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Commentary

Making the leap from science to implementation: Strategic agricultural conservation in Michigan's Saginaw Bay watershed

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ABSTRACT

There is growing evidence that addressing nonpoint source pollution within intensely agricultural regions of the Great Lakes will require innovative solutions to achieve meaningful ecological outcomes. Recognizing this, a broad coalition of partners is collaborating across Michigan's Saginaw Bay watershed to develop and test innovative approaches to achieve the vision of Strategic Agricultural Conservation. The strategy focuses on using science, technology, and new ways of incentivizing practices and delivering services to producers to address challenges and barriers to Strategic Agricultural Conservation. It uses science to model relations between conservation actions, water quality and fish community health, allowing the coalition to establish realistic ecological outcomes and both short and long-term implementation goals at a variety of scales. It uses a decision tool and pay-for-performance methods to strategically target conservation practices and increase their efficiency. It uses nontraditional partners to help increase the ability to engage landowners and streamlined the application process to help increase landowner participation. Finally, it uses secure, privacy respecting, methods to track practices and progress towards short and long-term goals. Herein we present three case studies that demonstrate the practical application of this strategy including developing and testing new innovative conservation programs across the Saginaw Bay watershed. The success of this work will ultimately be determined by a variety of factors that affect conservation at landscape scales. However, what is clear is that without the science and complementary decision tool, this collaborative adaptive management approach would be impossible to implement across such a large geography.

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Introduction

Over the past decade The Nature Conservancy (TNC) has been working with numerous partners to find balanced solutions for addressing agricultural nonpoint source pollution across the Saginaw Bay watershed in Michigan. Ultimately, this coalition is striving to achieve “Strategic Agricultural Conservation”, which seeks to get the right conservation practices to the right places in the right amount, as efficiently as possible, to reach shared desired outcomes. However, agricultural nonpoint source pollution is a complex problem, from both an ecosystem and socioeconomic perspective, that presents many challenges to achieving Strategic Agricultural Conservation (Table 1).

In the Introduction of this paper we discuss some of the key challenges and barriers to Strategic Agricultural Conservation. Next, in the General Methods section, we describe innovative science, technology, and programmatic solutions this coalition has developed and is testing to help address these challenges and barriers. We then present three case studies to illustrate the practical application of these solutions. Finally, in the discussion we present lessons learned from the case studies and steps that can be taken to expand and improve the approach and move closer to the vision Strategic Agricultural Conservation. We hope to demonstrate the value of this approach and how it can be implemented across the larger Great Lakes region and beyond. There are many challenges to achieving Strategic Agricultural Conservation, but we focus on what we believe are eleven of most critical challenges and barriers, which are listed in Table 1 and discussed more thoroughly in the remainder of the Introduction.

Ideally, success of biodiversity conservation programs is measured by progress towards desired biological outcomes and progress towards short and long-term conservation action goals (i.e., implementation goals) needed to achieve those outcomes. This requires having a scientific understanding of the relationships between these very different measures of program performance (Fig. 1; Tear et al., 2005; Wilhere,

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Table 1
Eleven major challenges and barriers to strategic agricultural conservation and the proposed science, technology and program solutions developed and tested across Saginaw Bay.

		Proposed solutions	
Major components of strategic conservation	Challenges and barriers	Science & technology	Programs and process
Establish biological outcomes and related short and long-term implementation goals	Lack of data and models to predict potential biological response to conservation practices	Relate field measurements of fish community health to predicted water quality conditions at sampled locations	NA
	Health of stream fish communities is determined by many habitat factors	Use quantile regression to isolate marginal influence of water quality on fish community health	NA
Target conservation practices at multiple scales	Lack of resources for incentive payments and technical assistance	NA	Secure public or private funding to complement funding of U.S. Farm Bill
	Targeting is often politically contentious and not allowed under most conservation programs	NA	Secure public or private funding that do not have restrictions on targeting
	Targeting is a complex process that requires decision tools that are often difficult to use	Develop a decision tool (GLWMS) that can account for this complexity and support multi-scale targeting and new incentive payment programs	Establish targeting programs that account for this complexity, like pay-for -performance, and maximize the ecological benefits of each dollar spent
Increase network capacity and reduce administrative burden	Lack of network capacity to provide program services to producers	NA	Secure funding to support full-time technicians and work with nontraditional partners to provide technical assistance
	Producers often perceive that government programs have too much “red tape”	Ensure the GLWMS reduces the complexity and time it takes to assess producer eligibility and payments	Streamline sign-up process for conservation programs and estimation of incentive payments
Track and assess progress towards short and long-term implementation goals and biological outcomes	Difficult and time consuming to map conservation practices	Ensure the GLWMS has the ability to easily map practices in the field	Provide training on how to map practices with the GLWMS
	Difficult to track the cumulative footprint and estimate the ecological benefits of conservation practices at multiple scales	Ensure the GLWMS has these challenges and so it can report on progress towards short and long-term implementation goals at multiple scales	NA
	Privacy concerns of producers	Ensure the GLWMS stores practices in a secure database with no sensitive information	Establish secure administrative processes for tracking and reporting the cumulative benefits of practices
	Risk of cuts to long-term monitoring programs	NA	Demonstrate value of and advocate the need for long-term ecological monitoring programs

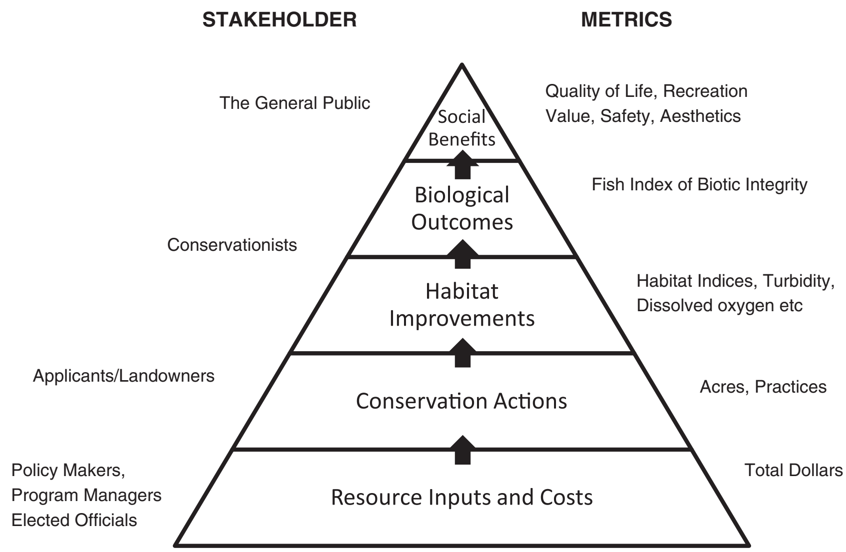

Fig. 1. Pyramid of conservation outcomes and associated performance metrics and stakeholder groups.

2008; Sowa et al., 2016–in this issue). Unfortunately, establishing relations between conservation actions and biological endpoints is extremely challenging and rare in conservation due to *data limitations* and the *number of factors that determine the distribution and abundance of biota* (Margoluis and Salafsky, 1998; Tear et al., 2005). This is certainly true for conservation efforts in agricultural landscapes (USDA NRCS, 2011b). There are many watershed models that can predict changes in water quality resulting from agricultural management scenarios that are used to help set implementation goals (Borah and Bera, 2003; Borah and Bera, 2004). However, extending these predictions to biological endpoints, like measures of fish community health, adds another layer of complexity that until recently has been difficult to address. Fortunately, advancements in watershed modeling and the availability of key geospatial data make it possible to address this challenge. They have been a major focus of the coalition's work in Saginaw Bay (Sowa et al., 2016–in this issue).

Funding is always limited and presents a significant challenge to large-scale restoration efforts (Vigmostad et al., 2005) and efforts to address agricultural non-point source pollution are no exception. Results of Keitzer et al. (2016–in this issue) and Sowa et al. (2016–in this issue) reinforce this reality by showing that current levels of funding available to incentivize and offset costs of conservation practices under the U.S. Farm Bill are insufficient to treat the acres needed to see measurable improvements in stream health. When this reality is combined with recent trends of decreasing conservation funding, it becomes apparent that steps must be taken to maximize the efficiency of conservation efforts (Diebel et al., 2008; USDA NRCS, 2011b; Legge et al., 2013). There are several ways in which conservation programs can increase overall efficiency, like targeting critical areas or pay-for-performance, but there are also *many sociopolitical and administrative barriers to targeting* that must be addressed (Claassen et al., 2008; Wardropper et al., 2015; Messer et al., 2016). In fact, U.S. Farm Bill programs have recently shifted policies away from targeting except at larger watershed scales as targeting is often viewed as politically contentious (Claassen, 2003; Shortle et al., 2012; Kalcic et al., 2014).

Even when targeting is an option there still exists the challenge of dealing with the *complexities of the targeting process*. Benefits that accrue from conservation practices are affected by numerous variables such as soil type, distance to a water body, topography, and crop (Qiu, 2003; Gitau et al., 2005). To address this complexity numerous decision tools have been developed to help technical assistance providers identify the most cost-effective locations for implementing conservation practices (Hession and Shanholtz, 1988; Richardson and Gatti, 1999; Veith et al., 2003; Mishra et al., 2007; Schilling and Wolter, 2009; Tuppad et al., 2010). However, these systems are often difficult to use and focused on individual outcomes (e.g., sediment or nutrients) (Legge et al., 2013), which are barriers that can limit their use for targeting. Ultimately conservation practices are implemented for multiple benefits and decision tools should be designed to easily and efficiently assess costs of multiple practices and potential benefits to multiple factors to provide a more flexible, realistic, and useful tool for resource managers and producers (Wünscher et al., 2008).

Reluctance of producers to participate in conservation programs presents yet another significant challenge to addressing agricultural nonpoint source pollution (Reimer and Prokopy, 2014; Palm-Forster et al., 2016–in this issue). Technical assistance in the form of outreach, education, conservation planning, and program sign-up and administration are essential forms of support for producers and can greatly influence their participation in conservation programs. In fact, the "local networking capacity" available to producers to provide these forms of assistance is often identified as one of the most important factors affecting participation (Baumgart-Getz et al., 2012). Unfortunately, *local networking capacity is often limited* and in many instances shrinking to the point that landowners of the highest priority lands may never be contacted or may be unwilling to participate due to the lack of technical assistance (Stubbs, 2010). Overcoming this barrier will require finding innovative ways to increase the local networking capacity available to landowners—particularly those on high priority lands—and provide them with the technical assistance they need to increase participation rates.

Another barrier to landowner participation is the *perception that administrative burden of USDA programs is too complex and cumbersome* (Stubbs, 2010). There are many U.S. Farm Bill conservation programs. Each program operates under a unique set of parameters including different application periods and different eligibility and selection criteria and payment rates. Interested landowners must navigate conservation options across these programs and once applications are submitted may wait months to receive acceptance into a program. As a result, landowners often report avoiding federal conservation programs due to negative perceptions about the complexity of the process required for participation (Reimer and Prokopy, 2014). Ultimately, conservation programs have to balance the necessary rigidity and complexity with flexibility and simplification.

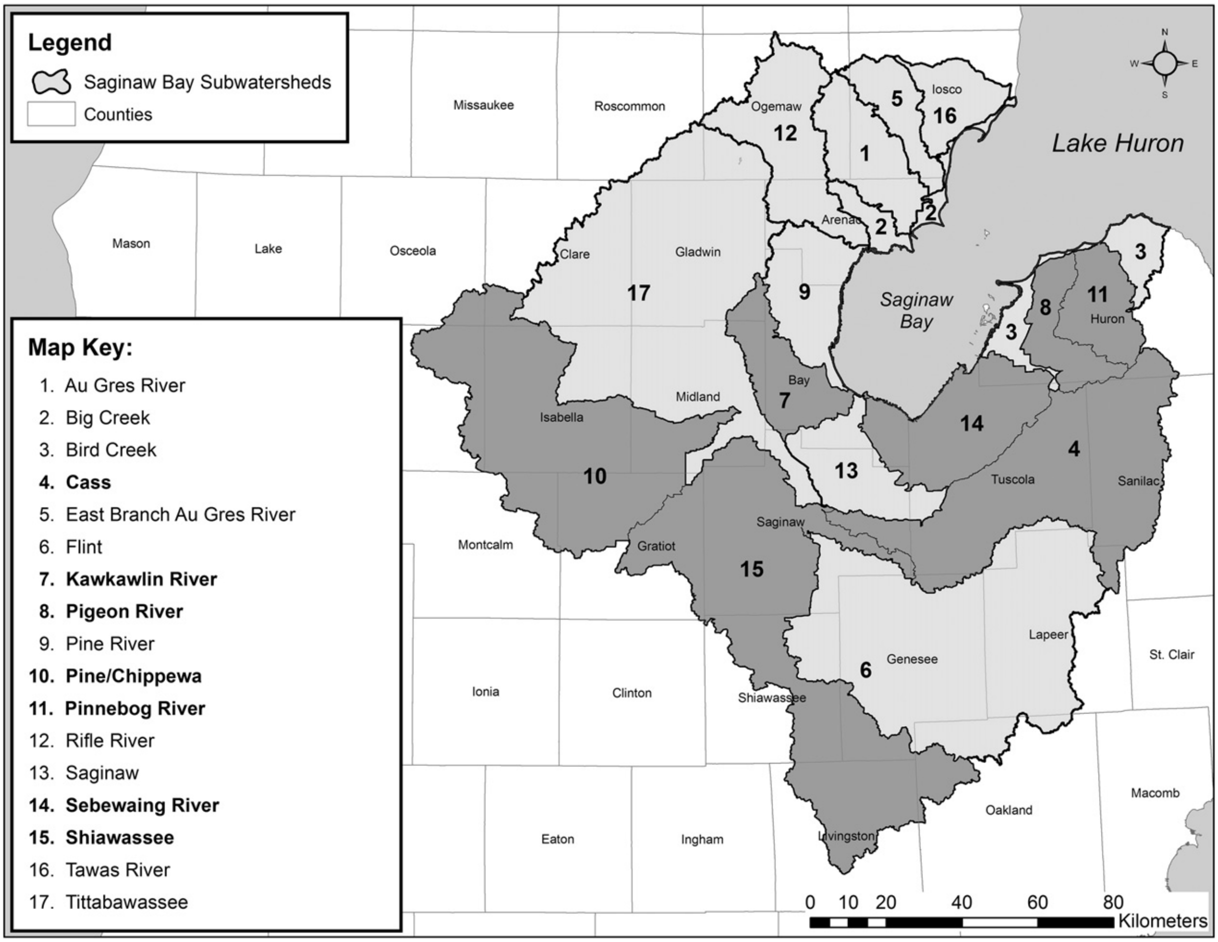

Fig. 2. Map of the Saginaw Bay subwatersheds. Subwatersheds in dark grey and corresponding name in bold highlight those that are the focus of the work described in the case studies.

It is not enough to establish desired biological outcomes and related implementation goals needed to achieve them. Equally important is tracking and assessing progress towards these outcomes and both short and long-term implementation goals. Thankfully state and federal water quality and biological monitoring programs are in place to track progress towards these ecological outcomes (MDEQ, 2014; USEPA, 2009). However, there are always concerns about possible cuts to these monitoring programs that could pose a challenge to assess progress in the future (Gitzen et al., 2012). There are also federal programs in place that monitor national and regional status and trends in agricultural conservation practices (USDA NRCS, 2007; USDA NRCS, 2011a, 2016). These programs are critical to assessing status and trends in the implementation of agricultural management practices, but are too coarse for assessing progress of local programs and projects being

Table 2
Area and percent land cover within subbasins of the Saginaw Bay watershed.
(Source: 2012 National Land Cover Database.)

Name	MapRef ID	Area (acres)	% Developed	% Forest	% Hay/ Pasture	% Cultivated Crops	%Wetland/ Open water
Au Gres River	1	156,261	7	37	13	19	24
Big creek	2	61,819	11	31	5	12	40
Bird creek	3	106,235	9	8	11	59	12
Cass	4	581,039	8	22	16	41	13
East Branch Au Gres River	5	94,012	7	53	8	5	27
Flint	6	851,497	20	23	18	27	11
Kawkawlin River	7	144,153	13	24	6	41	17
Pigeon River	8	100,708	6	6	10	72	6
Pine River	9	166,624	10	25	7	41	16
Pine/Chippewa	10	656,384	8	28	13	34	17
Pinnebog River	11	119,335	8	6	12	66	8
Rifle River	12	244,073	9	53	10	8	20
Saginaw	13	160,800	30	4	7	54	5
Sebewaing River	14	250,429	8	3	7	79	2
Shiawassee	15	810,055	12	17	14	42	14
Tawas River	16	99,741	8	57	4	4	27
Tittabawassee	17	926,359	10	43	9	15	23

implemented in Saginaw Bay. It is critical to be able to track and assess progress at finer spatial grains that align with the jurisdictions of local practitioners (e.g., conservation districts and crop advisors) and producers so they cannot just define, but also celebrate milestones and success. However, *mapping conservation practices can be time consuming*. It is also *difficult to track the cumulative footprint of practices* and estimate their ecological benefits. There are also *privacy concerns of producers* and the agricultural community in general (Hively et al., 2013). Consequently, it is important to ensure that tracking and assessing progress at these finer spatial grains is accurate, efficient, and has the security measures in place to protect the privacy concerns of individual landowners and operators.

Addressing these challenges and barriers to achieve Strategic Agricultural Conservation requires a blend of science and "art". As we outline in the General Methods the science provides the enabling conditions for setting goals, targeting practices and tracking progress. However, as we hope to demonstrate with the case studies there also there is an "art" to identifying the right partners and building the collaborations that lead to new ways of providing services to producers and incentivizing practices that ultimately make it possible to get the right practices to the right place in the right amount to achieve desired environmental outcomes.

Study area

The Saginaw Bay Watershed is the largest watershed within the State of Michigan and is an important component of the Great Lakes ecosystem (Fig. 2). Containing more than 8700 mile^2 and encompassing portions of 22 counties, the watershed accounts for about 15% of Michigan's total land area. It is home to nearly 1.4 million people and is a key part of Michigan's economy and agricultural production (MDNR, 1994). The watershed can typically be divided into seventeen subbasins of varying sizes (Fig. 2) with the northern half of the watershed predominantly forested and the southern half of the watershed predominantly agricultural. The coalition's efforts to address agricultural nonpoint source pollution has largely been focused in the subbasins located in the southern half of the watershed, especially in the Shiawassee, Cass, Pigeon and Pinnebog River watersheds (Fig. 2) which were also the focus of the work of Sowa et al. (2016–in this issue). Some of the work has also occurred in other similar watersheds including the Sebewaing, Chippewa, Kawkawlin and Saginaw Rivers (Fig. 2).

The predominantly glacial geology and soils of the watershed, especially the clay plain and lake plain prairie soils, are extremely fertile and proved very suitable for agriculture (Arthur et al., 1996; MDEQ, 2003). By the mid-1880s, the watershed had been transformed from a mostly forested and coastal wetland system into one of the most productive agricultural regions in Michigan (Comer et al., 1993). Presently, approximately 46% of the Saginaw Bay Watershed is in agricultural land use (cultivated cropland plus hay and pasture) although this percentage varies widely across individual subwatersheds from 8% in the Tawas River to 86% in the Sebewaing River (Table 2). The most common row crops are corn for grain, soybeans, wheat, dry edible beans and sugar beets (USDA NASS, 2014).

Over the years, runoff from agricultural and urban lands, combined with improper manure management, combined sewer overflows, and industrial pollution, have led to high sediment and nutrient loadings leading to loss of fish and wildlife habitat and eutrophication in the tributaries and Saginaw Bay (MDNR, 1988; He and Croley, 2008; He and DeMarchi, 2010). Since enactment of the Great Lakes Water Quality Agreement in 1972 and subsequent federal and state water quality policies, there has been significant progress in addressing many of the urban and industrial point sources (PSC, 2000, 2002; Selzer et al., 2014). Addressing sediments and nutrients from rural nonpoint sources has proven to be a greater challenge in the Saginaw Bay watershed.

General methods for implementing strategic agricultural conservation

Defining realistic outcomes and related implementation goals

To help address the challenges to setting realistic desired outcomes and related implementation goals the coalition used the models developed by Sowa et al. (2016–in this issue) (see Table 1). This modeling process used a downscaled Soil and Water Assessment Tool (SWAT) model (Arnold et al., 1998; Arnold and Fohrer, 2005) to help fill gaps in water quality data at fish sampling locations. It also used modeling techniques, like quantile regression, to isolate the influence of water quality from the many other habitat factors that influence fish community health. The modeling process specifically focused on relating potential benefits of management scenarios, consisting of ten conservation practices, to various measures of water quality and an Index of Biotic Integrity (IBI). The IBI is a widely used measure of overall fish community health (Karr, 1981), with scores used by Sowa et al. (2016–in this issue) ranging from 0 to 100, with higher scores indicating better fish community health. The overall modeling process generates "dose-response" curves that show relations between different amounts of conservation, water quality, and potential IBI scores. These curves can be used to determine the amount of conservation needed to improve water quality conditions to the point they are no longer limiting fish community health. Since the models do not address all potential limiting factors (e.g., instream habitat or invasive species), they provide an estimate of the potential IBI score that could be achieved at a site if there were no other limiting factors (Cade and Noon, 2003; Wang et al., 2007; Weigel and Robertson, 2007; Keitzer et al., 2016–in this issue; Sowa et al., 2016–in this issue).

The "dose-response" curves were iteratively evaluated with partners to assess costs and benefits of additional conservation practices and help establish realistic outcomes and short and long-term implementation goals. Based on these evaluations the coalition established a goal of achieving potential IBI scores of 90 for subbasins in the Shiawassee and Cass Rivers and slightly lower potential IBI scores of 80 within the Pigeon and Pinnebog Rivers (see Fig. 2). We refer to these ecological outcome goals as the "80/90 IBI goal." These goals are intended to strike a reasonable balance between what is ultimately desirable and what is currently realistic. Ultimately, it is desirable for streams to have the potential to achieve IBI scores of 100, but the coalition collectively determined this was too high of a bar in the subbasins where it is working. However, if new technologies or conservation practices provide more cost effective means for reducing sediment and nutrients, then revisions to these goals might be appropriate.

After establishing the 80/90 IBI goals, these same models generate estimates of the acres of conservation practices needed to achieve those goals and established both short- and long-term implementation goals for each subbasin. The models suggested a long-term implementation goal of approximately 209,000 acres for selected conservation practices would achieve the 80/90 goals for subbasins across the Cass, Pigeon, Pinnebog, and Shiawassee River watersheds. The other three focal watersheds, the Chippewa, Kawkawlin, and Sebewaing River watersheds, were not included as part of the modeling efforts of Sowa et al. (2016–in this issue), so goals were set by applying the dose-response relationships established by Sowa et al. (2016–in this issue) to a related model by Nejadhashemi et al. (2012). This related model had data on *current* nutrient and sediment concentrations for these three watersheds, making it possible to generate an estimate of the number of acres needed to be treated to improve these water quality parameters in accordance with the 80/90 goal. This process generated the estimate that an additional 120,000 acres of conservation practices would need to be implemented in these three watersheds (see Fig. 2). This resulted in an overall long-term implementation goal of approximately 329,000 acres across all seven focal watersheds. This seems like a daunting goal, but the partners understand that it would be possible to achieve the ecological goals treating substantially fewer acres if the location of the conservation practices is targeted (Weinberg and Claassen, 2006; Legge et al., 2013).

Targeting conservation practices

To address the challenges and barriers to targeting of conservation practices the coalition has focused on a) securing funding from outside U.S. Farm Bill programs, and b) developing an easy-to-use decision support tool (see Table 1). Substantial funding from the U.S. EPA and several private funders has complemented the funds available through conservation programs administered under the U.S. Farm Bill. These additional funding resources do not have restrictions on targeting, and this has been essential to the development and testing of new targeting methods.

A decision tool, called the Great Lakes Watershed Management System (GLWMS), was developed that could address the complexities and facilitate targeting of conservation investments (see Table 1). The GLWMS was also developed to help the coalition increase administrative efficiency and track progress towards goals (see Table 1), which are described further in those corresponding sections below. The GLWMS is an online tool, accessible at www.iwr.msu.edu/glwms/, that is currently available in several important watersheds within the Great Lakes region.

The GLWMS provides users with several options for targeting at coarse watershed scales. Users can view existing map layers showing erosion, sedimentation, and nutrient runoff across all of the watersheds where it is available. Users can also run their own analyses for smaller hydrologic units (8, 10, and 12–digit HU's) and visualize these results. In the Saginaw Bay watershed, the GLWMS also includes a layer termed “Fish Habitat” that allows users to view results of the analyses by Sowa et al. (2016–in this issue) that shows which watersheds conservation practices are expected provide the most environmental benefit, and which practices will maximize those benefits. There is also a layer showing the eligible watersheds for one of the conservation programs discussed below (see Case study #2). Collectively, the results of the analysis by Sowa et al. (2016–in this issue) and the functionality of GLWMS provide have allowed the coalition to develop scoring systems that direct funding to the highest impact watersheds and determine program eligibility. This approach applies to all three case studies.

The GLWMS can also access and compare potential benefits of a variety of best management practices (e.g., no-till, cover crops, filter strips, etc.) at watershed and field scales. The field-scale analysis capabilities of the GLWMS have been critically important to all of the projects in the Saginaw Bay watershed. Users can easily map individual fields and estimate changes to multiple ecological factors, including soil erosion, sediment loading, nutrient runoff, and groundwater recharge. The GLWMS does not identify the most cost-effective or impactful *combination* of practices for any given field. Those recommendations are still dependent on the advice of an experienced technician and an evaluation of resource concerns on the farm. More recently the functionality of the GLWMS was expanded beyond ecological factors so users can assess the potential effect of different management practices on crop yields, which is a critical economic factor affecting whether or not a producer will implement a practice (Veith et al., 2003).

The GLWMS uses the High Impact Targeting tool (HIT; Ouyang et al., 2005; Renard et al., 1997; Fraser, 1999) to estimate annual soil erosion and sediment delivery. It combines the Revised Universal Soil Loss Equation (Renard et al., 1997) with the Spatially Explicit Delivery Model (Fraser, 1999) to estimate annual sediment delivery from each 100 m^2 area on the landscape to the stream network. Its primary inputs are land cover (including crop rotations and tillage for agricultural lands), slope, soil type, distance to the stream and rainfall. To estimate annual runoff and nutrient loading to streams, the GLWMS uses the Long Term Hydrologic Impact Assessment (L-THIA; Lim et al., 1999), which employs a curve-number approach. This approach uses a land cover classification, hydrologic soil group, and weather to calculate annual runoff, and then multiplies that by a loading coefficient derived from literature for particular nutrients and land covers. Users can define a specific field or area of interest and select from over 30 agricultural conservation practices available in the system. The model outputs quantify environmental benefits in terms of reduced loading of sediment (tons), runoff (acre-ft) and nutrients (lbs).

The coalition is also testing pay-for-performance programs (see Case study #3) in which incentive payments are determined based on the estimated environmental benefit of practices put in place rather than the acreage that they cover. Measuring actual performance is not yet possible, but the GLWMS system makes it possible to simulate the environmental impact of a wide range of conservation practices on any given parcel of land. Drawing on this capability, it becomes possible to link incentive payments to their simulated conservation impact.

Paying for performance as opposed to paying for practices offers great advantages for targeting the location of conservation investments. In particular, payments can be offered for conservation practices to be put in place on parcels where they are expected to have a strong environmental impact, and they can be withheld from lands where they are not expected to have an impact.

Case study 3 demonstrates a situation in which the coalition has sufficient flexibility due to its funding sources to offer pay for performance as described here. Case studies 1 and 2, on the other hand, partner with US federal government programs and are thus constrained the rules under which they operate, making pay for performance infeasible.

Testing new methods to increase network capacity and administrative efficiency

To help increase producer participation in conservation programs the coalition uses both technology and new program delivery methods to increase network capacity available to producers and reduce the administrative burden of the programs (see Table 1). Producers often make decisions based on input from trusted individuals and organizations, including crop advisors and agribusinesses (Loy et al., 2013; Prokopy et al., 2014). Because of this the coalition is experimenting with different ways of training and making more of these trusted individuals available to provide technical assistance to producers. Funds under the program support full-time conservation technicians (employed at local conservation districts) to conduct targeted outreach to landowners in high impact areas. Experience from the program shows that conservation district staff, who work closely with NRCS and FSA, typically have the necessary experience and conservation expertise to provide the technical assistance, but they often lack the dedicated funding to allow them to conduct targeted outreach activities. The program is also increasing network capacity by engaging with non-traditional conservation partners, such as local agribusinesses and crop advisors, to help recruit eligible landowners in high impact areas. This new recruitment method is meant to complement and bolster rather than replace traditional recruitment methods.

When conservation funding is delivered via traditional NRCS programs like EQIP, the coalition has limited ability to alter the application, processing and contracting requirements. However, all of the case studies discussed below use a pre-screening process that makes it possible to incorporate a degree of targeting while also reducing administrative burden. This process is embedded within the GLWMS, which can be used on a tablet in the field. The GLWMS can quickly quantify scores and determine eligibility of producers and also quickly assess and compare potential costs and benefits of practices and calculate pay-for-performance incentive payments. This pre-screening process makes it possible to quickly evaluate potential projects before landowners are asked to fill out and technical staff are required to assess time consuming applications. For projects that successfully pass the pre-screening process, landowners have an increased level of certainty that their project will receive funding as long as they can submit the necessary paperwork and funding is still available. The coalition has also improved administrative efficiency by devising a process that depends on one central staff person to conduct the outreach, evaluate potential projects and execute contracts. In most instances all of these steps can be completed in one day with minimal paperwork due to the pre-screening process and increased efficiencies provided by the GLWMS. Finally, in the pay-for-performance projects (see Case study #3), specific sign-up periods were eliminated and replaced by rolling applications to further reduce the complexity of the enrollment process.

Developing tools and secure methods for tracking and assessing progress towards goals

As stated earlier it is not enough set goals; it is equally important to track progress towards those goals. For the efforts in Saginaw Bay that means tracking progress towards both implementation goals and ultimate ecological outcomes. Addressing the challenges with tracking progress towards short and long-term implementation goals required adding additional functionality into the GLWMS (see Table 1). The first step was to make sure the process of digitizing practices was simple and that users can set up accounts to store practices into a database. Users can also batch load practices that have already been mapped and georeferenced elsewhere, which significantly speeds up the process. Training materials and sessions are included to train all of the participating conservation practitioners. The GLWMS can also process the practices in the databases to track their cumulative footprint, estimate their ecological benefits, and report on progress towards implementation goals (see Table 1).

To address privacy concerns there are many layers of security within the GLWMS and the overall reporting process to ensure privacy of landowners is maintained (see Table 1). First, each user is provided a secure, password protected, account. Next, the GLWMS does not require users to enter any personally identifying information about the landowner. Finally, two staff at MSU are the only ones with access to the information stored within GLWMS and who can generate reports that summarize progress at the level of a county or subwatershed. These reports provide actual progress towards short and long-term implementation goals by each practice and also estimated progress towards intermediate ecological goals (i.e. total tons of sediment or total pounds of nutrients reduced) that can then be extrapolated to progress towards the 80/90 IBI goals via the models provided by Sowa et al. (2016–in this issue). Ultimately, progress towards ecological outcomes will be tracked through data provided by the Michigan Department of Environmental Quality's long-term monitoring program (MDEQ, 2003, 2014). Additional funds are also being sought for more targeted monitoring of the focal watersheds that could provide a more detailed and rapid assessment of changes in water quality and fish community health.

Assessing project performance and collaboration

If a program does not operate effectively, communicate clearly or effectively influence producer participation, then it will still be unsuccessful even if it has all the major components needed for achieving Strategic Agricultural Conservation (see Table 1). A comprehensive evaluation of the Saginaw Bay Regional Conservation Partnership Program (RCPP; see Case study #2) aims to assess project effectiveness and efficiencies over time. To compile these data, the coalition is working with NRCS and the Natural Resources Social Science Lab (NRSSL) at Purdue University. NRSSL will lead an independent, third-party social evaluation that will measure and track changes in various social indicators such as landowner and crop advisor awareness, attitudes, behaviors and their understanding of water quality and conservation issues. This evaluation will consist of a comprehensive survey of landowners farming in the Saginaw Bay region, a survey of local agribusinesses and crop advisors operating in the region, one-on-one interviews with key project team members, landowners and crop advisors and observation of training meetings and RCPP-related events. This evaluation will be ongoing throughout the first five years of implementation and the annual analysis will be used to manage the projects for optimal effectiveness. The data collected from this study will identify changes in social indicators such as awareness, attitudes and beliefs about water quality and conservation issues, as well as long-term continued use of the approach, tools and conservation practices. These data will also help assess the influence of crop advisors, funding sources and economics on landowner decision making. Collectively, this information will be used to identify successes of and barriers to the new approaches that the coalition is undertaking and help it adaptively manage and improve these projects and the overall approach in real time.

Table 4
Short-term implementation goals for six conservation practices that were the focus of the Cass River Watershed project (see Fig. 2). Achieving these goals represents the first milestone towards achieving the long-term implementation goal of ~62,000 ac that analyses by Sowa et al. (2016–in this issue) estimated were needed to achieve the desired fish community outcome for this watershed (i.e., and IBI potential of 90).*

Practice	5-year Implementation goal	Achieved in 3-year project
Nutrient management	12,000	10,276
Conservation crop rotation	3000	1190
Filter strips/conservation cover	130	81
Residue and tillage management	15,000	3230
Cover crop	3000	2750
Wetland creation/restoration	5–7 new wetlands	13

* Note: units are in acres except for wetlands.

Case studies

Below we present three case studies that demonstrate the practical application of the methods described above. All three case studies involve many important partners and provide a complementary mix of the proposed solutions the coalition is using to address the challenges and barriers to Strategic Agricultural Conservation (Tables 1 and 3). Although the process of implementing and testing some of the approaches is relatively new, already the partners have learned a great deal from these case studies.

Case study #1: targeted conservation in the Cass River watershed

The Cass River watershed (Fig. 2) was identified as the first location to implement and test some of the approaches to the challenges and barriers to Strategic Agricultural Conservation (Tables 1 and 3). This was because TNC had the science to help set realistic ecological outcomes and implementation goals, the technology to target practices and track progress (i.e., GLWMS) and partners (e.g., Sanilac and Tuscola County conservation districts) willing to engage at the local level.

Table 3
Summary of elements of the strategic agricultural conservation process implemented and tested, indicated by an "X", in the three case studies.

Case study	Ongoing (O) or completed (C)	Outcome based goals	Watershed scale targeting	Field scale targeting	Outcome based payments	Traditional (T) or non-traditional outreach (NT)	Reduce admin burden
#1 Cass River	C	X	X			T	
#2 Saginaw Bay Watershed RCPP	O	X	X	X		T, NT	X
#3 Pay for performance	O	X	X	X	X	T	X

TNC and its partners used the results of Sowa et al. (2016–in this issue) to identify and target outreach efforts of conservation district staff to seven priority subbasins (116,000 acres of row-crop) of the Cass River Watershed. These subbasins were predicted to have the highest rates of water quality and biological improvement with increasing conservation practices. In addition, these subbasins were located upstream of reaches where water quality goals could actually be achieved with relatively modest investment by reducing nutrient and sediment laden runoff. They also used the models developed by Sowa et al. (2016–in this issue) to establish long-term implementation goals (62,213 acres) based on estimates of the acres of treatment needed reach the 80/90 IBI goals. Sanilac and Tuscola Conservation Districts then set short-term implementation goals for a variety of practices based on what they believed could be achieved over a 5-year period (Table 4). These districts then used GLWMS to make a concerted effort to help landowners in the priority subbasins apply for federal payments via USDA's EQIP and CRP.

Unlike most conservation initiatives, this three-year project (2013–2015) did not include dedicated funding to compensate landowners for implementing conservation practices. Instead, it provided funding to support a full-time technician to demonstrate how outcome-based implementation goals and targeted outreach could increase the effectiveness and efficiency of conservation programs. Without this dedicated outreach, local conservation district and NRCS staff rely primarily on press releases, word of mouth and walk-in traffic to generate program interest and secure applications from landowners.

In total, the conservation technician assisted 41 landowners with implementing 8 different practices across 11,214 acres. This represents 18% of the long-term goal and almost 10% of the total high impact acres in the Cass River Watershed. The partners exceeded their 5-year goals for wetland creation and are on target to achieve 5-year goals for all other practices except residue and tillage management (Table 4). Most practices were contracted through EQIP for three years at a total funding level of $1,195,744. It was difficult to measure the full impact of the targeted outreach because not all potential contracts were funded. EQIP and CRP are competitive programs with infrequent and brief sign-up periods. EQIP had five sign-up periods during the project and CRP had two. Ultimately, only 28 of 53 EQIP applications were funded and it is possible that some interested landowners did not apply due to limited enrollment periods. Using GLWMS, it was calculated that 2470 acres of reduced tillage, cover crops and filter strips prevented 2031 ton of soil erosion and 473 ton of sediment from reaching surface waters. This represents a 6% increased efficiency above the expected average sediment reduction of 445 ton. It was not possible to analyze environmental benefits of all 11,214 treated acres because some of the practices that were implemented currently cannot be analyzed by GLWMS.

Because the funding was delivered through EQIP the partners were unable to substantially change targeting at the field scale, offer performance-based payments, or address certain administrative burdens. Even so, results indicate that conservation practitioners were willing to accept and adopt outcome-based implementation goals and that targeted outreach can help to meet these conservation goals more efficiently than relying on traditional outreach mechanisms alone.

Table 5
Desired outcomes for fish community health as measured by the Index of Biotic Integrity on a scale from 0 to 100 (IBI Goals) and the estimated long-term implementation goals needed to achieve those goals for the six focal watersheds (see Fig. 2) of the Saginaw Bay RCPP. Long-term implementation goals are based on analyses of Sowa et al. (2016–in this issue). An initial short-term (5-year) milestone of 25,000 acres was also established.

Subwatershed	IBI goals	Associated long-term Implementation goals (acres)
Chippewa-Pine	90	28,859
Cass	90	62,213
Shiawassee	90	102,625
Pigeon/Pinnebog	80	43,671
Kawkawlin	90	33,872
Sebewaing	90	57,800
Total		329,000

Case study #2: Saginaw Bay regional conservation partnership program

In the 2014 Farm Bill, USDA developed a new conservation initiative called the Regional Conservation Partnership Program (RCPP) to fund conservation under the direction of diverse project teams addressing critical conservation concerns across the country. The Saginaw Bay Watershed Conservation Partnership (Saginaw Bay RCPP) is one of those teams and represents a unique collaboration between conservation organizations, agronomy retailers, higher education, commodity groups, and agribusinesses. This team is working with NRCS to allocate $8 million in direct financial assistance and $12 million in technical assistance (via in-kind contributions from project partners) to growers in the watershed to implement conservation practices. Like the Cass River watershed project, the Saginaw Bay RCPP is designed to test the potential benefits of outcome-based implementation goals and targeting practices to fields that offer the greatest environmental benefits per dollar spent (Table 3). However, unlike the Cass River pilot, this project is also testing the involvement of nontraditional partners (e.g. agribusiness and crop advisors) willing to increase network capacity to provide targeted outreach and strategies to reduce administrative burden (Table 3).

Based on the analyses of Sowa et al. (2016–in this issue) and input from project partners, six watersheds were selected as eligible under the Saginaw Bay RCPP. These included the Cass, Kawkawlin, Pigeon/Pinnebog, Pine/Chippewa, Sebewaing, and Shiawassee River watersheds (Fig. 2). The partnership then established long-term implementation goals for each of these watersheds using the approach described in the General Methods section (Fig. 2; Table 5). A more general short-term goal of 25,000 acres, across all six watersheds, was established based on available funding and what was determined to be realistically achievable over the 5-year project.

The RCPP provides incentive payments to landowners through USDA's EQIP funding. The project is testing strategies to increase the effectiveness of this funding by reaching more landowners through crop advisors who typically have a significant influence on landowners' farm management decisions (Loy et al., 2013; Prokopy et al., 2014). It is also replacing the EQIP ranking tool and process with a pre-screening and scoring process that prioritizes farm parcels based on their estimated environmental benefits. It is providing specialized training to agronomy retailers and their crop advisors, who already provide year-round agronomic advice and technical assistance to landowners. This training is designed to help them evaluate resource concerns, identify appropriate conservation practices and provide assistance to landowners with funding applications.

Financial assistance available through the Saginaw Bay RCPP is targeted to specific fields based on a two-step approach that includes first pre-screening the project *location* and then scoring the estimated *benefits of the proposed conservation practice*. The entire pre-screening and scoring process is automated in the GLWMS. The first step of this process determines if all or the majority of the fields of interest are located in one of the six project watersheds and thus eligible for funding (Fig. 2; Table 5). Then the pre-screening process uses GLWMS to categorize each field based on 1) what percentage of the field is at high risk for sediment runoff and 2) the degree of water quality impairment and current fish community health. Through a series of simple steps and user inputs the GLWMS reveals if projects are low, medium or high priority for funding. Landowners with fields that score as medium and high priority are encouraged to submit an application. Landowners with only “low priority” fields are not allowed to apply because their application would not meet EQIP requirements that the practices will result in substantial environmental benefits. This pre-screening process saves both landowners and technical assistance providers valuable time because they learn if the landowner is qualified *before* completing the lengthy application process.

Fields that make it through the pre-screening process are then put through the scoring process to evaluate the environmental benefits of the proposed conservation practice and generate a ranking to help prioritize funding of projects. Points for the scoring process are assigned based on current water quality and the estimated annuals tons of sediment reduction. More points are given to fields in subbasins with poorer water quality. Funding is distributed by project, which consist of one or more fields owned by a single landowner. Project scores are generated by averaging scores of all the fields in the project area. Initially, all parcels that make it through pre-screening are funded on a first-come, first-served basis once a completed application is submitted to NRCS. However, as funding under the RCPP nears its end, projects will be funded based on the project scores and ranks.

At this early stage, there is evidence that the diverse set of Saginaw Bay RCPP partners were willing to accept and adopt outcome-based goals based on their voluntary participation in the RCPP. The RCPP was launched in 2015 and funding was first available beginning January 2016. As of July 2016, 31 landowners have submitted applications representing 18,276 acres of conservation practices. This represents over 73% of the five-year 25,000-acre goal. These practices include cover crops, mulch tillage, nutrient management and drainage water management and total over $2 million in federal incentive payments. Once applications are fully obligated and practices are implemented, Michigan State University will use GLWMS to quantify nutrient and sediment load reductions for each conservation practice. They will also calculate the cumulative benefits of these practices and track progress towards short- and long-term implementation goals. However, long-term outcomes will ultimately be measured by examining trends in stream health of these six watersheds by tracking improvements in water quality and fish IBI scores provided by the Michigan Department of Environmental Quality (MDEQ, 2003, 2014). These are critical short- and long-term indicators and measures of success for the Saginaw Bay RCPP. However, equally important will be the data from the ongoing social evaluation being conducted by NRSSL at Purdue University, described above in the General Methods section. These survey data along with along with the more traditional types of indicators will be reviewed annually to gauge success and identify needed adjustments.

It is still early in the implementation of this five-year project, yet there are some notable initial observations. For instance, while most of the nontraditional project partners (e.g., agribusiness and crop advisors) are well aware of funding opportunities available to landowners through USDA, NRCS and EQIP, most are also unfamiliar with program details that are essential to recruitment and providing technical assistance. To increase knowledge of these program details TNC has put a lot of effort into developing guidance materials for these partners and providing both group and one-on-one training. However, details of these funding programs, such as project eligibility, enrollment periods, application processes and funding levels, present a steep learning curve. One year into the project, agribusinesses and crop advisors have been slow to engage and secure applications. To date only three of the thirty-one applications were secured by these nontraditional partners. The intention is that as initial learning curves are overcome, the number of applications secured by traditional and nontraditional partners will become more balanced and demonstrate that crop advisors can be an important complimentary way to promote strategic implementation of conservation practices.

Despite efforts to reduce administrative burden it is impossible to eliminate all of it. For example, EQIP requires comprehensive, on-site, farm assessments by NRCS staff. Also required are additional assessments of eligibility related to income (USDA FSA, 2009) and internal quality assurance and quality control assessments of all applications. These administrative requirements take a lot of time and as a result, at the time of this writing, NRCS has not been able to obligate any of the funds to the 31 successful applications. Consequently, creating efficiencies on the front end (pre-screening and project ranking) of the overall application process may lead to little or no improvements in overall efficiency if key bottlenecks exist on the back end of the process. Improving the efficiencies of these processes will likely require streamlining of or increasing staff capacity available for these processes, or both. And, while Saginaw Bay RCPP partners are concerned about these issues impacting project success, some actions are already being considered to lessen these impacts.

Case study #3: pay-for-performance projects

Excess sediment is limiting fish communities in many tributaries of the Saginaw Bay watershed (Sowa et al., 2016–in this issue). Below we describe two similar projects focused on maximizing the efficiency of sediment reduction efforts through pay-for-performance programs. The first project is located within the Bad River watershed in Gratiot County, which is a tributary to the Shiawassee River watershed (Fig. 2). This project was funded by the Great Lakes Commission's Great Lakes Basin Program for Soil Erosion and Sediment Control and is managed by the Gratiot Conservation District. The second project includes the Cass, Pine/Chippewa, and Shiawassee River watersheds (see Fig. 2) and was funded by the Environmental Protection Agency under the Great Lakes Restoration Initiative.

Both projects were designed to implement and test all elements of a Strategic Agricultural Conservation strategy (Tables 1 and 3). A primary focus of these projects was testing the use of pay-for-performance to help target conservation practices, which is simple in concept but difficult in practice (Kerr et al., 2016–in this issue). This was possible because the funds for these projects are not allocated through USDA programs, making it possible to offer performance-based payments that would not be possible in USDA programs. Claassen et al. (2008) found that even when farming practices can be definitively linked to water quality, the *value* of water quality improvements is difficult to quantify. This is not uncommon for environmental goods, such as water quality, that are generally not bought and sold in markets, which must be measured through indirect means or estimated using alternative indicators. To address this problem, the 80/90 IBI goals and models developed by Sowa et al. (2016–in this issue) were used to establish sediment reduction goals for these two projects. The partnership set an annual sediment reduction goal of 1000 ton per year for the Bad River project and 7000 ton per year for the second project covering the other three watersheds. These sediment reduction goals serve as an indirect measure of the true ecological goal while providing a measurable baseline number from which performance-based payment structures can be established.

Both projects used the same performance-based payment structure that determines payments based on each ton of reduced sediment. This type of payment scheme was selected over other alternative payment structures, like reverse auctions, in order to reduce administrative burden and provide landowners with immediate payment calculations. Reverse auctions can potentially lower conservation expenditures overall, but they also require a substantial administrative framework in setting up bidding periods, providing information to potential bidders and collecting and analyzing bids which increases the time required to execute contracts (Hellerstein et al., 2015; Palm-Forster et al., 2016–in this issue).

Both projects used the GLWMS to quantify the tons of sediment reduced annually for each field and practice. Models, like those used in the GLWMS, are an important tool for such calculations as they provide an efficient and sufficiently accurate means for estimating environmental benefits compared to more complex models (Shortle et al., 2012; Winsten and Hunter, 2011). The GLWMS makes it possible to calculate payment estimates in a matter of minutes versus hours or days required for other models.

The Bad River watershed project was launched in 2014 and dedicated funding was available to support the work of one full-time conservation technician. The technician was able to direct mail about 550 landowners, hold an informational workshop, and advertise in the local newspaper, on the conservation district's website and in its newsletter. The technician also developed a simple two-page contract and verification process. Currently, there is no accepted rate or market for sediment reduction. The project initially set a sediment reduction payment rate at $15 per ton. However, during the first year it was found that payment rates, even for fields with the highest potential estimated environmental benefits, were not competitive with traditional per-acre payments. Therefore, the payment rate was increased to $156 per ton of sediment reduced. In year one, six landowners representing 308 acres of conservation practices enrolled into the project. This led to an estimated annual reduction of 19 ton of sediment. In year two, eight additional landowners enrolled 3426 acres into the program reducing another 313 ton per year. The partners anticipate enrollment of 2000 more acres and another 200 ton per year in the remaining two years of the project. This would yield close to 50% of the overall annual sediment reduction goal.

The Saginaw River Watershed project just began enrolling landowners in 2016, with a starting payment of $150 per ton of sediment reduced. At the time of this writing one contract had been executed for 323 acres of cover crops in Cass River Watershed with an estimated annual sediment reduction of 55 ton. To increase the project's ability to target practices to the watersheds with the poorest water quality, it will pair the performance-based payment rate with an additional incentive payment of $500 in the most impaired subbasins. This project also includes dedicated funding to support one full-time conservation technician. The technician will serve as the main contact person and will manage outreach, project evaluation and contracting, which can be completed in one day using a simple three-page contract.

The two demonstration projects, although different in scope and partners, follow a similar approach of collaborating with local Conservation Districts (Gratiot and Sanilac County) to recruit landowners into the program and using the GLWMS to assess benefits of conservation practices and determine payments. Together, the landowner and Conservation District staff identify practices suitable to address resource concerns on the farm, which may include cover crops, buffer strips, hay land plantings, reduced tillage, conservation cover, and no-till. The programs are both operated on a first-come, first-served basis; there is no specified application period and applications do not go through a competitive scoring process because payments are performance-based. This payment system preferentially selects high impact projects and increases the overall return on investment (Weinberg and Claassen, 2006).

While the Saginaw River Watershed project is early in implementation, the primary lessons learned from the execution of the Bad River project are that the incentive rate, and communication of the incentive rate, are critical. Also, having flexibility in establishing a payment rate that was competitive with payments available under traditional federal programs was essential to generating landowner interest and participation. It was also necessary to translate the per ton incentive payment a per acre payment since landowners typically evaluate their participation costs and benefits on a per acre basis and traditional per acre payments are more familiar.

Another lesson is that pay-for-performance projects can provide complimentary conservation funding and delivery strategies to traditional USDA cost-share programs. Technicians working to implement these performance-based programs provide another touch point for landowner dialogue and potentially a more attractive opportunity for trying new conservation practices. Also, because funds for these projects are not allocated via USDA programs it has been possible to substantially reduce administrative burden and increase recruitment efforts to high impact areas. These two projects also demonstrated that it is possible to develop the science and technology needed to make pay-for-performance projects feasible. In addition, these projects have demonstrated that landowners are interested and willing to participate in these programs if payments are attractive and can be communicated in a manner that facilitates informed decision making. Finally, just like all of the other case studies, partners in this project have embraced outcome-based goals and believe that focused outreach and incentive-based transactions can help to meet these outcome-based goals more efficiently than traditional programs (Weinberg and Claassen, 2006).

Discussion

There is growing evidence that existing conservation programs and funding sources, like those provided through the U.S. Farm Bill, are critical but likely insufficient to achieve desired ecological conditions in intensely agricultural regions such as the Saginaw Bay Watershed (USDA NRCS, 2011b; Bosch et al., 2013; Keitzer et al., 2016–in this issue). For instance, Sowa et al. (2016–in this issue) identified multiple watersheds within the Saginaw Bay drainage that likely require more than 50% of their agricultural lands treated with a suite of conservation practices to achieve desirable water quality and biological improvements. Yet, recent data for the Great Lakes region show that only about 8% of planted corn acres participated in U.S. Farm Bill Conservation Programs (USDA ERS, 2016). There are many reasons for these low participation rates, such as limited funding or lack of farmer willingness to participate in some of these traditional programs (Reimer and Prokopy, 2014). No matter what the reason, it is clear that new collaborations among landowners, industry, governments, and NGOs are needed to complement and leverage these existing programs. The coalition believes that collaborative efforts to address agricultural nonpoint source pollution in the Saginaw Bay watershed are helping develop these complimentary conservation delivery mechanisms. Although it is early in this collaborative journey, the coalition has already learned much. Below, for each of the four major components of the Strategic Agricultural Conservation process (see Table 1), we discuss which of the proposed solutions appear to be working versus those that do not and what more needs to be learned and done.

Defining realistic outcomes and related implementation goals

While the continuous improvement of water quality and other natural resource conditions can be a useful framework for voluntary conservation programs, its more critical to understand *how much conservation is needed to meet environmental goals* and *what will it cost*? Without this information to guide conservation initiatives it is impossible to assess progress and effectiveness and to ultimately judge long term program success (Tear et al., 2005; Wilhere, 2008). The analyses by Sowa et al. (2016–in this issue) made it possible to answer these questions and set realistic biological goals and associated short and long-term implementation goals. These goals have provided a critical foundation for all of the case studies presented herein as they provided a common understanding of short and long-term success. The analyses also helped in developing realistic project work plans and budgets and establish realistic expectations on the part of funders. Finally, these analyses allowed discussion of restoration efforts in multiple currencies (e.g. IBI scores, nutrient concentrations and loadings, acres of conservation practices,) which has helped foster more effective communication and collaboration among the diverse set of partners. With so many partners ranging from conservation districts, agribusinesses, and commodity groups to environmental NGOs, regulatory agencies, watershed organizations and corporations, it is critical to be able to clearly communicate the potential effects of conservation actions to each partner's interest, role and responsibility.

The analyses and models of Sowa et al. (2016–in this issue) have been critical to goal setting efforts. However, this work focuses on stream health and cannot provide information on the actions needed to improve conditions within Saginaw Bay itself, which are of significant interest to the numerous stakeholders (Stow et al., 2014). Agricultural production and nonpoint source pollution is linked to many different aquatic and terrestrial ecosystem factors and associated socioeconomic values in the Great Lakes (Zhang et al., 2007). As such, there is a need to continue to expand the socioeconomic factors that are included in such cost-benefit analyses (Swinton et al., 2007; Zhang et al., 2007). This requires looking for ways to continually improve and expand the scientific foundation of the work.

Keitzer et al. (2016–in this issue) represents one of the efforts that both improved and expanded upon the modeling techniques of Sowa et al. (2016–in this issue), by linking conservation actions to *both* stream health and phosphorous reduction goals established for reducing the occurrence of harmful algal blooms within Western Lake Erie (Ohio, 2010; Annex 4, 2015). Karpovich et al. (2016) represents another effort to expand this work by developing a new method of assessing the potential benefits of agricultural management practices to *multiple* ecological and socioeconomic endpoints within Saginaw Bay. These twelve endpoints ranged from fish spawning sites and coastal wetland habitat to drinking water supplies and beach use. TNC is currently looking at ways to incorporate the results of these analyses into its projects across Saginaw Bay.

In establishing short and long-term implementation goals it is important to look for more ways to incorporate potential costs and benefits to landowners and other components of the agricultural supply chain (Spurlock and Clifton, 1982; Swinton et al., 2007; Veith et al., 2003). The GLWMS does allow users to estimate and assess potential changes in crop yield associated with the implementation of certain conservation practices, but this capability must be expanded. Efforts like those described here must strive towards full assessments of costs and benefits to help set realistic goals and inform policies and programs to sustainably manage agricultural landscapes in manner that balances the values and needs multiple stakeholders (Zhang et al., 2007).

Targeting conservation practices

Targeting of conservation practices is often politically contentious (Claassen, 2003; Shortle et al., 2012; Kalcic et al., 2014). And, we agree that we ultimately all farm lands should have comprehensive plans that ensure they are treated with the right practices in the right place and right amount (USDA NRCS, 2011a, 2011b). However, we also believe it is important to see early returns on significant investments that are made in large-scale restoration efforts like those being made to address agricultural nonpoint source pollution (Vigmostad et al., 2005). In theory, maximizing environmental benefit of each dollar spent will speed up the ecosystem response, which is a key reason the coalition has put so much emphasis on targeting. Even so, legacy sediments and nutrients within fields and the tributary network might take decades to move through these systems and delay ecosystem responses (Sharpley et al., 2013).

Securing public and private funds, to complement conservation program funding of the U.S. Farm Bill, has been instrumental to the targeting efforts described in all three case studies. These funds did not have restrictions on targeting and allowed the coalition to develop and implement multi-scale targeting (i.e., watershed to field scale) and pay-for-performance programs that help direct incentive funds to those lands that offer the highest return on investment. However, can this model of complementary public and private funding be sustained? And, if not, what other funding mechanisms or policies could be changed or developed to incentivize the targeting of practices? These are important questions that we currently cannot answer.

The GLWMS has been critical to all the targeting efforts described here. When developing any decision tool, like the GLWMS, it is important to understand the information needs and practical realities of decision makers (Von Winterfeldt, 2013; Messer et al., 2016). This is why the coalition invested so much time, money and effort into understanding the needs and realities of key decision makers involved in addressing agricultural nonpoint source pollution. This understanding guided the design and functionality of the GLWMS to ensure it was easy to use and allowed practitioners to rapidly perform a variety of relevant assessments that aid in a) multi-scale targeting and accurate and b) efficient calculations of performance-based incentive payments. This ease of use and rapid estimation of nutrient and sediment reductions made it possible to develop and test multiple new targeting programs.

The many project partners have demonstrated their willingness to participate in programs that target conservation practices through their participation in these programs. Producers have also demonstrated their willingness to participate in these programs if payments are attractive enough, which presents a potential limitation of pay-for-performance programs. Although the program had the resources and flexibility to increase payment rates by over ten times the initial rate ($15 to $156 per ton of sediment) in the Bad River project, it is unlikely this flexibility would exist in most other circumstances. Another limitation of these current pay-for-performance programs is that producers can only choose from a limited set of practices. Ideally, a pay-for-performance program would allow producers to choose from any practice that addresses the resource concern (Kerr et al., 2016–in this issue). This ideal may never be reached, but the coalition is continually working to expand the number of practices in the GLWMS to move closer to this ideal.

Increasing network capacity and administrative efficiency

The amount of technical assistance available to producers (i.e., network capacity) and administrative burden are two important factors affecting the participation of producers in conservation programs (Baumgart-Getz et al., 2012; Reimer and Prokopy, 2014). The Cass River (Case study #1) and Bad River (Case study #3) projects both secured supplemental funding for a full-time technician to conduct targeted outreach and technical assistance to producers. The rapid enrollment of producers and progress towards short-term implementation goals in both of these projects is evidence of the value of this type of increased network capacity. However, this solution also suffers from the risk of not being able to sustain supplemental funding for these types of services.

It is too early to tell if nontraditional partners, like certified crop advisors, will provide an effective means for increasing network capacity. Introducing agribusinesses to the administration of federal conservation programs represents a substantial learning curve. One-on-one interviews conducted by Purdue University researchers revealed some degree of skepticism from the traditional conservation partners who about the intended role of agribusiness in recruiting producers and executing conservation programs. Still, there is certainly evidence of agribusinesses effectiveness in playing this role in other conservation efforts like the 4R Nutrient Stewardship Program in Ohio (Vollmer-Sanders et al., 2016–in this issue). In any newly established partnership, trust and relationships need time to build before true collaboration can begin. Although the coalition experienced and continues to experience challenges in implementing Strategic Agricultural Conservation, we believe that these case studies represent valuable models for others.

It is also too early to say if the coalition's efforts to reduce administrative burden are working. However, there is some important anecdotal evidence of the value of the efforts to streamline the overall contracting process. Some partners have stated that the pre-screening process using the GLWMS has significantly reduced the time it takes to conduct assessments and has opened up entirely new conservation program delivery options (M. Meersman, Van Buren Conservation District, personal communication). Yet, as mentioned earlier, these increased efficiencies on the front end of the enrollment process may not lead to improvements in overall program efficiency if key bottlenecks exist on the back end of the process. Determining if these administrative efficiencies and all the proposed solutions are working is going to take more time and a more comprehensive evaluation like the one being conducting in partnership with NSSL at Purdue University. Results from these surveys will be critical to help adapt and improve the complex collaborative social processes that represent the art side, as opposed to the science side, of Strategic Agricultural Conservation (Moore, 2009). However, even without these results, many lessons have already been learned and the coalition is making progress towards addressing some of the most pressing challenges and barriers to achieving the vision of Strategic Agricultural Conservation.

Tracking and assessing progress towards goals

The coalition understands that achieving the vision of Strategic Agricultural Conservation requires assessing if conservation investments are achieving the desired ecological outcomes. To do this requires setting goals and tracking progress towards multiple, related, performance metrics (Tear et al., 2005; see Fig. 1). Ultimately, success of the projects presented here is being measured by long-term water quality and fish community monitoring data (MDEQ, 2003, 2014). On the front end, these data were critical to developing the models described by Sowa et al. (2016–in this issue). They are equally important on the back end as key measures of success. Unfortunately, budgets of long-term monitoring programs are always at risk of funding cuts (Biber, 2011). The work in Saginaw Bay presented here, along with additional work conducted elsewhere in the Great Lakes (e.g., Keitzer et al., 2016–in this issue) can further demonstrate the importance and value of these monitoring programs. Additional funds are also being sought for more targeted monitoring of the focal watersheds that could provide a more detailed and rapid assessment of changes in water quality and fish community health and a more explicit link to the conservation investments and actions.

Due to legacy effects and lag times in ecosystem response, it could take decades for the fish communities in the project watersheds to respond to even significant increases in conservation practices (Hamilton, 2011; Sharpley et al., 2013). This is why having both short and long-term implementation goals is so important. In particular, short-term goals provide meaningful milestones to carve up the more daunting long-term goals (e.g., over 300,000 acres) into more manageable chunks. Achieving and celebrating these early milestones can help maintain or even gain momentum and support for the work in Saginaw Bay and help achieve the long-term implementation goals and ecological outcomes (Vigmostad et al., 2005).

Conclusion

At the core of any kind of complex strategy is a solid understanding of the purpose (the Why?) and which partners need to be involved (the Who?). Usually, these are the easiest, most intuitive elements of a project and one that all partners should agree on. The collective purpose of the conservation work in Saginaw Bay presented in this paper is to find sustainable solutions to address impacts of agriculture on surface waters to improve water quality and protect biodiversity for the benefit of future generations. Identifying which entities must be involved to accomplish this purpose has been equally important to project success.

A good strategy also requires an understanding of what actions are needed to achieve the desired outcomes (the What?), where are the best places to work (the Where?) and what methods could or should be used to accomplish the required actions (the How?). These final questions are the most difficult questions to answer and where the role of science and technology is paramount. The work in the Saginaw Bay watershed presented here demonstrates how science can provide practitioners the basic information they need to help address “what?” and “where?”. Furthermore, this work demonstrates the value of technology, in the form of decision tools like the GLWMS, that can provide decision makers the information they need in a user-friendly format to strategically target practices and track progress.

Without basic scientific information and associated decision tools, conservation strategies can never be truly effective no matter which collaborative methods are employed because there are no guideposts to measure success. However, making the leap from science to real-world implementation is also an art because the science cannot answer the other core questions of “who?” and “how?” The real-life examples of conservation in action described herein demonstrate this complimentary balance of science and art to developing and implementing landscape-scale strategies to address agricultural non-point source pollution. Finally, attaining large scale, socially desirable improvements in watersheds dominated by intensive agriculture will require innovative approaches, collaborations and investments meant to complement existing programs and sources of conservation funding. In that respect, the approaches that the collation is taking to address the challenges and barriers to Strategic Agricultural Conservation throughout the Saginaw Bay watershed can serve as a model for other regions of the Great Lakes and beyond.

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