Blue-Green Algae: Unclear Water Raises Issues of Danger

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June 2018

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We gratefully acknowledge the support of the **McKnight Foundation** and the **Fred and Charlotte Hubbell Foundation**. Views expressed are solely the perspective of the authors and the Iowa Policy Project.

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The Iowa Policy Project promotes public policy that fosters economic opportunity while safeguarding the health and well-being of Iowa's people and the environment. By providing a foundation of fact-based, objective research and engaging the public in an informed discussion of policy alternatives, the Iowa Policy Project advances accountable, effective and fair government.

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EXECUTIVE SUMMARY

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Ten years later — the unaddressed problem of cyanobacteria in Iowa

By Carolyn Buckingham, Mary Skopec and David Osterberg

Cyanobacteria, or blue-green algae, cause a water body to be less clear. What is clear, however, is that this substance is more prevalent, and alarmingly may also carry toxins. Blooms may or may not produce a toxin and it is sometimes difficult to know if cyanobacteria are even present.

Fresh analysis confirms warnings in an Iowa Policy Project report nearly 10 years ago that this serious problem is expanding.[1] Cyanobacteria already affect recreational use of Iowa water even with Iowa's limited monitoring of beaches. But the issue is about more than recreation.

The closing of the water system in Toledo, Ohio, in 2014 was a wakeup call for those responsible for ensuring that U.S. drinking water is safe. The U.S. Environmental Protection Agency and Iowa Department of Natural Resources are aware that it is a looming threat to drinking water systems that draw source water from surface waters.

It is also clear that the Iowa Nutrient Reduction Strategy (NRS), designed to confront the addition of nitrogen and phosphorus to Iowa waters, is not addressing the job adequately. New scientific studies show Iowa is not doing enough to stop nutrient pollution. However, one agricultural practice endorsed by the NRS — vegetative buffers — can become a potent policy if it is greatly expanded. Establishing buffers along water bodies is a valuable agricultural practice beneficial to wildlife, aesthetics, and the removal of nutrients. They are very effective in reducing phosphorus loads to water inside the state and from the state to the hypoxia zone in the Gulf of Mexico.

While such buffers are among the practices being promoted by Iowa's NRS, stronger action is necessary. Iowa should follow Minnesota and Vermont to make such buffers mandatory. We agree with the Environmental Working Group that this practice is the "low-hanging fruit" that should be used to reduce Iowa's serious nutrient pollution problem. That is why we conclude that our goal should be to buffer all Iowa streams in the next 10 years — a reasonable goal and one far less arbitrary than to have no timeline at all — the present situation with the NRS.

As cyanobacteria becomes even more of an issue, buffers are almost designed to contribute greatly to its control. Buffers directly address the nutrient problem that is making cyanobacteria blooms worse but they will also add carbon storage to Iowa farms, which indirectly contributes to confronting and curbing climate change, the other reason blooms are proliferating. In this sense vegetative buffers address two problems at once: climate change and polluted runoff.

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[1] Heffernan, Andrea and Teresa Galluzzo. Scum in Iowa's Waters: Dealing with the Problem of Excess Nutrients. (2009) Iowa Policy Project.

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INTRODUCTION

Annie, Fannie and Mike are names used by some researchers to describe three genera of cyanobacteria that commonly form blooms. The toxins produced by *Anabaena*, *Aphanizomenon* and *Microcystis* can make algal blooms more than a mere inconvenience.[1] There is also *Cylindrospermopsis* but Microcystis and to an extent Cylindrospermopsis are the ones on which we concentrate in Iowa.[2]

Cyanobacteria, also known as blue-green algae, cause a water body to be less clear. But, also less clear, is whether a particular bloom is actually toxic. An Iowa Policy Project report warned nearly 10 years ago of this expanding problem in Iowa.[3]

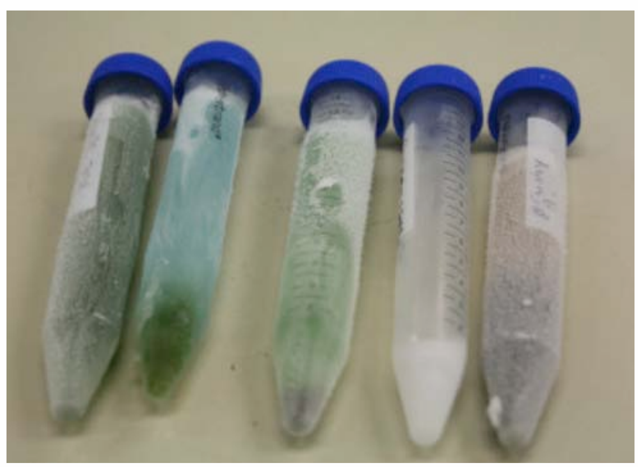
As authors Andrea Heffernan and Teresa Galluzzo point out, it is difficult to be appropriately cautious around cyanobacteria. "It is not possible to tell whether a bloom contains cyanotoxins just by looking at it. It is natural to avoid cyanobacterial blooms that have risen to the surface as they tend to look unpleasant and have a foul smell. However, because some blooms will remain below the water's surface, it is not always possible to tell where harmful algae blooms are located."[4]

The present IPP report should find an audience that is more aware of the dangers of this water contaminant,

Blue-green algae: What's the problem?

Cyanobacteria are a form of bacteria present in various aquatic environments and when conditions are favorable for them — abundant nutritional sources, adequate sunlight and temperature — cyanobacteria can reproduce rapidly and form high-density blooms. Some blooms, known as cyanobacterial harmful algae blooms, will produce and release toxins. These harmful algae blooms contaminate waterways and are harmful to wildlife and humans that come into direct contact with contaminated water. When the blooms occur in drinking water sources, they can also cause difficulties in water treatment.

Heffernan and Galluzzo (2009) Iowa Policy Project



Test tubes on Aug. 2, 2015 show samples from (left to right) Lake Wapello, Black Hawk Lake, Kent Park Lake, Green Valley Lake and Brushy Creek Lake after processing. The blue and green sample from Black Hawk and the clear sample Green Valley tested above the health advisory levels for microcystin. Kent Park's levels were elevated, at 12.5 micrograms per liter, but did not require an advisory.

Lauren Mills, IowaWatch

particularly due to the well-reported problem experienced by the City of Toledo, Ohio, in the summer of 2014. Between August 2, when a "do not drink" water advisory was issued, until August 7 — when the water plant returned to full capacity — the local newspaper, the *Toledo Blade*, had dozens of newspaper and breaking news articles on the water crisis in the city. In the next weeks there were dozens more as the topic continued to be newsworthy.[5] The crisis was national news. *The New York Times* wrote an extensive article.[6]

Cyanobacteria are organisms more commonly known about now than when the first IPP paper appeared, but what are we doing about it? Is the problem worse than it was in 2009? Is Climate Change making it worse? Is the Iowa Nutrient Reduction Strategy, our state's main way of addressing water pollution, adequate to address this particular problem?

HOW DANGEROUS ARE CYANOBACTERIA?

Source: Iowa Environmental Council

A recent publication of the Centers for Disease Control and Prevention (CDC) addresses the problem the agency describes as Harmful Algal Blooms (HABs). CDC begins to address some of our questions:

> *HABs appear to be increasing in frequency along the coastlines and in the surface waters of the United States according to the National Oceanic and Atmospheric Administration (NOAA). These increases are likely responses to an overabundance of nutrients, such as nitrogen from fertilizers, and warmer temperatures associated with climate change.*[7]

The CDC lists "dos" and "don'ts" of prevention and protection:

> ***Protect yourself, your family, and your pets from exposure to cyanobacterial HABs (CyanoHABs):***
>
> - *Don't swim, water ski, or boat in areas where water is discolored or where you see foam, scum, or mats of algae on the water. If you do swim in water that might have a CyanoHAB, rinse off with fresh water as soon as possible.*
> - *Don't let pets or livestock swim in or drink from areas where the water is discolored or where you see foam, scum, or mats of algae on the water. If pets (especially dogs) swim in scummy water, rinse them off immediately — do not let them lick the algae (and toxins) off their fur.*
> - *Don't irrigate lawns or golf courses with pond water that looks scummy or smells bad.*
> - *Report any "musty" smell or taste in your drinking water to your local water utility. Respect any water-body closures announced by local public health authorities.*[8]

Don't drink contaminated water and don't let your kids or your dog swim in it.

Nitrogen and Phosphorus boost blue-green algae

Cyanobacteria are an ancient life form. For a billion years it helped produce the oxygen we breathe on earth.

Some of the many varieties can fix Nitrogen which has pointed to limiting Phosphorus as a way to cut back on its blooms. However, both Nitrogen and Phosphorus — both heavily used in Iowa — contribute to its rapid growth.

Xu, H., H. W. Paerl, B. Q. Qin, G. W. Zhu, and G. Gao. 2010. Nitrogen and phosphorus inputs control phytoplankton growth in eutrophic Lake Taihu, China. Limnology and Oceanography 55:420–432.

Exposure to the HABs come in many forms. Dermal contact and ingestion during recreation is one problem. Consumption of drinking water and food is another route of exposure. Also, inhalation of toxins from aerosols, as from taking a shower in your home can be dangerous.[9]

There are also many health effects that can originate from these toxins. Liver and kidney toxicity, vomiting, diarrhea and fever are dangers. Some substances in the family of cyanobacteria are neurotoxic and cause paralysis and seizure. There can also be dermatoxic effects causing skin lesions or rashes, irritation to eyes, throat and ears.[10]

Other sources show that dogs are particularly susceptible to the adverse effects of cyanotoxins and a large number of canine deaths that are attributed to cyanotoxin exposure are reported in the United States each year.[11] Wildlife and livestock deaths due to exposure are also reported on a periodic basis.[12]

HOW HAS THE ENVIRONMENTAL PROTECTION AGENCY RESPONDED TO HARMFUL ALGAL BLOOMS?

There are two components in reducing the risk posed by cyanobacteria toxins. One relates to protecting or treating drinking water from toxins. The other approach is directed at reducing human contact through recreational activities.

Safe Drinking Water Act

Under the Safe Drinking Water Act (SDWA), every five years the U.S. Environmental Protection Agency must publish a list that identifies unregulated contaminants that are known or expected to occur frequently in public water systems around the country and that are a public health concern at certain levels.[13] The EPA also recognizes these contaminants as those where there might be a meaningful opportunity to develop regulations that help to reduce the health risks associated with the contaminants. This EPA list is also known as the Contaminant Candidate List (CCL). Cyanobacteria and cyanotoxins were listed on the first and second CCL in 1998 and 2005, respectively, and based on toxicological, epidemiology and occurrence studies, the CCL lists in 2009 and 2016 included anatoxin-a, cylindrospermopsin and microcystin-LR.[14] But while cyanobacteria and cyanotoxins are listed on the CCL, the contaminants on this list are not subject to any proposed or promulgated drinking water regulations.[15] The EPA instead uses the CCL to collect information and to identify contaminants that may need to be regulated in the future.

Before 2015, no federal or state regulations governed how to respond to a harmful algal bloom in drinking water. But in June 2015, (the summer after the Toledo, Ohio, outbreak) the EPA released a set of guidelines that outlined the monitoring, analysis, and response to cyanobacteria toxins, primarily microcystin and cylindrospermopsin, in drinking water sources.[16] The guidelines were purely voluntarily and not enforceable. However, in December of that year, also pursuant to the SDWA, the EPA proposed revisions to the Unregulated Contaminant Monitoring Rule (UCMR 4), which included 10 cyanotoxins that are to be monitored between 2018 and 2020 using analytical methods developed by the EPA. Under the UCMR 4, public water systems must monitor the 10 cyanotoxins during a four-month consecutive period between March 2018 and November 2020. All public water systems that serve more than 10,000 people are required to participate in the monitoring program.[17] Of the water systems serving less than 10,000 individuals, only 800 will be randomly selected for participation.

Beach monitoring to keep people and pets safe

To date, state efforts to sample for cyanotoxins and inform the public of any health risk has consisted of a patchwork of approaches and advisory levels. EPA developed materials in 2016 to assist recreational waterbody managers with monitoring and responding to cyanobacteria and cyanotoxins using common advisory thresholds.[18] However, as with the drinking water guidance, these materials are not enforceable and thus do not mandate any sort of action when it comes to harmful algae blooms in recreational waters.

WHAT IS THE STATE OF IOWA DOING ABOUT CYANOBACTERIA?

Iowa Microcystin Surveillance Study of Iowa's Public Water Supply Systems: July 11, 2016 – June 26, 2017

Source: NutritionFacts.org

While EPA has only just begun a national study of the presence of cyanotoxins at water treatment plants, the state of Iowa has completed a preliminary study of the question. A survey fielded between July 2016 and June 2017 looked at 28 treatment plants at 26 community public water systems in the state. Twenty-three of the plants took water from surface water sources and five took source water from influenced groundwater sources (IGW). Such systems pull water from close to a surface water source but the water is filtered through soil before it enters the treatment plant.

During the 51 weeks of testing there were no confirmed detections of total microcystin in finished water. Eleven of the 26 systems had at least one sample above the method detection limit (0.3 ug/L total microcystin) in raw water. No detections were found in the five IGW systems.

The timing of the detections reveals weaknesses in the traditional monitoring programs. Typically, contaminants move during times of rainfall — when they are washed from the land into nearby waterbodies. In the case of algal toxins, the algae use the nutrients delivered in the spring, but tend to bloom during the hot and stagnant months of late summer. Toxins are held within the cells and are not released until the cyanobacteria die and begin to decompose. Toxins are relatively slow to degrade and may be detected months after the algae disappear. Monitoring programs detect toxins during the summer bloom cycles, but rarely continue into the late summer and fall even though blooms may still be active and toxins are being released into the waters. The Iowa drinking water study illustrated this issue — the peak detection in raw water samples was the week of October 24th when 10 systems (38 percent of the total) occurred. Additionally, toxin was still detected in one system on December 27th.[19]

Des Moines Water Works' experience with microcystin in finished water

The state's largest drinking water system was not included in the DNR survey because its testing for all contaminants is extensive and more sophisticated than nearly every other system in the state. Des Moines Water Works (DMWW) detected microcystin in finished water during the period the DNR was doing its sampling. In response, DMWW made the following announcement on August 3, 2016:

Source: Des Moines Water Works

> *Drinking water samples analyzed by Des Moines Water Works show microcystin, a compound produced by cyanobacteria (or commonly*

referred to as blue-green algae), has been detected in the treated drinking water. At this time, there are no restrictions on water use. The United States Environmental Protection Agency has established national health advisory levels for microcystin when these compounds are detected in drinking water for at least 10 days. While Des Moines Water Works has detected elevated levels for only two days, and testing performed today shows results below advisory levels, the utility is exercising an abundance of caution in notifying customers of the detection of microcystin.[20]

Besides notification to users, the DMWW also changed its water source from the Raccoon River to the Des Moines River, which was not experiencing cyanobacteria blooms at the time. DMWW has initiated an aggressive testing program for microcystin and cylindrospermopsin and to this date there have been no new occurrences in finished water. [21]

Beach Monitoring in Iowa

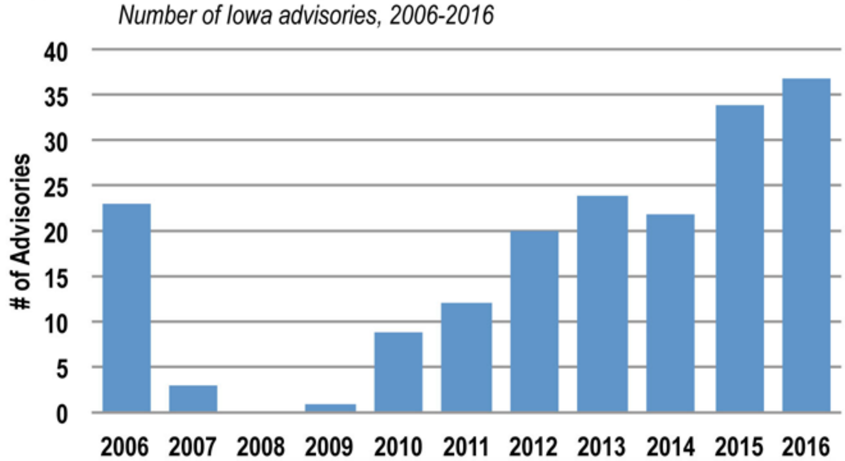
The state of Iowa has been measuring microcystin, one common toxin among the several produced by cyanobacteria, since 2006. Prior to that, the Iowa Department of Natural Resources measured bacteria levels at state park beaches to determine public health risk from contact with recreational waters. Microcystin was added to the monitoring program after a large bloom occurred at a popular beach resulting in the first swimming advisory in Iowa.

To assess risk from recreational uses, weekly measurements are taken at 39 state-owned beaches from Memorial Day through Labor Day when the beaches get their heaviest use. The sampling regimen follows EPA beach monitoring guidance established in the early 2000s. Samples are collected on either Monday or Tuesday and analyzed for microcystin toxin levels by the end of the week for reporting to the public. The Iowa DNR used the World Health Organization (WHO) guidance for issuing advisories based on a total microcystin threshold of 20 parts per billion.

Results from the Iowa DNR testing program show that the number of advisories steadily increased from 2009 through 2016 (Figure 1). More worrisome is that the number of lakes with an advisory also increased during this time (Figure 2). In 2009, nearly 50 percent of the monitored beaches in Iowa had an advisory recommending against swimming due to microcystin levels (17 of 39). In 2017, Iowa DNR altered protocols regarding testing and therefore data from 2017 may not be comparable to previous years and is not included in this report.

Figure 1. Increased Microcystin Advisories from 2009 through 2016

Number of Iowa advisories, 2006-2016

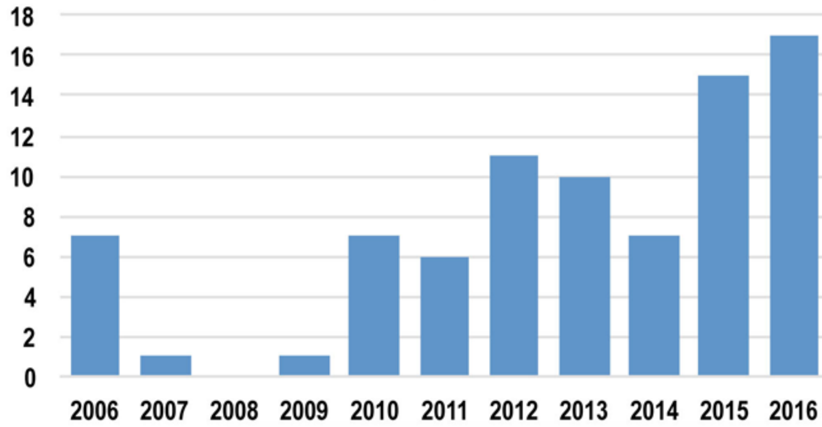


Mary Skopec

Recently, concerns about the adequacy of the WHO guidance have been raised and whether the threshold of 20 parts per billion (ppb) used to determine an advisory is protective enough for vulnerable populations (e.g. children). According to the WHO, the relative risk of acute human health effects is considered "high" at microcystin levels of 20 ppb and above. California uses a trigger warning threshold of 6 ppb, Illinois uses 10 ppb and Indiana uses a tiered system that starts as low as 4 ppb to warn citizens against contact with recreational waters .[22]

Figure 2. Growing Number of Iowa Lakes Face Microcystin Advisories

Number of Iowa lakes advisories, 2006-2016

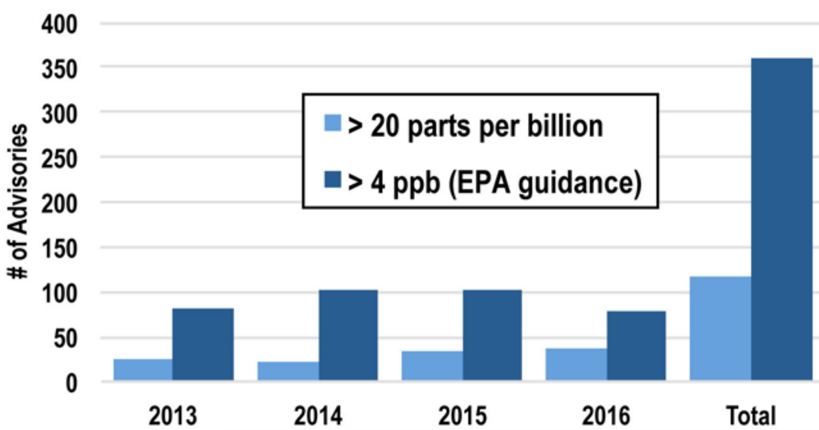


Mary Skopec

The lack of research that establishes clear thresholds for recreational use of waters with cyanotoxins has hampered states' ability to set policy. EPA produced draft guidance that proposes a microcystin threshold of 4 ppb and a cylindrospermopsin threshold of 8 ppb. Data from Iowa shows that a lowering of the microcystin threshold to 4 would more than triple the number of advisories issued (Figure 3). Lastly, few states (including Iowa) collect data on other cyanotoxins such as anatoxin, saxitoxin, cylindrospermopsin, which further leaves beach goers vulnerable to potential health risk from these compounds.

Figure 3. Stricter Microcystin Threshold Would Triple Advisories

Number of Iowa advisories under current standard vs. EPA guidance



Mary Skopec

WHY ARE CYANOBACTERIA MORE PREVALENT? WHAT IS CAUSING THE PROLIFERATION?

Cyanobacteria are capable of multiplying rapidly, particularly if the conditions are ideal for growth. In order to bloom, cyanobacteria typically require warmer water temperatures and a significant amount of nutrients. Accordingly, harmful algal blooms are occurring with increasing frequency as global temperatures rise and as more nutrients, such as nitrogen and phosphorus enter waterways.[23] In other words, climate change and increased levels of human-caused nutrient pollution in lakes, rivers, and other water bodies have played a substantial role in the growing regularity of harmful algal blooms.

Climate Change's Contribution to Increasing Algal Blooms

As global temperatures rise due to climate change, harmful algae blooms are proliferating in more and more regions since cyanobacteria have a tendency to out compete other types of algae in warmer temperatures.[24] Additionally, with warmer spring and fall weather, the harmful, toxic blooms tend to appear earlier and stay around for a lengthier period of time.[25]

In addition to the warmer water temperatures, increased carbon dioxide levels encourage the growth of harmful algal blooms. This is due to the fact that cyanobacteria need carbon dioxide to support photosynthesis, and the blooms that occur on water surfaces can draw the gas directly from the atmosphere.

Finally, climate change can also promote harmful algal blooms by causing hydrologic and weather changes within watersheds. For instance, changes in rainfall and weather patterns can lead to periods of drought followed by intense storms, particularly in the early spring. A heavy rainfall can cause a significant amount of nutrients to runoff into waterways, which can create the perfect conditions for algal blooms.[26]

Increased Nutrient Runoff Also Contributes to the Proliferation of Algal Blooms

Increased nutrient runoff resulting from human activities also cause algal blooms to thrive.[27] Many naturally occurring nutrients are found in soil and water, including nitrogen and phosphorus, but human activities have significantly contributed to an increase in the level of nutrient pollution in rivers and lakes. For instance, treated wastewater expelled from sewers and septic systems and runoff from towns and cities can cause additional nutrients to enter waterways.[28] In addition, household products like yard fertilizers and detergents, and even pet waste, can also contain phosphorus and nitrogen that wind up in water systems.[29] However, agricultural pollution, such as manure, fertilizer-laden runoff, and soil erosion, is one of the most substantial sources of nutrient pollution in the United States.[30]

According to the EPA, approximately 41 percent of the rivers and streams in the United States have elevated levels of nitrogen, and nearly 46 percent have high levels of phosphorus.[31] Just as nutrients like nitrogen and phosphorus are effective fertilizers for growing crops, they promote or aid in the growth of harmful algal blooms.[32] But unlike terrestrial plants, algae need significantly fewer nutrients to grow and multiply and, in fact, a single pound of phosphorus can provide enough nutrients to produce up to seven hundred pounds of algae.[33] So while a comprehensive plan to solve the algal bloom problem does include steps to slow down climate change, determining a solution that reduces the amount of nutrient pollution entering waterways also should play a big role in preventing harmful algal blooms.[34]

ARE PRESENT PROTECTIONS ADEQUATE?

The federal Clean Water Act

Under the Clean Water Act, it is illegal to discharge pollutants from a point source into the waters of the United States without a National Pollutant Discharge Elimination System (NPDES) permit.[35] However, nonpoint sources of pollution, such as agricultural runoff, are not included in the NPDES permitting structure.[36] Nonpoint source pollution is any source of water pollution that does not meet the federal Clean Water Act's definition of a "point source," which is an identifiable point from which a polluted discharge occurs, such as a pipe, ditch, or channel.[37] As the runoff, which is water that leaves farm fields due to rain, melting snow, or irrigation, moves across and off the fields, it carries harmful pollutants and sediment that are later deposited into lakes, rivers, streams, and other waterways, causing significant damage to water quality.[38]

Agricultural activities that cause nonpoint source pollution include poorly located or managed livestock feeding operations, intensive crop production, poorly managed livestock grazing, and manure and fertilizer runoff from farm fields.[39] Farmers and landowners can limit harmful runoff and soil erosion by managing facility and field wastewater and runoff with appropriate waste management systems and conservation practices. However, not all agricultural operations or facilities are monitored to ensure that proper waste management systems or conservation practices are in place, and unfortunately, current environmental and health regulations are inadequate to protect water sources from the adverse effects of agricultural operations. The Clean Water Act handles nonpoint source pollution inadequately, and the regulation of nonpoint source pollution in Iowa either lacks mandatory practices to curb pollution or adequate enforcement and monitoring procedures. As a 2017 federal court found in the lawsuit filed by the DMWW, agricultural runoff is not regulated by the federal Clean Water Act. Other measures must be used to attack the problem and one is the Iowa Nutrient Reduction Strategy (NRS).

The Iowa Nutrient Reduction Strategy

The NRS is a plan or framework that was created by the Iowa Department of Agriculture and Land Stewardship, the Iowa Department of Natural Resources, and the Iowa State University College of Agriculture and Life Sciences to assess and address the environmental and health effects of nutrient pollution within and outside of Iowa. The purpose of the NRS is to direct efforts to reduce the amount of nutrients that flow into surface waters from both point sources such a wastewater treatment plants and nonpoint sources such as farm fields. The NRS was originally prompted by the 2008 Gulf Hypoxia Action Plan that calls for Iowa and other states along the Mississippi River to develop strategies to reduce nutrient loadings in the Gulf of Mexico. The Action Plan set forth a goal of reducing total nitrogen and phosphorus loads by 45 percent. Some actions used to comply with the goals of nutrient runoff reduction under the NRS include the implementation of land management practices such as taking crop land out of production, changing tillage systems, planting cover crops and installing vegetative buffers. [40]

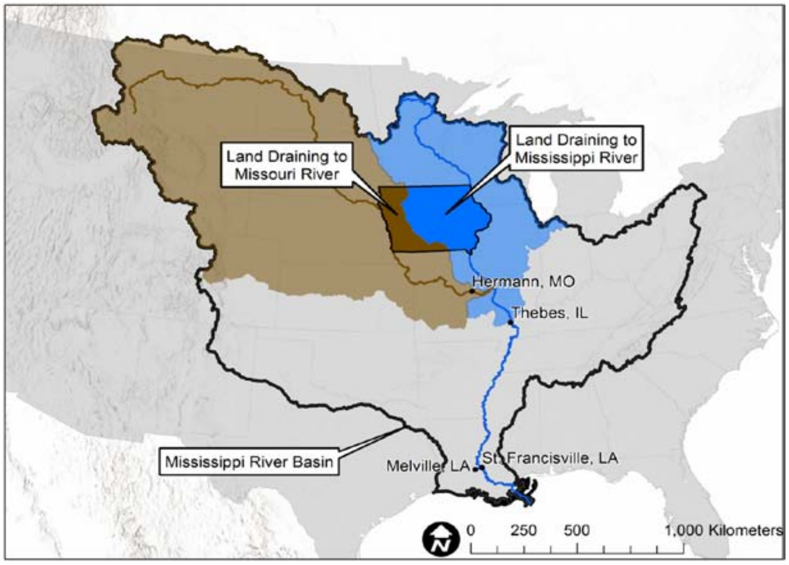
In December 2017, the latest annual NRS progress report provided updates on point-source and nonpoint-source efforts to reduce the nitrogen and phosphorus loads leaving Iowa. While the report noted that there was some progress in the work being done to improve water quality, even Iowa Deputy Secretary of Agriculture Mike Naig stated that efforts need to be scaled-up and accelerated.[41] So even though there was an increase in private and public-sector funding for NRS efforts during the 2018 Iowa legislative session, more is needed to address the nutrient runoff and harmful algal bloom problem. The fact that the NRS is not enough is evident given a recent report noted below about Iowa stream nitrate and the Gulf of Mexico.

The Jones study-more reason for concern

A recent report by Christopher Jones, et al., found that Iowa's nitrate contribution to the Mississippi River system is disproportionate compared to other states in the watershed and Iowa's landscape and land management practices are likely to blame. The 2018 Jones report looked at three segments of the river system, dividing it into the Mississippi-Atchafalaya River Basin (MARB) below where the Missouri River joins the Mississippi; the Upper Mississippi River Basin (UMRB); and the Missouri River Basin (MoRB). Iowa's average nitrate or NO3-N contribution to the various river segments during the years 1999 to 2016 were MARB = 29%, UMRB =45% and MoRB = 55%. These percentages are far in excess of Iowa's land area or runoff into the river systems. In other words, Iowa's disproportionate nitrate contribution to the river systems is not consistent with its contribution of water to those systems.

> *In the MARB, the state contributes 5.9% of the water and 29% of the NO3-N while occupying 4.5% of the basin area; for the UMRB, 21% of the water and 45% of the NO3-N with 21% of the*

land area; and for the MoRB, 12% of the water and 55% of the NO3-N but only 3.3% of the watershed area. [42]



Source: Jones, et al

Not only does Iowa have a much larger percentage of its land in crop production than other states in the basin, but the study found that the supply of NO3-N escaping farm fields is higher in Iowa which explains some of this dominance in nitrate pollution.

However, these factors do not explain what has happened recently. Unlike other states, Iowa is increasing its nutrient contribution to the dead zone in the Gulf of Mexico, implying that changes have either occurred in the Iowa landscape that are increasing NO3-N loads, or that changes are occurring in the non-Iowa areas that are preventing increases in NO3-N loading. Because other states in the basin significantly expanded their crop ground while Iowa did not (since so much of the state was already in row crop production), the authors concluded any landscape changes that have been driving NO3-N loading include crop and field management and specifically, drainage tile in Iowa:

> *Although accurate records are sparse to non-existent, much of Iowa's farmland requires artificial drainage to optimize conditions for corn and soybean production. There is anecdotal evidence that improvements in Iowa's drainage infrastructure have been extensive in recent years. Since this is the primary NO3-N delivery mechanism for Iowa streams, it would seem reasonable that this could be affecting NO3-N loads in Iowa more than other states where constructed drainage is less common.* [43]

The report makes clear that Iowa's NRS has not been adequate to address the state's nutrient runoff problem.

The Schindler study-taking the spotlight off Nitrogen

The Jones paper indicates that the NRS is inadequate. However, another recent paper has offered another solution. The 2016 Schlindler et al. article joins a long debate over which nutrient is the main contributor to algae blooms. The study concludes that phosphorus and not nitrogen is significantly more responsible for algae blooms and thus phosphorus is the nutrient on which policy should concentrate. Moreover, controlling phosphorus may be less expensive to control than nitrogen.[44] This IPP report in no way suggests we should ignore nitrogen, particularly given its impact on drinking water, but tackling the phosphorus problem can be an effective way to prevent harmful algal blooms.

The NRS scientific underpinnings show different practices affect nitrogen and phosphorus differently

The science assessment of nonpoint source practices for the NRS lists agricultural practices and the amount they can be expected to reduce both nitrogen and phosphorus. Taking land out of production with such practices as the Conservation Reserve Program is a major one. However, moving the acres in the program from approximately 1.7 million acres back to the more than 2 million acres enrolled in the early 2000s depends on federal not state policy.

Planting cover crops is another practice that has been promoted by the NRS. However, very few acres of cover crops are in place. The latest NRS progress report questions how much the program can be depended upon:

> *In fall 2016, 300,000 acres of cover crops were planted through cost-share funding, up from 260,000 in 2015. This data, however, does not account for the total acres of cover crops implemented in Iowa without cost-share funding. Estimates suggest that at least 600,000 acres of cover crops were planted in fall 2016. This assessment is promising in that cover crop adoption began on a wide scale in 2011. However, to correspond with the NRS scenarios 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 subsequent years.*[45]

A practice that covers many more acres is tillage improvement. Data from the latest NRS Annual Report lists the different tillage methods used on Iowa cropland (right). [46]

Conservation tillage	*8,760,000*
No-Till	*6,951,000*
Conventional tillage	*7,883,000*

Changing from conventional tillage seems to have the capacity to impact many more acres than encouraging cover crops.

THE MISSING PRACTICE

The importance of buffers

The CRP, cover crops, and changing tillage are all programs that should help reduce Iowa's nutrient pollution runoff to waterways. However, if phosphorus is the primary pollutant that should be controlled, buffers along streams, rivers, lakes, and other waterbodies stand out as a practice that should be greatly expanded.

Buffers, which are also known as riparian filter strips, are vegetated or grassy strips of land that are adjacent to rivers, lakes, streams or wetlands.[47] Vegetative buffers are an important conservation practice that help to keep water clean as they can filter out nitrogen, phosphorus, sediment and other pollutants that might run off of agricultural fields.[48] Buffers have the added advantage of creating habitat for animals along waterways and establishing wildlife corridors that allow animals to move from areas that are disrupted by development and the effects of climate change. The NRS science assessment demonstrates their multiple benefits but also their limitations for nitrogen removal:

> *Buffers along streams come in many sizes and shapes and can host a diverse plant population. Buffers additionally have habitat benefits, provide animal corridors, reduce sediment transport from fields, and stabilize stream banks. Only nitrate in water passing through the root zone of a buffer will be impacted by denitrification, therefore, the effect of buffers in tile-drained landscapes may be limited because only a small proportion of the total water yield passes through the root zone and tile flow is shunted through the buffer via the drainage pipe. However, the literature survey indicated an average nitrate-N concentration reduction of 91% for water actually passing through a buffer root zone. Many factors influence buffer performance including buffer width, vegetation type/age, and depth to the water table, yet nitrate-N removals are high in all situations.* [49]

While drainage tiling makes stream buffers less effective in controlling nitrogen, they are very effective of stopping soil loss and keeping phosphorus out of waterways. [50]

In Iowa, there are no laws or regulations that require the installation of vegetative buffers. The only mention of vegetative buffers or filter strips in the Iowa Code or Iowa Administrative Code are in the context of alternatives or exceptions to setback distances that are required in the case of land applying manure to farm fields.[51] A 2015 study by the Environmental Working Group calls stream buffers the low hanging fruit of nutrient removal in Iowa. In the study, EWG found that if Iowa implemented a buffer requirement of 35 feet along streams, it would affect a relative handful of Iowa landowners and cropland acres but would provide a boost to water quality.[52]

Minnesota: Setting an Example for States with Poor Water Quality

Minnesota's buffer law, signed by Governor Mark Dayton in June 2015, is an interesting model law for Iowa and other states that are struggling to clean up their rivers, lakes, streams, and other waterbodies that are polluted with agricultural runoff. The law requires the establishment of new perennial vegetation buffers of up to 50 feet along rivers, lakes, and streams and smaller buffers of 16.5 feet along most farm drainage ditches.[53] As is evident by studies reported by the Minnesota Pollution Control Agency, buffers are "critical to protecting and restoring water quality and healthy aquatic life, natural stream functions and aquatic habitat due to their immediate proximity to the water."[54] The Low Hanging Fruit report by EWG demonstrates that a law in Iowa that is similar to Minnesota's buffer law would really stimulate progress toward reducing polluted runoff from farm fields.[55]

Vermont: Another State that Requires Buffers

In July 2015, Vermont Governor Peter Shumlin signed Act 64, or the Vermont Clean Water Act, into law. Act 64 directed the Vermont Agency of Agriculture, Food and Markets (VAAFM) to update the state's Accepted Agricultural Practices (AAPs) to further reduce the impact of agriculture on water quality in Vermont.[56] The updated AAPs were renamed "Required Agricultural Practices," and were rewritten to reflect some additional requirements, including requirements that now apply to small Vermont farms.[57]

Included in these RAPs is a vegetative buffer provision that mandates a 25-foot vegetative buffer zone of perennial vegetation between croplands and the top of the bank of adjoining surface waters. Ditches must also be buffered from croplands by 10 feet of perennial vegetation, and surface inlets or open drains must be buffered by 25 feet of perennial vegetation. There are few exceptions to the buffer zone width requirements but in no case may buffer zones be less than 10 feet in width.[58]

The vegetative buffers in the Vermont RAPs are not as wide as some of those that are required in Minnesota, but Vermont's buffer regulation is an additional example that Iowa should look at, particularly because of its applicability to small farms.

The 2016 Iowa Climate Science Statement: Additional Proof Buffers are Beneficial and Necessary in Iowa

Over the last several years, researchers and educators at Iowa's universities and colleges have produced annual statements that discuss the impacts of climate change on Iowans. The sixth annual statement, entitled "Iowa Climate Statement 2016: The Multiple Benefits of Climate-Smart Agriculture," was released in October 2016.[59] The statement described the benefits of more widespread adoption of proven soil conservation practices and mentioned that the April 2015 USDA initiative Building Blocks for Climate-Smart Agriculture was a program that farmers, ranchers, and forest owners could use to confront climate change.

According to the statement, one way in which Iowa could become a leader in Climate-Smart Agriculture was through the creation of "carbon-storage farms." By transforming marginal croplands to perennial vegetation in land set-aside programs, carbon that would otherwise be released into the atmosphere could be stored permanently in soil and have the added benefit of reducing nitrogen, phosphorus, and sediment runoff. These carbon-storage farms could thereby reduce net greenhouse gas emissions that contribute to climate change by pulling heat-trapping carbon dioxide from the atmosphere while also improving soil health (soil carbon), wildlife and pollinator habitat, and water quality.

Although transforming whole agricultural fields that have previously been in production to deep-rooted perennial vegetation in order to store carbon would be beneficial, it may not work for some farmers for a variety of reasons. However, planting permanent vegetative buffer strips along Iowa's waterways might be a more feasible and less expensive alternative that could produce a similar carbon-trapping effect that ultimately curbs climate change.

Conclusion:
Iowa Needs a Mandatory Buffer Law to Adequately Address the State's Harmful Algal Bloom Problem

Cyanobacteria is a serious problem that already affects recreational use of Iowa water. Iowa's limited monitoring of beaches shows this threat is growing. The EPA and the Iowa DNR are aware that it is becoming a looming threat to drinking water systems that draw source water from surface waters.

Establishing vegetative buffers along water bodies is a valuable agriculture practice that is beneficial to wildlife, aesthetics, and the removal of nutrients. These buffers are very effective in reducing phosphorus loads to water inside the state and from the state to the hypoxia zone in the Gulf of Mexico.

While such buffers are among the practices being promoted by Iowa's NRS, stronger action is necessary. Iowa should follow Minnesota and Vermont to make such buffers mandatory. We agree with the Environmental Working Group that this practice is the "low hanging fruit" that should be used to reduce Iowa's serious nutrient pollution problem. That is why we conclude that our goal should be to buffer all Iowa streams in the next 10 years. While 10 years is arbitrary, more arbitrary is to have no timeline at all — the present situation with the NRS.

As cyanobacteria becomes even more of an issue, buffers are almost designed to contribute greatly to its control. Buffers directly address the nutrient problem that is making cyanobacteria blooms worse but they will also add carbon storage to Iowa farms, which indirectly contributes to confronting and curbing climate change, the other reason blooms are proliferating. In this sense vegetative buffers address two problems at once: climate change and polluted runoff.

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