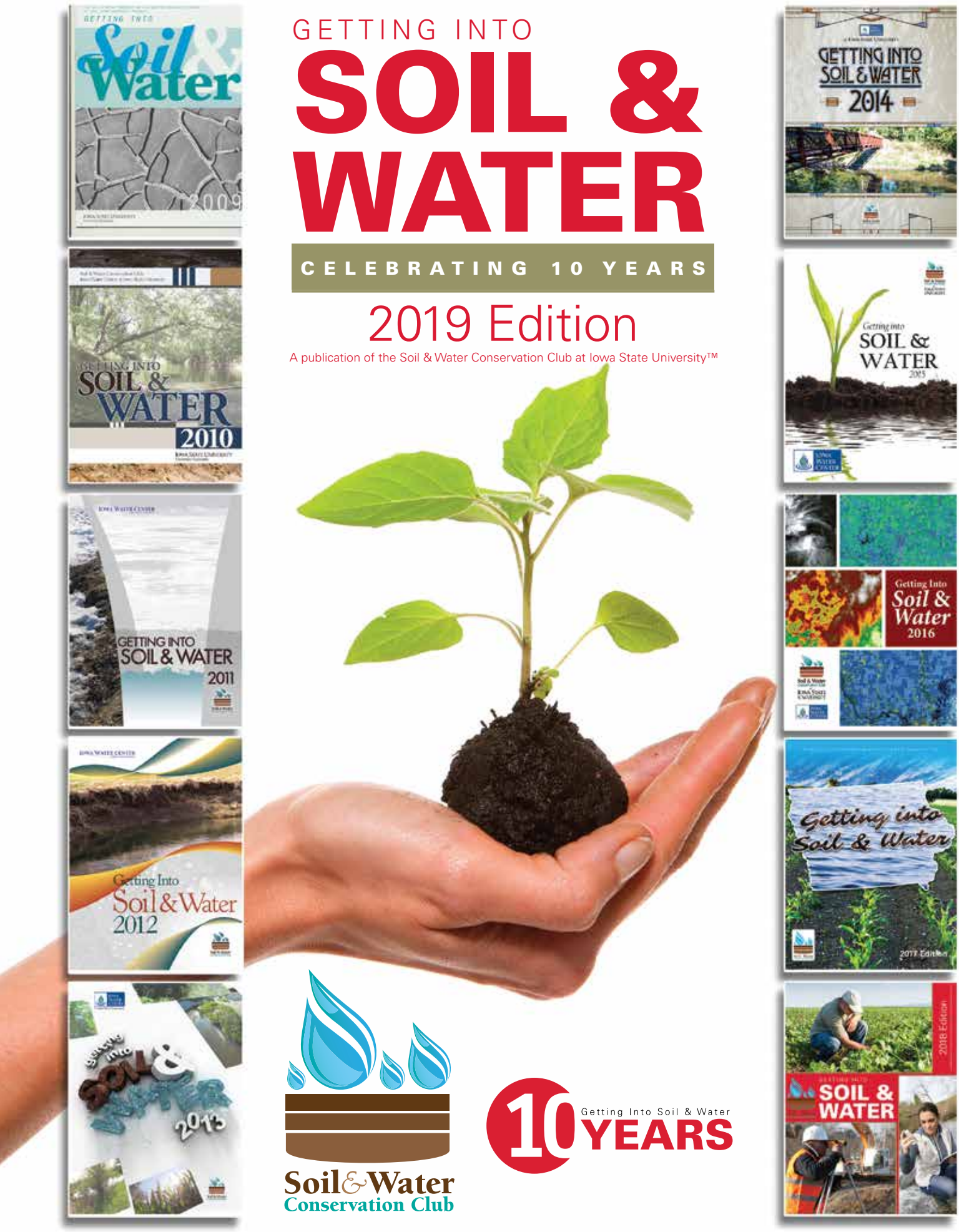
GETTING INTO

SOIL & WATER

CELEBRATING 10 YEARS

2019 Edition

A publication of the Soil & Water Conservation Club at Iowa State University™



Soil & Water Conservation Club

10 Getting Into Soil & Water YEARS

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Proudly Presenting GISW 2019

Jacob Wright, Shannon Breja and Justin Hunter
2019 Editors

In its tenth year, *Getting into Soil and Water* is packed full of great articles that we are excited to share with you. The goal of this year's publication is to showcase the diversity of opportunities within soil and water. Our team of three co-editors is made up of Jacob Wright, Shannon Breja, and Justin Hunter. We wanted to share with you a little bit about ourselves and what soil and water conservation means to us.

"The goal of this year's publication is to showcase the diversity of opportunities within soil and water."

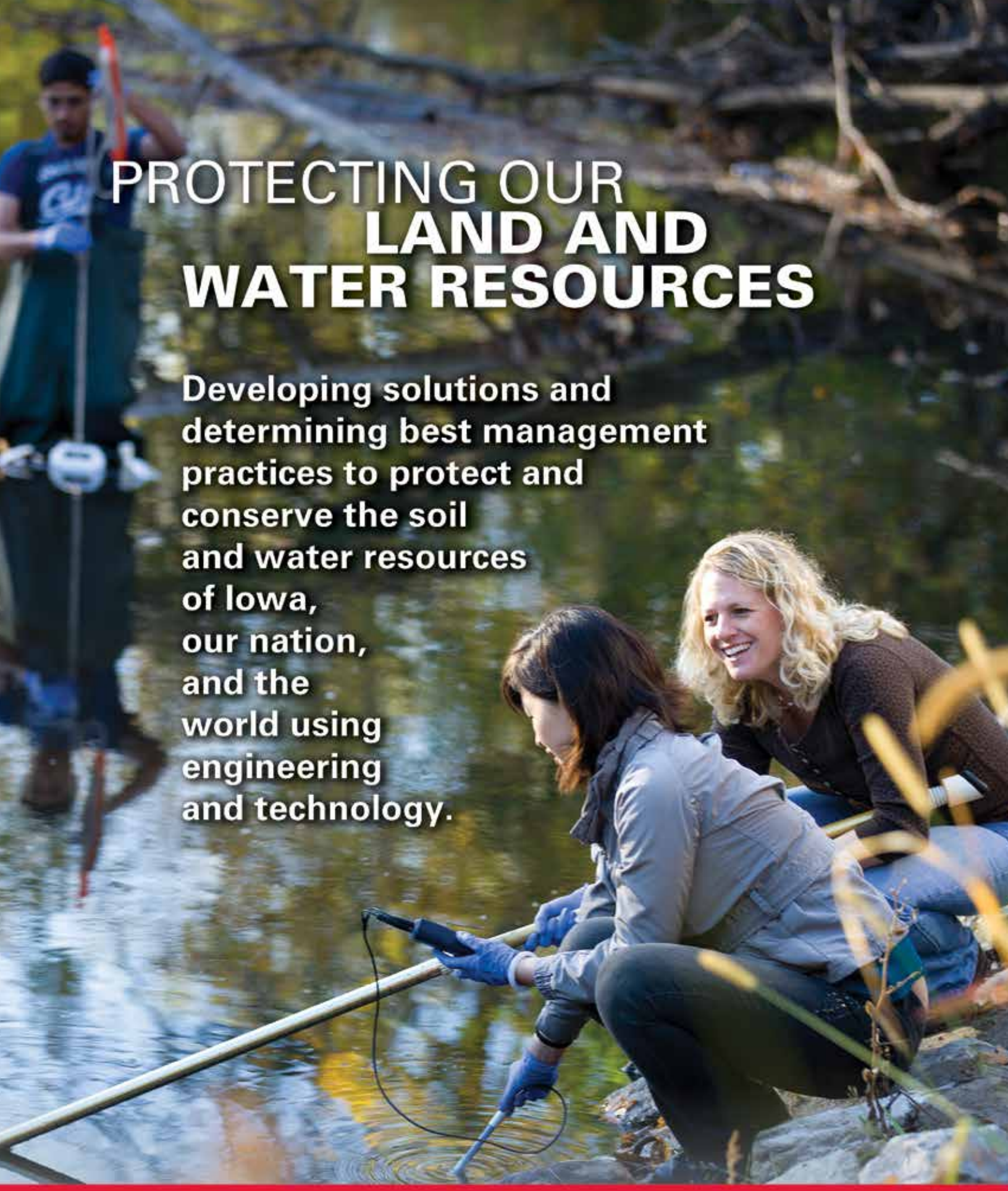
Jacob Wright: I am a junior in agronomy and environmental studies and joined the Soil and Water Conservation Club in the spring of 2017. Growing up on a dairy farm in Virginia, I always saw numerous articles and heard discussion about nutrient contamination in the Chesapeake Bay. This peaked my interest for soil and water conservation, and being a part of this club and publication has allowed me to learn more about current research and issues in this field of study. I have learned a lot from co-editing through reading different research studies and seeing the diverse perspectives and ideas that came together to showcase the variety of opportunities in soil and water conservation.

Shannon Breja: I am a sophomore in Agronomy, and I became a member of the Soil and Water Conservation Club in the fall of 2017. Although I grew up surrounded by agriculture, I did not realize the urgency of conservation until coming to college. With the environmental impacts of agriculture becoming increasingly prevalent, the club has allowed me to learn about current conservation issues. The club has also allowed me to be co-editor of this publication to share some of these relevant issues and provide different perspectives about them. My hope for all of you is that Getting into Soil and Water will increase your knowledge of conservation and strengthen your interests in it.

Justin Hunter: I am a junior in agronomy and joined the Soil and Water Conservation Club in the fall of 2017. My interest in conservation started my freshman year of college. Learning about the effects of soil erosion and water contamination motivated me to always try to be part of the solution rather than part of the problem. This club has allowed me to connect with people who share the same motivation as myself and to gain additional knowledge on agricultural conservation practices. Being a co-editor on this year's publication has brought great opportunities in networking with authors and learning more about the current conservation practices that are working today. I hope this publication gets the readers thinking about conservation and how these practices can improve both agriculture and the environment.

This publication would not be possible without the great help of our committee members. We would like to thank them for their dedication to making this publication unique and informative. We would also like to thank our advisors, Dr. Rick Cruse and Dr. Bradley Miller, for their knowledge and support throughout the publication process over the last ten years. They have been essential to this publication, and we are so thankful for them.

Finally, we need to send a huge thanks to you, our readers. Your support has given us the opportunity to create the tenth edition of Getting into Soil and Water, and we are excited to continue these publications for years to come.



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Department of Agricultural and Biosystems Engineering

www.abe.iastate.edu

Figure 2. Biochars produced from pine wood (left) and switchgrass

Improving our Soil and Water Resources with Biochar

Deborah Aller, PhD
Agricultural Stewardship Specialist
Cornell Cooperative Extension of Suffolk County

An ancient practice has become a new tool for agriculture and the environment. Biochar, a charcoal-like substance, has gained increasing attention over the last decade by farmers, businesses, scientists, and gardeners for numerous reasons. But what is it? How is it made? What are the potential benefits of it? and Can I use it on my farm?

Biochar is pyrogenic, carbon-rich material deliberately applied to soil to enhance soil quality, increase crop productivity, recycle nutrients, and sequester atmospheric carbon (Glaser et al., 2002; Lehmann et al., 2006; Laird, 2008). Interest in producing and applying biochar today is based on a thousand-year-old practice by indigenous Amazonians in Brazil. The intentional application of campfire and cooking residues in soils from 500-7000 years ago produced what are called "Terra Preta de Indio" or Amazonian Dark Earths. These soils are characterized by a dark color and high (long-lasting) fertility, resulting in greater crop yields and nutrient and water retention compared to surrounding sandy, low fertility, and highly weathered tropical soils typical of the region (Lehmann et al., 2003).

Making Biochar

Today, biochar is made via pyrolysis, the thermochemical decomposition of organic material by heating under no or very low oxygen conditions. Any organic material including woodchips, corn stover residue, switchgrass, tree trimmings, rice husks, leaves, and manure can be used to make biochar. Biochar looks like charcoal but differs because it is intended for use as a soil amendment, not for use as a fuel for heating or cooking (although small-scale kilns can serve both purposes in some parts of the world). Also, the pyrolysis process makes biochar chemically much more stable than charcoal and other soil amendments such as compost and manure. This stability means biochar is highly resistant to degradation and persists in soils for hundreds and thousands of years (Lehmann et al., 2009); making it more efficient than other forms of organic matter, and it does not need to be applied annually, but maybe every 3-4 years.

The properties of biochar are also unique compared to other organic materials. It is highly porous, with a high surface area and low bulk density, reducing compaction and acting like a sponge to retain water and nutrients.

A recent meta-analysis identified some of the numerous studies that support biochars ability to improve soil physical and

hydraulic properties (Blanco-Canqui, 2017). Additionally, biochar properties change over time as it slowly weathers in soils. For example, biochar surfaces tend to be hydrophobic (water-hating) immediately after production, but become hydrophilic (water-loving) quickly after exposure to wet and dry periods (Kinney et al., 2012; Aller et al., 2017), which is important for enhancing soil moisture and reducing nutrient leaching to the environment. Some of the many potential benefits of biochar are listed in Figure 1.

Proper Application

The greatest benefits from biochar to crop productivity and the environment are observed after just one application in degraded soils with low fertility and sandy soils with poor structure. Biochar is most often applied to agricultural fields via broadcast application or manual spreading followed by incorporation through surface tillage or raking (IBI, 2010). It should not be applied on windy days because it's a very light material that is easily blown away if not immediately incorporated.

Importantly, limitations of biochar do exist including: site specificity, product variability, availability, and cost. Biochars are diverse and not created equal, with each biomass feedstock producing a different biochar type (Figure 2). Its potential to have a positive impact on farms and various production systems depends on soil type, environmental conditions, application rate, and time. Therefore, biochar applications must be made strategically and with a specific goal in mind (i.e. what is the problem I am trying to solve?). Also, it is important to learn about the biochar product before purchasing it: feedstock type, production conditions, and who made it (is it a reliable source)? Cost is variable, but it is typically higher (upfront) than most other soil amendments due to markets and transportation costs. Use a sustainably sourced, locally produced biochar when possible. Lastly, there are currently no recommended application rates for biochar as this is production system and environment dependent, but consistent positive benefits have been observed with applications up to 10% (v/v) (Jeffery et al., 2011).

Nevertheless, biochar is a long-lasting soil amendment with promising agronomic and environmental benefits. The potential benefits of biochar are numerous; however, it is not a silver bullet solution, but rather another tool in your management toolbox!

To learn more about biochar's potential to improve soil and water resources, visit:

International Biochar Initiative
http://www.biochar-international.org

Iowa State University
https://www.biorenew.iastate.edu/research/thermochemical/biochar/

Cornell University, Department of Crop and Soil Sciences
http://www.css.cornell.edu/faculty/lehmann/research/biochar/biocharmain.html

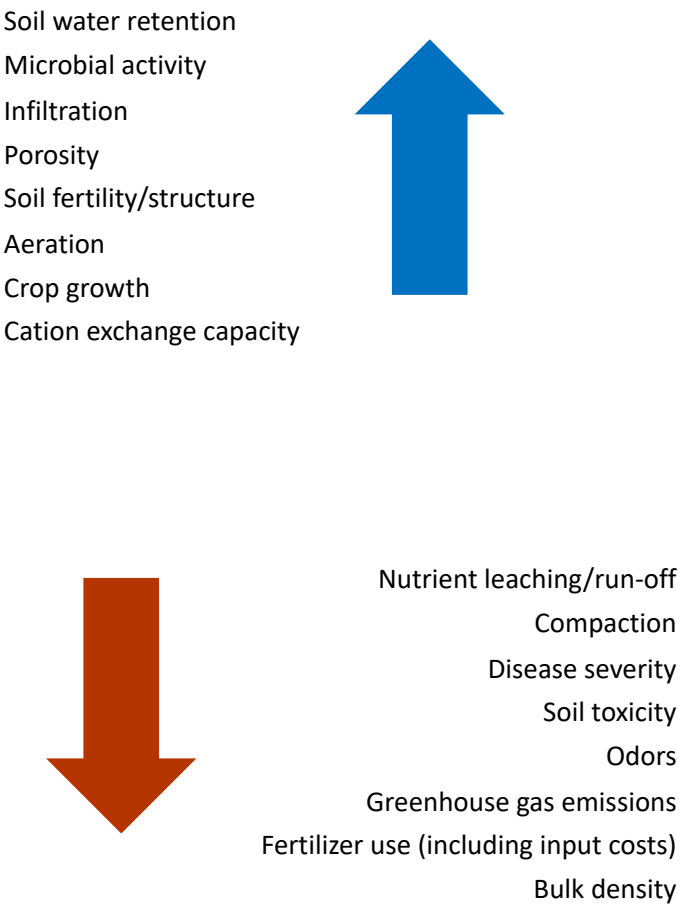

Figure 1. Some of the numerous potential benefits of biochar applications.

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SoilWeb screenshot showing the soil map and profile representation of the Nicollet soil series.

Soil Survey at Your Fingertips

Skye Wills, PhD
National Resource Soil Scientist
USDA-NRCS

Soil survey is part of our natural resource infrastructure. Just as maps tell us about roads and cities we move around in, soil survey tells us about our natural world.

Do you remember opening an atlas? I loved flipping through states, imagining the places I'd like to go and see. You could look in the corner and see a legend for what each type of line and dot represented.

These days, I use my phone app to navigate – I don't remember the last time I opened an atlas. Do you use a smartphone app for maps and GPS? When you open your map app, do you think about what the lines and dots represent?

If you're like me, you don't give a second thought to what the different line weights, colors, and styles mean. You have a vague notion that the big blue lines are large interstate highways and the small black lines are local roads. There isn't any legend, you don't need one; you have enough experience to know.

What does this have to do with soil survey again?

I think that soil survey data is equivalent to the roads and cities you see in an atlas. When we see information about how soils are arranged on a landscape, we can make decisions about where we want to go in terms of how directly, how quickly, etc.

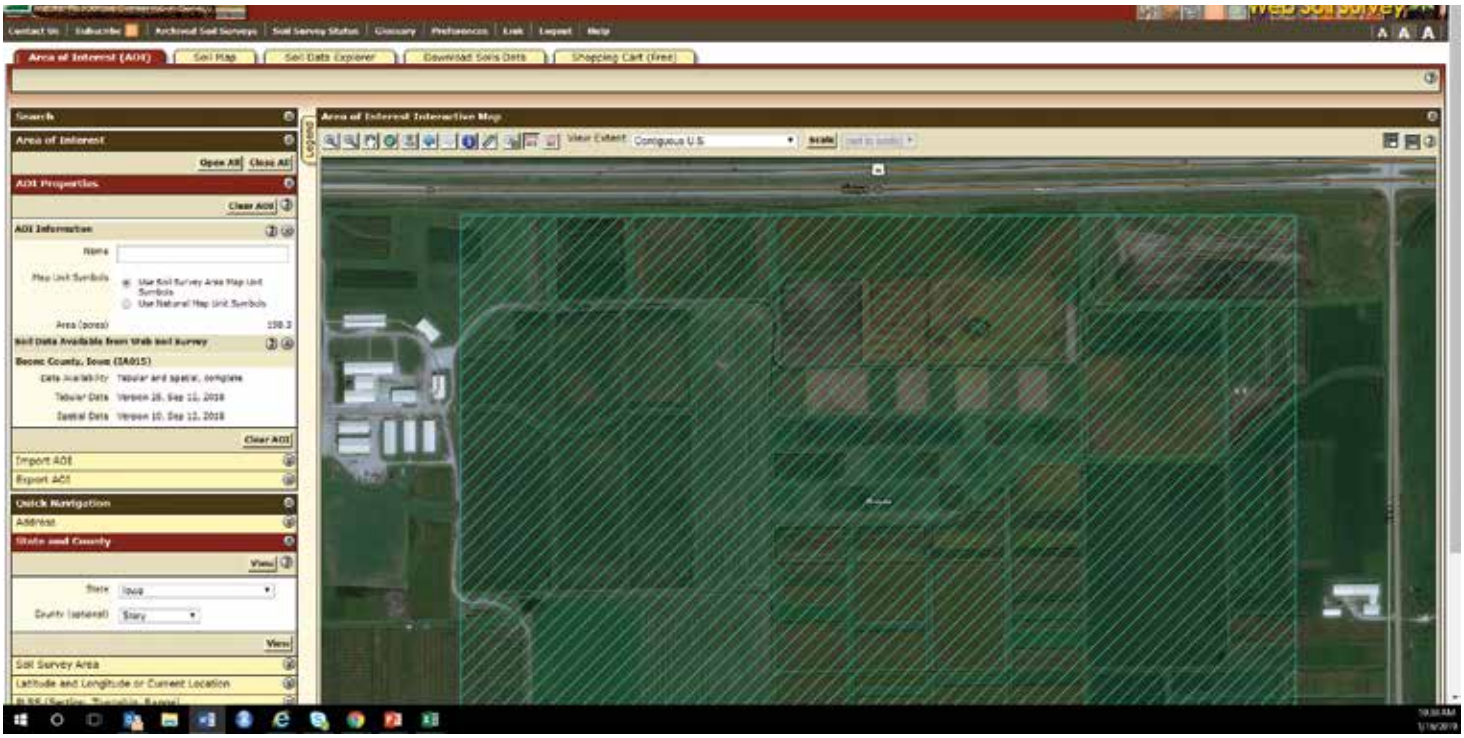
We can use soil survey infrastructure in the same way. It's a little more complicated because we don't all want to use soil information in the same way. I might want to know why two different areas of my field are responding to management differently, where as you might be curious about where best to put a new garden plot.

The traditional way to access soil survey information was a book. Just like an atlas, I think flipping through a soil survey publication is an experience that can be replicated on a smartphone. However, computers and smartphones have made soil survey information so easy to find and use that they've replaced the older format.

"Soil survey is part of our natural resource infrastructure. Just as maps tell us about roads and cities we move around in, soil survey tells us about our natural world."

The official source of USDA-NRCS soil survey information is Web Soil Survey (WSS), available at websoilsurvey.nrcs.usda.gov. This website is intended to help anyone from landowners, farmers, and ranchers to crop consultants and soil scientists. Try the "I want to…" list of topics to find some step-by-step instructions. There are also links to other data sources and portals, such as Official Soil Series Descriptions and characterization data. Scroll down to the "Getting Started…" link on the right-hand side to find step-by-step instructions for using WSS.

I find WSS easier to use on a computer

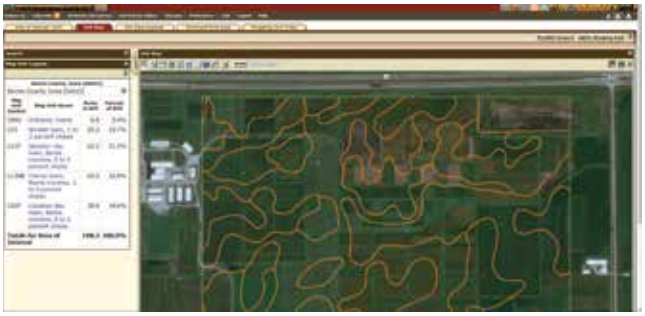


SoilWeb screenshot showing the soil map and profile representation of the Nicollet soil series.

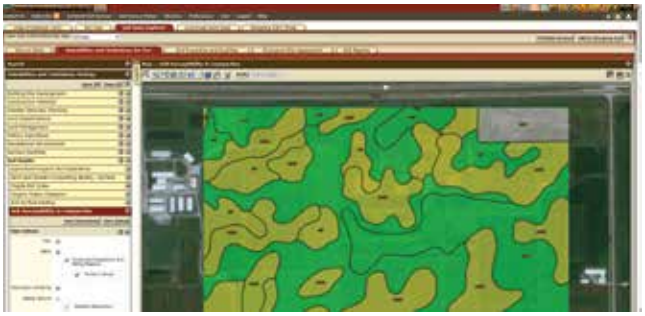
with an internet browser. Hit the big green "Start WSS" button to open the web application and get started. Define an AOI (area of interest—the area you want to investigate). I typically start by selecting the State and county on the left (under "Quick Navigation") then use the square "AOI" button to choose a smaller area. At the very top of the screen, you'll see tabs for "Soil Map" and "Soil Data Explorer." The Soil Data Explorer will give us some great information without having to get into details about soil properties. The "Suitabilities and Limitations Ratings" at the left interpret the soil data and put the information into general classes that make it easier to understand.

Since National Cooperative Soil Survey data is public, others are free to access, use, and republish the data as they see fit. The University of Idaho has an educational website of the 12 soil orders (https://www.uidaho.edu/cals/soil-orders) that makes use of soil survey maps and information. Iowa State University developed the Iowa Soil Properties and Interpretation Database (https://www.extension.iastate.edu/soils/ispaid), which simplifies and streamlines soil data delivery for the State of Iowa. The California Soil Resource Lab at UC Davis offers several soil survey-based tools and applications. The soil web app https://casoilresource.lawr.ucdavis.edu/soilweb-apps/ displays soil survey lines and laboratory data and provides a representation of what the soil horizons and colors look like according to depth under the surface.

I encourage you to use the apps to explore our soils – your farm, your back yard, your local park. Soil Survey is a powerful tool, and theses apps are a great way to use it.



Web Soil Survey screenshot showing the Soil Map for the AOI.



Web Soil Survey screenshot showing the Map of Soil Susceptibility to Compaction.

SoilWeb screenshot showing soil data available for the Nicollet soil series. This diagram shows the depth profiles and taxonomic classification of other series that commonly occur near the Nicollet series.

Modern Ag: Redefining Water Automation and Conservation Practices in Hawaii

Dan Clegg
Hawaii Business Operations Lead
Bayer -U.S. Crop Science- Hawaii

Innovation and advancements in technology play a major role in our everyday life. Where would we be without our smartphones? The same can be said about the agriculture industry. Science innovations and advancements in digital tools are helping farmers work more sustainably and become better stewards of the earth's natural resources.

At Bayer, advancements in digital tools are helping to collect data in real-time to address challenges, such as food production, labor shortage, water stresses, pest control and plant diseases. Also known as precision agriculture, these tools provide more timely and accurate information about what is happening in our fields, allowing us to be more precise in the amounts of water and other resources needed to grow food.

"Water is essential to agriculture, and it is more imperative than ever that we find new ways to farm more efficiently and conserve this natural resource," said Dan Clegg, Hawaii Business Operations Lead at Bayer. "We are committed to implementing modern agriculture practices across all of our farms in Hawaii and I am proud of our teams for utilizing these new technologies that allow us to operate in a more sustainable manner."

Improved Irrigation

In 2014, Bayer established a goal to increase irrigation water application efficiency by 25 percent by 2020. Having implemented advanced irrigation management techniques across its Hawaii farms on Oahu, Maui and Molokai, the company is proud to announce that it has surpassed its goal and continues to improve its farming and conservation practices through technological advancements including:

Soil Moisture Probes, also known as soil moisture sensors, extend about three feet underground. These provide data every 15 minutes on root depth

and water absorption activity to efficiently adjust irrigation recommendations as needed.

Weather Sensing Networks provide unique, real-time data that is captured through weather stations that are strategically positioned throughout Bayer's farms. The data allows Bayer to calculate irrigation needs to build better irrigation systems and management practices that optimize water application (like applying water only when needed) and better crop health monitoring throughout the growing season.

Satellite imagery is collected using an advanced difference vegetation index (ADVI) filter, which has been developed specifically for Bayer's primary corn crop. This imagery is designed to provide valuable information on irrigation stress and plant health which assists in management evaluations.

Water Automation Software technology allows Bayer to improve accuracy in the amount of water needed, by timing irrigation remotely via a smartphone app. This tool has helped to save millions of gallons of water annually across Bayer's Hawaii operations.

Digital tools help farmers become better informed and make better decisions. At Bayer, we rely heavily on science innovations and advancements in digital tools to help identify new solutions to address challenges and work more efficiently. To learn more about Modern Ag and Bayer's Hawaii farms' use of technology, please visit www.monsantohawaii.com.

"Water is essential to agriculture, and it is more imperative than ever that we find new ways to farm more efficiently and conserve this natural resource."

Getting Started with No-Till and Cover Crop System

Steve Berger
Southeast Iowa Farmer

Next spring will be 40 years since we began no-tilling corn and soybeans on our farm. Our goal was to cut soil erosion on the hills in southeast Iowa. We did not realize at the time, but the early adoption of no-till was a good decision for a lot of reasons. Ironically our first no-till corn was planted into a cereal rye cover crop in May 1979. We did not start using a rye cover crop on a regular basis until a few years later.

We were unaware the soil would become more biologically active by switching to a no-till system. The learning curve was steep and would continue for many years with some missteps. After a while, we learned that organisms living in the soil play a significant role in maintaining a healthy soil system and healthy plants. Learning how to manage this ecosystem in transition could prove challenging to growing corn. Experience has shown that it can take 7-9 years to transition from conventional farming to a long-term no-till system. Using a cover crop with continuous long-term no-till shortens the time period 2-4 years.

Having people available to assist with a new system was helpful. Jim Frier, Washington county extension director, was instrumental in organizing and inviting farmers to meetings to learn about no-till. There was a lot of interest and leadership from Iowa State Extension, Soil Conservation Service, (SCS), ag retail, and farmers. Today, Washington county leads the state in cover crop acres.

Two significant events helped convince me of the benefits and importance of cover crops. A fast 3-inch rainfall event one evening in April 2012 did not affect fields that had a cover crop history. The soils were resilient and absorbed the moisture without lasting effect. However, there was a sharp contrast with the continuous tilled fields with severe erosion, sedimentation and a lot of permanent damage.

Another important event was observing

"After a while, we learned that organisms living in the soil play a significant role in maintaining a healthy soil system and healthy plants."

the difference of organic matter levels between a fencerow and field situation. Soil organic matter levels in the fencerow were 7%, nearly twice that of probes taken a few feet away in the field. When someone references that Iowa has lost half of its soil resources, I can relate. The combine yield monitor confirms the high quality soil in old fencerows every time it transects it! Our fencerows indicate the potential of soil!

We have significantly reduced soil erosion through no-till and using cover crops. Determining soil health benchmarks are more challenging to quantify. Soil organic matter levels have increased to 4.0%. Soil aggregate structure, water infiltration, and water holding capacity have improved. Our ten year average corn yields are 20% higher than the county average and soybeans yields 13% above county average.

Through experience working with reduced tillage systems, I've learned there are three specific areas to manage that can directly impact yields: 1. Adapting the planter row unit modifications for high residue systems. 2. Using sufficient nitrogen at the proper time to meet the needs of soil microbes and the corn crop. And 3. Be prepared to manage insects that will be attracted to cover crops and other residue. Finally, we must have some patience while the soil biology is adjusting to a new system that may take several years in some situations.

Getting started and changing old habits can be challenging. Changes on the land may occur with changes in human attitudes and behavior, which are measured as conservation practice adoption. I believe a voluntary approach of making small adjustments every year while working toward a long term goal of reduced tillage will have the best outcomes. Using no-till and cover crops for many years has been a very good decision on our farm. I believe other farmers can enjoy the same benefits we have.

Cultivating a Legacy: Water for the Next Generation

Trygve Lien
Farmer and Agronomy Major
Iowa State University

I farm in Winneshiek county in far Northeast Iowa which is known for its good soils, but the land is very hilly and is typically in the ten to twenty-five percent slope range. Some areas have forty percent slopes which can make for a challenging growing season if the ground is not managed correctly. The ground that I farm has a mixture of soil textures that include clay loam and silt loam and has an average CEC (Cation Exchange Capacity) of around 19 to 21 meq/100g which allows me to apply 190 to 210 pounds of nitrogen at a time, which is on the higher end of the scale.

I started farming when I was in high school using my parents heritage farm equipment until I could afford to purchase some of my own. A majority of the equipment that I use ranges from the 1960's to the 1990's which is somewhat typical of some of the farms in the area. Up until a few years ago, I had been using a conventional tillage program, which usually meant using a moldboard plow, disk, field cultivator, and a row crop cultivator later on in the season. My operation has utilized many different crops over the years. A majority of the time I have grown corn and soybeans in an every other year rotation plan. I am now transitioning to a corn on corn rotation as well as a corn, oats, alfalfa rotation on a majority of my ground as I start my cow calf operation. Switching to this style of crop rotation will allow for reduced soil erosion as well as being able to do a full no-till system. In a market saturated by high volumes of corn and soybeans, a corn, oats, and hay rotation allows me to improve my yields and profits by selling my excess crops to area farmers who raise cattle.

Towards the end of my high school career and throughout my time at Iowa State University studying Agronomy, my father and I started to change how we do things and how we look at things. In the beginning, the main focus was on growing a high yielding crop and making a profit. As I learned of the importance of soil health and conservation, the more I learned how it can improve our crop, yield, and profit. While at Iowa State Dr. Elwynn Taylor and Dr. Erik Christian had the biggest impact on me and how I farm. Before starting at Iowa State, my father and I would attend the Iowa State Crop Advantage Series every year in Waterloo, Iowa. These events taught us about the importance of preventing soil erosion and how we could mitigate it. It also taught us many other aspects of modern agriculture to stay up to date with modern practices and knowledge. As a result of this, I purchased a larger disk and chisel plow to break up compaction and limit the use of our moldboard plow for sod. My land has never had a chisel plow used on it, and we could see an immediate benefit the following year after we spread lime and chisel plowed in the fall. My land had gone a long time without being limed; spreading the lime helped my soil by raising the pH, which also helps allow the plants take up important nutrients such as nitrogen and phosphorus. I was still not satisfied because I knew that I had erosion, and soil conservation is critical for maintaining production and for passing down the land to future generations.

To combat erosion, in the fall of 2017, we lightly disked the ground and seeded a cover crop of cereal rye. Since I had never planted a cover crop, I experimented with the seeding rate. It is commonly recommended to seed cereal rye at 50 pounds per acre, but I found the most success at 60 to 65 pounds an acre. This spring I terminated it by spraying it with glyphosate, and then after a few days, I no-tilled corn into it. Then this spring, I will be no-tilling corn into the residue from this year's corn crop. This coming year, I will be transitioning from 38" row spacing to 30" rows for my corn to help the crop canopy grow faster and to increase yields. In the next ten years, I will most likely transition to a twin row no-till planter, as well as slowly increase my population until I have all of my corn acres near 40,000 plants per acre. This will allow me to do more with the soil than ever dreamed by past generations.

Erosion prevention and sediment control are primary concerns for homeowners impacted by the California Wine Country Fires in 2017.

Working with Nature Following Wildfire in California

Rich Casale
Certified Professional in Erosion and Sediment Control (CPESC) #3-Fellow
USDA-NRCS Agricultural Conservation Experience Services Program (ACES)

When you control water, you control nature. So why not use nature in your erosion and sediment control efforts? Many, if not all, erosion and sediment control practices attempt to control rain drops or runoff in one form or another, especially those that are applied to landscapes following wildfire. If you are not fully aware of the natural processes in play following fire, then your erosion and sediment control efforts may fall short or even be self-defeating.

I spent 5 months assisting over 150 property owners impacted by the devastating 2017 Wine Country Wildfires in northern California and the Thomas Fire in southern California. The Thomas Fire became the largest wildfire in California history burning 281,893 acres and destroying 1063 structures.

I retired in 2016, after a 43 year career with the USDA Natural Resources Conservation Service (NRCS) as a field district conservationist. NRCS hired me back in October 2017 through ACES as a contractor to assist individuals with post fire restoration and erosion and sediment control.

I learn more with each fire, and these fires were no different. I not only advised property owners and contractors how to properly use erosion and sediment control measures following fire but also how NOT to respond and to let nature work her magic. Three of my most popular talking points are: Every site is unique; one size does not fit all; and work with nature.

Many property owners can't afford to cover their properties with expensive erosion control products and need information about softer approaches. In some cases, doing nothing at all can sometimes be the best thing you can do.

I saw situations where unnecessary measures were being installed in and

"It is absolutely critical to consider nature's role in post fire restoration before throwing everything but the kitchen sink at the fire damaged landscape."

around the burn areas. I also saw where the erosion or sediment control product was not being located or installed properly. I would not be going out on a limb by stating that more than half of all straw wattles that I saw were either unnecessary, improperly installed or located, and in some cases, potentially creating a problem rather than preventing one.

Other post fire erosion control practices I saw installed improperly were jute netting, erosion control blankets (ECB), seeding, mulching, sandbags, straw bales, water bars, drainage ditches, land grading, vegetation removal, and hydro-mulching. In most cases hydro-mulching was installed correctly, but it wasn't needed especially when seed was added in applications done in January.

Plastic sheeting was also being overused. In the majority of cases, plastic sheeting (especially non-transparent plastic) makes the situation worse and/or can cause other problems by killing slope-holding plant root systems and soil microorganisms, preventing seed/plant regeneration, increasing runoff, and maintaining saturated slope conditions when covering wet slopes with plastic instead of allowing the soil to dry out.

In many cases, straw mulching was being spread too deep or where it was not needed, like under trees where there were many leaves from trees only suffering from heat and smoke damage. Straw depths greater than two to three inches can delay native regeneration of plants and suppress the resident grass/forb seed bank in the soil.

Installing erosion control measures and removing fire damaged vegetation can cause disturbances to the soil, slopes, plant root systems, resident seed bank, and any natural plant regeneration taking place. These factors must be considered before deciding to make the disturbances. In some cases the disturbances are necessary to provide a higher level of protection but not always. In other cases less is more, or doing nothing at all may be best.

It is absolutely critical to consider nature's role in post fire restoration before throwing everything but the kitchen sink at the fire damaged landscape. Variables such as burn intensity, topography, soil type, geology, pre-existing conditions like plant type, wildlife habitat, disturbances made by the fire-fighting effort, surrounding land uses, drainage/runoff, etc. must be considered. Please, don't get me wrong because I believe there is a definite and necessary place for erosion and sediment control product installations in the post fire landscape. I just want to make sure, before making recommendations and working on the landscape, that nature's role is considered in any and all treatment solutions.

Straw wattles staking is inadequate, and wattles are "riding" on top of netting, not in complete contact with the soil. Jute netting "tenting" covers cut vegetation with too few staples and sand bags to help hold in place. Note: neighboring property in background covers slope with plastic.

Algal bloom in Union Grove Lake, Tama County, on July 31, 2018 (Photo courtesy of Amy Buckendahl, Iowa DNR)

Nutrients and Us: What We Know and Why We Should Care

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Iowa is a national leader in agricultural production and, due to fertilizer use and tile-drained farmland, a main contributor of nutrients that cause the hypoxic zone in the Gulf of Mexico. In 2008, the US Environmental Protection Agency called for the 12 states along the Mississippi river basin to mitigate the hypoxic zone by creating an action plan to reduce nitrogen and phosphorous fertilizer use. This led to the creation of the Iowa Nutrient Reduction Strategy.

Many Iowans have never been to the Gulf of Mexico, so why should we care about reducing nutrients there? The simple answer is that nutrient pollution is harmful to Iowa, too.

Nutrient pollution threatens our drinking water through elevated nitrite levels and algal toxins (microcystin), which are largely caused by excessive phosphorus. Nitrate levels are particularly relevant to the 45% of Iowans who rely on groundwater for their drinking water supply, while phosphorous is relevant to the other 55% who get their drinking water from surface water.

State and Federal authorities monitor the public water supply systems throughout Iowa to ensure that nitrate levels do not exceed the 10mg/L Environmental Protection Agency standard. Nearly two-thirds of nitrate violations are from public water systems serving less than 500 people, many of which cannot afford nitrate removal technology. In addition, private wells, which serve nearly 8% of Iowans, are neither regulated nor

DID YOU KNOW?

The hypoxic zone, often called the "dead zone," is an area where nutrient-enriched waters coming from freshwater rivers and streams cause excess growth of plants that deplete oxygen in the water, making the area unsuitable for animals. The dead zone is harmful to both the finishing industry and recreational users of the Gulf of Mexico. Monitoring of the dead zone started in 1985; and, in 2017, it reached its largest recorded size, an area bout the size of New Jersey. In 2018, the size of the dead zone decreased, thouh it is still the size of Connecticut.

regularly monitored. In 2016, more than 18% of private wells in Iowa were found to contain unhealthy nitrate levels. This represents the highest percentage since the Iowa Department of Natural Resources began tracking nitrate levels in private wells in 2001. That being said, Iowans living in rural areas are more vulnerable to the threat of elevated nitrate. Removing nitrate at home is not easy and often requires an advanced filtering system. The practice of boiling water will increase nitrate concentration as a result of evaporation. While researchers are still exploring the association between nitrate exposure and long-term health, current information shows consuming water with high (> 5mg/L), although lower than the EPA standard, nitrate level is not necessarily safe.

Algal toxins have led to several drinking water crises across the nation. One of the most prominent cases was a 2014 outbreak of harmful algal bloom in Lake Erie, which disrupted the water services in Toledo, OH. In Iowa, Des Moines Water Works detected microcystin in their treated drinking water in 2016. In July, 2018, the City of Greenfield, IA issued the state's first ever drinking water advisory due to a potential contamination from algal toxins. Although incidents are rare, algal toxins are worrisome because we are likely to see more in the future and because the majority of public water systems have no technology to remove them from their source water. Similar to nitrate, boiling water will not destroy algal toxins and could make them more concentrated. In addition, harmful algal blooms pose a threat to animals that consume surface water.

Harmful algal blooms can lead to beach advisories and closures, which deteriorates one of Iowa's most important recreation resources. When contact occurs, algal toxins can cause skin rashes and eye, nose, and mouth irritation. In summer 2016, Iowa witnessed a record-breaking 37 beach advisories at state parks, most of them due to high levels of algal toxins (> 20ug/L). If you head to Iowa beaches this summer, be sure to pay attention to the signs posted along the beach. Even before you go, you can check state park beach monitoring information at the website of Iowa Department of Natural Resources.

According to a study conducted by researchers at Iowa State University, reducing nitrogen and phosphorus in Iowan lakes by 45%, which achieves the goal of the Iowa Nutrient Reduction Strategy, will generate about $30 million in annual benefits in terms of recreational improvements for all Iowans. In addition, studies have also found that better water quality can increase the values of houses near water bodies.

Policies designed to reduce nutrients benefit both local and downstream water, and many benefits can be achieved simultaneously. Given the current condition, the benefits of reducing nitrogen will be mainly reflected through reducing the dead zone in the Gulf of Mexico, while the benefits of reducing phosphorus will be reflected through decreasing the likelihood of algal blooms and improving water clarity in Iowa lakes. With limited resources, how can we make the best choices to balance both local and downstream needs? One key component for answering this question is understanding how Iowans make tradeoffs between the multidimensional benefits of the Iowa Nutrient Reduction Strategy. Researchers at Iowa State University will be conducting a survey to explore the answers to this question this year.

State Park Beaches with Most Weeks with Microcystin > 20ug/L between Year 2006 and 2018

Beach	County	Weeks with Microcystin > 20ug/L
Green Valley Beach, Green Valley State Park	Union	37
Black Hawk Campground Beach, Black Hawk State Park	Sac	19
Geode Lake Beach, Geode Lake State Park	Henry	16
Denison Beach, Black Hawk State Park	Sac	13
Rock Creek Beach, Rock Creek State Park	Jasper	10

Data Source: AQuIA (https://programs.iowadnr.gov/aquia)

Blue-green algae bloom in the Green Valley Lake on July 31, 2015 (Photo Credit: Lauren Mills, IowaWatch)

DID YOU KNOW?

The Iowa Department of Public Health offers free water quality tests for all of Iowa's private well owners. Owners can contact their county environmental health sanitarians for more information.

Discussing Farmer Goals in Conservation Planning, Iowa NRCS 2011

Sociology and Conservation: Seeing Things from a Farmer's Perspective

Chris Morris
Rural Sociology and Sustainable Agriculture Graduate Research Assistant
Iowa State University

Hugh Hammond Bennett, known as the "father of soil conservation" and the creator of the agency that would eventually become the USDA Natural Resources Conservation Service, stated the quote at right while discussing conservation planning back in 1943. For those of us who have taken on the fundamentally important task of helping to protect and conserve our nation's soil, water, animal, plant, air, human, and energy natural resources, Bennett's assertion that farmers need our technical help with conservation is an easy one to understand. But why would he choose to include the phrase "moral support and encouragement" in his description of our job as conservationists? Why should something that seems so subjective and philosophical be included in the scope of natural resource conservation?

"Many farmers—most farmers, and that means millions—need some technical help in making the change to this more efficient, easier, and more productive type of farming, and they need also moral support and encouragement."

-Hugh Hammond Bennett

Bennett knew that simply giving farmers the technical information about implementing conservation practices on their farmland was only half of the equation for success. If we truly want farmers to adopt these sustainable practices to protect

their land in the long run, Bennet knew that we would have to identify what their values and goals are so that we could help weave conservation stewardship ethics into the very fabric of their identities as farmers. In other words, if we want to help farmers and their land, we first have to understand who they are, where they're coming from, and where they want to go.

That is the job of rural sociologists working in the field of sustainable agriculture. Most rural sociologists work at universities conducting research to address some of the most challenging and pressing issues of the 21st century. We study how we can grow enough healthy, affordable food for an increasing human population while also preserving our natural resources and sustaining the rural communities that produce our food. At the heart of these issues is understanding how and why people who work in agriculture make the decisions they do. What are their motivations and goals? What are the beliefs and values of their communities? What are their greatest concerns and challenges? What trusted sources of information do they turn to when they need help? How can we best provide technical assistance to farmers, as well as moral support and encouragement? Most importantly, how can we help farmers make the decisions that will most benefit their families, their land, and society as a whole?

These are the types of questions rural sociologists help answer with our research. We use social theories and scientific methods to develop surveys, interviews, and case studies to collect information from farmers and other agricultural professionals, and then we use statistical methods to analyze that data to find patterns and reach conclusions. Ultimately, we present our findings and recommendations to people who work in agriculture—farmers, educators, natural resource professionals, and governmental policy makers—so that they can make more informed and effective decisions in their jobs.

Challenges associated with agriculture and natural resource conservation have been in the news headlines across Iowa recently, from the impaired quality of our drinking water due to bacteria, sediment, and chemical contaminants, to the loss of healthy farmland soil from erosion, to the dead zone in the Gulf of Mexico caused by excess fertilizer in our creeks and rivers. There are viable solutions to these challenges: planting vegetation buffers along creeks, restoring natural wetlands, using cover crops and no-till farming practices, installing bioreactors, and restoring lower-productive farmland to native prairie. These types of practices have been shown to reduce soil erosion and improve water quality, all while increasing wildlife and pollinator habitat. On the downside, these practices can also be very expensive to implement, and change of this magnitude can be very hard for farmers.

This is why learning how to see things from a farmer's perspective is so important to us. Rural sociologists help government officials design better policies and programs to make the implementation of conservation technologies easier and more affordable for farmers. We help bridge the gap between those who work with farmers and the farmers themselves. Together, we can help improve the lives of farmers and protect our natural resources, ensuring that the food we eat will be sustainably grown for ourselves and for future generations to come.

Wetland Conservation Planning with Farmers, Iowa NRCS 2011

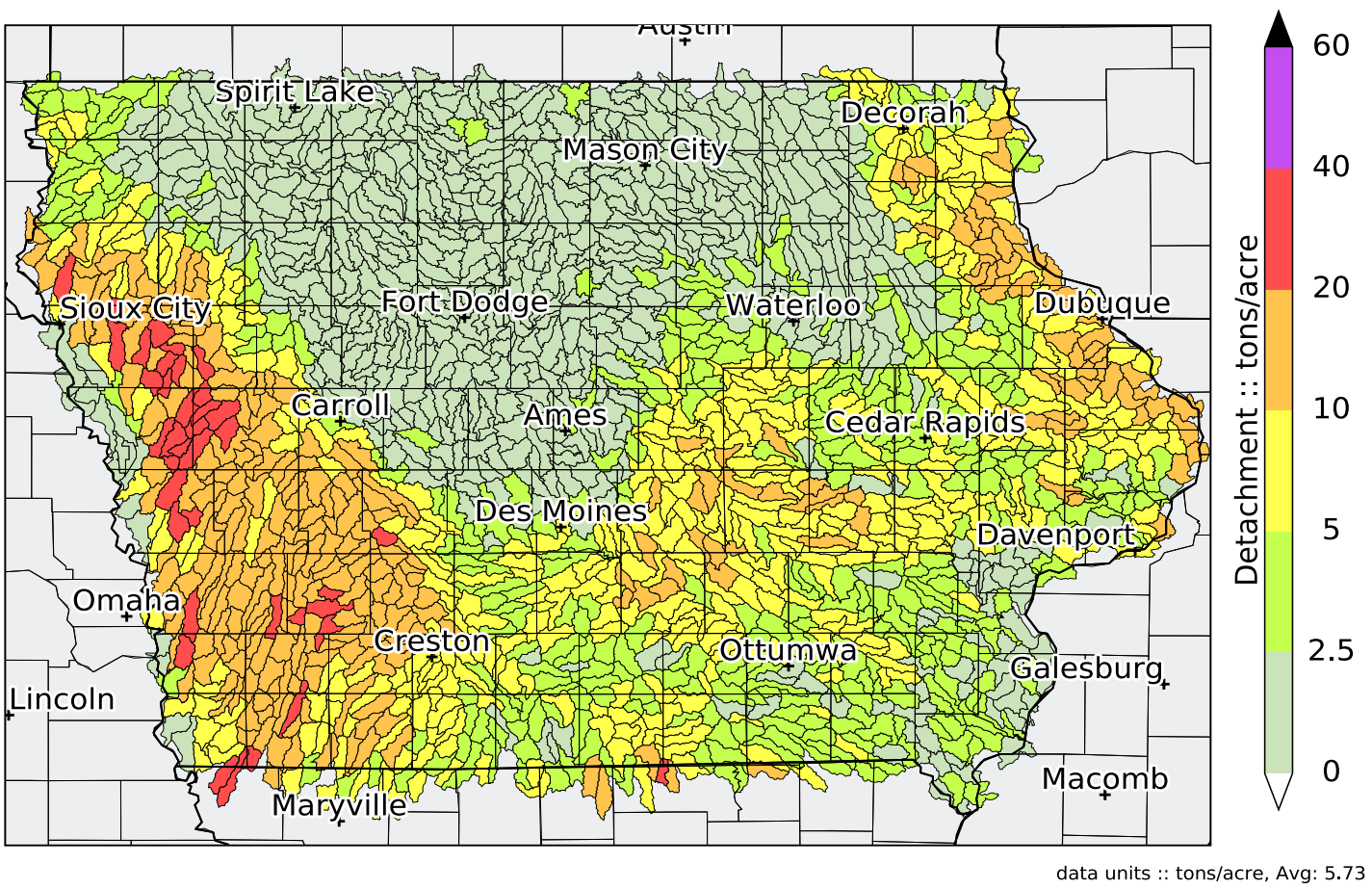

Figure 1: Daily Erosion Project estimated yearly average soil loss (erosion) between the inclusive years of 2008 and 2017. The simple arithmetic HUC12 average is 5.73 tons per acre.

The Daily Erosion Project (DEP): Near Real-time Estimates of Iowa Soil

Daryl Herzmann
Systems Analyst III
Iowa Environmental Mesonet

Iowa's soil is arguably the state's most valuable resource. This soil coincides with a climate that typically provides sufficient rainfall and warmth to support some of the most intensive agriculture in the world. The aforementioned rainfall combines with common agricultural practices to erode the landscape. For example, heavy springtime rainfall events happen during periods when fields are freshly tilled and have little residue cover. As a first approximation, soil erosion happens when water is able to exert a force on soil (either by falling as droplets from the sky impacting the soil or running over/through the soil). Erosion not only physically displaces the soil, but it also degrades the soil health by removing nutrients and organic matter.

A number of government and scientifically accepted estimates quantify how much soil erosion occurs over Iowa on an average year. These bulk estimates are generally around five tons per acre per year. This value is based on agricultural practices and the rainfall rates from a few decades ago. This value is also a spatial and temporal average, thus it does not provide much insight into what actually happens during a specific time period or location. A changing climate and agricultural management practices also cast some uncertainty on the value.

The Daily Erosion Project (DEP) is an effort at Iowa State University to model daily "sheet and rill" soil erosion over agricultural areas in Iowa and beyond.

This class of erosion is typically what you can't visually see in fields, such as gullies, and is estimated by the Water Erosion Prediction Project (WEPP) model. DEP assimilates observational and remotely sensed data sets of soil, agricultural management practices, slope profiles, and weather to produce an estimate each morning of the previous day's erosion. These results are aggregated to 12-digit hydrologic unit code (HUC12) watersheds. DEP results and products can be found on the website https://dailyerosion.org. Assembling the input data to DEP is a "Big Data" challenge as formats, protocols, and size issues abound.

One of the key inputs to DEP is weather. While automated weather stations have become more pervasive, their spatial density is on the approximate order of one per county in the state. Thankfully, weather can be remotely observed through passive sensors like satellite and active sensors like RADAR. Through recent advancements, the National Weather Service provides high resolution weather data from these remotely sensing platforms at scales suitable for HUC12 modeling. DEP utilizes precipitation data from the Multi-RADAR Multi-Sensor System which provides data at an approximate 1 km and 2 minute interval resolution. Other variables like solar radiation, wind, humidity and temperatures are provided by the Iowa Environmental Mesonet (IEM). The IEM maintains a data analysis system that combines National Weather Service data along with weather stations maintained by Iowa State.

For the Daily Erosion Project, this high resolution weather information is merged with field scale soil, crop management, and slope information. DEP does not explicitly model every agricultural field in the state, but utilizes statistical sampling within HUC12 watersheds to generate enough samples to provide a confident estimate. The number of samples is generally about 100 hillslopes per HUC12 and amounts to over 200,000 hillslopes modeled daily for our domain.

For soil information, DEP relies on the USDA-NRCS Soil Survey Geographic (gSSURGO) 10m grid resolution database. This database provides soil attributes like texture, coarse fraction, organic matter, and cation exchange capacity.

For management practices, DEP relies on the Agricultural Conservation Planning Framework to provide information on crop rotations used and field boundaries for agricultural areas. The WEPP model within DEP contains physical models of crop growth, so regionally appropriate dates of crop planting and harvest are used. Tillage information is derived from remotely sensed satellite information that provides surface estimates of roughness, which are a proxy to the tillage implement used on the field.

For hill slope information, digital elevation models (DEM) are constructed, which are derived from remotely sensed sources like LIDAR. These DEMs are conditioned such that water will flow throughout a watershed. A part of this process involves adding items like culverts to allow water to flow under a roadway.

Software algorithms process all of this information and construct hill-slopes within each watershed that should match reality. The DEP database contains a rich combination of high resolution input datasets of soil, slopes, managements, and weather along with the resulting analyses of runoff and erosion. Development work on our project continues as refinements are made. We welcome questions and collaborators on our project.

"The DEP database contains a rich combination of high resolution input datasets of soil, slopes, managements, and weather along with the resulting analyses of runoff and erosion. Development work on our project continues as refinements are made."

Lessons from a Year in Leadership

Clare Lindahl
CEO
Soil and Water Conservation Society

In August of 2017, at age 34, I became the first woman CEO of the Soil and Water Conservation Society. The Society's mission is to foster the science and art of natural resource conservation. The Society and its membership of professionals working in the field of conservation study and practice have been advancing conservation through advocacy, special projects, a scientific journal, education, and events since 1943.

In my work, I absolutely see a current need for new conservation leaders. Many leadership positions in our field will soon turn over, so there is a real opportunity for individuals who are prepared to fill these roles. Bringing on new leadership can provide a different perspective and a refreshed approach to an organization. Leadership is consuming, but it is also empowering and rewarding.

I would encourage new leaders who are eager to make a difference to jump right in as I did. One of my first leadership positions was as a board member with the Iowa Chapter of the Soil and Water Conservation Society. This position enabled me to practice and grow my leadership skills by facilitating a board to execute meetings, events, and projects like a conservation tent at the Farm Progress Show, the nation's largest outdoor farm event, and a new website. Many leadership lessons are gained through experience, and there is always room to learn how to lead more effectively.

The Society's history has been one of the greatest sources of inspiration for me in my role as CEO. I am thankful for the leaders that came before us and paved the way for soil and water conservation. I am often reminded that the ideas of those we consider leaders today were not always embraced at the time. The SWCS founder, Hugh Hammond Bennett, faced his fair share of resistance in developing the nationwide network of resources that exists today to conserve soil and water. Often, we hear farmers using conservation practices say that their neighbors think they are crazy! Roselinde Torres, who has advised more than 200 CEOs across industry sectors and markets, reminds us in her TED Talk that weathering this kind of criticism can help shape a great leader: "The most impactful development comes when you are able to build the emotional stamina to withstand people telling you that your new idea is naïve or reckless or just plain stupid."

As CEO of an organization dedicated to supporting conservation professionals on the job and growing new leaders, I am particularly excited about the engagement we are having with the next generation of conservationists, our students and new professionals. This year, we unveiled a new Conservation Career Center that offers an array of job postings and other services, including resume review, to members. Also this year, we began releasing career profiles of conservation professionals and brought on an intern to create a student and early career professional development guide. We have also enhanced the conference experience of our student attendees through various activities, including pairing them up with mentors in their desired future fields. The work done by the Society in the last year to engage and support the next generation of leaders, gives me much hope for the future of our membership and our natural resources.

I encourage those entering the field of conservation to engage with the Soil and Water Conservation Society, through membership and by following us on social media. Let us be a resource for you as a leader, a professional, and a person who cares about our natural resources.

"As CEO of an organization dedicated to supporting conservation professionals on the job and growing new leaders, I am particularly excited about the engagement we are having with the next generation of conservationists, our students and new professionals."

Cultivating a Legacy: Water for the Next Generation

Laura Stowater
Winner of the Iowa Water Center Paper
Algona High School

As a Kossuth County native, Dr. Michael McNeill is a farmer entrusted to his family's legacy and an agronomist with a passion for doing things right. He cares greatly about the water, food supply, and natural resources he will leave for the next generation. He cultivates his legacy through organic farming, good tillage practices, the use of cover crops, and his work as an agronomist. As a farmer and consultant at Ag Advisory Ltd. in Algona, he helps farmers utilize water, chemicals, and other resources efficiently. In addition to helping farmers, McNeill has served as my high school science fair mentor by sharing his knowledge and laboratory with me for two years. His knowledge of water practices has helped propel my projects to two international science fairs. I have learned about sustainable water practices that produce more crops with less water. As an agronomist, he specializes in nutrient management which can have a profound effect on plant growth and water quality. A major aspect of his occupation is assisting farmers with ways to be more profitable while protecting the environment. Tillage can impact runoff greatly as soil compaction prevents water from infiltrating the soil effectively when it rains. Water "runs off" the surface and carries nutrients into lakes, streams, and rivers (McNeill, 2017). This increases the nutrient load in water, contributing to increased algae growth and degradation of the water quality. Runoff also carries pesticides aimed to protect the crop, thus carrying the chemicals into the water which can destroy living organisms in the water and affects those who use it as a drinking source including livestock.

One of McNeill's passions is organic farming. Organic farming involves eliminating synthetic pesticides and fertilizers, the use of cover crops and crop rotations, a focus on soil and water conservation, and managing ecological balance (Nationwide, SARE). McNeill leads by example by growing crops organically on his own farm to demonstrate to others how effective it can be. They can observe first-hand that organic farming works and can replicate it on their own land to enjoy the same reduction in water pollution, improved food quality, and more efficient use of nutrients. For example, McNeill has observed increased worm activity that opens pores in the soil and reduces runoff. Crop rotation techniques and plant residue prevent sheet erosion (McNeill, 2017). Because organic farming increases tillage passes, it must be done correctly with the right equipment to reduce erosion. Dr. McNeill has been farming organically for 14 years and has been certified organic for 11 years. He is motivated to reduce pollution that he's seen from herbicides, insecticides, and fungicides contaminating our food and water supply. He is encouraged by higher yields from his organic farming without the reliance on pesticides used in conventional farming. The increased yield and reduced production costs is a welcome improvement to profitability.

Another sustainable practice to improve water quality in agriculture is cover crops. Cover crops play a crucial role in preventing nutrient loss into water supply and can prevent soil erosion. The cover crop uses the nutrients that could otherwise leach into tile lines that lead to streams and retains the nutrients in an organic form thereby making them available for next year's crops. "With new interest in cover crops and new technology in how to use them more effectively, I see this as a tremendous boom to improving water quality" (McNeill, 2017). Farmers, like other citizens, play a role in protecting our water resources. Because farmers utilize the majority of land surface that contributes to runoff, they can dramatically reduce water pollutants; however, they are not the only ones who affect the water quality.

Water is important whether you live on a farm or in a city; we all must work together and do our part for a solution. There are many misconceptions about farmers and how they treat our water. McNeill believes it is important that the public knows that many farmers try very hard not to pollute the water because when nutrients leave the property, that is money going down the drain. There are some people who cut corners and fail to use good water practices in the pursuit of money. That gets the public's attention and gives agriculture a bad name.

The water problem is not only bad for Iowa's environment, but also for its bottom line. There are over 6.5 million pounds of toxic discharge in Iowa's waterways. The USDA predicts that it would cost $4.8 billion annually to clean the nitrate pollution in the waterways (Environment, 2013). With numbers like that, some pre-emptive action and education can go a long way in protecting and enhancing water resources. McNeill believes that one simple way to improve water quality is through education. A main source of information for growers is from the sellers of production inputs. Pressure or eagerness to sell can result in over application of these inputs. Providing accessible, unbiased information sources to farmers can help them find solutions that keep our water sources healthy.

Aldo Leopold once said, "The privilege of possessing the earth entails the responsibility of passing it on, the better for our use, not only to the immediate posterity, but to the Unknown Future." To me, Leopold reminds us whether in agriculture or otherwise, we must be good stewards of our natural resources, especially water. Through the implementation of the agricultural practices described above and others, we can help fulfill the water responsibility Aldo Leopold professes. The impact of Dr. Michael McNeill's work and his mentorship has broadened my career interests, and has made water quality part of my daily life. That kind of legacy is just like the family farm McNeill cares for and the advice he shares with his clients to improve their agricultural endeavors. This legacy of awareness and education in agriculture can bring about great improvement for Iowa's water.

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Figure 3: Flows at our stream study site show increased flow following the input of the treated wastewater effluent.

Pharmaceuticals in Iowa's Waters: Chemicals You Can't See, Can Impact Ecosystems

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In the last century, human life expectancy has dramatically increased because of improved sanitation and modern medicine. Sanitation collects and treats human waste so that dangerous pathogens (dangerous microbes, like E. coli) are killed and that the treated wastewater does not excessively degrade the quality of the river or lake to which the treated water is returned—or recycled. Medicines taken by humans to treat illnesses can transfer pharmaceuticals into wastewater treatment plants when people go to the bathroom because some of the pharmaceuticals pass through the human body. Water treatment plants were designed mainly to remove pathogens and excessive nutrients from human waste and were not designed to remove pharmaceuticals. This means that some pharmaceuticals can be released into rivers and streams and expose aquatic ecosystems, including fish.

Why does it matter that pharmaceuticals are present in rivers and streams? Pharmaceutics chemicals are designed to be bioactive, which means that the chemicals impact the functions of an organism. Bioactivity is very important because pharmaceuticals must alter organisms to treat illness or diseases, but they can also have unintended effects such as endocrine disruption (alteration of the hormone system). For example, the US Geological Survey (USGS) conducted studies of fish that demonstrated that fish downstream from wastewater treatment plants exhibit higher rates of intersex characteristics (possessing both male and female gonadal structures).[1] The USGS researchers also report high levels of pharmaceuticals in these locations; however, after a treatment plant upgrade there was a significant reduction in endocrine disruption in fish. Thus, improving water treatment technologies can have direct impacts on organisms in aquatic ecosystems.

The streams that are most impacted by pharmaceutics in wastewater are

"Water treatment plants were designed mainly to remove pathogens and excessive nutrients from human waste and were not designed to remove pharmaceuticals. This means that some pharmaceuticals can be released into rivers and streams and expose aquatic ecosystems, including fish."

1 https://toxics.usgs.gov/highlights/fish_endocrine_disruption.html
2 https://toxics.usgs.gov/highlights/wastewater_fish.html
3 https://toxics.usgs.gov/highlights/pharm_watershed/index.html
4 https://toxics.usgs.gov/highlights/boulder_wwpt/index.html
5 https://toxics.usgs.gov/highlights/2014-09-22-pharms2gw.html

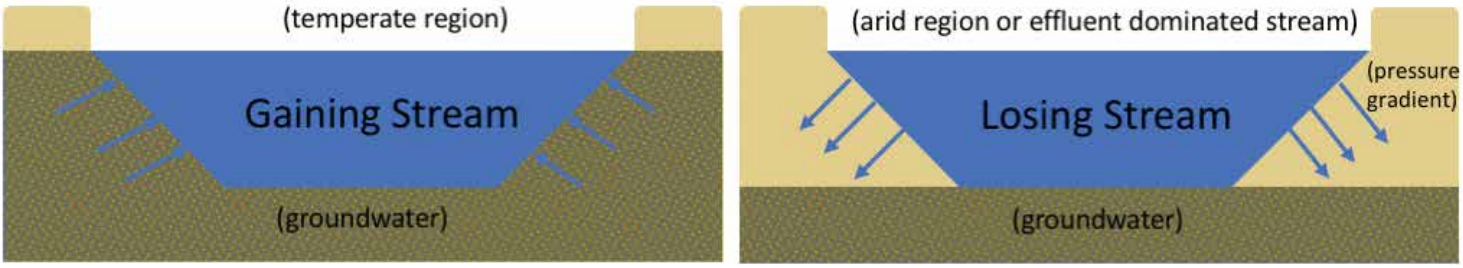

Figure 1: Cross-section diagrams showing the difference between gaining streams (groundwater contributes to stream flow) and losing streams (stream flow contributes to groundwater).

effluent dominated streams. Effluent dominated streams are bodies of water where the majority of the flow for a significant portion of the year comes from treated wastewater. Because there is less water flow to dilute any pharmaceuticals present, the concentrations to which fish are exposed is typically higher. Effluent dominated streams are common in arid regions like Arizona, Colorado, and California—but can also occur in temperate (moist) regions like Iowa. For example, the USGS studied Fourmile Creek near Des Moines, which is an effluent dominated stream that contains pharmaceuticals. The researchers report that pharmaceutics interact with the local groundwater (water that fills the spaces between soil particles) and can actually move into the streambanks. This is because the addition of the wastewater effluent to the stream—at such a high proportion of the natural flow—alters the stream hydrology (the science of Earth's water systems). Specifically, the additional water creates a pressure gradient that causes water to move from the stream into the groundwater and thus transports water-soluble pharmaceuticals. In most temperate regions, groundwater levels tend to be high, and thus groundwater flows into stream, creating a "gaining stream." In most arid regions, groundwater levels are low, so water flows from the stream into the groundwater, creating a "losing stream." The extra flow from a wastewater discharges can alter the hydrology of a temperate region effluent dominated stream such that a gaining stream is transformed to a losing stream due to the pressure gradient (Figure 1). This causes pharmaceuticals in the effluent to travel into the shallow groundwater, where they can remain for a long time.

My laboratory at the University of Iowa in the Environmental Engineering program is collaborating with the USGS and eco-toxicologists to study the presence and effects of pharmaceuticals at a temperate region effluent dominated stream in eastern Iowa. We identified the study site by examining the stream hydrograph (Figure 2) from a stream gage, which shows a diurnal flow pattern that reflects inputs from wastewater treatment. Most hydrographs are smooth flows, with bumps following rain storms, but this stream exhibits a regular pattern related to the inputs of treated effluent (because people use water for dishwashing and flushing in patterns).

Our study objective is to characterize how complex pharmaceuticals charge through space and time and can impact fish. We have now collected water samples every two weeks for a year at the stream and measure pharmaceuticals and their metabolites (compounds formed when the pharmaceuticals transform in the human body or by bacteria during waste treatment). Students and I bring the samples back to our laboratory, process them, and then chemically analyze them using chromatography and mass spectrometry. We are still analyzing data, but have noted that

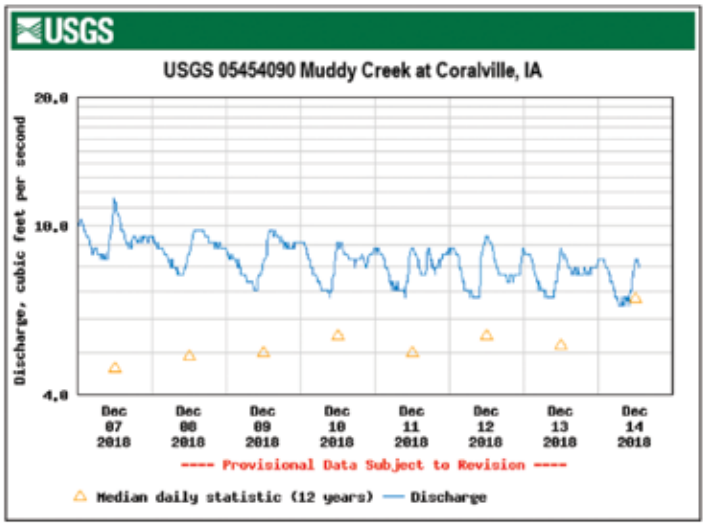

Figure 2: A hydrograph of an effluent dominated stream shows diurnal flows from wastewater inputs.

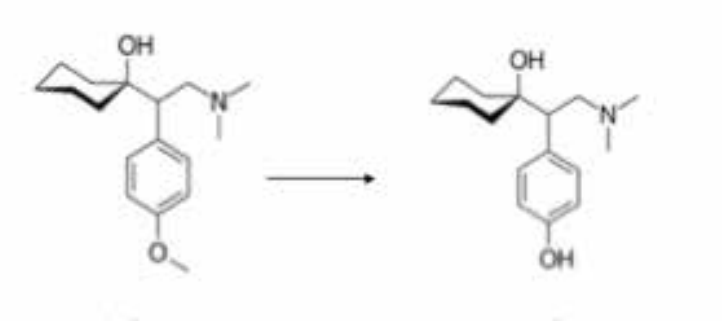

Figure 4: Bacteria can biotransform the pharmaceutical venlafaxine to the metabolite desvenlafaxine (note the loss of the methyl group). Both compounds are bioactive.

pharmaceutical levels in the stream vary significantly by season; for example, allergy medicines are significantly higher in the summer than winter. We also find that some pharmaceuticals are significantly attenuated (lost) 5 km downstream, whereas some are recalcitrant (resistant to degradation) and thus persist in the stream. We are studying formation of chemical transformation products (resulting from chemical reactions) from pharmaceuticals. Chemical reactions involving oxidation-reduction, bacterial metabolism, sunlight, mineral surfaces, and water can generate transformation products. Sometimes transformation products or metabolites can also be bioactive and impact aquatic life (Figure 4). Next year, the study will deploy live, caged fish to study the effects of pharmaceuticals on organisms. Overall, we expect to better understand pharmaceuticals and the effects in effluent dominated streams so we can better engineer treatment systems.

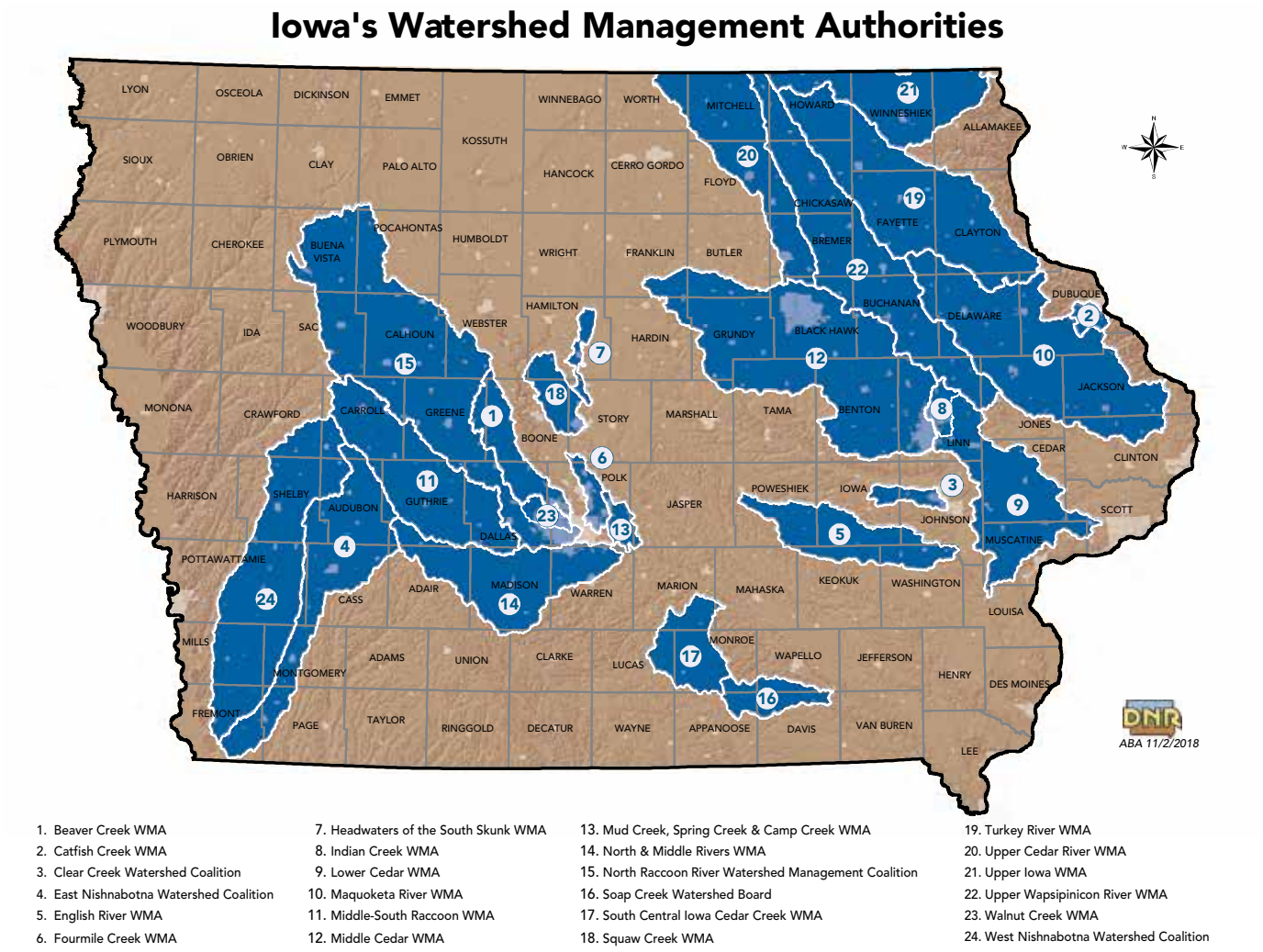

Figure 1. Map of Iowa's WMAs as of November 2017. Source: IDNR

Crossing Political Jurisdictions for Watershed Management

Melissa Miller
Iowa Water Center Associate Director
Iowa State University

Improving water management on a watershed scale is a complex undertaking due to the variety and sheer numbers of stakeholders. Watersheds (an area of land that drains to a common body of water) do not adhere to political jurisdictions; they often cross borders of different cities or towns, counties, and in some cases, states. Each of these different place-based communities brings their own set of cultures, demographics, and regulations; community leaders must acknowledge these differences when engaging in environmental planning and management.

According to the 2001 Iowa Watershed Task Force report, Iowa used a watershed approach for water resource management projects as early as the 1940s, though with little consistency or comprehensive support from the state. In that same report, the multidisciplinary task force called for a framework to enhance cooperation and coordination within watersheds, to build local capacity for watershed initiatives, and to emphasize the role of watershed efforts in flood hazard mitigation. In 2003, the Iowa Water Summit produced a follow-on report, encouraging watersheds to use existing authority under Iowa code for watershed improvement. In 2007, the Watershed Quality Planning Task Force recommended funding for watershed planning on several scales.

Then, in 2008, the state of Iowa experienced some of the worst flooding on record. It resulted in the United State's sixth largest Federal Emergency Management Administration (FEMA) disaster declaration at $848 million in financial public

assistance (2008 Flood Facts, n.d.). The City of Cedar Rapids alone reported the floods displaced an estimated 10,000 people, flooded over 7,700 properties, and impacted more than ten square miles.

Recognizing the urgency of local government cooperation within the watershed, the State of Iowa passed legislation in 2010 authorizing the creation of Watershed Management Authorities (WMA). WMAs are voluntary, intergovernmental planning entities, formed when two or more eligible political subdivisions (cities, counties, and Soil and Water Conservation Districts) within a HUC-8 watershed enter into a 28E (joint exercise of governmental powers) agreement. HUC stand for "Hydrologic Unit Code" and refers to the size of the watershed – to put it to scale, Iowa has 56 HUC-8 watersheds, most spanning several counties and broken into hundreds of smaller "sub-watersheds," or HUC-12s.

The legislation identifies seven duties of the WMAs:

1. Assess the flood risks in the watershed.
2. Assess the water quality in the watershed.
3. Assess options for reducing flood risk and improving water quality in the watershed.
4. Monitor federal flood risk planning and activities.
5. Educate residents of the watershed area regarding water quality and flood risks.
6. Allocate money made available to the authority for purposes of water quality and flood mitigation.
7. Make and enter into contracts and agreements and execute all instruments necessary or incidental to the performance of the duties of the authority. A watershed management authority shall not acquire property by eminent domain.

The seven duties in the Iowa Code tell us what a WMA is supposed to do, but why do community leaders form a WMA to accomplish those tasks? WMAs function as coalitions, organizations within a community that form to achieve a common goal (Feighery and Rogers, 1990). Coalitions are commonly utilized to address public health issues: tobacco cessation, suicide prevention, childhood obesity. Members join coalitions because they believe the community need must be addressed through mutual action (Wood and Gray, 1991). Coalitions have many documented benefits, including the exchange of knowledge, ideas, and strategies, demonstrating and developing community support for an issue, and engaging in new issues without assuming sole responsibility for the outcome (Whitt, 1993).

The first WMA formed in 2012. There are currently 23 WMAs in the state, with additional WMAs in the formation stages. The Iowa Department of Natural Resources (IDNR) maintains an information page about the WMAs, including contact information and website links to individual WMAs.

Just as each community within the WMA is unique to one another, each WMA is different from the next. They are in different stages of development (along a continuum from formation to maintenance to institutionalization), have different funding sources and mechanisms, utilize different staffing models, and engage in planning activities in different ways. The names of the WMAs even differ: while many are called [name of watershed] Watershed Management Authority, some have chosen a name that doesn't include the word "Authority," to signify the cooperative, not authoritative, nature of the organization.

Local decision-making is one thing that WMAs have in common. To overcome the challenges of watershed management - working across political boundaries- representatives from those political boundaries commit to participatory planning, designed to bring people together and manage conflict (LeFevre et. al., 2010). Participatory planning that connects rural and urban stakeholders was the original goal of the WMA legislation, according to those involved in the developing policy (L. Kinman, personal communication, November 17, 2017).

What's next for WMAs? In 2016, stakeholders of the state's WMAs expressed a desire to form a "collaborative body" to help WMAs overcome common challenges in shared governance (Boddy, 2017). With expertise in leading diverse, statewide committees, Iowa Water Center staff volunteered to facilitate the formation of this collaborative body, called "WMAs of Iowa." This group works to unite WMAs for further advancement in the state; share resources, ideas, and best practices; provide support to members through technical assistance and celebrating successes; and build and support ongoing public-private partnerships for success.

How can you be involved with WMAs? Check the map to see if there is a WMA in your area. WMA meetings are public meetings and your attendance is welcome; in fact, a crucial part of participatory planning is citizen engagement. Many WMAs have websites with information about local events or happenings within the watershed. If you don't have a WMA, consider contacting your local elected officials at the city or county level and asking them about their environmental management policies. If they aren't already planning at the watershed scale, invite them to consider forming a WMA.

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Project coordinator Anna Golightly goes over a conservation plan with a farmer in the watershed.

Watershed Work Over The Decades: Planning and Partnerships are Key!

Anna Golightly
Badger Creek Lake Watershed Project Coordinator
Madison County Soil & Water Conservation District

As water quality improvement has become an increasingly important part of our conservation work in Iowa, so have watershed projects. There are currently about 75 active watershed projects in Iowa, and each has a story to tell.

This story is about Badger Creek Lake Watershed, and it begins back in the 1950s, when farmers in the watershed had become concerned about frequent floods, and the damage that floodwaters and erosion were causing to the land. In 1956, those farmers came together to form an organization to promote soil and water conservation and flood prevention.

The watershed was approved for funding through Public Law 566, the Watershed Protection and Flood Prevention Act, and the partners started developing a work plan to identify where practices should be installed in the watershed. The work plan was approved in 1960, and the watershed received over one million dollars to implement the plan. Over 40 structures were built throughout the watershed to reduce flooding and erosion. Badger Creek Lake, the largest of the flood control structures, was built in 1980, and the 269-acre lake became a destination for outdoor recreation, especially fishing.

Added to the List

However, in 1998, the lake was added to the Iowa 303(d) Impaired Waters List. In 2002, a Total Maximum Daily Load (TMDL) was completed by the Iowa Department of Natural Resources (DNR), which identified the causes of the impairment as excessive siltation and

"Things have changed over the past 60 years, but many things remain the same when it comes to conservation work in Badger Creek Watershed."

nutrients. It also identified the problems associated with the impairment, the sources of pollutants, and targets for reducing sediment and phosphorus loads.

The TMDL identified the problem and what to do, but we still needed a plan for how to do it. The Madison and Dallas County Soil and Water Conservation Districts (SWCDs) applied to the U.S. Environmental Protection Agency (EPA) for federal funding from Section 319 of the Clean Water Act to collect data and develop a Watershed Management Plan (WMP), which was approved in 2012.

Then the SWCDs applied for funding to implement the plan. Section 319 funding was approved, and the current watershed project began in 2013. The project uses federal and state funding to support the project coordinator who works with farmers and landowners to provide increased incentives (cost share) to implement conservation practices and to monitor water quality.

Things have changed over the past 60 years, but many things remain the same when it comes to conservation work in Badger Creek Watershed.

Protection from Erosion

Initially, the focus was on the entire Badger Creek Watershed and protecting the land from flooding and erosion. With the impairment of Badger Creek Lake, the focus has shifted to the lake's subwatershed and reducing sediment and phosphorus loading to the lake.

We still depend on planning to give us direction and keep us on track. From the 1960 work plan, to the 2002 TMDL, to the 2012 WMP, to the annual work plans for the watershed project, and the conservation plans we develop with landowners for their farms; these have been the roadmaps for our conservation journey.

We continue to provide technical assistance and cost share for conservation practices. Many of the recommended practices

The watershed project has promoted cover crops since 2013 and works to increase awareness by putting out cover crop field signs.

Leadership from farmers and landowners can kick a watershed project into high gear.

"Many pieces need to come together to make watershed work possible, but perhaps the most important piece - the keystone for getting conservation on the ground - is the farmers and landowners in the watershed!"

are the same (e.g., terraces, waterways, ponds), but now there is also more emphasis on management practices (e.g., no till and cover crops) that promote soil health, improve infiltration, and reduce runoff.

Since its inception, the Badger Creek Watershed has been an organization of partners; in 1956 it was the farmers, the local Soil Conservation Districts, and the Soil Conservation Service (SCS). We still rely on partners for support and funding today; the local SWCDs, Natural Resources Conservation Service (formerly the SCS), Iowa Department of Agriculture and Land Stewardship, Iowa DNR, and U.S. EPA all have a stake in the project. With help from our partners, we have been able to accomplish more together than any one individual, agency, or organization could do alone.

Many pieces need to come together to make watershed work possible, but perhaps the most important piece - the keystone for getting conservation on the ground - is the farmers and landowners in the watershed!

Farmers started the Badger Creek Watershed organization over 60 years ago because they saw how conservation could improve their land while protecting the watershed. They worked together with partners to implement a system of flood control and conservation on a watershed scale. Today, farmers continue to adopt and install conservation practices because they can see the benefit to their farms and because many want to do their part to protect and improve water quality.

Going forward, I expect that watershed projects will continue to require planning, partnerships, funding, people, cooperators, and time. If the watershed is lucky, it will also have leadership from farmers and landowners to kick the project into high gear.

In addition to traditional conservation practices such as terraces, waterways, and grade stabilization structures, the watershed project is also promoting management practices that promote soil health, such as no till and cover crops.

This grade stabilization structure was built to treat classic gully erosion, but it will also capture any sediment coming from the surrounding crop ground.

Iowa Agriculture Water Alliance Iowa Watershed Awards

Sarah Feehan
Communications Intern
Iowa Agriculture Water Alliance

The Iowa Agriculture Water Alliance (IAWA) Iowa Watershed Awards were presented on March 12 at the 2019 Iowa Water Conference in Ames, Iowa. These awards honor watershed coordinators for their many contributions and steadfast dedication to improve water quality across the state.

IAWA developed the Iowa Watershed Awards program with Iowa State University (ISU) Extension and Outreach, Conservation Districts of Iowa, the Iowa Department of Agriculture and Land Stewardship (IDALS), and the Iowa Department of Natural Resources.

Working alongside Farmers to Improve Water Quality

Colton Meyer with the West Branch of the Floyd River Water Quality Initiative (WQI) was named the 2019 Iowa Watershed Coordinator of the Year.

"Colton is a shining example of the positive impact and difference that watershed coordinators can make when they're given the right tools," observes Sean McMahon, Executive Director of IAWA. "His leadership has inspired numerous and diverse partners to pull on the same rope in the same direction at the same time, in alignment with the Iowa Nutrient Reduction Strategy (NRS) and a shared vision to improve water quality in the West Branch of the Floyd."

Meyer was recognized with the Watershed Coordinator of the Year award because of his collaboration and successful engagement with watershed stakeholders, including producers, community members, and public and private entities.

"If I had to give credit to one component of our watershed project, it would be the people," says Meyer. "I can't speak highly enough about the partners and farmers that choose to work with our project voluntarily. The time and effort they contribute to make this project successful and the actions taken to improve soil health and water quality are unparalleled."

The West Branch of the Floyd River WQI has surpassed its no-till goal of 1,200 acres by almost 400%. Its cover crops goal of 1,200 acres has been exceeded by over 200%. Since 2017, both no-till and cover crops continue to see substantial increases in adoption from local landowners and farmers.

Meyer graduated from ISU in 2010. Post-graduation, he returned home to farm before becoming the watershed coordinator for the West Branch of the Floyd River WQI in November of 2016.

"I'm able to tie what I've learned from agriculture with my dad to my degree in environmental science to try to improve water quality," Meyer says. "I think it's a really great fit."

He says his dad has always been environmentally-minded. "Ever since I was a kid, my dad has had some of his most vulnerable acres enrolled in the Conservation Reserve Program (CRP)," he shares, to protect that ground and to provide habitat for pheasant and deer.

"Staying involved with agriculture and being able to work alongside farmers to help develop that relationship is why I chose this career," he says.

Last year, Meyer was honored with the Circle of Excellence award through the inaugural IAWA Iowa Watershed Awards. He has since used a part of the professional development funding from the award to develop his grant writing skills. He took a class that taught him how to strategically look for grant opportunities and how to write grants.

"It was a really great experience," Meyer says. In fact, with his enhanced writing skills, he applied for and was successfully awarded an $181,000 grant from the Mississippi River Basin Healthy Watersheds Initiative (MRBI) for his project in 2019.

Colton Meyer with the West Branch of the Floyd River Water Quality Initiative (WQI) was named the 2019 Iowa Watershed Coordinator of the Year.

The main goal of the new MRBI cost-share is to accelerate the adoption and implementation of conservation practices supported by the Iowa NRS. "By complementing our state funding with these new federal funds, the WQI should attract new farmers and expand the acres of science-based practices among farmers already involved in the project," Meyer says.

Four IAWA Iowa Watershed Award recipients were recognized with the Circle of Excellence award for their unique efforts to work with many diverse partners in an inclusive watershed approach that best fits the landscape of each local area. They include:

- Caleb Waters, Lake Geode Watershed Project
- Erin Ogle, Taylor County Water Quality Initiative
- Julie Perreault, Easter Lake Watershed Project
- Neil Shaffer, Silver Creek Water Quality Project

For more information about IAWA and its mission to increase the pace and scale of farmer-led efforts to improve water quality in Iowa please visit https://www.iowaagwateralliance.com.

IOWA STATE UNIVERSITY
Department of Agronomy

I'M AN
AGRONOMIST

SUSTAINABILITY MASTERMIND

ImAnAgronomist.net

By the time I got to Iowa State, I knew I wanted to make a difference in the world, but I wasn't sure how. Until I learned about implementing sustainable food systems in our world. That's why I'm studying soil, plant, and social sciences and the interactions that support sustainable plant growth. So I can become an agronomist. So I can leave our world better than I found it.