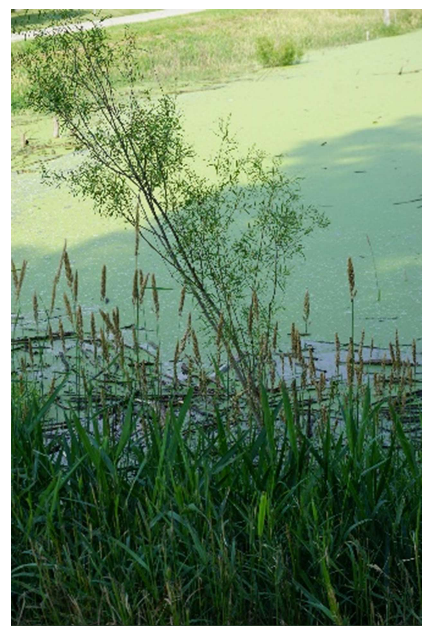
Iowa's Nutrient Problem –
Iowa is the Major Contributor to the Dead Zone in the Gulf of Mexico

For many years the media have been reporting on Iowa's nutrient reduction strategy and the dead zone in the Gulf of Mexico off the coast of Texas and Louisiana.

The dead zone, also called hypoxic zone, is an area that is so depleted of oxygen that fish and other marine animals are not able to live in the water. The northern Gulf of Mexico has the largest area affected by hypoxia in the United States.[1] In 2017, the dead zone in the Gulf of Mexico covered an area the size of New Jersey.[2] Nutrients – nitrogen and phosphorus – are the culprits, beginning a cycle of spurring the growth of algae and leading to a decomposition process that uses the oxygen in the water and leaves less oxygen available for the marine life.

Iowa Nitrogen and Phosphorus Pollution Contributes to the Dead Zone in the Gulf of Mexico


Algae covering a waterbody.

The water in Iowa's streams and rivers eventually flows into the Mississippi River and the Gulf of Mexico. Consequently the nitrogen and phosphorus pollution from Iowa's waters is a direct contributor to the dead zone in the Gulf of Mexico.

A major study, released in the spring of 2018, titled "Iowa stream nitrate and the Gulf of Mexico" by Christopher S. Jones, Jacob K. Nielsen, Keith E. Shilling, and Larry J. Weber lays out the contribution Iowa makes to the dead zone in the Gulf of Mexico. To summarize the results of the study:

- Three major watershed basins drain into the Gulf of Mexico – Mississippi-Atchafalaya Basin, Upper Mississippi River Basin, and the Missouri River Basin.
- The hypoxia is driven by nitrogen and nitrates.
- Iowa contributes an average of 29% of the nitrate load to the Upper Mississippi Basin.
- Iowa contributes an average of 45% of the nitrate load to the Missouri River Basin.
- Iowa contributes an average of 55% of the nitrate load to the Mississippi-Atchafalaya Basin.
- Since 1999, nitrate loads in the Iowa-inclusive basins have increased.
- The increases in nitrate loads do not appear to be driven by changes in discharge and cropping intensity unique to Iowa.

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[1] "Hypoxia and Nutrient Reduction Zone: Advice for Prevention, Remediation and Research", Scientific and Advisory Panel of the Global Environment Facility, September, 2011, page 41

[2] Keeley Belva, "Gulf of Mexico 'dead zone' is the largest ever measured", Media Release, National Oceanic and Atmospheric Administration, August 2, 2017

- The 5-year running annual average of Iowa nitrate loading has been above the 2003 level for ten consecutive years.
- The goals of reducing the dead zone in the Gulf of Mexico will be very difficult to achieve if nitrate retention cannot be improved in Iowa.[3]

Further, most of the nutrient pollution comes from Iowa's farmland:

- Ninety-two percent of the nitrogen and eighty percent of the phosphorus in Iowa's waters originates from non-point sources,[4] which includes runoff from farm fields and lawns.
- The remaining eight percent of the nitrogen and twenty percent of the phosphorus comes from sewage treatment plants and industries that are directly discharging into rivers and streams.[5]
- Ninety percent of the nitrates in Iowa's waters come from Iowa's crop land.
- Seventy-two percent of Iowa's landmass is dedicated to crops.[6]

A comparison of the water flowing off Iowa's landscape into the three basins affecting the dead zone in the Gulf of Mexico indicates that Iowa is a relatively small contributor to the overall quantities of water flowing into the major water basins.[7] At the same time the contribution to the nitrate-nitrogen load is significantly higher than the lower levels of water flowing into the basin and the overall land area in the basin.

River basin	Iowa's contribution to water in the basin	Iowa's contribution to the nitrate-nitrogen load in the basin	Iowa's land area in the basin
Mississippi-Atchafalaya River Basin	5.9%	29%	4.5%
Upper Mississippi River Basin	21.0%	45%	21.0%
Missouri River Basin	12.0%	55%	3.3%

Clearly Iowa is playing an outsized role in contributing to the dead zone in the Gulf of Mexico.

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[3] Christopher S. Jones, Jacob K. Nielsen, Keith E. Shilling, and Larry J. Weber, "Iowa stream nitrate and the Gulf of Mexico", PLOS One, April 12, 2018, abstract. Available at http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0195930
Also "Iowa's Poor Water Quality Goes South", On Point, WBUR radio, July 16, 2018, www.wbur.org/onpoint/2018/07/16/iowa-water-pollution

[4] Craig Cox and Andrew Hug, "Murky Waters: Farm Pollution Stalls Cleanup of Iowa Streams," Environmental Working Group, December, 2012, page 5.
And
Marie-Pier Hebert, Vincent Fugere, and Andrew Gonzalez, "The overlooked impact of rising glyphosate use on phosphorus loading in agricultural watersheds", *Frontiers in Ecology and the Environment*, December 5, 2018

[5] Craig Cox and Andrew Hug, "Murky Waters: Farm Pollution Stalls Cleanup of Iowa Streams," Environmental Working Group, December, 2012, page 5.
And
Christopher S. Jones, Chad W. Drake, Claire E. Hurby, Keith E. Schilling, Calvin F. Wolter, "Livestock manure driving stream nitrate", *Royal Swedish Academy of Sciences*, December 19, 2018
And
Chris Jones, "Iowa's Real Population", Blog post on March 14, 2019. See www.iihr.uiowa.edu/cjones/iowas-real-population/

[6] Christopher S. Jones, Jacob K. Nielsen, Keith E. Shilling, and Larry J. Weber, "Iowa stream nitrate and the Gulf of Mexico", PLOS One, April 12, 2018, page 2.

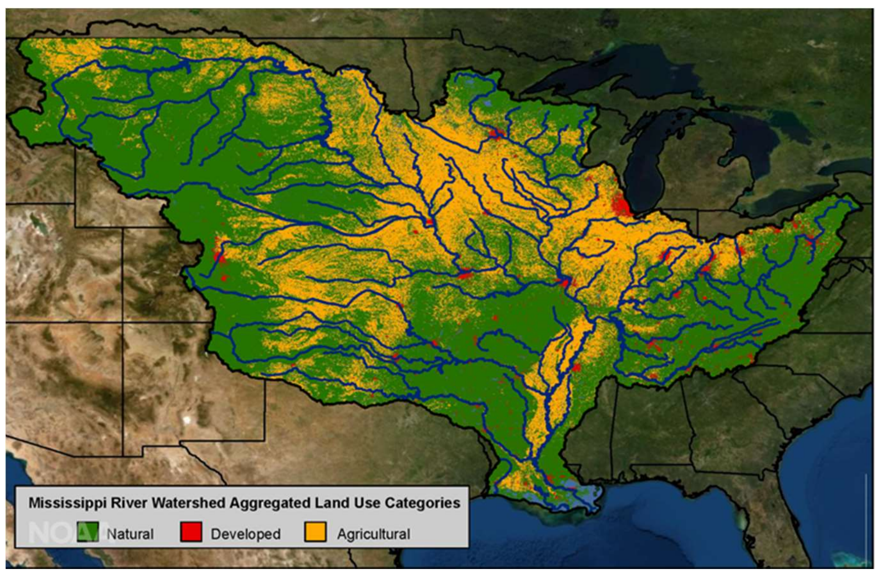
[7] Christopher S. Jones, Jacob K. Nielsen, Keith E. Shilling, and Larry J. Weber, "Iowa stream nitrate and the Gulf of Mexico", PLOS One, April 12, 2018, page 2.

"Iowa stream nitrate levels have increased approximately 10-fold over the past century and possible a lot more than that in some rivers."[8]

Iowa's contribution of stream nitrate-nitrogen (NO3-N) is staggering when you compare it to equivalent human populations. Humans generate about 5 pounds of nitrogen per person, based on discharges from wastewater treatment plants. "The total Iowa statewide NO3-N load in 2018 water year was 626 million pounds, which in treated sanitary sewer discharge would be the equivalent of 123 million people, very similar to the population of Japan. Iowa's largest NO3-N loading year ever was 2016, when over a billion pounds (1.25 billion) of nitrogen left the state in its rivers, equivalent to 245 million people (Indonesia, the world's 4th-most populous country). The average state-wide NO3-N load since 1999 has been 580 million pounds per year."[9]

The Iowa Department of Natural Resources, along with researchers at Iowa State University, undertook a mapping project to identify on-the-ground techniques that have been implemented that reduce nutrients – grassed waterways, ponds, terraces, water and sediment control basins, contour strip cropping, and contour buffer strips and prairie strips.[10] Between 2007 and 2010, airplanes mounted with LIDAR mapping technology were flown across the state.[11] Since this mapping was performed three years before Iowa's nutrient reduction strategy was published, this work establishes the baseline to evaluate the implementation of nutrient-reducing projects across the state.

Complicating the matter is the number of livestock living in the state. Iowa's 110 million chickens, turkeys, pigs, and cattle, along with Iowa's 3.2 million human residents, generate the amount of waste as 168 million people.[12] The livestock manure is applied to farm fields. Ensuring that manure remains on the fields where it can be used by crops and so it is not running off the fields is challenging.



Mississippi River Watershed, from National Oceanic and Atmospheric Administration

Another complicating factor is the tiles that drain farm fields in northern Iowa which move nitrate-laden water off the farms and into streams and rivers. Additionally

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[8] Christopher S. Jones, "Elephants in the room", The Gazette Iowa Ideas, Cedar Rapids, Iowa, August 25, 2019
[9] Chris Jones, "Trainloads", Blog post on April 12, 2019. See www.iihr.uiowa.edu/cjones/trainloads/
[10] Press release, "Initial statewide mapping of conservation practices now complete", Iowa Department of Natural Resources, July 21, 2018
Also
Rod Boshart, "Iowa takes inventory of conservation practices", *Cedar Rapids Gazette*, August 1, 2018
[11] Erin Jordan, "Mapping conservation practices", *Cedar Rapids Gazette*, August 5, 2018
[12] Donnelle Eller, "50 Shades of Brown: Iowa ranks No. 1 in, ahem, No. 2, UI researcher calculates", Des Moines Register, June 10, 2019

karst geology, which is found in northeast Iowa, allows nitrates to quickly move through the porous bedrock into streams.

"If all of the 102 large cities are successful in reducing their nitrate and phosphorus discharge, the state estimates it will represent a 4 percent nitrate reduction and 16 percent phosphorus reduction. This is a relatively small piece of the overall 45 percent goal. The vast majority of nitrate and phosphorus going into lakes, streams and rivers come from nonpoint sources, mostly agriculture."[13]

The Nitrate Problem Also Affects Iowa's Drinking Water

Large quantities of nitrates are entering Iowa's lakes, rivers, and streams. Some of those water bodies are perilously close to exceeding drinking water standards for humans. In fact, nitrates are already affecting Iowan's drinking water sources. Municipal water treatment facilities are required to keep the nutrients in drinking water below 10 milligrams per liter, even when the water source is higher than that.

On July 17, 2018, Greenfield, Iowa, residents were told to avoid drinking the city's water after an algae bloom in its water source - Lake Greenfield.[14] Ultimately testing showed no harmful toxins in the drinking water.[15]

During the summer of 2018, In Iowa City, the University of Iowa Water Plant installed a reverse-osmosis system that will remove nitrates from drinking water. The water plant draws its water from the Iowa River. At times, that water became so high in nitrates that it was diluted with well water.[16]

Paddlers enjoying the Maquoketa River.

The Des Moines Water Works uses an ion exchange process to remove nitrates from its drinking water[17] which must be run at great expense when the source water carries too many nitrates. The Water Works pulls its drinking water from the Raccoon River and from the Des Moines River, both which periodically reach high levels of nitrates. The Water Works first installed nitrate-removal equipment in the 1990s.[18]

Voluntary actions are not working

One way to reduce the nitrates in Iowa's waters is to reduce the nutrients applied to the land, in the form of fertilizer or manure. Other techniques involve restoring the landscape so that those nutrients are trapped before they enter the water body. Techniques include restoring stream buffers, grass waterways,

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[13] Erin Jordan, "Upgrades to wastewater plants stress small towns", *Cedar Rapids Gazette*, August 18, 2019
[14] "Bottled Water Advisory Issued for Greenfield After Water System Potentially Contaminated", *WHO TV*, July 17, 2018
[15] Mike Peterson, "Greenfield water situation improving", *KMA Radio*, July 20, 2018
[16] Julia Poska, "UI Water Plant to target nitrate wit reverse osmosis", *The Daily Iowan*, July 30, 2018
[17] http://www.dmww.com/water-quality/treatment-process/
[18] Clay Masters, "Iowa's Nasty Water War, Des Moines' lawsuit against farming counties is about more than just pollution", *Politico Magazine*, January 21, 2016

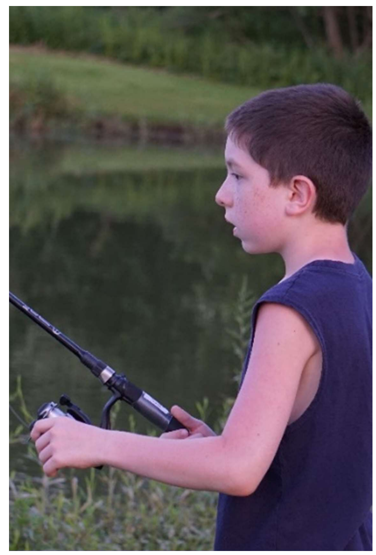
and wetlands. Another technique is to plant cover crops on farm fields, which helps to reduce runoff and erosion.

Current efforts to reduce nitrates entering Iowa's water bodies are voluntary. Those voluntary actions are not aggressive enough to protect the water sources for the city of Des Moines nor are they protecting other water bodies in Iowa. In fact, a review of the amount of nitrogen used on crops has been increasing. The average application of commercial and manure nitrogen by year[19] is shown below:

	1980 to 1996	2006 to 2010	2017 to 2019
Corn-soybean rotations	149 pounds per acre	151 pounds per acre	170 to 178 pounds per acre
Continuous corn	199 pounds per acre	201 pounds per acre	200 to 202 pounds per acre

For 2019, the fields that have corn-soybean rotations vary widely in the amount of commercial nitrogen that is applied[20], as shown below:

Pounds of commercial fertilizer	Percentage of fields applying fertilizer at that level
176 to 200 pounds per acre	40 %
151 to 175 pounds per acre	33 %
150 pounds per acre or less	12 %
201 pounds per acre or more	15 %


A child fishing

At the 2015 Iowa Soybean Association annual research conference, Patricia Sinicropi, director of legislative affairs for the National Association of Clean Water Agencies, told the attendees that "here in Iowa you have a $4 billion problem that can be solved much more cost effectively at the farm level than at the water treatment plant level". Additionally she stated that "the cost of removing nitrate at the farm level ranges from about $1.50 to $5 a pound, while the comparable cost as a water treatment plant ranges from $15 to $50 a pound".[21]

Policy

It is obvious that Iowans will need to work diligently to reduce the overall contribution of nitrates into the waters flowing to the Gulf of Mexico.[22]

Iowa's Nutrient Reduction Strategy, published in 2013, aims to reduce Iowa's contribution of nutrients by 45 percent. Working toward this goal will significantly reduce the dead zone in the Gulf of Mexico. The effort entails:

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[19] J. Gordon Arbuckle, Alejandro Plastina, Suraj Upadhaya, Laurie Nowatzke, Jim Jordahl, Lisa Shulte Moore, "Adoption of Agricultural Practices that Reduce or Remove Carbon", Iowa State University, September 20, 2021
[20] J. Gordon Arbuckle, Alejandro Plastina, Suraj Upadhaya, Laurie Nowatzke, Jim Jordahl, Lisa Shulte Moore, "Adoption of Agricultural Practices that Reduce or Remove Carbon", Iowa State University, September 20, 2021
[21] Orlan Love, "Farmers seek 'quantum leap' in reducing nitrogen pollution", Cedar Rapids Gazette, Feb. 21, 2015
[22] The nutrient reduction strategy was initiated after Nancy K. Stoner, Acting Assistant Administrator for the Environmental Protection Agency, wrote a memo titled "Working in Partnership with States to Address Phosphorus and Nitrogen Pollution through Use of a Framework for State Nutrient Reductions" to the EPA regions and the state water directors on March 16, 2011, about the high levels of nutrients in the country's waterbodies.

- Adequate money needs to be available to fund projects to improve water quality in Iowa. Iowa has begun investing in practices that improve the levels of nutrients entering our water bodies, but the levels of investment are not nearly large enough to solve the problem. The projects that would be funded include installing stream buffers, bioreactors, and saturated buffers; planting cover crops; and installing grassed waterways and prairie strips.
- Numerical standards for nutrients for Iowa's rivers, streams, and lakes should be established, including a reasonable date for each water body to meet the standards. Other states around us have already begun establishing numerical standards for nutrients, including Wisconsin, Minnesota, Illinois, Missouri, and Nebraska.[23]
- Each of the major watersheds and lakes should be regularly monitored for nutrients throughout the year. Iowa needs to expand the network of water quality monitoring sensors. Currently 88 percent of the land in Iowa drains into a location with water quality sensors[24]; this needs to reach 100 percent.
- Regular updates of the LIDAR maps showing nutrient-reducing techniques should be produced, along with evaluations of the changes on the landscape versus how successful the techniques are in reducing the nutrient contribution by the state.
- It is time to require mandatory nutrient reduction strategies to be implemented on farms, along with the financial assistance to pay for the work and to compensate the landowner for the idling of farm land.

Taxpayers expect that their taxes will be wisely spent on projects to reduce nutrients. Farmers need to be able to identify practices that effectively reduce those nutrients. Numerical standards provide a target to meet. If you don't have a measurable target, you don't know if you are hitting the target or if you need to continue working on improvements. Regular monitoring tells if the targets are being met.

Chris Jones[25] suggest several other solutions:

- Stop planting crops in the 2-year floodplain. That would affect about 400,000 acres of farmland in Iowa.
- Ban fall tillage.
- Ban applying manure on snow and frozen ground. Current Iowa laws allow manure to be applied beginning on March 1, a time when the ground can still be covered with snow.
- Require farmers to adhere to the Iowa State University fertilization guidelines.
- Reform Iowa's confined animal feeding regulations.

The conflict over who should pay

The dilemma is who should pay to restore the landscape to reduce the amount of nitrate pollution entering Iowa's water bodies. This question pits those who use and enjoy Iowa's water resources against the farmers.

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[23] See "State Progress Toward Developing Numeric Nutrient Water Quality Criteria for Nitrogen and Phosphorus", www.epa.gov/nutrient-policy-data/state-progress-toward-developing-numeric-nutrient-water-quality-criteria

[24] "Summary of Progress of the Iowa Nutrient Reduction Strategy, 2017-18 Reporting Period", Iowa Department of Agriculture and Land Stewardship, Iowa Department of Natural Resources, and Iowa State University College of Agriculture and Life Sciences

[25] Dr. Chris Jones works at the University of Iowa in the IIHR—Hydroscience & Engineering department. His research involves studying water quality. See his presentation "The State of Iowa's Water", February, 2021, www.youtube.com/watch?v=DibLwrVebuA

Farmers are clamoring for public support, to assist them in restoring the landscape and to pay for taking land out of production.

To the city-dweller, this just doesn't seem fair. The municipal water customers have to pay for removing the nitrates in their drinking water while the sources of those nitrates are not penalized in any way, shape, or form.

Over the years, the farmers ripped out buffers, fencerows, grass waterways, and wetlands. They chose to farm the land the way they are, which is destructive to water quality. However, the farmers did this, with the advice and support of the large agriculture industries, college and university professors and researchers, and federal government incentive programs. Some of this advice was ill-conceived; some of it was clearly wrong as we now know.

Unfortunately some of those experts and advisors have not admitted that their advice has caused the nitrate problem. Some of the actors are actively trying to place the blame on others, trying to block any improvements, and are even denying that there is a problem.

How do we fund clean water?

When bad advice is given, it behooves all of us to dial back the techniques we are using, restore the landscape, and to return to proven techniques.

Clean water brings people to live and start businesses in Iowa. It provides recreation, and tourism. We all have to have clean water to survive.

It may be cheaper to fund restoration projects upstream than to locate and develop alternate sources of water, to purchase nitrate-removal equipment or to operate the nitrate-removal equipment.

Likewise it might even be cheaper to fund restoration work than to have the National Guard distributing water to a community with contaminated water.

The Iowa Economic Development department, county governments, and city governments are handing out jaw-dropping incentives to developers, businesses, and industries in the form of outright grants, tax-increment financing (TIF), and give-aways of public land at significantly reduced prices. Even the Iowa Department of Transportation is involved in funding economic development, including RISE grants that pay for construction of roads, streets, and accesses to businesses.

However Iowa farmers are never propped up by those give-aways and incentives given to other large businesses and industries. For this reason the Iowa Chapter supports granting incentives to restore the landscape so that it can better retain nitrates on the land and not allow them to enter the water. Iowa Economic Development and Iowa Department of Agriculture and Land Stewardship need to step up to the plate and fund these incentives.

On the other hand, people living in urban areas in Iowa pay for stormwater management as part of their monthly water bills. Runoff from farm fields is no different than the stormwater running off urban lawns. In fact, urban lawns already use a cover crop that keeps the soil in place through the winter. It only makes sense that we all pitch in and reduce polluted stormwater, including farmland owners.

Conclusion

Iowa's agriculture is so productive that Iowa leads the nation in exports of pork ($2.3 billion), corn ($2.1 billion), feed grain ($1.3 billion), and eggs ($232 million). What's more, Iowa is second in the nation in soybean exports ($2,8 billion) and fourth in beef ($507 million).[26] Unfortunately Iowa is number one in exporting nutrients to the Gulf of Mexico.

The Gulf Hypoxia Action Plan 2008 state that the goal of the national effort to reduce the dead zone in the Gulf of Mexico was to cut the nitrate and phosphorus pollution reaching the Gulf by 45 percent by 2015, with a dead zone of 1,900 square miles. That goal was not met.[27]

Currently, the average size of the dead zone is 5,772 square miles, three times larger than that goal.[28]

The goal was changed in 2014[29] to:

> "The updated Coastal Goal, including an Interim Target, is as follows: We strive to reduce the five-year running average areal extent of the Gulf of Mexico hypoxic zone to less than 5,000 square kilometers by the year 2035. Reaching this final goal will require a significant commitment of resources to greatly accelerate implementation of actions to reduce nutrient loading from all major sources of nitrogen and phosphorus in the Mississippi/Atchafalaya River Basin (MARB). An Interim Target of a 20% reduction[30] of nitrogen and phosphorus loading by 2025 is a milestone for immediate planning and implementation actions, while continuing to develop future action strategies to achieve the final goal through 2035. Federal agencies, States, Tribes and other partners will work collaboratively to plan and implement specific, practical and cost-effective actions to achieve both the Interim Target and the updated Coastal Goal."

2025 will arrive soon. In the meantime, we have a lot of work to do in reducing nutrients. The longer we wait, the harder it will be the meet the goal. Unfortunately, according to Christopher Jones' research, "nitrate loss in Iowa has increased more than 70 percent since 2003."[31]

Iowa released its draft nutrient reduction strategy in November, 2012.[32] Unfortunately, we have made little progress in reducing Iowa's contribution to the Dead Zone since then.

Iowa can and must do better in reducing nutrients in our waterbodies.

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[26] "2019 Trade Statistics", Iowa Department of Economic Development, using 2018 US Department of Agriculture data

[27] In 2015, the goal was modified to a 45% reduction by 2035 with an interim goal of 20% reduction by 2025. See "Mississippi River Gulf of Mexico Watershed Nutrient Task Force New Goal Framework", December 3, 2014, www.epa.gov/sites/production/files/2015-07/documents/htf-goals-framework-2015.pdf

[28] Erin Jordan, "Treading Water: Unfocused and underfunded, clean water goal falters", *Cedar Rapids Gazette*, December 2, 2018

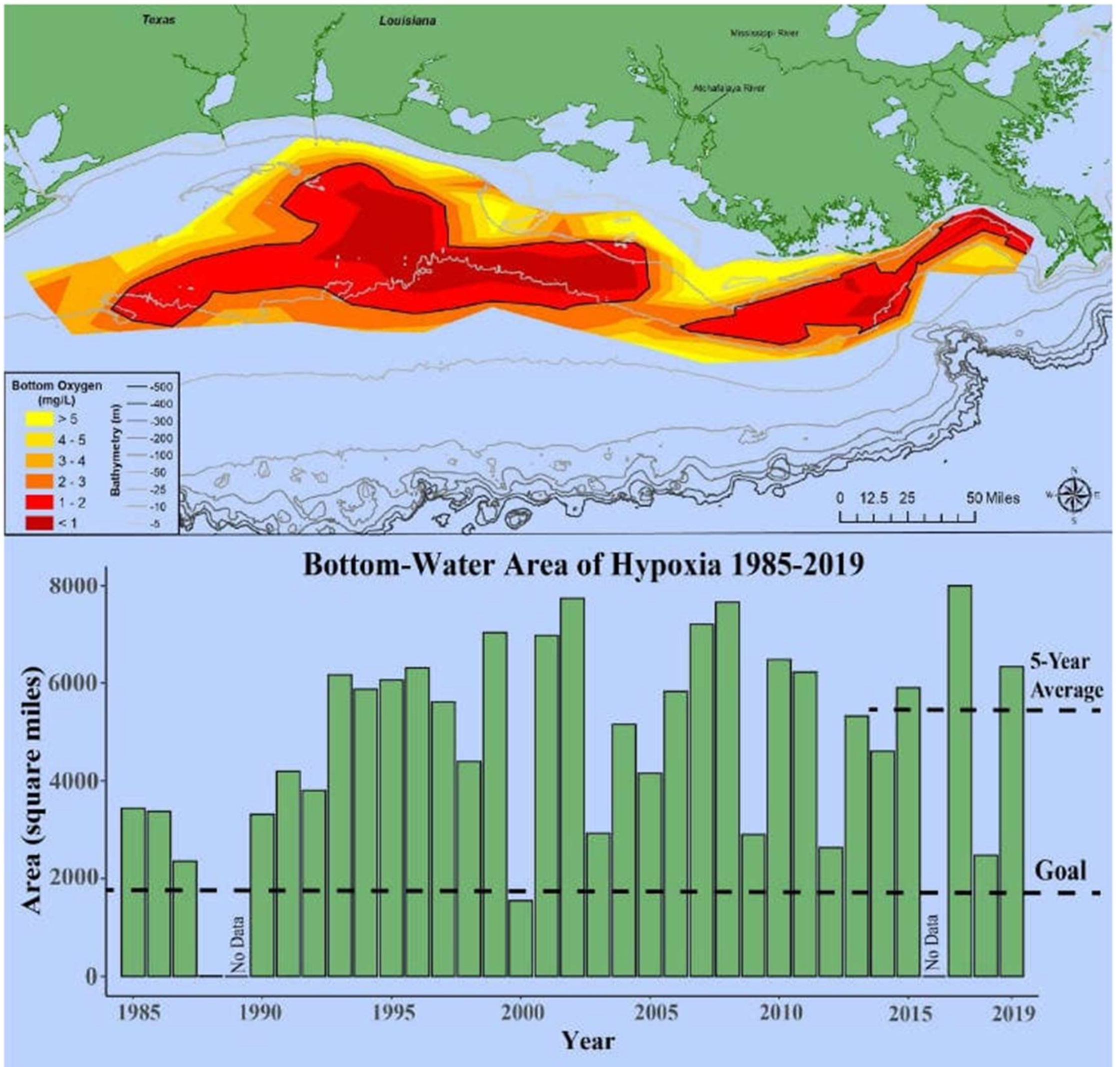
[29] "Mississippi River Gulf of Mexico Watershed Nutrient Task Force New Goal Framework", December 3, 2014, www.epa.gov/sites/production/files/2015-07/documents/htf-goals-framework-2015.pdf

[30] "The percent reduction is relative to the average MARB nutrient loading to the Gulf of Mexico during the 1980-1996 period.", from "Mississippi River Gulf of Mexico Watershed Nutrient Task Force New Goal Framework",

[31] Christopher S. Jones, "Elephants in the room", The Gazette Iowa Ideas, Cedar Rapids, Iowa, August 25, 2019

[32] See www.nutrientstrategy.iastate.edu/documents

The Dead Zone



Top panel: At 6,952 square miles, the 2019 hypoxic zone in the Gulf of Mexico is the 8th largest ever measured in the 33-year record. The red area denotes two milligrams per liter of oxygen or lower, the level which is considered hypoxic, at the bottom of the seafloor. Bottom panel: The long-term measured size of the hypoxic zone, indicated with green bars, measured during ship surveys since 1985; black dashed lines indicate the target goal established by the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force and the five-year average measured size of the zone. Graphic credit: Louisiana Universities Marine Consortium.