Door County Well Monitoring Program - Spring 2024 Summary

UW OSHKOSH

ENVIRONMENTAL RESEARCH AND INNOVATION CENTER

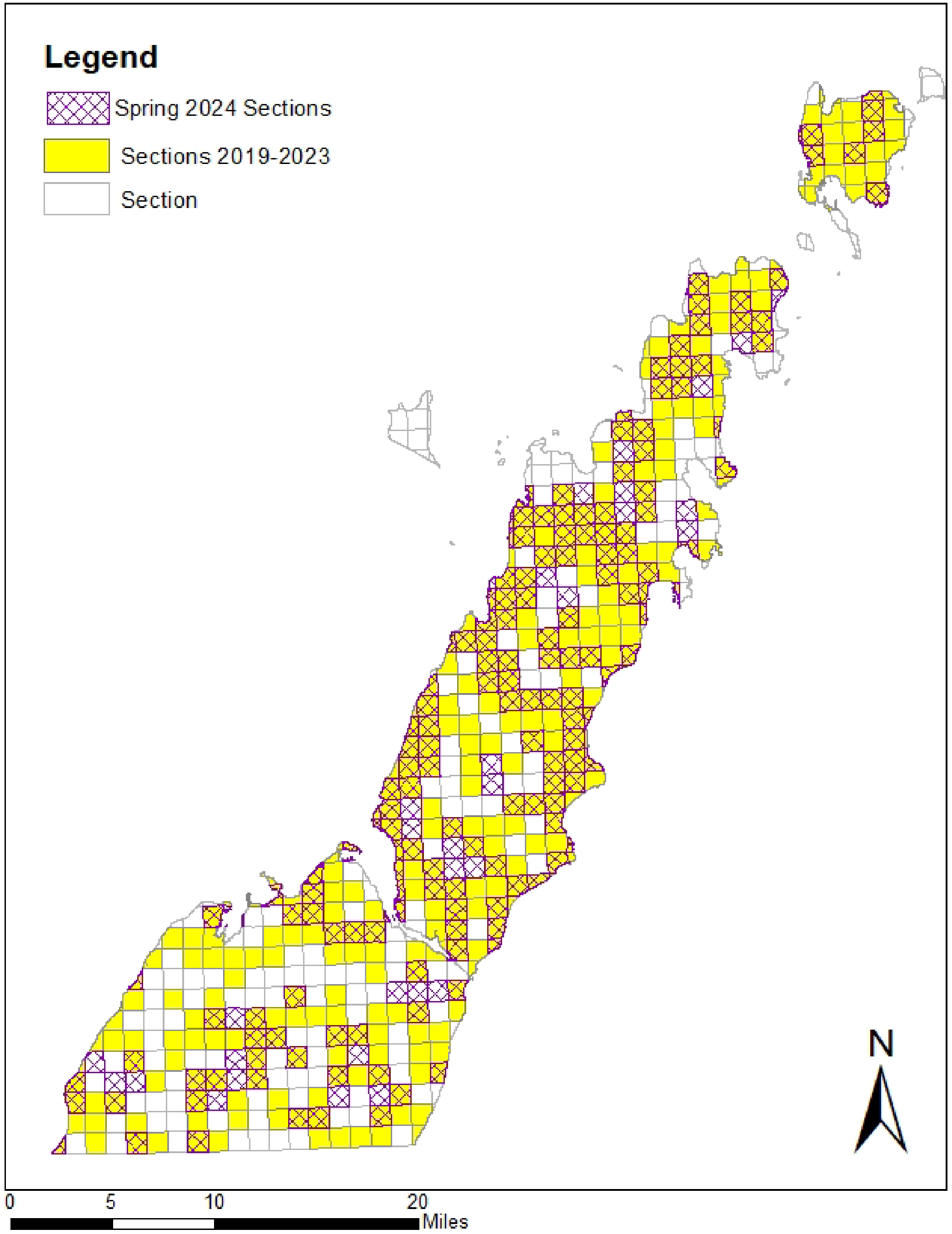
JUNE 13TH, 2024

Program Goals

- Provide continued education on water resources in Door County, WI
- Provide avenue for residents and guests to have the most accurate information on their drinking water quality
- Provide reliable information to guide county resources for the protection and maintenance of drinking water resources
- Be proactive with respect to drinking water resources, rather than reactive
- Create a groundwater water quality database for Door County
- Establish trends in groundwater data over time

Program Goals

- Target is at least one well per section (square mile) of Door County
  - 30 new sections added this spring!
  - 406 sections covered since 2019 – that's 62% of the county!
- Spatially distributed data to look for trends and relationships
  - Soil type
  - Depth to bedrock
  - Water table depth
  - Land use



Karst Geology & Groundwater Susceptibility

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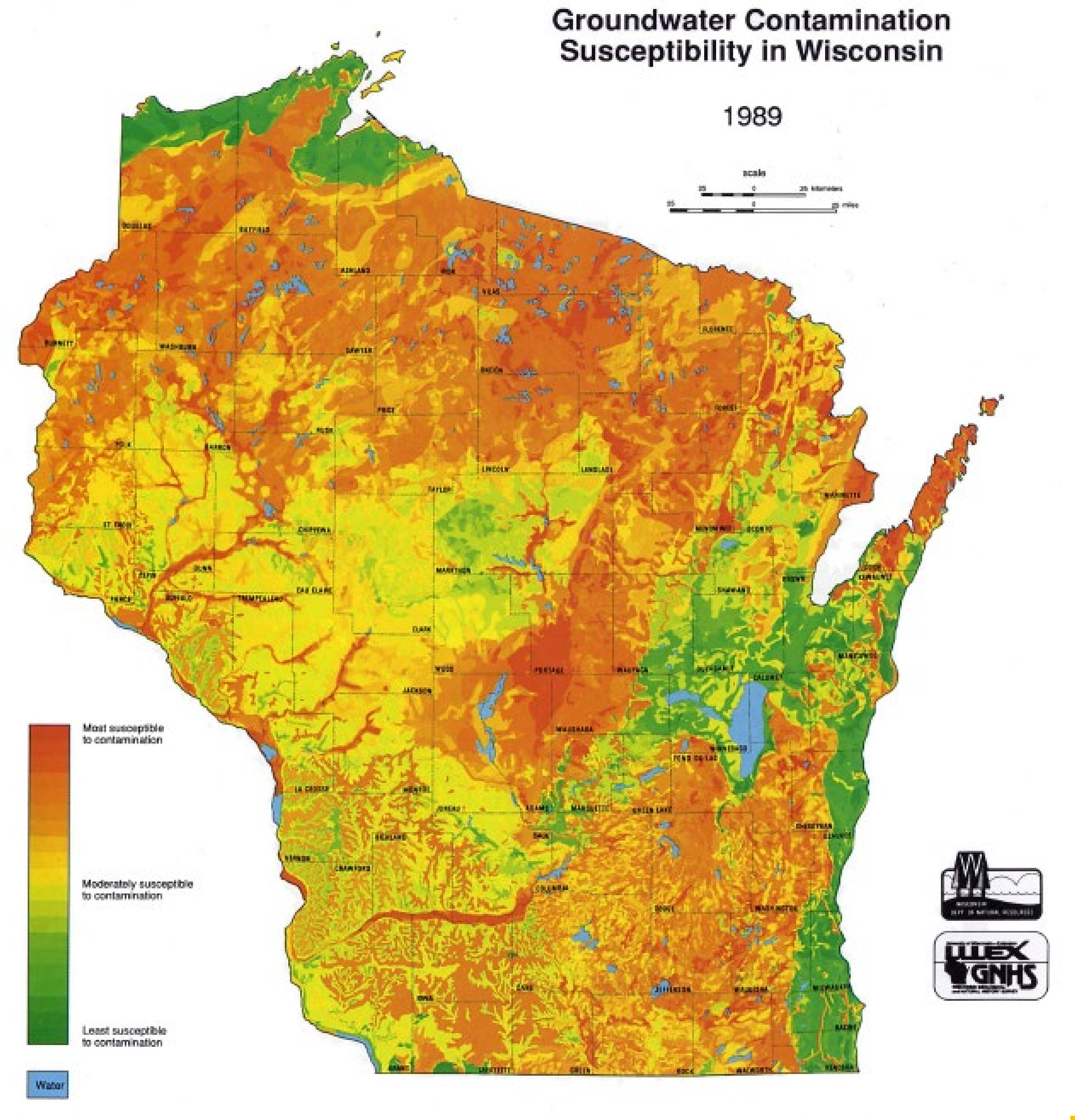
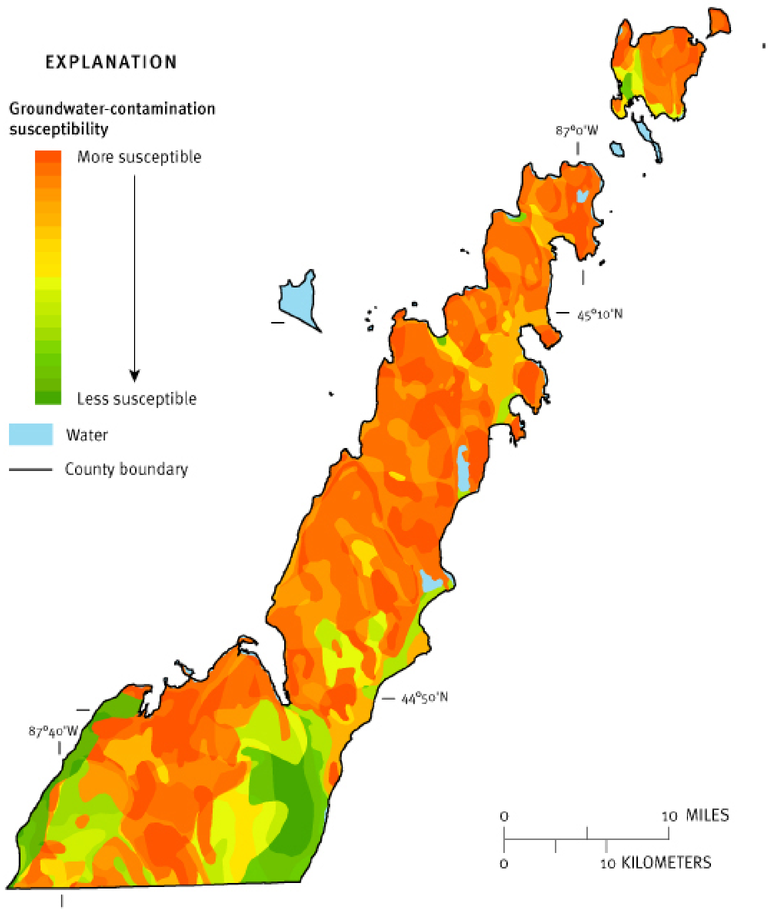
Susceptibility

- Based on factors such as:
  - Bedrock depth
  - Soil type
  - Depth to water table



Door County – Groundwater-Contamination Susceptibility Analysis

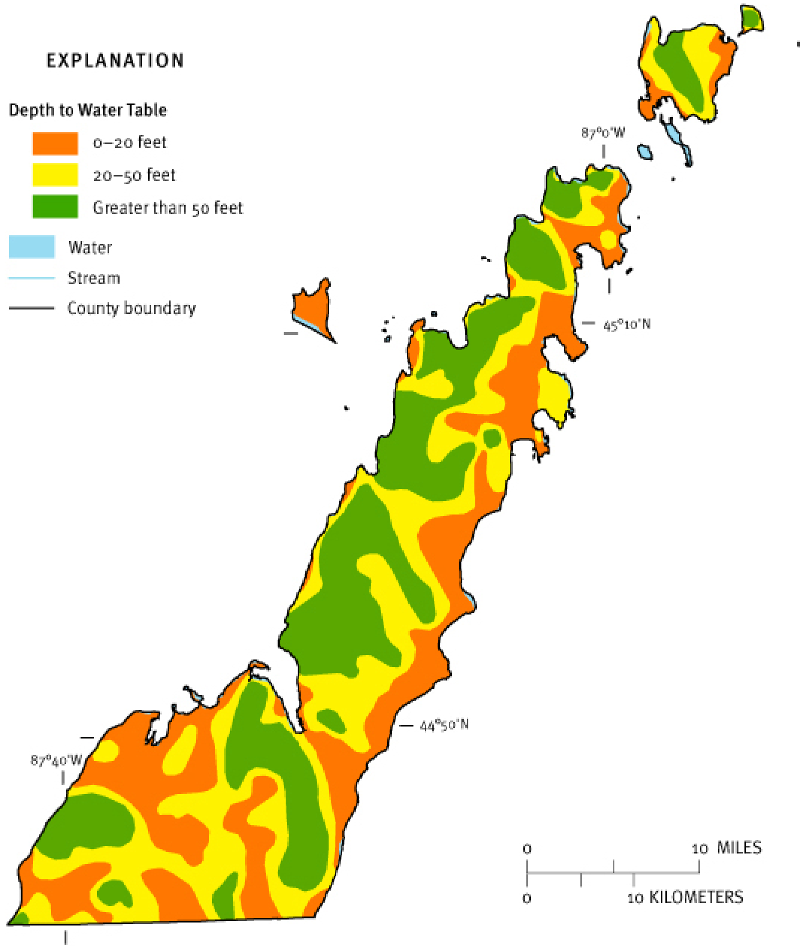


This groundwater-contamination susceptibility map is a composite of five resource characteristic maps, each of which was derived from generalized statewide information at small scales, and cannot be used for any site-specific purposes.

Map source: Schmidt, R.R., 1987, Groundwater contamination susceptibility map and evaluation: Wisconsin Department of Natural Resources, Wisconsin's Groundwater Management Plan Report 5, PUBL-WR-177-87, 27 p.

Figure created for the "Protecting Wisconsin's Groundwater Through Comprehensive Planning" web site, 2007, *http://wi.water.usgs.gov/gwcomp/*

Door County – Depth to Water Table



This resource characteristic map was derived from generalized statewide information at small scales, and cannot be used for any site-specific purposes.

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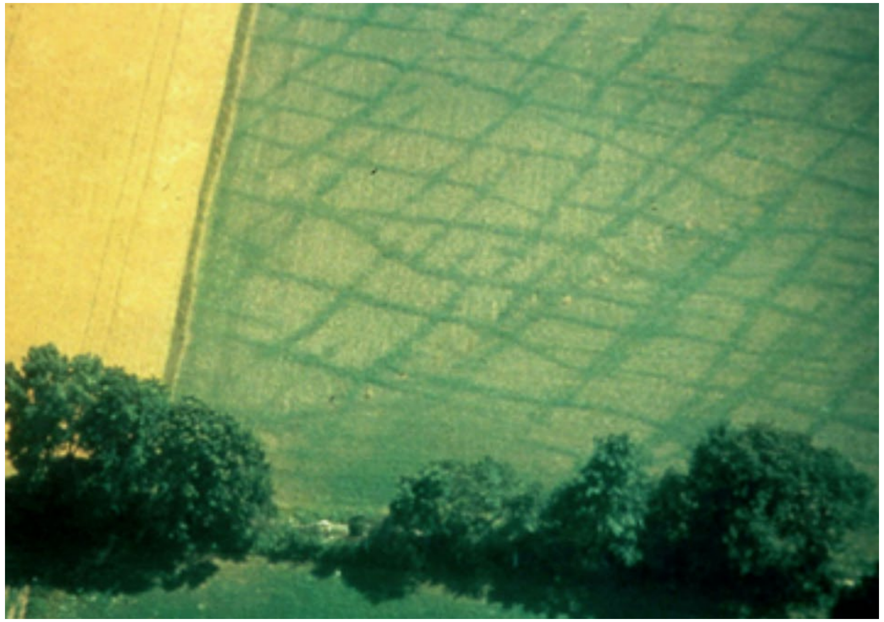
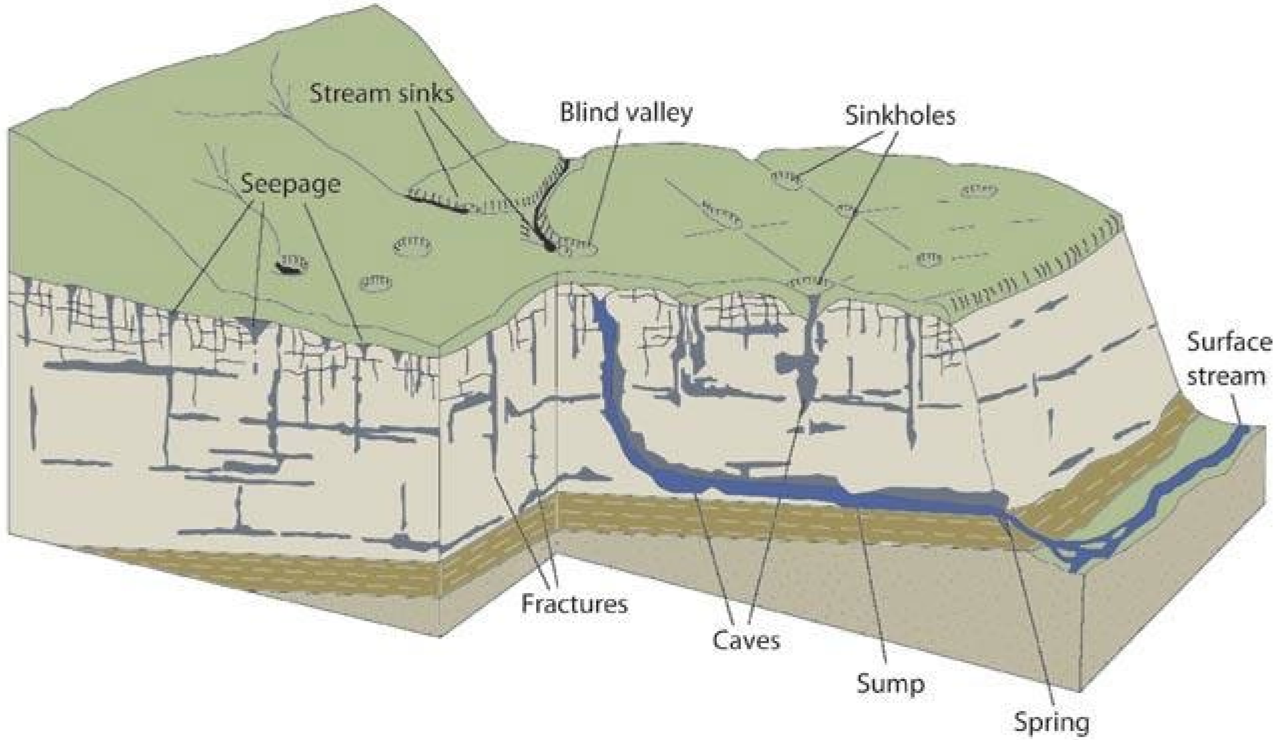
Figure created for the "Protecting Wisconsin's Groundwater Through Comprehensive Planning" web site, 2007, *http://wi.water.usgs.gov/gwcomp/*

What is Karst Geology?

- A landscape created when water dissolves rocks
- Made of dolomite and limestone



Karst Geology Impact on Groundwater



Karst Geology features as seen above create direct conduits to groundwater, where contaminants can easily make their way into our drinking water

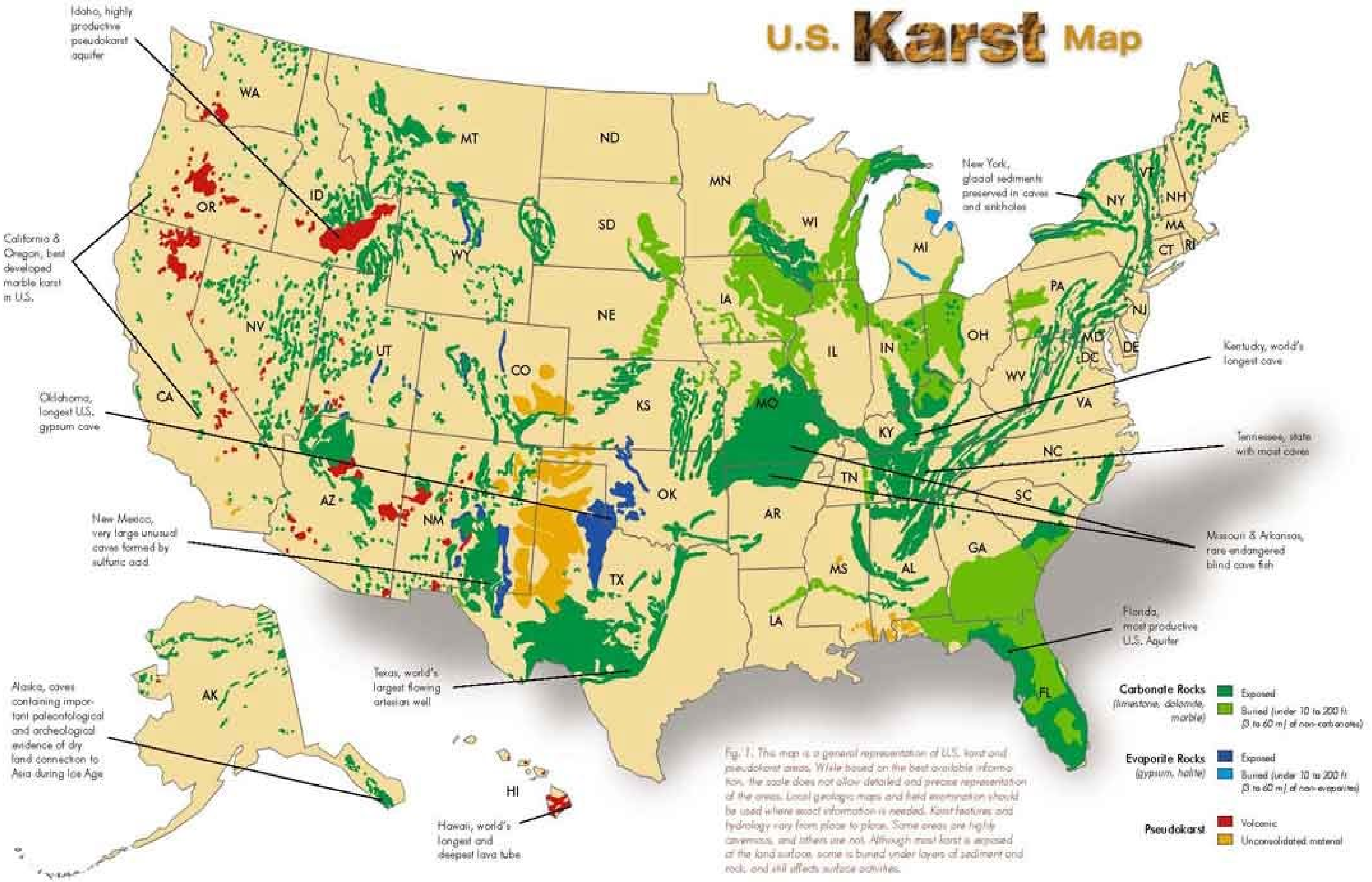
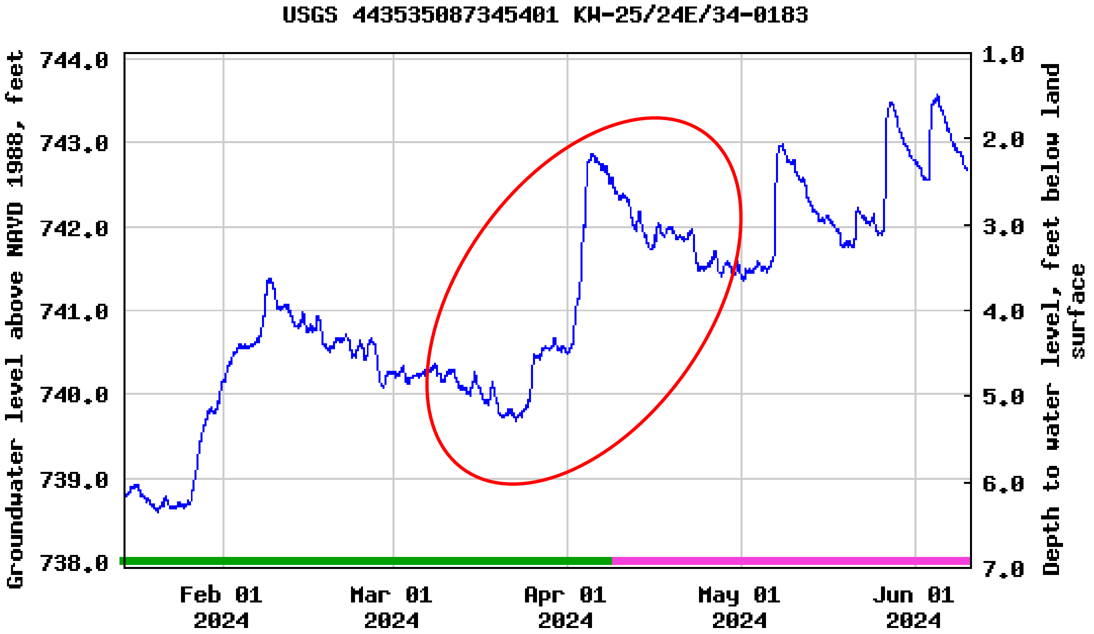
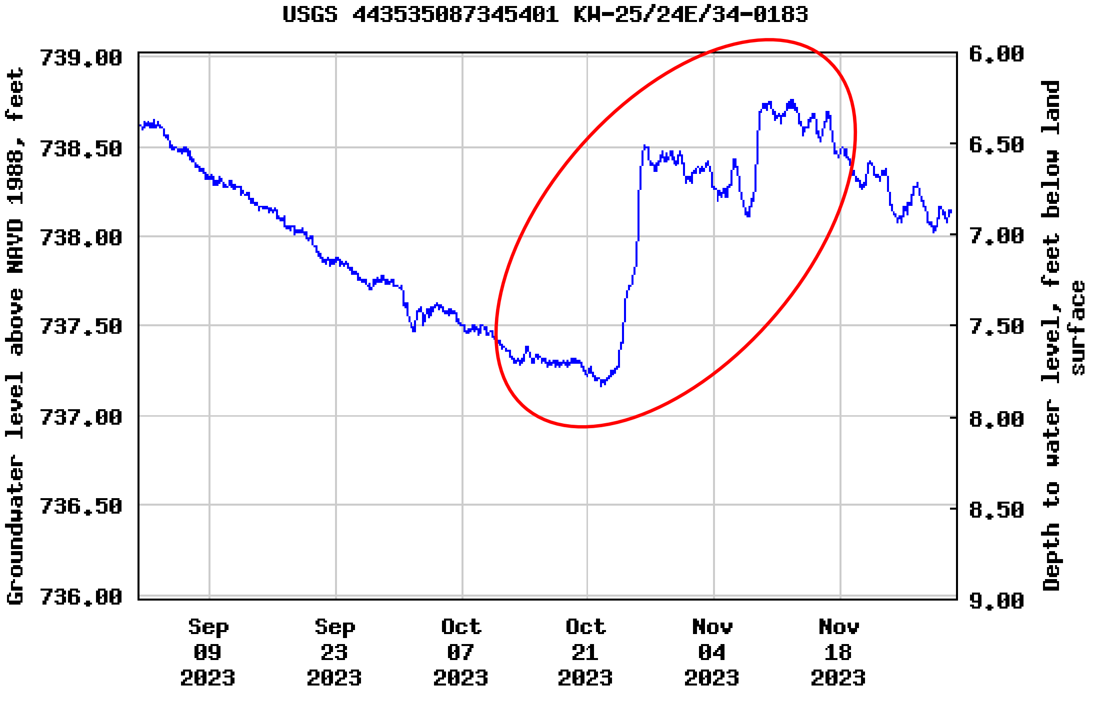


Fig. 1. This map is a general representation of U.S. karst and pseudokarst areas. While based on the best available information, the scale does not allow detailed and precise representation of the areas. Local geologic maps and field examination should be used where exact information is needed. Karst features and hydrology vary from place to place. Some areas are highly cavernous, and others are not. Although most karst is exposed at the land surface, some is buried under layers of sediment and rock, and still affects surface activities.

Groundwater Recharge

- Study design requires samples to be collected in a narrow window of time (within ~30 hours) – **but why?**
  - Reduce any variables in groundwater quality
    - Weather conditions
    - Groundwater conditions – dry period or recharge period
    - Greater effects with karst geology





Testing Parameters

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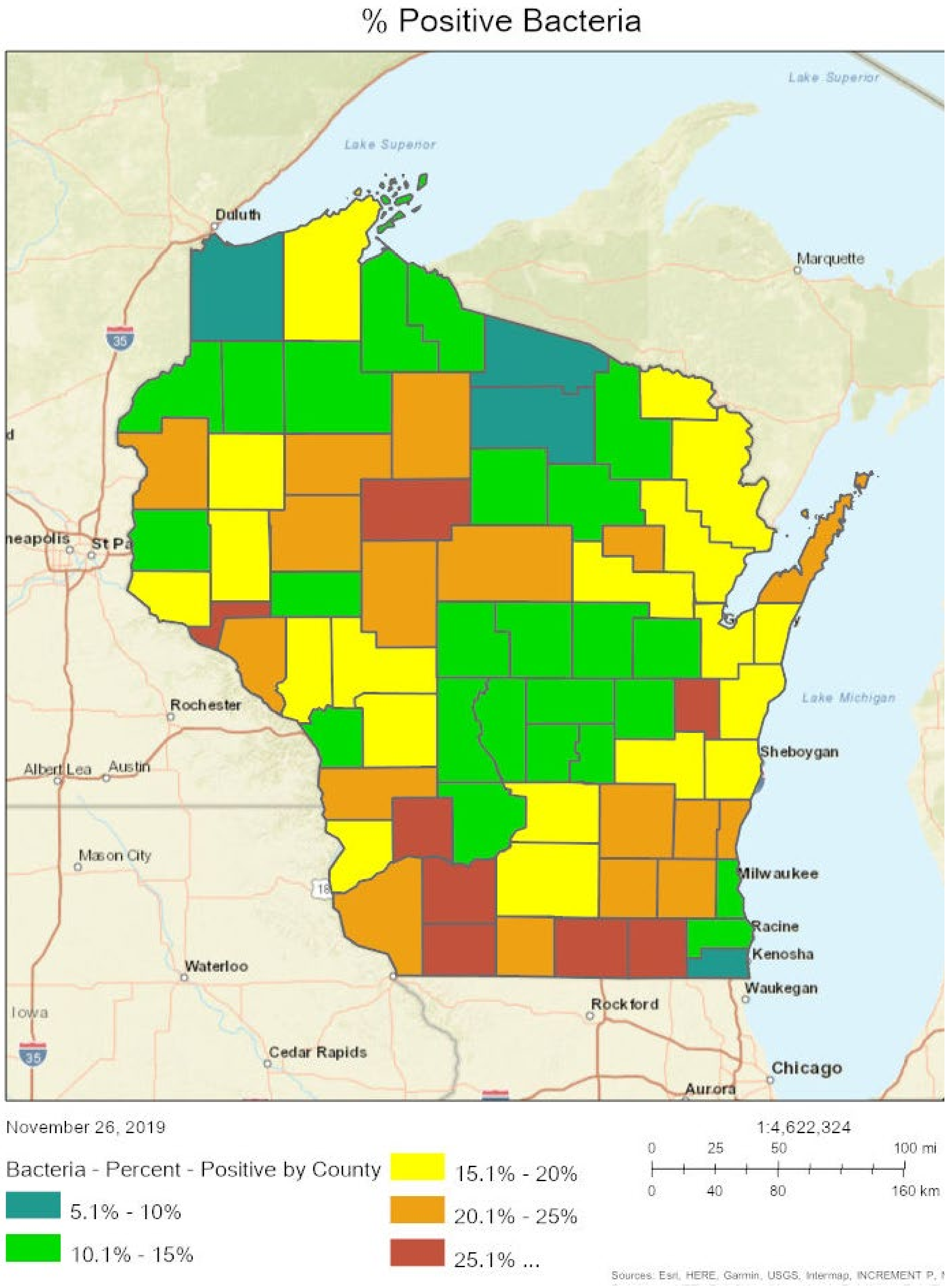
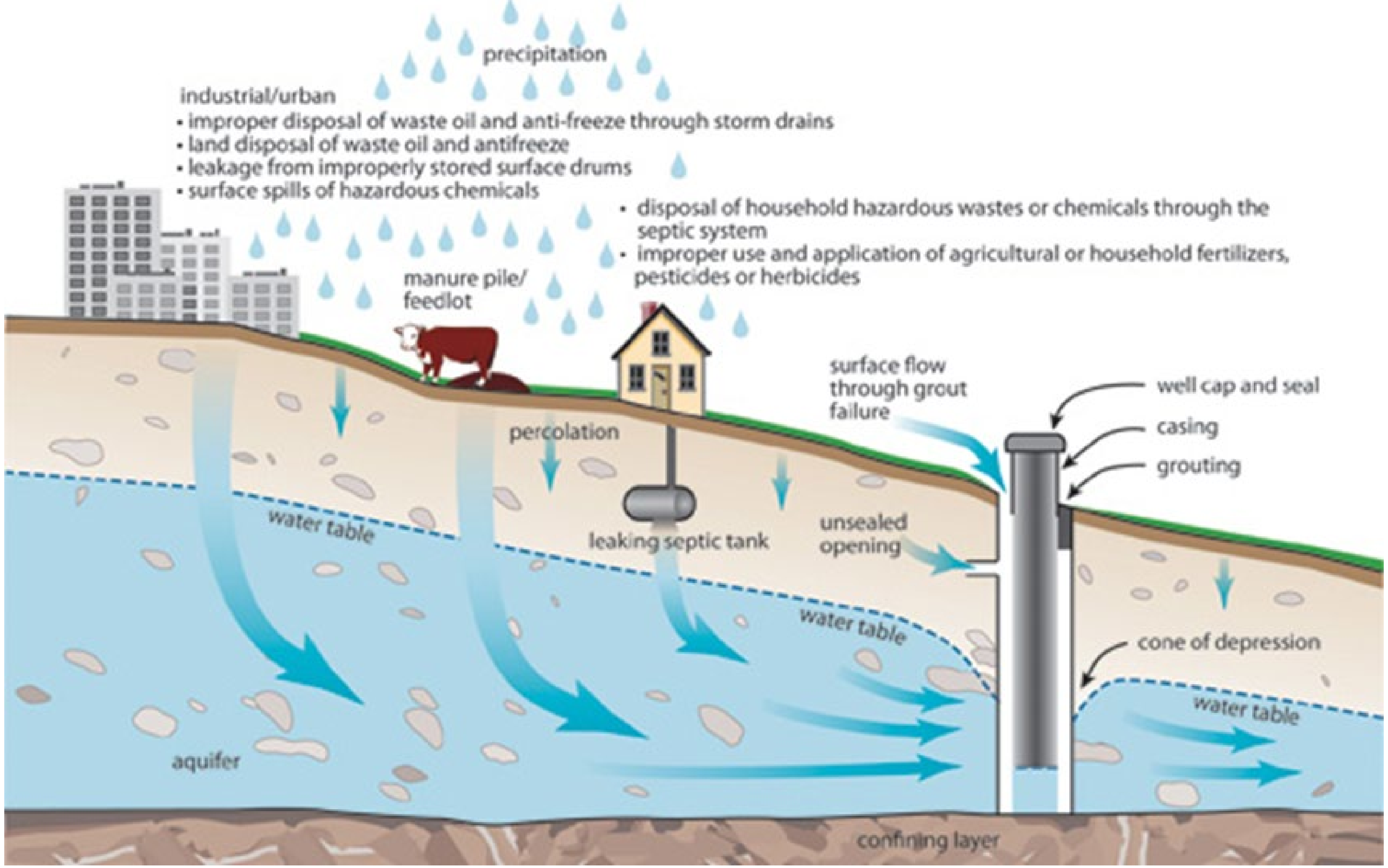
Bacteria

- Feces contain millions of microorganisms/gram
- Pathogens (disease-causing) usually found in low numbers
- Pathogens are more difficult than indicator organisms to recover and identify in the lab
- Pathogens can be bacteria (*E.coli*), viruses (Norovirus), or protozoans (*Cryptosporidium*)
- We look for fecal indicator organisms that "indicate" that a recent contamination has occurred (which suggests that pathogens also are likely present)

Bacteriological contamination in private wells throughout Wisconsin – percent positive by county

-Can be caused by several factors

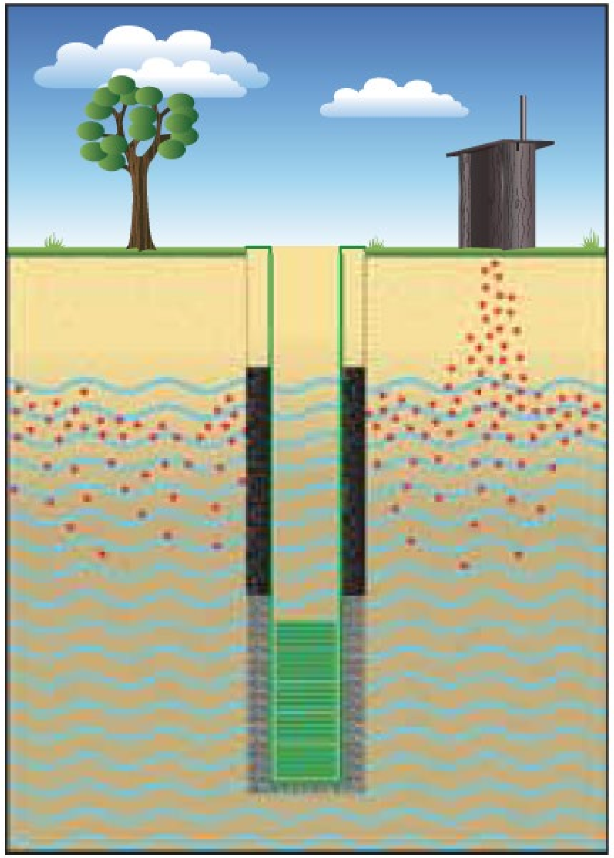




Sources of Bacteria

Sources of Bacteria

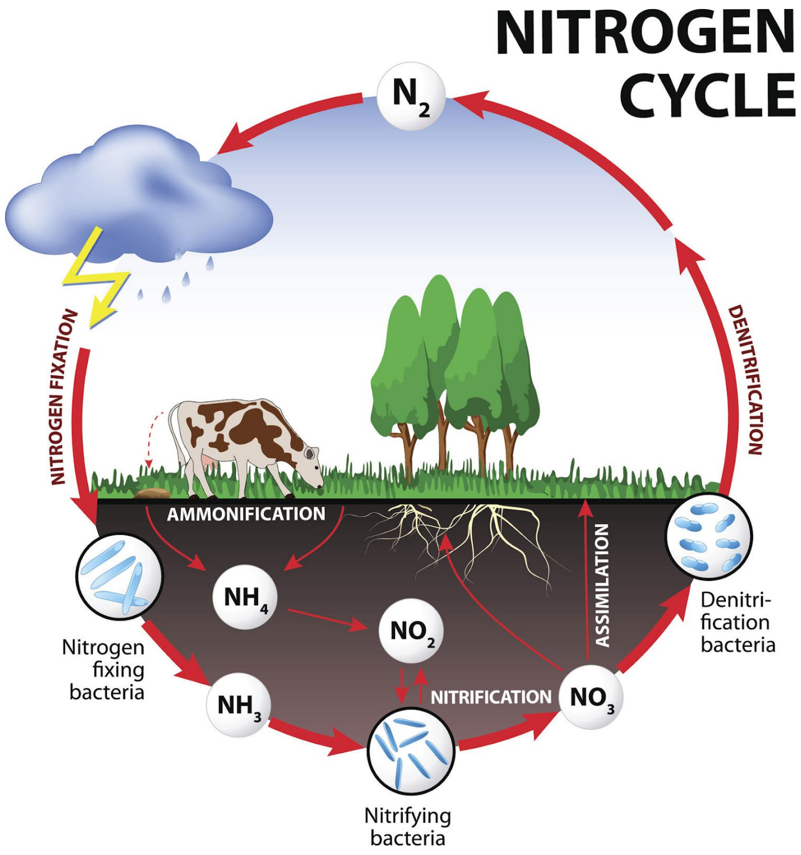
- Sources
  - Improperly constructed well
  - Older or damaged well
  - Distribution system issue (cracked pipe, dead end, etc)
  - Outside source of bacteria (agriculture, animal waste, human waste)



Sanitary Well

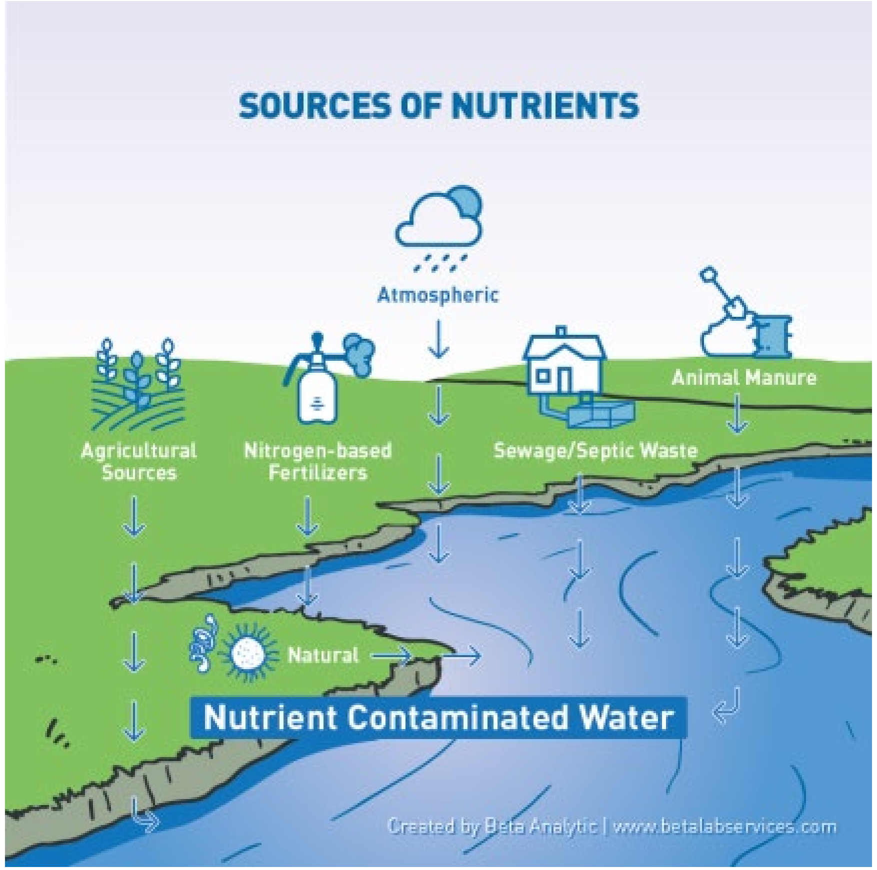
Nitrate

- Formed when nitrogen combines with oxygen in water
- Soluble – commonly found in runoff

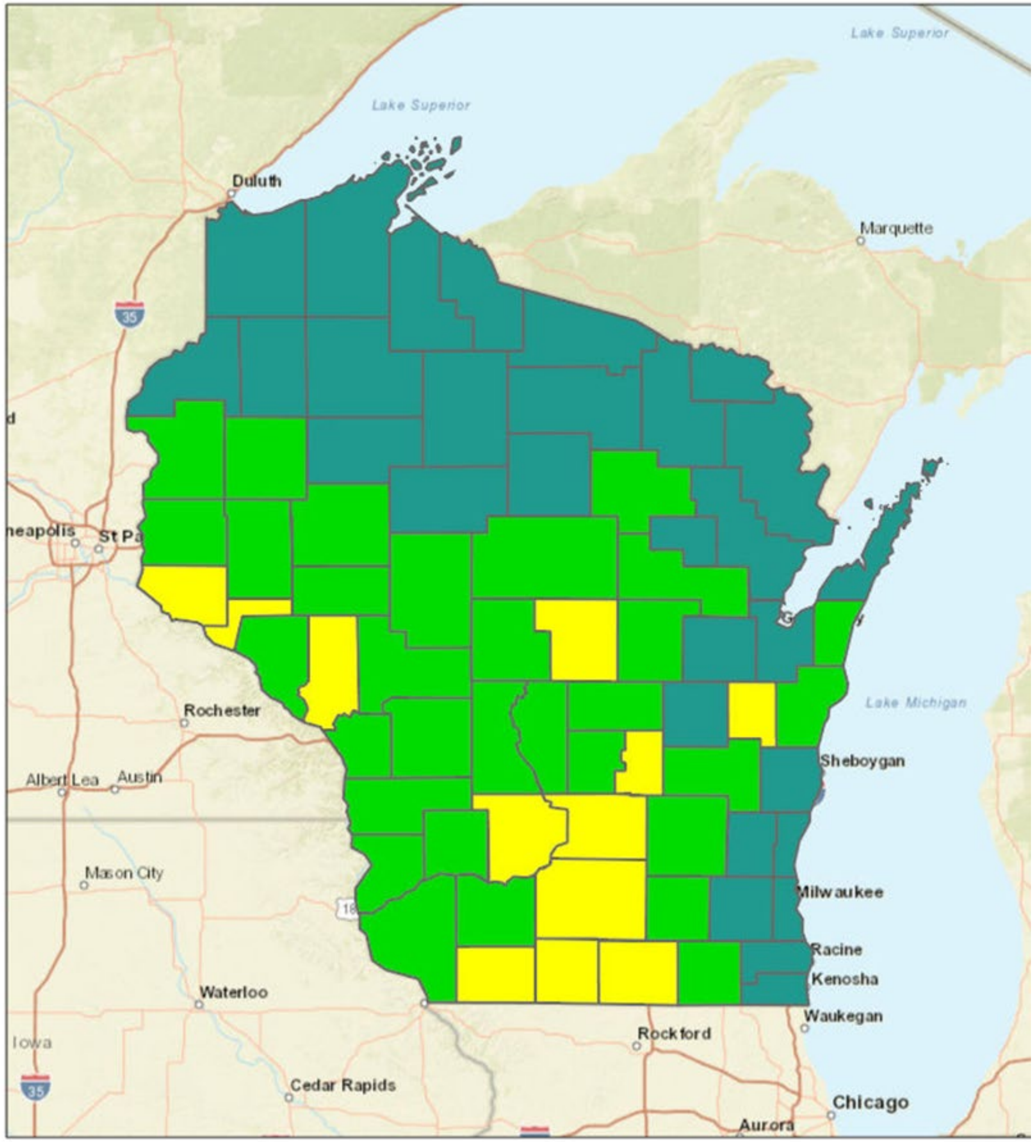


Nitrate

- Sources
  - Agriculture (manure and/or fertilizer)
  - Sewage/Septic
  - Animal waste
  - Atmospheric (trace amounts)
  - Lawn care (fertilizer)
  - Very low naturally occurring nitrate



Average Nitrate



November 26, 2019

1:4,622,324

0 25 50 100 mi

0 40 80 160 km

Nitrate - mg/l N - Average by County

... 2.0 mg/l as N

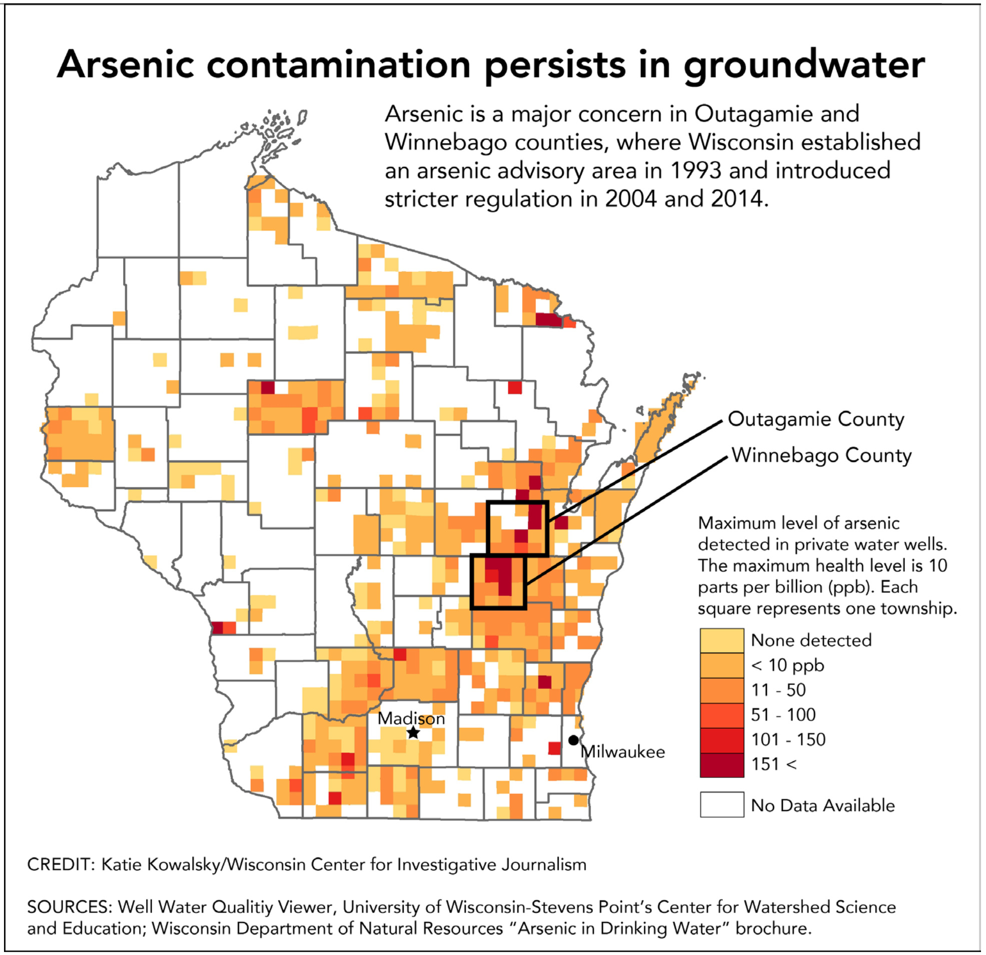
2.1 - 5.0

5.1 - 10.0

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NR
Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thai
NGCC, (c) OpenStreetMap contributors, and the GIS User Community

Arsenic

- Sources
  - Most naturally occurring in bedrock
  - Lead arsenate pesticides were used in orchards from 1890s-1960s (binds to soil, does not usually migrate into groundwater)



Interpreting Results

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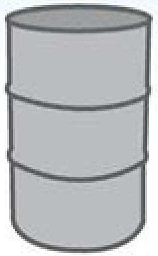
How much is one part per ...

million (ppm)

milligrams/liter (mg/L)



= three drops added to a 42-gallon barrel

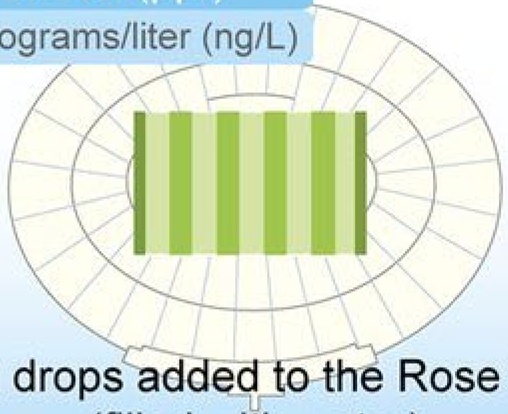
billion (ppb)

micrograms/liter (µg/L)

= one drop added to a large tanker truck

trillion (ppt)

nanograms/liter (ng/L)



= ten drops added to the Rose Bowl (filled with water)

quadrillion (ppq)

picograms/liter (pg/L)

= two teaspoons added to the Great Salt Lake of Utah

What’s considered unsafe?

Parameter	**Maximum Contaminant Level (MCL)**	**"Unsafe" Levels***
Total Coliform	0 MPN/100 mL	> 0 MPN/100 mL
E. coli	0 MPN/100 mL	> 0 MPN/100 mL
Nitrate	10 mg/L	> 10 mg/L
Arsenic	10 µg/L	> 10 µg/L

* "Unsafe" Levels refers to samples that exceed the MCL

Safe Drinking Water Act (SDWA) sets these thresholds for public health.

Interpreting Results

BACTERIA

- Tested for presence of Coliform and *E. coli* bacteria
- A negative or “0” result: there is no bacteria present in the sample and it is safe to drink
- A positive or any number: bacteria is present in the sample, and it is unsafe to drink

NITRATE

- “ND”: nitrate was not detected in the sample; water is safe to drink
- Between 0-9.9 mg/L: nitrate was detected in the “safe” range
- Over 10 mg/L: nitrate was detected over the “safe” range, water is unsafe to drink

Interpreting Results

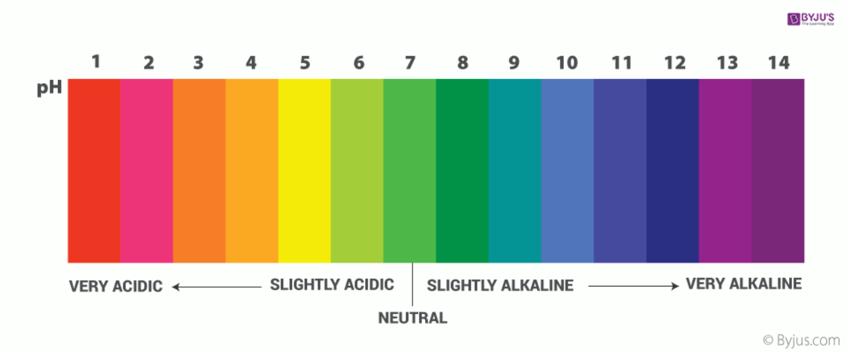
ARSENIC

- ND: arsenic was not detected in the sample
- Between 0-10 µg/L: arsenic was detected in the "safe" range
- Over 10 µg/L: arsenic was detected over the "safe" range

Interpreting Results

CUMULATIVE

pH: measure of the acid-base balance. Carbon dioxide concentration & increase in temperature can decrease pH of water.



Iron: a metal element that makes up 5% of the earth's crust. Iron is not considered hazardous to health. Recommended level is less than 0.3 mg/L

Hardness: water's ability to react with soap and produce a lather. Caused by ions such as calcium and magnesium. Not considered hazardous to health. Hard water can cause lime buildup/scaling on plumbing fixtures.

Water Hardness Scale		
Grains/Gal	**mg/L & ppm**	**Classification**
Less than 1	Less than 17.1	**Soft**
1 – 3.5	17.1 - 60	**Slightly Hard**
3.5 - 7	60 - 120	**Moderately Hard**
7 - 10	120 - 180	**Hard**
Over 10	Over 180	**Very Hard**

Alkalinity: water's ability to neutralize acids. Can be affected by natural deposits in the earth and industrial practices. It is not considered to be hazardous to health. Recommended level is between 75-200 mg/L

Spring 2024 Results

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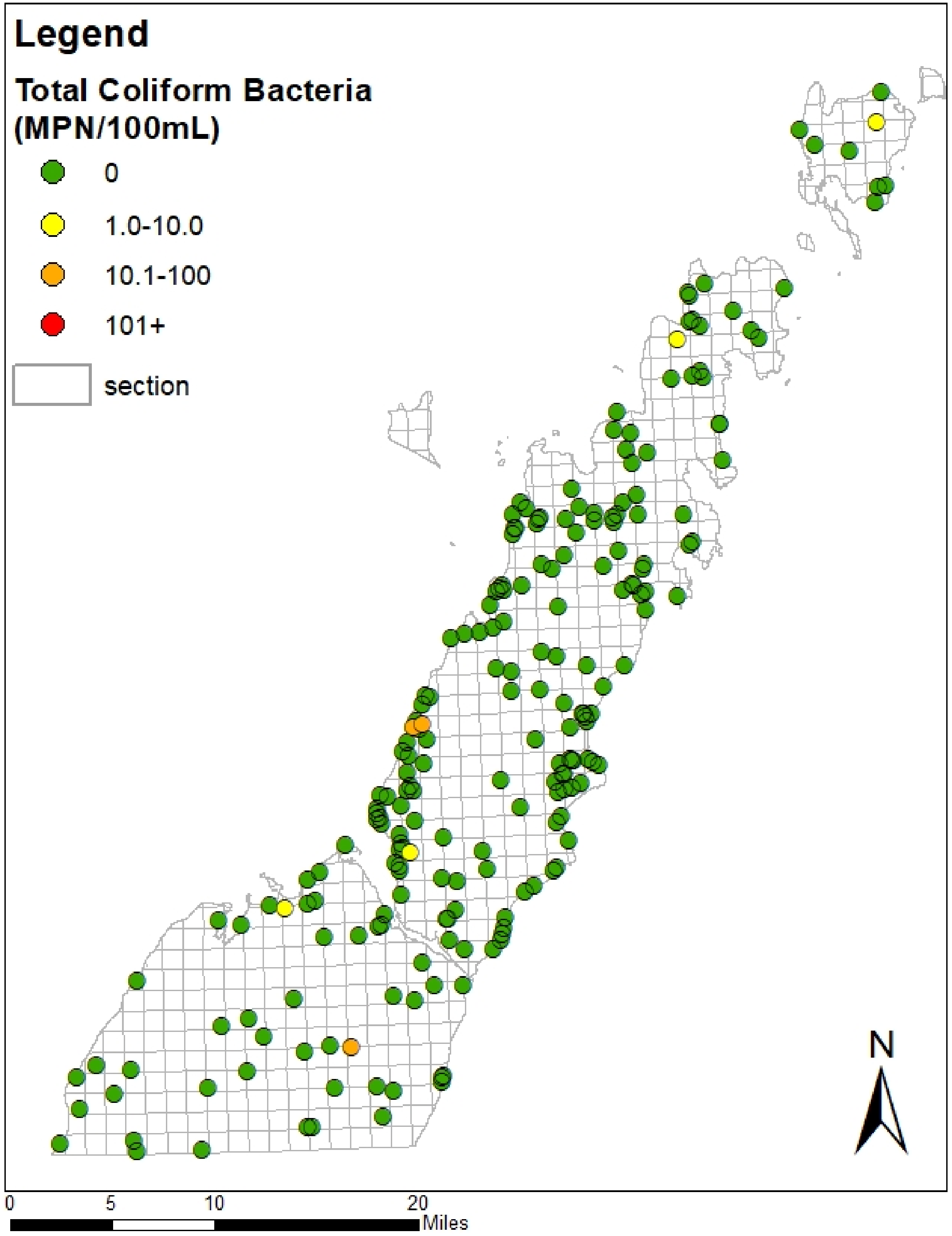
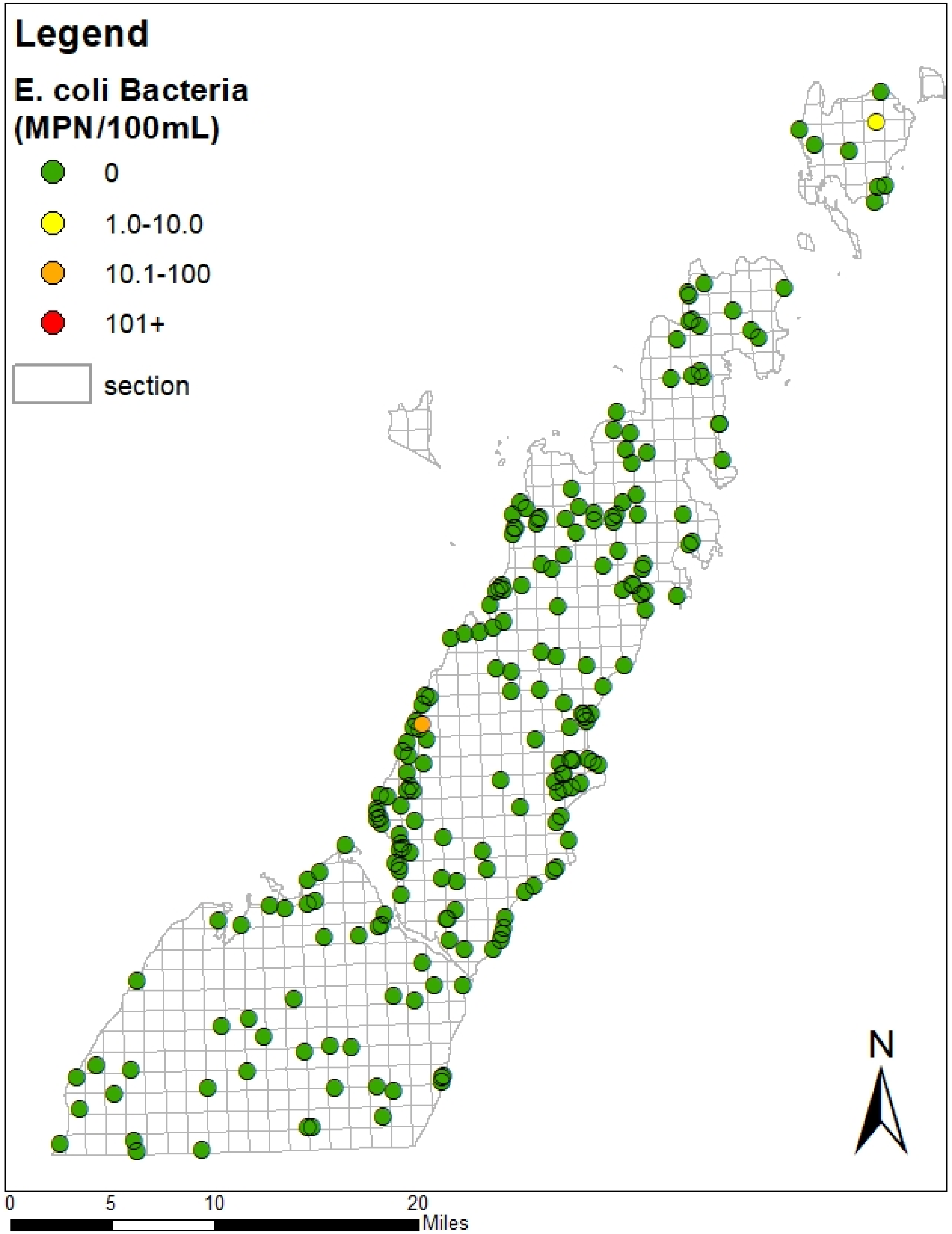
Coliform Bacteria

Coliform Result (MPN/100 mL)	# Samples	% Samples
0	216	96
1-10	5	2
10-100	3	1
100+	0	0
n=224		



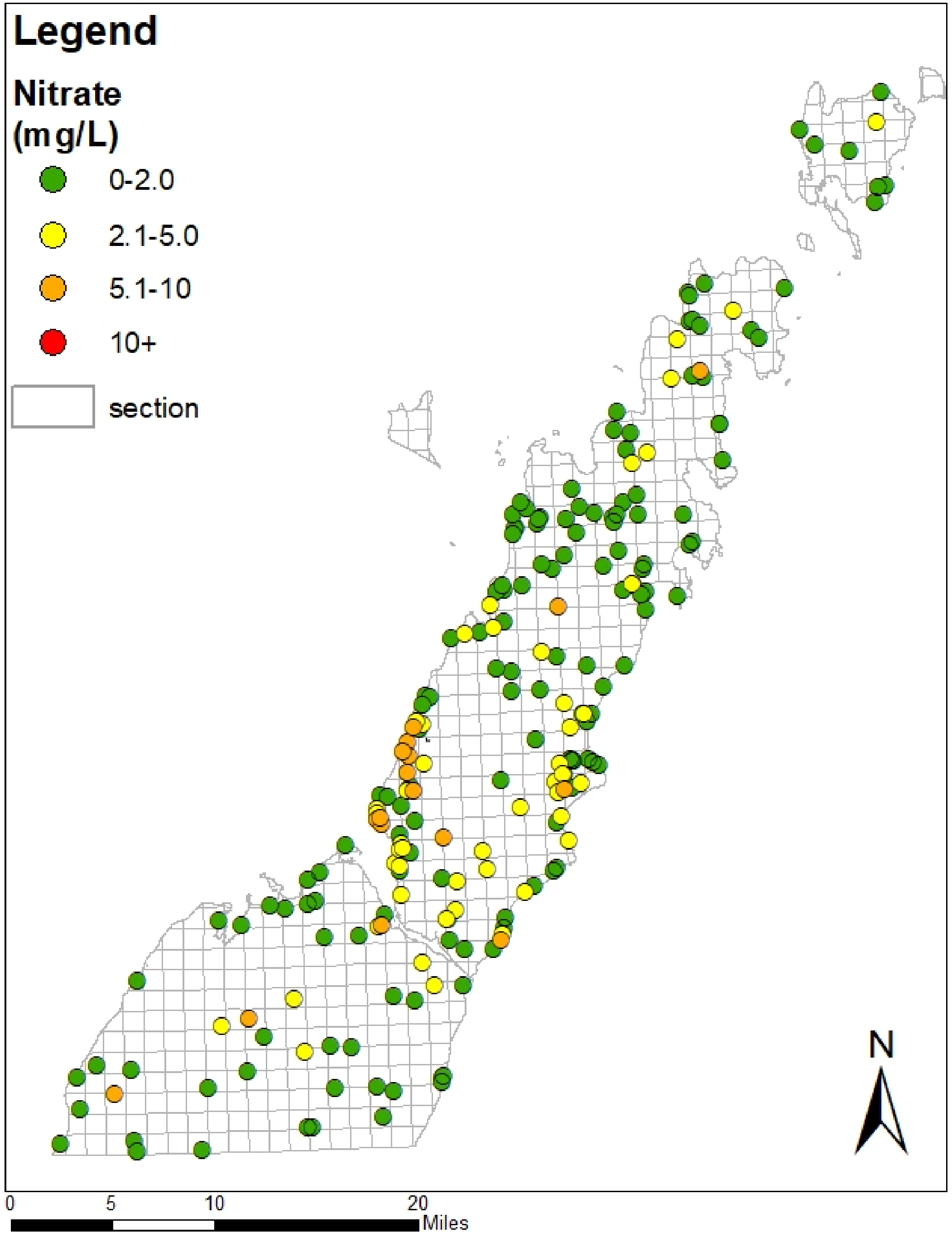
E. Coli Bacteria

E coli **Result (MPN/100 mL)**	**# Samples**	**% Samples**
0	222	99
1-10	1	0
10-100	1	0
100+	0	0
n=224		



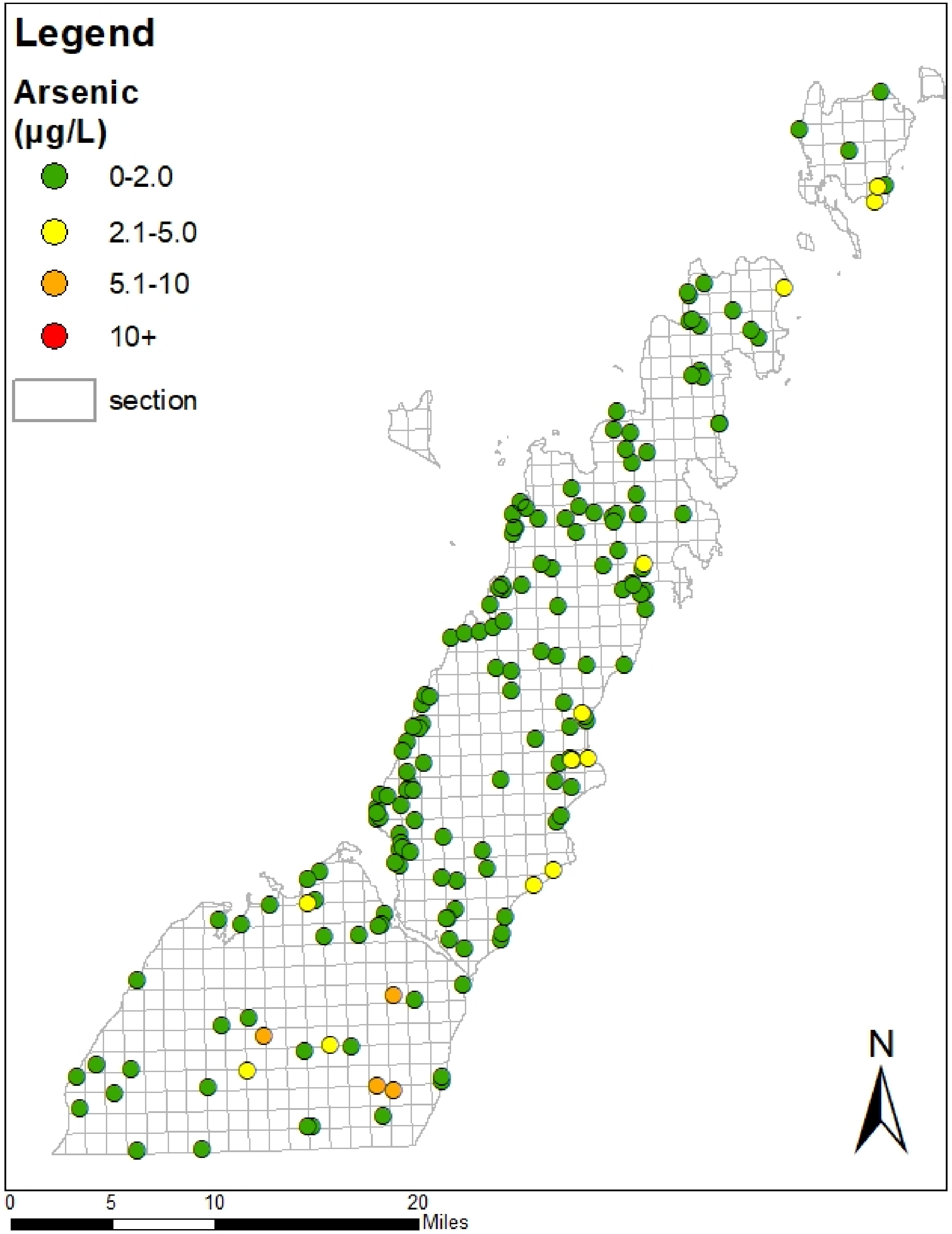
Nitrate

Nitrate Result (mg/L)	# Samples	% Samples
Less than 2	151	69
2-5	51	23
5-10	17	8
10+	0	0
n=219		



Arsenic

Arsenic Result (µg/L)	# Samples	% Samples
Less than 2	156	91
2-5	12	7
5-10	4	2
10+	0	0
n=172		



Previous Data - Coliform

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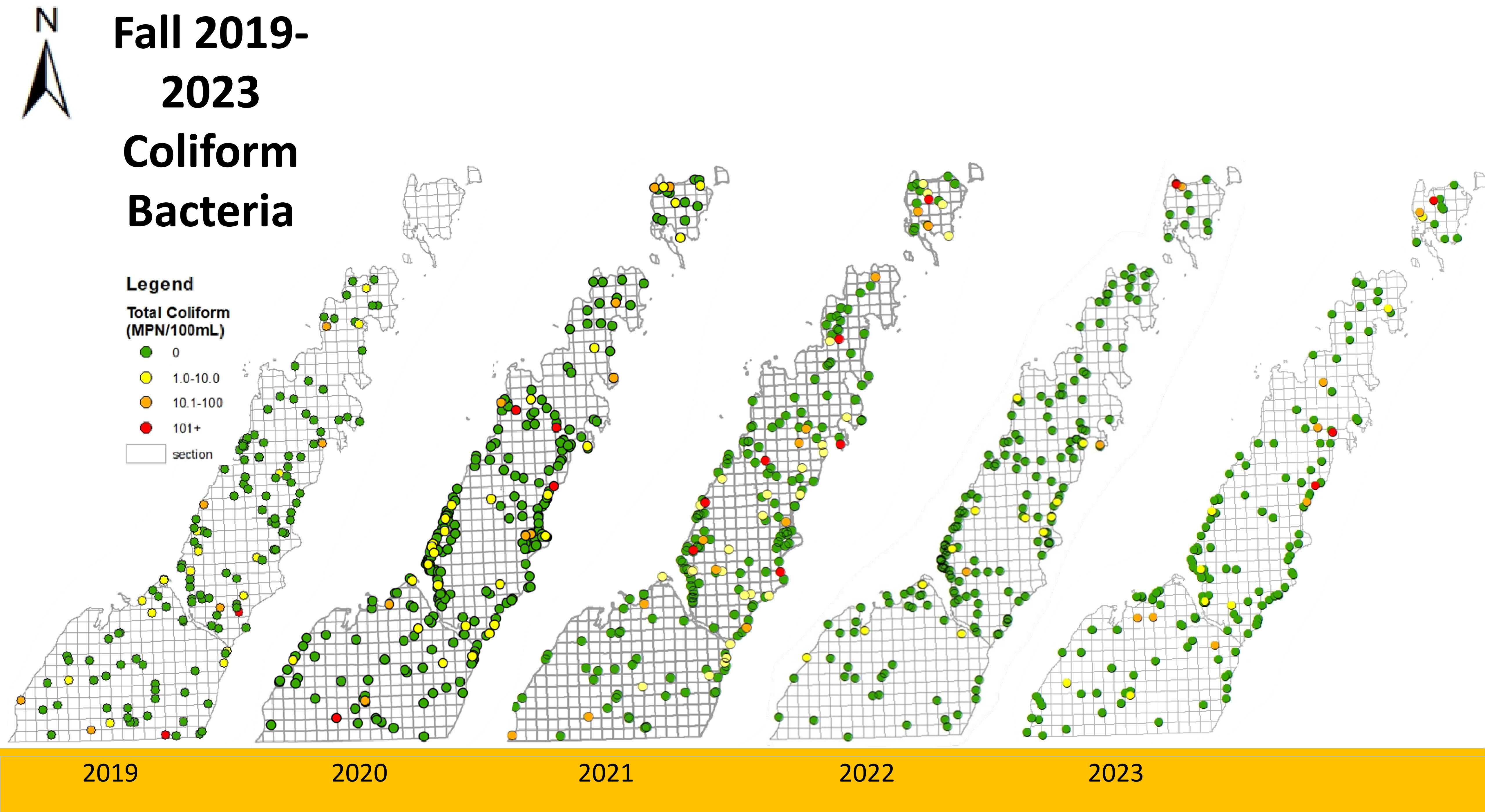
Fall 2019-2023 Coliform Bacteria



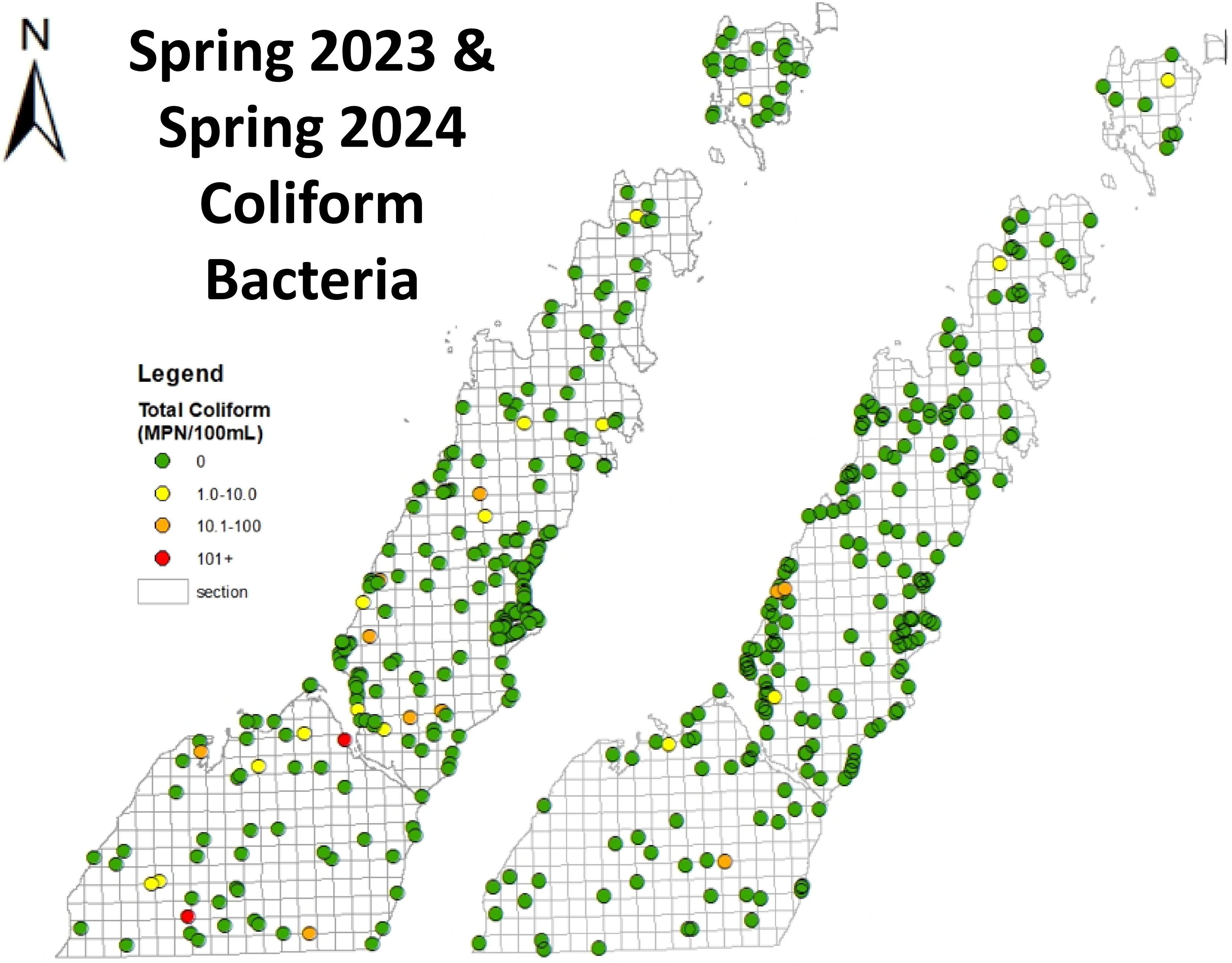
Coliform Bacteria

2019			2020			2021			2022 (Spring + Fall)			2023 (Spring + Fall)		
Coliform Result (MPN/100 mL)	# Samples	% Samples	Coliform Result (MPN/100 mL)	# Samples	% Samples	Coliform Result (MPN/100 mL)	# Samples	% Samples	Coliform Result (MPN/100 mL)	# Samples	% Samples	Coliform Result (MPN/100 mL)	# Samples	% Samples
0	125	84	0	254	86	0	166	76	0	414	91	0	328	92
1-10	15	10	1-10	28	9	1-10	30	14	1-10	28	6	1-10	18	5
10-100	6	4	10-100	9	3	10-100	14	6	10-100	11	2	10-100	7	2
100+	2	1	100+	4	1	100+	7	3	100+	2	0.4	100+	4	1
n=148			n=295			n=217			n=456			n=357		

Spring 2024		
Coliform Result (MPN/100 mL)	# Samples	% Samples
0	216	96
1-10	5	2
10-100	3	1
100+	0	0
n=224		

Potential sampling errors? (Sample faucets must be properly disinfected)

Spring 2023 & Spring 2024 Coliform Bacteria



Spring 2023		
Coliform Result (MPN/100 mL)	# Samples	% Samples
0	185	95
1-10	9	5
10-100	0	0
100+	1	1
n=195		

Spring 2024		
Coliform Result (MPN/100 mL)	# Samples	% Samples
0	216	96
1-10	5	2
10-100	3	1
100+	0	0
n=224		

Spring 2023 Spring 2024

Previous Data – *E. coli*

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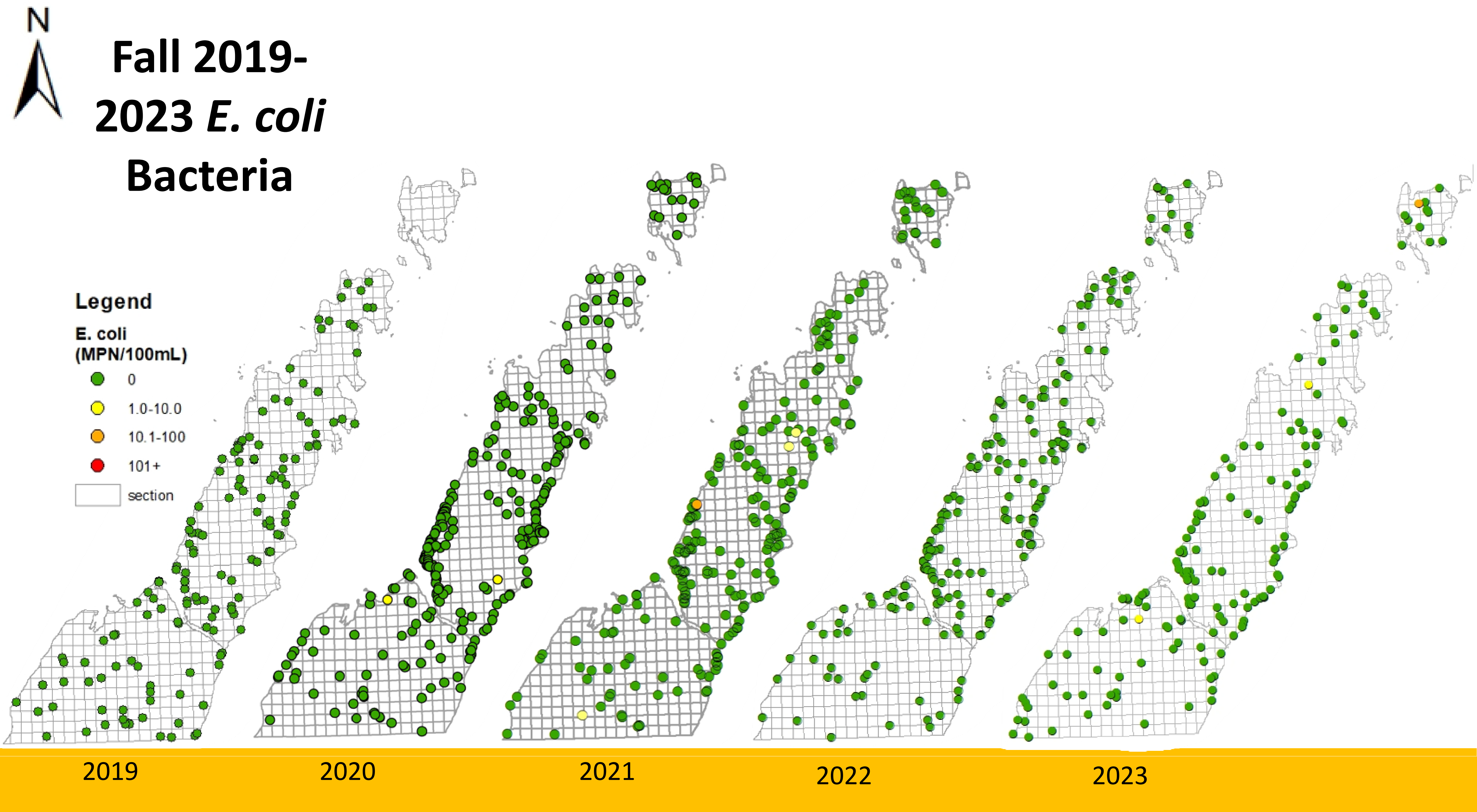
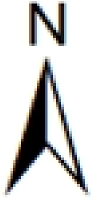
Fall 2019-2023 *E. coli* Bacteria



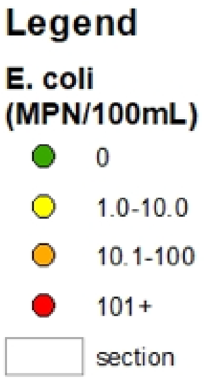
E. coli Bacteria

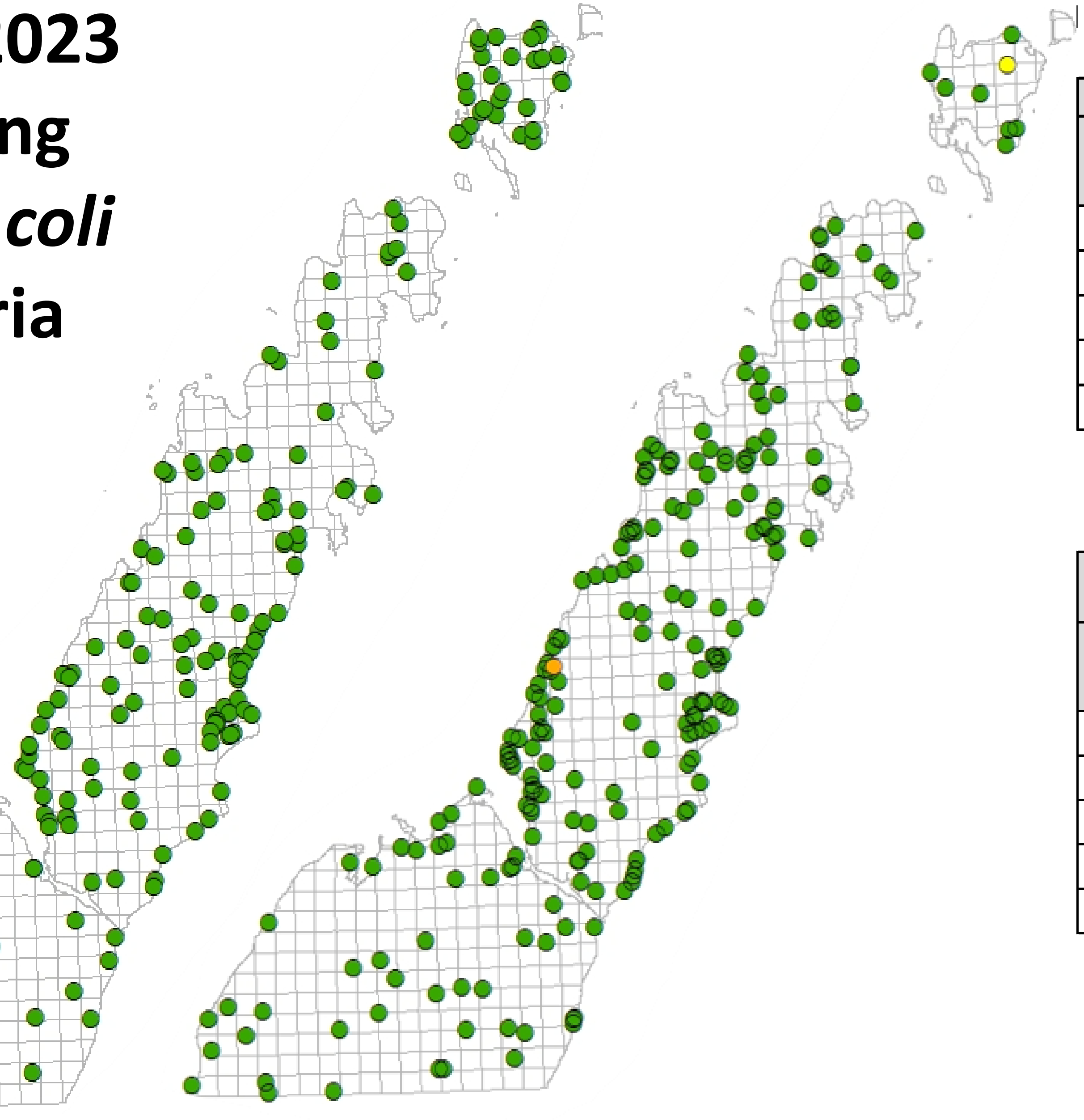
2019			2020			2021			2022 (Spring + Fall)			2023 (Spring + Fall)		
E coli **Result (MPN/100 mL)**	**# Samples**	**% Samples**	***E coli*** **Result (MPN/100 mL)**	**# Samples**	**% Samples**	***E coli*** **Result (MPN/100 mL)**	**# Samples**	**% Samples**	***E coli*** **Result (MPN/100 mL)**	**# Samples**	**% Samples**	***E coli*** **Result (MPN/100 mL)**	**# Samples**	**% Samples**
0	148	100	0	293	99	0	213	98	0	454	100	0	354	99
1-10	0	0	1-10	2	1	1-10	3	1	1-10	2	0.4	1-10	2	1
10-100	0	0	10-100	0	0	10-100	1	<1	10-100	0	0	10-100	1	<1
100+	0	0	100+	0	0	100+	0	0	100+	0	0	100+	0	0
n=148			n=295			n=217			n=456			n=357		

Spring 2024		
E coli **Result (MPN/100 mL)**	**# Samples**	**% Samples**
0	222	99
1-10	1	0
10-100	1	0
100+	0	0
n=224		



Spring 2023 & Spring 2024 *E. coli* Bacteria





Spring 2023		
***E coli* Result (MPN/100 mL)**	**# Samples**	**% Samples**
0	195	100
1-10	0	0
10-100	0	0
100+	0	0
n=195		

Spring 2024		
***E coli* Result (MPN/100 mL)**	**# Samples**	**% Samples**
0	222	99
1-10	1	0
10-100	1	0
100+	0	0
n=224		

Spring 2023 Spring 2024

Previous Data – Nitrate

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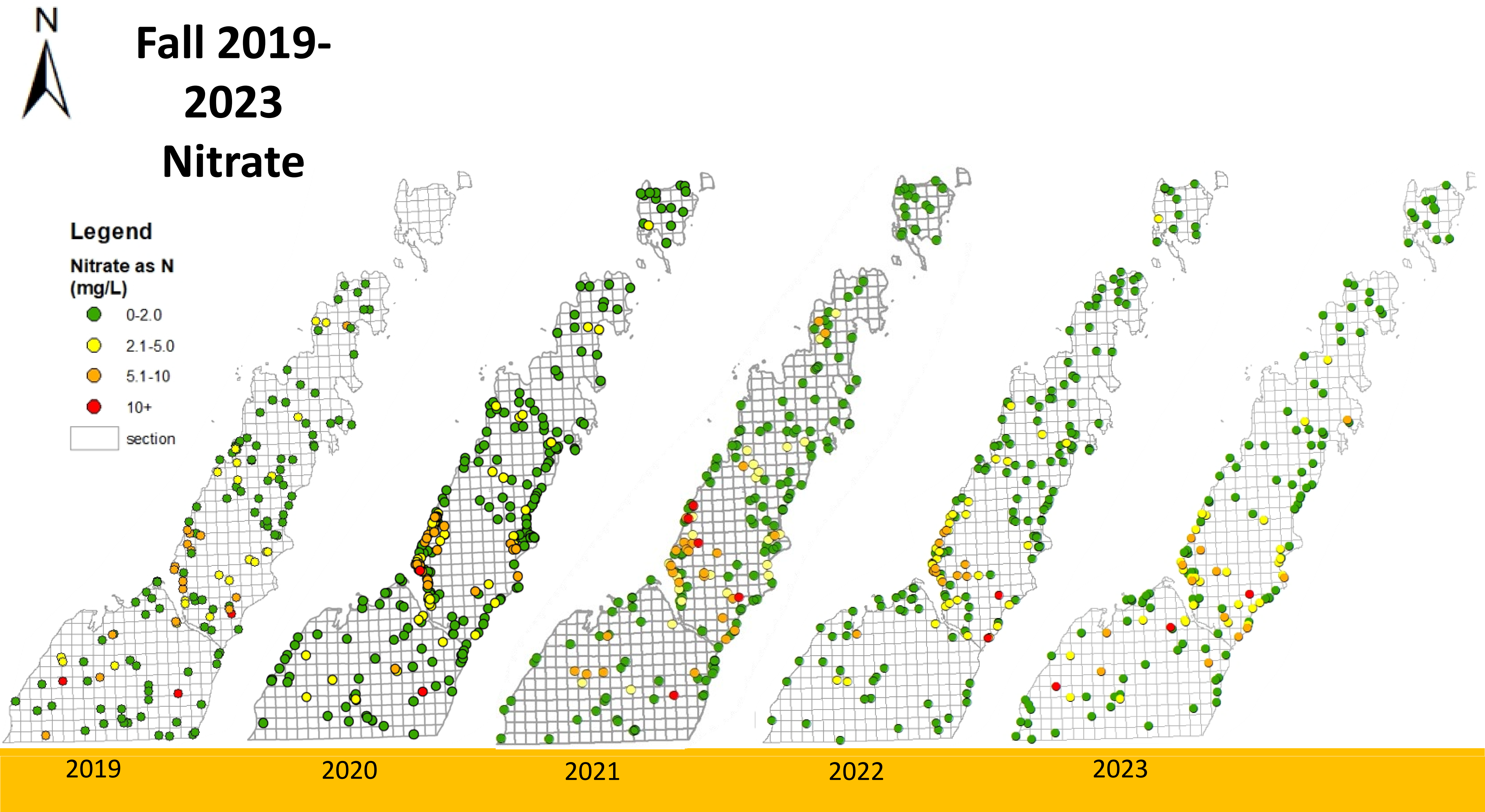
Fall 2019-2023 Nitrate



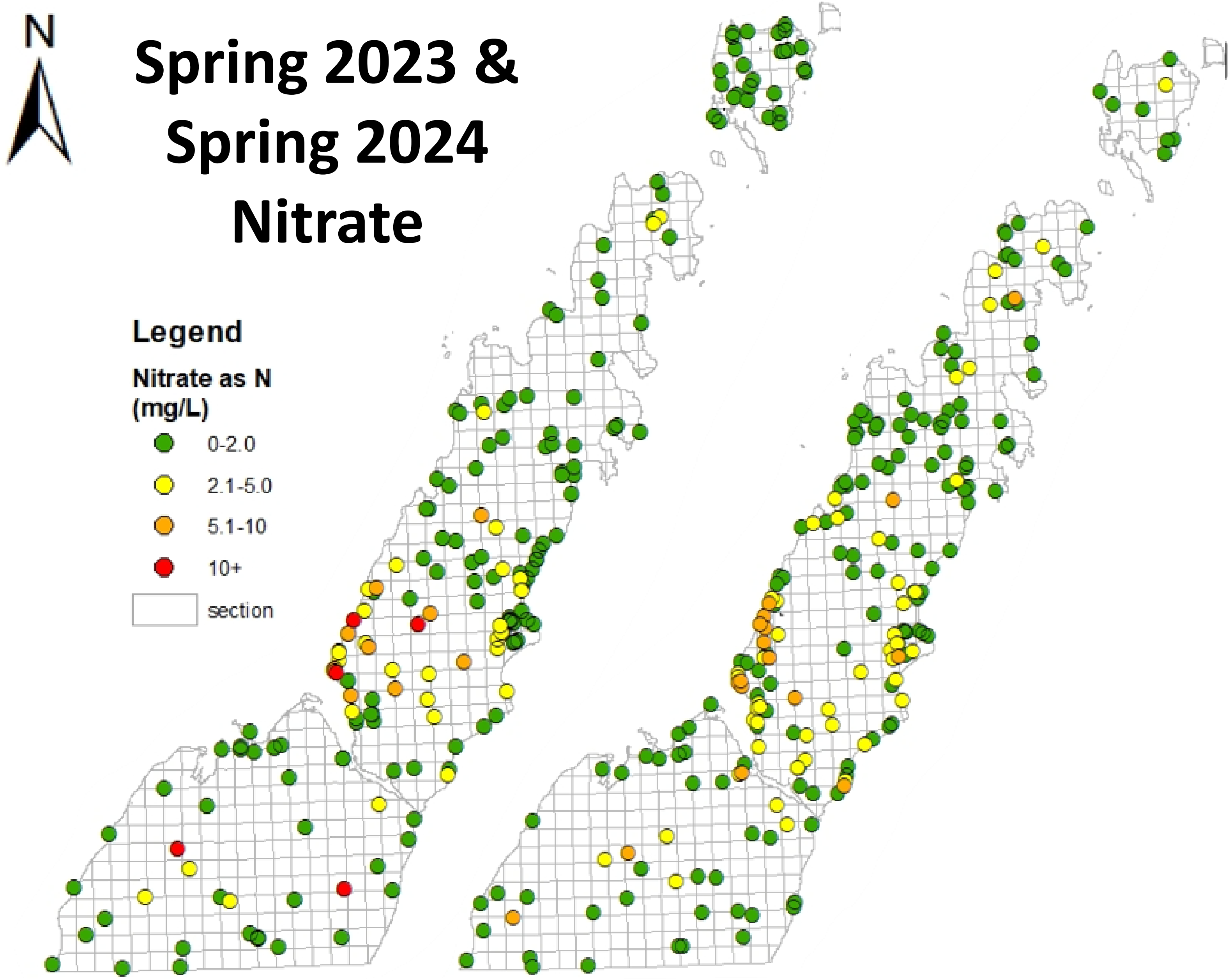
Nitrate

2019			2020			2021			2022 (Spring + Fall)			2023 (Spring + Fall)		
Nitrate Result (mg/L)	**# Samples**	**% Samples**	**Nitrate Result (mg/L)**	**# Samples**	**% Samples**	**Nitrate Result (mg/L)**	**# Samples**	**% Samples**	**Nitrate Result (mg/L)**	**# Samples**	**% Samples**	**Nitrate Result (mg/L)**	**# Samples**	**% Samples**
Less than 2	104	71	Less than 2	206	72	Less than 2	157	75	Less than 2	347	77	Less than 2	261	75
2-5	23	16	2-5	46	16	2-5	23	11	2-5	76	17	2-5	58	17
5-10	16	11	5-10	34	12	5-10	25	12	5-10	25	6	5-10	23	7
10+	3	2	10+	2	1	10+	5	2	10+	2	<1	10+	8	2
n=146			n=288			n=210			n=450			n=350		

Spring 2024		
Nitrate Result (mg/L)	**# Samples**	**% Samples**
Less than 2	151	69
2-5	51	23
5-10	17	8
10+	0	0
n=219		

Concentrations of nitrate greater than 3 mg/l generally indicate contamination.

Spring 2023 & Spring 2024 Nitrate



Spring 2023		
Nitrate Result (mg/L)	# Samples	% Samples
Less than 2	147	77
2-5	30	16
5-10	10	5
10+	5	3
n=192		

Spring 2024		
Nitrate Result (mg/L)	# Samples	% Samples
Less than 2	151	69
2-5	51	23
5-10	17	8
10+	0	0
n=219		

Spring 2023 Spring 2024

Previous Data – Arsenic

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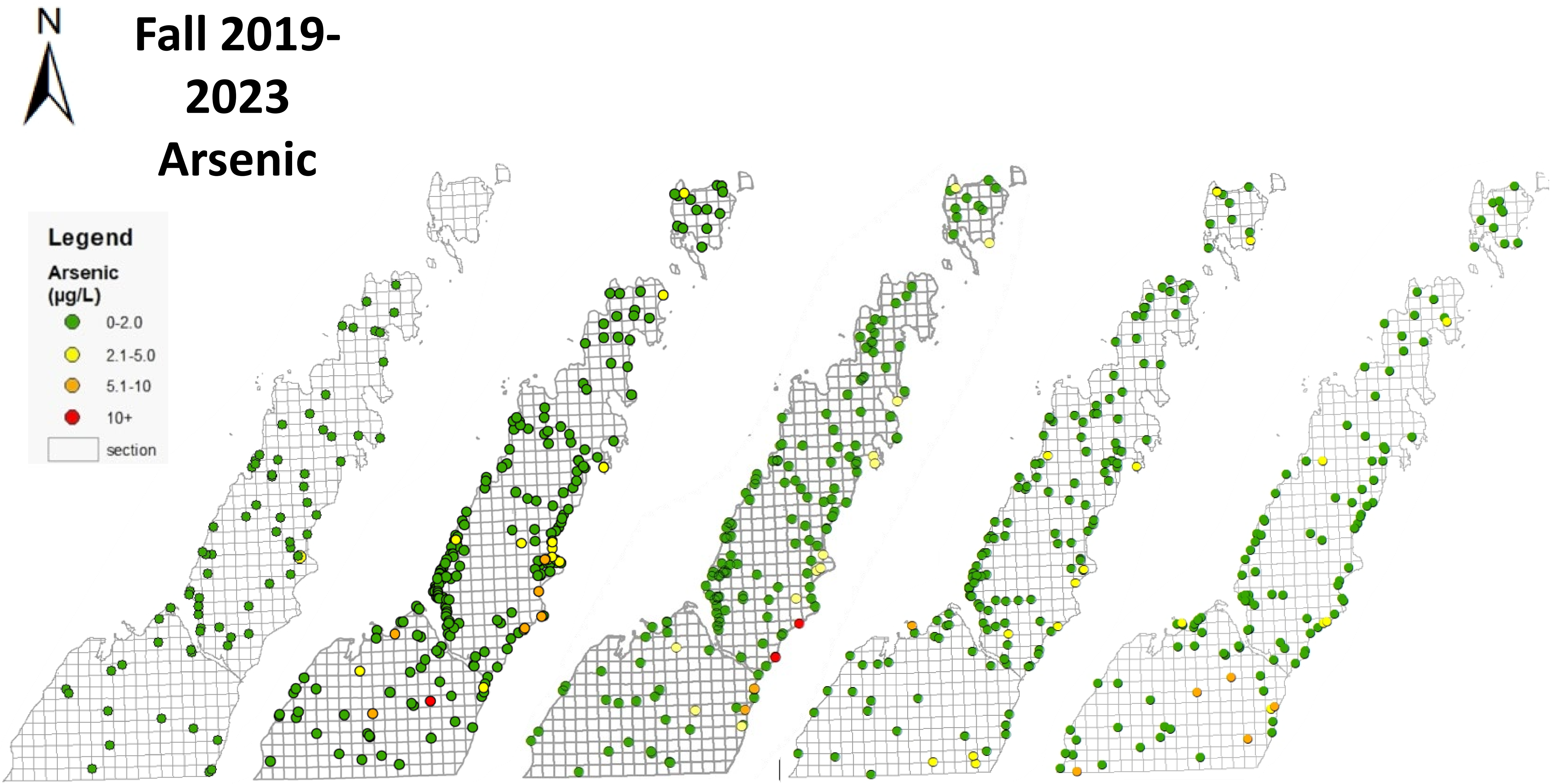
Fall 2019-2023 Arsenic



2019 2020 2021 2022 2023

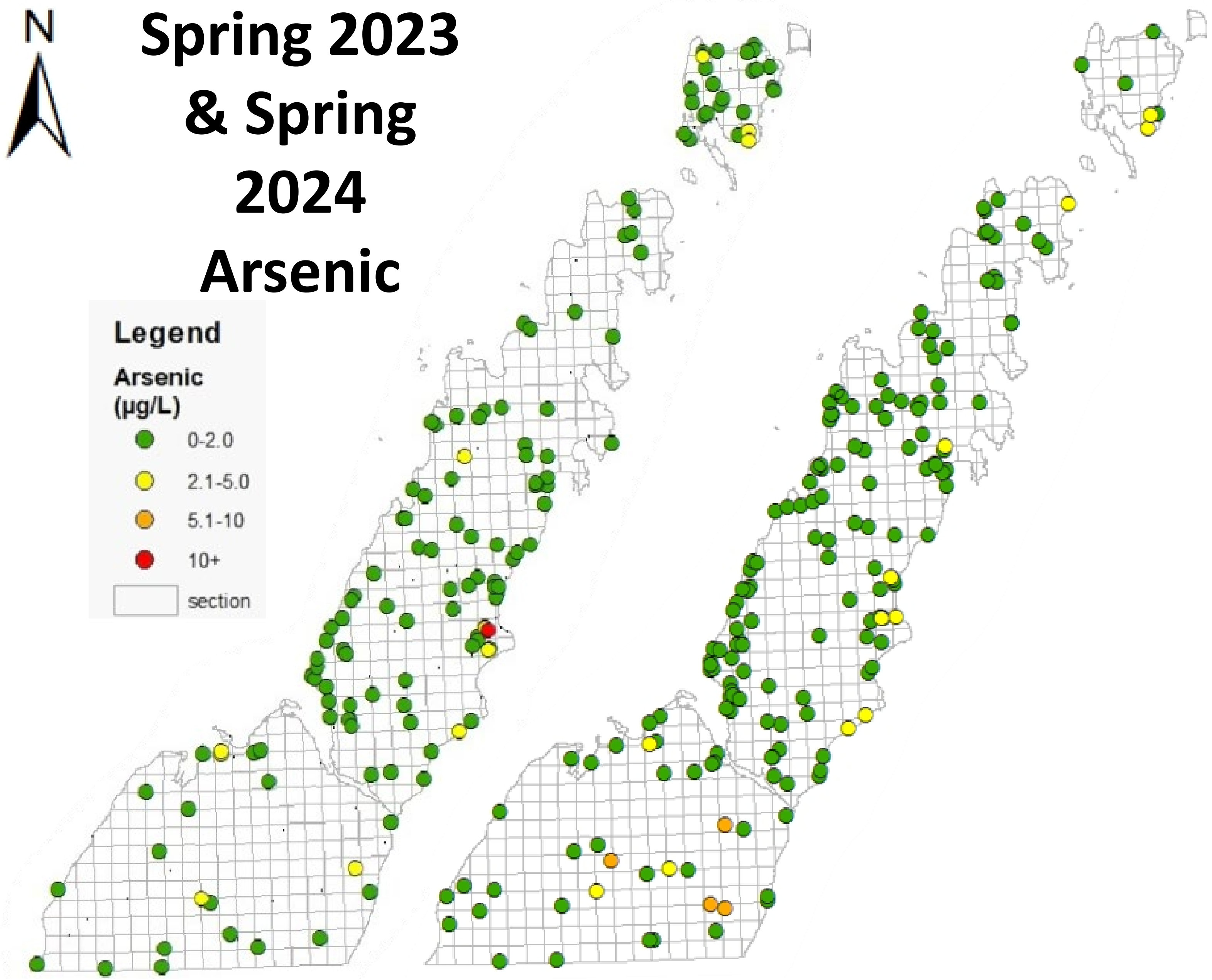
Arsenic

2019			2020			2021			2022 (Spring + Fall)			2023 (Spring + Fall)		
Arsenic Result (µg/L)	# Samples	% Samples	Arsenic Result (µg/L)	# Samples	% Samples	Arsenic Result (µg/L)	# Samples	% Samples	Arsenic Result (µg/L)	# Samples	% Samples	Arsenic Result (µg/L)	# Samples	% Samples
Less than 2	70	99	Less than 2	214	90	Less than 2	149	89	Less than 2	328	90	Less than 2	235	90
2-5	1	1	2-5	15	6	2-5	15	9	2-5	33	9	2-5	20	8
5-10	0	0	5-10	7	3	5-10	2	1	5-10	4	1	5-10	5	2
10+	0	0	10+	1	<1	10+	2	1	10+	1	0.3	10+	1	0
n=71			n=237			n=168			n=366			n=261		

Spring 2024		
Arsenic Result (µg/L)	# Samples	% Samples
Less than 2	156	91
2-5	12	7
5-10	4	2
10+	0	0
n=172		

Generally low arsenic concentrations from sampling events.

Spring 2023 & Spring 2024 Arsenic



Spring 2023		
Arsenic Result (µg/L)	# Samples	% Samples
Less than 2	122	89
2-5	14	10
5-10	0	0
10+	1	1
n=137		

Spring 2024		
sult (µg/L)	# Samples	% Samples
Less than 2	156	91
2-5	12	7
5-10	4	2
10+	0	0
n=172		

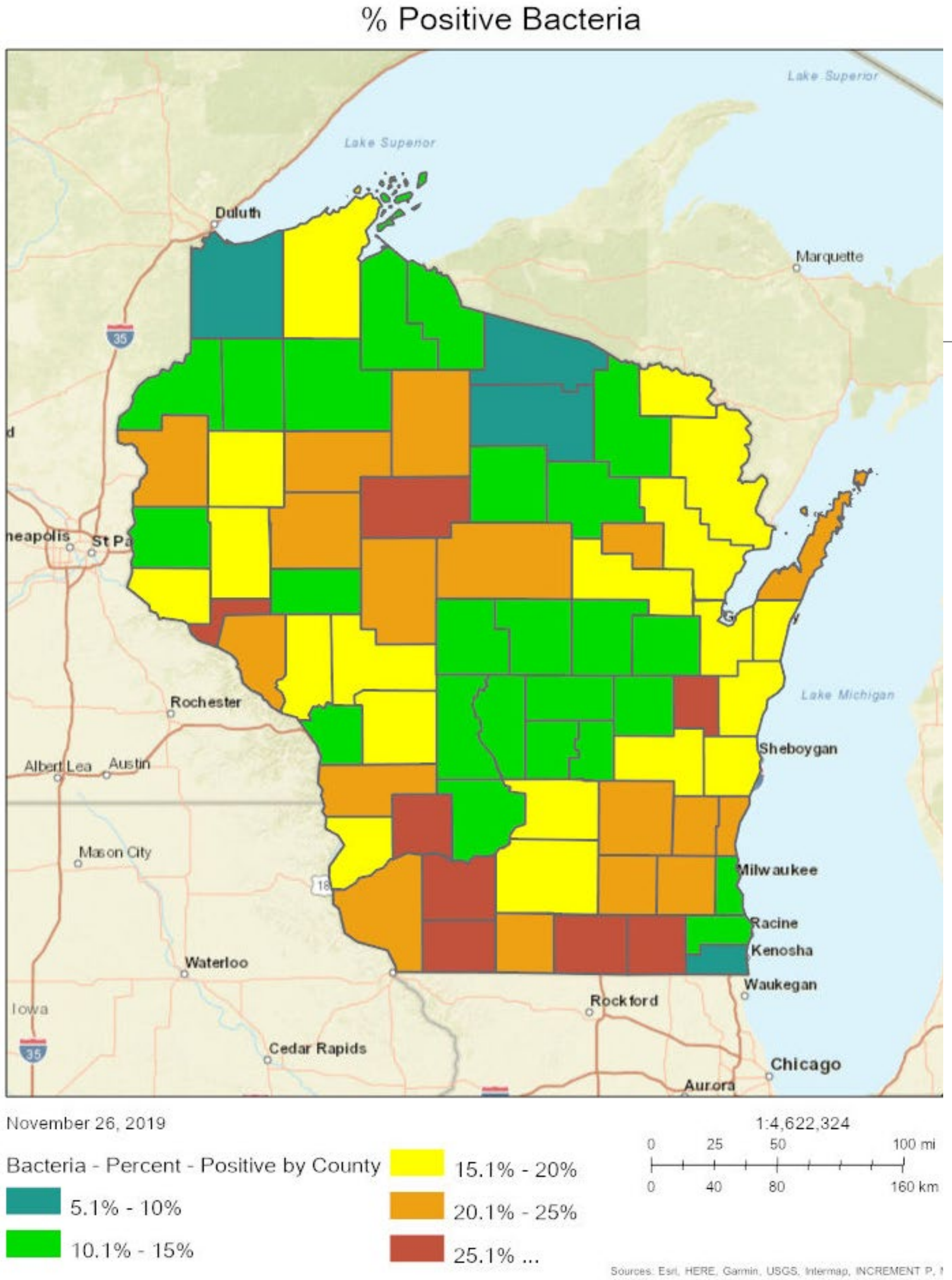
Spring 2023 Spring 2024

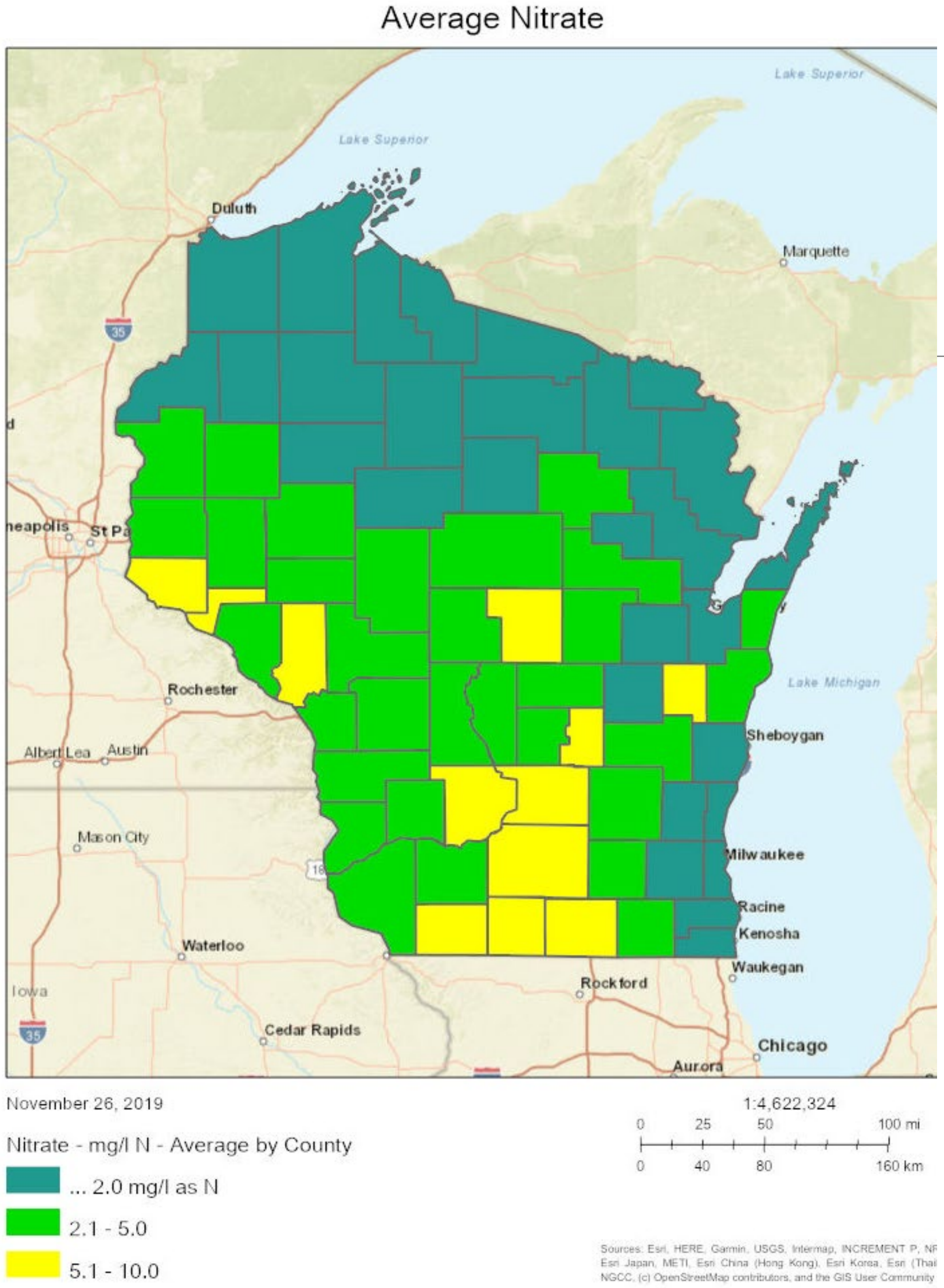
County-Wide Sampling Efforts

Percentage Exceeding Safe Water Quality Standards										
Water Quality Standard	**Spring 2024 Door County Results**	**Fall 2023 Door County Results**	**Spring 2023 Door County Results**	**Fall 2022 Door County Results**	**Spring 2022 Door County Results**	**Fall 2021 Door County Results**	**Fall 2020 Door County Results**	**Fall 2019 Door County Results**	**Previous Door County Results* (Average)**	**Wisconsin****
Total Coliform (> 0 MPN/100 ml)	4%	12%	5%	8%	10%	24%	14%	16%	18%	17%
E. coli (> 0 MPN/100 ml)	1%	2%	0%	0%	1%	2%	1%	0%	6%	5%
Nitrate (> 10 mg/L)	0%	3%	3%	1%	0%	2%	1%	2%	2%	8%
Arsenic (> 10 µg/L)	0%	0%	<1%	0%	<1%	1%	<1%	0%	3%	5%

*Data derived from UWSP Well Viewer, UWO 2015 (480 samples) & 2016 (392 samples) community program, 2011-2015 UWEx Private Well Program (582 samples)

**Data derived from the Wisconsin Groundwater Coordinating Council Report & UWSP Well Viewer

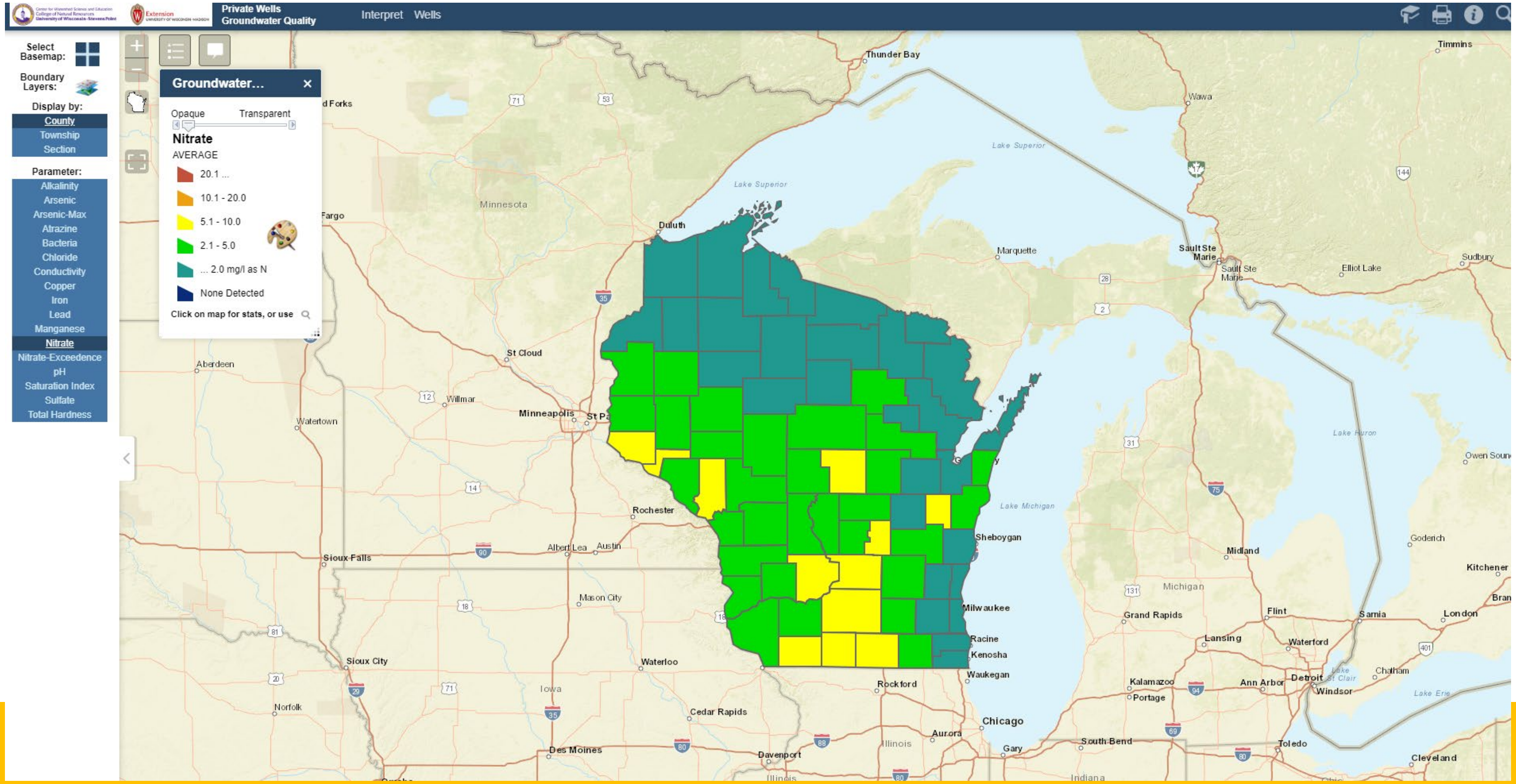




Statewide Private Well Data

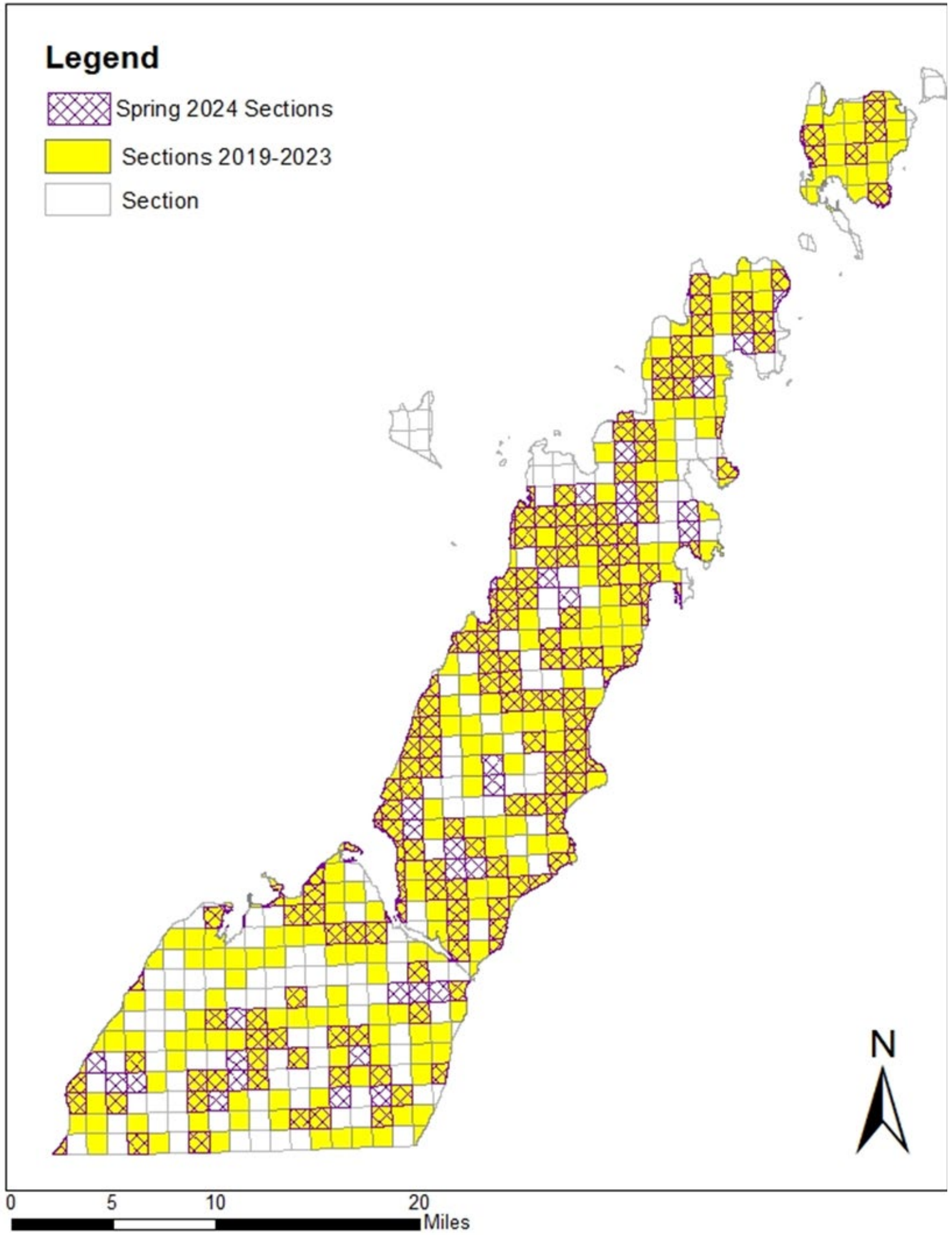
Where is the data going?

- Long-term goal is to upload all data onto UWSP Well Water Data Viewer https://www.uwsp.edu/cnr-ap/watershed/Pages/WellWaterViewer.aspx



Further Research & Plans

- Continue targeted sampling in spring, summer, and/or fall (seasonal)
- Recruiting same volunteers from previous years plus additional wells in other sections across county
- Continuation as a long-term study (ongoing annual program)



Take Home Messages

- Karst geology makes Door County groundwater highly vulnerable to contamination and causes high variability in water quality results
- Sample your well <u>at least annually</u> for bacteria and nitrate, or more often if changes or problems observed (recommended)
- Do not hesitate to use your resources if you have questions or concerns about Door County groundwater quality
  - Wisconsin DNR
  - Door County Soil & Water Conservation Department
  - Door County Public Health

Special Thanks

- Thank you to Door County Soil & Water Department and Door County Public Health for your support throughout the last 5 years of sampling

QUESTIONS? CONTACT US AT ERIC@UWOSH.EDU OR (920) 424-3148

PRESENTATION & RECORDING AVAILABLE ONLINE

Thank you – we can't do this without you!