



2020 Door County Well Study Program: Final Report

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1. Project Scope & Goals

1.1. Goals

The goals of the Door County Private Well Monitoring Program are to provide education to county residents and visitors about well water quality monitoring while simultaneously building a database of groundwater quality data that can be used by county officials to monitor and maintain safe and healthy drinking water in Door County.

1.2. Project Scope

UW Oshkosh is conducting a long-term spatially distributed groundwater study throughout Door County. This will be done by sampling at least one well per PLSS section (1 square mile area) of the county, totaling 619 sections. UW Oshkosh randomly selected well(s) in each section in Door County and invited residents to participate in the study by letter. Any Door County resident that owns a well could participate in the study even if their well was not selected. Previous participants were invited for the fall 2020 sampling by emailing a registration link and/or sending a mail invitation.

1.2.1. Activities

- Advertise a 2020 sampling event and public forum via social media, radio, local press and at local community events and/or meetings
- Randomly select well(s) in each remaining section by sending letters and invite former participants to take part in the study
- Hold a virtual public forum(s) with three primary objectives:
 - Discuss the groundwater study and importance of testing well water quality
 - Teach study participants how to collect water samples and
 - Drop-off logistics - when/where to drop off samples
- Mail out sampling kits to participating wells
- Hold 3 water sample drop-off “drive-thru” locations on Friday evening and Saturday morning (Special arrangements made for Washington Island)
- Run samples at UW Oshkosh lab and notify participants immediately of any unsafe results
- Release results to study participants, build a county-wide database with results, and share results with the WI Well Water Quality Interactive Viewer (Managed by UWSP)
- Hold a virtual public forum after study completion to educate public of study results and next steps

1.3. Study Parameters

The study covered the quantification of total coliforms/*E. coli* in units of most probable number (MPN) per 100 mL and nitrate + nitrite as N in units of mg/L. In addition, participants had the option to add arsenic (mg/L) testing. The maximum contaminant levels (MCL) set by the Environmental Protection Agency for each parameter tested in this study can be seen in Table 1 below.

Table 1. Maximum contaminant levels (MCLs) for the parameters tested in the study.

Parameter	Maximum Contaminant Level (MCL)	"Unsafe" Levels*
Total Coliform	0 MPN/100 mL	> 0 MPN/100 mL
<i>E. coli</i>	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		

2. Deliverables

2.1. Participating wells

There was a total of 295 wells (169 sections) that participated in the 2020 well study compared to the 148 wells (138 sections) from 2019. Of these 169 sections from 2020, 69 of them were repeat sections from 2019. Figure 1 shows the spatial distribution of sections with participating wells for 2019 and 2020.

In 2019 samples were collected November 8th and 9th and 2020 samples were collected October 2nd and 3rd. Participants were taught the proper sampling technique for each testing parameter. Participants were instructed to collect their total coliform/*E. coli* bacteria samples from a faucet within the distribution system such as a kitchen or bathroom sink. They were also instructed to collect their nitrate and arsenic samples from the pressure tank tap or the closest faucet to the point of entry into the home.

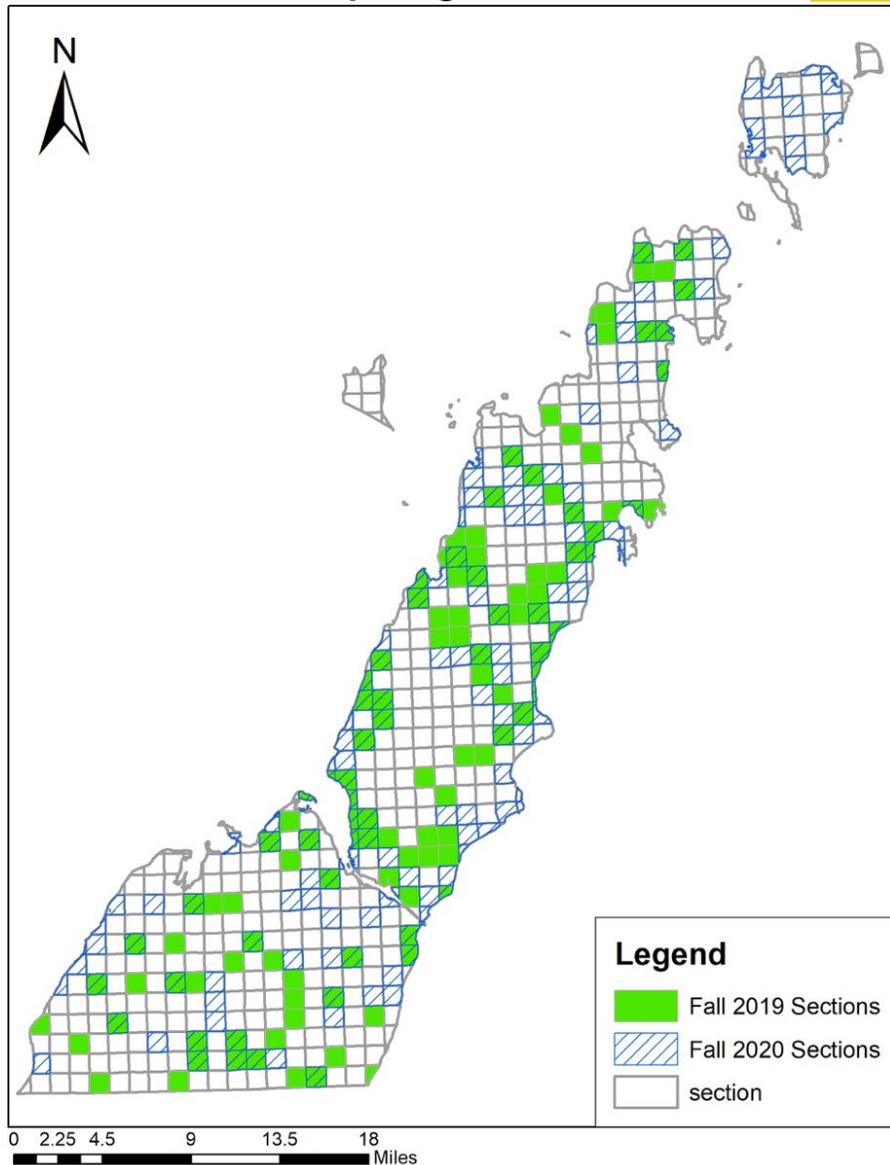


Figure 1. Spatial distribution of sections with participating wells for 2019 and 2020.

2.2. Study results

2.2.1. Total coliform results

13% of the wells tested in 2020 came back “unsafe” with a total coliform result of greater than 1 MPN/100mL vs 15% in 2019. Table 2 shows the total coliform results for both 2019 and 2020. Figure 2 shows the total coliform results from 2020 on a map and a 2019 result map can be found in Appendix 1.

Table 2. Comparison of 2019 vs 2020 total coliform results.

2019			2020		
Coliform Result (MPN/100 mL)	# Samples	% Samples	Coliform Result (MPN/100 mL)	# Samples	% Samples
0	125	84	0	254	86
1-10	15	10	1-10	28	9
10-100	6	4	10-100	9	3
100+	2	1	100+	4	1
n=148			n=295		

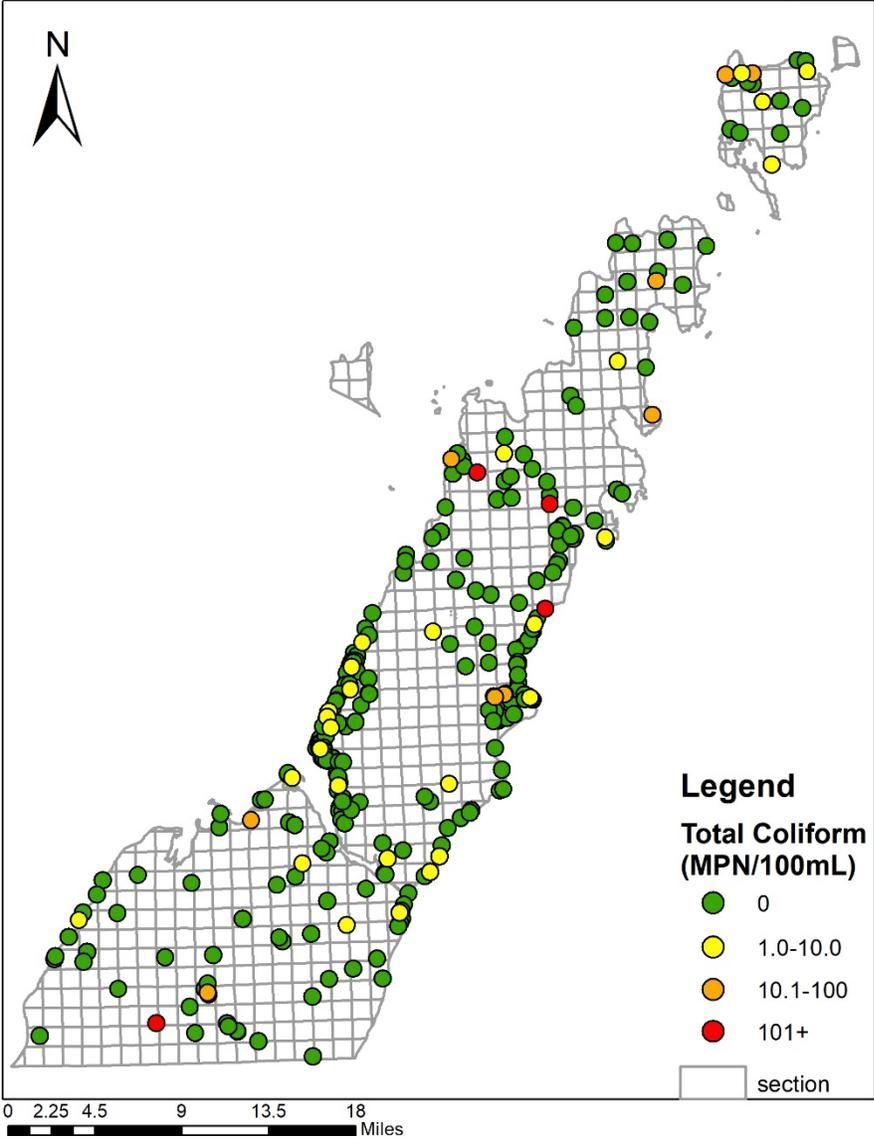


Figure 2. Total coliform results from 2020.

2.2.2. *E. coli* results

1% of wells tested in 2020 came back “unsafe” with an *E. coli* result of greater than 1 MPN/100mL vs 0% in 2019. Table 3 shows the *E. coli* results for both 2019 and 2020. Figure 3 shows the *E. coli* results from 2020 on a map and a 2019 result map can be found in Appendix 1.

Table 3. Comparison of 2019 vs 2020 *E. coli* results.

2019			2020		
<i>E. coli</i> Result (MPN/100 mL)	# Samples	% Samples	<i>E. coli</i> Result (MPN/100 mL)	# Samples	% Samples
0	148	100	0	293	99
1-10	0	0	1-10	2	1
10-100	0	0	10-100	0	0
100+	0	0	100+	0	0
n=148			n=295		

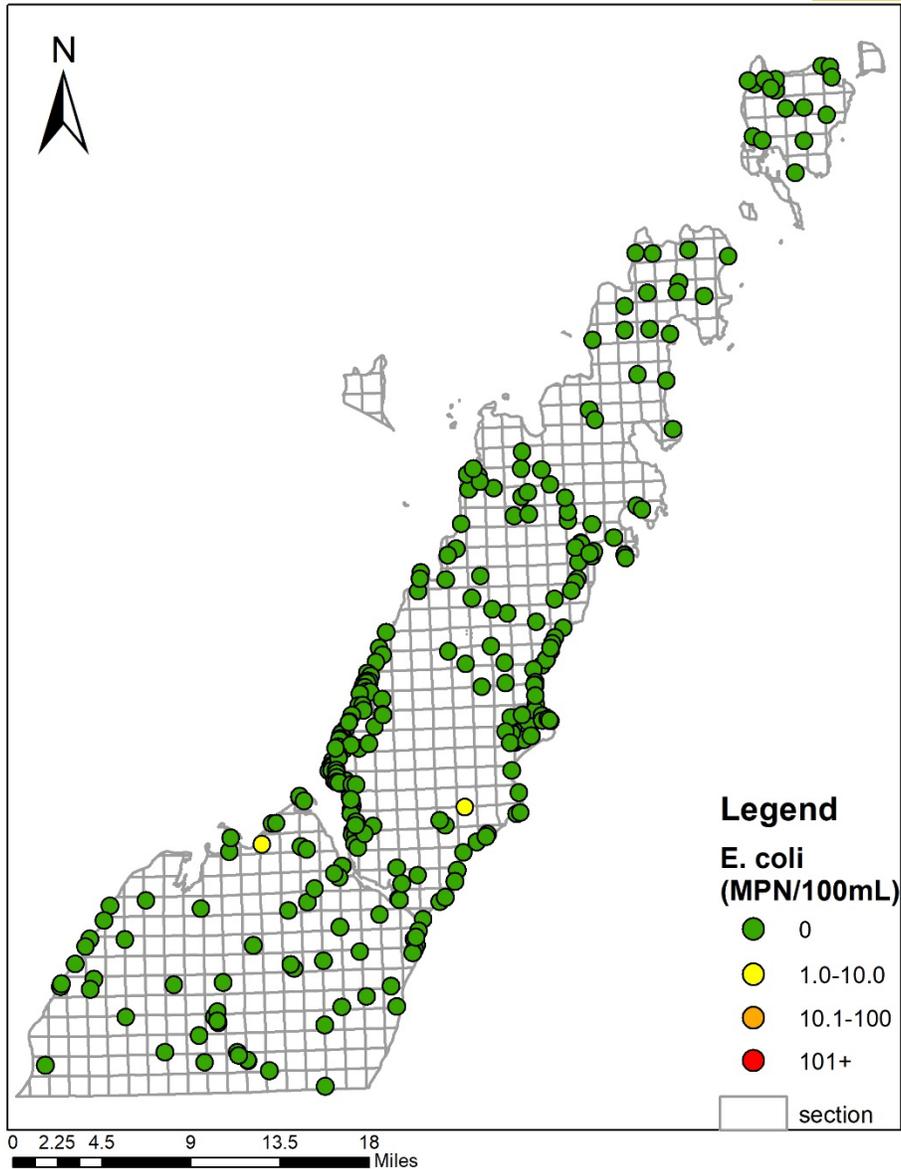


Figure 3. *E. coli* results from 2020.

2.2.3. Nitrate results

1% of the wells tested in 2020 came back “unsafe” with a nitrate result of greater than 10 mg/L vs 2% in 2019. Table 4 shows the nitrate results for both 2019 and 2020. Figure 4 shows the nitrate results from 2020 on a map and a 2019 result map can be found in Appendix 1.

Table 4. Comparison of 2019 vs 2020 nitrate results.

2019			2020		
Nitrate Result (mg/L)	# Samples	% Samples	Nitrate Result (mg/L)	# Samples	% Samples
Less than 2	104	71	Less than 2	206	72
2-5	23	16	2-5	46	16
5-10	16	11	5-10	34	12
10+	3	2	10+	2	1
n=146			n=288		

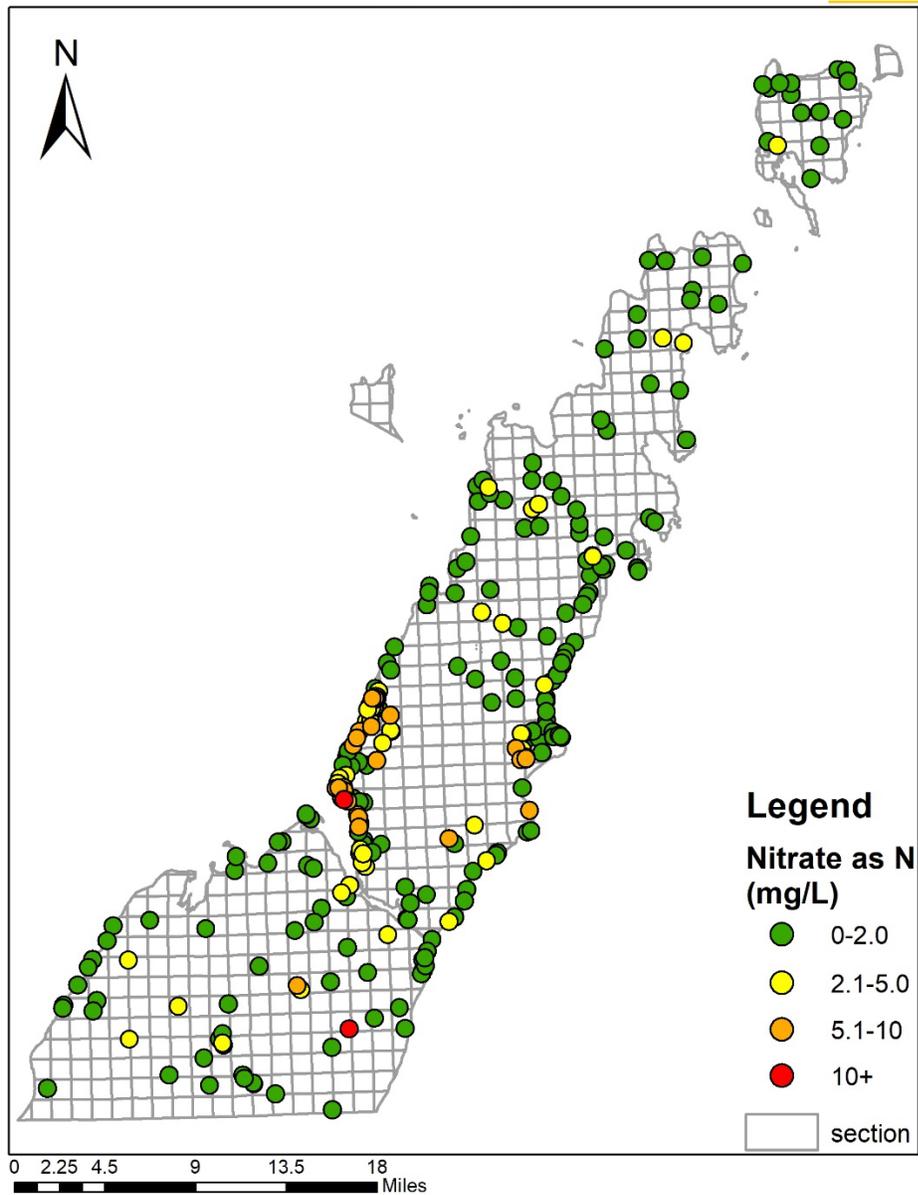


Figure 4. Nitrate results from 2020.

2.2.4. Arsenic results

<1% of the wells tested in 2020 came back “unsafe” with an arsenic result of greater than 10 µg/L vs 0% in 2019. Table 4 shows the arsenic results for both 2019 and 2020. Figure 5 shows the arsenic results from 2020 on a map and a 2019 result map can be found in Appendix 1.

Table 5. Comparison of 2019 vs 2020 arsenic results.

2019			2020		
Arsenic Result (µg/L)	# Samples	% Samples	Arsenic Result (µg/L)	# Samples	% Samples
Less than 2	70	99	Less than 2	214	90
2-5	1	1	2-5	15	6
5-10	0	0	5-10	7	3
10+	0	0	10+	1	<1
n=71			n=237		

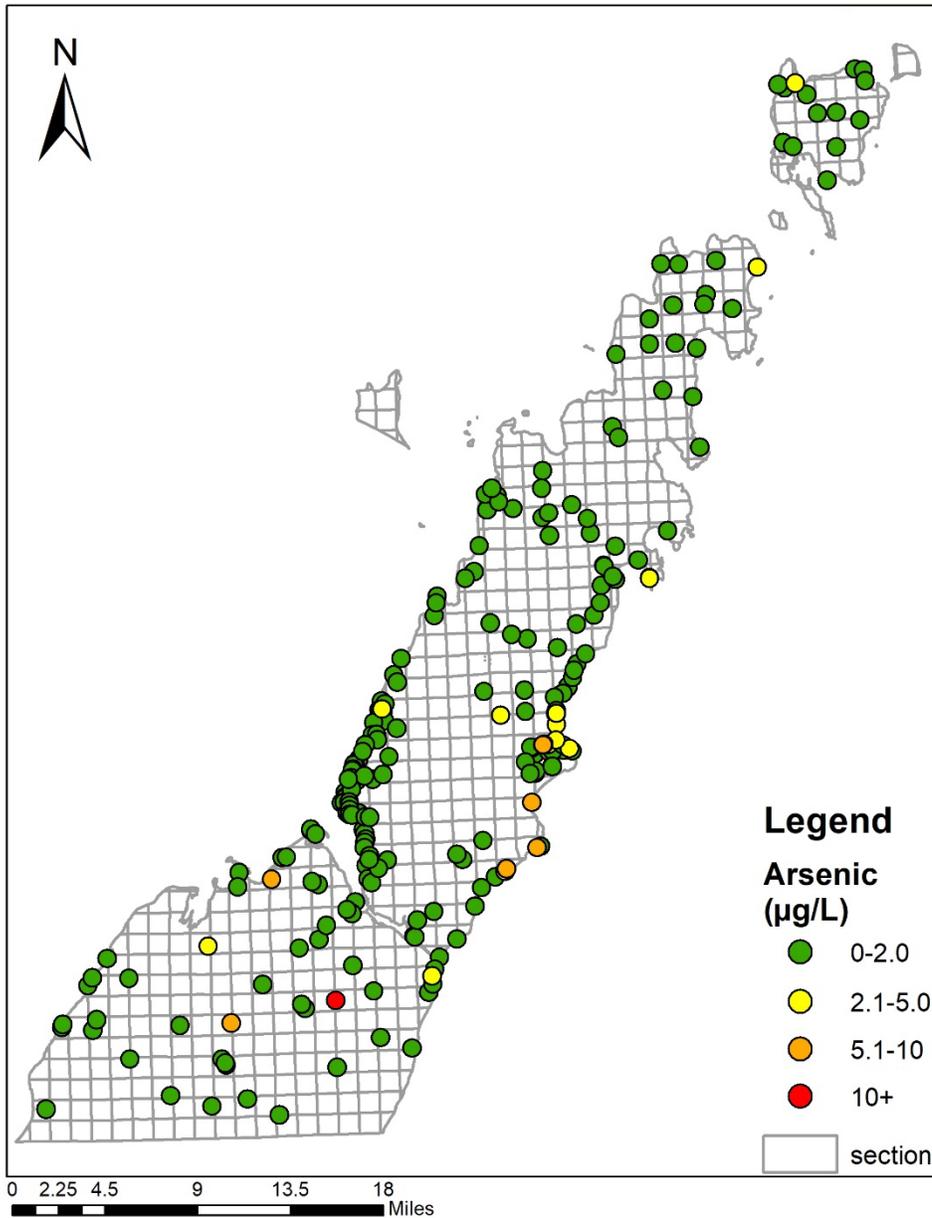


Figure 5. Arsenic results from 2020.

3. Recommendations

Karst geology makes Door County groundwater highly vulnerable to contamination. It is recommended for well owners to test their well annually for bacteria and nitrate, or more often if changes in their water (color, taste, turbidity, etc.) or other problems are observed.

Results from fall 2019 and 2020 are consistent with previous sampling efforts in Door County and statewide as seen in Table 6. Elevated levels of nitrate and arsenic appear to be concentrated in certain areas (Figures 4 & 5). Further research is recommended to

determine whether these higher concentrations are correlated. Collecting data such as well construction, well properties (for example, casing depth) and whether the home has water treatment devices installed would be useful for future studies.

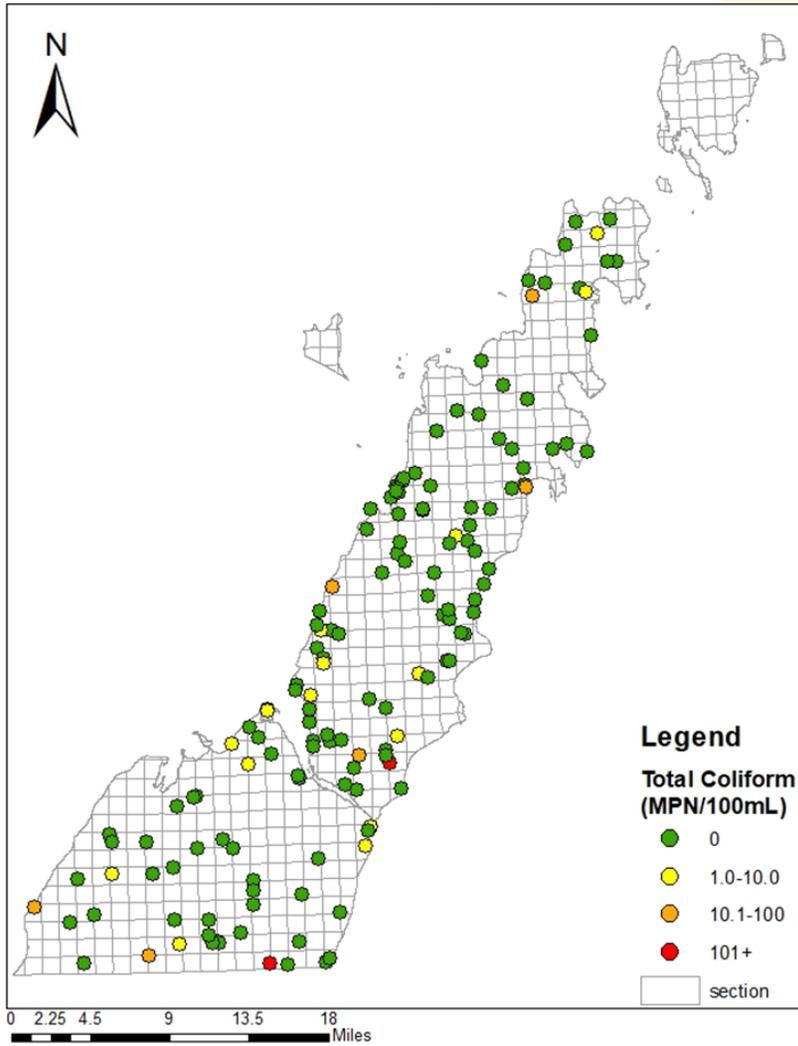
Table 6. Comparison of previous Door County and statewide sampling efforts.

Water Quality Standard	2020 Door County Results	2019 Door County Results	Previous Door County Results (Average)	Wisconsin**
Total Coliform (> 0 MPN/100 ml)	14%	16%	18%	17%
<i>E. coli</i> (> 0 MPN/100 ml)	1%	0%	6%	5%
Nitrate (> 10 mg/L)	1%	2%	2%	8%
Arsenic (> 10 µg/L)	<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				

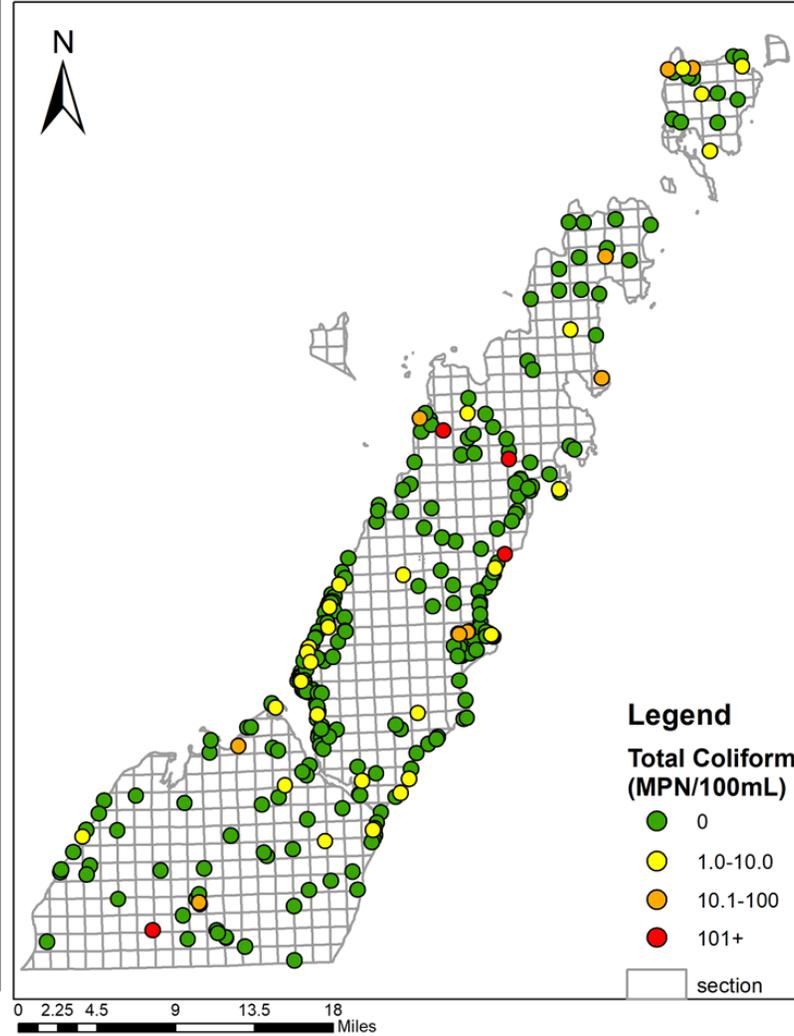
Repeated sampling in 2021 in spring will help identify seasonal changes in groundwater quality. The addition of other water quality parameters such as microplastics or PFAs can further help determine the anthropogenic impact on the groundwater in Door County.

4. Appendix 1 – 2019 vs 2020 Results Maps

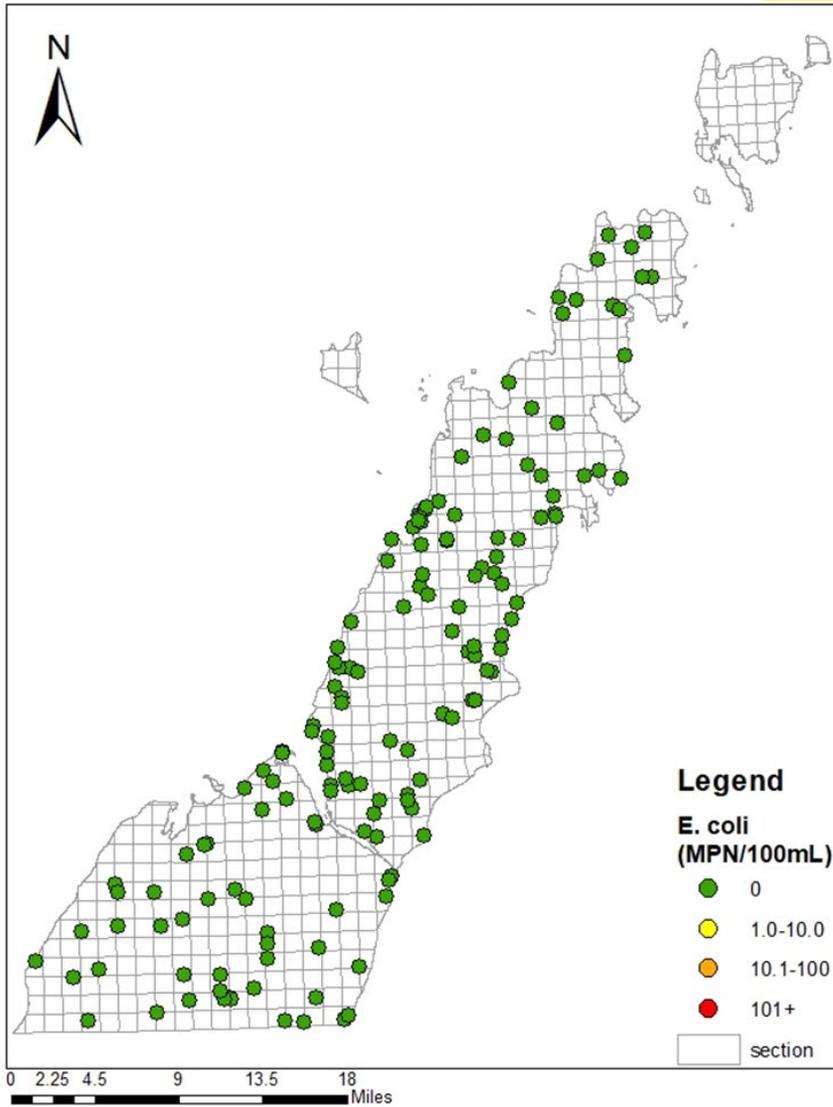
Door County Total Coliform Results:
Fall 2019



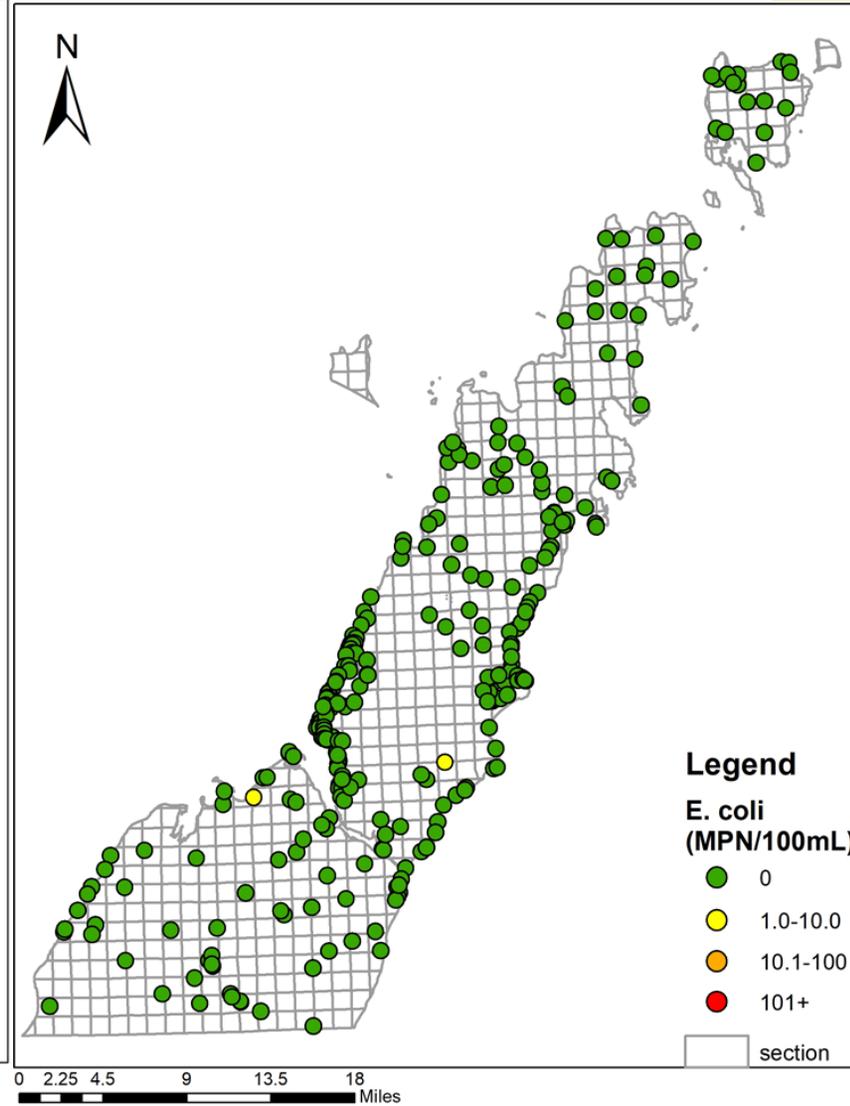
Door County Total Coliform Results:
Fall 2020



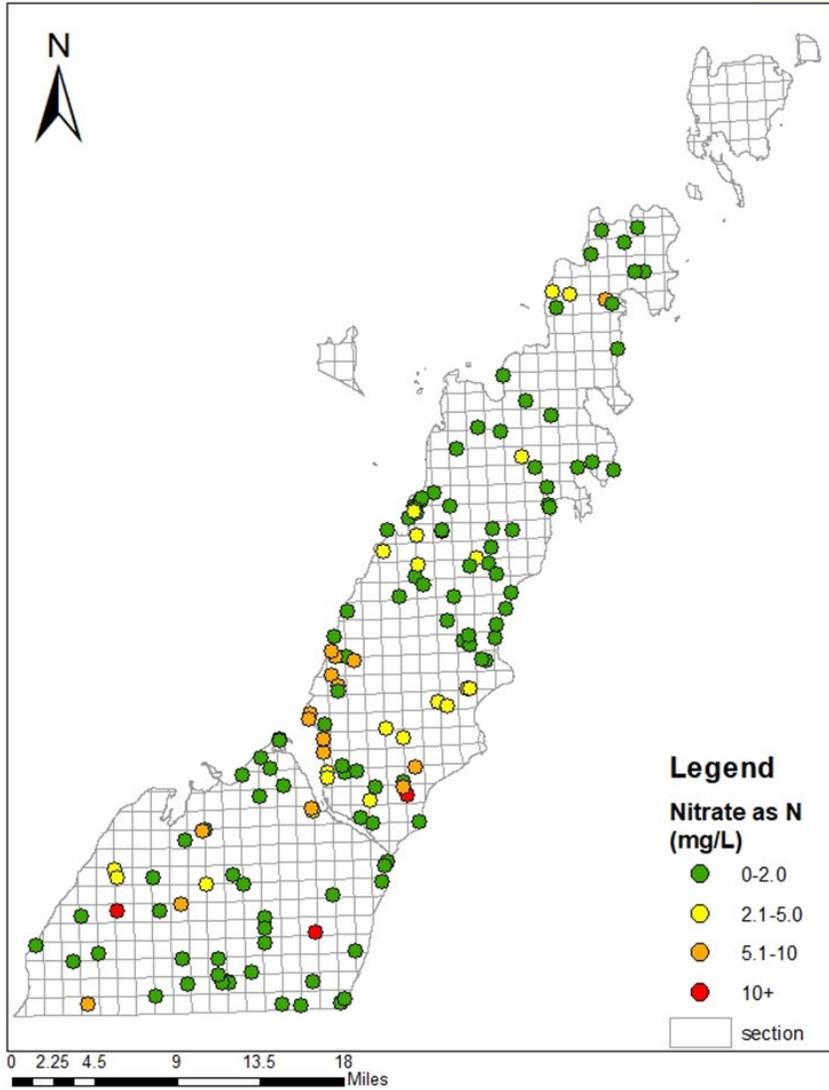
Door County E. coli Results: Fall 2019



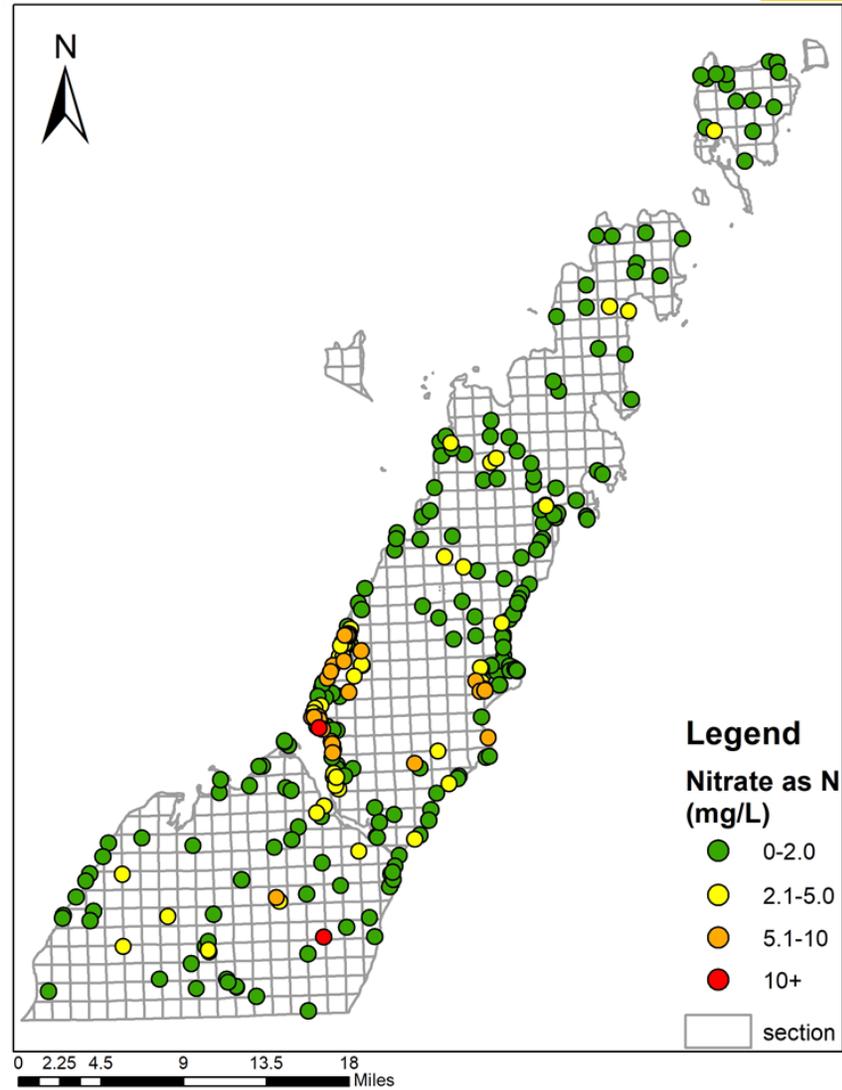
Door County E. coli Results: Fall 2020



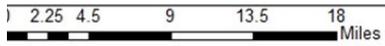
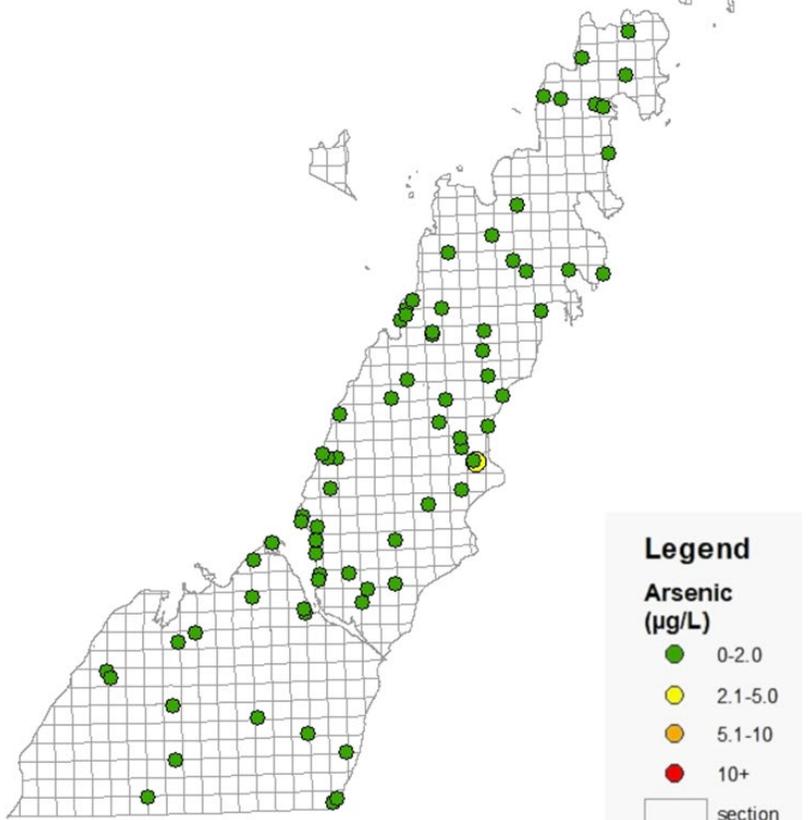
Door County Nitrate Results: Fall 2019



Door County Nitrate Results: Fall 2020



Door County Arsenic Results: Fall 2019



Door County Arsenic Results: Fall 2020

