Right Practice, Right Place
NRCS Conservation Innovation Grant
Final Report

Grantee Name: Environmental Defense Fund, Inc.
Project Title: Right Practice, Right Place: Development and deployment of a conservation planning toolkit and improved incentive strategies to reduce nutrients in HUC 12 watersheds in the Upper Mississippi River Basin
Agreement Number: NRCS 69-3A75-11-223
Project Director: Eileen McLellan, (202) 276-5492, emclellan@edf.org
Administrative Contact: Amanda Lichtenberg, (212) 616-1213, alichtenberg@edf.org
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Project Deliverables

1) *Online web-GIS conservation planning toolkit* will enable NRCS and other conservation planners to dramatically increase practice effectiveness by targeting the right practice to the right place on the landscape. The web-GIS application will include the following:
    - A mapping tool that uses remotely sensed data to locate tile drains and ditches
    - A simple geospatial analysis tool that identifies the likely location of denitrification "hotspots" appropriate for buffer and wetland placement
    - A suite of GIS-based tools that use terrain analysis of LiDAR data to locate potential locations for constructed wetlands, buffers, 2-stage ditches, controlled drainage, and bioreactors

2) *Nutrient reduction assessment tool* to estimate the watershed-scale nitrogen reduction benefits of practice implementation.

3) *Customizable and web-based conservation funding assessment template* that will enable stakeholders to identify watershed-specific funding opportunities and assess the economic impacts of conservation.

We will link all tools together in a web-GIS to enable stakeholders to evaluate the environmental (water quality) and economic (net farm income) implications of different conservation strategies.

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Executive Summary

Environmental Defense Fund (EDF)'s *Right Practice, Right Place* (RPRP) project successfully addressed a critical and unmet need for a suite of conservation planning tools that can be used by state and local entities to design conservation scenarios capable of reducing the export of nutrients from agricultural landscapes in the Midwest. Increasing awareness of the problems caused by agriculture-related nutrient pollution has been accompanied by increasing recognition that new and innovative nutrient-removal practices will be needed to treat nitrogen and phosphorus lost from farm fields. The RPRP project has demonstrated the need for and value of such nutrient-removal practices, and developed tools that enable planners to systematically and strategically incorporate these practices into local and regional conservation efforts. The project's greatest innovation lies in adapting and scaling up these tools for use across a variety of landscapes and combining them into a user-friendly conservation planning system.

Specifically, *Right Practice, Right Place* has:

1) Shown the important role that edge-of-field and downstream nutrient removal practices must play if regional water quality goals are to be achieved;
2) Developed an online tool that helps prioritize watersheds for nutrient reduction efforts;
3) Developed an online tool to identify priority conservation practices needed in these and other watersheds;
4) Created a planning framework and tool to identify the "right places" for these "right practices" at the small watershed scale;
5) Demonstrated how these tools can be utilized by local conservation staff and stakeholders to develop conservation scenarios capable of achieving specified nutrient reduction goals; and
6) Made the entire suite of tools available via the *Right Practice, Right Place* project website.

We demonstrated the value of the conservation planning tools developed in our project through a set of peer-reviewed publications in prominent conservation journals, an online planning toolkit, and three demonstration projects. States and local entities are already using RPRP project technology to develop strategies for mitigating water quality problems, ranging from local drinking water impairments to hypoxia in the Gulf of Mexico. While the most immediate beneficiaries of this grant are conservation planners in state and local Natural Resources Conservation Services (NRCS) offices and local Soil and Water Conservation Districts, a wide array of stakeholders also benefit indirectly, including agricultural producers, who can work with local conservation staff to design conservation scenarios that achieve desired environmental outcomes with minimal impact to agricultural production; downstream communities, which benefit from improved water quality; and taxpayers, whose tax dollars can be spent more effectively through use of our toolkit. As our project was designed to develop a planning toolkit, rather than to test a new conservation practice or technology, it is not possible to quantify the project's physical results, but we anticipate that our toolkit will facilitate reductions in nitrogen and phosphorus losses from agriculture as it becomes more widely adopted.

Demonstrating the value of *Right Practice, Right Place,* Iowa and Minnesota have already adopted our planning toolkit as part of their effort to reduce Gulf hypoxia; conservation planners across the Midwest have expressed interest in trainings on use of the tools; and food supply chain companies are interested in undertaking water quality initiatives facilitated by our toolkit.

Project funds were spent as anticipated in our original proposal. However, we had to modify our original vision of a toolkit when we discovered it could not be *fully* customized by the user to optimize nutrient reductions and economic impacts in individual watersheds due to a number of factors beyond our control. In particular, the lack of a well-accepted, widely-available water quality model, and the challenges of developing a watershed-scale economic optimization tool to identify scenarios for economic analysis, delayed project completion. We are on track to address the former and will continue to support water quality model development beyond the grant period, but we have reluctantly concluded that there are too many variables to successfully develop a customizable economic optimization tool. Despite these challenges, our toolkit represents a huge advance beyond the resources that were previously available, and the excitement with which it is being embraced by stakeholders indicates that it has tremendous value. We requested and received a no-cost 12-month extension, which allowed us to not only meet our objectives and complete the project website, but to better assist the agricultural community—including Environmental Quality Incentives Program (EQIP)-eligible producers—in planning and managing conservation efforts based on sound science and economics.

Our primary recommendation resulting from the *Right Practice, Right Place* project, which is already being pursued by NRCS, is to incorporate our toolkit into the next generation of conservation tools being developed for use in local and regional NRCS offices.

Introduction

The goal of the RPRP Conservation Innovation Grant (CIG) is to bring an innovative approach to improving water quality by increasing the effectiveness and implementation of drainage water management and vegetative filter practices for treatment of nitrogen lost from agricultural fields. EDF's work demonstrated the need for and value of these practices in achieving regional water quality goals, and brought critical innovations to the table for improving conservation outcomes through effective selection and placement of priority practices. We developed a suite of user-friendly analysis and modeling tools that enable conservation planners to design effective conservation scenarios at watershed scale and allow stakeholders to evaluate and optimize the environmental impacts of alternative scenarios. These tools will allow NRCS and other agencies to map a new course for conservation across the Upper Mississippi River Basin (UMRB) that maximizes water quality improvements, while maintaining or even enhancing agricultural productivity to the extent possible.

The RPRP project had four key objectives:

1. Develop science-based tools for conservation planning and evaluation
2. Increase the economic viability of practice implementation
3. Link science and economics for watershed planning
4. Advance stakeholder use of developed tools

Project tasks related to these objectives included:

1. Develop science-based tools for conservation practice planning and evaluation
2. Adapt and scale up conservation practice planning tools
3. Compile and test a conservation planning toolkit
4. Evaluate water quality benefits of alternative conservation scenarios
5. Increase the economic viability of practice implementation
6. Link science and economics for watershed planning
7. Engage the agricultural community
8. Disseminate and evaluate project results

Primary partners and key personnel included:

1. Ralph Heimlich, of Agricultural Conservation Economics, who developed a set of models to simulate the sources, flows, and export of nitrogen from watersheds across the Upper Mississippi and Ohio River Basins (UMORB). Mr. Heimlich is the former Deputy Director of the U.S. Department of Agriculture (USDA)'s Economic Research Service (ERS).
2. Dr. Keith Schilling of the University of Iowa and Calvin Wolter of Iowa's Department of Natural Resources, who developed a framework for identifying which conservation practices would be most effective in specific watersheds. Dr. Schilling and Mr. Wolter have published numerous peer-reviewed articles on hydrology and water quality in the UMORB and were leaders in the development of Iowa's Nutrient Reduction Strategy.
3. USDA's Agricultural Research Service (ARS), specifically Dr. Mark Tomer and Sarah Porter at the National Lab for Agriculture and the Environment in Ames, Iowa, who developed the LiDAR-based tool that can be used to identify potential sites for priority practices within specific watersheds. Dr. Tomer has published numerous peer-reviewed articles on precision conservation and has led several watershed projects as part of USDA's Conservation Effects Assessment Project (CEAP) efforts. Dr. Mike White and Dr. Doug Smith of ARS's Grassland, Soil and Water Research Lab in Temple, Texas, were also involved in developing a tool to evaluate the environmental impact of alternative conservation scenarios. Drs. White and Smith are actively involved with a variety of USDA modelling efforts, including development of the Soil and Water Assessment Tool (SWAT) watershed model and various CEAP activities.
4. Dr. Nate Torbick of Applied Geosolutions, who developed the project website. Applied Geosolutions is the leading company in developing interactive websites to effectively communicate spatial and environmental information.

This project received matching funds through the support of a number of individuals and foundations, and in-kind support from partner organizations.

Background

Decades of conservation work on the part of USDA and its partners have greatly reduced soil erosion from agricultural lands. However, as demonstrated by CEAP's extensive study of cropland in the UMRB, we must do much more to address nutrient loss from agriculture—particularly the loss of nitrogen—in order to address pressing water quality issues in the UMRB and beyond. The health of local and regional waters, many drinking water supplies, and the Gulf of Mexico are at stake, as well as that of the countless communities that depend on these vital resources. Meeting environmental goals while sustaining agricultural viability requires adaptive approaches to identifying conservation options that enhance environmental outcomes (i.e., maximum nutrient and sediment reductions), while minimizing impacts to crop production and farm income. While there has been considerable work to develop conservation planning tools to reduce the losses of particulate phosphorus, prior to our project there were no corresponding planning tools to address losses of nitrogen. The RPRP CIG project developed an approach and set of tools to facilitate such an adaptive approach.

The RPRP CIG addressed the challenge of balancing environmental and agricultural needs by developing new tools and approaches; maximized the effectiveness and water quality benefits of priority practices by matching the right practice to the right place at both regional (major basin) and local (within HUC-12 watershed) scales; stimulated producer interest in implementing the right practice in the right place through improved incentives; and enabled stakeholders to assess and compare the environmental outcomes associated with different combinations of practices and practice locations at the watershed scale. RPRP developed, tested, and refined these tools and approaches in collaboration with a variety of governmental and non-governmental partners across the UMRB.

Review of Methods

RPRP builds on innovative tools and approaches developed and proven successful at smaller scales in the Mississippi River Basin and elsewhere. The project's greatest innovation lies in adapting and scaling up these tools for use across a variety of landscapes, and combining them into a user-friendly conservation planning system. A significant project outcome is a web-based geographic information system (GIS) package of analytical and modeling tools that will allow stakeholders—including NRCS, watershed planners, and others—to identify the optimal mix and placement of conservation practices at regional and local scales across the UMRB.

The RPRP project brought critical innovations to the table for improving conservation outcomes by advancing more effective practice selection and placement, as well as stronger, more diverse economic incentives for practice adoption. The RPRP CIG: 1) created a strategic conservation planning framework to maximize the effectiveness of priority practices at regional and local scales; 2) enabled conservation planners to access new kinds of geospatial approaches and products without in-depth GIS expertise; 3) developed tools that enable NRCS, state agency, and conservation district staff to connect individual practices with one another and to the broader watershed context; 4) improved practice adoption by engaging new public and private funding partners to improve the economic drivers of conservation, and facilitating stakeholder access to new and existing funding opportunities; and 5) enabled producers, watershed managers, and other stakeholders to evaluate the environmental outcomes of alternative conservation scenarios at the HUC-12 watershed scale.

As proposed, we undertook the following tasks to achieve project objectives:

I. Develop science-based tools for conservation practice planning and evaluation

Ia. Adapt and scale up conservation practice planning tools

With project partners, we developed an integrated suite of tools to identify priority watersheds that are the most significant contributors of nitrogen to the Gulf of Mexico; identify the priority water quality issues in those watersheds and the priority conservation practices best suited to addressing those issues; and develop watershed-scale conservation scenarios that combine a variety of priority practices at the small watershed scale (HUC-12) in order to achieve nutrient reduction goals.

With project partner Ralph Heimlich of Agricultural Resource Economics, we refined the U.S. Geological Survey (USGS)-developed SPARROW watershed model of the UMORB. Within the model, we incorporated the ability to simulate use of a variety of in-field nitrogen management and edge-of-field nitrogen removal practices, including improved fertilizer management, cover crops, riparian buffers, restored wetlands, tile drainage treatment wetlands, ditch enhancement practices, stream restoration, and floodplain reconnection. To do so, we developed a set of rules to govern practice selection and placement and applied these rules to maps showing the distribution of tile drainage and hydric soils across the UMORB. We used this model to assess a variety of regional-scale conservation scenarios' ability to achieve the 45% reduction in nitrogen export to the Gulf of Mexico that the U.S. Environmental Protection Agency (EPA) has deemed necessary to address Gulf hypoxia. Our findings, published as two papers in the *Journal of the American Water Resources Association* in 2015,[1] demonstrated that solving hypoxia requires the combined use of in-field nitrogen management practices and edge-of-field nitrogen removal practices. We translated our analysis into an online clickable map, enabling planners and stakeholders to identify the nitrogen loads delivered to the Gulf from any small watershed in the UMORB.

Having demonstrated the critical importance of edge-of-field nitrogen removal practices, we proceeded to develop conservation planning tools that would enable conservation planners to identify which practices would be best suited for a specific small watershed and identify the locations within that watershed where they would be most effective. With project partners Dr. Keith Schilling and Calvin Wolter, we developed a framework for identifying hydrologic landscape units, characterized by distinct combinations of soil types and slopes, which could be anticipated to have different water quality challenges and hydrologic flowpaths. We also used a logic model to identify the suite of conservation practices best suited to reduce nutrient export for each hydrologic landscape unit. The framework and logic model were published in *Environmental Management* in 2015,[2] and we again translated the results into an online

[1] McLellan, E., Robertson, D., Schilling, K., Tomer, M., Kostel, J., Smith, D., & King, K. (2015). Reducing nitrogen export from the corn belt to the Gulf of Mexico: Agricultural strategies for remediating hypoxia. *JAWRA Journal of the American Water Resources Association*, *51*(1), 263-289; McLellan, Eileen, Keith Schilling, and Dale Robertson. "Reducing Fertilizer-Nitrogen Losses from Rowcrop Landscapes: Insights and Implications from a Spatially Explicit Watershed Model." *JAWRA Journal of the American Water Resources Association* 51.4 (2015): 1003-1019.
[2] Schilling, Keith E., Calvin F. Wolter, and Eileen McLellan. "Agro-hydrologic Landscapes in the Upper Mississippi and Ohio River Basins." *Environmental management* 55.3 (2015): 646-656.

clickable map, enabling planners and stakeholders to identify the priority conservation practices recommended for each small watershed in the UMORB.

We worked with project partners Dr. Mark Tomer and Sarah Porter from ARS to develop a conservation planning framework that guides planners in developing a suite of practices designed to systematically address nutrient sources, transport, and treatment across the landscape from farm field to stream. Building on the hydrologic landscape unit concept described above, the planning framework helps planners identify how in-field nitrogen management and edge-of-field and edge-of-stream nitrogen removal practices can be combined in watersheds of different types. A summary of the framework was published in the *Journal of Soil and Water Conservation* in 2013[3] and a more detailed discussion was published in the *Journal of Environmental Quality* in 2015.[4]

In addition to the planning framework, we built a planning tool that enables planners to identify the most effective placement of various practices within a specific small watershed. To do so, we built a GIS-based database that integrates information on land use (including crop rotation), soil type, and topography (from LiDAR imagery); a set of flow-routing models to simulate the flow of water and nutrients across the landscape; a set of GIS-based practice placement criteria that specifies the soil types, landscape positions, and flow accumulations needed for each conservation practice; and a suite of GIS-based programming routines that enable the user to match practice placement criteria with appropriate sites at the small watershed scale. These tools (detailed in the papers referenced above) enable conservation planners to identify, within any small watershed in the UMORB, the optimal locations for conservation practices including grass waterways, contour filter strips, restored depressional wetlands, blind inlets, tile drainage treatment wetlands, water and sediment control basins, farm ponds, saturated buffers, and floodplain reconnection. While in our original proposal we had committed to developing practice siting tools only for contour filter strips and tile drainage treatment wetlands, we were able to go far beyond what we had proposed in response both to stakeholder interest in an expanded suite of practices and to additional support provided by project partner Mark Tomer of ARS.

In addition, we developed two approaches to evaluate the environmental outcomes of implementing a given suite of priority practices at appropriate locations within a small watershed. One approach (described in the *Journal of Environmental Quality* paper referenced above) is a screening tool that enables planners and stakeholders to assess whether or not a given conservation scenario achieves a specified nutrient reduction goal. The other approach, which we will continue to develop beyond the grant period, is a web-based watershed model that enables stakeholders to directly compare the effects of changing conservation practice type and extent; the model is being developed by Drs. Mike White and Doug Smith of ARS, and is based on an update of the Texas Best Management Practice Evaluation Tool

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[3] Tomer, M. D., Porter, S. A., James, D. E., Boomer, K. M., Kostel, J. A., & McLellan, E. (2013). Combining precision conservation technologies into a flexible framework to facilitate agricultural watershed planning. *Journal of Soil and Water Conservation*, *68*(5), 113A-120A.
[4] Tomer, M. D., Porter, S. A., Boomer, K. M. B., James, D. E., Kostel, J. A., Helmers, M. J., ... & McLellan, E. (2015). Agricultural Conservation Planning Framework: 1. Developing Multipractice Watershed Planning Scenarios and Assessing Nutrient Reduction Potential. *Journal of Environmental Quality*, *44*(3), 754-767.

(TBET) previously developed by Dr. White, with adaptations for UMORB landscapes and the conservation practices included in our planning tools.

Ib. Compile and test a conservation planning toolkit

With assistance from project partner Applied Geosolutions, we have compiled the tools into a conservation planning toolkit, available online at rprp.oka.ags.io. The toolkit enables conservation planners and stakeholders to: 1) understand the scientific basis for regional water quality problems in the UMORB and downstream, and become familiar with a arrange of innovative conservation practices to address these problems; 2, identify, for a specific small watershed in the UMORB, the annual nitrogen load exported to the Gulf of Mexico, the hydrologic landscape type, and the suite of priority conservation practices recommended for that watershed; 3) understand how a GIS-based planning tool can be used at small watershed scale to identify priority places in a specific watershed where priority conservation practices can best be implemented; and 4) link to a user manual and other resources providing detailed instructions for using the GIS-based planning tool.

We have tested the conservation planning toolkit in three small watersheds within and beyond the UMORB—Beaver Creek, Iowa; Middle Fork of the Whitewater River, Minnesota; and Matson Ditch, Indiana—allowing us to improve the individual tools and overall toolkit in response to stakeholder comments. We purposefully selected three test watersheds representing different hydrologic landscape units as this allowed us to demonstrate the utility of the tools across the region. In addition, we are continuing in-depth testing in a fourth watershed, Beargrass Creek in Indiana. For each test watershed, we conducted a minimum of three and a maximum of five meetings with local conservation staff, farmers, agribusinesses, district engineers, drainage contractors, and other stakeholders to raise awareness of water quality problems; discuss and refine the selection of priority conservation practices; review and refine maps showing potential locations for priority practices; and evaluate various watershed-scale scenarios and their ability to achieve a specific nutrient reduction goal. In general, we found that stakeholders believed the tools did a good job of characterizing their watershed—i.e., that the suite of priority practices identified using our tool was in good agreement with practices considered by the local conservation staff. In several instances when our tools predicted that a particular location would be viable for a particular practice, we learned that the practice had already been implemented there with positive effects. Perhaps even more importantly, stakeholders reported that our tools provided them with a much-appreciated opportunity to look at water quality problems and solutions from the perspective of the whole watershed, rather than just their farm. While we originally intended our tools to be used primarily by local conservation staff, we found that stakeholders were interested in learning how to use the tools themselves to develop alternative conservation scenarios for their farms and for the watershed.

Ic. Evaluate water quality benefits of alternative conservation scenarios

In our original proposal, we planned to develop a nutrient reduction assessment tool that would quantify the watershed-scale benefits associated with various conservation scenarios. This task proved to be the most challenging part of the project as there is no suitable “off-the-shelf” water quality model that is both capable of representing the conservation practices of interest and broadly transferable across the region. We reviewed an array of water quality models—including Agricultural Policy/Environmental eXtender (APEX), SWAT, and many others—and found that all required significant amounts of watershed-specific input data in order to be used in any given watershed, and none were capable of simulating the impacts of innovative edge-of-field nitrogen removal practices needed to effectively address water quality problems. We ultimately decided to pursue two distinct approaches to this challenge: 1) a spreadsheet model, described in the *Journal of Environmental Quality*, which allows users to assess whether or not a given conservation scenario is likely to achieve a specific level of nutrient load reduction; and 2) a modified version of an existing empirical model, which Drs. White and Smith at ARS-Temple are refining for application to the UMORB and to include innovative conservation practices. We propose to continue development of this latter model in the coming years

II. Increase the economic viability of practice implementation

We compiled a summary report based on an analysis of current and potential future funding opportunities for the implementation of innovative conservation practices such as stream and wetland restoration. Our report noted that current Farm Bill programs only provide limited funding for such practices; while individual states may have developed interim standards for select practices, no state provides funding for more than one or two of these potentially valuable practices, making it difficult to implement a systemic approach. We also explored the potential for a variety of environmental markets to support practice implementation (e.g., water quality trading, wetland mitigation banking, and the sale of carbon credits) and, likewise, found that such opportunities are very limited. In most cases, limited opportunities were a result of limited demand for environmental credits within the UMORB region, as well as market rules that constrain agricultural land's eligibility to supply credits for the few urban areas where there is demand. We did, however, identify a previously-unrecognized potential driver for practice implementation in the form of increasing demand for sustainability along the food supply chain. Stakeholders ranging from retailers and food manufacturers to grain aggregators and farm supply companies increasingly recognize both consumer demand for more sustainable products, and the business case for increased sustainability as a driver of improved operational efficiency and reduced institutional risk. Over the past few years, we have engaged supply chain entities in discussions on the value of improving sustainability in grain production—whether for food or feed usage—and we are beginning to see interest from these companies in investing in increased sustainability practices in their grain-sourcing regions. In coming years, we believe such interest will translate into support and incentives for the adoption of a variety of conservation practices, including innovative edge-of-field nitrogen removal practices.

III. Link science and economics for watershed planning

In our original proposal we had hoped to develop an economic assessment tool which could quantify, for specific practices in a specific watershed, the costs and potential benefits (in the form of increased crop yields and/or revenues from the sale of credits in environmental markets) associated with practice adoption. At that time, we proposed to utilize linear programming to develop an optimization tool for identifying the conservation scenario that would offer the greatest environmental and economic value. Unfortunately, our analysis of the potential role of environmental markets in such a tool indicated that there were relatively few locations where environmental credits might be realized. Additionally, while it would be possible to develop a process for quantifying and minimizing practice costs at the scale of an individual watershed, it was not possible to scale up the process into a tool that could be deployed in the thousands of small watersheds across the UMORB. This development has been reflected in our interim reporting and other communications with NRCS.

IV. Engage the agricultural community

We have engaged a broad cross-section of the agricultural community throughout the project. In our three test watersheds, we worked with a wide array of agricultural stakeholders—including local conservation staff, producers, local agricultural retailers, and service companies—to test the toolkit and its applicability in developing local conservation plans. Through project partners ARS, we have engaged conservation planners in an additional 15–20 small watersheds across the UMORB in using our tools, and those conservation planners are now working with producers in their watersheds to develop detailed conservation plans. We have shared information on the tools and the toolkit with producer organizations representing corn, soybean, and wheat producers in several states, and we have been in discussions with the AGree Initiative (a multi-stakeholder food and agricultural policy initiative that is supporting pilot projects in collaborative landscape conservation) about using our tools in their producer-led pilot projects. Perhaps most importantly in terms of driving future demand, we are in ongoing discussions with several food companies that collectively influence the operations of thousands of producers about use of our planning toolkit in various pilot projects.

V. Disseminate and evaluate project results

We have disseminated project outcomes through the publication of peer-reviewed papers in the *Journal of the American Water Resources Association*, *Journal of Environmental Quality*, *Journal of Soil and Water Conservation,* and *Environmental Management*, as well as presentations at Soil Science Society of America (SSSA) meetings. In addition, we organized a symposium attended by over 100 people at the 2014 Soil and Water Conservation Society national meeting, and project partner ARS organized a symposium attended by 70 people at the 2015 meeting. ARS conducted two sets of trainings on toolkit usage for a total of 45 local conservation staff across the UMORB. The state of Iowa has contracted to use the planning toolkit in several watersheds across the state to demonstrate Nutrient Reduction Strategy implementation, and the state of Minnesota is considering using the toolkit for water quality projects funded through the state's Clean Water Legacy fund. Project partner Mark Tomer has made several presentations on the tools to NRCS Deputy Chief for Science and Technology Wayne Honeycutt and other staff at USDA headquarters, as well as presenting to U.S Secretary of Agriculture Tom Vilsack.

Schedule of Events

Action	Timeline	Milestone
Develop rules and conditions for practice selection and placement	9/2011 – 12/2011	Workshop and report on practice selection and placement criteria
Map artificial drainage across UMRB	9/2011 – 10/2011	Map of artificial drainage
Map hydrologic landscape units across UMRB	10/2011 – 12/2011	Map classifying primary flowpaths of undrained HUC12 watersheds.
Select test watersheds for development of practice placement tools	1/2012 – 2/2012	List of test watersheds
Develop remote sensing, LiDAR and hydrogeologic mapping tools	2/2012 – 12/2012	GIS-based mapping tools to site priority practices
Test tools in select watersheds; calibrate tools for regional variation across UMRB	1/2013 – 3/2013	Improved suite of practice planning tools
Compile tools into web-GIS toolkit	3/2013 – 6/2013	Web-GIS toolkit and documentation

Test toolkit in 4-5 watersheds	6/2013 – 12/2013	Evaluation of toolkit; improved conservation planning tools
Develop training materials and conduct training on toolkit use with potential users	1/2014 – 6/2014	Training materials
Develop nutrient assessment reduction tool	1/2013 – 12/2013	Nutrient assessment reduction tool
Review economic drivers for drainage water and vegetative filter practices	9/2011 – 3/2012	Report on existing and new funding opportunities
Advance new economic incentives with public private entities and policymakers	3/2012 – 8/2014	A set of options for improved economic incentives for practice implementation
Convene watershed planning forums, test integrated tools, and report outcomes	3/2014 – 8/2014	Improved watershed planning tools; case studies
Meetings with and presentations to producers and producer organizations	Throughout as documented in semi-annual reports	At least 4–6 meetings and presentations/year
Peer-review of conservation planning tools	Throughout as documented in semi-annual reports	Presentations and publications
Stakeholder interaction	Throughout	At least 4-6 meetings and presentations/year
Interim project reports	Semi-annually	Interim project reports
Final project report	12/2015	Final project report
Project website	Initial version 6/2014; completed 9/2015	website

Discussion of quality assurance

Project results have been subject to peer review through the journal publication process; via presentations to conservation planners, scientists, policy-makers, producer organizations, and other stakeholders; and the NRCS CIG showcase and other NRCS events. Because our project delivered new planning tools (rather than a field project which would test new practices or technologies) further discussion of site characteristics, site locations, rational, maps, etc., is not applicable.

Findings

- The RPRP project has shown that innovative nitrogen removal practices including wetlands construction or restoration will be critical to achieving ambitious water quality goals such as mitigating Gulf hypoxia.
- Through these innovative practices, RPRP has also demonstrated that water quality goals can be met with very limited (1-2%) conversion of cropland at the regional scale.
- In our demonstration watersheds, agricultural producers expressed great interest in the role that innovative nitrogen removal practices such as the construction or restoration of wetlands could play

in achieving water quality goals.

- Farm Bill funding for such innovative practices is currently limited, and there appears to be little opportunity to fund these practices through water quality trading, wetland mitigation banking, or other ecosystem markets.
- We did, however, identify a potential driver for practice implementation in the form of increasing demands for sustainability along the food supply chain. We discussed the value of improving sustainability in grain production with supply chain entities—whether for food or feed usage—and are beginning to see interest from these companies in investing in increased sustainability practices in their grain-sourcing regions. We believe such interest will translate into support and incentives for the adoption of a variety of conservation practices, including innovative edge-of-field nitrogen removal practices. EDF is committed to continuing this work through our five-year strategic plan, Blueprint 2020.
- The development of the RPRP conservation planning toolkit and website has proven to be a crucial innovation that enables local conservation planners and stakeholders to visualize how a variety of conservation practices, including innovative nitrogen removal practices, can be implemented in their watershed to achieve local and regional water quality goals.

State and local conservation planners have expressed great enthusiasm for the project's planning toolkit: project partner ARS conducted two sets of trainings on toolkit usage for a total of 45 local conservation staff across the UMORB; the state of Iowa has contracted to use the planning toolkit in several watersheds across the state to demonstrate Nutrient Reduction Strategy implementation; and the state of Minnesota is considering using the toolkit for water quality projects funded through the state's Clean Water Legacy fund. Project partner Mark Tomer has made several presentations on the tools to NRCS Deputy Chief for Science and Technology Wayne Honeycutt and other staff at USDA headquarters, as well as presenting to Secretary Vilsack.

Recommendations

Our project went far beyond what we envisioned at the time of proposal submission in each of the following areas: (1) documenting the need for and value of innovative nitrogen removal practices; (2) developing a conservation planning toolkit that assists local stakeholders in determining which of these practices will be of most value in their watershed and which locations within the watershed are best suited to practice implementation; (3) incentivizing the use of these practices by stimulating demand in food supply chains (a previously-unrecognized potential driver); and (4) engaging stakeholders at the national, regional and local level in using our conservation planning toolkit.

Our primary recommendation from this project, is that our planning tools be incorporated into the next generation of conservation tools being developed for use in local and regional NRCS offices; this is already underway, as staff at the NRCS Central National Technology Support Center are in the process of working with State NRCS offices to disseminate and provide training on the use of our toolkit.