Water Quality Monitoring in Story County, Iowa

2023 Annual Report

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Acknowledgements

Author

Dan Haug, Prairie Rivers of Iowa

Photos by Prairie Rivers of Iowa unless otherwise acknowledged

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Story County Conservation

City of Ames

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Outdoor Alliance of Story County

HACH Company

Hamilton County Conservation

Water monitoring in the field

Volunteers:

Dan Barr, Melissa Bauman, Ryan Benjegerdes, Ryan Bergman, Mary Brunet, Jody Brogden, Robin De Penning, Jody De Penning, Janet Dixon, Rick Dietz, Connor Drake, Taylor Drake, Jean Eichmeier, Ron Eichmeier, Ed Engle, Tom Gust, Bob Hartzler, Anna Hamlett, Mark Hayes, Mark Johnson, Tom Johnson, Steve Jungst, Carol Kersey, Ken Kopecky, Laura Kopecky, Mike Lazere, Amanda Malaski, Kathy Solko-Manternach, Steve Manternach, Laura Merrick, Deb O'Brien, Kimberly Olson, Erica Place, Kurt Plagge, Shari Randall, Jacob Reischaeur, David Rolfes, Rose Rollenhagen, Davin Roberts, Mike Schmidt, Susan Siev, Michelle Ward, Dale Watson, Jeff White, Linda Wild, Karen Wickert

Staff of partner organizations: Jody Brogden, Liz Calhoun, Sara Carmichael, Jordan Cook, Mike Cox, Russ DeWall, Dan Haug, Nathan Hovick, Jeremy Johannsen, Laura Johnston, Taylor Jorgensen, Jerry Keys, Tyler Kelley, Pat Shehan, Ryan Wiemold

HACH team: Steve Arthur, Kyle Holland, Russel Robinson

Support with laboratory analysis, training, and data management

City of Ames Laboratory Services Division: Maryann Ryan, Derek Crawford, Jason Peterson, Maureen Moroney

Izaak Walton League of America: Samantha (Briggs) Puckett, Heather Wilson, Abby Hileman

Iowa State University: Leigh Ann Long

Leadership

The following people participated in regular meetings in 2023 to provide direction and resources for local monitoring efforts, following a 10-year plan the group developed in 2020:

Story County: Sara Carmichael, Mike Cox, Kimberly Grandinetti, Laura Johnston

City of Ames: Dustin Albrecht, Liz Calhoun, Lyle Hammes, Tracy Peterson, Maryann Ryan

City of Gilbert: Tim Mattingly

City of Nevada: Ryan Hutton

City of Roland: Nate Hovick

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

Prairie Rivers of Iowa: Penny Brown Huber, Dan Haug

Thank you to Mark Rasmussen, Danny Johnson, and Tim Mattingly for leading tours.

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
Prairie Rivers of Iowa: 3116 S. Duff Avenue, Suite 201, Ames, Iowa 50010. 515-232-0048

South Skunk River at Story City.

Highlights from the 2023 Monitoring Season

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

- **The volunteer program continues to grow and improve in consistency**.
  - 49 volunteers entered 969 data sheets into the Clean Water Hub this season.
  - Many volunteers are monitoring their assigned site biweekly, with 20 sites sampled at least 20 times (see page 6).
- **This was a challenging year for fish and aquatic insects.**
  - In addition to many creeks drying up, volunteers observed dissolved oxygen drop to low levels at 53% of stream sites (see page 23).
  - Biological surveys showed mixed results, with some streams scoring poorly but sensitive insects like mayflies present in others (see page 55).
- ***E. coli* bacteria levels in streams remained high.**
  - All thirteen streams with enough data to evaluate this season exceeded the primary contact recreation standard. Three streams exceeded the secondary contact recreation standard (see page 40).
  - However, over the last four years, most sites on the South Skunk River meet the standard when there is enough water to float a canoe (see page 49).
- **Wastewater treatment plants are not yet capable of removing some of the pollutants we monitor, and can have a large influence during drought when effluent is less diluted.**
  - Effluent from the old sewage treatment plant in Nevada was found to be a major source of *E. coli* bacteria (see page 40). The new plant should address the problem.
  - Stream sites downstream of sewage treatment plants tend to have elevated chloride and phosphate (see page 29).
- **The encouraging trends we noted in the 2022 report held up with another year of data** (see page 44). Water quality trends are often driven by weather, but we pulled out subsets based on streamflow to remove some of this influence.
  - *E. coli* in the South Skunk River below the Ames Water Pollution Control Facility has improved relative to the pre-2014 baseline period, especially during dry conditions when wastewater has the greatest influence.
  - Nitrate in the South Skunk River below the confluence with Ioway Creek improved relative to the pre-2014 baseline period, even after excluding dry periods. This pattern is consistent with improvement from conservation practices.

Monitoring Sites and Activity in 2023

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

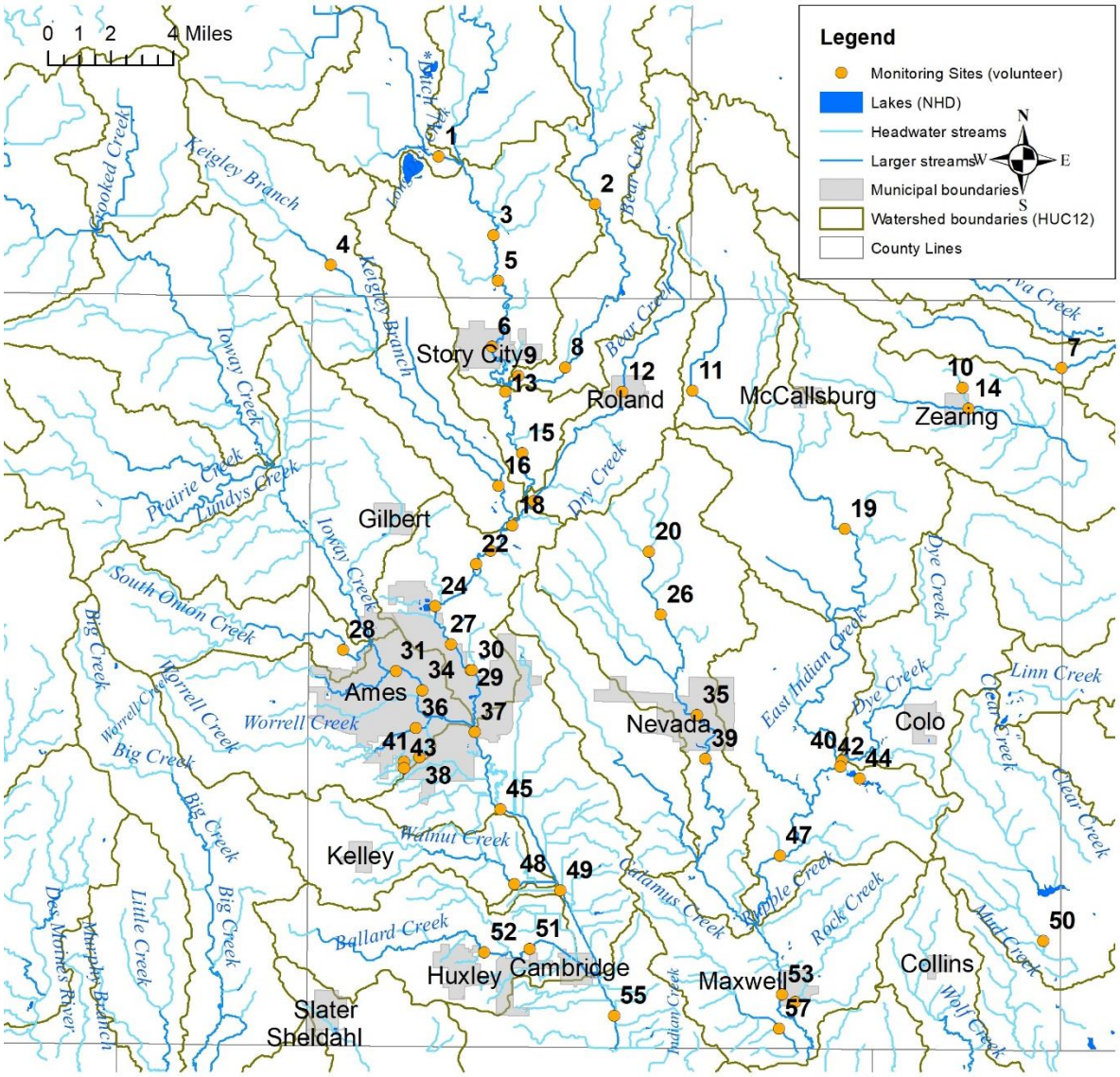
Water quality testing in the field by volunteers

Story County Conservation continued to equip staff and volunteers with kits to regularly monitor streams around the county. The following metrics show the continued growth and improvement of the program.

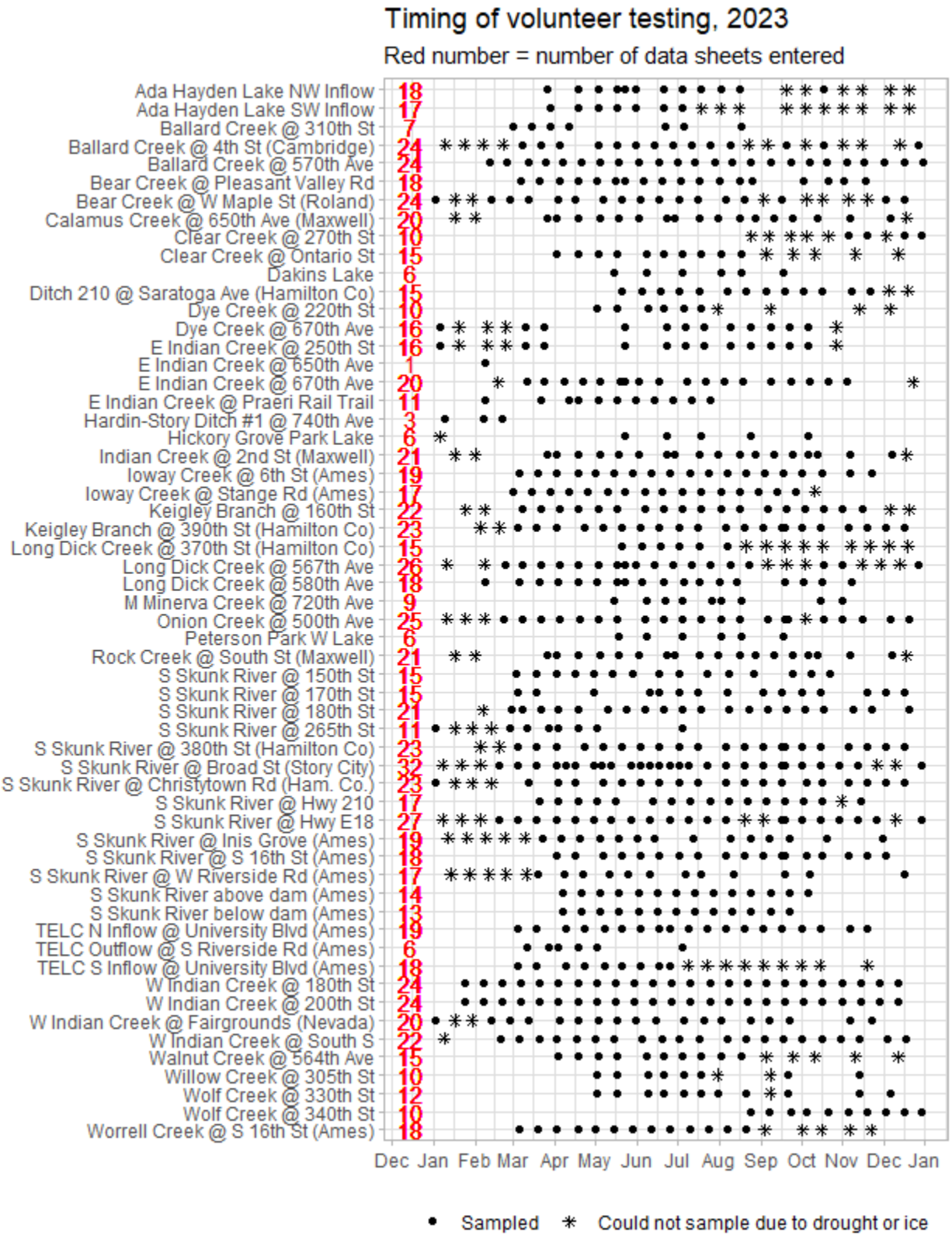
2023 Season	2022 Season	2021 Season
38	40	17
Volunteers participating	Volunteers participating	Volunteers participating
58	56	38
Sites tested at least once	Sites tested at least once	Sites tested at least once
50	43	17
Sites tested at least 10 times	Sites tested at least 10 times	Sites tested at least 10 times
20	16	0
Sites tested at least 20 times	Sites tested at least 20 times	Sites tested at least 20 times
969	855	305
Data sheets entered in the Clean Water Hub	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. If a site could not be tested due to drought, thick ice, or a safety concerns, volunteers were asked to submit a blank data sheet with a note about the conditions—154 of the 969 data sheets entered in the Clean Water Hub this year were for days when it was not possible to test water quality. The following pages show the locations of monitoring sites and how often they could be tested. In addition to the map in this report, an interactive map is available showing which sites are currently assigned to volunteers[1].

[1] https://arcg.is/1zKTzu



On map	ID in Hub	Site name	On map	ID in Hub	Site name	On map	ID in Hub	Site name
1	12583	Ditch 210 @ Saratoga Ave (Hamilton Co)	21	10971	S Skunk River @ 180th St	41	11780	TELC N Inflow @ University Blvd (Ames)
2	12584	Long Dick Creek @ 370th St (Hamilton Co)	22	10969	Peterson Park W Lake	42	10942	E Indian Creek @ 250th St
3	12585	S Skunk River @ 380th St (Hamilton Co)	23	31058	Ada Hayden Lake NW Inflow	43	11781	TELC S Inflow @ University Blvd (Ames)
4	12586	Keigley Branch @ 390th St (Hamilton Co)	24	11515	S Skunk River @ W Riverside Rd (Ames)	44	12535	Hickory Grove Park Lake
5	12181	S Skunk River @ Christytown Rd (Ham. Co.)	25	31057	Ada Hayden Lake SW Inflow	45	11577	S Skunk River @ 265th St
6	11578	S Skunk River @ Broad St (Story City)	26	10972	W Indian Creek @ 200th St	46	34713	Clear Creek @ 270th St
7	12184	Hardin-Story Ditch #1 @ 740th Ave	27	12179	S Skunk River @ Inis Grove (Ames)	47	10940	E Indian Creek @ 650th Ave
8	10931	Long Dick Creek @ 580th Ave	28	10977	Onion Creek @ 500th Ave	48	11575	Walnut Creek @ 564th Ave
9	12183	Long Dick Creek @ 567th Ave	29	11777	S Skunk River above dam (Ames)	49	11583	S Skunk River @ 290th St
10	10968	Dakins Lake	30	11870	S Skunk River below dam (Ames)	50	12203	Wolf Creek @ 305th St
11	10744	E Indian Creek @ Praeri Rail Trail	31	12182	Ioway Creek @ Stange Rd (Ames)	51	11598	Ballard Creek @ 570th Ave
12	10932	Bear Creek @ W Maple St (Roland)	32	31059	Clear Creek @ Ontario St	52	11779	Ballard Creek @ 310th St
13	10723	S Skunk River @ Hwy E18	33	32005	Dye Creek @ 220th St	53	10975	Indian Creek @ 2nd St (Maxwell)
14	10970	M Minerva Creek @ 720th Ave	34	11975	Ioway Creek @ 6th St (Ames)	54	12025	Rock Creek @ South St (Maxwell)
15	10726	S Skunk River @ 150th St	35	10241	W Indian Creek @ Fairgrounds (Nevada)	55	12185	S Skunk River @ Hwy 210
16	10939	Keigley Branch @ 160th St	36	11823	Worrell Creek @ S 16th St (Ames)	56	31980	Wolf Creek @ 330th St
17	10937	Bear Creek @ Pleasant Valley Rd	37	10981	S Skunk River @ S 16th St (Ames)	57	12026	Calamus Creek @ 650th Ave (Maxwell)
18	10980	S Skunk River @ Soper's Mill	38	11782	TELC Outflow @ S Riverside Rd (Ames)	58	34712	Wolf Creek @ 340th St
19	11581	E Indian Creek @ 670th Ave	39	11573	W Indian Creek @ South S			
20	12207	W Indian Creek @ 180th St	40	10967	Dye Creek @ 670th Ave			


Timing of volunteer testing, 2023
Red number = number of data sheets entered
Ada Hayden Lake NW Inflow 18
Ada Hayden Lake SW Inflow 17
Ballard Creek @ 310th St 7
Ballard Creek @ 4th St (Cambridge) 24
Ballard Creek @ 570th Ave 24
Bear Creek @ Pleasant Valley Rd 18
Bear Creek @ W Maple St (Roland) 24
Calamus Creek @ 650th Ave (Maxwell) 20
Clear Creek @ 270th St 10
Clear Creek @ Ontario St 15
Dakins Lake 6
Ditch 210 @ Saratoga Ave (Hamilton Co) 15
Dye Creek @ 220th St 10
Dye Creek @ 670th Ave 16
E Indian Creek @ 250th St 16
E Indian Creek @ 650th Ave 1
E Indian Creek @ 670th Ave 20
E Indian Creek @ Praeri Rail Trail 11
Hardin-Story Ditch #1 @ 740th Ave 3
Hickory Grove Park Lake 6
Indian Creek @ 2nd St (Maxwell) 21
Ioway Creek @ 6th St (Ames) 19
Ioway Creek @ Stange Rd (Ames) 17
Keigley Branch @ 160th St 22
Keigley Branch @ 390th St (Hamilton Co) 23
Long Dick Creek @ 370th St (Hamilton Co) 15
Long Dick Creek @ 567th Ave 26
Long Dick Creek @ 580th Ave 18
M Minerva Creek @ 720th Ave 9
Onion Creek @ 500th Ave 25
Peterson Park W Lake 6
Rock Creek @ South St (Maxwell) 21
S Skunk River @ 150th St 15
S Skunk River @ 170th St 15
S Skunk River @ 180th St 21
S Skunk River @ 265th St 11
S Skunk River @ 380th St (Hamilton Co) 23
S Skunk River @ Broad St (Story City) 32
S Skunk River @ Christytown Rd (Ham. Co.) 23
S Skunk River @ Hwy 210 17
S Skunk River @ Hwy E18 27
S Skunk River @ Inis Grove (Ames) 19
S Skunk River @ S 16th St (Ames) 18
S Skunk River @ W Riverside Rd (Ames) 17
S Skunk River above dam (Ames) 14
S Skunk River below dam (Ames) 13
TELC N Inflow @ University Blvd (Ames) 19
TELC Outflow @ S Riverside Rd (Ames) 6
TELC S Inflow @ University Blvd (Ames) 18
W Indian Creek @ 180th St 24
W Indian Creek @ 200th St 24
W Indian Creek @ Fairgrounds (Nevada) 20
W Indian Creek @ South S 22
Walnut Creek @ 564th Ave 15
Willow Creek @ 305th St 10
Wolf Creek @ 330th St 12
Wolf Creek @ 340th St 10
Worrell Creek @ S 16th St (Ames) 18
Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
• Sampled * Could not sample due to drought or ice

Staff and volunteers follow the protocols of the **Izaak Walton League of America's** Save Our Streams program[2] and enter data in the IWLA's online platform for volunteer monitoring—the Clean Water Hub[3]. 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.

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

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

Snapshot Events

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 twice a year water quality snapshots going back to 2006. After loss of state support for volunteer monitoring, **Prairie Rivers of Iowa** began coordinating the events in 2019.

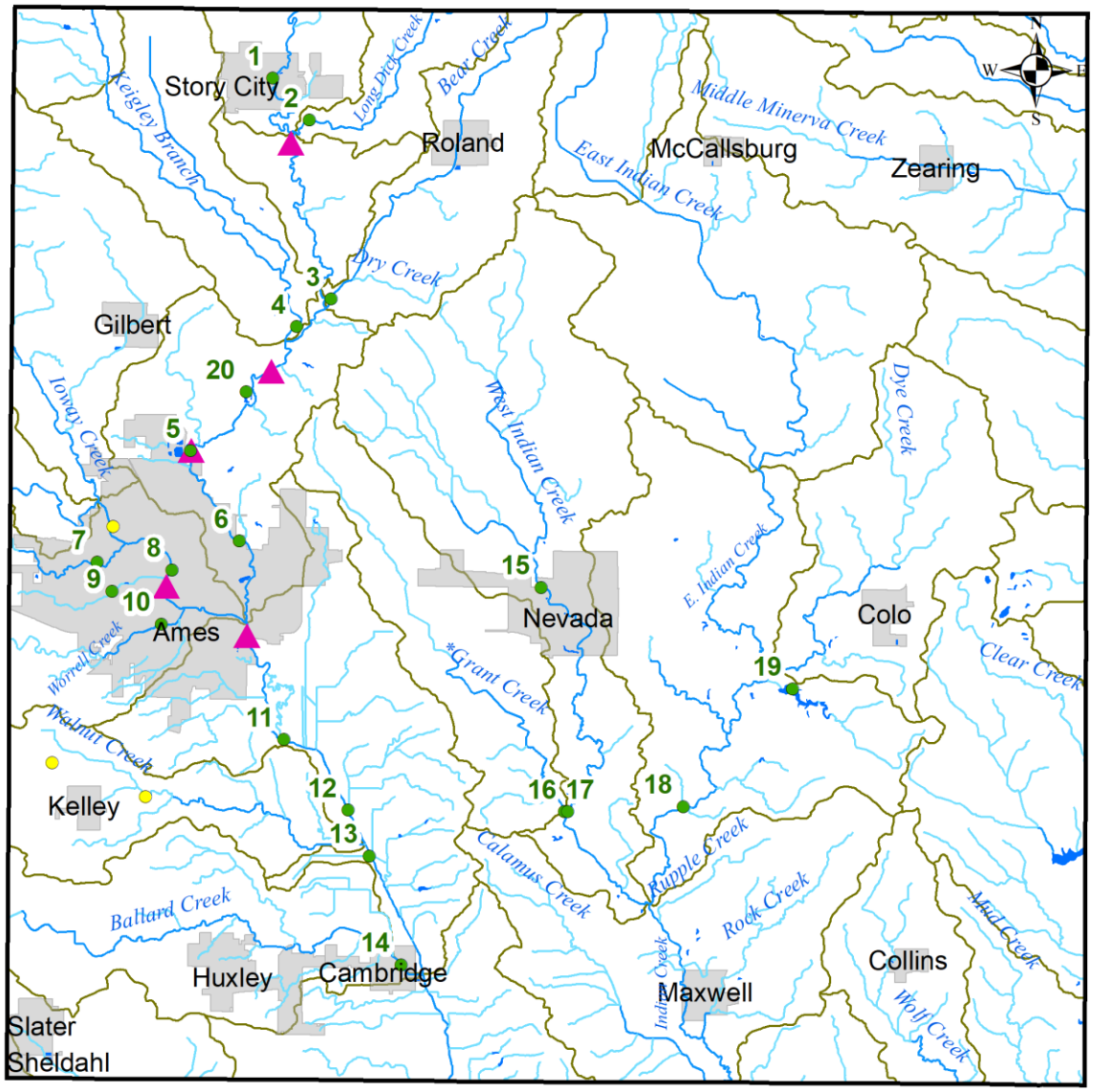
- **May 23, 2023.** 17 volunteers tested 30 sites[4]. Most sites had "good" transparency, chloride and phosphate, but 22 sites had nitrate levels around or exceeding the drinking water standard for nitrate (10 mg/L).
- **September 19, 2023.** 11 volunteers tested 30 sites[5]. Scattered thunderstorms limited participation and made interpretation of the data challenging. However, the snapshot event was coordinated with Polk County Conservation and the Panora Chapter of the Izaak Walton League (who monitored in Greene County). We combined data from 120 sites in 3 counties into a color-coded, interactive web-map[6]. Interactive maps may replace static reports for sharing water quality data in future seasons.

The entire Kopecky family helped with water monitoring during the 2023 spring snapshot event.

[4] Results from Ioway Creek watershed and Story County for spring snapshot: https://www.prrcd.org/wp-content/uploads/2024/03/2023-05-snapshot-results.pdf
[5] Results from Ioway Creek watershed and Story County for fall snapshot: https://www.prrcd.org/wp-content/uploads/2024/03/2023-09-snapshot-results.pdf
[6] https://rpubs.com/dhaugprrcd/snapshot202309

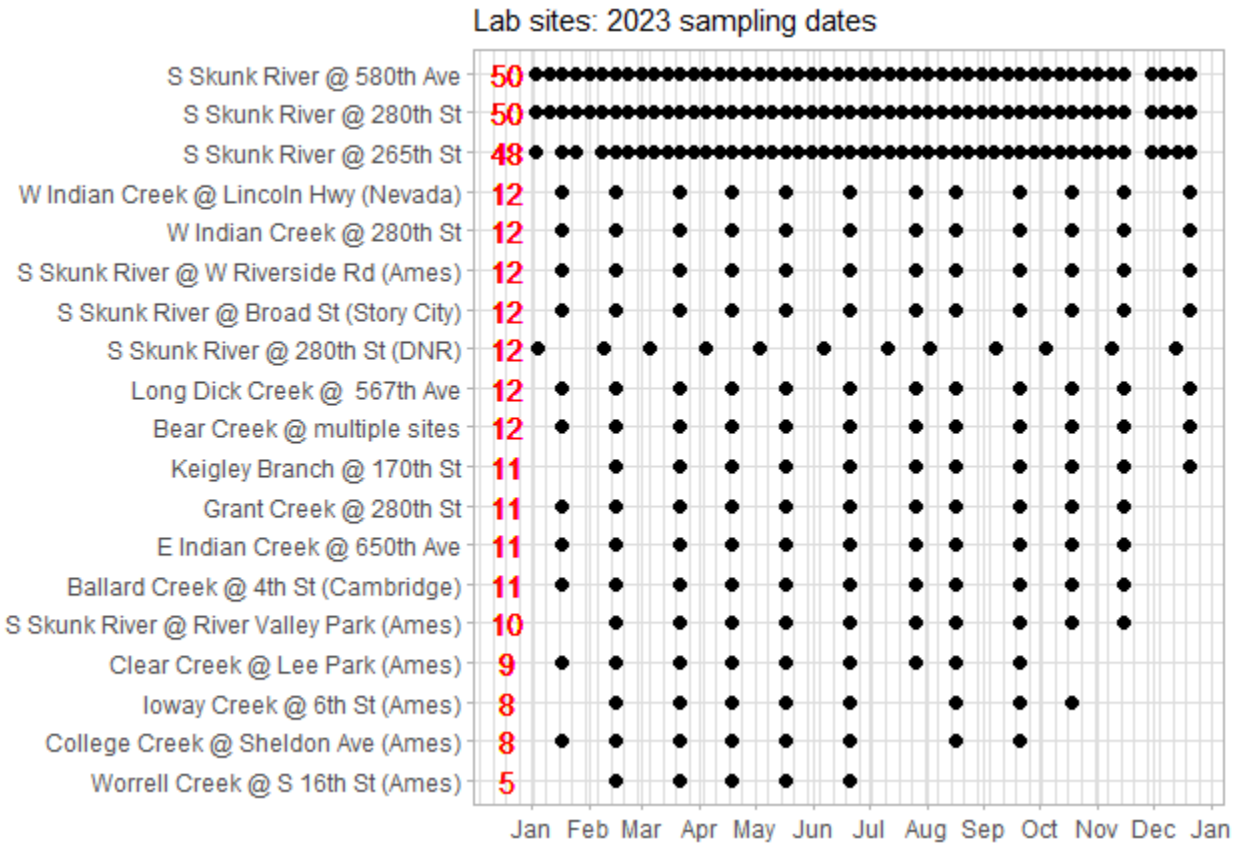
Laboratory testing of water samples

This map shows surface water sites regularly sampled in 2023 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.



As part of the Ambient Stream Monitoring Network, the Iowa Department of Natural Resources (IDNR) 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 IDNR (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.*[7]

Hickory Grove Lake and Ada Hayden Lake are also sampled at their 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*.

The Water Quality Research Lab (WQRL) at Iowa State University continued to support collaborative research at the Tedesco Environmental Learning Corridor through laboratory analysis of monthly water samples for *E. coli*.

[7] During the summer, the most recent advisories and monitoring data for swimming beaches are posted here. https://programs.iowadnr.gov/aquia/Programs/Beaches

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.

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 2023, volunteers surveyed benthic macroinvertebrates at four site using Save Our Streams protocols:

- Bear Creek at West Maple St. (Roland)
- Ioway Creek @ 6th St. (Ames)
- West Indian Creek @ Story County Fairgrounds (Nevada)
- Worrell Creek @ S. 16th St. (Ames)

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. The following sites were surveyed in 2023.

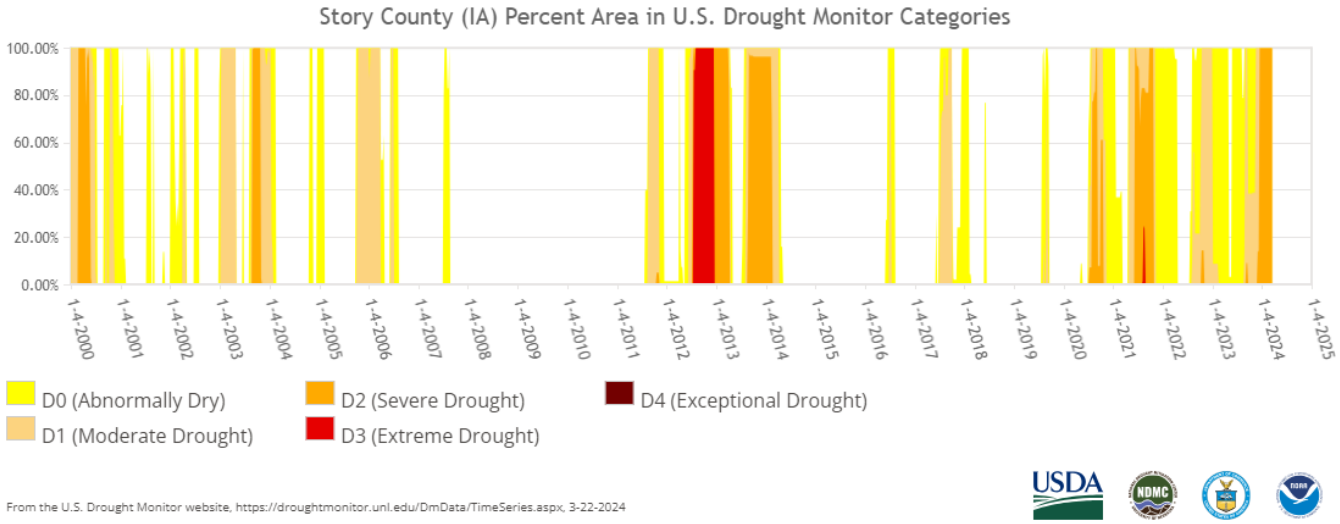
- West Indian Creek at Carroll Prairie
- South Skunk River at Soper's Mill
- Unnamed tributary to South Skunk River, north of Ames
- Ballard Creek near Cambridge

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.

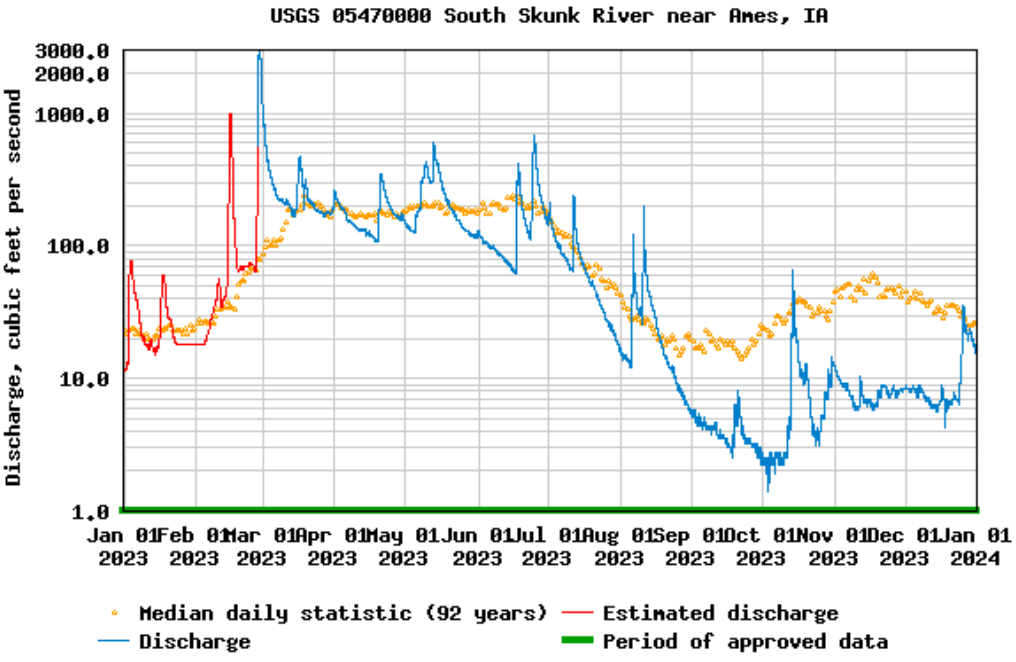
Mayflies (left) are pollution sensitive. Damselflies (right) are somewhat pollution tolerant.

Weather and water levels

According to the US Drought Monitor[8], Story County suffered from abnormally dry conditions for all but one week of 2023. By September, most of the county was facing moderate drought, worsening to severe drought in late December. The US Drought Monitor considers physical indicators like precipitation, streamflow, and soil moisture, as well as field observations of drought stress and interpretation by local experts.



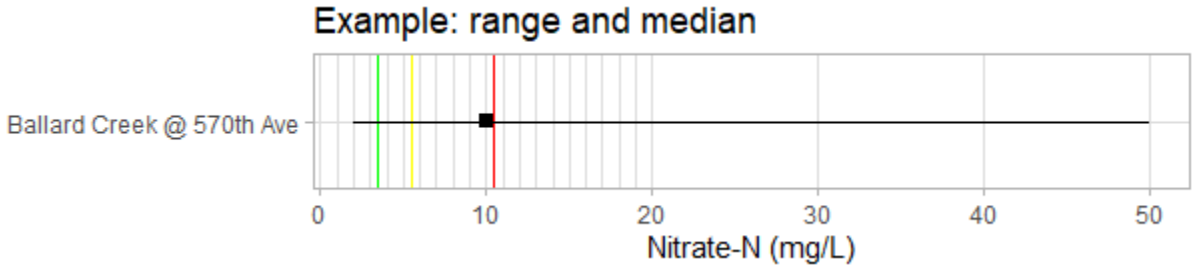
However, the South Skunk River near Ames appeared to be around normal levels for much of the year until drying up in late August. It remained below 10 cubic feet per second for the rest of the year, except for brief periods in October and December following rainstorms.



[8] https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx?fips_19169

Results: Volunteer Testing of Water Chemistry, 2023

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 the median (a black square) and the range of values measured (a horizontal bar). For example, nitrate at this site ranged from 2 mg/L to 50 mg/L, with a median of 10 mg/L.



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.

	Excellent	**Good**	**Fair**	**Poor**
Dissolved Oxygen (% saturation)	80 - 120	70 - 79	50 - 69	< 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 (mg/L)	0 – 20	21- 50	51 - 250	> 250
Reactive Phosphate (mg/L)	0 – 0.2	0.3 – 0.5	0.6 – 2.0	>2.0
Nitrate (mg/L)	0 - 3	> 3 - 5	> 5 - 10	> 10
Transparency (cm)	>= 65	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".

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. 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.

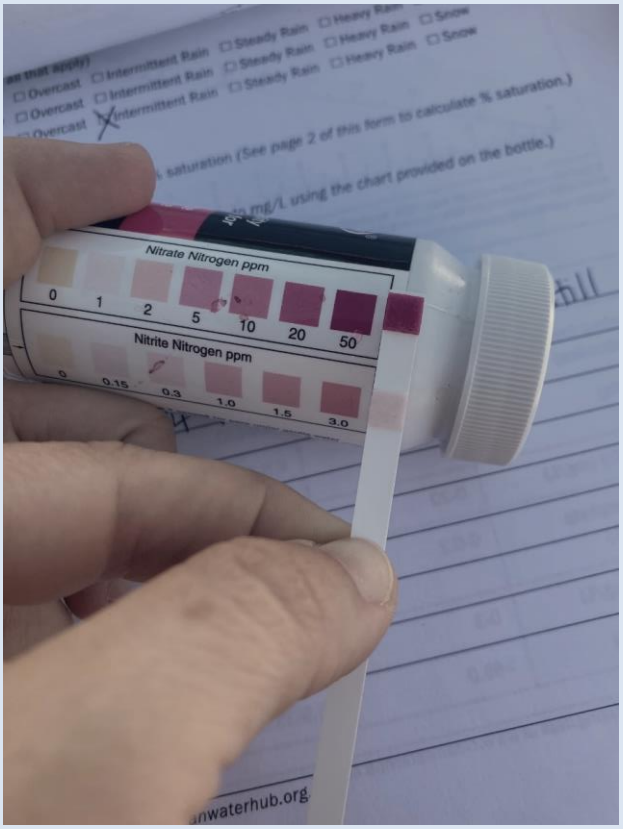
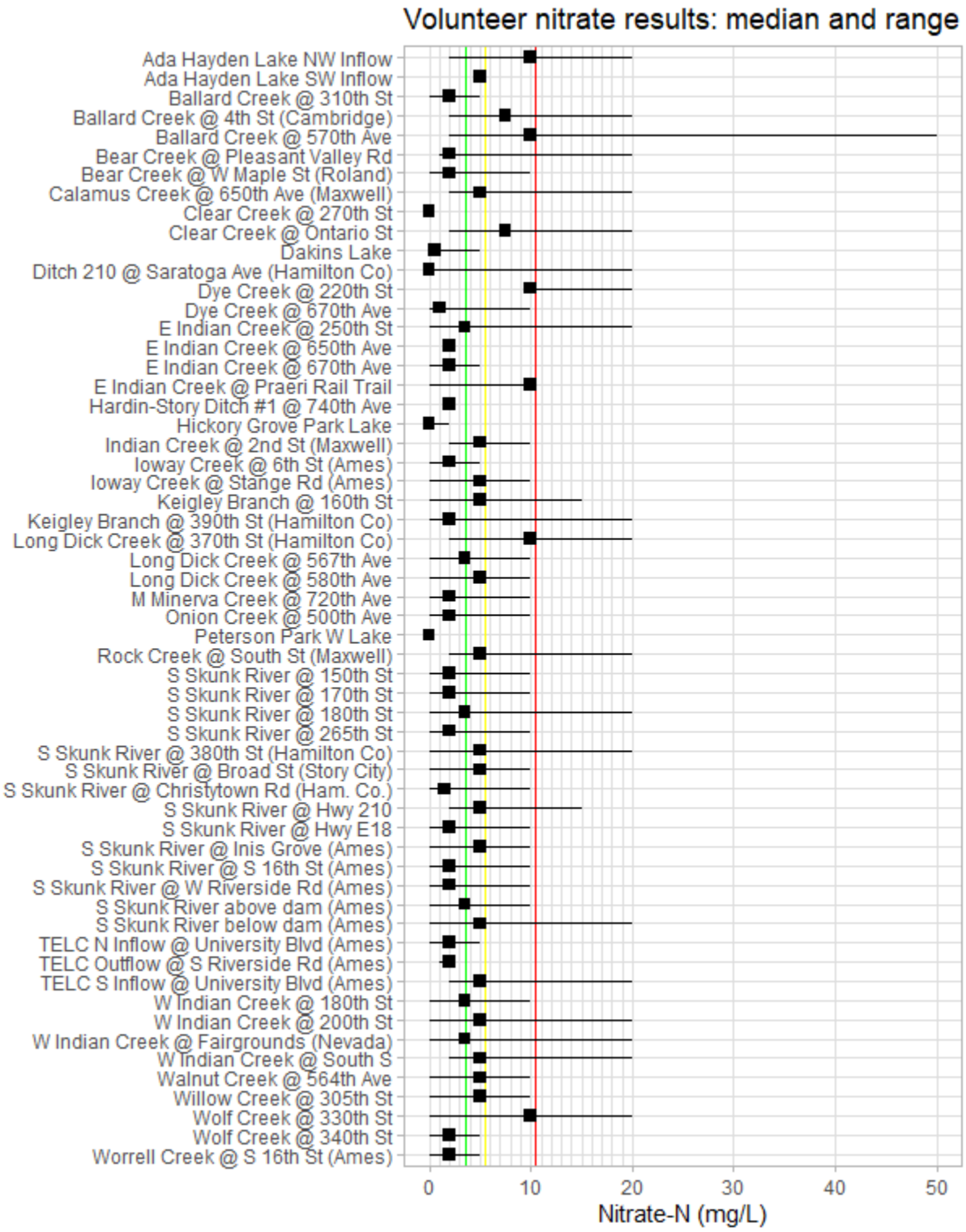


Photo Credit: Story County Conservation

Median nitrate concentrations at 27 sites (47%) were in the "excellent" range (<3 mg/L) and 23 sites (40%) were in the "good" range (3-5 mg/g). Nitrate at most sites was lower than last year, probably because of lower rainfall.

Nitrate has a strong seasonal pattern, so inconsistencies in timing may explain some of the differences between sites. One site on Long Dick Creek (at 370th St) appears to have higher nitrate than the others because it was only monitored in the spring and summer. One site on Wolf Creek (at 340th St) appears to have lower nitrate than the other because it was only monitored in fall and winter.

Median nitrate concentrations at eight sites (14%) was in the "fair" range (6-10 mg/L). Seven of these sites dried up in fall. The exception is Ballard Creek at 570th St, which remained flowing because of wastewater from the City of Huxley. Nitrate at this site reached 50 mg/L in September.


Volunteer nitrate results: median and range
Ada Hayden Lake NW Inflow
Ada Hayden Lake SW Inflow
Ballard Creek @ 310th St
Ballard Creek @ 4th St (Cambridge)
Ballard Creek @ 570th Ave
Bear Creek @ Pleasant Valley Rd
Bear Creek @ W Maple St (Roland)
Calamus Creek @ 650th Ave (Maxwell)
Clear Creek @ 270th St
Clear Creek @ Ontario St
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Ditch 210 @ Saratoga Ave (Hamilton Co)
Dye Creek @ 220th St
Dye Creek @ 670th Ave
E Indian Creek @ 250th St
E Indian Creek @ 650th Ave
E Indian Creek @ 670th Ave
E Indian Creek @ Praeri Rail Trail
Hardin-Story Ditch #1 @ 740th Ave
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Ioway Creek @ 6th St (Ames)
Ioway Creek @ Stange Rd (Ames)
Keigley Branch @ 160th St
Keigley Branch @ 390th St (Hamilton Co)
Long Dick Creek @ 370th St (Hamilton Co)
Long Dick Creek @ 567th Ave
Long Dick Creek @ 580th Ave
M Minerva Creek @ 720th Ave
Onion Creek @ 500th Ave
Peterson Park W Lake
Rock Creek @ South St (Maxwell)
S Skunk River @ 150th St
S Skunk River @ 170th St
S Skunk River @ 180th St
S Skunk River @ 265th St
S Skunk River @ 380th St (Hamilton Co)
S Skunk River @ Broad St (Story City)
S Skunk River @ Christytown Rd (Ham. Co.)
S Skunk River @ Hwy 210
S Skunk River @ Hwy E18
S Skunk River @ Inis Grove (Ames)
S Skunk River @ S 16th St (Ames)
S Skunk River @ W Riverside Rd (Ames)
S Skunk River above dam (Ames)
S Skunk River below dam (Ames)
TELC N Inflow @ University Blvd (Ames)
TELC Outflow @ S Riverside Rd (Ames)
TELC S Inflow @ University Blvd (Ames)
W Indian Creek @ 180th St
W Indian Creek @ 200th St
W Indian Creek @ Fairgrounds (Nevada)
W Indian Creek @ South S
Walnut Creek @ 564th Ave
Willow Creek @ 305th St
Wolf Creek @ 330th St
Wolf Creek @ 340th St
Worrell Creek @ S 16th St (Ames)
0
10
20
30
40
50
Nitrate-N (mg/L)

Phosphate

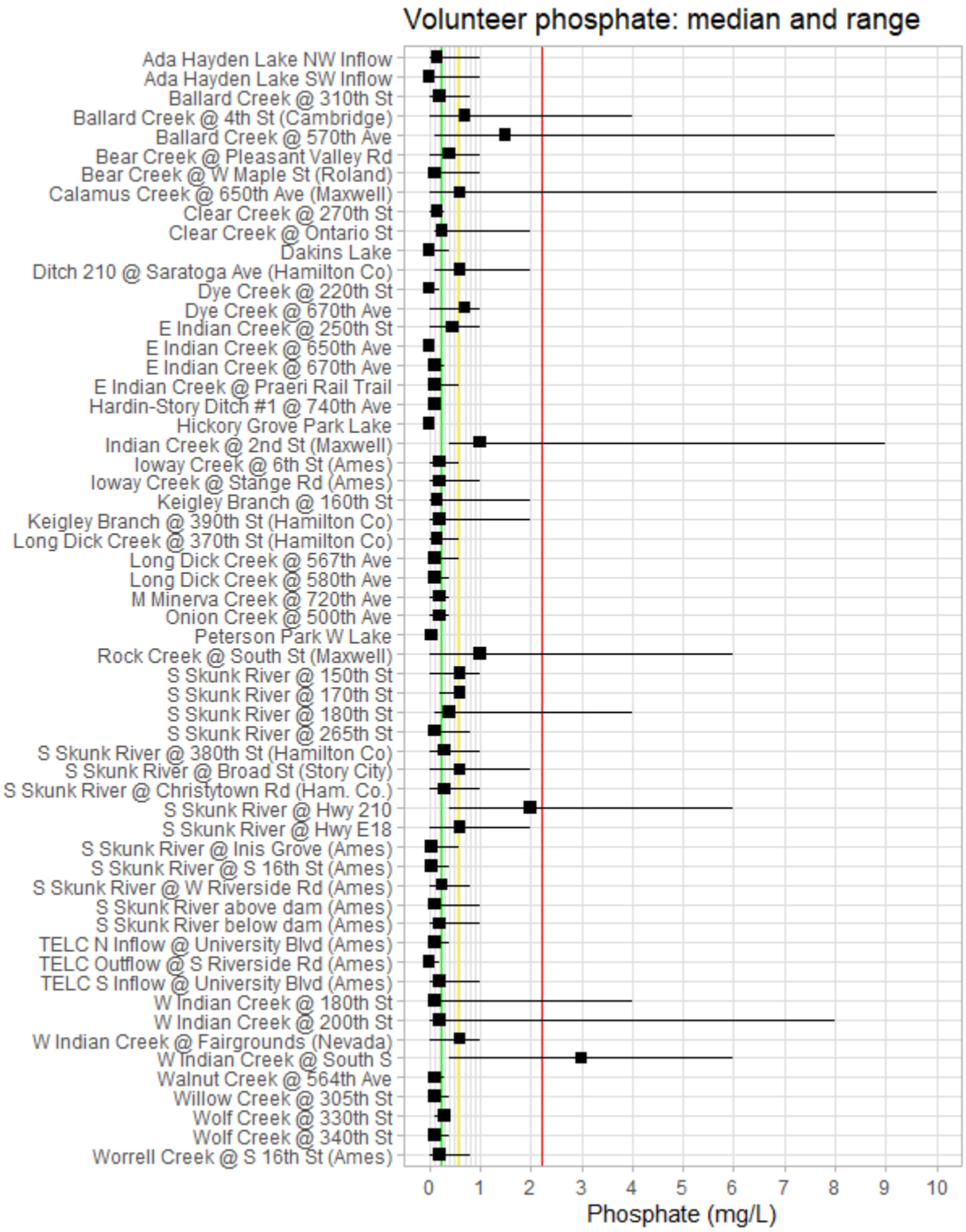
What are Phosphates?
Phosphorous is a naturally occurring mineral in rock formations and is an essential nutrient of bacteria, plants, and animals. It is usually present in waterways as dissolved orthophosphate. Phosphates levels are measured as a concentration in milligrams per liter. Excess phosphates 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.

Median phosphate at 44 sites (76%) was in the "good" to "excellent" range (0 – 0.5 mg/L).

Thirteen sites had median phosphate in the "fair" range (0.6 to 2.0 mg/L) and one site had median phosphate in the "poor" range (> 2.0 mg/L). Most of these sites are downstream of wastewater treatment plants (see page 29 for details).

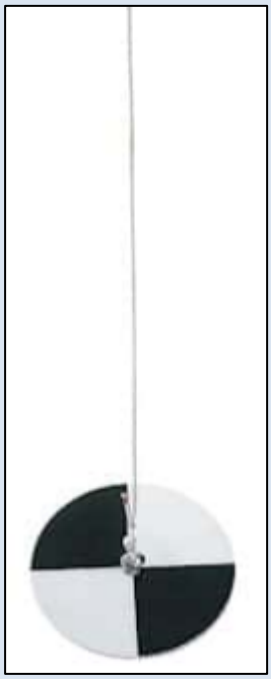

Volunteer phosphate: median and range
Ada Hayden Lake NW Inflow
Ada Hayden Lake SW Inflow
Ballard Creek @ 310th St
Ballard Creek @ 4th St (Cambridge)
Ballard Creek @ 570th Ave
Bear Creek @ Pleasant Valley Rd
Bear Creek @ W Maple St (Roland)
Calamus Creek @ 650th Ave (Maxwell)
Clear Creek @ 270th St
Clear Creek @ Ontario St
Dakins Lake
Ditch 210 @ Saratoga Ave (Hamilton Co)
Dye Creek @ 220th St
Dye Creek @ 670th Ave
E Indian Creek @ 250th St
E Indian Creek @ 650th Ave
E Indian Creek @ 670th Ave
E Indian Creek @ Praeri Rail Trail
Hardin-Story Ditch #1 @ 740th Ave
Hickory Grove Park Lake
Indian Creek @ 2nd St (Maxwell)
Ioway Creek @ 6th St (Ames)
Ioway Creek @ Stange Rd (Ames)
Keigley Branch @ 160th St
Keigley Branch @ 390th St (Hamilton Co)
Long Dick Creek @ 370th St (Hamilton Co)
Long Dick Creek @ 567th Ave
Long Dick Creek @ 580th Ave
M Minerva Creek @ 720th Ave
Onion Creek @ 500th Ave
Peterson Park W Lake
Rock Creek @ South St (Maxwell)
S Skunk River @ 150th St
S Skunk River @ 170th St
S Skunk River @ 180th St
S Skunk River @ 265th St
S Skunk River @ 380th St (Hamilton Co)
S Skunk River @ Broad St (Story City)
S Skunk River @ Christytown Rd (Ham. Co.)
S Skunk River @ Hwy 210
S Skunk River @ Hwy E18
S Skunk River @ Inis Grove (Ames)
S Skunk River @ S 16th St (Ames)
S Skunk River @ W Riverside Rd (Ames)
S Skunk River above dam (Ames)
S Skunk River below dam (Ames)
TELC N Inflow @ University Blvd (Ames)
TELC Outflow @ S Riverside Rd (Ames)
TELC S Inflow @ University Blvd (Ames)
W Indian Creek @ 180th St
W Indian Creek @ 200th St
W Indian Creek @ Fairgrounds (Nevada)
W Indian Creek @ South S
Walnut Creek @ 564th Ave
Willow Creek @ 305th St
Wolf Creek @ 330th St
Wolf Creek @ 340th St
Worrell Creek @ S 16th St (Ames)
0
1
2
3
4
5
6
7
8
9
10
Phosphate (mg/L)

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.

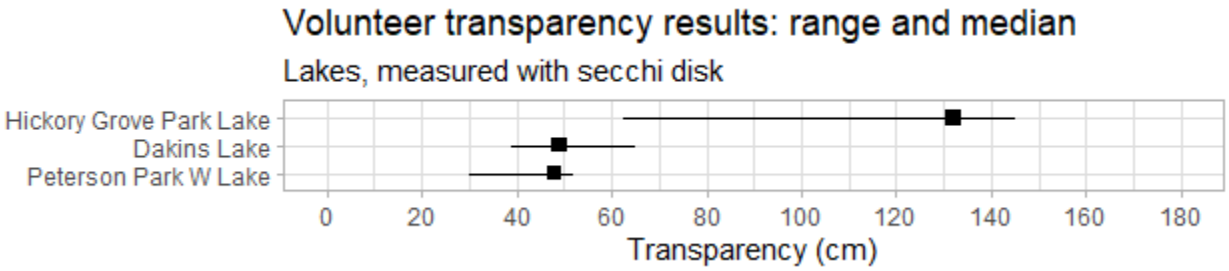
Why is Turbidity Important?
Aquatic organisms depend on high water clarity for survival. As more material is suspended in the water column, less light can penetrate, reducing plant growth. Additionally, when the suspended particles settle they can reduce available habitat, food, and clog the gills of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



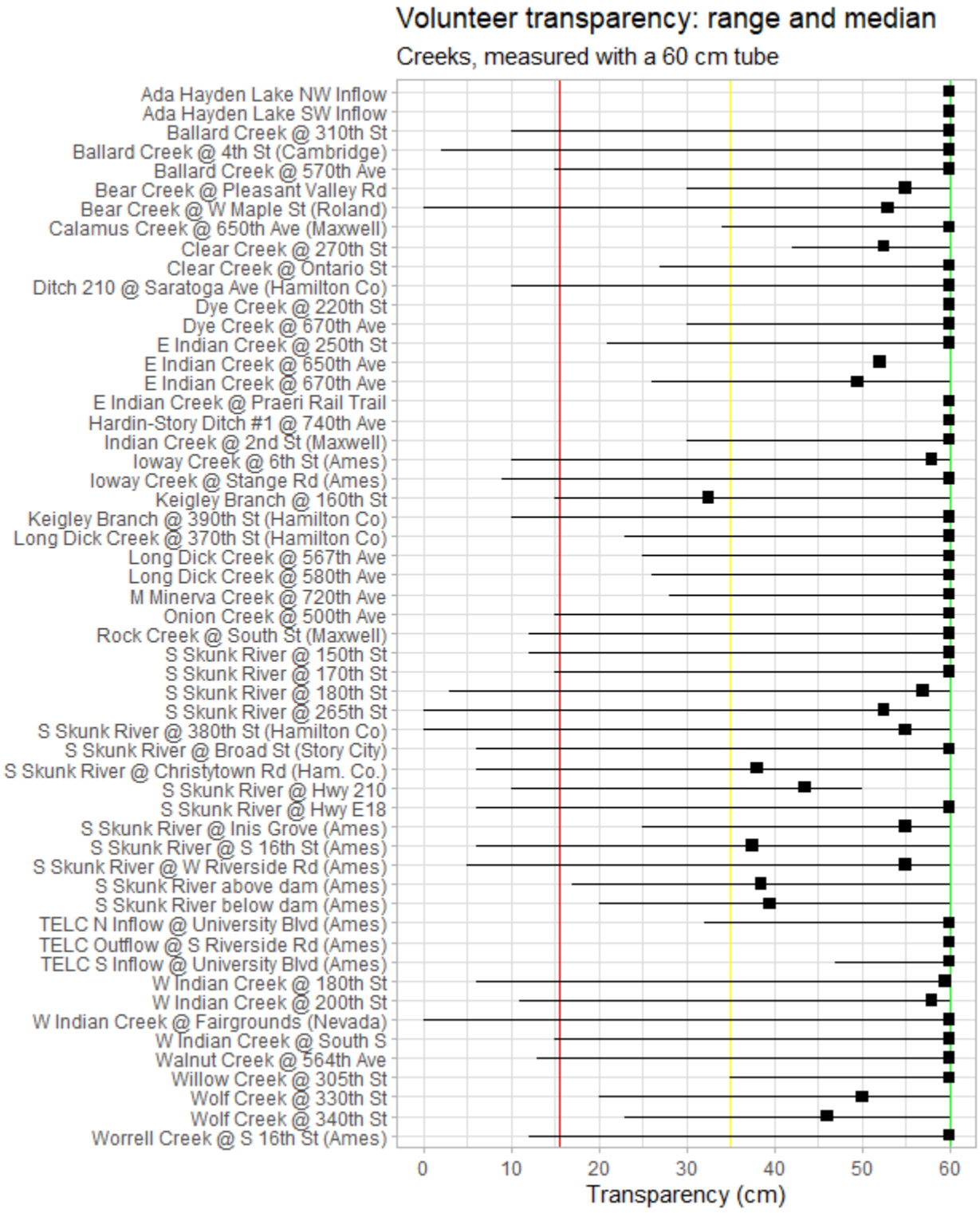
Secchi Disk

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 is Keigley Branch at 160th St. However, transparency at most sites varied widely over the course of the season. Twenty-seven sites (47%) had at least one sample in the "poor" range.



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).

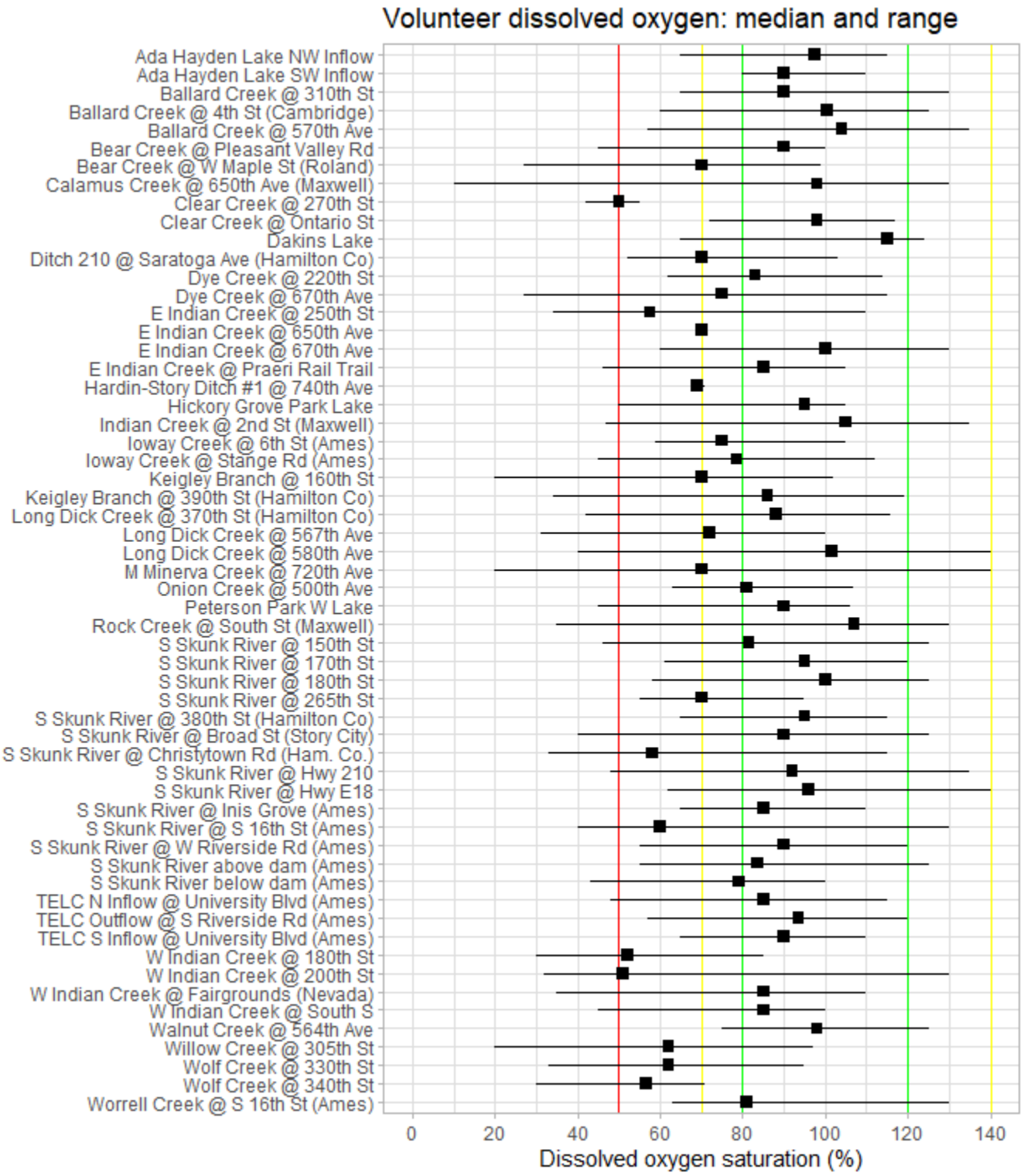
Why is Dissolved Oxygen Important?
Dissolved Oxygen is an essential element when it comes to the survival of aquatic organisms, such as macroinvertebrates and fish. It is also a necessary component in the decomposition of organic matter. Low levels of dissolved oxygen may result in a decrease in species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

Median dissolved oxygen saturation was in the "good" to "excellent" range at 48 sites (83%). However, even a temporary drop in dissolved oxygen can prove fatal for sensitive aquatic life. At least one "poor" reading was observed at thirty-one sites (53%). Low dissolved oxygen levels were most common between August and November, so were probably influenced by the drought.

Median dissolved oxygen was "poor" at one site, Clear Creek @ 270th St. However, this site was only monitored a few times in late fall. Hardin Ditch #1 ("fair") was only tested in winter.

The following sites need further attention, as they were monitored across the season and median dissolved oxygen was in the "fair" range (below 70% saturation).

- Bear Creek @ W Maple St
- Ditch 210 @ Saratoga Ave (Hamilton Co)
- E Indian Creek @ 250th St
- S Skunk River @ Christytown Rd (Hamilton Co)
- S Skunk River @ S 16th St (Ames)
- Willow Creek @305th St
- Wolf Creek @ 330th St and 340th St
- W Indian Creek @ 200th St (Carroll Prairie) and 180th St

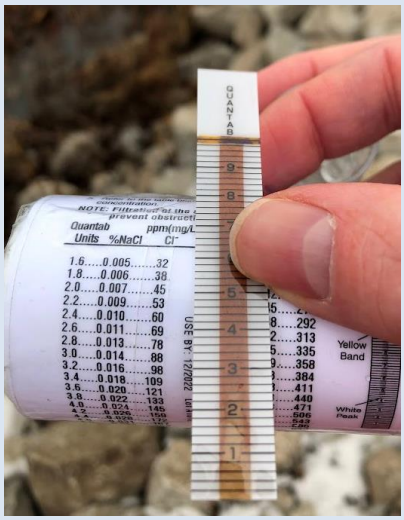

Volunteer dissolved oxygen: median and range
Ada Hayden Lake NW Inflow
Ada Hayden Lake SW Inflow
Ballard Creek @ 310th St
Ballard Creek @ 4th St (Cambridge)
Ballard Creek @ 570th Ave
Bear Creek @ Pleasant Valley Rd
Bear Creek @ W Maple St (Roland)
Calamus Creek @ 650th Ave (Maxwell)
Clear Creek @ 270th St
Clear Creek @ Ontario St
Dakins Lake
Ditch 210 @ Saratoga Ave (Hamilton Co)
Dye Creek @ 220th St
Dye Creek @ 670th Ave
E Indian Creek @ 250th St
E Indian Creek @ 650th Ave
E Indian Creek @ 670th Ave
E Indian Creek @ Praeri Rail Trail
Hardin-Story Ditch #1 @ 740th Ave
Hickory Grove Park Lake
Indian Creek @ 2nd St (Maxwell)
Ioway Creek @ 6th St (Ames)
Ioway Creek @ Stange Rd (Ames)
Keigley Branch @ 160th St
Keigley Branch @ 390th St (Hamilton Co)
Long Dick Creek @ 370th St (Hamilton Co)
Long Dick Creek @ 567th Ave
Long Dick Creek @ 580th Ave
M Minerva Creek @ 720th Ave
Onion Creek @ 500th Ave
Peterson Park W Lake
Rock Creek @ South St (Maxwell)
S Skunk River @ 150th St
S Skunk River @ 170th St
S Skunk River @ 180th St
S Skunk River @ 265th St
S Skunk River @ 380th St (Hamilton Co)
S Skunk River @ Broad St (Story City)
S Skunk River @ Christytown Rd (Ham. Co.)
S Skunk River @ Hwy 210
S Skunk River @ Hwy E18
S Skunk River @ Inis Grove (Ames)
S Skunk River @ S 16th St (Ames)
S Skunk River @ W Riverside Rd (Ames)
S Skunk River above dam (Ames)
S Skunk River below dam (Ames)
TELC N Inflow @ University Blvd (Ames)
TELC Outflow @ S Riverside Rd (Ames)
TELC S Inflow @ University Blvd (Ames)
W Indian Creek @ 180th St
W Indian Creek @ 200th St
W Indian Creek @ Fairgrounds (Nevada)
W Indian Creek @ South S
Walnut Creek @ 564th Ave
Willow Creek @ 305th St
Wolf Creek @ 330th St
Wolf Creek @ 340th St
Worrell Creek @ S 16th St (Ames)
0
20
40
60
80
100
120
140
Dissolved oxygen saturation (%)

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.

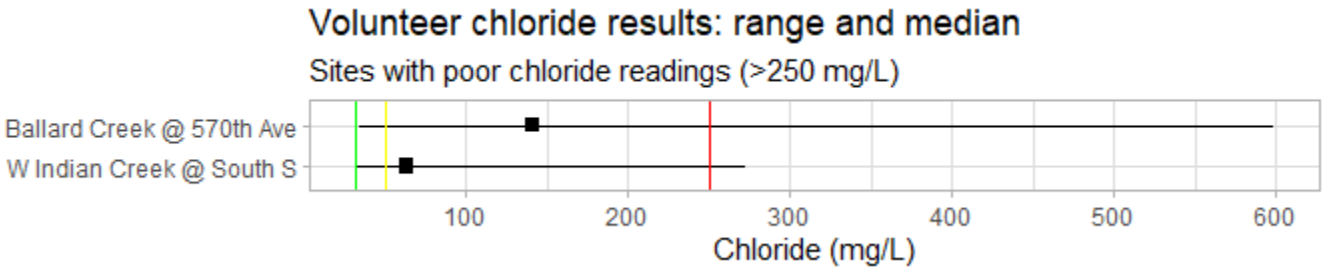
Why is Chloride Important?
Aquatic organisms have adapted to live in different levels of salinity. When chloride levels exceed the acceptable range for various organisms, if can lead to stressors or a decrease in organism diversity.

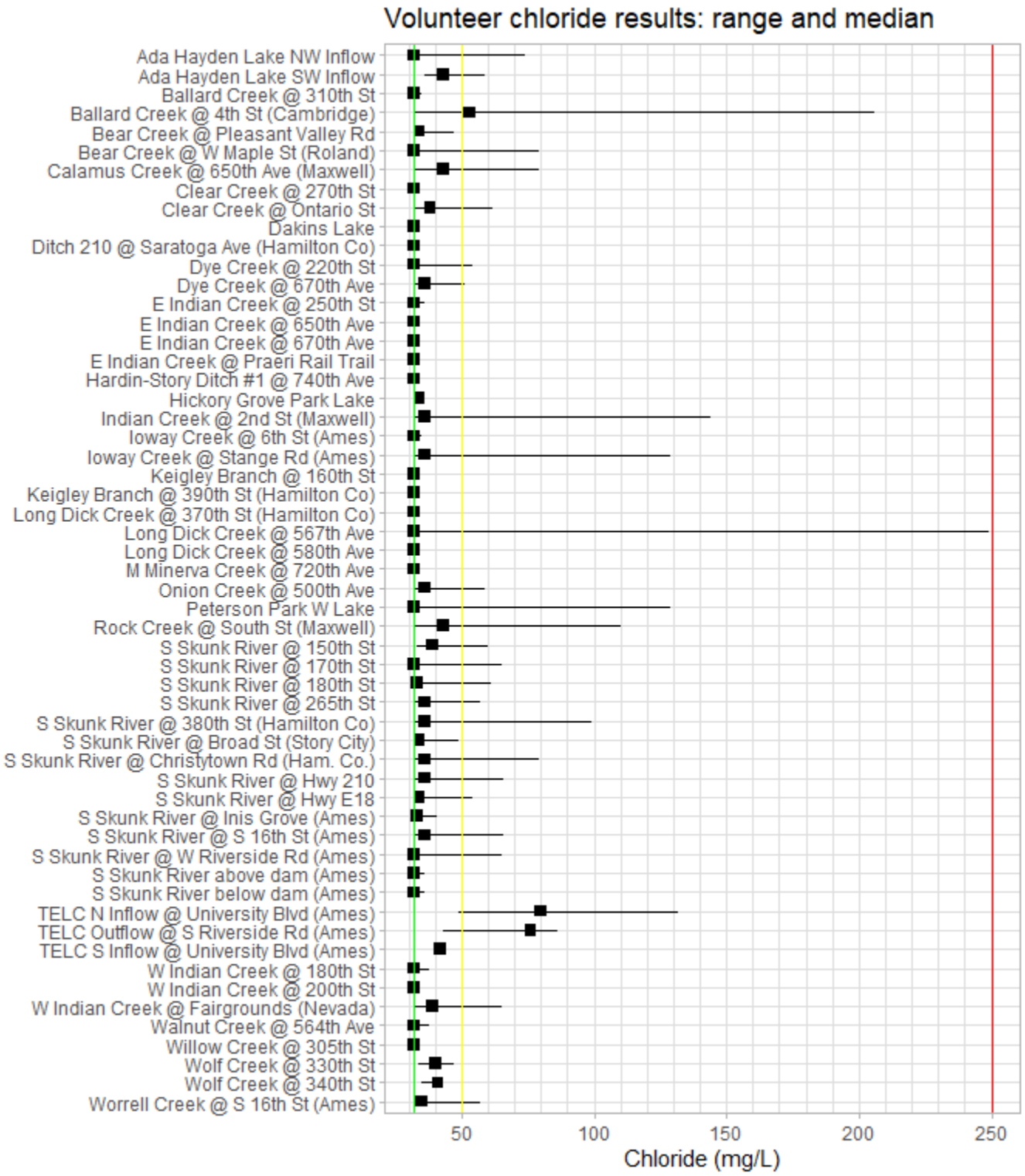


Median chloride concentrations were in the “good” to “excellent” range at 53 sites (91%).

Median chloride concentrations were in the “fair” range (50-250 mg/L) at 5 sites (9%). Ballard Creek @ 570th St and 4th St and West Indian Creek @ South S are downstream of wastewater treatment plants, so discharge from water softeners is a likely source. High chloride in the Tedesco Environmental Learning Corridor appears to originate from the north inflow during dry conditions. Further investigation is needed to determine the source.

To improve legibility, sites with chloride readings above 250 mg/L are shown a separate graph.



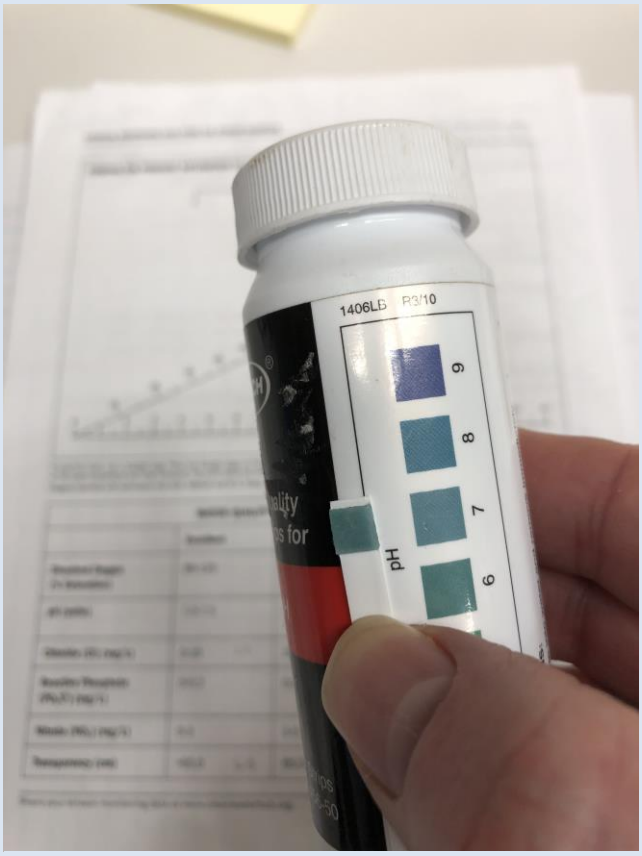

Volunteer chloride results: range and median
Ada Hayden Lake NW Inflow
Ada Hayden Lake SW Inflow
Ballard Creek @ 310th St
Ballard Creek @ 4th St (Cambridge)
Bear Creek @ Pleasant Valley Rd
Bear Creek @ W Maple St (Roland)
Calamus Creek @ 650th Ave (Maxwell)
Clear Creek @ 270th St
Clear Creek @ Ontario St
Dakins Lake
Ditch 210 @ Saratoga Ave (Hamilton Co)
Dye Creek @ 220th St
Dye Creek @ 670th Ave
E Indian Creek @ 250th St
E Indian Creek @ 650th Ave
E Indian Creek @ 670th Ave
E Indian Creek @ Praeri Rail Trail
Hardin-Story Ditch #1 @ 740th Ave
Hickory Grove Park Lake
Indian Creek @ 2nd St (Maxwell)
Ioway Creek @ 6th St (Ames)
Ioway Creek @ Stange Rd (Ames)
Keigley Branch @ 160th St
Keigley Branch @ 390th St (Hamilton Co)
Long Dick Creek @ 370th St (Hamilton Co)
Long Dick Creek @ 567th Ave
Long Dick Creek @ 580th Ave
M Minerva Creek @ 720th Ave
Onion Creek @ 500th Ave
Peterson Park W Lake
Rock Creek @ South St (Maxwell)
S Skunk River @ 150th St
S Skunk River @ 170th St
S Skunk River @ 180th St
S Skunk River @ 265th St
S Skunk River @ 380th St (Hamilton Co)
S Skunk River @ Broad St (Story City)
S Skunk River @ Christytown Rd (Ham. Co.)
S Skunk River @ Hwy 210
S Skunk River @ Hwy E18
S Skunk River @ Inis Grove (Ames)
S Skunk River @ S 16th St (Ames)
S Skunk River @ W Riverside Rd (Ames)
S Skunk River above dam (Ames)
S Skunk River below dam (Ames)
TELC N Inflow @ University Blvd (Ames)
TELC Outflow @ S Riverside Rd (Ames)
TELC S Inflow @ University Blvd (Ames)
W Indian Creek @ 180th St
W Indian Creek @ 200th St
W Indian Creek @ Fairgrounds (Nevada)
Walnut Creek @ 564th Ave
Willow Creek @ 305th St
Wolf Creek @ 330th St
Wolf Creek @ 340th St
Worrell Creek @ S 16th St (Ames)
50
100
150
200
250
Chloride (mg/L)

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.

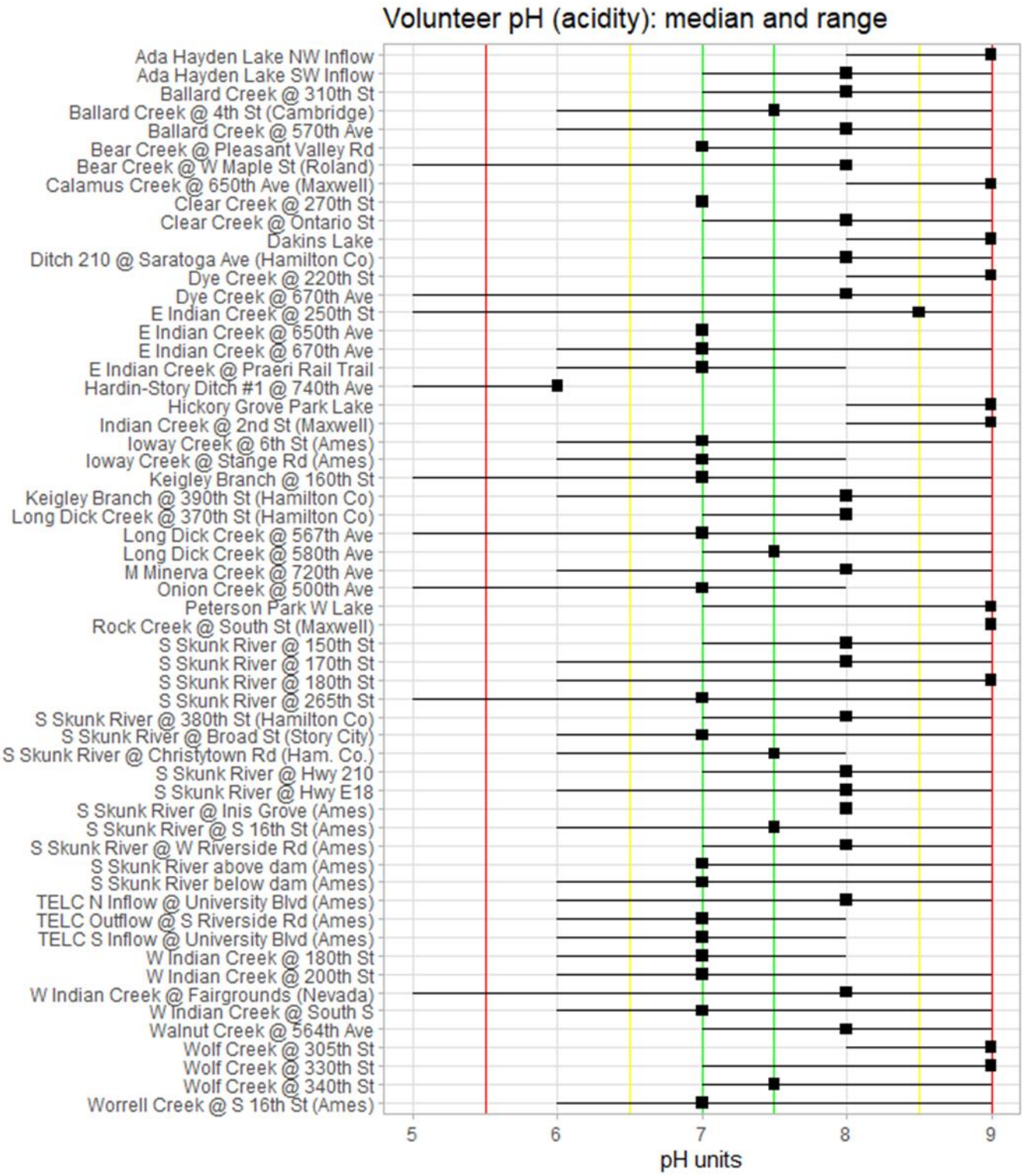
How do we measure pH?
Using the standard Save Our Streams method pH is measured sing the Hach pH test strips.

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.



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 pH thresholds used by the national program may not be appropriate for Iowa, since an 8.5 on a test strip may be read as a 9 and scored as "fair.

However, the acidic water (pH of 5) at nine sites is a cause for concern. One site (Hardin-Story Ditch #3) had consistently low pH, but was only tested three times. 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-three sites (40%).


Volunteer pH (acidity): median and range
Ada Hayden Lake NW Inflow
Ada Hayden Lake SW Inflow
Ballard Creek @ 310th St
Ballard Creek @ 4th St (Cambridge)
Ballard Creek @ 570th Ave
Bear Creek @ Pleasant Valley Rd
Bear Creek @ W Maple St (Roland)
Calamus Creek @ 650th Ave (Maxwell)
Clear Creek @ 270th St
Clear Creek @ Ontario St
Dakins Lake
Ditch 210 @ Saratoga Ave (Hamilton Co)
Dye Creek @ 220th St
Dye Creek @ 670th Ave
E Indian Creek @ 250th St
E Indian Creek @ 650th Ave
E Indian Creek @ 670th Ave
E Indian Creek @ Praeri Rail Trail
Hardin-Story Ditch #1 @ 740th Ave
Hickory Grove Park Lake
Indian Creek @ 2nd St (Maxwell)
Ioway Creek @ 6th St (Ames)
Ioway Creek @ Stange Rd (Ames)
Keigley Branch @ 160th St
Keigley Branch @ 390th St (Hamilton Co)
Long Dick Creek @ 370th St (Hamilton Co)
Long Dick Creek @ 567th Ave
Long Dick Creek @ 580th Ave
M Minerva Creek @ 720th Ave
Onion Creek @ 500th Ave
Peterson Park W Lake
Rock Creek @ South St (Maxwell)
S Skunk River @ 150th St
S Skunk River @ 170th St
S Skunk River @ 180th St
S Skunk River @ 265th St
S Skunk River @ 380th St (Hamilton Co)
S Skunk River @ Broad St (Story City)
S Skunk River @ Christytown Rd (Ham. Co.)
S Skunk River @ Hwy 210
S Skunk River @ Hwy E18
S Skunk River @ Inis Grove (Ames)
S Skunk River @ S 16th St (Ames)
S Skunk River @ W Riverside Rd (Ames)
S Skunk River above dam (Ames)
S Skunk River below dam (Ames)
TELC N Inflow @ University Blvd (Ames)
TELC Outflow @ S Riverside Rd (Ames)
TELC S Inflow @ University Blvd (Ames)
W Indian Creek @ 180th St
W Indian Creek @ 200th St
W Indian Creek @ Fairgrounds (Nevada)
W Indian Creek @ South S
Walnut Creek @ 564th Ave
Wolf Creek @ 305th St
Wolf Creek @ 330th St
Wolf Creek @ 340th St
Worrell Creek @ S 16th St (Ames)
5
6
7
8
9
pH units

Sites with water quality concerns for follow-up

The following sites had elevated phosphate and chloride levels that are likely due to effluent from wastewater treatment plants (WWTPs).

- Ballard Creek @ 4th St. Downstream of Huxley WWTP.
- Ballard Creek @ 570th. Downstream of Huxley WWTP. The high (50 mg/L) nitrate reading was measured in late summer when nitrate in other creeks was low, so is probably also from wastewater.
- Dye Creek @ 670th St. Downstream of mobile home park.
- Indian Creek @ 2nd St. Downstream of Nevada WWTP.
- W Indian Creek @ South S. Downstream of Nevada WWTP.
- Rock Creek @ South St (Maxwell). Downstream of Maxwell WWTP.
- S Skunk River @ Hwy 210. Downstream of Ames WWTP.
- S Skunk River @ E18. Downstream of Story City WWTP.

The following sites had pH readings as low as 5, and need further attention. Excess algae growth in streams can be linked to changes in pH.

- Bear Creek @ W Maple St.
- Dye Creek @ 670th St.
- E Indian Creek @ 250th St.
- Hardin-Story Ditch.
- Keigley Branch @ 160th St.
- Onion Creek @ 500th Ave.
- S Skunk River @ S 16th St.
- S Skunk River @ 265th St.
- W Indian Creek @ Fairgrounds (Nevada).

The following sites had consistently low dissolved oxygen levels (median below 70% saturation) and need further attention. Excess algae growth in streams can be linked to changes to overnight swings in dissolved oxygen.

- Bear Creek @ W Maple St.
- Ditch 210 @ Saratoga Ave (Hamilton Co).
- E Indian Creek @ 250th St.
- S Skunk River @ Christytown Rd (Hamilton Co).
- S Skunk River @ S 16th St (Ames).
- Willow Creek @305th St.
- Wolf Creek @ 330th St and 340th St.
- W Indian Creek @ 200th St (Carroll Prairie) and 180th St.

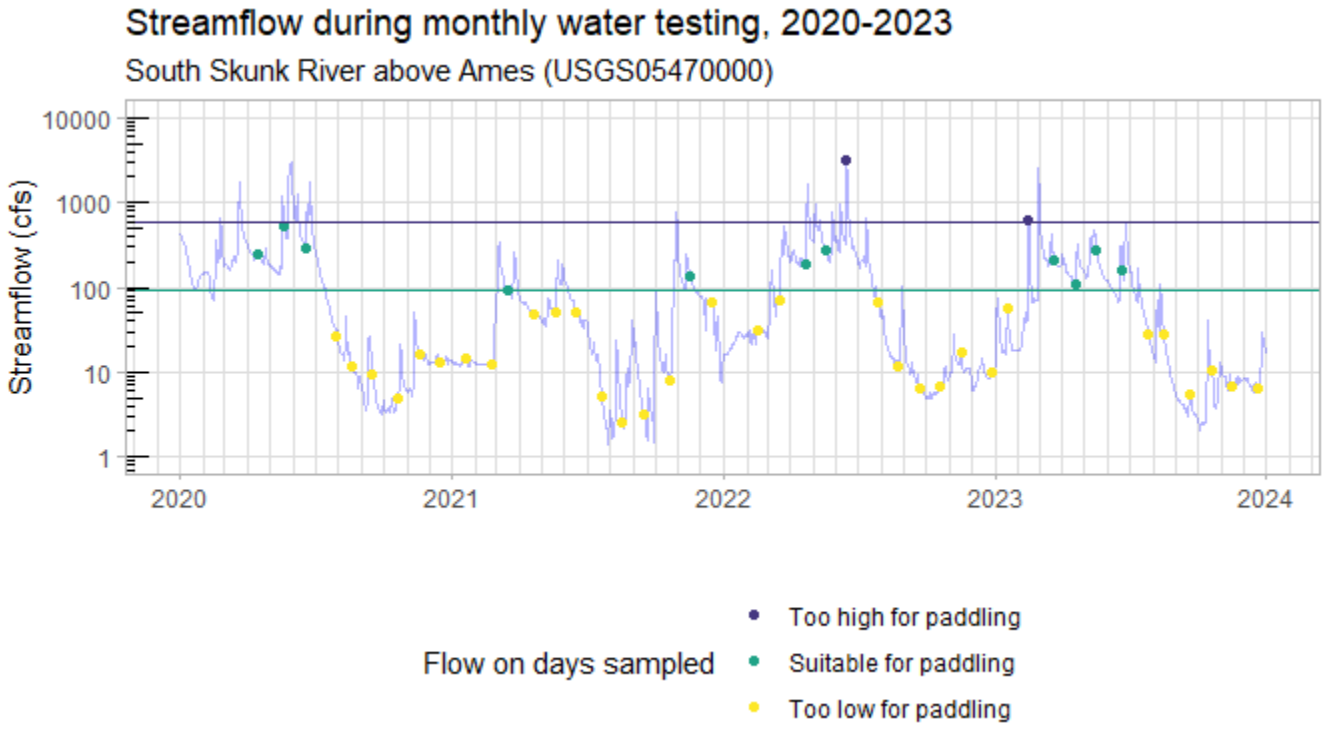
Two sites at the Tedesco Environmental Learning Corridor (TELC) have average chloride levels in the “fair” range and need further attention. Chloride is elevated year-round, so is unlikely to be caused by de-icing salts.

Results: Lab Testing, 2020-2023

Our report from the 2021 season[9] 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.

Many of the samples from the first four years of our monitoring program were collected during periods of drought. **In order to look separately at wet and dry periods, we are combining four years of water quality data. This should be more informative than averages for a single season.** [10]

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?"



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

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

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

- **Too high for paddling (600+ cfs).** Monthly sites were sampled at least twice during these conditions: on June 15, 2022 following a storm event, and on February 15, 2023 following both rain and snowmelt. Intense scattered storms on May 18, 2022 affected only streams in the southern part of the County, and only the streams in Ames were monitored on May 19, 2020.
- **Suitable for paddling (90-600 cfs).** Most monthly sites were sampled 11 times during these conditions.
- **Too low for paddling (0-90 cfs).** Monthly sites were monitored up to 30 times during these conditions, depending on how often streams were dry (in summer and fall) or frozen (in winter).

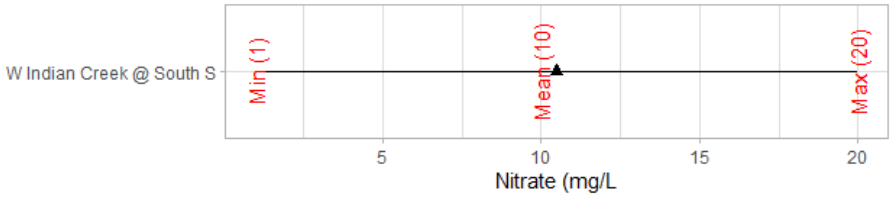
744 cfs
Too high for paddling
(For most people)

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.

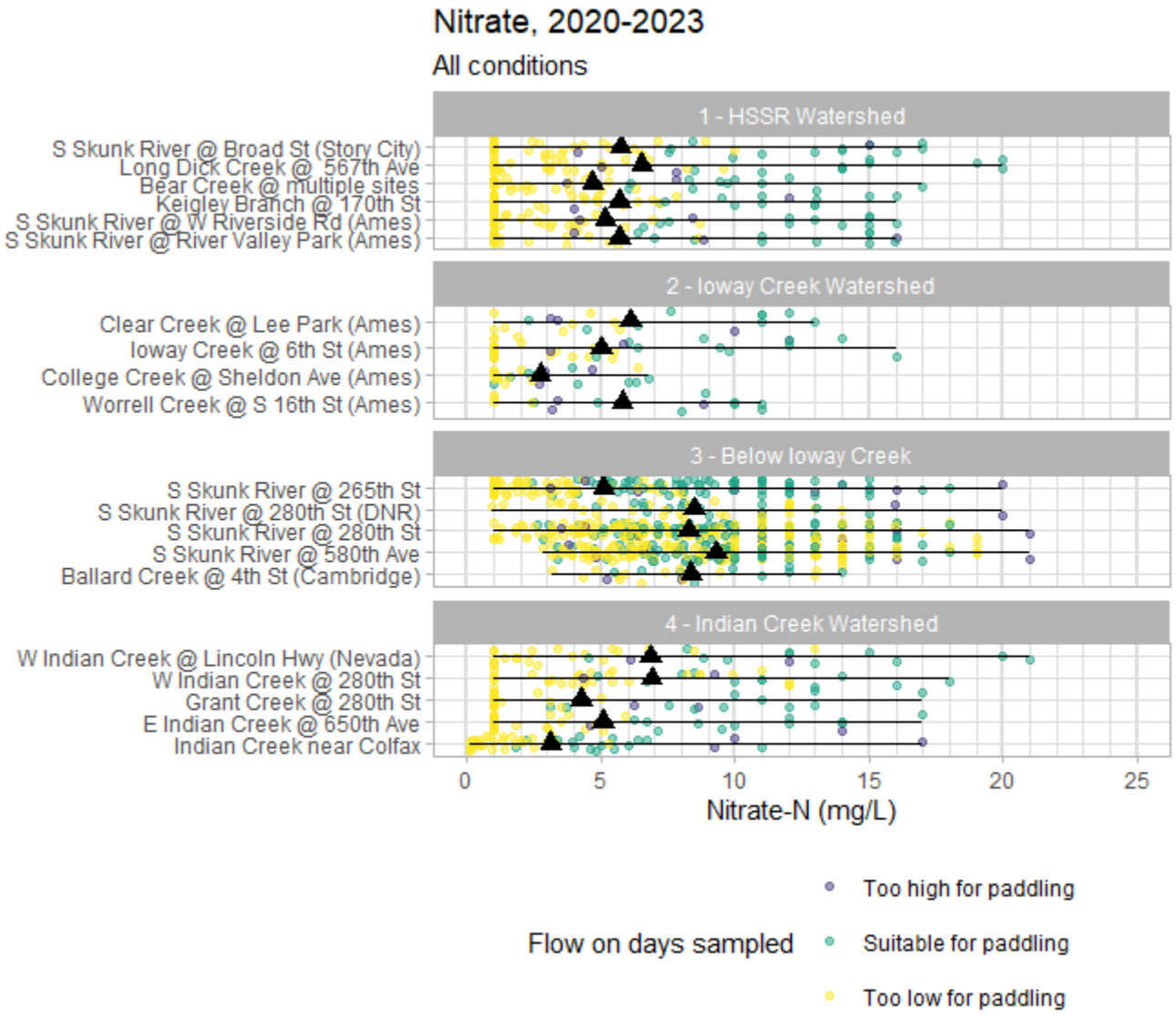


Nitrate

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 2020-2023:

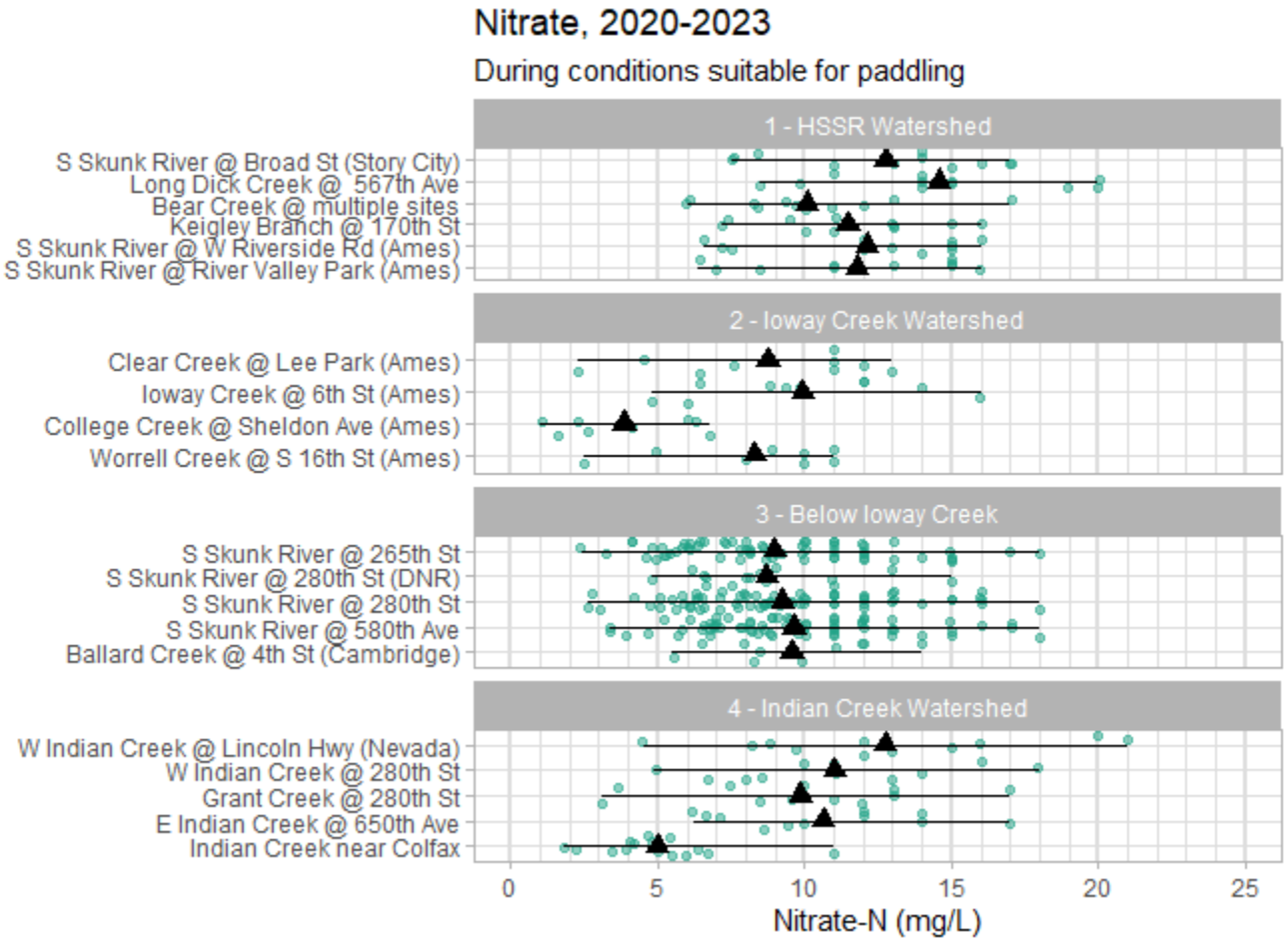
- Average nitrate concentrations ranged from 3-9 mg/L. Most samples were collected during dry conditions when nitrate tends to be lower. The exception is small creeks like Clear Creek and Worrell Creek were not flowing during dry periods.



- 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.

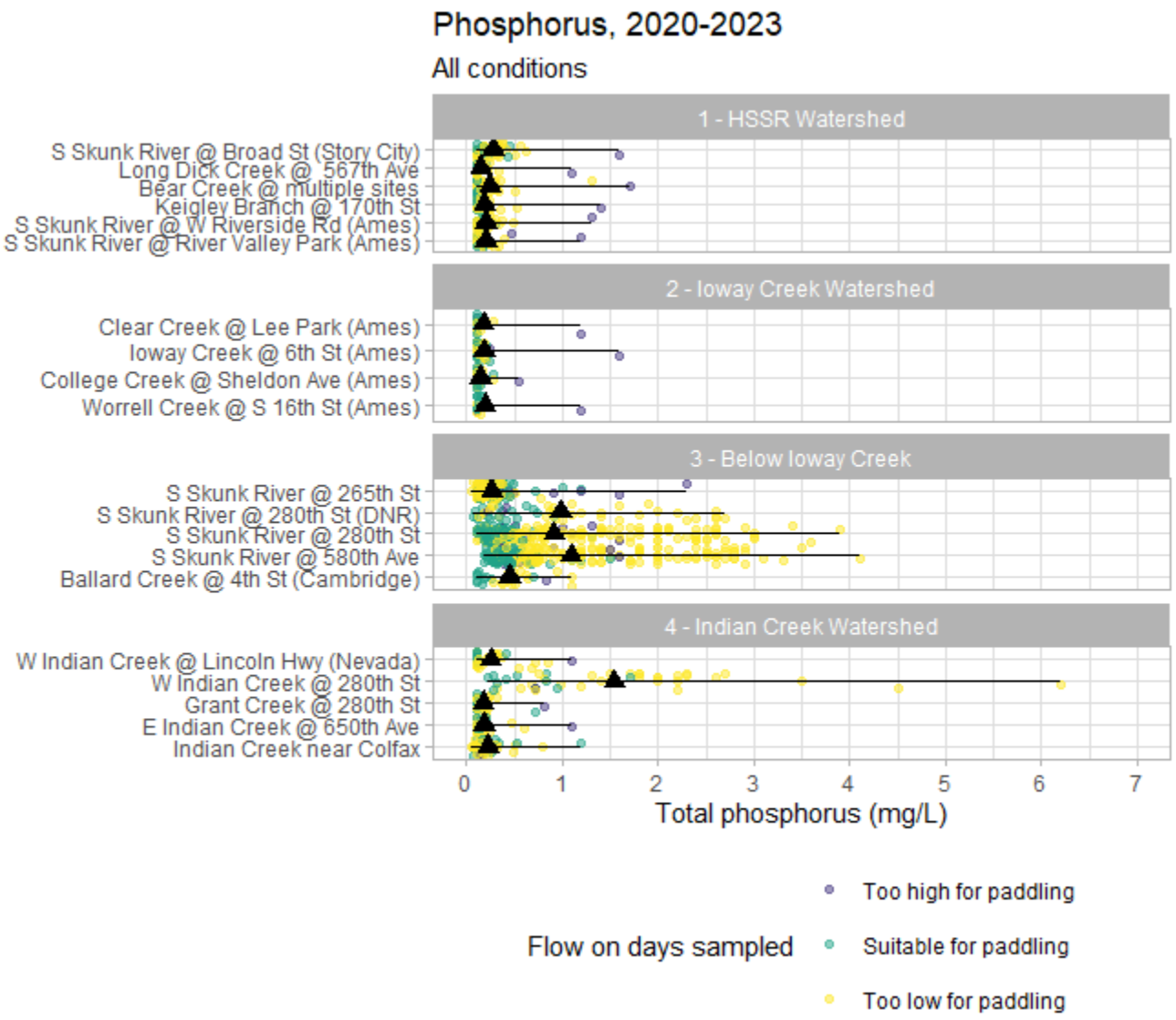
During conditions suitable for paddling:

- **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 (4-10 mg/L) than sites in the Headwaters of the South Skunk River watershed (10-15 mg/L).
- Nitrate is lowest in College Creek @ Sheldon Ave (4 mg/L) which has a mostly urban watershed.
- Nitrate is highest at Long Dick Creek @ 567th Ave (15 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 (9-13 mg/L), probably because it passes through land with drier soils, hillier terrain, and more pasture and woodland.



Phosphorus

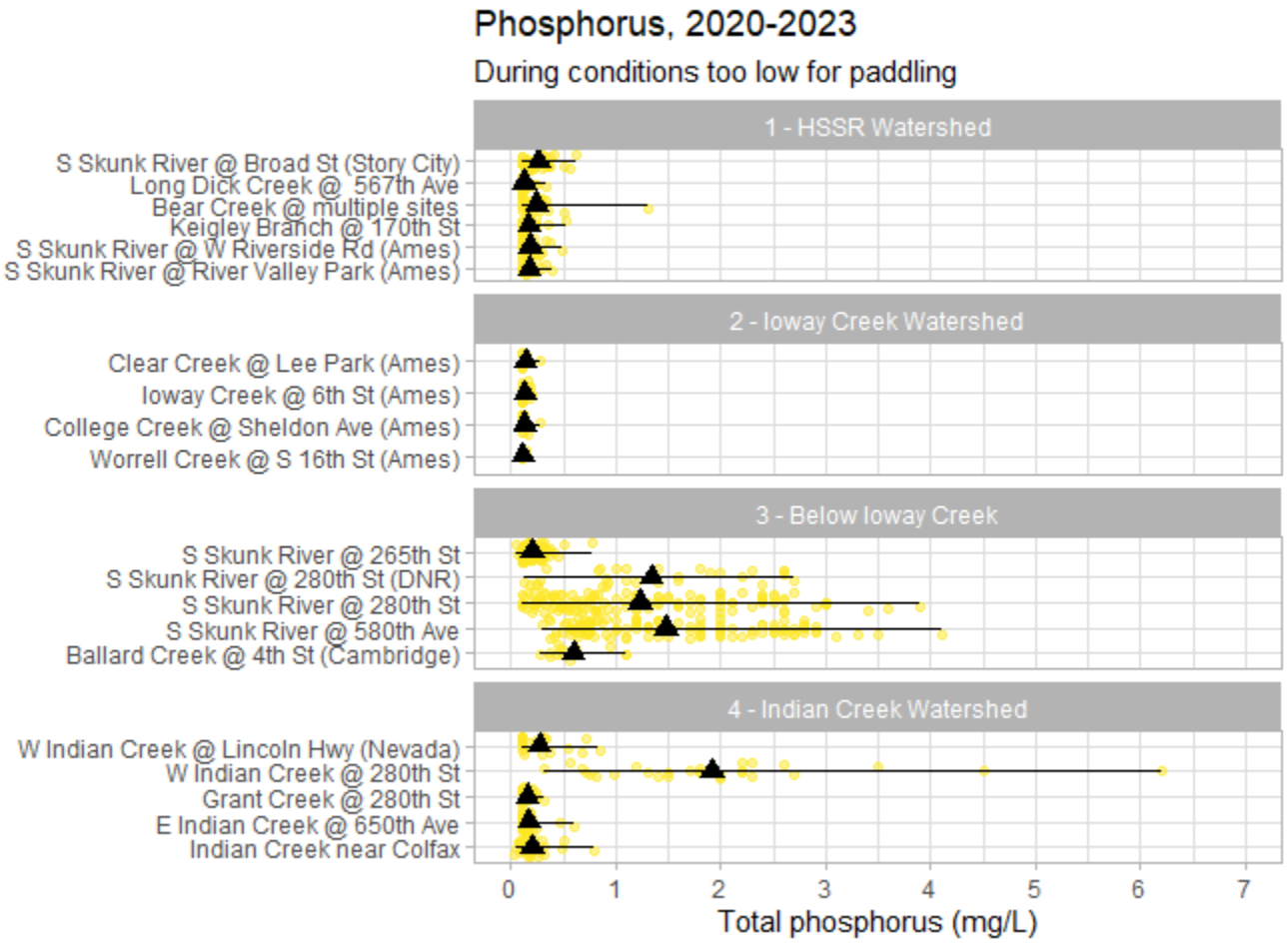
Phosphorus is an essential plant nutrient. Excess nitrogen and phosphorus in lakes and rivers can lead to harmful algae blooms, and hypoxia in the Gulf of Mexico. The lab measures total phosphorus, which includes both dissolved forms and forms bound to sediment. There are no relevant state standards 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 four years, but is more clearly seen by focusing on conditions too low for paddling.

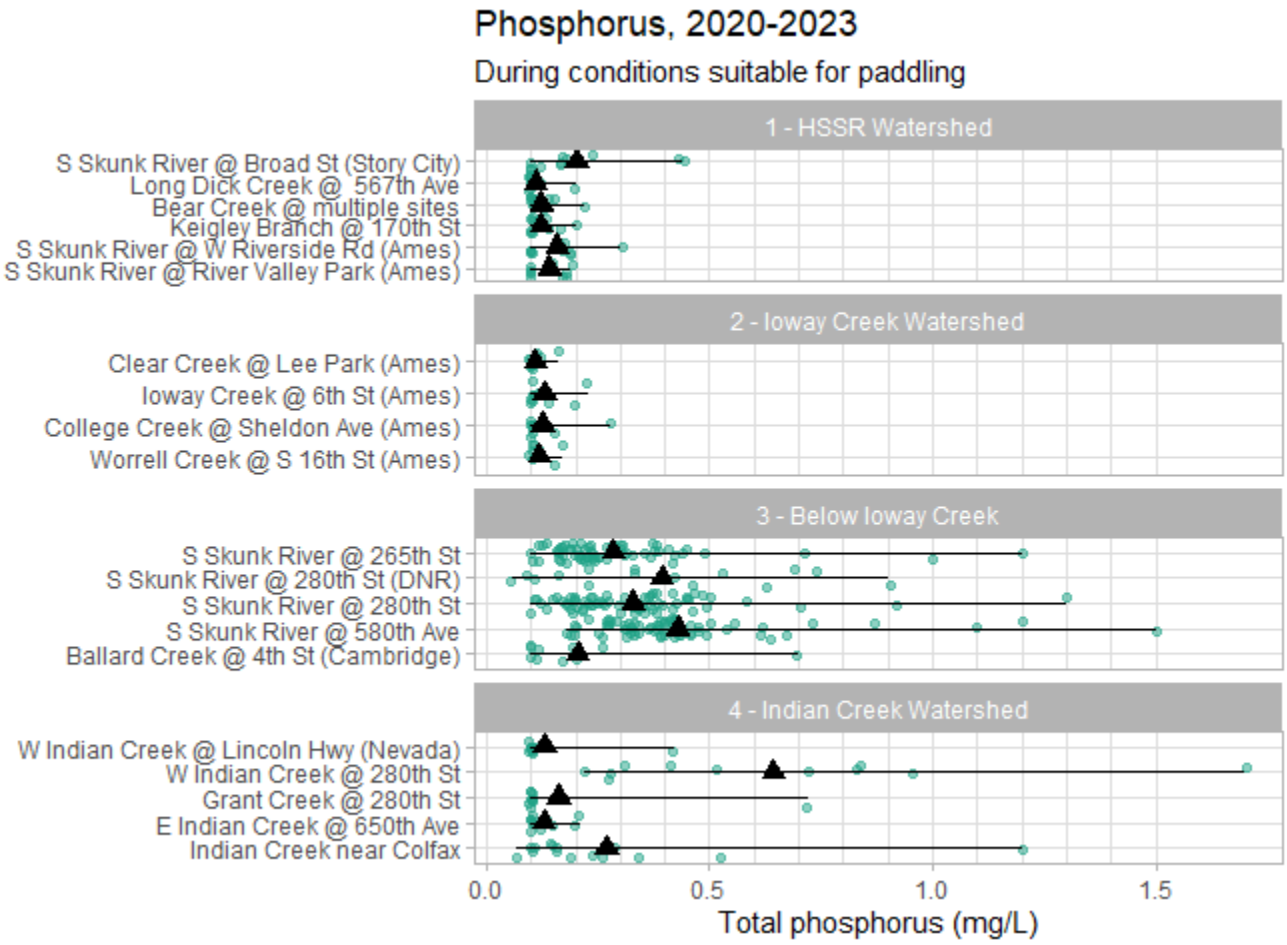
During conditions too low for paddling:

- Average total phosphorus is highest at sites that receive effluent from wastewater treatment plants (WWTP).
  - West Indian Creek @ 280th St (1.91 mg/L) is about 3 miles below the Nevada WWTP.
  - The South Skunk River @ 280th St (1.23 mg/L) is 0.3 miles below the outfall of the Ames WWTP. The S. Skunk River @ 580th St (1.48 mg/L) is 1.3 miles below the outfall (at the confluence with Walnut Creek).
  - Ballard Creek @ 4th St (0.60 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 systems 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 (0.13 mg/L) is about 6 miles downstream of the Gilbert WWTP and the S. Skunk River @ W. Riverside Rd (0.18 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:

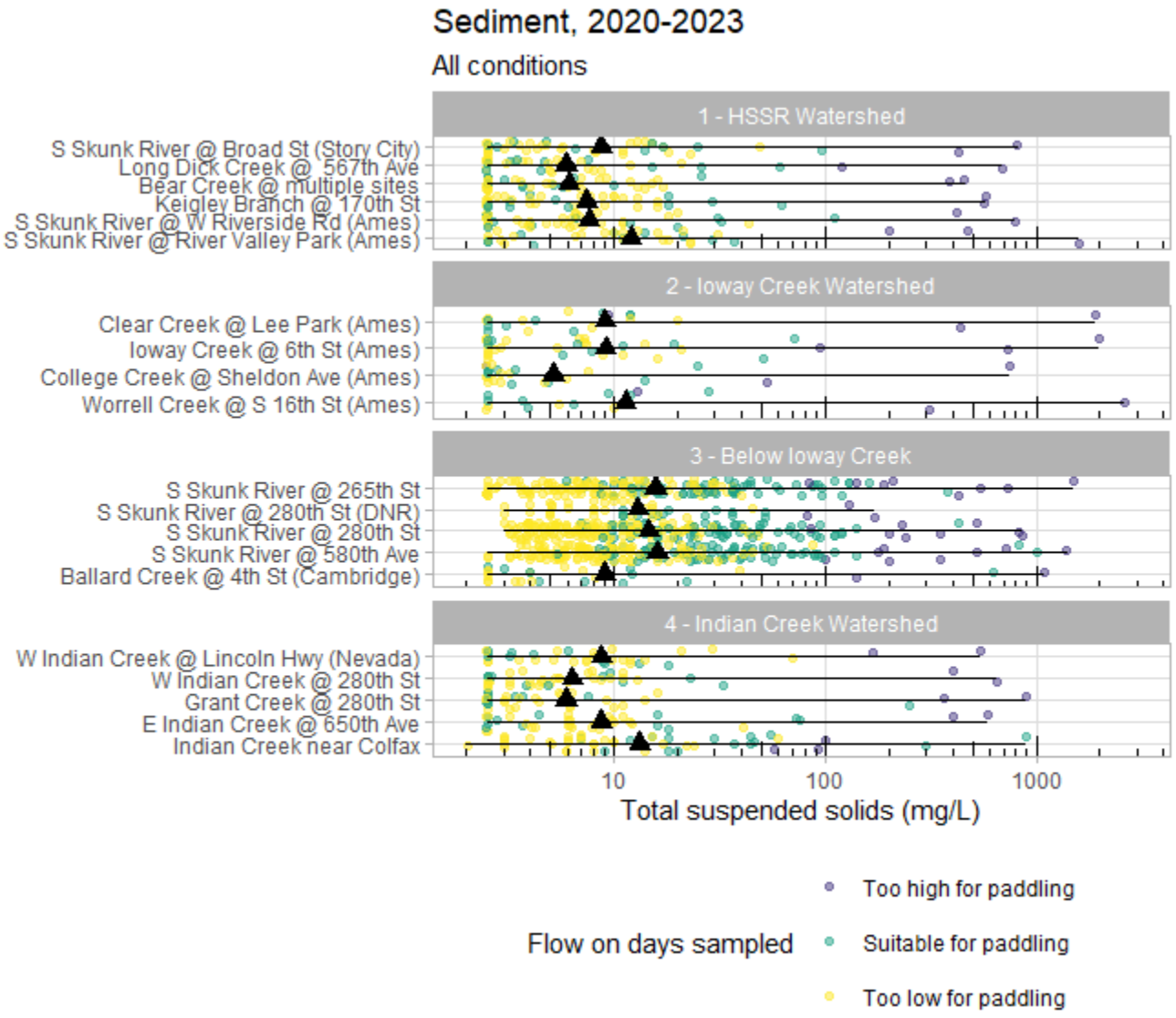
- Most sites were sampled eleven times.
- Total phosphorus is still highest at sites downstream of wastewater treatment plants, but much lower than during conditions too dry for paddling.
    - 0.64 mg/L at West Indian Creek @ 280th St, versus 1.91 mg/L during dry conditions.
    - 0.43 mg/L in the South Skunk River @ 580th St, versus 1.48 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 (0.13 mg/L) this could indicate a phosphorus source somewhere in Ames.



Total suspended solids

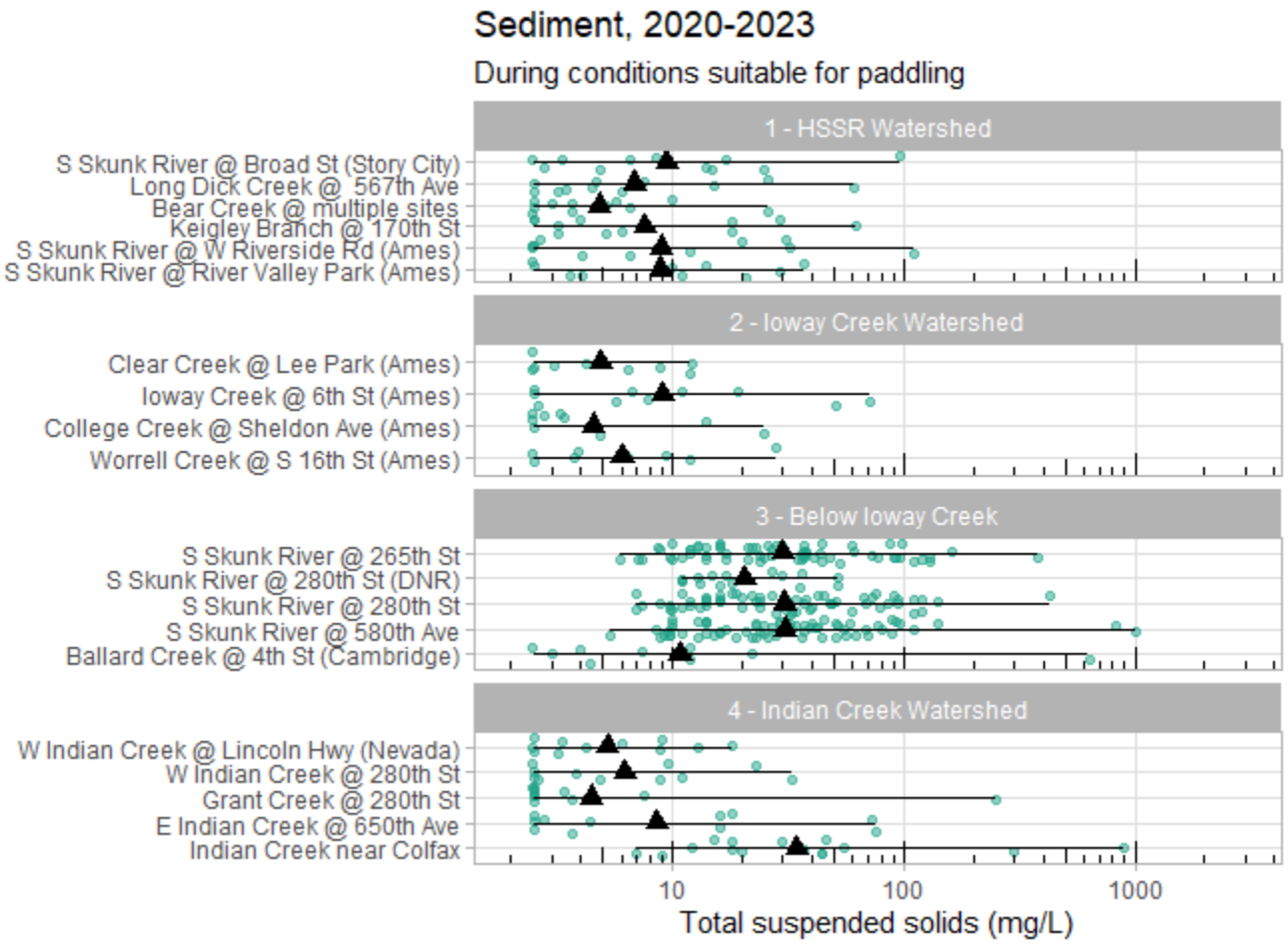
Too much sediment in the water can harm aquatic life and eliminate quality habitat (i.e. covering up rocks with silt). Sediment in the water is also an indication of the severity of erosion in the watershed or within the stream corridor. Total suspended solids (TSS) is one of several ways to measure 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 TSS between 2 and 20 mg/L. However, after heavy rains, we've measured total suspended solids as high as 1,900 mg/L, 10-100 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 eleven 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 30 mg/L vs 20 mg/L, respectively).



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 they are equivalent.

2023 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. If more than 9 samples are collected, no more than 10% of the samples can exceed this threshold.

Of the thirteen stream sites with enough data to evaluate, none met the primary contact standard. One site on the South Skunk River met the geometric mean criteria, but had multiple samples exceeding 235 colonies/100mL. Three sites exceeded the secondary contact recreation standard (630 colonies/100mL).

Streams	Number of samples	Number of samples exceeding 235	*E. coli* geometric mean (MPN/100mL)
S Skunk River @ W Riverside Rd (Ames)	9	4	106
S Skunk River @ 280th St (DNR)	8	0	149
S Skunk River @ River Valley Park (Ames)	9	5	161
Grant Creek @ 280th St	9	4	186
E Indian Creek @ 650th Ave	9	6	221
Long Dick Creek @ 567th Ave	9	6	323
S Skunk River @ Broad St (Story City)	9	4	377
Bear Creek @ Pleasant Valley Rd	9	6	401
W Indian Creek @ Lincoln Hwy (Nevada)	9	5	451
Keigley Branch @ 170th St	9	7	539
Ioway Creek @ 6th St (Ames)	7	6	864
Ballard Creek @ 4th St (Cambridge)	9	9	1115
W Indian Creek @ 280th St	9	8	1969

This is not the first year we have seen extremely high *E. coli* concentrations in West Indian Creek (see page 41). In last year's report, we looked at differences between our two sites across different weather conditions. There was little difference between sites during dry weather (which seemed to rule out wastewater as a major source), and E. coli was higher at the downstream site during normal conditions (which seemed to rule out agricultural runoff as a major source). To try to identify the source, we collected additional samples between the two sites, on a day (May 17) when water levels were high enough for paddling in the South Skunk River, and appeared normal in West Indian Creek.

Sites (arranged upstream to downstream)	***E. coli* (MPN/100mL)**
W Indian Creek @ Lincoln Hwy (Nevada)	213
W Indian Creek @ E Ave (Nevada)	242
W Indian Creek @ Hwy 30 (immediately upstream of WWTP)	262
Effluent from (old) Nevada WWTP	**48,392**
W Indian Creek @ Jennett Heritage Area (several miles downstream of WWTP)	9,208

Surprisingly, *E. coli* was extremely high in the treated effluent from the Nevada Wastewater Treatment Plant, and much higher downstream of the wastewater treatment plant than upstream. The problem should be resolved later this year when construction is complete on the new sewage treatment plant. The new plant will include a disinfection system with banks of ultra-violet (UV) lights, which can be expected to reduce E. coli bacteria to below the detection limit (10 MPN/100mL). This finding underscores the importance of continued investments in improved wastewater treatment to protect quality.

Of the two swimming beaches in Story County, only Peterson Park met the primary contact recreation standard in 2023. Hickory Grove Lake met the geometric mean criteria, but had multiple samples exceeding 235 colonies/100mL. Peterson Park has consistently low *E. coli* levels thanks in part to the wooded shoreline, which discourages geese from loafing at the beach. Hydrology may also be a factor—surface water inflows play a bigger role at Hickory Grove Lake, with more opportunity for animal manure to wash into the lake. Peterson Park, a former gravel pit, is mostly fed by groundwater.

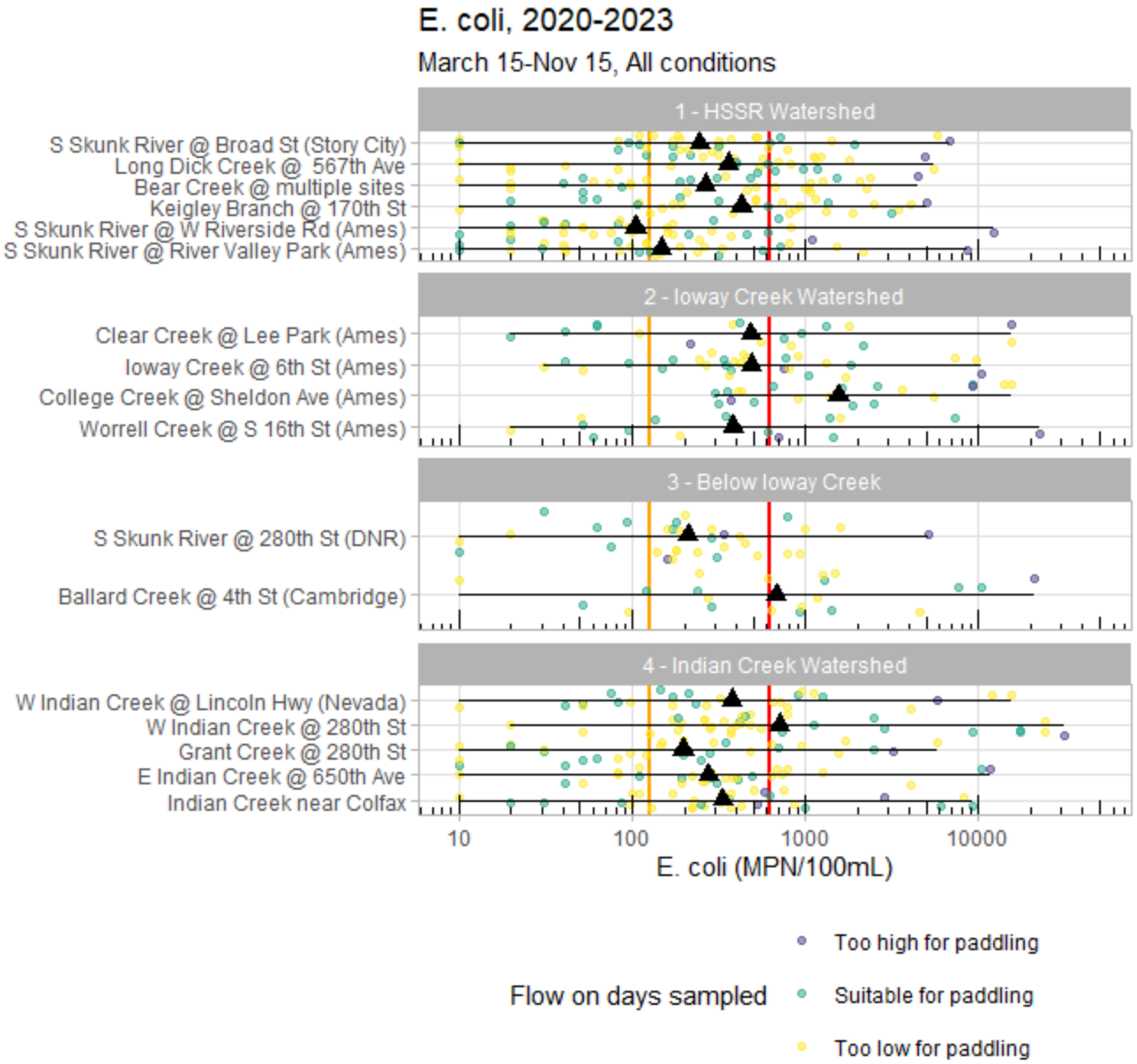
Lakes	Number of samples	Number of samples exceeding 235	*E. coli* geometric mean (MPN/100mL)
Peterson Park Beach	14	0	11
Hickory Grove Park Lake	15	5	101

Bacteria in 2020-2023

The results from 2023 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).

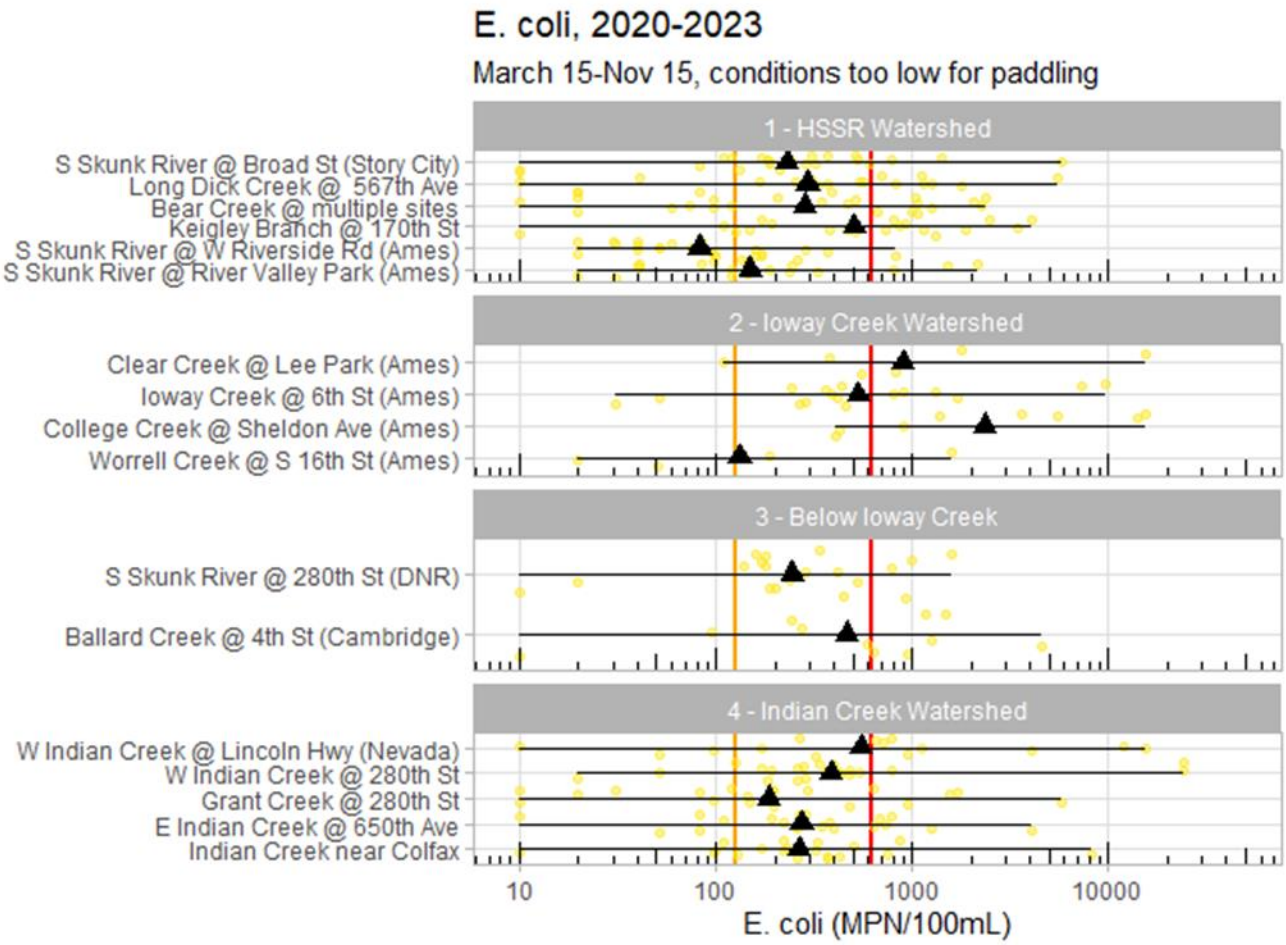
Over the past four years, during the recreation season when standards apply (March 15-November 15):

- 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 known to be effective at removing *E. coli* and other pollutants from runoff.
- 3 out of 17 sites (College Creek at Sheldon Ave, W. Indian Creek at 280th St, and Ballard Creek at 4th St) exceeded the secondary contact recreation standard.



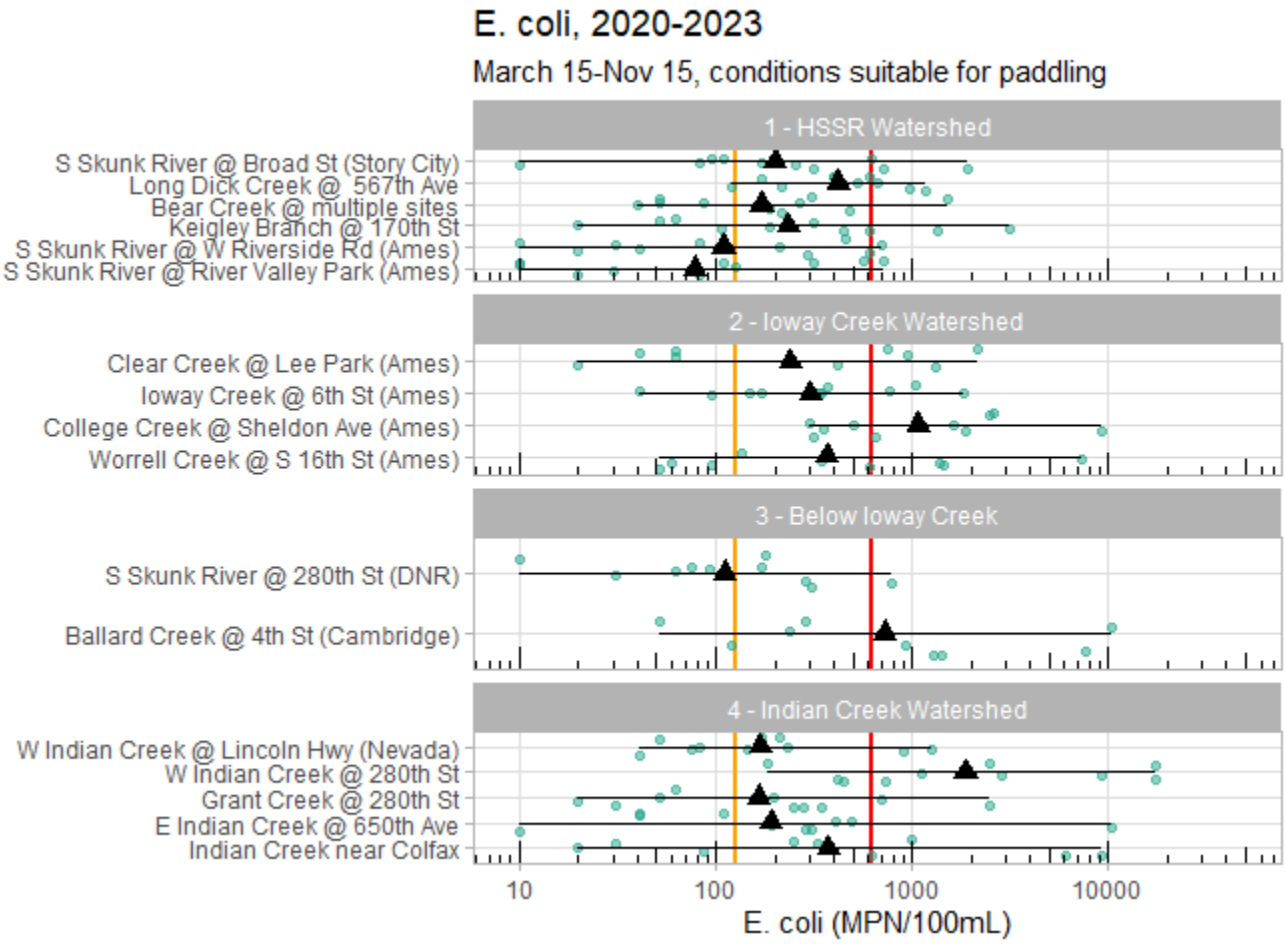
During conditions too low for paddling:

- 1 out of 16 sites (the South Skunk River at W. Riverside Rd) met the primary contact recreation standard.
- 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.
- 2 out of 16 sites exceeded the secondary contact recreation standard: Clear Creek and College Creek in Ames.
- *E. coli* in the South Skunk River is lowest immediately upstream of Ames.
- *E. coli* in West Indian Creek is higher coming into Nevada than downstream.



During conditions suitable for paddling:

- Most sites were sampled ten times during the recreational season.
- 3 out of 17 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.
- *E. coli* in the South Skunk River generally declined from upstream to downstream.
- 3 out of 17 sites exceeded the secondary contact recreation standard: College Creek at Sheldon Ave in Ames, Ballard Creek near Cambridge, 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).



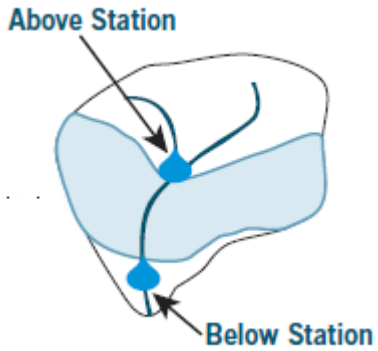
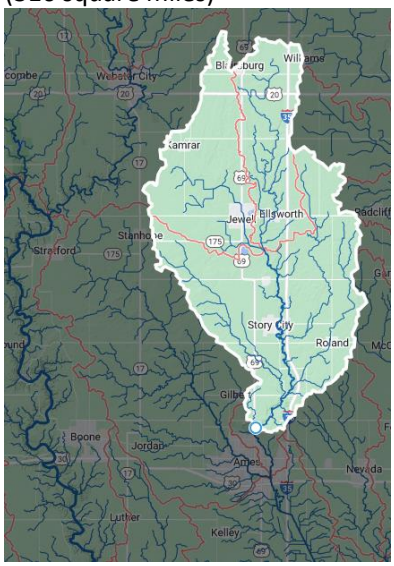
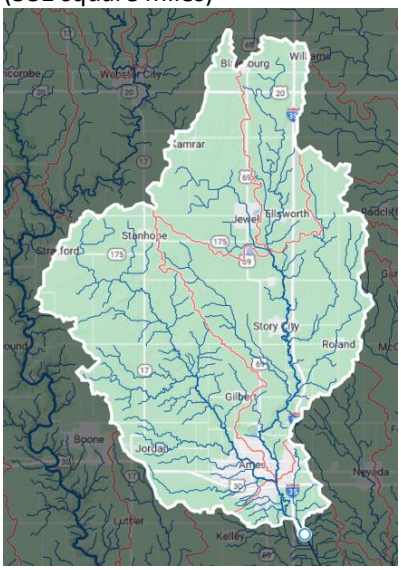
Results: Lab Testing, Long-term trends

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 monthly by the IDNR 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.**

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

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.[11]

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 4 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.

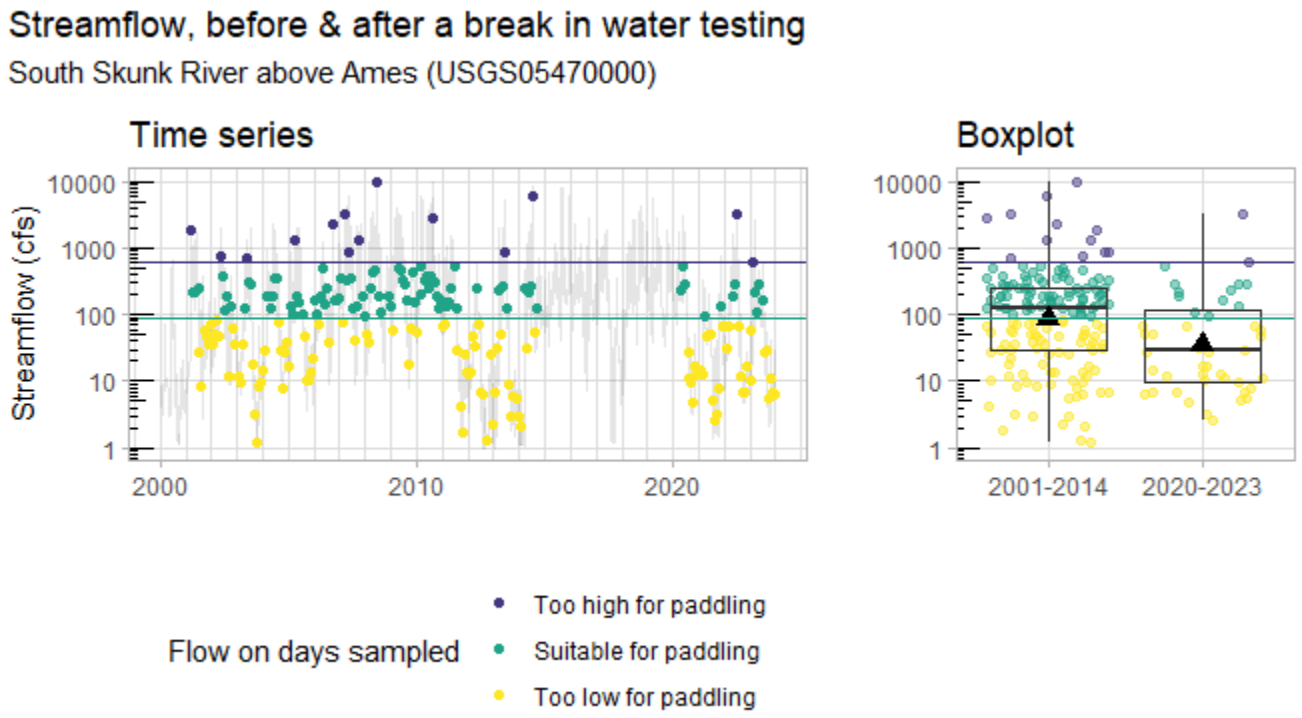
Unlike a medical study, we can't ensure that the "treatment" group takes its medicine, or that the "control" group gets only a placebo. In the final year of the Ioway Creek watershed project, farmers that participated in the program installed a bioreactor, planted 1,529 acres of cover crops, and converted 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.

[11] "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 four years have been drier than normal. Almost three quarters of the monthly samples from 2020-2023 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 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.



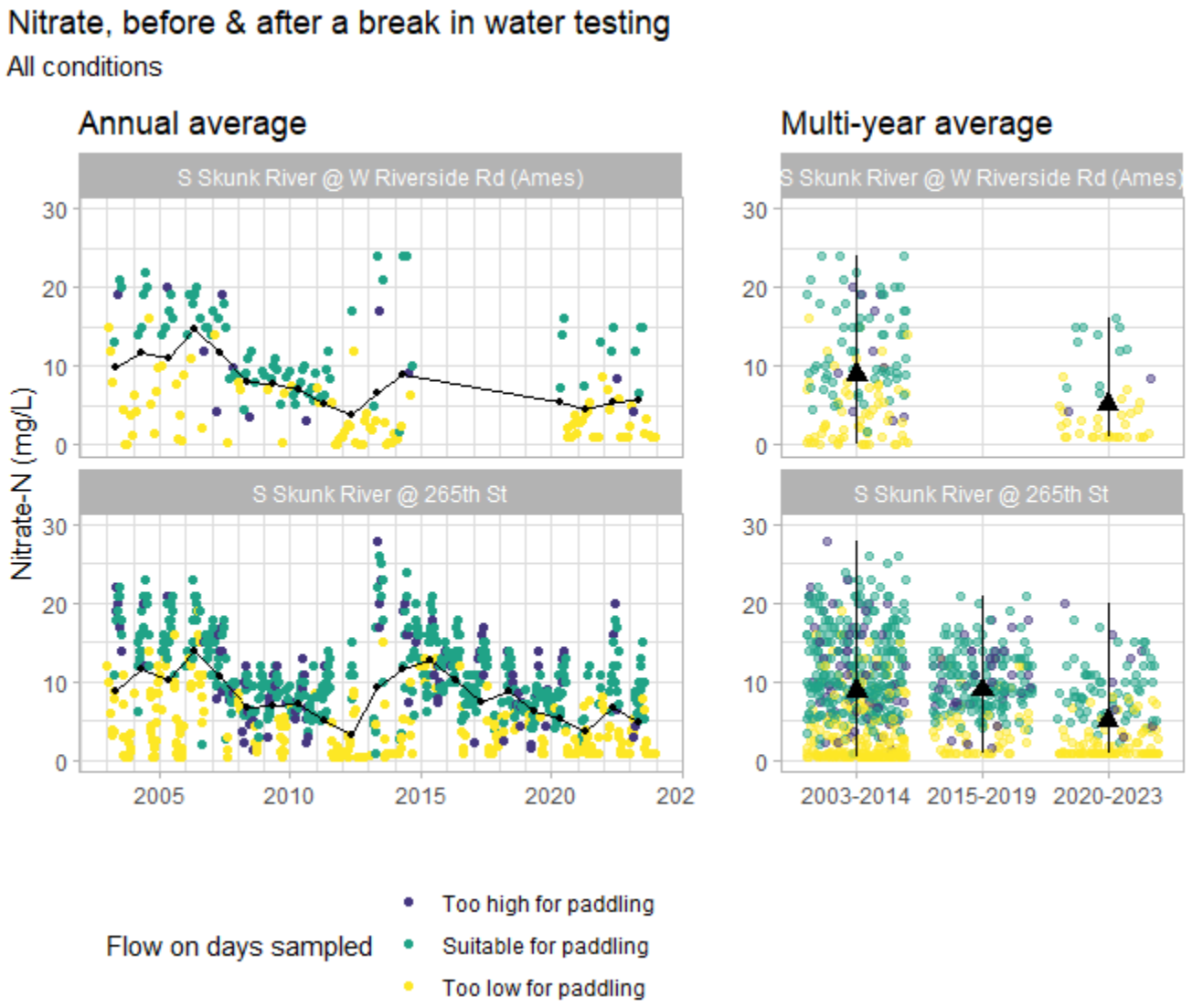
Key findings

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 (2020-2023) 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 2020-2023 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 5.2 mg/L) than the downstream site (8.8 mg/L to 5.1 mg/), but is the improvement related to conservation or just drier weather in the 2020-2023 period?

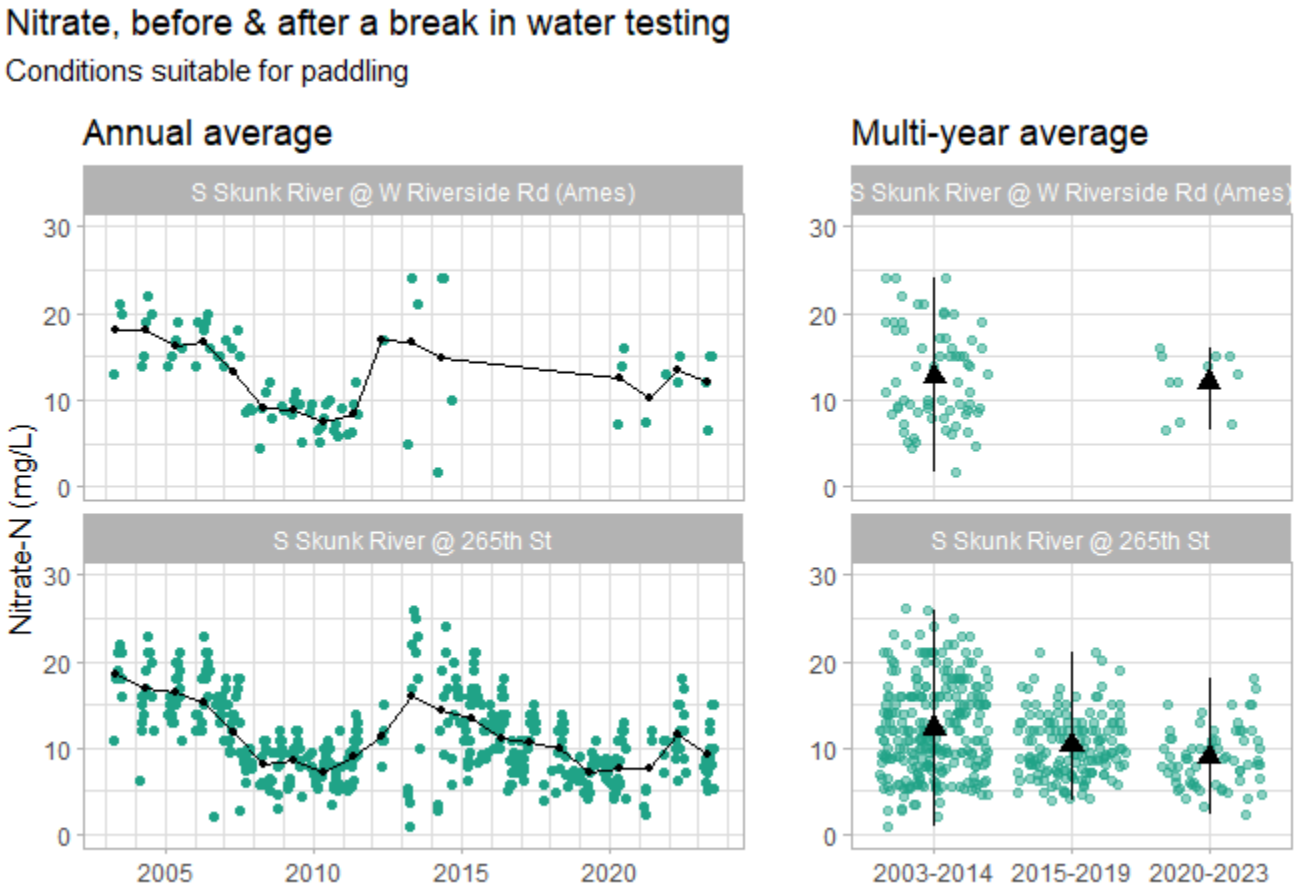


Nitrate in the South Skunk River shows a cyclical pattern, not a linear trend. We tend to get our highest nitrate readings when a wet spring follows a drought[12] but this can be balanced out by low nitrate concentrations during dry periods. At 265th St, average annual nitrate fell from 14.0 mg/L in 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.

[12] 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:

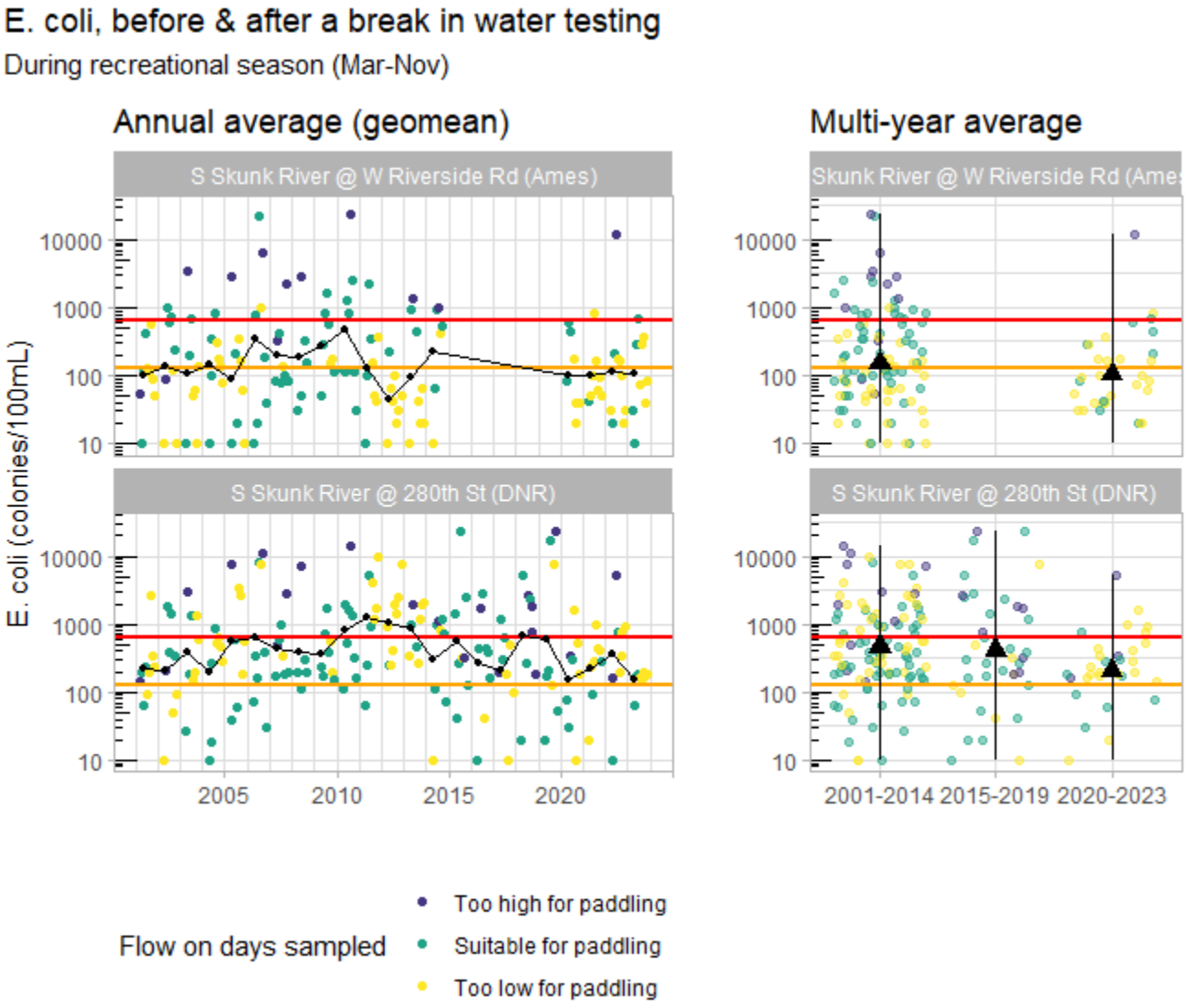
- Average nitrate concentrations at the upstream site (S. Skunk River at W. Riverside Rd) decreased by 1.0 mg/L, from 13.1 mg/L to 12.1 mg/L between 2003-2014 and 2020-2023.
- Average nitrate concentrations at the downstream site (S. Skunk River at 265th St) decreased by 3.3 mg/L, from 12.3 mg/L to 9.0 mg/L. This is consistent with improvements due to conservation in the Ioway Creek watershed.
- A long-term cycle is still apparent, but recent nitrate levels following drought have been lower than in 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 5.0 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 9.2 mg/L) and monthly data from the Iowa DNR (declining from 11.8 to 8.7 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, 2022, and 2023.
- *E. coli* exceeded the standard in 2014 and in 12 out of 17 years between 2021-2014.
- On average, *E. coli* has decreased from 150 colonies in 2001-2014 to 105 colonies/100mL in 2020-2023.

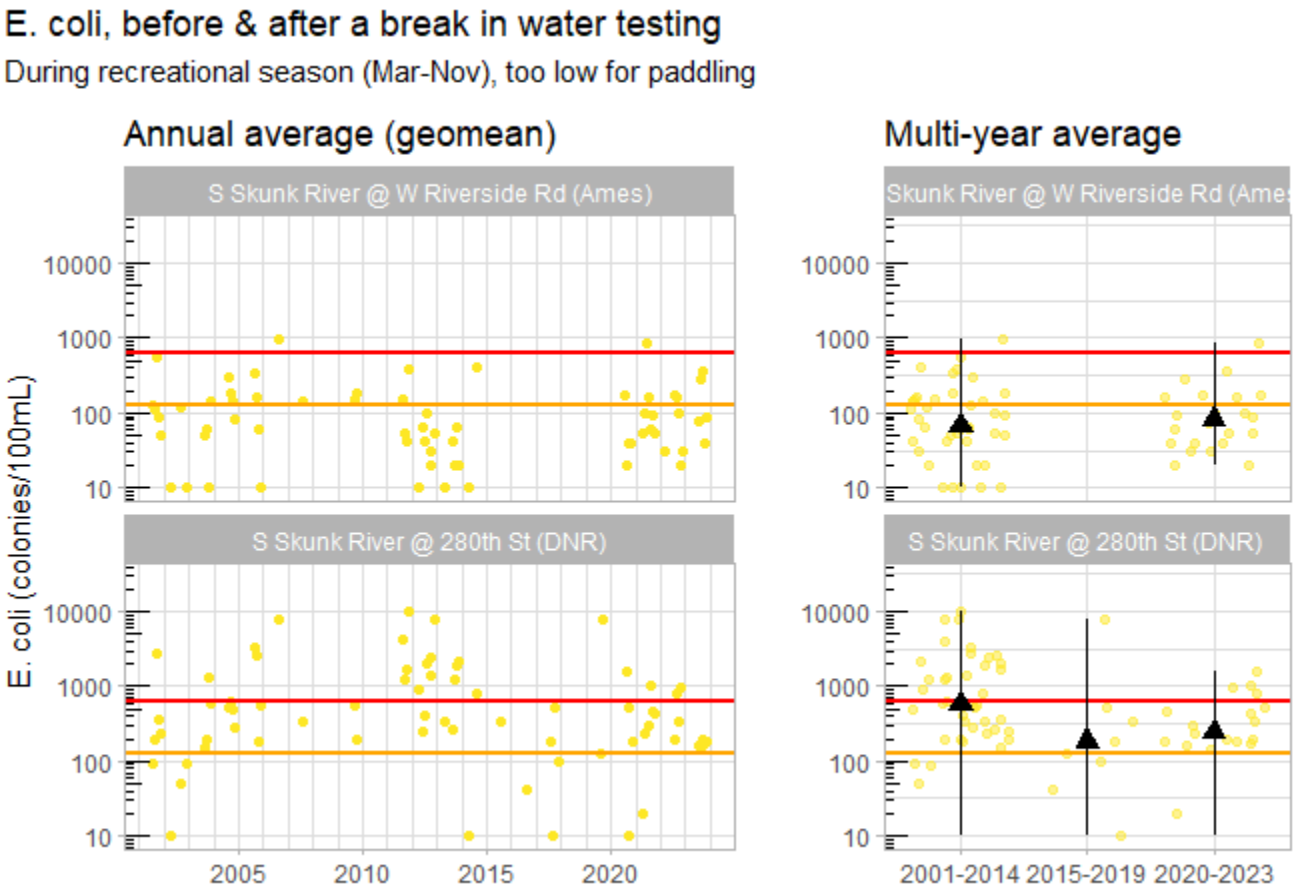
At the downstream site:

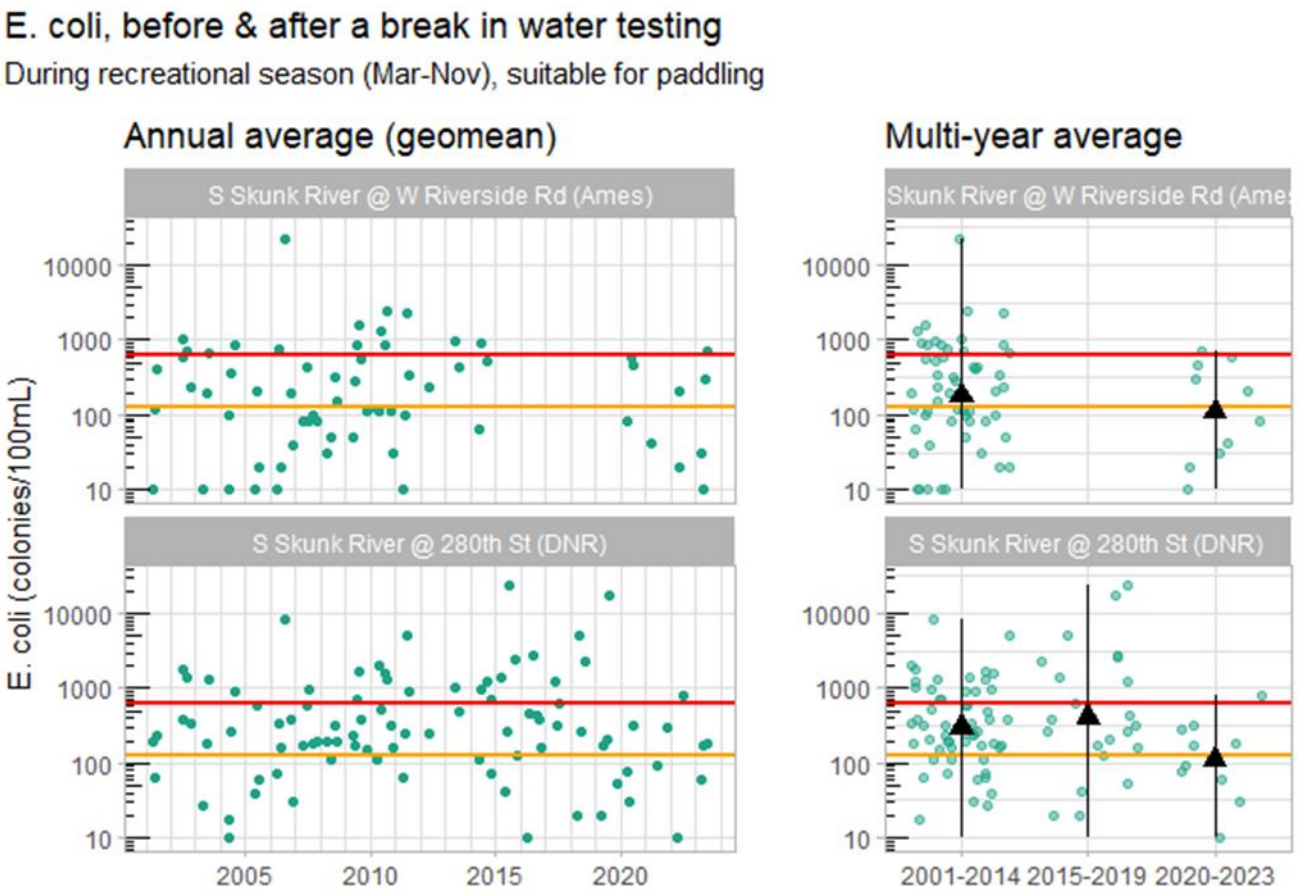
- *E. coli* exceeded the primary contact recreation standard in every year tested.
- *E. coli* exceeded the secondary contact recreation standard in 2010, 2011, 2012, 2013, and 2018.
- *E. coli* decreased from 464 colonies/100mL in 2001-2014 to 210 colonies/100mL in 2020-2023.

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 83 colonies/100mL in 2020-2022.
- *E. coli* at the downstream site decreased from 572 colonies/100mL in 2001-2014 to 246 colonies/100mL in 2020-2023. *E. coli* was especially low in the 2015-2019 period (182) 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 110 colonies/100mL in 2020-2023.
- *E. coli* at the downstream site decreased from 299 colonies/100mL in 2001-2014 to 111 colonies/100mL in 2020-2023. *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 four 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

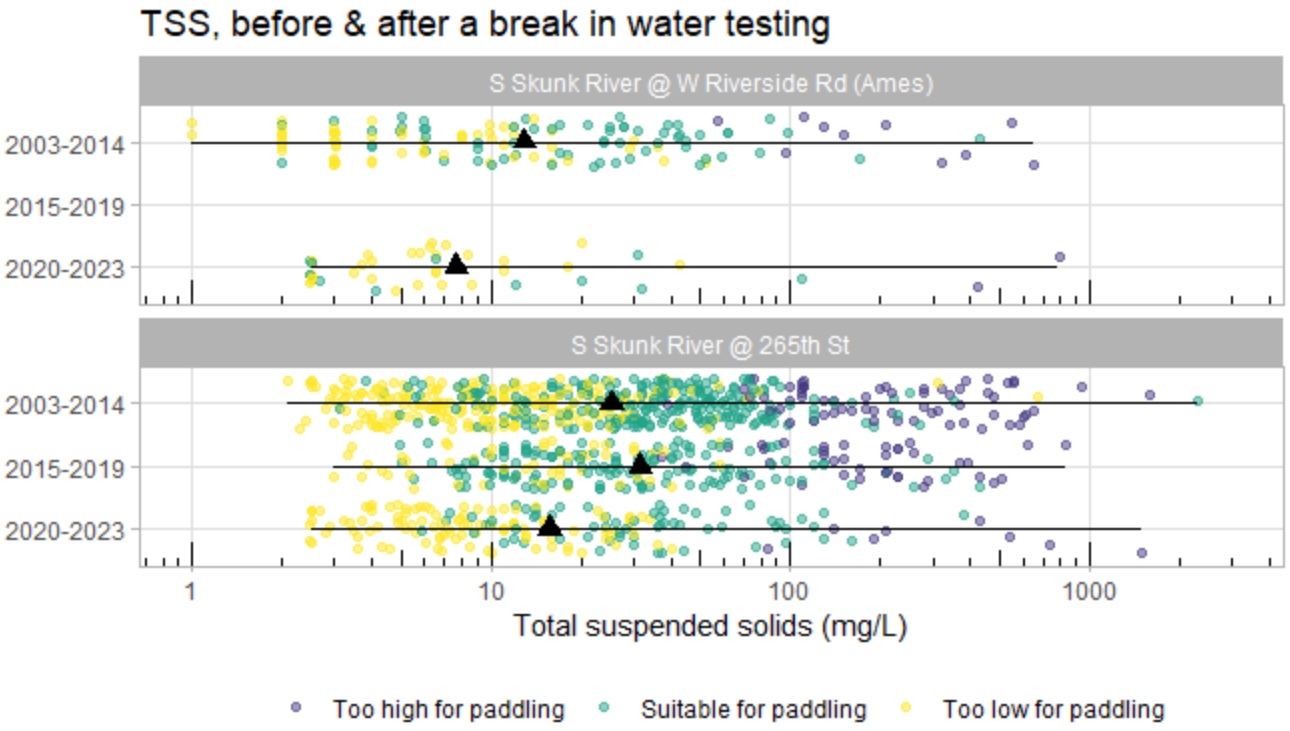
Phosphorus is often attached to sediment, and conservation practices that prevent soil erosion or filter out sediment from runoff will address both pollutants, so we will look at these trends together. Total phosphorus and total suspended solids (TSS) data are available from five sites, but for simplicity 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).

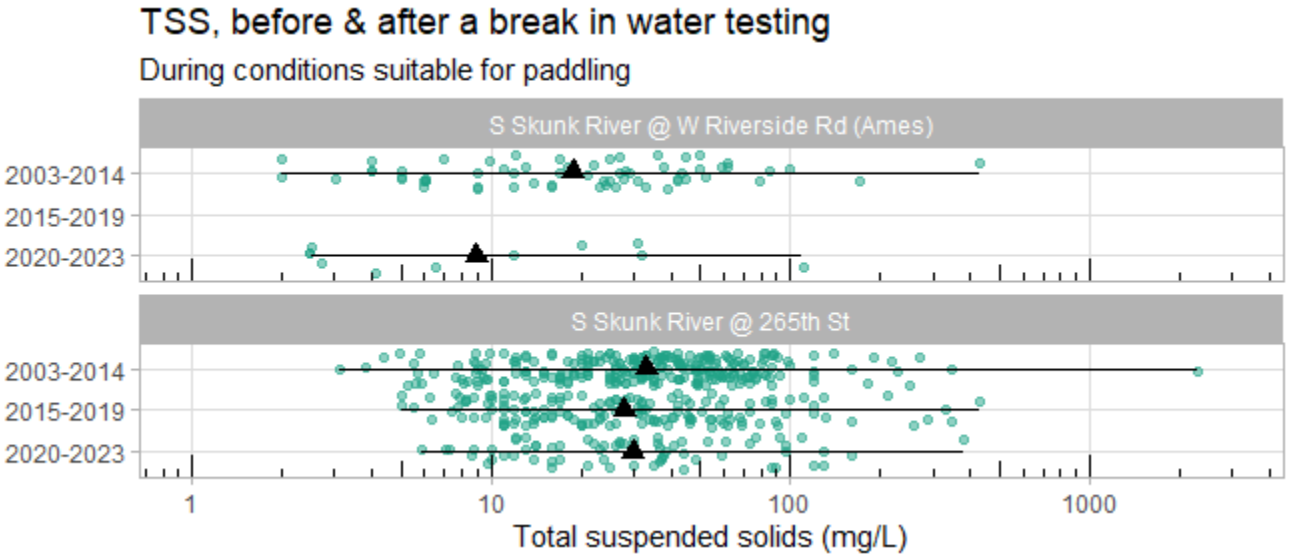
Comparing total suspended solids (a geometric mean) in the 2003-2014 and 2020-2023 periods:

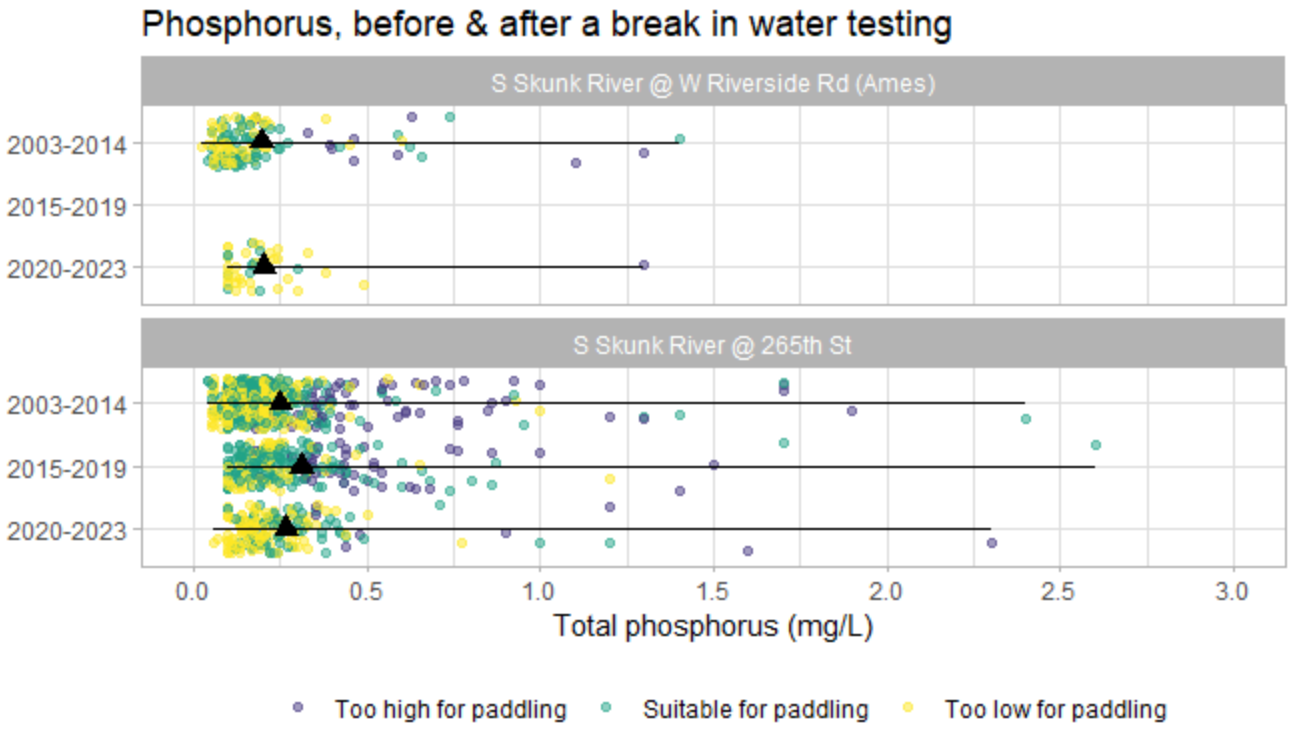
- Total suspended solids decreased at both sites. This is likely due to a larger proportion of samples collected during drier conditions.
- The trend at the downstream site disappears when we focus on conditions suitable for paddling.
- TSS decreased from about 23 mg/L to 7 mg/L at the upstream site. This report does not include any tests for statistical significance, but results from weekly and monthly sampling at 280th St differed by 13 mg/L, suggesting that differences between time periods would be within the margin of error.

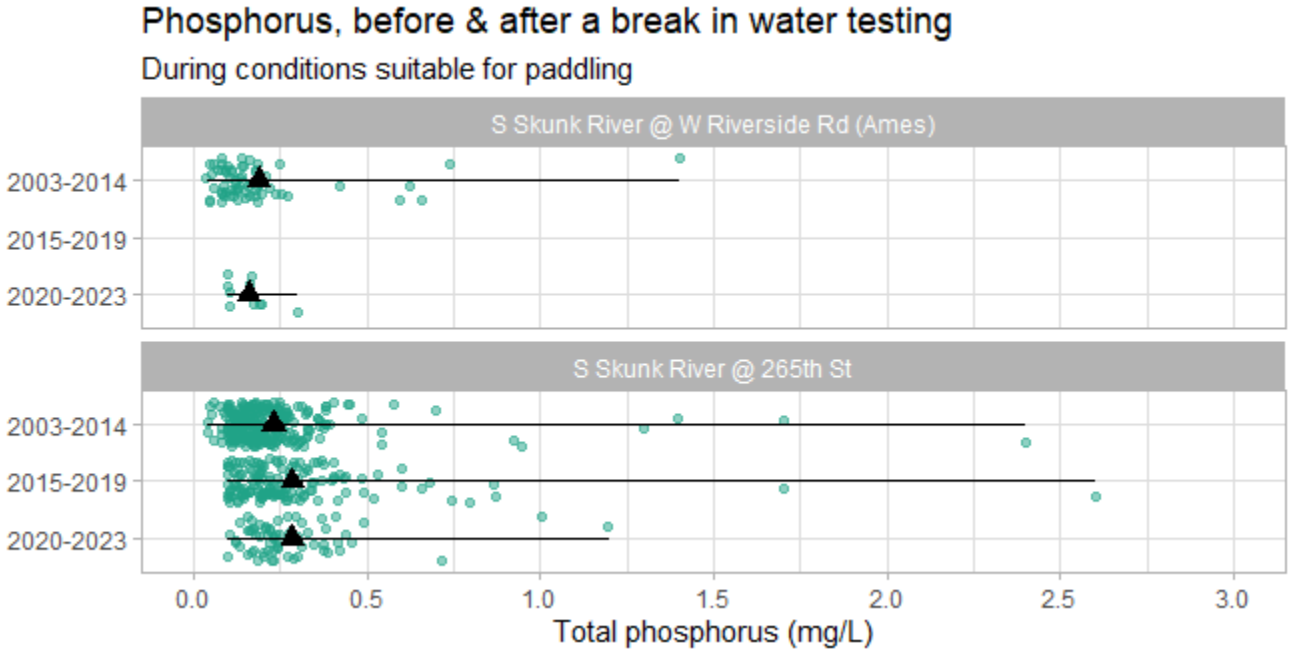
Comparing total phosphorus (mean) in the 2003-2014 and 2020-2023 periods:

- Phosphorus increased slightly at the downstream site (0.25 mg/L to 0.27 mg/L) and decreased slightly at the upstream site (from 0.23 to 0.20 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 0.28 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
2020-2023
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
2020-2023
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
2020-2023
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
2020-2023
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Total phosphorus (mg/L)

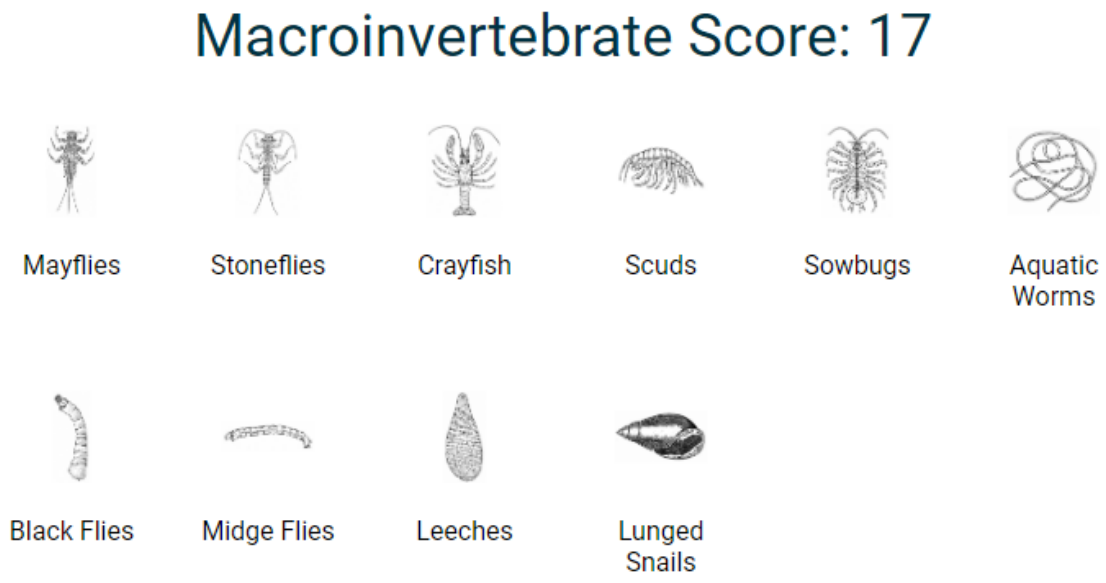
Results: Biological Monitoring, 2023

Save Our Streams program

Volunteers completed five biological surveys using the Save Our Streams protocol in 2023, with one site sampled in both spring and fall. Biological index scores are based on the number of groups of macroinvertebrates present and whether those groups are sensitive to pollution. Scores ranged from 13 ("fair") at Worrell Creek to 23 ("excellent") at Ioway Creek. All streams had at least two of the sensitive groups present, but some scored in the "fair" range due to relatively few groups being present. This could indicate that habitat rather than dissolved oxygen was the limiting factor for biological diversity.

Site	Type	Survey Date	Sensitive Score (x 3)	Less Sensitive Score (x 2)	Tolerant Score (x 1)	Total Score
Bear Creek at West Maple St. (Roland)	Muddy Bottom	5/30/2023	9	2	3	14 Fair
Ioway Creek @ 6th St. (Ames)	Rocky Bottom	4/28/2023	12	4	1	17 Good
Ioway Creek @ 6th St. (Ames)	Rocky Bottom	8/30/2023	12	8	3	23 Excellent
West Indian Creek @ Story County Fairgrounds (Nevada)	Rocky Bottom	6/14/2023	6	6	5	17 Good
Worrell Creek @ S. 16th St. (Ames)	Muddy Bottom	5/24/2023	6	6	1	13 Fair

West Indian Creek in Nevada scored higher this year (17, Good) than last year (10, Fair). These figure shows the macroinvertebrates found there.



Iowa DNR

The Iowa Department of Natural Resources completed biological surveys at 5 streams in Story County in 2023. 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.

- Ballard Creek near Cambridge, July 17
  - Fish Index of Biological Integrity: 3, "Poor".[13]
  - Benthic Macroinvertebrate Index of Biotic Integrity: 48, "Fair".[14]
- South Skunk River at Soper's Mill, September 28 and October 19
  - Fish Index of Biological Integrity: 44, "Fair".[15]
  - Benthic Macroinvertebrate Index of Biotic Integrity: 57, "Good".[16]
- Unnamed tributary to South Skunk River, north of Ames, July 3
  - Fish Index of Biological Integrity: 3, "Poor".[17]
- West Indian Creek, Carroll Prairie, August 3
  - Fish Index of Biological Integrity: 22, "Poor".[18]
  - Benthic Macroinvertebrate Index of Biotic Integrity: 24, "Poor".[19]

[13] https://programs.iowadnr.gov/bionet/Fish/Session/2385
[14] https://programs.iowadnr.gov/bionet/Inverts/IBI/3617
[15] https://programs.iowadnr.gov/bionet/Fish/Session/2325
[16] https://programs.iowadnr.gov/bionet/Inverts/IBI/3538
[17] https://programs.iowadnr.gov/bionet/Inverts/IBI/3541
[18] https://programs.iowadnr.gov/bionet/Fish/Session/2329
[19] https://programs.iowadnr.gov/bionet/Inverts/IBI/3541