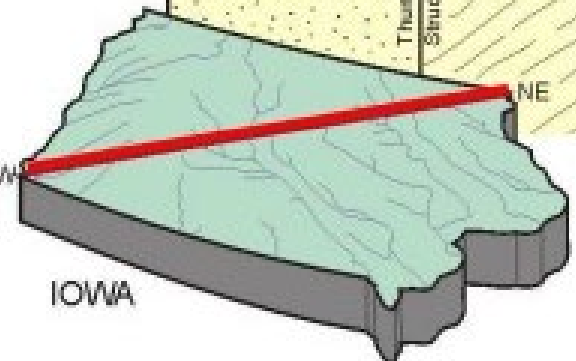
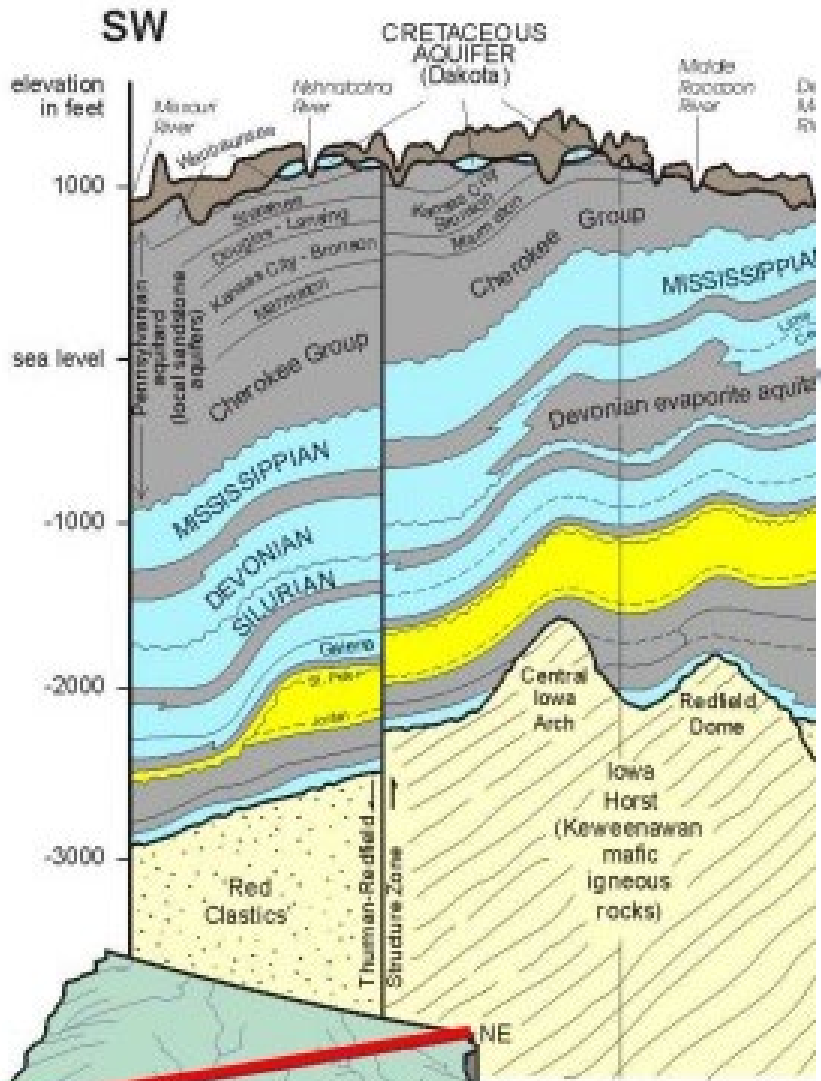


# Water in Iowa Contamination to Recreation

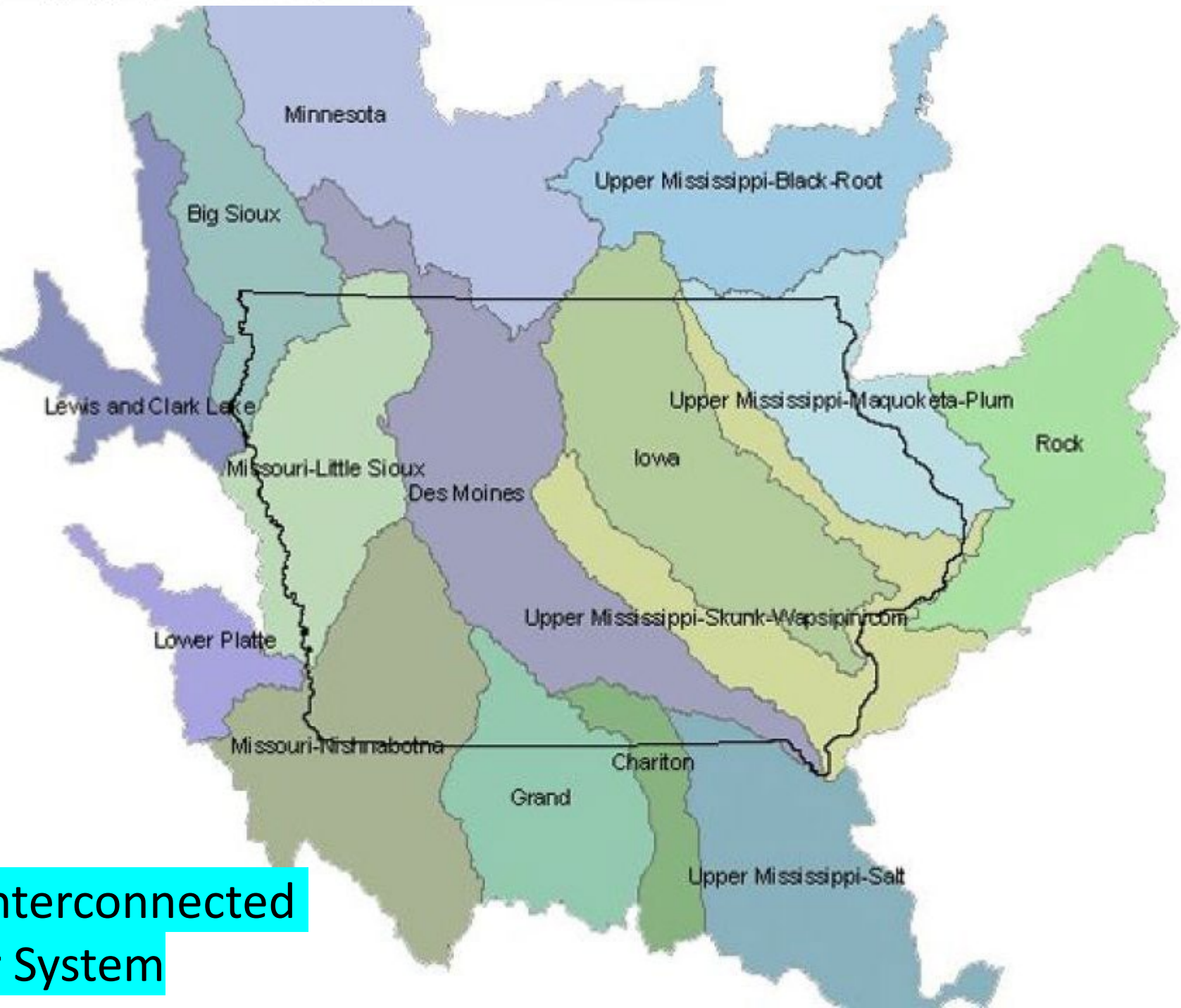
April 9

Session 4

# Bedrock A



One Interconnected Water System



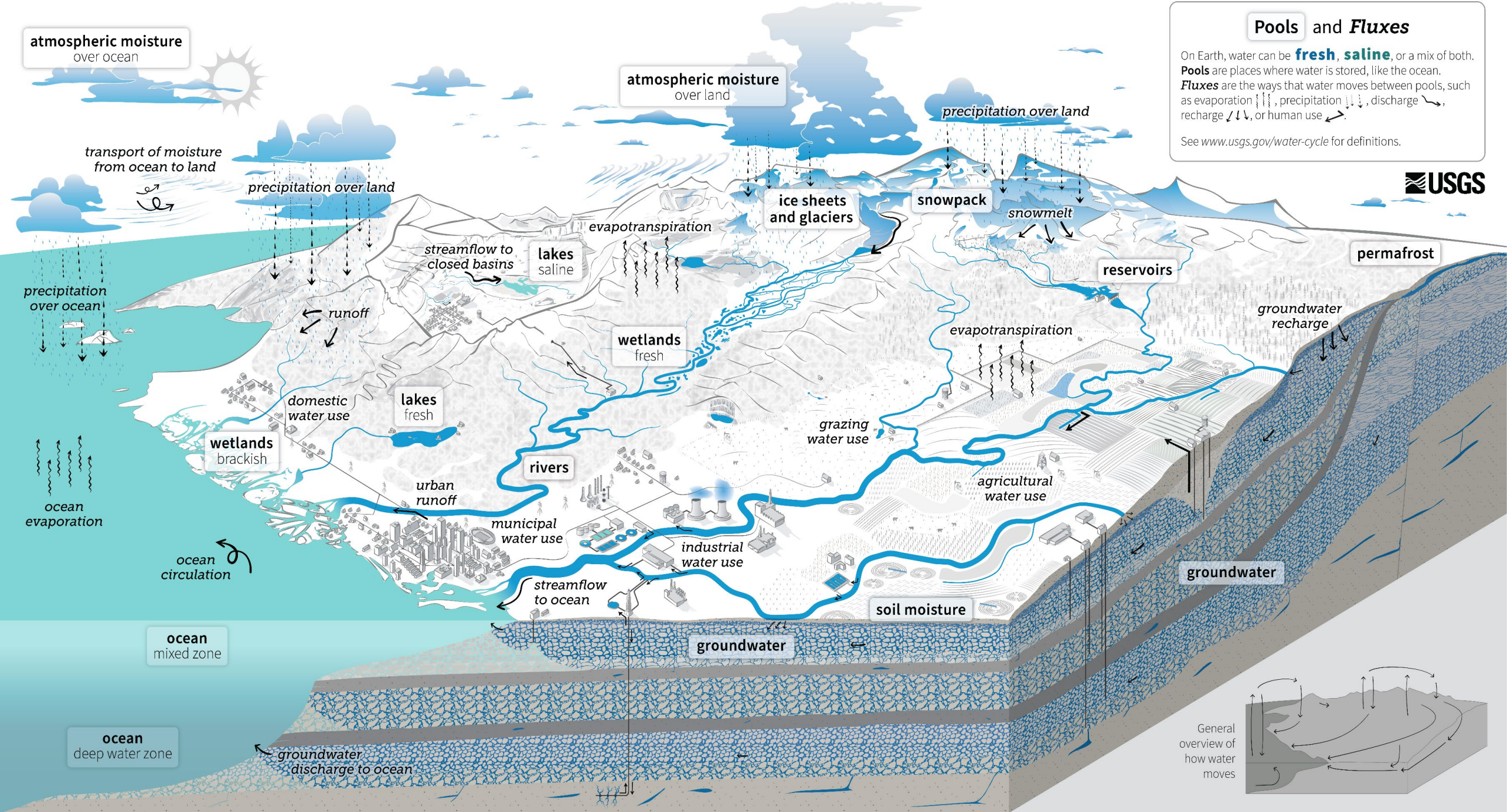
atmospheric moisture  
over ocean

atmospheric moisture  
over land

### Pools and Fluxes

On Earth, water can be **fresh**, **saline**, or a mix of both. **Pools** are places where water is stored, like the ocean. **Fluxes** are the ways that water moves between pools, such as evaporation ↑↑↑, precipitation ↓↓↓, discharge ↘, recharge ↙↘, or human use ↖.

See [www.usgs.gov/water-cycle](http://www.usgs.gov/water-cycle) for definitions.



transport of moisture  
from ocean to land

precipitation over land

precipitation over land

ice sheets  
and glaciers

snowpack

snowmelt

reservoirs

permafrost

precipitation  
over ocean

streamflow to  
closed basins

lakes  
saline

evapotranspiration

wetlands  
fresh

evapotranspiration

groundwater  
recharge

ocean  
evaporation

wetlands  
brackish

domestic  
water use

lakes  
fresh

grazing  
water use

agricultural  
water use

ocean  
circulation

urban  
runoff

rivers

municipal  
water use

industrial  
water use

groundwater

ocean  
mixed zone

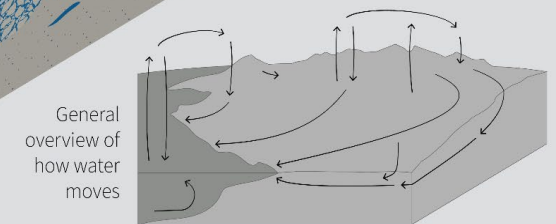
streamflow  
to ocean

groundwater

soil moisture

ocean  
deep water zone

groundwater  
discharge to ocean



General  
overview of  
how water  
moves





We-no-nah

IA8622 AY

2022

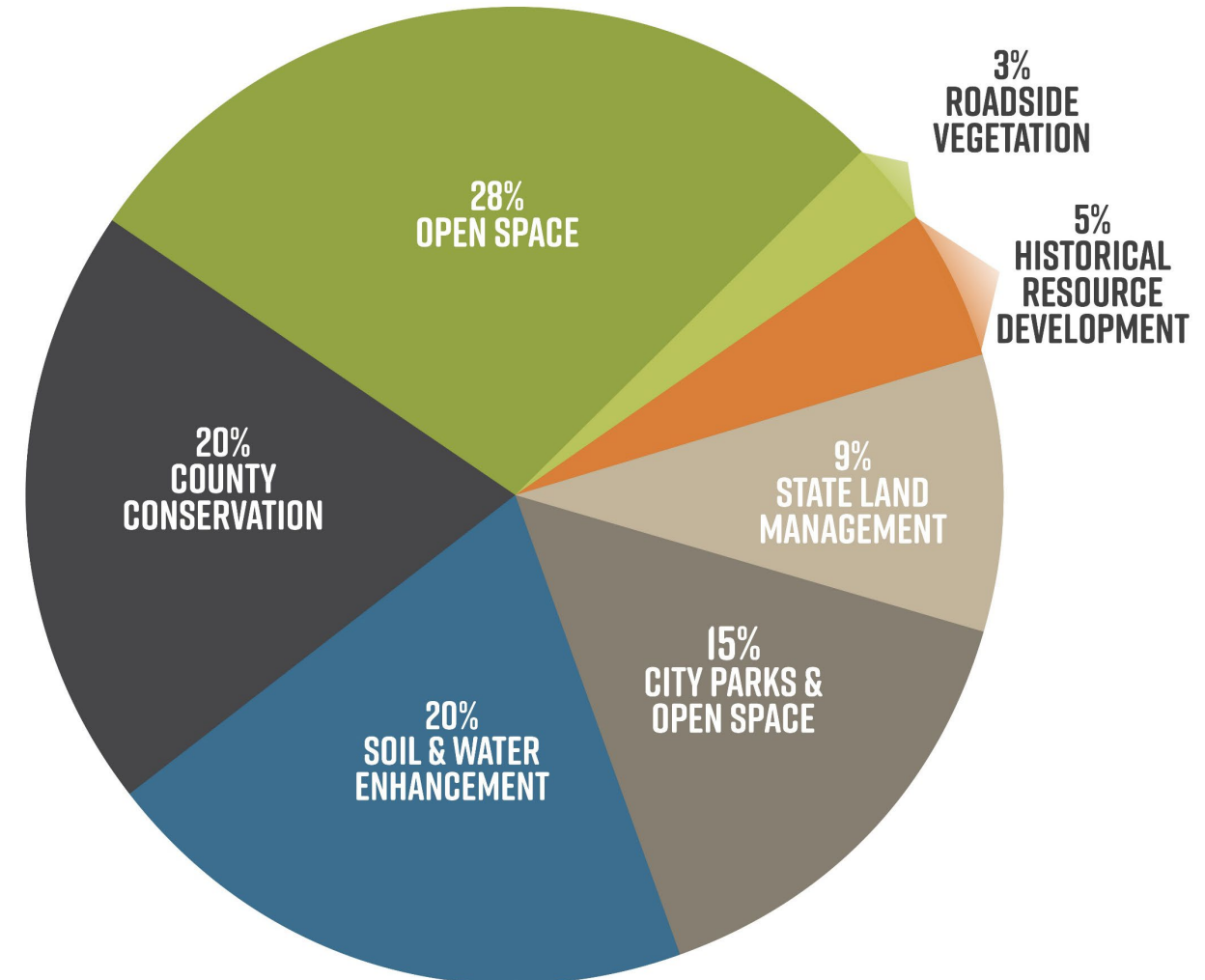
# Recreation in Iowa

- Beach monitoring
- Boating
- Canoeing and Kayaking
- Camping
- Cycling
- Dog Training
- Equestrian
- Geocaching/Earth Caching
- Fishing and hunting
- Hiking



## FUND DISTRIBUTION

\$350,000 CONSERVATION EDUCATION & 1% ADMINISTRATION

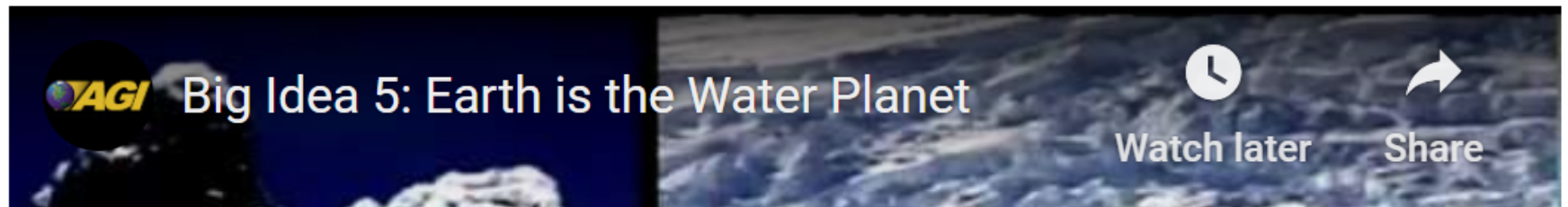


# EXPLORE IOWA GEOLOGY

## Iowa The Rivers of Her Valleys 4.0 (IRHV) Curricula

Water is a curious thing: although vital to life, it costs almost nothing, where as gold and diamonds, which are useless for survival, cost a fortune.- **Adam Smith, Wealth of Nations 1776**

This project add to a growing conversation regarding environmental and river education in Iowa. Rivers are the 'life-blood' of a landscape providing access to drinking water, recreation and contribute to the development of thriving economies. Iowa's waterways are the closest we can get to interacting with and learning from wild/natural landscapes. We aim to develop new and locally pertinent earth science curricula that create meaningful learning opportunities for Iowa's teachers, students and communities. The activities below were developed by and with a group of Iowa teacher while they participated in a UNI/Iowa REP CEP course. The activities will always be a work in process designed to create a sustain effort working to bring one of Iowa's resources our streams aand rivers. Perhaps increased understand will lead to appreciation, human-environmental reciprocity and care.





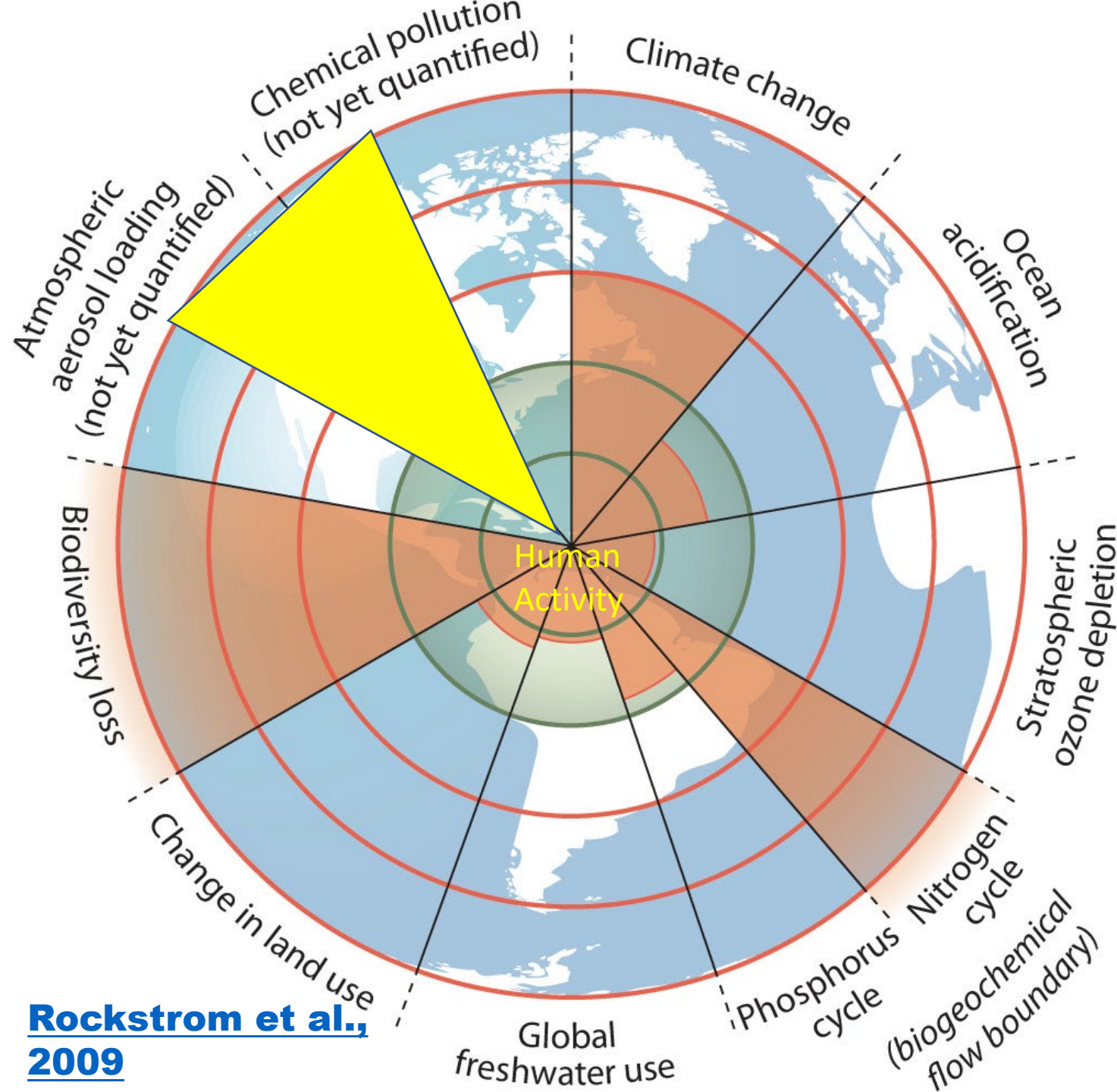


# Basic Environmental Pattern

- Something bad happens
- How did we let this happen? Enact rules, regulations, policies
- Time progresses (1 to 10 years)
- People forget something bad happened
- Loosen rules, regulations and policies because they inhibit business and profit
- Something bad happens
- Why did we loosen rules, regulations and policies? Better sue someone

# Earth Systems Under Stress

## *BioGeoChemistry*



**Rockstrom et al., 2009**

1962

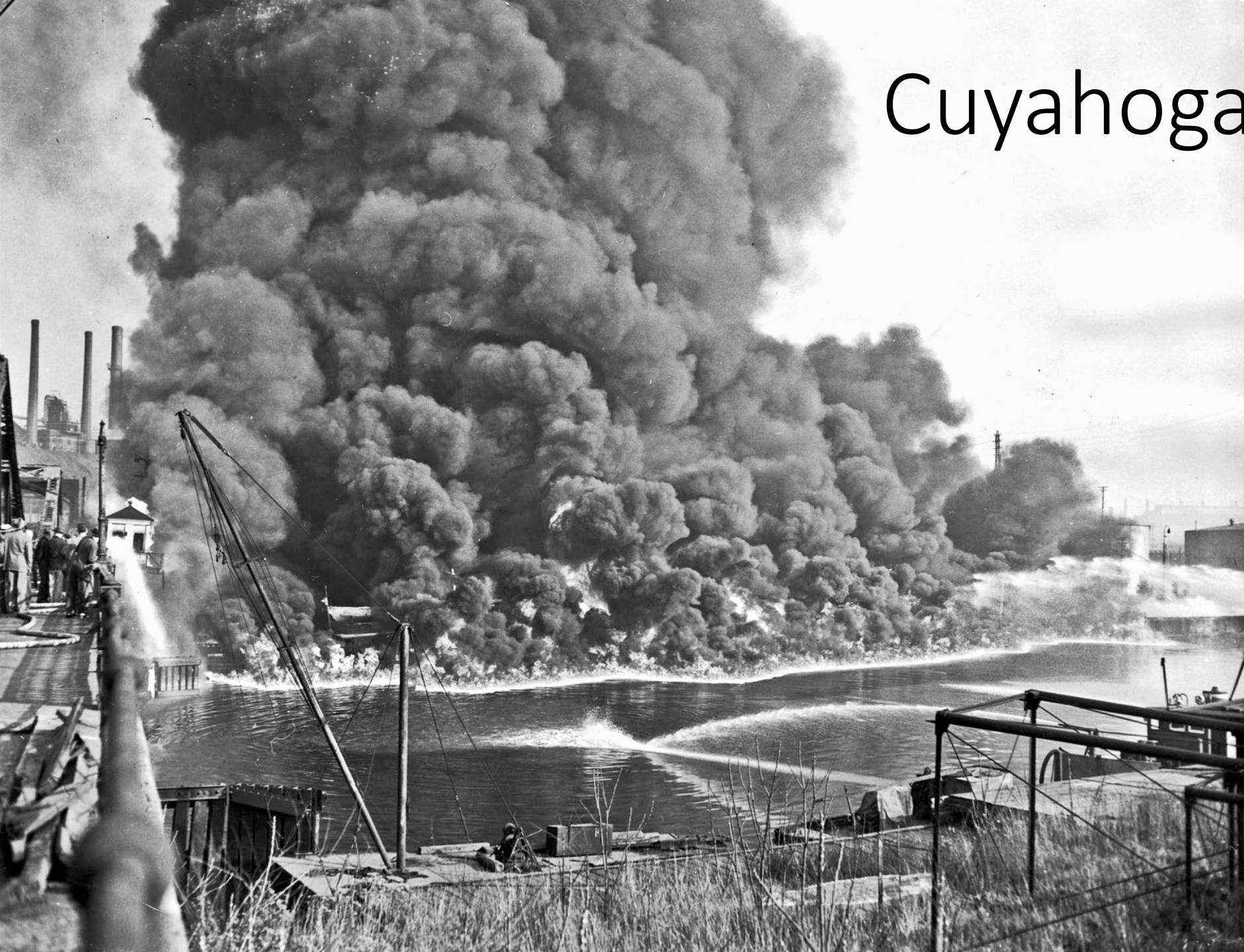


# SILENT SPRING

*The* CLASSIC *that* LAUNCHED  
*the* ENVIRONMENTAL MOVEMENT

RACHEL  
CARSON

*Introduction by* LINDA LEAR *Afterword by* EDWARD O. WILSON



# Cuyahoga River

1868, 1883, 1887,  
1912, 1914, 1922,  
1930, 1936, 1941,  
1948, 1949, 1951,  
1952, 1969

1970



# The New York Times

LAT  
Weat  
and to  
Temp  
67-68.

3,997

© 1970 The New York Times Company.

NEW YORK, THURSDAY, APRIL 23, 1970

## Millions Join Earth Day Observances Across the Nation



NEW YORK TIMES

NEW YORK TIMES

1970





# 1972 – Apollo 17

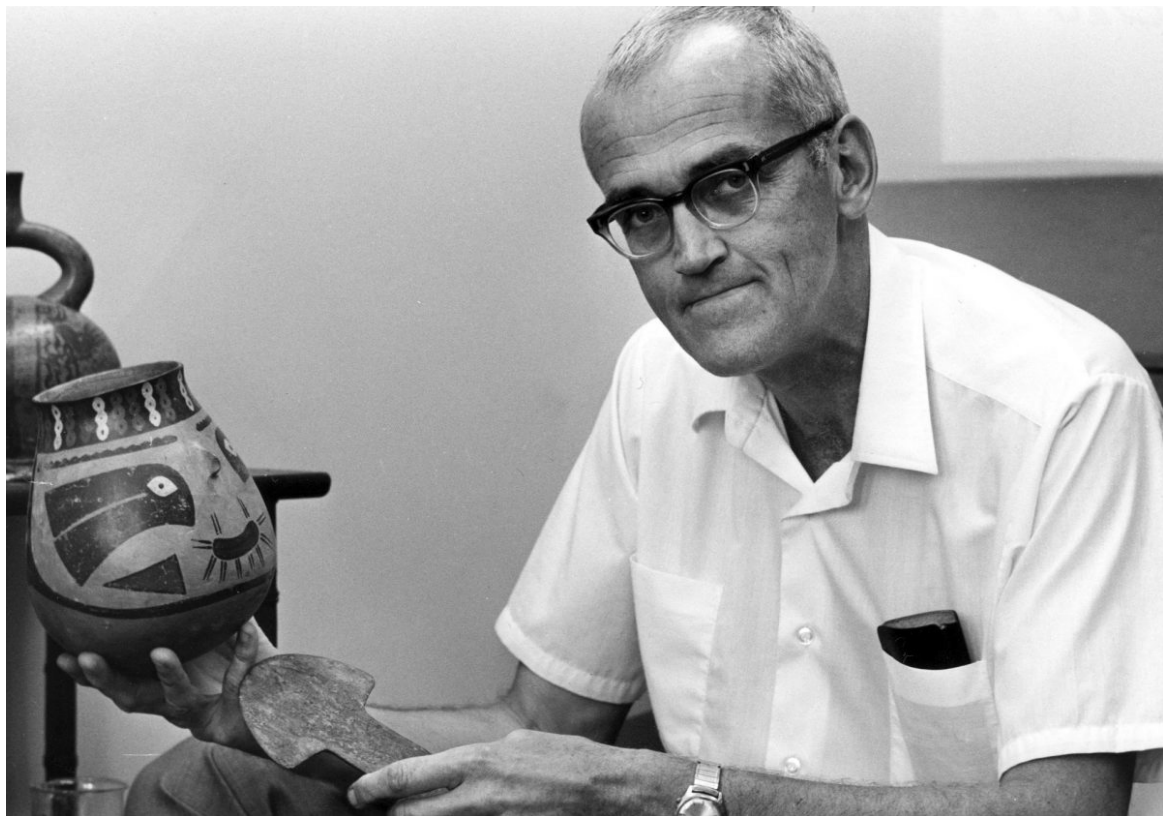




Cuyahoga River  
August, 2020



# 1971 – Get the lead out



<https://californiascienceweekly.com/2019/11/08/the-little-known-california-scientist-who-may-have-saved-millions-of-lives/>



# 1973 Endangered Species Act



Wait lead is still an  
issue?

13 Years!

1973 to 1986



"SAFE  
DRINKING  
WATER  
FROM ANY  
SOURCE,  
ANYWHERE"



1974 Safe Water  
Drinking Act  
(SDWA)



# Drinking water standards – EPA , est. 1974

- Safe Drinking Water Act
- Maximum Contaminant Levels (MCLs)
- Maximum Contaminant Level Goals (MCLG)

Contaminant	Secondary MCL	Noticeable Effects above the Seco
Aluminum	0.05 to 0.2 mg/L	colored w
Chloride	250 mg/L	salty tas
Color	15 color units	visible ti
Copper	1.0 mg/L	metallic taste; blue-
Corrosivity	Non-corrosive	metallic taste; corroded pip
Fluoride	2.0 mg/L	tooth discolor
Foaming agents	0.5 mg/L	frothy, cloudy; bitt
Iron	0.3 mg/L	rusty color; sediment; metallic tast
Manganese	0.05 mg/L	black to brown color; black stain
Odor	3 TON (threshold odor number)	"rotten-egg", musty or
pH	6.5 - 8.5	<i>low pH</i> : bitter metallic <i>high pH</i> : slippery feel; s
Silver	0.1 mg/L	skin discoloration; graying of
Sulfate	250 mg/L	salty tas
Total Dissolved Solids (TDS)	500 mg/L	hardness; deposits; colored wa
Zinc	5 mg/L	metallic taste

## National Primary Drinking Water Regulations

Contaminant	MCGL mg/L	MCL mg/L	iCAP Qa MDL mg/L
Barium	2	2	0.000027
Copper	1.3	1.3	0.000119
Chromium (total)	0.1	0.1	0.000022
Selenium	0.05	0.05	0.000084
Uranium	0	0.03	0.000006
Lead	0	0.015	0.000007
Arsenic	0	0.01	0.000011
Antimony	0.006	0.006	0.000010
Cadium	0.005	0.005	0.000017
Beryllium	0.004	0.004	0.000013
Thallium	0.0005	0.002	0.000007
Mercury	0.002	0.002	0.000011

EPA, <http://water.epa.gov/drink/contaminants/secondarystandards.cfm>. Accessed September 09, 2013.

Current data indicated that Mn has no taste at 0.05 mg/L (Sain et al. 2014)

# 1978 – Love Canal

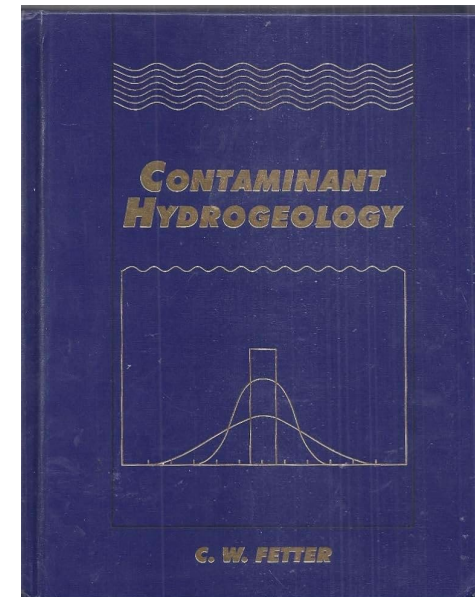


# Water pollutant categories - Basic

1. Micro-organisms, (E. coli, Giardia, and noroviruses)
2. Inorganic chemicals (lead, arsenic, salts, nitrates, & nitrites)
3. Organic chemicals (atrazine, glyphosate, trichloroethylene, and tetrachloroethylene)

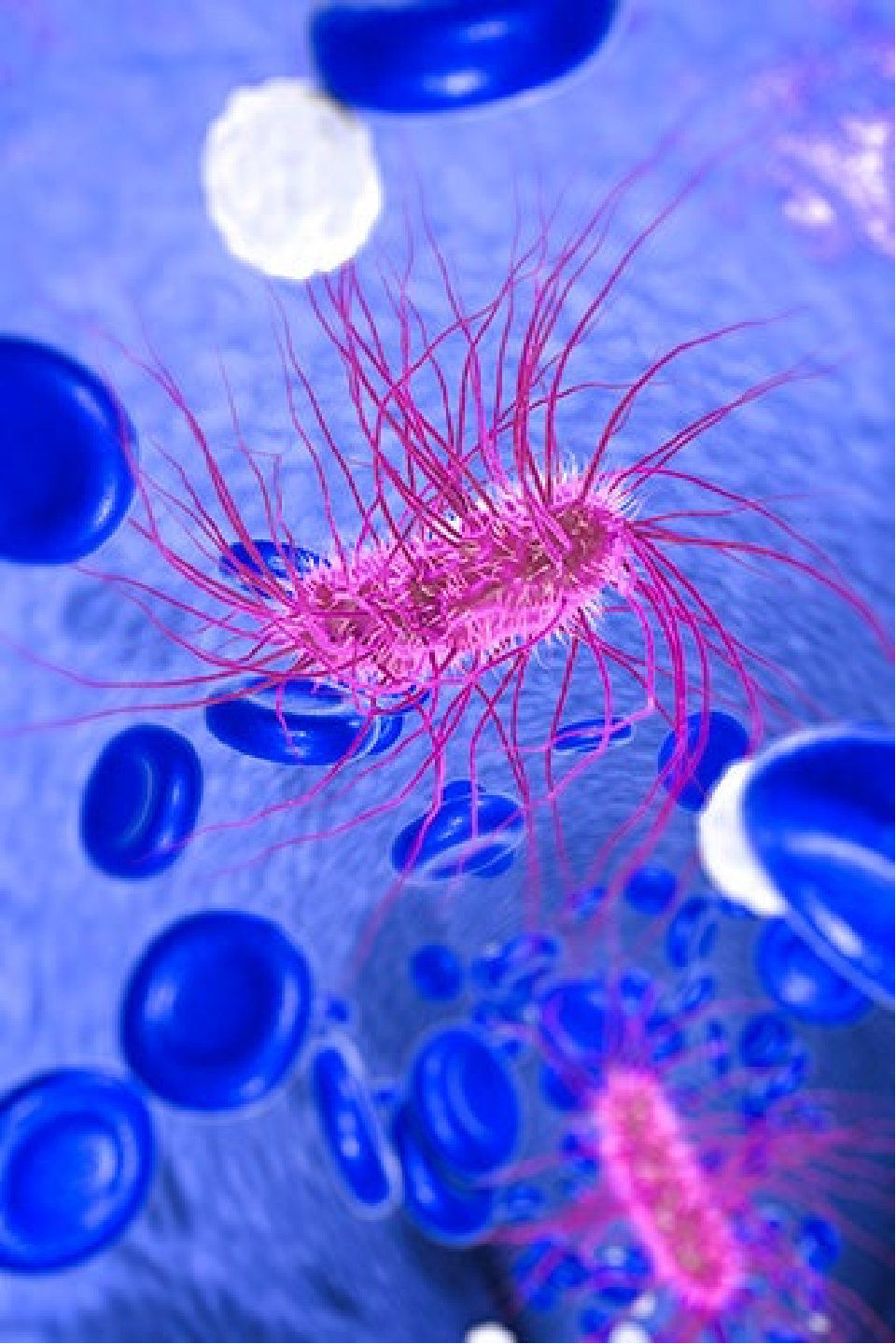
## Natural vs. Anthropogenic sources

10 page, 6 font table of known possible contaminants, circa 1992





# Micro-organisms



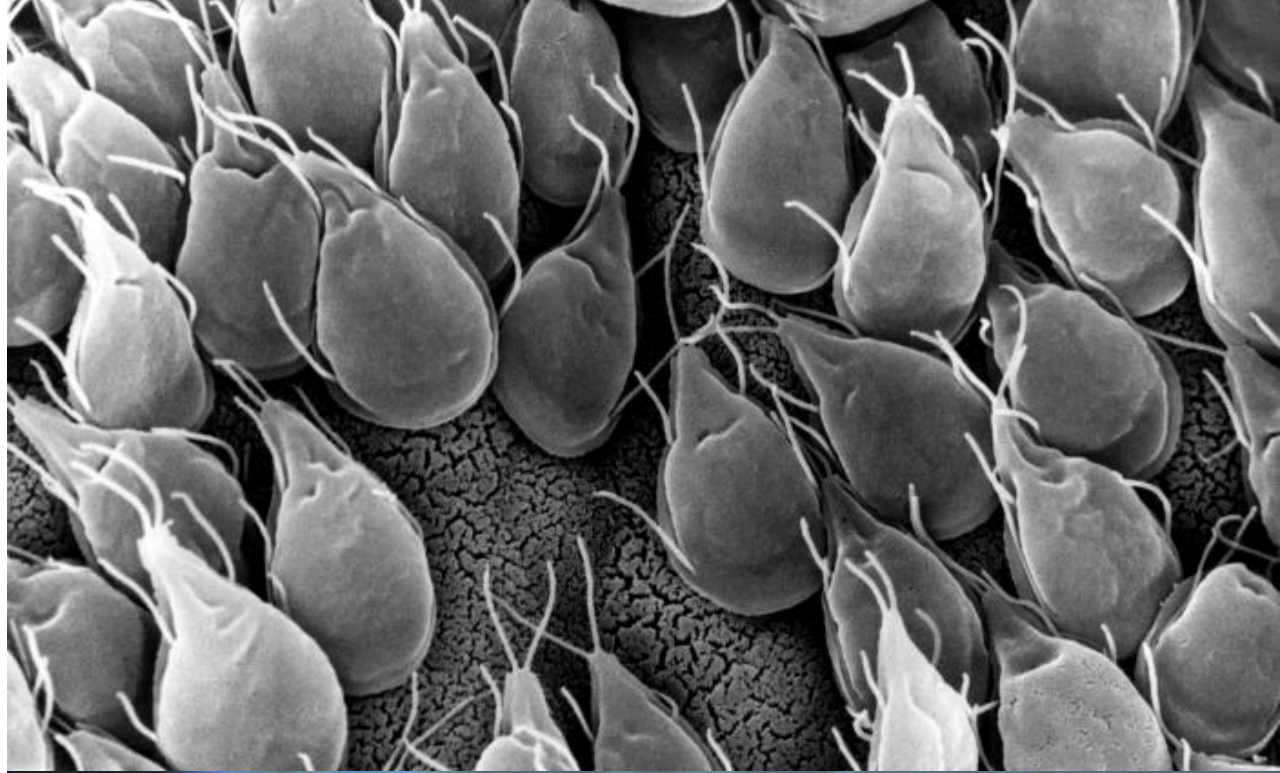
# Escherichia coli (E. coli)

- coliform bacteria

- Contact with contaminated food or water
- Human or animal waste
- Stomach pain, diarrhea, urinary infection
- Treatment – Antibiotics

# Giardia – Parasite

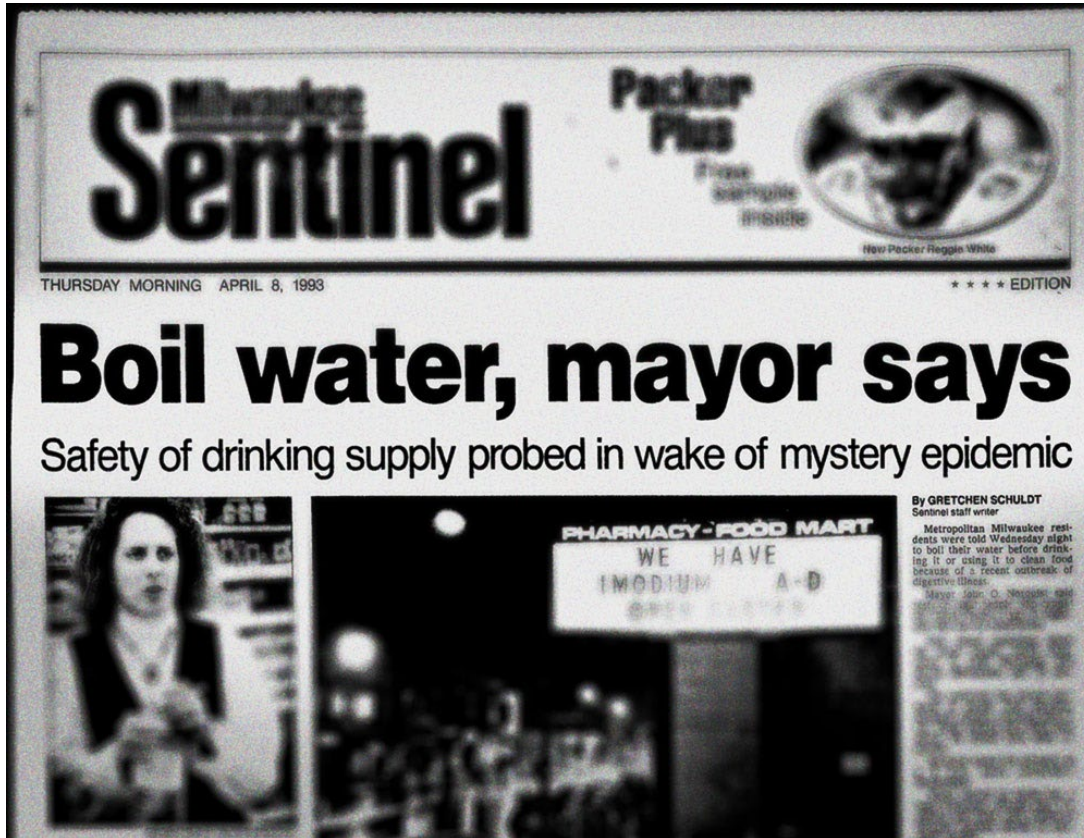
- Contact with contaminated food or water
- Human or animal waste
- Stomach pain, diarrhea, urinary infection, fatigue
- Treatment – Antibiotics



# Cryptosporidium – Parasite



1993 – 400,000+ get diarrhea at the same time!



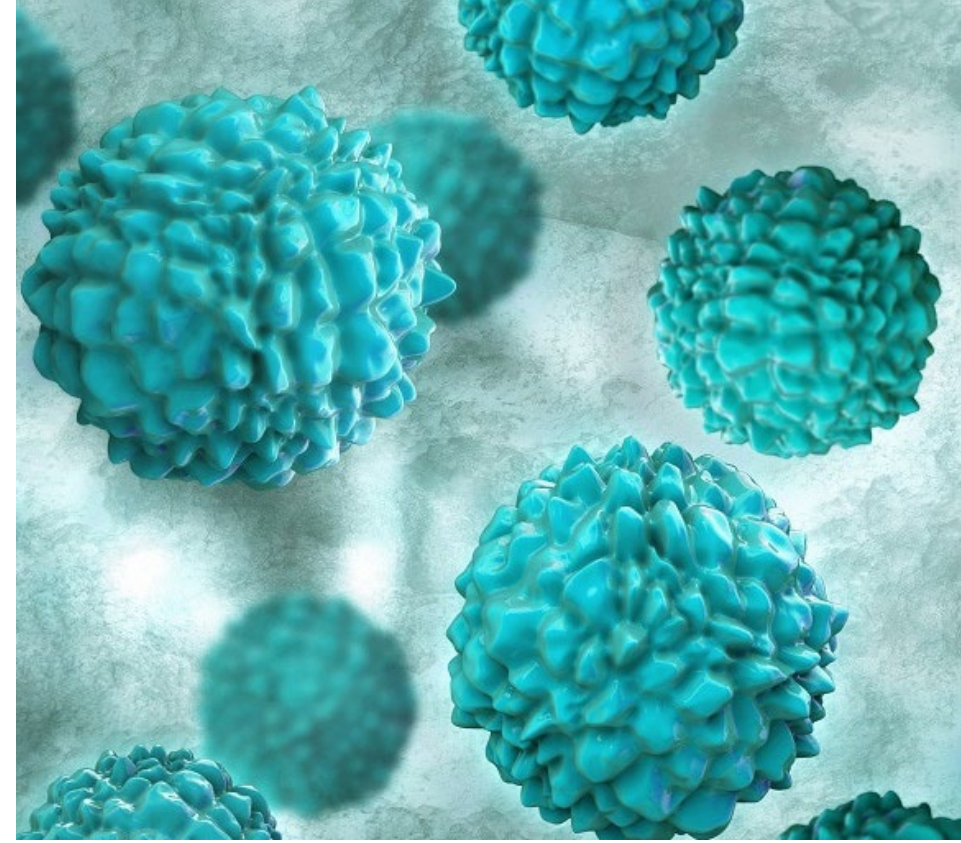
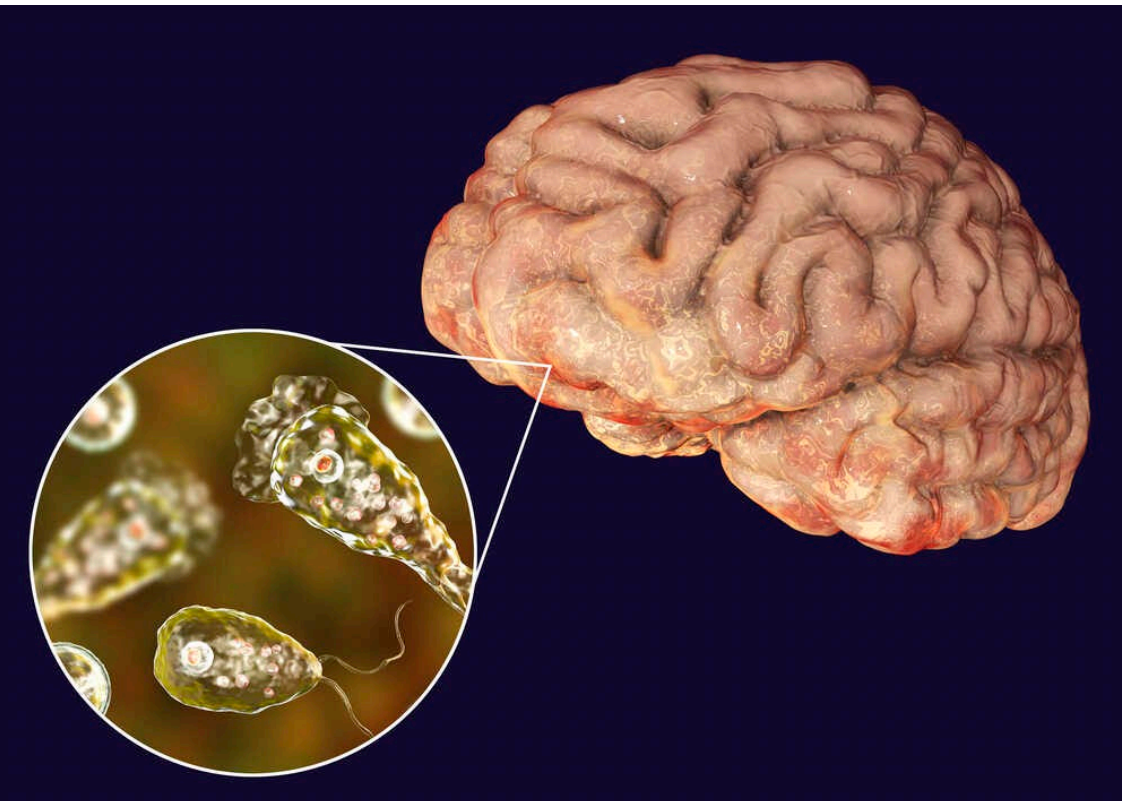
cryptosporidium



Milwaukee, WI

# Naegleria fowleri, an amoeba

Naturally found in fine grained sediment of ponds and rivers  
Causes a disease called primary amebic meningoencephalitis (PAM).  
It's both extremely rare — and extremely deadly (97% mortality)  
Lake of Three Fires State Park- SW Iowa 2022



Norovirus

Human or animal waste  
Stomach pain, diarrhea, urinary infection,  
fatigue  
Treatment – Antibiotics



To notify the public about potentially dangerous water contamination in recreational areas, **public agencies may rely heavily or solely on signs posted at the affected beach.**



COURTESY MELISSA MARTIN / DENISE MINTZ



USA TODAY

## Causes

- + Excess phosphorus and nitrogen from:
  - Agricultural fertilizers
  - Residential sewer/septic leakage
  - Stormwater runoff (streets, roofs)
  - Hog, cattle & poultry manure
  - Industrial discharge
  - Wind & rain deposition
  - Shorebird droppings
  - Soil erosion (storms and flooding)
- + Warmer water temperatures
- + Unfiltered sunlight
- + Stagnant water
- + Stratified water layers
- + Invasive mussels

# Algal Blooms

Warmer weather and increased runoff create ideal conditions for Harmful Algal Blooms (HABs) — the abnormal growth of blue-green algae in lakes. It is a complex problem with many harmful consequences.



## Effects

- **Human health:**
  - Skin rashes, illness (cyanotoxins)
  - Noxious odors
  - Drinking water contamination
- **Ecosystem:**
  - Healthy food web disruption
  - Fish kills
  - Shellfish toxicity
- **Environmental:**
  - Dead zones
  - Acid rain
  - Air pollution
- **Recreational:**
  - Beach closures
  - Boating restrictions
  - Fishing bans
- **Economic:**
  - Expensive water purification
  - Commercial fishing losses
  - Decreased tourism revenue
  - Decrease in recreational business
  - Decreased property values

1 Warmer weather fuels bigger rain events

2 Sediments and agricultural fertilizers runoff into rivers, feeding the algae and clouding the water

3 Algae grow into a thick mat on surface, further blocking sunlight

4 Deep-water plants cannot photosynthesize, so they stop producing oxygen and die

5 Fish and other animals suffocate, die and fall to the lake bottom

ALGAL BLOOM

Blue-green algae are really cyanobacteria. They are microscopic and are naturally found in bodies of water.

Excess Nutrient Cycling

Hypoxic Zone (LOW OXYGEN)

BOTTOM MUCK

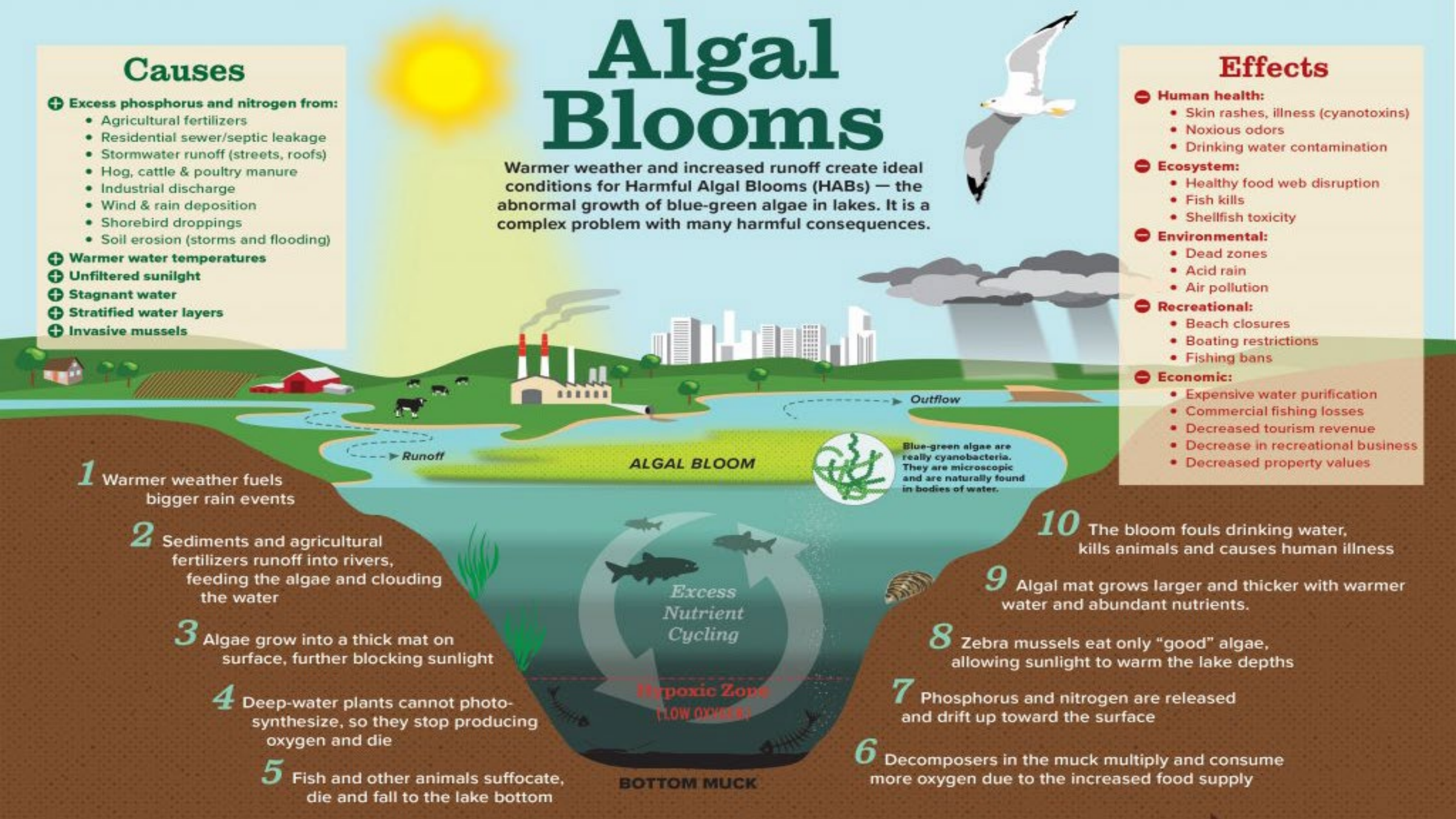
10 The bloom fouls drinking water, kills animals and causes human illness

9 Algal mat grows larger and thicker with warmer water and abundant nutrients.

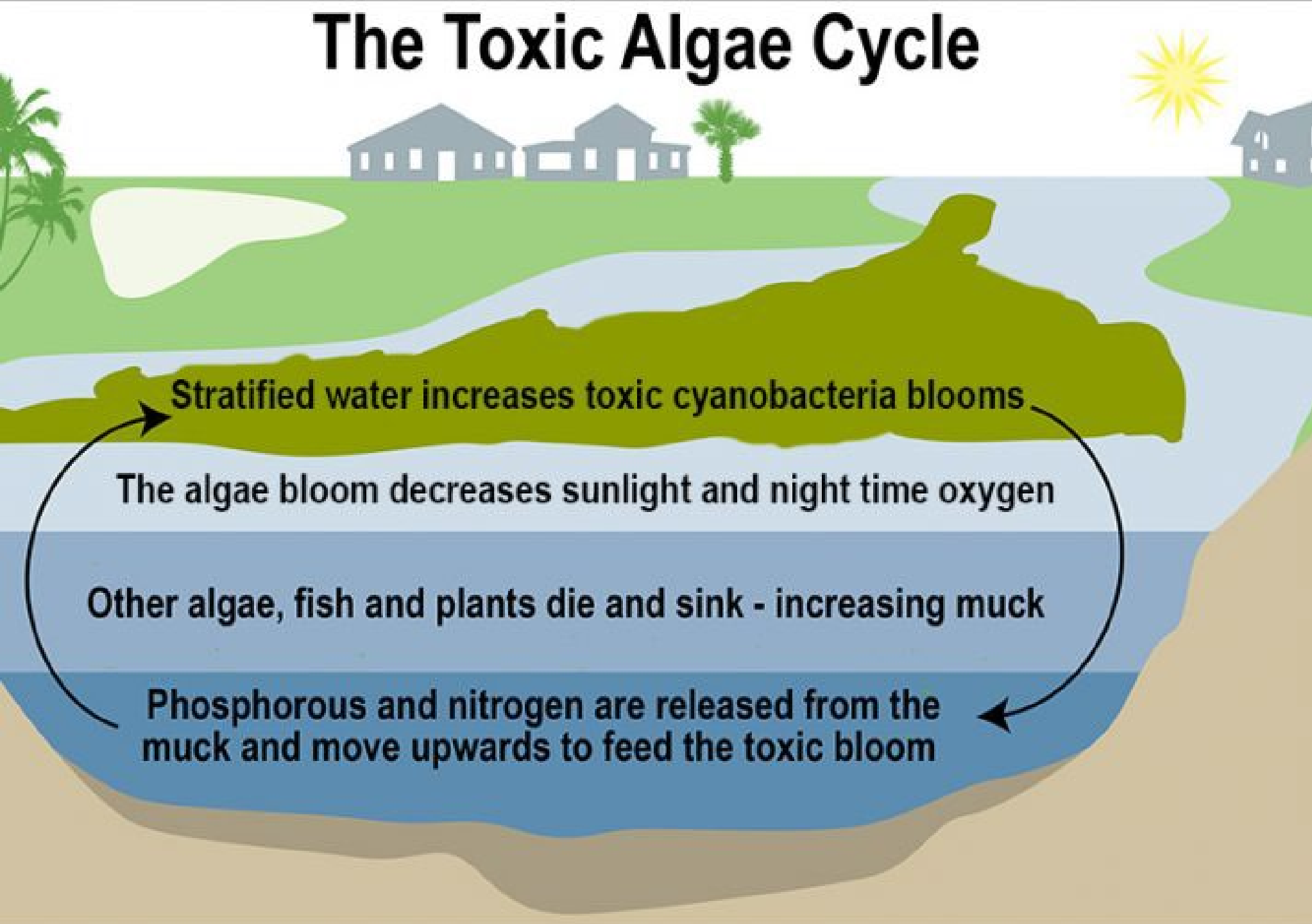
8 Zebra mussels eat only "good" algae, allowing sunlight to warm the lake depths

7 Phosphorus and nitrogen are released and drift up toward the surface

6 Decomposers in the muck multiply and consume more oxygen due to the increased food supply



# The Toxic Algae Cycle

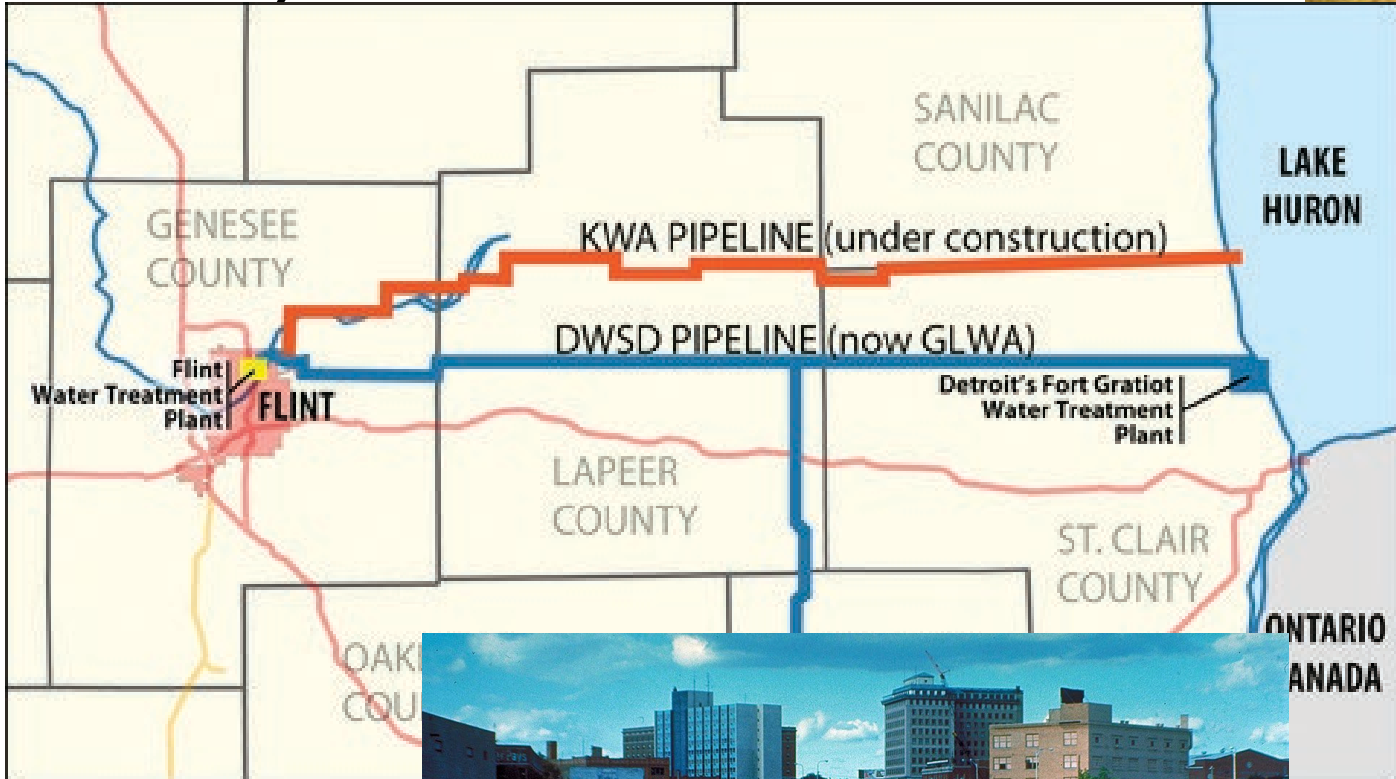






# Inorganic chemicals

# Flint, MI 2014



Treated Water From Different Sources		
	Detroit River/ Lake Huron	Flint River
pH	7.38	7.89
Na, mg/L	4.6	18
K	0.8	1
Ca	22.5	40
Mg	5.8	3
Al	0.215	0.037
Fe	0.175	0.097
Mn	0.005	0.0037
Alk	106	118
SO4	33.9	31
Cl	39.8	95
PO4	1.05	0
TOC, before treatment	1.5-1.8	6.

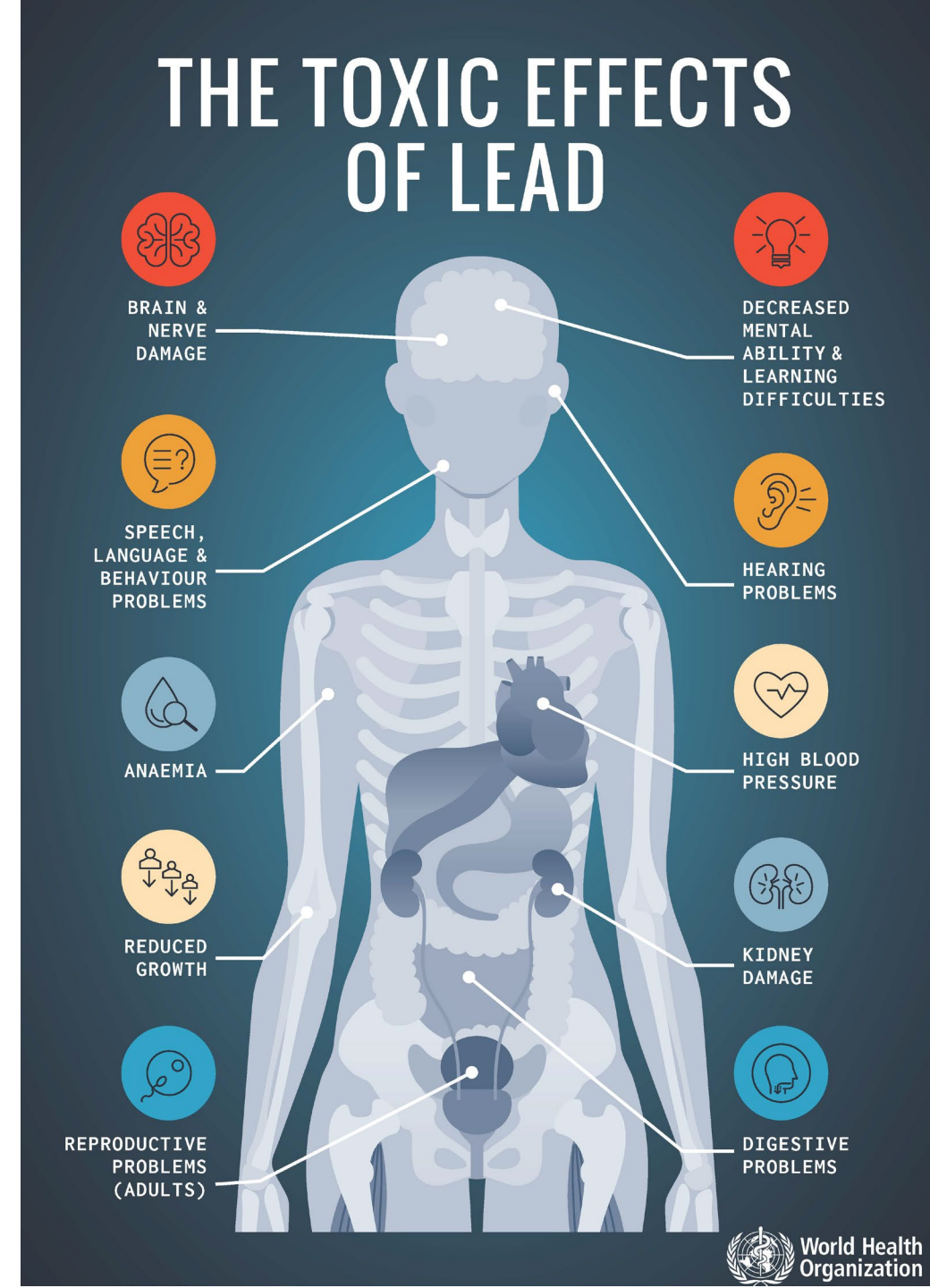
# Small variations lead to big changes – Unintended consequences of trying to save money

- Daily fluctuations often varied between  $\pm 0.2$  to 0.3 pH units, and as high as 1.1 log units in late April 2014.
- By contrast, the pH of the DWSD water varied no more than 0.34 log units over the course of a month.
- Changes in pH more than 0.2 units per week are not recommended (Hill & Cantor 2011), as such rapid changes in water chemistry (as experienced in the Flint system) may adversely affect system equilibrium and the passivation layer and scales on the insides of the pipes.

# Lead concerns

- Lowered IQ.
- Damage to the brain and nervous system.
- Learning and behavioral difficulties.
- Slowed growth.
- Hearing problems.
- Headaches.

Chelation therapy (a treatment that uses a medication to remove lead from the body when BLLs are very high)



# Lead (Pb) in water

- EPA WIIN Grant
  - Lyn Jenkins -Education Program Consultant
  - Melissa Walker - Administrative Consultant of School Health
- <https://educate.iowa.gov/pk-12/operation-support/school-facilities/lead-testing>
- <https://cheec.uiowa.edu/sites/cheec.uiowa.edu/files/Des-Moines-Register-Related-Article.pdf>

- <https://sites.google.com/iowa.gov/wiin-grants/home>



# Rome



# Other common metal – water contaminants

- Beryllium
- Strontium
- Barium
- Chromium
- Cobalt
- Nickel
- Copper
- Cadmium
- Mercury

Volcans  
Heavy metal-rich minerals  
Sulfide oxidation  
Microbial activity  
Geochemical conditions  
Geothermal sources  
Clay minerals  
Soil pH  
Soil weathering  
Salt concentrations  
Soil organic matter

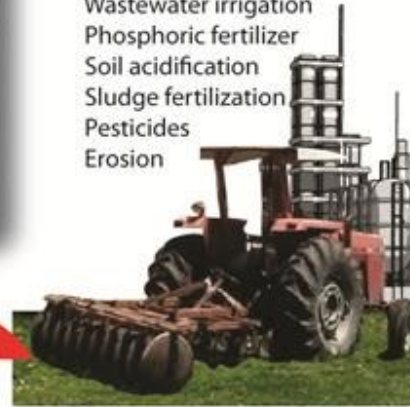


### Mining activities

Metal plating  
Smelting

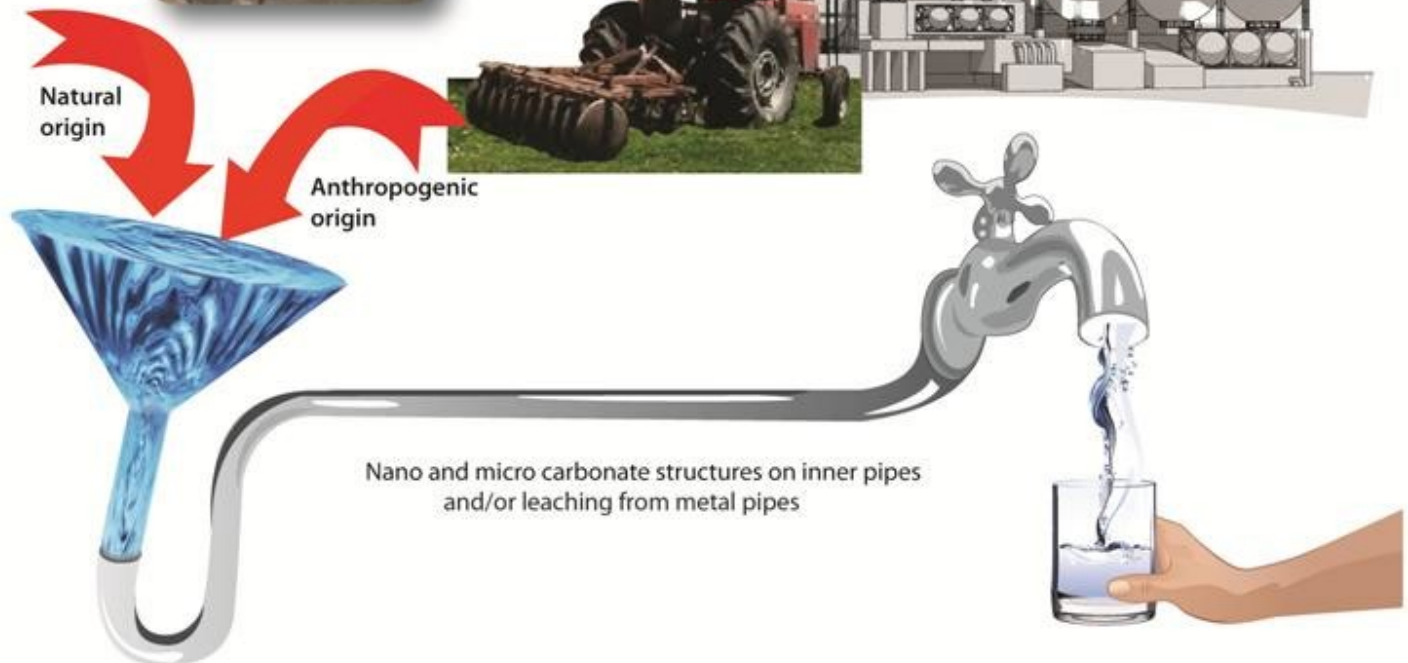
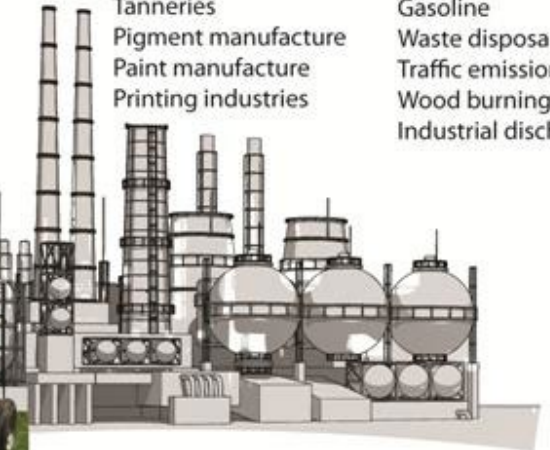
### Agronomic activities

Wastewater irrigation  
Phosphoric fertilizer  
Soil acidification  
Sludge fertilization  
Pesticides  
Erosion



### Industrial activities

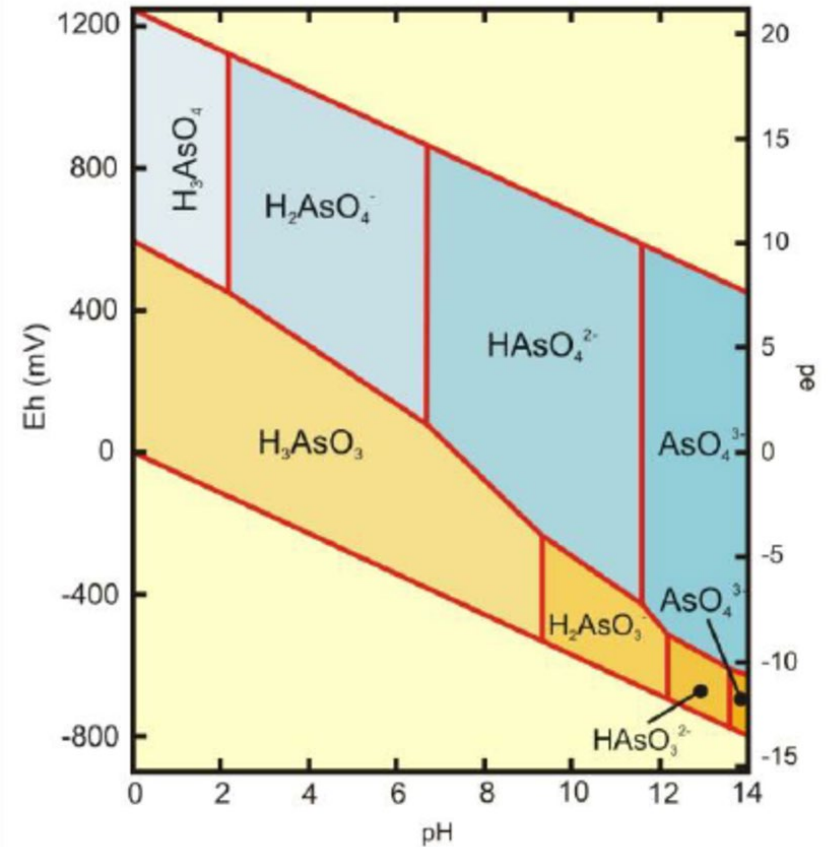
Sewage sludge disposal	Electronic components
Battery manufacture	Combustion
Petroleum refining	Plastic
Tanneries	Gasoline
Pigment manufacture	Waste disposal
Paint manufacture	Traffic emissions
Printing industries	Wood burning
	Industrial discharges





# Non metal - e.g. Arsenic

- Source
  - Burning coal
  - Ore smelting
  - Insecticides
  - Embalming
- Carcinogen , skin lesions, death
- Remedy – hydration, most will leave the body through kidneys and urine in days to months



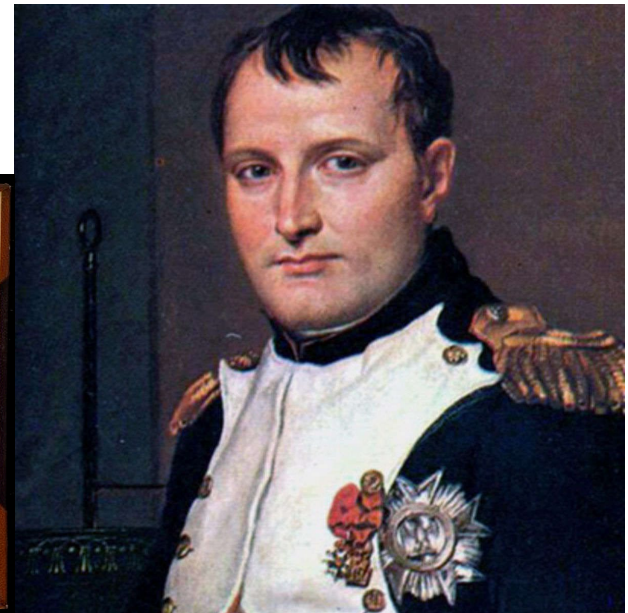
Eh represents the oxidation-reduction potential based on the standard hydrogen potential (SHE)

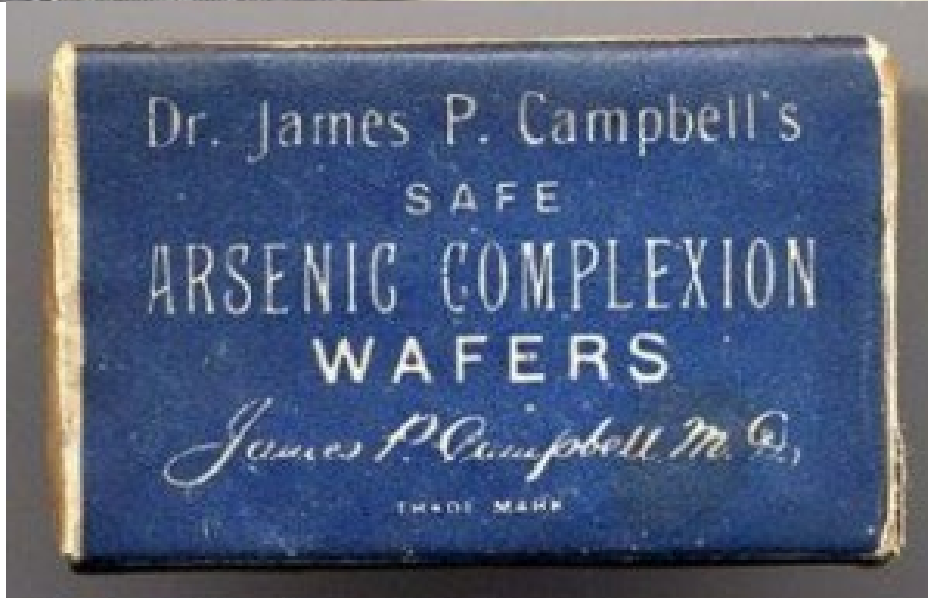
pH represents the activity of the hydrogen ion ( $H^+$ , also known as a proton)

# Scheeles Green, late 1700s



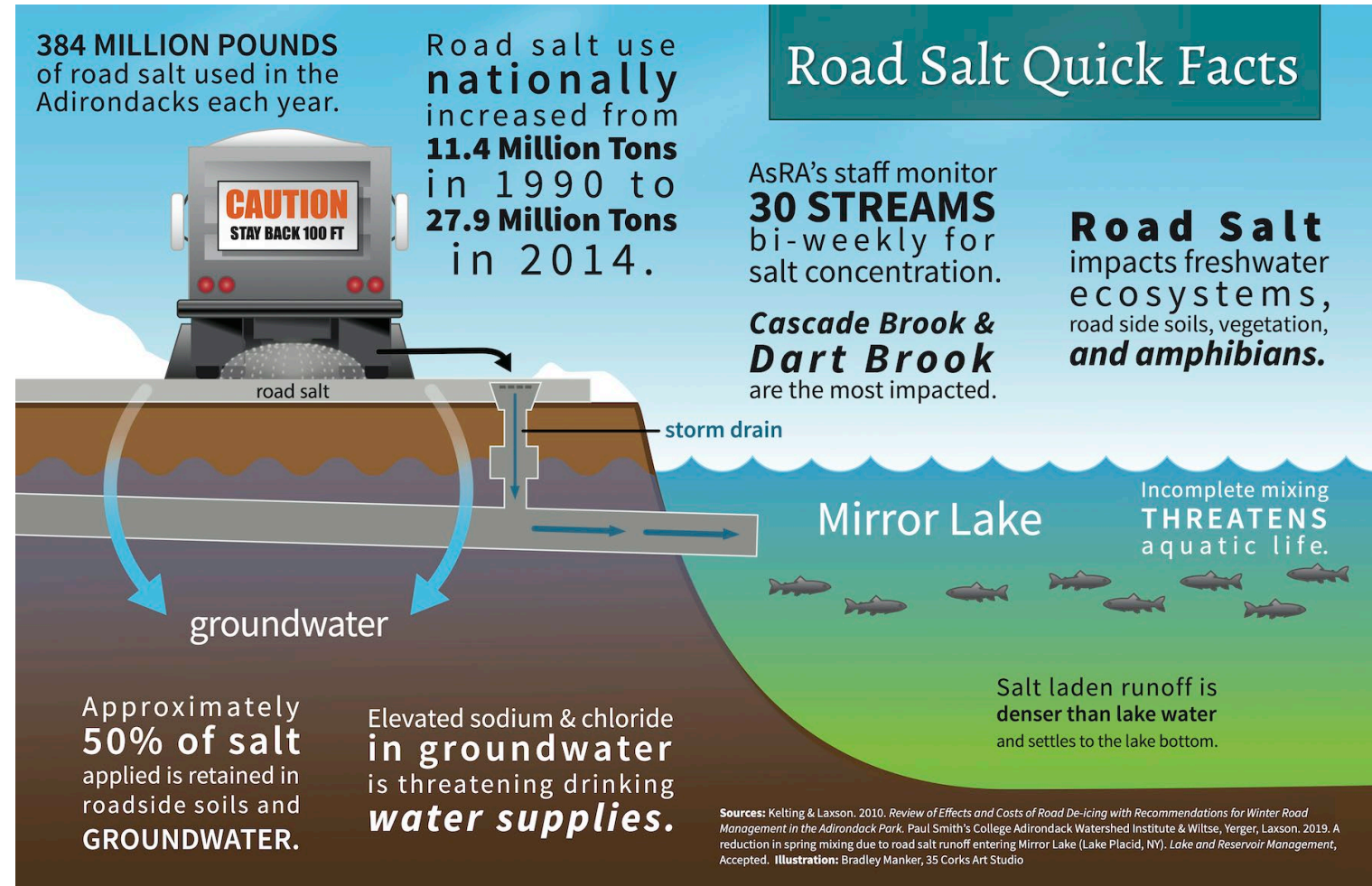
THE ARSENIC WALTZ.  
THE NEW DANCE OF DEATH. (DEDICATED TO THE GREEN WHEATH AND DUSK-MONGERS.)



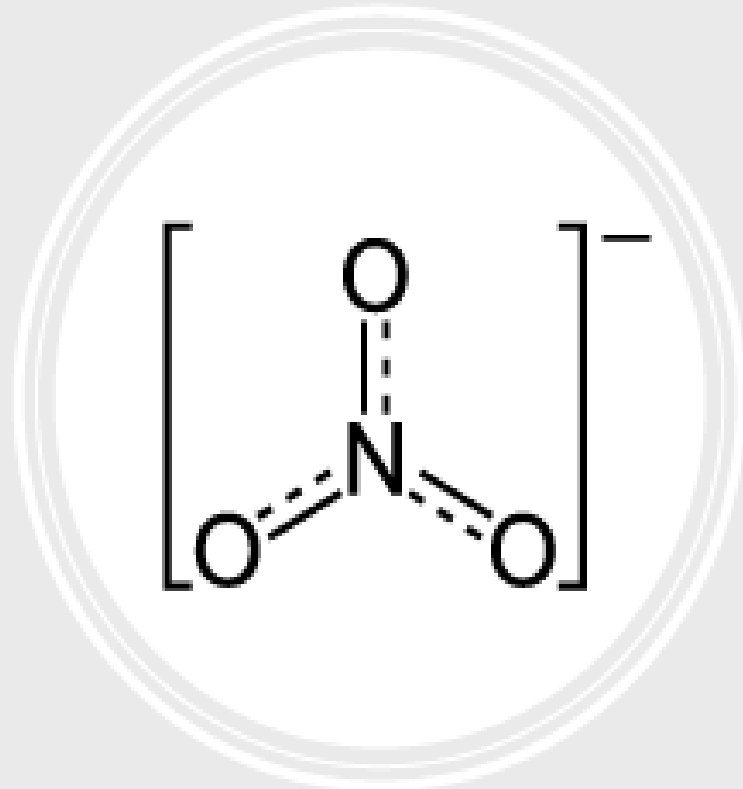


# Salt

- Winter road salt
- Environmental contamination
  - Surface water
  - Soil
  - Groundwater

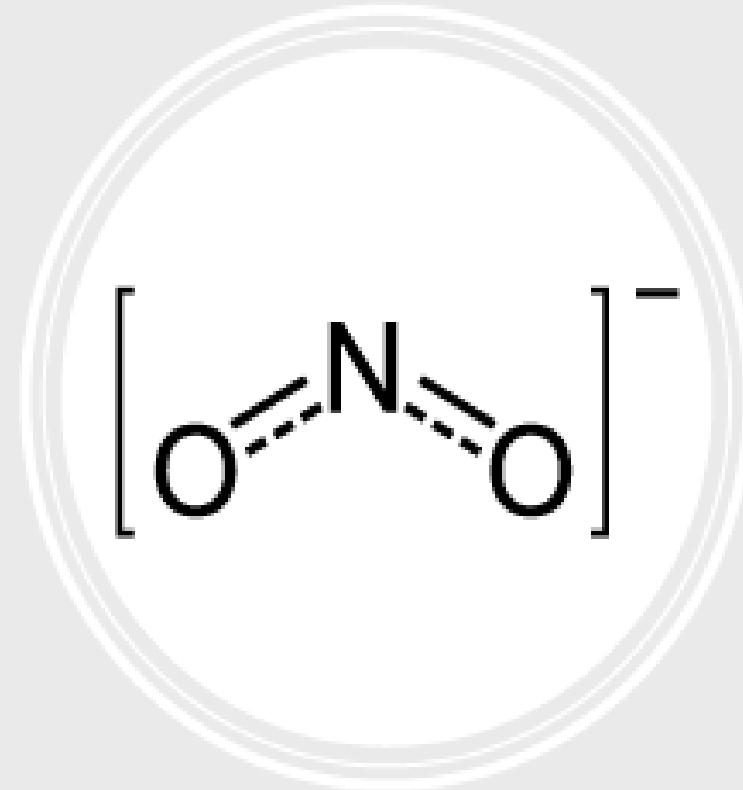


# NITRATE VS. NITRITE



## NITRATE

- Nitrate is made up of three Oxygen atom and one Nitrogen atom.



## NITRITE

- Nitrite is made up of one Nitrogen atom and two Oxygen atoms.

Nitrates are compounds which form naturally when nitrogen combines with oxygen, and they exist naturally in soil and in water.

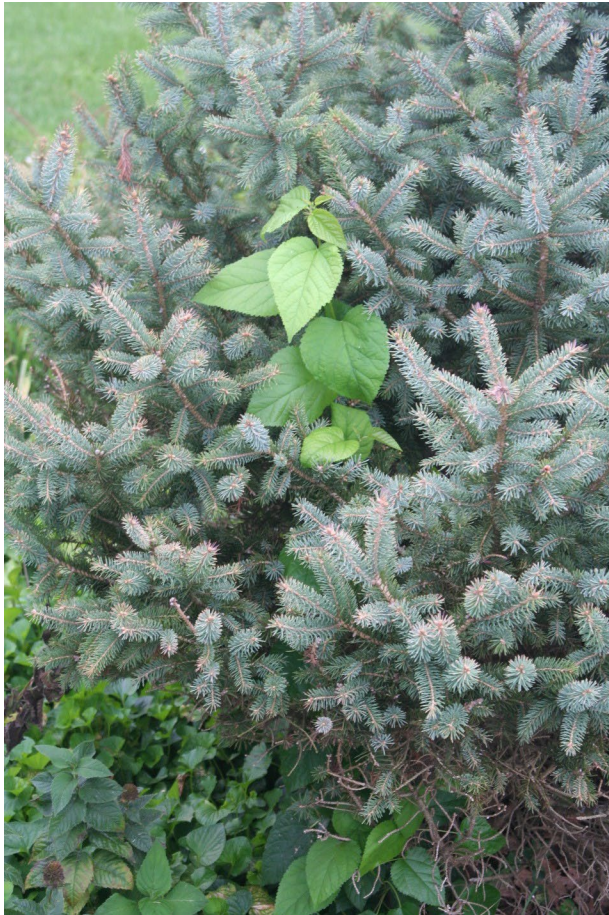
This benefits plants, which absorb nitrates from the soil to make amino acids. Farmers use fertilizers to increase the level of nitrates in the soil, and help crops grow

# Anhydrous Ammonia



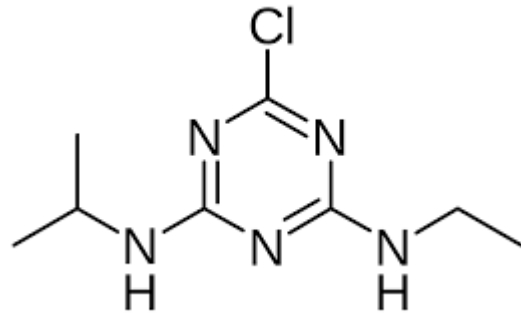
# Organic chemicals

# Tordon Herbicide





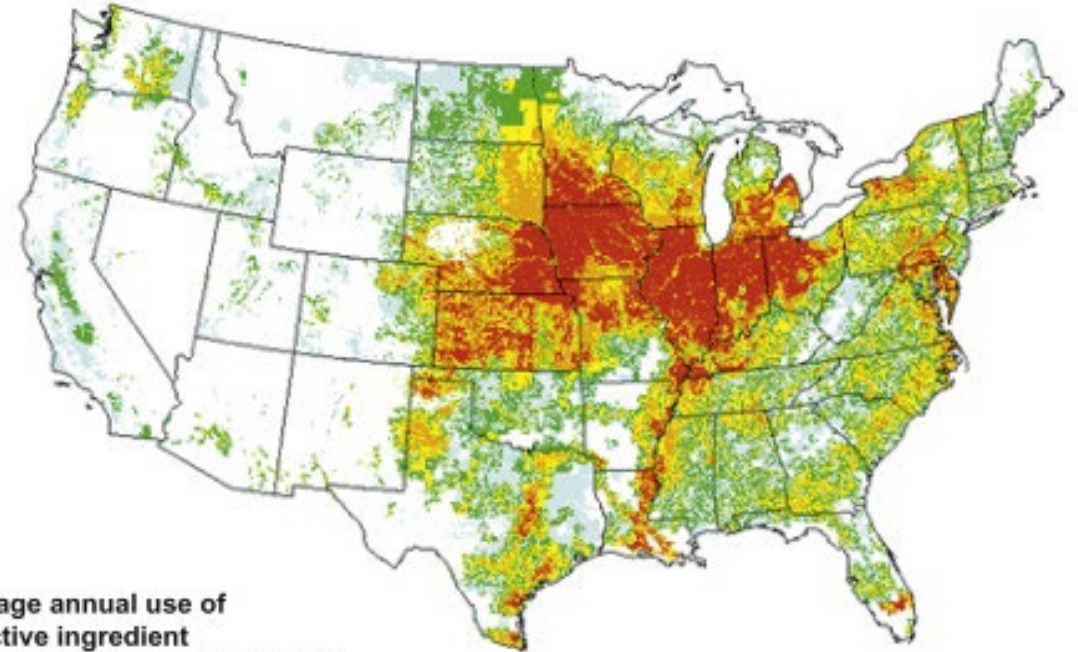
# Atrazine



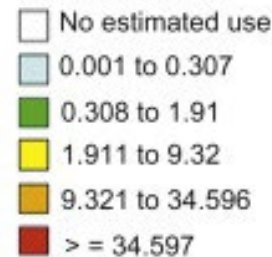
- Herbicide that is widely used to kill weeds
- Adverse effect on health such as tumors, breast, ovarian, and uterine cancers as well as leukemia and lymphoma.

## Atrazine – Herbicide

2002 estimated annual agricultural use



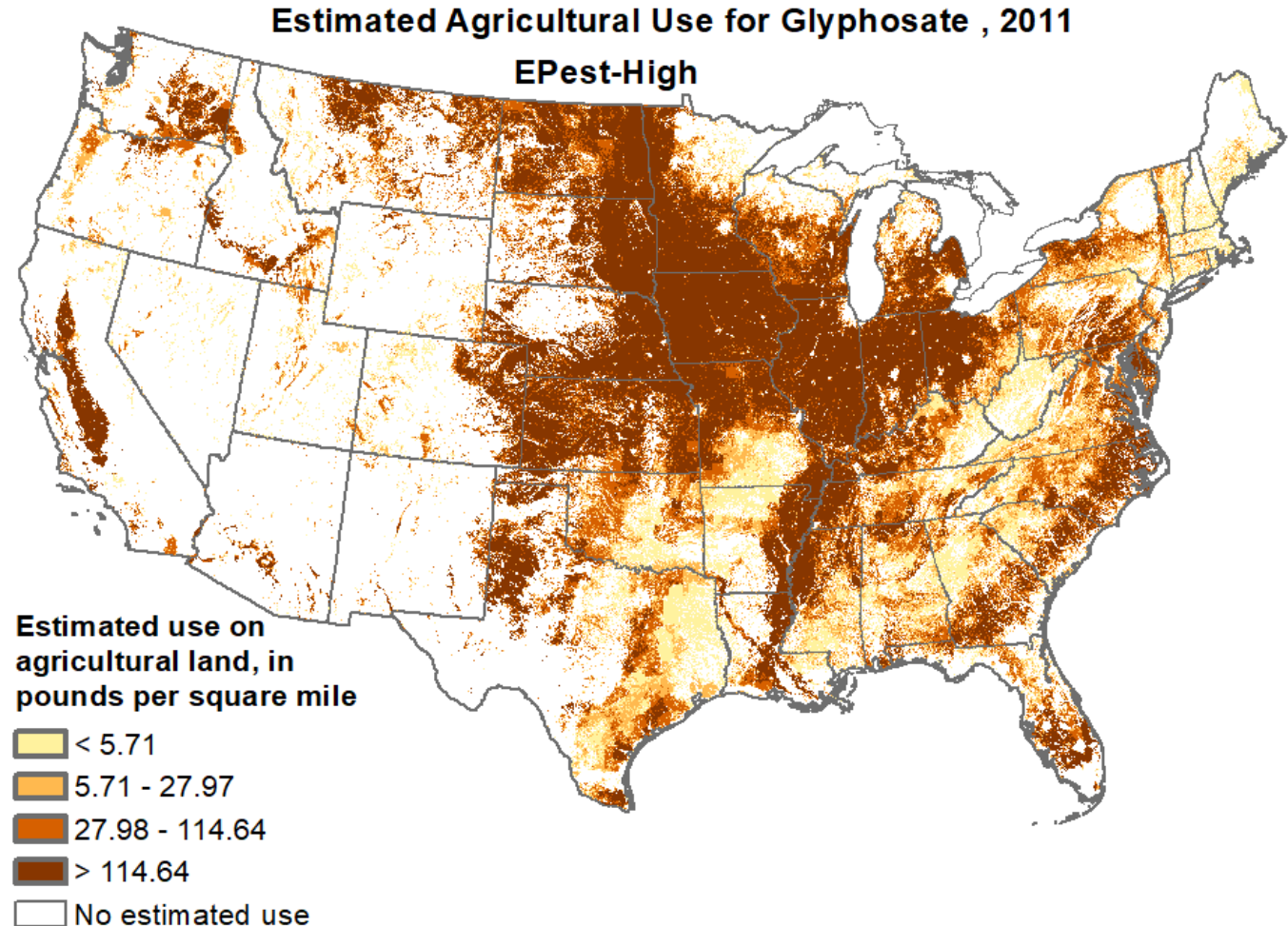
Average annual use of active ingredient (pounds per square mile of agricultural land in country)



Crops	Total pounds applied	Percent national use
Corn	66149829	86.47
Sorghum	5636302	7.37
Sugarcane	2377458	3.11
Cropland in summer fallow	1843850	2.41
Sweet corn	423851	0.56
Sod harvested	54700	0.07
Other hay	7013	0.01
Field and grass seed crop	620	0.00

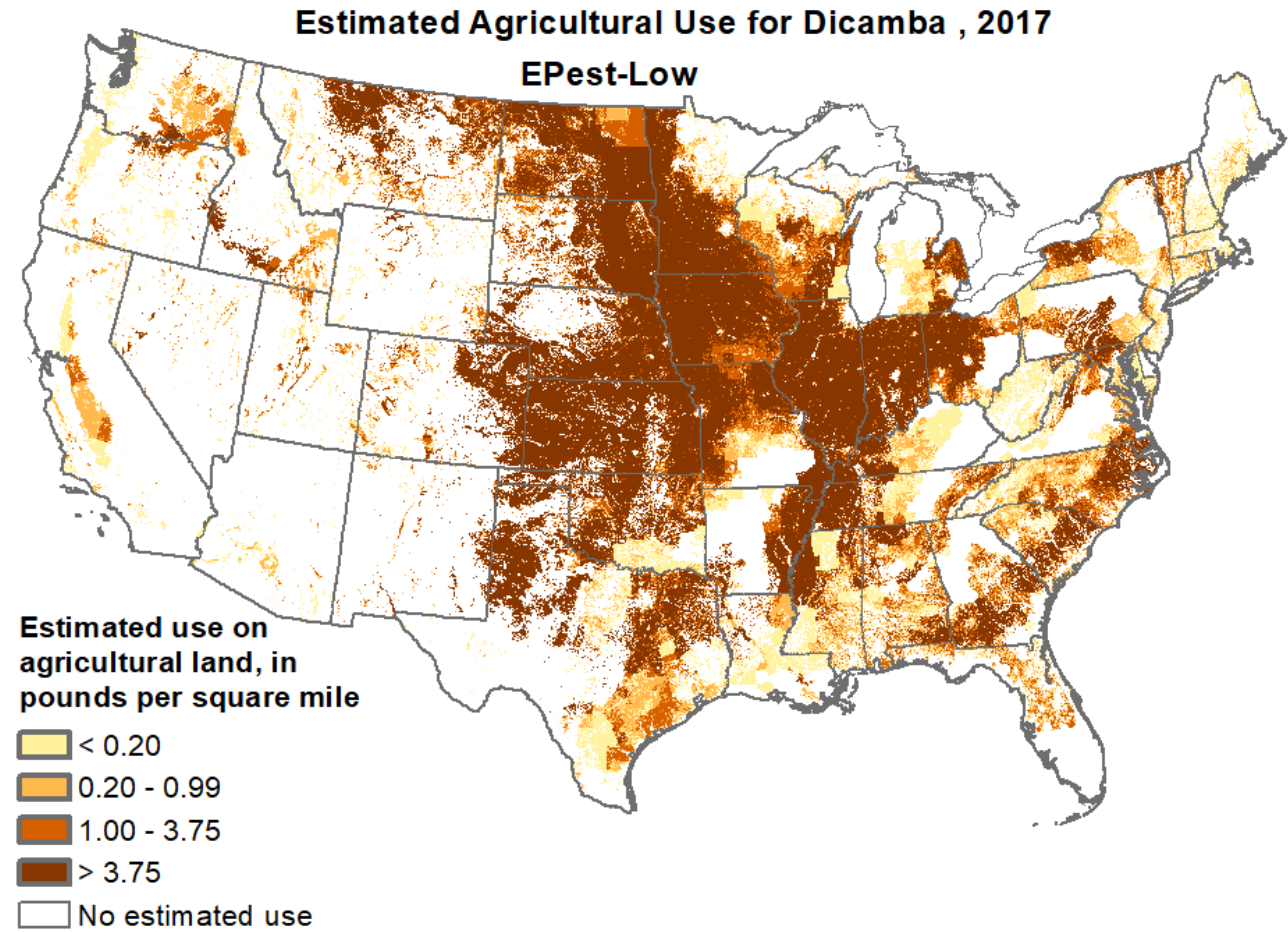
# Glyphosate/Roundup

- Herbicide that kills certain weeds and grasses. It blocks an enzyme essential for plant growth. Used primarily in agriculture, but also in forestry and lawn and garden care.
- Harm? Pending...

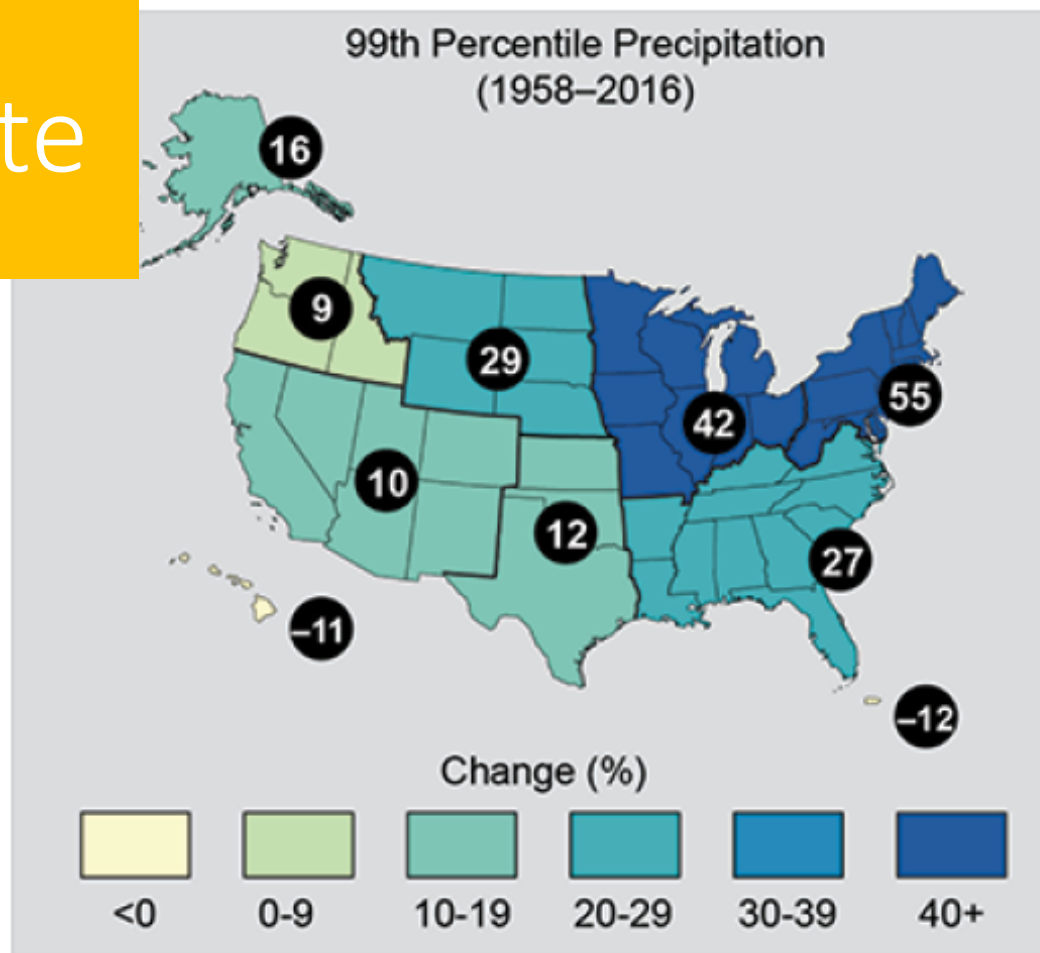


# Iowa's Air and Water, 2020

- Quadruple D Summer
- Derecho
- Drought
- Dicamba 2020: What went wrong in Iowa?
  - Atmospheric Loading, Avg daily wind speeds



# Climate



Observed change in heavy precipitation (the heaviest 1%) between 1958 and 2016. Figure taken from The Climate Science Special Report (Easterling et al. 2017) (<https://science2017.globalchange.gov/>).

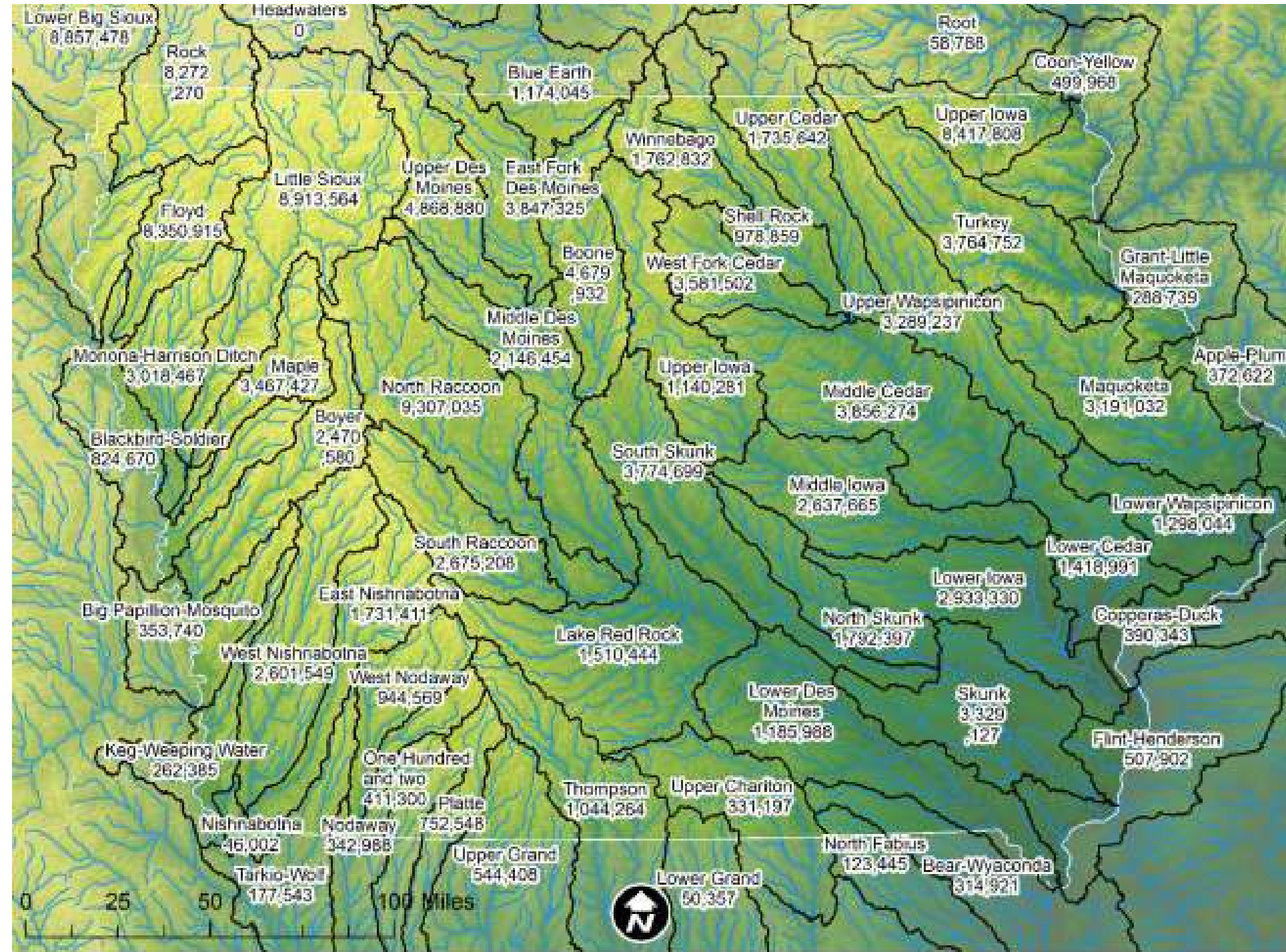
Date	Grundy Center ppt (inches)	Date	Vinton ppt (inches)
7/10/2000	5.91	<b>8/12/2016</b>	<b>6.04</b>
4/25/2008	4.35	5/30/2008	4.15
<b>8/29/2015</b>	<b>4.11</b>	6/15/1982	3.98
<b>9/4/2018</b>	<b>3.98</b>	<b>6/12/2015</b>	<b>3.8</b>
<b>8/6/2018</b>	<b>3.76</b>	11/4/2003	3.49
<b>5/30/2013</b>	<b>3.56</b>	<b>7/1/2014</b>	<b>3.33</b>
9/11/2006	3.36	7/9/1993	3.29
7/27/1990	3.22	6/17/1990	3.25
<b>7/1/2018</b>	<b>3.17</b>	8/8/1991	3.18
9/13/1991	3.16	<b>4/18/2013</b>	<b>2.93</b>

Antonio Arenas

U. Iowa IIHR

Date	Cedar Rapids ppt (inches)
6/17/1990	4.42
<b>8/12/2016</b>	<b>4.14</b>
7/17/2007	3.85
<b>6/12/2015</b>	<b>3.75</b>
<b>4/18/2013</b>	<b>3.66</b>
<b>6/10/2018</b>	<b>3.36</b>
8/26/1987	3.28
<b>4/14/2014</b>	<b>3.16</b>
6/15/1982	3.11
7/18/1982	3.1

(Data source: <http://www.prism.oregonstate.edu/>)



Population, from  
294,122  
to with animals  
3,289,237

Statewide  
24 million pigs  
3 million people  
8:1

Chris Jones  
U Of Iowa  
IIHR

# Monitoring

## IOWA WATER QUALITY

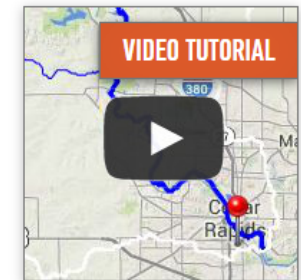
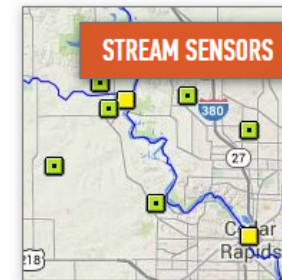
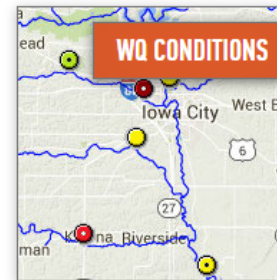
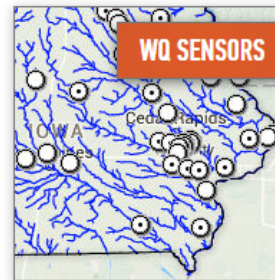
### INFORMATION SYSTEM

Welcome to the Iowa Water Quality Information System.

The IWQIS allows access to real-time water-quality data and information such as **nitrate**, **pH**, and **dissolved oxygen concentrations**, discharge rates, and **temperature**.

LAUNCH IWQIS

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



ABOUT  
IWQIS



TOOLS &  
FEATURES



HELP &  
TUTORIALS



DATA  
REQUEST



EMBED  
WIDGET

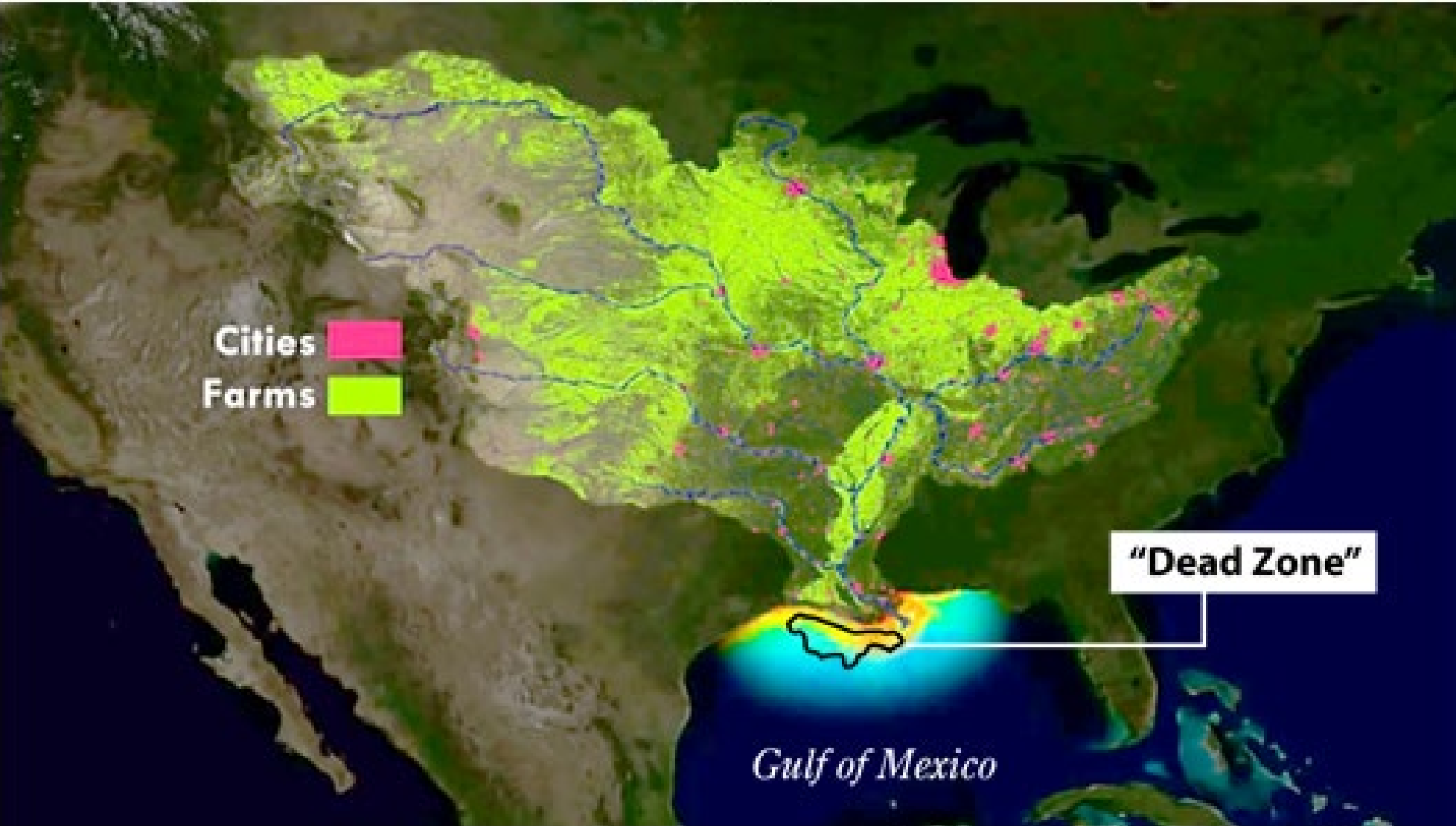


CONTACT  
US



# Gulf 'Dead Zone' Chokes Marine Life

The Gulf of Mexico at the Mississippi River Delta experiences a seasonal *hypoxia*, or "dead zone," where there is not enough oxygen in the water to sustain marine life.



Nitrate  
equivalents

2019 – may surpass  
previous record due  
to record flooding

Chris Jones

U Of Iowa  
IIHR

# Stressors

## Urbanization of Cedar Falls, Iowa

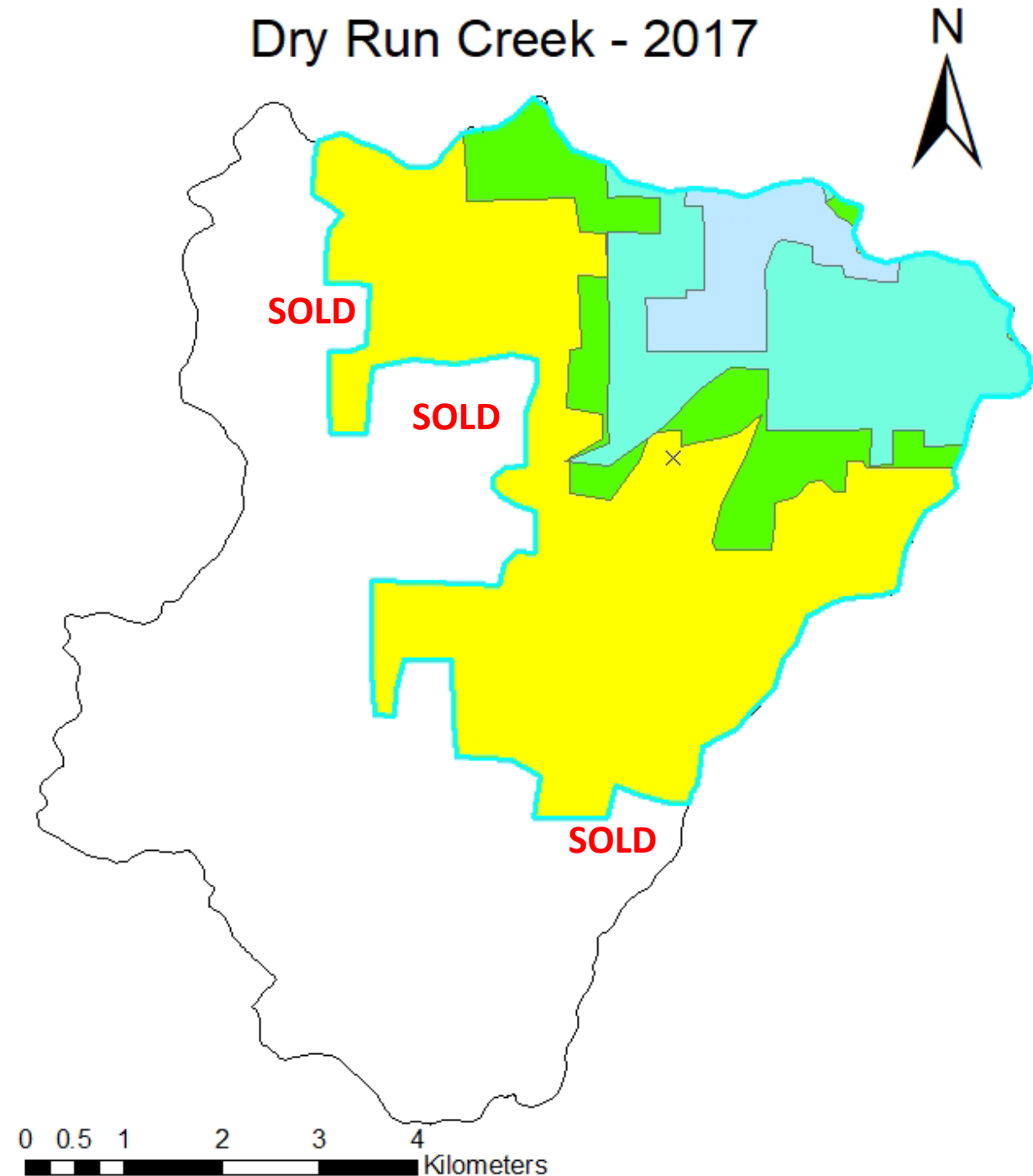
2017 – 41,570

1990 – 34,298

1960 – 21,195

1930 - 7,632

Dry Run Creek - 2017





# In the Headlines

- 2023 Iowa DNR tells rangers to move out of state-owned houses at State Parks
- 2024 Iowa DNR will no longer have Park Rangers in State Parks Plan
  - ‘Due to differed maintenance’
  - *Pattern = Defund, Deteriorate then Demolish*
- 2022/24 Bill to limit purchases of new public land/ restrict state recreational land
  - Passes House in March 2024
  - The new bill has the support of the Iowa Farm Bureau Federation and the Iowa Cattlemen’s Association, which have said the cheaper farmland that is sometimes obtained by the DNR would be better suited to beginning livestock farmers.

# Headlines cont.

- 2024 Iowa cancer rates on the rise, #2 in the Nation
- 2024 Iowa Senate Oks Bill to ban lawsuits against Bayer/Monsanto
  - ‘Bill is needed to protect modern farming practices’
  - Ban use of drones
- Iowa has the second-highest and fastest-rising incidence of cancer among all states.
  - An estimated 21,000 new cancer cases are expected to develop this year and 6,100 Iowans will die from cancer, Iowa Cancer Registry Director Mary Charlton said in announcing the new report. Mar 26, 2024 DSM Register



# Fish Kill Database

• <https://programs.iowadnr.gov/fishkill/>

The **Iowa DNR Fish Kill Database** stores the data for fish kills in the state. The primary function of this database application is to track causes and locations of fish kills for the purposes of assessing Iowa's water quality.

The Integrated Report, which combines federal requirements for state Section 305(b) water quality assessments and Section 303(d) impaired waters listings, required the Iowa Department of Natural Resources Watershed Monitoring and Assessment Section to begin tracking fish kills. A fish kill can affect the 305(b) [water quality assessment](#) of the waterbody and can potentially result in the addition of the water body to the 303(d) list of impaired waters.

**View Fish Kill Data**

- List of Fish Kill Events**  
Sortable, text-based table of fish kill events
- Map**  
Map of fish kill events
- Summaries**  
Charts and graphs summarizing fish kill data
- Documentation**  
More information about fish kills and this database

**Fish Kill Reporting**

If you believe a fish kill has occurred, immediately contact the nearest Iowa DNR [Field Office](#) or [Fisheries Office](#).

You should have available the name of the stream, the location of the kill, and any other conditions or observations that may aid in the investigation of the cause and source of the kill.

**Do not touch the water or remove any dead fish.**

**515-725-8694**

**Recent Additions**


<b>Des Moines River</b> - 7/10/2023 - Environmental	last week
<b>East Nishnabotna River</b> - 3/11/2024 - Ammonia/Fertilizer	last week
<b>Des Moines River</b> - 8/25/2023 - Environmental	7 months ago
<b>Upper Iowa River</b> - 8/21/2023 - Environmental	7 months ago
<b>Bee Branch Detention Basin</b> - 6/18/2020 -	7 months

# Fish Kill Event - East Nishnabotna River

- 265,000 gallons of liquid nitrogen
- 800,000 fish dead over a 60 mile length of the river
- \$2 to 5 per gallon \$530,000 to \$1,325,000
  - Over flow shut off valve not installed? \$12 part
- <https://programs.iowadnr.gov/fishkill/Events/1045>

# *Iowa Fertilizer Spill Kills Nearly All Fish Across 60-Mile Stretch of Rivers*

Officials in Iowa and Missouri estimated that nearly 800,000 fish had died in waters that flow into the Missouri River.

 Share full article



 312



<https://www.nytimes.com/2024/03/29/us/iowa-spill-fish-kill.html>

# IWILL competes with NoWill?

- Lawmakers approved the creation of the Natural Resources and Outdoor Recreation Trust Fund in 2008 and 2009. The next year, Iowa voters amended the state's constitution to include a framework for the fund: The next time the state passed a sales tax increase, three-eighths of a cent of the tax would go toward water quality, outdoor recreation and wildlife conservation.
- Statewide support: 2010 - 63% , 2021 – 70%
- The issue: Iowa hasn't passed a statewide sales tax increase since then, leaving the fund empty for over 18 years and counting...

<https://www.iowapf.net/iwill/> ,

<https://www.inhf.org/what-we-do/conservation-policy/iowas-water-and-land-legacy/>

Stage of Denial	Coronavirus	Climate Change
<p><b>Stage 1</b> It's not happening</p>	<p>"The Democrats are politicizing the coronavirus ... This is their new hoax" - [REDACTED]</p>	<p>"It's a hoax; I think the scientists are having a lot of fun." - [REDACTED]</p>
<p><b>Stage 2</b> It's not our fault</p>	<p>"China is to blame because the culture where people eat bats and snakes and dogs and things like that, these viruses are transmitted from the animal to the people" - Sen. [REDACTED]</p>	<p>"China does not do anything to help climate change. They burn everything you could burn; they couldn't care less" - [REDACTED]</p>
<p><b>Stage 3</b> It's not that bad</p>	<p>"One day like a miracle it will disappear" - [REDACTED]</p>	<p>"[The climate] will change back." - [REDACTED]</p>
<p><b>Stage 4</b> Solutions are too costly</p>	<p>"We cannot let the cure be worse than the problem itself." - [REDACTED]</p>	<p>"I think the climate change is just a very, very expensive form of tax." - [REDACTED]</p>
	<p>"It is going to spread further and I</p>	<p>"The climate... is</p>

Yale Climate Connections, [Dana Nuccitelli](#), April 14, 2020  
[REDACTED]