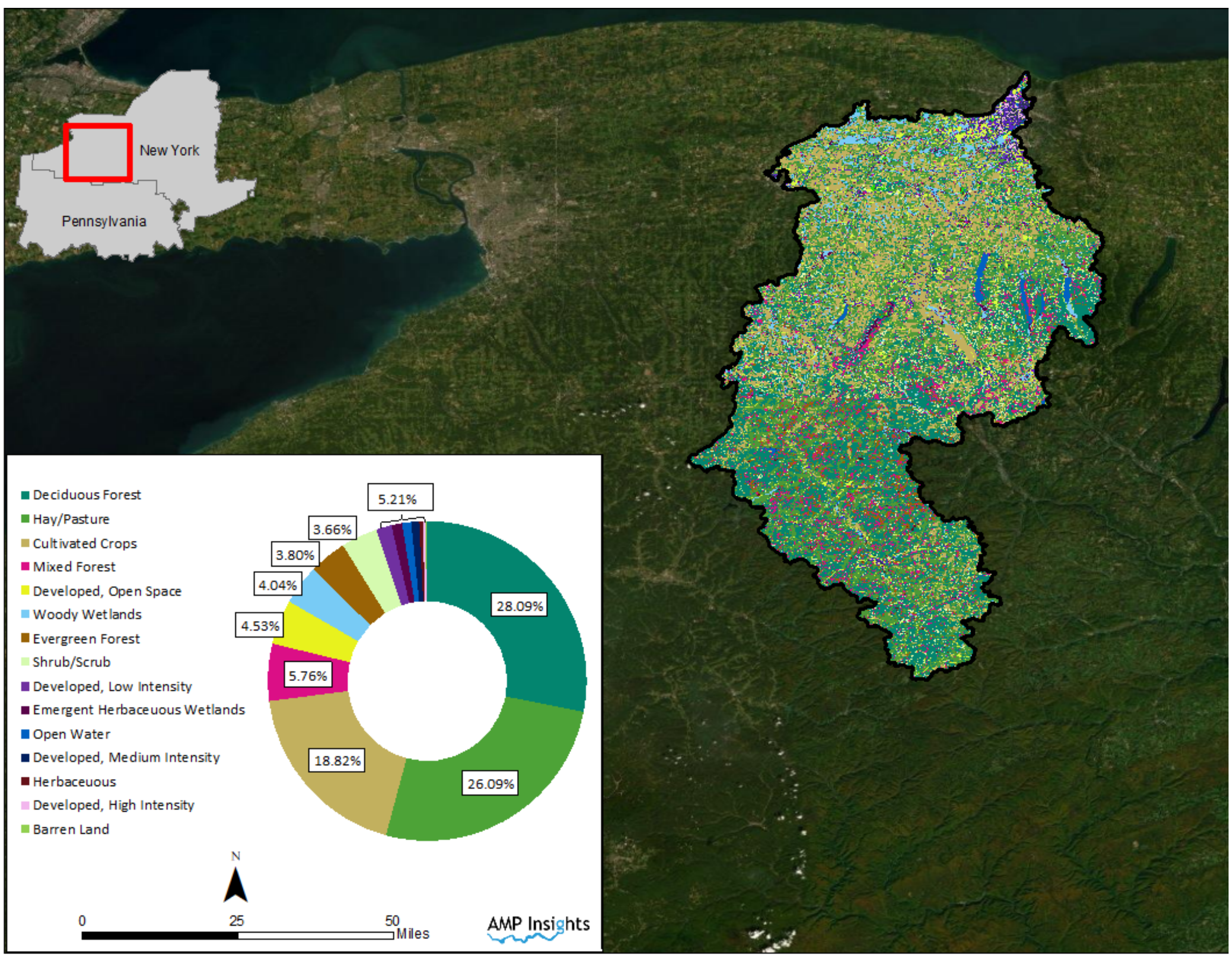


Figure 10. Land Use in the Lower Fox Watershed 2011

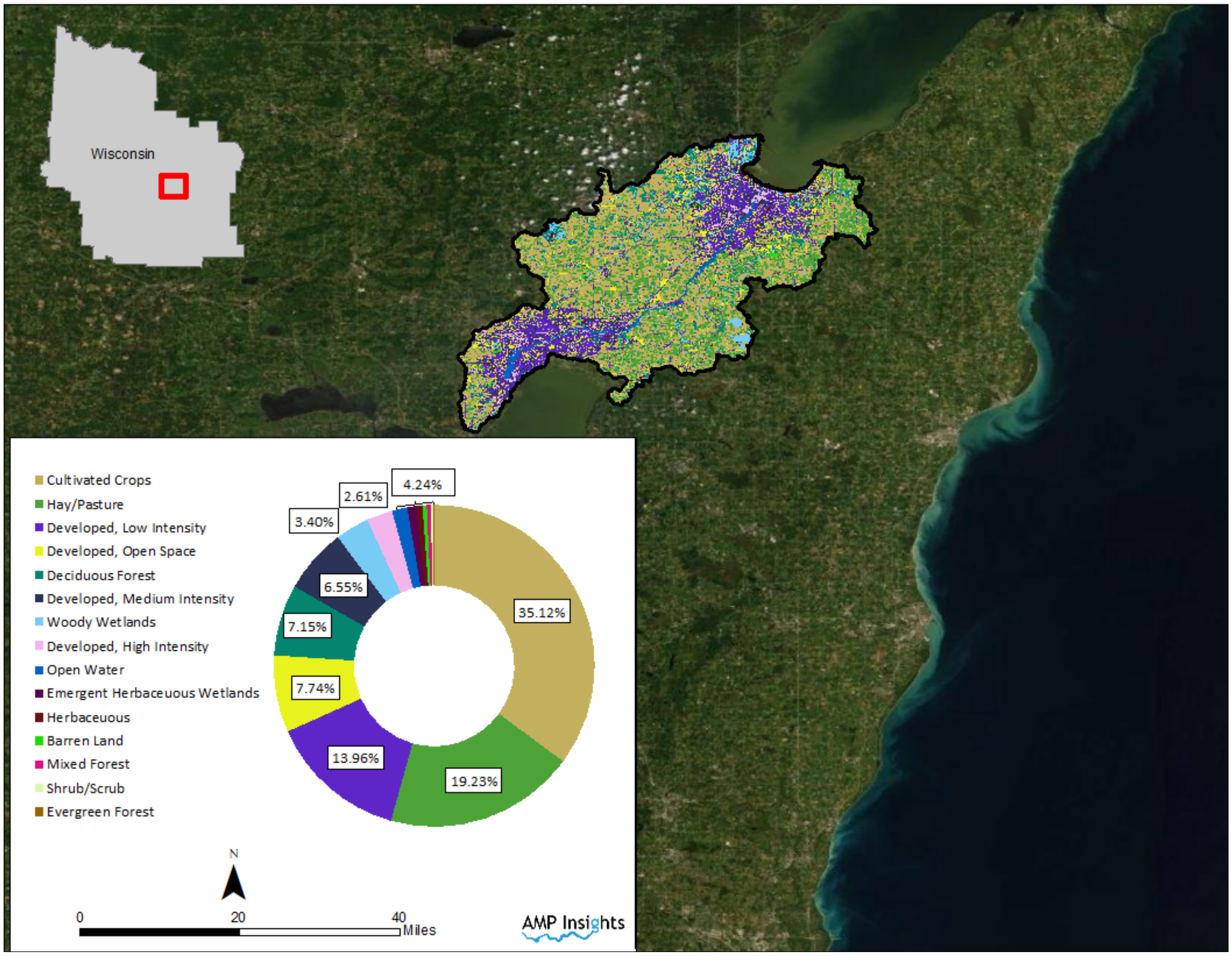


Figure 11. Land Use in the Maumee Watershed 2011

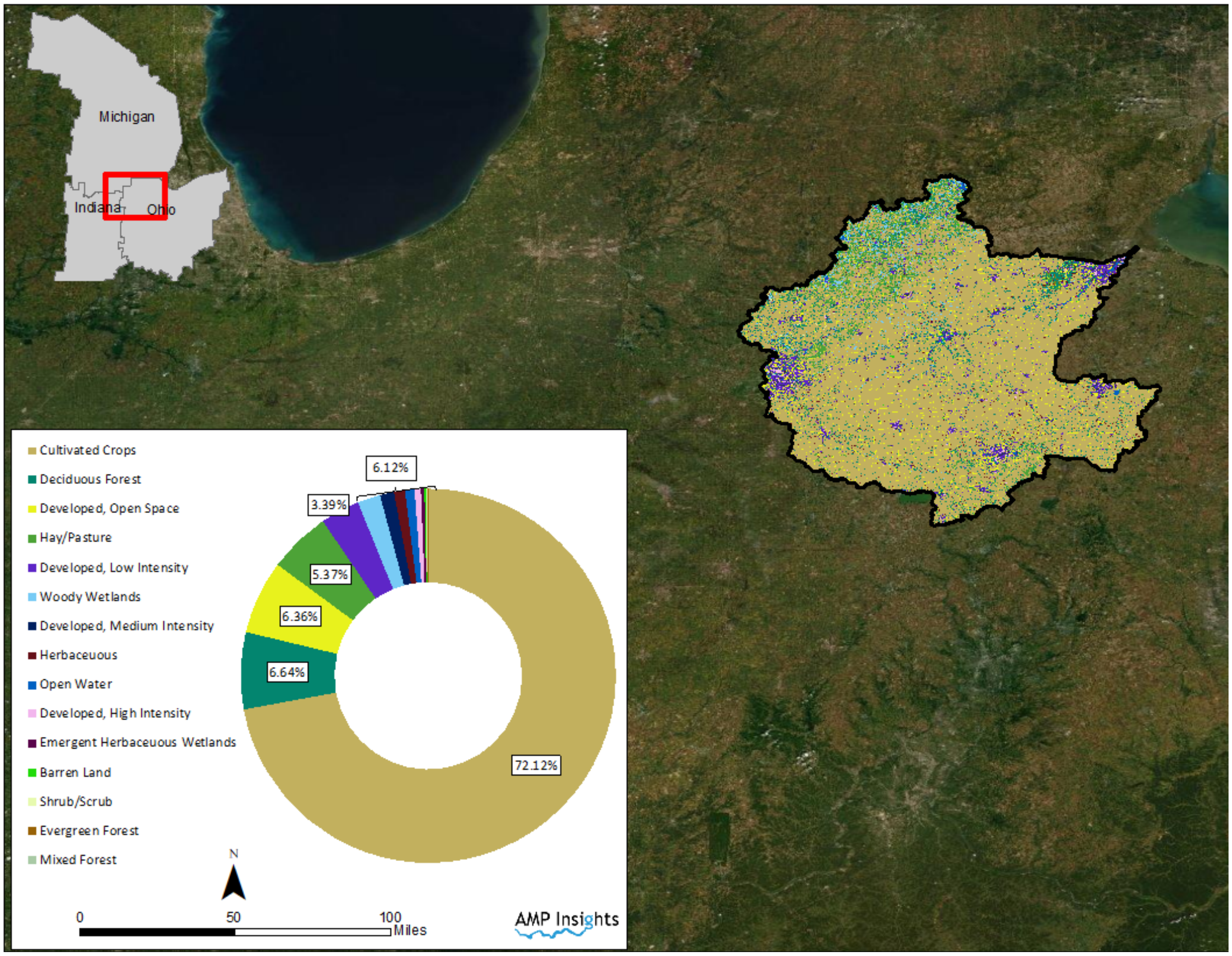


Figure 12. Land Use in the Saginaw Watershed 2011

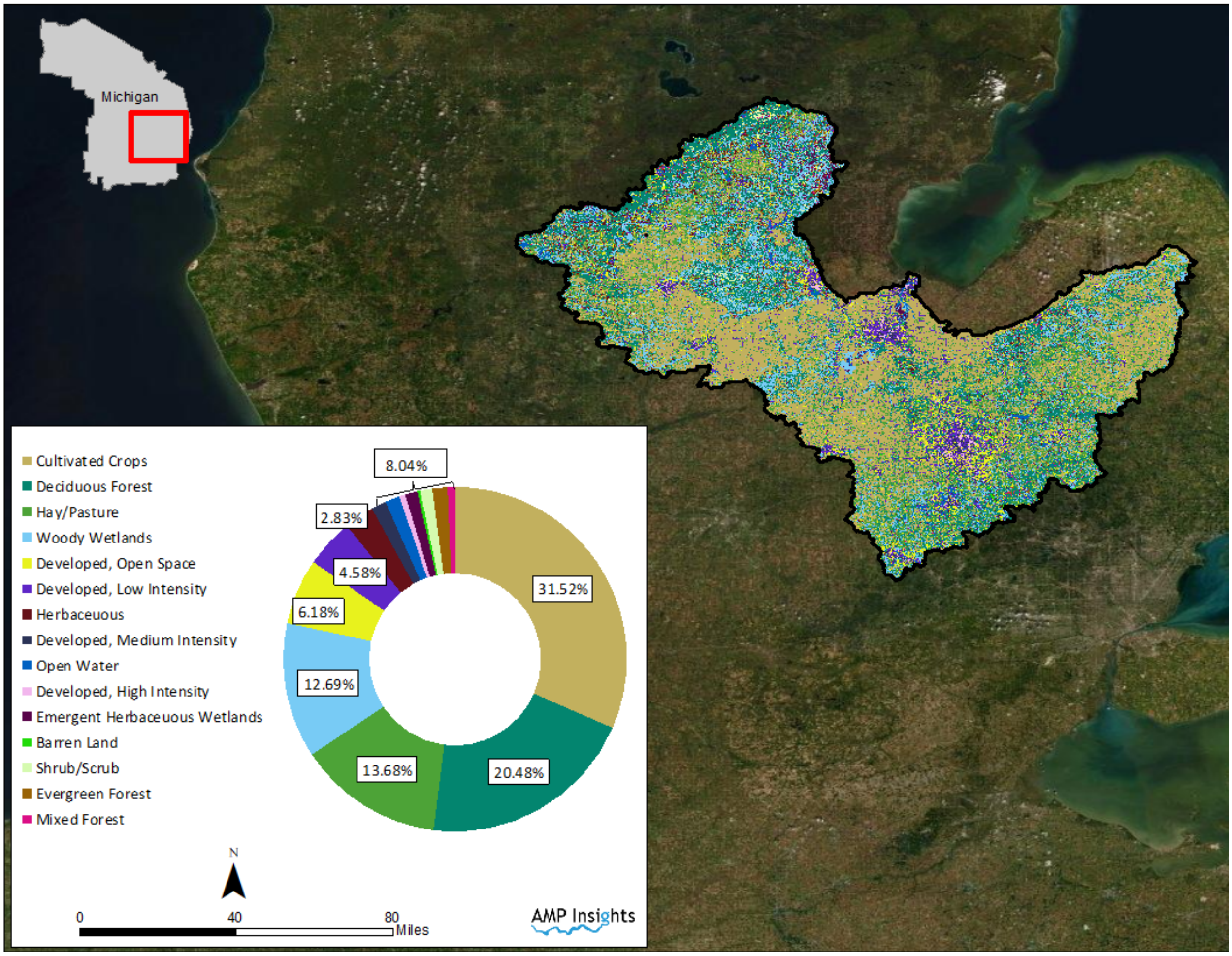


Table 15. Land Use in the Priority Watersheds for 2011 and 2016

Land Use	Genesee			Lower Fox			Maumee			Saginaw		
	2011	2016	Change	2011	2016	Change	2011	2016	Change	2011	2016	Change
Barren land	0.2%	0.2%	0.0%	0.4%	0.4%	0.0%	0.1%	0.1%	0.0%	0.3%	0.2%	-0.1%
Cultivated crops	18.8%	24.3%	5.4%	35.1%	49.1%	14.0%	72.1%	73.5%	1.4%	31.5%	40.0%	8.5%
Deciduous forest	28.1%	31.7%	3.6%	7.2%	5.3%	-1.9%	6.6%	6.6%	0.0%	20.5%	16.9%	-3.6%
Developed, high intensity	0.3%	0.3%	0.0%	2.6%	2.8%	0.2%	0.5%	0.6%	0.0%	0.6%	0.6%	0.0%
Developed, low intensity	1.6%	1.7%	0.1%	14.0%	12.9%	-1.0%	3.4%	3.5%	0.1%	4.6%	4.3%	-0.3%
Developed, medium intensity	0.8%	0.8%	0.0%	6.6%	6.9%	0.4%	1.2%	1.2%	0.0%	1.4%	1.5%	0.1%
Developed, open space	4.5%	5.3%	0.8%	7.7%	7.6%	-0.1%	6.4%	5.3%	-1.0%	6.2%	5.4%	-0.8%
Emergent herbaceous wetlands	1.1%	0.6%	-0.5%	0.9%	1.0%	0.1%	0.3%	0.4%	0.1%	1.2%	0.8%	-0.4%
Evergreen forest	3.8%	3.3%	-0.5%	0.1%	0.0%	0.0%	0.1%	0.1%	0.0%	1.4%	1.0%	-0.4%
Hay/pasture	26.1%	15.9%	-10.2%	19.2%	5.4%	-13.9%	5.4%	4.1%	-1.3%	13.7%	5.0%	-8.7%
Herbaceuous	0.4%	0.4%	0.0%	0.6%	0.3%	-0.4%	1.0%	0.3%	-0.6%	2.8%	1.2%	-1.6%
Mixed forest	5.8%	9.0%	3.3%	0.4%	0.1%	-0.3%	0.0%	0.1%	0.1%	0.7%	2.6%	1.9%
Open water	0.9%	1.0%	0.1%	1.5%	1.6%	0.1%	0.8%	0.9%	0.1%	1.4%	1.4%	0.1%
Shrub/scrub	3.7%	0.6%	-3.0%	0.3%	0.1%	-0.2%	0.1%	0.1%	-0.1%	1.1%	0.3%	-0.8%
Woody wetlands	4.0%	4.8%	0.8%	3.4%	6.4%	3.0%	2.0%	3.1%	1.1%	12.7%	18.8%	6.1%

5.2 Agricultural Land

The Census of Agriculture reports county-level estimates of agricultural land by type—cropland, pastureland, woodland and other. Table 16 shows watershed level estimates presented both in acres and as a percentage of total agricultural land within each watershed for the years 2007, 2012 and 2017. For all four watersheds, cropland represented the largest percentage of agricultural land across all three years considered. While the Lower Fox and Saginaw had similar profiles with regards to how agricultural land within the watershed was distributed by type, the Genesee had more pastureland and woodland relative to the other three watersheds and cropland represented the majority of agricultural land in the Maumee.

With regards to changes over the time frame considered, few land type categories saw increases in acreage. The exceptions were acres in cropland, which increased in three of the four watersheds (i.e., Lower Fox, Maumee and Saginaw) and acres in pastureland, which increased only in the Lower Fox. It is important to note, however, that the trends in acreage by agricultural land type diverge slightly from the trends in percentage of total agricultural land, which is the result of the total amount of agricultural land decreasing over time for all four watersheds such that the absolute change in acres may decrease while the percentage of agricultural land increases.

Table 16. Agricultural Land by Type (a) by Acres and (b) by Percentage of Total

Watershed	2007	2012	2017	Change (Acres)
Genesee				
Cropland	426,787	403,637	424,978	-1,809
Pastureland	70,179	54,959	52,949	-17,229
Woodland	103,769	104,254	94,852	-8,917
Other	43,821	41,147	42,396	-1,424
Lower Fox				
Cropland	184,462	179,149	187,677	3,215
Pastureland	8,349	7,847	9,448	1,099
Woodland	18,218	15,993	12,542	-5,676
Other	11,306	14,319	9,850	-1,457
Maumee				
Cropland	2,970,576	2,922,546	3,044,249	73,673
Pastureland	84,597	55,818	41,867	-42,730
Woodland	165,941	152,482	131,671	-34,270
Other	123,147	124,823	95,407	-27,740
Saginaw				
Cropland	1,393,783	1,363,395	1,425,678	31,895
Pastureland	114,191	80,953	71,083	-43,108
Woodland	155,224	150,138	128,107	-27,117
Other	91,267	88,738	71,022	-20,245

Watershed	2007	2012	2017
Genesee			
Cropland	66.2%	66.8%	69.1%
Pastureland	10.9%	9.1%	8.6%
Woodland	16.1%	17.3%	15.4%
Other	6.8%	6.8%	6.9%
Lower Fox			
Cropland	83.0%	82.4%	85.5%
Pastureland	3.8%	3.6%	4.3%
Woodland	8.2%	7.4%	5.7%
Other	5.1%	6.6%	4.5%
Maumee			
Cropland	88.8%	89.8%	91.9%
Pastureland	2.5%	1.7%	1.3%
Woodland	5.0%	4.7%	4.0%
Other	3.7%	3.8%	2.9%
Saginaw			
Cropland	79.4%	81.0%	84.1%
Pastureland	6.5%	4.8%	4.2%
Woodland	8.8%	8.9%	7.6%
Other	5.2%	5.3%	4.2%

5.3 Operations

County-level Census of Agriculture data were used to estimate the acres operated and number of farm operations within each watershed. As seen in Table 17, total acres operated decreased in three of the four watersheds over the timeframe considered–the exception being the Maumee. It is also worth noting that for all four watersheds, 2012 estimates of acres operated were lower than those in 2007 or 2017.

Table 17. Acres Operated

Watershed	2007	2012	2017	Change (Acres)	Change (%)
Genesee	615,536	589,611	595,375	-20,161	-3.3%
Lower Fox	217,990	214,326	216,733	-1,257	-0.6%
Maumee	3,290,569	3,239,075	3,297,993	7,424	0.2%
Saginaw	1,692,796	1,655,514	1,670,898	-21,898	-1.3%

The number of farm operations decreased in all four watersheds from 2007-2017, with the Maumee experiencing the greatest decrease in absolute terms and the Saginaw experiencing the greatest percentage change (see Table 18).

Table 18. Number of Farm Operations

Watershed	2007	2012	2017	Change (Operations)	Change (%)
Genesee	2,452	2,241	2,224	-228	-9.3%
Lower Fox	1,208	1,176	1,074	-134	-11.1%
Maumee	15,447	14,671	13,896	-1,551	-10.0%
Saginaw	9,136	8,261	7,782	-1,354	-14.8%

5.4 Farm Size

In addition to providing data on the number of operations and acres operated, the Census of Agriculture also estimates the number of operations by the size of the area operated. Since 2007, as seen in Table 19, all four watersheds had relatively similar distributions of farms across the size categories and the majority of farms in all four watersheds were less than 500 acres.

What is perhaps more interesting is the change in distribution over time—more specifically, for all four watersheds, the percentage of farms with 50.0-499.9 acres decreased and, with the exception of the Genesee, this was the only category that decreased. In contrast, the category with the greatest increase in all four watersheds was small farms (i.e., 1.0-49.9 acres).

Table 19. Operations by Area Operated

Watershed	2007	2012	2017	Change (%)
Genesee				
1.0-49.9 acres	31%	32%	38%	7.3%
50-499.9 acres	58%	57%	50%	-8.1%
500-999 acres	6%	6%	6%	0.0%
1,000 acres or more	5%	6%	6%	0.8%
Lower Fox				
1.0-49.9 acres	41%	46%	48%	7.0%
50-499.9 acres	51%	46%	42%	-8.7%
500-999 acres	6%	5%	6%	0.2%
1,000 acres or more	2%	3%	4%	1.4%
Maumee				
1.0-49.9 acres	42%	41%	44%	2.0%
50-499.9 acres	46%	47%	43%	-3.6%
500-999 acres	7%	7%	8%	0.6%
1,000 acres or more	5%	5%	6%	1.0%
Saginaw				
1.0-49.9 acres	45%	43%	46%	1.1%
50-499.9 acres	47%	47%	44%	-2.6%
500-999 acres	5%	5%	5%	0.7%
1,000 acres or more	4%	4%	5%	0.8%

The Census of Agriculture also reports on the estimated mean acres operated per farm operation. As seen in Table 20, the average number of acres per operation varies substantially across the watersheds—for all three Census years, the Lower Fox and the Maumee had the lowest and highest average number of acres per operation, respectively.

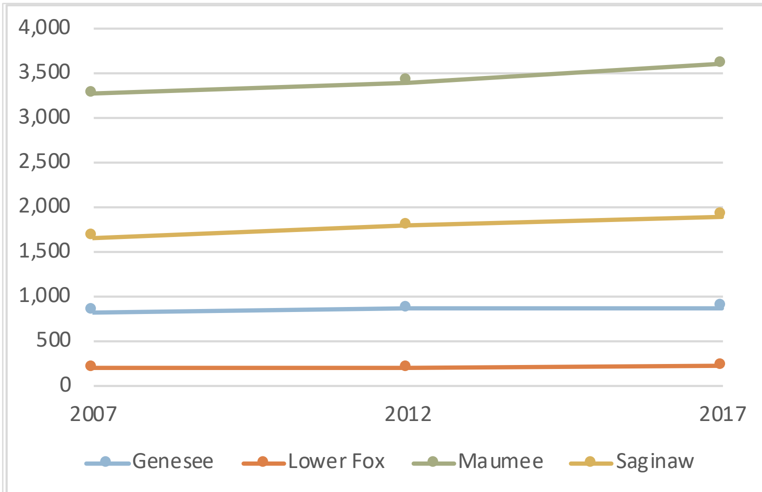
Table 20. Mean Acres per Operation

Watershed	2007	2012	2017	Change (Acres)	Change (%)
Genesee	817	854	871	55	6.7%
Lower Fox	196	196	218	22	11.5%
Maumee	3,267	3,390	3,595	328	10.0%
Saginaw	1,655	1,781	1,892	237	14.3%

Since 2007, the average number of acres operated increased in all four watersheds. As an absolute value and as a percentage, mean acres per operation increased the most in the Maumee and Saginaw, respectively (see

Figure 13). In 2017, the average number of acres per operation in the Maumee was sixteen times greater than that of the Lower Fox.

Figure 13. Mean Acres per Operation



5.5 Tenure

The Census of Agriculture classifies all farms by the tenure of the operators. The classifications are defined as follows:

- full owners operated only land they owned;
- part owners operated land they owned and also land they rented from others; and
- tenants operated only land they rented from others or worked on shares for others (USDA, National Agricultural Statistics Service, n.d.).

In all four watersheds, the majority of operations were classified as full owner (see Table 21); however, part owners operated the majority of acres across the time frame considered (see Table 22). The percentage of operations run by full owners decreased from 2007-2017 in all four watersheds, while part ownership increased in all watersheds except the Genesee. Similarly, in all four watersheds, the percentage of acres operated by full owners and part owners decreased and increased, respectively.

Table 21. Percentage of Total Operations by Tenure

Watershed	2007	2012	2017	% Change
Genesee				
Full Owner	67.5%	65.7%	66.3%	-1.2%
Part Owner	29.5%	30.2%	29.5%	0.0%
Tenant	2.9%	4.1%	4.2%	1.2%
Lower Fox				
Full Owner	60.6%	61.6%	59.6%	-1.0%
Part Owner	34.5%	33.4%	35.4%	1.0%
Tenant	4.9%	5.0%	5.0%	0.0%
Maumee				
Full Owner	64.3%	62.6%	62.7%	-1.6%
Part Owner	29.7%	31.6%	31.3%	1.6%
Tenant	6.0%	5.8%	6.0%	0.0%
Saginaw				
Full Owner	68.8%	66.2%	66.3%	-2.5%
Part Owner	27.3%	29.8%	28.8%	1.5%
Tenant	3.9%	4.0%	4.9%	1.0%

Table 22. Percentage of Total Acres Operated by Tenure

Watershed	2007	2012	2017	Change (%)
Genesee				
Full Owner	32.7%	28.1%	26.4%	-6.3%
Part Owner	64.8%	68.3%	69.9%	5.1%
Tenant	2.5%	3.6%	3.6%	1.2%
Lower Fox				
Full Owner	23.9%	21.4%	17.6%	-6.3%
Part Owner	71.9%	73.9%	78.3%	6.4%
Tenant	4.2%	4.8%	4.1%	-0.1%
Maumee				
Full Owner	22.2%	21.5%	19.9%	-2.3%
Part Owner	70.8%	71.5%	73.1%	2.3%
Tenant	7.0%	7.0%	7.0%	0.0%
Saginaw				
Full Owner	27.3%	25.5%	23.0%	-4.3%
Part Owner	66.9%	68.8%	71.9%	5.0%
Tenant	5.8%	5.7%	5.1%	-0.8%

5.6 Family Farms

The Census of Agriculture reports on tax status of farm operations, separating out family farms from other operations. For 2007-2017, family farms were included in the tax statuses of family-held corporations, partnerships including family partnerships, and family and individually owned farms. The tax status for partnerships, however, does not separate out family-held partnerships from other partnership types and it was excluded from this analysis.

Using the Census of Agriculture's farm operations – acres operated and number of operations categories (used and referenced in Section 5.2 and 5.3), the proportion of acres and operations in family farms were calculated. For the time period 2007-2017, across the four priority watersheds a large proportion (83%-88%) of farming operations were held by families and individuals. The proportion of acres operated by family-owned farms, however, is smaller (52%-74% total for family and individual farms) indicating that family farms, on the whole, hold a smaller number of acres per operation than non-family farms.

From 2007-2017 the number of acres held by family and individually owned farms decreased, following the general trend in these watersheds of decreasing land in agriculture (shown in Sections 5.1, 5.2 and 5.3), such that the proportion of agricultural acres in family and individually held farms experienced little change for this time period (see Table 23). The proportion of farming operations held by individuals and families followed the same trend with family farms suffering small loses across all watersheds. In contrast, farms under the tax status of family-held corporations experienced relative stability from 2007 to 2017 in terms of both proportion of acreage (-0.2% to 4.2% change) and number of operations (0.8% to 1.5% change) in this tax designation (see Table 24).

Table 23. Individually and Family Owned Farms as a Proportion of Watershed Totals

Watershed	2007	2012	2017	Change (%)
Proportion of Acres in Farming Operations				
Genesee	52.2%	52.9%	52.0%	-0.2%
Lower Fox	65.3%	67.1%	63.0%	-2.3%
Maumee	73.3%	74.1%	68.3%	-5.1%
Saginaw	62.2%	67.4%	61.8%	-0.3%
Proportion of Farming Operations				
Genesee	83.9%	84.7%	83.6%	-0.3%
Lower Fox	86.6%	86.0%	83.3%	-3.3%
Maumee	83.5%	84.7%	82.8%	-0.7%
Saginaw	87.1%	87.5%	86.4%	-0.7%

Table 24. Farms Under Family-Held Corporations as a Proportion of Watershed Totals

Watershed	2007	2012	2017	Change (%)
Acres				
Genesee	16.4%	15.6%	16.8%	0.4%
Lower Fox	8.3%	10.2%	12.4%	4.2%
Maumee	9.1%	10.3%	11.6%	2.5%
Saginaw	12.2%	11.6%	12.0%	-0.2%
Number of Operations				
Genesee	5.0%	4.9%	5.9%	0.9%
Lower Fox	3.8%	4.9%	5.2%	1.5%
Maumee	4.0%	3.9%	4.8%	0.8%
Saginaw	3.8%	4.1%	4.5%	0.8%

5.7 Agricultural Land Value

Agricultural land value could be indicative of multiple socio-economic factors – key amongst them are the values of the crops being grown, the productiveness of the land, access to markets, the size of the farm operations, and the desirability of the quality of life in the community. Agricultural land values, inclusive of buildings, at the county-level are available every five years from the Census of Agriculture and are available at the state-level annually through USDA censuses and surveys. Some state farm bureaus and departments of agriculture do produce agricultural land value reports on an annual basis at the state-level and inconsistently at the region-level (for example, Ohio and Michigan through state or university entities report annual estimates of agricultural land value by region in the state every year, whereas a state like New York does not appear to have a comparable dataset).

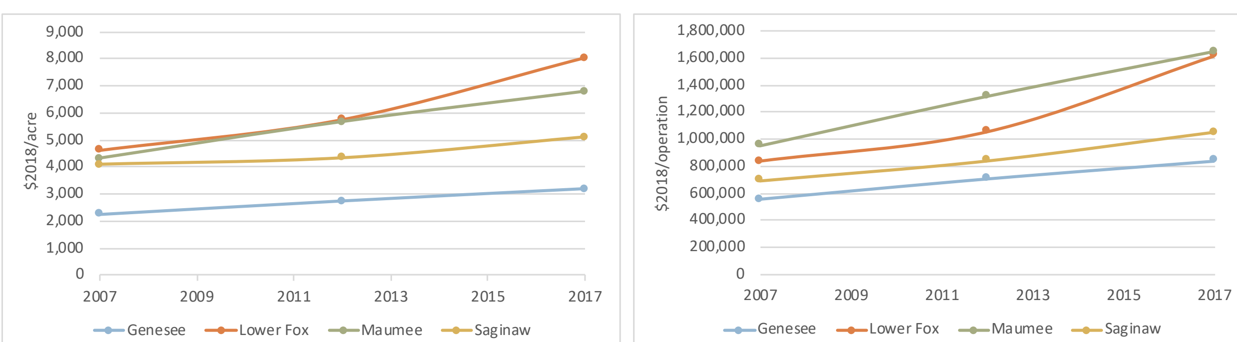
Agricultural land values were evaluated for 2007, 2012, and 2017 from the Census of Agriculture and were weighted according to the schema described in Section 2 and adjusted to $2018. Agricultural land was valued in the billions for each of the four priority watersheds with total land value following the expected values of watershed area – i.e., Maumee Watershed exhibits the greatest total land value, followed by Saginaw, Genesee, and Lower Fox Watershed (Table 25).

Table 25. Total Agricultural Land and Building Values ($2018 Billions)

Watershed	2007	2012	2017
Genesee	$ 1.4	$ 1.7	$ 2.0
Lower Fox	$ 1.0	$ 1.2	$ 1.7
Maumee	$ 14.1	$ 18.5	$ 22.5
Saginaw	$ 6.5	$ 7.2	$ 8.5

Assessing land value per acre, however, shows that the Lower Fox had the greatest land value per acre over the three available years of data. The Lower Fox additionally displayed high per agricultural operation values as well, though the per operation values were higher for the Maumee than the Lower Fox (Figure 14). This indicates that Maumee agricultural operations were, on average, of greater acreage than Lower Fox operations. An additional point of importance is that while Genesee, Maumee, and Saginaw per acre and per operation agricultural values increased steadily from 2007-2017, values in the Lower Fox increased somewhat exponentially indicating that some change to agriculture in the Lower Fox watershed precipitated a substantial change to agricultural land value. The cause of this change is an increase in agricultural operations valued at $2 million or more (see Appendix C for graphics on numbers of operators by agricultural operation value class). As shown in Section 5.4, farm size in the Lower Fox was increasing at both ends of the acreage spectrum with small farms increasing the most from 2007-2017. Therefore, the cause of the more exponential trend exhibited by Lower Fox agricultural land values by acre and operation is likely caused by some other factor than consolidation and could be indicative of a switch to higher value crops, higher yield crops, more access to markets, an effect of the region's recovery from the 2008 recession, or some other external factors.

Figure 14. Agricultural Land Value (a) by Acre and (b) by Operation



How agricultural land values at the state-level compared to those in the four priority watersheds for 2007, 2012, and 2017 was also explored. State values of agricultural land including buildings were weighted by the percentage of the watershed comprised of counties in each state. The results show that the per acre values of agricultural land in the watersheds were all much lower than the weighted state value (between 19% and 60% less). However, the per operator value of agricultural lands in the watersheds are, on the whole, greater than the weighted state per operator agricultural values (0.5% to 46% greater). This suggests that operators in the watersheds are larger than the state-wide average.

5.8 Crops

As noted in the land use section, all four priority watersheds' largest category of land use is cropland with the exception of the Genesee. In order to explore more deeply, data on the dominant crop types by watershed were sourced from the USDA's Census of Agriculture and Cropscape database. Although Cropscape is produced for each year using satellite imagery, the 2017 data were chosen so at to be comparable to other agricultural data sourced from the 2017 Census of Agriculture.

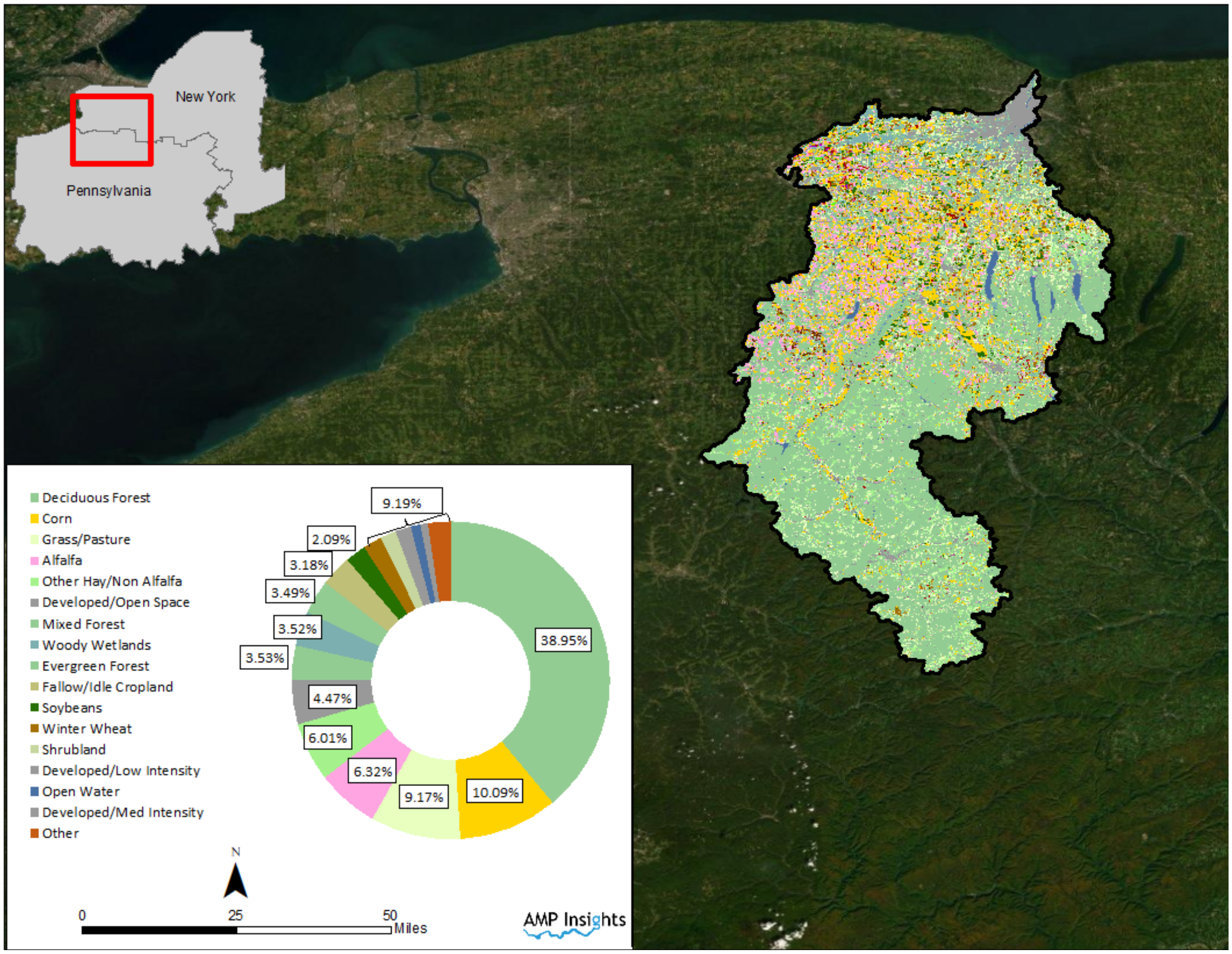
The dominant crops across the watersheds included corn, grass/pasture, soybeans, and alfalfa (see Table 26). Other grains (barley, oats, rye, etc.) and specialty crops comprised just a small portion of the land cover for each watershed – typically less than 5%.

Table 26. Watershed Crop Cover by Five Most Dominant Crops in 2017

Crop	Genesee	Lower Fox	Maumee	Saginaw
Corn	10.1%	16.9%	23.3%	10.9%
Soybeans	2.1%	8.4%	39.8%	14.4%
Grass/Pasture	9.2%	9.8%	7.3%	7.5%
Alfalfa	6.3%	12.9%	1.4%	3.8%
Winter wheat	1.9%	1.7%	4.1%	2.8%

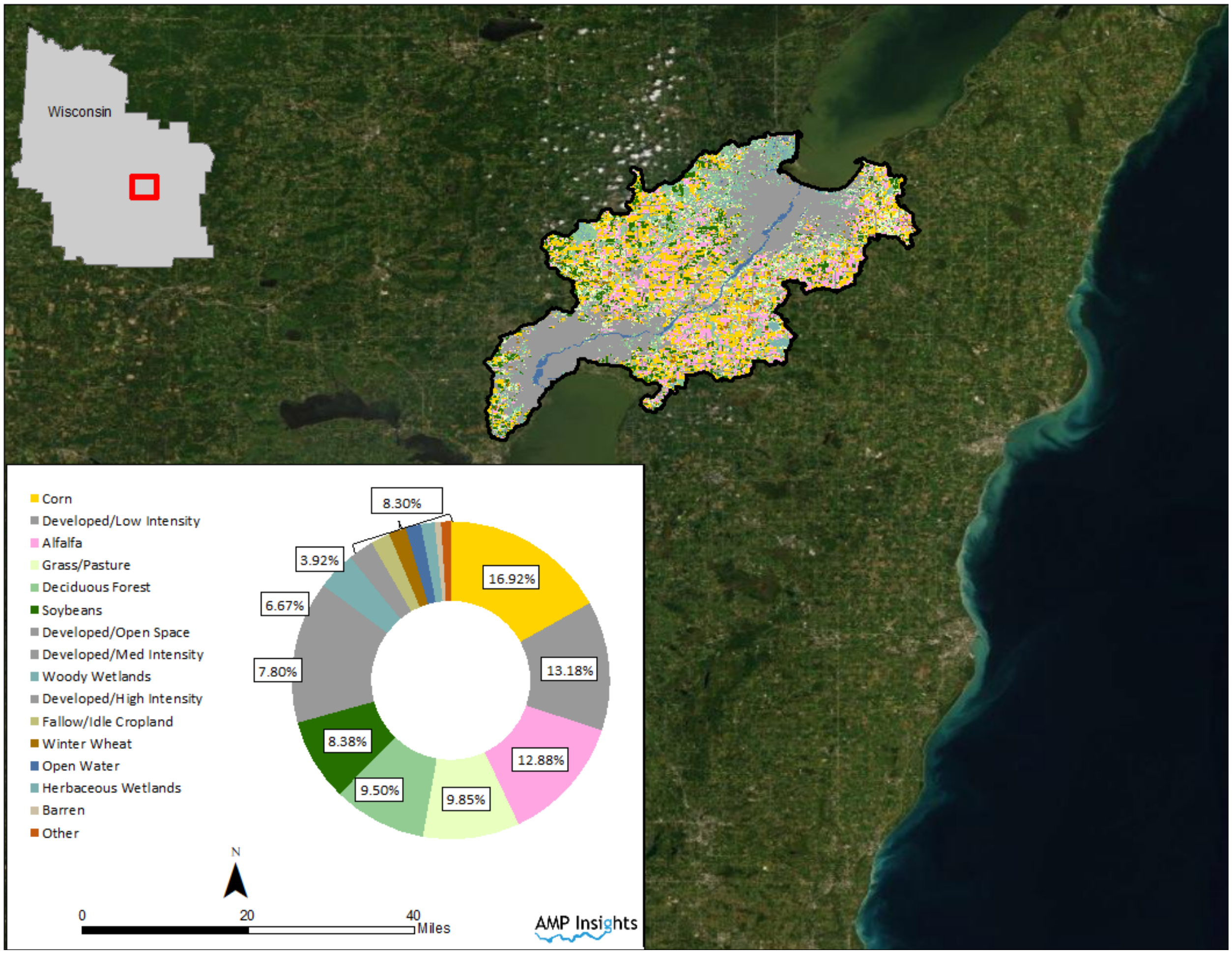
Variation in the distribution and coverage of crop land was evident in the four priority watersheds. The Genesee cropland was concentrated in the northwest of the watershed with forestland dominating in the south and development in the north (Figure 15). Cropland in the Lower Fox, however, was primarily in the central east and western sides of the watershed bordered by development to the north and south (Figure 16). The Maumee was dominated by cropland and with relatively even distribution of cropland throughout the watershed (Figure 17). Crop cover in the Saginaw was varied and did not follow the easily distinguished patterns of the other three watersheds (Figure 18).

Figure 15. Genesee Watershed Cropscape Crop Cover 2017



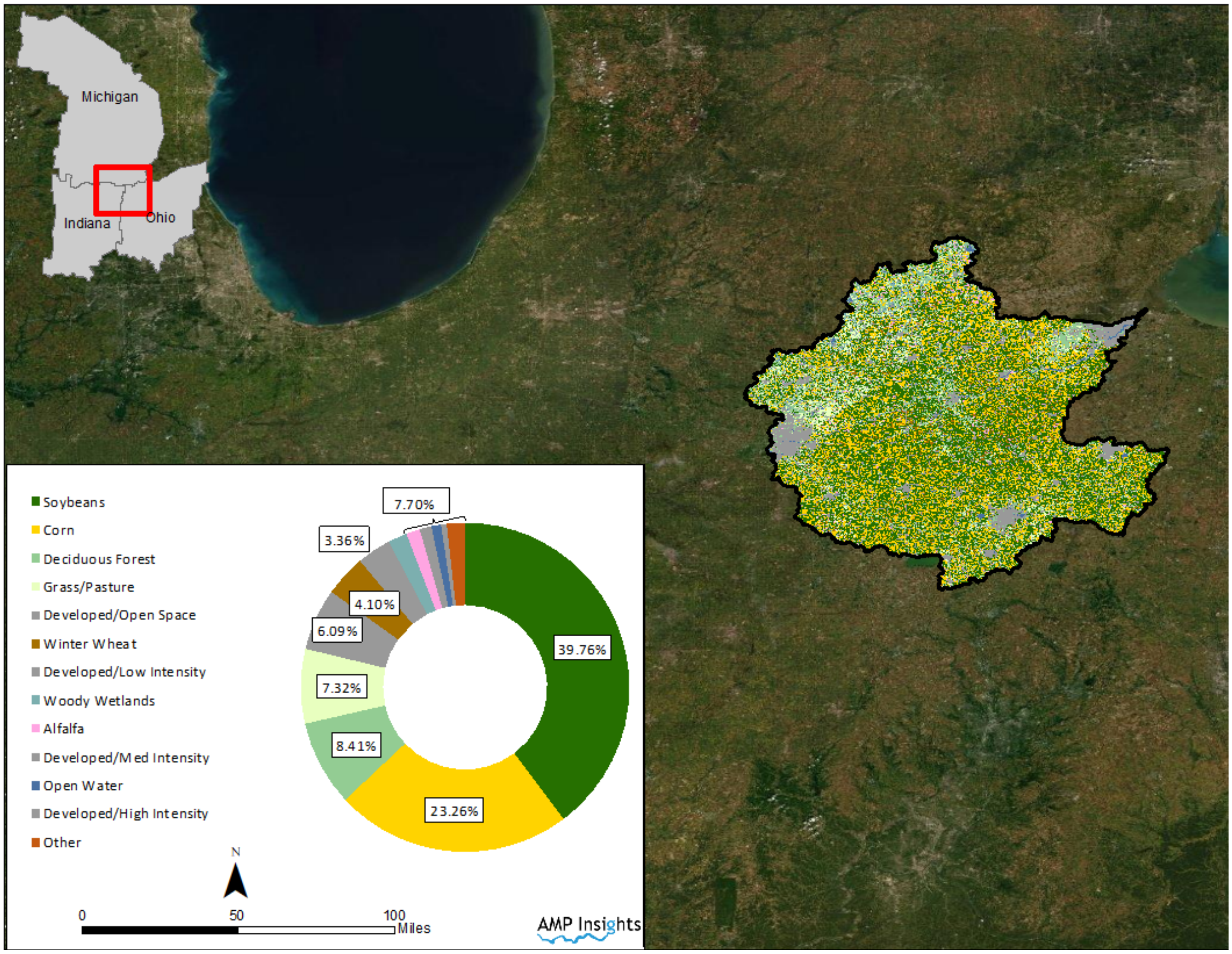
Note: The category "Other" is comprised of many specialty crops and land use categories included in the Cropscape dataset that account for less than 1% of watershed land cover.

Figure 16. Lower Fox Watershed Cropscape Crop Cover 2017



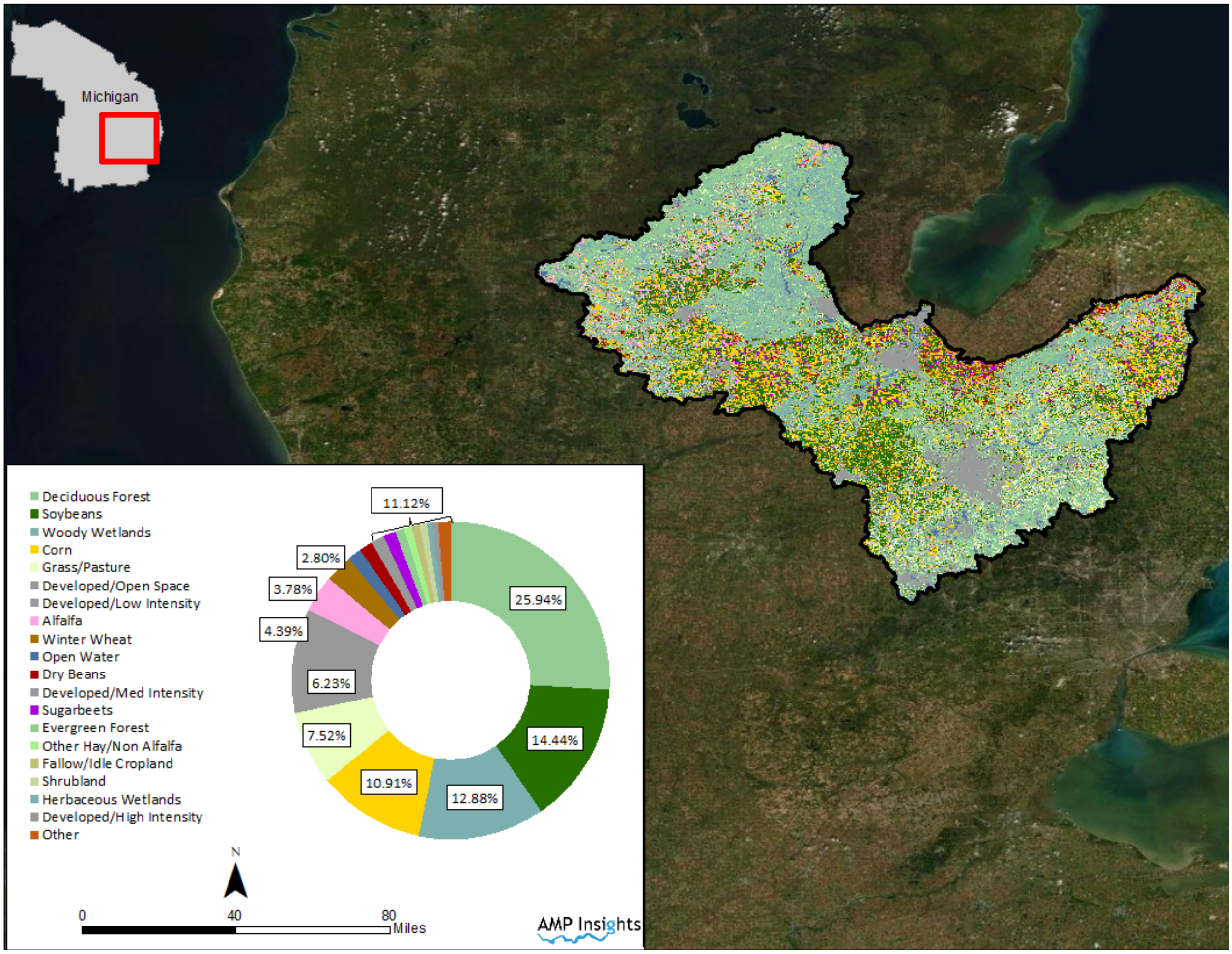
Note: The category "Other" is comprised of many specialty crops and land use categories included in the Cropscape dataset that account for less than 1% of watershed land cover.

Figure 17. Maumee Watershed Cropscape Crop Cover 2017



Note: The category "Other" is comprised of many specialty crops and land use categories included in the Cropscape dataset that account for less than 1% of watershed land cover.

Figure 18. Saginaw Watershed Cropscape Crop Cover 2017



Note: The category "Other" is comprised of many specialty crops and land use categories included in the Cropscape dataset that account for less than 1% of watershed land cover.

5.9 Value of Agricultural Production

Farm sales data were downloaded from the Census of Agriculture and updated to constant 2018 dollars. As seen in Table 27, both the volume of sales and the percentage of sales attributed to animal (including animal products) versus crop production varied substantially between the four watersheds. For all three years of available data, animal sales accounted for the majority of farm sales in the Genesee and Lower Fox, while crop sales represented a greater overall proportion of total sales in the Maumee and Saginaw.

Table 27. Farm Sales as (a) 2018 Dollars and (b) Percentage of Watershed Total

Watershed	2007	2012	2017	Change (%)
Genesee				
Animal	$ 386,980,753	$ 393,643,391	$ 395,963,302	2.3%
Crop	$ 140,460,369	$ 224,786,607	$ 173,439,654	23.5%
Total	$ 527,441,122	$ 618,429,998	$ 569,402,956	8.0%
Lower Fox				
Animal	$ 248,666,558	$ 247,573,470	$ 229,000,763	-7.9%
Crop	$ 50,711,554	$ 83,667,784	$ 57,372,742	13.1%
Total	$ 299,378,112	$ 331,241,254	$ 286,373,505	-4.3%
Maumee				
Animal	$ 939,858,608	$ 990,162,494	$ 1,116,101,401	18.8%
Crop	$ 1,314,112,862	$ 1,929,893,203	$ 1,493,697,822	13.7%
Total	$ 2,253,971,470	$ 2,920,055,697	$ 2,609,799,223	15.8%
Saginaw				
Animal	$ 332,130,749	$ 355,915,864	$ 395,711,766	19.1%
Crop	$ 594,325,449	$ 1,042,083,539	$ 667,705,377	12.3%
Total	$ 926,456,198	$ 1,397,999,403	$ 1,063,417,143	14.8%

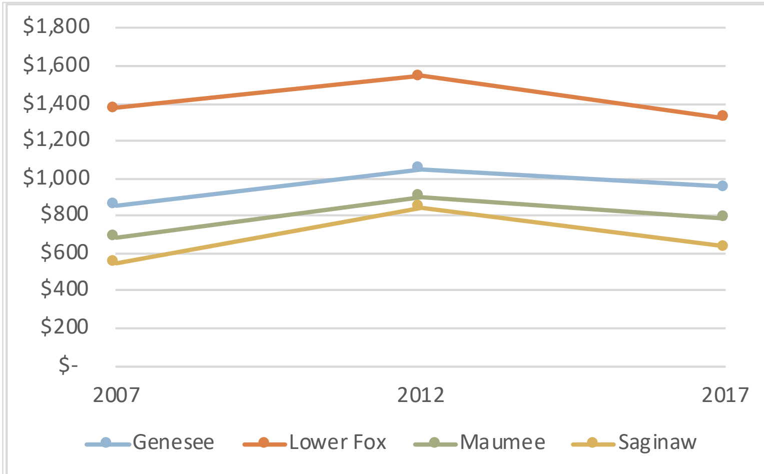
Watershed	2007	2012	2017
Genesee			
Animal	83%	75%	80%
Crop	17%	25%	20%
Lower Fox			
Animal	83%	75%	80%
Crop	17%	25%	20%
Maumee			
Animal	42%	34%	43%
Crop	58%	66%	57%
Saginaw			
Animal	36%	25%	37%
Crop	64%	75%	63%

Another way to describe farm sales is by calculating sales per acre operated, which also varied substantially between the four watersheds (see Table 28). Across the time frame considered, the Lower Fox consistently exhibited the highest sales per acre operated; however, it is interesting to note that this value decreased from 2007 to 2017 and, in fact, the Lower Fox was the only watershed where sales per acre decreased across this time frame considered. Sales per acre increased in the three other watersheds (12% to 16% change); however, in 2017 the sales per acre in the Lower Fox were still $365 to $685 higher than sales per acre in the other three watersheds (see Figure 19).

Table 28. Sales per Acre Operated ($2018)

Watershed	2007	2012	2017	Change (%)
Genesee	$ 857	$ 1,049	$ 956	11.6%
Lower Fox	$ 1,373	$ 1,546	$ 1,321	-3.8%
Maumee	$ 685	$ 902	$ 791	15.5%
Saginaw	$ 547	$ 844	$ 636	16.3%

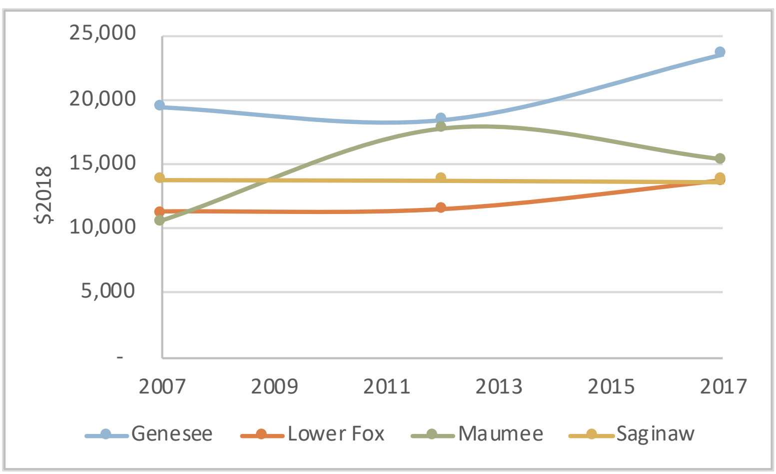
Figure 19. Sales per Acre Operated ($2018)



5.10 Income

Income data by farming operation and government conservation and wetlands payments[1] by farming operation are available from the Census of Agriculture and were adjusted to $2018 and analyzed for 2007, 2012, and 2017. For all four priority watersheds, with the exception of Saginaw, total income per operation from farm-related sources increased from 2007 to 2017 (Figure 20).

Figure 20. Income from Farm-Related Sources ($2018/Operation)



Trends in government conservation payments were more mixed among the watersheds from 2007 to 2017, but each priority watershed experienced a dip in conservation payments in 2012 (see Figure 21). Overall, farming operations in the watersheds received between 12% and 27% of their farm-related income from government conservation payments. The Saginaw consistently received the highest

[1] "Amount from Conservation Reserve, Wetlands Reserve, Farmable Wetlands, and Conservation Reserve Enhancement Programs. See Land enrolled in the Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP), Farmable Wetlands Program (FWP), or Conservation Reserve Enhancement Program (CREP)"

percentage of income from conservation payments and was also the only watershed to experience growth in this area from 2012 to 2017 (see Table 29).

Figure 21. Income from Conservation and Wetland Payments ($2018/Operation)

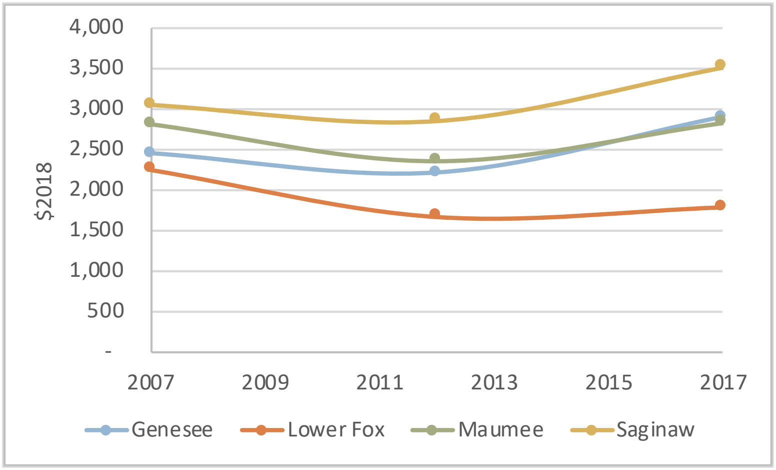


Table 29. Comparison of Total Income from Farm-Related Sources and Conservation Payments

Watershed	2007	2012	2017	Change (%)
Genesee				
Total income from farm-related sources/operation	19,393	18,388	23,562	21.5%
Government conservation & wetland payments/operation	2,462	2,226	2,908	18.1%
Percentage of income from conservation payments	12.7%	12.1%	12.3%	-0.4%
Lower Fox				
Total income from farm-related sources/operation	11,260	11,445	13,740	22.0%
Government conservation & wetland payments/operation	2,256	1,687	1,804	-20.0%
Percentage of income from conservation payments	20.0%	14.7%	13.1%	-6.9%
Maumee				
Total income from farm-related sources/operation	10,542	17,729	15,323	45.4%
Government conservation & wetland payments/operation	2,821	2,372	2,835	0.5%
Percentage of income from conservation payments	26.8%	13.4%	18.5%	-8.3%
Saginaw				
Total income from farm-related sources/operation	13,821	13,802	13,760	-0.4%
Government conservation & wetland payments/operation	3,062	2,862	3,526	15.1%
Percentage of income from conservation payments	22.2%	20.7%	25.6%	3.5%

5.11 Subsidies

Data on farm subsidies were obtained from the EWG Farm Subsidy Database, which is based on data "from the U.S. Department of Agriculture pursuant to the Freedom of Information Act". The database contains annual data on four subsidy categories:

1. Commodity programs – includes funding supporting production of specific commodities (e.g., corn, soybeans, wheat, cotton, and rice), which is distributed through a variety of programs (see farm.ewg.org for more information on these programs).

2. Conservation programs – includes funding from four federal programs – Environmental Quality Incentives Program (EQIP), Wildlife Habitat Incentives Program (WHIP), Conservation Stewardship Program (CSP) and Conservation Reserve Program (CRP).
3. Crop insurance subsidies – includes funding to reduce the cost of crop insurance premiums paid by producers enrolling in crop insurance programs.
4. Disaster programs – includes funding "to compensate farmers who experience losses in a given year due to natural disasters." (Environmental Working Group, n.d.)

County-level data were downloaded and aggregated to the watershed level. Note that some negative values are included in the data. Negative values indicate repayments or corrections of subsidies distributed that were either overpayments or distributed to ineligible recipients for either the current or previous year. For those years in which there are negative values, this indicates that the repayments or corrections exceeded the payments in that program for the year.

Table 30 shows mean annual subsidies for the years 2007-2017 by type and as a percentage of total subsidies for each watershed. Not surprisingly, mean annual total subsidies ranked by value follow the same ranking as watershed area (i.e., Maumee, Saginaw, Genesee, and Lower Fox). For all four watersheds, commodity and crop insurance subsidies accounted for the majority of total subsidies on an annual basis. While subsidies per recipient would have been a useful datapoint, the data provided did not identify whether individuals received more than one subsidy per year. For example, a producer might receive both conservation and crop insurance subsidies in a year, but the data would report this as two separate recipients. Subsidies per recipient by subsidy type as well as additional details on each subsidy are provided in the sections that follow.

Table 30. Mean Annual Subsidies (a) by Total and (b) as a Percentage of Total ($2018 millions)

Subsidy	Genesee	Lower Fox	Maumee	Saginaw
Commodity	$ 6.6	$ 3.5	$ 59.1	$ 20.3
Conservation	$ 0.6	$ 0.3	$ 17.9	$ 5.9
Disaster	$ 0.3	$ 0.4	$ 4.2	$ 1.0
Crop insurance	$ 3.0	$ 3.6	$ 47.1	$ 21.9
Total	$ 10.6	$ 7.8	$ 128.2	$ 49.0

Subsidy	Genesee	Lower Fox	Maumee	Saginaw
Commodity	63%	45%	46%	41%
Conservation	6%	4%	14%	12%
Disaster	2%	5%	3%	2%
Crop insurance	29%	47%	37%	45%

5.11.1 Commodity Program Subsidies

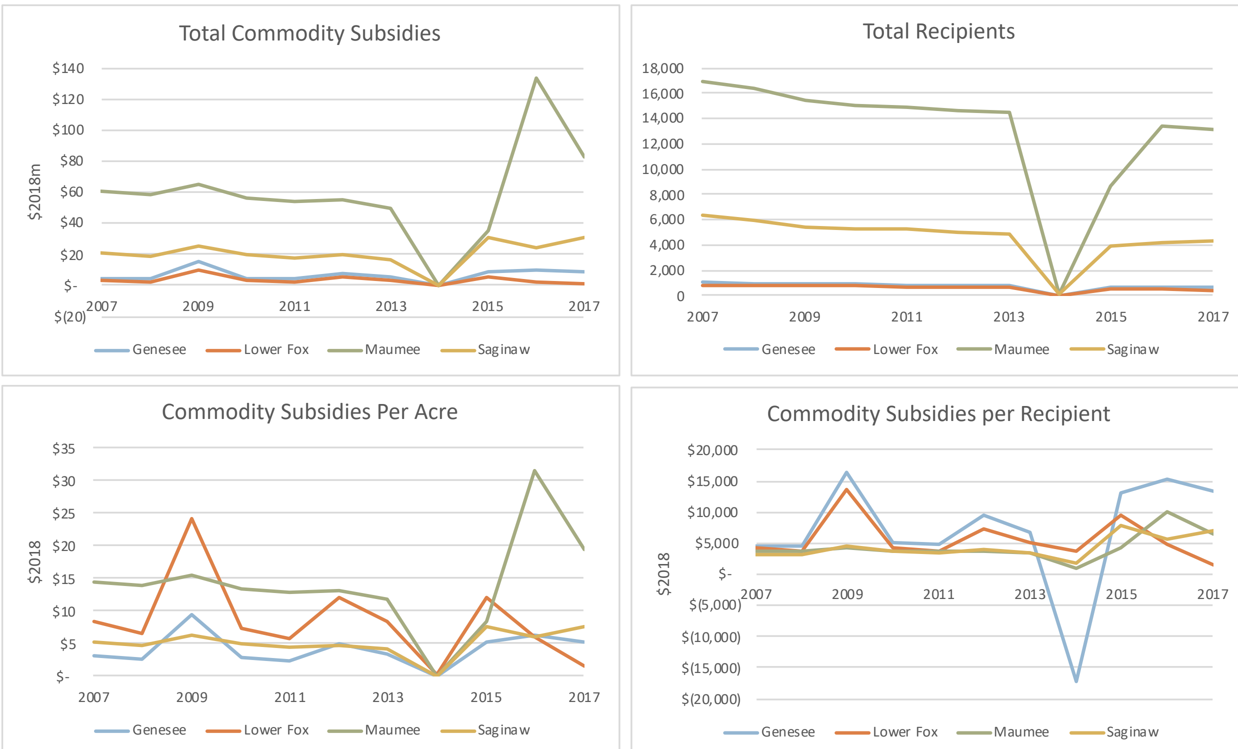
Total annual subsidies from commodity programs varied substantially between watersheds, with the Maumee and the Lower Fox consistently receiving the highest and lowest amount of funding, respectively (see Figure 22). From 2007 to 2017, average annual commodity program funding ($2018) by watershed was as follows: Genesee ($6.6 million), Lower Fox ($3.5 million), Maumee ($59.1 million) and Saginaw ($20.3 million).

Given that the overall size of the watersheds varies as does proportion of total acres in farmland, subsidies would ideally be presented per operation or per acres of farmland; however, as these data were not available on an annual basis, total acres in the watershed were used instead. While the Maumee still received, on average, the highest amount of commodity program funding per square mile ($14.04/acre), it is interesting to note that Lower Fox received the next highest amount ($8.41/acre). Average commodity subsidies in the Genesee and Saginaw were $4.16/acre and $5.09/acre, respectively.

Data also were analyzed by the number of producers receiving commodity program funding on an annual basis. Again, the Maumee, on average, had the greatest number of participants and the Lower Fox had the fewest. From 2007 to 2017, average annual commodity program recipients by watershed were as follows:

Genesee (751), Lower Fox (590), Maumee (13,009) and Saginaw (4,622). When analyzed as funding per recipient, however, results are relatively similar between the watersheds (see fourth graph in Figure 22)—ranging, on average, from $4,358 (Saginaw) to $6,940 (Genesee).

Figure 22. Commodity Program Subsidies



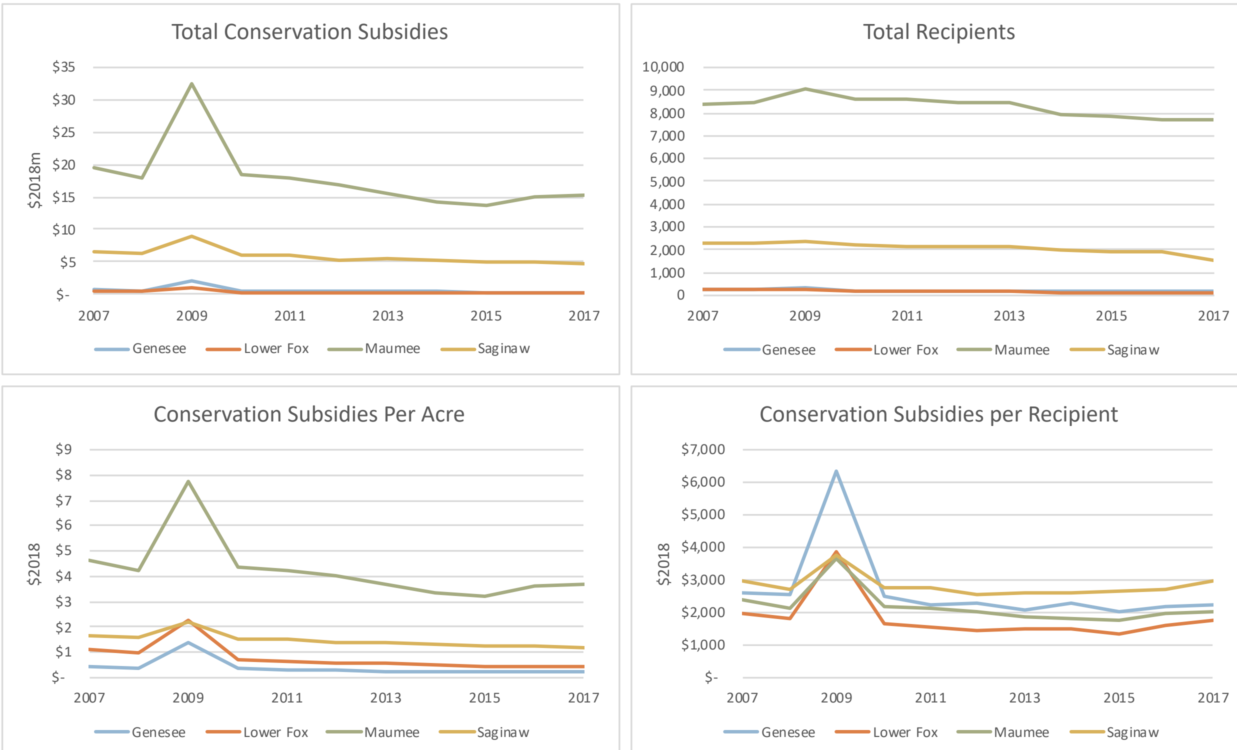
5.11.2 Conservation Program Subsidies

Total annual funding from conservation programs and participation levels were relatively consistent across time within each watershed, but varied substantially between watersheds (see Figure 23). From 2007 to 2017, average annual conservation program funding ($2018) by watershed was as follows: Genesee ($0.6 million), Lower Fox ($0.3 million), Maumee ($17.9 million) and Saginaw ($5.9 million).

Results are also presented per acre given the variation in the overall size of the watersheds. The Maumee still received, on average, the highest amount of conservation program subsidies per acre ($4.25/acre), which was substantially higher than the other three watersheds (Genesee - $0.39/acre, Lower Fox - $0.78/acre and Saginaw - $1.47/acre).

Data again were analyzed by the number of producers receiving conservation subsidies on an annual basis. Not unexpectedly, given the relative size of each watershed, the Maumee, on average, had the greatest number of participants and the Lower Fox had the fewest. From 2007 to 2017, average annual recipients of conservation subsidies were as follows: Genesee (215), Lower Fox (168), Maumee (8,299) and Saginaw (2,083). When analyzed as funding per recipient, however, results are relatively similar between the watersheds (see fourth graph in Figure 23)—ranging, on average, from $1,811 (Lower Fox) to $2,824 (Saginaw).

Figure 23. Conservation Program Subsidies



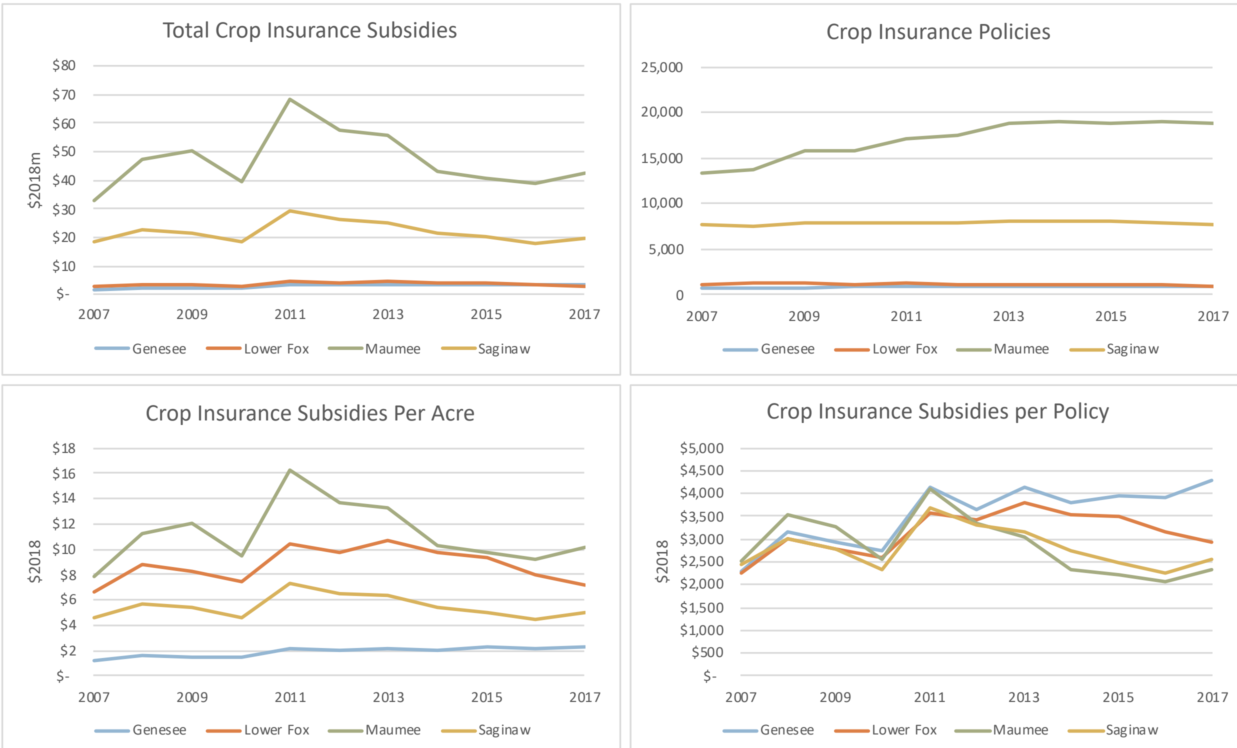
5.11.3 Crop Insurance Subsidies

From 2007 to 2017, average annual crop insurance subsidies ($2018) by watershed were as follows: Genesee ($3.0 million), Lower Fox ($3.6 million), Maumee ($47.1 million) and Saginaw ($21.9 million). Assessing crop insurance subsidies on a per acre basis, the Maumee and the Genesee received, on average, the highest and lowest annual crop insurance subsidies at $11.19/acre and $1.91/acre, respectively. The Lower Fox received an annual average of $8.76/acre, while the Saginaw received $5.49/acre.

Data were analyzed by the number of policies issued annually (see Figure 24). From 2007 to 2017, average annual commodity program recipients by watershed were as follows: Genesee (856), Lower Fox (1,158), Maumee (17,077) and Saginaw (7,864). It is worth noting that, while the number of policies remained relatively consistent across the time frame considered for three of the watersheds, there has been a distinct upward trend in the Maumee.

Subsidies per policy were of relatively similar value and followed a similar trend for all four watersheds until 2012, after which they diverged. The Genesee experienced the greatest increase in subsidies per policy, with an 86% increase in value from 2007 to 2017.

Figure 24. Crop Insurance Subsidies

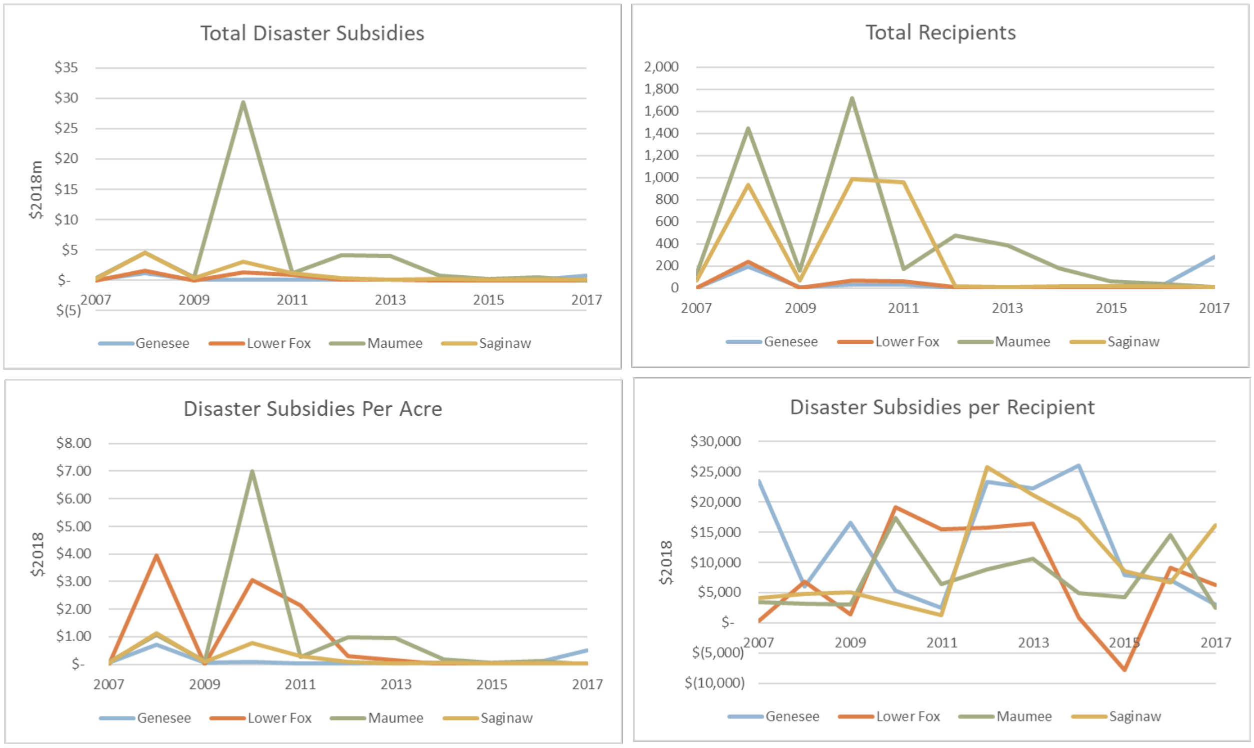


5.11.4 Disaster Program Subsidies

Disaster subsidies represented a relatively small proportion of total subsidies in all four watersheds, with the exception of a single year (i.e., 2010) for the Maumee. The Maumee ($0.99/acre), again being influenced by an anomalous year, and Lower Fox ($0.87/acre) received, on average, higher disaster program subsidies per acre relative to the Genesee ($0.17/acre) and the Saginaw ($0.24/acre).

Data again were analyzed by the number of recipients on an annual basis (see Figure 25). Not unexpectedly, given the relative size of each watershed, the Maumee, on average, had the greatest number of participants and the Lower Fox had the fewest. From 2007 to 2017, average annual recipients by watershed were as follows: Genesee (53), Lower Fox (35), Maumee (434) and Saginaw (281). When analyzed as funding per recipient, however, unlike the other types of subsidies, there is substantial variation both within and between watersheds.

Figure 25. Disaster Program Subsidies



5.12 Irrigation

Irrigation data were obtained from the Census of Agriculture. For the three years of data analyzed, irrigated acres represented a very small proportion of total acres operated in all four watersheds (see Table 31). In three of the four watersheds — the Lower Fox, Maumee and Saginaw — irrigated acres increased slightly as a percentage of total acres increased from 2007 to 2017; however, in 2017 irrigated acres still accounted for only 0.3% to 2.2% of total acres operated.

Table 31. Irrigated Acres as a Percentage of Acres Operated

Watershed	2007	2012	2017	Change (%)
Genesee	1.0%	0.9%	0.5%	-0.5%
Lower Fox	0.2%	0.2%	0.3%	0.1%
Maumee	0.3%	0.4%	0.8%	0.5%
Saginaw	1.5%	1.9%	2.2%	0.7%

As seen in Table 32, the percentage of operations with irrigation was also low across all four watersheds. Over the time frame considered, the percentage of operations with irrigation remained relatively similar with slight increases in three of the four watersheds (0.8% to 2.0% change).

Table 32. Operations with Irrigation

Watershed	2007	2012	2017	Change (%)
Genesee	5%	6%	7%	2.0%
Lower Fox	3%	3%	3%	0.0%
Maumee	2%	2%	3%	0.8%
Saginaw	5%	5%	6%	1.1%

5.13 Fertilizer Use

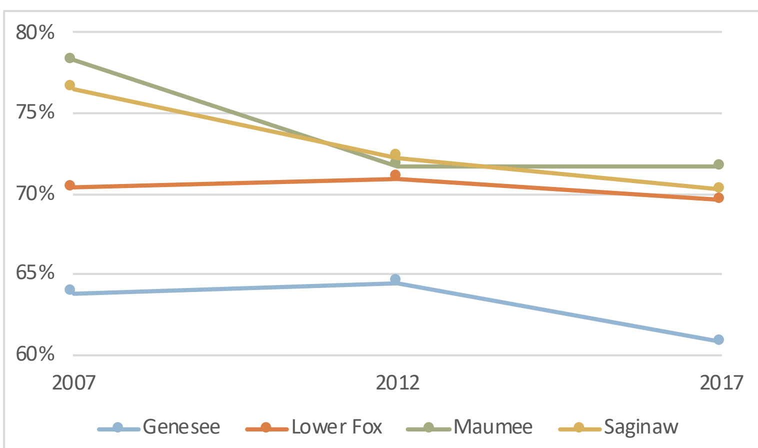
Based on Census of Agriculture data, fertilized acres decreased as percentage of total acres of cropland for all four watersheds from 2007 to 2017 (see Table 33). Across this same time period, total acres on which fertilizer was used decreased in three of the four watersheds – Genesee, Maumee and Saginaw. The Lower Fox had a marginal increase in the number of cropland acres on which fertilizer was used. The Genesee had the lowest percentage of acres on which fertilizer was used for all three years considered (see Figure 26).

Table 33. Fertilizer Use by (a) Acres and (b) Percentage of Cropland Acres

Watershed	2007	2012	2017	Change (Acres)	Change (%)
Genesee	272,355	260,202	258,243	-14,112	-5.2%
Lower Fox	129,767	127,085	130,565	798	0.6%
Maumee	2,325,778	2,096,833	2,180,848	-144,930	-6.2%
Saginaw	1,066,911	984,988	1,001,850	-65,061	-6.1%

Watershed	2007	2012	2017	Change (%)
Genesee	63.8%	64.5%	60.8%	-3.0%
Lower Fox	70.3%	70.9%	69.6%	-0.8%
Maumee	78.3%	71.7%	71.6%	-6.7%
Saginaw	76.5%	72.2%	70.3%	-6.3%

Figure 26. Percentage of Total Acres with Fertilizer Use



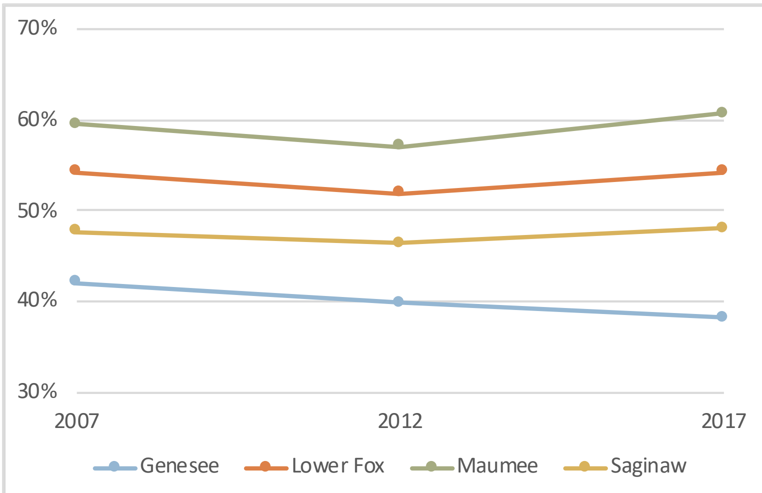
Similarly, the number of operations using fertilizer decreased across all four watersheds from 2007-2017 (see Table 34). The percentage of total operations using fertilizer, however, experienced relatively little change, with the Genesee and Lower Fox decreasing slightly and the Maumee and Saginaw increasing slightly (see Figure 27).

Table 34. Fertilizer Use by (a) Operations and (b) Percentage of Total Operations

Watershed	2007	2012	2017	Change (Operations)	Change (%)
Genesee	1,032	892	850	-183	-17.7%
Lower Fox	655	610	582	-73	-11.2%
Maumee	9,196	8,364	8,429	-766	-8.3%
Saginaw	4,351	3,829	3,738	-614	-14.1%

Watershed	2007	2012	2017	Change (%)
Genesee	42.1%	39.8%	38.2%	-3.9%
Lower Fox	54.2%	51.9%	54.2%	0.0%
Maumee	59.5%	57.0%	60.7%	1.1%
Saginaw	47.6%	46.4%	48.0%	0.4%

Figure 27. Percentage of Operations with Fertilizer Use

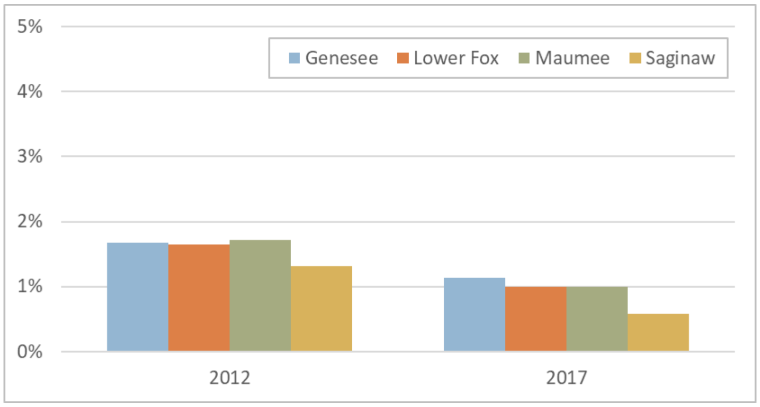


5.14 Conservation Practices

Select conservation practices for agricultural land and cropland have been tracked in the two most recent Censuses of Agriculture (2012 and 2017) by county. The practices tracked included farms, acres, and average acres/farm in conservation easements, no-till or minimum tillage, other conservation or reduced tillage, conventional tillage, and cover crops. These five categories of conservation practices were assessed for the four priority watersheds using the weighting schema described in Section 2. In addition to assessing the conservation practices based on the three categories of measurement reported (farms, acres, and average acres/farm), conservation practices were also assessed by the percentage of agricultural land (easements) or cropland (all other practices) in each conservation practice. The percentage of agricultural land or cropland was calculated by dividing the number of acres in a conservation practice by the percent area of the watershed in all agricultural lands or cultivated crops as reported in the Census of Agriculture.

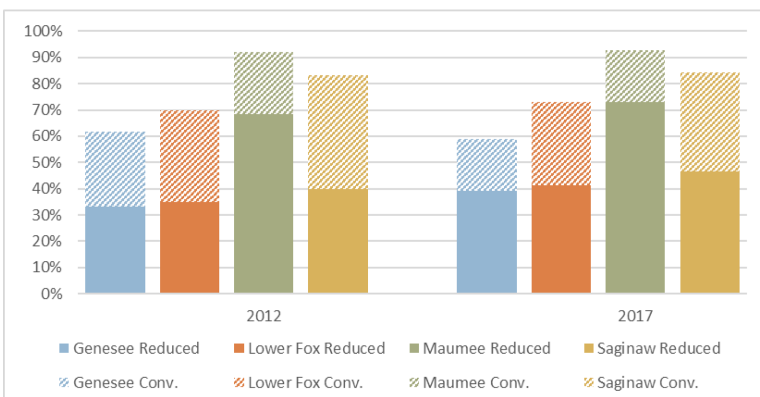
In comparing the four priority watersheds, normalizing by watershed size, the Genesee was particularly active in the use of conservation practices. Overall, from 2012 to 2017 agricultural land in conservation easements, the least widely implemented conservation practice of those tracked in the Censuses, decreased across all four watersheds when assessed as a percentage of acres in agricultural land (see Figure 28) and as the number of farms with conservation easements (see Table 35).

Figure 28. Percent Agricultural Land in Conservation Easements



Trends in reduced and no-till practices (termed reduced or conservation and no-till or minimum till in the Census of Agriculture) were varied, with the number of farms using no-till practices increasing from 2012 to 2017 for the Genesee, Lower Fox, and Saginaw, and the number of farms using reduced tillage practices increasing across the board. The percentage of cropland on which these practices were implemented also increased for all watersheds (see Figure 29). The use of conventional (also termed intensive tillage in the CoA) tillage practices across the watersheds decreased from 2012 to 2017 for both the number of farms and the percentage of cropland tilled conventionally, while the acres/farm of conventionally tilled cropland increases (see Figure 29). This suggests that although conventional tillage decreased overall, the farms that are using conventional tilling have a greater percentage of their acreage in conventional tilling than those that transitioned to reduced tillage, conservation easement, or idle cropland.

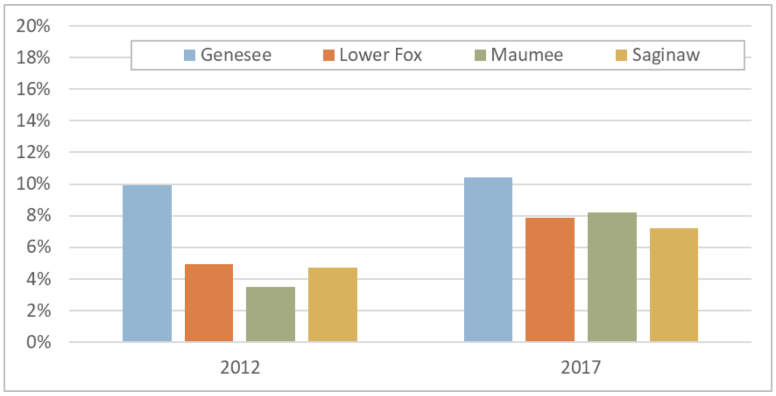
Figure 29. Percent Cropland by Type of Tillage



Note: The difference between the sum of percent cropland in reduced (no-till and reduced tillage) and conventional tillage is presumed to be cropland left idle or fallow.

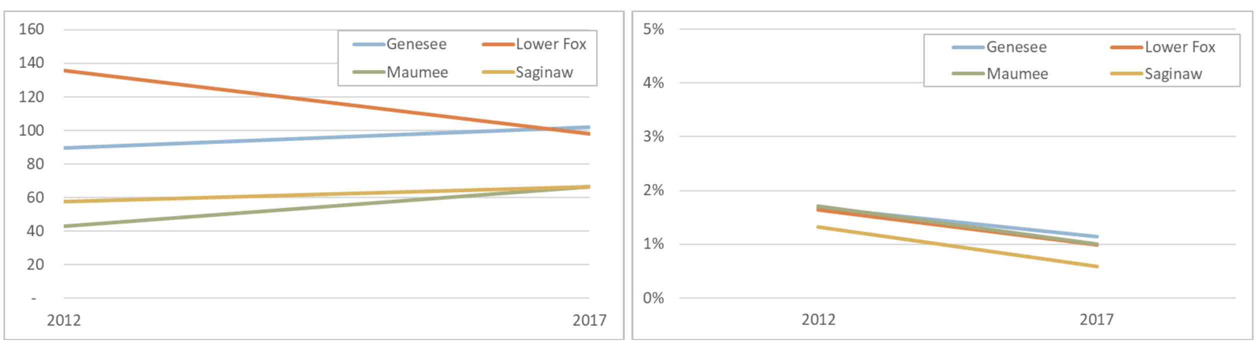
Trends in the use of cover crops were varied across the watersheds. Although the number of acres in cover crops increased from 2012 to 2017 for all four watersheds, the percentage of cropland with cover crops was relatively static for the Genesee, while increasing for the other three watersheds (see Figure 30).

Figure 30. Percent Cropland in Cover Crops



A significant trend for each of the five conservation practices is that a disconnect could be observed between the trends for the number of farms, acres, and percentage of cropland by conservation practice and the trend for that of conservation practices as measured by average acres per farm. For example, in the Genesee, Maumee, and Saginaw, cropland in conservation easements has been decreasing by farm, acreage, and percentage of total agricultural land, whereas the acres per farm in conservation easements have been increasing (see Figure 31). The same trend can be seen across all four watersheds for conventional tillage, where the number of farms, acres, and percentage of total cropland in conventional tillage is decreasing, but the average acres/farm is increasing. Additional disconnects between average acres per farm and trends by farm, acres, and/or percentage of total cropland are present at the individual watershed level (Table 35). As shown in Section 5.4, across the watersheds there has been a decrease in mid-sized farms (50.0-499.9 acres) and growth in smaller farms sized 1.0-49.9 acres. This may suggest that there are additional factors at play that may be impacting smaller farms' abilities to implement or maintain conservation practices.

Figure 31. Conservation Easements by (a) Average Acres/Farm and (b) % of Total Cropland



The individual trends for conservation practices in each watershed are presented in the tables below (see Table 35 and Table 36).

Table 35. Conservation Practices by Watershed and Year

Conservation Practice	Genesee			Lower Fox			Maumee			Saginaw		
	2012	2017	Change	2012	2017	Change	2012	2017	Change	2012	2017	Change
Conservation Easement, Farms	91	55	-39%	28	25	-11%	1,342	479	-64%	430	161	-63%
Conservation Easement, Acres	10,151	7,008	-31%	3,579	2,180	-39%	55,704	33,126	-41%	22,196	9,839	-56%
Conservation Easement, % Agricultural Land	2%	1%	-1%	2%	1%	-1%	2%	1%	-1%	1%	1%	-1%
Conservation Easement, Acres/Farm	90	102	14%	136	98	-28%	43	67	55%	57	66	16%
No-till Practices, Farms	156	249	59%	186	190	2%	5,953	5,354	-10%	1,289	1,333	3%
No-till Practices, Acres	37,364	43,992	18%	17,839	28,112	58%	1,298,389	1,239,504	-5%	259,705	280,448	8%
No-till Practices, % Cropland	9%	10%	1%	10%	15%	5%	44%	41%	-4%	19%	20%	1%
No-till Practices, Acres/Farm	253	155	-39%	97	150	55%	223	232	4%	174	175	1%
Reduced Tillage, Farms	242	357	48%	211	237	12%	3,138	3,745	19%	1,005	1,284	28%
Reduced Tillage, Acres	96,685	122,083	26%	44,476	49,478	11%	698,997	977,996	40%	282,551	385,974	37%
Reduced Tillage, % Cropland	24%	29%	5%	25%	26%	2%	24%	32%	8%	21%	27%	6%
Reduced Tillage, Acres/Farm	359	310	-14%	208	207	0%	232	267	15%	269	275	2%
Conventional Tillage, Farms	729	542	-26%	523	379	-28%	5,167	3,694	-29%	2,941	2,387	-19%
Conventional Tillage, Acres	115,077	84,526	-27%	62,771	59,517	-5%	692,325	605,511	-13%	593,385	537,245	-9%
Conventional Tillage, % Cropland	29%	20%	-9%	35%	32%	-3%	24%	20%	-4%	44%	38%	-6%
Conventional Tillage, Acres/Farm	139	146	5%	119	156	31%	137	170	24%	182	203	12%
Cover Crop, Farms	267	346	29%	139	109	-22%	1,290	1,849	43%	776	856	10%
Cover Crop, Acres	39,933	44,385	11%	8,859	14,768	67%	102,462	250,056	144%	64,089	102,748	60%
Cover Crop, % Cropland	10%	10%	1%	5%	8%	3%	4%	8%	5%	5%	7%	3%
Cover Crop, Acres/Farm	118	111	-6%	62	137	121%	79	136	74%	77	103	35%

Table 36. Comparison of Conservation Practices Across Watersheds and Year

Conservation Practice	Genesee		Lower Fox		Maumee		Saginaw	
	2012	2017	2012	2017	2012	2017	2012	2017
Conservation Easement, % Agricultural Land	2%	1%	2%	1%	2%	1%	1%	1%
Conservation Easement, Acres/Farm	90	102	136	98	43	67	57	66
No-till Practices, % Cropland	9%	10%	10%	15%	44%	41%	19%	20%
No-till Practices, Acres/Farm	253	155	97	150	223	232	174	175
Reduced Tillage, % Cropland	24%	29%	25%	26%	24%	32%	21%	27%
Reduced Tillage, Acres/Farm	359	310	208	207	232	267	269	275
Conventional Tillage, % Cropland	29%	20%	35%	32%	24%	20%	44%	38%
Conventional Tillage, Acres/Farm	139	146	119	156	137	170	182	203
Cover Crop, % Cropland	10%	10%	5%	8%	4%	8%	5%	7%
Cover Crop, Acres/Farm	118	111	62	137	79	136	77	103

Note: Color ramp runs horizontally such that the values are compared and colored across watersheds within a single conservation practice type and not across conservation practices. The watershed with the greatest number of green cells has implemented the highest amount of conservation practices measured by the normalized values.

6. Farmer Characteristics

This section describes demographic characteristics of famers within each watershed that pertain to the analysis of GLRI funding distribution and subsequent socio-economic outcomes. Similar to the farm characteristics, the majority of data used to describe farmer characteristics were obtained at the county level, then weighted and aggregated (as described in Section 2) in order to create watershed level estimates.

For the years 2007 and 2012, data were gathered by the Census of Agriculture for "operators". This term was replaced with the term "producers" in the 2017 Census of Agriculture. An operator/producer is defined by the Census of Agriculture as "a person who is involved in making decisions for the farm operation including decisions about such things as planting, harvesting, livestock management, and marketing." Note that farm operations could have more than one producer per farm and information was collected by the Census of Agriculture for up to four producers per operation. In this section, the term "producers" will be used to represent information from both datasets.

6.1 Gender

The Census of Agriculture reports producers by gender. In 2007, females producers accounted for less than one-third of all producers, however, from 2007 to 2017, that percentage increased in all four watersheds (see Table 37). For the three years considered, the Genesee had the highest percentage of female producers and also saw the greatest percentage increase over the time frame considered.

Table 37. Females as a Percentage of Producers

Watershed	2007	2012	2017	Change (%)
Genesee	30.1%	32.0%	35.8%	5.7%
Lower Fox	29.7%	30.4%	33.8%	4.1%
Maumee	22.6%	22.3%	27.7%	5.1%
Saginaw	30.3%	29.3%	34.1%	3.8%

6.2 Age and Experience

The Census of Agriculture also reports the average age of producers. The average age of producers was relatively similar for all four watersheds, as was the change in age from 2007-2017 (see Table 38). Over that time period, the average age of operators increased by 1.0-2.3 years—suggesting an aging population of producers across all four watersheds. The Lower Fox had the lowest average age across all three years considered; however, the average age of producers in the Lower Fox also increased more than in the other three watersheds.

Table 38. Average Age of Producers

Watershed	2007	2012	2017	Change (Years)
Genesee	56.3	57.4	57.3	1.0
Lower Fox	54.1	55.4	56.4	2.3
Maumee	55.7	57.0	57.5	1.8
Saginaw	56.2	57.4	57.8	1.6

While only reported for the 2012 and 2017 Censuses of Agriculture, the average years of experience for producers was similar for all four watersheds, ranging from 26-28 years and, with the exception of the Lower Fox, average years of experience decreased slightly from 2012 to 2017 (see Table 39).

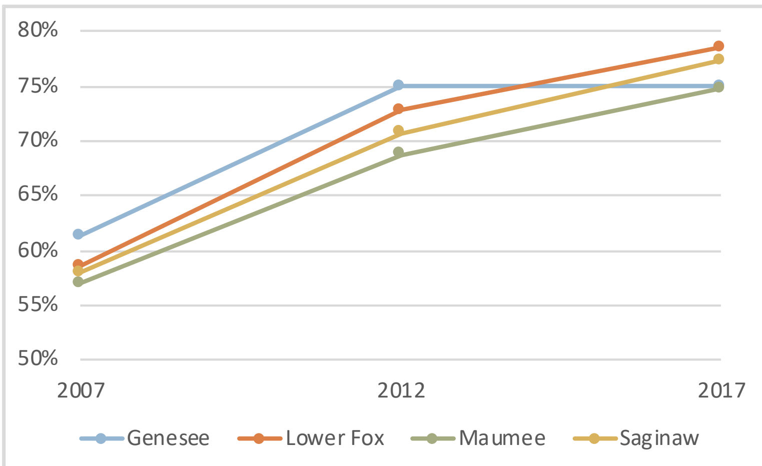
Table 39. Average Years of Experience

Watershed	2012	2017	Change (Years)
Genesee	26.0	25.5	-0.6
Lower Fox	25.9	26.4	0.5
Maumee	27.6	27.3	-0.3
Saginaw	26.0	26.0	0.0

6.3 Internet Access

Data on whether farm operations have internet access is collected by the Census of Agriculture and is included here as a proxy measure of the availability of information on various farming practices, technologies, and markets to farmers. County-level data on the number of farm operations with internet access were downloaded and aggregated to the watershed level (see Figure 32). Results are presented as a percentage of total farm operations within each watershed as the number of active farm operations within each watershed has also changed over time. Across the three years considered, the percentage of operations with internet access increased across all four watersheds (14% to 20% change). While all four watersheds followed a similar trend from 2007 to 2012, it is interesting to note that there was no change in the percentage of farm operations with internet access in the Genesee from 2012 to 2017.

Figure 32. Percentage of Operations with Internet Access



7. Other Characteristics

7.1 Annual Precipitation

Annual precipitation could be impactful to multiple factors contributing to the outcome of GLRI investments as precipitation can impact erosion, crop suitability, and perceptions of farm-level activities impacts' on the environment. Average annual precipitation data for the reference time period 1981-2010 was sourced from the NRCS. Across the watersheds, precipitation varied from 29-45 inches per year with higher precipitation and larger gradients manifesting in the south of or more southerly watersheds—particularly the Genesee and Maumee (see Figure 33). Of the four priority watersheds, the Genesee displayed the greatest variability in rainfall and the Lower Fox the least (see Figure 34).

Figure 33. Average Annual Precipitation (1981-2010)

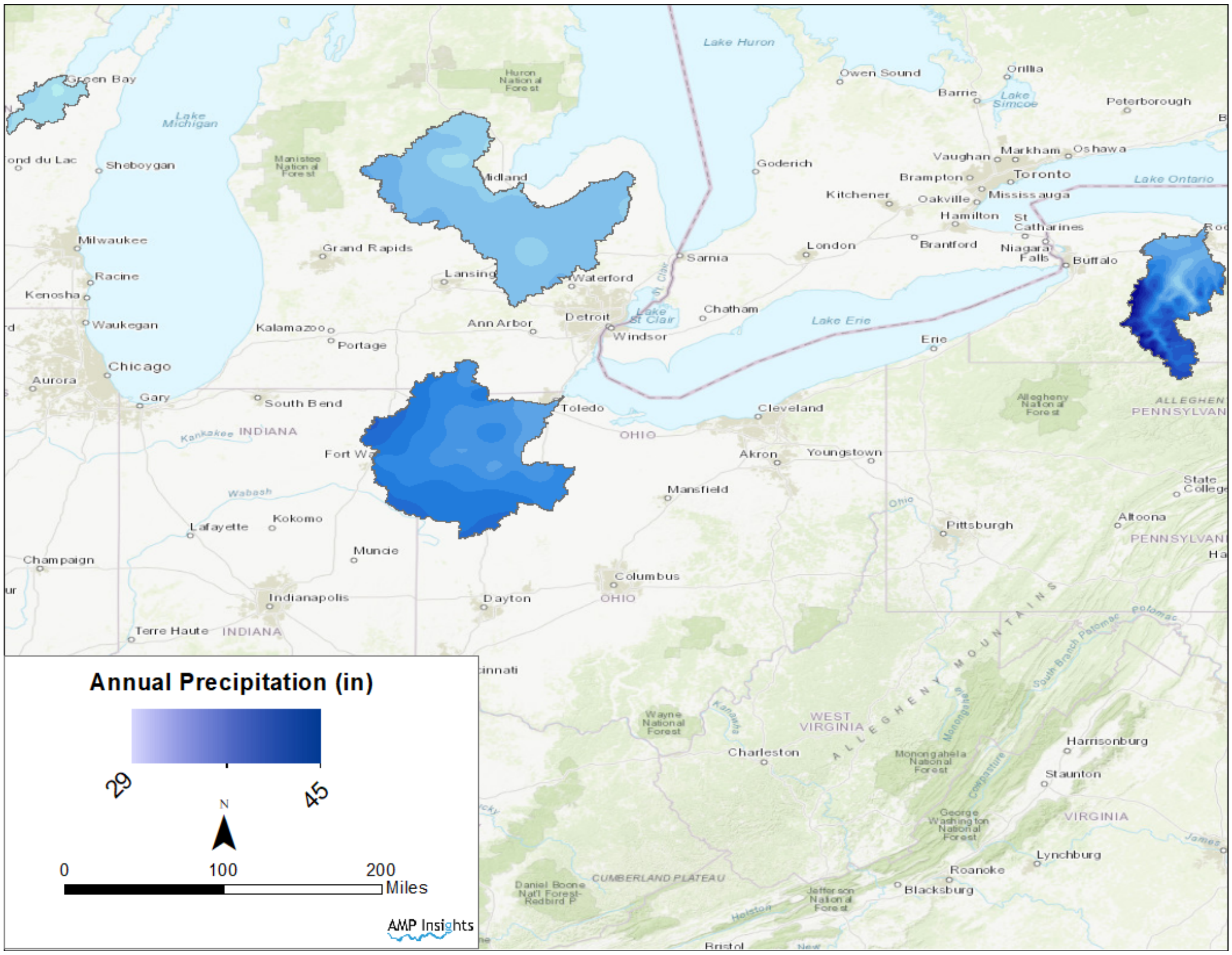
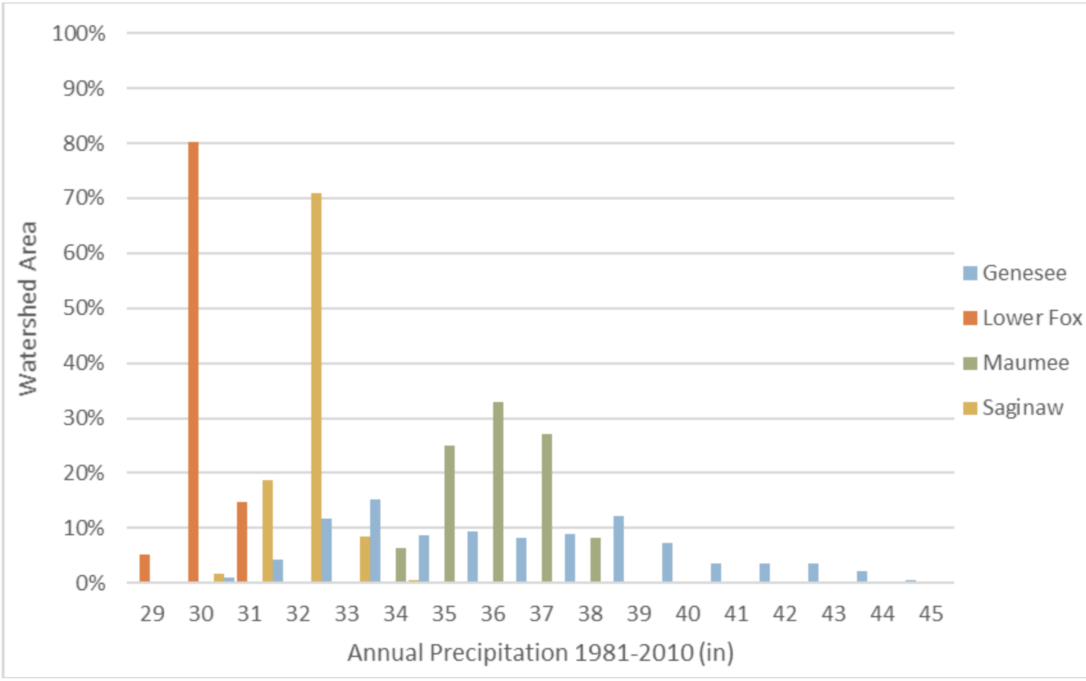


Figure 34. Average Annual Rainfall (1981-2010) by Percentage of Watershed Area

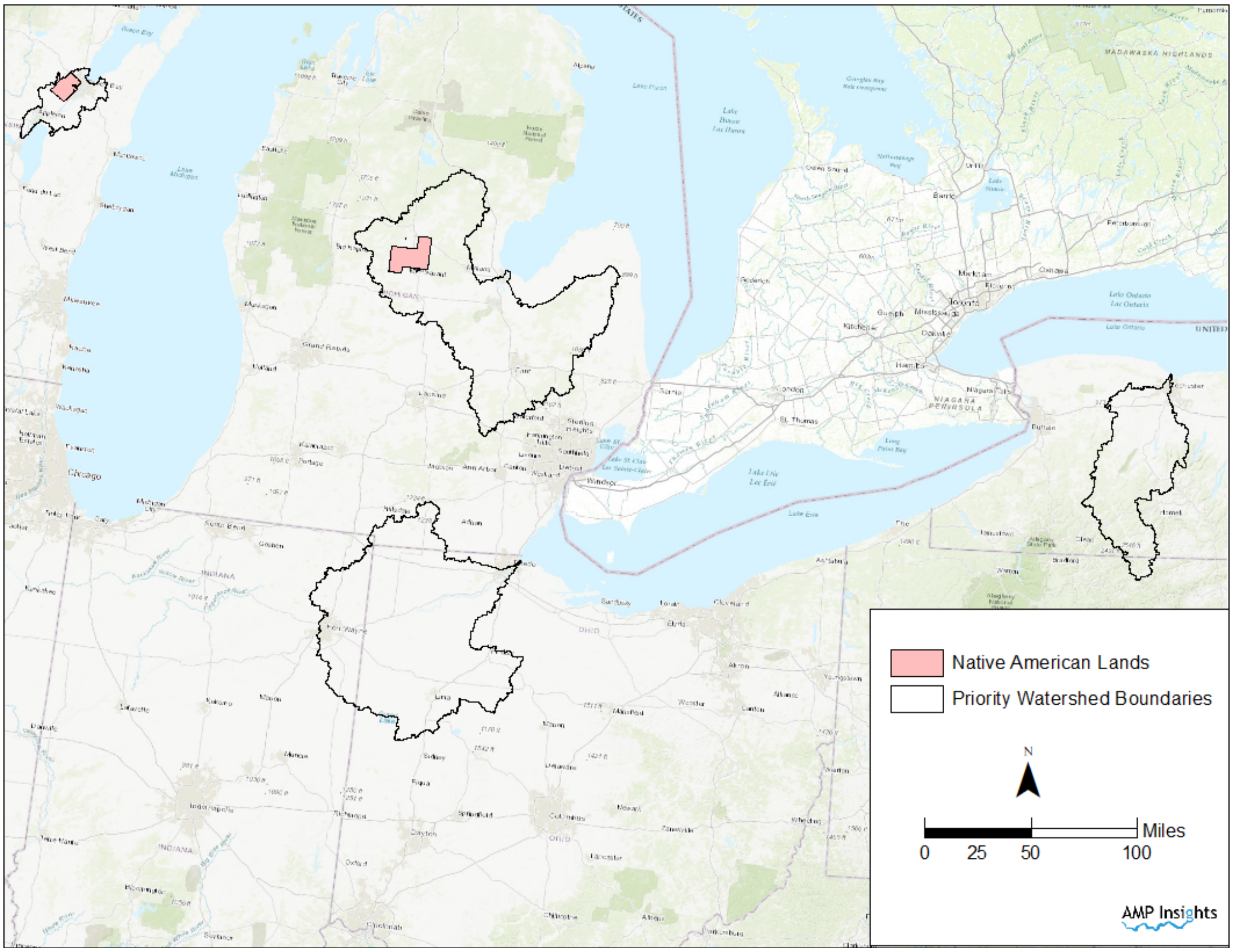


7.2 Presence of Other Cultural Interests in Priority Watersheds

It is recognized that other cultural interests may play a strong role on the impacts of GLRI investments in priority watersheds. The cultural interests related to agriculture and potentially GLRI investment impacts in the priority watersheds include, but are not limited to, Native American tribal influence, Amish cultural influence, and Mennonite cultural influence. The Census of Agriculture and other national databases do not track information on Amish and Mennonite farms and communities in an easily accessible way. This would be an area for greater research and data collection that could improve this analysis of GLRI investments.

There is, however, information more readily available that may inform upon the potential for Native American cultural influence on agriculture and GLRI investment outcomes. The USGS' National Map maps areas administered by the Bureau of Indian Affairs, including reservations and trust land. Of the four priority watersheds, the Lower Fox and the Saginaw are the only watersheds that contain lands established by treaty, statute, and/or executive or court order as Native American lands. The Lower Fox contains 169,650 acres of the Wisconsin Oneida Reservation and the Saginaw contains 361,604 acres of the Isabella Reservation and 2,737 acres of off-reservation trust land (Figure 35). With this limited information on percent land cover by Native American lands, in these two watersheds it can be assumed that Native Americans may be a significant stakeholder in the agricultural community and subsequently the GLRI investment impacts. Since the Census of Agriculture does track some agricultural information by producer type, of which American Indian is a category, additional analyses on the Native American agricultural community could enhance future studies.

Figure 35. Native American Lands in Priority Watersheds



8. GLRI Investments

8.1 Great Lakes Commission GLRI Data

The Great Lakes Commission (GLC) compiled data on the majority of the GLRI investments distributed to the four priority watersheds. The total number of high-level projects funded by the GLRI was 34, with eight of the 34 projects implemented over multiple priority watersheds resulting in a total of 59 projects when separated out by watershed (see Table 40). Within the high-level projects, a total of $95,808,771 was recorded as GLRI funds distributed, of which $54,809,881 was recorded as funding 8,388 conservation practices (CPs) across the four priority watersheds.

The information on the CPs is considered to be incomplete, but still could be useful in understanding how and where GLRI funds were distributed. One point that must be made when evaluating the number of CPs implemented and their aggregated costs is that many different types of CPs were funded and have been implemented with GLRI funding. These summary statistics are not asserting that one CP is equal to another in regards to any characteristic such as type, scale, or effectiveness. In addition, the data set on CPs does not specify if/when multiple CPs were implemented at a single location or if a single farmer or operation was the recipient of assistance to implement multiple CPs. Therefore, the total acreage that benefitted from CP implementation and the total number of farmers/operations engaged in the implementation of CPs through GLRI cannot be determined.

Of the instances of CP implementation recorded in the GLC dataset, 26 instances are not coded to a priority watershed and have been removed from this dataset. For many of the high-level GLRI funded projects, funds were distributed to other project elements in addition to CPs so it is not possible to parse out differences in the reported funding between these datasets. For the “Supplementing Ag Farm Bill Conservation Program”, however, GLRI funding was indicated as only funding CP implementation allowing for the datasets to be compared and no difference in the funds recorded was found for the high-level project and the sum of the CP funding.

Table 40. GLRI Projects and Funding by Watershed and for Conservation Practices

Watershed	GLRI Funded Projects	CPs	Project Funds	CP Funds
Genesee	6	513	$ 7,993,680	$ 5,475,525
Lower Fox	13	1,603	$ 24,320,835	$ 14,061,674
Maumee	24	4,805	$ 43,998,861	$ 23,137,750
Saginaw	16	1,467	$ 19,495,394	$ 12,134,931

In addition to CPs, funding for GLRI projects was allocated towards seven other project elements—direct outreach, indirect outreach, traditional capacity building, innovative capacity building, edge of field monitoring & research, other monitoring & research, and decision support tool development or application. The number of high-level projects that had a component of each of the project elements are detailed in Table 41 and arranged in descending order by number of project elements. The information was not specific enough to parse out the funding allocated within each project to the specific project elements.

Table 41. Number of Projects by Project Element and Watershed

Watershed	CP Installation	Outreach (Direct)	Outreach (Indirect)	Capacity Building (Traditional)	Capacity Building (Innovative)	Monitoring & Research (Edge of Field)	Monitoring & Research (Other)	Decision Support Tool Development or Application
Maumee	11	13	7	11	8	5	6	7
Saginaw	8	9	6	6	6	3	4	5
Lower Fox	7	4	5	7	3	3	5	5
Genesee	3	2	2	2	0	2	3	3

Although the information on CPs implemented under the GLRI investments is incomplete, there is enough information coded at different spatial levels to give insight into areas of high and low activity under GLRI. CP implementation under GLRI has been mapped by HUC 8 sub-basin, county, and HUC 12 sub-watershed (see Figure 36, Figure 37, Figure 38, and Figure 39 at the end of this sub-section).

GLRI funding can also be categorized by the funding distribution pathway – either direct or indirect funding (see Table 42). The indirect funding pathway distributes funds to an intermediary organization that then may make sub-grants to carry out the project. Sub-grantees were recorded for some of the projects that provided indirect funding, such that, of the 21 high-level projects that received indirect funding nine projects were missing this information. For the 12 projects that were indirectly funded and had recorded sub-grantee information, 41 sub-grantees were recorded.

Funding cannot not be parsed by funding distribution pathway and watershed using the available data as there are six projects that were implemented in two or more watersheds and the breakdown of funding by watershed for these projects is not available. Overall, $68,697,958 were distributed as indirect grants and $27,110,813 were distributed as direct grants.

Table 42. GLRI Projects' Funding Pathway by Watershed

Watershed	Direct Funding	Indirect Funding
Maumee	17	7
Saginaw	10	6
Lower Fox	7	5
Genesee	4	3

GLRI projects also reported on other project outcomes such as the number of enrolled landowners under the project, the number of acres in conservation, the number of people hired through GLRI, and the number of programs established with GLRI money to existing organizations. With the exception of the number of programs established with GLRI money, the data for the other outcomes is largely unknown.

Figure 36. Conservation Practices Implemented with GLRI Funding by HUC 8

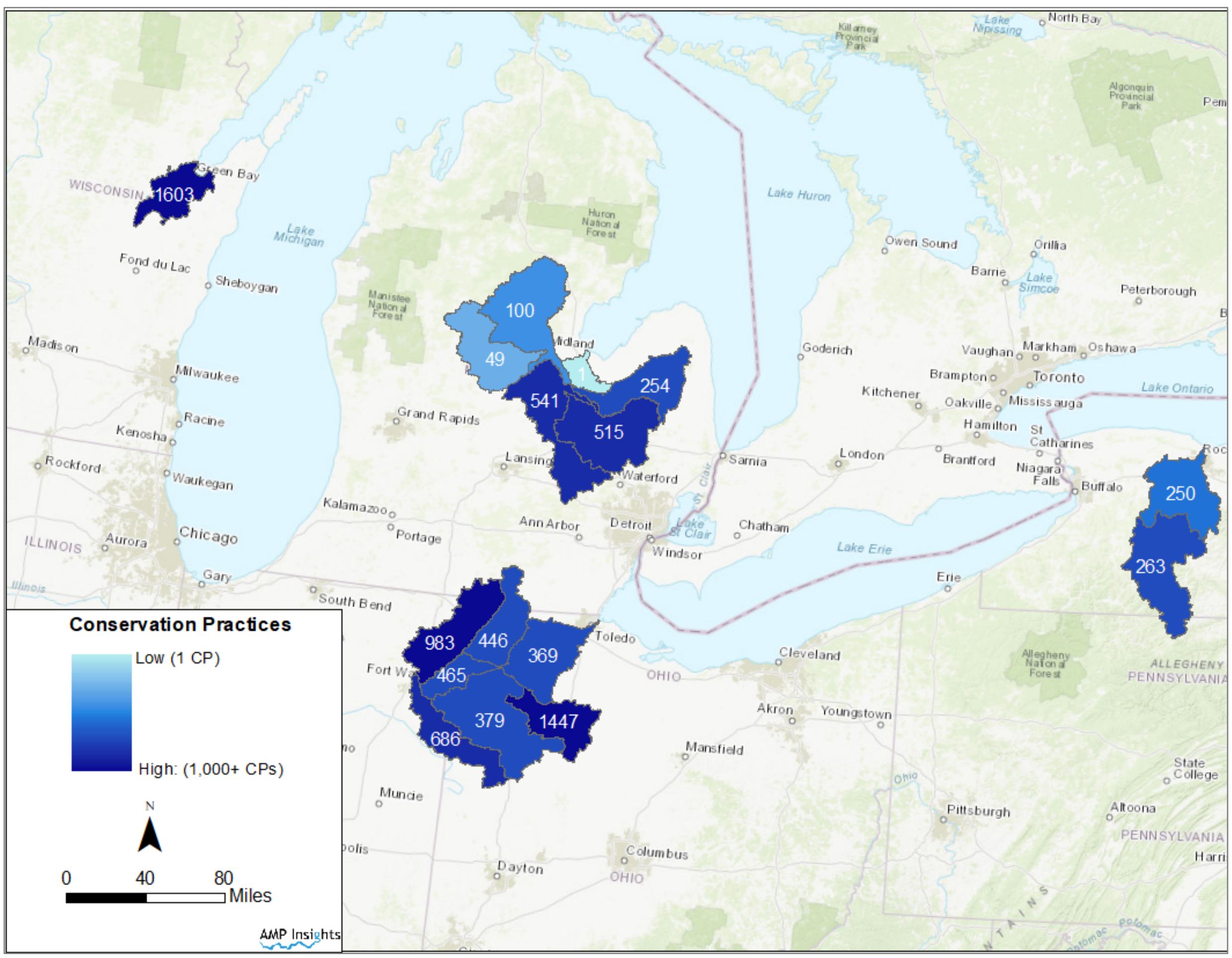


Figure 37. Conservation Practices Implemented with GLRI Funding by County

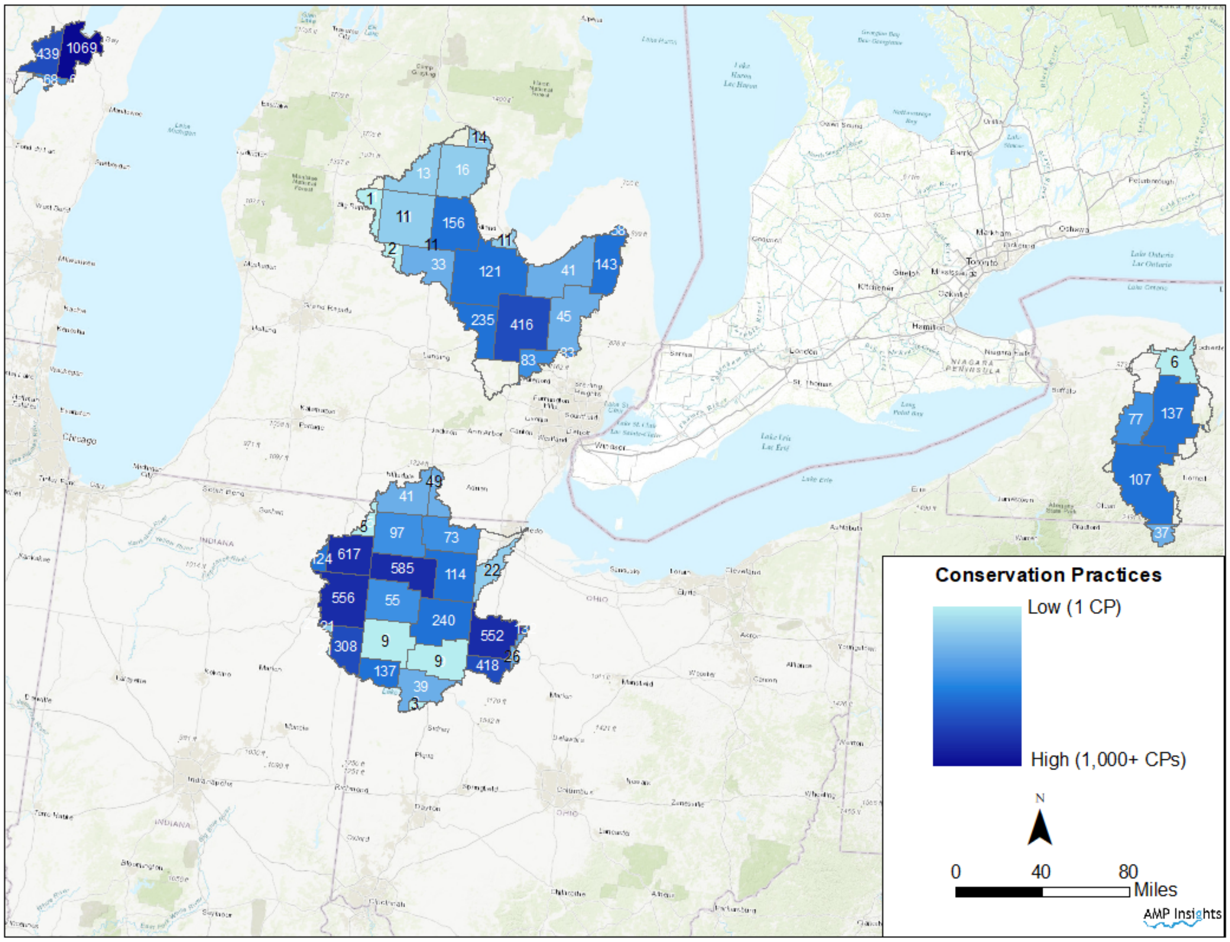
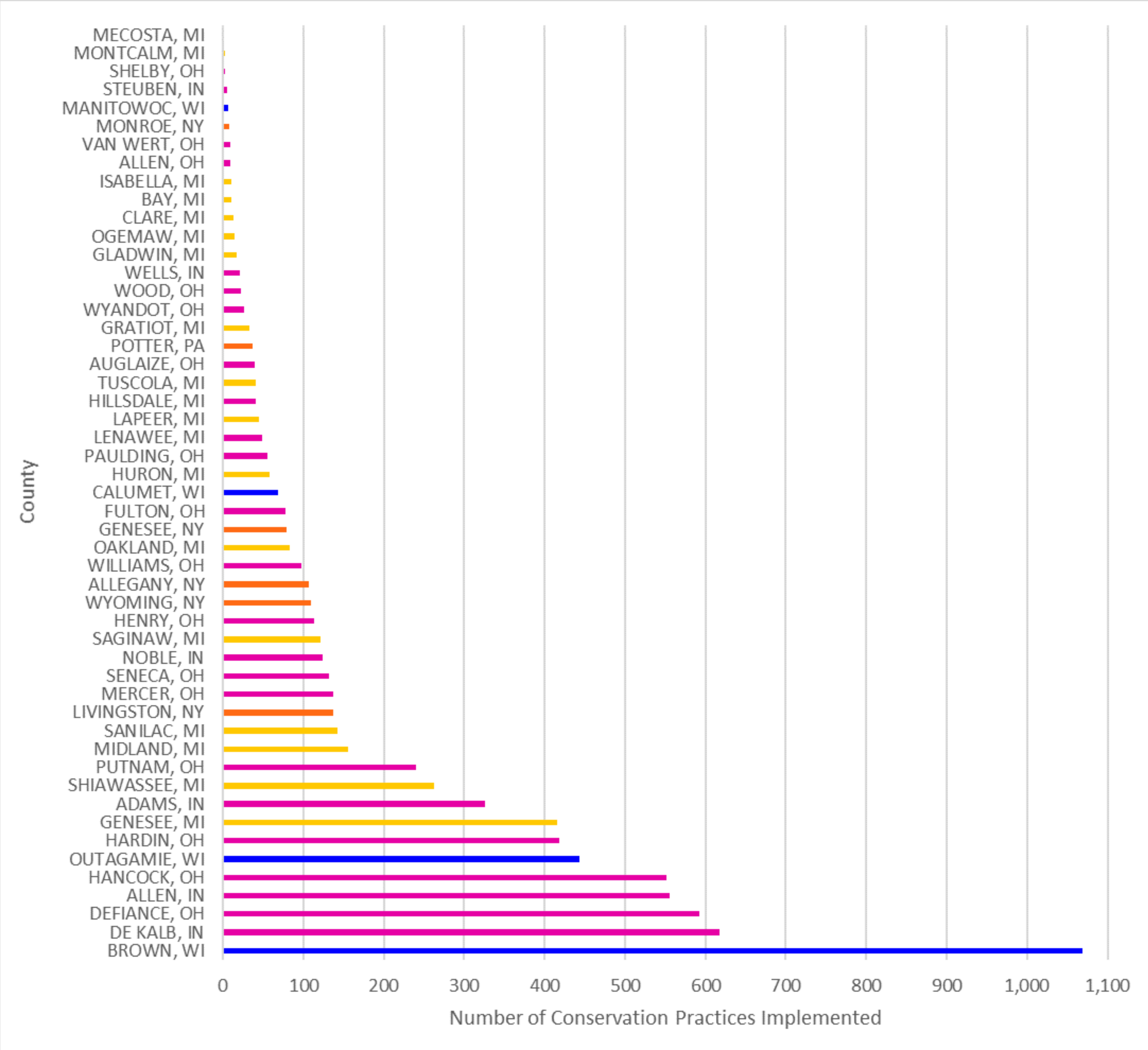
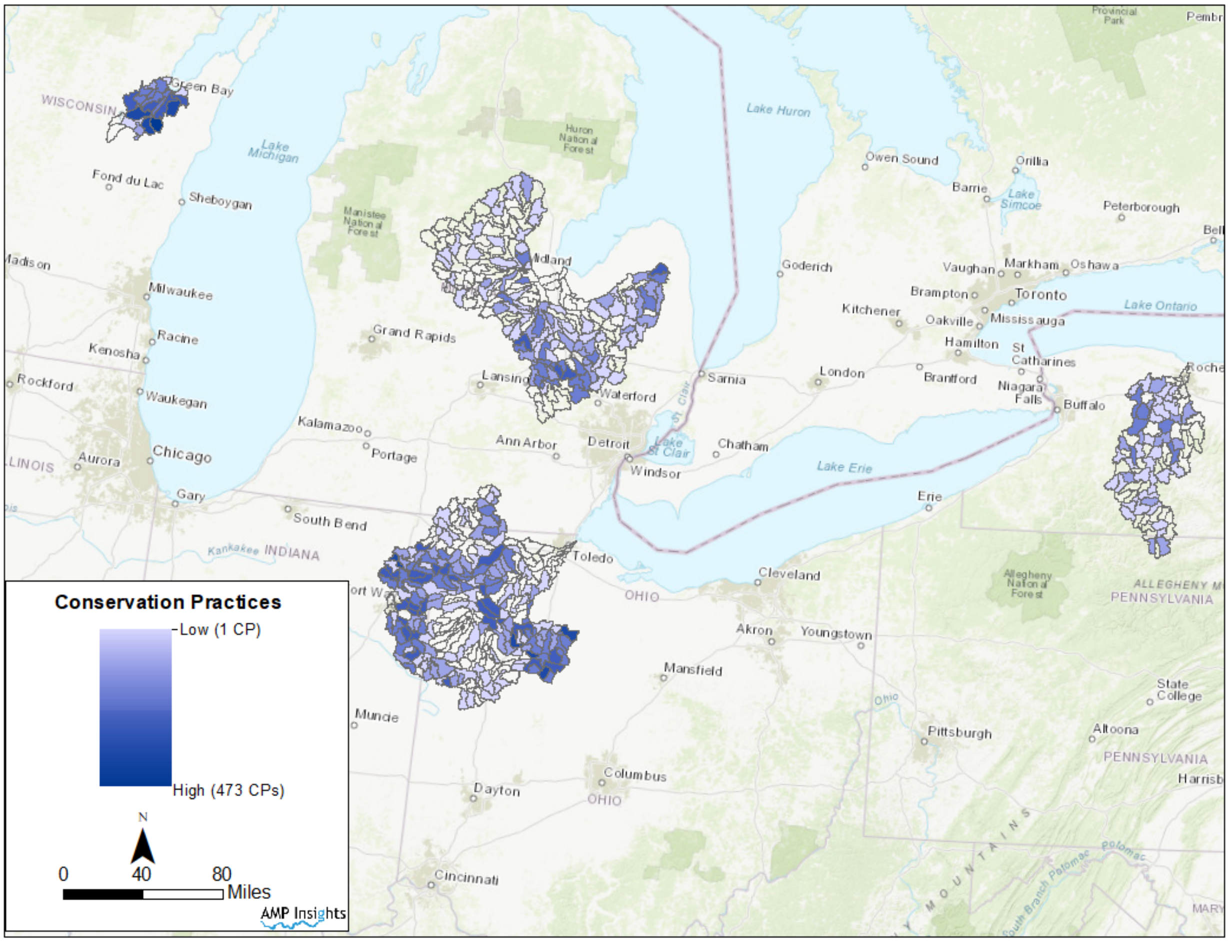


Figure 38. Number of Conservation Practices Implemented with GLRI Funding by County



Notes: Counties are color-coded by priority watershed (Genesee = orange, Lower Fox = blue, Maumee = pink, Saginaw = yellow).

Figure 39. Conservation Practices Implemented with GLRI Funding by HUC 12



Note: Please note that, despite the use of the same color ramp, there is a difference in scale used for the HUC12 CP map compared to that used for the counties and HUC8 maps.

8.2 NRCS Conservation Technical Assistance Data

A dataset on conservation technical assistance (CTA) projects, which provide technical assistance to land users for implementing conservation systems, was compiled and maintained by the NRCS. The data were cleaned for the information related to the GLRI investments of interest – Focus Area 3 investments with initial funding distributions occurring between 2010 and 2016 in one or more of the four EPA priority watersheds. The spatial scale for reporting of the CTA data was primarily at the HUC 4 or subregion level, whereas the priority watersheds are defined at the more specific HUC 8 (sub-basin) level, which is how the GLC dataset reports projects and funding. Since priority watersheds are defined at a smaller spatial scale, the projects and funding reported at the HUC 4 scale could fall within or outside of those priority watershed boundaries. At this larger spatial scale $7.4 million was distributed amongst 47 projects with two additional projects reported without associated funding amounts.

Approximately half of the projects and funding reported at the HUC 4 scale were reported at the scale of the priority watersheds (Table 43).

Table 43. NRCS CTA Projects and Funding by Priority Watershed

Watershed	Projects	Funding
Genesee	0	$ -
Lower Fox	14	$ 2,529,831
Maumee	2	$ 448,938
Saginaw	9	$ 901,987
Total	25	$ 3,880,756
Missing	26	$ 3,526,748
Data Available at Watershed Level	49%	52%

The Phosphorous Priority Watershed, defined at the HUC 12 level, was often reported for those projects otherwise only recorded to the HUC 4 level. Therefore, the number of projects per priority watershed could be determined, though it cannot be assumed that the entirety of the funding for those projects was allocated to the priority watershed. Assessing the number of CTA projects by Phosphorous Priority Watershed increases the number of projects in the Genesee to 1 and Saginaw to 15. Similar to the findings of the GLC dataset, the Lower Fox attracted a number of conservation funding projects and activity whereas the Genesee has the least for the timeframe of interest.

At the county-level CTA data were reported at even a lower frequency, with only 27% of the total reported projects and 14% of the total reported funding available at the county-level. Of the reported funding, two counties in Wisconsin in the Lower Fox – Brown and Outagamie – received the most CTA funding ($303,550 and $293,319 respectively), followed by Adams, Indiana (Maumee) with $250,844. These highly funded counties align with the findings from the GLC data and the other highly funded counties reported in the GLC dataset that were not represented in the CTA dataset may be missing due to the limited reporting at this scale.

The CTA dataset also contained information on project outputs, such as leveraged funds, number of hires, and number of projects that focused on direct and indirect outreach (see Table 44). Research and monitoring components of projects were also reported, but none of these projects were reported to the priority watershed scale. These project outputs were similar to the type reported in the GLC dataset and align with some of the eight defined GLRI project elements. The lack of project outcomes available for the Genesee and Maumee is due to the limited CTA projects in the watershed – in the case of the Genesee – and the lack of coding to the HUC 8 level – for both the Genesee and Maumee. Similar to the findings of the GLC dataset, a greater number of the CTA projects engaged in outreach directly rather than indirectly.

Table 44. CTA Project Outcomes by Priority Watershed

Watershed	Leveraged Funds	Hires through GLRI/Partner Funds	Outreach	
			Direct	Indirect
Genesee	$ -	0	0	0
Lower Fox	$ 991,261	17	10	1
Maumee	$ 149,674	0	0	0
Saginaw	$ 583,119	10	7	2
Total	$ 1,724,054	27	17	3

The CTA dataset also provided more detailed project outputs that go beyond the project reporting in the GLC dataset. The types of "outcomes" reported in the dataset were specific and varied, but were grouped into broader categories to allow for comparison across projects and watersheds. These categories were as follows:

1. Workshops and Events: the number of workshops or events organized and held.
2. People Engaged: the number of landowners and producers engaged during group or individual activities.
3. Contracts Implemented: the number of Farm Bill contracts managed and implemented using CTA project funding.
4. Plans Drafted: the number of conservation, nutrient management, pest management, and forest management plans drafted using CTA project funding (some projects reported on the number of acres covered by the plans, some projects on the number of plans, and some reported on both).
5. Acres Incorporated Under Conservation, Nutrient, Forest, and Pest Management Plans: the area of land managed under these types of plans (some projects reported on the number of acres covered by the plans, some projects on the number of plans, and some reported on both).
6. Acres of CPs (cover crops, buffers, and prescribed grazing): the area of land on which CPs were implemented using project funding.

The numbers of project outputs reported by priority watershed (see Table 45) likely represent low estimates as some projects did not report outcomes beyond the hours of service or an indication that a type of outcome was produced but not the magnitude.

Table 45. CTA Categorized Project Outputs

Watershed	Workshops and Events	People Engaged	Contracts Implemented	Plans Drafted	Acres Incorporated Under Conservation, Nutrient, Forest, and Pest Mgmt. Plans	Acres of CPs (cover crops, buffers, prescribed grazing)
Genesee						
Lower Fox	120+		21+	210		X
Maumee						
Saginaw	9	585+	725	157	24,000	3,125

Notes: An "X" indicates that this type of output was reported for CTA project(s) in the watershed, but the magnitude was not reported whereas a "+" indicates that in the priority watershed a mix of numbers and qualitative reporting was used such that the value preceding the "+" likely represents the lower bound of the magnitude of this output.

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Appendix A. Counties by Watershed

The counties by watershed considered for the weighting schema used in analyzing county-statistics at the watershed level is shown in Table A-1.

Table A-1. Weighting Schema for Counties in the Four Priority Watersheds

Watershed	State Name	County Name	% of County in Watershed	% of Watershed Covered by County	% County Weighting
Genesee	New York	Allegany	74.7%	31.0%	31.2%
Genesee	New York	Genesee	40.7%	8.1%	8.1%
Genesee	New York	Livingston	97.5%	25.0%	25.2%
Genesee	New York	Monroe	18.0%	9.9%	9.9%
Genesee	New York	Ontario	20.5%	5.4%	5.5%
Genesee	New York	Steuben	6.6%	3.7%	3.7%
Genesee	New York	Wyoming	51.6%	12.3%	12.4%
Genesee	Pennsylvania	Potter	8.9%	3.8%	3.9%
Lower Fox	Wisconsin	Brown	51.6%	49.1%	49.1%
Lower Fox	Wisconsin	Calumet	11.4%	7.0%	7.0%
Lower Fox	Wisconsin	Outagamie	36.5%	36.3%	36.4%
Lower Fox	Wisconsin	Winnebago	8.5%	7.6%	7.6%
Maumee	Indiana	Adams	78.6%	4.1%	4.2%
Maumee	Indiana	Allen	76.6%	7.7%	7.9%
Maumee	Indiana	DeKalb	96.8%	5.4%	5.5%
Maumee	Indiana	Steuben	24.1%	1.2%	1.2%
Maumee	Michigan	Hillsdale	55.7%	5.1%	5.3%
Maumee	Michigan	Lenawee	17.3%	2.0%	2.1%
Maumee	Ohio	Allen	99.2%	6.1%	6.3%
Maumee	Ohio	Auglaize	76.5%	4.7%	4.8%
Maumee	Ohio	Defiance	100.0%	6.3%	6.5%
Maumee	Ohio	Fulton	86.2%	5.3%	5.5%
Maumee	Ohio	Hancock	73.4%	6.0%	6.1%
Maumee	Ohio	Hardin	35.1%	2.5%	2.6%
Maumee	Ohio	Henry	100.0%	6.4%	6.6%
Maumee	Ohio	Lucas	27.9%	2.5%	2.6%
Maumee	Ohio	Mercer	42.2%	3.0%	3.1%
Maumee	Ohio	Paulding	100.0%	6.4%	6.5%
Maumee	Ohio	Putnam	100.0%	7.4%	7.6%
Maumee	Ohio	Van Wert	100.0%	6.3%	6.4%
Maumee	Ohio	Williams	100.0%	6.4%	6.6%
Maumee	Ohio	Wood	29.3%	2.8%	2.8%
Saginaw	Michigan	Bay	10.8%	1.1%	1.1%
Saginaw	Michigan	Clare	56.4%	5.2%	5.3%
Saginaw	Michigan	Genesee	100.0%	10.4%	10.5%
Saginaw	Michigan	Gladwin	94.8%	7.8%	7.9%
Saginaw	Michigan	Gratiot	62.7%	5.8%	5.8%
Saginaw	Michigan	Isabella	100.0%	9.3%	9.4%
Saginaw	Michigan	Lapeer	73.7%	7.8%	7.9%
Saginaw	Michigan	Livingston	42.2%	4.0%	4.0%
Saginaw	Michigan	Mecosta	23.0%	2.1%	2.1%
Saginaw	Michigan	Midland	90.8%	7.7%	7.8%
Saginaw	Michigan	Montcalm	10.2%	1.2%	1.2%
Saginaw	Michigan	Oakland	18.8%	2.7%	2.8%
Saginaw	Michigan	Ogemaw	12.3%	1.1%	1.2%
Saginaw	Michigan	Roscommon	11.6%	1.1%	1.1%
Saginaw	Michigan	Saginaw	99.0%	13.0%	13.1%
Saginaw	Michigan	Sanilac	20.5%	5.2%	5.3%
Saginaw	Michigan	Shiawassee	56.7%	4.9%	5.0%
Saginaw	Michigan	Tuscola	57.7%	8.5%	8.6%
Maumee	Indiana	Noble	14.9%	0.9%	
Maumee	Ohio	Wyandot	10.5%	0.6%	
Maumee	Ohio	Shelby	6.0%	0.4%	
Maumee	Indiana	Wells	5.5%	0.3%	
Saginaw	Michigan	Osceola	5.0%	0.5%	
Maumee	Ohio	Seneca	1.6%	0.1%	
Saginaw	Michigan	Arenac	1.6%	0.2%	
Saginaw	Michigan	Huron	1.3%	0.4%	
Genesee	New York	Cattaraugus	1.1%	0.6%	
Maumee	Michigan	Branch	0.5%	0.0%	
Genesee	New York	Orleans	0.5%	0.2%	
Lower Fox	Wisconsin	Manitowoc	0.0%	0.1%	
Saginaw	Michigan	Clinton	0.0%	0.0%	

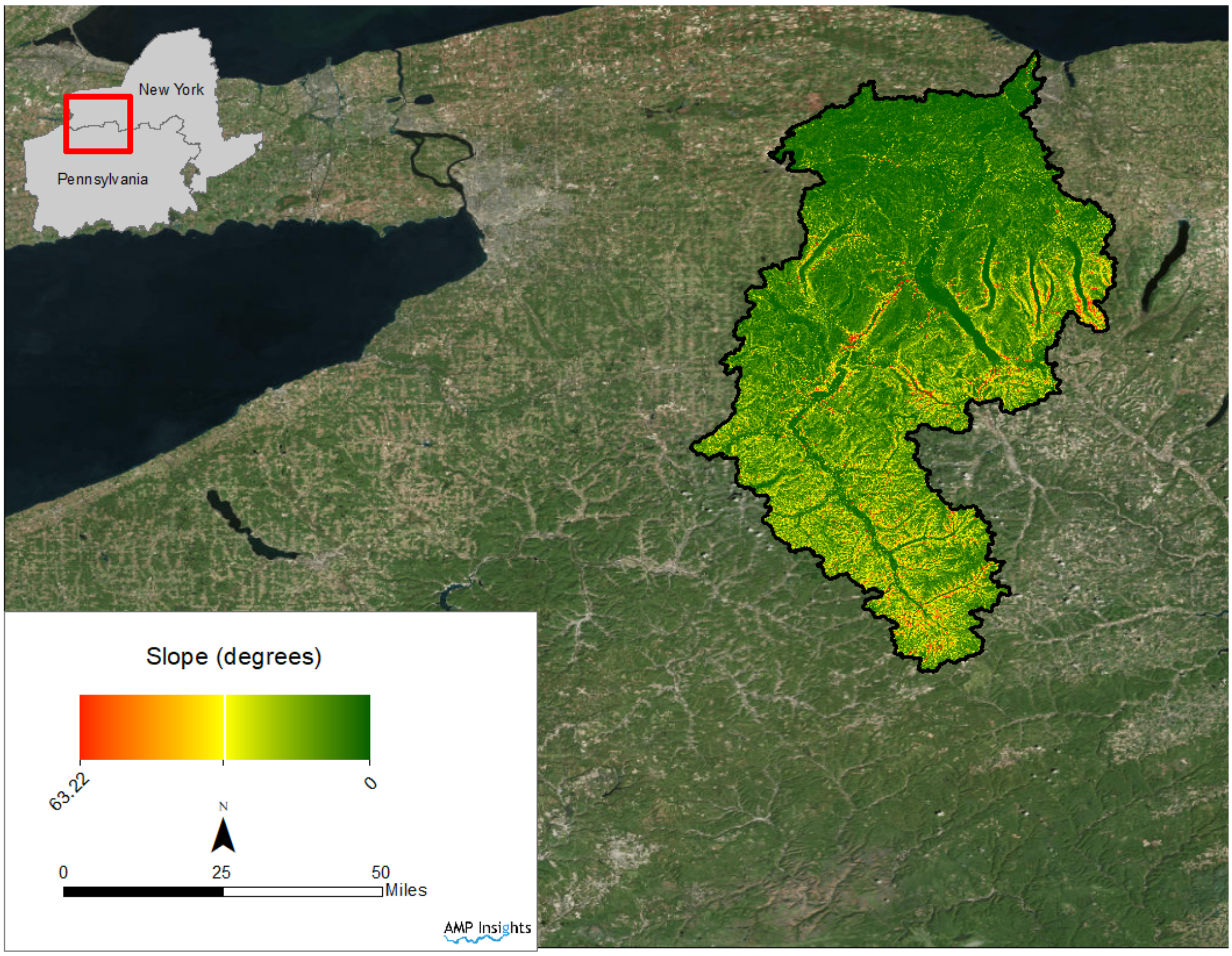
Appendix B. Physical Characteristics

B.1 Slope

B.1.1 Genesee Watershed

Hillslopes in the Genesee Watershed range from 0 to 63 degrees with more moderate slopes occurring in the north of the watershed and steeper slopes prevalent in the south and east. Steeper slopes around depressions clearly outline waterbodies and drainages (Figure B-1).

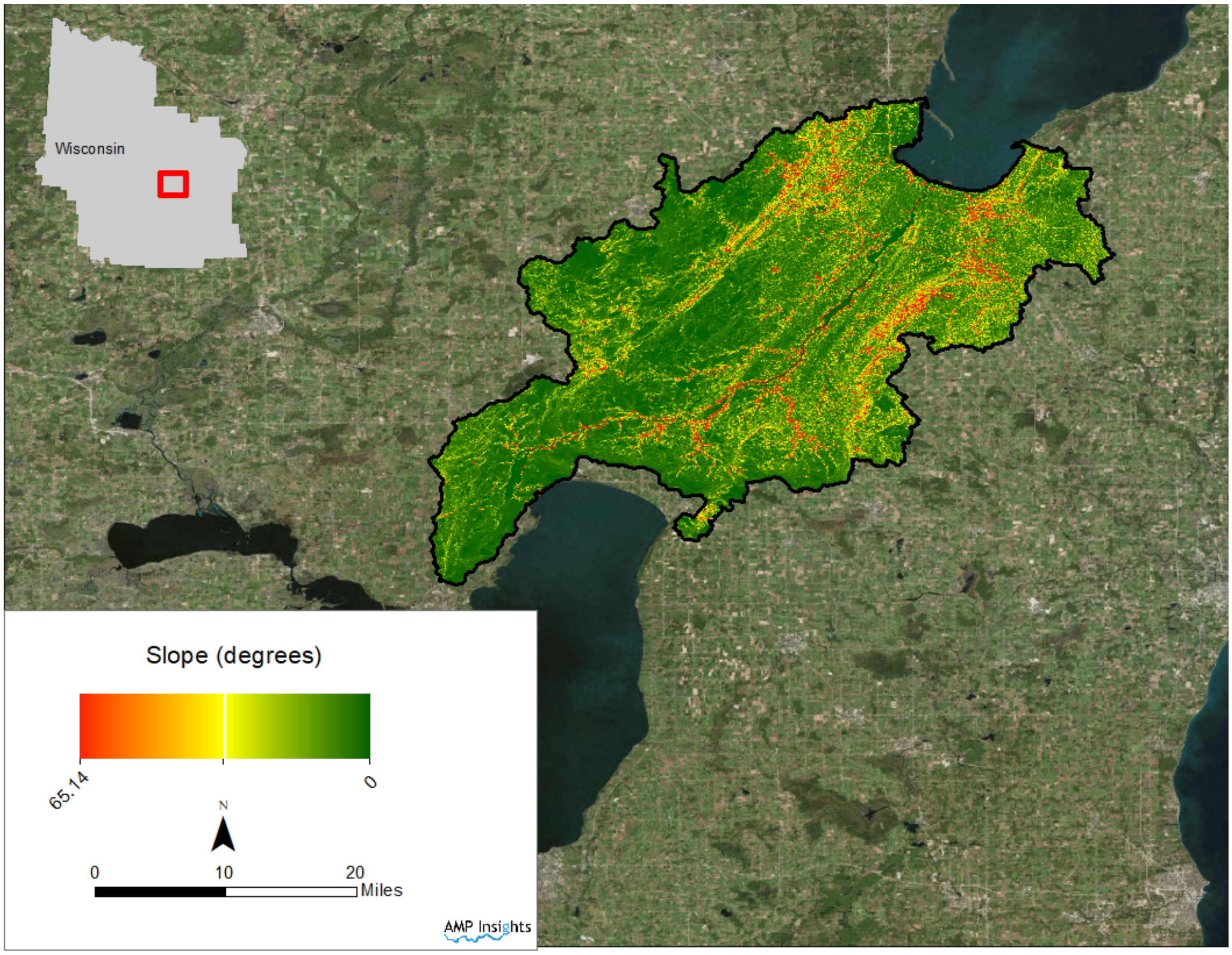
Figure B-1. Genesee Watershed Slope Profile



B.1.2 Lower Fox Watershed

Hillslopes in the Lower Fox Watershed range from 0 to 65 degrees with steeper slopes distributed throughout the watershed and concentrated in the north and east (Figure B-2).

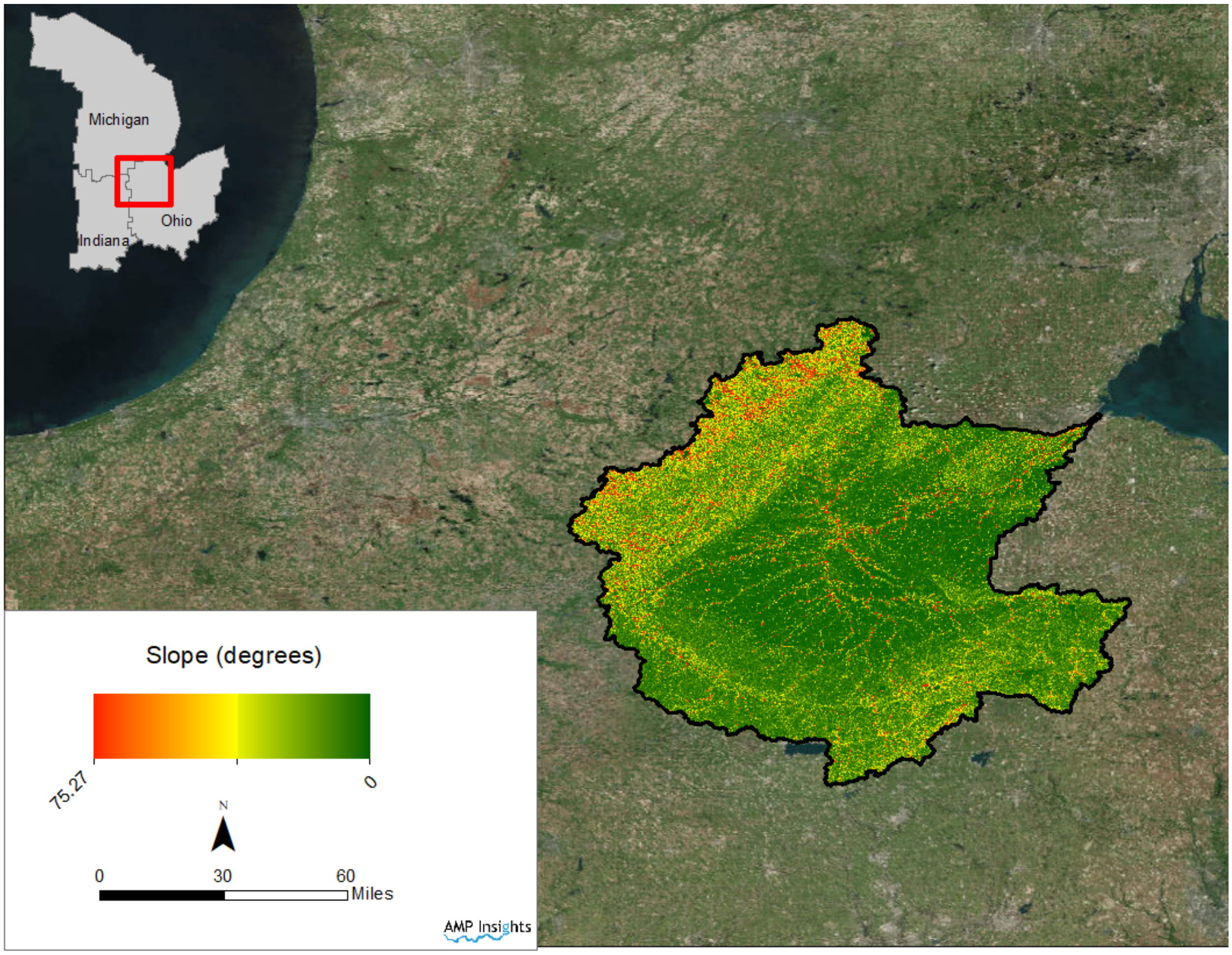
Figure B-2. Lower Fox Watershed Slope Profile



B.1.3 Maumee Watershed

The Maumee Watershed contains hillslopes that range from 0 to 75 degrees. Although steeper slopes are distributed throughout the watershed, more moderate slopes occur in the center and the east side of the watershed whereas steeper slopes are concentrated in the west (Figure B-3).

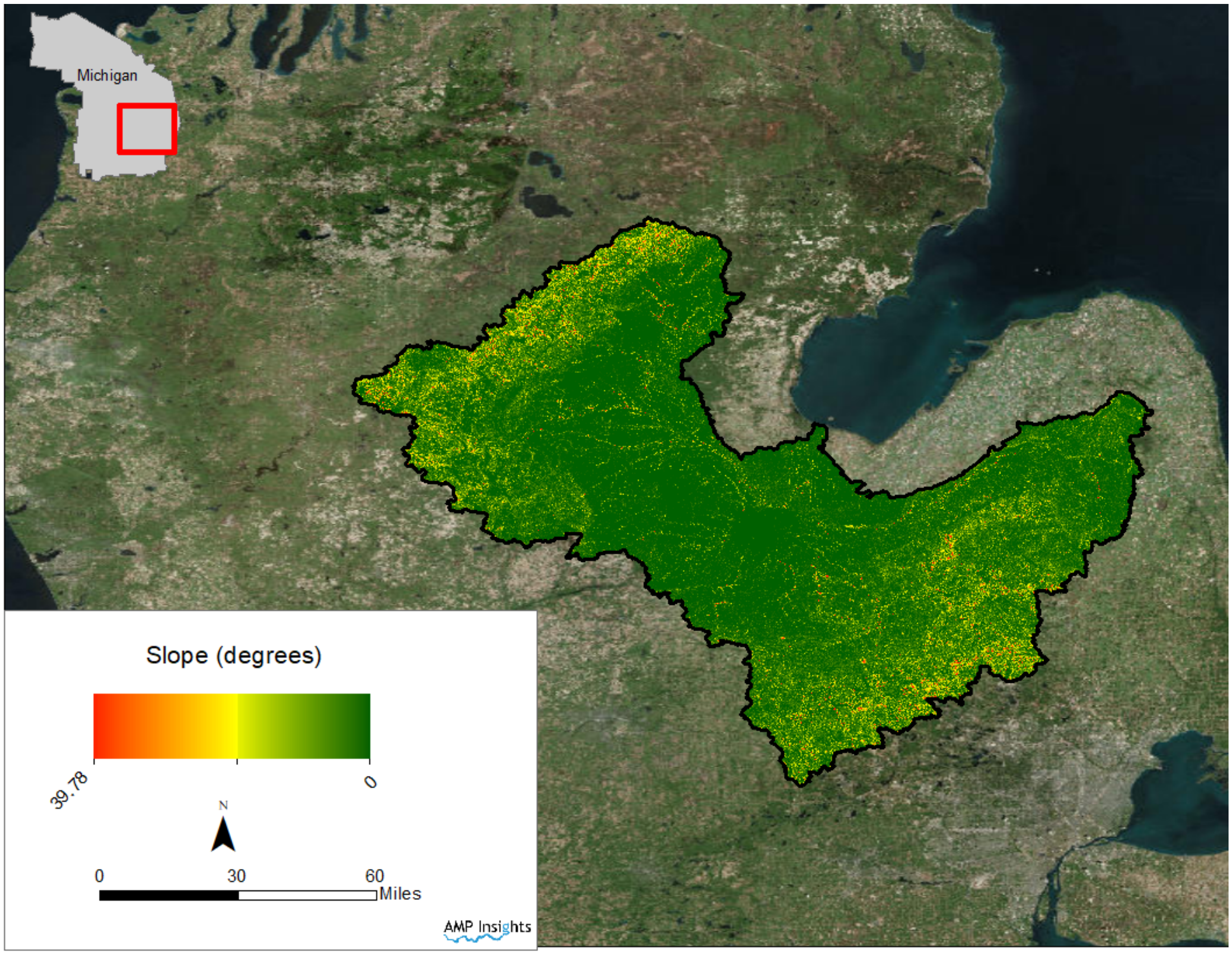
Figure B-3. Maumee Watershed Slope Profile



B.1.4 Saginaw Watershed

Compared to the three other watersheds, slopes in the Saginaw Watershed are much more moderate with a range of 0 to 40 degrees. Steeper slopes are more prevalent on the eastern and western edges of the watershed (Figure B-4).

Figure B-4. Saginaw Watershed Slope Profile



B.2 Soil Characteristics

B.2.1 Genesee Watershed

There are 12 soil types that each comprise at least 1% of the land area of the watershed. Together, these 12 soil types make up approximately 10% of the watershed. The remaining 90% of the watershed land area is comprised of 975 soil types (including cover by water) that each cover less than 1% of the watershed land area.

Table B-1. Genesee Watershed Five Soil Types of Greatest Spatial Extent

Soil Type	Area (Acres)	% Watershed Cover
Volusia channery silt loam, 3 to 8 percent slopes	30,295	1.90%
Volusia channery silt loam, 8 to 15 percent slopes	27,710	1.74%
Ontario loam, 3 to 8 percent slopes	27,584	1.73%
Ontusia channery silt loam, 8 to 15 percent slopes	25,098	1.57%
Ontusia channery silt loam, 3 to 8 percent slopes	21,534	1.35%

B.2.2 Lower Fox Watershed

The Lower Fox Watershed has 23 soil types that each comprise at least 1% of the land area of the watershed. Together, these 23 soil types make up approximately 60% of the watershed. The remaining 40% of the watershed land area is comprised of 193 soil types that each cover less than 1% of the watershed land area.

Table B-2. Lower Fox Watershed Five Soil Types of Greatest Spatial Extent

Soil Type	Area (Acres)	% Watershed Cover
Kewaunee silt loam, 2 to 6 percent slopes	48,290	11.65%
Manawa silty clay loam, 0 to 3 percent slopes	35,512	8.56%
Hortonville silt loam, 2 to 6 percent slopes	29,527	7.12%
Oshkosh silt loam, 2 to 6 percent slopes	20,415	4.92%
Symco silt loam, 0 to 3 percent slopes	12,876	3.11%

B.2.3 Maumee Watershed

Seventeen soil types in the Maumee Watershed cover at least 1% of watershed land area and together make up 54% of watershed land area. For soil types that make up less than 1% of watershed land area, 951 soil types make up the remaining 46% of land area.

Table B-3. Maumee Watershed Five Soil Types of Greatest Extent

Soil Type	Area (Acres)	% Watershed Cover
Pewamo silty clay loam, 0 to 1 percent slopes	437,199	10.39%
Blount silt loam, ground moraine, 0 to 2 percent slopes	258,845	6.15%
Hoytville silty clay loam, 0 to 1 percent slopes	207,322	4.93%
Blount silt loam, ground moraine, 2 to 4 percent slopes	182,571	4.34%
Hoytville silty clay, 0 to 1 percent slopes	178,704	4.25%

B.2.4 Saginaw Watershed

The Saginaw Watershed has 13 soil types that each comprise at least 1% of the land area of the watershed and make up approximately 11% of the watershed. The remaining 89% of the watershed land area is comprised of 1,266 soil types that cover less than 1% of the watershed land area.

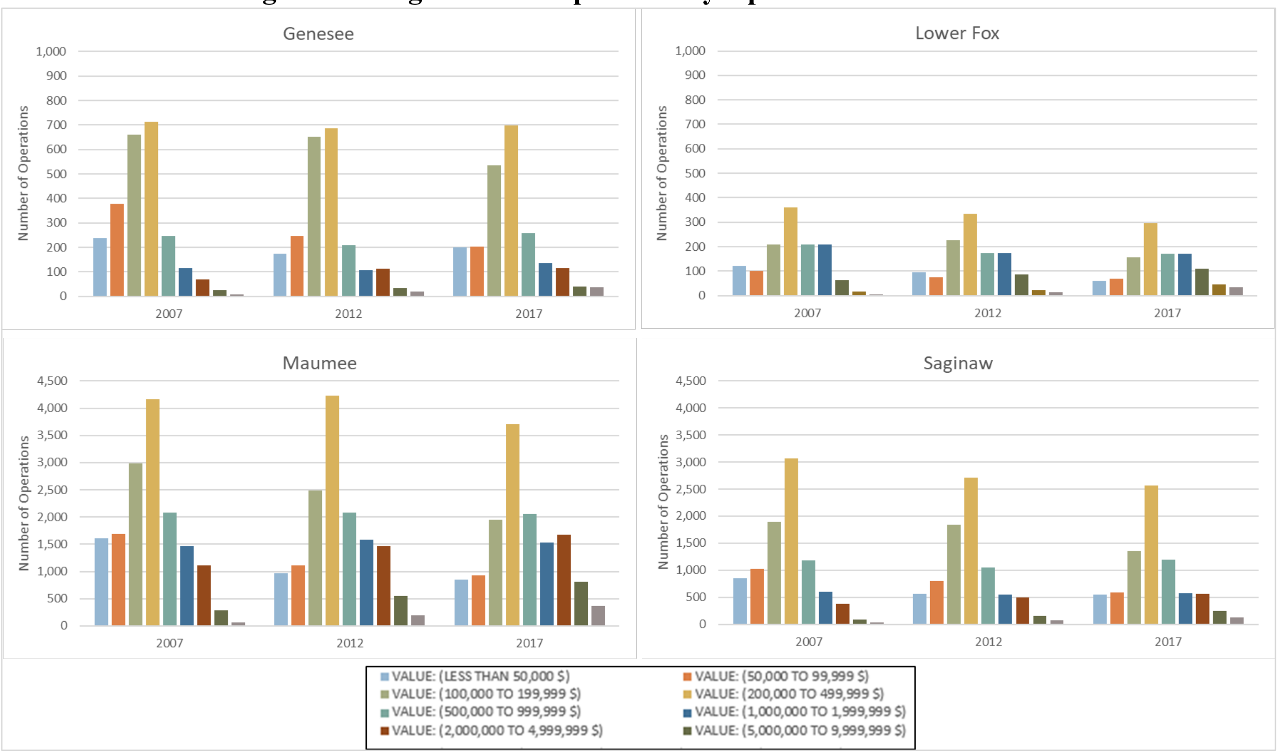
Table B-4. Saginaw Watershed Five Soil Types of Greatest Extent

Soil Type	Area (Acres)	% Watershed Cover
Parkhill loam, 0 to 1 percent slopes	165,428	4.15%
Selfridge loamy sand, 0 to 3 percent slopes	144,360	3.62%
Conover loam, 0 to 4 percent slopes	142,393	3.57%
Pipestone sand, Erie-Huron Lake Plain, 0 to 3 percent slopes	137,939	3.46%
Conover loam, 0 to 3 percent slopes	104,002	2.61%

Appendix C. Farm Characteristics

C.1 Agricultural Land Value

Figure C-1. Agricultural Operators by Operation Value Class



Note: Please note that the y-axis for Genesee and Lower Fox are different scales than Maumee and Saginaw to show variation between years.

Appendix H

Analysis of Investments & Outcomes Using Data from GLRI Focus Area 3 Projects & Program Reports

Great Lakes Commission des Grands Lacs

REAP Researching the Effectiveness of Agricultural Programs

Analysis of Investments & Outcomes Using Data from GLRI FA3 Projects & Program Reports

FINAL

October 2019

Sarah Kruse, PhD

Tess Gardner, MSEM

AMP Insights

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ACRONYMS

CoA	Census of Agriculture
CP	Conservation Practice
CRP	Conservation Reserve Program
CSP	Conservation Stewardship Program
CTA	Conservation Technical Assistance
EQIP	Environmental Quality Incentives Program
EWG	Environmental Working Group
GLC	Great Lakes Commission
GLRI	Great Lakes Restoration Initiative
IA	Interagency Agreement
NRCS	Natural Resources Conservation Service
OSU	The Ohio State University
PI	Principal Investigator
REAP	Researching Effectiveness of Agricultural Programs
US	United States
USGS	United States Geological Survey
WHIP	Wildlife Habitat Incentives Program

Executive Summary

This report has been produced in support of the project known as Researching the Effectiveness of Agricultural Programs (REAP) funded under a Great Lakes Restoration Initiative (GLRI) Cooperative Agreement between the U.S. Environmental Protection Agency and the Great Lakes Commission. The objective of REAP is to evaluate the impact on long-term on-farm behavior as a result of GLRI Focus Area 3 investments with four GLRI priority watersheds; the Genesee, Lower Fox, Maumee, and Saginaw watersheds. The analysis presented here is meant to serve as a starting point for determining if, and the degree to which, project design elements and funding structures impact socioeconomic outcomes.

This document describes the data available for analysis, provides a general overview of GLRI Focus Area 3 investments in the priority watersheds from 2010-2016 as well as summary outputs from analyses of project-level data including a) structure and elements of high-level projects; b) implementation of conservation practices (CPs); c) comparison of project elements with farm survey data provided by The Ohio State University (OSU); and d) cost effectiveness of various CP types. The document concludes with a summary ranking, an evaluation of projects and watersheds, and list of recommendations for future GLRI data collection based on findings from the previous sections.

Summary outputs of project-level data demonstrate that most projects involved multiple project elements (see Figure ES-1) and that the two project elements that are considered exemplary of Great Lakes Restoration Initiative projects – direct outreach and innovative capacity building – are included in 57% of the funded projects (see Figure ES-2). Overall the Maumee and Saginaw watersheds implemented the greatest percentage of projects with these two elements. It was also found that funding mechanism may play a role in the success that projects had in achieving stated goals for acres in conservation as a larger percentage of indirectly funded projects achieved the stated goals than directly funded projects. No conclusive pattern could be drawn between the achievement of stated conservation goals and project elements.

Figure ES-1. Total High-Level Projects by Number of Project Elements

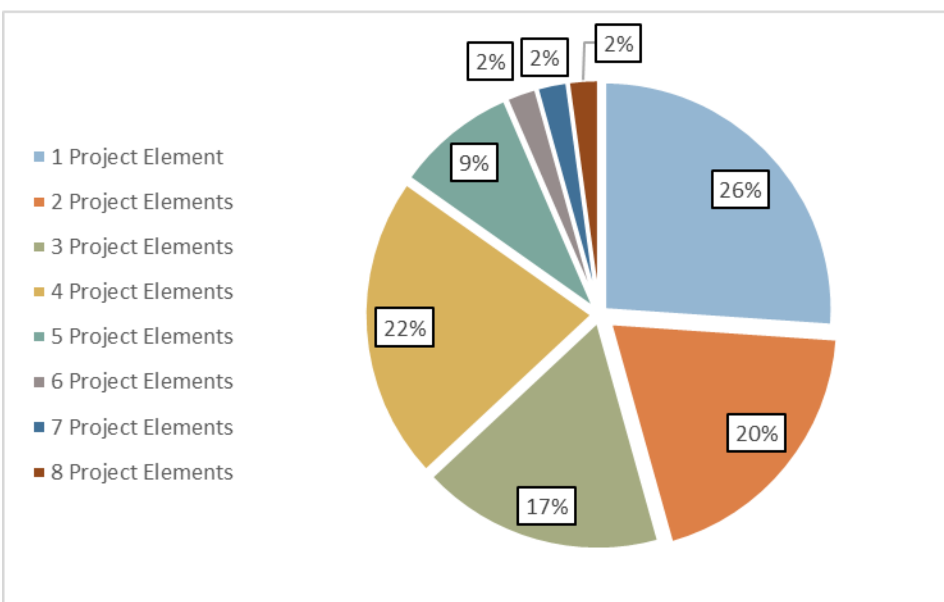
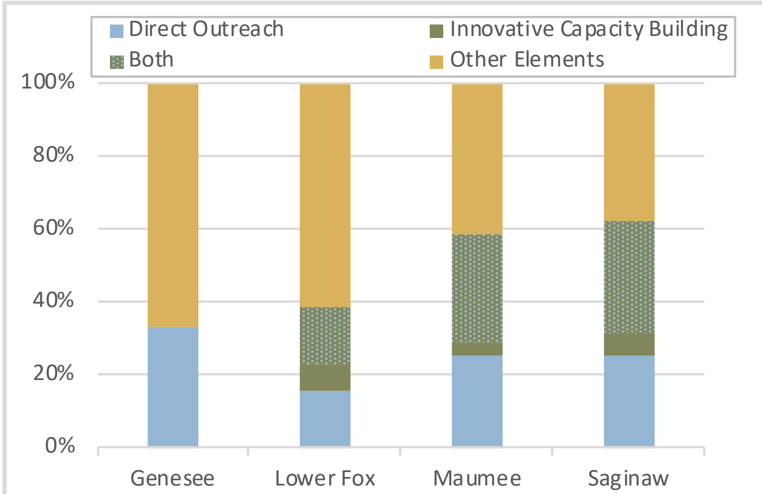


Figure ES-2. Projects with Direct Outreach and Innovative Capacity Building



The analysis of the implementation of conservation practices found that a majority of total project funding by watershed was allocated to conservation practices implementation, ranging from 53% (Maumee) to 68% (Genesee). The projects that funded conservation practices, however, were overwhelming indirectly funded projects (95%).

Of the 106 types of conservation practices implemented under these projects cover crops were the most frequently implemented conservation practice across all four watersheds both in total and in each watershed individually (see Table ES-1). In total, cover crops represented approximately a quarter of all conservation practices implemented. Outside of cover crops, however, variation was seen across the watersheds in terms of which conservation practices were most frequently implemented, and by units of conservation practices implemented, nutrient management (301,978 acres) and cover crops (275,876 acres) were the conservation practice types implemented on the greatest number of acres.

Table ES-1. CP Implementation by Type and Cost – Watershed

Practice Type	# of CPs	% of CPs in Watershed		Practice Type	$1000s	% of Funding in Watershed
Genesee				Genesee		
Cover Crop	62	12%		Waste Storage Facility	$ 2,025	37%
Heavy Use Area Protection	33	6%		Heavy Use Area Protection	$ 805	15%
Waste Transfer	33	6%		Cover Crop	$ 476	9%
Nutrient Mgmt	28	5%		Roofs and Covers	$ 413	8%
Prescribed Grazing	27	5%		Waste Transfer	$ 321	6%
Lower Fox				Lower Fox		
Cover Crop	258	16%		Waste Storage Facility	$ 4,466	32%
Critical Area Planting	126	8%		Cover Crop	$ 1,885	13%
Grassed Waterway	120	7%		Heavy Use Area Protection	$ 1,407	10%
Heavy Use Area Protection	106	7%		Waste Transfer	$ 760	5%
Mulching	103	6%		Waste Facility Closure	$ 717	5%

Table ES-1(Continued). CP Implementation by Type and Cost – Watershed

Practice Type	# of CPs	% of CPs in Watershed	Practice Type	$1000s	% of Funding in Watershed
Maumee			Maumee		
Cover Crop	1,465	30%	Cover Crop	$ 6,745	29%
Nutrient Mgmt	744	15%	Nutrient Mgmt	$ 4,328	19%
Conservation Crop Rotation	480	10%	Conservation Crop Rotation	$ 2,738	12%
Amending Soil w/ Gypsum Produc	457	10%	Residue & Tillage Mgmt, No-Till	$ 1,558	7%
Residue & Tillage Mgmt, No-Till	424	9%	Waste Storage Facility	$ 1,376	6%
Saginaw			Saginaw		
Cover Crop	349	24%	Nutrient Mgmt	$ 2,771	23%
Nutrient Mgmt	304	21%	Cover Crop	$ 2,346	19%
Integrated Pest Management	155	11%	Agrichemical Handling Facility	$ 2,091	17%
Heavy Use Area Protection	70	5%	Integrated Pest Management	$ 1,205	10%
Residue & Tillage Mgmt, No-Till	58	4%	Waste Storage Facility	$ 1,104	9%

The data reported for the projects themselves was primarily related to project structure, funding, and outputs such as acres of conservation achieved. The task of analyzing socioeconomic impacts by different project structures, however, required data on outcomes. To obtain this type of data, the results of a mixed mode survey conducted by the Wilson Lab, at OSU were used.

Based on the data available none of the intentions of the survey participants regarding participation in GLRI funded programs, current/future participation in government funded conservation programs, future use of cover crops, or future use of vegetative buffers were strongly correlated with inclusion of either a direct outreach element or an innovative capacity building element in a project. Where information on project structures failed to elucidate a clear correlation with survey results of interest, comparisons of survey data with applicable watershed characteristics were explored.

Across all project and watershed characteristics evaluated, however, animal sales as a percentage of total sales appeared to be the only characteristic that may influence the adoption of cover crops and vegetative buffers (see Table ES-2). It may be possible that cover crops are a more attractive CP in watersheds with higher animal sales as cover crops could be implemented on cropland devoted to producing feed crop for livestock. Since the cover crops themselves can also have value as feed crop, cover crops may be more widely implemented on cropland for livestock than on land where higher value crops may be grown or where there is less value to be gained from the growth of cover crops.

The results of the survey also indicated that, although agriculturalists in the four priority watersheds tend to rely on different sources of information – Genesee: Crop Advisor (34%), Lower Fox: Crop Advisor (45%), Maumee: Fertilizer Retailer (37%), Saginaw: University Extension (29%) – other local farmers were the information source stated to be most used “some” or “a lot” across the watersheds. This finding has bearing on how agriculturalists can be best engaged in future programs.

Table ES-2. Agricultural Sales, Cover Crops and Vegetative Buffers

Watershed	Average % Sales from Animals	More Cover Crops Next Year	Will Likely or Definitely Use Cover Crops w/o Incentives	More Buffers Next Year	Will Likely or Definitely Use Buffers w/o Incentives
Saginaw	32%	25%	58%	9%	39%
Maumee	39%	26%	56%	26%	55%
Genesee	69%	22%	76%	28%	55%
Lower Fox	79%	37%	66%	37%	58%

Finally, the project costs were examined from the only angle for which sufficient cost data were available – conservation practices by unit of conservation practice. This analysis of does not inform on the cost-effectiveness of the conservation practices with regard to impact on either water quality or socioeconomic outcomes, but rather provides some information on the least or most costly conservation practices per unit implemented and how these costs differ across watersheds (Table ES-3). Across all four watersheds combined, the most least costly conservation practice type was soil testing ($9/acre), followed by written integrated pest management plans ($13/acre). For the three practice types reporting implementation of more than 100,000 acres, integrated pest management was the most cost effective ($15/acre), followed by nutrient management ($25/acre) and cover crops ($42/acre).

Table ES-3. Cost of Conservation Practice Types by Watershed

	Genesee		Lower Fox		Maumee		Saginaw		Total	
Practice Type	Acres	Cost/Acre	Acres	Cost/Acre	Acres	Cost/Acre	Acres	Cost/Acre	Acres	Cost/Acre
Nutrient Mgmt	10,284	$ 8	28,671	$ 12	148,769	$ 29	114,254	$ 24	301,978	$ 25
Cover Crop	7,625	$ 62	57,623	$ 33	152,879	$ 44	54,988	$ 43	275,876	$ 42
Integrated Pest Mgmt			43,777	$ 16	18,555	$ 7	75,830	$ 16	138,162	$ 15
Residue & Tillage Mgmt, No-Till	4,711	$ 31	7,121	$ 11	67,917	$ 23	19,509	$ 12	99,258	$ 20
Conservation Crop Rotation			547	$ 11	44,856	$ 61	4,314	$ 4	49,716	$ 56
Soil Testing					37,131	$ 9			42,685	$ 9
Amending Soil Properties w/ Gypsum Prod					31,098	$ 26	5,330	$ 25	36,428	$ 26
Residue & Tillage Mgmt, Reduced Till			187	$ 12	25,443	$ 19	8,180	$ 16	33,810	$ 18
Heavy Use Area Protection	1,374	$ 586	6,611	$ 213	33	$ 3,331	18	$ 29,240	8,037	$ 356
Prescribed Grazing	1,578	$ 24	4,748	$ 53	157	$ 81	1,282	$ 32	7,764	$ 45
Conservation Tillage					7,313	$ 15			7,313	$ 15
Equipment Modification					5,767	$ 16			5,767	$ 16
Upland Wildlife Habitat Mgmt	3	$ 180	214	$ 3			4,025	$ 15	4,242	$ 14
Lined Waterway or Outlet	1,360	$ 28	1,325	$ 20	231	$ 49			2,916	$ 26
Forage and Biomass Planting	202	$ 290	1,333	$ 147	663	$ 152	164	$ 104	2,361	$ 157
Brush Mgmt					1,552	$ 81	470	$ 125	2,022	$ 91

This analysis of the impact of Great Lakes Restoration Initiative investments on socioeconomic impacts falls short primarily due to a lack of reported project outputs and data or long-term trends on project outcomes that can be analyzed alongside project data. As a result, this document concludes with a list of recommendations for future data collection related to this program. The recommendations, while not exhaustive, focus primarily on the importance of identifying the data needed to create relevant metrics and clearly defining such data at the beginning of each project, standardized reporting, consistently collecting data on outputs, and including the assessment of outcomes into projects themselves.

1. Introduction

This report has been produced in support of the project known as Researching the Effectiveness of Agricultural Programs (REAP) funded under a Great Lakes Restoration Initiative (GLRI) Cooperative Agreement between the U.S. Environmental Protection Agency and the Great Lakes Commission. The objective of REAP is to evaluate the impact on long-term on-farm behavior as a result of GLRI Focus Area 3 investments with four GLRI priority watersheds; the Genesee, Lower Fox, Maumee, and Saginaw watersheds. The analysis presented here is meant to serve as a starting point for determining if, and the degree to which, project design elements and funding structures impact socioeconomic outcomes.

This document is organized such that general information on how data were analyzed is described first. The next several sections of the document provide a general overview of GLRI investments in the priority watersheds from 2010-2016 as well as summary outputs from analyses of project-level data including a) structure and elements of high-level projects; b) implementation of conservation practices (CPs); c) comparison of project elements with farm survey data provided by The Ohio State University (OSU); and d) cost effectiveness of various CP practice types. The final section provides a summary ranking and evaluation of projects and watersheds based on findings from the previous sections.

2. Data

The primary source of data for analyses conducted as part of this effort was a database compiled by the REAP Project Management Team on the majority of GLRI Focus Area 3 investments distributed to the four priority watersheds – data were not included for GLRI investments in other focus areas. The database included two tabs – one on high-level projects and one on CPs implemented as part of the high-level projects. The information on the CPs was considered to be incomplete, but still was useful in understanding how and where GLRI funds were distributed.

A second source was data collected as part of mixed mode survey conducted by the Wilson Lab, at OSU. In early 2019, the OSU team mailed surveys to a stratified sample of farmers in all counties intersecting the four priority watersheds. Respondents could fill out the mail version or respond online. In order to ensure confidentiality, the OSU team provided survey results aggregated to the county-level for specific questions relevant to this effort.

3. GLRI Project Output Analysis

The total number of high-level projects funded by the GLRI from 2010-2016 was 34, with eight of the 34 projects implemented over multiple priority watersheds. Separating these projects by watershed resulted in a total of 59 projects (see Table 1). Within the high-level projects, a total of $95.8 million was recorded as GLRI funds distributed across the four priority watersheds over the time frame considered. It should be noted that the GLRI funds aggregated into the REAP Master Database may represent just the cost-share portion of project cost for government partners, such as those projects associated with NRCS.

Table 1. GLRI Focus Area 3 Projects and Funding by Watershed

Watershed	GLRI Funded Projects	Project Funds ($1000s)
Genesee	6	$ 7,994
Lower Fox	13	$ 24,321
Maumee	24	$ 43,999
Saginaw	16	$ 19,495

Funding for GLRI projects was allocated towards eight project elements (see Table 2). Information in the database was not specific enough, however, to parse out the funding allocated within each project to the specific project elements; however, the distribution and frequency of project elements across high level projects is assessed in Section 3.1.

Table 2. Project Elements

Project Element	Definition
CP Installation	Project funds provide monetary incentives to offset costs of CPs to benefit water quality
Outreach (Direct)	Project funds used to support in-person public and private meetings and individual interactions
Outreach (Indirect)	Project funds dedicated to producing mailers, press releases, fact sheets, newsletters, websites
Capacity Building (Traditional)	Project funds used to help existing agencies/programs increase implementation of widely-adopted traditional CPs
Capacity Building (Innovative)	Project funds used to help expand the use of innovative tools, methods, and CPs, that are not currently available through other major federal and state agricultural incentive programs
Monitoring & Research (Edge of Field)	Project funds allocated to measuring nutrient runoff leaving fields before it enters waterways
Monitoring & Research (Other)	Project funds allocated to measuring nutrients in-stream and in open water
Decision Support Tool Development or Application	Project funds supporting the development and usage of models and databases created to improve on-farm decision making and assist with strategic water quality investments

GLRI funding also could be categorized by the funding distribution pathway. First, grants could either be given to a non-Federal agency or a Federal agency, the latter though an interagency agreement (IA). Grants also could be considered either direct or indirect funding – direct grants were awarded to the recipients(s) would directly carry out the project, while indirect grants were awarded to recipient(s) who did not directly carry out the project, but rather, distributed funds to one or more sub-grantees who would then carry out the project.

Overall, $68.7 million was distributed as indirect grants – where funding was distributed to an entity engaged in activities (e.g., outreach, capacity-building, monitoring, etc.) that included providing funds to a producers that installed CPs among other activities (72%) and $27.1 million was distributed as direct grants (28%) – where funding was distributed directly to a producer or entity that installed CPs.

As seen in Table 3, approximately two-thirds of GLRI investments were awarded through IAs. The majority of IA grants were funded directly (69%), while the number of non-federal agency grants were split almost evenly between direct (48%) and indirect (52%). While funding (in terms of dollar value) of non-federal agencies was again relatively evenly split between direct (47%) and indirect (53%) grants, the majority of funding allocated to IAs was done through the indirect grants.

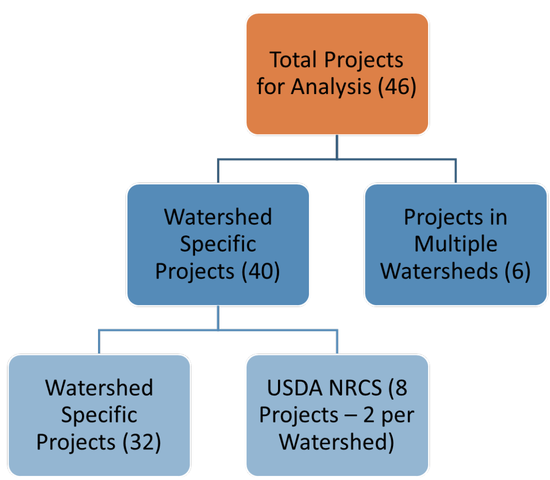
Table 3. Funding Distribution Pathways

	Funding Type	Non-Federal Agencies	Interagency Agreements
Projects (#)	Direct	16	9
	Indirect	17	4
	Total	33	13
Projects (% of Total by Recipient Type)	Direct	48%	69%
	Indirect	52%	31%
GLRI Investments ($1000s)	Direct	$ 16,438	$ 10,672
	Indirect	$ 18,433	$ 50,265
	Total	$ 34,872	$ 60,937
GLRI Investments (% of Total by Recipient Type)	Direct	47%	18%
	Indirect	53%	82%

3.1 Project Elements

As mentioned in the previous section, 34 unique high-level GLRI projects to reduce nutrient runoff from agricultural activities were implemented across the four priority watersheds between 2010 and 2016. Two of these 34 projects were subdivided to reflect investments in distinct priority watersheds and an additional six projects were implemented across two or more priority watersheds, but the reporting for these six projects was not broken out by watershed, so 46 projects were used for the purposes of analyzing project elements (see Figure 1).

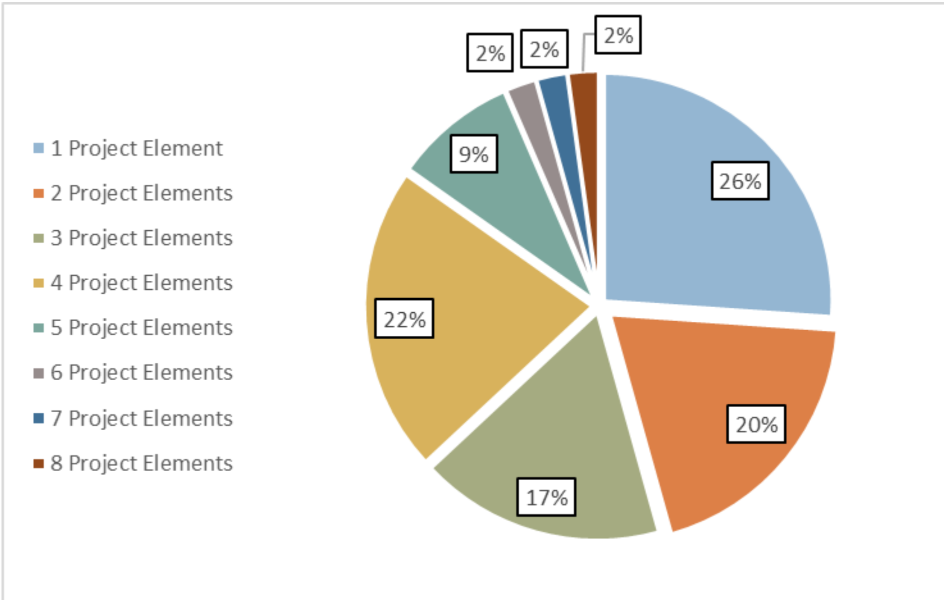
Figure 1. High-Level Projects Analyzed



First, the number of project elements – conservation practices (CPs), direct outreach, indirect outreach, traditional capacity building, innovative capacity building, edge of field monitoring & research, other monitoring & research, and decision support tool development or application – undertaken by each project was calculated.

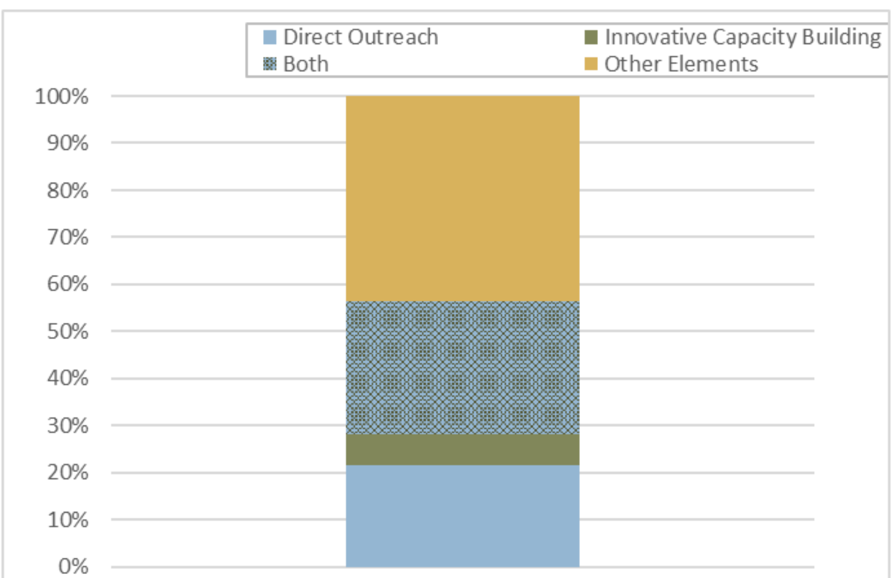
Of the 46 projects, the greatest percentage of projects (26%) implemented only one project element (see Figure 2), of which CP installation and edge of field monitoring & research were project elements most often implemented alone. The only project with all eight projects elements implemented occurred in the Lower Fox under the project titled *Targeting Outcome-Based Sediment Reduction in the Lower Fox Watershed*.

Figure 2. Total High-Level Projects by Number of Project Elements



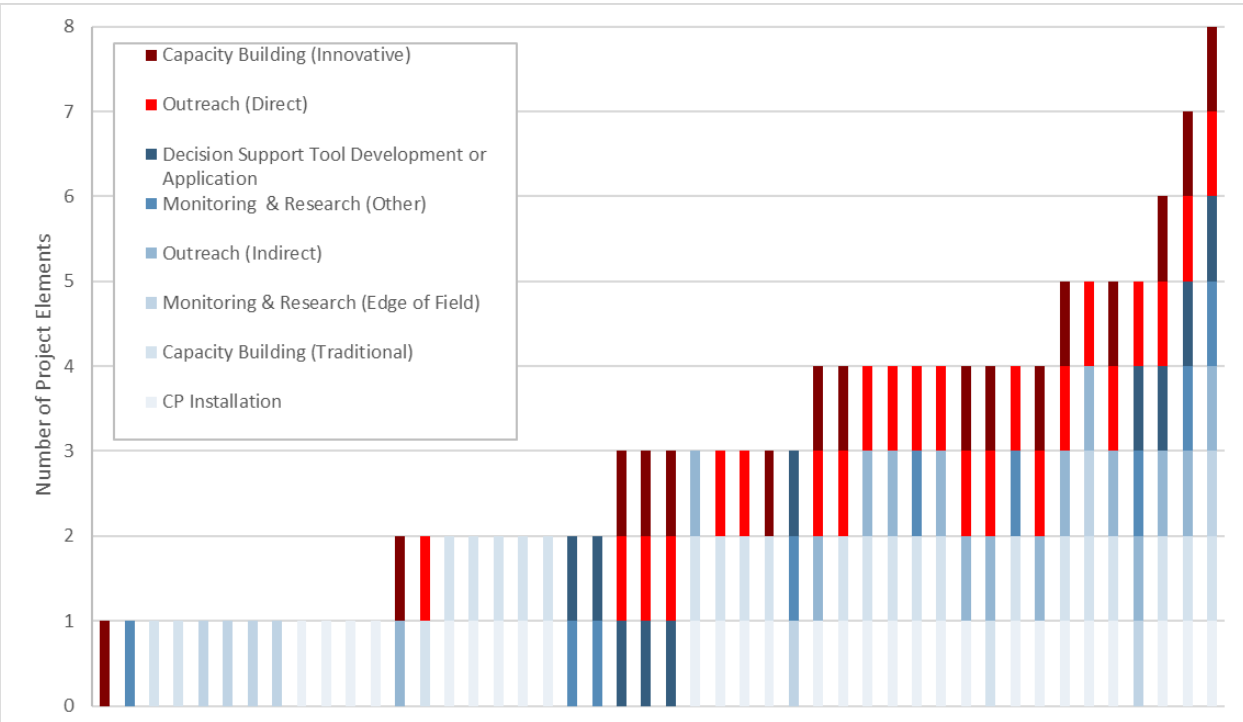
A more detailed analysis was done of two specific project elements – direct outreach and innovative capacity building – as they are elements exemplary of GLRI investment projects (as compared to traditional USDA-NRCS agricultural conservation programs that focus on direct payments to producers to install CPs), which aim to be more innovative than traditionally funded projects. Indeed, direct outreach and innovative capacity building appeared frequently in the 46 high-level projects with one of the two elements appearing in 57% of projects and both elements appearing in 28% (see Figure 3).

Figure 3. Projects with Direct Outreach and Innovative Capacity Building



These two elements, however, rarely appeared on their own as the only project element executed by a project. It is possible this result is a function of NRCS and USEPA policy and funding priorities that place a strong emphasis on CP installation. Of the 12 GLRI projects that implemented only a single project element, that project element was either direct outreach or innovative capacity building for only one project (see Figure 4). For projects with more elements, in which direct outreach and innovative capacity building appear more frequently, direct outreach was most frequently paired with CP installation and indirect outreach, while innovative capacity building was most frequently paired with direct outreach. Of the 15 projects that had multiple project elements, one of which was innovative capacity building, 13 also included direct outreach.

Figure 4. All Projects by Number and Type of Project Element



It also was of interest to explore how project elements were implemented differently across the four priority watersheds. For those six projects that were carried out in two or more watersheds, but not reported on separately, the project elements corresponding to that project were assumed to be implemented in each of the watersheds in which that project was active (see Table 4). It is interesting to note that CP installation was one of the most frequently used project elements in the Genesee and Lower Fox and that projects in both of these watersheds used innovative capacity building the least. In contrast, direct outreach was most frequently used by projects in the Maumee and Saginaw while edge of field monitoring and research was least used by projects in both these watersheds.

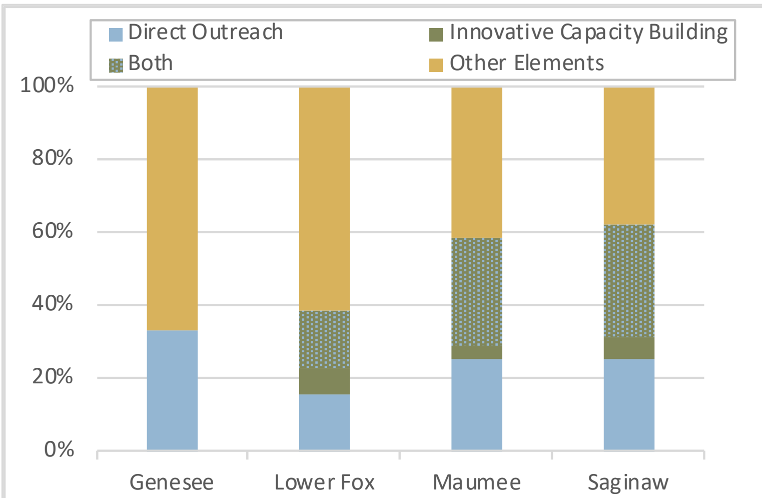
Table 4. Proportion of Projects by Project Element and Watershed

Watershed	CP Installation	Outreach (Direct)	Outreach (Indirect)	Capacity Building (Traditional)	Capacity Building (Innovative)	Monitoring & Research (Edge of Field)	Monitoring & Research (Other)	Decision Support Tool Development or Application
Genesee	50%	33%	33%	33%	0%	17%	50%	50%
Lower Fox	54%	31%	38%	54%	23%	31%	38%	38%
Maumee	46%	54%	29%	46%	33%	21%	25%	29%
Saginaw	50%	56%	38%	38%	38%	19%	25%	31%

Most frequently used within each watershed
Least frequently used within each watershed

The Maumee and Saginaw had the most direct outreach and innovative capacity building projects implemented in both raw values and as a proportion of total projects in the watershed (see Figure 5).

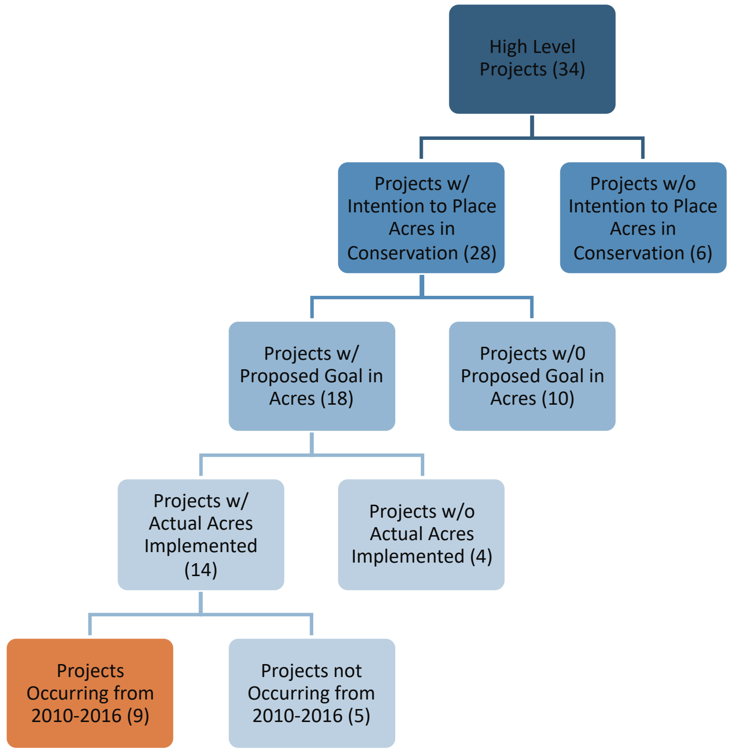
Figure 5. Projects with Direct Outreach and Innovative Capacity Building



3.2 Acres in Conservation

Twenty-seven of the 34 high-level projects (79%) intended to place acres in conservation, of which 18 were recorded as reporting a numerical proposed goal for acres in conservation. Of these 18 projects, 14 projects also reported actual acres in conservation in interim or final reports; however, only nine of the 14 projects had ended at or during the timeframe of interest (prior to 2016). For these nine projects, the acres in conservation were compared to the proposed acres in conservation to determine if the goal was met (see Figure 6).

Figure 6. Projects with Conservation Goals and Outcomes for Analysis



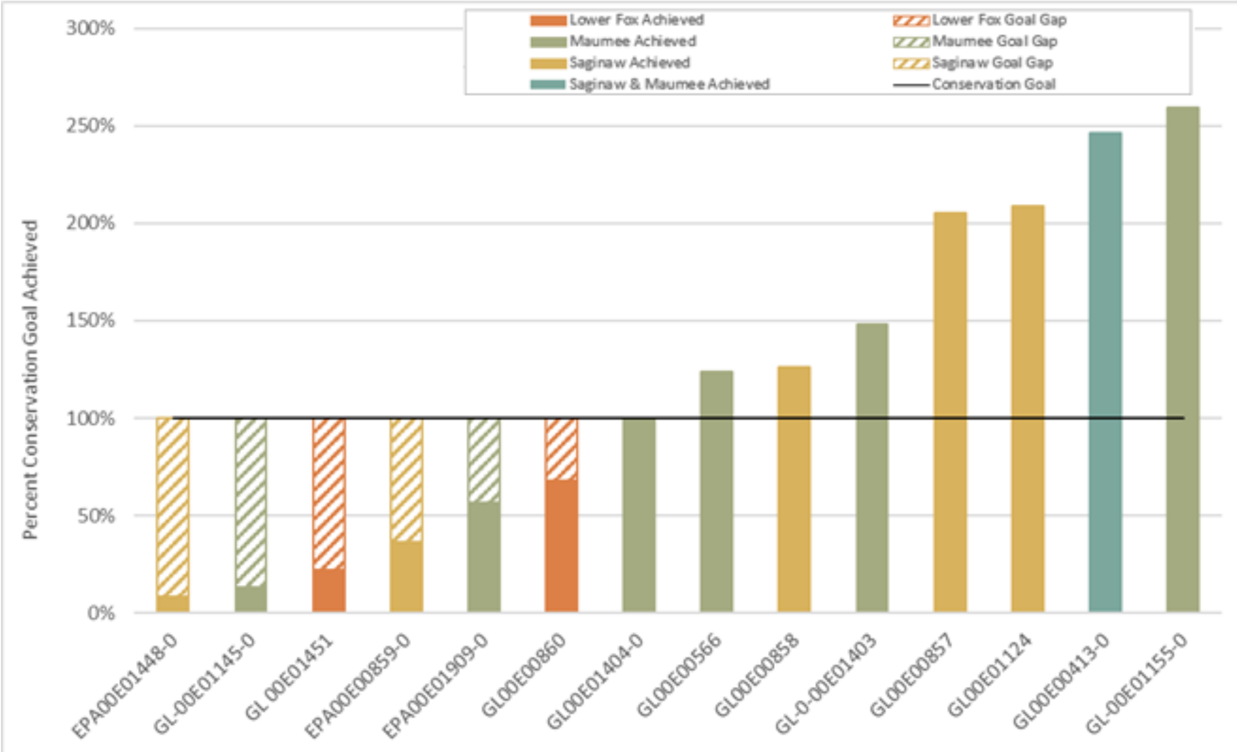
For the five projects with end dates after 2016, the proposed acres in conservation were divided by the project lifespan to get a per year figure for acres in conservation. This value was multiplied by the number of years of the project between its start date and the end of 2016. This value of estimated acres to be in conservation by the end of 2016 for the project to be on track with achieving the proposed acreage goal by the end of the project lifespan was then compared to the reported acres in conservation. This methodology necessarily makes assumptions about the processes involved in a project, such that projects for which there is a long planning process followed by quick implementation may be unfairly represented as in danger of not achieving the set conservation goal.

Overall, the number of actual acres of conservation slightly exceeded the proposed acres of conservation (see Table 5). This was not, however, due to each project achieving its stated conservation goal and was instead due to some projects exceeding their goal and making up for projects that fell behind their conservation goals (see Figure 7). Therefore, success in achieving conservation goals was not equal across projects or watersheds.

Table 5. Proposed Versus Actual Acres of Conservation Implemented Across All Reported Projects

Unit	Proposed	Actual
Acres	265,687	266,299
Percent of Proposed Acres		100%

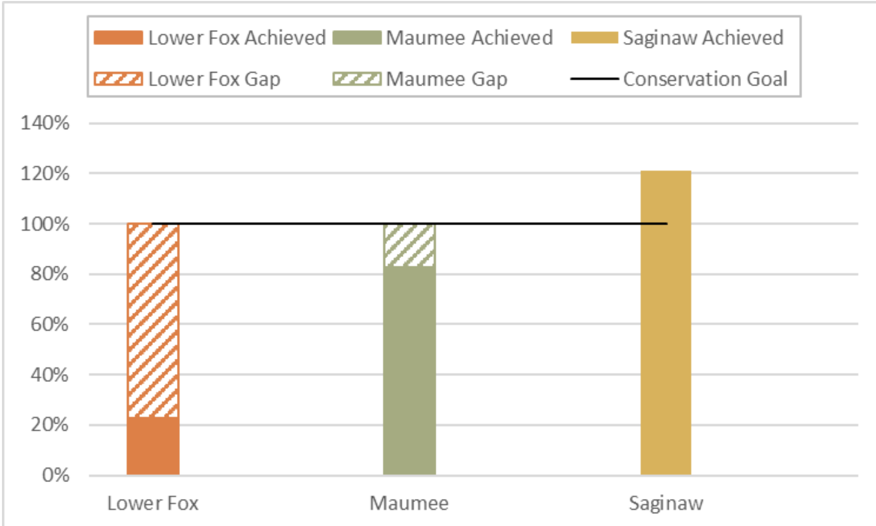
Figure 7. Proposed versus Actual Acres of Conservation by Reported Projects



Of those projects whose end date extended beyond 2016 and had not accomplished the project conservation goal (EPA00E01448-0, GL 00E01451, and EPA00E01909-0), none were on-track to achieve the proposed acres in conservation as assessed using the methodology described above. By watershed, the percentage of proposed acres of conservation actually accomplished (for those projects that reported both proposed and achieved acres in conservation) across all projects in Lower Fox, Maumee, and Saginaw were 23%, 83%, and 121% respectively (see Figure 8). Of the three projects in the Genesee, none reported both proposed and achieved acres in conservation.

As mentioned previously, not all projects had stated conservation goals that could be collected by the REAP PMT (either they did not exist or were not readily available through the documentation available to the REAP PMT) – including this as a requirement of projects in the future would allow for a more comprehensive assessment of GLRI investments.

Figure 8. Proposed versus Actual Conservation by Projects in Watersheds



Of the 14 projects whose success (or potential for success) at achieving the proposed acres in conservation could be assessed, the funding mechanism and projects elements were also tallied. Those projects that achieved or exceeded the conservation goal tended to be funded indirectly (see Table 6).

Table 6. Funding Mechanism for Projects Reporting on Achieved Acres in Conservation

Target Achieved	Direct Funding	Indirect Funding
Yes	2	5
No	5	2

Most of the 14 projects implemented three or more project elements with only one project apiece reporting one (achieved conservation goal), two (did not achieve goal), or eight (did not achieve goal) elements. There was no discernable trend in regards to the project elements present in projects that achieved their conservation goals as compared to those that didn't (see Table 7).

Table 7. Project Elements for Projects Reporting on Achieved Acres in Conservation

Target Achieved	CP Installation	Outreach (Direct)	Outreach (Indirect)	Capacity Building (Traditional)	Capacity Building (Innovative)	Monitoring & Research (Edge of Field)	Monitoring & Research (Other)	Decision Support Tool Development or Application	Outreach (Direct) and Capacity Building (Innovative)
Yes	6	6	5	6	3	1	1	0	3
No	7	5	5	5	4	1	1	2	4

Given that few discernible trends were identified from which conclusions could be drawn about the impact of project structures on the achievement of GLRI project conservation goals, it was of interest to see whether watershed characteristics might provide some potential explanatory correlations. One watershed characteristic in particular with potential to impact interest in conservation of agricultural lands is the tenure of agricultural operations (full ownership, part ownership, or tenant) with the hypothesis that a tenant would be less interested in investing in conservation of agricultural lands than a full owner. Although the four watersheds exhibited different trends with regards to percentage of total acres operated by tenure from 2007-2017, as reported in the Census of Agriculture (CoA), no discernible correlation was uncovered between land tenure and the percentage of the proposed acres in conversation achieved, indicating that a range of factors (both project structure and watershed characteristics) likely impact conservation goals and these are difficult to observe with the limited data available.

4. Conservation Practices Output Analysis

While conservation practices (CPs) represent only one of the eight project elements identified for analysis in REAP, additional data points (e.g., practice type, units implemented, cost of implementation using GLRI funds, etc.) were collected on CPs allowing for more detailed analysis. One point that must be made when evaluating the number of CPs implemented and their aggregated costs is that many different types of CPs were funded and have been implemented with GLRI funding. The following summary statistics are not asserting that one CP is equal to another in regards to any characteristic such as type, scale, or effectiveness. In addition, the dataset on CPs does not specify if/when multiple CPs were implemented at a single location or if a single farmer or operation was the recipient of assistance to implement multiple CPs. Therefore, the total acreage that benefitted from CP implementation and the total number of farmers/operations engaged in the implementation of CPs through GLRI cannot be determined. For CPs that did report associated units implemented, estimates of total acreage that benefitted was calculated in Section 4.3.

4.1 Conservation Practices Summary

From 2010-2016, a reported $55.3 million (58%) of GLRI funding supported implementation of CPs in the four priority watersheds (see Table 8). It should be noted, however, that nine of the 23 GLRI funded projects reporting CP implementation did not include associated costs. Therefore, more than $55.3 million may have been spent to implement the 8,414 CP projects reported in Table 8. Almost half of reported GLRI funding directed at CPs went to efforts in the Maumee (42%), which implemented 58% of CPs reported.

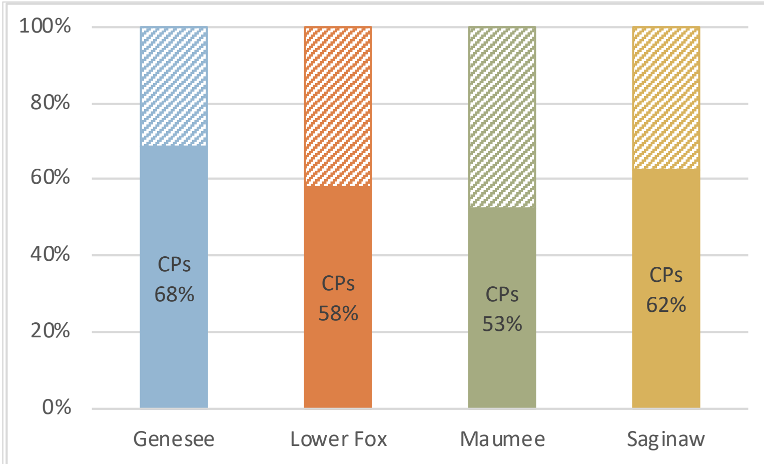
Table 8. Summary of Overall GLRI Focus Area 3 Funded Conservation Practice Implementation[1]

Output	Genesee	Lower Fox	Maumee	Saginaw	Total
Total GLRI Funding ($1000s	$ 7,994	$ 24,321	$ 43,999	$ 19,495	$ 95,809
GLRI CP Funding ($1000s)	$ 5,476	$ 14,062	$ 23,138	$ 12,135	$ 55,319
% Total Funding	8%	25%	46%	20%	—
% of Total CP Funding	10%	25%	42%	22%	—
# of CPs Reported	513	1,603	4,850	1,467	8,414
% of Total CPs Reported	6%	19%	58%	17%	—

Figure 9 shows the percentage of total GLRI Focus Area 3 investments in each watershed directed at CP implementation as reported in the REAP database. For all four watersheds at least half of total GLRI Focus Area 3 investments were spent on CP implementation, with the Genesee and Maumee having the highest percentage (68%) and lowest percentage (53%), respectively.

[1] Watershed values do not necessarily add to the total value as some practice types and associated funding were not identified by watershed.

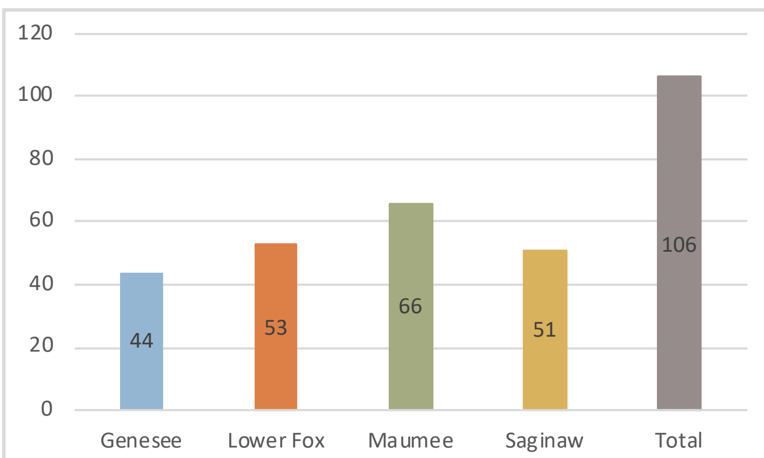
Figure 9. CP Funding as a Percentage of Total Watershed GLRI Focus Area 3 Investments



4.2 CP Implementation by Practice Type and Funding

In total, 106 different practice types were implemented, however, the number and type used varied by watershed (see Figure 10). The Genesee and Maumee implemented the lowest and highest number of CP types, respectively, which is not surprising given that these two watersheds implemented the lowest and highest number of CPs in total.

Figure 10. Number of CP Practice Types Implemented



Measured in terms of frequency of implementation, the most popular CPs across all four watersheds were cover crops (25%), and nutrient management (14%) (see Table 9). Results were similar, but not identical, when measured in terms of GLRI funding used to implement CPs, with cover crops (21%) and nutrient management (14%) also ranking in the top three in terms of funding allocation.

Table 9. Top Five CP Types Implemented by Frequency and Cost – Total

Practice Type	# of CPs	% of CPs in Watershed		Practice Type	$1000s	% of Funding in Watershed
Total				Total		
Cover Crop	2,138	25%		Cover Crop	$ 11,521	21%
Nutrient Mgmt	1,176	14%		Waste Storage Facility	$ 8,971	16%
Residue & Tillage Mgmt, No-Till	573	7%		Nutrient Mgmt	$ 7,546	14%
Conservation Crop Rotation	498	6%		Heavy Use Area Protection	$ 2,860	5%
Amending Soil w/ Gypsum Produc	489	6%		Conservation Crop Rotation	$ 2,760	5%

Table 10 shows the five most frequently reported CPs in terms of implementation (number of entries in the REAP Master Database) and costs (total costs covered with GLRI funding associated with a given CP across all entries). While cover crops, nutrient management, heave use area protection and residue & tillage management – no till were popular across the watersheds, there were also differences. For example, water transfers and prescribed grazing were more likely to be used in the Genesee, while the Lower Fox implemented more critical area plantings, grassed waterways and mulching. The Maumee was more likely to use conservation crop rotation and amending soil with gypsum products, while integrated pest management was most used in the Saginaw.

Table 10. Top Five CP Types Implemented by Frequency and Cost – Watershed

Practice Type	# of CPs	% of CPs in Watershed		Practice Type	$1000s	% of Funding in Watershed
Genesee				Genesee		
Cover Crop	62	12%		Waste Storage Facility	$ 2,025	37%
Heavy Use Area Protection	33	6%		Heavy Use Area Protection	$ 805	15%
Waste Transfer	33	6%		Cover Crop	$ 476	9%
Nutrient Mgmt	28	5%		Roofs and Covers	$ 413	8%
Prescribed Grazing	27	5%		Waste Transfer	$ 321	6%
Lower Fox				Lower Fox		
Cover Crop	258	16%		Waste Storage Facility	$ 4,466	32%
Critical Area Planting	126	8%		Cover Crop	$ 1,885	13%
Grassed Waterway	120	7%		Heavy Use Area Protection	$ 1,407	10%
Heavy Use Area Protection	106	7%		Waste Transfer	$ 760	5%
Mulching	103	6%		Waste Facility Closure	$ 717	5%
Maumee				Maumee		
Cover Crop	1,465	30%		Cover Crop	$ 6,745	29%
Nutrient Mgmt	744	15%		Nutrient Mgmt	$ 4,328	19%
Conservation Crop Rotation	480	10%		Conservation Crop Rotation	$ 2,738	12%
Amending Soil w/ Gypsum Produc	457	10%		Residue & Tillage Mgmt, No-Till	$ 1,558	7%
Residue & Tillage Mgmt, No-Till	424	9%		Waste Storage Facility	$ 1,376	6%
Saginaw				Saginaw		
Cover Crop	349	24%		Nutrient Mgmt	$ 2,771	23%
Nutrient Mgmt	304	21%		Cover Crop	$ 2,346	19%
Integrated Pest Management	155	11%		Agrichemical Handling Facility	$ 2,091	17%
Heavy Use Area Protection	70	5%		Integrated Pest Management	$ 1,205	10%
Residue & Tillage Mgmt, No-Till	58	4%		Waste Storage Facility	$ 1,104	9%

As can be seen from a comparison of the tables of CPs implemented overall (Table 9) and by watershed (Table 10), activity in Maumee has a proportionately large influence on the frequency and funding of the types of CPs implemented. Two CP types that are in the top five most implemented projects overall – conservation crop rotation and amending soil with gypsum products – and one CP type that is in the list of five CP types receiving the greatest amount of funding – conservation crop rotation – were only implemented in large amounts in the Maumee. This underscores the importance of analyzing future GLRI data by priority watershed because, without separating or weighting by watershed, the conclusions drawn from GLRI data could be heavily skewed by watersheds that have outsized impacts on the analysis.

4.3 CP Implementation by Units Implemented

The majority (99%) of CPs reported included information on the number of units implemented. Data first were analyzed across all four priority watersheds in total and then for each watershed individually. It should be noted that units reported were not necessarily unique – for example, cover crops planted on the same acre for four years in a row could have been counted as four acres. For this reason, total number of acres and percentage of total acres by practice type are not reported in order to avoid double counting. Improved tracking in future projects of CP units implemented would improve the robustness of this analysis.

Multiple units were used to measure CPs implemented (e.g., acres, feet, number). The unit most frequently used was acres, which was used for approximately 75% of the CPs implemented. As mentioned previously, 106 practice types were used across the four watersheds, however, only 81 reported both units implemented and associated implementation costs.

Across all four watersheds, nutrient management and cover crops were the practice types implemented on the greatest number of acres (see Table 11).

Table 11. Acres Implemented by Top Practice Types

Practice Type	# of Acres
Nutrient Mgmt	301,978
Cover Crop	275,876
Integrated Pest Mgmt	138,162
Residue & Tillage Mgmt, No-Till	99,258
Conservation Crop Rotation	49,716

Similar calculations were done at the watershed level. .

Table 12 includes the top five practice types in terms of acres implemented for each watershed. In general, CPs with the most acres implemented were similar between the watersheds – nutrient management, cover crops and residue & till management – no till were included in the top five practice types for all four watersheds.

Table 12. Acres Implemented by Top Five CP Types - Watershed

Practice Type	# of Acres
Genesee	
Nutrient Mgmt	10,284
Cover Crop	7,625
Residue & Tillage Mgmt, No-Till	4,711
Prescribed Grazing	1,578
Heavy Use Area Protection	1,374
Lower Fox	
Cover Crop	57,623
Integrated Pest Mgmt	43,777
Nutrient Mgmt	28,671
Residue & Tillage Mgmt, No-Till	7,121
Heavy Use Area Protection	6,611
Maumee	
Cover Crop	152,879
Nutrient Mgmt	148,769
Residue & Tillage Mgmt, No-Till	67,917
Conservation Crop Rotation	44,856
Soil Testing	37,131
Saginaw	
Nutrient Mgmt	114,254
Integrated Pest Mgmt	75,830
Cover Crop	54,988
Residue & Tillage Mgmt, No-Till	19,509
Residue & Tillage Mgmt, Reduced Till	8,180

It should be noted that the top five practice types by unit in the four watersheds do not dramatically differ from the top five practices by watershed based on number of projects or funding.

4.4 CP Implementation by Project Type

In total, 23 high-level projects reported implementing CPs as part of their GLRI funded efforts. Seven of these were categorized as direct grants, while the remaining 16 were indirect. Table 13 shows a summary of CPs and associated costs by funding type, however, it should be noted that only two direct grants and 11 indirect grants reported costs associated with the CPs implemented and this is reflected in the results. In total, for those projects that reported on GLRI investments used for CP implementation, projects funded indirectly accounted for 95% of CP implementation.

Table 13. CP Implementation by Funding Type

	Genesee		Lower Fox		Maumee		Saginaw		Total	
Funding Type	# CPs Reported	$1000s	# CPs Reported	$1000s	# CPs Reported	$1000s	# CPs Reported	$1000s	# CPs Reported	$1000s
Direct	0	$ -	5	$ 258	38	$ 2,206	25	$ -	73	$ 2,884
Indirect	513	$ 5,476	1,598	$13,804	4,767	$20,932	1,442	$12,135	8,341	$52,435

Direct and indirect grants implemented 16 and 97 different practice types, respectively, and cover crops were the CP most likely to be implemented under both direct and indirect grants.

4.5 CP Implementation by NRCS Phosphorus Priority Area (PPA)

While all CPs included in the dataset were implemented in one of the four priority watersheds, for the majority of them, it was also possible to identify whether or not they were implemented in an NRCS Phosphorus Priority Area (PPA). Table 14 shows the number of CPs implemented in PPAs by watershed as well as the amount of GLRI funding associated with their implementation. Note that the total number of CPs and total amount of GLRI funding are both less than values presented in previous tables —this is because some CPs did not included identification of the watershed in which they were implemented or whether they were implemented in a PPA.

Table 14. CP Implementation in NRCS PPAs

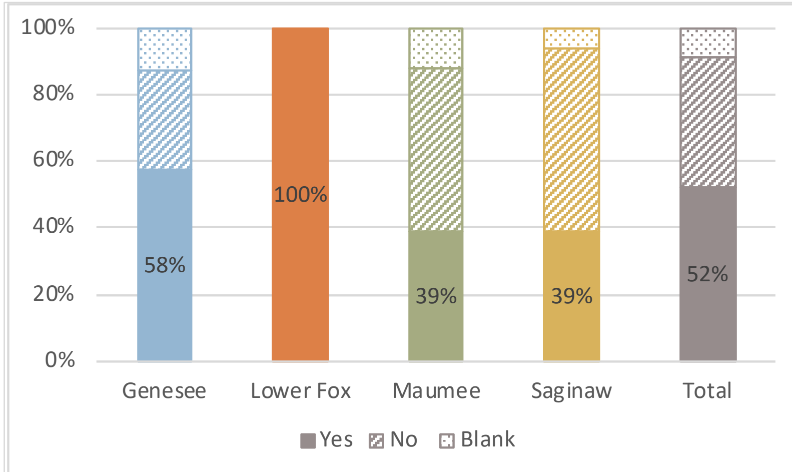
Implemented in NRCS PPA	Genesee		Lower Fox		Maumee		Saginaw		Total	
	# CPs Reported	$1000s	# CPs Reported	$1000s	# CPs Reported	$1000s	# CPs Reported	$1000s	# CPs Reported	$1000s
No	151	$ 1,810		$ -	2,335	$10,580	801	$ 6,463	3,287	$18,853
Yes	296	$ 3,286	1,603	$14,062	1,880	$ 9,381	573	$ 5,232	4,352	$31,961
Blank	66	$ 380		$ -	590	$ 3,177	93	$ 440	749	$ 3,996
Total	513	$ 5,476	1,603	$14,062	4,805	$23,138	1,467	$12,135	8,388	$54,810

All four watersheds implemented a higher percentage of CPs in PPAs as compared to the amount of watershed land area in PPAs (see Table 15 and Figure 11), with the exception of the Lower Fox as a result of the entirety of the watershed being considered a PPA. While the greatest absolute number of CPs implemented within NRCS PPA boundaries occurred in the Maumee, both Maumee and Saginaw had a lower percentage (39%) of total CPs in NRCS PPAs. Maumee also has the lowest percentage overall of CPs implemented in PPAs as compared to the percentage of watershed land area in PPAs. Again, with the exception of the Lower Fox which is all PPA, the Genesee has the greatest percentage of CPs implemented in the PPA for that watershed.

Table 15. Percentage of Watershed Land Area in PPAs

Watershed	Land Area in PPAs (%)
Genesee	23%
Lower Fox	100%
Maumee	20%
Saginaw	25%

Figure 11. Percentage of CPs in NRCS PPAs



5. GLRI Project Comparison with OSU Survey Data (Outcome Analysis)

In the following section, potential correlations between the GLC project element datasets and OSU survey data were assessed. More specifically, project data were compared with OSU survey data on participation in government programs; likeliness to participate in future programs; current and future use of cover crops and vegetative buffers; and the sources from which farmers receive information (e.g., direct outreach, NRCS, demonstration farms/field days).

As OSU data were aggregated at the county-level, it was necessary to develop a weighting schema to normalize county-level data to accurately represent the footprints of priority watersheds as all four encompass portions of multiple counties. For all analyses in this section, county-level survey data were weighted by the percentage of county area in the watershed and then summed.

5.1 Participation in GLRI Funded Programs

As part of the survey, participants were asked “Have you participated in any Great Lakes Restoration Initiative (GLRI) funded programs?” to which they could answer “Yes”, “No” or “Don’t Know”. Results from this question were aggregated to the watershed level and compared to GLRI funding and project element information.

Total GLRI funds allocated by watershed from 2010-2016 first were compared to the percentage of survey respondents that have participated in GLRI funded programs (see Table 16). While a definitive pattern does not emerge, it is interesting to note that the two watersheds with the highest funding in total (Maumee and Lower Fox) were the two watersheds with the highest participation rates in GLRI funded programs.

Table 16. GLRI Participation Compared to Total GLRI Focus Area 3 Funding

Watershed	GLRI Funding ($1000s)	% Participating in GLRI Funded Programs
Maumee	$ 43,995	12%
Lower Fox	$ 24,321	18%
Saginaw	$ 19,495	7%
Genesee	$ 7,994	5%

The percentage of survey respondents in each watershed that have participated in GLRI funded programs also were compared to the percentage of projects implemented in each watershed that contained a direct outreach and/or innovative capacity element. While no clear pattern of correlation emerged, this does not mean that direct outreach and/or innovative capacity building are not correlated with GLRI-funded program participation, but rather, that such a relationship could not be established with the limited, highly aggregated data available.

5.2 Participation in Government-Funded Conservation Programs

Similarly, participants were asked "Are you currently enrolled in any other government-funded programs for conservation" to which they could answer "Yes" or "No". Results from this question were aggregated to the watershed level and compared to project element information.

As with participation in GLRI funded programs, survey results were compared to total GLRI funding per watershed (see Table 17). The Lower Fox and Maumee again had the highest participation rates in government funded conservation programs.

Table 17. Participation Compared to Total GLRI Focus Area 3 Funding

Watershed	GLRI Funding ($1000s)	% Enrolled in Gov't Funded Programs
Maumee	$ 43,995	36%
Lower Fox	$ 24,321	28%
Saginaw	$ 19,495	19%
Genesee	$ 7,994	27%

The percentage of survey respondents in each watershed that were currently enrolled in any other government-funded conservation program were compared to the percentage of projects implemented in each watershed that contained a direct outreach and/or innovative capacity element; however, participation did not appear to be strongly correlated with either element. Again, this does not mean enrollment in government funded conservation programs is not correlated with specific project elements, simply that such a correlation was not able to be established with the limited data available.

5.3 Future Participation in Government-Funded Conservation Programs

Participants also were asked "Will you continue to participate in government-funded programs in the future" to which they could answer "Yes", "No" or "Don't Know". As seen in Table 18 , with the exception of the Maumee having the highest total funding and highest percentage of respondents likely to participate in future government conservation programs, no clear patterns of correlation could be identified.

Table 18. Participation Compared to Total GLRI Focus Area 3 Funding

Watershed	GLRI Funding ($1000s)	Likely to Participate in Future (%)
Maumee	$ 43,995	44%
Lower Fox	$ 24,321	41%
Saginaw	$ 19,495	31%
Genesee	$ 7,994	42%

Because no clear correlations between GLRI project structure and survey responses were found, trends in farm related income and conservation payments for the four priority watersheds from 2007-2017, as reported by the CoA, were compared to the survey responses to determine if applicable watershed characteristics might correlate with the survey results. No clear correlations were found between the survey respondents' likelihood to participate in future government programs and change in income from farm-related sources, change in income from conservation payments, or the percentages of income from conservation payments for this time period.

5.4 Cover Crops

Funding allocations and project elements were also compared to results from two survey questions focused on cover crops that asked:

- What are your plans for using cover crops on your farm next year?¨
  - Answer options: Do less, Do more, Do the same
- How likely are you to use cover crops in the future without incentives?
  - Answer Options: Will not use, Unlikely to use, Likely to use, Will definitely use

As with the participation data, survey results on plans for using cover crops on farms next year were compared to GLRI funding per operation and total GLRI funding per watershed (see Table 19). Survey respondents from the Lower Fox, which had substantially more GLRI funding per farm operation, were most likely to plan to use more cover crops on their farm next year (37%).

Table 19. Future Cover Crops Compared to Total GLRI Focus Area 3 Funding

Watershed	GLRI Funding ($1000s)	More Cover Crops Next Year
Maumee	$ 43,995	26%
Lower Fox	$ 24,321	37%
Saginaw	$ 19,495	25%
Genesee	$ 7,994	22%

As seen in Table 20, which is sorted from highest to lowest percentage of projects within each watershed containing a) a direct outreach element and b) an innovative capacity building element, the likelihood of respondents increasing use of cover crops on their farms next year does not appear to be strongly correlated with either element. It is interesting to note, however, that almost all respondents indicated that they intend to plant cover crops next year at a level similar to this year.

Table 20. Project Elements and Future Cover Crops

Watershed	% Projects w/ Direct Outreach	More Cover Crops Next Year	Same or More Cover Crops Next Year		Watershed	% Projects w/ Innovative Capacity Building	More Cover Crops Next Year	Same or More Cover Crops Next Year
Saginaw	56%	25%	100%		Saginaw	38%	25%	100%
Maumee	54%	26%	98%		Maumee	33%	26%	98%
Genesee	33%	22%	100%		Lower Fox	23%	37%	97%
Lower Fox	31%	37%	97%		Genesee	0%	22%	100%

The same comparisons were made to funding and project elements for responses on likeliness to use cover crops in the future without incentives (see Table 21).

Table 21. Cover Crops w/o Incentives Compared to Total Focus Area 3 GLRI Funding & Project Elements

Watershed	GLRI Funding ($1000s)	% Projects w/ Direct Outreach	% Projects w/ Innovative Capacity Building	Will Definitely Use Cover Crops w/o Incentives
Genesee	$ 7,994	33%	0%	24%
Saginaw	$ 19,495	56%	38%	15%
Lower Fox	$ 24,321	31%	23%	11%
Maumee	$ 43,995	54%	33%	10%

No general patterns of correlation emerged from these data either; however, it is interesting to note that respondents from the Genesee were most likely to state they will definitely use cover crops in the future without incentives even though this watershed does not stand out in any particular way with regards to funding or inclusion of specific project elements.

Given this somewhat anomalous result in regards to the Genesee, additional analyses were undertaken to attempt to uncover correlations of survey respondents' interests in future use of cover crops and underlying watershed characteristics. Four analyses were performed: (1) a comparison of survey responses on questions related to cover crops and change in tenure (full ownership, partial ownership, and tenant farming) of total acres of agricultural operations from 2007-2017; (2) a comparison of survey responses to trends and percentages of income from farm related sources and conservation payments; (3) a comparison of survey responses and the average proportion of watershed agriculture sales attributed to animal versus crop production and (4) a comparison of survey responses to the per acre value of agricultural land, per operation value of agricultural land, and the change in both from 2007-2017. Watershed characteristic variables were calculated from CoA data from 2007, 2012 and 2017.

No correlations were observed between the change in tenure of agricultural operations or income from farm related sources or conservation payments and survey respondents' likelihood to implement more cover crops with and without incentives. There was a correlation, however, with the average percentage of sales from animals by watershed, such that those watersheds with higher average sales from animals as a percentage of total sales (Genesee and Lower Fox) tended to report a greater likelihood to implement cover crops without incentives than those watersheds with lower average sales from animals as a percentage of total sales (see Table 22).

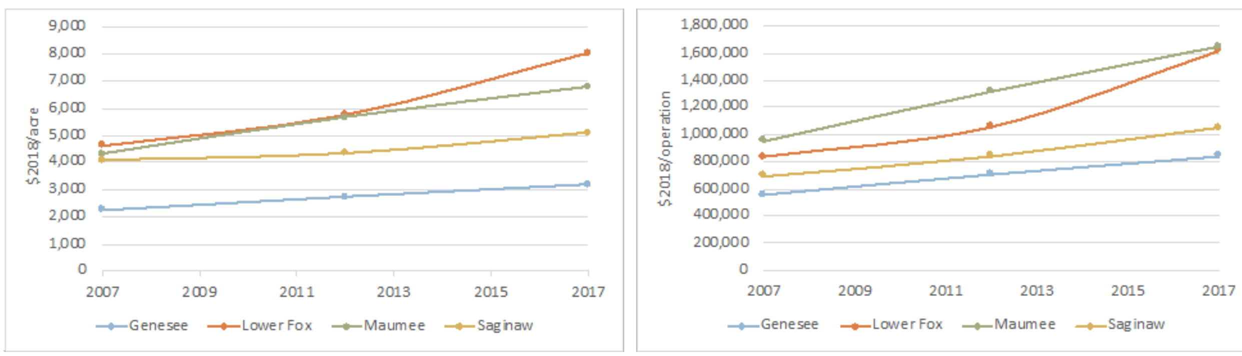
This result is not surprising as it is possible that cover crops may be a more attractive CP in watersheds with higher animal sales as cover crops could be implemented on cropland devoted to producing feed crop for livestock. Since the cover crops themselves can also have value as feed crop, cover crops may be more widely implemented on cropland for livestock than on other cropland in the Saginaw and Maumee where higher value crops may be grown or where there is less value to be gained from the growth of cover crops. Additionally, however, it is recognized that there was limited data available particularly for GLRI projects in Genesee, indicating that some differentiating information on project elements or funding may not be represented here that helps to explain these trends without the overlay of watershed characteristics.

Table 22. Agriculture Sales and Cover Crops

Watershed	Average % Sales from Animals	More Cover Crops Next Year	Will Likely or Definitely Use Cover Crops w/o Incentives
Saginaw	32%	25%	58%
Maumee	39%	26%	56%
Genesee	69%	22%	76%
Lower Fox	79%	37%	66%

A correlation was also found in the comparison of survey respondents' likelihood to implement cover crops with and without incentives with the per acre and per operation agricultural land value. Higher per acre and per operation agricultural land value (see Figure 12) tended to yield a higher willingness to implement more cover crops, but a lower willingness to do so without incentives.

Figure 12. Agricultural Land Value (a) by Acre and (b) by Operation



This may, however, simply be a coincidence due the highest agricultural land value per acre and second highest land value per operation occurring in the Lower Fox. The Lower Fox appears to be a well-known focus of agricultural conservation activities and investments, therefore, operators in this watershed may simply be aware of the funding opportunities for implementing such CPs as cover crops and are willing to do so primarily because they know there is funding for it. This assumption was tested by comparing survey respondents' perception of funding opportunities available for implementing cover crops (i.e., survey respondents' answers to questions on enrollment in GLRI funded programs, enrollment in government programs, and likelihood to participate in future government programs) with their intentions regarding cover crops in the future (see Table 23).

Table 23. Perceptions of Funding Opportunities and Cover Crop Usage

Watershed	% Enrolled in GLRI Funded Programs	% Enrolled in Gov't Funded Programs	% Likely to Participate in Future Gov't Funded Programs	More Cover Crops Next Year	Will Definitely Use Cover Crops w/o Incentives
Genesee	5%	27%	42%	22%	24%
Lower Fox	18%	28%	41%	37%	11%
Maumee	12%	36%	44%	26%	10%
Saginaw	7%	19%	31%	25%	15%

A slight correlation is uncovered that suggests that watersheds where the perception of funding opportunities is high (Lower Fox and Maumee) agriculturalists exhibit a likelihood to use more cover crops in the future, but only if there is an incentive to do so. Watersheds where there is a perception of limited available funding (Genesee and Saginaw) show that their intentions to use cover crops are more muted, but are less affected by whether there is an incentive to do so or not.

5.5 Vegetative Buffers

Results from similar survey questions which focused on vegetative buffer use were also compared to project funding and elements:

- What are your plans for using vegetative buffers on your farm next year?¨
    - Answer options: Do less, Do more, Do the same
- How likely are you to use vegetative buffers in the future without incentives?
    - Answer Options: Will not use, Unlikely to use, Likely to use, Will definitely use

Survey results on plans for using vegetative buffers on farms next year first were compared to GLRI funding per operation and total GLRI funding per watershed (see Table 24). Survey respondents from the Lower Fox, which had substantially more GLRI funding per farm operation, were most likely respond that they were planning to use more vegetative buffers on their farm next year (37%).

Table 24. Future Buffers Compared to Total GLRI Focus Area 3 Funding

Watershed	GLRI Funding ($1000s)	More Buffers Next Year
Maumee	$ 43,995	26%
Lower Fox	$ 24,321	37%
Saginaw	$ 19,495	9%
Genesee	$ 7,994	28%

As seen in Table 25, which again is sorted from highest to lowest percentage of projects within each watershed containing a) a direct outreach element and b) an innovative capacity building element, the likelihood of respondents increasing use of vegetative buffers on their farms next year does not appear to be strongly correlated with either element. It is interesting to note, however, that almost all respondents indicated that they intend to maintain the buffers currently in place; however, this may be a result of the fact that buffers are often multi-year commitments.

Table 25. Project Elements and Future Vegetative Buffers

Watershed	% Projects w/ Direct Outreach	More Buffers Next Year	Same or More Buffers Next Year
Saginaw	56%	9%	96%
Maumee	54%	26%	92%
Genesee	33%	28%	96%
Lower Fox	31%	37%	94%

Watershed	% Projects w/ Innovative Capacity Building	More Buffers Next Year	Same or More Buffers Next Year
Saginaw	38%	9%	96%
Maumee	33%	26%	92%
Lower Fox	23%	37%	94%
Genesee	0%	28%	96%

The same comparisons were made to funding and project elements for responses on likeliness to use vegetative buffers in the future without incentives. Again, no general patterns of correlation emerged; however, it is interesting to note that, similar to the findings for cover crops, respondents from the Genesee were most likely to state they will definitely use vegetative buffers in the future without incentives.

Similar to the additional analyses conducted on survey responses regarding cover crops, survey responses on questions related to vegetative buffers also were compared to change in agricultural land tenure, income from farm related sources and conservation payments, the average proportion of watershed agriculture sales attributed to animal versus crop production, and agricultural land value. Trends and percentages were calculated from CoA data from 2007, 2012 and 2017.

Again, neither land tenure nor income from farm related sources or conservation payments were found to correlate with survey responses on questions related to vegetative buffers. Average percentage of sales from animals, however, exhibited a distinct correlation with survey responses on both the intent to put in more vegetative buffers next year and the likelihood of doing so without incentives (see Table 26). Similar to cover crops, vegetative buffers may represent additional financial incentives to livestock operations than to farming operations for cultivated crops. In cultivated crop operations, some land may need to be taken out of cultivation in order to create buffers, thereby reducing the potential value of the land. For livestock operations, the financial incentive may not be in creating value as in the case of cover crops, but rather may be a best practices action undertaken to protect operations from pollution sanctions produced by waste runoff. A cropping operation would not necessarily have the same incentives.

Table 26. Agricultural Sales and Vegetative Buffers

Watershed	Average % Sales from Animals	More Buffers Next Year	Will Likely or Definitely Use Buffers w/o Incentives
Saginaw	32%	9%	39%
Maumee	39%	26%	55%
Genesee	69%	28%	55%
Lower Fox	79%	37%	58%

The comparison of survey responses to agricultural land value uncovered a slight negative correlation only between land value and likelihood to implement vegetative buffers without incentives. Although there was not the disconnect between intention to use more buffers next year and likelihood to use buffers without incentives as there was with cover crops, intended usage of buffers was compared to the perception of funding availability (see Table 27).

Table 27. Perceptions of Funding Opportunities and Vegetative Buffer Usage

Watershed	% Enrolled in GLRI Funded Programs	% Enrolled in Gov't Funded Programs	% Likely to Participate in Future Gov't Funded Programs	More Buffers Next Year	Will Definitely Use Buffers w/o Incentives
Genesee	5%	27%	42%	28%	14%
Lower Fox	18%	28%	41%	37%	11%
Maumee	12%	36%	44%	26%	12%
Saginaw	7%	19%	31%	9%	13%

Similar to the finding with usage of cover crops, perception of funding opportunities appears to have a positive correlation with more intended future usage of buffers and a negative correlation with intended usage of buffers without incentives.

5.6 Cover Crops versus Vegetative Buffers

Results on likeliness to use cover crops and vegetative buffers both next year and in the future without incentives were compared. Respondents in the Lower Fox were most likely state that they plan to implement more of both practices next year on their farm (see Table 28); however, as seen in Table 29, Lower Fox respondents were the least or second to least likely to state they would definitely use vegetative buffers and cover crops in the future without incentives.

Table 28. Plans for Cover Crops and Vegetative Buffers Next Year

Watershed	More Cover Crops Next Year	More Buffers Next Year
Lower Fox	37%	37%
Genesee	22%	28%
Maumee	26%	26%
Saginaw	25%	9%

As mentioned previously, respondents from the Genesee were most likely to state that they would definitely use both practices in the future without incentives. When combining results for "will likely use" and "will definitely use", it is also interesting to note that respondents in all four watersheds would be more likely to use cover crops without incentives as compared to vegetative buffers (see second table in Table 29), which may be related to the "life of the practice". More specifically, cover crops are typically an annual practice so that the decision to implement the practice can be made each year, whereas vegetative buffers are often a multi-year commitment and require that land be taken out of production.

Table 29. Use of Cover Crops and Vegetative Buffers w/o Incentives

Watershed	Will Definitely Use Cover Crops w/o Incentives	Will Definitely Use Buffers w/o Incentives
Genesee	24%	14%
Lower Fox	11%	11%
Maumee	10%	12%
Saginaw	15%	13%

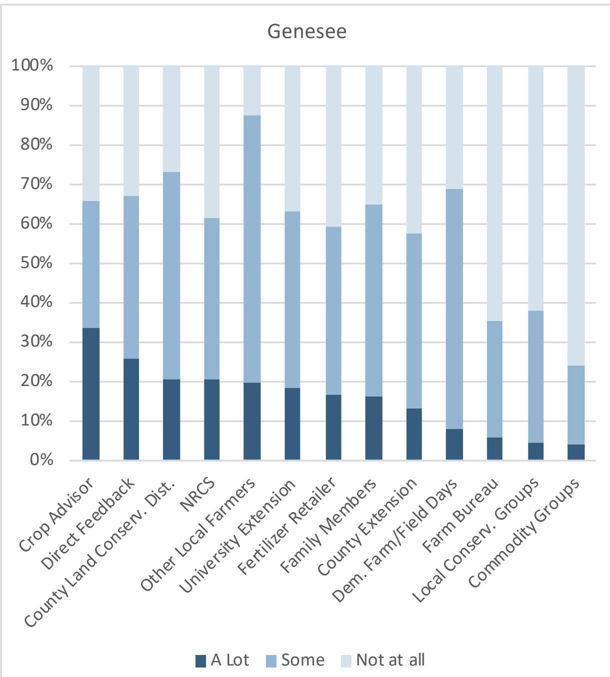
Watershed	Will Likely or Definitely Use Cover Crops w/o Incentives	Will Likely or Definitely Use Buffers w/o Incentives
Genesee	76%	55%
Lower Fox	66%	58%
Maumee	56%	55%
Saginaw	58%	39%

5.7 Information Sources

Finally, survey respondents were asked "How much do you rely on the following sources for information when introducing and managing new conservation practices on your farm" for which answer choices were "Not at all", "Some" and "A lot". Thirteen information source options were provided as well as two blank spaces, in which the respondent could write in other sources.

Figure 13 shows the distribution of reliance on various information sources by watershed. As can be seen, the information source most relied on "a lot" varied by watershed both by source and the degree to which is was relied upon: Genesee – Crop Advisor (34%), Lower Fox – Crop Advisor (45%), Maumee – Fertilizer Retailer (37%), Saginaw – University Extension (29%).

Figure 13. Information Sources by Watershed



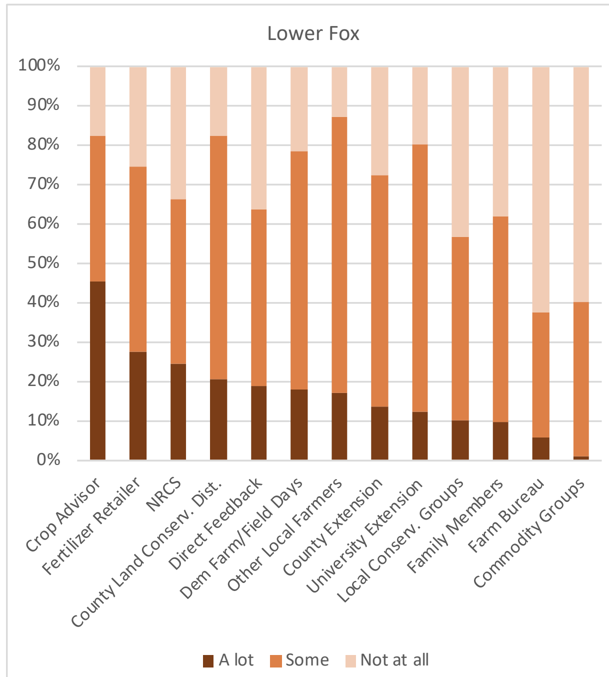
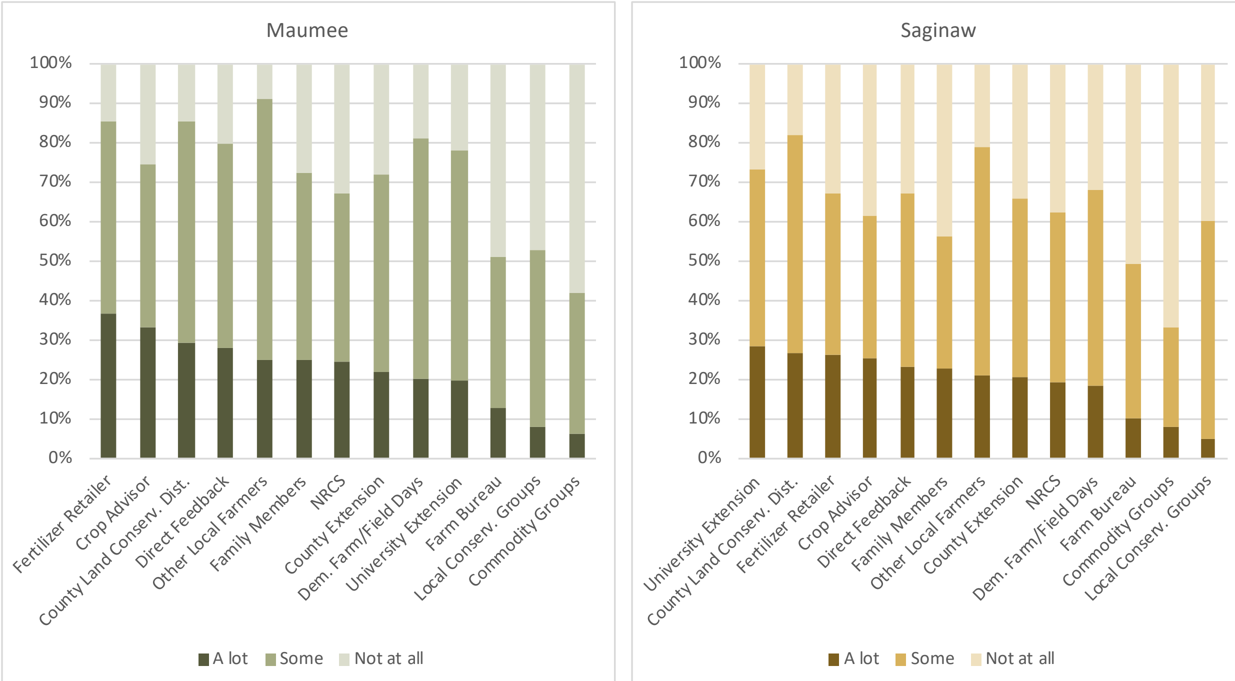


Figure 13 (continued). Information Sources by Watershed



Principal investigators (PIs) that received money from GLRI to implement projects or provide sub-grants for project implementation include, notably, county land and conservation districts, NRCS, universities, non-profit organizations, state and federal entities, and tribal organizations (see Table 30). Indirectly funded GLRI projects are typically implemented by county conservation districts or other local entities. As such, one would expect that, with higher proportions of projects with direct outreach, the preferred sources of information for respondents would align with the category of PI with the greatest number of projects.

Table 30. Number of GLRI Projects by Principal Investigator

Principal Investigator	Genesee Projects (#)	Lower Fox Projects (#)	Maumee Projects (#)	Saginaw Projects (#)	Total
Federal		5	8	6	19
State			5		5
Non-profit			2	2	4
Universities			2	2	4
County Land and Water District		1			1
Tribal		1			1
Other		1			1
Indirectly Funded Projects	3	5	7	6	21

Note: Genesee has no projects that were directly funded.

A review of the top five information sources used “a lot” within each watershed, however, shows six sources used regularly across all four watersheds – crop advisor, fertilizer retailer, county land conservation district, direct feedback, NRCS and other local farmers (see Table 31). The only information source in the top five used “a lot” that was unique to a single watershed was the reliance on university extension in the Saginaw. As mentioned previously, this was also the top source used “a lot” within this watershed.

Table 31. Information Sources Used "A Lot" by Watershed

Watershed	Direct Outreach	Information Sources Used "A Lot"				
		1st	2nd	3rd	4th	5th
Genesee	33%	Crop Advisor	Direct Feedback	County Land Cons. Dist.	NRCS	Other Local Farmers
Lower Fox	31%	Crop Advisor	Fertilizer Retailer	NRCS	County Land Cons. Dist.	Direct Feedback
Maumee	54%	Fertilizer Retailer	Crop Advisor	County Land Cons. Dist.	Direct Feedback	Other Local Farmers
Saginaw	56%	Univ. Extension	County Land Cons. Dist.	Fertilizer Retailer	Crop Advisor	Direct Feedback

There may be some alignment of the GLRI PIs to the information sources used "a lot" by respondents. In Saginaw, where there was significant direct outreach, university extensions and county land conservation districts are the first and second preferred sources of information for respondents and are two of the key PIs on GLRI projects (assuming that the six indirectly funded grants were implemented by or with the assistance of county land conservation districts). This is not true, however, in the Maumee where those two entities play a similar role as PIs, but are not ranked as highly as preferred sources of information. What should be noted, however, is that a crop advisor is somewhat of an ambiguous term as a crop advisor could be a representative of a private, local, or university entity.

Perhaps the most notable finding of this analysis, however, is that other local farmers were the information source stated to be most used "some" or "a lot" in three of the four watersheds – Genesee, Lower Fox and Maumee – and was the second most used in the Saginaw behind county land conservation district.

6. Per Unit Cost Analysis

Of the 23 high-level projects that reported CP implementation as part of their GLRI funded efforts only 20 reported the watershed in which the CPs were implemented. Eighteen of these 20 projects were implemented in a single watershed only: Genesee (3), Lower Fox (5), Maumee (6) and Saginaw (4), with the remaining two projects implementing CPs across two or more watersheds. The highlighted rows in Table 32 are projects that reported CPs implemented, but did not report out on the associated costs of implementation.

Table 32. CP Implementation by Project

GLRI Project	Genesee		Lower Fox		Maumee		Saginaw		Total	
	# CPs	$1000s	# CPs	$1000s	# CPs	$1000s	# CPs	$1000s	# CPs	$1000s
EPA00E00859-0									8	$ 88
EPA00E01448-0							18		18	
GL 00E01143					4				4	
GL 00E01423					2				2	
GL 00E01449					17				17	
GL 00E01451			7						7	
GL-0-00E01403					6				6	
GL-00E01450			3						3	
GL00E00413-0					5		7		12	
GL00E00857									6	
GL00E00858							1	$ 23	1	$ 23
GL00E00860			2	$ 258					2	$ 258
GL00E01124									7	
GL00E01404-0					25	$ 2,206			30	$ 2,627
GL97220600-0	5	$ 73							5	$ 73
NRCS-IA-EQIP-1					4,215	$19,961			4,215	$19,961
NRCS-IA-EQIP-2							1,374	$11,695	1,374	$11,695
NRCS-IA-EQIP-3			1,580	$13,513					1,580	$13,513
NRCS-IA-EQIP-4	447	$ 5,096							447	$ 5,096
NRCS-IA-GLSNRP-1					531	$ 971			531	$ 971
NRCS-IA-GLSNRP-2							67	$ 417	67	$ 417
NRCS-IA-GLSNRP-3			11	$ 291					11	$ 291
NRCS-IA-GLSNRP-4	61	$ 307							61	$ 307
Total	513	$ 5,476	1,603	$14,062	4,805	$23,138	1,467	$12,135	8,414	$55,319

It is important again to note that a CP could vary by both type and number of units implemented, so dividing total GLRI funds by CPs implemented using the values in the table above would be an incorrect way of calculating cost per unit. For projects that included CP type, number of units implemented and associated costs, a cost per unit analysis was conducted to assess the cost of implementing different CP types.

It is important to note that this analysis does not analyze the effectiveness of the CPs on desired water quality impacts, but rather analyzes the per unit cost of CPs by type. If a cost-effectiveness analysis were desired, the cost of implementing CPs would need to be correlated with some measure of water quality impact or change in a socio-economic attribute resulting from the CP implementation. With the data available for this analysis, neither comparison could be undertaken with sufficient rigor. Future efforts addressing data collection on GLRI projects should keep analysis of cost-effectiveness of the investments in mind when requesting reporting documentation from fund recipients. Relevant data could be time-series water quality measurements in water bodies downstream of specific CP implementation sites, changes in perception of CPs or agricultural impacts on water quality by agriculturalists who instituted specific CPs, time series data of the value of agricultural products for lands treated by specific CPs, etc.

As noted previously, the majority of CPs reported included the associated units implemented. Table 33 includes the estimated cost per acre for practice types reporting the twenty highest number of acres implemented. Note that for these practice types, the number of units implemented ranged from over 300,000 acres (nutrient management) to fewer than 1,000 (mulching and forest stand improvement). Implementation of fewer than 600 acres were reported for other practice types not included in Table 33.

Results are sorted from lowest to highest cost per acre. Across these practice types, the practice type with the lowest cost per unit was soil testing ($9/acre), followed by written integrated pest management plans ($13/acre). For the three practice types reporting implementation of more than 100,000 acres, integrated pest management was the lowest per unit cost ($15/acre), followed by nutrient management ($25/acre) and cover crops ($42/acre).

Table 33. Cost per Acre

Practice Type	Acres Implemented	Cost per Acre
Soil Testing	42,685	$ 9
Integrated Pest Mgmt Plan - Written	6,576	$ 13
Upland Wildlife Habitat Mgmt	4,242	$ 14
Integrated Pest Mgmt	138,162	$ 15
Conservation Tillage	7,313	$ 15
Equipment Modification	5,767	$ 16
Residue & Tillage Mgmt, Reduced Till	33,810	$ 18
Residue & Tillage Mgmt, No-Till	99,258	$ 20
Nutrient Mgmt	301,978	$ 25
Amending Soil Properties w/ Gypsum Prod	36,428	$ 26
Waste Recycling	2,416	$ 31
Cover Crop	275,876	$ 42
Prescribed Grazing	7,764	$ 45
Conservation Crop Rotation	49,716	$ 56
Agronomic System	2,944	$ 65
Brush Mgmt	2,022	$ 91
Forest Stand Improvement	827	$ 142
Forage & Biomass Planting	2,361	$ 157
Heavy Use Area Protection	8,037	$ 298
Mulching	634	$ 542

The per acre cost of various CPs also was examined at the watershed level. The top ten CPs for each watershed were included in the analysis (measured in terms of acres implemented) in order to highlight both number of acres implemented and cost per acre across the watersheds. As seen in Table 34, which is sorted by greatest to fewest total number of acres implemented, there was substantial variability across the watersheds in terms of acres implemented and cost per acre both within and between CPs. Note that cost is color coded by conservation practice type – with green representing the lowest cost per acre for each practice types across the watersheds in which it was implemented and yellow the highest cost. Three practice types were only implemented in the Maumee and, as such, were not color coded.

Table 34. Cost per Acre by Watershed

Practice Type	Genesee		Lower Fox		Maumee		Saginaw		Total	
	Acres	Cost/Acre	Acres	Cost/Acre	Acres	Cost/Acre	Acres	Cost/Acre	Acres	Cost/Acre
Nutrient Mgmt	10,284	$ 8	28,671	$ 12	148,769	$ 29	114,254	$ 24	301,978	$ 25
Cover Crop	7,625	$ 62	57,623	$ 33	152,879	$ 44	54,988	$ 43	275,876	$ 42
Integrated Pest Mgmt			43,777	$ 16	18,555	$ 7	75,830	$ 16	138,162	$ 15
Residue & Tillage Mgmt, No-Till	4,711	$ 31	7,121	$ 11	67,917	$ 23	19,509	$ 12	99,258	$ 20
Conservation Crop Rotation			547	$ 11	44,856	$ 61	4,314	$ 4	49,716	$ 56
Soil Testing					37,131	$ 9			42,685	$ 9
Amending Soil Properties w/ Gypsum Prod					31,098	$ 26	5,330	$ 25	36,428	$ 26
Residue & Tillage Mgmt, Reduced Till			187	$ 12	25,443	$ 19	8,180	$ 16	33,810	$ 18
Heavy Use Area Protection	1,374	$ 586	6,611	$ 213	33	$ 3,331	18	$ 29,240	8,037	$ 356
Prescribed Grazing	1,578	$ 24	4,748	$ 53	157	$ 81	1,282	$ 32	7,764	$ 45
Conservation Tillage					7,313	$ 15			7,313	$ 15
Equipment Modification					5,767	$ 16			5,767	$ 16
Upland Wildlife Habitat Mgmt	3	$ 180	214	$ 3			4,025	$ 15	4,242	$ 14
Lined Waterway or Outlet	1,360	$ 28	1,325	$ 20	231	$ 49			2,916	$ 26
Forage and Biomass Planting	202	$ 290	1,333	$ 147	663	$ 152	164	$ 104	2,361	$ 157
Brush Mgmt					1,552	$ 81	470	$ 125	2,022	$ 91

Some general findings include:

- The Lower Fox had the lowest cost per acre for six of the sixteen practice types evaluated and the highest per acre cost for only one.
- Three different watersheds had the lowest per unit cost for the three most implemented practice types: nutrient management – Genesee ($8/acre); cover crops – Lower Fox ($33/acre); and integrated pest management – Maumee ($7/acre).
- For practice types implemented in at least three of the four watersheds, the one with least variation in cost per acre was residue and tillage management – reduced till, with per unit costs ranging from $12/acre to $19/acre.
- It is unclear why the per unit cost for heavy use area protection was so high in the Saginaw.

Some highlights by watershed include:

- Genesee – Nutrient management was the practice type with the highest number of acres implemented and the lowest per acre cost ($8/acre).
- Lower Fox – While upland wildlife habitat management had the lowest per acre cost ($3/acre), only 214 acres were implemented using this practice type. Of the three most frequently implemented practice types, nutrient management was the most cost effective ($12/acre), followed by integrated pest management ($16/acre), and cover crops ($33/acre).
- Maumee – Integrated pest management was the lowest cost practice type ($7/acre), however, of the three most frequently implemented practice types, residue tillage and management – no till, had the lowest cost ($23/acre), followed by nutrient management ($29/acre) and cover crops ($44/acre).
- Saginaw – While conservation crop rotation had the lowest cost per acre ($4/acre), it was not one of the more frequently implemented practice types in the watershed. Of the top three, integrated pest management had the lowest per acre cost ($16/acre), followed by nutrient management ($24/acre) and cover crops ($43/acre).

7. GLRI versus Other Conservation Funding

In this section, total GLRI funding from 2010-2016 is compared to conservation subsidy data reported as part of the EWG Farm Subsidy Database. Conservation program subsidies reported by EWG include funding from four federal programs – Environmental Quality Incentives Program (EQIP), Wildlife Habitat Incentives Program (WHIP), Conservation Stewardship Program (CSP) and Conservation Reserve Program (CRP).

For GLRI projects whose entire funding distribution occurred within the timeframe of interest (2010-2016) the lump sum of the project funding was used. For those GLRI projects whose distribution fell partly outside of the 2010-2016 timeframe, it was assumed that funding was distributed evenly across years so that the funding value for the time period of interest was determined by dividing the total funding by the years of the project and multiplying by the number of project years that fell between 2010 and 2016.

Analysis was done in nominal dollars as lump sum GLRI funding amounts could not be consistently converted to real dollars without making multiple assumptions. The calculated GLRI investments were then compared to conservation subsidies distributed to the four priority watersheds as reported by county weighted by the percentage of each county's area in the watershed of interest.

Using this method of calculation, $71.6 million in GLRI investments were distributed from 2010-2016. In comparison, $141.3 million in conservation subsidies were distributed to the priority watersheds during this time period. A similar comparison could not be done at the watershed level as six projects occurred in multiple watersheds.

8. Summary Ranking and Evaluation

This section summarizes general findings, answers key REAP research questions addressed by the analyses conducted in previous sections and provides recommendations as to ways data could be collected in the future to allow for improved ranking and measure of indicators of success.

Table 35 provides a summary ranking of watersheds across key project structure and element types as well as outputs. As noted previously in this document, limited data, missing data, and variation in key watershed characteristics should be considered when interpreting these results (e.g., 100% of CPs being implemented in NRCS PPAs in the Lower Fox is not necessarily a result of effort, but rather that the entirety of the watershed being considered a PPA).

Table 35. Summary Ranking of Watersheds

	Project Structure (% of Projects)		Project Elements (% of Projects)		Acres in Conservation	PPAs
Watershed	Indirect Funding	Direct Funding	Direct Outreach	Innovative Capacity Building	Proposed Acres Achieved (%)	% of CPs in NRCS PPAs
Genesee	43%	57%	33%	0%	n/a	58%
Lower Fox	42%	58%	31%	23%	23%	100%
Maumee	29%	71%	54%	33%	83%	39%
Saginaw	38%	63%	56%	38%	121%	39%

Other notable findings are as follows:

- Of the 46 projects, the greatest percentage of projects (26%) implemented only one project element, of which CP installation and edge of field monitoring & research were project elements most often implemented.
- Direct outreach and innovative capacity building appeared frequently in the 46 high-level projects with one of the two elements appearing in 57% of projects and both elements appearing in 28%.
- The percentage of total funding by watershed allocated to CP implementation ranged from 53% (Maumee) to 68% (Genesee).
- Cover crops were the most frequently implemented conservation practice across all four watersheds both in total and in each watershed individually. In total, cover crops represented approximately 25% of CPs implemented. Outside of cover crops, however, variation was seen across the watersheds in terms of which CPs were most frequently implemented.
- In terms of units implemented, nutrient management (301,978 acres) and cover crops (275,876 acres) were the conservation practice types implemented on the greatest number of acres.
- In total, for those projects that reported on GLRI investments used for CP implementation, projects funded indirectly accounted for 95% of CP implementation.
- Based on the limited data available current participation in GLRI funded programs and current/future participation government funded conservation programs do not appear to be strongly correlated with inclusion of either a direct outreach element or an innovative capacity building element in a project.
- Across all project and watershed characteristics evaluated, animal sales as a percentage of total sales appears to be a characteristic with influence on the adoption of cover crops and vegetative buffers.
- Agriculturalists in watersheds who are aware of funding opportunities may be more likely to express interest in implementing more cover crops and vegetative buffers in the future, but are less likely to do so without incentives.
- The information source most relied on “a lot” varied by watershed both by source and the degree to which is was relied upon: Genesee – Crop Advisor (34%), Lower Fox – Crop Advisor (45%), Maumee – Fertilizer Retailer (37%), Saginaw – University Extension (29%).
- Other local farmers were the information source stated to be most used “some” or “a lot” in three of the four watersheds – Genesee, Lower Fox and Maumee – and was the second most used in the Saginaw behind county land conservation district.
- Across all four watersheds combined, the least costly conservation practice type was soil testing ($9/acre), followed by written integrated pest management plans ($13/acre). For the three practice types reporting implementation of more than 100,000 acres, integrated pest management was the most cost effective ($15/acre), followed by nutrient management ($25/acre) and cover crops ($42/acre).

Table 36 list key REAP research questions and whether analyses conducted as part of this effort were able to answer each question. Reponses then show, if the question was answered, what the findings were, and if not, why.

Table 36. REAP Research Question

Question	Was this question answered?	If YES, what were the findings? If NO, why not?
What project or program structure yields the highest levels of CP adoption by farmers?	Partially	The primary metrics for measuring results were number and units of CP implemented. As 95% of CPs were implemented using indirect funding, assessing the degree to which indirect/direct funding affected results was not able to be ascertained.
Where were most CPs installed (priority watersheds vs PPAs)?	Yes	All CPs analyzed as part of this effort were located in a priority watershed. Approximately 9% of CPs implemented did not report on whether they were implemented in a PPA or not. Across all four watersheds 52% and 39% of CPs were implemented or not implemented in PPAs, respectively. At the watershed level, including reponses left blank, the percentage of CPs implemented in PPAs were: Genesee - 58%, Lower Fox - 100%, Maumee - 39%, and Saginaw - 39%.
Which of these is most cost effective?	No	As information on the impact on water quality of each CP type was not available, a cost effectiveness analyiss could not be done; however, a cost per unit analysis was done. Of the ten CP practice types implementing the greatest number of units (measured in acres), the one with the lowest cost was soil testing, with an estimated cost of $9/acre, followed by integrated pest management, which had an estimated cost of $15/acre.
What were the most popular CPs installed (why)?	Partially	The CP most implemented in terms of both number and cost was cover crops. Cover crops were the most popular CP in total and in all four watersheds individually. In terms of units implemented, however, nutrient management (301,978) was the most popular CP, followed by cover crops (275,876 acres).
How many producers participated?	No	The number of land owners enrolled as part of GLRI funded projects was only reported for five of the 46 high-level projects. The total number of landowners enrolled for these five projects was 343 - Genesee (53), Lower Fox (19), Maumee (258), and Saginaw (13).

Table 36 (continued). REAP Research Questions

Question	Was this question answered?	If YES, what were the findings? If NO, why not?
How many acres were covered?	Partially	For CPs reporing units implemented, acres covered could be calculated. In total, 47 practice types used acres as the unit of measurement. For these, implementation of CPs on 1,030,505 acres were reported. However, the way that data was collected does not allow for the determination of total acres treated as the is no indication of whether mutliple CPs were implemented on the same acreage.
For each: How much did it cost? How long did it take?	Partially	For the 1,030,505 acres, total cost and average per unit cost were \$33.6 million and \$33/acre, respectively. Length of time was not able to be estimated (other than duration of the project—i.e., all these CPs were implemented between 2010-2016).
What structures to administer GLRI funding yielded the greatest results?	Partially	At the high-level GLRI project results were assessed by comparing the number of proposed acres in conservation to those that were achieved. Although no conclusions could be drawn about the impact of project elements on these results, indirectly funded projects (i.e., those awarded to recipient(s) who did not directly carry out the project, but rather, distributed funds to one or more sub-grantees) tended to be correlated with more projects that achieved the stated conservation goals than directly funded projects. In examining intent to continue to participate in future government programs and maintain or increase usage of cover crops or vegetative buffers with or without incentives no clear correlations could be drawn with the two key project elements examined (direct outreach and innovative capacity building).

Based on lessons learned during this effort, the following are recommendations as to ways data could be collected in the future to allow for improved ranking and measure of indicators of success:

- Identify data needed to create relevant metrics and clearly define at the beginning of each project
    - Information, to the extent allowable by privacy issues, on location of people engaged (by county, HUC8, zip), location of implemented CPs (by parcel), type of operations impacted (crop type, size, tax status, ownership details of age, sex, ethnicity).
    - Records of what entity does implement projects if the project is indirectly funded. This would help with the alignment of preferred sources of information (as reported by the OSU survey) to the organizations attempting to implement projects for/with agriculturalists.
    - Metrics associated with project elements (e.g., individuals reached and how, events held, number of contracts implemented).
    - Methodologies and metrics associated with changes in water quality resulting from specific GLRI project activities.
- Standardize reporting
    - Standardize reporting of units, type of information collected, metadata, etc. across entities collecting data/implementing projects and the projects themselves.
    - Provide funding recipients with a standardized template and require regular reporting as a part of their contract.
    - Break funding out by watershed (no grouping of watersheds where funding is distributed). Consider even a smaller spatial resolution as project(s) allow.
    - Break funding out by project element in order to see how funding was spent.

  - Clearly track CPs in terms of units implemented. Indicate whether some acres are treated with multiple CPs, if so, which CPs and which acres so that a total number of acres impacted could be calculated.
- Consistently collect data on outputs
  - For those projects whose timelines differ (start and end dates) still attempt to do yearly assessments of progress so there is some annual indication of whether the project is on-track to meet its goals.
- Conduct assessment of outcomes
  - Integrate assessments of project outcomes into the projects themselves including a list of outcomes in which the EPA is particularly interested. For example, the EPA may be interested in whether participant's perceptions about the financial benefit of implementing cover crops has changed or whether their trust of the NRCS is impacted by a project.
    - Example: for a workshop, follow up with a post-card questionnaire about how it impacted attendees.
    - Example: for cover crops implemented, follow up (in-person or by aerial imagery) to see if the practice is being continued post-investment.

Appendix A. GLRI Focus Area 3 Projects

Project ID	Project Name
EPA00E01448-0	Accelerating Outcome-Based Ag Conservation in Saginaw Bay
GL 00E01143	Alternative Ditches to Reduce Nutrients in the Upper Blanchard
EPA00E00441-0	Baird Creek Riparian Protection
EPA 00E00995-0	Binational Stakeholder Engagement for Nutrients in the Lake Erie Basin
GL00E00413-0	Cover Crops and Conservation Tillage Reduce NPS Pollution
GL00E00858	Erosion Reduction in the Swartz Creek Watershed
EPA00E01405-0	Expanded Maumee Tributary Monitoring To Measure Success Of Agricultural Conservation Actions
GL97220600-0	Improving Water Quality in NE Lake Ontario Basin
GL-00E01128-0	Improving Water Quality Restoration Partnerships in Michigan's Shiawassee and Flint River Watersheds
GL-00E01145-0	Increasing Nutrient Management Plan Expertise in Blanchard Watershed
GL00E01124	Kawkawlin River - Targeted Phosphorus and E. coli Reduction
GL-00E01155-0	Locating and Targeting High-Impact Farm Fields to Reduce Phosphorus Discharges
GL 00E01449	Maumee River Sediment and Nutrient Reduction Initiative
NOAA-IA-1	NOAA – Nutrient Runoff Risk Advisory Forecast Tool – IL, IN, NY (2015-686a)
NOAA-IA-2	NOAA Nutrient Runoff Risk Advisory Forecast Tool -Saginaw and Maumee Watersheds (2014-686)
BIA0157	Nonpoint Pollution Abatement
GL00E00566	Phosphorus Reduction: Variable Rate Technology Program
GL00E00860	Plum & Kankapot Creeks Riparian Protection (2)
GL00E01131-0	Powell Creek Nutrient Reduction Project
EPA00E00859-0	Sediment Reduction in the Sebewaing River Watershed
GL-00E01450	Silver Creek Sediment and Nutrient Reduction & Habitat Restoration
GL00E01408-0	Soil Health Agronomic Assistance & BMPs for Farmers in the Western Lake Erie Basin
GL-0-00E01403	Supplement Michigan's Targeted Response to Repair WLEB Health
GL 00E01423	Supplementing Michigan's Targeted Response to Repair WLEB through new Approaches
GL00E01404-0	Supporting Ohio Clean Lakes Initiative: Impaired Watershed Restoration
GL00E00857	Targeted Phosphorus Reduction in the Pigeon River Watershed
GL 00E01906	Targeting Hard to Reach Reductions - Additonal Streambank Protection in the Plum & Kankapot Creek Subwatersheds
GL 00E01451	Targeting Outcome-Based Sediment Reduction in the Lower Fox Watershed
GL00E01020-0	Watershed Improvements in Lye Creek in the Upper Blanchard Watershed
NRCS-IA-GLSNRP-1	Great Lakes Sediment and Nutrient Control Program-Maumee
NRCS-IA-GLSNRP-2	Great Lakes Sediment and Nutrient Control Program-Saginaw
NRCS-IA-GLSNRP-3	Great Lakes Sediment and Nutrient Control Program-Lower Fox
NRCS-IA-GLSNRP-4	Great Lakes Sediment and Nutrient Control Program-Genesee
EPA00E01909-0	Accelerating Farmer Adoption of Variable Rate Technology
GL00E00577-0	Best Management Practices in the Maumee River Basin
ACOE-IA	Great Lakes Tributary Model
USGS-IA-1	Forecast/Nowcast Great Lakes Nutrient and Sediment Loadings & Impacts of Nutrients from Agricultural Watersheds in Nearshore Areas
USGS-IA-2	Effects of Nutrient Runoff from Agricultural Watersheds
USGS-IA-3	Maumee River Edge of Field Monitoring
USGS-IA-4	Evaluation of Phosphorus Reduction - Fox River
USGS-IA-5	Saginaw River Edge of Field Monitoring
USGS-IA-6	Edge of Field Monitoring
NRCS-IA-EQIP-1	Supplementing Farm Bill Ag Conservation Programs-Maumee
NRCS-IA-EQIP-2	Supplementing Farm Bill Ag Conservation Programs-Saginaw
NRCS-IA-EQIP-3	Supplementing Farm Bill Ag Conservation Programs-Lower Fox
NRCS-IA-EQIP-4	Supplementing Farm Bill Ag Conservation Programs-Genesee

Note: For the purposes of analysis, NRCS-IA-GLSNRP ad NRCS-IA-EQIP projects were broken out by watershed. Project IDs for these projects are specific to this analysis and are not the actual cooperative agreement numbers.

Appendix I

Economic Analysis of GLRI Investment Data using RIMS Multiplier Analysis

Great Lakes Commission
des Grands Lacs

REAP
Researching the Effectiveness of Agricultural Programs

Economic Analysis of GLRI Investment Data Using RIMS II Multiplier Analysis

FINAL

November 2019

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AMP Insights

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ACRONYMS

CP	Conservation Practice
GLRI	Great Lakes Restoration Initiative
I-O	Input-Output
NRCS	Natural Resources Conservation Service
PMT	Project Management Team
REAP	Researching Effectiveness of Agricultural Programs
RIMS II	Regional Input-Output Modeling System
US	United States
USDA	United States Department of Agriculture

1. Introduction

This report has been produced in support of the project known as Researching the Effectiveness of Agricultural Programs (REAP) funded under a Great Lakes Restoration Initiative (GLRI) Cooperative Agreement between the U.S. Environmental Protection Agency and the Great Lakes Commission. The objective of REAP is to evaluate the impact on long-term on-farm behavior as a result of GLRI Focus Area 3 investments with four GLRI priority watersheds; the Genesee, Lower Fox, Maumee, and Saginaw watersheds.[1] The goal of this report is to estimate the broader economic impact of GLRI funded projects in each watershed. From 2010-2016 the GLRI funded 34 projects across the four watersheds (see Table 1).

Table 1. GLRI Focus Area 3 Funding by Watershed

Watershed	Project Funds	Funds as % of Total
Genesee	$ 7,993,680	8%
Lower Fox	$ 24,320,835	25%
Maumee	$ 43,998,861	46%
Saginaw	$ 19,495,394	20%
Total	$ 95,808,771	—

Input-output (I-O) modeling is a method commonly used to model the interrelationships of economic sectors/industries and describe the multiplier effect of changes in one sector/industry across a broader economy and is frequently used to assess the potential economic impact of a new program or investment in a particular industry. Results of I-O analyses are typically expressed as multipliers that represent the additional economic impact above the direct contributions of the industry being considered.

Input-output analyses typically include measurement of three rounds of impacts:

- Direct Impacts – Increase in regional economic output/increases in regional employment
- Indirect Impacts – Increased demand for regionally produced inputs (i.e., goods and services), which in turn generates increased demand for inputs and employment.
- Induced Impacts – Individuals employed by jobs created will in turn spend some of their earnings on regionally produced goods and services.
- Feedback Loop – Regional industries for which demand of good and services increased in the first round of indirect and induced effects also will require additional inputs and labor.

In this analysis, direct economic contributions of GLRI investments were the funds spent within each watershed. These investments then supported a) indirect impacts - the purchase of supplies and services to support implementation of conservation practices (e.g., purchase of plants for a vegetative buffer or

[1] It should be noted that the Genesee only became a GLRI priority watershed under GLRI Action Plan II, which was active from 2015-2019. As the time frame for this analysis is 2010-2016, only two years of data (i.e., 2015 and 2016) were available for the Genesee.

hedgerow planting); and b) induced impacts - personal spending by farmers receiving GLRI funding as well as any employees of industries providing supplies and services (e.g., purchase of groceries).

2. Data and Methods

Two data sources were used for this analysis – a database compiled by the REAP Project Management Team (PMT) on the majority of GLRI Focus Area 3 investments distributed to the four priority watersheds and Regional Input-Output Modeling System (RIMS II) multipliers purchased from the U.S. Bureau of Economic Analysis.

2.1 REAP Database

The database compiled by the REAP PMT includes two tabs – one on high-level projects and one on CPs implemented as part of the high-level projects. The information on the CPs is considered to be incomplete, but still was useful for understanding how and where GLRI funds were distributed (see Table 2). Only funds associated with CP implementation could be linked to a particular sector/industry with any level of confidence — meaning approximately 58% of GLRI funding could be mapped to the appropriate sector/industry as needed to be included in the I-O analysis.

Table 2. GLRI Focus Area 3 CP Funding by Watershed[2]

Watershed	Project Funds	CP Funds	CP Funds as % of Total
Genesee	$ 7,993,680	$ 5,475,525	68%
Lower Fox	$ 24,320,835	$ 14,061,674	58%
Maumee	$ 43,998,861	$ 23,137,750	53%
Saginaw	$ 19,495,394	$ 12,134,931	62%
Total	$ 95,808,771	$ 55,319,044	58%

The Natural Resources Conservation Service (NRCS) has conducted a number of studies on the local/state economic impact of implementing conservation practices using a propriety software called IMPLAN, which is based on the input-output economic model and data-sets assembled from a variety of government sources including the US Bureau of Economic Analysis, the USDA, the US Bureau of Labor Statistics and the US Census, among others.

According to the IMPLAN website, the United States Department of Agriculture (USDA) Forest Service originally developed IMPLAN in the 1970s in order to conduct community level impact analyses. The USDA Forest Service, however, was not able to "sustain a large-scale nationwide system", so the responsibility for updating and maintaining IMPLAN datasets was given to the University of Minnesota in 1985. Since 2013, IMPLAN has been managed and sold by a privately held company under the same name (IMPLAN 2019).

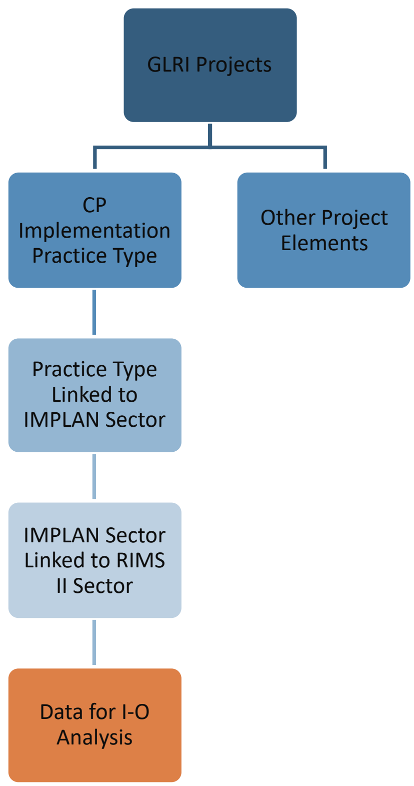
In order to estimate the economic impact of conservation practices, the NRCS had to identify the industry sectors in which funds would be spent to implement a particular conservation practice (CP). For example,

[2] Total CP funds are greater than the sum of CP funds for the four watersheds as some CPs did not identify the watershed in which they were implemented.

implementation of a riparian forest buffer would support the industry "greenhouse nursery and floriculture production" through the purchase of plants needed to create the buffer. Several of the studies conducted by NRCS on the economic impact of conservation practices included tables linking NRCS CP types to IMPLAN industrial sectors (see USDA NRCS, n.d.; n.d.).

As IMPLAN is a proprietary (and costly) software, Regional Input-Output Modeling System (RIMS II) multipliers were purchased from the U.S. Bureau of Economic Analysis and served as the underlying data for the input-output analysis conducted here. In order to make them relevant, IMPLAN sector codes were converted to RIMS II codes. GLRI funding for CP implementation was then summed by practice type and by watershed and linked to the RIMS II codes (see Figure 1).

Figure 1. Process for Preparing GLRI Data for I-O Analysis



Recognizing that this represents just over half of total GLRI funding, some basic assumptions are made about how the other 42% of funds were spent and a sensitivity analysis is run to assess the degree to which these assumptions impact results (see Section 4.2).

2.2 RIMS II Multipliers

RIMS II multipliers can be purchased by region or by industry. For the purposes of this study, four regions were needed (i.e., one representing each priority watershed). A region can be defined in a variety of ways (e.g., county, metropolitan area, customized region, etc.), with RIMS II creating the appropriate multipliers for the region defined. Multipliers produced for a given region are indicative of the economic structure of that region and the interrelationships of industries within that region only. As such, it is typical to see a multiplier increase as the size of the region examined increases. This is relevant in the context of this analysis given the substantial variation in the land area within each of the four watersheds (see Table 3).

Table 3. Watershed Area

Watershed	Area (Acres)
Genesee	1,596,168
Lower Fox	414,394
Maumee	4,208,092
Saginaw	3,988,803

Unlike previous analyses done in the context of this study, where counties within a watershed were weighed in order to create an aggregate value, the purchase of multipliers for individual counties was cost prohibitive, and so a determination needed to be made as to which counties should be included to produce a representative multiplier for each watershed which could then be applied to all the CP funding in that watershed. Additionally, the rationale for not including all counties was that counties with little or no CP funding, if included in the regions, would have equal weight with highly-funded counties in the way the RIMS II multipliers for a given region were aggregated, potentially skewing the impact of the small amount of funding in that county.

In order to do this, CP funding by county was sorted from highest to lowest within each watershed (see Appendix A) and mean and median values were calculated. For watersheds with a relatively normal distribution (i.e., Lower Fox, Genesee), counties with CP funding above the mean value were included. For watersheds with a more skewed distribution (i.e., Maumee and Saginaw), counties with CP funding above the median were included. Using this methodology for choosing the RIMS II multipliers, the counties included in the calculation of the multipliers represented at least 88% of funding allocated towards CPs (see Appendix A).

3. Allocation of GLRI Funding Data to RIMS II Industries

Individual RIMS II multipliers are produced for select industries within a region. There are 64 aggregate industries and 406 detailed industries in RIMS II. Previous NRCS reports provided the basis by which funds spent on CP implementation were partitioned amongst the industries, but a separate strategy for allocating funding to industries was needed for the approximately $40 million in GLRI project funding not allocated to CP implementation in the REAP Master Database.

3.1 CP Funding

The use of the of the NRCS IMPLAN industry tables allowed for the categorization of CP funding at the detailed industry level and the use of specific, targeted RIMS II industry multipliers. Some CPs – Forest Stand Improvement, Forage and Biomass Planting, Tree/Shrub Establishment, Cover Crop, Integrated Pest Management, Prescribed Grazing, and Nutrient Management – involve activities that are associated with multiple industries. As a result, the funding for these CPs was allocated across applicable industries using percentages previously employed in other NRCS IMPLAN analyses (see USDA NRCS, n.d.; n.d.). Additional CPs, such as Soil Testing and CPs associated with the application of chemicals, were aggregated under the term Agronomic System and the aggregated funding was split amongst multiple industries.

The dollar value of estimated GLRI expenditures for each industry was then multiplied by the industry RIMS II multiplier associated with each watershed to produce measures of the estimated economic impact of GLRI investments in CPs on total output and employment across and for each of the four priority watersheds.

3.2 Non-CP GLRI Funding

GLRI funding allocated to CP implementation accounted for 58% of total GLRI funding gathered in the REAP Master Database. The remaining 42% of funding was not categorized in such a way that the funds could be allocated to specific detailed industries within the RIMS II framework. As a result, some assumptions regarding the use of these funds to support GLRI Focus Area 3 projects had to be made. CP implementation is only one of eight project elements into which GLRI projects were categorized in the REAP Master Database. The remaining seven project elements deal primarily with outreach, capacity building, research and monitoring, and tool development.

As funding data were not broken out by project element (other than for CP implementation), a simple formula was used to allocate remaining project funds. First, reported funds used for CP implementation were subtracted from total funds for each project. Projects then were identified as having 1) only outreach or capacity building elements; 2) only monitoring, research or tool development elements; or 3) a combination of both. Funding for each project was then assigned to either outreach/capacity building, monitoring/research/tool development, or, in cases where a project included both types of elements, 50% of funds were allocated to each. Summing these results, project funds were relatively evenly distributed between outreach or capacity building elements (57%) and monitoring, research or tool development elements (43%).

As a result, three separate RIMS II analyses were performed for the non-CP GLRI funds so as to provide a sensitivity analysis of the impact of allocating the funds. The analyses were as follows: 1) 100% of non-CP GLRI Focus Area 3 funds were allocated to the RIMS II industry "support activities for agriculture and forestry"; 2) 100% of funds were allocated to the RIMS II industry "professional, scientific, and technical services"; and 3) non-CP funds were split 50%-50% between the two industries.

4. GLRI Program Impacts

Principal model outputs of RIMS II multipliers provide information on total economic output and employment. Output is a duplicative total that estimates the value of goods and services counted multiple times within the region's economy to produce a value for the total amount of economic activity generated by new spending, such as that associated with the GLRI project spending on CPs, and represents the degree to which the original dollars spent are circulated throughout the economy.

An output multiplier also can indicate the degree to which inputs to a given industry are from inside or outside the region. A lower multiplier suggests that more of the inputs for a given industry are produced outside the region and, therefore, a higher proportion of the new spending will leak out of the regional economy. Because a multiplier is a proxy for the regionality of other inputs, the magnitude of an output multiplier may be correlated with the size of a region. The smaller a region the greater the likelihood that goods and services would be imported from outside that region, which would result in new economic value leaking out of that region as reflected by a lower RIMS II multiplier. Given the differing geographic extents of the four priority watersheds, this correlation may be important when interpreting the results of the analysis.

Employment multipliers, on the other hand, determine the increase in overall labor demand – full- and part-time jobs created and retained – that is likely to result from spending in the industry (and related industries) associated with that multiplier. Again, the size of the region considered may impact the size of employment multipliers, as the larger the region, the great the likelihood that jobs created will stay within the region.

For this analysis, the results of the RIMS II multiplier analysis are reported in nominal dollars – i.e., not adjusted for inflation. While the CP implementation funding is associated with a specific project year, the remaining project funds span multiple years, and, because assumptions would need to be made about how those funds were dispersed across years to allow for reporting in real dollars and because these assumptions could impact the magnitude of the outputs, it was decided to report outputs in nominal dollars for the whole analysis.

4.1 CP Implementation Impacts

4.1.1 Impacts on Total Output

Measured in terms of total output, the estimated overall economic impact of the $55 million in GLRI funds invested in CP implementation is $82 million. Across the four watersheds combined, the investment to output multiplier is 1.5. The greatest estimated economic impact is seen in the Maumee, a result of both higher initial investment in CPs in that watershed (see Table 4) and RIMS II multipliers of greater overall magnitude, which, as was mentioned previously, may have to do with the geographic size of the Maumee as compared to the other watersheds.

The percentage yield (i.e., the overall ratio of total economic impact to GLRI investments) is highest in the Lower Fox where the estimated total impact of over $22 million is 158% of the initial investment (i.e., $14 million). This is a result of the fact that in the Lower Fox GLRI funds were spent on CP types that fell into industries with higher multipliers.

Table 4. Estimated Economic Impact of GLRI Investments in CP Implementation[3]

Watershed	Total CP Funding ($)	Total Output ($)	Investment to Output Multiplier
Genesee	$ 5,475,525	$ 7,649,945	1.4
Lower Fox	$ 14,061,674	$ 22,199,715	1.6
Maumee	$ 23,137,564	$ 35,104,244	1.5
Saginaw	$ 12,134,931	$ 17,369,360	1.4
All Watersheds	$ 54,809,694	$ 82,323,265	1.5

The Genesee, overall, exhibits lower multiplier values than the other watersheds, indicating that goods and services demanded by industries supporting CP implementation are more likely to be produced outside the region (i.e., the Genesee watershed). Of the fourteen detailed industry RIMS II multipliers, the Genesee exhibited the lowest value for thirteen and the Maumee exhibited the highest value for nine. This result, at least to some degree, is likely related to the smaller size the Genesee as compared to some of the other watersheds.

RIMS II detailed industries with the highest total output multipliers for each watershed and the CPs associated with each industry are included in Appendix B.

[3] Total CP funds differ from that shown in Table 4 as a result of some CPs not having an indication of the watershed tin which they were implemented. The unallocated CP funds were accounted for in Table 4, but not accounted for in Table 3.

4.1.2 Impacts on Employment

GLRI investments in CPs spanned multiple years and because there is not enough data to determine the number of jobs retained versus the actual number of new jobs created by the implementation of CPs, calculating this number using all GLRI funds invested may overestimate the employment impact as a result of double-counting jobs retained across the years of GLRI investments. To estimate a conservative number representative of total jobs created and retained for the timeframe analyzed (2010-2016), the funds invested in CP implementation were divided by seven – the number of years in the timeframe of interest – prior to calculation of the employment metric using RIMS II multipliers. The conservative estimate of jobs created and retained by GLRI investments in CPs for the 2010-2016 timeframe is 85.

The greatest number of jobs created or retained by GLRI funding allocated to CP implementation occurred in the Maumee, where 39 jobs are estimated to be created and retained (see Table 5). While this number of jobs may again be, in part, the result of the higher overall investment in CPs in this watershed, the ratio of jobs created and retained to total funding was also highest in the Maumee. This result is the product of high multiplier values in the Maumee and the concentration of funding for CPs in industries with the highest RIMS II employment multipliers. As with the results of the total output, the Genesee exhibits the lowest number of jobs created and retained and the lowest ratio of employment to funding for the four watersheds. Of the fourteen detailed industry RIMS II multipliers, the Genesee has the lowest value for twelve and the Maumee has the highest value for seven. Interpretation of these findings, however, also should take into account the size difference of the watersheds.

Table 5. Estimated Jobs Created by GLRI Investments in CP Implementation

Watershed	Total Jobs (#)	Investment to Jobs Multiplier
Genesee	7	1.3
Lower Fox	22	1.6
Maumee	39	1.7
Saginaw	17	1.4
All Watersheds	85	1.5

Note: The investment to jobs multiplier is calculated here as the ratio of the number of jobs per one million dollars of GLRI CP funds invested.

RIMS II detailed industries with the highest total job multipliers within each watershed and the CPs associated with each industry are included in Appendix B. Although each industry may encompass many CP types, the consistent ranking of job multipliers across watersheds indicates that there are some CP types that may be more universally capable of stimulating job growth.

4.2 Non-CP GLRI Funding Impacts

4.2.1 Impacts on Total Output

As mentioned previously, given that a large portion of GLRI Focus Area 3 investments could not be attributed to a specific industry, three separate RIMS II analyses were performed for the non-CP GLRI funds so as to provide a potential range of estimated total economic impact.

The estimated total economic impact, measured in terms of total output, of the $40.5 million in GLRI Focus Area 3 funds not invested in CP implementation, and for which there were data, is estimated to fall between $60 and $66 million. For this range, the high-end was arrived at using the methodology wherein

100% of the remaining GLRI funds were allocated to support services for agriculture and forestry (Ag Services) and the low-end of the range was the result of allocating 100% of the remaining GLRI funds professional, scientific, and technical services (Prof Services). Allocating 50% of the non-CP funds to each of the two industries (50%-50%) results in an average of the output impact of $63 million. Across the four watersheds, the estimated investment to output multiplier for the remaining GLRI Focus Area 3 investment is between 1.26 and 1.68.

Although the allocation of the remaining funding changed the magnitude of estimated total economic impact across the watersheds (see Figure 2), it did not change the ranking of the watersheds in regards to the percentage yield of the economic impact, with the Lower Fox experiencing the highest ratio of total output to initial GLRI investment and the Genesee yielding the least (see Table 6).

Figure 2. Estimated Total Economic Impact of Non-CP Funds Invested for Three Scenarios

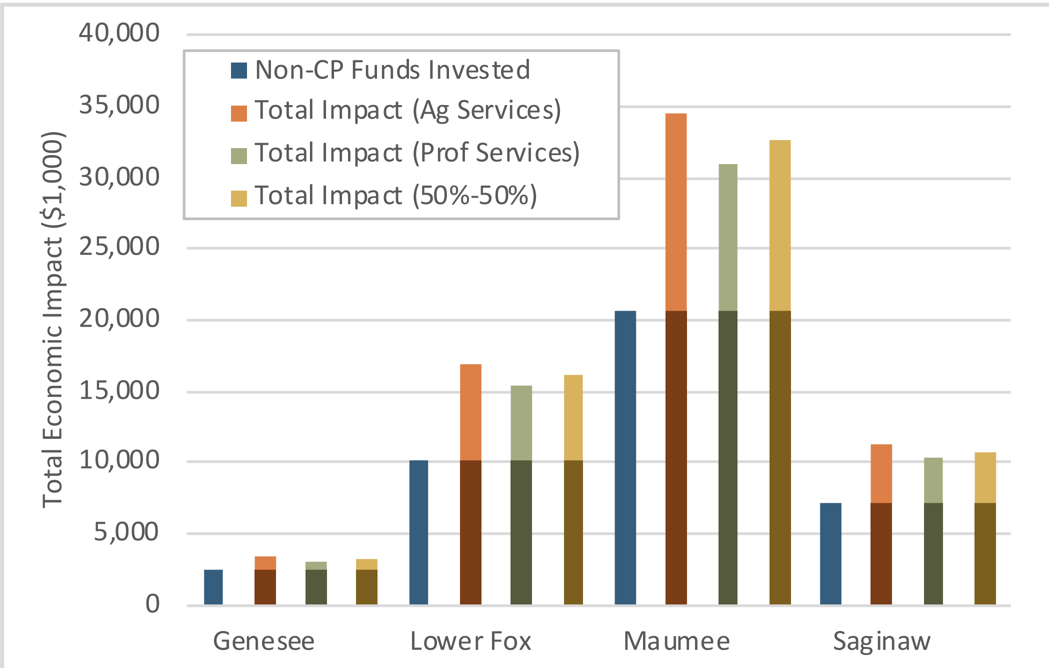


Table 6. Investment to Output Multipliers for Three Scenarios

Watershed	100% Ag Services	100% Prof Services	50%-50%
Genesee	1.44	1.26	1.35
Lower Fox	1.68	1.53	1.60
Maumee	1.67	1.49	1.58
Saginaw	1.56	1.43	1.49

Because the method by which funding was allocated to the industries was consistent across watersheds this result is directly correlated to the magnitude of the RIMS II multiplier(s), with the Lower Fox having the highest magnitude multiplier and Genesee having the lowest multiplier for both support activities for agriculture and forestry and for professional, scientific, and technical services. As with the findings from the CP implementation RIMS II analysis, these results indicate that the Genesee regional industries that provide the goods and services required by support activities to agriculture and forestry and professional, scientific and technical service industries are more likely to be produced outside the region (i.e., the Genesee watershed).

Taking into account variation in the size of the watersheds, the fact that the Lower Fox, the smallest watershed of the four, has the highest multipliers for both support activities for agriculture and forestry and for professional, scientific, and technical services is notable. This suggests that other industries supporting and supported by these two are more likely to be located within the Lower Fox watershed than is the case in the other watersheds.

4.2.2 Impacts on Employment

Using the same method as that used in the analysis of CP funds to estimate a conservative total impact on employment, an estimated 50 to 126 full and part-time jobs are found to be created and retained by the non-CP GLRI investments.

Again, the high-end of the range is represented by the RIMS II analysis allocating 100% of the non-CP funds to support activities for agriculture and forestry, the low end of the range corresponds to the analysis that allocated that 100% of remaining funds to professional, scientific, and technical services, and splitting the funds evenly amongst the two industries produces an average of the two – i.e., 88 jobs (see Table 7).

Table 7. Estimated Jobs Created by Non-CP GLRI Investments for Three Scenarios

Watershed	Non-CP Funds	100% Ag Services	100% Prof Services	50%-50%
Genesee	$ 2,390,864	8	2	5
Lower Fox	$ 10,131,870	29	13	21
Maumee	$ 20,733,820	66	26	46
Saginaw	$ 7,233,172	23	9	16

In terms of magnitude, the Maumee watershed achieves the highest impact on employment simply as a result of the GLRI funds invested in that watershed (RIMS II multipliers for Maumee were similar to Saginaw and less than those for Lower Fox). In contrast to the total output analysis, however, in the case of the employment analysis the allocation of the funding to either support activities for agriculture and forestry or to professional, scientific, and technical services not only changed the magnitude of the outcome but also the ranking of the watersheds by impact (see Table 8).

When 100% of the non-CP GLRI funds are allocated to support services, the Genesee achieves the highest impact on employment in relation to funding level with Lower Fox achieving the lowest impact, however, when that funding is allocated instead to professional, scientific, and technical services Lower Fox achieves the highest impact and the Genesee the least. This was a result of the Genesee having the highest RIMS II employment multiplier for support services for agriculture and forestry, but the lowest for professional, scientific, and technical services. The reverse was true for the Lower Fox. Results across the watersheds are very similar when the funding was allocated equally to the two industries.

Table 8. Investment to Jobs Multiplier for Non-CP GLRI Investments for Three Scenarios

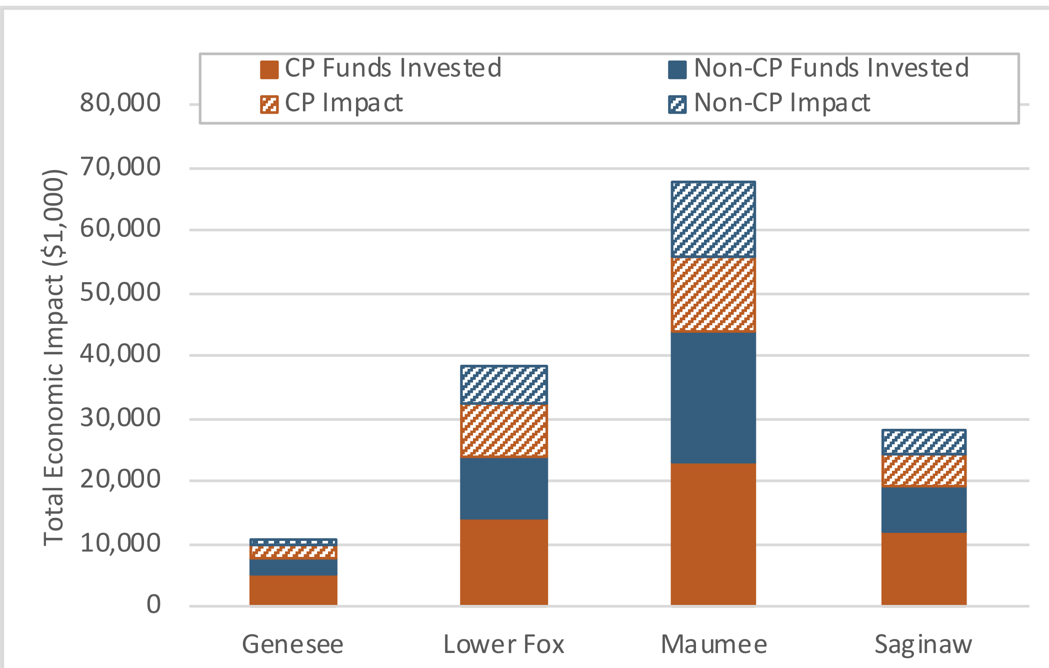
Watershed	100% Ag Services	100% Prof Services	50%-50%
Genesee	3.3	0.7	2.0
Lower Fox	2.9	1.3	2.1
Maumee	3.2	1.3	2.2
Saginaw	3.2	1.2	2.2

Note: The investment to jobs multiplier is calculated here as the ratio of the number of jobs per one million dollars of GLRI non-CP funds invested.

5. Summary and Overall Investment Impact

Overall GLRI Focus Area 3 investments of $95 million has an estimated economic impact, measured in terms of total output, of between $142 and $149 million (see Figure 3). This results in an investment to output multiplier of 1.48 to 1.55 times the original GLRI investment. The employment impact is slightly more difficult to interpret due to the potential for double-counting of jobs retained across the years included in the analysis. The methodology employed to confront this issue is intended to provide a conservative estimate of jobs created and retained. This conservative estimate ranges from 135 to 210 full- and part-time jobs created and retained by GLRI Focus Area 3 investments.

Figure 3. Estimated Total Economic Impact of GLRI Focus Area 3 Investments



Note: For the non-CP impact shown in the graph, the third industry allocation alternative – 50% of funds allocated to support services for agriculture and forestry and 50% of funds allocated to professional, scientific, and technical services – was used as this provides the average impact of the three allocation scenarios.

Not only does this analysis indicate that the GLRI investments in Focus Area 3 projects yield substantial economic benefits, but the analysis also underscores that, if achieving positive economic impacts is an important secondary aim of GLRI investments, the prioritization of projects could be thoughtfully approached to emphasize geographic locations and applicable industries to achieve greater economic outputs and employment.

In examining the magnitude of all industry RIMS II multipliers across the four watersheds, it is found that, while the highest magnitude multipliers are not associated with the industries that support CP implementation, the highest magnitude multipliers are associated with agricultural industries. This indicates that for all four watersheds, the industries that retain the greatest economic benefit from economic activity within the region are agricultural industries, the industry of greatest interest for GLRI investments. Interestingly, however, within the agricultural industries of the four watersheds, the highest magnitude multipliers are associated with livestock products rather than cultivated crops, a finding that may be unexpected for the Maumee and Saginaw where row-crops are predominant.

It is recognized, however, that, as with all investments, the ability to prioritize for economic impact does not factor in external conditions such as water availability, water quality or other environmental impacts, climate change, local, state or national laws, etc. Finally, this analysis further drives home a recommendation that projects funded by GLRI require tracking of project funding by the year in which it is spent and by the project element(s) on which it is spent. This would allow for a more robust analysis that reports findings in real dollars and require fewer assumptions regarding the allocation of funding by industry to analyze non-CP implementation funding.

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Appendix A

Counties within each watershed included as part of the RIMS II "region" are in bold and the percentage of CP funds in the watershed allocated to these counties is highlighted in orange.

Genesee	CP Funds	% of Total	Cumulative %
Wyoming	$ 1,604,247	30%	30%
Livingston	$ 1,347,154	25%	55%
Genesee	$ 1,172,997	22%	77%
Allegany	$ 939,909	18%	94%
Potter	$ 208,275	4%	98%
Monroe	$ 91,795	2%	100%
Ontario	—	—	—
Steuben	—	—	—
Cattaraugus	—	—	—
Orleans	—	—	—

Saginaw	CP Funds	% of Total	Cumulative %
Genesee	$ 3,995,635	33%	33%
Shiawassee	$ 2,407,539	20%	53%
Sanilac	$ 1,365,045	11%	65%
Saginaw	$ 1,257,501	10%	75%
Midland	$ 996,622	8%	83%
Gratiot	$ 427,989	4%	87%
Huron	$ 398,405	3%	90%
Lapeer	$ 377,664	3%	93%
Ogemaw	$ 348,420	3%	96%
Tuscola	$ 207,294	2%	98%
Oakland	$ 178,432	1%	99%
Isabella	$ 22,530	0%	100%
Clare	$ 22,212	0%	100%
Bay	$ 13,395	0%	100%
Gladwin	$ 10,779	0%	100%
Montcalm	$ 815	0%	100%
Mecosta	—	—	—
Livingston	—	—	—
Roscommon	—	—	—
Osceola	—	—	—
Arenac	—	—	—
Clinton	—	—	—

Lower Fox	CP Funds	% of Total	Cumulative %
Brown	$ 8,075,390	58%	58%
Outagamie	$ 4,120,148	30%	88%
Calumet	$ 1,463,463	11%	98%
Manitowoc	$ 220,173	2%	100%
Winnebago	—	—	—

Maumee	CP Funds	% of Total	Cumulative %
Hancock	$ 3,663,171	18%	18%
Defiance	$ 3,046,880	15%	33%
Hardin	$ 2,897,595	14%	48%
Allen	$ 1,613,367	8%	56%
De Kalb	$ 1,351,281	7%	62%
Putnam	$ 955,955	5%	67%
Lenawee	$ 906,844	5%	72%
Mercer	$ 749,370	4%	75%
Williams	$ 744,224	4%	79%
Adams	$ 734,007	4%	83%
Hillsdale	$ 635,373	3%	86%
Noble	$ 566,640	3%	89%
Seneca	$ 513,817	3%	91%
Henry	$ 507,045	3%	94%
Wyandot	$ 330,918	2%	96%
Auglaize	$ 219,405	1%	97%
Fulton	$ 215,922	1%	98%
Paulding	$ 186,669	1%	99%
Wood	$ 143,678	1%	99%
Wells	$ 71,393	0%	100%
Van Wert	$ 27,394	0%	100%
Shelby	$ 15,288	0%	100%
Steuben	$ 14,289	0%	100%
Allen	$ 7,425	0%	100%
Lucas	—	—	—
Branch	—	—	—

Appendix B

Table A1. RIMS II Detailed Industries and Associated CPs with the Highest Total Output Multipliers

Watershed	RIMS II Detailed Industries w/ Highest Total Output Multipliers	Multiplier Value
Genesee	Beef cattle ranching and farming	2.0591
	Greenhouse, nursery, & floriculture production	1.5972
Lower Fox	Beef cattle ranching and farming	2.1608
	Construction non-residential structures	1.726
Maumee	Beef cattle ranching and farming	2.3325
	Fabricated pipe and pipe fitting manufacturing	1.8687
Saginaw	Beef cattle ranching and farming	2.149
	Greenhouse, nursery, & floriculture production	1.7173

RIMS II Detailed Industry	CP Type
Beef cattle ranching and farming, including feedlots and dual-purpose ranching and farming	Access Control
Greenhouse, nursery, and floriculture production	Hedgerow Planting
	Riparian Forest Buffer
	Windbreak/Shelterbelt Establishment
	Windbreak/Shelterbelt Renovation
	Tree/Shrub Establishment
Construction non-residential structures	Agrichemical Handling Facility
	Animal Mortality Facility
	Composting Facility
	Roof Runoff Structure
	Roofs and Covers
	Waste Storage Facility
	Well Decommissioning
Fabricated pipe and pipe fitting manufacturing	Blind Inlet
	Equipment Modification
	Structure for Water Control
	Subsurface Drain
	Watering Facility

Table A2. RIMS II Detailed Industries and Associated CPs with the Highest Job Multipliers

Watershed	RIMS II Detailed Industries w/ Highest Job Multipliers (per $1 million investment)	Multiplier Value
Genesee	Greenhouse, nursery, and floriculture production	23.9345
	Support activities for agriculture and forestry	22.8027
Lower Fox	Greenhouse, nursery, and floriculture production	29.7812
	Support activities for agriculture and forestry	20.376
Maumee	Greenhouse, nursery, and floriculture production	25.5447
	Support activities for agriculture and forestry	22.1416
Saginaw	Greenhouse, nursery, and floriculture production	27.2985
	Support activities for agriculture and forestry	22.2133

RIMS II Detailed Industry	CP Type
Greenhouse, nursery, and floriculture production	Hedgerow Planting
	Riparian Forest Buffer
	Windbreak/Shelterbelt Establishment
	Windbreak/Shelterbelt Renovation
	Tree/Shrub Establishment
Support activities for agriculture and forestry	Brush Management
	Buffer Strip
	Comprehensive Nutrient Mgmt Plan
	Drainage Water Management Plan
	Forest Management Plan - Written
	Integrated Pest Management Plan - Written
	Irrigation Water Management Plan - Written
	No-Till
	Nutrient Management CAP
	Residue and Tillage Management, No Till
	Soil Testing
	TA Application, TA Check-Out, TA Design
	Vegetated Treatment Area
	Waste Recycling
	Waste Separation Facility
	Waste Transfer
	Waste Treatment
	Forest Stand Improvement
	Integrated Pest Management
	Nutrient Management
	Forage and Biomass Planting
	Tree/Shrub Establishment
	Cover Crop
	Prescribed Grazing
	Agronomic System

Appendix J

Assessment of GLRI-Supported Water Quality Tools

Great Lakes Commission des Grands Lacs

Researching the Effectiveness of Agricultural Programs

Assessment of GLRI Supported Water Quality Tools in the Great Lakes

Informational Assessment of Water Quality Tools to support the "Researching the Effectiveness of Agricultural Programs" (REAP) Project

MARCH 5, 2019

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Assessment of Water Quality Tools

Introduction

This report was developed with funding from the U.S. Environmental Protection Agency (EPA) Great Lakes Restoration Initiative (GLRI) as a part of the Great Lakes Commission's (GLC) Researching the Effectiveness of Agricultural Programs (REAP) project. This assessment supports their work by evaluating and comparing tools used to estimate or predict reductions in pollutant loading and water quality improvements. It provides an informational assessment of tools that were either developed in part by funding through the GLRI or those that can support GLRI focus area three - *nonpoint source pollution impacts on nearshore health* objectives.

Background

Information in this report is intended to support future discussions through the REAP project. These discussions are intended to build confidence in water quality professionals using these tools and to explore a more unified approach for modeling water quality improvements. The following statement by GLC describes in more detail the rationale for these discussions and need for the informational assessment provided in this report.

> *In the absence of more comprehensive monitoring data, multiple watershed tools have been developed with GLRI financial support to estimate or calculate reductions in pollution loading and resulting water quality improvements. These tools provide federal, state and local entities and agricultural producers (as well as the GLC-led research team) the ability to estimate the benefits of conservation practices at the field and watershed scale. Field-scale tools in particular can potentially influence on-farm management decisions to avoid large nutrient losses in critical seasons during large rain events. Comparing these tools and summarizing their capacities may build confidence among Great Lakes agriculture and water quality practitioners toward a more unified approach in modeling water quality improvements.*

Methods

Comparing different types of water quality tools poses significant challenges due to variability in the uses, functionality, and outputs of these tools. This report focuses more on informational assessments rather than a direct comparison between tools.

The criteria used in this assessment are not intended to determine which tool is superior but to provide a means for the reader to quickly assess common characteristics of the tools to select which may be most appropriate for their use and how those tools were used for GLRI activities.

To conduct this assessment, a number of proposed criteria were reviewed and selected by IWR and the GLC. The criteria used are based on common factors exhibited in all of the tools being evaluated. Although the evaluation factors may be common, some tools have dissimilar purposes which should be noted when comparing tools.

Information on the water quality tools listed in this report was obtained through website and promotion materials as well as interviews with key contacts or managers of the tools.

Discussion

Table 1 provides a list of criteria used to deliver comparative information across tools. For each water quality tool discussed in this report, a narrative overview of the tool and accompanying table is provided. The GLC and EPA selected the tools included in this assessment report. Most of these tools were developed or supported by GLRI funding. Following is a brief overview of the tools with an attached informational table.

Tools Reviewed

Harmful Algal Bloom Tracker
NOAA Runoff Risk Model
NOAA Tipping Point Planner
Great Lakes Watershed Management System
Nutrient Tracking Tool
USGS NowCast

Criteria Table

Table 1. List of criteria to evaluate GLRI Water Quality Tools.

ID	Criteria	Description
1	Geographic Extent	Description of the geographic area(s) the tool can model.
2	Scale of Analysis	Scale of analysis (field, watershed, regional, etc.).
3	Delivery Platform	Description of the platform used by the tool (web-based, local installation, mobile device, etc.).
4	Pollutants Modeled	What pollutants can be modeled (sediment, phosphorus, nitrogen, etc.)
5	Level of Expertise/Training	How much training is required to use the tool.
6	Model Outputs	What are the total model outputs and in what format.
7	Data Requirements	What data are required to be collected or input by the user?

8	Funding Source	What agency or group funded the development of the tool?
9	Model Administrator	Who currently manages and supports the tool?
10	Legislated or Required Use	Is the tool required by legislation or by agreement; if it is, name the law and describe where, how, and when its use is required
11	Developer of Tool	Who created the tool?
12	Sub Models	What sub models, if any, are used in the tool?
13	Purpose of Tool	What does the tool do generally?
14	Software Requirements	What software is required to run the program?
15	Target User	Who is the tool designed for, and can anyone use it? (state agency, researchers, conservation districts, etc.)

Assessment of Tools

HAB Tracker

The Experimental Lake Erie Harmful Algal Bloom (HAB) Tracker was first developed in 2014 as a forecast model that provides the location, size, and trajectory of blooms in Lake Erie. HAB Tracker evolved out of projects and activities such as the National Oceanic and Atmospheric Administration (NOAA) Lake Erie HAB Bulletin and NOAA Lake Erie HAB Forecast Tool. GLRI funding to NOAA and the Great Lakes Environmental Research Laboratory (GLERL) helped support the development of the tool by GLERL and the Cooperative Institute for Great Lakes Research (CIGLR), NOAA, and NOAA Ocean Service.

The NOAA Experimental Lake Erie HAB Tracker uses the latest satellite imagery of Lake Erie to produce an up-to-date estimate of the present location and 5-day forecast of HABs in western Lake Erie. In addition to these images, weather forecast information and modeled currents in Lake Erie during the HAB season are also used to produce a forecast.

The subset of models/technology used to produce the forecast include a remote sensing satellite-derived cyanobacterial index, lake currents forecasted by the Great Lakes Coastal Forecasting System (GLCFS), and a Lagrangian particle model to determine vertical bacterial distribution.

These forecasts are used by public water systems, anglers, beach-goers, researchers, and others to avoid negative impacts from the blooms and for better enjoyment of the water resources.

The HAB Tracker is available at: https://www.glerl.noaa.gov/res/HABs_and_Hypoxia/habTracker.html

ID	Criteria	Discussion
1	Geographic Extent	Currently is available for Western/Central Lake Erie
2	Scale of Analysis	Regional
3	Delivery Platform	The HAB tracker is delivered through a web browser https://www.glerl.noaa.gov/res/HABs_and_Hypoxia/habTracker.html
4	Pollutants Modeled	Cyanobacterial biomass
5	Level of Expertise/Training	No training required to read or use
6	Model Outputs	Animated image similar to a precipitation radar
7	Data Requirements	No data are required to be input by the user
8	Funding Source	GLRI with early work and products produced through NOAA
9	Model Administrator	GLERL and CIGLR
10	Legislated or Required Use	No
11	Developer of Tool	GLERL, CIGLR, NOAA, NOAA Ocean Service
12	Sub Models	Remote sensing satellite-derived cyanobacterial index, Great Lakes Coastal Forecasting System (GLCFS) provides lake currents, Lagrangian particle tracking model for vertical bacterial distribution.
13	Purpose of Tool	Provide information on the size, location, and projected direction of algal blooms.
14	Software Requirements	Internet connection and web browser
15	Target User	Public water systems, anglers, beach-goers, and researchers

NOAA Runoff Risk Model

The Runoff Risk Decision Support model provides real-time forecasting guidance that gives farmers and nutrient applicators information about when not to apply fertilizers or manure to their fields. The Runoff Risk model was jointly developed by NOAA and Wisconsin around 2009. In 2014, the National Weather Service (NWS) received funding through the GLRI to expand the tool to other Great Lake states including Michigan, Ohio, and Minnesota and to update the previously-used lumped Operational River Forecasting model to a gridded version.

NWS works with state and university partners to deliver a web-based service that estimates a low, medium, or high risk of runoff probability. Each state operates and develops their websites. The presence of risk is defined by 1) runoff occurring, 2) upper layers of soil near saturation, and 3) meteorological driver (rain or snow melt occurring). NWS provides two model runs per day each with a 10-day forecast posted to a secure file transfer protocol (FTP) site. Partnering states download the new information and display it through their own web-based interface.

The Runoff Risk Model runs the Snow 17 Snow Accumulation and Ablation Model and Sacramento Soil Moisture Accounting Model with Heat Transfer and Enhanced Evapotranspiration (SAC-

HTET). The model is run on a 4km x 4km HRAP grid using the NWS Hydrology Lab Research Distributed Hydrologic Model (HL-RDHM) structure to help predict the risk of runoff. The only data requirements for these two models are precipitation and temperature. The Snow 17 model accounts for the accumulation and ablation of snow, while the Sacramento Soil Moisture model predicts hydrological soil conditions, evapotranspiration, runoff, and percolation. For each grid cell, simulated runoff from the SAC-HTET model is accumulated into events that are then compared to the historical event magnitudes for that grid cell over a historical simulation. These events are then stratified into risk categories based on the historical event magnitudes. Risk categories have initially been chosen based on a comparison analysis of simulated event presence versus observed edge-of-field runoff presence.

For each model run a set of geoTIFF files is provided. For each forecast day NWS provide grids for daily average model states. Data include runoff risk, soil temperature, soil saturation, precipitation, temperature, and winter snow pack. This service is currently available for all Great Lakes states. However, only Michigan, Wisconsin, Ohio, and Minnesota have developed web-based interfaces to share with target audiences, which include producers, fertilizer applicators, agricultural and state agencies, and the public.

ID	Criteria	Discussion
1	Geographic Extent	Modeled for the Great Lakes. MI, WI, MN, and OH have web-based interfaces available
2	Scale of Analysis	4km grid for analysis with decisions made at the field level
3	Delivery Platform	Web-based systems: MI: https://enviroimpact.iwr.msu.edu/ OH: https://www.arcgis.com/home/webmap/viewer.html?webmap=b5d6145c98ad481bac08e8a63b957c32 WI: http://www.manureadvisorysystem.wi.gov/app/runoffrisk MN: https://mnag.maps.arcgis.com/apps/MapSeries/index.html?appid=7a6538ffc8994715ba668f0579fe53a2
4	Pollutants Modeled	No pollutants modeled, runoff risk generated
5	Level of Expertise/ Training	No training required to read or use
6	Model Outputs	Geotiff containing runoff risk, soil temperature, soil saturation, precipitation, temperature, and winter snow pack
7	Data Requirements	No data are required to be input by the user
8	Funding Source	GLRI with early work initiated by the NWS and Wisconsin
9	Model Administrator	NWS with each state managing their own website delivering runoff risk maps

10	Legislated or Required Use	No
11	Developer of Tool	NWS and participating states – WI, MI, OH, MN
12	Sub Models	Snow 17 model, which requires temperature and precipitation; hydrological soil model, which simulates soil conditions; Evapotranspiration model, with precipitation and temperature inputs required. Gridded data is a 20 yr historical run. Runoff risk by magnitudes and runoff events, comparing to historical data for that grid cell.
13	Purpose of Tool	Provides forecasted runoff risk to aid in decision making for when to apply nutrients to a field.
14	Software Requirements	Internet connection and web browser
15	Target User	Those applying nutrients to landscape, ag agencies, producers, applicators, and the public.

NOAA Tipping Points Model

The Tipping Points Model is used to assist Lakewide Action and Management Plans (LAMPs), watershed and fisheries communities, along with watershed planning groups with planning and visioning for their community. By identifying the status of watershed health and exploring the impacts of land use change, communities learn how future development will move ecosystems closer to or further from tipping points. A "tipping point" is a threshold of human-induced ecological stress and indicators of natural resource condition that can indicate change in how ecosystems function.

A web-based tool provides users with dials and gauges representing indicators that can be used to connect the effects of land use changes on stream and near-shore biota. Users can conduct “what if?” scenarios by modifying land use changes and seeing how those changes impact changes in water quality. Phosphorus, nitrogen, and heavy metals are some of the pollutants modeled in this system.

Several models are run in the background to predict impacts from various land use changes. These models include a spatially-explicit land use change model (Land Transformation Model) and a Stream Health model that is indexed by fish and invertebrate community composition. The SPARROW model considers landscape factors (climate, soils, topography, etc.) as well as transport and fate properties (stream network, loss, etc.) at the stream segment catchment level to estimate the mean-annual load delivered to the stream.

Catchment loads are then aggregated to estimate the phosphorus load at the HUC 8 spatial scale. In addition, the Spatially Explicit Nutrient Sources model identifies nutrient sources at the 12 digit HUC for atmospheric deposition, septic tanks, agriculture and non-agriculture chemical fertilizer, animal manure, and point sources. The Long-Term Hydrologic Impact Assessment (L-THIA) model calculates the impact of land use changes on the hydrology of a watershed. The gauges display changes in nitrogen, phosphorus, suspended solids, lead, copper, and zinc before and after land use changes are made. Food web models predict impacts of nutrient loads on biomass of plankton, benthos and fish in nearshore and offshore waters in Lakes Michigan, Huron and Erie, and in development for Lake Ontario. The food web models are coupled with the land use and nutrient models to predict water quality and bio-health impacts from land use changes. A model linking wetland health to land use is completed and will be available through the web site.

The Tipping Points Model provides a number of maps and plans for watersheds and water resources in the community in the form of an action plan. The watershed action plan is a product of the community's vision because it is developed with extensive community input.

Tipping Points Model is available at: http://tippingpointplanner.org/resources/model-resources

ID	Criteria	Discussion
1	Geographic Extent	Modeled for MI, WI, MN, and OH
2	Scale of Analysis	HUC 12 Watershed
3	Delivery Platform	The Tipping Point Planner is delivered through a web browser http://tippingpointplanner.org/
4	Pollutants Modeled	Phosphorus, Nitrogen, heavy metals
5	Level of Expertise/Training	No level of training required to read or use, but intended to be used with trained Tipping Points professional
6	Model Outputs	Watershed action plan that includes maps, documents, plans
7	Data Requirements	No data are required to be input by the user
8	Funding Source	A variety of funding sources including EPA Star and GLRI
9	Model Administrator	Tool is hosted at Purdue University
10	Legislated or Required Use	No
11	Developer of Tool	University of Michigan, Purdue University, Michigan State University, Natural Resource Research Institute at University of Minnesota Duluth, NOAA GLERL.
12	Sub Models	Land Transformation Model, Stream Health Model, SPARROW Model, Spatially Explicit Nutrient Sources, L-THIA Model, Food Web Model
13	Purpose of Tool	Provide communities with a watershed health based planning tool to help with strategic planning
14	Software Requirements	Internet connection and web browser
15	Target User	Watershed communities, LAMP communities, fisheries communities, and watershed planning groups

Great Lakes Watershed Management System

The Great Lakes Watershed Management System (GLWMS) is an online tool for field and watershed scale modeling of water quality and quantity in the Great Lakes region. It was released by the Institute of Water Research at Michigan State University (IWR-MSU) in 2013 with support from the Michigan Chapter of The Nature Conservancy (MI-TNC) and the U.S. Army Corps of Engineers. The tool provides a user-friendly mapping interface to delineate farm fields, view local catchments, explore current estimates of soil erosion, sediment loading, nutrient loading, groundwater recharge, and wind erosion, and to evaluate the impacts of various conservation practices on those outputs. To produce these outputs the GLWMS links multiple environmental models in the backend, including the Revised Universal Soil Loss Equation (RUSLE), Wind Erosion Prediction System (WEPS), Soil and Water Assessment Tool (SWAT), Long-Term Hydrological Impact Analysis (L-THIA), and Spread Sheet Tool for Estimating Pollutant Load (STEP-L). Web services are hosted by Purdue University's Agricultural & Biological Engineering Department. The system allows users to store model outputs to their accounts, build reports, and run batch simulations. Modeled outputs are reported on an annual basis.

The GLWMS has been utilized as a platform for implementing multiple conservation programs. MI-TNC used the GLWMS to track and monitor sediment load reductions for a USDA-NRCS Regional Conservation Partnership Program project, GLRI Saginaw Bay Pay for Performance Sediment program, and groundwater recharge enhancements for a Mott Foundation conservation project. IWR-MSU and The Stewardship Network are currently utilizing the GLWMS to estimate conservation payments for GLRI-funded phosphorus reduction efforts in the River Raisin watershed of the western Lake Erie basin. The Delta Institute is currently using the system to carry out a sediment reduction pay for performance project in the Rabbit River watershed of southwest Michigan.

The GLWMS is available at: https://iwr.msu.edu/glwms

ID	Criteria	Discussion
1	Geographic Extent	Saginaw Bay basin (Michigan), Maumee River basin (Ohio and Michigan), Kalamazoo River basin (Michigan), Fox River basin (Wisconsin), Genesee River basin (New York), River Raisin Watershed, MI.
2	Scale of Analysis	Field scale
3	Delivery Platform	The GLWMS is delivered through a web browser https://iwr.msu.edu/glwms
4	Pollutants Modeled	Water quality: sediment, phosphorus, nitrogen. Water quantity: groundwater recharge
5	Level of Expertise/Training	No level of training required to read or use, though familiarity with background models (e.g. RUSLE, SWAT,

		STEP-L) will aid interpretation of results. System includes user-guides.
6	Model Outputs	Depending on the models run the GLMWS will provide sediment, nutrients, or gallons of groundwater recharge by modeled area. These are displayed on screen in a report format, downloadable PDF reports with modeled results and maps can be produced, and batch simulations produce downloadable spreadsheet outputs.
7	Data Requirements	User must digitize field boundaries, though there is an option to upload shapefiles of existing field boundaries. System can utilize default data for current cropping system, crop rotation, and crop residue. However the user is able to provide more detailed model inputs (e.g. RUSLE C-factors, SWAT crop rotations, current land covers, etc.)
8	Funding Source	Michigan TNC, U.S. Army Corps of Engineers though GLRI
9	Model Administrator	Institute of Water Research, MSU
10	Legislated or Required Use	No
11	Developer of Tool	Institute of Water Research, MSU
12	Sub Models	RUSLE, SEDMOD, STEP-L, L-THIA, SWAT, WEPS
13	Purpose of Tool	Field-scale evaluation of potential impacts of conservation on water quality and quantity.
14	Software Requirements	Internet connection and web browser
15	Target User	Conservation technicians, farmers, crop consultants, researchers, government farming agency, government environmental regulators

The Nutrient Tracking Tool

The Nutrient Tracking Tool (NTT) is an online tool that models sediment and nutrient losses from fields. It was developed and is hosted by the Texas Institute for Applied Environmental Research (TIAER) at Tarleton State University, with funding from USDA. Though the tool is available nationally, it is primarily focused on evaluating losses from farm fields and its default inputs were tailored for the western Lake Erie basin. However, the tool's home page indicates that future updates will tailor parameters for other regions.

NTT utilizes the Agricultural Policy Environmental eXtender (APEX) model as its primary analytical engine. Users can define field boundaries within a browser window, which NTT then utilizes to retrieve soils input from backend databases. The user can then describe various aspects of their agricultural operation, including crop rotations, drainage systems, nutrient applications, irrigation management, tillage methods, and scheduling to view annual and monthly baseline averages of sediment and nutrient losses, crop yields, and water flows. Users can also model conservation practices such as cover crops, grassed waterways, and buffer strips to evaluate their impacts on model outputs.

Results can be viewed in a tabular format displaying total nitrates, total phosphorus, organic phosphorus, soluble phosphorus, and sediment. A variety of pathways for these pollutants including surface, subsurface, and tile drains are displayed. Crop yields and plan stress indicators are also available. All these results can be stored in a user's account.

NTT is available at: http://ntt.tiaer.tarleton.edu

ID	Criteria	Discussion
1	Geographic Extent	National, though initial inputs are tailored for Ohio and Western Lake Erie Basin.
2	Scale of Analysis	Field and small watersheds.
3	Delivery Platform	NTT is delivered through a web browser http://ntt.tiaer.tarleton.edu
4	Pollutants Modeled	Sediment, total phosphorus (organic and PO4_P), nitrogen
5	Level of Expertise/Training	User must have basic understanding of agricultural management to utilize system and interpret outputs.
6	Model Outputs	Tabular and graphical outputs of sediment and nutrient losses, crop yields. These include a variety of pathways for pollutants including surface and subsurface, along with plant stress indicators.
7	Data Requirements	User must digitize field boundaries. System utilizes backend soil databases, but the advanced user can customize soil inputs. Users must describe agricultural management options.
8	Funding Source	USDA, NRCS.
9	Model Administrator	Ali Saleh, Ph.D., Texas Institute for Applied Environmental Research (TIAER) at Tarleton State University
10	Legislated or Required Use	No
11	Developer of Tool	TIAER at Tarleton State University
12	Sub Models	APEX
13	Purpose of Tool	Field-scale simulation of sediment and nutrient losses on agricultural fields, evaluation of conservation practices
14	Software Requirements	Internet connection and web browser
15	Target User	Conservation technicians, farmers, crop consultants, researchers, government farming agency, government environmental regulators

USGS NowCast

NowCast is a forecasting system used to predict *E. coli* concentrations in swimmable water. Managers can use that information to determine the likelihood of whether or not recreational water body contact standards will be exceeded.

Through a mathematical system, NowCast uses easily measured environmental and water-quality "variables," such as turbidity and rainfall, to estimate levels of fecal indicator bacteria (FIB). Mathematical models are developed from several years of measurements taken at a particular site, and all models used in the NowCast are swimming area or site specific. A multivariate statistical model is used to develop relationships between bacterial concentrations and parameters that influence them.

NowCast variables are measured each morning by a beach manager or technician and entered into computer software. The NowCast for swimming areas provides the probability (in percent) that the established state recreational water quality standard will be exceeded. So on any given morning, there can be from a 1- to 100- percent probability that the standard will be exceeded.

The NowCast is the result of multi-year partnerships on several projects between the U.S. Geological Survey (USGS), and other federal, state, and local agencies and universities. Current and past partners include Chautauqua County Department of Health (NY), Cleveland Metroparks (OH), Cuyahoga County Board of Health (OH), Erie County Health Department (OH), Erie County Department of Health (NY), Erie County Department of Health (PA), Lake County General Health District (OH), Monroe County Health Department (NY), Muskingum Watershed Conservancy District (OH), New York State Department of Health, New York State Office of Parks, Recreation and Historic Preservation, Northeast Ohio Regional Sewer District (OH), Ohio Department of Health, Ohio Department of Natural Resources, Ohio Lake Erie Office, Ohio Water Development Authority, University of Toledo (OH), EPA, and the U.S. National Park Service.

ID	Criteria	Discussion
1	Geographic Extent	Modeled in Lake Erie at beaches in New York, Pennsylvania, and Ohio.
2	Scale of Analysis	Beach swim areas
3	Delivery Platform	NowCast has a web-based interface that shows predicted colony forming units. https://ny.water.usgs.gov/maps/nowcast/
4	Pollutants Modeled	*E. coli*

5	Level of Expertise/Training	Beach manager reads results compared to state's recreational standards and make decisions on swimming. Knowledge of required parameters measured at the beach and entered into the modeling software requires training.
6	Model Outputs	Digital report of percent chance of exceeding a state's recreational *E. coli* exposure standard
7	Data Requirements	Parameters needed include turbidity (water clarity), rainfall, wave height, water temperature, day of the year, and lake level.
8	Funding Source	GLRI, USGS
9	Model Administrator	USGS
10	Legislated or Required Use	No
11	Developer of Tool	USGS with support from local, state, and federal partners
12	Sub Models	A multivariate statistical model is used to develop relationships between bacterial concentrations and parameters that influence them. Additional tools to compile data include software for creating predictive models (Virtual Beach) developed by U.S. Environmental Protection Agency; software to process weather data from the nearest National Weather Service airport site (PROCESSNOAA); and a spreadsheet to process lake-level data from the National Oceanic and Atmospheric Administration (NOAA).
13	Purpose of Tool	Provides near real-time *E. coli* concentration forecasts for beach managers to assess the safety of recreation contact
14	Software Requirements	Internet connection and web browser and software for data input
15	Target User	Beach managers and the public

Summary

There are a number of customized tools available to agricultural and water quality practitioners in the Great Lakes region that help in forecasting, measuring, and estimating pollutant loads and water quality changes. There have been significant investments in financial and human resources to develop, adopt, and promote these systems. In exploring opportunities to move water quality practitioners toward a unified modeling approach it is import to recognize that: 1) not all of the water quality tools address the same pollutants, 2) significant investments have been made in creation and adoption of particular models that drive these tools, and 3) when water quality tools are successful it is often because they have simple user requirements and are focused in their design. The combination of these factors present significant challenges in promoting a unified approach in modeling water quality improvements.

These challenges may include building or using tools that address too many different pollutants in one interface. These tools often overwhelm users with choices and may become too complex with the number of input requirements from the user. Additionally, "favorite" models or preexisting investments in model development make it very difficult to select a different model that might fit into a more unified modeling approach.

One approach to address some of the challenges mentioned above is to develop a common delivery platform that provides basemaps, visualization, and common mapping requirements that many of these tools discussed utilize. The platform would not be bound to any particular model but could utilize outputs from any model of choice. The Great Lakes Watershed Management System, which is one example of this, is not tied to a particular model but can utilize results from any number of models. In many cases this type of platform can be used to deliver model results from models that water quality practitioners are currently using.

In summary there are potential benefits to using a unified water quality modeling approach, however, there are several significant challenges that need to be addressed. Exploring the use of platforms or interfaces that do not require users to abandon currently used models, and that do not overwhelm users with too many input requirements or choices are likely to yield the best results.

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