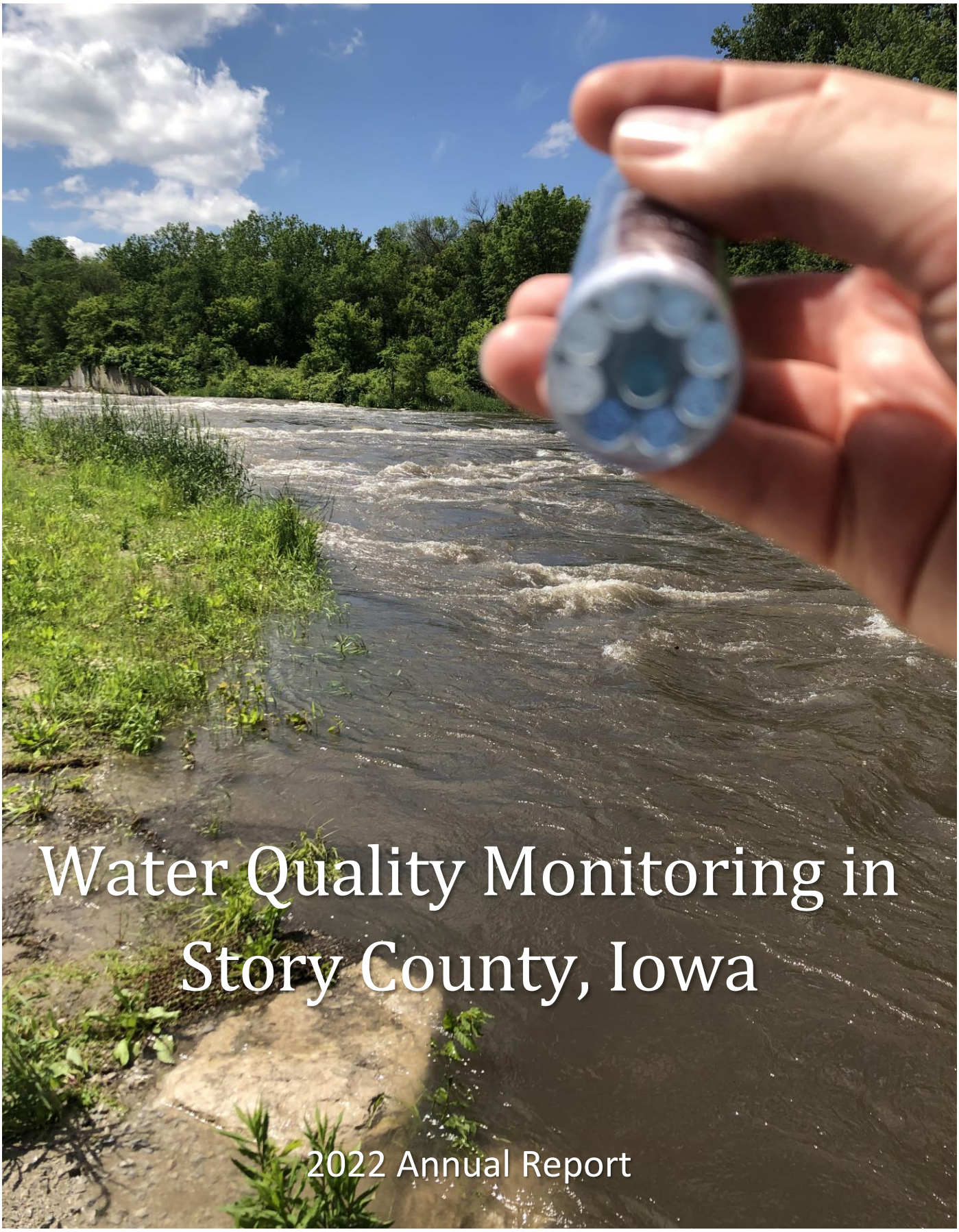

Water Quality Monitoring in Story County, Iowa

2022 Annual Report

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Acknowledgements

Author

Dan Haug, Prairie Rivers of Iowa

Photos by Prairie Rivers of Iowa unless otherwise acknowledged

Funding

Major funding to support water monitoring in 2022 was provided by:

Story County Conservation

City of Ames

Additional funding was provided by:

City of Nevada

Story County Soil & Water Conservation District

Outdoor Alliance of Story County

Water monitoring in the field

Volunteers: Dan Barr, Melissa Bauman, Ryan Benjegerdes, Eric Blakley, Mary Brunet, Jaime Chambers, Robin De Penning, Jody De Penning, Janet Dixon, Rick Dietz, Connor Drake, Taylor Drake, Jean Eichmeier, Ron Eichmeier, Ed Engle, Susan Fritzell, Kurt Gruber, Tom Gust, Bob Hartzler, Mark Hayes, Dan Jaynes, Margaret Jaynes, Mark Johnson, Tom Johnson, Steve Jungst, Angie Kolz, Kathy Solko-Manternach, Steve Manternach, Kimberly Olson, Erica Place, Kurt Plagge, Ben Rearick, Mike Schmidt, Gary Seite, Susan Siev, Ron Smith, Michelle Ward, Dale Watson, Barbara Wheelock

Staff of partner organizations: Liz Calhoun, Sara Carmichael, Jordan Cook, Mike Cox, Russ DeWall, Dan Haug, Nathan Hovick, Jeremy Johannsen, Taylor Jorgensen, Jerry Keys, Joe Kooiker, Pat Shehan, Ryan Wiemold

Support with laboratory analysis, training, and data management

City of Ames Laboratory Services Division: Derek Crawford, Andrew Curtis, Christy McCloud, Maryann Ryan

Izaak Walton League of America: Samantha Briggs, Susan Heathcote, Heather Wilson

Iowa State University: Jake Petrich, Dorian Twedt Gutierrez, Mark Rasmussen (retired)

Leadership

The following people participated in regular meetings in 2022 to provide direction and resources for local monitoring efforts, following a 10-year plan the group developed in 2020:

City of Ames: Tracy Peterson, Liz Calhoun, Neil Weiss, Maryann Ryan, Dustin Albrecht, Ashley Geesman

Story County: Mike Cox, Sara Carmichael, Kimberly Grandinetti

City of Nevada: Jordan Cook, Jeremy Rydl

City of Gilbert: Sonia Arellano Sundberg

Izaak Walton League: Heather Wilson (IWLA), Paul Readhead (Ames Chapter)

Prairie Rivers of Iowa: Penny Brown Huber, Dan Haug

The 10-year plan can be found at www.prrcd.org/story-county-water-monitoring or www.storycountyiowa.gov/1536/Water-Quality-Monitoring

Contact us

We appreciate the engagement of the public in this important work. Please contact Dan Haug at dhaug@prrcd.org
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East Indian Creek at County S27.

Highlights from the 2022 monitoring season

This report shares findings from the third year of a locally-led effort to monitor water quality in streams and lakes across Story County, Iowa.

The size of the volunteer program more than doubled in 2022.

- Story County Conservation provided 40 volunteers and staff with kits to monitor 54 lakes and streams. Over 800 data sheets were entered into the Izaak Walton League's *Clean Water Hub*.

A coordinated volunteer event in May gave us a snapshot of water quality at over 150 sites in central Iowa.

- Streams in Story County tended to have higher nitrate, but lower chloride and phosphate than streams in neighboring Polk County.

Volunteers observed high nitrate at many sites this year and identified some streams with poor water quality that need further attention.

- Nitrate was as high as 20 mg/L at 74% of sites tested this year.
- West Indian Creek in Nevada has poor water quality by several metrics—including biological monitoring, dissolved oxygen and phosphate.
- Chloride and phosphate are especially high during drought at sites downstream of wastewater treatment plants.

With laboratory support from the City of Ames, we now have three years of monthly data at 15 streams. By combining multiple years of data, we can look separately at wet and dry periods and narrow down likely pollution sources and effective conservation strategies.

- Ten out of eleven streams with enough data to evaluate in 2022 exceeded the primary contact recreation standard for *E. coli* bacteria. *E. coli* is especially high in West Indian Creek when water level are normal, and in College Creek across all conditions.
- Nitrate tends to be highest in the Headwaters of the South Skunk River watershed, when water levels are normal and drainage tiles are flowing.

We have over 14 years of baseline data at several sites on the South Skunk River. By comparing recent data to the baseline, and making sure we're comparing similar weather conditions, we can begin to see some encouraging trends.

- When water levels are normal, nitrate was lower in 2020-2022 than during the baseline period at one of the sites. This could be related to conservation efforts in the Ioway Creek watershed.
- When water levels are low, E. coli was lower in 2020-2022 than the during baseline period at one of the sites. This could be related to improvements to wastewater treatment systems in Ames and Gilbert.

Monitoring Sites and Activity in 2022

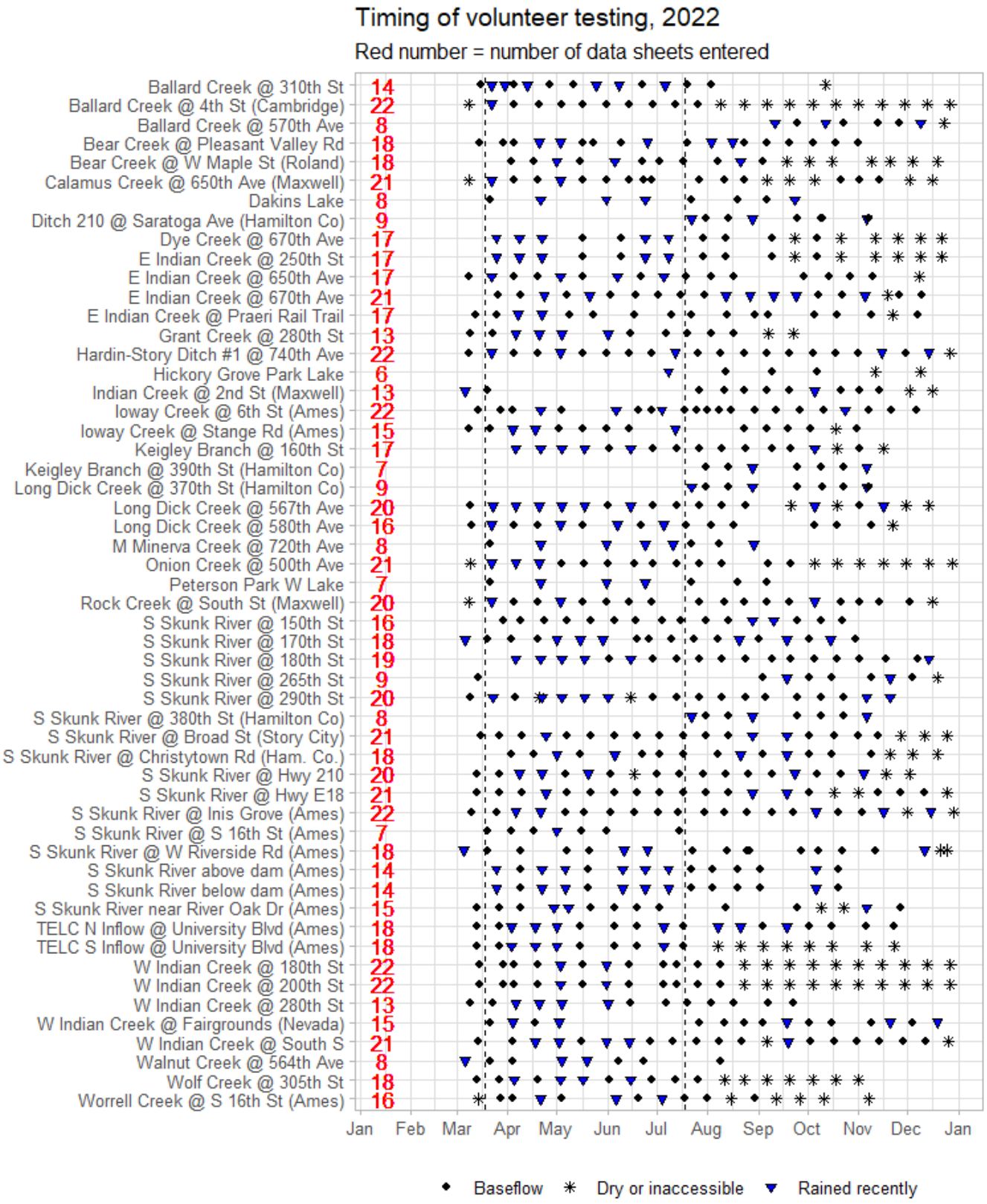
Bold text indicates activity by partners in the Story County Water Monitoring 10-year Plan.

Water quality testing in the field by volunteers

Story County Conservation continued to equip staff and volunteers with kits to regularly monitor streams around the county. The program has grown in both number of participants and number of sites since 2021, and volunteers are monitoring more often. Results from 54 sites are included in this report—one duplicate site was consolidated and another site that was discontinued early in the season was dropped.

2022 Season	2021 Season
40	17
Volunteers participating	Volunteers participating
56	38
Sites tested at least once	Sites tested at least once
43	17
Sites tested at least 10 times	Sites tested at least 10 times
16	0
Sites tested at least 20 times	Sites tested at least 20 times
855	305
Data sheets entered in the Clean Water Hub	Data sheets entered in the Clean Water Hub

Story County Conservation recommended that sites be monitored on the first and third week of each month, and this year more volunteers were able to monitor their assigned site on this schedule. The graph on the following page shows when each site was monitored, and the weather conditions in the South Skunk River during monitoring. There was a wetter period from late March to mid-July, but many streams dried up in the summer and fall, as Story County entered a drought.


Timing of volunteer testing, 2022
Red number = number of data sheets entered
Ballard Creek @ 310th St 14
Ballard Creek @ 4th St (Cambridge) 22
Ballard Creek @ 570th Ave 8
Bear Creek @ Pleasant Valley Rd 18
Bear Creek @ W Maple St (Roland) 18
Calamus Creek @ 650th Ave (Maxwell) 21
Dakins Lake 8
Ditch 210 @ Saratoga Ave (Hamilton Co) 9
Dye Creek @ 670th Ave 17
E Indian Creek @ 250th St 17
E Indian Creek @ 650th Ave 17
E Indian Creek @ 670th Ave 21
E Indian Creek @ Praeri Rail Trail 17
Grant Creek @ 280th St 13
Hardin-Story Ditch #1 @ 740th Ave 22
Hickory Grove Park Lake 6
Indian Creek @ 2nd St (Maxwell) 13
Ioway Creek @ 6th St (Ames) 22
Ioway Creek @ Stange Rd (Ames) 15
Keigley Branch @ 160th St 17
Keigley Branch @ 390th St (Hamilton Co) 7
Long Dick Creek @ 370th St (Hamilton Co) 9
Long Dick Creek @ 567th Ave 20
Long Dick Creek @ 580th Ave 16
M Minerva Creek @ 720th Ave 8
Onion Creek @ 500th Ave 21
Peterson Park W Lake 7
Rock Creek @ South St (Maxwell) 20
S Skunk River @ 150th St 16
S Skunk River @ 170th St 18
S Skunk River @ 180th St 19
S Skunk River @ 265th St 9
S Skunk River @ 290th St 20
S Skunk River @ 380th St (Hamilton Co) 8
S Skunk River @ Broad St (Story City) 21
S Skunk River @ Christytown Rd (Ham. Co.) 18
S Skunk River @ Hwy 210 20
S Skunk River @ Hwy E18 21
S Skunk River @ Inis Grove (Ames) 22
S Skunk River @ S 16th St (Ames) 7
S Skunk River @ W Riverside Rd (Ames) 18
S Skunk River above dam (Ames) 14
S Skunk River below dam (Ames) 14
S Skunk River near River Oak Dr (Ames) 15
TELC N Inflow @ University Blvd (Ames) 18
TELC S Inflow @ University Blvd (Ames) 18
W Indian Creek @ 180th St 22
W Indian Creek @ 200th St 22
W Indian Creek @ 280th St 13
W Indian Creek @ Fairgrounds (Nevada) 15
W Indian Creek @ South S 21
Walnut Creek @ 564th Ave 8
Wolf Creek @ 305th St 18
Worrell Creek @ S 16th St (Ames) 16
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Baseflow
Dry or inaccessible
Rained recently

Staff and volunteers follow the protocols of the **Izaak Walton League of America's** Save Our Streams program[1] and enter data in the IWLA's online platform for volunteer monitoring—the Clean Water Hub[2]. Nitrate, pH, and chloride are measured with Hach test strips; orthophosphate and dissolved oxygen with Chemetrics ampoules; water clarity is measured with a transparency tube; and water temperature is measured with a thermometer. Lakes were tested with the same approach, substituting a secchi disk for the transparency tube.

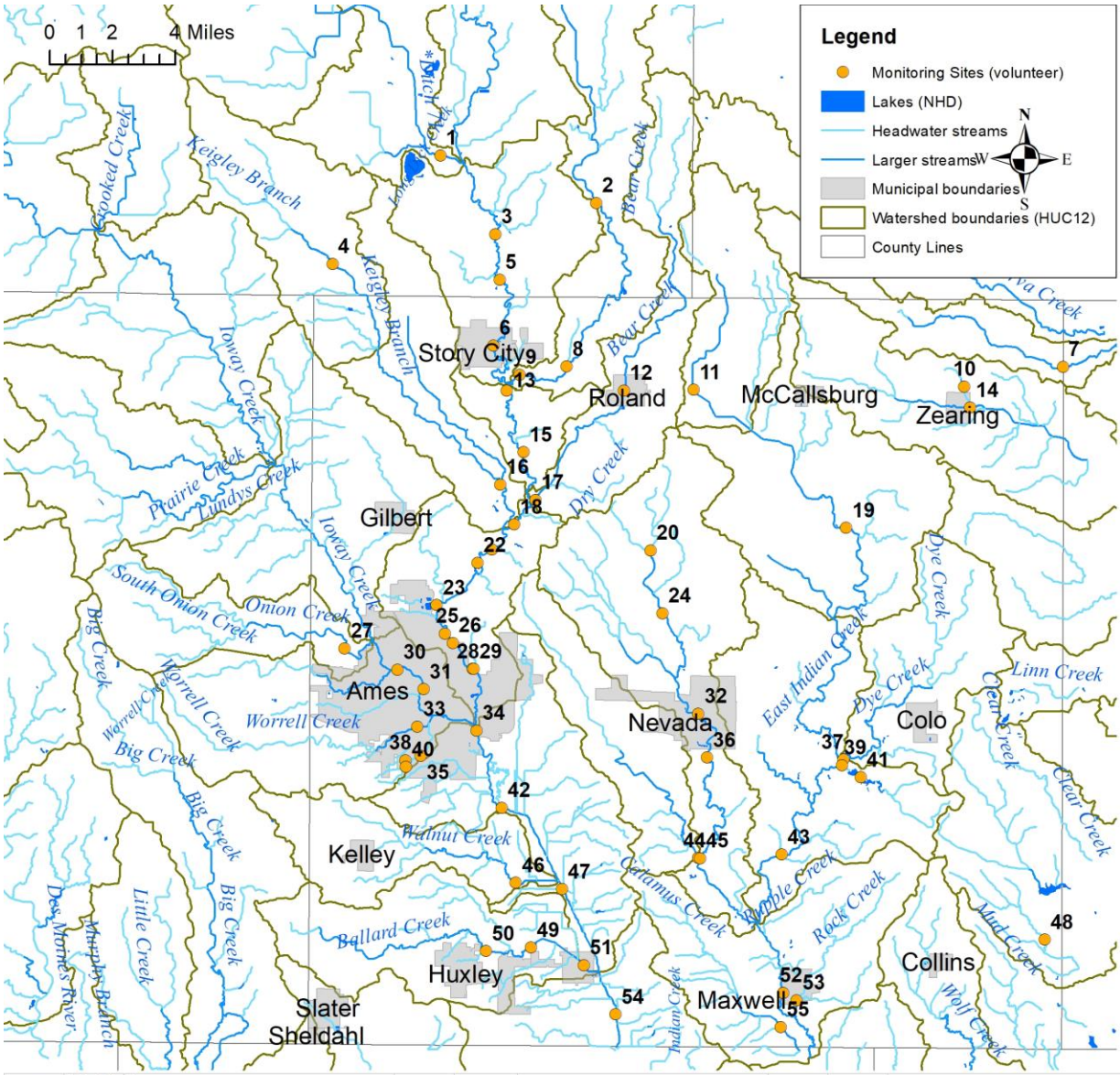
The main goal of the volunteer program is to educate and engage the public. The data will be useful for its wide geographic coverage, establishing a baseline for streams and lakes not previously monitored.

An example of a kit for monitoring water chemistry. Nitrate, pH, and chloride are measured with Hach test strips, orthophosphate and dissolved oxygen with Chemetrics ampoules, water clarity is measured with a transparency tube, and water temperature is measured with a thermometer.

[1] The Save Our Streams Volunteer Water Quality Monitor Manual can be found at: https://www.iwla.org/water/resources-for-monitors

[2] All sites monitored by Story County Conservation can be accessed on the Clean Water Hub at: https://www.cleanwaterhub.org/organization/39

This map shows sites actively monitored by volunteers in 2022. Site names have been edited for length and consistency, so site identification numbers used in the Clean Water Hub are included for reference.



on map	ID in Hub	Site name						
1	12583	Ditch 210 @ Saratoga Ave (Hamilton Co)	21	10971	S Skunk River @ 180th St	41	12535	Hickory Grove Park Lake
2	12584	Long Dick Creek @ 370th St (Hamilton Co)	22	10969	Peterson Park W Lake	42	11577	S Skunk River @ 265th St
3	12585	S Skunk River @ 380th St (Hamilton Co)	23	11515	S Skunk River @ W Riverside Rd (Ames)	43	10940	E Indian Creek @ 650th Ave
4	12586	Keigley Branch @ 390th St (Hamilton Co)	24	10972	W Indian Creek @ 200th St	44	10195	Grant Creek @ 280th St
5	12181	S Skunk River @ Christytown Rd (Ham. Co.)	25	11584	S Skunk River near River Oak Dr (Ames)	45	561	W Indian Creek @ 280th St
6	11578	S Skunk River @ Broad St (Story City)	26	12179	S Skunk River @ Inis Grove (Ames)	46	11575	Walnut Creek @ 564th Ave
7	12184	Hardin-Story Ditch #1 @ 740th Ave	27	10977	Onion Creek @ 500th Ave	47	11583	S Skunk River @ 290th St
8	10931	Long Dick Creek @ 580th Ave	28	11777	S Skunk River above dam (Ames)	48	12203	Wolf Creek @ 305th St
9	12183	Long Dick Creek @ 567th Ave	29	11870	S Skunk River below dam (Ames)	49	11598	Ballard Creek @ 570th Ave
10	10968	Dakins Lake	30	12182	Ioway Creek @ Stange Rd (Ames)	50	11779	Ballard Creek @ 310th St
11	10744	E Indian Creek @ Praeri Rail Trail	31	11975	Ioway Creek @ 6th St (Ames)	51	10941	Ballard Creek @ 4th St (Cambridge)
12	10932	Bear Creek @ W Maple St (Roland)	32	10241	W Indian Creek @ Fairgrounds (Nevada)	52	10975	Indian Creek @ 2nd St (Maxwell)
13	10723	S Skunk River @ Hwy E18	33	11823	Worrell Creek @ S 16th St (Ames)	53	12025	Rock Creek @ South St (Maxwell)
14	10970	M Minerva Creek @ 720th Ave	34	10981	S Skunk River @ S 16th St (Ames)	54	12185	S Skunk River @ Hwy 210
15	10726	S Skunk River @ 150th St	35	11782	TELC Outflow @ S Riverside Rd (Ames)	55	12026	Calamus Creek @ 650th Ave (Maxwell)
16	10939	Keigley Branch @ 160th St	36	11573	W Indian Creek @ South S			
17	10937	Bear Creek @ Pleasant Valley Rd	37	10967	Dye Creek @ 670th Ave			
18	10980	S Skunk River @ 170th St	38	11780	TELC N Inflow @ University Blvd (Ames)			
19	11581	E Indian Creek @ 670th Ave	39	10942	E Indian Creek @ 250th St			
20	12207	W Indian Creek @ 180th St	40	11781	TELC S Inflow @ University Blvd (Ames)			

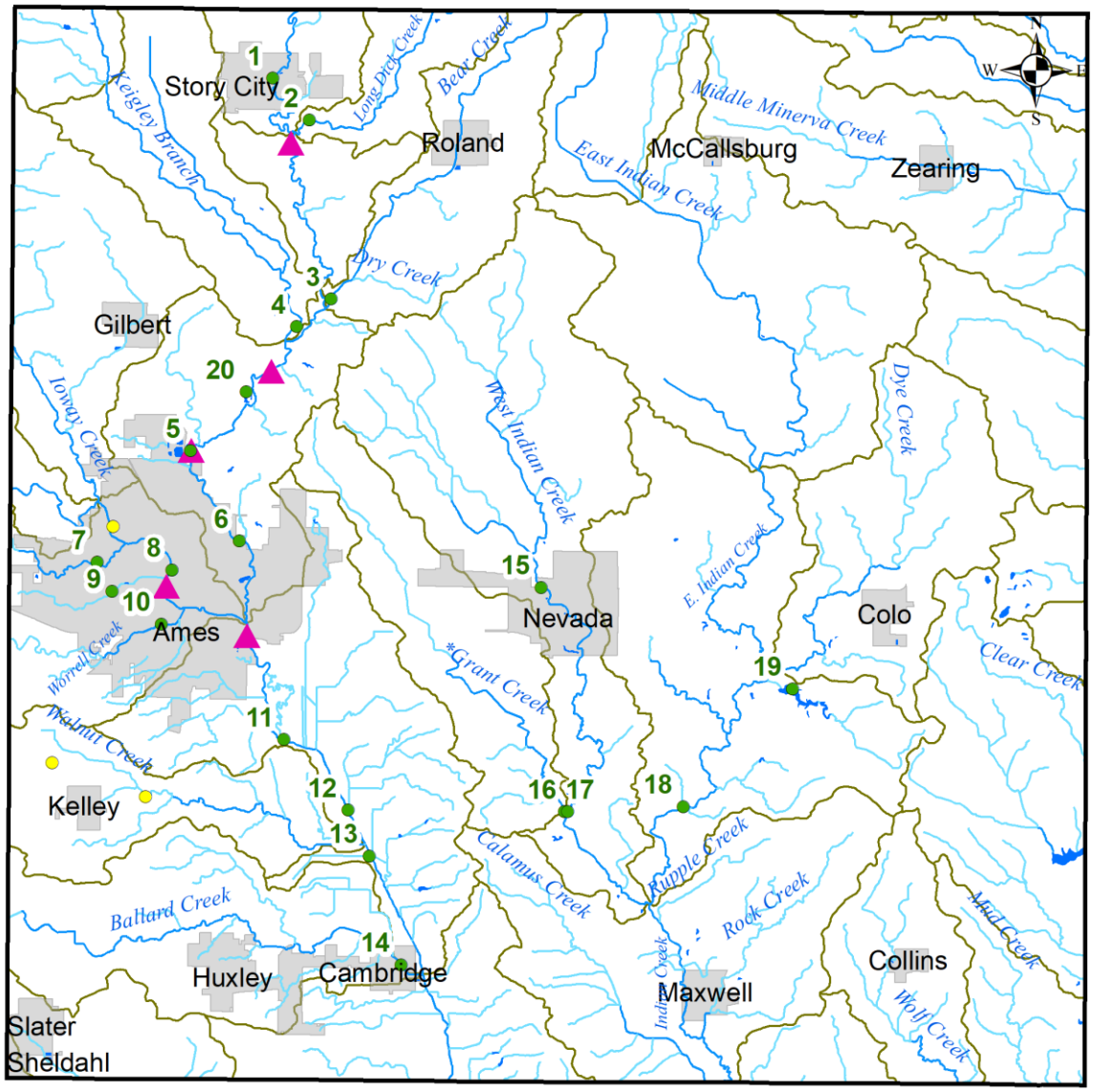
Having volunteers test multiple sites on the same day provides a "snapshot" of water quality across a broad area. The **Ioway Creek Watershed Coalition** has a tradition of May and October snapshots going back to 2006. Since the loss of state support for volunteer monitoring, **Prairie Rivers of Iowa** has been organizing these events.

- **May 17, 2022**: Fourteen volunteers tested 28 sites in the Ioway Creek watershed (Hamilton, Boone, and Story counties) and several others tested their regular sites in other watersheds in Story County on the same day, for a total of 42 sites. This year, the spring snapshot was held on the same day as the Polk County snapshot, to enable comparisons across a wider area. Story County Conservation and **Outdoor Alliance of Story Count**y assisted with supplies.
- In October, smaller creeks dried up, so we made the decision to cancel the fall snapshot. Switching gears, twelve volunteers helped experts with Daguna Consulting to find and relocate fifty-three mussels in Ioway Creek. Since two threatened species had been found, the City of Ames was asked to relocate the mussels prior to work on stream restoration project.

A cylindrical papershell mussel in Ioway Creek, on the state list of threatened species.

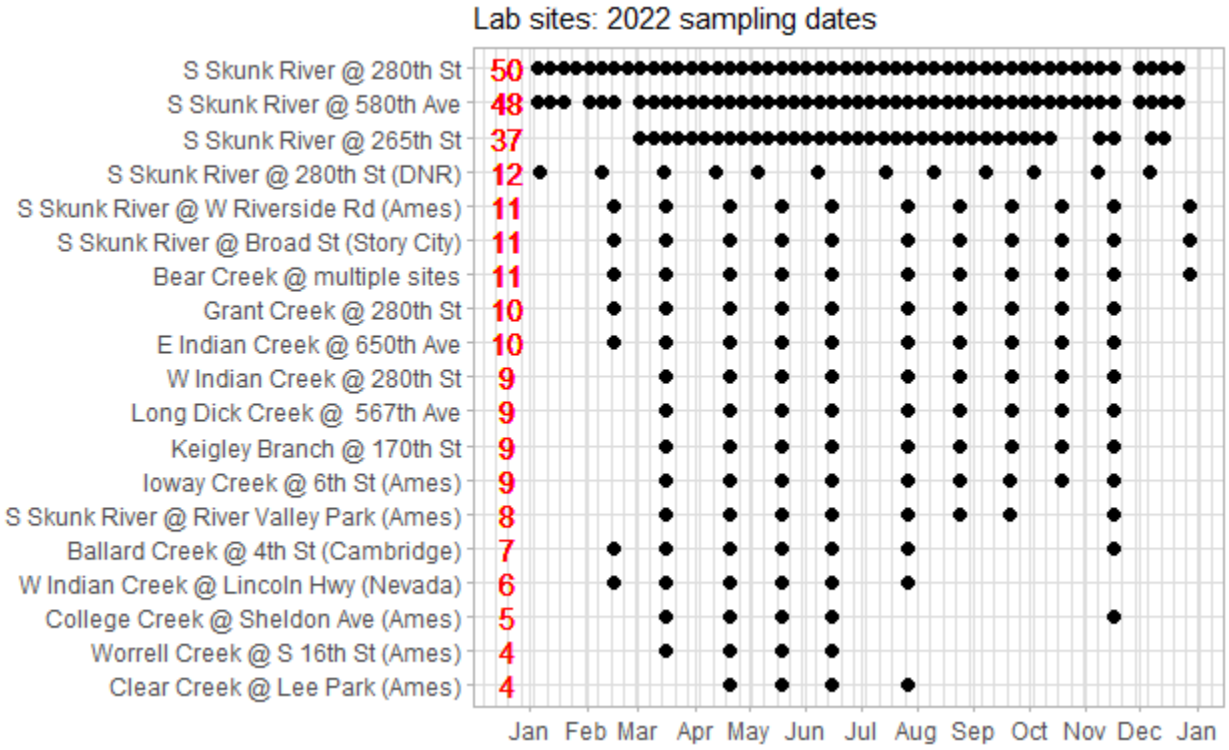
Laboratory testing of water samples

This map shows surface water sites regularly sampled in 2022 and analyzed by a certified lab.



1	S Skunk River @ Broad St (Story City)	11	S Skunk River @ 265th St
2	Long Dick Creek @ 567th St	12	S Skunk River @ 280th St
3	Bear Creek @ Pleasant Valley Rd	13	S Skunk River @ 580th Ave
4	Keigley Branch @ 170th St	14	Ballard Creek @ 4th St (Cambridge)
5	S Skunk River @ W Riverside Rd (Ames)	15	W Indian Creek @ Lincoln Hwy (Nevada)
6	S Skunk River @ N River Valley Park (Ames)	16	W Indian Creek @ 280th St
7	Clear Creek @ Lee Park (Ames)	17	Grant Creek @ 280th St
8	Ioway Creek @ 6th St (Ames)	18	E Indian Creek @ 650th Ave
9	College Creek @ Sheldon Ave (Ames)	19	Hickory Grove Lake (swimming beach)
10	Worrell Creek @ S 16th St (Ames)	20	Peterson Park West Lake (swimming beach)

As shown by the chart below, some sites were tested monthly and others weekly. The red number on the left is the number of samples. Reasons for missing samples include dry or stagnant conditions in smaller streams during the drought and thick ice cover during the winter. Bear Creek was tested near its mouth at Pleasant Valley Road, except on June 15, when flooding prevented access and we had to test upstream in Roland.



As part of the Ambient Stream Monitoring Network, the Iowa Department of Natural Resources (DNR) continued monthly testing of the South Skunk River near Cambridge and Indian Creek near Colfax. They are monitored monthly for 70 different parameters, including nutrients, *E. coli* bacteria, and pesticides. *Because of the variety of chemicals tested and the length of the record (going back to October of 1998), this data is especially useful for understanding which pollutants are a concern, seasonal patterns and trends, and for comparison to other sites across the state.* In this report, these sites are labelled as:

- "S. Skunk River @ 280th St (DNR)". Site #10850002 in AQuIA. This site is just downstream of the outfall for the Ames Water Pollution Control Facility.
- "Indian Creek near Colfax". Site #10500001 in AquIA. Since we do not have a site on Indian Creek after the branches converge, we included this downstream site for reference. It is located on N 51st Ave W in Jasper County.

The City of Ames Water & Pollution Control (W&PC) Department operates a certified laboratory and does weekly testing of the same site monitored by Iowa DNR (at 280th St) as well as another site upstream (265th St) and further downstream (580th Ave) from the Water Pollution Control Facility (WPCF). This is a rich dataset going back to 2003, and has continued in 2021. Samples are tested for nitrate, total phosphorus, suspended solids, and several other parameters, but not *E. coli*. *Because of the volume of data (weekly, going to back to January 2003) it is especially useful for understanding trends.*

- South Skunk River @ 265th St (0.3 miles above WPCF)
- South Skunk River @ 280th St (0.3 miles below WPCF)
- South Skunk River @ 580th St (1.3 miles below WPCF)

The South Skunk River at 265th St, one of three sites tested weekly by the City of Ames.

To this, local partners have added 15 other stream sites. The Ames W&PC Department provided laboratory services to test these sites for nitrate, total phosphorus, suspended solids, and *E. coli* bacteria. **Prairie Rivers of Iowa** collected year-round monthly water samples from 10 rural streams and Ames WPC collected samples from another 5 sites within Ames.

Since samples are collected on the same day, this dataset is especially useful for making geographic comparisons that can help to prioritize conservation projects. Data from the South Skunk River at Sleepy Hollow Canoe Access (W Riverside Rd, north of Ames) will also be useful for evaluating trends, since this site was monitored by Iowa DNR from October 1999 to September 2014.

Story County Conservation continued to partner with Iowa DNR this year to test *E. coli* bacteria at two swimming beaches (West Peterson Park Lake and Hickory Grove Lake), on a weekly basis between Memorial Day and Labor Day. *This data is useful for informing swimmers of health hazards, or reassuring them if risk is minimal.*[3]

Hickory Grove Lake is also sampled at its deepest point as part of the Ambient Lakes Monitoring program, a partnership between the Iowa DNR and the Iowa State University Limnology Laboratory. Each lake is sampled three times between May and September: once in early summer, once in mid-summer, and once in late summer/early fall. *This data is used to assess the ecological health of lakes.*

[3] During the summer, the most recent advisories and monitoring data for swimming beaches are posted here. https://www.iowadnr.gov/things-to-do/beach-monitoring

Biological monitoring

Biological monitoring of streams usually involves capturing aquatic invertebrates with nets, sorting them into groups, and calculating a biological index based on the number of groups present and whether they are more or less sensitive to pollution.

Families at the Community Academy event pictured here caught invertebrates in Ioway Creek and learned about aquatic life and water monitoring but did not record data

The Izaak Walton League's Save Our Streams program involves identification of insects into broad groupings generally corresponding to taxonomic order. To submit biological data, at least one volunteer in the group must have completed a training a certification process. In 2022, volunteers surveyed benthic macroinvertebrates at one site using Save Our Streams protocols:

- W Indian Creek @ Fairgrounds (Nevada), Sept 19

The Iowa Department of Natural Resources uses a more rigorous invertebrate survey, typically narrowing down insects to the genus level. DNR also surveys fish in shallow streams using electroshocking to stun and net them. Fish are identified to the species level.

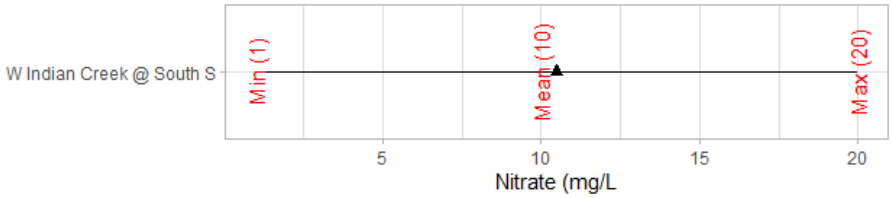
- South Skunk River near Soper's Mill Canoe Access, September 19. Fish and invertebrates.
- West Indian Creek at Jennett Heritage Area, August 12. Fish and invertebrates.
- Wolf Creek near Collins, August 1. Fish only.

Biological surveys complement water quality monitoring. If sensitive species are absent or diversity is low where suitable habitat exists, this is an indication of a problem with water quality.

Mayflies (left) are pollution sensitive. Damselflies (right) are somewhat pollution tolerant.

Results: Volunteer Testing of Water Chemistry, 2022

The goal of this section is to be able to see on single page how water quality varies between sites around the county. The graphs show both an average (either the median or the mean) and the range of values measured.



To help interpret the readings, we have reproduced the explanations for each parameter and the good/fair/poor categorization scheme that appear on the Izaak Walton League's Clean Water Hub.

WATER QUALITY SUMMATION for Chemical Tests				
	Excellent	**Good**	**Fair**	**Poor**
Dissolved Oxygen (% saturation)	80-120	70-79 121-140	50-69 >140	<50
pH (units)	7.0-7.5	6.5-6.9 7.6-8.5	5.5-6.4 8.6-9.0	<5.5 >9.0
Chloride (Cl) (mg/L)	0-20	21-50	51-250	>250
Reactive Phosphate (PO_4X^3) (mg/L)	0-0.2	0.3-0.5	0.6-2.0	>2.0
Nitrate (NO_3) (mg/L)	0-3	>3-5	>5-10	>10
Transparency (cm)	≥65.0	64.9-35.0	34.9-15.5	<15.5

The graphs include a red line to mark the threshold between "fair" and "poor", a yellow line to mark the threshold between "good" and "fair", and a green line to mark the threshold between "good" and "excellent." Our transparency tubes are 60 cm long and most chloride kits have a lower detection limit of 28-32 mg/L, so we used these reporting limits as the threshold for "excellent".

After presenting sites in alphabetical order to make it easy to look up a given site, we may include a second graph with sites ranked from highest to lowest, focusing in on a condition of interest for a given pollutant. Nitrate is usually transported in the spring and early summer when drainage tiles are flowing, sediment is highest after heavy rains, dissolved oxygen is lowest in the morning, etc. At this stage, we do not always have an explanation for why some sites have water quality in the "poor" range. This information is meant as a jumping off point for further conversation and investigation.

Mistakes happen—both in the field (i.e. a volunteer entering Quantab units instead of mg/L for chloride) and during data entry (i.e. a missed decimal place). Quality control steps include: removal multiple of duplicate or conflicting data sheets, deletion of readings outside the range of the equipment (i.e. 20 mg/L phosphate, 1.8 mg/L chloride), and replacement of zeros with N/A when no sample could be collected. It may take some time before these corrections

are reflected on the Clean Water Hub. There are fewer issues than last year and we continue to work with volunteers to improve accuracy and consistency.

Nitrate

What are Nitrates?
Nitrogen is an essential plant nutrient. It is usually present in waterways as Nitrate. Nitrate levels are measured as a concentration in milligrams per liter. Excess nitrate that enters waterways can cause pollution through a variety of different discharge methods, such as animal waste, sewage, fertilizer, and decomposing plants.

How do we measure Nitrates?
Using the standard Save Our Streams method, nitrate levels are measured using the Hach nitrate-N/nitrite-N test strips.

Why is Nitrate Important?
Nitrogen is an essential element in the cellular formation of bacteria, plants, and animals. However, excess levels of nitrates can lead to rapid population growth of bacteria and algae. These "blooms" can result in a decrease in dissolved oxygen levels and may excrete toxins harmful to life.

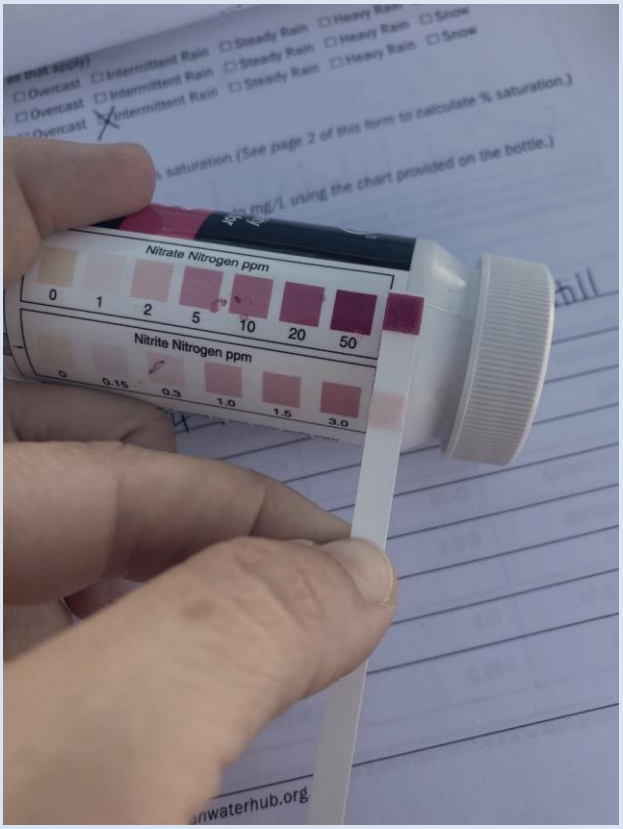
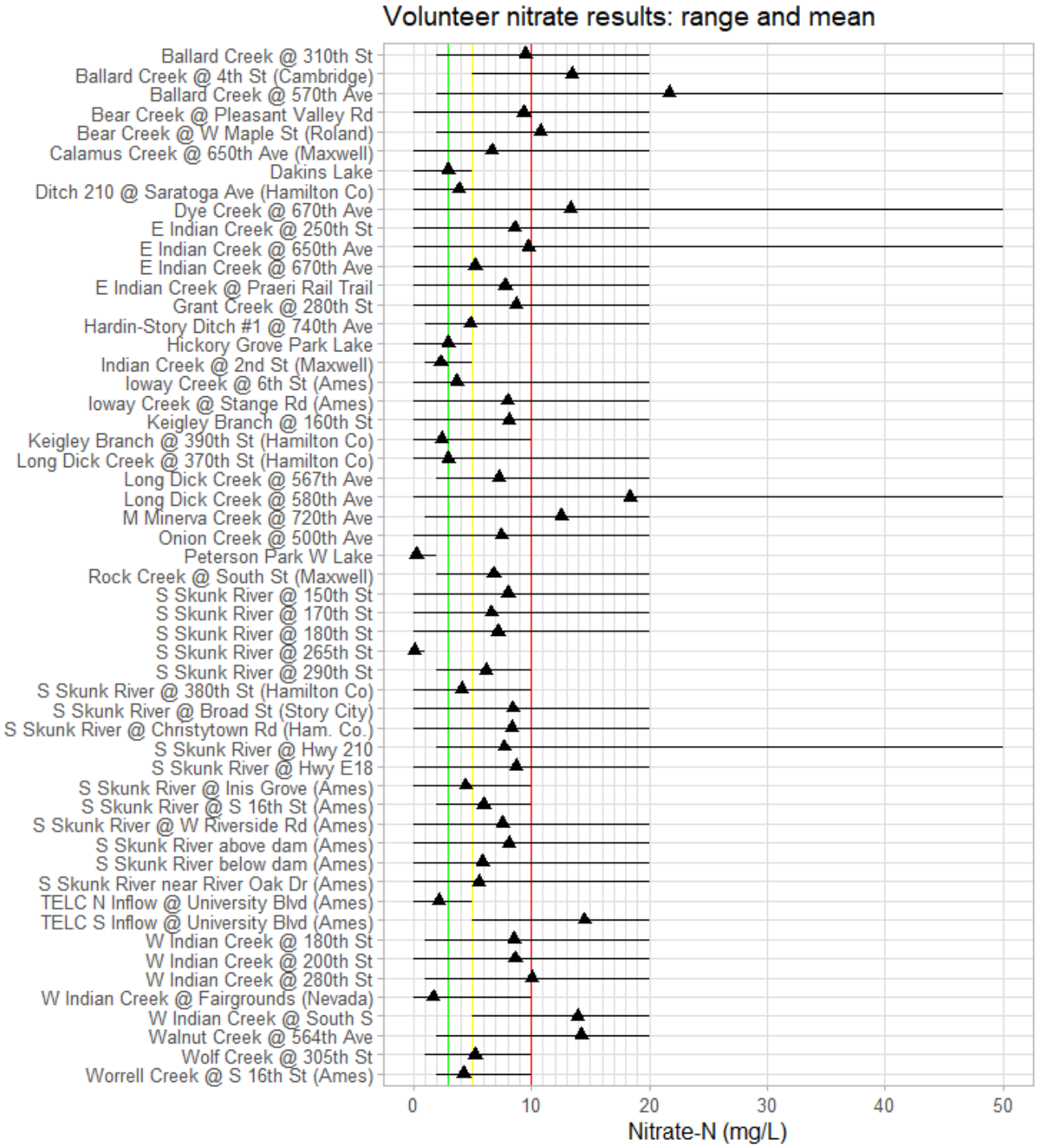


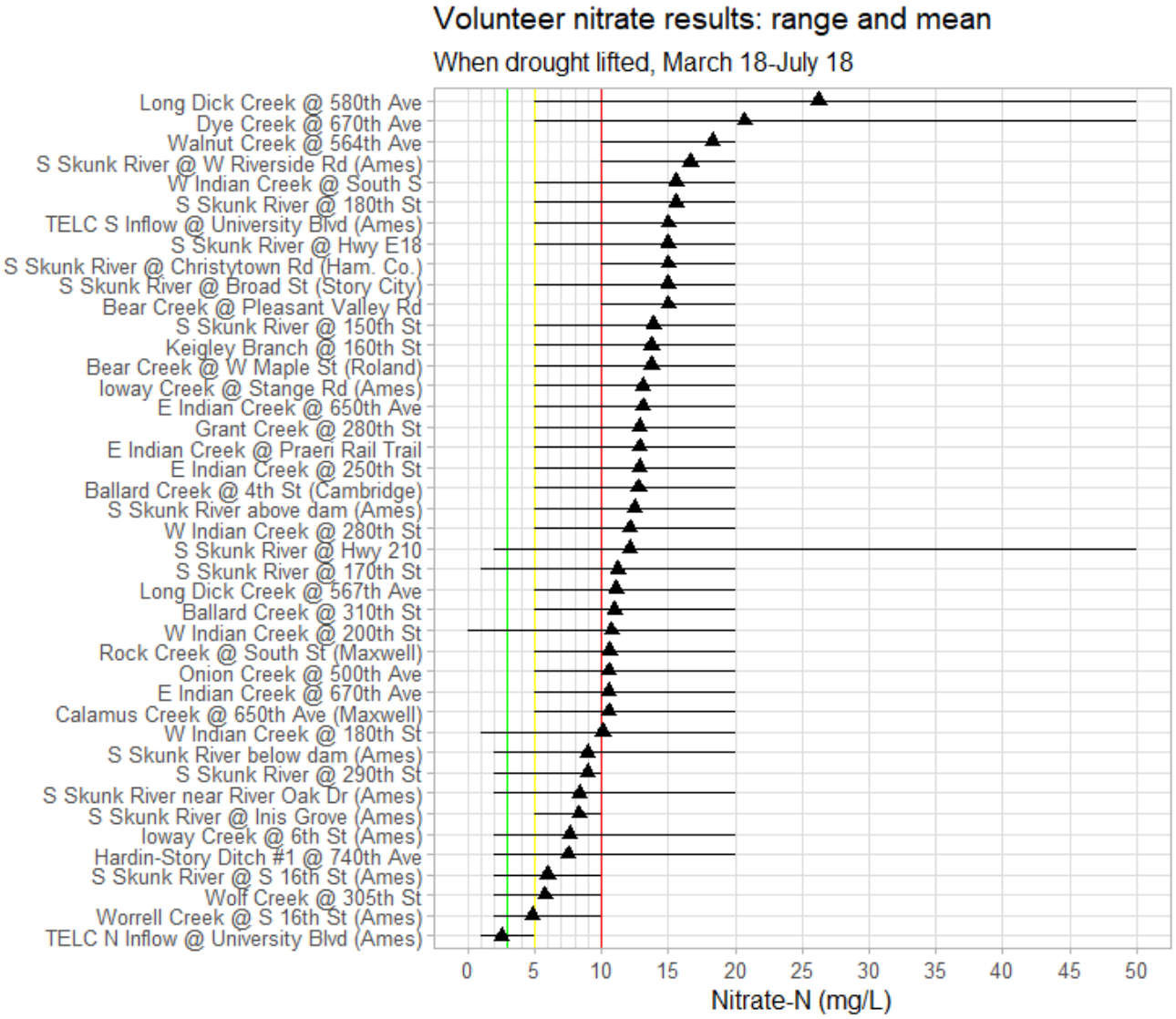
Photo Credit: Story County Conservation

Long Dick Creek often has high nitrate concentrations. Photo credit: Story County Conservation.

Nitrate is often highest in a wet spring following a drought. Volunteers observed nitrate as high as 50 mg/L at five sites (9% of sites) and nitrate as high as 20 mg/L at forty of fifty-four sites (74%). Since some streams dried up in fall or were not monitored for the entire season, pay special attention to the timing of sampling when interpreting yearly averages. For example, Ballard Creek @ 570th St was mostly tested in summer and fall at a time when other reaches of the creek had dried up, but this section was sustained by effluent water from the Huxley Sewage Treatment Plant.



In central Iowa, agriculture drainage tiles are a major pathway for nitrate to get from cropland to streams. To identify streams most affected by nitrate from agriculture, we can look at results from a wetter period. Between March 18 and July 18, nitrate in Ioway Creek was elevated (based on data from a real-time sensor), the South Skunk River was high enough for paddling, and the US Drought Monitor issued no advisory for Story County.



Outlet of drainage tile system to Walnut Creek near Kelley.

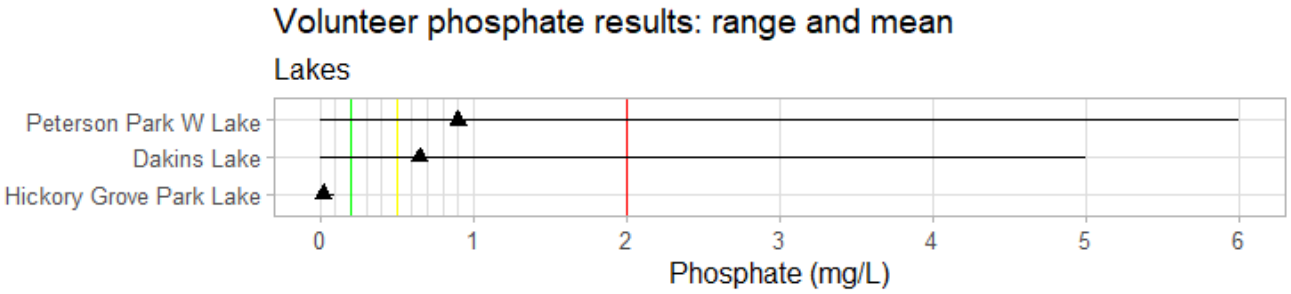
Phosphate

What are Phosphates?
Phosphorous is a naturally occurring mineral in rock formations and is an essential nutrient of bacteria, plants, and animals. It is usually present in waterways as dissolved orthophosphate. Phosphates levels are measured as a concentration in milligrams per liter. Excess phosphates that enter waterways can cause pollution through a variety of different discharges methods, such as fertilizers, sewage, industrial waste, and soil erosion.

How do we measure Phosphates?
Using the standard Save Our Streams method phosphate levels are measured using the CHEMetrics Phosphate, ortho kit (K-8510).

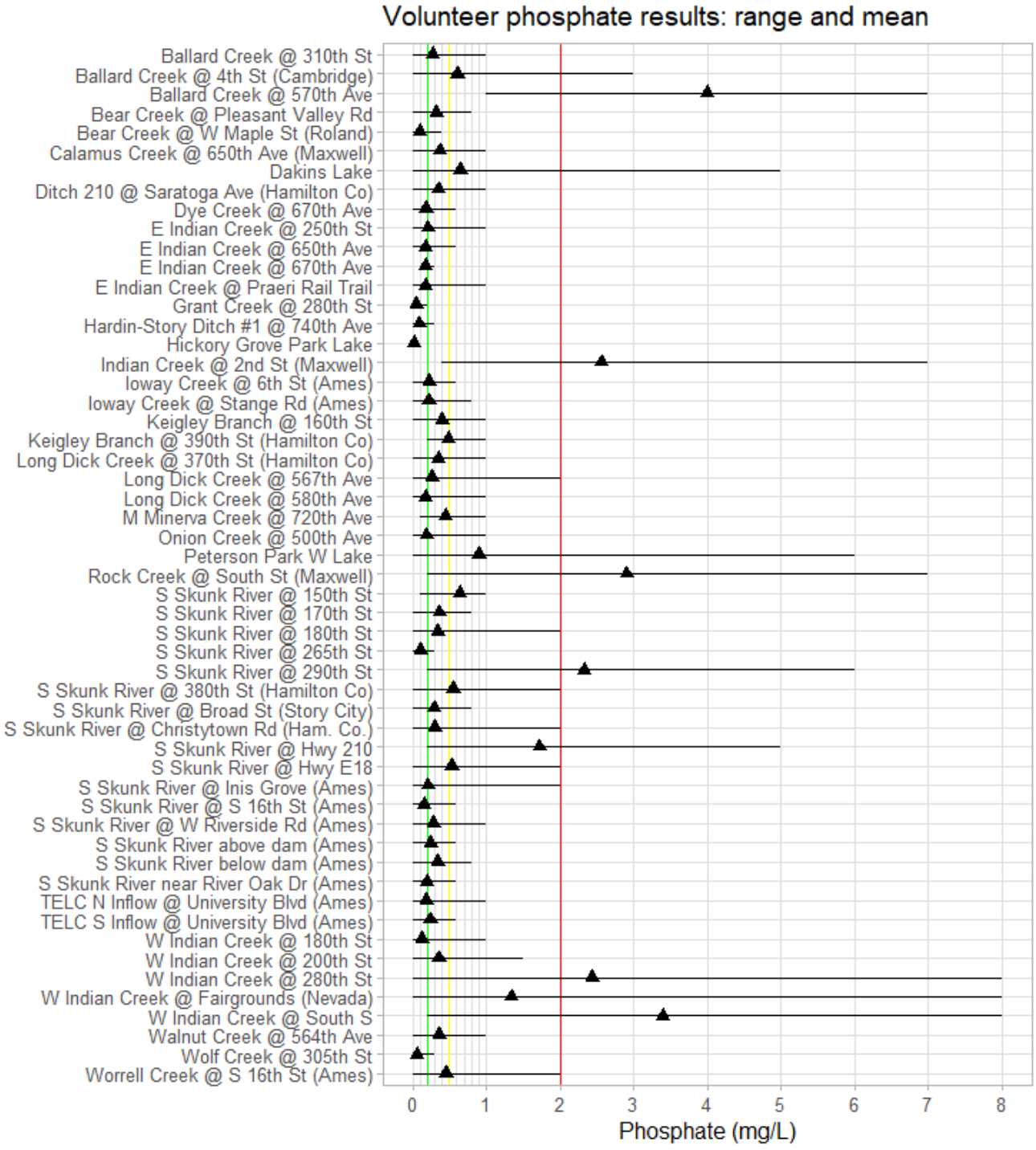
Why is Phosphate Important?
Phosphorous is an essential nutrient of bacteria, plants, and animals. However, excess levels of phosphates can lead to rapid population growth of bacteria and algae. These "blooms" can result in a decrease in dissolved oxygen levels and may excrete toxins harmful to life.

Of the three lakes tested, Hickory Grove Lake had lowest phosphate concentrations, following extensive work to restore the lake and reduce pollutant sources in the watershed. Phosphate in the "fair" range at Peterson Park and Dakins Lake could contribute to algae growth.



Algae growth in Lake Laverne, in Ames.

Most sites had average phosphate levels in the "good" to "excellent" range. Six sites (11%) had an average phosphate level in the "poor" range, and another six (11%) had average phosphate levels in the "fair" range.

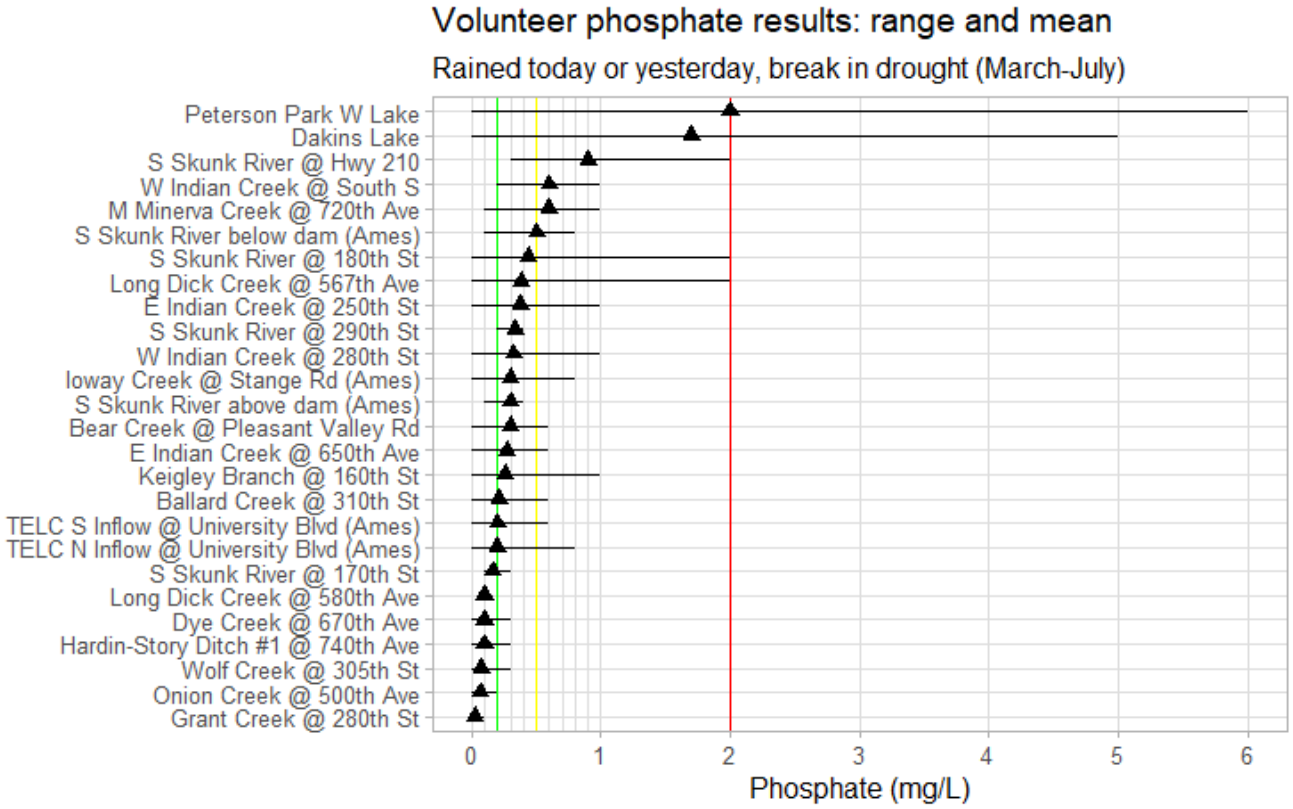


Sites with high phosphate tend to be downstream from wastewater treatment plants that discharge into the stream: these include Indian Creek at 2nd St, Ballard Creek at 570th St and at 4th St, Rock Creek @ South S, the South Skunk at Hwy 210 and at 290th St, and W. Indian Creek at South S and at 280th.

A key finding from the 2021 report was that during drought, effluent from wastewater treatment plants is less diluted and can have a strong influence on phosphate, dissolved oxygen, and chloride levels in the receiving water bodies. Until recently, nutrient reduction has not been a requirement for wastewater treatment, so larger communities will have to upgrade their systems over the next decade.

Treated effluent from the Ames Water Pollution Control Facility enters the South Skunk River near 280th St.

Soil erosion and stormwater runoff is another common source of phosphorus. To capture periods when runoff is likely, we can focus on the March 18-July 18 period when streams were at a normal level, and when there has been rain in the past 48 hours. "Poor" phosphate readings at two lake (Dakins Lake and Peterson Park Lake), Long Dick Creek, and the South Skunk River at 280th St are likely due to runoff. However, the highest phosphate readings in W. Indian Creek at the Fairgrounds in Nevada occurred during drier conditions. Since this site also had low dissolved oxygen and a "poor" biological score, further investigation is needed.

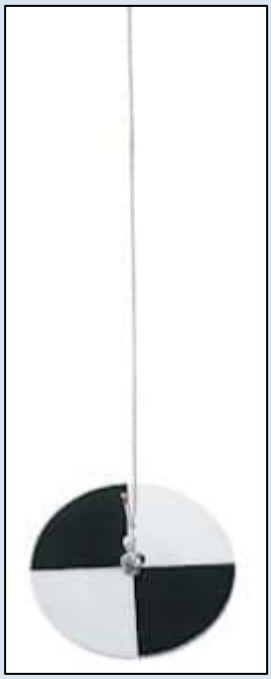


Transparency/Turbidity

What is Turbidity?
Turbidity is the measurement of suspended particles in the water column.

How do we measure Turbidity?
Using the standard Save Our Streams method turbidity is measured using a transparency tube. This is a clear plastic tube with a checkered white-and-black pattern on the bottom of the inside of the tube. Volunteers fill the tube with water and will look directly into the tube (top of the water column), water will then be released until the volunteer can just make out the checkered pattern.

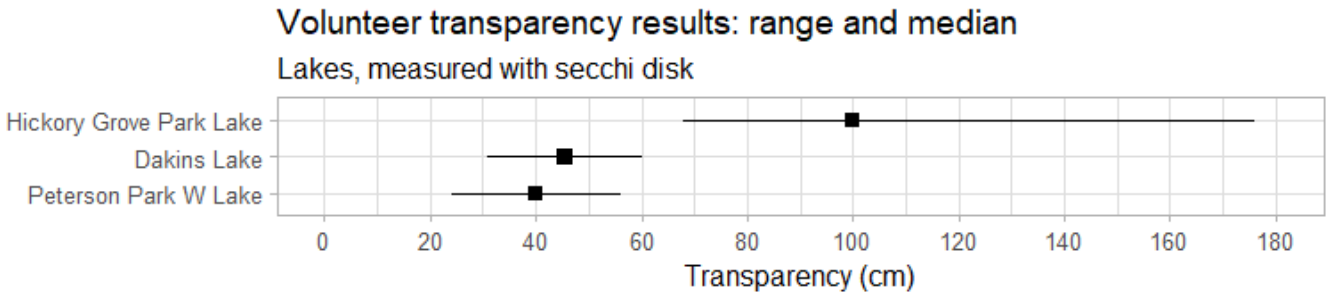
Why is Turbidity Important?
Aquatic organisms depend on high water clarity for survival. As more material is suspended in the water column, less light can penetrate, reducing plant growth. Additionally, when the suspended particles settle they can reduce available habitat, food, and clog the gills of aquatic organisms.



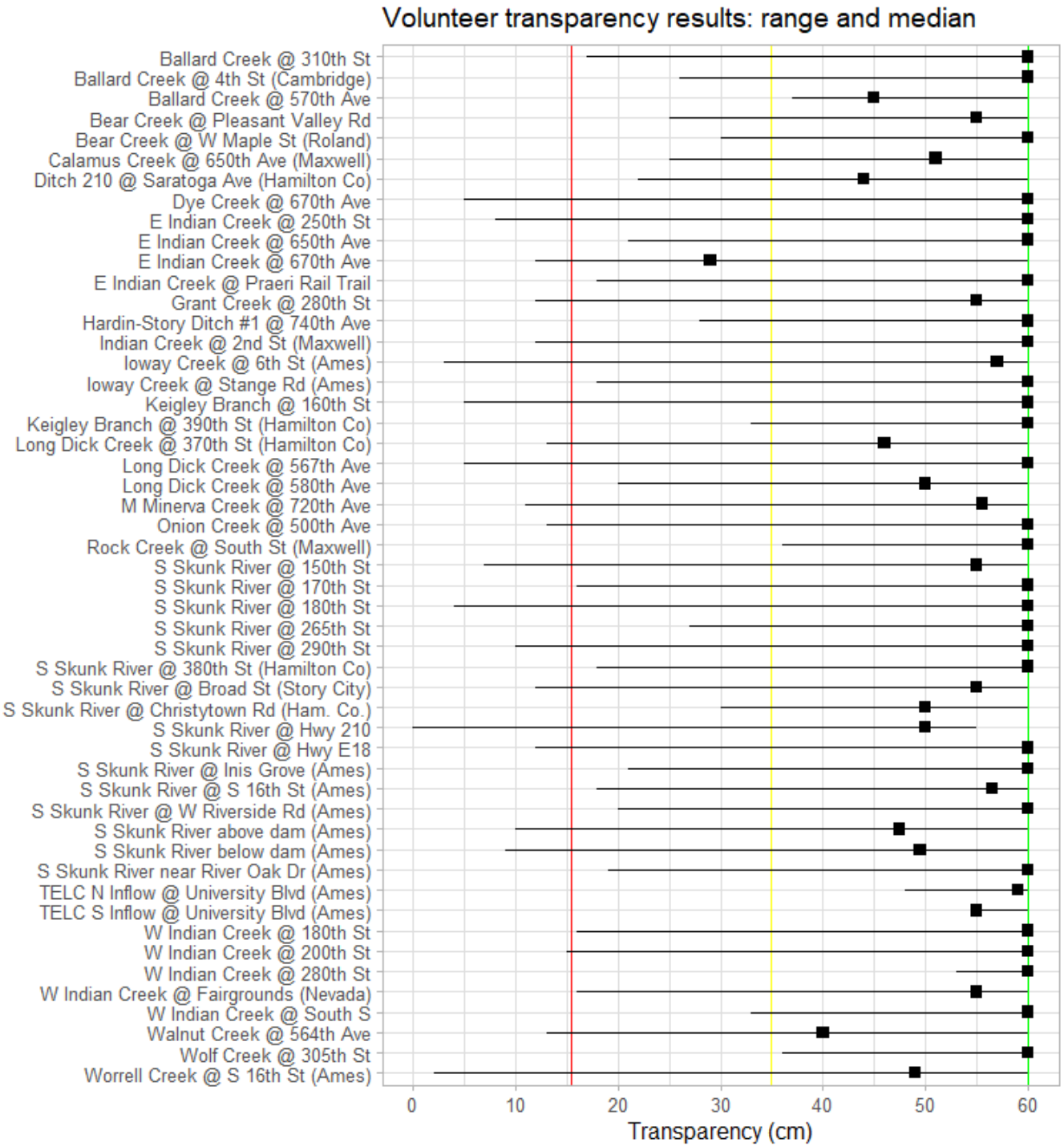
Secchi Disk

Transparency Tube

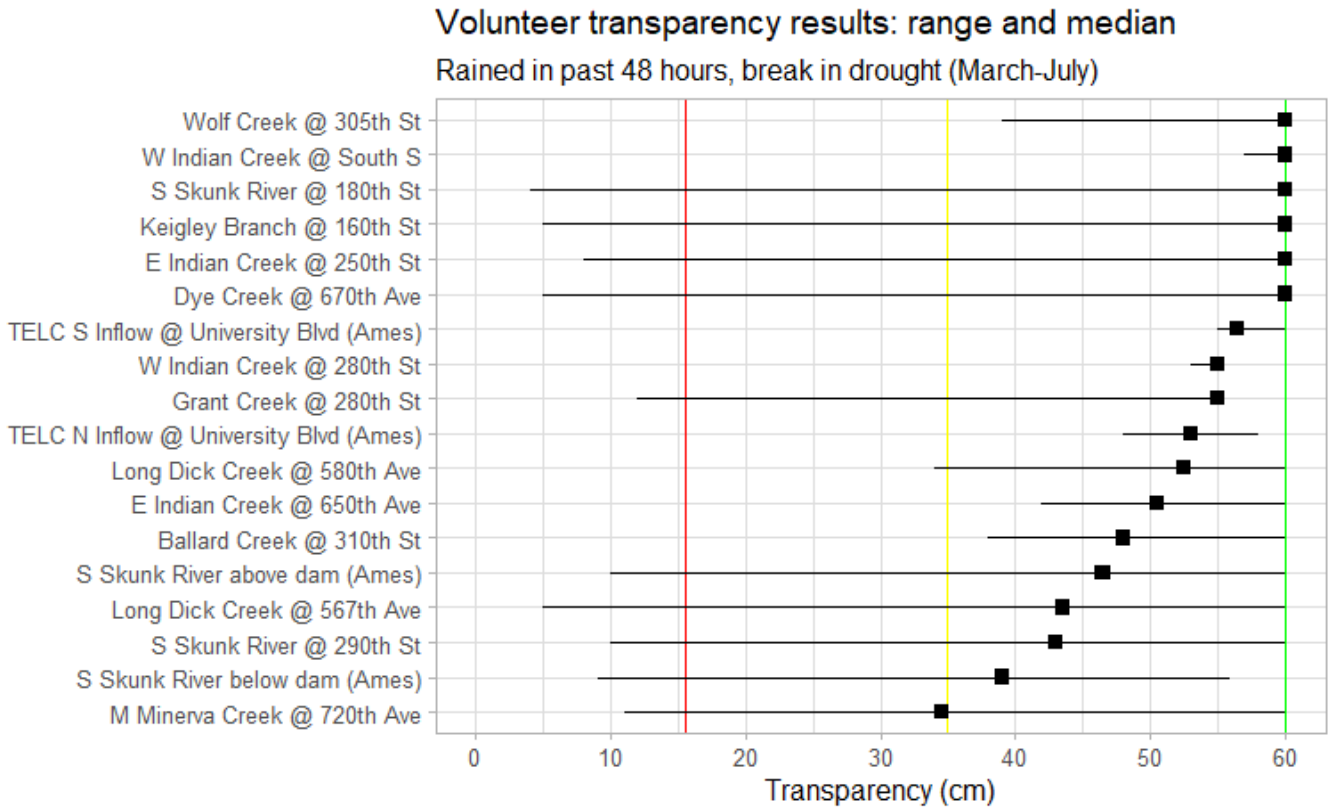
Water clarity was tested in three lakes using a secchi disk on a rope. Following extensive work to address pollution sources in the watershed and to restore the lake, Hickory Grove Lake is the clearest and also has the lowest phosphate concentrations.



Streams were tested with a 60 cm transparency tube. Almost all sites (98%) normally had clear water (median transparency in the good to excellent range). The exception, East Indian Creek at 670th Ave, needs further investigation. However, transparency at most sites varied widely over the course of the season. Twenty two sites (41%) had at least one sample in the "poor" range.

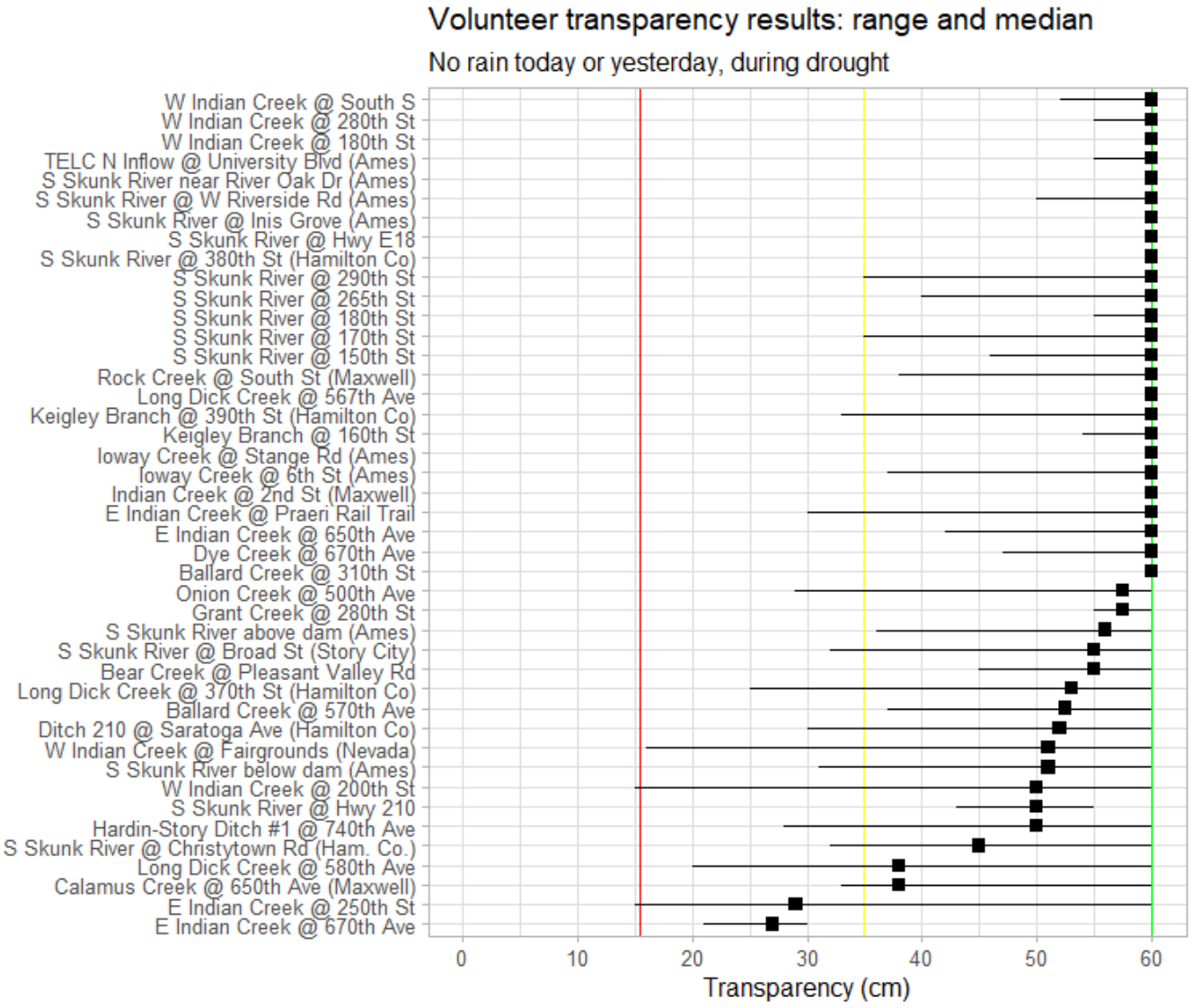


To evaluate which creeks are affected by sediment from streambank erosion and polluted runoff, we can focus on samples collected when Story County was not in a drought and when volunteers reported rain either on day of sampling, or the previous day. These creeks had at least 3 samples collected during these conditions.



Muddy water in Long Dick Creek @ 567th Ave, following heavy rains.

Much of the data was collected during drought conditions when we would not expect much erosion. The "fair" transparency results during these conditions are curious and need some follow-up. This includes two sites on East Indian Creek. Maybe the mud has been stirred up by animals or human activity upstream. However, it's also possible that some of these measurements were made in error. When the water is very shallow it can be difficult to fill the transparency tube without disturbing sediment from the stream bottom.



Dissolved oxygen

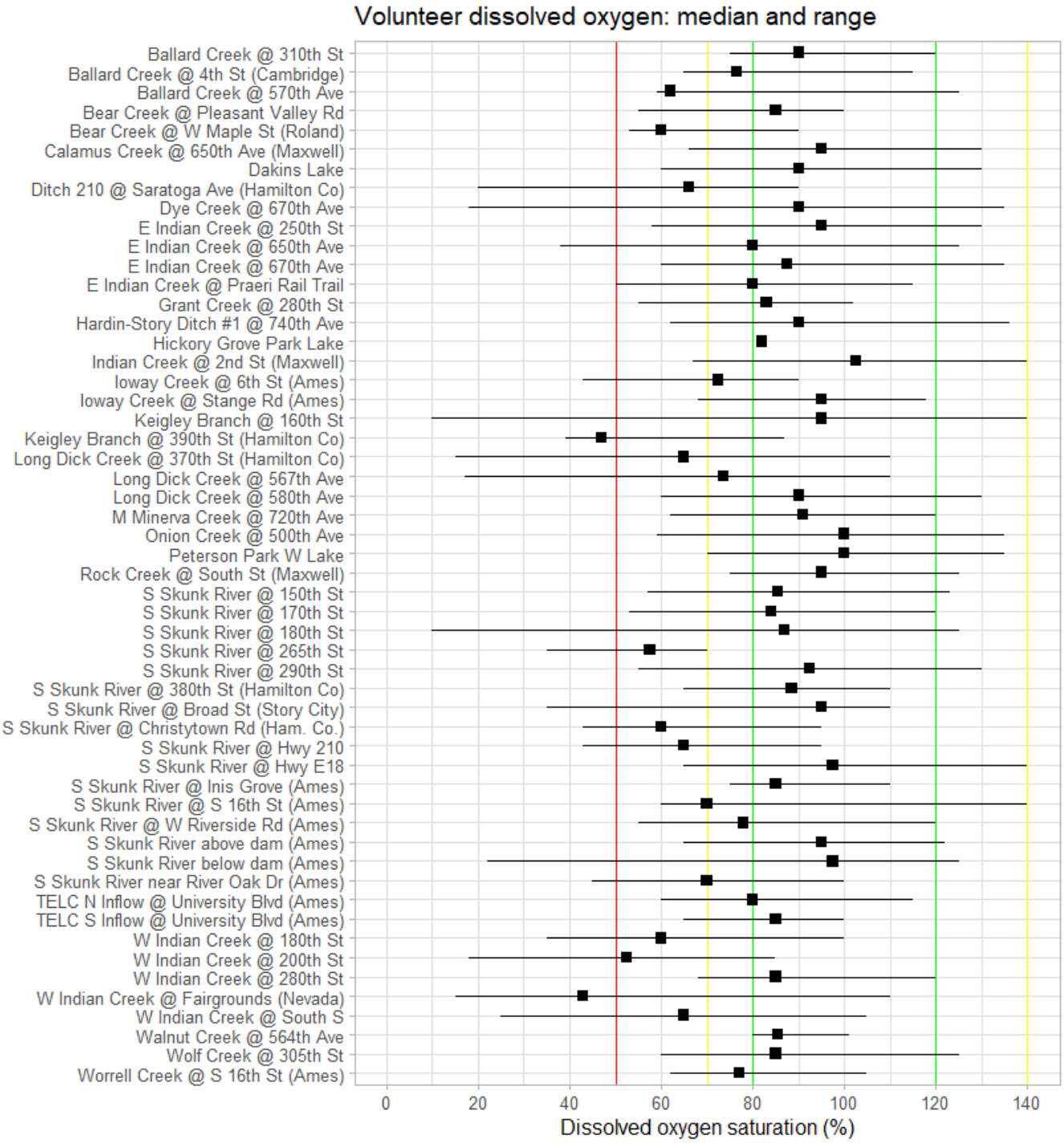
What is Dissolved Oxygen?
Dissolved Oxygen is the measurement of oxygen present in a body of water and available to aquatic organisms. Measured as a concentration in milligrams per liter, and as a percent-saturation. The percent-saturation is used to indicate how much oxygen the water can hold at a given temperature.

How do we measure Dissolved Oxygen?
Using the standard Save Our Streams method dissolved Oxygen is measured using the CHEMetics Oxygen, dissolved kit (K-7512).

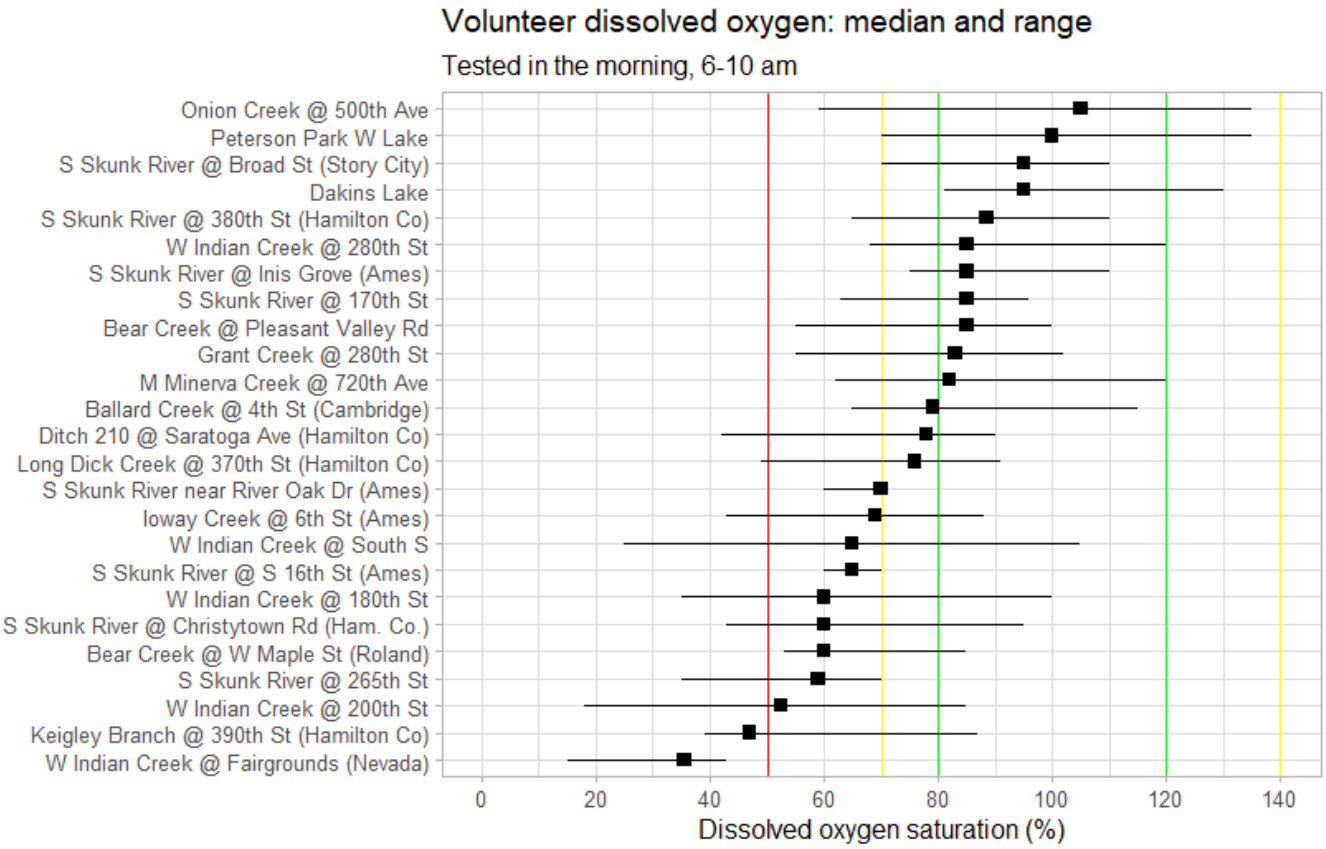
Why is Dissolved Oxygen Important?
Dissolved Oxygen is an essential element when it comes to the survival of aquatic organisms, such as macroinvertebrates and fish. It is also a necessary component in the decomposition of organic matter. Low levels of dissolved oxygen may result in a decrease in species diversity.

This stonefly, found in Ioway Creek, needs high levels of dissolved oxygen to survive.

At nineteen sites (35%), volunteers measured dissolved oxygen saturation in the "poor" range. Even a temporary drop in dissolved oxygen can prove fatal for sensitive aquatic life. Dissolved oxygen was consistently poor at Keigley Branch at 390th St and W. Indian Creek at the Fairgrounds in Nevada. W. Indian Creek at the Fairgrounds was also surveyed for benthic macroinvertebrates and received a "poor" score.



Dissolved oxygen has a daily cycle, rising during the afternoon when algae and plants are doing photosynthesis and falling overnight. The following data was collected in the morning when dissolved oxygen tends to be lower.



Keigley Branch at 390th St.
Photo credit Story County Conservation

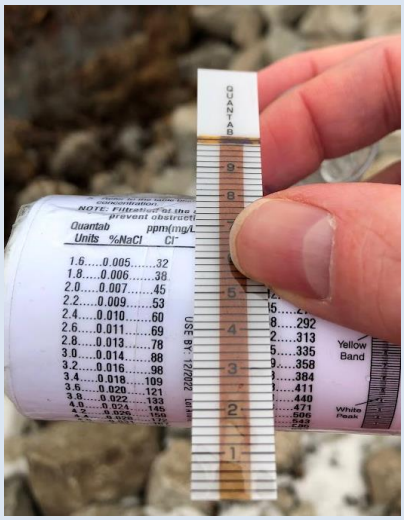
W. Indian Creek near fairgrounds in Nevada

Chloride

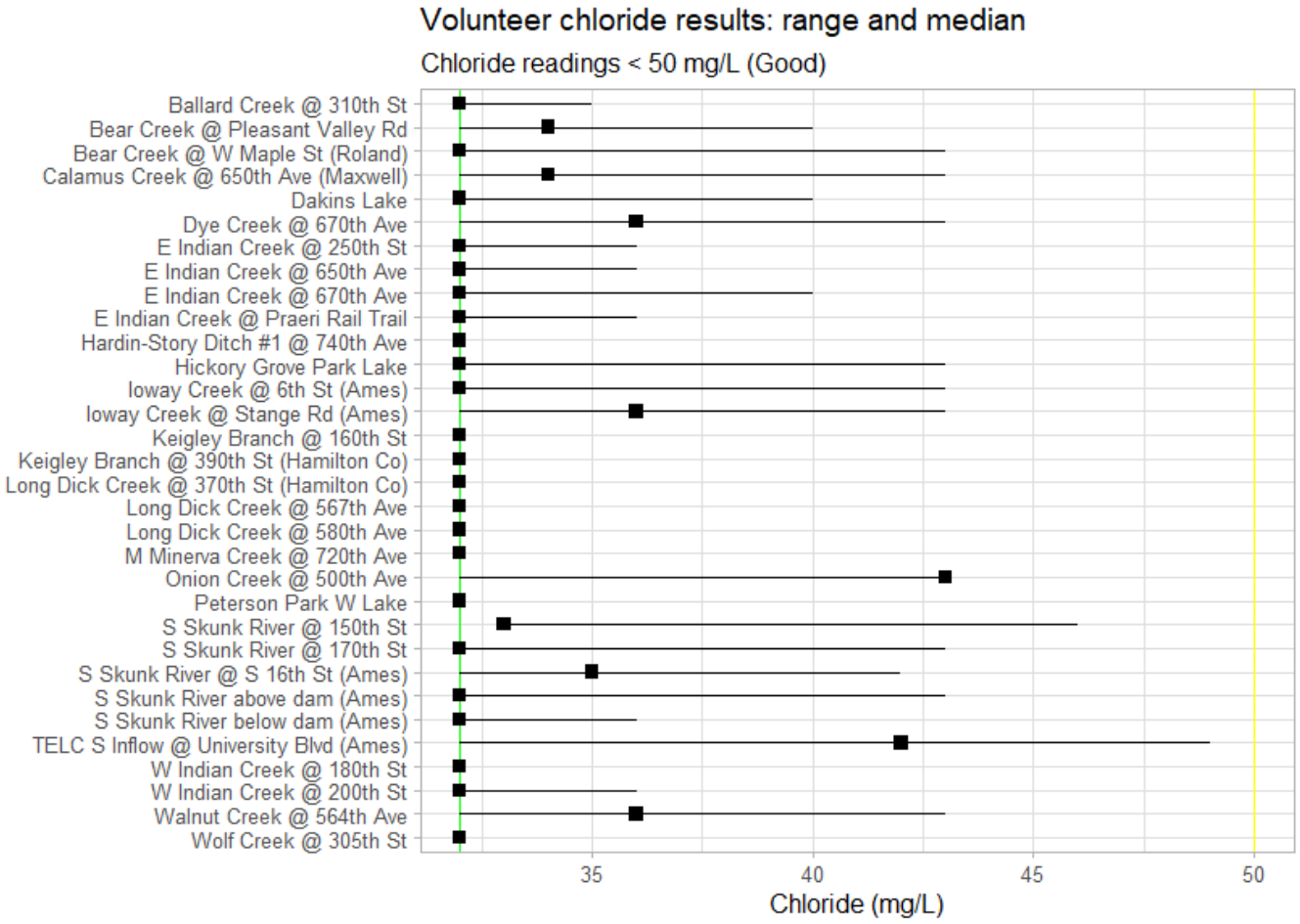
What is Chloride?
Chloride is the measurement of the concentration of dissolved salt. Chloride is measured as a concentration in milligrams per liter. Freshwater streams can have a natural chloride level range from 1 to 250 mg/L.

How do we measure Chloride?
Using the standard Save Our Streams method chloride is measured using the Hach Chloride QuanTab titration test strip.

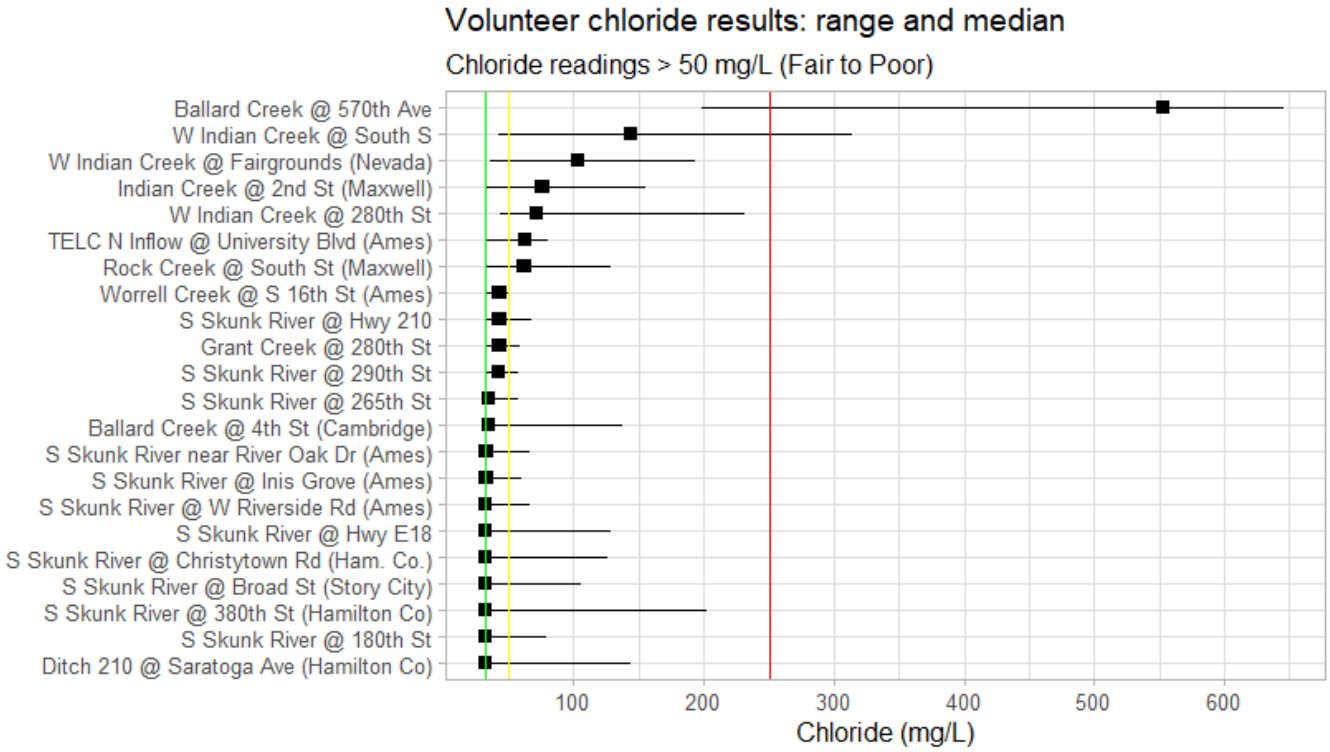
Why is Chloride Important?
Aquatic organisms have adapted to live in different levels of salinity. When chloride levels exceed the acceptable range for various organisms, if can lead to stressors or a decrease in organism diversity.



Chloride varied enough that we need two graphs to clearly see the results. Most sites (63%) had chloride levels that never exceeded 50 mg/L, in the "good to excellent" range.



Chloride concentrations in the "poor" range were measured in Ballard Creek and Indian Creek below wastewater treatment plants, especially in the summer and fall. Water softeners can be a major source of chloride in wastewater, which cannot be removed by conventional wastewater treatment. Chloride concentrations in the "fair" range were observed at 22 sites (41%), but further investigation will be needed to narrow down the most likely sources. Next year's report will include data collected after winter storms in January and February of 2023 when de-icing salts could have been washed directly into streams.

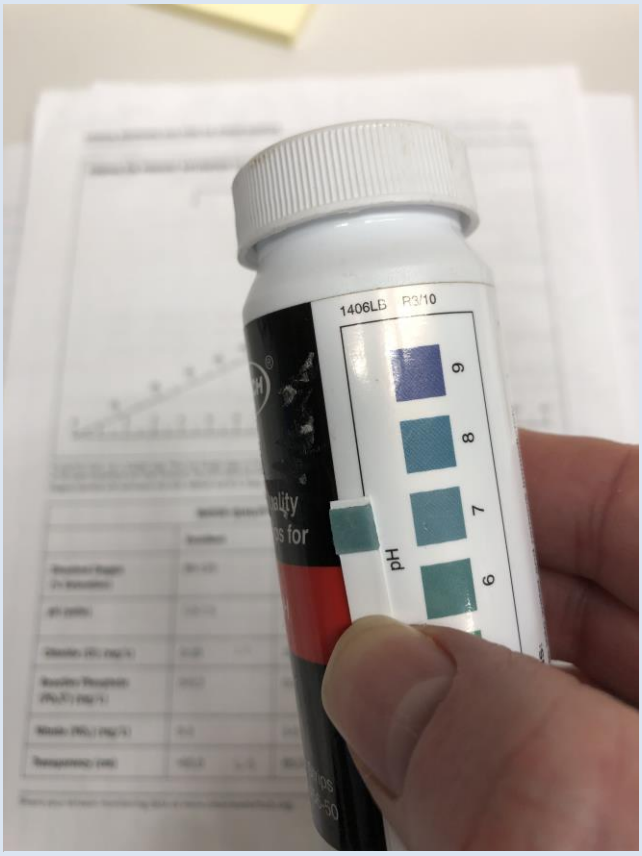


pH (acidity/alkalinity)

What is pH?
pH is the measurement of the concentration of hydrogen ions in water. It measures the water's acid/base content, using a logarithmic scale (0-14 pH units). Lower values are considered acidic and high values considered basic.

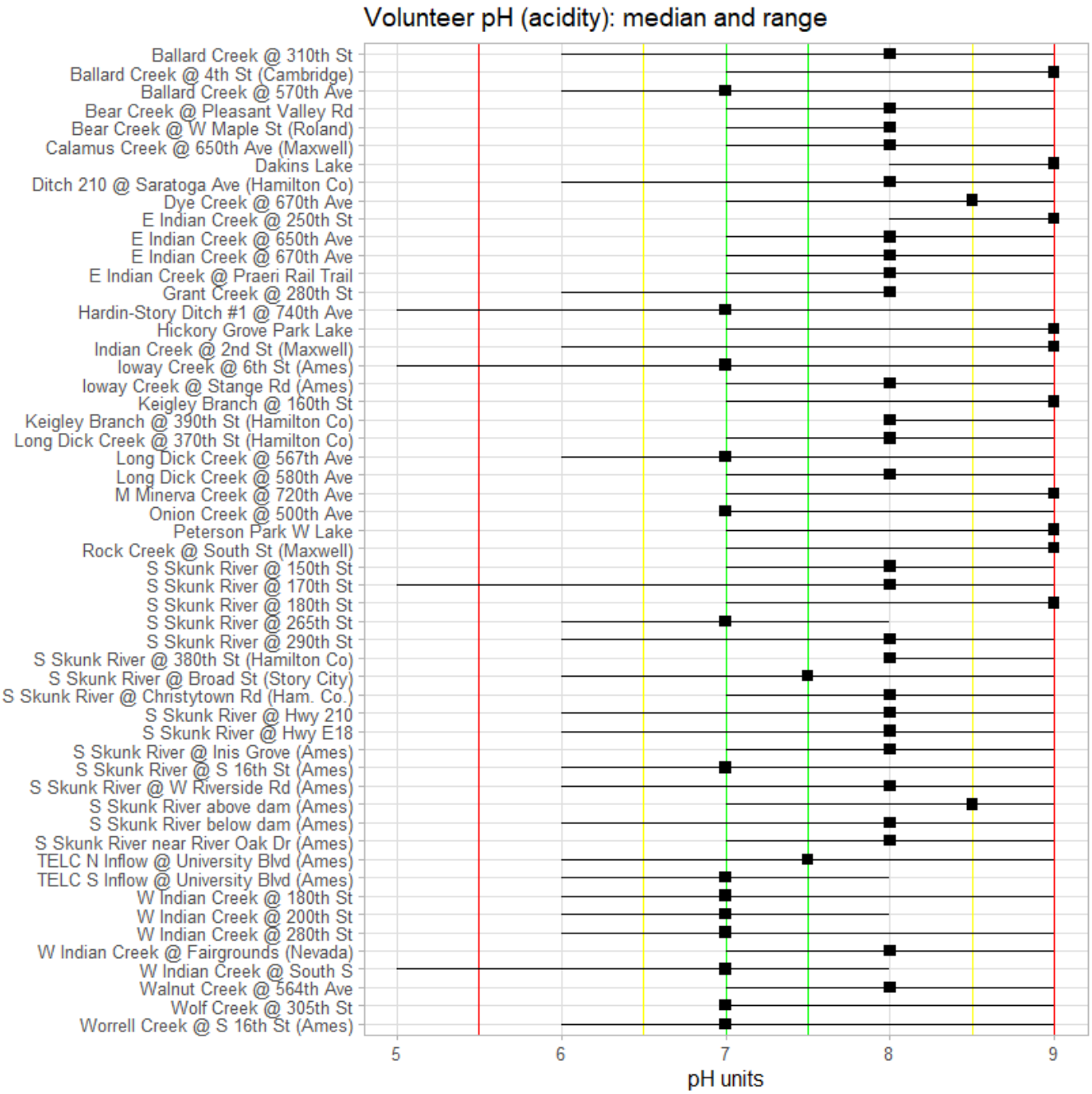
How do we measure pH?
Using the standard Save Our Streams method pH is measured sing the Hach pH test strips.

Why is pH important?
A consistent and moderate level of pH is critical for the survival of aquatic life. pH affects the availability of essential nutrients and minerals. A low pH level (acidic) can increase the availability of phosphorous, resulting in algae blooms. A high pH level (basic) can increase the availability of ammonia in the water, which is toxic to aquatic life.



Hardin-Story Ditch #1 ranged from acidic (pH 5) to basic over the course of the season. Photo credit: Story County Conservation

Most Iowa waters are slightly basic to moderately basic in their natural condition (pH 7.5 to 8.5), because of minerals in the groundwater. The thresholds used for the national program may not be appropriate here, since an 8.5 on a test strip would probably be read as a 9 and scored as "poor." However, the acidic water at four sites is a cause for concern and needs follow-up. Algae growth can cause large changes in pH that can stress aquatic organisms. We see a wide variation in pH (three or four units) at twenty-two sites (41%).



Spring snapshot

Having volunteers test multiple sites on the same day provides a "snapshot" of water quality across a broad area. This year, we arranged to hold our annual spring water quality snapshot event on the same day as a water quality snapshot in Polk County.

May 17, 2022

- Story County and Ioway Creek: 42 sites
    - Ioway Creek watershed snapshot: 28 sites
    - Other sites monitored by Story County Conservation: 14 sites
- Polk County Conservation: 113 sites

Using the same format that Polk County used for reporting the results for their snapshot, can see how results from the two areas compare. High nitrate levels were more common in Story County and Ioway Creek watershed, but high chloride and phosphate levels were more common in Polk County.

Nitrate	**0-3 mg/L**	**4-7 mg/L**	**8-14 mg/L**	**>14 mg/L**
Polk County	55 sites (51%)	32 sites (30%)	18 sites (17%)	2 sites (2%)
Story/Ioway	1 site (2%)	5 sites (12%)	25 sites (59%)	11 sites (26%)

Transparency	**< 20 cm**	**20-39 cm**	**40-59 cm**	**> 60 cm**
Polk County	0 sites	7 sites (6%)	23 sites (21%)	80 sites (73%)
Story/Ioway	0 sites	0 sites	4 sites (10%)	38 sites (90%)

pH	**5**	**6**	**7 or 8**	**9**
Polk County	0 sites	3 sites (3%)	93 sites (84%)	15 sites (14%)
Story/Ioway	0 sites	1 site (2%)	31 sites (74%)	5 sites (12%)

Dissolved oxygen	**0-5 mg/L**	**6-7 mg/L**	**8-10 mg/L**	**12 mg/L**
Polk County	6 sites (5%)	24 sites (22%)	77 sites (69%)	4 sites (4%)
Story/Ioway	1 sites (2%)	4 sites (10%)	24 sites (57%)	12 sites (29%)

Phosphate	**0-0.1 mg/L**	**0.2 mg/L**	**0.3-0.4 mg/L**	**> 0.4 mg/L**
Polk County	72 sites (65%)	18 sites (16%)	13 sites (12%)	7 sites (6%)
Story/Ioway	39 sites (93%)	2 sites (5%)	1 site (2%)	0 sites

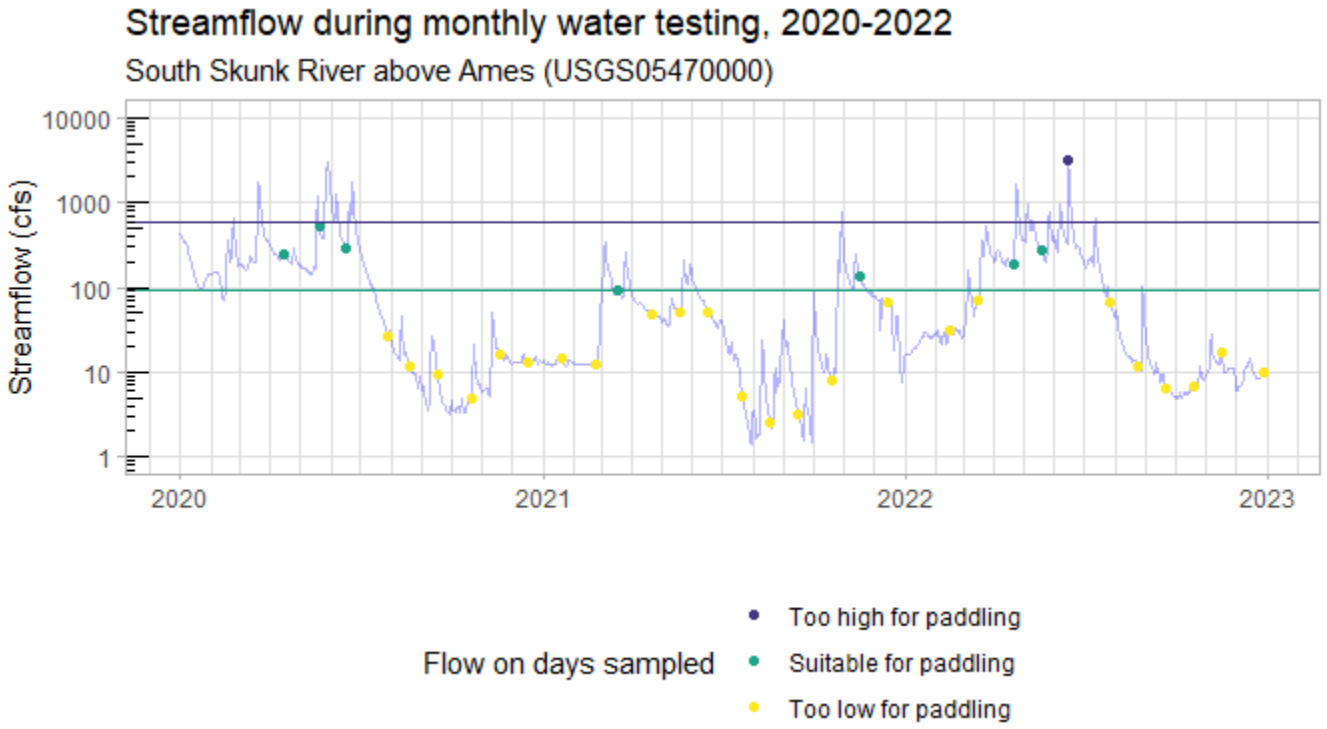
Chloride	**< 60 mg/L**	**60-79 mg/L**	**80-98 mg/L**	**> 99 mg/L**
Polk County	62 sites (57%)	9 sites (8%)	8 sites (7%)	29 sites (27%)
Story/Ioway	39 sites (93%)	1 site (2%)	1 site (2%)	1 site (2%)

Results: Lab Testing, 2020-2022

Our report from the 2021 season[4] illustrated how water quality is strongly influenced by precipitation and streamflow and recommended focusing on the conditions relevant for pollutants of interest. For example, if we're interested in evaluating conservation practices like bioreactors that treat nitrate from drainage systems, or determining where such practices are most needed, we can focus on nitrate data collected during periods when drainage tiles are likely to be flowing but rivers are not flooded. During a drought, nitrate and sediment concentrations are low almost everywhere, and influences of land use and land management on water quality are less apparent.

Despite rain in the spring, most of the monthly samples from 2022 were collected during abnormally dry conditions. **In order to look separately at wet and dry periods, we are combining three years of water quality data. This should be more informative than averages for a single season.** [5]

The categories and color coding in this section are based on the question "is there enough water in the South Skunk River to float a canoe?"



[4] https://www.prrcd.org/2021-monitoring/

[5]However, lab results from 2022 only were posted here and are still available. https://rpubs.com/dhaugprrcd/storycounty2022

With three years of data we can look separately at the following conditions.

- **Too high for paddling (600+ cfs).** Most monthly sites were sampled once, on 2022-06-15. The five sites in Ames were monitored on a different schedule during the first year of the program and have a second sample from high flow conditions, on 2020-05-19.
- **Suitable for paddling (90-600 cfs).** Most monthly sites were sampled 6-7 times.
- **Too low for paddling (0-90 cfs).** Monthly sites were monitored up to 24 times, depending on how often streams were dry (in summer and fall) or frozen (in winter).

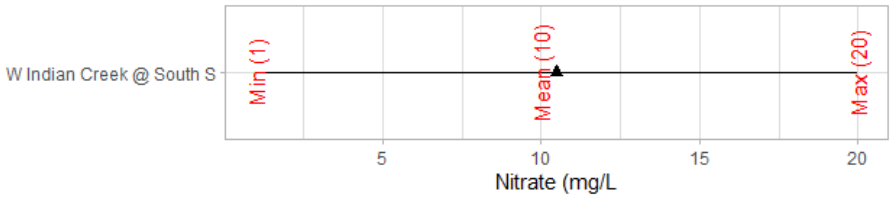
744 cfs
Too high for paddling
(For most people)

180 cfs
Suitable for paddling

9 cfs
Too low for paddling

Water levels in the South Skunk River should give an indication of broad scale weather patterns affecting all streams in Story County, however, scattered showers can affect some sites more than others. The goal was to use a consistent framework that would make intuitive sense to readers.

As with the volunteer section, graphs show both an average (mean or geometric mean) and the range of values measured.

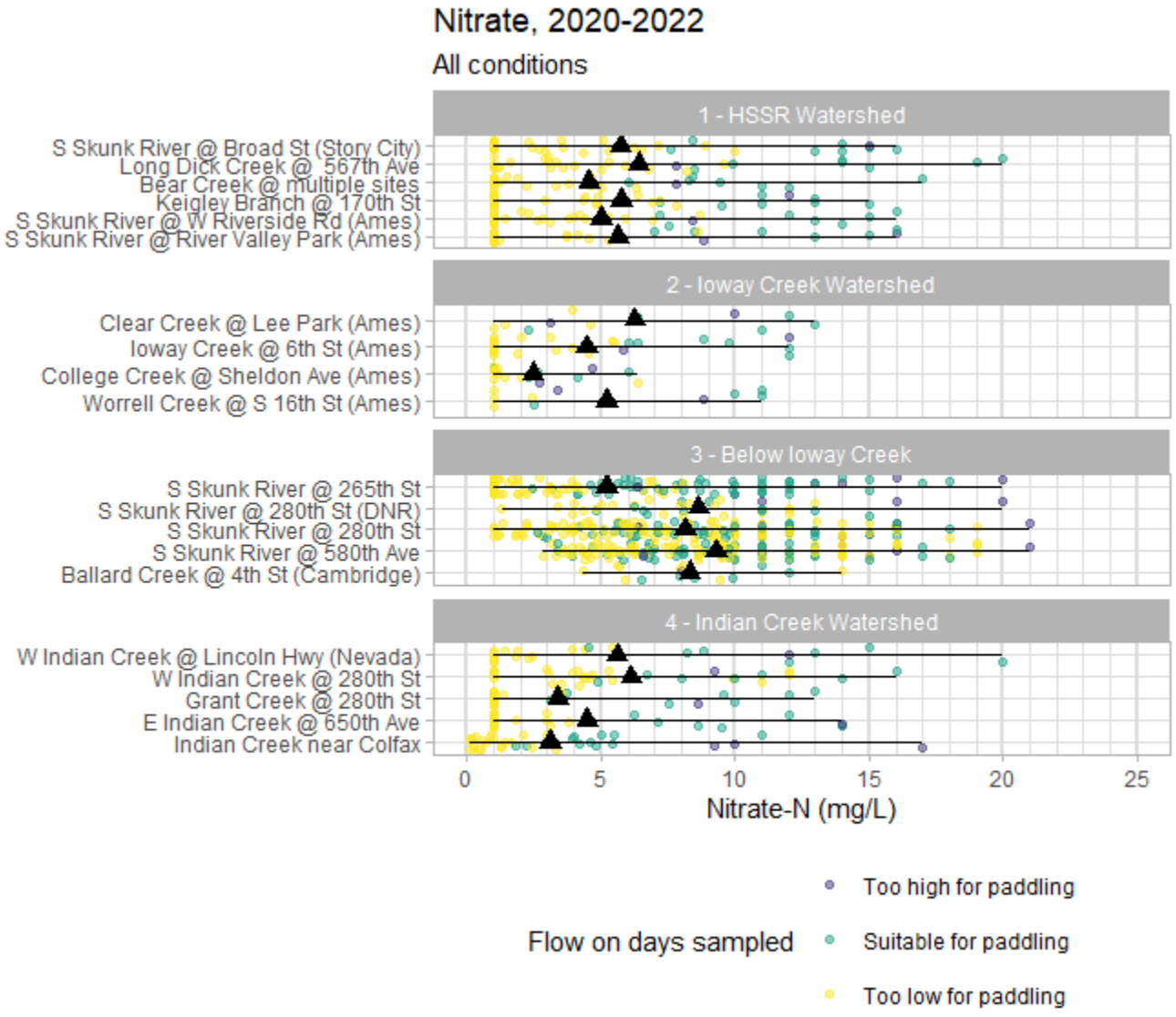


Nitrate

Nitrate is the most water-soluble form of nitrogen, an essential plant nutrient. Excess nitrogen and phosphorus in lakes and rivers can lead to harmful algae blooms, and to hypoxia in the Gulf of Mexico. Note that the minimum detection limit of our tests is usually 1 mg/L. These streams are not used as a source for public drinking water supplies, so the 10 mg/L drinking water standard would not apply, and there are no other relevant state standards. Here we are most concerned with which streams have higher and lower nitrate concentrations.

Across all conditions in 2020-2022:

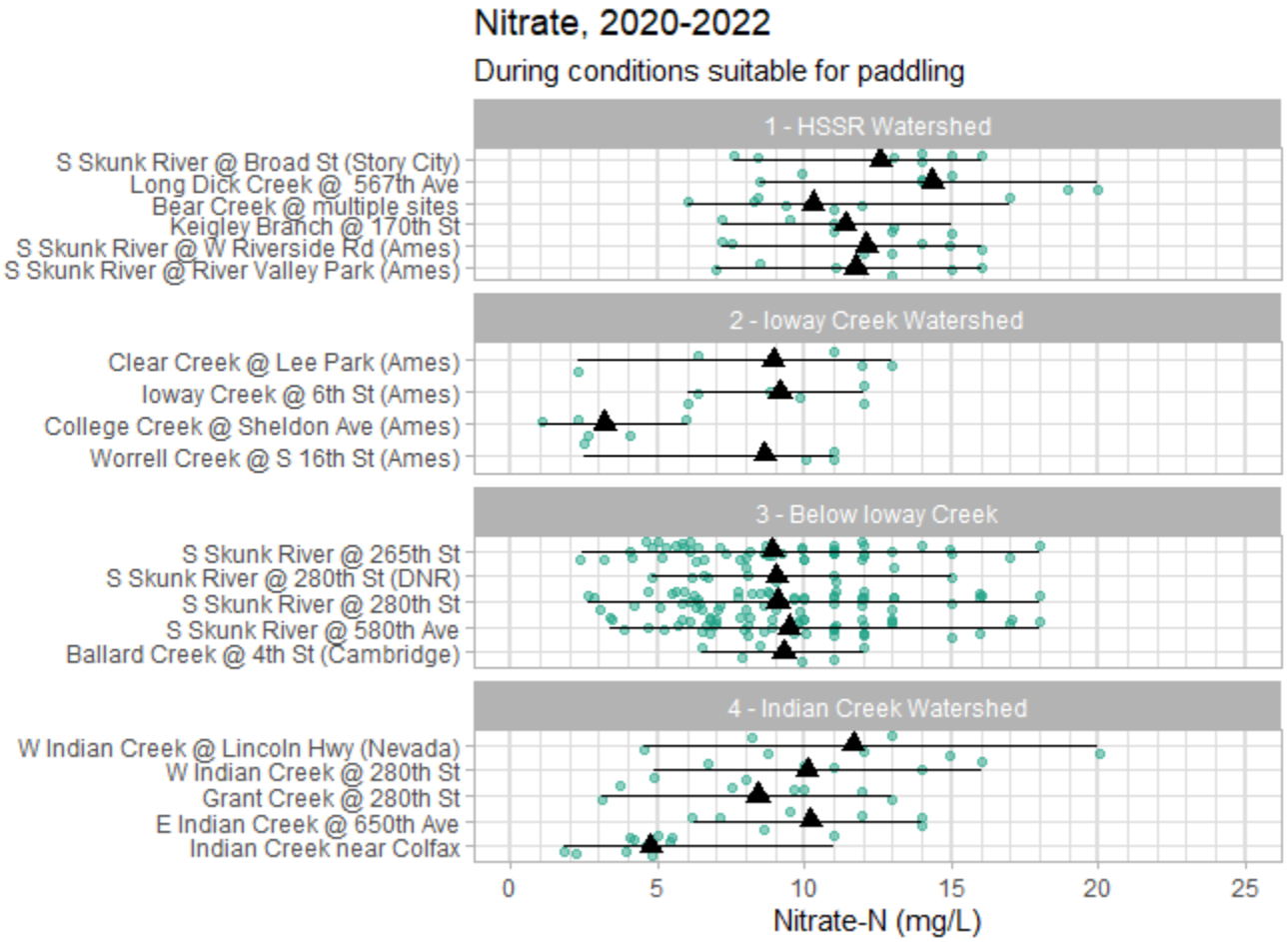
- Average nitrate concentrations ranged from 2-10 mg/L. Most samples were collected during dry conditions when nitrate tends to be lower. The exception is small creeks like Clear Creek and Worrell Creek were not flowing during dry periods.



- During dry conditions, nitrate is elevated immediately downstream from wastewater treatment plants. Average nitrate concentrations in the South Skunk River increased between 265th St and 280th St, downstream of the Ames Water Pollution Control Facility.

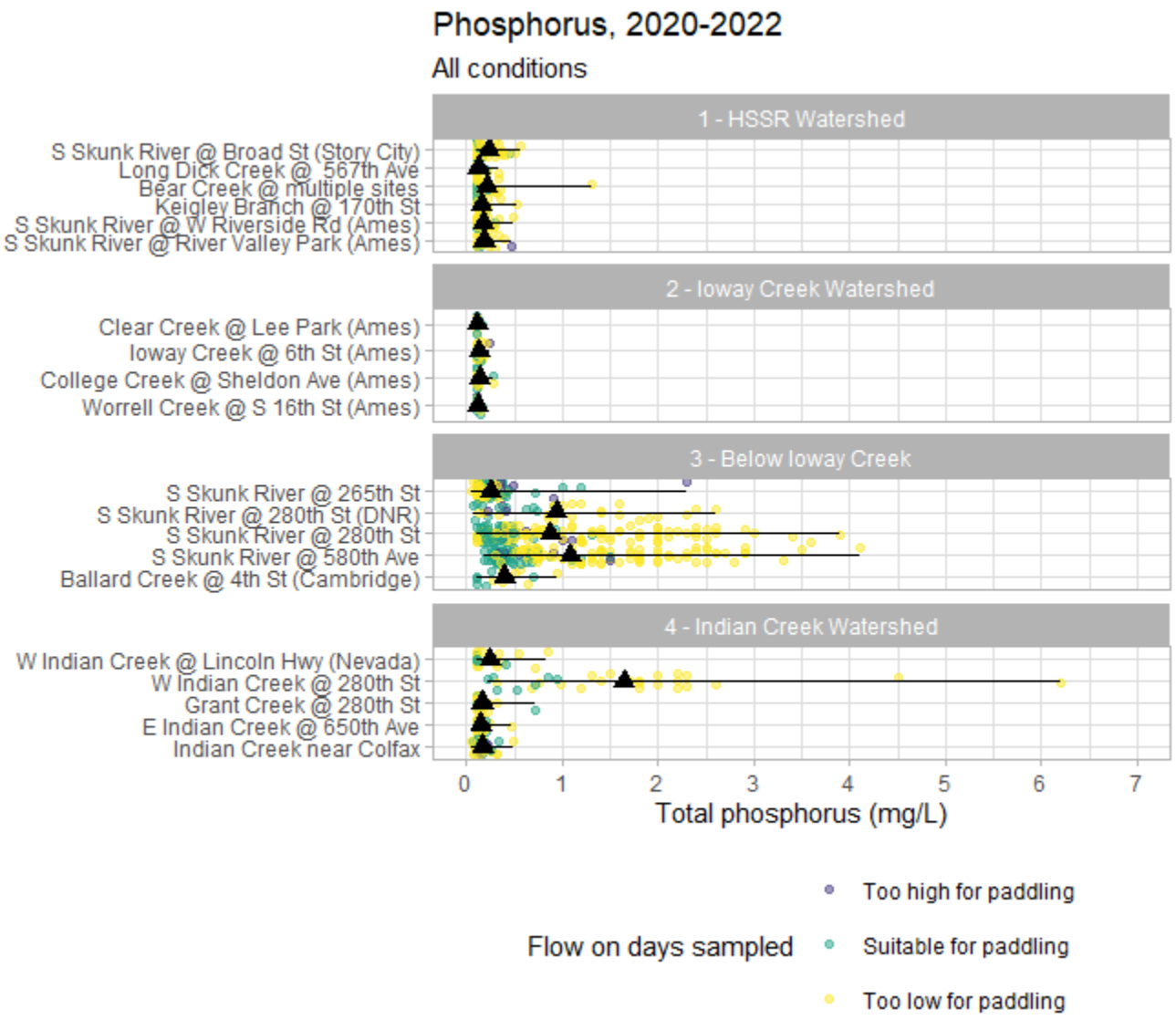
During conditions suitable for paddling:

- **Average nitrate concentrations in the South Skunk River are higher upstream of the confluence with Ioway Creek (12 mg/L at River Valley Park) than downstream (9 mg/L at 265th St).**
- Sites in the Ioway Creek watershed all have lower average nitrate concentrations (3-9 mg/L) than sites in the Headwaters of the South Skunk River watershed (10-14 mg/L).
- Nitrate is lowest in College Creek @ Sheldon Ave (3 mg/L) which has a mostly urban watershed.
- Nitrate is highest at Long Dick Creek @ 567th Ave (14 mg/L), which has a watershed dominated by cropland that receive manure from confined animal feeding operations.
- Indian Creek near Colfax (5 mg/L) has much lower nitrate than its tributaries in Story County (8-12 mg/L), probably because it passes through land with drier soils, hillier terrain, and more pasture and woodland.



Phosphorus

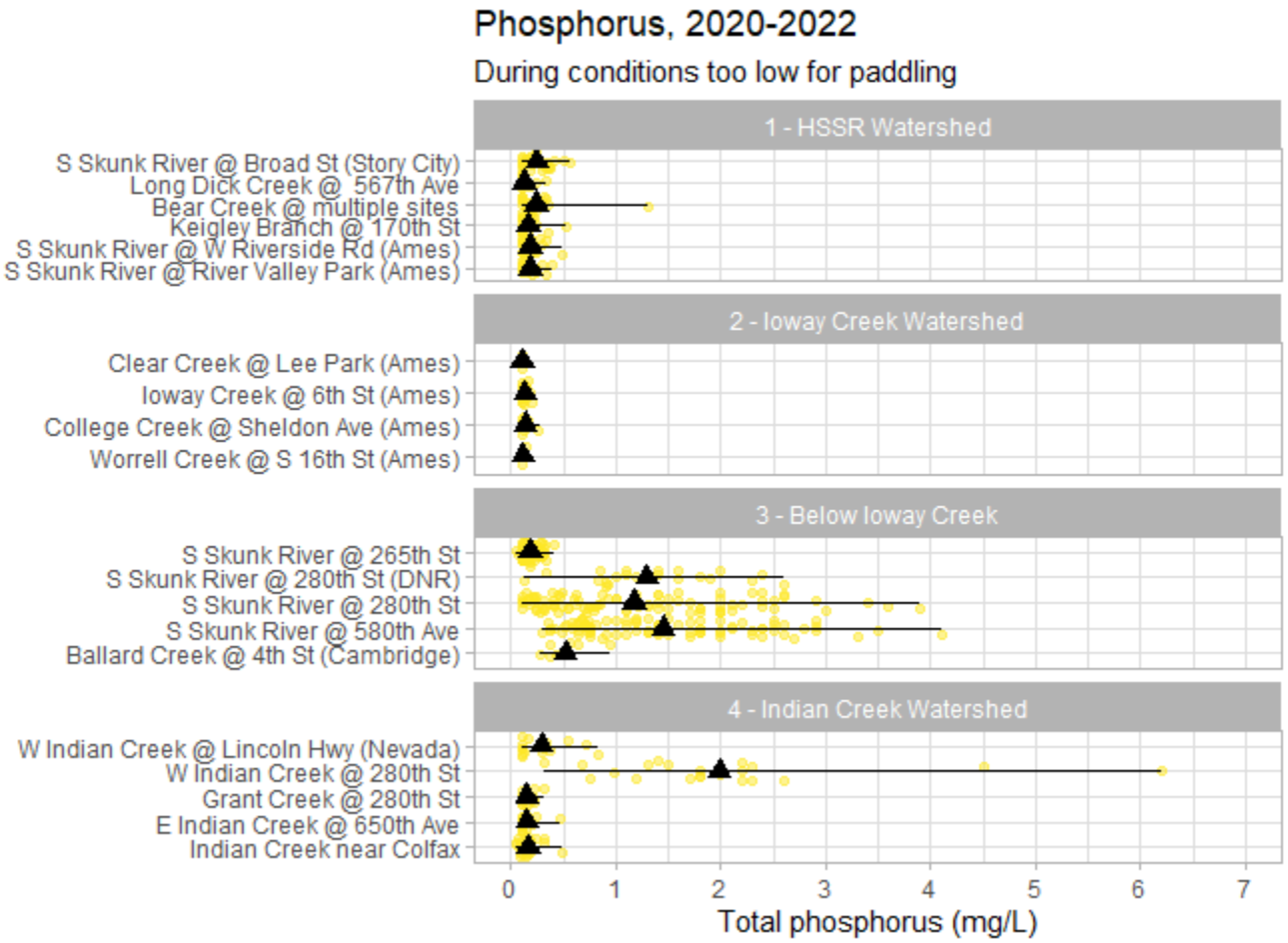
Phosphorus is an essential plant nutrient. Excess nitrogen and phosphorus in lakes and rivers can lead to harmful algae blooms, and hypoxia in the Gulf of Mexico. The lab measures total phosphorus, which includes both dissolved forms and forms bound to sediment. There are no relevant state standards for phosphorus in streams. Here we are most concerned with which streams have higher and lower phosphorus concentrations. Note that the minimum detection limit of our tests is usually 0.1 mg/L.



A major finding of the 2021 report was that phosphorus in Story County streams is highest at sites immediately downstream from wastewater treatment plants, especially during dry conditions when effluent is less diluted. This is true for all three years, but is more clearly seen by focusing on conditions too low for paddling.

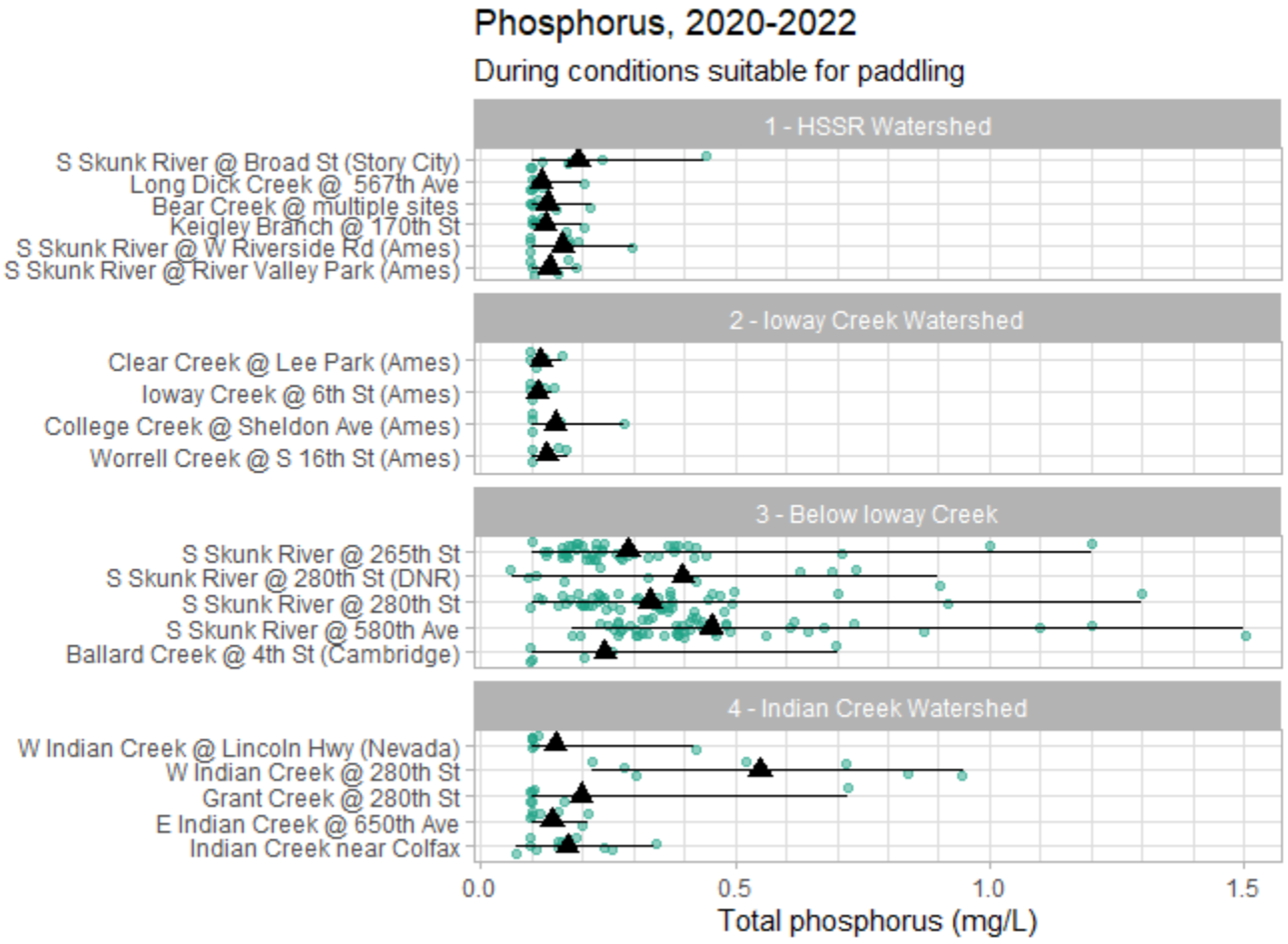
During conditions too low for paddling:

- Average total phosphorus is highest at sites that receive effluent from wastewater treatment plants (WWTP).
    - West Indian Creek @ 280th St (2.0 mg/L) is about 3 miles below the Nevada WWTP.
    - The South Skunk River @ 280th St (1.2-1.3 mg/L) is 0.3 miles below the outfall of the Ames WWTP. The S. Skunk River @ 580th St (1.5 mg/L) is 1.3 miles below the outfall (at the confluence with Walnut Creek).
    - Ballard Creek @ 4th St (0.5 mg/L) is about 4 miles below the Huxley WWTP but was frequently dry in summer and fall.
- Average total phosphorus at most sites is less than 0.3 mg/L.
    - Some of these sites are also downstream from a wastewater treatment plant, but the system may be smaller relative to the size of the stream or the distances are great enough to expect additional dilution or removal in the stream. For example, Ioway Creek @ 6th St (0.1 mg/L) is about 6 miles downstream of the Gilbert WWTP and the S. Skunk River @ W. Riverside Rd (0.2 mg/L) is 8 miles downstream of the Story City WWTP.
- A single high measurement at Bear Creek may be due to an issue during sample collection.



During conditions suitable for paddling:

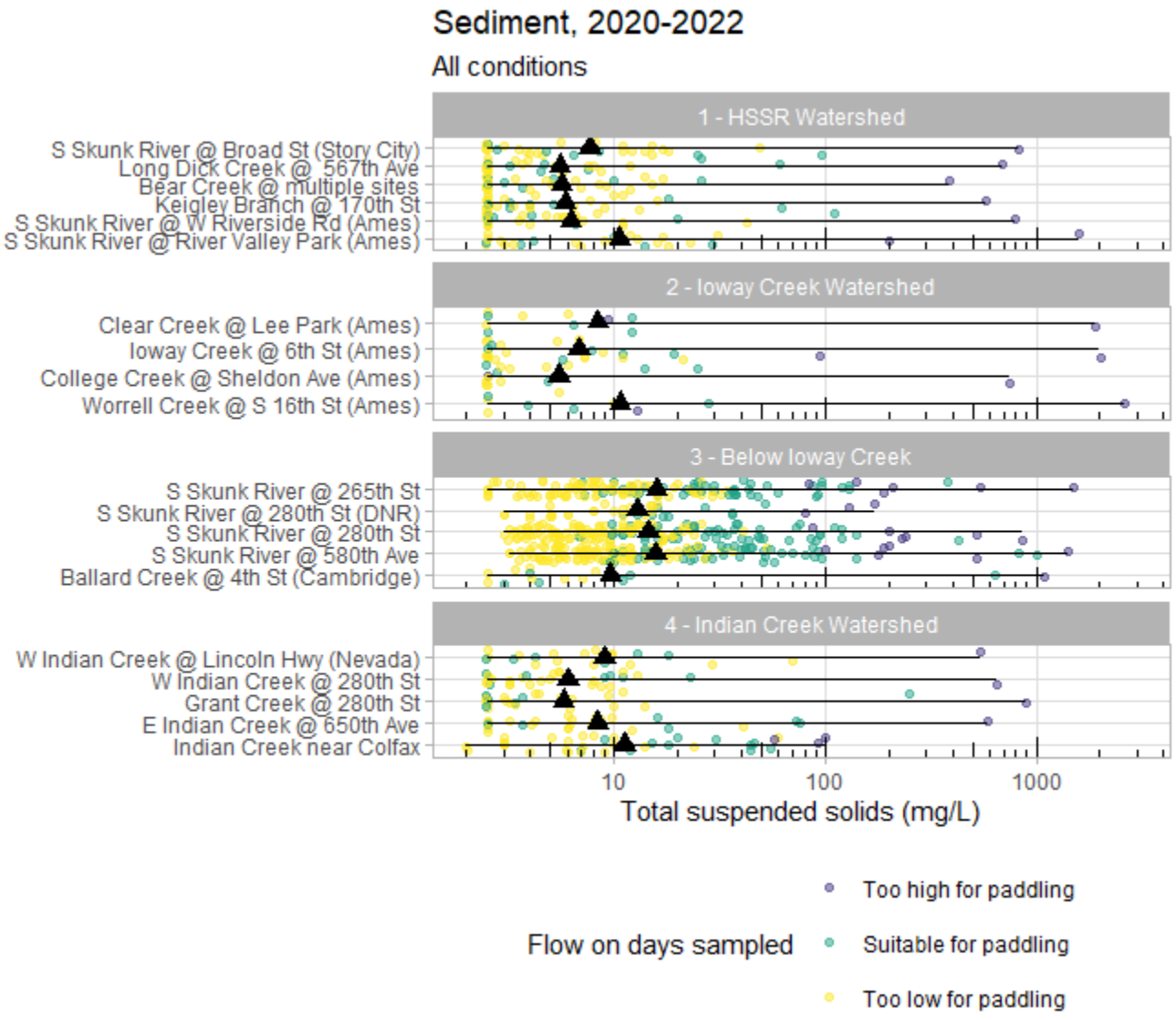
- Most sites were sampled seven times.
- Results are sensitive to sampling error, so small differences may not hold up. For example, the same site (South Skunk River at 280th St) was monitored weekly by City of Ames and monthly by Iowa DNR, with slightly different results (average of 0.33 mg/L vs 0.40 mg/L).
- Total phosphorus is still highest at sites downstream of wastewater treatment plants, but much lower than during conditions too dry for paddling.
    - 0.55 mg/L at West Indian Creek @ 280th St, versus 1.99 mg/L during dry conditions.
    - 0.45 mg/L in the South Skunk River @ 580th St, versus 1.46 mg/L during dry conditions.
- In the South Skunk River, total phosphorus was much higher at 265th St than at River Valley Park (0.29 mg/L versus 0.14 mg/L). Since Ioway Creek @6th St had low phosphorus (0.11 mg/L) this could indicate a phosphorus source somewhere in Ames.
- A storm event in May of 2022 affected some of sites in the southern part of the county, explaining some of the outliers.



Total suspended solids

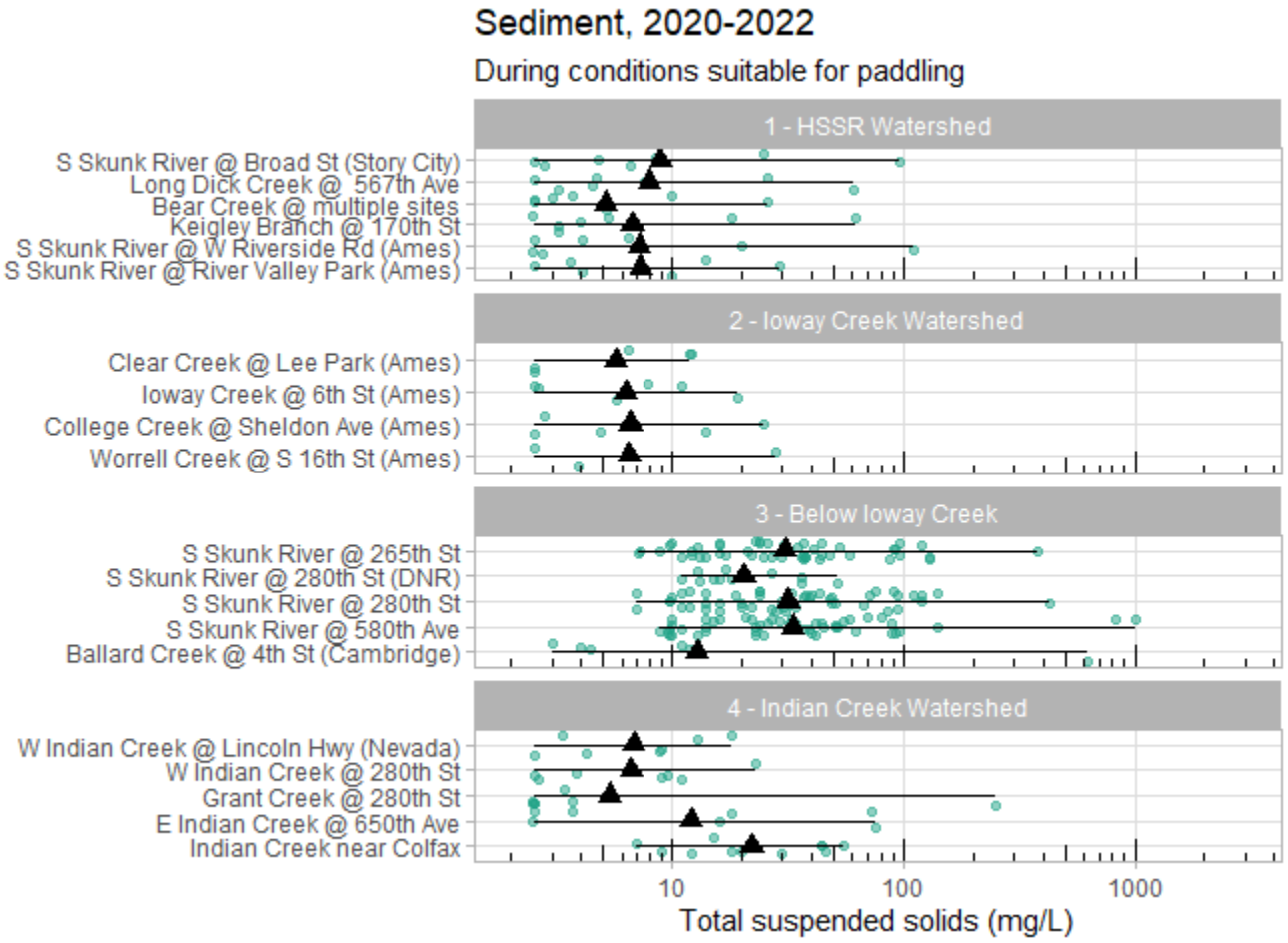
Too much sediment in the water can harm aquatic life and eliminate quality habitat (i.e. covering up rocks with silt). Sediment in the water is also an indication of the severity of erosion in the watershed or within the stream corridor. Total suspended solids (TSS) is one of several ways to measure sediment in the water, in this case, the dry weight of solids that settles out of a water sample.

Clear Creek in Ames normally lives up to its name with a median total suspended solids concentration of 6 mg/L. The lower limit of the test is 2.5 mg/L. However, after heavy rains, we've measured total suspended solids as high as 1,900 mg/L, 160 times higher! Most of our sites exhibit this degree of variability, which is why we will present the results on a logarithmic scale, with each tick mark representing a ten-fold increase. The average used is a geometric mean. We do not have a relevant benchmark for this metric, but the focus is on comparisons between streams.



During conditions suitable for paddling:

- Most monthly sites were sampled seven times. Given how much TSS varies, this does not appear to be enough data to draw reliable conclusions.
- In the South Skunk River, TSS was higher downstream of the confluence with Ioway Creek. However, these sites were monitored weekly and it's clear that timing and luck of the draw (sampling error) can influence results. The same site (South Skunk River at 280th St) was monitored weekly City of Ames and monthly by Iowa DNR, with different results (geomean of 32 mg/L vs 20 mg/L, respectively).
- Few samples were collected after heavy rains. A storm event in May of 2022 affected some of sites in the southern part of the county, explaining some of the outliers. (For more analysis of storm events, see page 47.)



Bacteria

E. coli is a bacteria found in the guts and feces of humans, other mammals, and birds. Because it is abundant in feces and easy to culture, we test it as an indicator of fecal contamination and a stand-in for a variety of other pathogens that could make people sick if they ingest contaminated water while recreating. *E. coli* counts may be measured and recorded as Colony Forming Units (CFU) or Most Probable Number (MPN) per 100 mL but for simplicity we will record both as "colonies/100mL".

2022 Recreational Season

The state standard for primary contact recreation or children's recreation has two components.

- The geometric mean for *E. coli* during the recreational season (March 15-November 15) should not exceed 126 colonies/100mL. At least seven samples are needed, spaced at least a week apart.
- Individual *E. coli* samples collected during the season should not exceed 235 colonies/100mL.

Of the two swimming beaches in Story County, one met the primary contact recreation standard in 2022.

Lakes	Number of samples	Number of samples exceeding 235	*E. coli* geometric mean (colonies/100mL)
Hickory Grove Park Lake	15	7	245
Peterson Park Beach	15	0	16

Of the 11 streams sites with enough data to evaluate a season geometric mean, only one site (the S. Skunk River at W. Riverside Road) met the primary contact recreation standard in 2022 (indicated in green). This site did have one sample exceeding 235 colonies per 100 mL, but it was collected following heavy rains and flooding. West Indian Creek (indicated in red) exceeded the secondary contact standard (a geometric mean of 630 colonies/100mL).

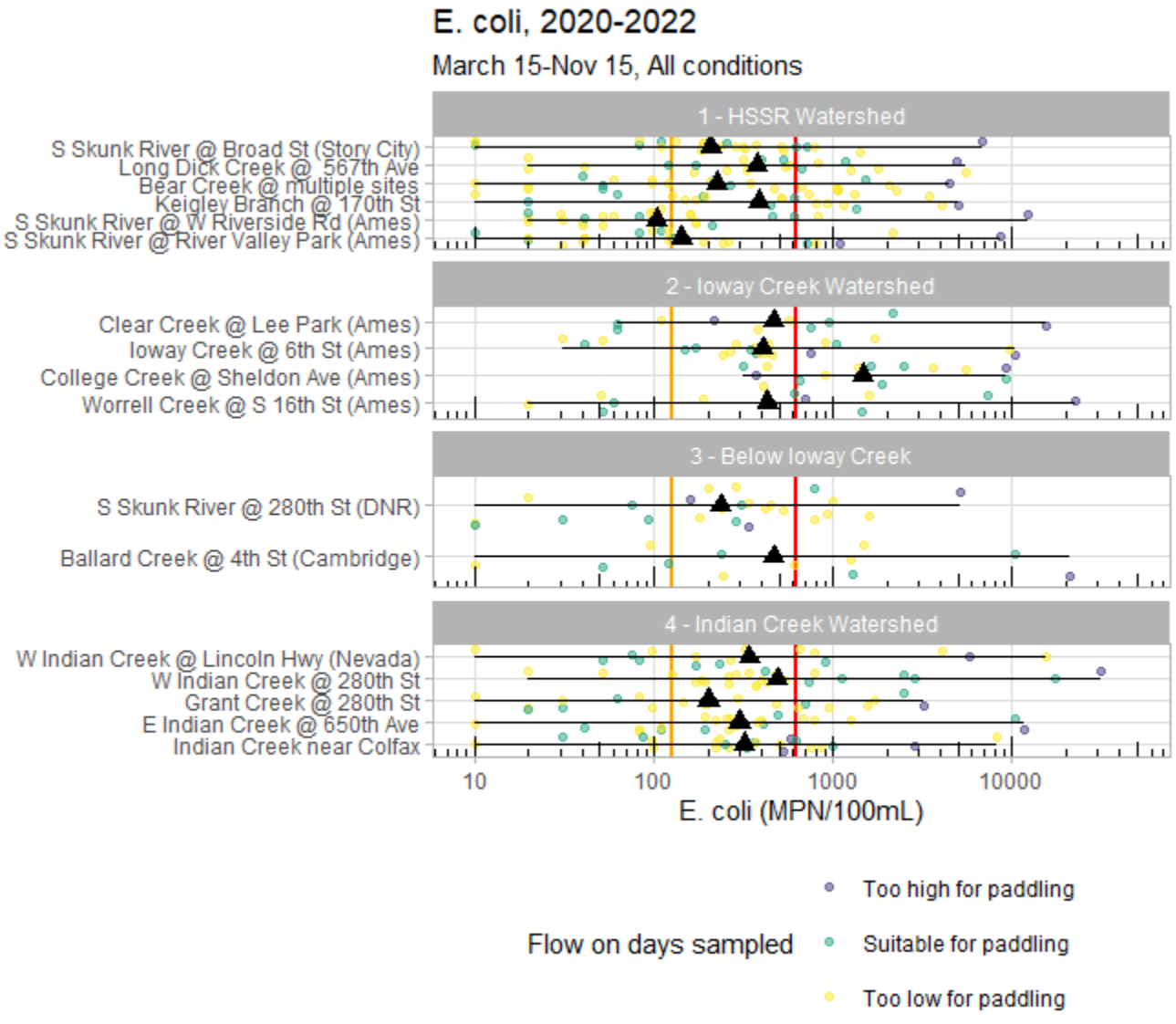
Streams	Number of samples	Number of samples exceeding 235	*E. coli* geometric mean (colonies/100mL)
W Indian Creek @ 280th St	9	6	843
Ioway Creek @ 6th St (Ames)	9	7	539
Keigley Branch @ 170th St	9	6	521
E Indian Creek @ 650th Ave	9	7	413
S Skunk River @ 280th St (DNR)	8	5	367
Long Dick Creek @ 567th Ave	9	6	306
Bear Creek @ Pleasant Valley Rd	9	5	291
S Skunk River @ River Valley Park (Ames)	8	4	225
Grant Creek @ 280th St	9	4	207
S Skunk River @ Broad St (Story City)	9	4	177
S Skunk River @ W Riverside Rd (Ames)	9	1	111

Bacteria in 2020-2022

The results from 2022 are typical of the past three years. On these graphs, the triangles are a geometric mean, the orange line indicates the primary contact recreation standard (a geometric mean of 126 colonies per 100mL) and red line indicates the secondary contact recreation standard (a geometric mean of 630 colonies/100mL).

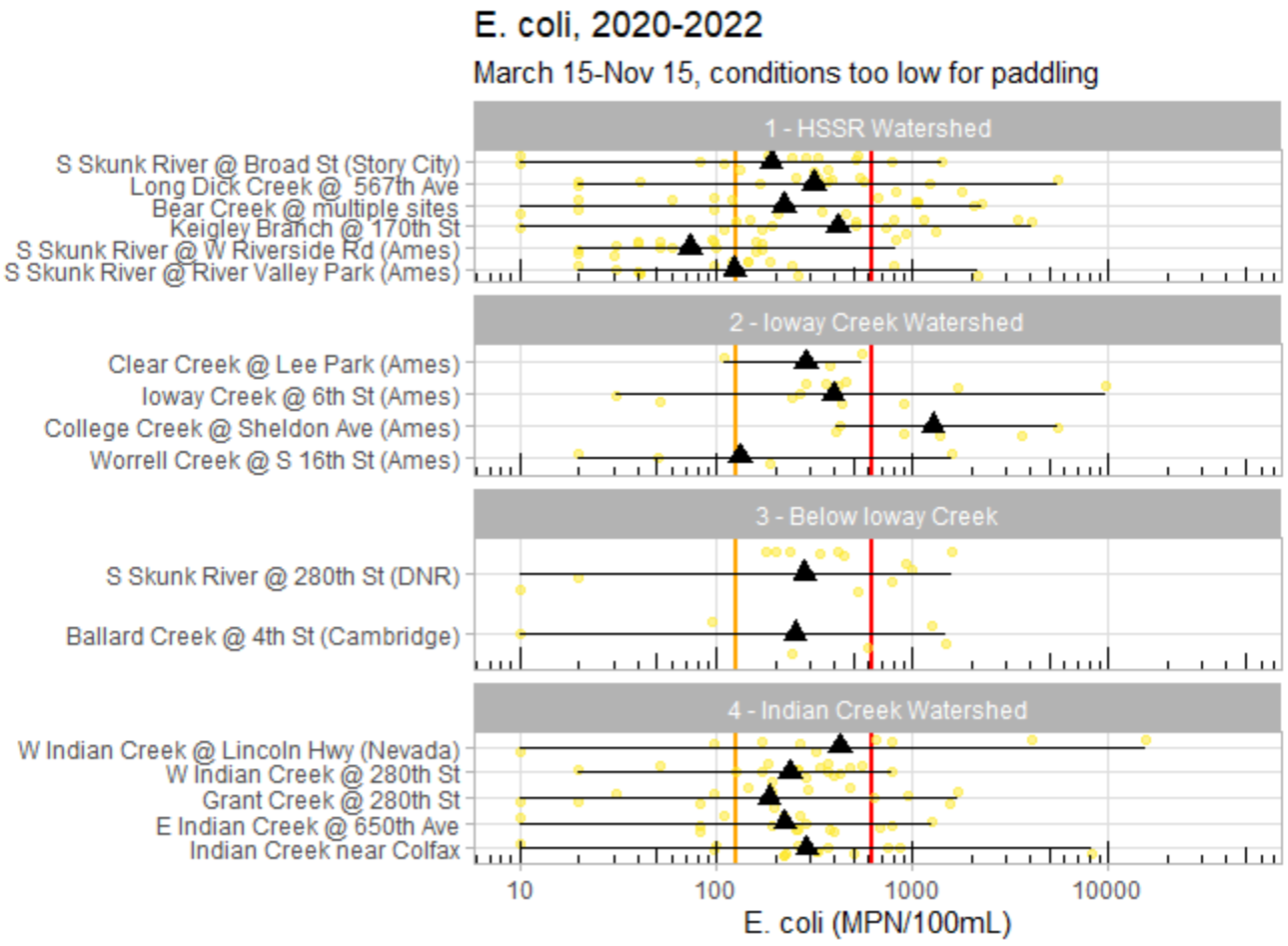
Over the past three years, during the recreation season when standards apply (March 15-November 15):

- 1 out of 17 sites met the primary contact standard. The South Skunk River at W. Riverside Rd. is downstream of the Skunk River Greenbelt. Riparian buffers are effective at removing E. col and other pollutants from runoff.
- 1 out of 17 sites (College Creek) exceeded the secondary contact recreation standard.



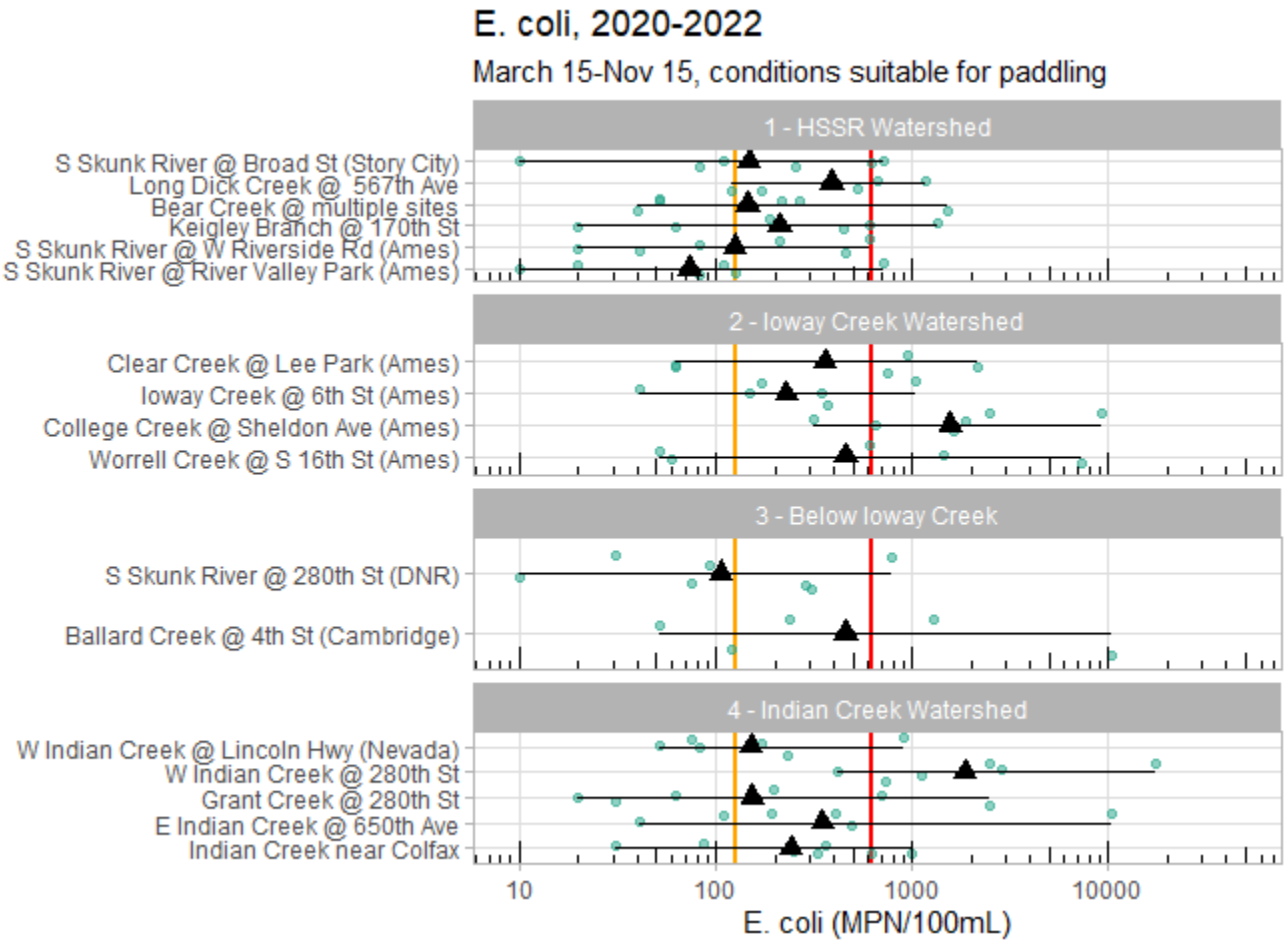
During conditions too low for paddling;

- 2 out of 16 sites met the primary contact recreation standard. Both are on the South Skunk River upstream of the confluence with Ioway Creek.
- Many streams are still used by children for wading, so high *E. coli* levels at Ioway Creek in Ames and West Indian Creek in Nevada are concerning.
- 1 out of 16 sites exceeded the secondary contact recreation standard. College Creek has previously been affected by illicit discharge, and we are now investigating whether aging sanitary sewers could be a source of bacteria.
- *E. coli* in the South Skunk River is higher downstream of Ioway Creek and Ames.
- *E. coli* in West Indian Creek is higher coming into Nevada than downstream.
- Possible sources of bacteria that would have a stronger influence when streams are low include:
    - Effluent from wastewater treatment plants that do not have a disinfection system.
    - Septic systems that need maintenance or are improperly discharging to the stream.
    - Droppings from cattle, geese, and other animals in and around the stream. *E. coli* is lowest in the S. Skunk River downstream of the greenbelt, which suggests that wildlife is not a major source.



During conditions suitable for paddling:

- Most sites were sampled six times during the recreational season. This may not be enough data to make reliable conclusions, but it does help that most sites (with the exception of the S. Skunk River at 280th St and Indian Creek near Colfax) were monitored on the same day.
- 3 out of 16 sites met the primary contact recreation standard. Of the four sites on the South Skunk River water trail, all but the Story City site met the standard.
- 3 out of 4 sites on the S. Skunk River water trail met the primary contact recreation standard.
- *E. coli* in the South Skunk River generally declined from upstream to downstream.
- 2 out of 16 sites exceeded the secondary contact recreation standard: College Creek at Sheldon Ave in Ames and W. Indian Creek at 280th St. These sites are both affected by runoff from developed areas.
- *E. coli* in West Indian Creek is much higher downstream of Nevada (at 280th St) than where it enters Nevada (at the Lincoln Hwy). Since this pattern does not happen during drier conditions, effluent from the wastewater treatment plant is not likely to be the main source. Other possibilities include stormwater runoff or leaking sanitary sewers.

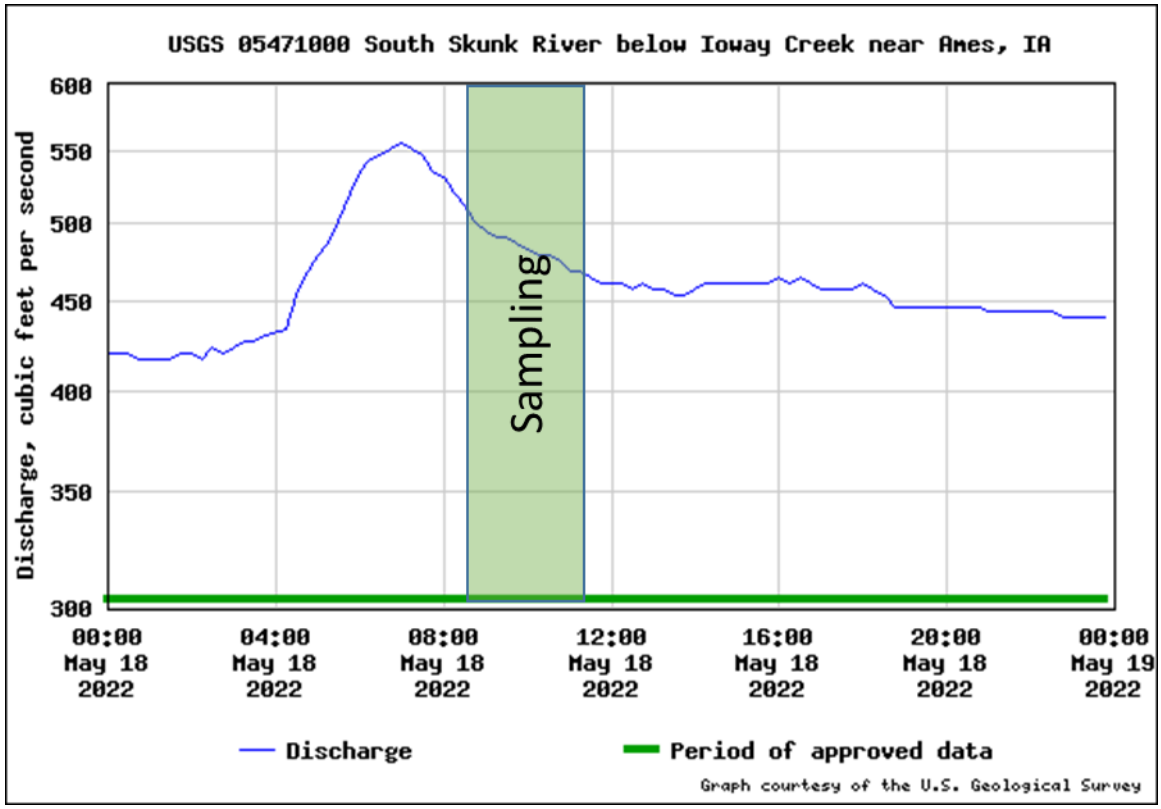


Results from two storm events

For our monthly sites, we only have one or two data points collected when streams were too high for paddling. However, a closer look at data from individual storms can be informative.

Heavy rains on June 15 lead to ponding and runoff across Story County. This grassed waterway is helping to reduce erosion.

We sampled on May 18, 2022, following overnight scattered showers that affected streams in the southern part of the county. Water levels in the South Skunk River were still suitable for paddling.

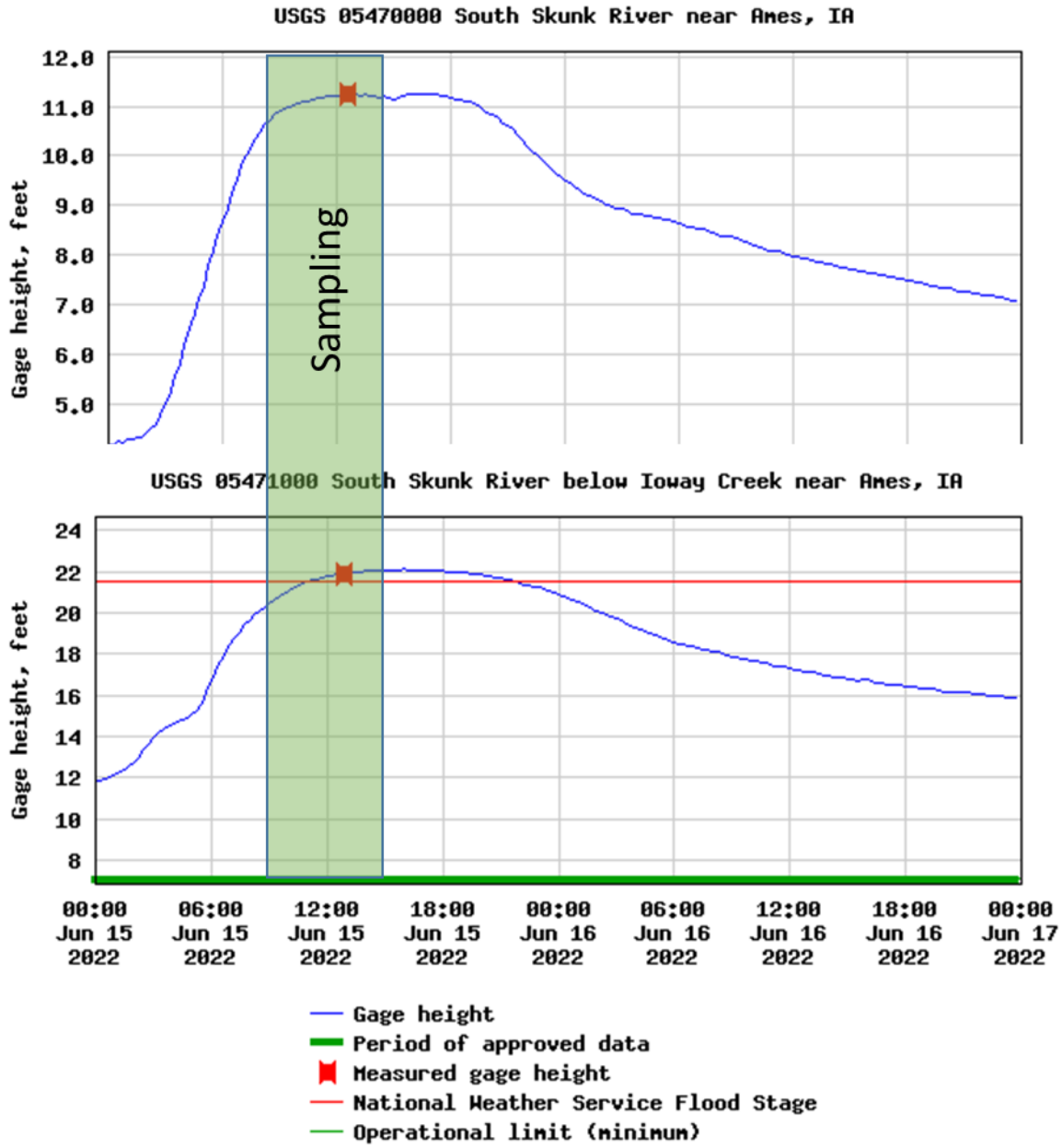


Findings from the May 18 storm include:

- Streams in the northern part of the county received light rain or no rain, and had TSS less than 20 mg/L and total phosphorus less than 0.2 mg/L. Sites in this normal range are shaded in gray.
- TSS exceeded 200 mg/L at three sites (shaded in red). Total phosphorus at these sites was at least 0.7 mg/L.
- Sediment, phosphorus, and *E. coli* were all 5-10x higher in the South Skunk River at 580th St compared to 280th St. We noticed a plume of muddy water from a drainage ditch that enters the South Skunk River between these sites. Walnut Creek also affects the 580th St site.
- Some sites with TSS and total phosphorus in the intermediate range have *E. coli* exceeding the secondary contact standard for a single sample (2,880 colonies/100mL). Perhaps *E. coli* remains suspended in the water after a pulse of runoff for longer than sediment and phosphorus.
- Despite their close proximity, Grant Creek had much higher sediment and phosphorus than West Indian Creek @ 280th St.
- Effluent does not have much influence on total phosphorus when the water is this high. Total phosphorus was about the same at 265th St (above the Ames WWTP) and at 280th St (below).

Site	Total Suspended Solids (mg/L)	Total phosphorus (mg/L)	*E. coli* (MPN/100mL)	Nitrate-N (mg/L)
W Indian Creek @ Lincoln Hwy (Nevada)	3.3	0.10	235	20
Bear Creek @ multiple sites	3.7	0.10	265	12
Long Dick Creek @ 567th Ave	4.5	0.10	529	19
Keigley Branch @ 170th St	5.2	0.10	452	13
S Skunk River @ W Riverside Rd (Ames)	6.5	0.10	213	15
Ioway Creek @ 6th St (Ames)	7.8	0.10	345	12
S Skunk River @ Broad St (Story City)	8.5	0.12	256	14
S Skunk River @ River Valley Park (Ames)	9.9	0.10	109	15
Clear Creek @ Lee Park (Ames)	12	0.10	2,143	11
W Indian Creek @ 280th St	23	0.31	17,329	16
College Creek @ Sheldon Ave (Ames)	25	0.15	9,208	2.3
Worrell Creek @ S 16th St (Ames)	28	0.17	7,270	11
E Indian Creek @ 650th Ave	73	0.21	10,462	14
S Skunk River @ 280th St	95	0.23	1,518	12
S Skunk River @ 265th St	120	0.24	1,816	12
Grant Creek @ 280th St	250	0.72	2,475	13
Ballard Creek @ 4th St (Cambridge)	630	0.70	10,490	8.5
S Skunk River @ 580th Ave	1000	1.50	10,170	11

We sampled on June 15, 2022 when the South Skunk River was too high for paddling. At the Ames Airport it rained 0.51 inches late on June 14, and 1.66 inches on the morning of June 15. The South Skunk River reached flood stage by noon at the S. 16th St gage, below the confluence with Ioway Creek.



On June 15, 2022:

- All sites had total suspended solids exceeding 200 mg/L.
  - Five sites had TSS exceeding 1000 mg/L.
  - TSS in Clear Creek @ Lee Park in Ames measured 1,900 mg/L, 160 times higher than typical levels observed during the past three years (median 6 mg/L, all conditions).
- All sites had *E. coli* bacteria exceeding the secondary contact recreation standard (2,880 colonies/100 mL).
- In West Indian Creek, *E. coli* was much higher downstream of Nevada, but TSS was not much higher.
- In the South Skunk River, TSS is not much different above and below the confluence with Ioway Creek.
- Phosphorus was not be tested due to a supply chain issue.
- *E. coli* is not tested at the three weekly sites. The Iowa DNR tests at 280th St, but on a different schedule.

Site	Total Suspended Solids (mg/L)	*E. coli* (MPN/100mL)	Nitrate-N (mg/L)
S Skunk River @ Broad St (Story City)	820	6,896	15.0
Long Dick Creek @ 567th Ave	690	4,962	7.8
Bear Creek @ multiple sites	390	4,494	7.8
Keigley Branch @ 170th St	580	4,978	12.0
S Skunk River @ W Riverside Rd (Ames)	790	12,262	8.4
S Skunk River @ River Valley Park (Ames)	1,600	8,704	8.8
Clear Creek @ Lee Park (Ames)	1,900	15,402	3.1
Ioway Creek @ 6th St (Ames)	2,000	10,344	5.8
College Creek @ Sheldon Ave (Ames)	750	9,222	2.7
Worrell Creek @ S 16th St (Ames)	2,600	22,398	3.4
S Skunk River @ 265th St	1,500		6.4
S Skunk River @ 280th St	860		6.4
S Skunk River @ 580th Ave	1,400		6.6
Ballard Creek @ 4th St (Cambridge)	1,100	20,924	8.0
W Indian Creek @ Lincoln Hwy (Nevada)	540	5,818	12.0
W Indian Creek @ 280th St	650	31,062	9.2
Grant Creek @ 280th St	890	3,194	8.6
E Indian Creek @ 650th Ave	590	11,588	14.0

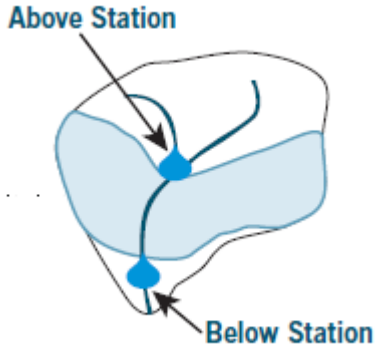
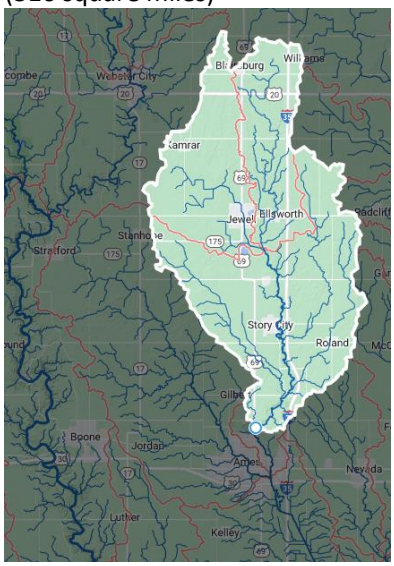
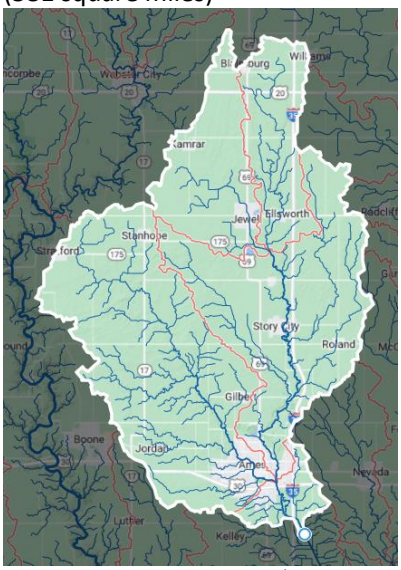
Results: Lab Testing, Long-term trends

The South Skunk River at W. Riverside Rd was monitored monthly by the Iowa DNR from October 2000 to September of 2014. Local partners resumed monthly monitoring in April of 2020. This site is just upstream of Ames and has a watershed closely corresponding to the Headwaters of the South Skunk River Watershed Management Authority.

For the newly formed Headwaters of the South Skunk River WMA, having a fourteen year baseline will be helpful for progress tracking as conservation efforts proceed. However data from this site is also helpful for tracking the progress of conservation efforts in the Ioway Creek Watershed and the City of Ames.

- We can compare this site to the South Skunk River at 265th St, which has been monitored weekly by the City of Ames since January of 2003. This site is downstream from the confluence with Ioway Creek, but upstream from the Ames Water Pollution Control Facility. Available data includes nitrate, total phosphorus, and total suspended solids.
- We can compare *E. coli* data from this site to the South Skunk River at 280th St, which has been monitored by the Iowa Department of Natural Resources monthly since October of 1998. This site is downstream from the Ames Water Pollution Control Facility.

By comparing an upstream site to a downstream site, and comparing recent data to a baseline period, we effectively have a ***nested watershed*** **or** ***upstream/downstream*** **monitoring design, which is much more effective for trend monitoring than a single station.**

Nested watershed design	Watershed for upstream station	Watershed for downstream station
	S. Skunk River @ W. Riverside Rd (316 square miles) 	S. Skunk River @ 280th St (581 square miles)  Or S. Skunk River @ 265th St (573 square miles)

Ioway Creek Watershed was the focus for a state Water Quality Initiative project (2016-2019), managed by Prairie Rivers of Iowa and supported by members of the Watershed Management Authority. We held field days and helped farmers to plant cover crops, switch to no-till, and construct a bioreactor. The project included biweekly monitoring of Ioway Creek at Lincoln Way during the growing season in 2016, 2017, and 2018 but we shifted our focus after learning that to detect a subtle trend over the noise of weather-related variation, we would need both a large number of samples and a monitoring strategy that can control for some of the variation.[6]

Coming at the challenge indirectly, we were able to get more data and a sampling design that can control for variation! We have 14 years of water quality data from before this project, and 3 years of data from after the project. We have one site on the South Skunk River downstream from the confluence with Ioway Creek, and another in the South Skunk River upstream of the confluence. It's a bit like a medical study with treatment and control groups, and a before and after period.

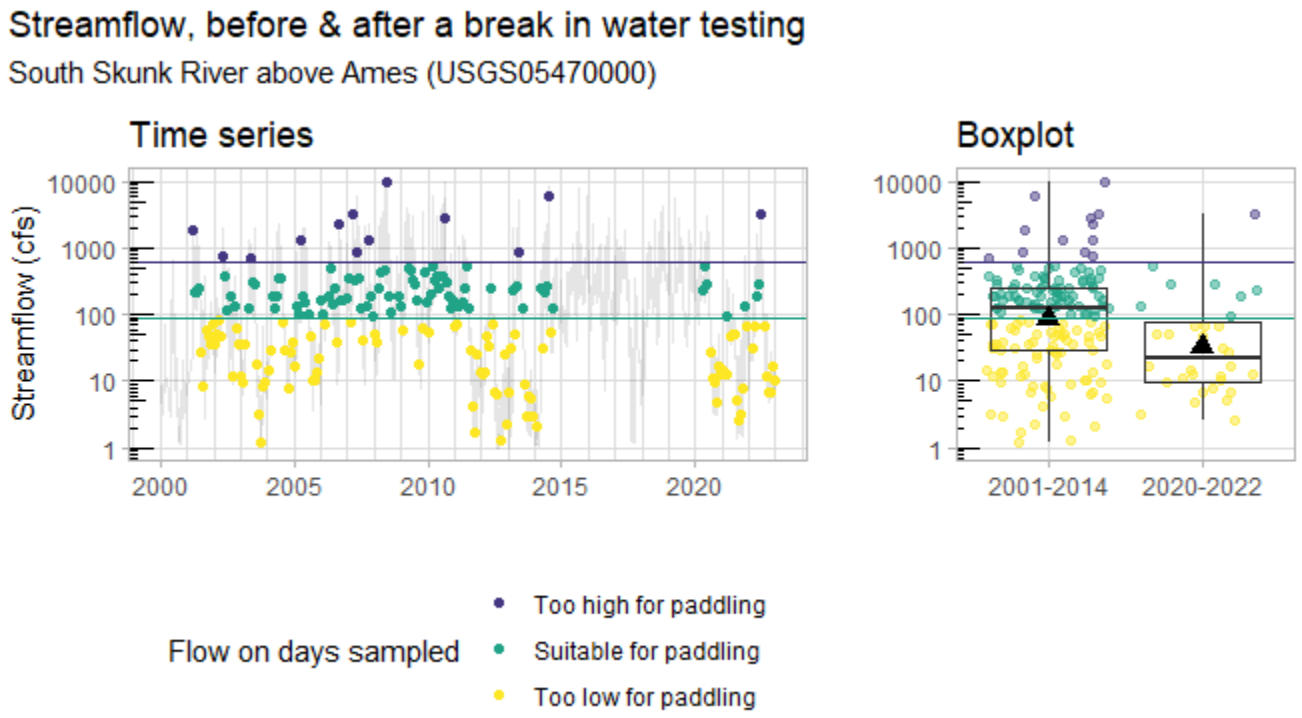
Unlike a medical study, we can't ensure that the "treatment" group takes its medicine, or that the "control" group gets only a placebo. In the final year of the Ioway Creek watershed project, farmers that participated in the program installed a bioreactor, planted 1,529 acres of cover crops and converted 2,300 acres to strip till or no-till. In a 147,000 acre watershed, we would not expect that to reduce nitrogen and phosphorus by more than a percent or two. While we hope that farmers who tried cover crops or no-till have continued the practice and persuaded some of their neighbors to give it a try, we don't know for sure that this has happened. The Headwaters of the South Skunk River Watershed also includes some conservation practices. Some were installed prior to the baseline period (a greenbelt on the South Skunk River and a riparian buffer demonstration project on Bear Creek) but we know of saturated buffers, at least one CREP wetland, one bioreactor, and some cover crops that have been installed since. A more complete inventory of practices in both watersheds would be helpful.

The focus of the Ioway Creek watershed project was nitrogen and phosphorus, but there have been several other projects installed since the baseline period that should improve water quality at the downstream site. These include:

- UV disinfection systems installed by the City of Ames (2015), City of Gilbert (2015) and Squaw Valley Neighborhood Association (2020) which should reduce *E. coli*, especially during dry conditions when effluent is less diluted.
- Lining of aging sanitary sewers in Ames (2017-present). The purpose is to reduce the amount of rainwater getting into sanitary sewers (infiltration and inflow), but this could also prevent sewage from leaking out into streams—reducing *E. coli*, nitrogen, and phosphorus. Further investigation is needed to determine whether this is a likely source of contamination and where and under what conditions it would have occurred.
- Stream stabilization at three parks in Ames: the Tedesco Environmental Learning Corridor (2017-2019), Stuart Smith Park (2016-2017), and Carr Park (2021) which should reduce sediment and phosphorus pollution from bank erosion, especially after large storm events.
- Various projects in Ames to control stormwater runoff and flooding, including a permeable parking lot and storage at Ames City Hall (2017). Reducing the velocity of water after storm events should also reduce sediment and phosphorus pollution from bank erosion after storm events.

[6] "Progress tracking is not a realistic use for typical stream monitoring approaches", Dan Haug, presented at the 2021 Iowa Water Conference. https://www.prrcd.org/poster-2021-iwc/

The last three years have been drier than normal. Three quarters of the monthly samples from 2020-2022 were collected when the South Skunk River was too low for paddling, versus one-half the monthly samples in the 2001-2014 period. This raises the possibility that any water quality trends we observe are an artifact of differences in precipitation and streamflow that will be reversed if we get a few years with more normal rainfall. We can use streamflow in the South Skunk River (see pg 34) to sort out the relevant conditions and make an apples-to-apples comparison. To evaluate conservation practices that treat nitrate in drainage water or runoff, we can focus on periods "suitable for paddling" when tiles are likely to be flowing. To evaluate the benefits of UV disinfection systems that treat wastewater, we can focus on periods "too low for paddling" when effluent is less diluted.



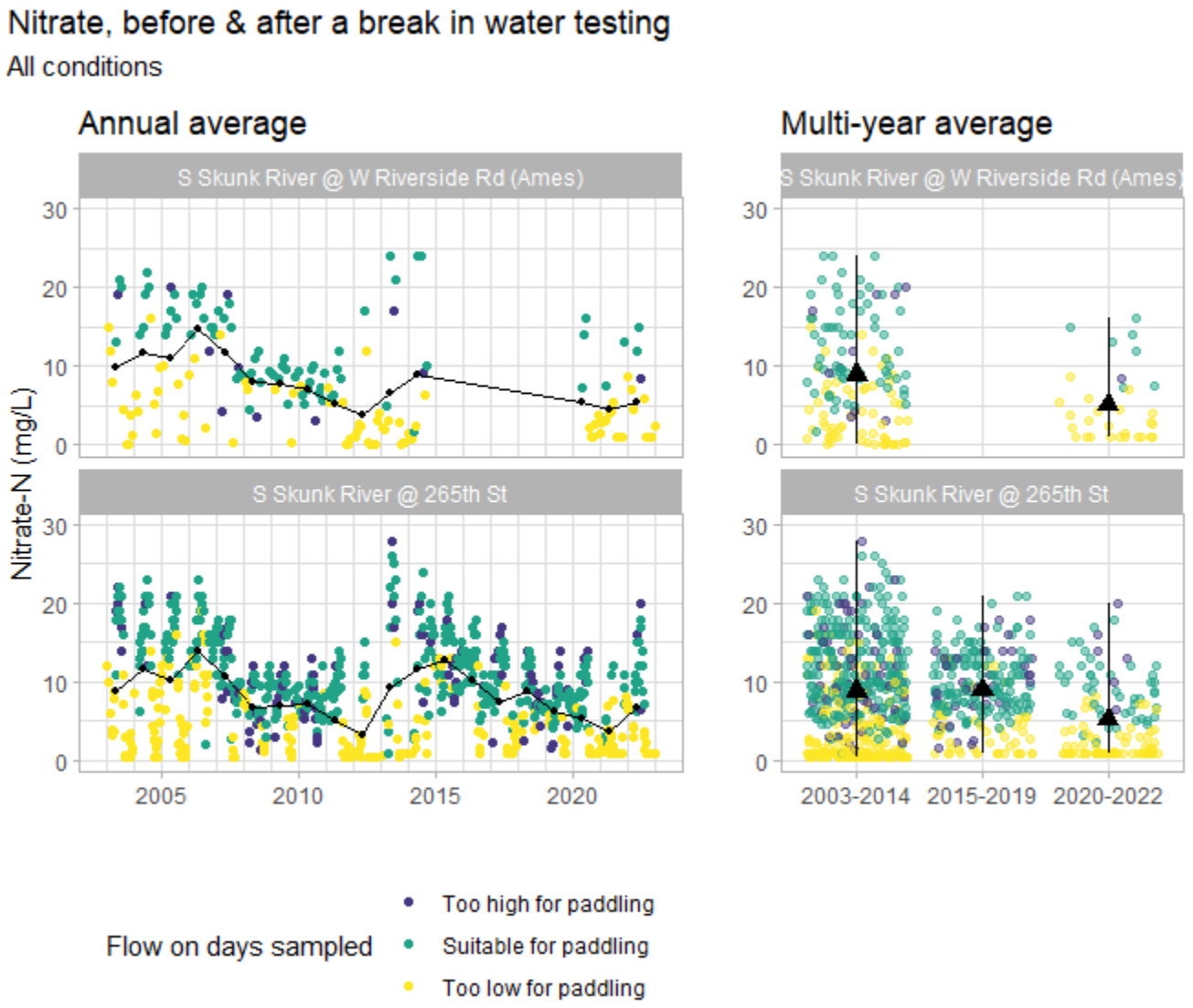
Key findings

Bottom line, there has been a lot of work done in the past decade to improve water quality in the South Skunk River, and we might expect there would be a little more improvement below the confluence with Ioway Creek than in the South Skunk River upstream of Ames (the Headwaters of the South Skunk River watershed). By comparing recent data (2020-2022) to our baseline (2001-2014 or 2003-2014), we observe the following:

- During conditions suitable for paddling when tiles are usually flowing, nitrate decreased at the downstream site.
- During conditions suitable for paddling, *E. coli* has decreased at both sites.
- During conditions too low for paddling when wastewater would have the most influence, *E. coli* decreased at the downstream site.
- Trends for sediment and phosphorus are less certain, and we do not have enough recent data from periods of high flow. During conditions suitable for paddling, total suspended solids decreased at both sites, but total phosphorus increased at the downstream site.

Nitrate

Comparing 2020-2022 to the baseline period, nitrate has decreased at both sites following the gap in monitoring. The drop is bigger at the upstream site (from 9.3 mg/L to 5.0 mg/L) than the downstream site (8.4 mg/L to 5.2 mg/), but is the improvement related to conservation or just drier weather in the 2020-2022 period?

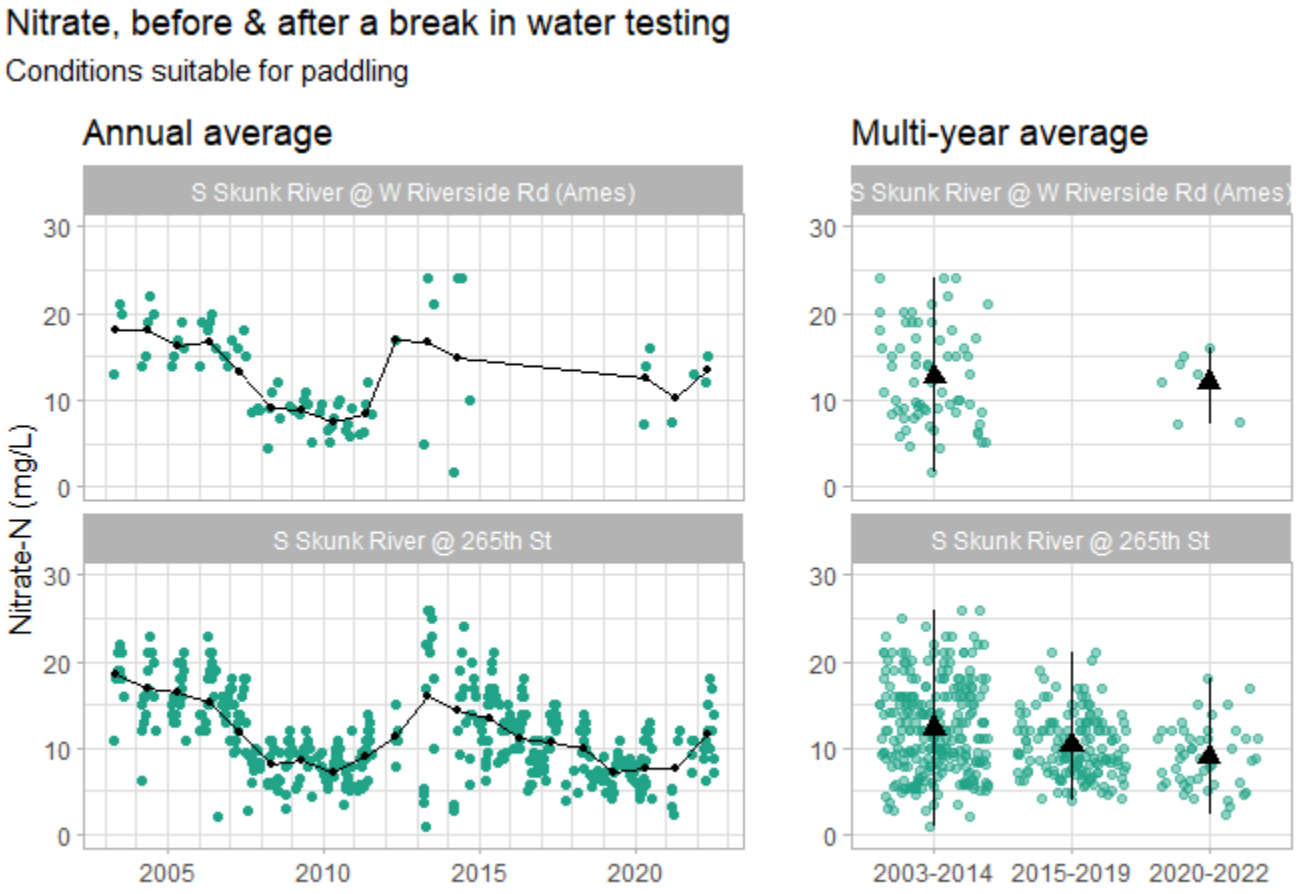


Nitrate in the South Skunk River shows a cyclical pattern, not a linear trend. We tend to get our highest nitrate readings when a wet spring follows a drought[7] but this can be balanced out by low nitrate concentrations during dry periods. At 265th St, average annual nitrate fell from 14.0 mg/L in 2006 to 3.1 mg/L in 2012, rose to 12.8 mg/L in 2015, and fell back to 3.7 mg/L in 2021.

[7] See: Loecke et al. 2017. Weather whiplash in agricultural regions drives deterioration of water quality. https://link.springer.com/article/10.1007/s10533-017-0315-z

Focusing only on periods when there was enough water in the river for paddling and drainage tiles were generally flowing:

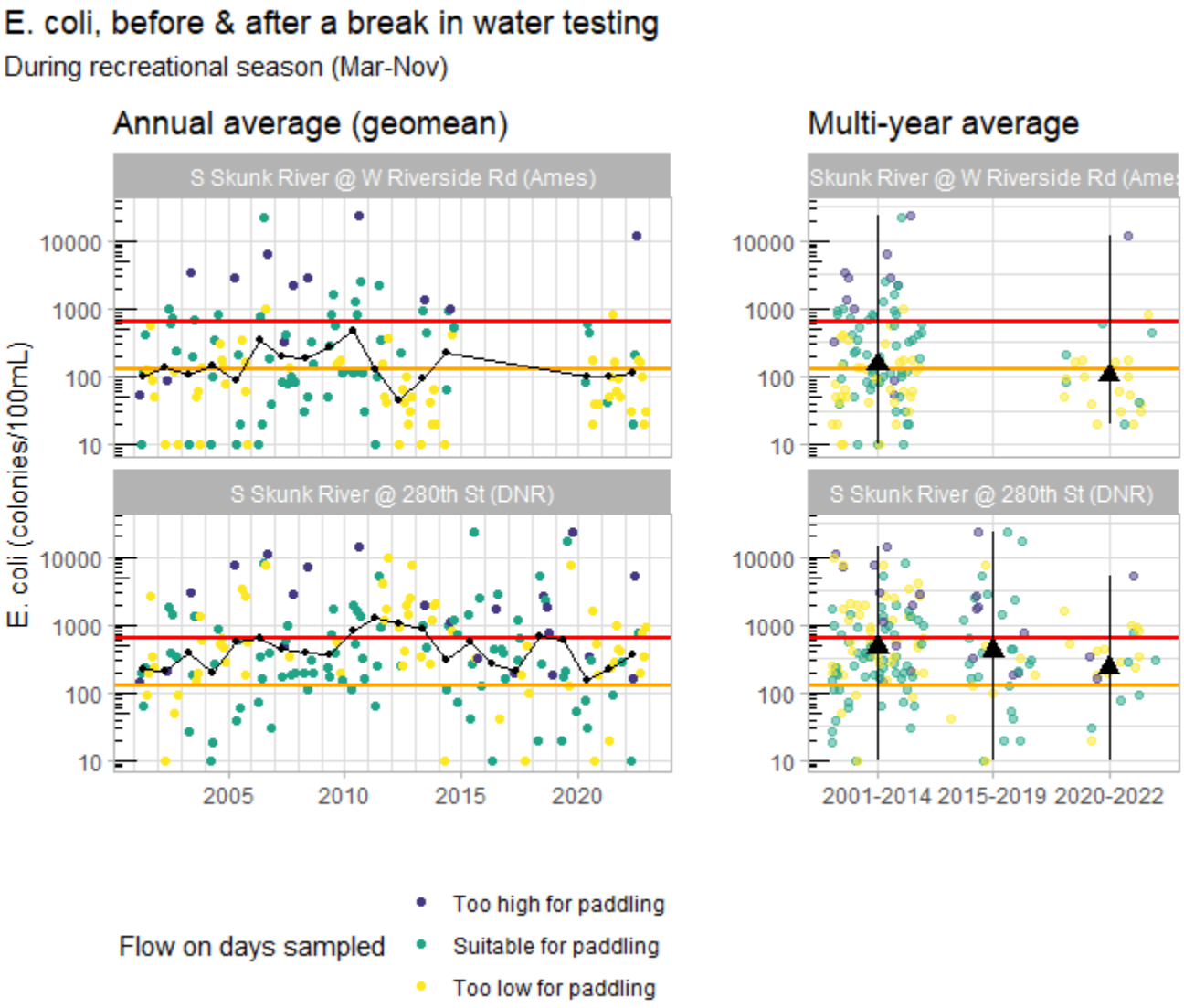
- Average nitrate concentrations at the upstream site (S. Skunk River at W. Riverside Rd) decreased by 1.0 mg/L, from 13.1 mg/L to 12.1 mg/L between 2003-2014 and 2020-2022.
- Average nitrate concentrations at the downstream site (S. Skunk River at 265th St) decreased by 3.4 mg/L, from 12.3 mg/L to 8.9 mg/L. This is consistent with improvements due to conservation in the Ioway Creek watershed.
- A long-term cycle is still apparent, but nitrate in 2022 is not as high as in some previous episodes of "weather whiplash."



- Though not shown here, nitrate also decreased by 3.4 mg/L at Indian Creek near Colfax (8.2 to 4.8 mg/L). If these changes are related to land management, then this watershed is also making good progress.
- This report does not include tests of statistical significance, but it is encouraging that we get very similar results for the South Skunk at 280th St using weekly data from the City of Ames (declining from 12.1 to 9.0 mg/L) and monthly data from the Iowa DNR (declining from 11.8 to 9.0 mg/L).

Bacteria

E. coli was not tested at the weekly sites, but was tested monthly by Iowa DNR in the South Skunk River at 280th St . These graphs show a geometric mean for individual years. The recreational standard only applies from March 15-November 15, so samples collected during winter were omitted. The orange line indicates the primary contact recreation standard (a geometric mean of 126 colonies per 100mL) and red line indicates the secondary contact recreation standard (a geometric mean of 630 colonies/100mL).



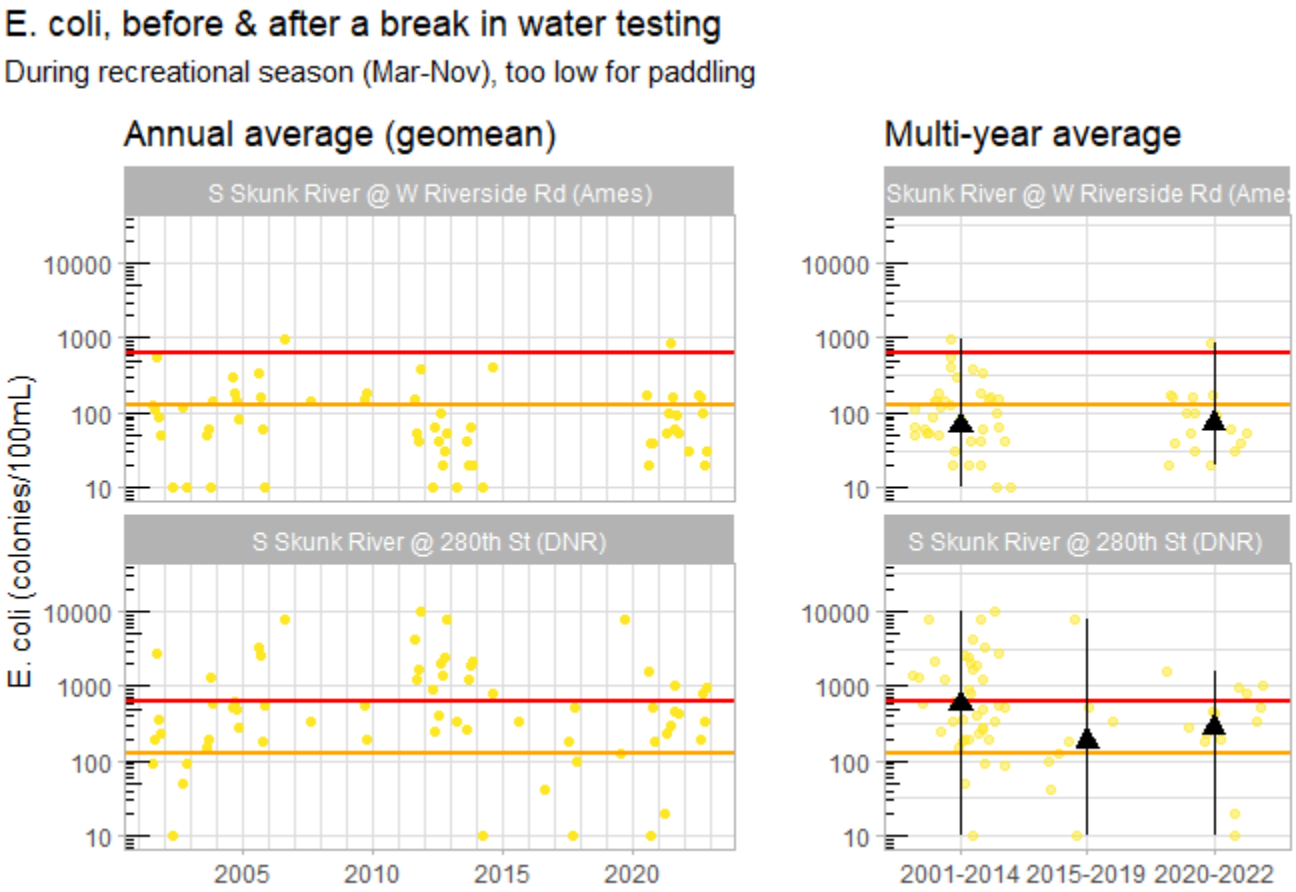
At the upstream site:

- *E. coli* met the primary contact standard in 2020, 2021, and 2022
- *E. coli* exceeded the standard in 2014 and in 12 out of 17 years between 2021-2014.
- On average, E. coli was decreased from 150 colonies in 2001-2014 to 104 colonies/100mL in 2020-2022.

At the downstream site:

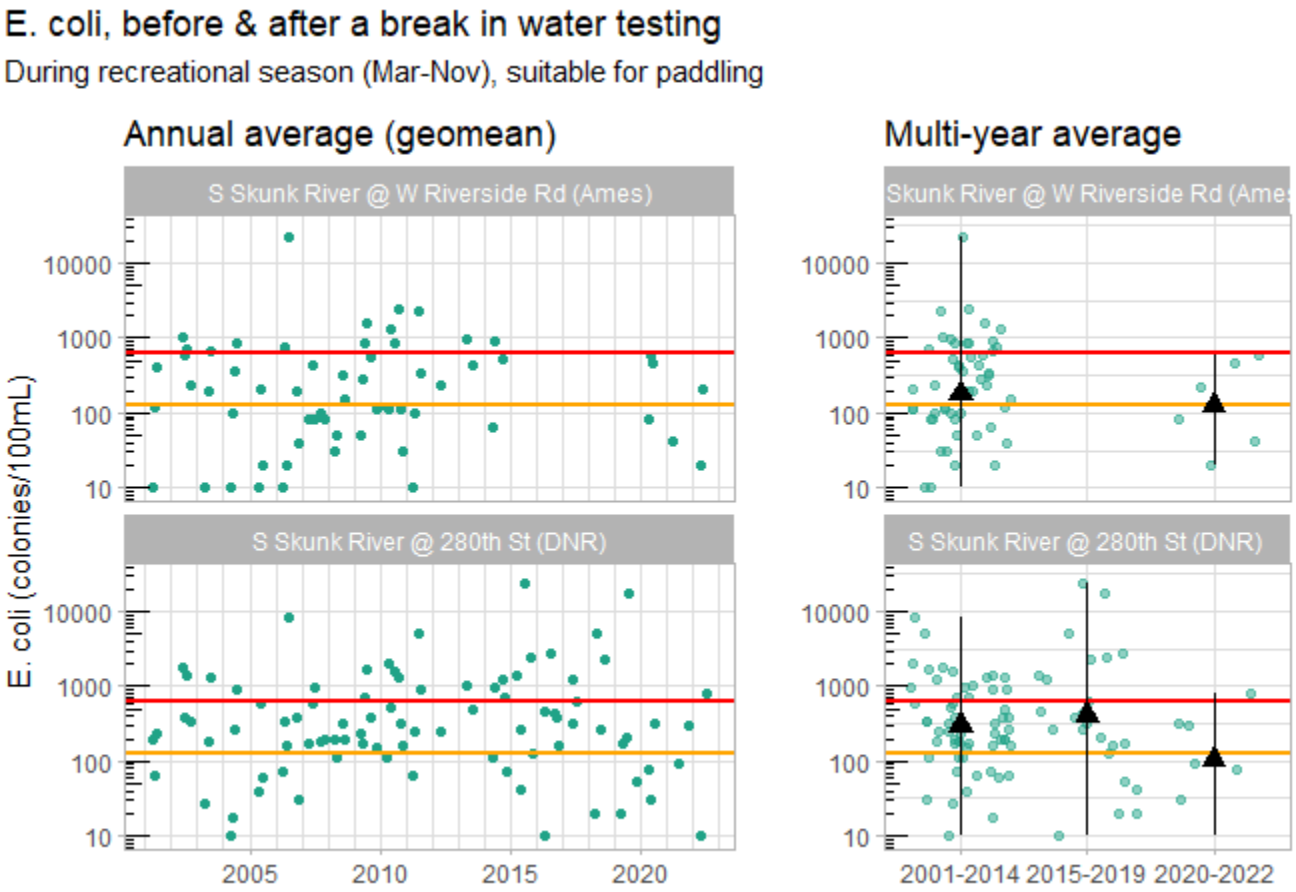
- *E. coli* exceeded the primary contact recreation standard in every year tested.
- *E. coli* exceeded the secondary contact recreation standard in 2010, 2011, 2012, 2013 and 2018.
- *E. coli* decreased from 464 colonies/100mL in 2001-2014 to 236 colonies/100mL in 2020-2022.

The Ames Water Pollution Control Facility installed a UV disinfection system in 2015. The Gilbert sewage treatment plant installed a UV disinfection system in 2019. These would affect the downstream site only, especially when water levels are low and effluent is less diluted. Both sites are likely affected by septic systems and animals in the stream during these conditions.



During conditions too low for paddling:

- *E. coli* at the upstream site increased slightly from 67 colonies/100mL in 2001-2014 to 74 colonies/100mL in 2020-2022.
- *E. coli* at the downstream site decreased from 572 colonies/100mL in 2001-2014 to 74 colonies/100mL in 2020-2022. *E. coli* was especially low in the 2015-2019 period (180) but these were wetter years and we have fewer samples.
- Annual averages are not shown, since some years only have one or two samples collected during these conditions.



During conditions suitable for paddling:

- *E. coli* at the upstream decreased from 180 colonies/100mL in 2001-2014 to 126 colonies/100mL in 2020-2022.
- *E. coli* at the downstream site decreased from 299 colonies/100mL in 2001-2014 to 106 colonies/100mL in 2020-2022. *E. coli* was highest in the 2015-2019 period (405 colonies/100mL).
- It's not clear what changes in the watershed would explain these trends.
- During the past three years, both sites generally met the primary contact standard during conditions the South Skunk River Water Trail is mostly likely to be used for canoeing, kayaking, and swimming.
- Annual averages are not shown, since some years only have one or two samples collected during these conditions.

Paddling on the South Skunk River between Ames and Cambridge

Phosphorus and suspended solids

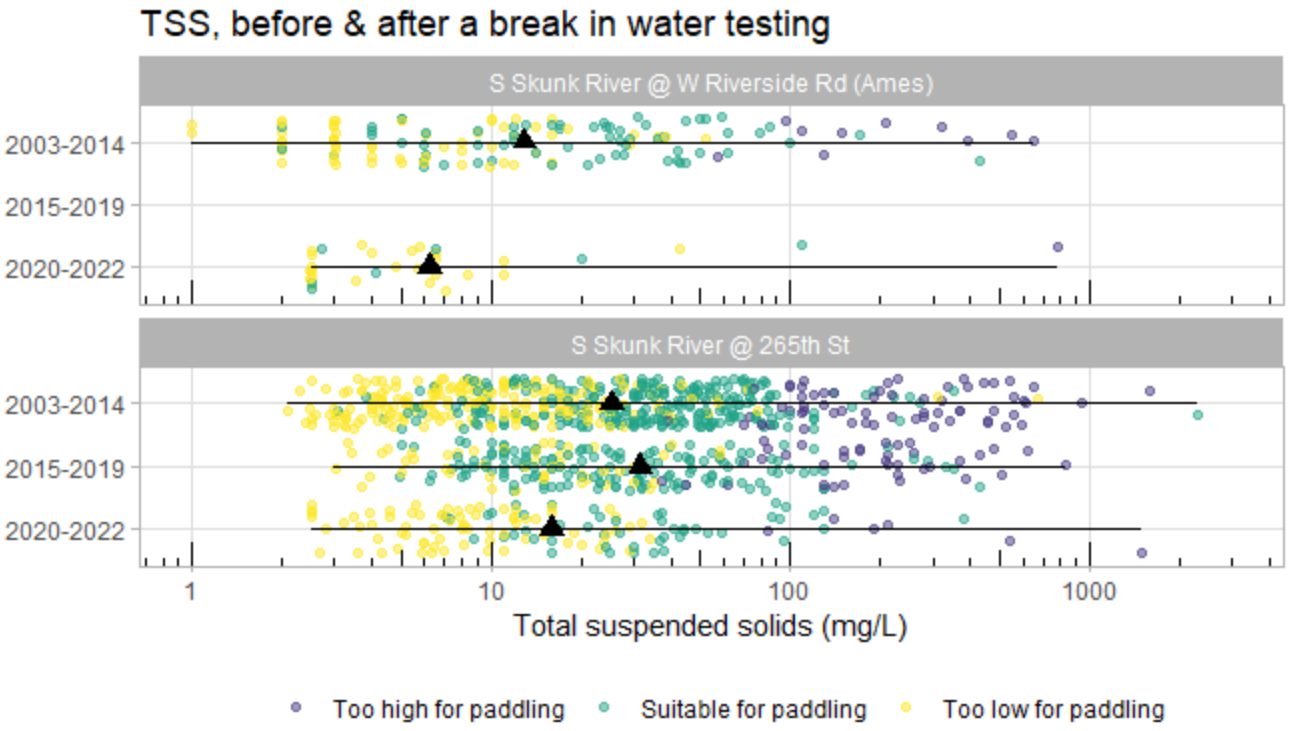
Phosphorus is often attached to sediment, and conservation practices that prevent soil erosion or filter out sediment from runoff will address both pollutants, so we will look at these trends together. Total phosphorus and total suspended solids data are available from five sites, but for simplicity we will focus on two sites—the South Skunk River at W. Riverside Rd (upstream from Ames) and the South Skunk River at 265th St (downstream from Ames and downstream from the confluence with Ioway Creek).

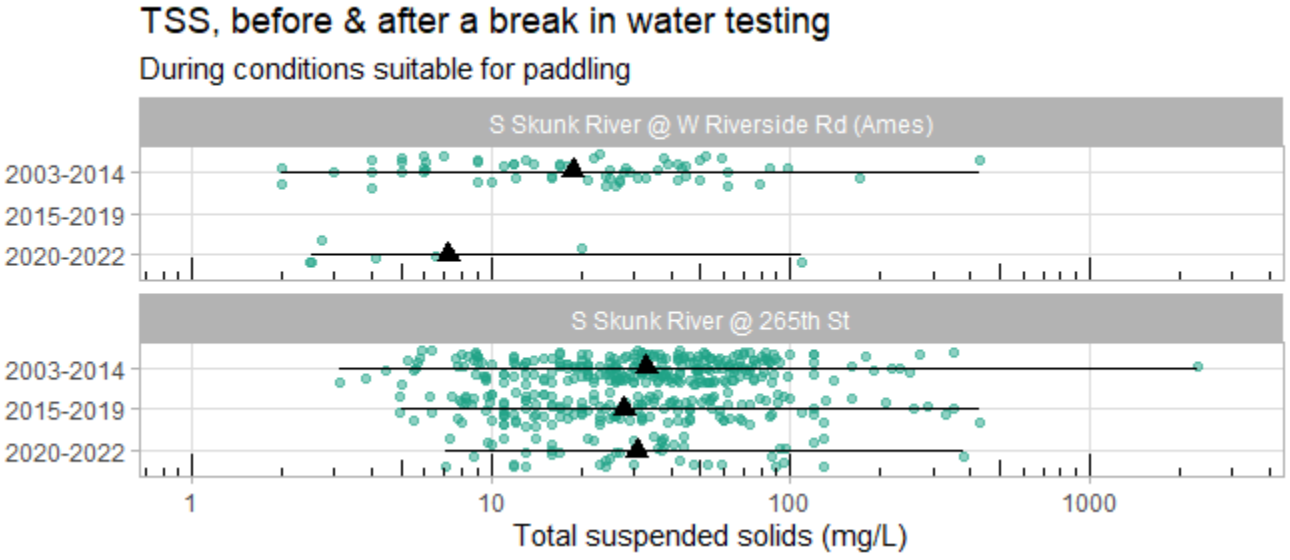
Comparing total suspended solids (a geometric mean) in the 2003-2014 and 2020-2022 periods:

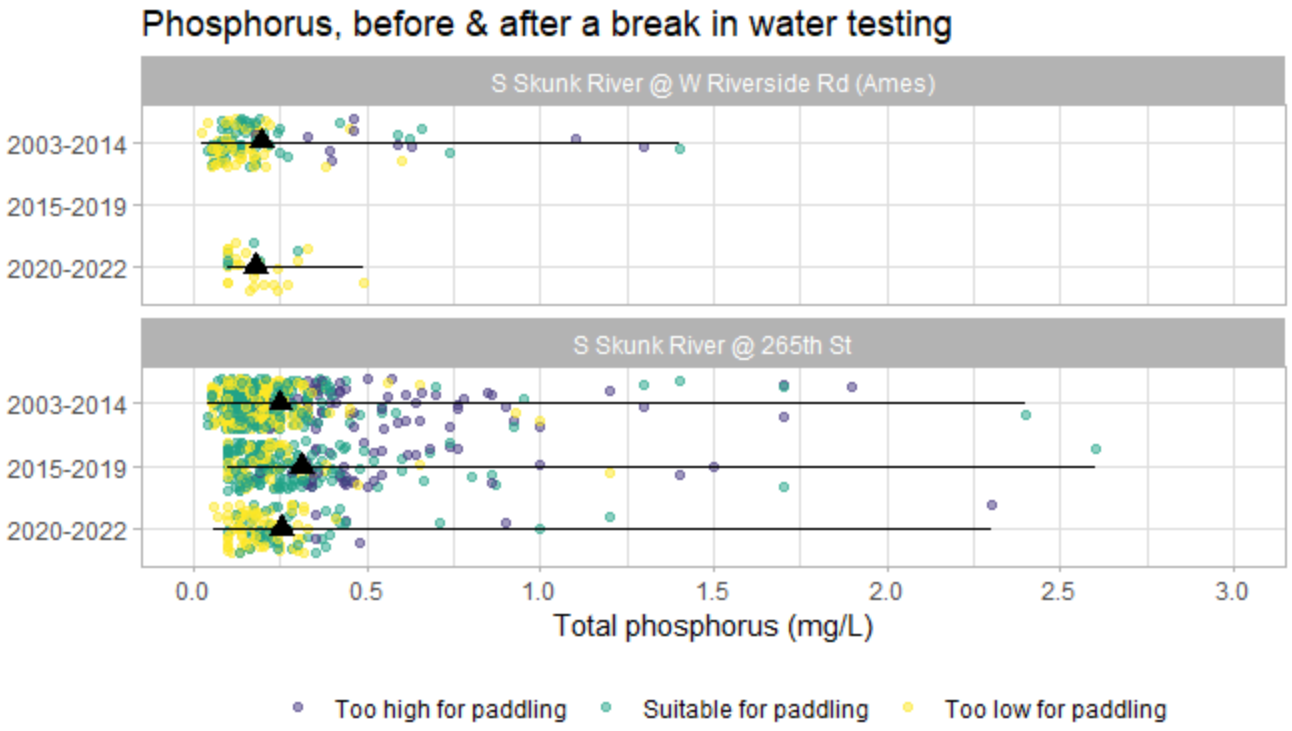
- Total suspended solids decreased at both sites. This is likely due to a larger proportion of samples collected during drier conditions.
- The trend at the downstream site disappears when we focus on conditions suitable for paddling.
- TSS decreased from about 20 mg/L to 8 mg/L at the upstream site. However we only have 7 data points from 2020-2022 period, so this trend may not hold up. This report does not include any tests for statistical significance, but results from weekly and monthly sampling at 280th St differed by 10 mg/L, suggesting that differences between time periods would be within the margin of error.

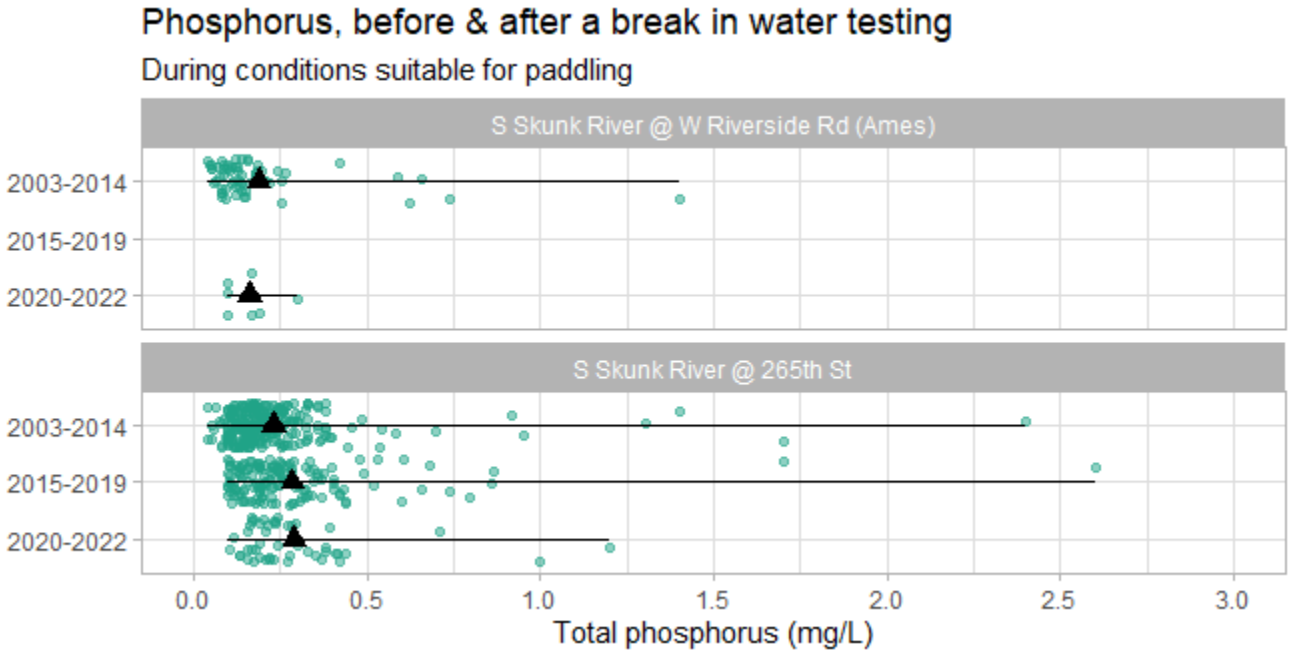
Comparing total phosphorus (mean) in the 2003-2014 and 2020-2022 periods:

- Phosphorus was unchanged at the downstream site (0.25 mg/L in both periods) and decreased slightly at the upstream site (from 0.23 to 0.18 mg/L).
- When we focus on the conditions suitable for paddling, phosphorus decreased slightly at the upstream site (from 0.19 mg/L to 0.16 mg/L) and increased slightly at the downstream site (from 0.23 to 0.29 mg/L).
- This report does not include any tests for statistical significance, but results from weekly and monthly sampling at 280th St differed by 0.07 mg/L, suggesting that differences between time periods would be within the margin of error.


TSS, before & after a break in water testing
S Skunk River @ W Riverside Rd (Ames)
S Skunk River @ 265th St
2003-2014
2015-2019
2020-2022
1
10
100
1000
Total suspended solids (mg/L)
Too high for paddling
Suitable for paddling
Too low for paddling


TSS, before & after a break in water testing
During conditions suitable for paddling
S Skunk River @ W Riverside Rd (Ames)
S Skunk River @ 265th St
2003-2014
2015-2019
2020-2022
1
10
100
1000
Total suspended solids (mg/L)


Phosphorus, before & after a break in water testing
S Skunk River @ W Riverside Rd (Ames)
S Skunk River @ 265th St
2003-2014
2015-2019
2020-2022
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Total phosphorus (mg/L)
Too high for paddling
Suitable for paddling
Too low for paddling


Phosphorus, before & after a break in water testing
During conditions suitable for paddling
S Skunk River @ W Riverside Rd (Ames)
S Skunk River @ 265th St
2003-2014
2015-2019
2020-2022
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Total phosphorus (mg/L)

Results: Other monitoring projects, 2022

Biological Monitoring

Volunteers surveyed aquatic life at only one site in 2022: West Indian Creek at the Story County Fairgrounds in Nevada. While the composition of the invertebrate community was different than when previously tested in 2019, the overall score remained “Poor.” Only a few groups of invertebrates were found, and none of the pollution-sensitive groups were present.

Damselflies

Dragonflies

Commons Net Spinning Caddisflies

Scuds

Clams

Survey Date	Sensitive Score	Less Sensitive Score	Tolerant Score	Total Score
Sep 19, 2022	0	10	0	10
Oct 18, 2019	6	3	1	10

When water chemistry was tested (from mid-March through April and mid-July through December), this site usually had dissolved oxygen in the "poor" range. This may have been low enough to kill off more sensitive groups like mayflies and stoneflies.

Net-spinning caddisflies are abundant in West Indian Creek, but more sensitive insects are absent.

The Iowa DNR completed biological surveys at three stream sites in Story County. An index of biological integrity is calculated based on both the number of species or taxonomic groups present, and whether sensitive or ecologically important groups are present. Complete survey results can be found on BioNet and are linked below.

- Wolf Creek near Collins, August 1.
  - Fish survey following up on reported fish kill. The methodology is different for this kind of follow-up, so no score was reported.[8]
- West Indian Creek at Jennett Heritage Area, August 12.
  - Fish Index of Biological Integrity: 38, "Fair".[9]
  - Benthic Macroinvertebrate Index of Biotic Integrity: 53, "Fair".[10]
- South Skunk River near Soper's Mill Canoe Access, September 19.
  - Fish Index of Biological Integrity: 39. "Fair".[11]
  - Benthic Macroinvertebrate Index of Biotic Integrity: 55, "Fair".[12]

Ambient lake monitoring

Hickory Grove Lake is part of the Ambient Lakes Monitoring program, a partnership between the Iowa Department of Natural Resources and the Iowa State University Limnology Laboratory. Each lake is sampled at their deepest point three times between May and September: once in early summer, once in mid-summer, and once in late summer/early fall. The 2022 season was the first summer the lake has been tested since it was drawn down for a restoration project[13]. A trophic state index (TSI) measures the interaction of three factors that together influence the suitability of a lake for fisheries and recreation. A TSI greater than 65 can indicate problem levels of nutrient enrichment and algae growth.

- Water clarity (measured with a secchi disk) can be influenced by both sediment and algae growth. Brown lakes may turn into green lakes if sediment pollution is addressed but phosphorus remains high. Based on this metric, TSI was 52, down from 66 in 2018.
- Total phosphorus is usually the limiting factor for algae growth in lakes. Based on this metric, TSI was 60, below the threshold and down from 75 in 2018.
- Chlorophyll A is a measure of algae growth. Based on this metric, the TSI was 57, below the threshold and similar to 2018.

Iowa DNR removed an impairment for algae growth in the 2022 assessment cycle based on three previous seasons with TSI below the threshold. TSI can vary from year to year, but this year's results are encouraging.

[8] https://programs.iowadnr.gov/bionet/Fish/Session/2223
[9] https://programs.iowadnr.gov/bionet/Fish/Session/2189
[10] https://programs.iowadnr.gov/bionet/Inverts/IBI/3436
[11] https://programs.iowadnr.gov/bionet/Fish/Session/2311
[12] https://programs.iowadnr.gov/bionet/Inverts/IBI/3520
[13] https://programs.iowadnr.gov/aquia/Sites/22850001

Recommendations for future monitoring

Recommendation 1: More biological monitoring

Volunteers monitored benthic macroinvertebrates at only one site in 2022. We should have the capacity to do more in 2023, as several additional volunteers recently completed training with the Save Our Streams program and are certified to lead biological monitoring. Biological monitoring can be a fun learning experience for youth, and provides a more complete picture of stream health than chemical monitoring alone.

Results from the past three years could be influenced by drought, so we recommend re-testing the South Skunk River and West Indian Creek following a normal or wet year.

Recommendation 2: Follow up on sites with unusual results

Volunteer monitoring this year revealed widespread nitrate pollution (the majority of sites had nitrate exceeding 10 mg/L during wetter conditions), but other water quality issues were more localized. We have a good explanation for why phosphate is high at some sites (effluent from wastewater treatment plants) but will need more information to interpret "fair" and "poor" dissolved oxygen, pH, chloride, and transparency readings.

- As volunteers get more familiar with what is "normal" for Story County and for their assigned site, we encourage them to be alert for anything out of the ordinary and communicate their observations with others. One of the goals of the program to have citizens who are informed and engaged about water quality in their community!
- Some volunteers are already doing this. Now that we have a broad overview of water quality in Story County, we can take a closer look at comments recorded on the data sheets (including observations about weather, animals, or human activity near the monitoring site) to see if this can explain some of the more unusual results.
- We recommend that volunteers notify the volunteer coordinator whenever a measurement falls in the "poor" range. This will give us the opportunity to re-test within a day or two, before conditions change, to verify the reading and help diagnose the problem.

Lab testing over the past three years revealed especially high levels of *E. coli* bacteria in West Indian Creek and College Creek. Testing some additional sites along the stream can help narrow down likely sources of fecal bacteria. The lab is able to accommodate some additional samples as a temporary project. City staff in Ames and Nevada are advising on the location and condition of sewers and storm sewers which may help to explain the results.

It's also important to notice which sites have usually good water quality. We want to be able to celebrate success stories and identify what influences help to safe guard water quality.

Recommendation 3: Collect additional E. coli samples to support trend analysis

The nested monitoring design used to evaluate trends (see page 51) was serendipitous, not planned, and may not be a high priority. However, if we continue using this approach to evaluate trends, the statistical analysis used for this type of study (a paired t-test) requires same day testing of the upstream and downstream sites. Same-day testing improves the accuracy of comparisons between sites. Prior to 2014, both upstream and downstream sites on the South Skunk River were tested monthly by Iowa DNR, usually on the same day. In 2020, local partners resume monitoring the upstream site, but was not able to match the Iowa DNR's schedule—they test monthly, but not on a consistent day of the month. The simplest way to address this would be for local partners to collect an additional *E. coli* sample, once a month, from the South Skunk River at 280th St. Currently this site is tested weekly by the City of Ames, but the analysis does not include *E. coli*.

Grant Creek, at Jennett Heritage Area.

Local partners are committed to continuing water monitoring in Story County, to increase residents' knowledge and understandings, identify problems in our watersheds, and support and improve water quality.