Iowa Nutrient Reduction Strategy

2017-18 Annual Progress Report

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Iowa Department of Natural Resources and
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Perennial cover. Photo courtesy of Jason Johnson, USDA Natural Resources Conservation Service.

Table of Contents

Preface....3

Summary of Progress of the Iowa Nutrient Reduction Strategy....5

Part One: Progress of the Iowa Nutrient Reduction Strategy....7

Introduction....7

Inputs....9

Human....26

Land....33

Water....46

Appendix A: Public Comment....65

Appendix B: Updates to the Strategy....66

Contact Information....67

Acknowledgments....67

Preface

The Iowa Nutrient Reduction Strategy celebrated its five-year anniversary in spring 2018. In those five years, the initiative has evolved considerably, adapting as new knowledge, understanding, and challenges arose. This 2018 Annual Progress Report serves as the fifth overview of the progress that's been made in the complex work of reducing the loads of nitrogen and phosphorus that Iowa exports to the Mississippi River. There has been clear progress in some indicators, while others represent the many challenges that remain.

The Strategy's first five years have seen positive indicators of early progress. One of the most striking is the rapid coordination of partner organizations to work towards Strategy goals. The Water Resources Coordinating Council, comprised of state and federal public entities, convenes on a quarterly basis to tackle challenges associated with water resource concerns, while the Watershed Planning Advisory Council – made up of private and non-governmental organizations – provides valuable feedback on the implementation of water quality programs. Various public-private partnerships fund and support watershed projects, research, and outreach and education for nonpoint source – primarily agricultural – nutrient reduction.

Similarly, point source entities – wastewater treatment facilities – and related organizations have demonstrated their cooperation with the Strategy's objectives and convened for a five-year review of efforts in April 2018. As a result, the Strategy's designated point source facilities continue to collaborate on nutrient reduction goals. Of the 154 wastewater treatment facilities listed in the Strategy, 125 have received new permits. These permits require facilities to monitor nutrients and submit studies to determine if it is feasible and reasonable to install nutrient removal technologies and, if so, to commit to a schedule to construct these installations. This permitting process has occurred at a faster rate than agencies anticipated.

Funding is another early positive story; with annual funding increasing or staying the same each year, the overall capacity for implementing the Strategy has expanded (page 9). Community and agricultural outreach continues to reach audiences throughout the state, with field days and education events occurring in 92 of Iowa's 99 counties in 2018 (page 27).

While these progressions are encouraging, the primary challenge facing the Strategy is one of scale – both temporal and spatial. The pace at which conservation practices are installed and implemented must continue to accelerate if Strategy goals are to be met within 20-30 years. Cover crop acres increased from an estimated 15,000 acres in 2011 to 760,000 in 2017. This substantial increase should be celebrated, given the time period in which it occurred. Still, it is estimated that at least 10 million acres of cover crops are needed to meet goals. Similarly, the need for nitrogen-reducing wetlands is 5-10 million acres treated; there are 104,000 acres treated statewide so far. Two factors are generally considered the main barriers to widespread adoption and implementation of nonpoint source nutrient reduction measures: spreading awareness among farmers and landowners, and establishing the infrastructure needed to scale up, such as technical service providers, engineers, and cover crop seed production. Outreach to farmers and landowners continues and is evaluated using social surveys (page 28). Conservation Infrastructure, a multistakeholder initiative, aims to strengthen technical capacities for delivering conservation services, particularly in the private sector (page 15).

Senate File 512, passed and signed in 2018, will dedicate an additional $270 million over the next 12 years for agricultural conservation practices and wastewater treatment improvements. This funding source will provide reliable support for programs that aim to scale up Strategy implementation, particularly when it comes to installing edge-of-field practices – such as wetlands and saturated buffers – that require a large upfront monetary investment. Due to the semi-permanence of these practices, the projects funded by the bill are expected to be in place for decades to come, and will have positive impacts on water quality over time.

Water monitoring in Iowa is poised to capture the impacts of Strategy efforts over time. Nitrate and turbidity sensors are deployed throughout the state, providing the necessary data for reliably estimating the state's nitrogen and phosphorus loads on an annual basis. Page 51 presents the annual nitrate-N load that Iowa exports to the Mississippi River, alongside data that represent annual streamflow. At this time, there is uncertainty surrounding the number of annual load values that will be needed to confidently ascertain overall trends. Due to the effects of streamflow and other factors on nitrate-N load, trends are difficult to detect at this time (page 47). To add to this complexity, the implementation of agricultural conservation practices one year may not result in measurable water quality changes within the following year or two. Paired watershed studies, whereby changes are made in a small watershed and compared to a "control" watershed of similar size and topography, will help researchers and practitioners better understand the time-lag between implementation and water quality improvement (page 57).

The Strategy originally called for annual, modeled estimates of nitrogen and phosphorus loads to be calculated, and the Annual Progress Report provides these estimates each year (page 51). Phosphorus estimates are expected to be available starting in 2019.

As the Strategy and its associated programs and efforts evolve, so too does measurement of Strategy progress. The first Annual Progress Report, published in 2014, was comprised of 17 pages of updates on new point source facility permits, the establishment of the Iowa Nutrient Research Center, and the first Iowa Water Quality Initiative demonstration watershed projects, among additional efforts that occurred in the Strategy's first year of implementation. In 2015, the Strategy's Logic Model was developed to visualize the progression of changes necessary for meeting nutrient reduction goals (page 7). In 2016, the measurement project established new protocols for standardizing the metrics that are used in the Annual Progress Report. Beginning spring 2016, partner organizations in the public, private, and non-governmental sectors committed to providing information on funding, outreach, and water monitoring that they conducted during the previous year. Most of those organizations continue to report annually, and a few additional organizations have joined the effort (see Part Two of the 2018 Annual Progress Report). These partner reports have made possible the ability to track a variety of indicators:

1) Annual Strategy funding, which can be broken down by program
2) Strategy-related outreach events, which are recorded by date and location
3) Conservation practice implementation that occurs outside publicly funded programs
4) Water monitoring efforts beyond the university- and agency-conducted monitoring programs

Prior to the initiation of these multistakeholder reporting commitments, the measurement of Strategy progress was limited to public administrative data on conservation program funding and cost-share practices. By standardizing a multi-partner reporting process, the Annual Progress Report aims to present a broader view of the actions taken by all organizations involved.

A key change to measurement efforts occurred during Iowa's 2018 Legislative Session. In response to the Environmental Protection Agency's (EPA) call for states to establish nutrient reduction plans, the Iowa legislature has established 1980-96 as the "baseline" period against which Strategy efforts will be compared. In other words, the Strategy will aim to reduce annual nitrogen and phosphorus by 45 percent compared to the average annual loads that occurred during that baseline time period. Estimates of those loads were determined by university and agency researchers (page 9). Due to the fact that the EPA had already established this baseline for the Gulf Hypoxia Task Force, this shift in Strategy measurement aims to be consistent with regional efforts. The Strategy originally used 2006-10 for the first annual load estimates due to data availability at the time.

To improve upon existing efforts to track conservation practice use in Iowa, and to allow for effective accounting of change since the baseline period, the BMP Mapping Project quantifies practice use in the 1980-96, 2007-10, and 2016-18 time periods (page 43). Using aerial imagery and remote sensing, this project has digitized the structural conservation practices – terraces, water and sediment control basins, ponds, wetlands, and stripcropping – that were in place during those three time periods. This effort is nearly complete. The data are publicly available, with the full dataset predicted to be available in spring 2019. The project will help usher Strategy measurement beyond the current use of cost-share program data, which has significant limitations (page 43). This project has been a long-term, public-private effort that is impactful in its utility for statewide conservation practice tracking.

Given the extent of multistakeholder efforts conducted for promoting Strategy goals, measurement and evaluation of the Strategy continue to evolve. As described throughout this report, data availability has increased rapidly in the last few years. With more available data, there are a number of questions that can be explored in future reports. For instance, how has increased funding affected change in Iowa's nutrient loss management, particularly regarding outreach, conservation practice adoption, and wastewater treatment upgrades? How have farmers' attitudes and receptiveness about conservation been impacted as a result of these scaled-up efforts? What barriers remain to the voluntary adoption of nutrient reduction practices? Have these efforts measurably affected change in nutrient loads? Finally, how can the answers to these questions inform future management of nutrient loss in Iowa? The measurement of Strategy progress will continue to explore these questions and others throughout the next five years and beyond.

Written by Laurie Nowatzke, measurement coordinator for the Iowa Nutrient Reduction Strategy at Iowa State University.

Summary of Progress of the Iowa Nutrient Reduction Strategy

2017-18 Reporting Period

The Iowa Nutrient Reduction Strategy (NRS) directs efforts to reduce nutrients in surface water from both point and nonpoint sources in a scientific, reasonable, and cost-effective manner.

The Strategy was prompted in an effort to reduce nutrient loads that are transported to the Gulf of Mexico. The plan established a goal of 45 percent reduction of total nitrogen and total phosphorus loads.

INPUTS

- **$512 million** in public and private funds were dedicated to NRS-related efforts in the 2018 reporting period, with non-Conservation Reserve Program funding remaining relatively the same as in the previous year. Private funding increased by about $500,000.

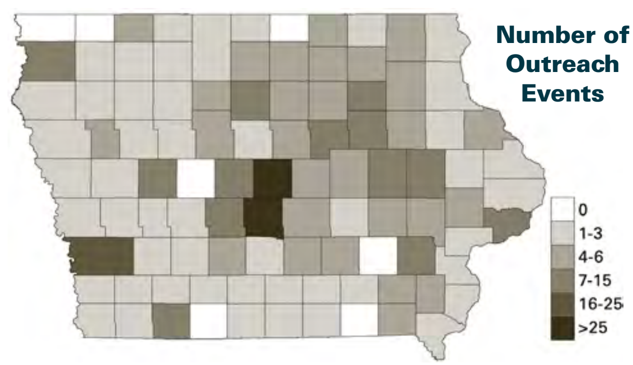
- Of the **154 municipal wastewater plants and industrial facilities** required to assess their nutrient removal capacity, 125 have been issued new permits. Of those, 82 have also submitted feasibility studies on potential technology improvements.

> - Fourteen cities and ten industries met the NRS point source reductions targets for nitrogen removal this year (66% removal).
> - Eight cities and three industries met the NRS point source reduction targets for phosphorus removal this year (75% removal).
> - Twenty-seven wastewater treatment plants have committed to construct upgrades to remove nitrogen and phosphorus.

- Through its competitive grants program since 2013, the Iowa Nutrient Research Center has funded over 30 projects with a primary focus of evaluating the performance of conservation practices in reducing nutrient loss from agricultural landscapes.

HUMAN

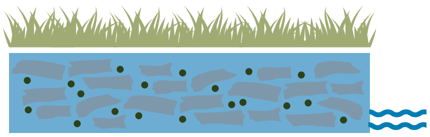
- **Outreach events** were conducted in **92 counties** in the 2018 reporting period. In the latest reporting period, partner organizations reported 511 events – up from 474 events in 2017 – with 45,800 total attendees, a slight decrease in attendance compared to the previous year.



- Farmers' responses to surveys vary in different areas of the state. In two-year farmer surveys in various regions of Iowa, knowledge and attitudes related to the NRS are showing little change over time. However, some regions are showing an increase in farmers' reported use of conservation practices, while other regions show no statistically significant change.

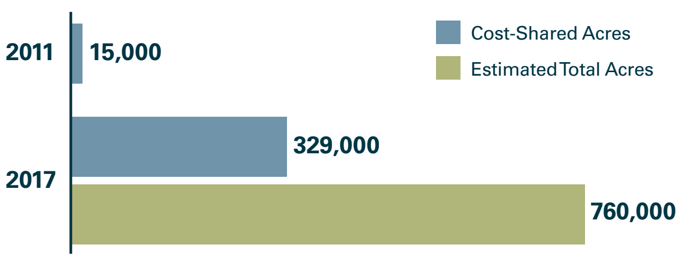
LAND

- In recent decades, government conservation programs have focused strongly on practices that reduce phosphorus loss, such as terraces, and on practices that address both **phosphorus** and **nitrogen**, such as cover crops and land-use change. Practices that address only nitrogen, such as **bioreactors** and nitrate-treating **wetlands**, are now receiving increased focus from conservation programs.

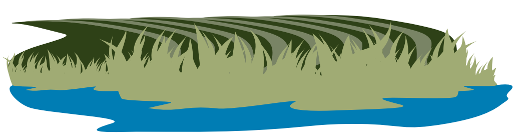


- Government cost-share programs enrolled 330,000 **cover crop** acres in 2017. Iowa has experienced a steady increase in cover crop acres since 2011, and statewide estimates (beyond just cost-share) indicate **760,000** acres were planted in 2017.

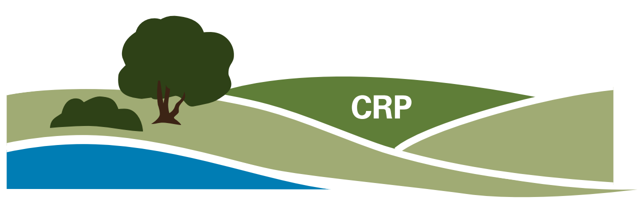
Iowa Cover Crops Acres



- Installations of structural practices continue on an even trend. **Terraces** and **water and sediment control basins** that have been constructed since 2011 treat approximately **290 thousand acres** through government programs to reduce soil and phosphorus loss. Approximately 104,000 total acres benefit from 86 nitrogen removal **wetlands** in the state.



- At **1.8 million acres, land retirement** through the Conservation Reserve Program is currently about 200,000 acres greater than in 2011, with annual fluctuations.



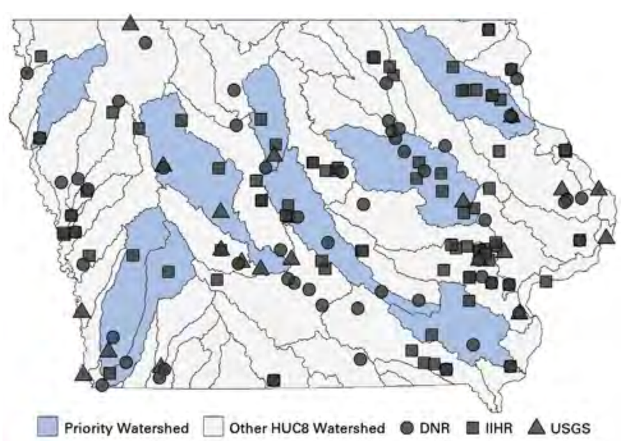
WATER

- To establish consistency with the Gulf of Mexico Hypoxia Task Force, researchers estimated **Iowa's baseline annual loads** of nitrogen and phosphorus that occurred from **1980-96**. This baseline will complement the previously established benchmark loads of the 2006-10 time period.

- At least **88 percent** of **Iowa's land** drains to a location with **water quality sensors** installed and maintained mainly by the Iowa Department of Natural Resources, University of Iowa IIHR-Hydroscience & Engineering, and the US Geological Survey. In 2018, IIHR has **32** more real-time nitrate sensors deployed than in 2016. Water monitoring occurs at various scales, from **edge-of-field to large watersheds**. Long-term data collection will contribute to our understanding of nutrient export over time.

- In addition, grab samples of surface water are collected regularly by the Iowa Soybean Association and Agriculture's Clean Water Alliance at 302 locations, plus 582 edge-of-field sites.

Iowa Surface Water Monitoring Sites



- A method has been developed and evaluated for efficiently **estimating Iowa's annual nitrogen export** using empirical monitoring data. A similar method for phosphorus has been researched and is currently under development; the first annual estimate of phosphorus export will likely be available at the end of 2018.

Part One: Progress of the Iowa Nutrient Reduction Strategy

Introduction

The Iowa Nutrient Reduction Strategy (NRS) is a research- and technology-based approach to assess and reduce nutrients delivered to Iowa waterways and the Gulf of Mexico. The strategy outlines opportunities for efforts to reduce nutrients in surface water from both point sources, such as municipal wastewater treatment plants and industrial facilities, and nonpoint sources, including agricultural operations and urban areas, in a scientific, reasonable, and cost-effective manner.

The NRS was developed in response to recommendations provided by the United States Environmental Protection Agency (EPA) in their March 16, 2011, memo, "Working in Partnership with States to Address Phosphorus and Nitrogen Pollution through Use of a Framework for State Nutrient Reduction." Ongoing action for nutrient load reductions is further supported by the recent EPA recommendations, "Renewed Call to Action to Reduce Nutrient Pollution and Support for Incremental Actions to Protect Water Quality and Public Health," released on September 22, 2016.

This Annual Progress Report, revised and published each year, provides updates on point source and nonpoint source efforts related to specific action items listed in the elements of the NRS. The Annual Progress Report also provides updates on statewide efforts and activities that aim to achieve reductions in nitrogen and phosphorus loads. The NRS documents, including each year's **Annual Progress Report**, can be accessed at www.nutrientstrategy.iastate.edu.

Partners

The NRS and the Annual Progress Report are a collaboration of representatives of the Iowa State University College of Agriculture and Life Sciences, Iowa Department of Natural Resources (DNR), and Iowa Department of Agriculture and Land Stewardship (IDALS). The Water Resources Coordinating Council (WRCC), a body of governmental agencies that coordinate water-related issues in Iowa, is presented with the Annual Progress Report each year.

Additional partners comprise the Watershed Planning Advisory Council (WPAC), which includes private and non-governmental organizations. These partners, and others outside WRCC and WPAC, voluntarily contributed valuable data that provided the basis for analysis of NRS funding, staff, outreach, practices, and water monitoring to track efforts that have been conducted during the 2018 reporting period (June 1, 2017 to May 31, 2018). A list of these partner organizations is displayed on page 67.

The Logic Model Approach

The 2015 NRS Annual Progress Report introduced a logic model framework as the basis of considerations set forth by the WRCC Measures Subcommittee. The NRS Logic Model is guided by measurable indicators of desirable change that can be quantified, and represents a progression toward goals for achieving a 45 percent reduction in nitrogen (N) and phosphorus (P) loads. This measurement framework assists the annual reporting process, which was recommended by the 2011 and 2016 EPA memos.

Navigating this report

Each section of this annual report explores a dimension of the NRS Logic Model – Inputs, Human, Land, and Water. A significant reduction in nutrient loads is the ultimate goal of the NRS, and is represented by the right-most category of Figure 1. In order to affect change in water quality, there is a need for increased inputs, measured as funding, staff, and resources. Inputs affect change in outreach efforts and human behavior. This shift toward more conservation-conscious attitudes in the agricultural and point source communities is a desired change in the human dimension of water quality efforts. With changes in human attitudes and behavior, changes on the land may occur, measured as conservation practice adoption and wastewater treatment facility upgrades. Finally, these physical changes on the land may affect change in water quality, which ultimately can be measured through both empirical water quality monitoring and through modeled estimates of nutrient loads in Iowa surface water. The measurable indicators that correspond to each category, as outlined in Figure 1, provide quantified parameters in which to track year-to-year changes and continual trends to develop a standardized protocol for evaluating NRS progress.

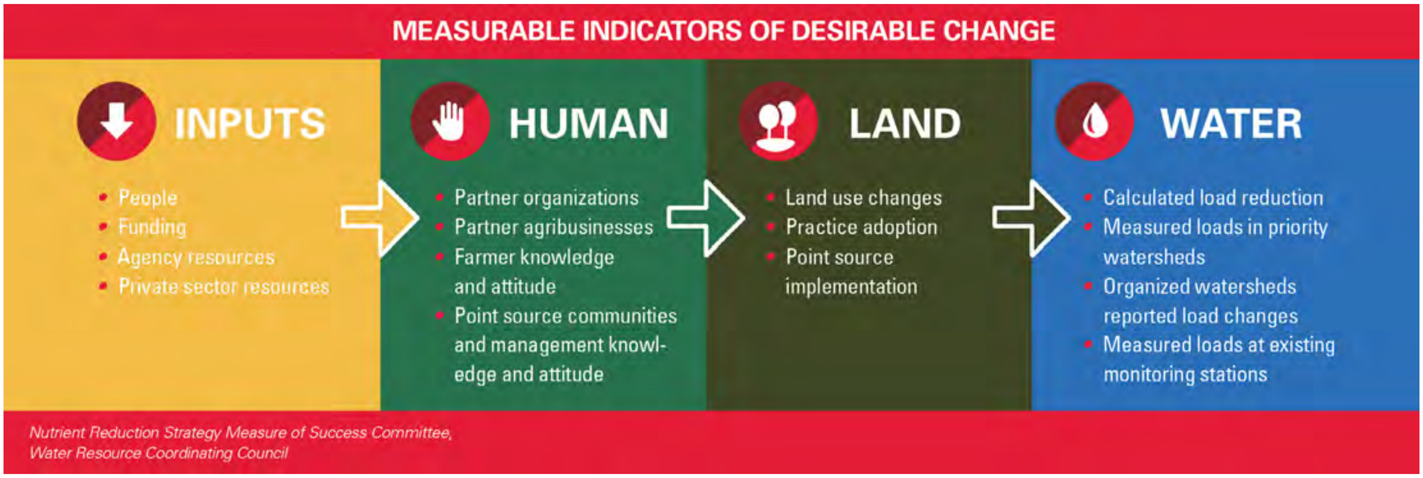


Figure 1. The logic model of the Iowa Nutrient Reduction Strategy, guided by measurable indicators of desirable change.

In measuring progress of the NRS, the logic model serves as a comprehensive reporting tool to inform data collection, indicator development, and assessment of the successes and challenges associated with reducing nutrient loads from point and nonpoint sources. The logic model guides the assessment of not only a progression of changes, but also can inform improvements in each of the four primary categories. With continually refined measurement of each category, potential adjustments may be made to the inputs and efforts that partner organizations devote to the NRS in order to impact change over time.

Challenges associated with measuring change

Measuring NRS progress is a complex undertaking that is accompanied by a variety of challenges, a few of which are outlined as follows. First, measurable indicators that direct change toward the end-goal must be identified and refined. In the case of the NRS, measurement efforts assess a wide variety of factors that are impacted by many stakeholders. In an effort to develop indicators that represent meaningful change in each logic model category, each indicator was evaluated based on:

- Data availability
- Trends or year-to-year changes that can be used to evaluate progress
- Whether the indicator can inform management if progress is not made

Data availability to accurately assess progress in each category of the logic model is a primary hurdle. For example, current analyses – as discussed in the "Land" section of this report – rely on governmental conservation program (i.e. cost-share) data to evaluate conservation practice adoption on agricultural land. There is limited knowledge of the extent to which farmers employ conservation without public financial assistance, but efforts are currently underway to capture this critical information. Similar challenges in data availability relate to many of the indicators discussed in this report; specific details and efforts to overcome these data limitations are described within each corresponding portion of this report.

A sufficient period of record is also needed to evaluate progress. In large, natural systems, it can be difficult to distinguish trends over a short period of time. As an example related to the "Water" dimension of the NRS Logic Model, in a high-precipitation year, nutrients in surface water may appear be overly elevated due to exceptional runoff. Conversely, in a drought year, nutrients may appear to be well controlled due to minimal runoff. It will take a multi-year period of time to get an accurate handle on progress by detecting an overall trend in what can be highly variable data.

The following sections highlight and discuss the evaluation of NRS logic model indicators and the progress that was made since June 1, 2017. Indicators of each category and the related data sources discussed are continually under evaluation and may be subject to change in the future.

Updates to the baseline and benchmark nutrient loads of the NRS

The Iowa State University College of Agriculture and Life Sciences, IDALS, and the Iowa DNR partnered in 2010 to develop the NRS. Iowa State and IDALS collaborated to conduct the NRS Nonpoint Source Science Assessment (NSSA), which involved estimating nutrient loads from agriculture and land use over the 2006-10 time period, reviewing scientific literature to assess potential performance of practices, estimating potential load reductions of implementing various scenarios involving nutrient reduction practices, and estimating implementation costs. The DNR conducted the Point Source Technology Assessment to evaluate the potential for point source facilities – publicly owned treatment works (POTWs) and industrial facilities – to increase nutrient removal capacities.

The initial NSSA estimated annual nitrate-N and phosphorus loads using information from the 2006-10 time period. This period was used due to the availability of data at the time the NSSA was conducted. However, the 2008 Gulf of Mexico Action Plan states that reductions "measured against the average load over the 1980-1996 time period, may be necessary", with targets of 20 percent reduction in nutrient loads by 2025 and 45 percent reduction by 2035. In 2017, researchers at Iowa State University and the DNR conducted parallel studies to quantify Iowa's average annual nutrient load during the 1980-96 period (Figure 2). Table 1 provides estimates of annual nitrogen and phosphorus loads from Iowa over this period by summarizing the results detailed in the two studies: "Assessment of the Estimated Non-Point Source Nitrogen and Phosphorus Loading from Agricultural Sources from Iowa During the 1980-96 Hypoxia Task Force Baseline Period", and "Nitrogen and Phosphorus Load Estimates from Iowa Point Sources During the 1980-96 Hypoxia Task Force Baseline Period". Both studies are available at www.nutrientstrategy.iastate.edu/documents. A brief summary of the studies' methods and results detailed is also available at the same web page.

Table 1. Baseline (1980-96) and benchmark (2006-10) average annual loads from nonpoint sources (NPS) and point sources (PS).

		1980-96 Baseline Load (tons)	*2006-10 Benchmark Load (tons)*	*Change 1980-96 to 2006-10*	
Nitrogen	NPS	278,852*	293,395	5.2%	Increase
	PS	13,170	14,054	6.7%	Increase
	Total	**292,022**	**307,449**	**5.3%**	**Increase**
Phosphorus	NPS	21,436	16,800	21.6%	Decrease
	PS	2,386	2,623	9.9%	Increase
	Total	**23,822**	**19,423**	**18.5%**	**Decrease**

* *The method used to derive the total nitrogen estimate of 292,022 tons indirectly reflected the point source contributions.*

Inputs

Inputs are a foundational indicator of change in Iowa's efforts to reduce nutrient loading within the state and further downstream. Increases in inputs are necessary to expand Iowa's capacity for encouraging and realizing changes in human behavior, and for promoting conservation and water quality improvement. Targeted inputs toward specific facets of NRS work may be required to have an effect on the goals set forth by the NRS, but this report aims to provide an overview of statewide funding, staff, research, and demonstrations that are dedicated to NRS implementation. Progress of NRS inputs is measured, in part, through the documentation of annual funding, staffing, and the extent of continued research.

Funding

The total estimated funding for NRS-related efforts in the 2017 reporting period – including education and outreach, research, practice implementation, and water monitoring – was an estimated $512 million. This estimate is an increase from the $388 million reported in 2016 and

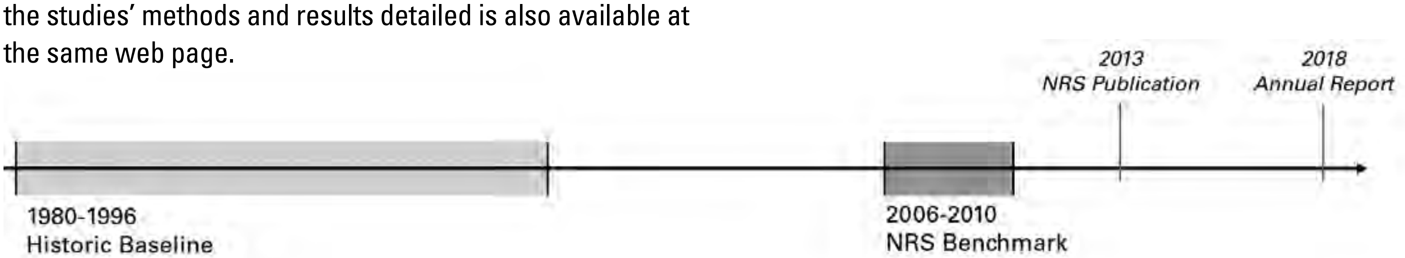


Figure 2. Conceptual timeline of the 1980-96 baseline, the 2006-10 benchmark, and selected subsequent events in the history of the Iowa Nutrient Reduction Strategy.

$438 million reported in 2017 (Figure 3).[1] These estimates encompass both public and private funding and were estimated from the voluntarily submitted reports of WRCC and WPAC member organizations and by other partner organizations that conduct work contributing to NRS implementation. The majority of public programs described in this report are considered base programs and have, in general, been in existence for decades. In addition, these estimates include the farmer and landowner contribution to the implementation of cover crops, terraces, water and sediment control basins (WASCOBs), and grade stabilization structures that received cost-share funding; other practices were not included due to insufficient financial cost-share data. This is due to the relative assurance of quantifying investments for the subset of practices based on currently available datasets. These annual estimates do not account for the investments made by private entities, farmers, or landowners or practices financed entirely outside of cost-share programs.

Of the total reported funding for the 2016 and 2017 reporting periods, 94 percent was appropriated through public funds. Conservation Reserve Program (CRP) rental payments accounted for more than half – 62 percent – of this public funding. This proportion is an increase from 56 percent of total funding reported in 2017. Six percent of total funding was private – landowner contribution to cost-share or funding reported by private and non-governmental organizations.

It is vital to note that most public funding comes from sources that could be considered base programs. These programs fund conservation efforts that were in place for many years before the NRS was initiated. Efforts to optimize manure management, reduce soil loss, monitor streams, and maintain many other long-term conservation activities have occurred in Iowa for decades; these programs were established to address single or multiple resource concerns and should not be solely evaluated on how they address or measure nutrient loss. It may be necessary for additional resources to be made available from a variety of sources – public and private – that target and launch innovative NRS efforts in order to advance towards meeting NRS goals. Public programs that are NRS-focused (i.e. implement newly established NRS efforts or were developed in response to the NRS) increased from 2016 to 2017 by about $7.5 million, and then decreased by approximately $2.7 million from 2017 to 2018.[2]

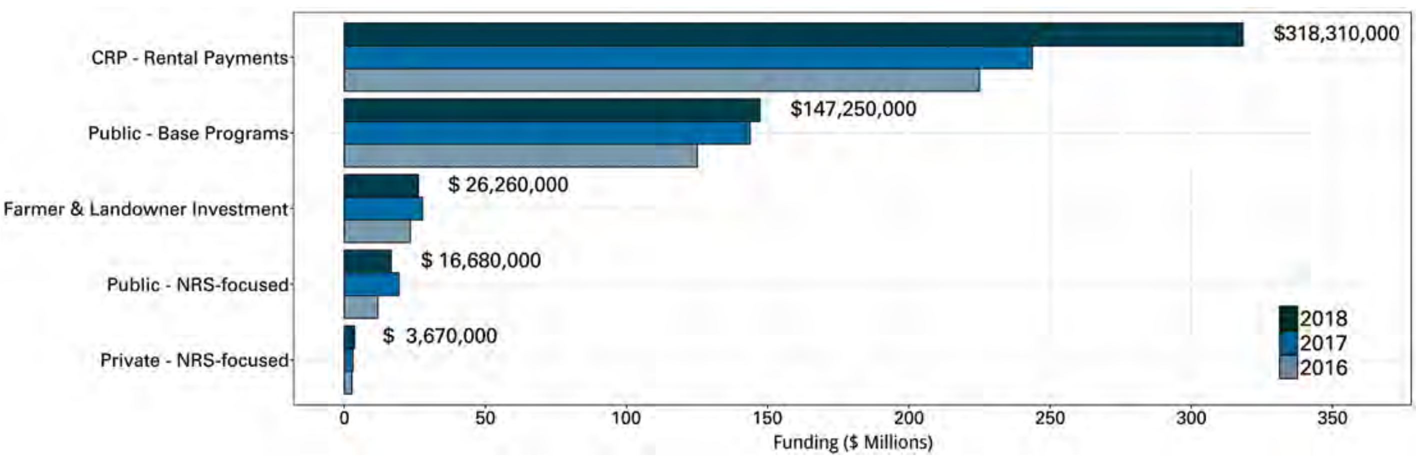


Figure 3. Funding obligated for NRS efforts by partner organizations in the 2016 through 2018 reporting periods. The inset text indicates the funding obligated by each funding source during the 2018 reporting period. The "Public – Base Programs" category captures public conservation programs that were in place prior to the start of the Iowa Nutrient Reduction Strategy. Farmer and landowner investment accounts only for investment in cover crops, terraces, water and sediment control basins (WASCOBs), and grade stabilization structures that received cost-share funding. Efforts to expand this analysis are underway, so these estimates will likely change in future reports. The "Public – NRS-focused" category captures public programs initiated in response to the Iowa Nutrient Reduction Strategy or similarly timed efforts. The "Private – NRS-focused" category captures funding obligated by private organizations in response to the Iowa Nutrient Reduction Strategy.

[1] Funding amounts are calculated and reported differently than in the 2016 Annual Progress Report. This discrepancy is due to factors outlined on page 11. In addition, funding estimates for the 2017 reporting period were adjusted in comparison to the 2017 Annual Progress Report, due to corrections to the reported funding for the Iowa State Revolving Fund.

[2] Federal conservation programs assessed for this report include: Conservation Reserve Program, Environmental Quality Improvement Program, Conservation Stewardship Program, Regional Conservation Partnership Program, EPA-319, Conservation Reserve Enhancement Program, and others. State conservation programs assessed for this report include: Iowa Financial Incentive Program, Water Quality Initiative, Resource Enhancement and Protection, and others.

While the level of public funding for NRS implementation in the 2018 reporting period accounts for the vast majority of total funding, non-governmental partners reported approximately $3.7 million of private funding for NRS efforts during this past reporting period, an increase from $3.2 million in the 2017 reporting period. Much of this funding was sourced from commodity check-offs and organizations' membership dues.

The 2016 annual report indicated that $112 million and $122 million were obligated for NRS efforts in 2015 and 2016, respectively. The discrepancy between those values and the funding estimates reported in this document is due to:

- The inclusion of CRP rental payments in the total funding estimate.
- The improvement of funding reporting by partner organizations, whereby higher-resolution data on specific programs made it impractical to compare 2016 and 2017 funding to the less standardized 2015 partner reports.
- The ability to account for some landowner investment in cost-share conservation practices.
- Participation by additional partner organizations in the reporting process.

Thus, the total funding estimates reported this year should not be compared to those published in the 2016 annual report. In addition, the funding estimate that was published in the 2017 annual report was adjusted here to account for a correction to estimates of Iowa State Revolving Fund spending. It is likely there are additional sources of funding that have not been accounted for in the above estimates of annual NRS funding. Measurement of NRS funding is continually improving to track change over time; a standardized reporting tool for gathering annual funding data, developed in 2016, will continue to allow for consistent reporting from 2016 onward. Additionally, to improve measurement of NRS progress that has occurred since the Strategy's introduction in 2013, efforts are underway to retroactively estimate annual funding for the years 2011 through 2015 using similar data collection methods as employed for this report.

Measuring Partner Efforts

Beginning in the 2015 reporting period, organizations affiliated with the Water Resources Coordinating Council (WRCC) and the Watershed Planning Advisory Council (WPAC) reported their NRS-related funding and efforts to be included in the annual report.

This data collection method was continued, but adapted, in the 2016 reporting period. Since 2016, funding, staff, outreach efforts, and monitoring efforts have been collected through this adapted, standardized data entry process. This method reduced duplication of reported inputs and efforts that are performed collaboratively. For example, a grant that was disbursed by one organization and awarded to another may be reported by both organizations, but double-reporting was minimized by obtaining specific information about different funding sources. Similarly, data on outreach events that were held by two or more partner organizations were evaluated to prevent double-counting of one event.

Distilled information from these partner reports is used for measuring progress of inputs and outreach in this annual report. Additionally, the full partner reports, including each organization's overview of its NRS efforts, are provided in Part Two of this report.

Estimated farmer investment in conservation

The following analysis aims to quantify annual farmer and landowner investment in conservation practices that reduce nutrient loss from agricultural nonpoint sources. Currently, because practice implementation data are limited to cost-share programs and exclude independently implemented practices, this assessment of financial investment in practices is also limited to cost-share programs.

This analysis utilized state program data, which provides the financial data that correspond to specific cost-share contracts, to estimate cost per acre treated for cover crops, terraces, WASCOBs, and grade stabilization structures. These cost-per-acre values were applied to federal cost-share practice data, which exclude landowner financial contributions but indicate acres or units installed. An initial assumption of 50 percent cost-share was applied to this average cost per practice to estimate farmer and landowner investment in federally funded practices. Other conservation practices had insufficient data to make these estimates, but a data-sharing relationship established by IDALS with the United States Department of Agriculture Natural Resource Conservation Service (USDA-NRCS) in 2017 will contribute to future financial analysis on practices funded through the Environmental Quality Improvement Program, the Conservation Stewardship Program, and additional cost-share programs.

Since 2011, approximately $171 million has been invested by farmers and landowners for cover crops, terraces, WASCOBs, and grade stabilization structures that received cost-share through public conservation programs. In 2017, farmers and landowners invested about $9.5 million in cover crop cost-share contracts, while they invested approximately $16.7 million in terraces, WASCOBs, and grade stabilization structures (Figure 4). Investment in these selected practices increased by $5 million from 2015 to 2016 and then decreased by about $1.5 million from 2016 to 2017. Rapid increases in cover crop adoption through cost-share programs since 2011 drives a steady increase in associated landowner and farmer investments. However, investment in the structural practices has fluctuated more in the last seven years. This fluctuation is partially due to variations in funding levels for these programs, but is also impacted by variations in practice installation affected by weather, time of survey and design, and other factors.

This estimate of farmer investment underrepresents true total investment in cost-share practices, as it only includes selected practices due to data availability. Additionally, this estimate excludes landowner spending for NRS practices that were financed entirely outside of cost-share programs. The lack of data available for independently adopted practices makes for difficult financial assessment, but efforts to track non-cost-shared practices (see page 43 for more details), coupled with these insights on overall cost of practices, will aid future efforts to better account for total investment.

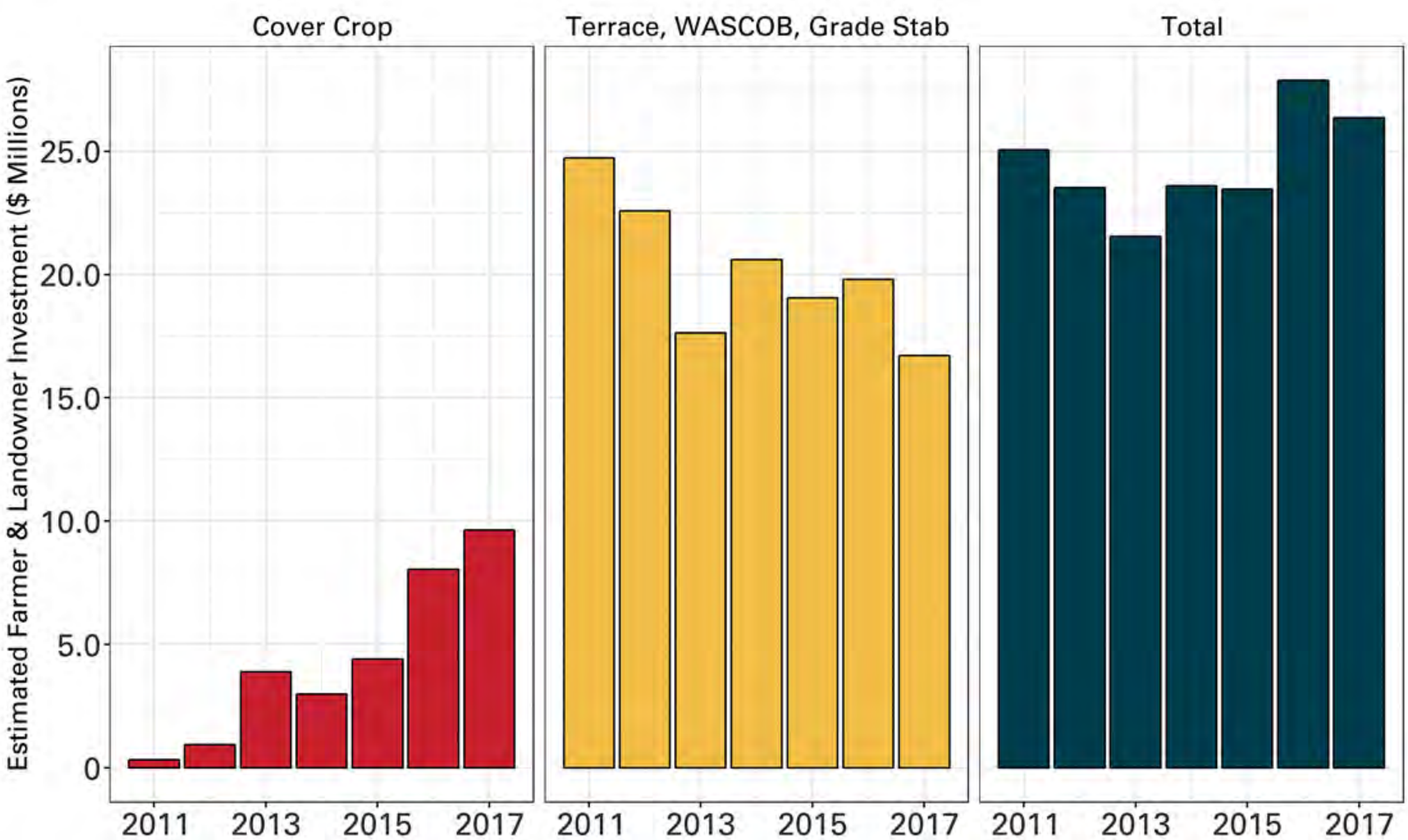


Figure 4. The estimated investment spent by farmers and landowners who used cost-share assistance for cover crops, terraces, WASCOBs, and grade stabilization structures. These estimates exclude investments by farmers and landowners that did not use any state or federal cost-share assistance for these practices.

The Iowa State Revolving Fund

The State Revolving Fund (SRF) is operated by the DNR and the Iowa Finance Authority (IFA), in partnership with IDALS. The Clean Water SRF finances water quality projects eligible under the Clean Water Act and the Drinking Water SRF covers water system improvements under the Safe Drinking Water Act, including source water protection. Cumulatively, the SRF programs have financed more than $3.2 billion to date.

Table 2 displays the assistance provided for water quality projects by the Clean Water SRF during the 2018 fiscal year.

Table 2. Clean Water State Revolving Fund assistance provided to water quality projects in the 2018 fiscal year.

Project type	Amount
Wastewater and sewer infrastructure	$232,711,000
Soil and sediment erosion control	$2,023,571
Manure management	$2,517,174
Onsite septic system upgrades	$1,212,829
Wetland, lake, and river restoration	$4,734,700
Green stormwater infrastructure	$4,599,000
Total	**$247,798,274**

The Clean Water SRF Water Resource Restoration Sponsored Projects program leverages investments made by municipalities to upgrade wastewater facilities to include additional resources for projects that address urban and agricultural runoff. Through June 2018, the program has awarded 90 sponsored projects in 72 communities for a total commitment of $60 million.

Sponsored project priorities are locally directed, allowing communities and their partners to create innovative approaches to watershed protection and urban-rural partnerships. Some examples include:

- The Iowa DNR Geode State Park used Sponsored Project funds in conjunction with DNR Lake Restoration and 319 funds to construct several sedimentation ponds on tributaries to Lake Geode in order to implement recommendations from the Lake Geode Watershed Management Plan to reduce sediment delivery from agricultural runoff and gully erosion.
- The City of Spencer constructed a stormwater wetland, sediment forebay, and bioretention cell. The purpose of these practices is to treat agricultural and urban runoff to the Little Sioux River. The stormwater wetland was constructed with cooperation from Walmart to acquire the land.
- The City of Dubuque used funding to address water quality problems and implement practices recommended in the Catfish Creek Watershed Management Plan. Projects include: stream restoration including stone toe protection, bank reshaping, floodplain benches, riparian buffer restoration along a segment of Catfish Creek, and development and funding of a cost-share program through the Catfish Creek Watershed Management Authority to reimburse landowners for constructing stormwater or agricultural best management practices.

Anticipated funding sources

Substantial sources of funding were announced in 2016. These multi-year projects took effect during the 2018 reporting period, but support long-term efforts and were not reflected in partners' 2018 funding reports. The following list contains highlights of new funding awards that have taken effect and will likely be reflected in partners' reports in the next few years.

- The EPA Gulf of Mexico program awarded IDALS a $1 million Farmer to Farmer cooperative agreement to establish the Iowa Transforming Drainage Demonstration Project over the next three years. The Iowa Transforming Drainage Demonstration project has assembled a project team with well-recognized expertise in conservation drainage concepts to address limitations, barriers, and opportunities to reduce the environmental impacts of cropping systems utilizing artificial, subsurface drainage. This project will demonstrate several proven edge-of-field (EOF) and drainage water management concepts, historically under-delivered by current state or federal programs, to further understanding and scale-up through on-farm installations.
- IDALS and the USDA-Risk Management Agency announced a new, three-year demonstration project aimed at expanded usage of cover crops through an innovative partnership with federal crop insurance

programs. The program provides an additional premium discount for acres in cover crops that are not already covered by current state or federal programs. More **information can be found** at www.cleanwateriowa.org/covercropdemo.

- The Iowa Legislature passed and Governor Kim Reynolds signed into law new legislation that will provide more than $270 million for water quality efforts in Iowa over the next 12 years. This long-term funding source will provide significant additional resources for water quality programs in the state. The funding will be divided into four areas:
  - Wastewater and Drinking Water Treatment Financial Assistance Fund
    - Amends an existing program to give grants to water and wastewater projects. Grants would be awarded annually and used for improvements to wastewater and drinking water treatment facilities, including source water protection projects. The maximum grant award is $500,000.
  - Water Quality Financial Assistance Fund
    - This is a new revolving loan fund which is to be a permanent source of water quality financial assistance. The purpose is to provide financial assistance to projects that improve water quality with a higher prioritization to collaborative efforts.
  - Water Quality Agriculture Infrastructure Fund
    - The purpose of this program is to support projects for the installation of practices to reduce nutrient loss to surface waters consistent with the Iowa Nutrient Reduction Strategy.
  - Water Quality Urban Infrastructure Program
    - The purpose of this program is to support projects that reduce runoff and improve infiltration rates in urban areas consistent with the Iowa Stormwater Management Manual.

Current challenge: the capacity for acceleration

The NRS serves as a foundation for improved partnership and collaboration for nutrient load reduction efforts in Iowa. This summary aims to provide a prospective on the current status of state and federal program delivery, while quantifying non-governmental investments. This effort is not complete and will continue to be refined and improved to gather additional information from other sectors currently not included in this assessment.

The capacity for accelerating the availability of these inputs remains a distinct challenge. New, dedicated long-term funding approved in 2018 will help. Short-term, grant-based funding constituted approximately 11 percent of NRS funding in the year prior to this announcement, as reported by partner organizations. Annual appropriations, as potentially more reliable sources of funding with some uncertainty surrounding year-to-year availability, account for 38 percent of NRS funding, as reported by partner organizations. This proportion of funding longevity was similar in 2017. Funding sources that are stable, predictable, and incrementally increased may help government agencies, non-governmental organizations, and private industry develop a greater capacity to hire staff, fund long-term research projects, and conduct multi-year education and outreach to better implement physical changes that will reduce nutrient losses to surface water. In short, stability and predictability of funding sources, coupled with increased funding, can assist the acceleration of NRS implementation. In the long term, grant and annual funding, which accounted for 55 percent of reported funding, may be most appropriate for trials of innovative new approaches and studies, but are difficult to rely upon for long-term management programs that maintain ongoing NRS progress.

The challenge of developing capacity for implementation continues to grow as increased funding becomes available. Reducing nonpoint and point source nutrient contributions will require technical assistance, practice design, and, in some cases, construction. Often this issue is exacerbated when trying to implement new or emerging practices. Existing staff tasked with delivering the current set of funding levels are typically at capacity. Therefore, additional resources will likely need to include new staff, which will require training. Whether this is in the private or public sector, staff capacity will need to be available to review and implement the practices that must occur across Iowa's landscape in order to reach the goal of 45 percent reduction of statewide nitrogen and phosphorus export. Current efforts operate this way to some extent, but are only able to deliver at the level of current focus and funding. Depending solely on existing efforts, processes, and staff levels to deliver more will continue to influence progress.

Streamlining and prioritizing will help, but the challenge will be to scale up these efforts and to incorporate new practices that are not widely deployed. Multi-year watershed projects and others that are supported by state and federal programs are helping to address this need for increased infrastructure and capacity for NRS implementation, but continued increases in capacity and semi-permanency in support of these efforts will be necessary.

The Conservation Infrastructure (CI) Initiative was started with a broad cross-section of leaders within and outside of the agriculture industry to help identify potential economic development opportunities associated with advancing the NRS. While many programs are in place to further the NRS, there is great need for developing other opportunities and investments that will support the enormous level of scaling-up that is required. Iowa Secretary of Agriculture Mike Naig and former American Soybean Association Chairman Ray Gaesser co-chair this conservation infrastructure effort. The initiative seeks to increase the investment and engagement from both public and private sectors in implementing the Iowa NRS. This will be achieved by accelerating farmer and landowner demand for conservation practices – through outreach, education, and training – and harnessing economic drivers, innovative market-based solutions, and new revenue streams to improve water quality.

The CI Initiative identifies barriers to scaling up conservation practices from current rates of adoption to the levels necessary to achieve the nutrient load reduction goals of the Iowa NRS, as well as potential solutions to overcome those obstacles. The CI Initiative recognizes that as the pace and scale of conservation practices increase, there will be job creation and economic development opportunities as well as water quality improvements that benefit all Iowans. At the same time, the CI Initiative seeks to signal to the private sector that there are robust, long-term business opportunities for investing in conservation related business lines.

The CI Initiative has brought together technical experts and industry representatives to initially look at three aspects of this challenge: the overall conservation infrastructure strategy, conservation drainage (e.g. bioreactors, saturated buffers, drainage water management, and nutrient removal wetlands), and cover crops. Core teams and working groups have been formed on each of these topics. Additional efforts on other NRS practices may be added later.

Since the CI Initiative was announced in August 2016, more than 100 representatives from the public and private sectors have been engaged in defining and developing the initiative. This includes rural and urban organizations, agricultural associations, conservation and environmental groups, agribusinesses, food companies, engineering firms, farmers, academic institutions, and federal, state, and local governments.

Key accomplishments of the CI Initiative effort to date are as follows:

- *Developed recommendations* – The three working groups have led diverse stakeholder engagement with public and private partners to develop 47 CI recommendations. When implemented, these recommendations will help achieve the CI Definition of Success and make substantial progress towards the Iowa NRS goals. The CI recommendations were developed through a review process and address the key sociological and economic forces that create barriers or opportunities to implementing the Iowa NRS.

- *Facilitated progress* – There are current, ongoing efforts to directly or indirectly advance 36 of the 47 CI recommendations.

- *Action Plan development and recommendation implementation* – The CI Initiative has provided a pathway for stakeholders to collaborate on projects. Six sample implementation projects that highlight specific activity and progress planned towards 14 of the CI recommendations are outlined in the full action plan. Implementation of other projects continues.

- CI members are focused on advancing these recommendations and projects in ways that improve soil and water quality, create jobs and business opportunities for Iowans, bring economic development opportunities to Iowa's rural communities and cities, and provide opportunities for farmers to increase their profitability and productivity.

- Collaboration, continuous improvement, and sustained effort will be needed to further the CI Initiative. To be successful, there must be greater participation in these implementation efforts. Additional partners will continue to be recruited to join these efforts.

More information on the **Conservation Infrastructure Initiative** can be found at www.iowaci.org.

Staff

One indicator for NRS progress in Iowa is the number of people working to implement elements of the strategy. There is a persistent need for administrative support, researchers, and technical staff including agricultural, conservation, and engineering specialists, for the continued implementation of conservation practices in rural and urban landscapes.

Member organizations of WRCC and WPAC, as well as other partner organizations, reported having 647 full-time equivalent (FTE) staff members working on NRS-related efforts in 2018 (Table 3). This value is a slight decrease from 2016 and 2017, when 665 and 666 FTEs were reported, respectively.[3] Of these staff members in 2018, 190 FTEs comprise the infrastructure, or administrative and planning support, of NRS-related efforts. Twenty-two FTEs comprise research staff, 407 conduct on-the-ground implementation of practices that reduce nutrient loss and improve water quality, and 28 were categorized as other forms of NRS support. Tracking of staff inputs will be continued annually through partner organization reports; future data collection will identify potential future changes.

Table 3. A summary of staff dedicated to water quality and the NRS during the 2017 and 2018 reporting periods.

FTE staff for ***infrastructure***	FTE staff for ***research***	FTE staff for ***implementation***	FTE staff for ***other areas***	Total FTE staff
2018 reporting period				
190	22	407	28	647
2017 reporting period				
184	18	442	23	666

Current challenge: Accounting for contractors

Generally, the method by which organizations report the number of NRS-focused staff members accounts for permanent employees that are paid directly by the organization. This method fails to track additional staff support through contractors, contract employees, accounting and legal staff, and various other contracted work. The need for accelerated adoption of conservation practices to reduce nutrient contributions from point and nonpoint sources will require frequent support from contracted or other support staff not commonly tracked through the current reporting structure. This need especially pertains to the installation of structural practices, such as terraces, wetlands, bioreactors, grade stabilization structures, and saturated buffers, which require skilled technical assistance, design, and construction. Efforts to explore options for measuring and tracking the extent of contracted duties is still a work in progress.

Continued water quality research

Continuation of research in the physical and social sciences is necessary for better understanding the processes driving conservation measures that can mitigate nutrient loss. A primary source of research funding and direction has stemmed from the Iowa Nutrient Research Center (INRC). An overview of the INRC's history and key accomplishments are discussed in the following sections.

Iowa Nutrient Research Center

The INRC was established in 2013 to help the NRS manage nonpoint source nitrogen and phosphorus pollution. The INRC, which was established by the Iowa Board of Regents in response to legislation passed by the Iowa Legislature, pursues science-based approaches to nutrient cycling that include evaluating the performance of current and emerging nutrient management practices, and providing recommendations on implementing existing practices and developing new practices.

Since 2013, the INRC has awarded over 60 grants amongst Iowa's three Regent Schools. The awards total slightly over $7 million dollars, with approximately 67 percent of the funds going towards nitrogen and phosphorus research, and approximately 33 percent going to water quality monitoring projects overseen by IIHR-Hydroscience & Engineering at the University of Iowa.

For funds directly targeting nitrogen and phosphorus research, the INRC has closely followed the NRS Nonpoint Source Science Assessment in its allocation of research dollars. The Science Assessment was led by the NRS Science Team, which is comprised of university and agency researchers. One of the main roles of the NRS Science Team was to identify science-based nutrient reduction practices and to provide the research-based foundation

[3] This estimate differs from that displayed in the 2016 Annual Progress Report. This discrepancy is due to new partner reports received in 2017. For consistent reporting year-to-year, the 2016 values were adjusted by assuming no change in staff FTEs for those new reporting organizations.

that quantified the effectiveness of current practices for reducing nutrient losses from the Iowa landscape.

Table 4. Annual and total awards to identified science assessment nutrient reduction practice categories.

Fiscal year	Science assessment nutrient reduction practice				Total projects
	Management practices	Land use practices	Edge-of-field practice	Non-categorized research*	
FY14	2	1	3	4	10
FY15	2	3	2	4	11
FY16	6	3	2	3	14
FY17	2	1	5	4	12
FY18	4	3	2	4	13
Total	16	11	14	19	60

* Includes annual funds to University of Iowa, IIHR for sensor work.

The NRS Nonpoint Source Science Assessment identifies three key categories for nutrient reduction: nitrogen and phosphorus management practices, land use practices, and edge-of-field practices. Some projects do not neatly fit into one of these categories. Thus, a fourth category, non-categorized research, was added by the INRC to accommodate this group. Table 4 identifies the projects awarded in each category according to the fiscal year, while Figure 5 shows the approximate total five-year dollar awards in each research category.

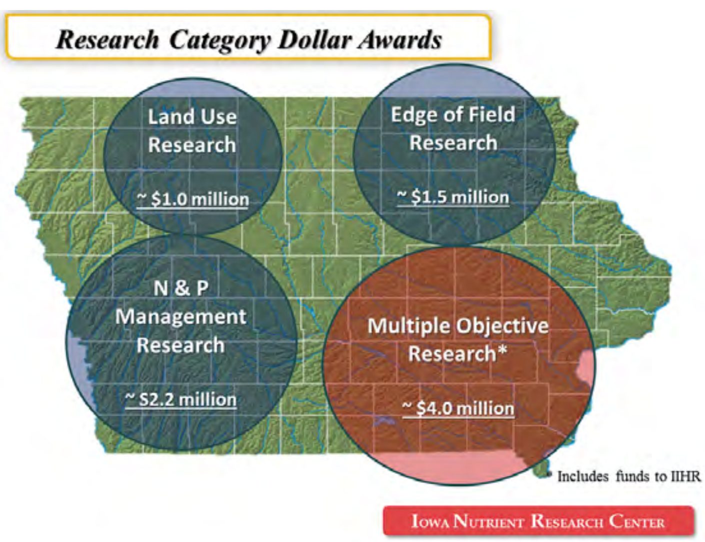


Figure 5. Total five-year dollar awards to various science assessment nutrient reduction practices.

While the INRC has supported a wide range of projects, three practices identified by the NRS Science Team stand out for the extensive research that has been conducted to better understand their implementation and development: cover crops, bioreactors, and saturated buffers. These practices and their related research are discussed in the following sections.

Cover Crops

Cover crop use has been identified by the NRS Science Team as a tool to reduce both nitrogen and phosphorus loss as well as prevent soil erosion. Although it is widely accepted that cover crops are effective at reducing soil erosion and nutrient loss, adoption of the practice around the state of Iowa is still in its early stages. Part of the INRC's approach to enhancing cover crop adoption is to provide research data that address the perceived risks associated with cover crops. These risks or barriers to the adoption of cover crops in Iowa are complex and can involve economic, social, abiotic, and biotic factors. Through the funding of targeted research projects over the past five years, the INRC has started to address some of these questions related to adopting and growing cover crops.

Preliminary findings on one cover crop project determined the effects of a rye and camelina cover crop on the following year's corn or soybean crop. This research collected and analyzed corn and soybean yield data and showed the cover crop had significant negative effect on corn yield. Corn yield was lowest whenever winter rye preceded a corn crop. Corn yield was also reduced following a cover crop of camelina compared to the no-cover crop control. The effect of the cover crop was significant on the number of harvestable corn ears, and a greater number of ears were counted in the no-cover crop control compared to cover crop treatments. Soybean yield data showed that the crop yield was greatest when the crop preceded winter rye cover and that the yield following a camelina cover crop was not different from the no-cover crop control. In this experiment, the fall cover crops were sown September 23 and October 10 after soybean and corn harvest, respectively. Stand count data were collected in all plots November 10 and it was found that the cover crop stand densities were greater after soybean compared to after corn. Moreover, the stand density of winter rye was better than that of the camelina cover crop. Experiments under controlled settings are in progress to further understand the negative effect of winter rye cover crop on corn seedling growth and root disease.

Bioreactors

Funding from the INRC enabled the design and installation of nine experimental bioreactors at the Iowa State University Agricultural Engineering/Agronomy and Central Iowa Research Farm, located west of Ames. The bioreactors were designed to allow for different hydraulic retention times, influent nutrient concentrations, and fill materials. Two sampling ports provide access to water and fill materials, and at the effluent location. This pilot-scale system for testing bioreactors for their effect on water quality and nutrient loss is unlike any other in the world. It will be used to answer relevant questions regarding bioreactor performance and inform improvements in the design of bioreactors for nutrient reduction.

Since field bioreactor performance varies greatly and is influenced by temperature, influent nitrate concentration, and hydraulic retention time, the INRC supported additional studies at the research site after the initial funding of the pilot project. Optimization of the size of a bioreactor, while achieving adequate nitrate removal was funded. In addition, recent questions have emerged regarding pollution swapping in bioreactors, wherein nitrate is converted to alternate end products instead of being lost as nitrogen gas through complete denitrification. As a result, a study is being conducted to evaluate nitrate-N fate in woodchip bioreactors over a range of water retention times while growing knowledge of improved bioreactor design for field implementation.

Saturated Buffers

Streamside buffers have been recognized as an important conservation technology for reducing the movement of nutrients from surface and shallow subsurface flows into receiving waters. In the Midwest, farmland may be artificially drained using tiles, resulting in much of the nitrate-laden water bypassing the filtration benefits of riparian buffers and being discharged directly into a surface-water body.

A saturated buffer is one approach to negating nitrate discharge into surface waters at the edge of tiled fields. The saturated buffer intercepts the field tile outlet where it crosses a riparian buffer and diverts a fraction of the flow as shallow groundwater within the saturated buffer. Most nitrate entering the buffer is removed by plant uptake, microbial immobilization, and denitrification.

The INRC supported a saturated buffer project in Iowa during the early development of this science that focused on establishing saturated buffers within a subset of the HUC12 watersheds targeted for practice implementation by the Iowa Water Quality Initiative. The initial saturated buffer research sites were located on privately owned fields in Hamilton and Story counties, in north-central Iowa. A subsequent project, funded by the INRC, supported monitoring of an additional three saturated buffer sites per year, as well as the existing sites. Over a four-year period, data showed that 35-59 percent of tile flow could be diverted into the saturated buffer and potentially 50 percent nitrate-N reduction occurred before the tile water reached the water body. These findings facilitated the approval of saturated buffers to be included in the NRS as an effective practice for reducing nitrogen loss.

The three targeted practices described above are only a portion of the critical research the INRC has funded over the past five years. In upcoming years, research will continue through the INRC to provide the scientific support necessary to meet NRS goals and disseminate research results to farmers, landowners, and stakeholders. Scientists will continue working to improve newer technologies and practices such as bioreactors, saturated buffers, prairie strips, drainage water recycling, and cover crops.

Addition of new practices in the NRS

As research on nonpoint source conservation practices is conducted, new insights are developed regarding the effectiveness of practices in reducing nitrogen and phosphorus loss. Data and literature reviews may be submitted by the public to the NRS science team, a group of university and public agency researchers that conducted the NRS Science Assessment for nonpoint sources and continue to review the effectiveness of conservation practices.

In the 2016 reporting period, saturated buffers were approved as an NRS practice. In the 2017 reporting period, blind tile inlets were approved. No new practices were approved during the 2018 reporting period. For more information on the review process, and to view the practices that were submitted and not approved, see Appendix B.

Iowa's role in the Hypoxia Task Force

Iowa has continued to play a significant leadership role in the Gulf of Mexico Hypoxia Task Force (HTF), a regional effort led by 12 states and five federal agencies. The HTF is co-chaired by the Iowa Secretary of Agriculture and the EPA Assistant Administrator of the Office of Water.

This collaborative effort aims to reduce the nitrogen and phosphorus load of all Mississippi River Basin states by 45 percent before 2035.

IDALS serves as co-chair of the Nonpoint Source Measures Committee for the HTF. This committee has worked to establish a set of common measures all participating states can collect and utilize to show progress and inform decision-making. To date, this committee has focused on improving data collection of practice installation across all identified sectors – federal, state, and private – through a variety of methods. Early progress includes development of a set of key parameters of the data being collected. This then resulted in data sharing with the NRCS to facilitate data availability of their programs. As a result, all basin states will have a source of common data that is compatible with state program data and, eventually, private program data; this effort will increase the understanding of the implementation of conservation programs in their states and in two additional pilot states (Arkansas and Indiana). This process and key learnings from the pilot projects will be instrumental in advancing similar efforts in other HTF states.

In part, by the work of the committee, the HTF was able to work through member federal agencies, states, and researchers of the Southern Extension and Research Activities committee 46 (SERA-46) to secure funding to help advance and bring capacity to the nonpoint source measures effort. With support from the Walton Family Foundation, this project will advance through the leadership of SERA-46 researchers and state and federal agencies in the basin to build a quantitative assessment of practice implementation from state and federal sources.

In addition, the Iowa DNR co-leads the HTF Point Source Measures Committee. This committee has established and populated metrics to determine the amount of facilities that monitor and have effluent limits for nitrogen and phosphorus established in their national pollutant discharge elimination system (NPDES) permits for all 12 HTF states. Current efforts are focused on creating a reliable point source nutrient loading metric and estimating a point source baseline for the 1980-96 time period.

Refining NRS measurement

The 2016 reporting period initiated the three-year NRS Measurement Pilot Project, which aims to develop protocols for measuring annual progress of the NRS. There have been various key improvements made in measuring NRS progress, including, but not limited to, new projects for enhancing conservation practice data and the streamlining of practice load reduction models.

There are two key projects highlighted in this report (page 43) that aim to estimate conservation practice use outside of public conservation programs. During the 2018 reporting period, efforts to develop these projects continued, but data are not yet available for statewide accounting of practices. First, the Iowa State University College of Agriculture and Life Sciences has partnered with the Iowa Nutrient Research and Education Council (INREC). INREC, a collaboration of agricultural businesses, organizations, and industries, will solicit information from agricultural retailers across Iowa who provide services to crop producers with a goal of gaining more insight into farmers' in-field nutrient management decision-making. These efforts will aim to address the challenges associated with reliable tracking of in-field practices, such as cover crops and fertilizer management.

Second, a project for tracking practices using aerial and LiDAR imagery is a partnership between the DNR, Iowa State University, INREC, and IDALS. This project digitizes imagery of watersheds across the state to enumerate existing terraces, ponds, WASCOBs, contour buffer strips, and contour strip cropping. Between these two projects, steps have been made toward better accounting for in-field, edge-of-field, and erosion control practices implemented in Iowa. These projects will also facilitate future tracking of these practices. Digitization of the entire state was completed during the 2018 reporting period, and the quality control process in underway to verify the accuracy of the database. Preliminary data (pre-quality control) are summarized in **Appendix E**, available at www.nutrientstrategy.iastate.edu.

Another key effort in the NRS measurement project is the streamlining of the nutrient load reduction models that were developed for the NRS Science Assessment. As a complementary approach to empirical water monitoring, this annual progress report aims to present updates in the estimated load reductions affected by newly implemented conservation practices each year (see page 55). In past years, these estimates were labor-intensive and time-consuming. New computational methods have been developed for more efficient calculations, and as the above data projects provide more insight on the extent of practices in Iowa during different time periods, researchers will be able to change the baseline inputs in these models.

By doing so, these models may be readily adjusted and improved in the future as new data become available. This work continued during the 2018 reporting period. A public-facing version of this model has been developed for calculating nitrogen loss at a field or watershed scale. A similar, user-friendly version is under development for calculating phosphorus loss. These tools will allow farmers, landowners, watershed coordinators, and other interested parties to estimate the effectiveness of new conservation practices in their own operations or regions.

Nutrient trading: Recent innovative approaches

The Iowa League of Cities was awarded a USDA-NRCS Conservation Innovation Grant (CIG) in October 2015 to develop a water quality credit trading (WQCT) framework as a means to advance the goals of the NRS and beyond. This work has steered toward the development of a pre-regulatory compliance strategy titled the "Nutrient Reduction Exchange" (NRE) that could serve as a tracking system and would allow nutrient sources across the state to register and track nutrient reductions resulting from installed best management practices (BMPs) that target NRS goals. In addition to nutrient reduction, the NRE acts as a registry to track additional benefits that drive watershed investment such as flood mitigation and source water protection.

The project team anticipates that the formal NRE structure and WQCT framework will be submitted to DNR for implementation by the end of 2018. The DNR and Iowa State University are working closely with stakeholders during this phase. Currently, there are five main areas of focus:

1) Process – NPDES permit integration (DNR) and practice application submittals (Iowa State University and DNR)

2) Incentives – evaluation of regulatory authority and potential for use

3) Database – U.S. Army Corps of Engineers RIBITS Iowa Pilot; ensuring an easy to use electronic application submittal process

4) NRE placement – evaluation of NRE placement in rule or policy

5) Nutrient load reduction model – evaluation and implementation of a specific model or models for load reduction estimates

Prioritization of watersheds

The 2011 memo, "Working in Partnership with States to Address Phosphorus and Nitrogen Pollution through Use of a Framework for State Nutrient Reduction Strategies," through which the EPA urged states to develop plans for reducing nutrient loss, called for the identification of watersheds that account for a substantial portion of the state's nutrient load export through surface water and to the Mississippi River. This work was further supported in the 2016 EPA memo, "Renewed Call to Action to Reduce Nutrient Pollution and Support for Incremental Actions to Protect Water Quality and Public Health." Identification of these watersheds was conducted during the 2014 reporting period and has guided the prioritization of watershed-based activities across the state.

In an effort to establish targeted action in watersheds that carry the majority of Iowa's nutrient export, demonstration projects have been established in hydrologic unit code-12 (HUC12) watersheds that lie within the priority HUC8 watersheds, with the goal of spreading awareness of nutrient reducing practices that can affect change in the nutrient load of these catchments. The Iowa Water Quality Initiative (WQI) provides targeted funding and support for 15 projects, three of which began in 2015 (Figure 6). These projects are working to address critical gaps and opportunities to advance a subset of practices underutilized through traditional funding programs or in certain situations that present a unique opportunity or method of targeting certain practices. These projects are prioritized to these watersheds and would result in providing information critical to advancing implementation in other key areas.

While these 15 projects target the priority watersheds, there are, in total, 36 ongoing watershed projects in 61 Iowa counties. The majority of these projects operate as locally led efforts, and are supported through leadership from Iowa's Soil and Water Conservation District commissioners, who, in partnership with watershed coordinators, tailor the projects to meet the specific needs, concerns, and values of the surrounding communities.

In 2016, the U.S. Department of Housing and Urban Development (HUD) awarded Iowa agencies with a total of $96.6 million to conduct a five-year demonstration of flood mitigation and nutrient reduction. This project will target four NRS priority watersheds to implement agricultural and urban practices that assist these goals. The project is in early planning, outreach, and implementation stages and will distribute cost-share funding for practices in the near future.

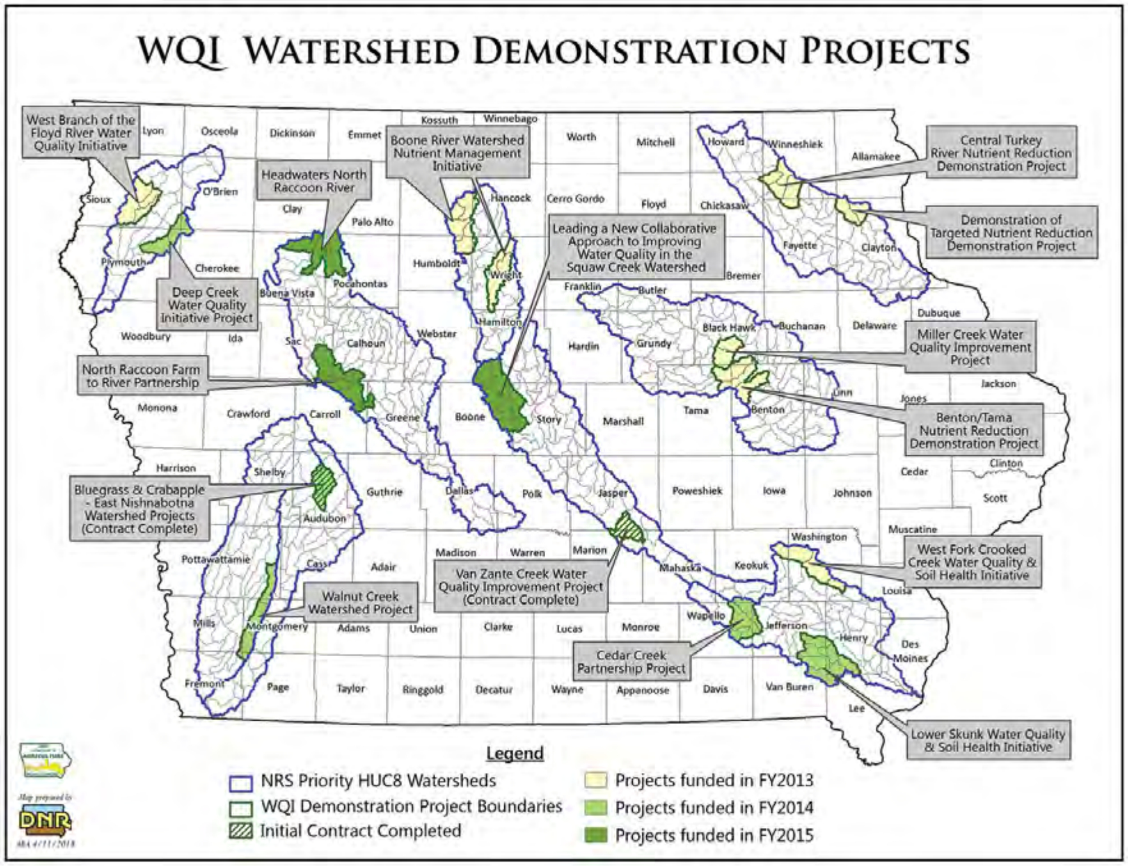


Figure 6. The geographic distribution of watershed demonstration projects funded by the Iowa Water Quality Initiative (WQI).

Stormwater, septic, and minor POTWs

Stormwater

The urban conservation program was established in early 2008. Early on, funding was limited, which led the urban conservation team to focus attention on education and training activities to help promote green infrastructure practices. Assistance was provided to many homeowners to implement small-scale projects with small amounts of cost-share from Resource and Enhancement Protection Program funds. Since then, the program has started to hit its stride. Currently, it has evolved from education and small-scale practices to implementing $12-15 million worth of urban conservation projects annually through partnerships with the DNR Sponsored Projects Program, the Iowa Economic Development Authority's Community Development Block Grant Program, and the IDALS WQI program. In the past three years, urban conservationists have worked with more than 100 communities to help plan, design, and implement urban projects totaling over $54 million dollars of work.

Septic/Minor POTWs

Upgrading failing septic systems continues through implementation of Iowa's time of transfer law that took effect in 2009. Database improvements continue to progress to better enumerate the success of this program. Approximately 12,000 out of an estimated 49,500 time of transfer records have been entered into a database that allows systems to be sorted by condition and type. These records are being loaded to a cloud-based storage system that will allow easier access to the records. There were approximately 4,416 time of transfer inspections of onsite wastewater systems in 2017.

Analysis was completed for this annual report to quantify annual statewide nitrogen and phosphorus reductions based on the information collected during time of transfer inspections. Of the approximately 12,000 inspections studied, there were 657 failed systems that have been replaced between 2009 and 2018. This translates to a septic replacement rate of 5.35 percent as a result of the time of transfer law and program. Using this rate, it is estimated 2,644 failed systems have been repaired or replaced when extrapolated to fully cover the approximately 49,500 inspections since 2009 resulting in the annual nutrient reductions outlined in Table 5 below.

Table 5. Nutrient load reductions based on analysis of Iowa's time of transfer program.

	Effluent (w/failures) (lbs/yr)	Effluent (w/fixed) (lbs/yr)	Extrapolated nutrient reduction (lbs/yr)
Nitrogen	1,070,000	1,050,000	20,000
Phosphorous	40,000	27,000	13,000

Source water protection

The Iowa Source Water Ag Collaborative, formalized in 2016, is dedicated to providing Iowans information and resources to protect their drinking water. Partners in the collaborative include the Agri-business Association of Iowa, Brinkman Ag Solutions, Conservation Districts of Iowa, Golden Hills Resource Conservation and Development, Heartland Co-op, Iowa Certified Crop Advisors, Iowa Corn Growers Association (ICGA), Iowa Soybean Association (ISA), IDALS, DNR, Iowa State University Extension and Outreach, Iowa Section of the American Water Works Association, U.S. Department of Agriculture Farm Service Agency (FSA), and NRCS. Accomplishments this year include a partnership with Conservation Districts of Iowa and DNR to hire two new source water specialists to facilitate Phase 2 plan development and implementation with local stakeholders. The collaborative received a McKnight Foundation grant to assist in increasing capacity to develop a comprehensive source water protection program in Iowa though engaging and coordinating with partners, compiling and branding resources, pursuing additional funding resources, and monitoring progress.

In February 2018, EPA contractors completed Source Water Protection (SWP) plans with a focus on reduction of nutrients and sediment into the lakes used by the cities of Winterset and Spirit Lake. These plans have been approved by the DNR as Phase 2 SWP plans. The plans identified resources for implementation and coordinating partners. The plans, utilizing the Agricultural Conservation Planning Framework (ACPF) model and the mapping of existing conservation practices, targeted BMPs that can be funded and deployed on the landscape. Implementation efforts are underway. For example, Winterset Municipal Utilities has hired a watershed coordinator and outreach events with landowners and coordinating partners are planned for summer and fall 2018.

Progress of point source facility permits

Steady progress has been made in issuing permits requiring the submittal of a nutrient reduction feasibility study to point sources listed in the strategy – the first step in advancing nutrient reductions by point sources. Progress has also been made in issuing such permits to point sources in priority watersheds; 77 percent of these permits have now been issued.

Table 6. Summary of NRS point source implementation.

Metric	Numbers required					Number complete					
	2013-14	2014-15	2015-16	2016-17	2017-18	2013-14	2014-15	2015-16	2016-17	2017-18	Total
Permits issued	130	147	149	151	154	21	32	29	24	20	125
Permits issued in priority watersheds	37	37	39	39	39	8	7	9	3	3	30
Feasibility studies submitted	-	-	20	30	27	0	1	19	31	31	82
Permits with construction schedule	-	-	-	-	-	0	0	2	13	12	27
Permits with limits	130	147	149	151	154	0	0	1	38	46	46
Total nitrogen	-	-	-	-	-	-	-	1	38	44	44
Total phosphorus	-	-	-	-	-	-	-	1	5	8	8
Permits meeting % reduction targets	-	-	-	-	-	-	-	-	-	-	-
Total nitrogen	-	-	-	-	-	-	9	14	19	24	19
Total phosphorus	-	-	-	-	-	-	2	6	9	11	9
Total permits with nutrient monitoring (including those not in nutrient strategy)	-	-	-	-	-	169	201	224	344	399	399

There was a significant increase in the number of feasibility studies submitted during the past year, as facilities whose permits were issued in 2015-16 completed the required two years of raw waste and final effluent monitoring and evaluated alternatives for nutrient reduction technologies. As these feasibility studies are reviewed and approved by IDNR, the schedules they contain for installing nutrient reduction technologies are added to facilities NPDES permits by amendment. Once the construction outlined by the schedules is complete and treatment processes are optimized, facilities will sample total nitrogen and total phosphorus for 12 months. Effluent limits based on those results will then be added to the permit and become enforceable.

This year additional data was available to further bolster the comparison of actual treatment plant loadings and reductions with the assumptions made during the development of the NRS. This continues to be one of the most complete sets of nutrient data available in the country for point sources, and the amount of data will continue to increase as more permits are issued. Using this data, we have determined what reductions in loadings of total nitrogen (TN) and total phosphorus (TP) are occurring today, even before nutrient reduction technologies are installed.

Additional facts and information on each of these measures as well as our preliminary analysis of data collected by point sources since the inception of the NRS are presented this report.

How many NPDES permits have been issued that require feasibility studies?

The NRS established a goal for the DNR to issue or reissue NPDES permits to at least 20 of the total point sources listed in the strategy each year. These permits include a requirement to complete and submit a nutrient reduction feasibility study that evaluates the feasibility and reasonableness of reducing the amounts of TN and TP discharged by larger POTWs and industries. Figure 7 shows that a total of 125 permits have been issued requiring feasibility studies as of May 31, 2018; 21 permits in the 2014 reporting period, 32 during the 2015 reporting period, 29 in the 2016 reporting period, 24 in the 2017 reporting period, and 20 in the 2018 reporting period. The goal of 20 permits per year has been met or exceeded in each of the five years the NRS has been in place and 81 percent of the 154 facilities affected by the NRS now have permits that require submittal of a feasibility study.

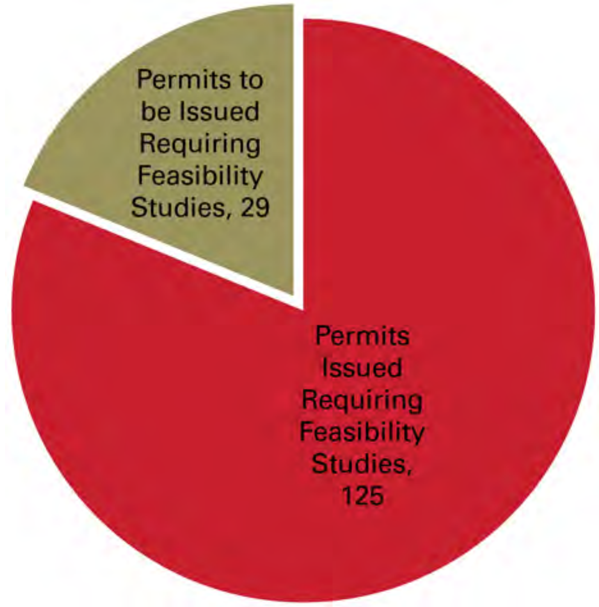


Figure 7. Of the 154 that are required by the NRS, 125 permits requiring feasibility studies have been issued.

The total number of facilities addressed by the NRS and therefore the number of permits that will require completion of a feasibility study changes slightly from year to year for several reasons:

- New industries begin operating. For example, Iowa Fertilizer Company and Iowa Premium Beef are new major industries that began operating facilities in Iowa after the NRS was released in 2013.
- Industries previously discharging to POTWs begin operating separately from the city. DairiConcepts is an existing minor industry that constructed and began operating a biological wastewater treatment facility after having discharged its wastewater to a city treatment facility for many years.
- An industry may cease operations altogether or dispose of its wastewater by means other than discharging to a river or stream. For example, Sioux Preme Packing Co. began land applying all of its wastewater beginning in May 2015.
- City wastewater treatment facilities are replaced with new facilities or are expanded to treat larger volumes. If the new or upgraded facility is designed to treat 1.0 million gallons or more per day it becomes a major facility and is subject to the NRS. The cities of Wapello and Hampton expanded their treatment plants to treat a larger volume in 2016 and 2017.

- A city may downsize its treatment plant capacity as industries leave the city. If this downsize results in the design flow dropping below 1.0 million gallons per day, the facility is no longer classified as a major facility and is therefore not subject to the NRS. For example, in 2013 the City of Garner replaced its treatment facility that had a design flow of 1.05 million gallons per day with a new facility that has a design flow of 0.873 million gallons per day.
- A city may eliminate its discharge by connecting to another facility that provides treatment for its wastewater. The City of Ankeny began sending its wastewater to the Des Moines Water Reclamation Facility in January 2014. The City of Waukee is scheduled to do the same by January 2019.

How many NPDES permits have been issued to facilities in priority watersheds?

In 2013, shortly after the NRS became effective, the WRCC designated nine watersheds throughout the state as priority watersheds. These priority watersheds are intended to serve as areas in which to focus targeted conservation and water quality efforts through nonpoint source demonstration projects, implementation activities by nonpoint sources, and implementation of nutrient reduction technologies by point sources. Thirty-nine of the point sources listed in the strategy discharge in one of these nine priority watersheds. Permits have been issued to 30 of these facilities, or 77 percent, as of May 31, 2018, up from 28 facilities last year.

All of the facilities in the Boone, East Nishnabotna, Turkey, and West Nishnabotna watersheds have permits that require the submittal of a feasibility study. Figure 8 shows the progress to date in issuing permits to point sources in the priority watersheds.

How many nutrient reduction feasibility studies have been submitted?

Point sources listed in the strategy are required to monitor raw waste and final effluent for TN and TP during a two-year period following the issuance of the first NPDES permit requiring completion of a feasibility study. However, some industries (e.g. power plants) that do not have a treatment plant are required to monitor only the final effluent. A facility uses the data collected during this two-year period to evaluate the feasibility and reasonableness of reducing the amounts of nutrients discharged into surface water. The NRS establishes a target of reducing TN and TP from point sources by 66 percent and 75 percent, respectively. The feasibility study must include an evaluation of facility operational changes that could be implemented to reduce the amounts of TN and TP discharged. If the implementation of operational changes alone cannot achieve the targets, the facility must evaluate new or additional treatment technologies that could achieve reductions in the nutrient amounts discharged. Eighty-two feasibility studies have been submitted as of May 31, 2018, and another 43 are required to be submitted (Figure 9).

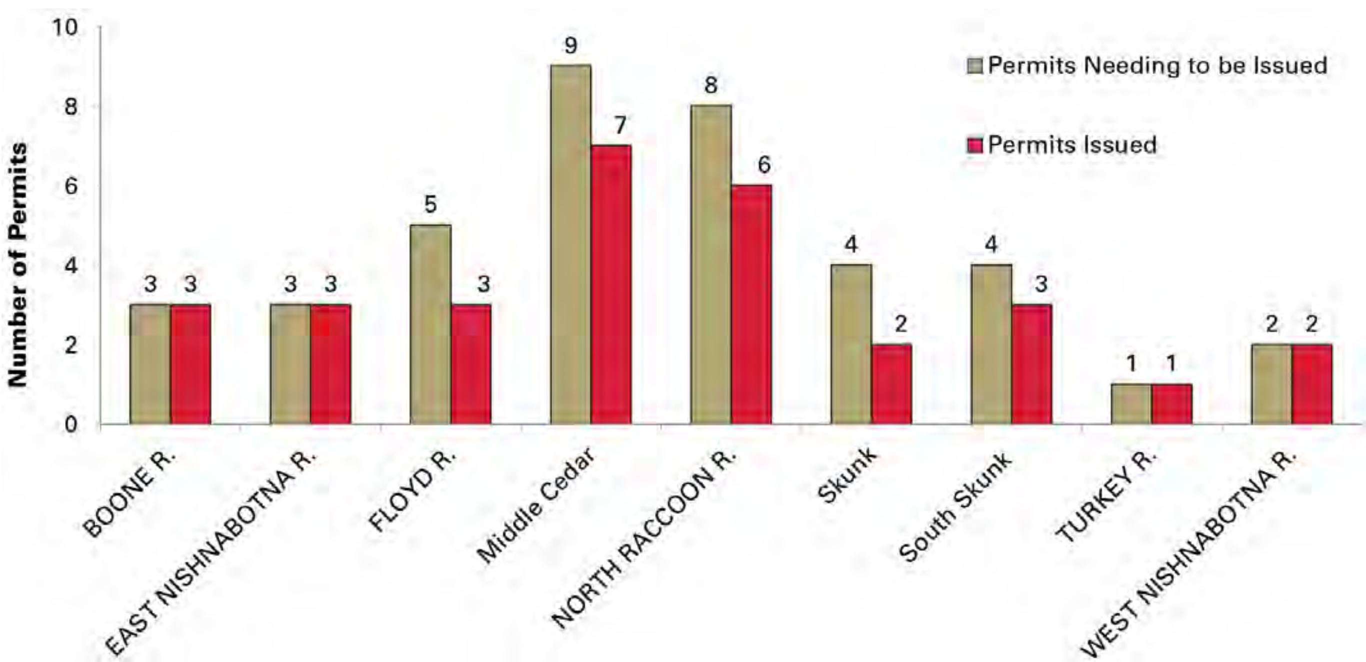


Figure 8. Point source progress priority watersheds.

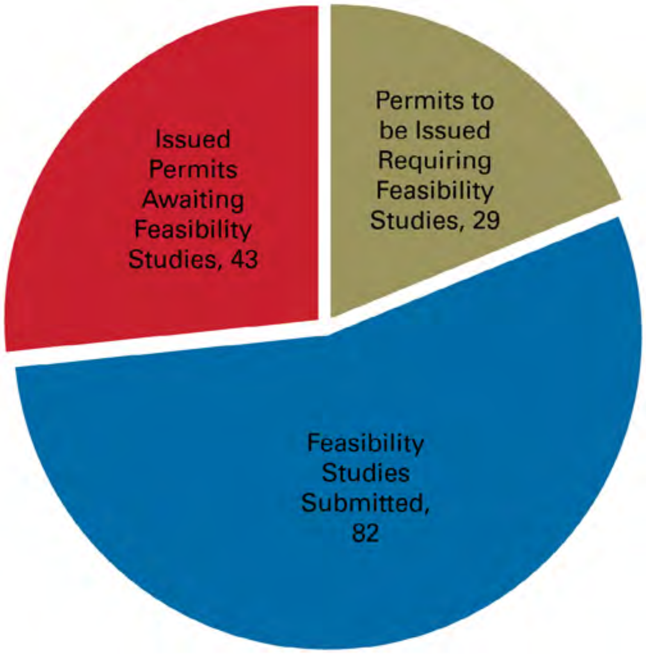


Figure 9. The progress of issued permits and submitted feasibility studies among the total NRS facilities.

How many NPDES permits have been amended to include schedules for constructing nutrient removal technologies?

The feasibility study must include a proposed schedule for implementing the operational changes or installing new or additional treatment technologies found to be feasible and reasonable. Upon approval of the proposed schedule by the DNR, the NPDES permit is amended to include the schedule for construction or implementation of changes. Currently, 27 permits have been amended to include construction schedules, up from 13 permits last year (Table 7).

Table 7. Municipal and industrial permits that have been amended with construction schedules.

Municipal permits that have been amended with construction schedules to meet strategy goals (as of 6/18/2018)	
Count of facilities	20
Earliest completion date	8/1/2018
Latest completion date	4/1/2027
Average length of schedule (years)	4.8
Industrial permits that have been amended with construction schedules to meet strategy goals (as of 6/18/2018)	
Count of facilities	7
Earliest completion date	1/1/2018
Latest completion date	12/1/2022
Average length of schedule (years)	3.2

How many permits have been amended to include nutrient limits?

Four permits were amended in 2017-18 to include effluent limits for TN or TP. Iowa City (South), Atlantic, Associated Milk Producers, and Mt. Vernon made operational changes or upgrades at their wastewater treatment facilities and determined that they were meeting one or more of the targets established in the NRS.

There are a total of 178 permits that have been issued to facilities that are not affected by the NRS that specify limits for one or more nitrogen compounds (excluding ammonia nitrogen). There is one permit that has been issued to a facility that is not affected by the NRS which specifies limits for one or more phosphorus compounds. Limits in these permits are either required by federal effluent standards in the case of certain industries (e.g. meat processing, fertilizer manufacturing) or are based on a total maximum daily load (TMDL) developed by DNR to address an identified water quality impairment. In many cases these limits do not require a reduction in the amount of nitrogen or phosphorus discharged, but the limits also do not allow for an increase in the amount discharged.

How many nutrient reduction facilities are in place or under construction?

Several POTWs and industries have constructed or are presently constructing biological or chemical nutrient reduction facilities. Many others are planning to construct facilities in the coming years. Improved metrics are being evaluated to better capture whether a treatment plant was upgraded to remove nutrients, if the treatment plant was optimized to meet these goals, and what facilities are currently under construction. Currently the data allows the reporting of facilities that met the NRS goals of 66 percent removal of total nitrogen and 75 percent removal of total phosphorus.

The cities and industries displayed in Table 8 met the percent reduction goals for total nitrogen or total phosphorus or both during the 2018 reporting year by either treatment plant improvement or optimization.

Table 8. Cities and industries that met the percent-reduction goals for total nitrogen, total phosphorus, or both during the 2018 reporting period.

2018 reporting year (5/1/2017-4/30/2018) percent removal (mass)		
	Facility	%
Municipal		
Nitrogen	Atlantic, City of, STP	79.4
	Clear Lake Sanitary District	81.2
	Eldridge, City of, South Slope	72.8
	Estherville, City of, STP	69.7
	Grimes, City of, STP	68.0
	Grundy Center, City of, STP	69.8
	Iowa City, City of, STP (South)	77.8
	Mount Pleasant, City of, STP (Main)	85.0
	Oelwein, City of, STP	87.0
	Sioux City, City of, STP	74.8
	Toledo, City of, STP	66.0
	Washington, City of, STP	72.8
	West Burlington, City of, STP	72.1
	West Liberty, City of, STP	83.4
Phosphorus	Carroll, City of, STP	87.6
	Coralville, City of, STP	81.0
	Davenport, City of, STP	79.7
	Grundy Center, City of, STP	80.1
	Iowa City, City of, STP (South)	80.5
	Mount Vernon, City of, STP	82.3
	Sioux City, City of, STP	75.2
	West Liberty, City of, STP	76.1
Industrial		
Nitrogen	Ag Processing Inc., a Cooperative	87.1
	Agropur, Inc.	90.7
	Associated Milk Prods., Arlington	91.3
	Cambrex, Charles City, Inc.	66.9
	Grain Processing Corporation	82.0
	John Deere Dubuque Works	83.9
	Michael Foods, Inc.	94.8
	OSI Industries (Oakland Fds.)	92.5
	Rembrandt Enterprises, Inc.	82.3
	Swiss Valley Farms	69.2
Phosphorus	Associated Milk Prods., Arlington	82.4
	John Deere Dubuque Works	98.1
	Michael Foods, Inc.	80.3

STP: Sewage Treatment Plant

Human

Inputs are applied to affect change in nutrient loads, which will require widespread adoption of conservation practices to reduce nutrient loss from nonpoint sources. In order to implement nutrient-reducing practices and cut nitrogen and phosphorus loss by 45 percent, attitudes of people must first shift to affect a change in perspectives and behavior related to water quality.

There are a variety of factors that have been analyzed in order to measure the progress of human attitudes related to the NRS. First, the annual extent of education and outreach by partner organizations is discussed, which was quantified as the number of events conducted during the reporting period. Second, farmer awareness, attitudes, and perspectives on the NRS are discussed as a metric for the potential for human behavior. Finally, updates on IDALS' annual cover crop users survey are presented.

Increased public awareness, education, and outreach

Outreach and education events

Outreach and education events that were held across Iowa during the 2018 reporting period reflect the efforts by partner organizations, both public and private, to spread awareness and educate the public about nutrient reduction options for water quality improvement.

These events, which provide information to make informed decisions about conservation practices, were self-reported by WRCC and WPAC members, and include five general categories of events: general community outreach, including fairs, tours, and other community events; field days, which often serve to educate farmers and landowners; workshops, which entail training in a particular skill or topic area; conferences, which facilitate knowledge-sharing, networking, and partnering; and youth education, which focus on spreading understanding about natural resource and watershed issues through K-12 educational programming. The outreach efforts reported by partner organizations virtually doubled (Table 9) from 2016 to 2017. Total events increased from 246 to 474, and the total number of attendees at these events increased from 21,000 to 54,000. Actual outreach may not have completely doubled during this time, as reporting efforts may have improved within and among partner organizations. However, this summary is strong evidence that, from 2016 to 2017, outreach efforts and the efforts to track these events increased substantially.

Pond. Photo courtesy of Lynn Betts, USDA Natural Resources Conservation Service.

Total outreach events increased once again in 2018 to 511 events, while total attendance decreased to just over 46,000 attendees. The types of outreach events and focus audiences changed between these two years; there was a substantial increase in youth-focused education events, while there was a decrease in the occurrence of other types of outreach. The occurrence of farm-focused field days increased from 111 to 138, but with a slight decrease in average attendance. General community outreach decreased substantially, likely due to the fact that partner organizations reported high attendance at state and county fairs in the 2017 reporting period, but these events were not reported in the 2018 reporting period.

These results suggest that overall outreach focused on NRS topics decreased slightly during the last reporting period. With minimal change in inputs such as funding and staff (Figure 3; Table 3), one potential reason for no increase in outreach events is that partner organizations have reached their current capacity to deliver NRS outreach.

Table 9. A summary of the education and outreach events held by partner organizations during the 2016 and 2018 reporting periods. The 2016 reporting period encompasses June 1, 2015 to May 31, 2016. The subsequent 2017 reporting period ended on May 31, 2017, and the 2018 reporting period ended on May 31, 2018.

2018	Number of events	Average attendance	Total reported attendance
Conference	16	204	3,262
Community outreach	82	39	3,198
Field day	138	48	6,611
Workshop	48	27	1,298
Youth and school visits	227	139	31,477
Total	**511**		**45,846**
2017			
Conference	13	252	3,279
Community outreach	168	69†	20,400
Field day	111	53	10,562
Workshop	55	37	1,695
Youth and school visits	127	146	18,542
Total	**474**		**54,478**
2016 Revised			
Conference	6	214	1,281
Community outreach	55	52†	8,877
Field day	88	47	4,159
Workshop	32	37	1,172
Youth and school visits	65	88	5,704
Total	**246**		**21,193**

† Iowa Learning Farms conducted outreach at the Iowa State Fair in 2015 and 2016, and reported 7,555 and 9,802 interactions with visitors each year, respectively. Also, the University of Iowa reported 300 outreach interactions at the 2016 Iowa State Fair. These high fair attendances were not included in the average event attendance, so as to not skew typical event attendance. However, these state fair attendees were included in the total reported attendance column.

Certain areas of the state, particularly central Iowa, receive more outreach than do other areas (Figure 10). There was a similar geographic distribution of outreach events in the 2017 and 2018 reporting periods. Efforts are underway to identify the geographic areas of the state that, over time, received the most attention in these efforts, and which areas still require increased attention. In addition, as annual data are collected, there is opportunity for greater understanding of the outcomes of increased outreach in local areas. NRS measurement efforts have begun to compile the data that are necessary to conduct preliminary analyses of these research questions.

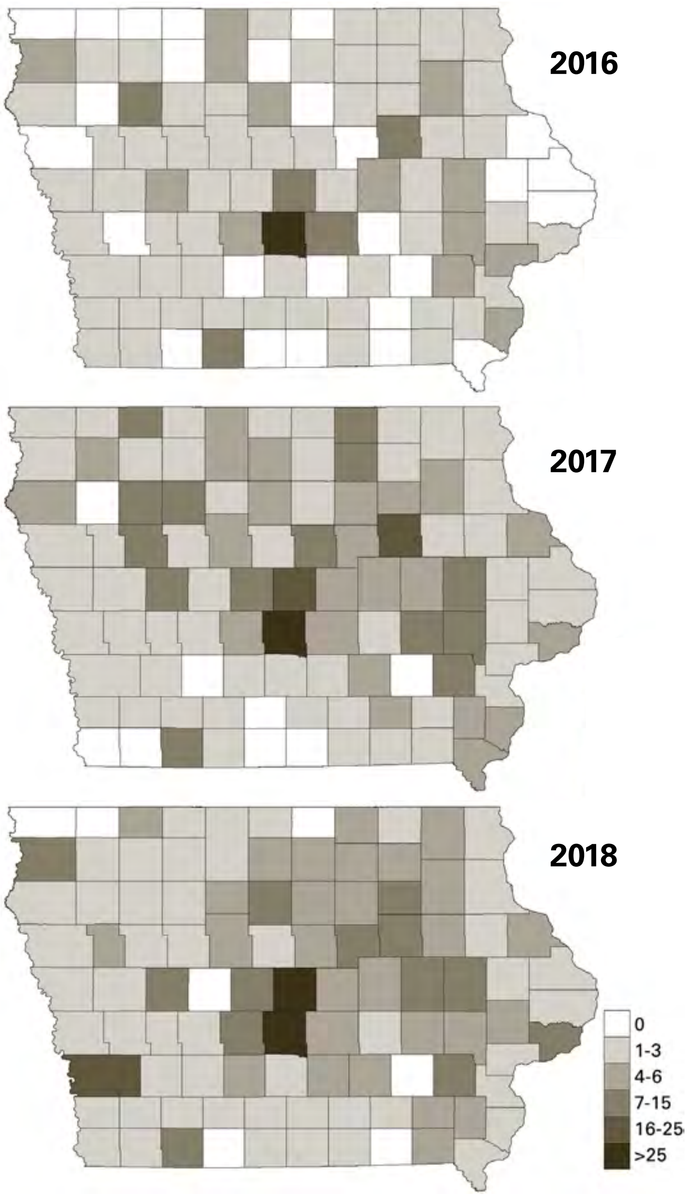


Figure 10. The distribution of outreach events conducted by partner organizations during the 2016, 2017, and 2018 reporting periods.

This assessment of NRS outreach excludes events that were conducted by Soil and Water Conservation District offices that did not have partnership with the surveyed organizations. Efforts are underway to collect this information from all Soil and Water Conservation Districts in a standardized, annual survey. This survey was conducted in 2017 and will also be conducted in late 2018; these data will be incorporated into this annual estimate of NRS outreach and education in future assessments.

Farmer knowledge and attitude

An ongoing, five-year (2015-19) survey project aims to increase the understanding of Iowa farmers' awareness of and attitudes toward the NRS, and their conservation behavior related to nutrient loss. The project is implemented through an annual semi-longitudinal survey that will cover six HUC6 watersheds. These HUC6 watersheds each contain one or more HUC8 watersheds that have been identified as NRS priority watersheds. Within each of these watersheds, the priority HUC8 watersheds are surveyed as the treatment area. Non-priority HUC8 watersheds within each HUC6 are also surveyed to allow comparison between priority areas, where demonstration projects receive dedicated conservation funding, and the watersheds that have not received priority designation. Watershed-level random samples of farmers were drawn from the population of farmers who operate at least 150 acres of row crops (i.e. corn or soybean). Table 10 shows the expected number of farmers surveyed in each HUC6 watershed over the five-year period.

In the first three years, four HUC6 watersheds were surveyed (Table 10). Each year, new respondents are sampled in the watersheds of focus. In addition, a subset of repeat respondents are surveyed each year. In the Iowa watershed, a subset of respondents are surveyed in all years. In the other HUC6 watersheds, a subset of respondents are surveyed in the year following the first year that they were surveyed. This sampling approach will allow

Table 10. Expected number of completed surveys each year, by watershed.

	HUC6 watersheds						
	Iowa	Missouri-Little Sioux	Upper Mississippi-Maquoketa-Plum	Des Moines	Missouri-Nishnabotna	Upper Mississippi-Skunk-Wapsi	Totals
2015	800	800					1600
2016	400	400	800				1600
2017	400		400	800			1600
2018	400			400	800		1600
2019	400				400	800	1600
Overall	2400	1200	1200	1200	1200	800	8000

the project to assess change in awareness, attitudes, and behaviors over time. In addition, the survey design will allow for comparisons between priority and non-priority areas.

As of the end of the 2018 NRS reporting period, the survey mailings and data processing were complete for two HUC6 watersheds: the Missouri-Little Sioux HUC6, and the Upper Mississippi-Maquoketa-Plum HUC6. As surveys in each watershed are completed, Iowa State University researchers conduct statistical analysis to examine whether significant change occurred in farmers' NRS knowledge, attitudes, and conservation behavior over time. The following sub-sections provide an overview of results from these watersheds; **final reports** are nearing completion and will be available at www.nutrientstrategy.iastate.edu/documents.

Missouri-Little Sioux HUC6 watershed

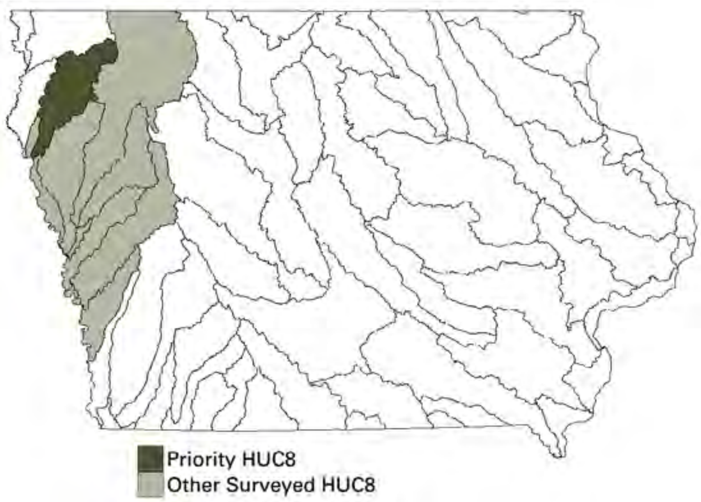


Figure 11. The survey area for the Missouri-Little Sioux HUC6 watershed, as part of the five-year NRS Farmer Survey.

The Missouri-Little Sioux HUC6 watershed is located in the west-central and northwestern portions of Iowa, and contains the Floyd HUC8 watershed, which is one of nine NRS priority watersheds (Figure 11). The Missouri-Little Sioux HUC6 was surveyed in 2015 and 2016. Between those two years, there was no statistically significant change in farmers' reported knowledge of the NRS or in their reported attitudes related to the NRS and nutrient reduction.

Farmers reported a statistically significant increase in whether they had learned about the NRS from commodity groups or farm organizations. In 2015, 48 percent of farmers reported that had learned about the NRS from these groups; this portion increased to 54 percent in 2016.

For a series of agricultural practices, some of which effectively reduce the loss of nutrient fields when compared to conventional practices, respondents were asked to indicate whether they had used the practice in the prior year, not used the practice but might use it in the future, or not used the practice and had no plans to use it. There was a statistically significant change in farmers' use of, or intended use of, some conservation practices from 2015 to 2016.

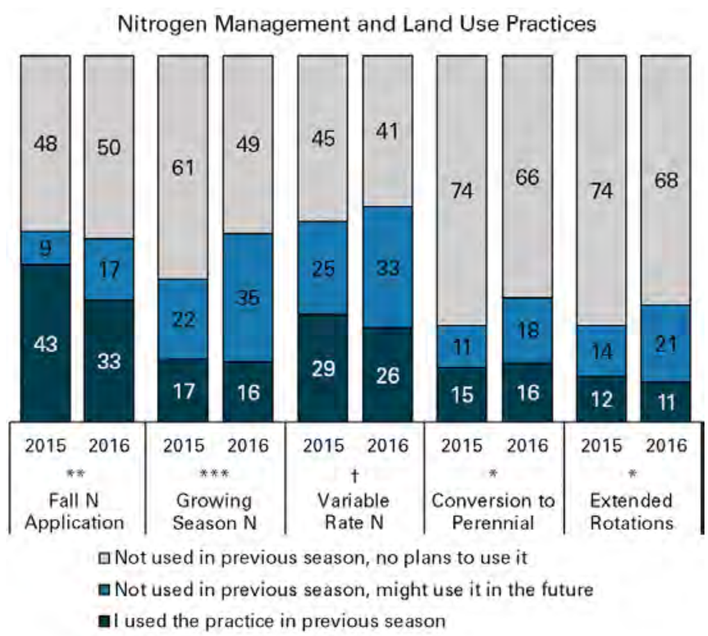


Figure 12. Percent of farmers in 2015 and 2016 in the Missouri-Little Sioux HUC6 watershed who indicated that they had used conservation practices in the prior season. Only practices that had a statistically significant change from 2015 to 2016 are displayed, as indicated by the chi-square test p-value.
† $\alpha < 0.1$; * $\alpha < 0.05$; ** $\alpha < 0.01$; * $\alpha < 0.001$**

Among the nutrient management practices, repeat respondents reported a statistically significant change in their use or potential use (i.e. not used the practice but might use it in the future) of fall nitrogen application ($p < 0.05$), growing season N application ($p < 0.01$), and variable rate N application ($p < 0.1$). Fall N application users fell from 43 percent to 33 percent, while potential users increased from nine to 17 percent. Growing season N non-users with no plans to use the practice decreased from 61 to 49 percent of repeat respondents. Potential users increased from 22 to 35 percent. Finally, variable rate N non-users decreased from 45 to 41 percent, while potential users increased from 25 to 33 percent. Users of variable rate N fell from 29 to 26 percent (Figure 12).

Among the land use practices, there was significant change in the use of row crop conversion to perennial crops ($p < 0.05$) and in the use of extended rotations ($p < 0.05$). From 2015 to 2016, non-users of conversion to perennial crops with no plans to use the practice fell from 74 to 66 percent of repeat respondents, and potential users increased from 11 to 18 percent. Extended rotations non-users fell from 74 to 68 percent and potential use rose from 14 to 21 percent (Figure 12).

Among the structural practices, there was statistically significant change in responses related to the use of ponds and sediment basins ($p < 0.05$) and of bioreactors ($p < 0.05$). From 2015 to 2016, non-users of ponds and basins fell from 72 to 68 percent of repeat respondents, and potential users rose from seven to 13 percent. Potential users of bioreactors rose from 10 to 17 percent, while non-users with no plans to use bioreactors decreased from 89 to 82 percent.

Respondents who had not used any of a subset of practices indicated the reasons they had not used the practices. The reasons provided as options were "cost", "don't know enough", "not appropriate for my soil or terrain", and "risk to crop yield". Respondents were asked to check all that applied to them. In the Missouri-Little Sioux HUC6 watershed, there was substantial evidence that, for many practices, limited knowledge decreased as a barrier from 2015 to 2016. The percent of non-users who indicated that knowledge was a reason for not using a practice decreased significantly from 2015 to 2016 for the following practices: cover crops, strip till, contour strips, stream buffers, bioreactors, and maximum return to nitrogen (MRTN) (Figure 13). The greatest decrease in knowledge as a barrier occurred for MRTN, which dropped from 70 percent of non-users to 55 percent ($p < 0.01$).

Figure 13. Percent of non-users in 2015 and 2016 in the Missouri-Little Sioux HUC6 watershed who indicated that limited knowledge was a barrier to using a conservation practice. Only practices that had a statistically significant change from 2015 to 2016 are displayed, as indicated by the chi-square test p-value.
† α < 0.1; * α < 0.05; ** α < 0.01

Upper Mississippi-Maquoketa-Plum HUC6 watershed

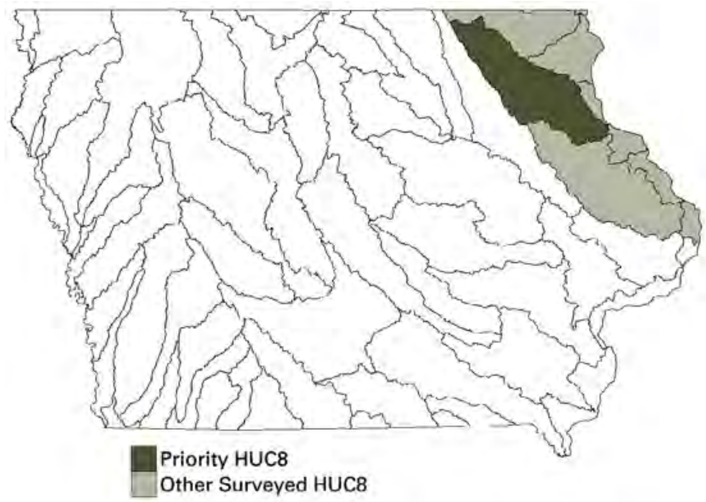


Figure 14. The survey area for the Upper Mississippi-Maquoketa-Plum HUC6 watershed, as part of the five-year NRS Farmer Survey.

The Upper Mississippi-Maquoketa-Plum HUC6 watershed is located in the northeast region of Iowa and contains the Turkey HUC8 watershed, which is one of nine NRS priority watersheds (Figure 14). The Upper Mississippi-Maquoketa-Plum HUC6 was surveyed in 2016 and 2017. Between those two years, there was no statistically significant change in farmers' reported knowledge of the NRS or in their reported attitudes related to the NRS and nutrient reduction. In addition, there was no significant change in the portion of farmers who used various conservation practices or intended to use them in the future.

Of those farmers who did not use various conservation practices, there was a decrease in knowledge as a barrier to using cover crops, spring nitrogen application, and extended rotations.

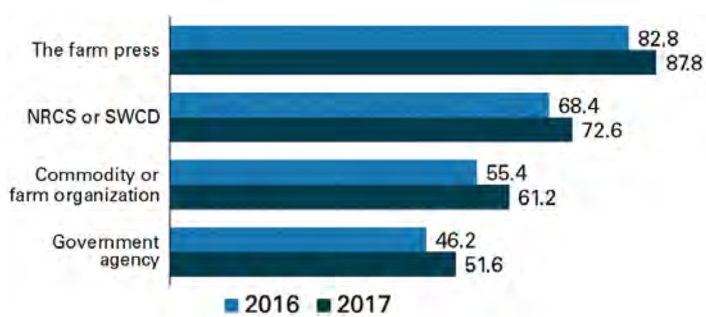


Figure 15. Percent of farmers in 2016 and 2017 in the Upper Mississippi-Maquoketa-Plum HUC6 watershed who indicated they had learned about the NRS from various information sources. Only sources that had a statistically significant change from 2016 to 2017 are displayed, as indicated by a chi-square test.

From 2016 to 2017, there was a statistically significant increase in the proportion of farmers who indicated they had learned about the strategy from commodity and farm organizations, the farm press, NRCS and Soil and Water Conservation Districts, and other government agencies (e.g. IDALS) (Figure 15).

Comparison of priority and non-priority HUC8 watersheds

The NRS farmer survey aims to compare priority HUC8 watersheds to non-priority HUC8 areas within the same HUC6 watershed, with the goal of examining whether increased financial and staff resources within priority watersheds has positively affected farmers' knowledge, attitudes, and behaviors related to conservation. Preliminary analysis to compare priority and non-priority areas in completed HUC6 watersheds are inconclusive so far. It is likely that the typical two-year rotation for four of the six watersheds is not sufficient to identify any potential variation within a HUC6. Ongoing analysis will continue to explore this research question during the 2019 reporting period and as the five-year survey project is completed.

Cover Crop Survey

IDALS conducts a cover crop user survey facilitated through local Soil and Water Conservation District offices. The survey has been conducted annually since in the fall of 2014. Participants using cover crops (with or without financial assistance) were asked to complete the survey. The goal of the survey was to learn the management practices of these cover crop users; assess their understanding of cover crops; examine what would help facilitate expanded acreage of cover crops on their operation or on other farms in their area; and to inform program design and operation. A question that carried over from 2014 to 2017 asked respondents whether they planned to use cover crops the subsequent year. In 2017, 83 percent reported they were planning use cover crops the following year, 16 percent reported they were unsure, and less than one percent reported they would not; these proportions were similar to the 2016 data, but represented an increase from the 77 percent of 2015 respondents who indicated that they planned to use cover crops the following year.

A separate question asked respondents whether they owned, rented, or managed the fields in which they planted cover crops. Most farmers (60 percent) owned and operated the field in which they seeded to cover crops. Twenty-four percent reported they were the tenant or operator on their cover crop fields, but the landowner did not request the practice be implemented. Nine percent reported they were a tenant or operator, and the landowner had requested the practice be implemented on their fields. These results showed effectively no change from 2015 and 2016, and continue to support the view that landowners present an opportunity for adapted outreach efforts that may facilitate increased adoption of cover crops and other conservation practices.

A list of the 2017 survey questions and a summary of responses can be found in Appendix D, available in the **online version** of this report at www.nutrientstrategy.iastate.edu/documents.

Recent innovations in NRS Outreach

The On-the-Edge trailer

In response to the need for expanded knowledge of edge of field practices, the Iowa Learning Farms launched the Conservation Station ON THE EDGE. It was designed to be visually harmonious with the existing Conservation Station trailer fleet, yet have its own identity for promoting edge-of-field practices. In fall 2017, the bioreactor and saturated buffer models and turntable were constructed by Agri Drain Corporation and finalized by researchers at Iowa State University. The trailer is available to be reserved by watershed groups and other outreach entities. Multiple events have been scheduled for the 2019 reporting period.

Transforming Drainage Demonstration Project

In 2017, IDALS received a cooperative agreement with the EPA-Gulf of Mexico Program to lead a demonstration project focused on on-farm demonstration of conservation drainage practices in the Des Moines River Basin. These concepts are not well known to a broad cross section of the agriculture and non-farming community. In partnership with Iowa State University, ISA, ICGA, and Iowa Agriculture Water Alliance (IAWA), IDALS will work with landowners to install the practices coupled with outreach efforts to highlight the importance and applicability of these practices to scale-up adoption.

Updates on previously highlighted outreach innovations

retaiN Nitrate Test Kits

In a partnership between Conservation Districts of Iowa, ISU Extension and Outreach, and Iowa Learning Farms, and with support from the IDALS Division of Soil Conservation and Water Quality, approximately 1,500 nitrate concentration test kits have been distributed to farmers and landowners through watershed projects, ISU Extension and

Outreach field specialists, ICGA, and agribusiness partners to date. A survey of project participants was conducted in early 2018 to gather information about kit use and outcomes, with 34 participants responding to the survey. The majority of project participants sampled tile outlets monthly (72 percent) with 14 percent sampling weekly and the final 14 percent sampling every other week. When asked what they like best about the kits, participants indicated ease of use and simplicity were two stand out features. Participating in the retiaN project has influenced conservation actions and decisions of the survey respondents: 32 percent plan to continue to monitor their tile outlet, 26 percent have attended a field day or workshop to learn more about water quality, 20 percent have consulted with a conservation professional about conservation or water quality practices, 12 percent have considered installing a new practice to reduce nitrate loss, six percent have installed a new conservation practice and four percent are now engaged in tile monitoring with ISA or a local conservation or watershed group.

Iowa Learning Farms

Iowa Learning Farms is an organization that provides extensive statewide outreach by bringing together farmers, landowners, agribusiness, researchers, and state and federal agency partners. In 2017, Iowa Learning Farms hosted or partnered with other organizations to deliver 92 outreach events that reached 7,372 people. To better evaluate event audiences, Iowa Learning Farms gathered additional demographic, communication, and event preference information in 2017. Eighty-three percent of field day attendees identified as farmers or landowners, eight percent as government employees, four percent people who would like to farm, two percent people who were new to farming, and 19 percent identified as other. Twenty-seven percent of attendees were women and 73 percent were men.

Attendees are hearing about field days primarily through their neighbors or word of mouth (25 percent), the newspaper (20 percent), and mailings (20 percent). For more information about the Iowa Learning Farms 2017 **event attendee survey and individual event information**, visit www.iowalearningfarms.org/content/ilf-reports.

Iowa Watershed Academy

The spring 2018 Iowa Watershed Academy training event was held May 30-31 at the Borlaug Learning Center and Iowa State University Northeast Research Farm near Nashua, Iowa. This event provided hands-on training for site assessment, in-field data collection, design, and installation considerations for bioreactors, saturated buffers, and wetlands. Each practice module combined a classroom and field component to provide watershed coordinators and conservation professionals with a background in design and data collection elements to complement the hands-on field exercise. Two new outreach tools for edge of field practices were featured: the Soil and Water Conservation Society Edge of Field outreach tools and resource library and the Iowa Learning Farms Conservation Station ON THE EDGE. The Iowa Natural Heritage Foundation presented information on conservation easements and land acquisition, and the two-day event closed with the Soil and Water Conservation Society applying the diffusion of innovations theory to encourage scale-up of practice implementation.

The fall 2017 Iowa Watershed Academy training event, held October 24-25 at the Iowa State Field Extension Education Lab (FEEL) featured general sessions on conservation planning, conservation sales skills development, the One Water approach, Conservation Infrastructure efforts, using Story Maps to communicate watershed data and the unveiling of the Conservation Station ON THE EDGE for edge-of-field practice outreach. A track for the Iowa Watershed Approach coordinators focused on watershed planning, using social assessments tools, and a watershed hydrologic assessment showcase. The WQI, IDALS, and DNR project coordinator track featured the latest cover crop research and scale-up plans, an innovative soil health measurement tool, source water protection, and outreach tracking tools and methods. This event was sponsored by the Iowa NRCS, Soil and Water Conservation Society, ISU Extension and Outreach, IAWA, Conservation Districts of Iowa, Iowa DNR, IDALS, and the Iowa Watershed Approach.

The participants conduct a self-assessment prior to the academy sessions and again at the completion to determine immediate knowledge change. The instructors will use the self-evaluation to shape future Watershed Academy training structure, topics, and other training courses.

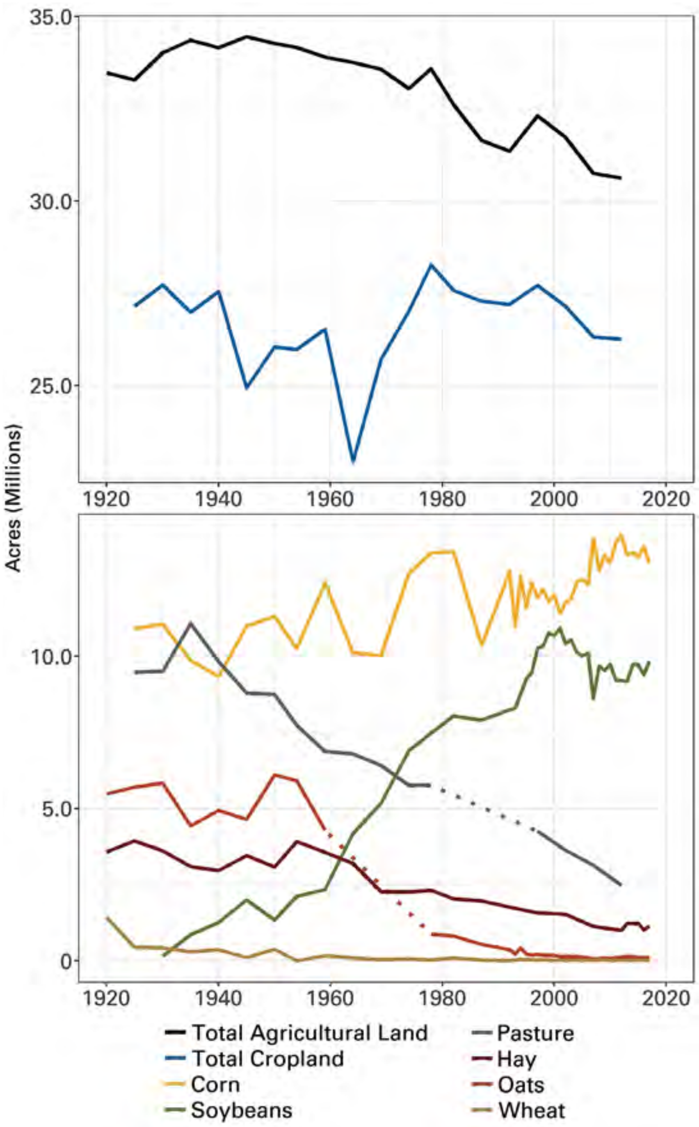


Figure 16. Iowa agricultural land use and major crop acreages from 1920-2017, as reported by the U.S. Department of Agriculture's Census of Agriculture and by the Farm Service Agency. Dotted lines represent periods of insufficient data. The post-1992 fluctuations in corn and soybean acres are attributed to the availability of annual data; prior to 1992, census data at intervals of approximately five years were used.

Land

This section describes the extent of practices implemented for the reduction of nitrogen and phosphorous loss from nonpoint sources. This portion of NRS progress measurement is a tool for examining the voluntary participation by the Iowa agricultural sector in nutrient reduction efforts. There is a role for participation by urban residents and sectors as well (see page 33), although urban practices for nutrient reduction are under research and evaluation and have not yet been quantified for nutrient reduction effectiveness.

In order to discuss the progress of agricultural nonpoint source nutrient reduction efforts, the following subsections present the current state of land use in Iowa; the effectiveness of approved NRS practices in nonpoint-source nutrient reduction and the status of progress toward NRS scenarios; the implementation of practices based on available data sources; and current efforts and projects to address data gaps.

Iowa's land use—a historical perspective

Iowa's total land area is 35.7 million acres.[4] The state's land is dedicated primarily to agriculture; total agricultural land – as reported by the USDA Census of Agriculture – has averaged 33 million acres since 1920, with a range of 30.6 million acres in 2012 to 34.5 million acres in 1945 (Figure 16). The land area dedicated to field crops – corn, soybeans, and other annual and perennial crops – has remained relatively steady since 1920, averaging 26.6 million acres. During that time, statewide pasture acres have decreased from a high of 11 million acres in 1935 to a low of 2.5 million acres in 2012. More recently, field cropland totaled approximately 24.3 million acres in 2015 and 24.1 million acres in 2016.

With a decline in pasture came a redistribution of cropland use. In 1935, pasture acres briefly exceeded corn acres. An abrupt reversal occurred in 1940; corn, and then soybean, acres climbed, while pasture, oat, and hay acres declined. Wheat and other small grains have experienced little production in Iowa over the last 50 years (Figure 16).

There are some key implications of this land use history as it pertains to nutrient loss. First, the increase in corn and soybean production coincided with the declining production of extended rotations and pasture. Second, annual field crops like corn and soybean rotations leave farm fields vulnerable to loss of nitrogen and phosphorus, particularly in the spring during the pre-plant period and just after planting, and in the fall after harvest. Third, while fluctuations in total corn and soybean acres occur from year to year, these two crops have dominated Iowa's landscape for the last 50 or more years.

4 www.census.gov/quickfacts/table/PST045216/19

Practice effectiveness in reducing nutrient load

As noted above, land use is a significant driver of nitrogen and phosphorus loss in Iowa's agricultural sector. Thus, land use change and agricultural land retirement can be highly effective for reducing the loss of nutrients from agricultural areas; however, because land use change may result in taking row crop acres out of production, this nutrient reduction benefit comes at a significant cost to public sector programs and to the economic viability of landowners and farmers of the state. Opportunities for nutrient loss reduction also lie in edge-of-field treatments and in-field management practices (Figure 17). These practices mitigate loss of nutrients while keeping farmland in production.

In-field practices for nutrient reduction comprise management techniques that are conducted on an annual basis for row crop production, such as cover crops, tillage, and in-field nutrient (i.e. fertilizer) management. Nutrient management practices tend to demonstrate lower nutrient reduction potential than do cover crops, tillage reduction, land use change, and edge-of-field practices, but are typically implemented with lower up-front financial investment. However, these practices must be conducted annually on an ongoing basis to achieve nutrient loss reduction effectiveness. With the exception of equipment investments, the costs for inputs, seed, and labor must be invested each year.

Finally, edge-of-field and erosion control practices show high effectiveness in reducing nutrient loss. These practices are structural installations (e.g. terraces, bioreactors), so they exhibit a lifespan of a decade or more. As a result, while these practices reduce impacts and allow for continued land use for row crop production, they require a high up-front financial investment. This investment, though, provides nutrient reduction benefits for the lifespan of the practice, as long as the practice is properly maintained and managed. Ultimately, a specialized suite of practices

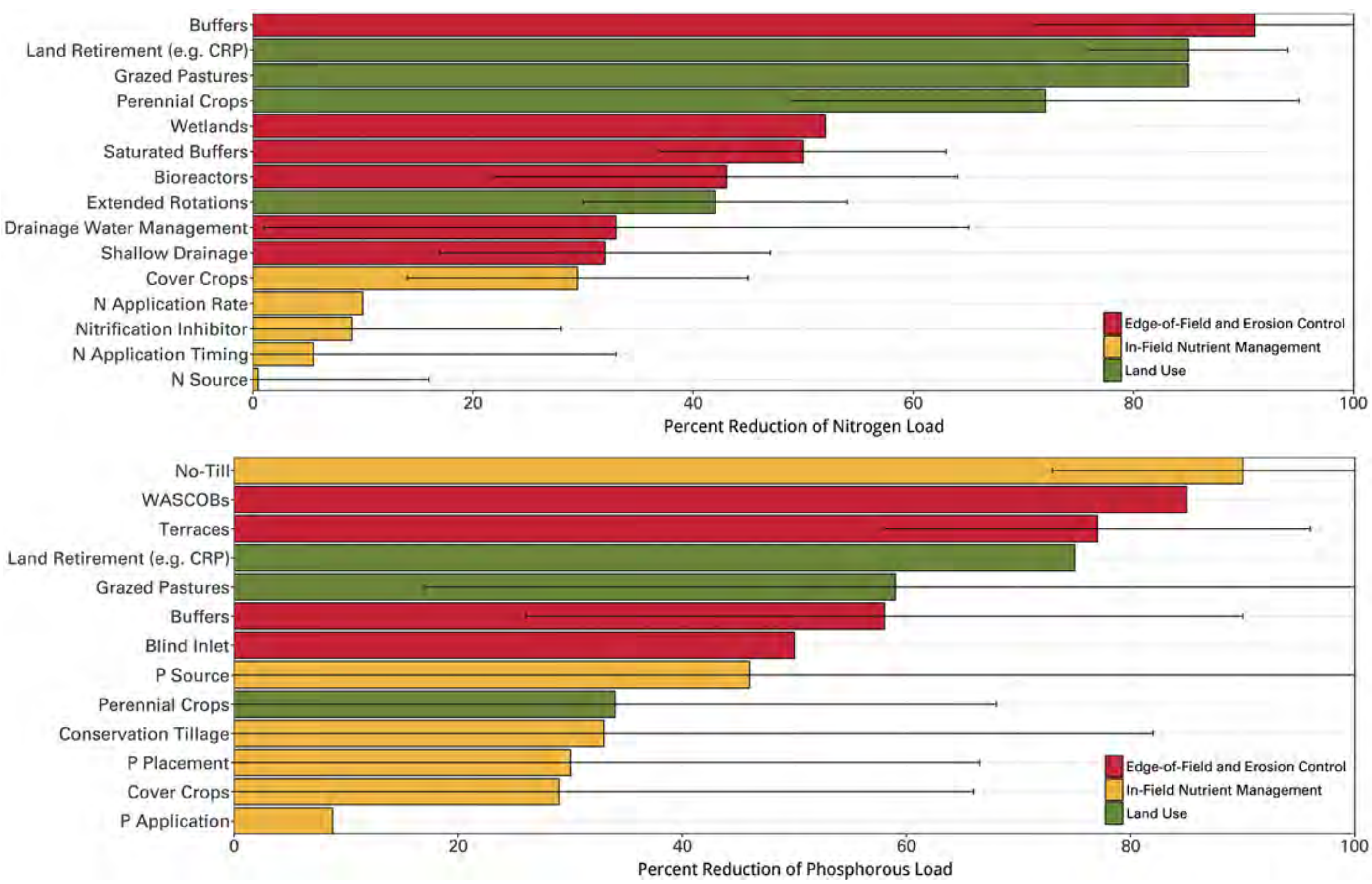


Figure 17. The effectiveness, presented as mean percent reduction of nitrogen and phosphorus loads, of conservation practices that have been approved for the Iowa Nutrient Reduction Strategy. Error bars represent one standard deviation above and below the mean. For some practices, scientific literature suggests a standard deviation larger than the mean reduction, representing high variability in measured effectiveness; review of recent literature will reevaluate these estimates in 2018. Figure concept by the Iowa Soybean Association.

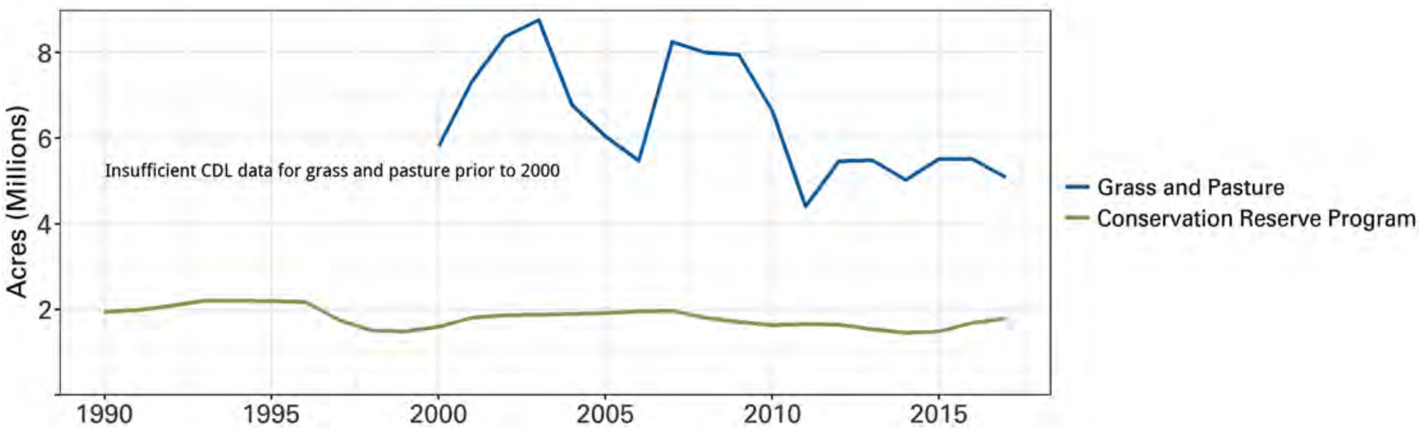


Figure 18. The annual acres of Conservation Reserve Program contracts in Iowa from 1990 to 2017 and the estimated total acres of grass and pasture from 2000 to 2017, as reported in the USDA's Cropland Data Layer.

– land retirement, in-field management, and edge-of-field – that addresses the variety of local resource concerns is necessary for any operation or watershed.

Updating the effectiveness values of NRS conservation practices

When the NRS Nonpoint Source Science Assessment was compiled and published in 2013, researchers from universities and public agencies in Iowa reviewed existing scientific literature from Iowa and surrounding states with Iowa-like conditions to determine the expected nitrogen and phosphorus reduction capacities of agricultural conservation practices. During the 2018 reporting period, an updated review began in order to revise estimated practice effectiveness. This updated review incorporates literature that has been published since the 2013 review. Results are expected to be available in 2019.

Progress of nonpoint source practice implementation

To evaluate the progress of the NRS, the statewide use of the practices that have been assessed for their effectiveness/ability to reduce nitrogen or phosphorus losses have been tracked. Primarily, practices are tracked using data from federal and state conservation programs, but there are ongoing efforts to identify and collect data from other sources (see page 43). This section describes the statewide progress of land use practices, in-field practices, and edge-of-field and erosion control practices.

Land use change for reducing nutrient loss

Land use change from annual crops to perennial vegetation is a highly effective approach for reducing nutrient loss. Conversion to a perennial land use reduces nitrogen loss by 72-85 percent and phosphorus loss by 34-75 percent. CRP is a widespread, federal land-rental program that incentivizes cropland conversion to perennials in exchange for long-term rental contracts (10-15 years) with participating landowners. The perennial vegetation in CRP acres acts as a temporary land retirement mechanism. This program depends on availability of funds and acreage limits for rental payments and fluctuates as a market structure, but acres were at 1.8 million in 2017, an increase of about 100,000 acres from the previous year (Figure 18). In 2017, the national cap on CRP implementation was 24 million acres. Because the national cap is nearly reached, there have been limited opportunities to gain additional acres through CRP.

Currently, CRP is the primary source of data for estimating and tracking the extent of land retirement in Iowa on an annual basis, due to its availability and reliability. Additionally, county-scale data published by the USDA FSA reflect changes in acres of planted crops; for instance, FSA data will allow for tracking of land use change in the case that row crop conversion to pasture or extended rotations may occur. Programs other than CRP, along with independent action taken by farmers, undoubtedly facilitate annual crop conversion to perennials; Figure 18 shows that the USDA Cropland Data Layer predicts there are between 4.0 and 8.5 million acres of grass and pasture annually in Iowa since 2000. Thus, CRP data likely does not capture the entire extent of row crop conversion to perennial vegetation. Work is underway to estimate the total acres of row crops – as opposed to acres of other land uses – that are converted to perennial vegetation each year using the USDA Cropland Data Layer. CRP acres peaked at 2.2 million in 1993 and have shown a gradual, though fluctuating, decline in recent years. Mechanisms for implementing and for collecting data on non-CRP land retirement may be necessary for the achievement of NRS goals and will continue to be evaluated.

Marginal pasture acres are eligible for certain CRP programs, but this is limited and fewer than 12,000 acres statewide are enrolled. This provides backing for nutrient loading calculations that increased enrollment corresponds with reductions in row crop acres. If a cost-share program enrolls a given field as perennial land use, then it is much more difficult to assess nutrient loading reductions since the prior land use was already limiting nutrient losses. While it can be assumed that acres that leave CRP enrollment return to row crop production, it is not necessarily true in all instances. It is important to account for this difference by tracking cropland, urban, and other land uses. Improved spatial resolution of CRP acres will also help understand these changes over time.

However, there is a challenge with quantifying the impacts of land in CRP at the current resolution the data is collected. County level data is difficult to track by watershed and the difference between CRP practices is needed to account for the disproportional effect they have on nutrients. For example, a CRP filter strip has advantages in nutrient reduction compared to whole-farm or whole-field CRP practices. These differences should be accounted for when tracking and quantifying progress. When CRP was established in the 1980s, the majority of enrollments were whole-field. As the program has evolved into more targeting and addressing other resource concerns (e.g. habitat), the enrollment has shifted more towards continuous, targeted areas of fields that provide additional benefits.

In-field practices for reducing nutrient loss

Cover crops are also an effective practice for reducing nitrogen and phosphorus loss at 28-31 percent and 29 percent, respectively. This practice has experienced substantial uptake in recent years, likely as a result of its integration into corn-soybean operations and its potential for improving soil health.

In fall 2017, 329,000 acres of cover crops were planted with cost-share funding, up from 305,000 in 2016 (Figure 19). These data, however, do not account for the total acres of cover crops implemented in Iowa without cost-share funding. Estimates suggest that 760,000 acres of cover crops were planted in fall 2017.[5] This assessment is promising in that cover crop adoption began on a wide scale in 2011. However, in comparison with the NRS scenarios

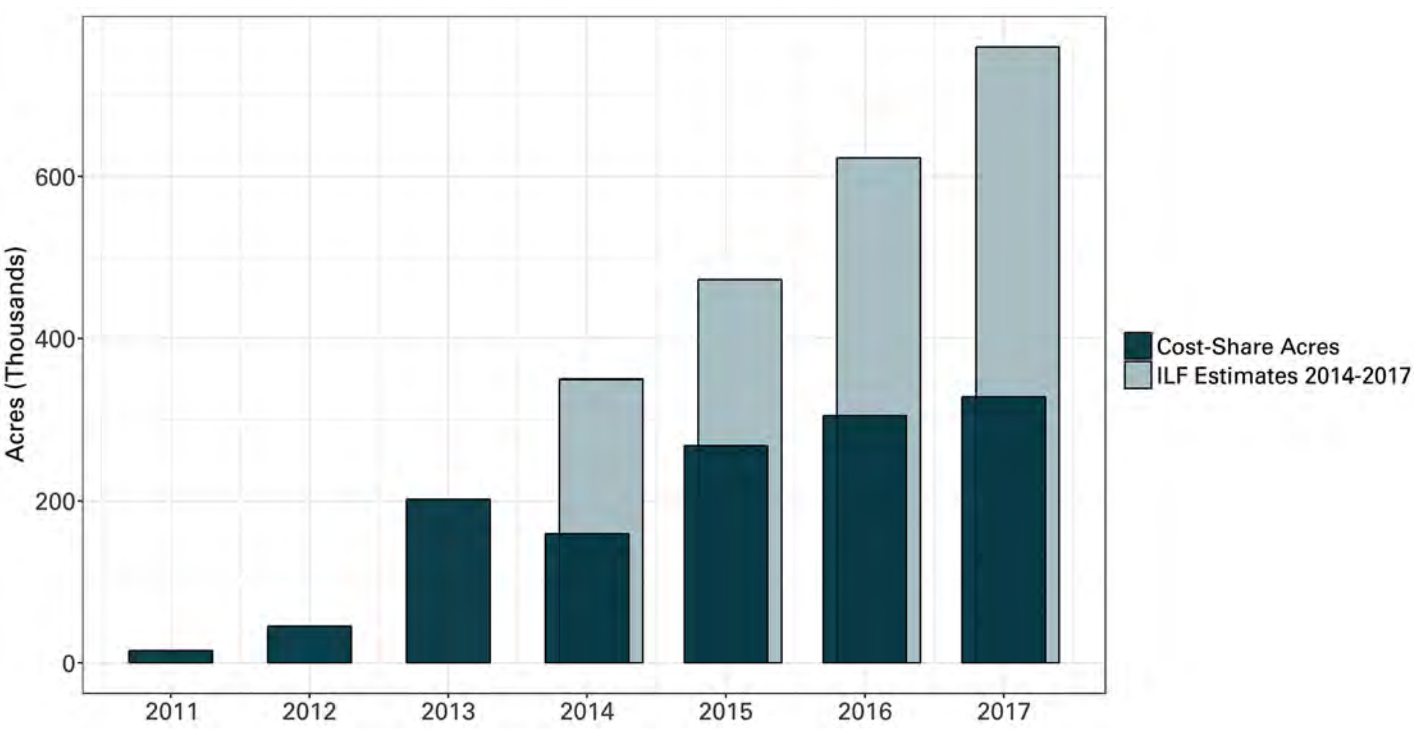


Figure 19. Cover crop acres implemented in each year from 2011-17 with cost-share assistance from state and federal conservation programs. Also displayed is an estimate of total state implementation (regardless of funding mechanism): the annual Iowa Learning Farms estimate from survey data extrapolated to reflect the entire state.

[5] Iowa Learning Farms surveyed farmers who attended their field days, asking how many acres of cover crops they plant. The average number of acres was extrapolated to reflect the entire state. **Iowa Learning Farms 2017 Evaluation Report**, www.extension.iastate.edu/ilf/content/ilf-reports.

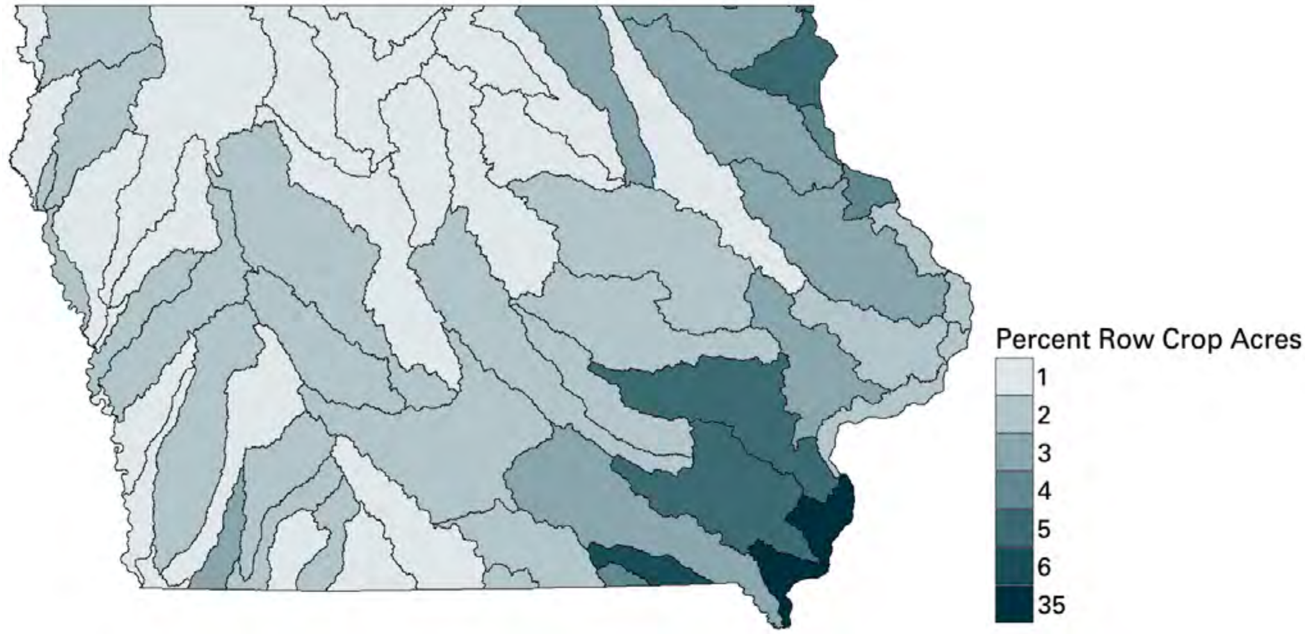


Figure 20. The relative densities of cover crops implemented with state and federal cost-share funding in 2017. In each HUC8 watershed, cover crop acres are indicated as a percent of the watershed's row crop acres, ranging from approximately one percent to 35 percent. This image does not account for cover crops that were implemented without government funding.

that present cover crops as part of a suite of practices implemented to meet the 45 percent reduction goal, cover crops need to be adopted on a scale of 10-14 million acres. This would require a significant acceleration of adoption rates in coming years; adoption rates high enough to achieve this scenario have not yet occurred.

Figure 20 displays the density of cover crop implementation in Iowa's HUC8 watersheds. These densities reflect only government conservation program contracts (i.e. cost-share acres); data for acres implemented without government funding are currently unavailable and not included in the image. Cover crop use is concentrated in the southeast portion of the state, and secondarily in the eastern and northeastern regions. A disproportional share of cover crop acres can be partially attributed to more favorable weather patterns to reliably establish and manage cover crops. However, it cannot discount the role of local knowledge and farmers' cover crop experience, the focus of locally delivered programs, and cropping and livestock systems in these areas.

Nutrient management improvements have an effect on nutrient loading to streams of up to 10 percent reduction for nitrogen and up to 46 percent reduction for phosphorus. Public programs can incentivize, promote, and encourage adoption, but the role of programs and ability to track adoption is limited due to a variety of factors. Most nutrient management decisions are primarily implemented through the private sector and are balanced with considerations for risk and economics of crop production. To date, estimates of the extent of nutrient management practices have focused solely on determining the average rate of nitrogen

Why are some NRS practices excluded from progress evaluation?

The annual progress of some NRS practices are not displayed in this report due to insufficient data availability:

- In-field nutrient management
- Tillage reduction
- Nitrification Inhibitor
- Extended rotations
- Drainage water management
- Ponds
- Non-CRP perennial vegetation

For more information on how these data challenges are currently addressed through new research and tracking projects, see page 43.

and phosphorus applied to corn or soybeans annually over time. This assessment involves utilizing existing data on commercial fertilizer sales and animal units to estimate nutrients applied through manure on a county scale. Based on these data sources, the application of nitrogen fertilizer – both commercial and manure – increased slightly from the 1980-96 baseline time period to the 2006-10 benchmark period.[6] During the 2006-10 period, an estimated 1.2 million pounds of nitrogen were applied annually. Similarly, estimated phosphorus (i.e. P_2O_5) application remained stable between these two time periods.[6] These changes occurred alongside some increases in corn and soybean acres, so per-acre application rates will be estimated to assess the trends in nutrient application. Additionally, geospatial variation cannot be determined from the currently available statewide estimates.

Efforts to assess more current nitrogen and phosphorus application practices, including geospatial variation and per-acre application rates, are underway. See page 46 for more details on ongoing survey efforts.

Tillage has a potential for large reductions in phosphorus loss from row crop fields. Conversion from moldboard plowing, by which no crop residue remains in the field, to conservation tillage results in an average 33 percent reduction in phosphorus loss, although research shows a wide variability in case-by-case results. Moving from conventional tillage – minimal residue – to no-till results in an average 90 percent reduction in phosphorus loss.

Tillage practices have shifted over the last few decades. There were effectively no acres of no-till in Iowa prior to 1987.[6] In 2012, aaccording to the USDA Census of Agricultural, there were 6.9 million acres of no-till. Additionally, there were 8.7 million acres of conservation tillage. Conventional tillage was reported as less prevalent than conservation tillage at 7.9 million acres (Figure 21). As a result, the shift to no-till in the last few decades has served as a main driver in Iowa's efforts to reduce soil loss, thereby reducing phosphorus loss.

Data on the progress of tillage since 2012 are limited, as reduced tillage through cost-share programs is minimal and farm operators are likely to reduce their tillage practices independently. The 2017 USDA Census of Agriculture was completed in 2017, but data will not be available until 2019. While the extent of no-till is promising for reducing phosphorus loss, there is a need for improved understanding of the extent and change of different tillage practices across each region of the state. An ongoing survey effort aims to fill in this knowledge gap and is discussed further on page 46.

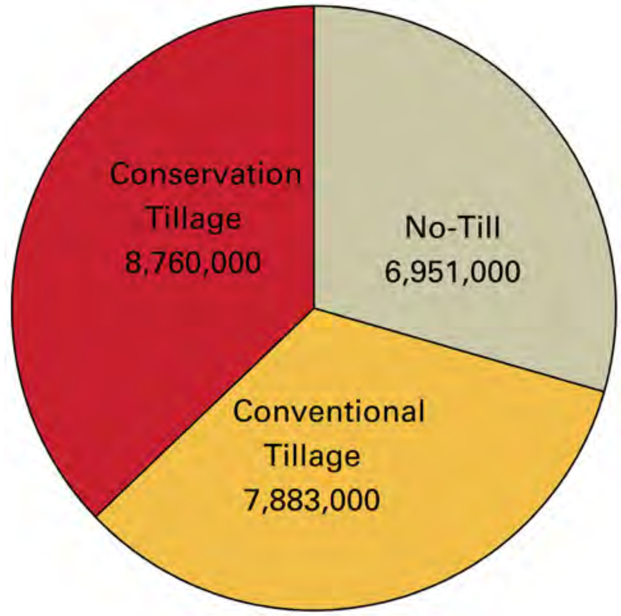


Figure 21. Acres of tillage practices in Iowa cropland in 2012, as reported by the USDA Census of Agricultural. Data from the 2017 USDA Census of Agriculture will be available in 2019.

Edge-of-field and erosion control practices

Bioreactors and **saturated buffers** are edge-of-field practices that treat tile flow to remove nitrate before the water enters an adjacent stream, ditch, or tile main. At 43 and 53 percent reduction, respectively, these practices are highly effective at reducing annual nitrate loads to streams.

As of the end of the 2017 calendar year, an estimated 25 bioreactors and four saturated buffers had been installed through cost-share programs in Iowa; there may be additional bioreactors and saturated buffers that were constructed but have not yet been confirmed and located through supplementary data sources. Using a conservative assumption that these practices each treat 50 acres of drained cropland, at least 1,450 acres are currently treated (Figure 22a). Of these 1,450 known treated acres, 1,400 acres have been newly treated since 2011. These practices are relatively new, so adoption will likely continue to rise as programs and partners focus inputs and outreach towards

[6] The 2013 baseline for buffers was selected due to data availability. Data on acreage of 2011 and 2012 CRP buffers are publicly available, but are inconsistent with the data provided for 2013-2016 and potentially misreported or underreported. Efforts to explore this discrepancy will be conducted in the 2018 reporting period.

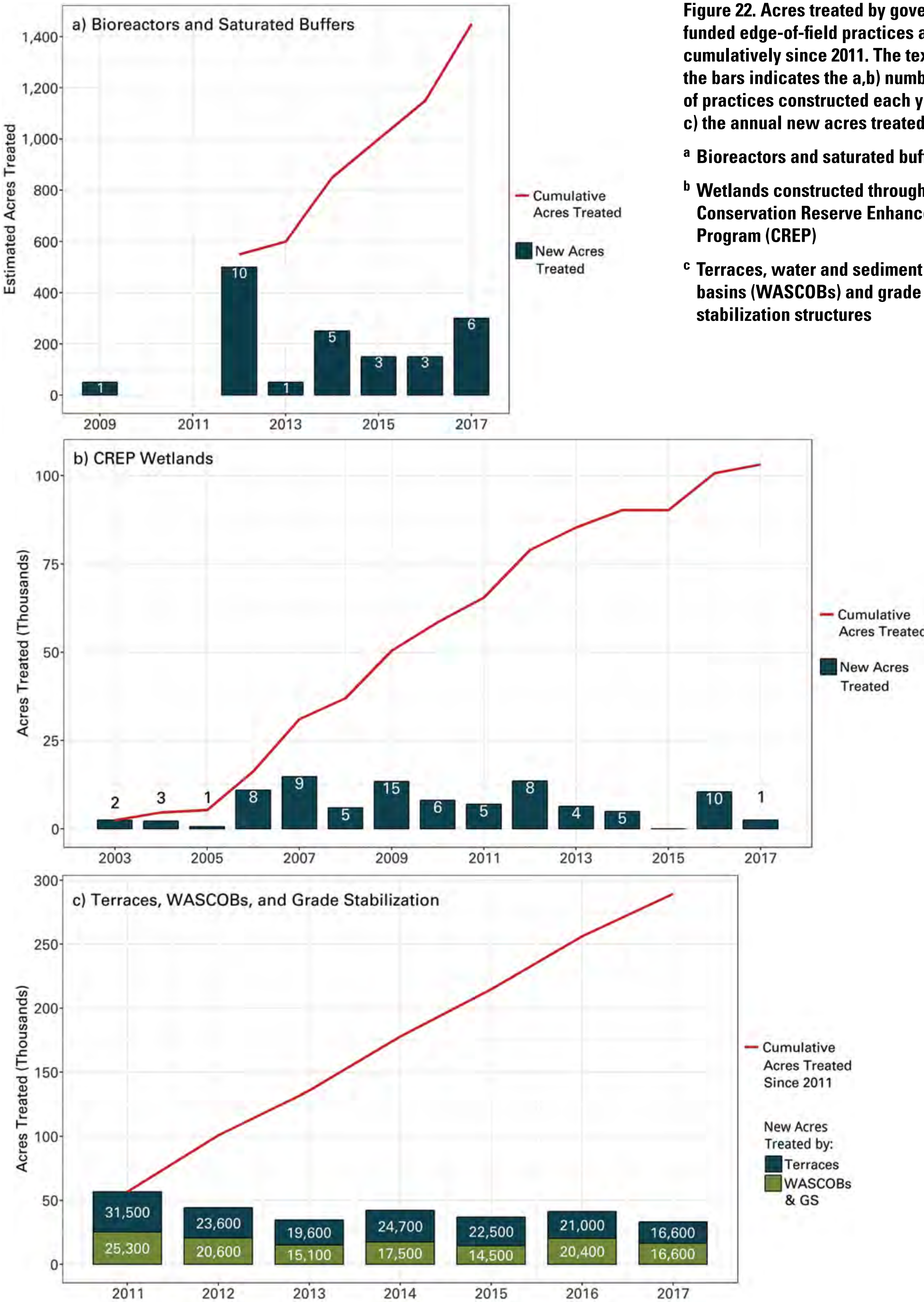


Figure 22. Acres treated by government-funded edge-of-field practices and cumulatively since 2011. The text inside the bars indicates the a,b) number of practices constructed each year, and c) the annual new acres treated.

[a] Bioreactors and saturated buffers

[b] Wetlands constructed through Conservation Reserve Enhancement Program (CREP)

[c] Terraces, water and sediment control basins (WASCOBs) and grade stabilization structures

implementation, but the level of acres treated by bioreactors and saturated buffers needs to increase significantly to address the goals of the NRS based on various scenarios. The NRS Science Assessment proposes that, in one scenario, six million acres – 60 percent of drained land – should be treated to meet its goals. A second scenario suggests a need for 70 percent of drained land, or 6.9 million acres, to receive treatment from a bioreactor. At 50 acres treated per bioreactor, these scenarios call for up to 138,000 bioreactors to be installed in selected regions of the state. While these scenarios serve as examples of the scope of implementation necessary, it may be that fewer bioreactors, coupled with other practices, will actually be needed for the NRS nitrogen reduction goals. This practice is limited by the topography and drainage system of any given field, so targeted application of this practice is necessary. In addition, this scenario was created prior to development and acceptence of saturated buffers as a viable practice to address nitrate loss. It may be assumed that saturated buffers and bioreactors are synonymous in terms of objective (i.e. reduction of nitrogen lost via drainage tiles) and effectiveness; these two practices may, together, contribute to the vast need for treatment of tile flow, with site characteristics determining the appropriate installation of one practice or the other.

Early installation of saturated buffers and bioreactors was partially hampered by CRP policy that prevented the installation of these practices into acres under contract through CRP. In 2016, after coordinating with multiple stakeholders, the FSA reversed their previous position and began allowing and even incentivizing these practices through the Clean Lakes, Estuaries, and Rivers (CLEAR) Initiative. Outreach to promote and facilitate adoption is ongoing.

To date, as with most practices, the true extent of bioreactor and saturated buffer implementation is difficult to estimate due to differences in tracking methods at this time. Data sharing between Iowa State University, NRCS, IDALS, and ISA has confirmed that there are at least 25 bioreactors in Iowa, although more may be in place. Bioreactors and saturated buffers currently cannot be tracked using remote sensing or aerial photography because they are not visible once vegetation has established over their footprint. As of 2017, the annual NRS partner organization reports now include data entry on structural practices – including bioreactors – in an attempt to help address future concerns about tracking bioreactors. An improved method of tracking is being explored, given the extent of adoption needed on the Iowa landscape.

Wetlands that treat agricultural drainage for the reduction of nitrogen export have an effectiveness of 52 percent reduction and are primarily constructed through the Conservation Reserve Enhancement Program (CREP). IDALS and FSA have partnered to construct these wetlands by entering into an easement agreement with landowners for a minimum of 30 years. This practice requires high financial investment, but has longevity of multiple decades. Similarly sited and installed wetlands have been completed historically by other programs and individuals, but data are currently not available to assess the extent of this implementation. Other wetland restoration programs not sited or intended to receive agricultural drainage are considered in nutrient load reduction calculations, but under the land use category due to the nature of their intended and designed function.

Currently, Iowa has 83 CREP wetlands that treat about 104,000 acres (Figure 22b). The program experienced its highest rate of installations in 2007, with nine new wetlands treating nearly 15,000 previously untreated acres. Implementation of the program continues, with 15 wetlands currently in the planning and construction phases. CREP has provided the initial investment required to generate participation by landowners, but future implementation must grow outside of this funding-limited mechanism.

Installation of wetlands that are designed to treat tile drainage will need to accelerate to reach the level of treatment outlined by the NRS Science Assessment scenarios. One scenario suggests a need for 27 percent of agricultural land, or 7.7 million acres, to be treated by wetlands, and a second scenario suggests a need for 31.5 percent of agricultural land, or 8.9 million acres.

Water and sediment control basins (WASCOBs) and **grade stabilization structures** are structural, erosion-control practices that reduce the loss of soil-bound phosphorus by 85 percent. These are an established conservation practice in Iowa, and have been a significant focus of cost-share program investment. There are also several thousand units of these practices installed outside of public investment by landowners for livestock watering, recreation, and soil conservation purposes. The ongoing BMP Mapping Project will provide a key ability to track and document these practices. While these structures have been used for decades to prevent soil loss, the rate of construction since 2011 has been assessed though public sector programs only. Between 2011 and 2017, 130,000 acres were newly treated by WASCOBs and grade stabilization structures (Figure 22c). Each year, between 500 and 770 units of these practices were constructed through cost-share funds. These estimates do not account for practices installed without cost-share assistance. For more information on efforts to account for all WASCOBs (without bias toward government funding data), see page 43.

Terraces reduce phosphorus loss by an average 77 percent and represent an established practice that has seen a large amount of construction over the last few decades. Terraces reduce phosphorus loss through reduced soil erosion, particularly on cropped slopes. This practice requires a relatively high financial investment and, like WASCOBs and grade stabilization structures, has been the historical

Streambank stabilization. Photo courtesy of Jason Johnson, USDA Natural Resources Conservation Service.

Terraces. Photo courtesy of Jason Johnson, USDA Natural Resources Conservation Service.

focus of public sector programs. Currently, it is assumed that a significant amount of terraces are constructed through the financial assistance of government cost-share programs and this report will represent information from those sources. The Land Improvement Contractors of America Iowa Chapter conducted a survey of their members that indicated approximately 50 percent of their work on these practices is installed with no assistance from public conservation programs. This information was key in developing the ongoing BMP mapping effort to better understand these additional practices and corresponding load reductions. The BMP Mapping Project will also provide the ability to track these practices over time due to their visibility on the landscape. For more information on this effort, see page 43.

State databases indicate the approximate acres protected by terraces constructed in each cost-share contract. These figures were used, as averages for each HUC8 watershed, to estimate the acres treated by each foot of terrace and applied these estimates to the federal cost-share data on terrace construction. Through this method, we have estimated the annual acres treated by new terraces (Figure 22c). Through cost-share programs, an estimated 160,000 acres cumulatively are treated by terraces constructed since 2011.

Progress toward NRS scenarios

During the development of the NRS, the NRS Science Team identified several scenarios that were estimated to achieve nutrient reduction goals. These scenarios – combinations of practices and levels of implementation – serve as examples of potential scenarios that meet the goals of NRS nonpoint source reductions in nitrogen and phosphorus loss, 41 and 29 percent, respectively. NRS success may not look exactly like any of these scenarios. Rather, these examples illustrate the scope of practice implementation needed to achieve nutrient loss reduction goals. The three scenarios provide for a comparison and were chosen as examples because, of the various scenarios modeled for the NRS Science Assessment, they are estimated to address the goals of both nitrogen and phosphorus.

Table 11. Three example scenarios estimated to meet the nitrogen and phosphorus goals of the NRS for nonpoint sources, as presented in the NRS. These scenarios were modeled for the NRS Science Assessment and serve to illustrate the potential scope of implementation needed to meet goals. They do not serve as exact recommendations.

Scenario	
Scenario one	Maximum return to nitrogen (MRTN) rate, 60% acreage with cover crop, 27% of ag land treated with wetland, and 60% of drained land has bioreactor.
Scenario three	MRTN rate, 95% of acreage in all major land resource areas (MLRA) with cover crops, 34% of ag land in MLRA 103 and 104 treated with wetland, and 5% land retirement in all MLRAs.
Scenario eight	MRTN rate, inhibitor with all fall commercial N, sidedress all spring N, 70% of all tile drained acres treated with bioreactor, 70% of all applicable land has controlled drainage, 31.5% of ag land treated with a wetland, and 70% of all agricultural streams have a buffer. Phosphorus reduction practices: phosphorus rate reduction on all ag land, convert 90% of conventional tillage (CS) and cover crop (CC) acres to conservation till and convert 10% of non-no-till CS and CC ground to no-till.

In 2017, approximately 330,000 acres of cover crops were planted through state and federally funded conservation programs. This acreage represents about 2.6 percent progress toward scenario one and 1.6 percent toward scenario three. Current data availability limits analysis to cover crop acres funded by cost-share programs; however, as discussed on page 36, general estimates through surveys suggest that there were approximately 760,000 acres after the 2017 growing season, which would more than double the recent progress of this practice reported here.

Wetlands that treat nitrate from tiled systems have been constructed across Iowa since 2004, but to maintain a consistent benchmark with other practices, we have applied only those wetlands constructed after 2011 in this analysis. In 2017, these wetlands collectively treated approximately 45,000 acres, representing 0.6 percent toward scenario one, 1.1 percent toward scenario three, and 0.5 percent toward scenario eight.

Twenty-eight known bioreactors and saturated buffers have been installed since 2011 and treat an estimated 1,400 acres, representing 0.02 percent toward scenario one and 0.02 percent toward scenario eight.

Net retirement of agricultural land through CRP has increased by 124,000 acres since 2011. This net acreage represents 12 percent toward scenario three.

Additional practices highlighted in these scenarios were excluded from this analysis due to insufficient data on recent progress that has occurred since these scenarios were modeled. However, ongoing efforts aim to better understand the implementation of many NRS practices. With the future availability of these data, progress toward these scenarios will be updated. Additionally, the scenarios outlined in Table 11 achieve 45 percent N and P reductions compared to the 2006-10 benchmark nutrient loads, because these scenarios were developed for the 2013 version of the NRS. Because gains have been made in reducing phosphorus loss since the 1980-96 baseline period, these scenarios would greatly exceed the 45 percent reduction goals for P.

While annual progress continues in the implementation of these practices, early NRS efforts only scratch the surface of what is needed across the state to meet the nonpoint source nutrient reduction. Progress has occurred, but not at the scale that would impact statewide water quality measures. Local water quality improvements may be realized in the short-term where higher densities of conservation practices are in use, but the ability to detect early trends in measured water quality will vary from case to case. Statewide improvements affected by conservation practices will require a much greater degree of implementation than has occurred so far.

Data Improvement Efforts – Updates

There are various, ongoing efforts to improve the understanding of practice implementation and capture practice use that occurred outside of government assistance programs. This sections describes two projects: the BMP Mapping Project to digitize existing structural practice locations and a public-private partnership to survey agricultural retailers about in-field practice use across the state.

BMP Mapping Project—Efforts to improve tracking of structural practices

In an effort to help support progress measurement and accountability efforts of the NRS, a collaborative project between Iowa State University, DNR, the Iowa Nutrient Research and Education Council, and IDALS aims to identify and enumerate the aggregate amount of certain structural best management – or conservation – practices, independent of government programs, as outlined in the NRS Science Assessment. Practices include terraces, WASCOBs, grassed waterways, pond dams, contour buffer strips, and contour strip cropping. These practices are identifiable by use of LiDAR elevation data and aerial photos, thereby enabling an accurate accounting of the practices present on the Iowa landscape.

This project is conducted in three parts. First, the 2010 benchmark existence of structural conservation practices will be digitized for 1,712 HUC12 watersheds in Iowa. These watersheds represent all HUC12s that are contained within or intersect the state border. Second, a historical tally of practices that were in place in the 1980-96 period will be determined by digitizing a sample – 25 percent – of HUC12 watersheds, using aerial photography from that time period. This 1980-96 estimate corresponds to the baseline targeted by the Gulf of Mexico HTF. Third, the same 25 percent sample of HUC12 watersheds will be digitized with emerging 2016-18 LiDAR imagery to estimate potential increased implementation or removal of the structural practices that were located in the 2010 benchmark phase.

Beneficial outcomes and potential utility of this project include the following:

- Establish an initial summary of structural practices that are already present in the Iowa landscape.
- Aid watershed planning efforts and encourage efficient use of available resources by highlighting areas for future conservation targeting and by indicating areas where nutrient reduction needs are already met.
- Assign nutrient and sediment load reduction or prevention amounts to current and future practice levels.
- Assess conservation implementation in a way that is blind of public or private investment, encapsulating all conservation activity.
- Track progress going forward from benchmark years (2007-10).
- Hindcast to past conditions using historic photos to show progress made over time and to evaluate alternative baselines (e.g. the EPA 1980-96 target).

The information generated by this project will supplement cost-share data and will paint a more complete picture of conservation in selected watersheds, while future installations can be tracked against this baseline. Figure 23 displays the progress of this project's mapping efforts in the 2017 and 2018 reporting periods. Digitization of the entire state has been completed; quality assurance and publication of all data will be completed in summer 2019. The benchmark practices will contribute to improved estimates of nutrient load reductions in future analyses.

a

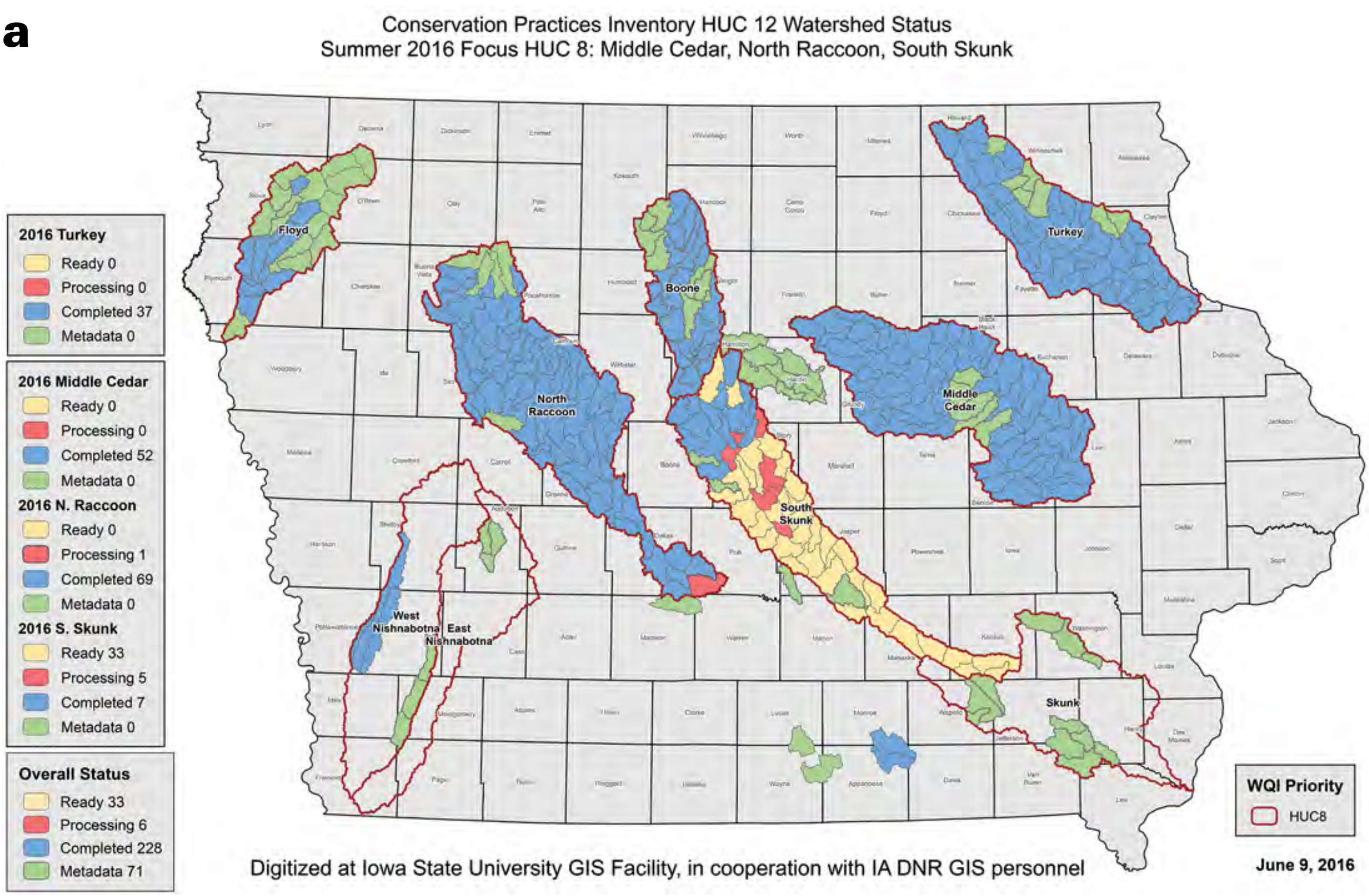
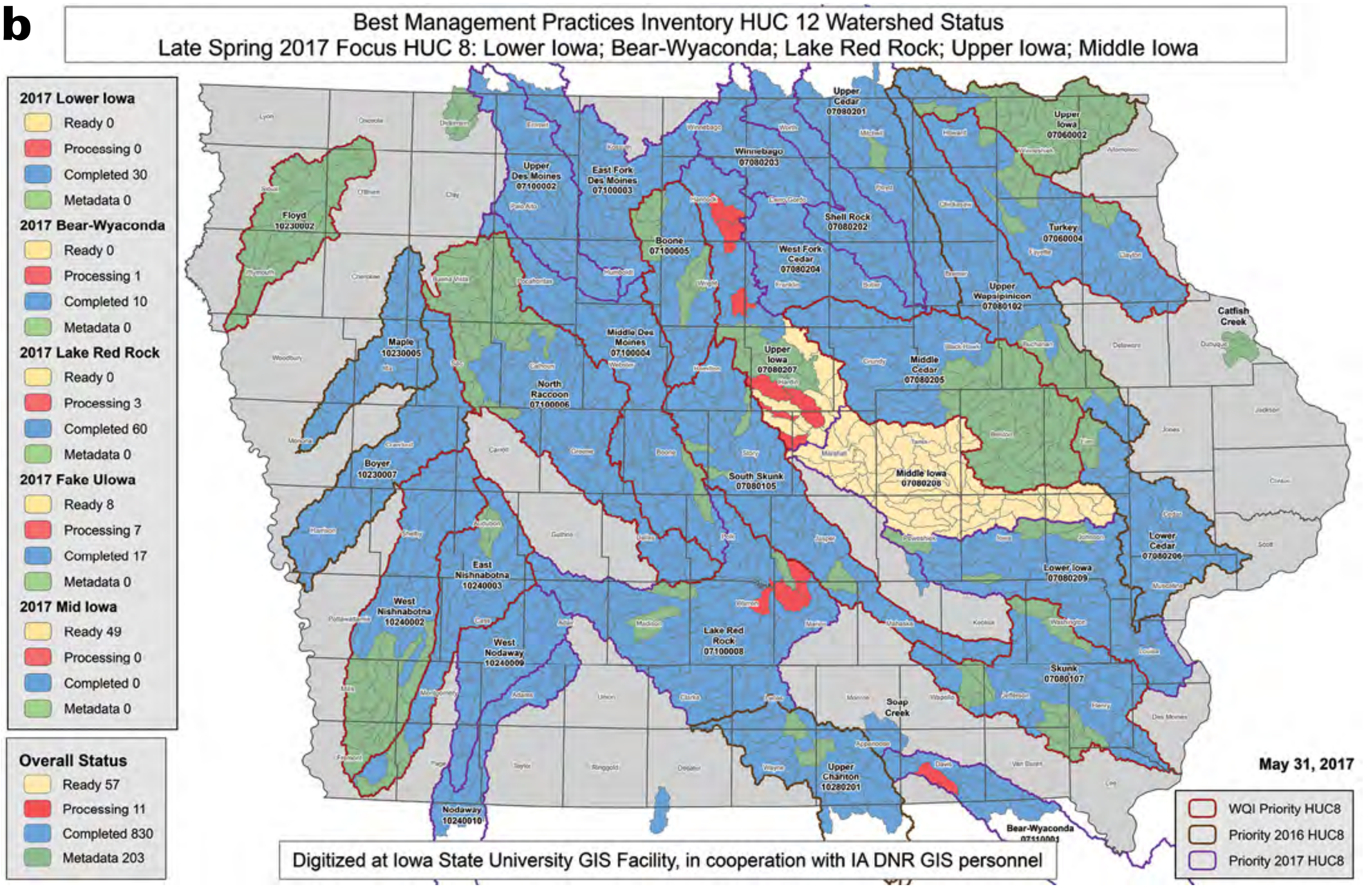
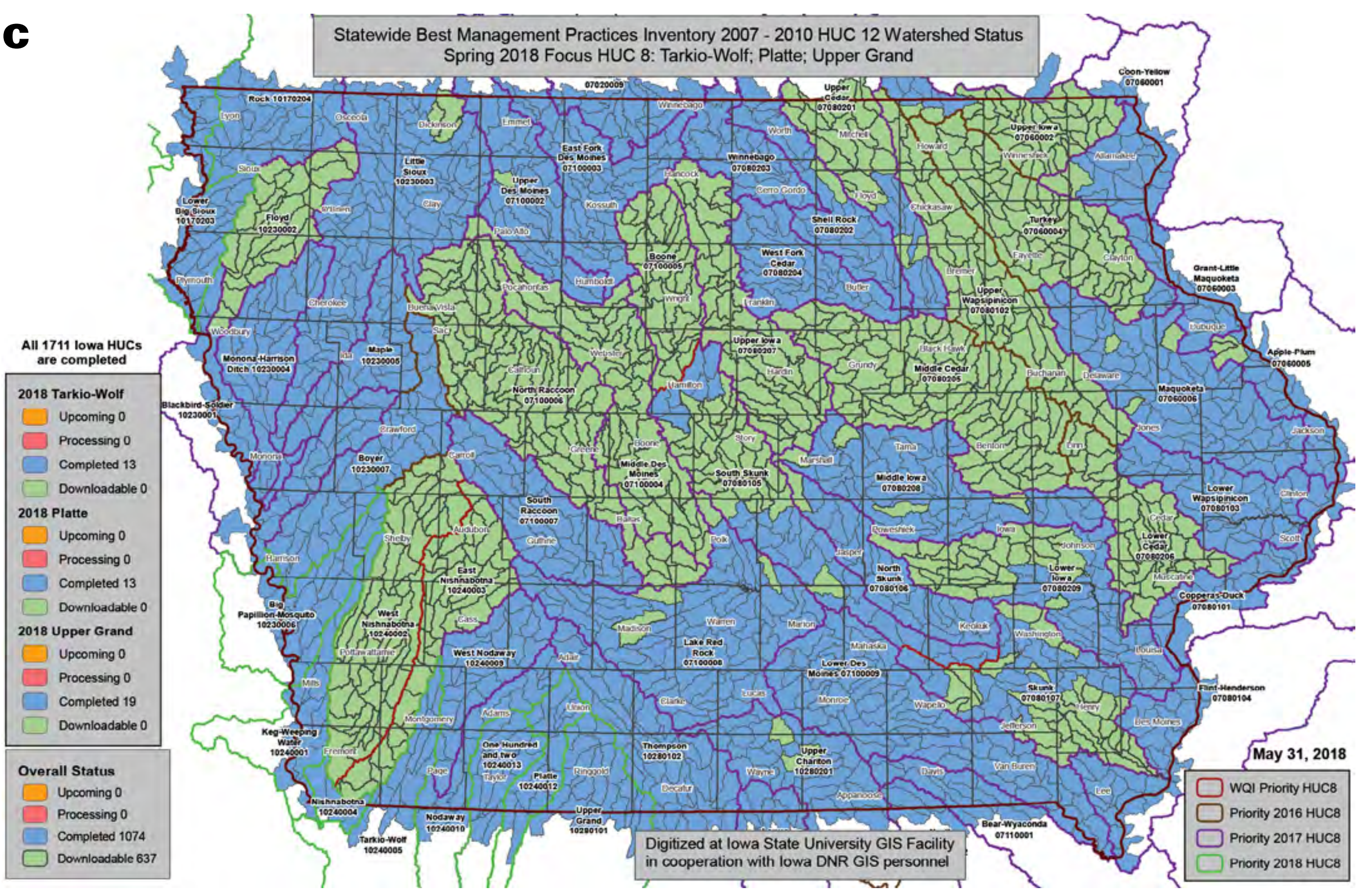


Figure 23. Time series of status of the ongoing BMP Mapping Project, displaying the completion of digitized watersheds for quantifying the existence of various structural conservation practices as of 2010. The status dates of these maps are a) June 9, 2016, b) June 6, 2017, and c) May 31, 2018. Green watersheds have fully compiled metadata, while blue watersheds are nearing that stage and awaiting quality assurance procedures. In maps a) and b), digitization of yellow and red watersheds was underway, but all watersheds have been digitized as of May 31, 2018. Researchers are aiming to complete quality assurance of the entire state's data by summer 2019.

b


Best Management Practices Inventory HUC 12 Watershed Status
Late Spring 2017 Focus HUC 8: Lower Iowa; Bear-Wyaconda; Lake Red Rock; Upper Iowa; Middle Iowa
2017 Lower Iowa
Ready 0
Processing 0
Completed 30
Metadata 0
2017 Bear-Wyaconda
Ready 0
Processing 1
Completed 10
Metadata 0
2017 Lake Red Rock
Ready 0
Processing 3
Completed 60
Metadata 0
2017 Fake Ulowa
Ready 8
Processing 7
Completed 17
Metadata 0
2017 Mid Iowa
Ready 49
Processing 0
Completed 0
Metadata 0
Overall Status
Ready 57
Processing 11
Completed 830
Metadata 203
May 31, 2017
WQI Priority HUC8
Priority 2016 HUC8
Priority 2017 HUC8
Digitized at Iowa State University GIS Facility, in cooperation with IA DNR GIS personnel

c


Statewide Best Management Practices Inventory 2007 - 2010 HUC 12 Watershed Status
Spring 2018 Focus HUC 8: Tarkio-Wolf; Platte; Upper Grand
All 1711 Iowa HUCs are completed
2018 Tarkio-Wolf
Upcoming 0
Processing 0
Completed 13
Downloadable 0
2018 Platte
Upcoming 0
Processing 0
Completed 13
Downloadable 0
2018 Upper Grand
Upcoming 0
Processing 0
Completed 19
Downloadable 0
Overall Status
Upcoming 0
Processing 0
Completed 1074
Downloadable 637
May 31, 2018
WQI Priority HUC8
Priority 2016 HUC8
Priority 2017 HUC8
Priority 2018 HUC8
Digitized at Iowa State University GIS Facility
in cooperation with Iowa DNR GIS personnel

Preliminary estimates of total structural BMP use during the 2007-10 period are provided in **Appendix E**, available at www.nutrientstrategy.iastate.edu/documents. The estimates are subject to change following quality assurance of the digitized imagery, which, as stated above, will be completed in 2019.

In-field practice survey

While the BMP Mapping Project will shed light on the extent of structural practices, another gap is an objective measure of the use of in-field practices such as nutrient management, tillage, and cover crops. It is certain that all practices, to some extent, are adopted and maintained without the use of governmental financial assistance. For example, some estimates suggest there were 760,000 acres of cover crops planted in Iowa in 2017, though cost-share programs financed only about 330,000 acres the same year (see footnote 5, page 36). This rough calculation has limitations, but emphasizes that there are more acres of cover crops than are funded by government programs. It is also certain that other nutrient-reducing practices, including no-till and nutrient management, are also in use by farmers who did not utilize federal or state cost-share.

In partnership with Iowa State University's College of Agriculture and Life Sciences, INREC will develop and pilot an objective, statistical method to measure Iowa farmers' use of in-field management practices to reduce nutrient loss. In the three-year pilot project, INREC will conduct a statistically valid survey of farmers' fields using the objective data held by agricultural retailers who provide services to farmers. The aggregation of field-scale data will contribute to efforts to track conservation practice adoption in Iowa. By combining the information gathered into an anonymized dataset, a more accurate view of nutrient-reducing practices and product implementation will be formed. This project, through its public-private partnership, will contribute to an improved understanding of the extent to which farmers employ practices recommended by the NRS. This project will rely upon the existing roles of Iowa's agricultural retailers and crop advisors who demonstrate a capacity for widespread one-on-one consultations with farmers. INREC will work to enhance retailers' roles by providing increased outreach and training to help these professionals with advising farmer decisions regarding conservation practices. This survey has undergone design and beta testing and data collection is scheduled for this fall. While assessment of the 2018 reporting period relies on the limited availability of conservation practice data, the BMP Mapping Project and the Iowa State-INREC project will facilitate improved reporting in the coming years.

Water

The goal of the NRS is to reduce Iowa's nitrogen and phosphorus load export by 45 percent; the strategy outlines a process for achieving this goal through increased efforts by both point sources and nonpoint sources to manage nutrient losses affected by human activities. As displayed in the NRS logic model (Figure1), nutrient reduction will result from effective changes in human behavior, land use, and point source nutrient removal processes.

This section aims to address the following questions. First, how are water quality changes and nutrient export tracked in Iowa? Second, what are the challenges associated with measuring change in Iowa's nutrient export? Third, what are the current efforts to track nutrient export? Finally, what are the recent findings from these efforts?

How are water quality and nutrient export tracked in Iowa?

In assessing early progress of the NRS, this document employs two complementary approaches. First, Iowa's annual nitrogen export is estimated from the measured nitrate and nitrite concentrations in surface water. Similar methods for estimating phosphorus export are under assessment. Second, the conservation practices implemented throughout the state, as quantified for the "Land" section of this report, feed into calculations of nutrient reductions. These values are modeled based on the current understanding of these practices' effectiveness in reducing the loss of nitrogen and phosphorus in Iowa agricultural landscapes. These efforts are complementary in that by tracking both, we get a better understanding of what is happening on the landscape in terms of practices, while also monitoring nutrients in water. This process has been done historically and is the basis of the practices assessed in the NRS Science Assessment. The monitored performance on nutrient loss of individual practices, at the appropriate implementation scale, indicates their ability to reduce nutrients when scaled up. Either approach looked at independently won't accomplish or inform progress of the NRS effectively.

One of the key elements of the NRS is to develop new efforts and maintain existing programs to measure water quality changes that occur over time as nutrient reduction practices are implemented by both point sources and nonpoint sources.

The 2015 NRS Annual Report states that "efforts are underway to improve understanding of the multiple nutrient monitoring efforts that may be available and can be compared to the nutrient water quality monitoring framework to identify opportunities and potential data gaps to better coordinate and prioritize future nutrient monitoring efforts." This description still applies; the current understanding of the extent and utility of the monitoring network is discussed as follows, though this represents a distilled, not exhaustive, discussion of Iowa's water monitoring.

What are the current challenges associated with measuring change in Iowa's nutrient export?

In September 2016, the DNR coordinated and published a collaborative report, titled "Stream Water-Quality Monitoring Conducted in Support of the Iowa Nutrient Reduction Strategy," that describes the current network of surface water monitoring in Iowa, details the challenges and data gaps associated with water quality monitoring, and suggests ways to improve and coordinate the collection and evaluation of water quality data for these purposes.[7] The report gathered participation by the DNR, IDALS, Iowa State University, and IIHR, and serves as a working document of the existing nutrient monitoring strategies in Iowa. This effort is consistent with the WRCC commitment highlighted in the NRS "to continue to coordinate and evaluate opportunities for monitoring locations and focused study areas in order to track progress." The following sections provide a summary of many of these discussions, along with an overview of current monitoring projects in Iowa.

Current known stream nutrient monitoring efforts in Iowa are reported in the context of the Nutrient Water Quality Monitoring Framework presented in Figure 24. The Nutrient Water Quality Monitoring Framework was developed to graphically show that the length of time needed to show a measureable change in water quality increases as the size of the monitored watershed increases. Generally, less time and fewer samples are needed to measure a change in the quality of runoff from an individual field of 10 to a few hundred acres in size following implementation of nutrient reduction practices, whereas more samples collected over a longer period of time are needed to show a change in water quality at the terminus of a larger watershed that consists of tens of thousands of acres or more. There are a variety of reasons that this is the case, pertaining to challenges associated with monitoring surface water quality, but, in general, as the watershed size increases there is an increase in the number of factors that affect water quality. Natural systems become more complex at increasing spatial scales.

Water quality monitoring presents challenges in estimating nutrient load exports from Iowa's watersheds. These challenges are discussed in more detail in the report on Iowa stream monitoring efforts, and are summarized in this report to highlight the need for increased research into options for addressing these challenges.

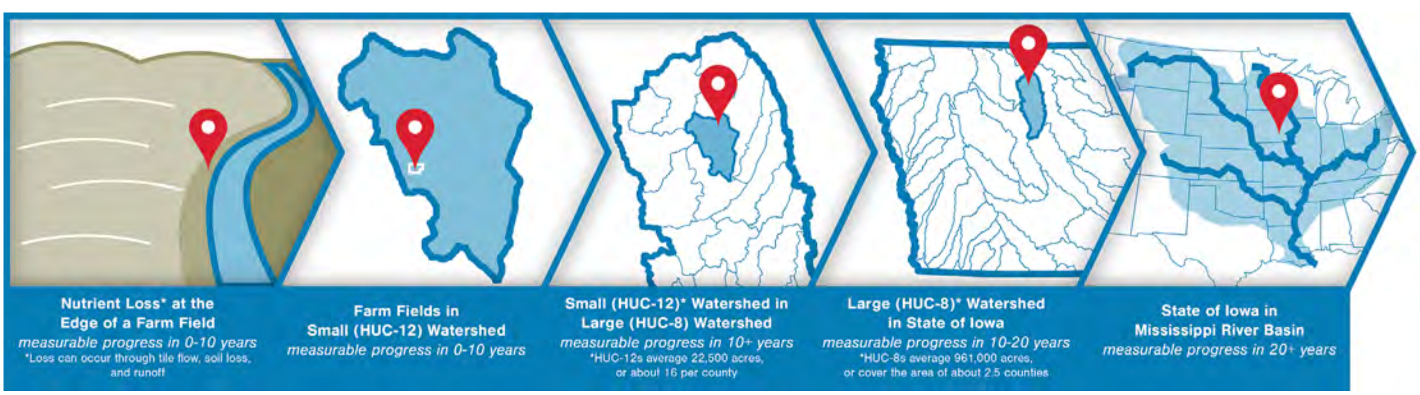


Figure 24. The Nutrient Water Quality Monitoring Framework is a summary of reasonable expectations regarding the expectations of conservation practice implementation and its impact on measured water quality at increasing spatial scales.

7 "Stream Water-Quality Monitoring Conducted in Support of the Iowa Nutrient Reduction Strategy" can be accessed at http://www.nutrientstrategy.iastate.edu/documents .

1. **Legacy nutrients**, which are present in the soil and groundwater from natural and anthropogenic sources, are released to surface water through bank erosion and groundwater movement. These legacy nutrients can be detected in surface water under a variety of landscape conditions, and so distort the effects that conservation has on surface water nutrient loads.
2. **Lag time**, or the difference in time between conservation implementation and measureable change in water quality, occurs on a variety of scales. Lag time is often dependent on watershed size, and the design of monitoring projects can impact the capacity to detect change in surface water quality.
3. **Variable precipitation and stream flow**, as well as extreme weather events, including heavy rainfall and flooding, lead to variability in measured nutrient concentrations. Increased intermittent heavy rainfall will make it more difficult to detect reductions or trends in nutrient export.
4. The importance of having **comprehensive data** on nutrient reduction practice implementation, as a means of assessing the causal human actions potentially associated with observed changes in water quality.
5. The value of **long-term monitoring** to measure progress and the importance of properly situated and maintained monitoring locations.

These considerations related to reliable water quality monitoring and estimated nutrient export contribute to concerns that measurable change in statewide nitrogen and phosphorus loads will not be detected in the short-term. Therefore, the following assessment provides an overview of the current monitoring network in Iowa and highlights progress in measuring nutrient concentrations and subsequently estimating annual nutrient export.

What are the current efforts to track nutrient export?

Monitoring nitrogen and phosphorus at varying geographic scales assists efforts to answer a variety of research questions. The current extent of known monitoring at edge-of-field, small and medium watershed, and large watershed scales is presented, as are descriptions of selected projects that examine water quality for more localized purposes, such as watershed comparisons and watershed "snapshots."

Monitoring at the edge-of-field and delivery scale

Nutrient loads at field and sub-field scale can differ substantially from loads actually delivered to surface waters. In addition, nutrient loads at larger watershed scales can differ substantially from loads actually delivered to surface waters due to the effects of in-stream processes (e.g. the effects of bed and bank erosion and phosphorous exchange with stream sediments). The most appropriate scale for assessing agricultural nonpoint source loads to surface water is the scale at which the load is actually delivered. For much of the cultivated cropland in Iowa that would be from a few hundred to a few thousand acres.

At this geographic scale of concern, data are collected to describe the nitrate concentrations of tile flow from specific agricultural fields. With the ISA, farmers participate in edge-of-field tile flow monitoring. During each growing season, grab samples are collected every two weeks and are analyzed in ISA's water lab. Farmers receive summary results that indicate their tiles' average nitrate concentration for the season, and they are offered guidance on management decisions to lower concentrations. Since 2014, participation in this on-farm project has increased from 16 to 582 sites (Figure 25). Results from the analysis of some of these samples, conducted in 2016, can be found in the **2017 NRS Annual Report** at www.nutrientstrategy.iastate.edu/documents.

IDALS, with partner organizations, has supported monitoring of nutrient loads at the delivery scale since 2007 (partly in association with monitoring of Iowa CREP wetlands and partly in association with other initiatives). In addition to better characterizing loads at delivery scale, this work aims to improve the predictability of practice performance, improve the understanding of practice uncertainty, and facilitate the validation of load reduction tools developed to evaluate progress toward nonpoint source load reduction.

Delivery-scale monitoring includes automated monitoring of incoming and outgoing loads at 10-15 Iowa CREP wetland sites annually. This allows researchers to assess nutrient loads delivered from the upper lying catchments as well as the effectiveness of the wetlands at reducing nutrient loads to downstream waters. In addition to documenting wetland performance, the ongoing monitoring and analyses support continued refinement of modeling and analytical tools used in site selection, design, and management of CREP wetlands.

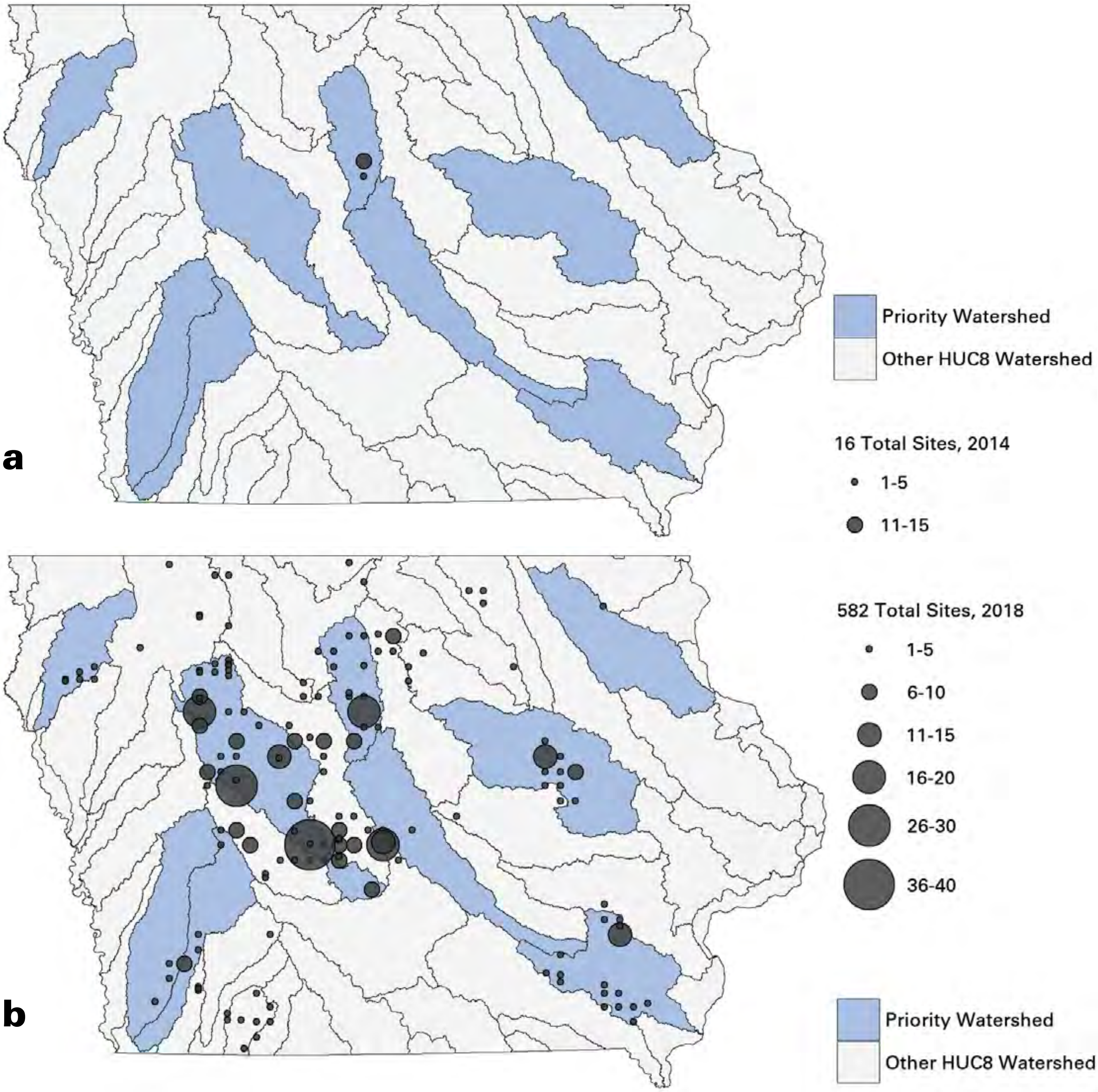


Figure 25. Distribution of tile monitoring sites managed by the Iowa Soybean Association in a) 2014 and b) 2018. The network has grown significantly in recent years and aids farmers in understanding the nitrate concentrations of their tile flow throughout much of the growing season (i.e. April through September). In addition, the project provides insight concerning the impact of field-scale practices on tile nitrate concentration. Each point represents the number of sites per township.

Finally, edge-of-field monitoring is prevalent in research plots that are studied by university and agency research groups. These focused projects typically aim to assess practice effectiveness in more controlled environments. As these projects do not typically occur on operating farmland and vary in time span and methods, they are not discussed in detail in this report.

Monitoring small and medium watersheds—up to 1,000 square miles

Surface water monitoring is conducted statewide on an ongoing basis. The primary organizations managing water quality grab samples and water quality sensors that transmit near real-time data are the DNR, U.S. Geological Survey

(USGS), and IIHR. The sensors measure nitrogen (nitrate and nitrite), turbidity (a surrogate for total phosphorus), flow, and other site-specific parameters, which may include pH, dissolved oxygen, temperature, and discharge, depending on the site. The entire monitoring network is displayed in Figure 26.

Each monitoring site collects information on some combination of a wide range of parameters, including nitrogen concentrations, turbidity, and flow. Any given sensor measures the surface water that drains from an upstream watershed area.

There are currently about 30 sites that monitor the outlets of watersheds that are less than 100 square miles in size. These sensors may provide information on land use and land management and these practices' impacts on the concentration of pollutants immediately downstream, although the ability to draw statistically significant conclusions depends on the understanding of practice implementation in the watershed and the timeframe and robustness of the dataset. These types of sensors gather data on proximate water quality changes over a relatively short period of time absent changes in practices or land use.

There are currently about 50 sites with sensors that monitor nitrogen, flow, and additional parameters at the outlets of watersheds that are 100-1,000 square miles in size. These sites allow for long-term monitoring of watersheds that range in size from a fraction of a county to two or three counties in size. Over the course of several years to a few decades, it is predicted that these sensors could

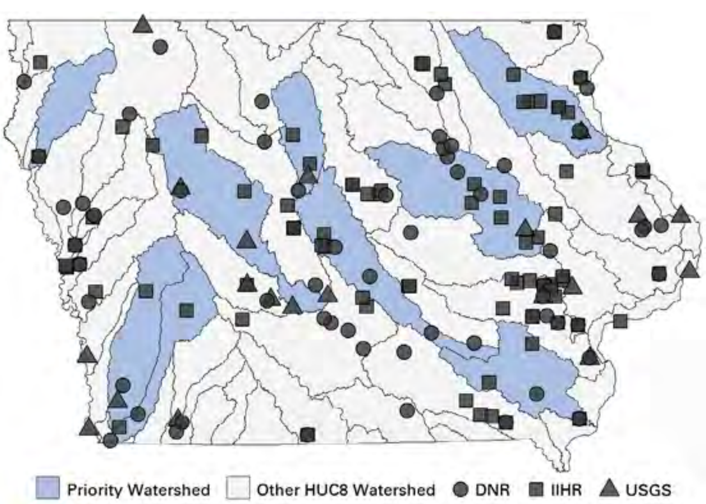


Figure 26. Locations of surface water monitoring sites operated DNR, IIHR, and USGS.

detect improvements or declines in water quality following major transitions in land use and practice implementation across the watershed given appropriate data availability. For instance, many watershed projects, which typically cover several HUC12 watersheds, have sites located at the outlets of their natural drainage areas, providing ongoing measurements and, potentially, the capacity to detect trends in water quality over the years if the projects and sites remain in place and have led to significant installation of nutrient reducing practices over that time period. Since the sensors only collect nitrogen levels, this also requires investments of practices that address nitrogen loss. As indicated sites remain in the inputs and land section, a disproportional investment has been made historically in soil conservation practices to address soil and phosphorus loss.

Monitoring large watersheds—greater than 1,000 square miles

Finally, there are nearly 40 monitoring sites that monitor very large watersheds for nitrogen, flow, and additional parameters that span more than 1,000 square miles. These sites provide the basis for statewide estimates of nitrogen export, as at least 88 percent of Iowa's land drains to monitored locations, allowing for tracking of the vast majority of Iowa's surface water. Monitoring challenges described on page 47 – including lag time, legacy nutrients, and weather variability – contribute to uncertainty and variability in detecting short-term trends in statewide nutrient loss; identifying trends that occur at smaller scales may be a more straight-forward task, although these challenges do apply at smaller scales as well. To ameliorate these challenges, the continuation of long-term data collection is necessary for monitoring nutrient concentrations and flow at these sites that monitor greater than 1,000 square miles. With Iowa's extensive water monitoring network in place and under regular evaluation, multi-decade monitoring is needed to evaluate Iowa's statewide water quality trends and to continue tracking Iowa's progress toward NRS goals of 45 percent reduction of annual nitrogen and phosphorus export.

In addition to the sites discussed in the preceding sections, Agriculture's Clean Water Alliance and ISA collect grab samples on a weekly to biweekly basis across the state. Collectively, these organizations collaborate to sample surface water at locations that drain varying spatial areas. Samples are collected at 206 HUC12 or smaller-scale sites, 80 HUC10 sites, and 16 HUC8 sites. Samples from all of these sites are analyzed for nitrate and turbidity, and selected sites are analyzed for additional parameters, including total phosphorus and flow.

What are the recent findings from these efforts to track Iowa nutrient export?

Nitrogen

The NRS called on the DNR to convene a technical work group beginning in 2013 to define the process for providing a regular nutrient load estimate based on the fixed-station stream water quality monitoring network displayed in Figure 26. This work group was to determine the most appropriate estimation method, the acceptability of existing data with which to evaluate methods, a process for making future adjustments based on the latest information and advancements in science and technology, and consider resource efficiency.

A team of Iowa scientists and engineers from state, federal, university, and commodity groups was assembled to evaluate and recommend a nitrate load estimation procedure for the State of Iowa. Representatives from the DNR, Iowa State University, IDALS, ISA, USGS, and University of Iowa first met on December 3, 2013. The work group first developed a methodology to compare the six most commonly used nitrogen load estimation models and also assembled a single standardized data set to use in comparing model results. Individual work group members were assigned to calculate a load estimate using the standardized data set and one of the load estimation methods. The full work group then compared the results obtained using each method using the same dataset.

The work group recommended using the linear interpolation method because it provides the simplest and most straightforward approach to estimate loads. Linear interpolation fills data gaps between measured concentrations by a straight line. Owing to its simplicity, different users can expect to produce approximately the same load estimate from a given set of data. Linear interpolation was also found to provide the best overall results for nitrate-nitrogen load estimation in agricultural and mixed-use watersheds. However, linear interpolation requires consistent and long-term sample collection to be effective. Missed sampling periods that lengthen the interval between measurements will result in greater potential error in the load estimate. The research behind this effort, titled "Variability of nitrate-nitrogen load estimation results will make quantifying load reduction strategies difficult in Iowa," was published in 2017.[8]

Table 12. The results of the linear interpolation estimates of annual nitrate export from Iowa. Estimates of nitrate load per acre use a value of 36,002,722 total acres of Iowa land.

Year	Nitrate-N load (tons N/year)	Flow (cm)	Load per acre (pounds)
2000	101,298	10.7	5.6
2001	300,428	25.8	16.7
2002	115,070	12.1	6.4
2003	144,049	12.8	8.0
2004	264,357	22.3	14.7
2005	186,995	15.8	10.4
2006	174,990	14.2	9.7
2007	450,132	36.5	25.0
2008	434,611	46.7	24.1
2009	281,029	32.3	15.6
2010	455,312	52.8	25.3
2011	297,246	28.2	16.5
2012	66,189	8.9	3.7
2013	342,921	26.0	19.0
2014	267,053	27.6	14.8
2015	417,793	32.9	23.2
2016	531,776	40.0	29.5
2017	318,111	26.6	17.7

The statewide nitrate-N estimates in Table 12 help provide understanding to what events may be occurring in a calendar year that are related to elevated or decreased loading levels. The annual load estimates are displayed along with streamflow, as streamflow amounts have the largest known impact on nutrient loading (Figure 27).

8 Schilling, K. E., Jones, C. S., Wolter, C. F., Liang, X., Zhang, Y.-K., Seeman, A., … Skopec, M. (2017). Variability of nitrate-nitrogen load estimation results will make quantifying load reduction strategies difficult in Iowa. **Journal of Soil and Water Conservation**, 72(4), 317–325. https://doi.org/10.2489/jswc.72.4.317

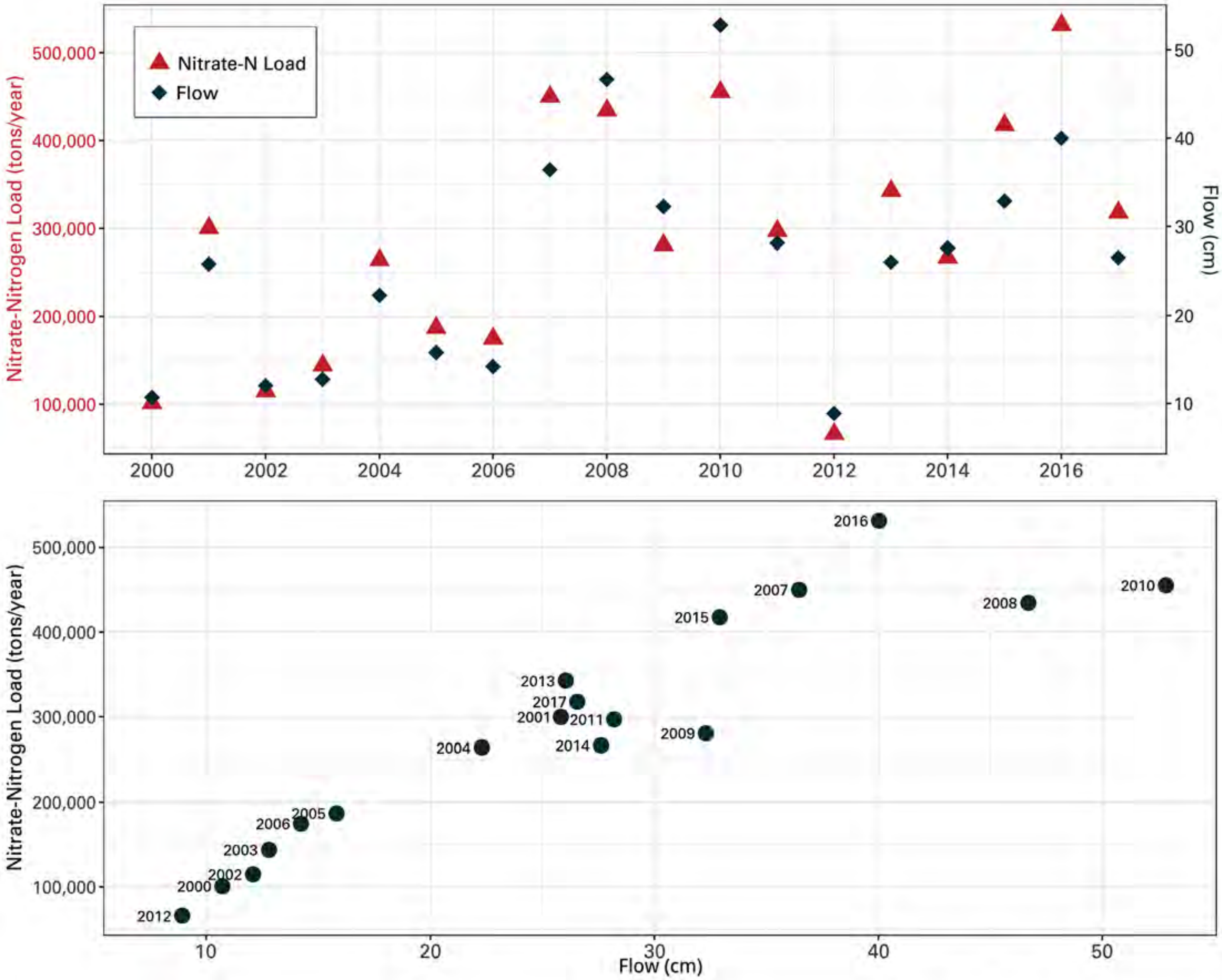


Figure 27. The results of the linear interpolation estimates of annual nitrate export from Iowa. These estimates were modeled using empirical data collected through the ambient stream-monitoring network operated by the DNR and USGS.

Phosphorus

An ongoing effort similar to the above methods for estimating nitrate loads is underway to develop a method for quantifying phosphorus loads. However, quantifying phosphorus loads has challenges distinct from those associated with quantifying nitrogen loads. A work group has compiled multiple phosphorus data sets to be used to evaluate different load estimation methods. Opposite the results from the nitrogen estimation method, the data sets indicate that the monthly frequency of monitoring at fixed-station sites is not sufficient to estimate phosphorus loads because the amount of phosphorus in rivers and streams changes very rapidly, from less than detection to a few milligrams per liter, with changes in stream flow. It is unlikely that phosphorus load estimates can be obtained without event-based sampling or continuous monitoring. Unlike nitrate however, in-stream total phosphorus sensors are not as readily available or functional to help overcome this challenge.

The work group explored the possibility of using surrogate parameters that can be measured with currently available and deployed sensors. Research of these potential surrogates was completed in 2017 and the results were published in the Journal of Hydrology: Regional Studies in spring 2017. In this study, “Use of water quality surrogates to estimate total phosphorus concentrations in Iowa rivers,” the relation of TP concentrations to water quality surrogates (turbidity, ortho-phosphorus, discharge, chlorophyll a, and chloride) was evaluated for 43 river monitoring sites in Iowa. Results indicate various combinations of these surrogates are capable of estimating TP concentrations with a high degree of accuracy at medium to large watershed size. Overall, turbidity and orthophosphorus (OP) are the dominant surrogates needed to estimate TP concentrations in Iowa rivers. Adding OP measurements to the regression models improved the model performance for nearly all sites, but the importance of OP was particularly apparent for rivers draining the tile-drained Des Moines Lobe region. There is typically less sediment bound phosphorus delivered due to this region's flatter topography. Additionally, subsurface drainage can contribute dissolved phosphorus loads to rivers that are not captured by traditional turbidity-TP relations. The extent of this contribution of dissolved phosphorus is under investigation. The DNR, IIHR, and USGS have worked together to deploy turbidity sensors at existing monitoring sites where major rivers drain into the Mississippi and Missouri Rivers. These locations have little or no influence from OP and the relationship of turbidity to total phosphorus is strong. Thirteen turbidity sensors were placed at these sites in 2018. Figure 28 displays the location of turbidity sensors, deployed in 2018. This monitoring network will facilitate the first estimates of annual phosphorus loads.

Finally, it may be possible to eliminate altogether the need for load estimation models for both nitrate and phosphorus by using in-stream sensors. Although sensors require periodic maintenance and calibration, they provide actual measurements of nutrient concentrations on a nearly continuous basis. When coupled with stream flow measurements made at or near the location of each sensor, loads can be measured and calculated rather than estimated.

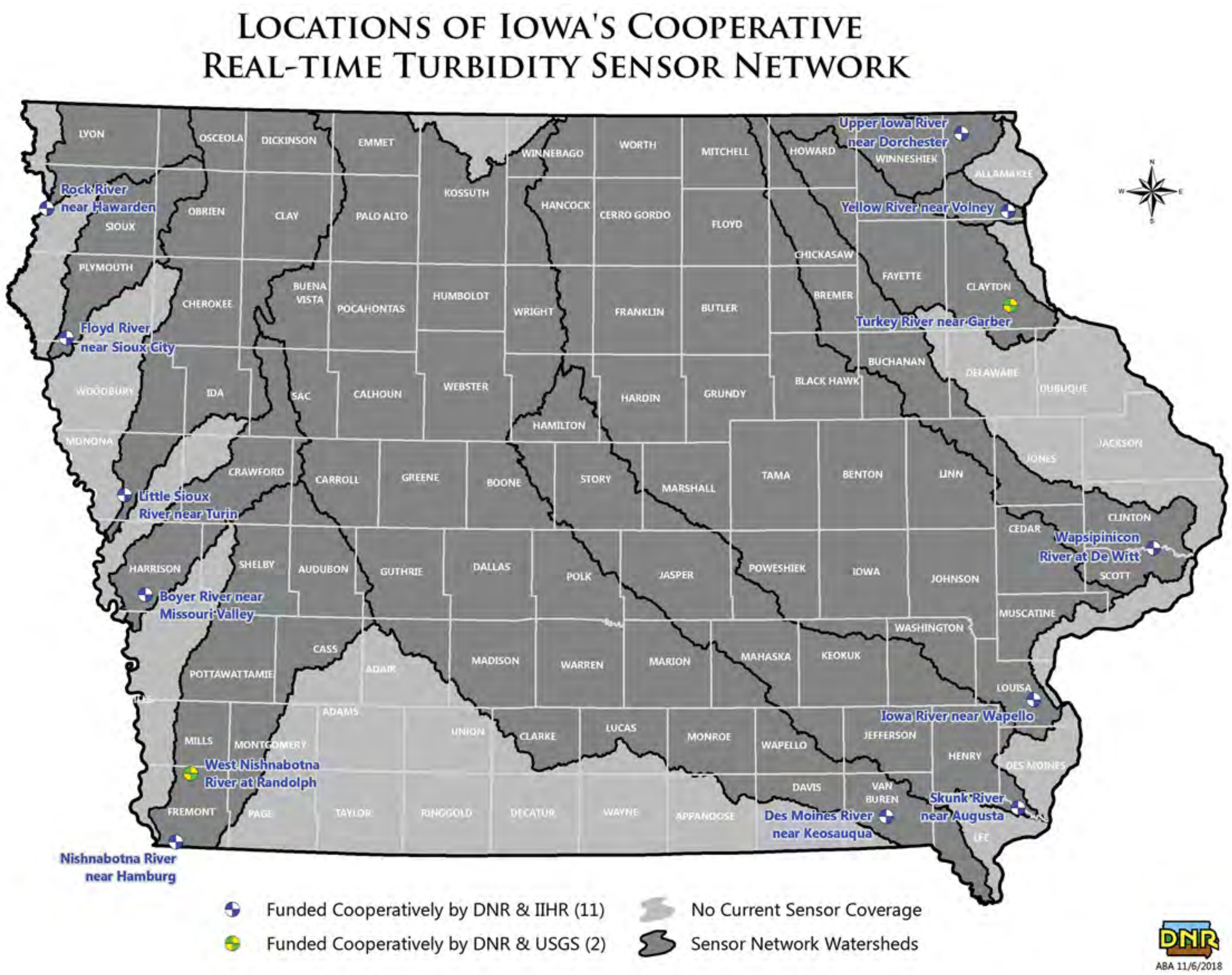


Figure 28. Locations of real-time turbidity sensors in Iowa. Turbidity serves as a surrogate measure of total phosphorus, facilitating annual estimates of phosphorus loads.

Novel research in water monitoring

Researchers at IIHR, Iowa State University, DNR, ISA, and additional partner organizations utilize the in-stream monitoring data that are collected at various spatial scales to explore trends and patterns in Iowa's surface water quality. A selection of research articles published during the 2018 reporting period are presented in Appendix C (available in the **online version of this report**, at www.nutrientstrategy.iastate.edu/documents). This list is not exhaustive, but provides an overview of recent efforts to derive insights from Iowa's extensive water monitoring network. Findings published during the 2018 NRS reporting period include, but are not limited to, the following items:

- Orthophosphorus to total P ratios were high (> 60 percent) in well-drained landscapes, while the ratios were lower (< 30 percent) in landscapes dominated by poorly drained soils. These findings contribute to the growing body of knowledge on the variation of P transport mechanisms in Iowa.[9]
- Annually, Iowa contributes an average of 29 percent of the overall nitrate-N load in the Mississippi-Atchafalaya River Basin (MARB). Researchers estimated that if Iowa meets its 45 percent reduction goal under existing conditions, MARB nitrate-N loads could be reduced by 15 percent.[10]
- High variability in modeled estimates of nitrate-N loads may lead to difficulty or inconsistency in quantifying and tracking nitrate-N loads from year to year. A main concern in this variability arises when load estimates derived from different models are compared to each other.[11]

[9] Schilling, K. E., Kim, S.-W., Jones, C. S., & Wolter, C. F. (2017). **Orthophosphorus Contributions to Total Phosphorus Concentrations and Loads in Agricultural Watersheds**. *Journal of Environment Quality*, 46(4), 828. https://doi.org/10.2134/jeq2017.01.0015

[10] Jones, C. S., Nielsen, J. K., Schilling, K. E., & Weber, L. J. (2018). **Iowa stream nitrate and the Gulf of Mexico**. *PLoS ONE*, 13(4), e0195930. https://doi.org/10.1371/journal.pone.0195930

[11] Schilling, K. E., Jones, C. S., Wolter, C. F., Liang, X., Zhang, Y.-K., Seeman, A., … Skopec, M. (2017). **Variability of nitrate-nitrogen load estimation results will make quantifying load reduction strategies difficult in Iowa**. *Journal of Soil and Water Conservation*, 72(4), 317–325. https://doi.org/10.2489/jswc.72.4.317

Photo courtesy of Mayland Aerial Photography.

Modeled nutrient loads during baseline and benchmark time periods

Statewide benchmark loads of nitrogen and phosphorus were estimated for the NRS in 2012 to determine the average annual load of nitrogen and phosphorus in the 2006-10 period (Table 1). While these initial loads have served as the reference for evaluating NRS progress, particularly pertaining to the impact of conservation practices on nutrient export, future analyses will incorporate more frequent calculations of nutrient loads using the linear interpolation method for nitrogen and, eventually, methods that are under assessment for modeling phosphorus loads (see page 51). Additionally, the load estimate accuracy will improve over time based on the extensive database that has been built as a result of the monitoring conducted by wastewater treatment facilities.

The original 2006-10 timeframe was utilized for the model development due to availability of ample data and timeliness with the understanding that efforts to assess previous timeframes would be conducted. However, in order to maintain consistency with the work of the Gulf of Mexico Hypoxia Task Force, a historic baseline of 1980-96 has been established for the NRS. Studies completed during the 2018 reporting period outline the estimated average annual nutrient loads from point and nonpoint sources during this time period (Table 1). For more information and context about these efforts, see page 54. Going forward, progress will be measured against the 1980-96 baseline and the 2006-10 benchmarks time periods, and will aim to utilize much higher resolution datasets and remote sensing information, such as the BMP Mapping Project (see page 43).

Calculated nutrient load reductions from practices implemented in 2017

The NRS Science Assessment evaluated the effects of conservation practices on nutrient losses from nonpoint sources based on water monitoring data and Iowa or Iowa-like conditions. Utilizing these evaluations of practice effectiveness, load reductions for recently implemented practices were calculated for this document for a subset of practices installed through government cost-share programs (cost-share programs are currently the most complete source of conservation data) based on the relative ability to enumerate the reductions. Efforts are underway to address the lack of data and information that would support a more robust calculation of load reductions; for instance, the Iowa State University-INREC in-field survey project and the BMP Mapping Project (see page 43) will provide more complete estimates of conservation practice use, regardless of whether practices received cost-share or not.

At 329,000 acres in 2017, cost-share cover crops implemented through cost-share programs reduced annual nitrogen loss by 1,465 tons (Table 13). These acres also affected a reduction in phosphorus loss by 111 tons (Table 14). Because cover crops are an annual practice, maintaining these reduction levels will require implementation of these acres each year. There were an estimated 760,000 total acres of cover crops planted in 2017 (cost-share and non-cost share acres); load reductions were not calculated for this value due to lack of data of geospatial variation.

Bioreactors that had been installed between 2011 and 2017 collectively treated 1,200 acres in Iowa, resulting in an estimated 7.1 tons reduction in nitrogen loss in 2017. Saturated buffers implemented during the same time period treated 200 acres and reduced nitrogen loss by 1.5 tons in 2017 (Table 13). CREP wetlands that have been constructed

Table 13. Nitrogen loss reduction from practices installed through cost-share programs since 2011.

Practice		2011	2012	2013	2014	2015	2016	2017
Cover crops	Acres installed annually	14,683	43,709	183,776	155,441	252,948	302,136	328,525
	N loss reduction (tons)	67.5	195.2	810.1	694.9	1,141.3	1,375.4	1,464.6
Bioreactors	Acres benefitted (cumulative 2011-2017)	0	500	550	800	900	950	1,200
	N loss reduction (tons)	0.0	2.9	3.2	4.6	5.3	5.6	7.1
Saturated buffers	Acres benefitted (cumulative 2011-2017)					50	150	200
	N loss reduction (tons)					0.4	1.1	1.5
CREP wetlands	Acres benefitted (cumulative 2011-2017)	6,965	20,484	26,818	31,758	31,758	42,206	44,654
	N loss reduction (tons)	44.7	136.0	179.8	214.0	214.0	286.7	303.5
Conversion of row crop to perennials (CRP)	Total acres benefitted annually	1,661,876	1,643,927	1,524,532	1,457,053	1,484,119	1,688,616	1,785,996
	Net N loss reduction compared to 2011 (tons)							2,323.9

since 2011 collectively treated 45,000 acres in 2017 and reduced nitrogen export by 304 tons that year. Bioreactors, saturated buffers, and CREP wetlands are structural practices, so the estimated effectiveness of each structure in reducing nitrogen loss will occur annually for the life of the practice.

Acres that had been converted from row crops to perennial vegetation through the CRP program totaled 1.79 million acres in 2017. Since 2011, when CRP totaled 1.66 million acres, there has been a net change of 2,324 tons of nitrogen and 57 tons of phosphorus reduced statewide (Table 13, Table 14). Buffers are included in this estimate as land retirement, though the models are capable of calculating buffers' impacts on nutrient loss. However, data on specific CRP practices are insufficient prior to 2013 and in 2017, so nutrient reductions affected by buffers are not presented here for the 2011-17 period. Buffers implemented by CRP have likely decreased slightly during these years, suggesting an increase in phosphorus loss in those fields that are converted back to row crops, but the true extent of buffers in Iowa is currently unknown. Efforts to collect data pertaining to this practice are ongoing.

This analysis excludes certain practices from analysis of annual change in nutrient loss reductions due to insufficient data. These excluded practices are:

- Hay, pasture, and land retirement beyond CRP land
- In-field nutrient management
- Nitrification inhibitors
- Tillage
- WASCOBs, grade stabilization structures, and ponds

As new data projects progress to better understand the implementation of various in-field and structural practices, these calculations may be conducted.

There are limitations to our understanding of the full impact of conservation adoption in Iowa. These reduction estimates are modeled using relatively complete and reliable cost-share program databases, but they neglect to incorporate estimates of non-cost-shared practices. Therefore, it is likely these estimates are conservative compared to the actual load reductions affected by newly adopted conservation practices. For instance, cost-share data reports 330,000 acres of cover crops statewide, and this value was used for reduction estimates, but the total statewide adoption is likely to be closer to 760,000 acres (Figure 19). Another consideration and limitation of cost-share data is the focus these programs have had on phosphorus reduction historically. Preliminary analysis of practice-specific funding from selected cost-share programs (i.e. those for which the pertinent data were available) suggest that phosphorus reducing practices have received 34 percent of cost-share funding since 2011. Practices that treat both nitrogen and phosphorus have received 20 percent – plus CRP rental payments for row crop conversion, which was not included in this funding analysis – and practices that treat only nitrogen received four percent. Since 2011, cost-share funding for practices that treat both nitrogen and phosphorus has effectively doubled. The remaining portion of funding went to practices that don't treat nitrogen or phosphorus, or went to practices that treat nutrients but are still under evaluation for effectiveness. This analysis suggests that reliance on cost-share implementation and for data availability may be biased toward program goals that center on soil loss prevention and, therefore, phosphorus reduction.

Table 14. Phosphorus loss reduction from practices installed through cost-share programs and the Conservation Reserve Program since 2011.

Practice		2011	2012	2013	2014	2015	2016	2017
Cover crops	Acres installed annually	14,683	43,709	183,776	155,441	252,948	302,136	328,525
	P loss reduction (tons)	4.1	12.0	60.6	50.3	83.2	103.6	111.0
Terraces	Acres benefitted (cumulative 2011-2016)	30,741	54,000	73,280	97,468	119,874	140,775	157,343
	P loss reduction (tons)	9.5	16.9	22.9	30.2	37.3	42.7	48.2
Conversion to perennials (CRP)	Total acres benefitted annually	1,661,876	1,643,927	1,524,532	1,457,053	1,484,119	1,688,616	1,785,996
	Net P loss reduction compared to 2011 (tons)							57.0

With the aforementioned data improvement projects (see page 43) underway to address the challenge of total conservation adoption uncertainty, future practice data will likely show greater levels of practice use and therefore greater rates of nutrient load reduction. Additionally, HUC8-scale reduction estimates will be calculated in 2018 to measure the respective progress of priority watersheds and other watersheds; HUC8-scale estimates will provide insight into whether increased efforts in priority watersheds have affected higher nutrient load reductions as compared to other watershed areas.

Targeted water monitoring projects

Paired Watersheds

Paired watershed projects involve the selection of two watersheds of similar size and land use characteristics. In one watershed conservation practices are extensively implemented while the other receives few new conservation practices. Stream water quality is monitored in both watersheds to assess the effect on water quality of the installed practices. There are four examples in Iowa of the use of the paired watershed approach to evaluate water quality effects associated with nutrient reduction conservation practices. Three of these projects were completed prior to the 2016 reporting period, but the Black Hawk Lake project commenced in 2015 under the NRCS National Water Quality Initiative (NWQI). Data collected in 2017 indicate similar patterns to 2015 and 2016, which suggest that nutrient losses from the subwatershed with a higher degree of BMP adoption are lower than those measured in the watershed without extensive BMP implementation. It is still early in the project, and too soon to say with certainty that these differences are sustainable and statistically significant. Additionally, baseline data was not collected prior to BMP implementation, so some differences in nutrient levels may be attributable to watershed characteristics other than BMP implementation. Continued sampling and additional analysis will be needed to answer those questions. This project extends through 2019.

Conservation Learning Labs

Iowa Learning Farms has partnered with IDALS and the NRCS to implement a watershed project that will measure the impact of widespread cover crop adoption on nitrate export in small watersheds. This project, the Conservation Learning Labs, targets small watersheds – between 500 and 1,300 acres in size – to promote and fund the adoption of cover crops. With water monitoring at the outlet of each watershed, the project aims to detect changes in nitrogen export over time as a result of high cover crop adoption rates. Landowners and farmers in two pilot watersheds, one in Story County and one in Floyd County, have received additional promotion and financial assistance for installing new conservation practices. In these watersheds, existing CREP wetland projects provide the water monitoring necessary for establishing background nutrient losses and for detecting change following the widespread use of cover crops within the watershed.

In the fall of 2017, 77 percent of the Floyd County watershed had been enrolled in three-year cover crop contracts and about 18 percent with first time strip-tillage. In Story County, enrollments will treat about 49 percent of the watershed's acres with cover crops and about 42 percent with first time strip-tillage.

Data collection for conservation plans included crop rotations, management practices, and nutrient application data for each field. Bulk density, infiltration rate, soil aggregate stability, and manure nutrient analyses have been conducted to inform the modeling component of the project.

Nutrient criteria development updates

Lakes - The DNR continues to collect and analyze lake nutrient data as part of the ambient lake monitoring and lake restoration programs. The development of quantitative indicators of lake health, including nutrient status, remains a high priority within these programs. Iowa, along with the states of Utah, Connecticut, and Oklahoma, continue to partner with the EPA to provide data for and to test new nutrient models that were developed using national datasets. After expressing interest in participating, Iowa was selected as one of the case studies given the extensive datasets available for Iowa lakes and the commitment in the NRS for the continued assessment and development of suitable nutrient criteria as a long term goal.

Progress to date includes using national and Iowa data to estimate chlorophyll-a and microcystin relationships. Preliminary results have shown that combining state and national data can improve the performance of these new models. The documentation and review of the underlying science is in the process of being completed, with a journal manuscript to be published within the next year. The next step for the Iowa case study in 2018-19 is to test the national models using the Iowa chlorophyll-a and nutrient (nitrogen and phosphorus) lake datasets.

River and Streams - The DNR continues to collect and analyze stream nutrient data to evaluate draft recommendations for wadeable streams and to support the development of recommendations for headwater creeks and large rivers. A focused three-year project (2018-20) is now underway on the South Fork of the Iowa River that is researching the interaction of nutrients in the wadeable stream environment and the impact of this interaction on the biological condition of the system. A goal of this project is to help address gaps in the understanding of how nutrients are expressed given dynamic environmental factors such as hydrology, stream morphology, substrate stability, riparian condition, and annual climatic conditions.

The South Fork of the Iowa River was chosen for this project due to the overlap between observed biological condition, a signature of possible nutrient expression, and the many active and historic outreach and research partnerships in the watershed. The South Fork of the Iowa River has also been the subject of numerous monitoring and assessment efforts over the last 20 years by multiple agencies and organizations. This project has included communications and collaborations with Iowa State University, IDALS, NRCS, IIHR, USDA, USDA Agricultural Research Service (ARS), DNR, private landowners and the South Fork Iowa Watershed Alliance.

Nutrient monitoring by point sources

When permits are issued to facilities listed in the NRS they require those facilities to monitor effluent TN and TP once per week. There are currently 125 facilities, up from 105 facilities last year, listed in the NRS that are required to monitor their effluent for TN and TP. This number will continue to grow as additional permits are issued that require this monitoring. In addition to these facilities, all cities and industries that treat the volume of wastewater generated by the equivalent of 3,001 or more people are required by rule to monitor effluent (but not raw waste) TN and TP. There are currently a total of 399 facilities monitoring for TN or TP or both and this number will continue to increase as more permits are reissued.

Treatment Facility Performance

At the time the NRS was developed, little monitoring data was available for the amounts of TN or TP discharged by point sources in Iowa. Assumptions were made based on respected engineering literature that Iowa POTWs treat raw wastewater that contains approximately 25 mg/L TN and 4 mg/L TP. These values were used together with a percentage of the wastewater treatment plant design flow to estimate the loads being discharged by each of the point sources listed in the strategy and assuming that facilities at that time were not removing any TN or TP. Estimates were also made of the amounts that would be discharged if target concentrations of 10 mg/L TN (66 percent removal) and 1 mg/L TP (75 percent removal) were achieved.

Table 15. Performance by all facilities with 10 or more months of data.

	Estimate (target)	POTW	Industry
Total nitrogen (average)			
Number of facilities		72	15
Raw waste (mg/L)	25	34.7 (range 15.6 - 104.9)	92.7 (range 15.5 - 271.5)
Final effluent (mg/L)	10	18.3 (range 4.1 - 63.1)	21.3 (range 1.8 - 94.7)
% removal (lbs)	66%	44.1% (range -2.0% - 87.0%)	73.4% (range 19.4% - 94.8%)
Total phosphorus (average)			
Number of facilities		72	21
Raw waste (mg/L)	4	6.6 (range 2.3 - 33.0)	26.3 (range 1.3 - 68.2)
Final effluent (mg/L)	1	3.9 (range 0.7 - 24.5)	13.5 (range 0.5 -82.5)
% removal	75%	40.0% (range -4.8% - 87.6%)	37.8% (range -286.5% - 98.1%)
Annual load reduction (2016-2018)			
Total nitrogen (tons)	-	7,998	856
Total phosphorus (tons)	-	1,452	337

Results of weekly monitoring are now available for 93 facilities whose permits have been issued since the strategy was released. Data in Table 15 reflect the actual results from 72 POTWs for which at least 10 months of weekly sample results are available for both raw waste and final effluent and 21 industries with at least 10 months of data for raw waste, final effluent or both. Not all industries operate wastewater treatment plants and therefore not all have raw waste data.

Fourteen of the 72 POTWs had an average annual effluent concentration for TN equal to or less than the target of 10 mg/L while five had an average TP concentration equal to or less than the target of 1.0 mg/L.

Fourteen POTWs met or exceeded the target percent removal for TN (66 percent) and eight met or exceeded the target for TP (75 percent), although it is likely that if data were available for the City of Clinton that it would also show that it met these targets.

By subtracting the average pounds per day in the effluent discharged by each POTW from the average pounds per day in the raw waste, then multiplying the resulting value by 365, reasonable approximations of the total pounds of TN and TP removed by each of the 72 POTWs during 2017-18 could be calculated. Adding the calculated values for all of these individual facilities shows that POTWs removed approximately 7,998 tons of TN and 1,452 tons of TP in a 12 month period. Industries removed approximately 856 tons of TN and 337 tons of TP in a 12 month period. These removal numbers are higher than last year simply due to more data being available from the additional permitted facilities.

Treatment Performance by Type of Treatment

Table 16 provides a summary of raw waste, final effluent, and percentage removal data for both TN and TP for the same 72 POTWs and 21 industries used to develop Table 12, but breaks down the data by the type of treatment system in use today.

As was the case in 2017, it is difficult to draw firm conclusions from this data because so few facilities are represented for most of the treatment types. For example, while the second highest removal percentages for POTWs were for aerated lagoons, the data is from three facilities which may not be representative of all aerated lagoon systems. Sequencing batch reactors had the highest percentage removals with the average removal for TN very close to the target removal of 66 percent. It is even more difficult to draw general conclusions with respect to industries because there are so few facilities represented by the data.

Table 16. Performance by treatment type for facilities with 10 months or more of data.

Treatment type	No.	Total nitrogen			Total phosphorus		
		Raw (mg/L)	Final (mg/L)	% R (lbs/d)	Raw (mg/L)	Final (mg/L)	% R (lbs/d)
POTW	72						
Activated sludge	29	39.3	20.6	45.1%	7.9	4.0	49.8%
Aerated lagoon	3	27.9	12.3	48.8%	5.2	2.7	41.4%
Oxidation ditch	1	25.8	22.5	11.6%	4.4	3.2	28.0%
Rotating biological contactor	6	22.7	12.5	40.5%	3.8	2.9	20.6%
Sequencing batch reactor	10	33.3	12.9	65.6%	6.3	3.2	52.5%
Trickling filter	23	33.9	19.8	35.2%	6.1	4.4	27.6%
Industry	TN-15, TP-21						
Activated sludge	TN-10, TP-16	59.5	15.5	68.7%	21.7	9.1	34.0%
Aerated lagoon	2	149.6	21.3	86.8%	19.8	5.2	75.7%
Oxidation ditch	1	223.7	94.7	57.6%	39.9	31.0	22.5%
Rotating biological contactor	0	-	-	-	-	-	-
Sequencing batch reactor	2	136.2	13.2	91.6%	62.5	48.9	37.6%
Trickling filter	0	-	-	-	-	-	-

Estimates versus Actual Data

The available data show the actual raw waste concentrations of TN and TP for POTWs are only slightly higher on average than the estimates used in preparing the NRS, but that those for industries are significantly higher. In the case of POTWs, considerable literature was available that described the characteristics of normal domestic sewage that could be used as a starting point for preparing estimates. That was not the case for industries where the NRS acknowledged that "data on the amounts of nitrogen and phosphorus discharged by industries is not readily available but likely varies significantly based on the type of industry." Several factors can affect the nutrient content of industrial waste including:

- The type of industry
- Production processes and flow rates
- Whether process wastewater is treated by the industry itself or discharged to a POTW for treatment
- The types and amounts of chemicals used
- Government regulations

For example, phosphoric acid is the most common chemical used by food processing establishments for cleaning in order to meet USDA regulations for cleanliness. The amount of cleaning required and the type of equipment cleaned using phosphoric acid likely has a bearing on the amounts of TP in both the raw waste and final effluent. A meat processing facility will have higher amounts of both nitrogen and phosphorus due to the nature of wastewater produced than a power plant. An industry that sends its process wastewater to a municipal system for treatment and discharges only cooling water and other utility waste streams will discharge lesser amounts of nutrients than the same type of industry that treats its own process wastewater.

In Table 16, the greatest departure from initial estimates is the removal percentages being achieved by some treatment facilities. It is noteworthy that significant reductions in the amounts of TN and TP occur even before most facilities have installed or implemented specific nutrient reduction measures. It was assumed at the time the strategy was developed that treatment facilities removed little, if any, TN or TP unless they were specifically designed and constructed for biological or chemical nutrient removal. However, the data show that POTWs on average remove about 40 percent of the TN and TP entering the treatment plant despite not having been specifically designed to do so. Industries appear to be achieving even higher rates of removal than POTWs although the data for industries represents only a small number of facilities and caution should be exercised in drawing conclusions based on this limited data.

Updating Information for Point Source Contributions in the NRS

With data now available to calculate annual raw waste and final effluent concentrations and percent removal rates for TN and TP for approximately 60 percent of the POTWs listed in the strategy, it is an appropriate time to reassess the estimates made of the total contribution of TN and TP from major point sources, and the reductions that can be expected as treatment facilities are upgraded or replaced to include nutrient removal processes.

Photo courtesy of Jason Johnson, USDA Natural Resources Conservation Service.

The NRS states that "Discharges from wastewater treatment plants contribute approximately eight percent of the total nitrogen (TN) and 20 percent of the total phosphorus (TP) entering Iowa's streams and rivers annually." The NRS also projected that if the 147 wastewater treatment plants listed in the strategy were to meet the goals by reducing TN loads by two-thirds and TP by three-fourths that would reduce the amount of nitrogen discharged by 11,000 tons per year and the amount of phosphorus by 2,170 tons per year. These figures represented a four percent reduction in nitrogen and 16 percent reduction in phosphorus in the total estimated statewide amounts entering Iowa's rivers and streams from both point sources and nonpoint sources.

These estimates of point source load contributions were derived by multiplying raw waste concentrations of 25 mg/L TN and 4 mg/L TP by two-thirds of the average wet weather design flow for each treatment facility and assuming no removal of TN or TP by treatment plants. The concentrations were values for typical domestic sewage taken from a respected engineering text. No removal was assumed because no treatment plants at the time were known to have been constructed with nutrient removal capabilities. While it was recognized that a number of plants were designed to treat ammonia nitrogen, that process simply converts ammonia to nitrate but does not remove total nitrogen from the wastewater. Since each facilities' annual average (long-term average day) flow was unknown at the time an approximation was derived using a peaking factor table in the EPA Nitrogen Control Manual (Table 13).

Table 17. Comparison of estimated versus actual nutrient levels.

Estimated or Actual	TN	TP
Estimated potential PS load reductions	11,000 T/yr	2,170 T/yr
Actual load reduction in 2017-18 for 72 POTWs (TN and TP), 15 industries (TN) and 21 industries (TP)	8,854	1,789
Estimated % removals w/BNR	66%	75%
Actual % removals by POTWs today (pounds)	44.1%	40.0%
Actual % removals by industries today (pounds)	73.4%	37.8%
Estimated raw waste concentrations	25 mg/L	4.0 mg/L
Actual raw waste concentrations - POTWs	34.7 mg/l	6.6 mg/l
Actual raw waste concentrations - industries	92.7 mg/l	26.3 mg/l

As can be seen from Table 17, the actual raw waste concentrations for POTWs for both TN and TP are quite similar to the original estimates. Those for industries differ significantly. What the original estimates failed to take into account was the significant amounts of nutrients already being removed even though most facilities have not yet installed nutrient reduction treatment technologies.

Iowa Point Source Baseline Pilot Project with the Gulf of Mexico Hypoxia Task Force

The HTF 2015 goal framework includes an interim target to reduce nitrogen and phosphorus loading 20 percent by 2025 while continuing efforts to achieve the 45 percent reduction target by 2035. These targets are to be measured relative to the average MARB nutrient loading to the Gulf of Mexico during the 1980-96 baseline period. Given this and efforts to implement the NRS, it will be important to have the ability to track point source progress in reducing nutrient loads from those loads present during the 1980-96 baseline period.

In 2016, DNR began coordinating with the USGS in an effort to better understand historical nutrient loads from point sources in Iowa. The USGS shared a draft data set which contained annual TN and annual TP load estimates for Iowa point sources for the years 1992, 1997, and 2002. DNR evaluated the 1992 annual nutrient loads and concluded the shared data set could be used, with modification, to estimate baseline nutrient loads for Iowa point sources. Annual TN and TP loads in 1992 were estimated for Iowa's major POTWs, minor domestic wastewater dischargers (including POTWs and semipublic facilities), and industrial dischargers that provide biological treatment of process wastewater (BTP). These loads were then summed to provide the point source baseline TN and TP load estimates shown in Table 18. The full report titled **"Nitrogen and Phosphorus Load Estimates from Iowa Point Sources During the 1980-96 Hypoxia Task Force Baseline Period"** can be found at http://www.nutrientstrategy.iastate.edu/documents.

Table 18. Iowa point Source 1992 Annual Baseline TN and TP load estimates.

Discharge type	Total nitrogen (tons)	Total phosphorus (tons)
Major POTWs	10,311	1,380
Minor domestic wastewater dischargers	1,597	324
Industrial (major and minor with BTP)	1,262	683
Sum	**13,170**	**2,386**

This work was presented at the NRS five-year point source implementation review and planning meeting on April 30, 2018. Based on feedback received at the meeting, stakeholders were interested in integrating these baseline estimates into NRS progress tracking efforts. More specifically, stakeholders wanted a clearer understanding of how current point source loads compare to the 1980-96 baseline, the loads at the time of the NRS development, and the estimated loads if all facilities covered by the NRS were to meet the NRS goals.

This required three main areas of work. First, the original point source loads estimated at the time of NRS development were recalibrated using the newer, more accurate methodology employed to estimate the 1980-96 baseline. This entailed using 2013 monthly average effluent flow data and either Iowa-specific typical pollutant concentrations for TN and TP (for major POTWs and minor domestic wastewater dischargers) or long-term average effluent concentrations (for industrial dischargers with BTP). Second, loads for the 2018 reporting period were calculated using actual facility-specific TN and TP load data when available and modeled estimates using the aforementioned new methodology. Third, TN and TP effluent concentrations of 10 mg/L and 1 mg/L, respectively, were used to estimate loads if all facilities covered by the NRS were to meet the NRS goals (assumes flows equal to 2013 levels). Figure 29 summarizes the outcomes of this effort by providing point source load values for the 1980-96 baseline, the 2013 recalibrated loads, and 2018 reporting period loads. The dashed lines in Figure 29 provide the estimated loads in the case that all facilities covered by the NRS meet the NRS goals.

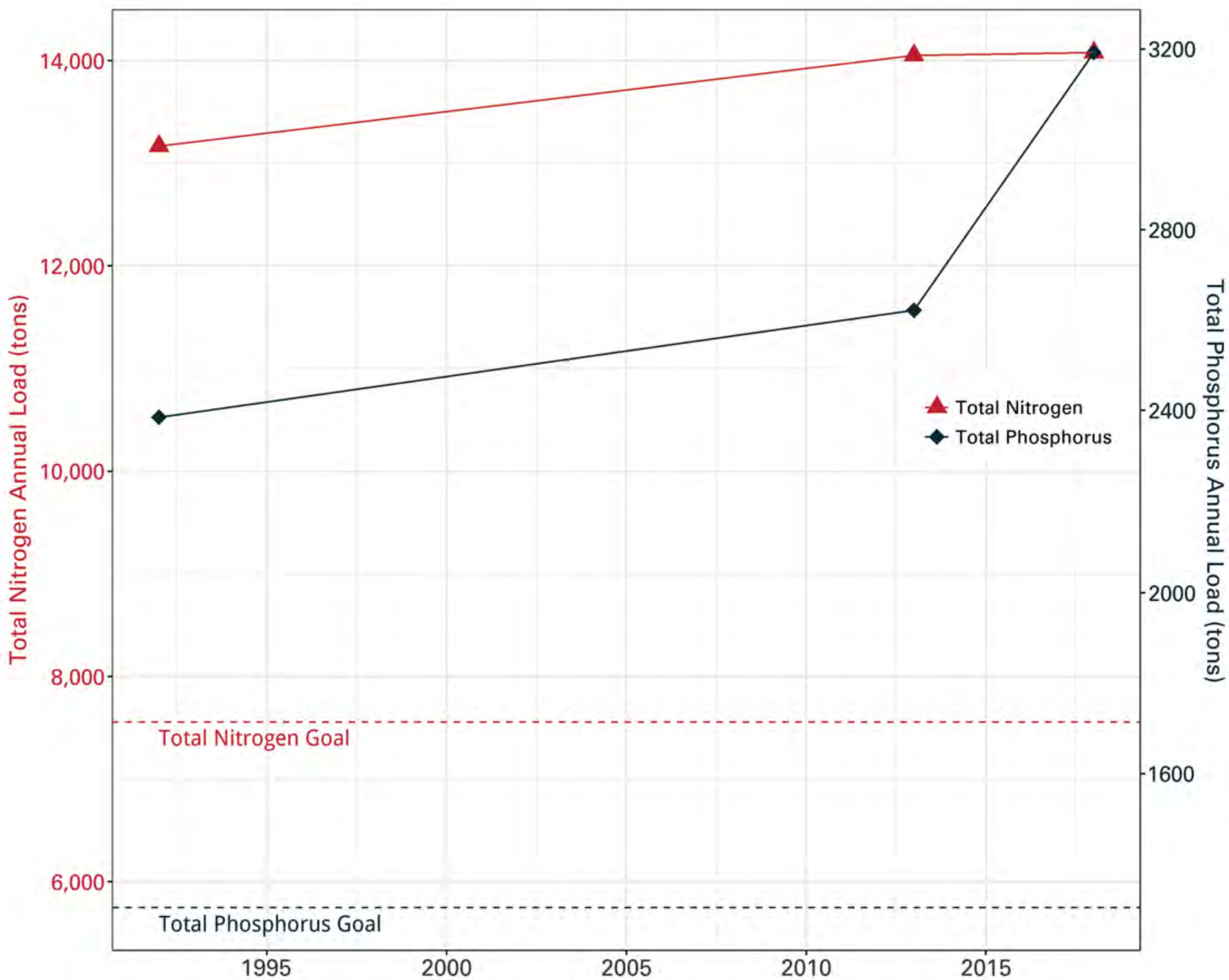


Figure 29. Iowa point source annual nutrient loads from major publicly owned treatment works, minor domestic, and industrial facilities with biological treatment of process wastewater.

Looking Ahead

- The list of affected facilities in Section 3.3 of the NRS will continue to be reviewed and updated annually as new facilities become subject to the strategy and facilities are dropped from the list because they no longer meet the criteria established for inclusion.
- Permits will continue to be issued to facilities listed in the NRS that will specify requirements to complete and submit nutrient reduction feasibility studies with a goal of issuing at least 20 more permits within the next year.
- The DNR will timely review nutrient feasibility studies as they are submitted and amend NPDES permits to include construction schedules for installing nutrient reduction treatment technologies. Where a feasibility study concludes that it is not feasible or reasonable to meet the targets identified in Section 3 of the NRS, the facility's permit will be amended to require submittal of another feasibility study five years from the DNR's approval of the first study.
- The DNR will continue to analyze raw waste and final effluent data for nutrients as data from more facilities becomes available to evaluate performance of treatment facilities both before and after operational changes are made or additional treatment is installed.

The DNR will attempt to correct or explain anomalies in data submitted by treatment facilities. Such anomalies can include but are not limited to the reporting of negative removal efficiencies, single high or low concentrations that are inconsistent with other reported data, and apparent data entry errors.

Photo courtesy of Lynn Betts, USDA Natural Resources Conservation Service.

Appendix A: Public Comment

Iowans and other interested parties are invited to review the updated Iowa Nutrient Reduction Strategy and supporting documents. The Iowa Department of Agriculture and Land Stewardship, the Iowa Department of Natural Resources, and Iowa State University seek to continue to broaden the engagement of stakeholders and further advance the strategy.

No-till soybean field. Photo courtesy of Iowa State University.

Areas of focus include

Strengthen collaborative local, county, state, and federal partnerships.

- Are there additional partners with a demonstrated ability to advance implementation of nutrient reduction technologies and conservation practices to improve water quality?
- Are there additional opportunities for accelerating cost effective nitrogen and phosphorus load reductions from both point and nonpoint sources?
- Are there additional or emerging practices or technologies that should be considered for inclusion in the NRS Science Assessment? The WRCC annual report on the strategy identifies a process for these new and emerging practices and technologies to be included in the list of practices.
- Are there additional delivery methods and opportunities that should be considered to increase the rate of adoption?

Electronic: **Submit your comments** online at www.nutrientstrategy.iastate.edu/comments

Mail: Comments may be mailed to Nutrient Reduction Strategy, ANR Program Services, 1151 NSRIC, Ames, Iowa 50011-3310.

Comments and contact information submitted here are considered public and are subject to Open Records Law requests from the media or others.

Comments received to date can be found at www.nutrientstrategy.iastate.edu/public.

Appendix B: Updates to the Strategy

Policy considerations updates (Section 1)

A description of the Conservation Infrastructure Initiative has been added as a formal response to the need for improved delivery of outreach, education, and collaboration. In particular, this initiative aims to address the needs for identifying enhanced roles for the private sector, expanding agribusiness consulting, and achieving market-driven solutions for statewide nutrient reduction.

Nonpoint source updates (Section 2)

As research on nonpoint source conservation practices is conducted, new insights are developed regarding the effectiveness of practices in reducing nitrogen and phosphorus loss. Data and literature reviews may be submitted by the public to the NRS Science Team, a group of university and public agency researchers that conducted the NRS Science Assessment for nonpoint sources and continue to review the effectiveness of conservation practices.

When approved, new practices are added to NRS documents. Updated versions of the **NRS** can be found at www.nutrientstrategy.iastate.edu/documents. In the 2018 reporting period, no new NRS practices were added.

Practice reviewed:
Restored oxbows

The restoration of oxbows in tiled row crop fields was reviewed as a potential nitrate reduction practice by the NRS Science Team. The team did not recommend the addition of this practice at this time due to insufficient data and high variability on the practice's effectiveness.

Point Source Updates (Section 3.3)

During the 2018 reporting period, four facilities were added to the NPDES required permits list. One was removed.

Facilities added:
LeClaire, City of, Sewage Treatment Plant
Cascade, City of, Sewage Treatment Plant
IPL – Ottumwa Generating Station
Wapello, City of, Sewage Treatment Plant

Facilities removed:
University of Iowa Power Plant

Riparian buffer. Photo courtesy of Lynn Betts, USDA Natural Resources Conservation Service.

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Floodplain restoration. Photo courtesy of Nathan Hook, Natural Heritage Foundation.

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Water Resources Coordinating Council Members

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United States Army Corps of Engineers – Rock Island District
United States Environmental Protection Agency – Region 7
United States Geological Survey
University of Iowa College of Engineering and IIHR – Hydroscience and Engineering

Watershed Planning Advisory Committee Members

Agribusiness Association of Iowa and Iowa Nutrient Research and Education Council
Agriculture's Clean Water Alliance
Conservation Districts of Iowa
Iowa Corn Growers Association
Iowa Environment Council
Iowa Farm Bureau Federation
Iowa Pork Producers Association
Iowa Soybean Association

Additional Partners

Iowa Agriculture Water Alliance
The Nature Conservancy
Trees Forever

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