

# How we use our land has consequences: the argument for public health

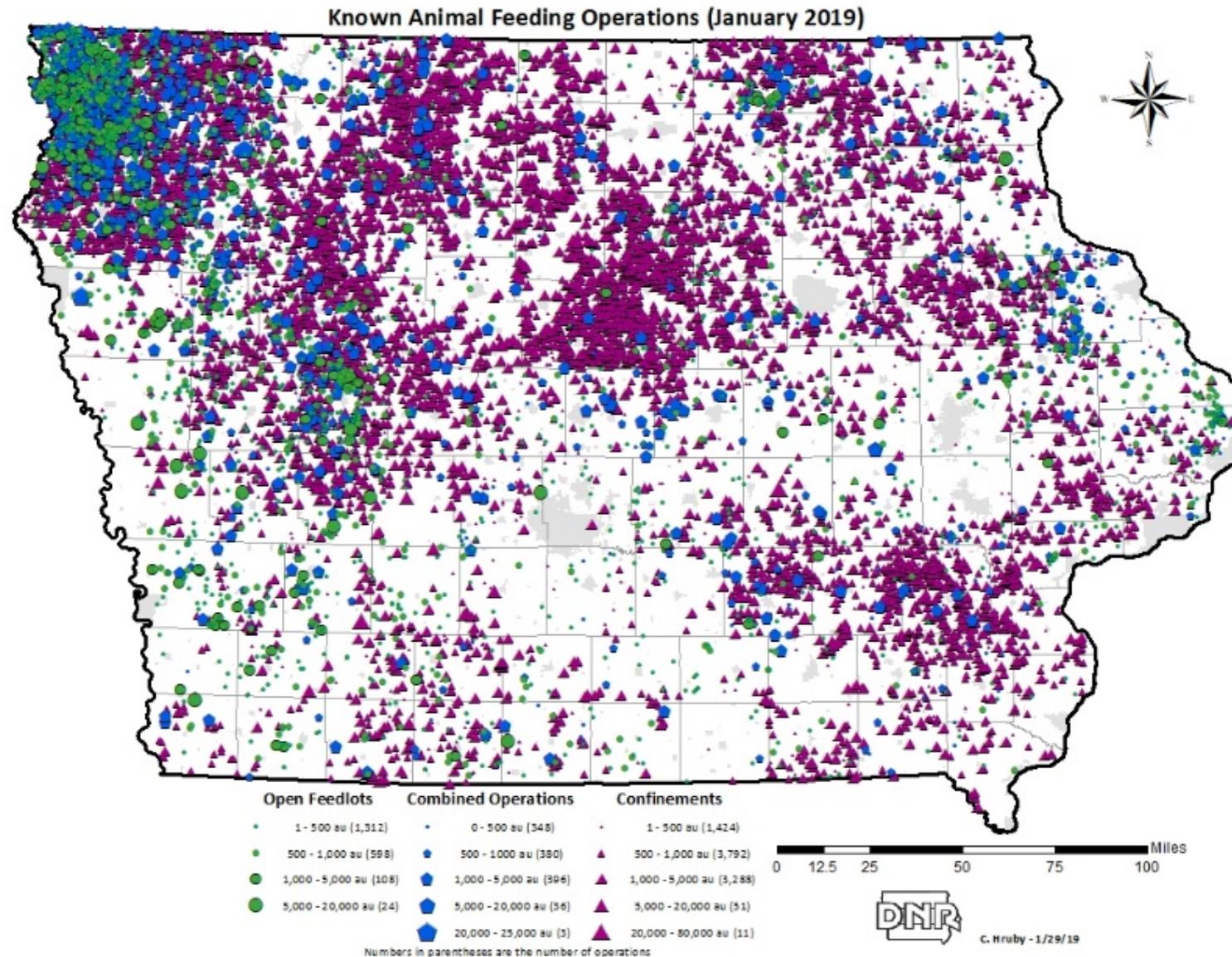
David Cwiertny

Professor, Department of Civil and Environmental Engineering  
Director, Center for Health Effects of Environmental Contamination  
Director, Environmental Policy Research Program, UI Public Policy Center



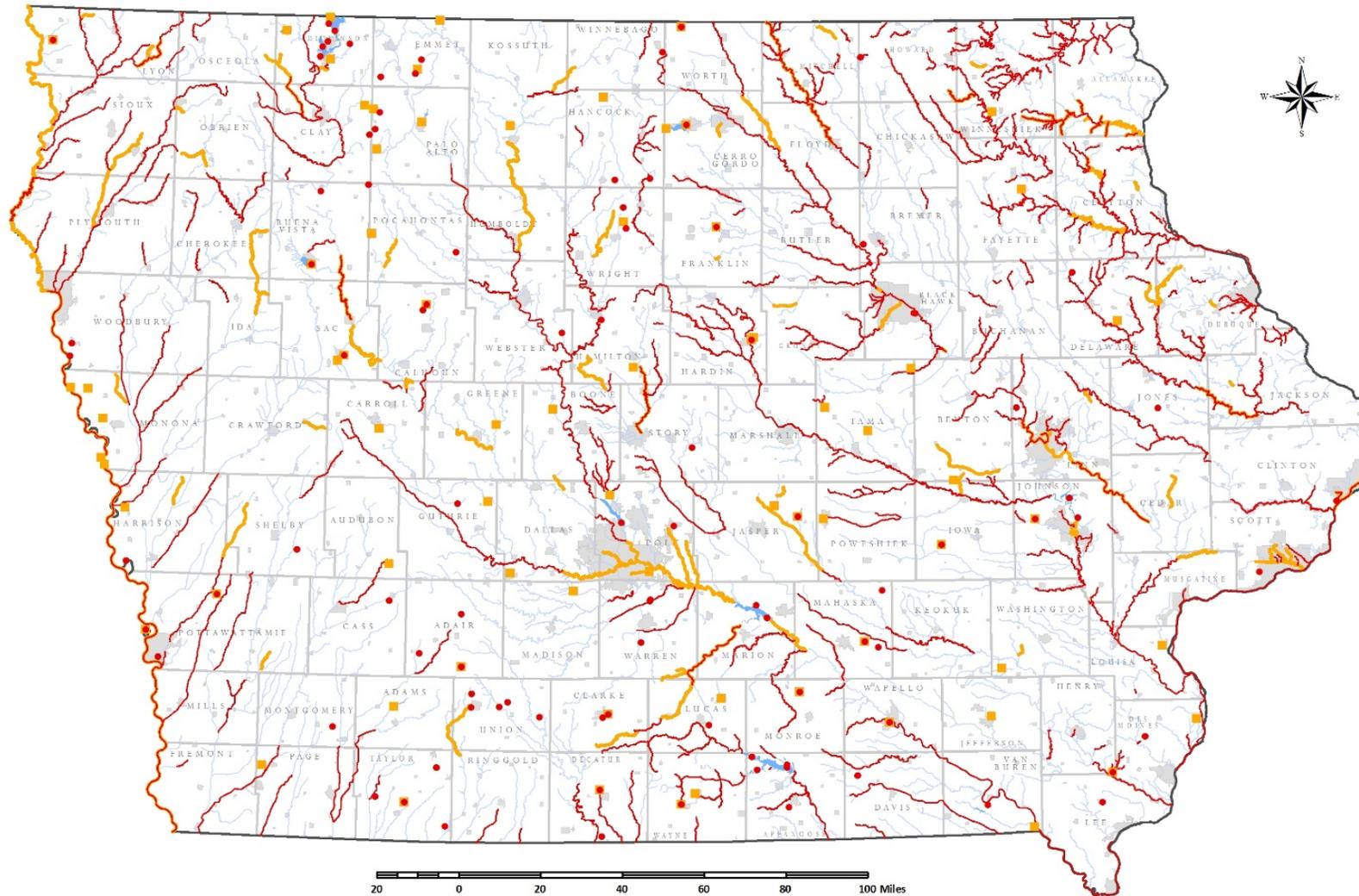
Scientific understanding of health effects is improving at a pace that far exceeds regulatory action

# In Iowa, we got Trouble (with a capital T)





# Iowa's Impaired Waterbodies, 2016



**Impaired Lakes**

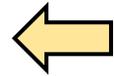
- Category 5 Impairment - TMDL Required
- Category 4 Impairment - TMDL Not Needed

**Impaired Stream Segments**

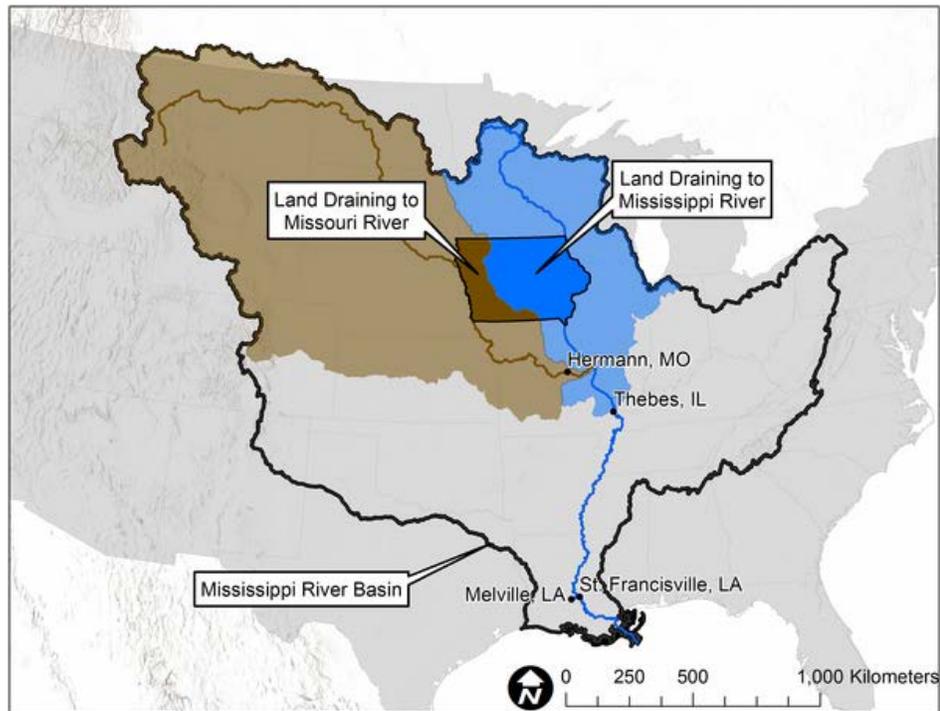
- Category 5 Impairment - TMDL Required
- Category 4 Impairment - TMDL Not Needed

**Table 1. Summary of the number of waterbodies in each category of Iowa’s draft 2016 integrated Section 305(b) / Section 303(d) report. The 608 waterbodies in Categories 5a, 5b, and 5p comprise Iowa’s draft 2016 Section 303(d) list; the 301 waterbodies in Category 3b comprise Iowa’s draft list of waters in need of further investigation.**

<b>Integrated Report Category</b>	<b>Category Description</b>	<b>Number of Waterbodies</b>
1	All designated uses met.	9
2a	At least one designated use met; insufficient data to determine whether other uses are met.	318
3a	Insufficient data to determine whether any designated uses are met.	1,103
3b	Insufficient data to determine whether any designated uses are met but at least one use is potentially impaired based on an "evaluated" assessment.	301
4a	All TMDLs need to result in attainment of all applicable water quality standards have been approved or established by EPA.	85
4b	Other required control measures are expected to result in the attainment of water quality standards in a reasonable period of time; TMDL not required.	0
4c	The impairment or threat is not caused by a pollutant; TMDL not required.	22
4d	Waterbody assessed as “impaired” due to a fish kill where enforcement action was taken to address the source of the kill: TMDL not required.	34
5a	Waterbody is impaired or threatened and a TMDL is needed.	257
5b	Impairment is based on results of biological monitoring or a fish kill investigation where specific causes and/or sources of the impairment have not yet been identified.	158
5p	A presumptively applied use is impaired.	193



# Most of our attention is paid to nutrients and the dead zone



*“Our analysis shows that Iowa contributes between 11 and 52% of the long-term nitrate load to the Mississippi-Atchafalaya Basin, 20 to 63% to the Upper Mississippi River Basin, and 20 to 89% to the Missouri River Basin, with averages of 29, 45 and 55% respectively.”*

The New York Times

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## Conflict Over Soil and Water Quality Puts ‘Iowa Nice’ to a Test

By MITCH SMITH APRIL 18, 2015



Brent Johnson straddling a tilled field and wetlands on his farm in Calhoun County, Iowa, one of three counties that have been sued over nitrates seeping into water supplies. Ryan Donnell for The New York Times

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MANSON, Iowa — The flat, endless acres of black dirt here in northern Iowa will soon be filled with corn and soybean seeds. But as farmers tuned up their tractors and waited for the perfect moment to plant, another topic weighed on their

# But nitrate is a problem closer to home

National Primary Drinking Water Regulations 

National Primary Drinking Water Regulations				EPA 816-F-09-004   MAY 2009
Contaminant	MCL or TT <sup>1</sup> (mg/L) <sup>2</sup>	Potential health effects from long-term <sup>3</sup> exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L) <sup>2</sup>
 Nitrate (measured as Nitrogen)	10	Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits	<b>10</b>

**Des Moines Register** HOME NEWS SPORTS THINGS TO DO BUSINESS ARCHIVES **USA TODAY** SUBSCRIBE MORE

## High nitrate levels plague 60 Iowa cities, data show

Donnelle Eller, [deller@dmreg.com](mailto:deller@dmreg.com) Published 9:48 p.m. CT July 4, 2015 | Updated 8:09 a.m. CT July 7, 2015



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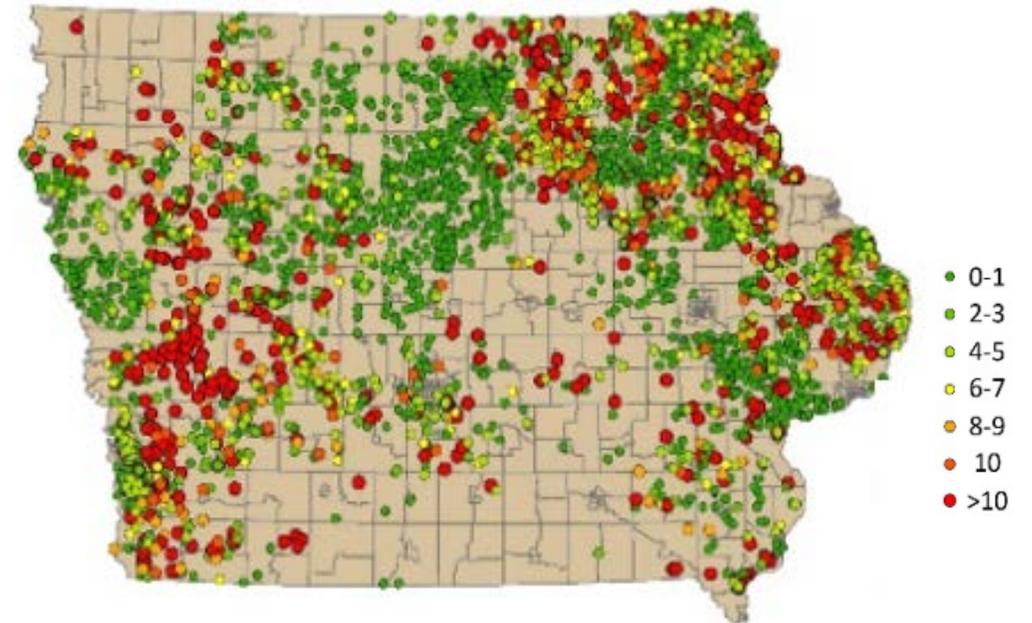
(Photo: Michael Zamora/Register photos)

More than 60 Iowa cities and towns have battled high nitrate levels in their drinking water over the past five years, evidence of a contamination problem that reaches across the state, state environmental data show.

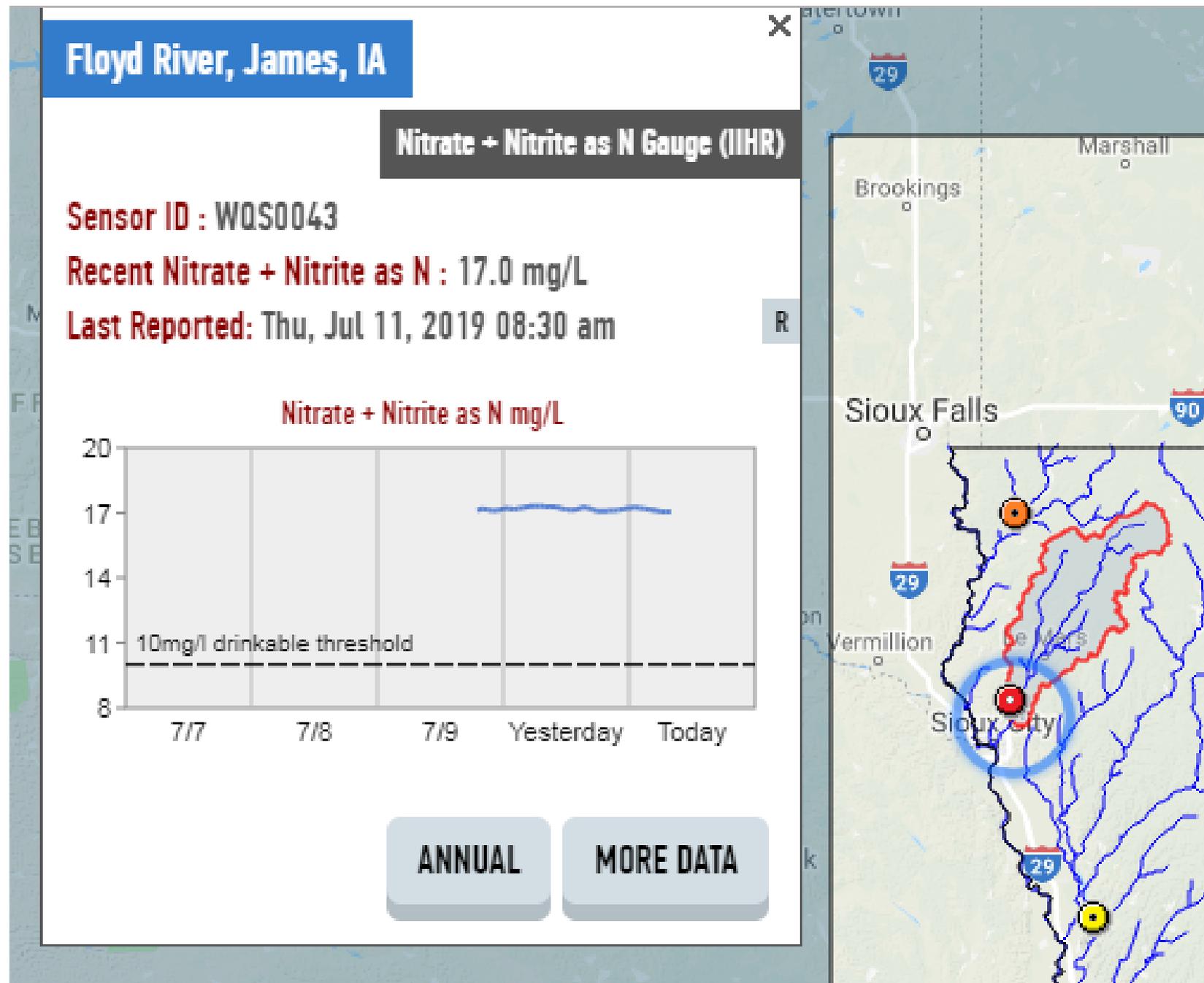
Nitrate pollution affects Iowa's largest cities — Des Moines, Cedar Rapids, Cedar Falls and Waterloo — but also many of its smallest — Elliott, Griswold, Manchester and Woodbine.

The Iowa Department of Natural Resources data provide a snapshot of the cities reporting nitrate levels of 5 milligrams per liter or higher, a warning sign that nitrates are approaching harmful levels.

Private Well Nitrate Levels (2016) (n = 4389)



# Iowa Water Quality Information System (IWQIS)



<https://iwqis.iowawis.org/>

# Is the MCL for nitrate strict enough?

National Primary Drinking Water Regulations				EPA 816-F-09-004   MAY 2009
Contaminant	MCL or TT <sup>1</sup> (mg/L) <sup>2</sup>	Potential health effects from long-term <sup>3</sup> exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L) <sup>2</sup>
 Nitrate (measured as Nitrogen)	10	Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits	<b>10</b>



Review

## Drinking Water Nitrate and Human Health: An Updated Review

Mary H. Ward <sup>1,\*</sup>, Rena R. Jones <sup>1</sup>, Jean D. Brender <sup>2</sup>, Theo M. de Kok <sup>3</sup>, Peter J. Weyer <sup>4</sup>, Bernard T. Nolan <sup>5</sup>, Cristina M. Villanueva <sup>6,7,8,9</sup> and Simone G. van Breda <sup>3</sup>

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  - <sup>3</sup> Department of Toxicogenomics, GROW-school for Oncology and Developmental Biology, Maastricht University Medical Center, P.O. Box 616, 6200 MD Maastricht, The Netherlands; t.dekok@maastrichtuniversity.nl (T.M.d.K.); s.vanbreda@maastrichtuniversity.nl (S.G.v.B.)
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  - <sup>5</sup> U.S. Geological Survey, Water Mission Area, National Water Quality Program, 12201 Sunrise Valley Drive, Reston, VA 20192, USA; btnolan@usgs.gov
  - <sup>6</sup> ISGlobal, 08003 Barcelona, Spain; cvillanueva@isiglobal.org
  - <sup>7</sup> IMIM (Hospital del Mar Medical Research Institute), 08003 Barcelona, Spain
  - <sup>8</sup> Department of Experimental and Health Sciences, Universitat Pompeu Fabra (UPF), 08003 Barcelona, Spain
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- \* Correspondence: wardm@mail.nih.gov

**Abstract:** Nitrate levels in our water resources have increased in many areas of the world largely due to applications of inorganic fertilizer and animal manure in agricultural areas. The regulatory limit for nitrate in public drinking water supplies was set to protect against infant methemoglobinemia, but other health effects were not considered. Risk of specific cancers and birth defects may be increased when nitrate is ingested under conditions that increase formation of *N*-nitroso compounds. We previously reviewed epidemiologic studies before 2005 of nitrate intake from drinking water and cancer, adverse reproductive outcomes and other health effects. Since that review, more than 30 epidemiologic studies have evaluated drinking water nitrate and these outcomes. The most common endpoints studied were colorectal cancer, bladder, and breast cancer (three studies each) and thyroid disease (four studies). Considering all studies, the strongest evidence for a relationship between drinking water nitrate ingestion and adverse health outcomes (besides methemoglobinemia) is for colorectal cancer, thyroid disease, and neural tube defects. Many studies observed increased risk with ingestion of water nitrate levels that were below regulatory limits. Future studies of these and other health outcomes should include improved exposure assessment and accurate characterization of individual factors that affect endogenous nitrosation.

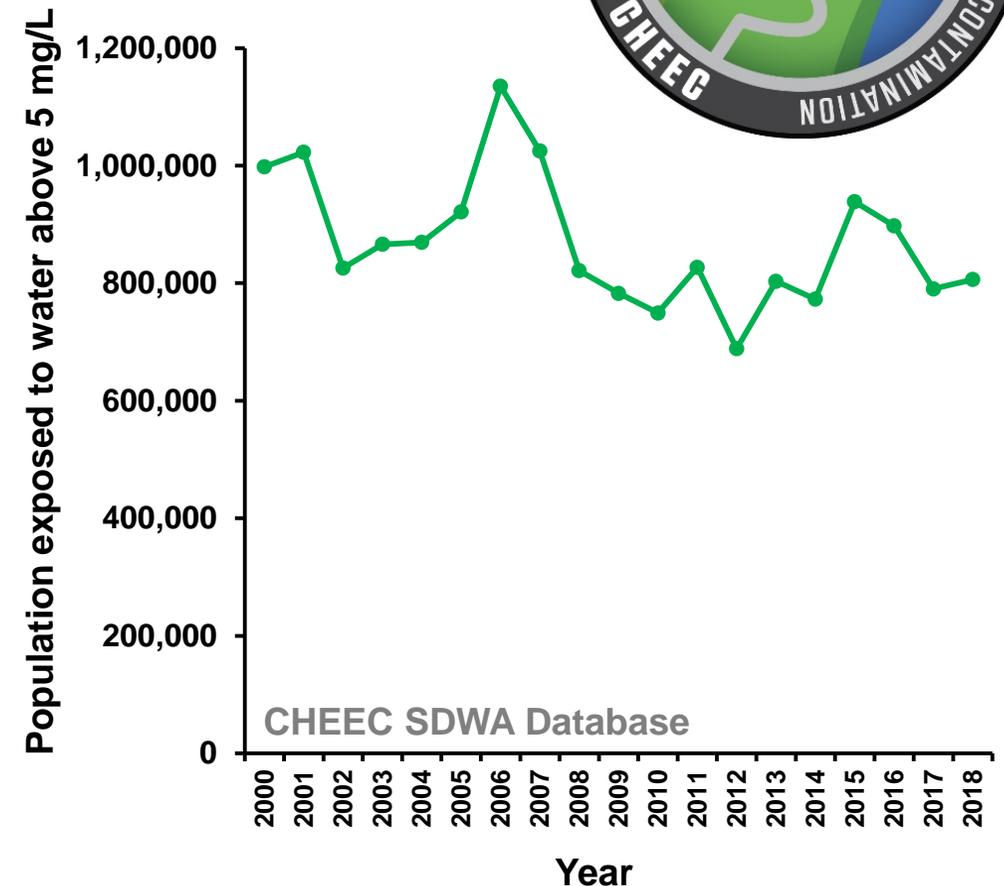
# Growing evidence supports adverse health effects at half the MCL

## Cancer Risks (Iowa Women's Health Study)

- Bladder cancer
  - 1.6x risk at **>5 mg/L** for  $\geq 4$  years (Jones 2016)
- Ovarian cancer
  - 2.0x risk at **>3.0 mg/L** for  $\geq 11$  years (Inoue-Choi 2015)
- Thyroid cancer
  - 2.6x risk at **>5 mg/L** for  $\geq 5$  years (Ward 2010)

## Reproductive Health (National Birth Defects Prevention Study)

- Iowa-Texas Study results (Brender, 2013)
  - Spina bifida: 2x more likely to ingest  $\geq 5$  mg of nitrate daily from drinking water than control mothers
  - Limb deficiencies: 1.8x more likely to ingest  $\geq 5.42$  mg of nitrate daily
  - Cleft palate: 1.9x more likely to ingest  $\geq 5.42$  mg of nitrate daily



# In the news: Nitrate pollution of U.S. tap water could cause 12,500 cancer cases each year



Contents lists available at [ScienceDirect](#)

Environmental Research

journal homepage: [www.elsevier.com/locate/envres](http://www.elsevier.com/locate/envres)



Exposure-based assessment and economic valuation of adverse birth outcomes and cancer risk due to nitrate in United States drinking water.

Alexis Temkin<sup>a,\*</sup>, Sydney Evans<sup>a</sup>, Tatiana Manidis<sup>b</sup>, Chris Campbell<sup>a</sup>, Olga V. Naidenko<sup>a</sup>

<sup>a</sup> Environmental Working Group, 1436 U Street NW Suite 100, Washington, DC, 20009, USA

<sup>b</sup> Duke University, Nicholas School of the Environment, 9 Circuit Dr, Durham, NC, 27710, USA

## ARTICLE INFO

### Keywords:

Nitrate  
Drinking water  
Economic analysis  
Colorectal cancer –reproductive outcomes

## ABSTRACT

**Background:** Nitrate ingestion from drinking water has been associated with an increased risk of adverse birth outcomes as well as elevated risk of colorectal cancer and several other cancers. Yet, to date, no studies have attempted to quantify the health and economic impacts due to nitrate in drinking water in the United States.

**Methods:** This study presents a first-of-its-kind comprehensive assessment of nitrate exposure from drinking water for the entire United States population. This exposure assessment serves as the basis for our analysis of the annual nitrate-attributable disease cases in the United States and the associated economic losses due to medical costs and lost productivity. Additionally, through a meta-analysis of studies on drinking water nitrate and colorectal cancer, we examine the exposure-response relationship for nitrate and cancer risk.

**Results:** On the basis of national nitrate occurrence data and relative risk ratios reported in the epidemiology literature, we calculated that annually, 2939 cases of very low birth weight, 1725 cases of very preterm birth, and 41 cases of neural tube defects could be related to nitrate exposure from drinking water. For cancer risk, combining nitrate-specific risk estimates for colorectal, ovarian, thyroid, kidney, and bladder cancers results in a range of 2300 to 12,594 annual nitrate-attributable cancer cases (mean: 6537 estimated cases). For medical expenditures alone, this burden of cancer corresponds to an annual economic cost of 250 million to 1.5 billion U.S. dollars, together with a potential 1.3 to 6.5 billion dollar impact due to lost productivity. With the meta-analysis of eight studies of drinking water nitrate and colorectal cancer, we observed a statistically significant positive association for nitrate exposure and colorectal cancer risk and calculated a one-in-one million cancer risk level of 0.14 mg/L nitrate in drinking water.

**Conclusion:** Health and economic analyses presented here suggest that lowering exposure to nitrate in drinking water could bring economic benefits by alleviating the impacts of nitrate-associated diseases.

Des Moines Register

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## Nitrates in drinking water may be tied to 300 cases of cancer in Iowa each year, study shows

Donnelle Eller, Des Moines Register Published 5:48 p.m. CT June 20, 2019 | Updated 7:17 p.m. CT June 27, 2019

# Meanwhile, EPA has proven incapable of creating new regulations for drinking water

**POLITICO** The Agenda Magazine Policy PRO U.S. Edition

**THE AGENDA** READING NOW: WHAT BROKE THE SAFE DRINKING WATER ACT? UP NEXT: 'I JUST STARTED FLOWING. IT WAS THE ONLY THING THAT HELPED'

**The Agenda**  
AGENDA 2020

## What broke the Safe Drinking Water Act?

There's perchlorate in this reservoir. Here's why Washington isn't doing anything about it.

By ANNIE SNIDER | 05/10/2017 04:49 AM EDT | Updated 05/11/2017 05:02 PM EDT

Getty

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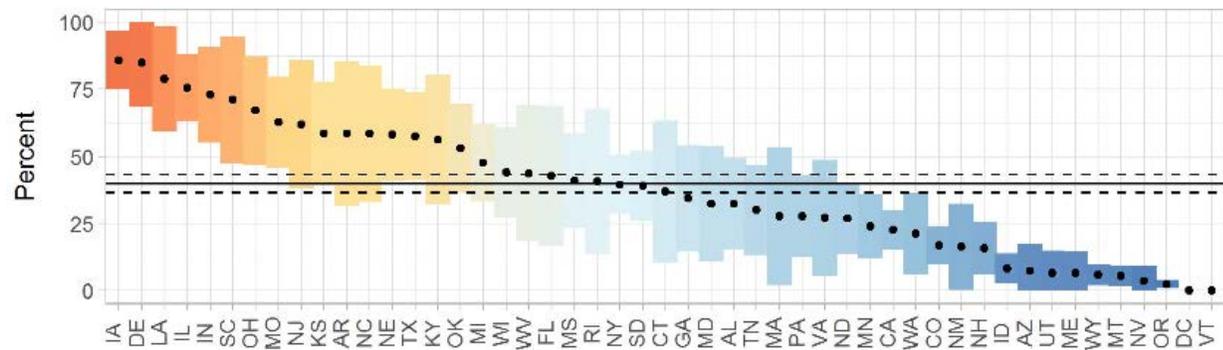
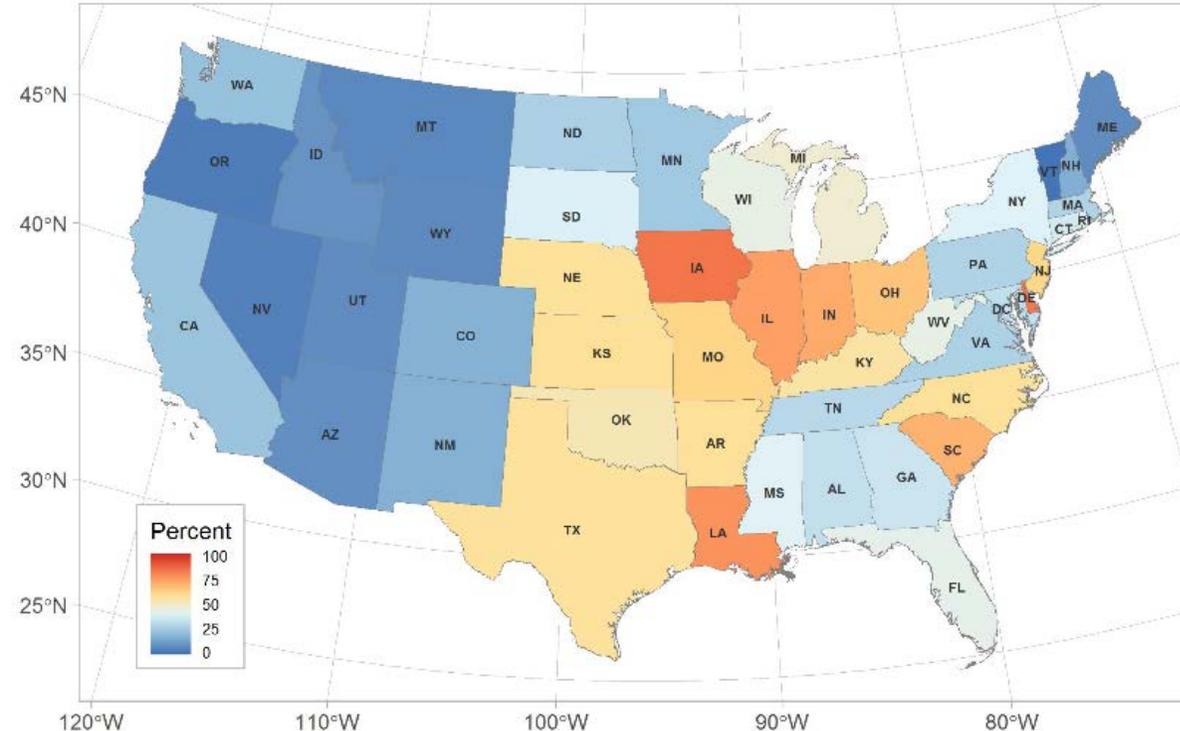
It was 1997 when Californians began to worry in earnest about a chemical called perchlorate. For decades, the ingredient in rocket fuel had been seeping from missile factories and testing sites into groundwater across the state and, thanks to a new testing method, it was suddenly clear it had reached hundreds of drinking water wells. Soon, researchers discovered that the toxic chemical had reached Lake Mead, the picturesque reservoir that supplies water to 25 million people in the American Southwest and irrigates the fields that grow the lion's share of the nation's winter produce.

Even in trace amounts, perchlorate can be dangerous, especially for pregnant women and young children. The chemical prevents the thyroid from absorbing iodine, which the gland needs to produce hormones that are critical for brain development. Although the military and its contractors dispute the level at which harm occurs, the companies that used the perchlorate settled a cascade of lawsuits with California communities and residents as the extent of contamination came to light, paying tens of millions of dollars toward compensation and cleanup efforts.

*“In the 20 years since that update (1996 SDWA Amendments) went into effect, not a single new contaminant has been regulated under the law.”*

# Manure is not just nutrients

Percent of river km above LLOQ *sul1*



## EPA National Rivers and Streams Assessment 2013/2014

### ANTIBIOTIC RESISTANCE

*Will Kill More People Than Cancer and Diabetes Combined By 2050*

#### How Resistance Develops and Spreads

**80%** of all antibiotics are given to livestock, mostly to speed their growth and prevent disease.

**Fertilizing with antibiotic resistant manure**

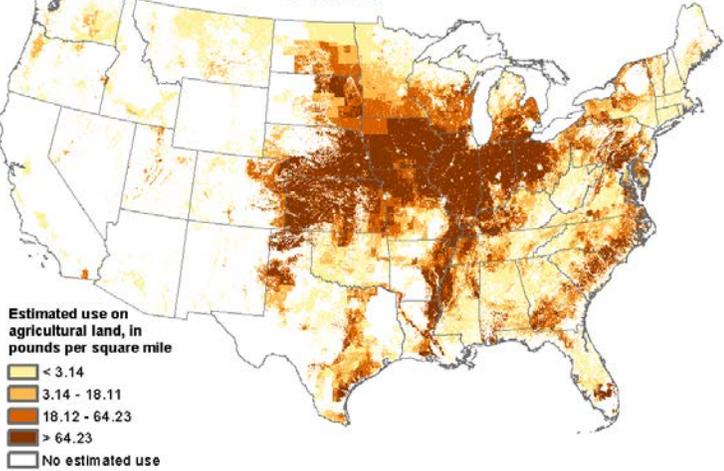
Manure encourages the proliferation of antibiotic resistant bacteria when applied as a fertilizer in agriculture.

**Consumption** of livestock and grain treated with multi-use antibiotics significantly increases the spread of resistance in bacteria.

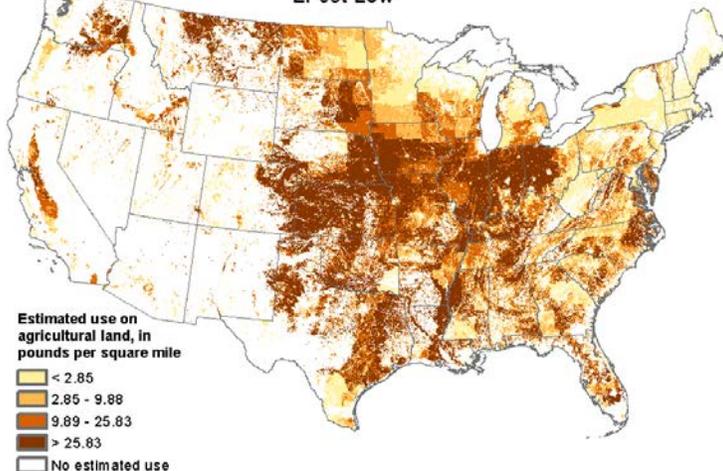
**50%** of all antibiotics given to humans are prescribed unnecessarily or used inappropriately.

# Iowa: Up to 66 million lbs. of 150 different active pesticide ingredients applied in 2016

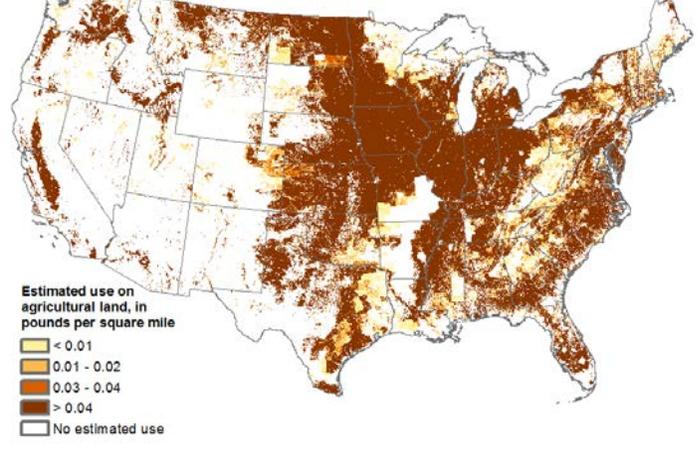
Estimated Agricultural Use for Atrazine , 2014 (Preliminary)  
EPEst-Low



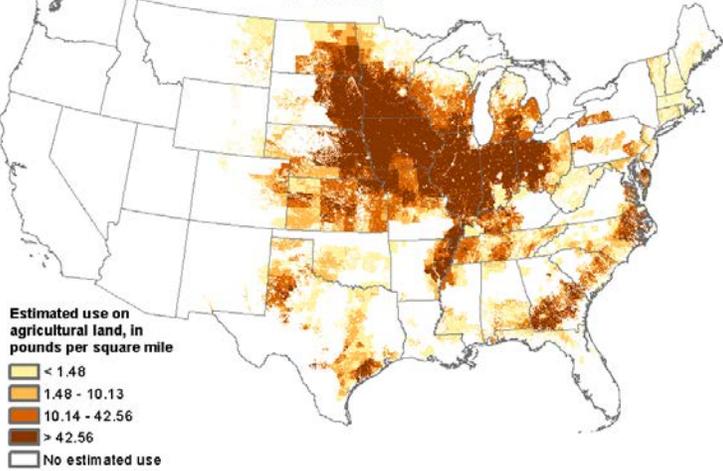
Estimated Agricultural Use for "2,4-D" , 2015 (Preliminary)  
EPEst-Low



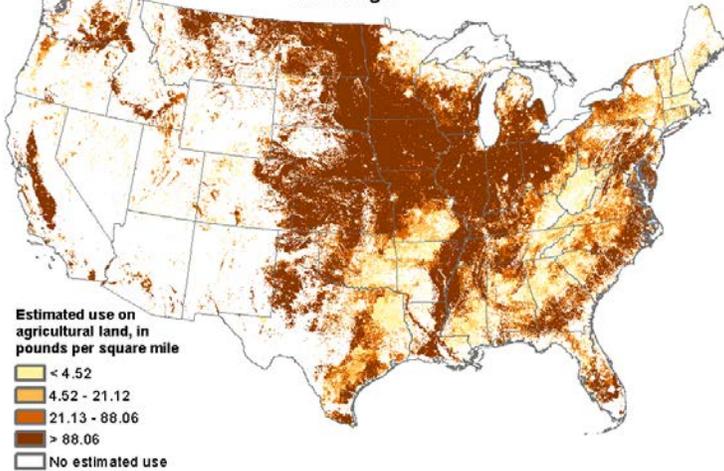
Estimated Agricultural Use for Imidacloprid , 2014 (Preliminary)  
EPEst-Low



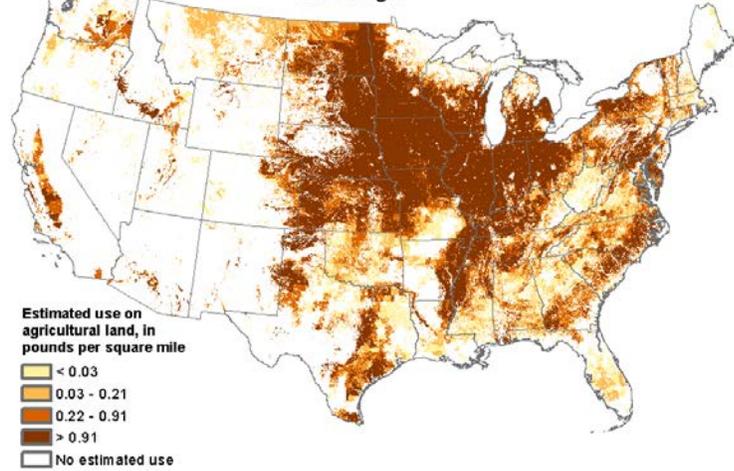
Estimated Agricultural Use for Acetochlor , 2014 (Preliminary)  
EPEst-Low



Estimated Agricultural Use for Glyphosate , 2015 (Preliminary)  
EPEst-High



Estimated Agricultural Use for Clothianidin , 2014 (Preliminary)  
EPEst-High



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WASHINGTON POST

TWEETS 218K FOLLOWING 1,345 FOLLOWERS 9.69M LIKES 4,514 LISTS 33 MOMENTS 25

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Washington Post @washingtonpost · 7m

**First evidence found of popular farm pesticides in drinking water**



**First evidence found of popular farm pesticides in drinking water**  
Regulators have not defined safe levels of neonicotinoids in drinking water, in part because the chemicals are relatively new.  
washingtonpost.com

14 101 46

United States Trends · Change

- #wednesdaywisdom @capitalweather is Tweeting about this
- #NationalWalkingDay @FiveThirtyEight is Tweeting about this
- #PictureAWorldWhere 8,148 Tweets
- Barry Manilow 3,316 Tweets
- Joint Base Andrews 3,245 Tweets
- #holdthefloor @fastlemer, @SenJeffMerkley and 5 m are Tweeting about this
- #AsambleaNacional 2,211 Tweets
- Troy Ave 2,471 Tweets
- Panera Bread 8,204 Tweets
- Bam Adebayo

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So in Iowa, this shouldn't be surprising

The Daily Iowan  
NEWSPAPER · ONLINE · TELEVISION

Night Owl

LOOKING FOR FIND

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Getting feisty by getting funny, feminist Research finds insecticide in UI water Dog trainer a

**RESEARCH FINDS INSECTICIDE IN UI WATER**

Metro

Apr 11, 2017



Kathryn Klarich & Gregory LeFevre

# Glyphosate and the evolving state of science regarding health risk to applicators

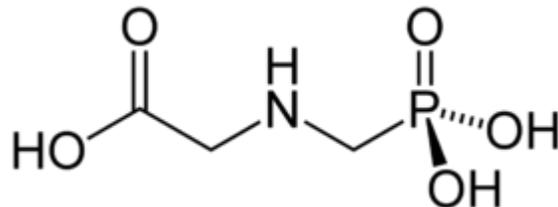


ENVIRONMENT MARCH 12, 2019 / 5:29 PM / 5 DAYS AGO

## Bayer Roundup cancer trial goes to jury after closing arguments

Jim Christie

4 MIN READ



## Mutation Research/Reviews in Mutation Research

Available online 10 February 2019

In Press, Accepted Manuscript



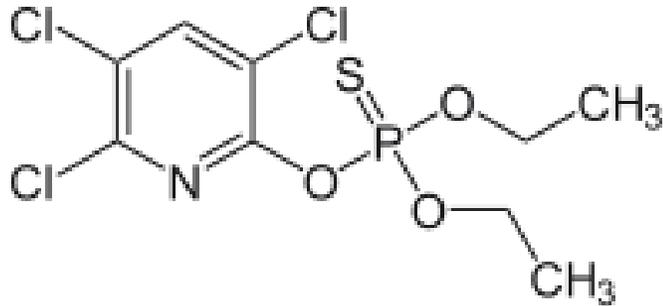
Review

## Exposure to Glyphosate-Based Herbicides and Risk for Non-Hodgkin Lymphoma: A Meta-Analysis and Supporting Evidence

Luoping Zhang <sup>a</sup>, Iemaan Rana <sup>a</sup>, Rachel M. Shaffer <sup>b</sup>, Emanuela Taioli <sup>c</sup>, Lianne Sheppard <sup>b, d</sup>

*“Overall, in accordance with evidence from experimental animal and mechanistic studies, our current meta-analysis of human epidemiological studies suggests a compelling link between exposures to GBHs and increased risk for NHL”*

# When science is “settled”: The ongoing case of chlorpyrifos



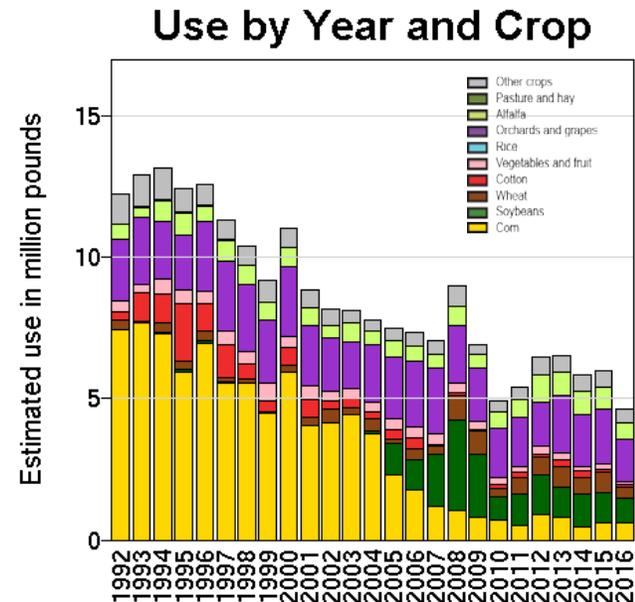
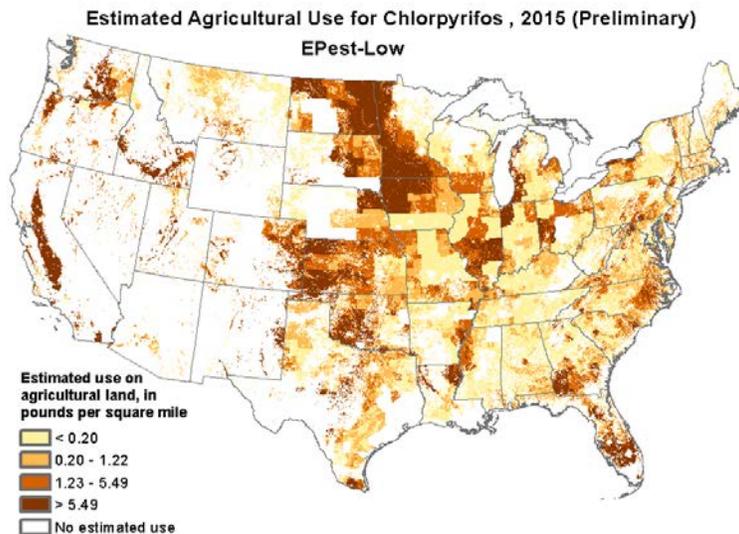
1965 - First registered as an insecticide

2000 – Nearly all in home uses eliminated (suspected neurotoxin)

2002 – Application rates restricted on most crops

2009 – Registration Review initiated under FIFRA

2012 – Further restrictions on application with “no spray” buffers



# Chlorpyrifos Registration Review & Revised Human Health Risk Assessment



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## Revised Human Health Risk Assessment on Chlorpyrifos

### 1. What does EPA's revised human health risk assessment show?

This assessment shows dietary and drinking water risks for the current uses of chlorpyrifos. Based on current labeled uses, the revised analysis indicates that expected residues of chlorpyrifos on food crops exceed the safety standard under the Federal Food, Drug, and Cosmetic Act (FFDCA). In addition, the majority of estimated drinking water exposure from currently registered uses, including water exposure from non-food uses, continues to exceed safe levels, even taking into account more refined drinking water exposure. This assessment also shows risks to workers who mix, load and apply chlorpyrifos pesticide products.

Energy and Environment

# EPA chief, rejecting agency's own analysis, declines to ban pesticide despite health concerns

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By **Brady Dennis** March 29 



# Revised Human Health Risk Assessment on Chlorpyrifos

## 1. What does EPA's revised human health risk assessment show?

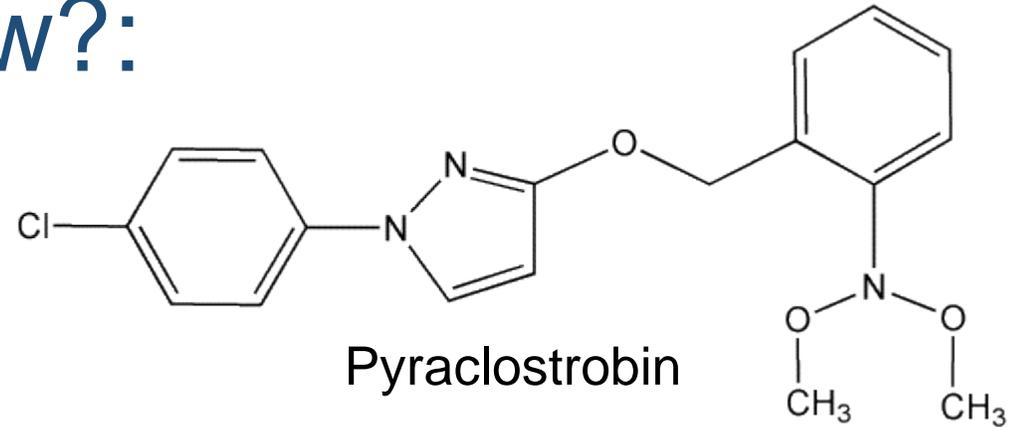
This assessment shows dietary and drinking water risks for the current uses of chlorpyrifos. Based on current labeled uses, the revised analysis indicates that expected residues of chlorpyrifos on food crops exceed the safety standard under the Federal Food, Drug, and Cosmetic Act (FFDCA). In addition, the majority of estimated drinking water exposure from currently registered uses, including water exposure from non-food uses, continues to exceed safe levels, even taking into account more refined drinking water exposure. This assessment also shows risks to workers who mix, load and apply chlorpyrifos pesticide products.

## 2. What are EPA's next steps?

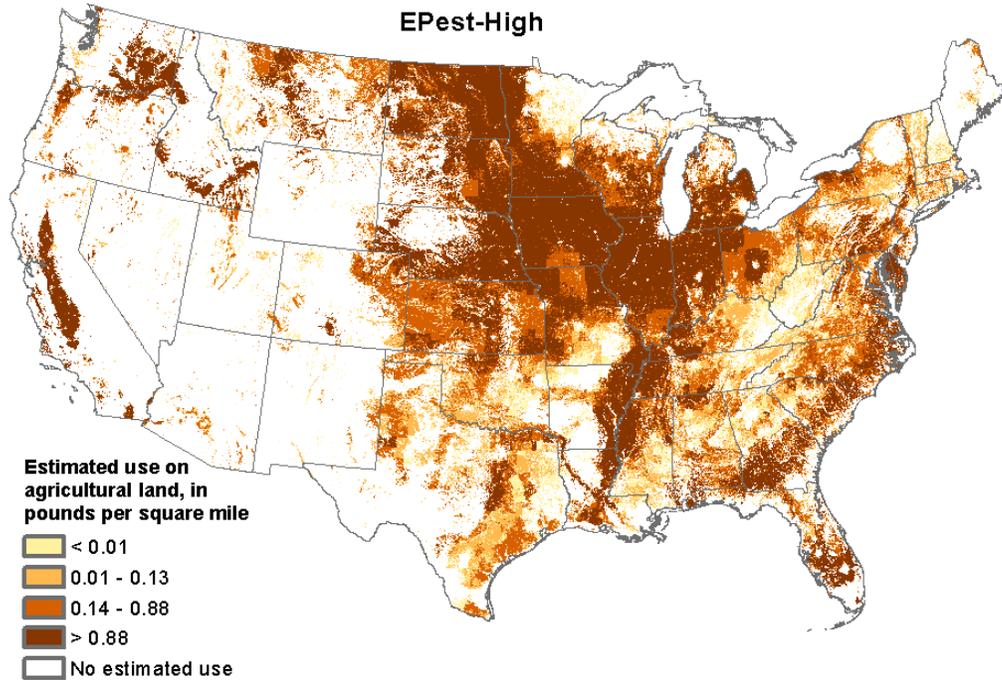
In March 2017, EPA denied a petition asking us to revoke all pesticide tolerances (maximum residue levels in food) for chlorpyrifos and cancel all chlorpyrifos registrations. We will continue to review the science addressing neurodevelopmental effects of chlorpyrifos as part of the ongoing registration review and complete our assessment by the statutory deadline of October 1, 2022. [Read the Federal Register notice announcing our response to the petition.](#)



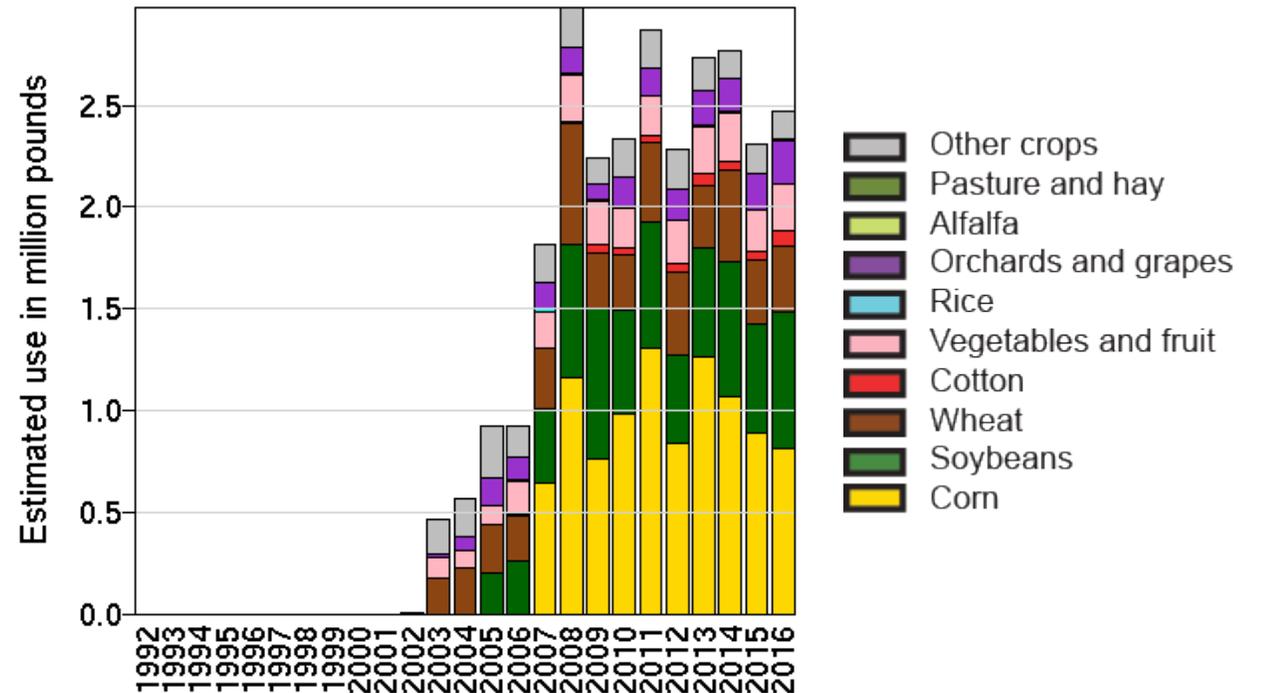
# What we are looking at now?: Strobilurin fungicides



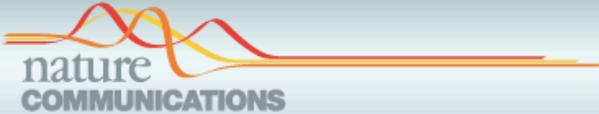
Estimated Agricultural Use for Pyraclostrobin , 2016 (Preliminary)  
EPest-High



Use by Year and Crop



# Strobulin fungicides: Environmental occurrence & evolving understanding of risks



nature  
COMMUNICATIONS

ARTICLE

Received 1 Dec 2015 | Accepted 29 Feb 2016 | Published 31 Mar 2016

DOI: 10.1038/ncomms11173 OPEN

## Identification of chemicals that mimic transcriptional changes associated with autism, brain aging and neurodegeneration

Brandon L. Pearson<sup>1,2,\*</sup>, Jeremy M. Simon<sup>1,2,\*</sup>, Eric S. McCoy<sup>1</sup>, Gabriela Salazar<sup>1</sup>, Giulia Fragola<sup>1</sup> & Mark J. Zylka<sup>1,2</sup>

Environmental factors, including pesticides, have been linked to autism and neurodegeneration risk using retrospective epidemiological studies. Here we sought to prospectively identify chemicals that share transcriptomic signatures with neurological disorders, by exposing mouse cortical neuron-enriched cultures to hundreds of chemicals commonly found in the environment and on food. We find that rotenone, a pesticide associated with Parkinson's disease risk, and certain fungicides, including pyraclostrobin, trifloxystrobin, famoxadone and fenamidone, produce transcriptional changes *in vitro* that are similar to those seen in brain samples from humans with autism, advanced age and neurodegeneration (Alzheimer's disease and Huntington's disease). These chemicals stimulate free radical production and disrupt microtubules in neurons, effects that can be reduced by pretreating with a microtubule stabilizer, an antioxidant, or with sulforaphane. Our study provides an approach to prospectively identify environmental chemicals that transcriptionally mimic autism and other brain disorders.

ScienceDaily®

Your source for the latest research news

## Could new class of fungicides play a role in autism, neurodegenerative diseases?

**Date:** March 31, 2016

**Source:** University of North Carolina Health Care

**Summary:** A class of commonly used fungicides has been found that produce gene expression changes similar to those in people with autism and neurodegenerative conditions, including Alzheimer's disease and Huntington's disease.

# Some parting thoughts...

- How we use our land certainly has consequences for public health.
- Our scientific understanding of “what is safe?” is advancing at a pace that far exceeds our ability to create new regulations or revise existing standards.
- There remain instances of chemical use (e.g., chlorpyrifos) where there should be little controversy, but nevertheless, regulatory inaction persists.
- (To me) It is inevitable that the nitrate drinking water standard will need to be lowered. And if EPA won't act, the States should (but probably won't).
- We need to expand our discussion beyond nitrate to include the hazards of and exposure to other byproducts of agricultural intensification (antibiotic resistance, emerging pathogens, pesticides...).