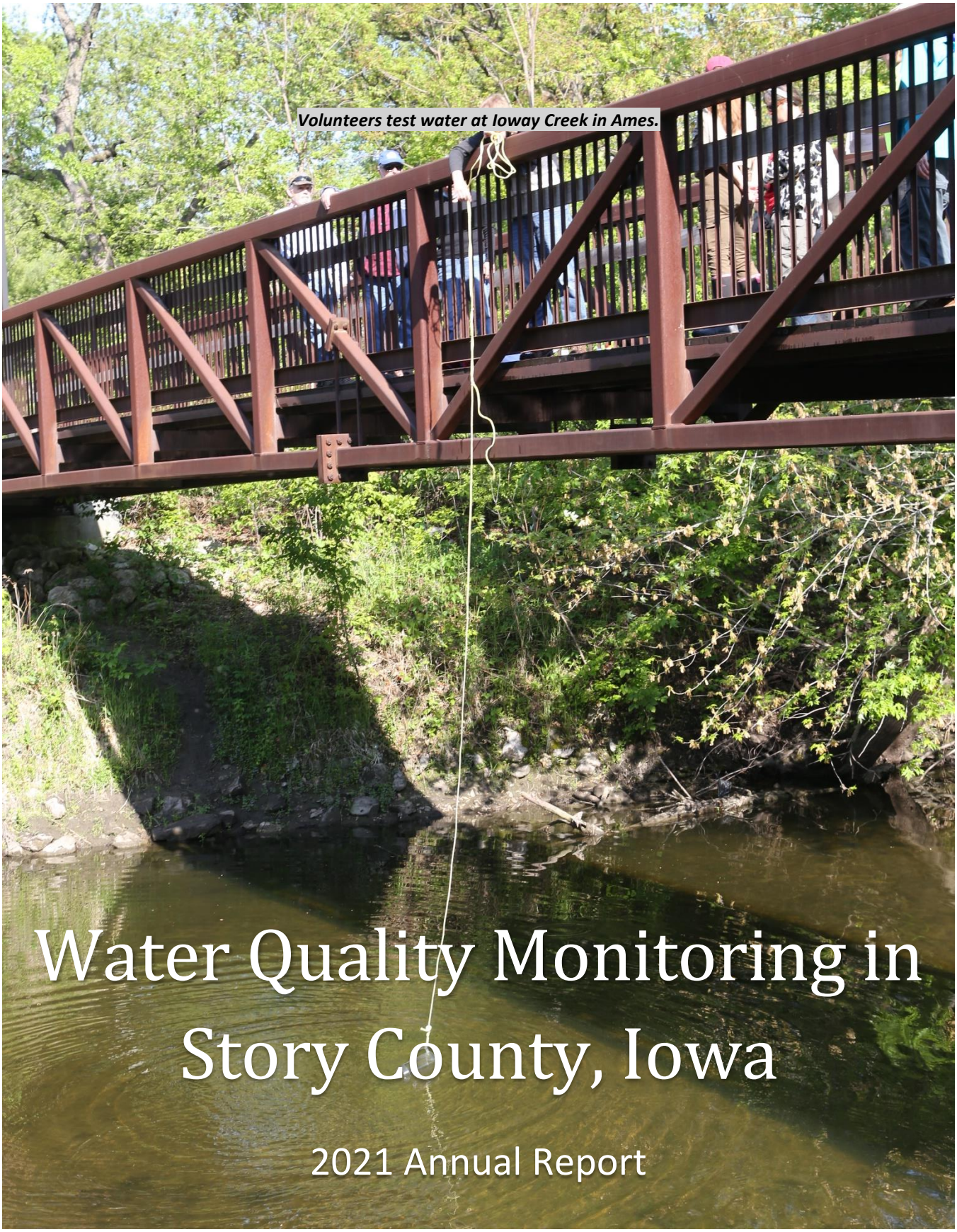

Volunteers test water at Ioway Creek in Ames.

Water Quality Monitoring in Story County, Iowa

2021 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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Major funding to support water monitoring in 2021 was provided by:

Story County

City of Ames

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Leopold Center for Sustainable Agriculture

City of Nevada

Outdoor Alliance of Story County

Story County Soil & Water Conservation District

Water monitoring in the field

Volunteers: Eileen Arevalo, Tasida Barfoot, Cindy Barrowcliff, Leah Barton, Diane Birt, Mary Brunet, Lia Carillo, Doug Cooper, Ruthellen Cunnally, Sam Degnan, Rick Dietz, Janet Dixon, Ed Engle, Susan Fritzell, Grace Feilmeier, Kurt Gruber, Thomas Gust, Ryan Hansen, Annie Hatch, Mark Hayes, Steve Jungst, Ken Kopecky, Angie Kolz, Pieter Maris, Diane Maxwell, Oliver McCormick, Owen McCormick, Meagan Mittman, Nicco Miyuskovich, Shellie Orngard, Kurt Plagge, staff of REG, Reed Riskedahl, Jim Richardson, Steve Ryan, Joy Sabl, Susan Siev, Mike Schmidt, Nadia Snow, Kelly Nayara Nascimento Thompson, Michelle Ward, Barbara Wheelock, Jeff White

Staff of partner organizations: Liz Calhoun, Sara Carmichael, Jordan Cook, Mike Cox, Russ DeWall, Dan Haug, Jerry Keys, Joe Kooiker, Pat Shehan, Noel Steckelberg, Ryan Wiemold

Support with laboratory analysis, training, and data management

Ames Water & Pollution Control Laboratory: Andrew Curtis, Maryann Ryan

Iowa State University: Leigh Ann Long, Jake Petrich, Michelle Soupir

Izaak Walton League of America: Samantha Briggs, Susan Heathcote, Zach Moss

Leadership

The following people participated in regular meetings in 2021 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: Jerry Keys, Mike Cox, Sara Carmichael, Margaret Jaynes, Kimberly Grandinetti

City of Nevada: Jordan Cook, Jeremy Rydl

City of Gilbert: Sonia Arellano Sundberg

Izaak Walton League: Zach Moss (IWLA), Paul Readhead (Ames Chapter)

Leopold Center for Sustainable Agriculture: Mark Rasmussen

Story County Soil & Water Conservation District: Kayla Bergman

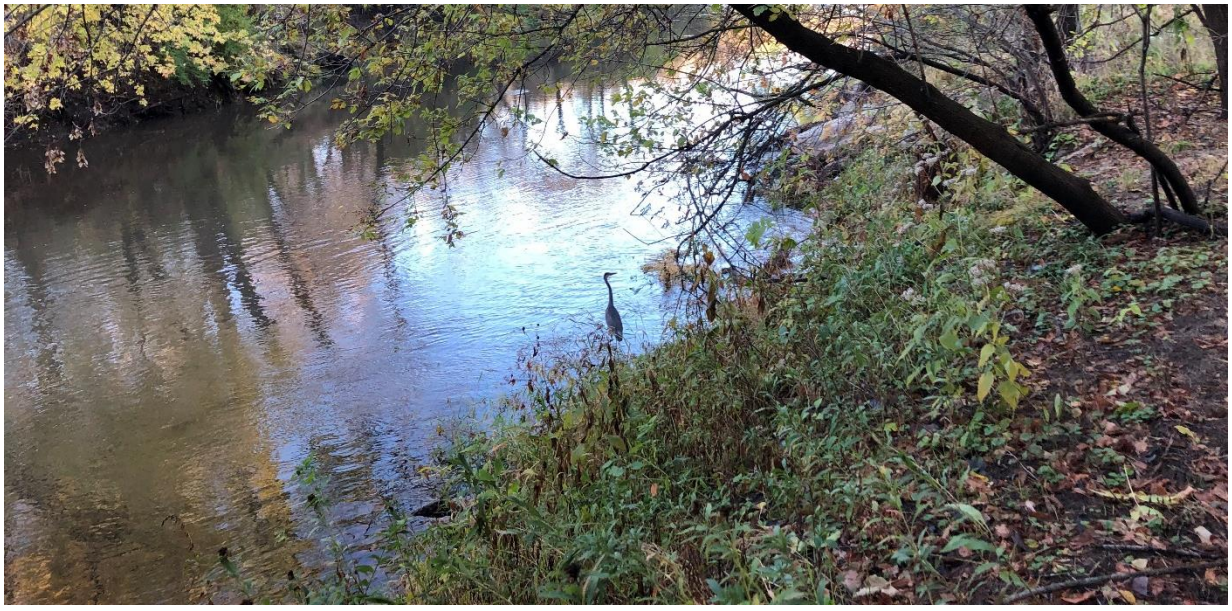
Ioway Creek Watershed Coalition: Laura Merrick, Rick Dietz

Prairie Rivers of Iowa: Penny Brown Huber, Dan Haug, David Stein

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: 2335 230th St, Ames, Iowa 50014. 515-232-0048



Heron in Ioway Creek.

Highlights

Accomplishments in 2021

- Local partners released a 10-year plan for water quality monitoring in Story County. Prairie Rivers of Iowa gave 12 presentations about the plan to stakeholders.
- Staff and volunteers from 9 organizations met 7 times in 2021 to implement the plan and provide direction and support for monitoring efforts.
- The City of Ames Water & Pollution Control laboratory tested water samples from 15 stream sites monitored monthly and 3 sites monitored weekly.
- Story County Conservation launched a volunteer monitoring program. Staff, 17 volunteers, and one business used field kits to monitor streams and lakes around the county.
- Story County Conservation partnered with Iowa DNR to do weekly bacteria testing of 2 swimming beaches at county lakes: West Peterson Park and Hickory Grove Lake.
- Local partners engaged new volunteers through 2 water monitoring events, a training event with the Izaak Walton League, and a cleanup of trash in Ioway Creek. In addition, local partners organized 4 in-person events and 3 webinars that offered opportunities for Story County residents to learn about water quality issues and solutions.
- Prairie Rivers of Iowa used special equipment to collect 40 samples of runoff from creeks and storm sewers during 5 rainstorms, with the help of volunteers.
- Prairie Rivers of Iowa published 12 articles about water quality and watersheds on their blog, as well as posting regular water quality updates and real-time data streams on a web page dedicated to monitoring efforts in Story County: www.prrcd.org/story-county-water-monitoring

Key Findings

Issues	**Metrics**	**Findings**
Recreation and waterborne illnesses	*Escherichia coli (E. coli)* bacteria	*E. coli* was usually low at swimming beaches and parts of the South Skunk River, but high in most creeks. We can narrow down likely sources of contamination by checking whether bacteria is highest during low flows or high flows.
Gulf Hypoxia and nutrient losses	Nitrogen and phosphorus load	This year was too dry to have much influence on Gulf Hypoxia. Focusing on normal-to-wet periods will help to identify hot spots where conservation practices are needed and evaluate whether conservation practices are working.
Nutrient enrichment and algae blooms in lakes and streams	Total phosphorus, orthophosphate, nitrate	During dry conditions, the highest nutrient levels are below wastewater treatment plants.
Fish and the insects they eat, stream and lake ecology	Index of benthic macroinvertebrates, dissolved oxygen, chloride	Low dissolved oxygen is harming invertebrates in some streams. Effluent from wastewater treatment plants could be a factor, but some patterns are still unexplained.
Erosion and sediment impacts on aquatic life	Total suspended solids, transparency	Untreated stormwater from older neighborhoods can have extremely high levels of sediment, phosphorus, and bacteria.

Introduction: To understand water quality, account for weather

In some ways, 2021 was an unlucky year to launch a water quality monitoring program. Story County was in drought conditions for much of the year, and smaller streams were frequently dry when we did our monitoring routes.

In some ways, it was an ideal year to launch a monitoring program, because weather always has an influence on water quality and the challenging conditions in 2021 forced us to better account for it. By comparing wet days to wet days and dry days to dry days, we are beginning to see patterns of land management that were previously hidden.

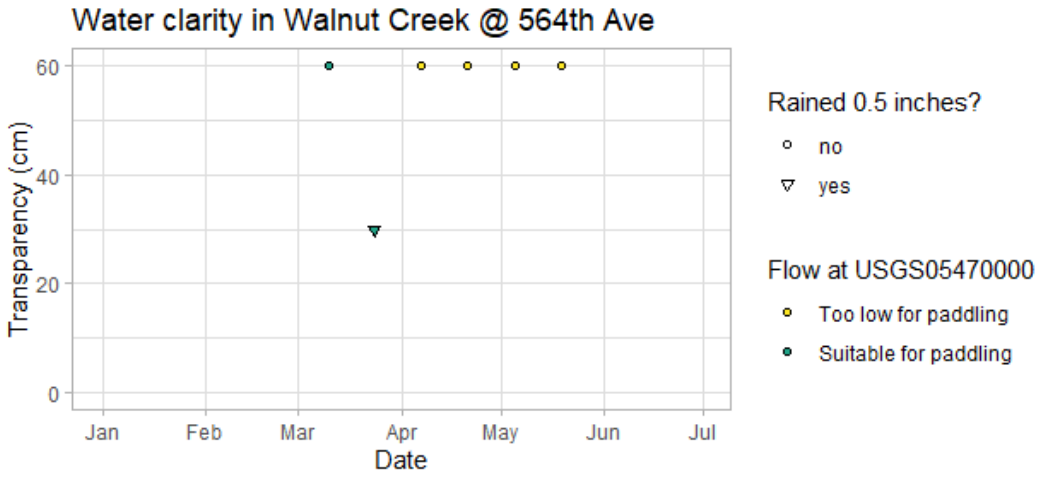
Ballard Creek was dry during the summer.

Day to day weather variation—did it rain recently?

Rain gage

We have noticed dramatic changes in water quality as rivers rise and fall in response to heavy rains, usually within a day (in smaller streams) or two days (in the South Skunk River). This is further described in the chapter about Sediment and Stormwater, along with more details about the equipment we are using to sample stormwater runoff. For this report, we cross-referenced water quality data with daily rainfall data from the Ames Airport. If a regular sample happened to fall on a day of a rainstorm of at least 0.5 inches, or the day after, we can make a note of that and see whether it influenced water quality results.

For example, Walnut Creek was only monitored for a short time but shows an interesting pattern. The decrease in water clarity in March can be explained by a recent storm that either worsened erosion or stirred up sediment from the streambed.



Week to week weather variation—can you float a canoe?

Water quality is often linked to stream flow. When streams are running high, the force of the water can carry more sediment. Drain tiles are likely flowing, providing a pathway for nitrogen to get from fields to streams.

For this report, we give an indication of longer-term weather condition using a single gage and a simple framework: **Is there enough water in the South Skunk River to float a canoe?**

There is a USGS gage and a boat ramp on the South Skunk River at W Riverside Rd, on the north edge of Ames. The Skunk River Paddlers recommend avoiding canoe and kayak trips if flow at that gage is higher than 600 cubic feet per second (which might be fast enough to be dangerous) or lower than 90 cfs (which might require walking some of the riffles). Alternately, we could set a lower threshold of 160 cfs to match the lines painted at the canoe access, but we don't have much recent water quality data for those conditions.

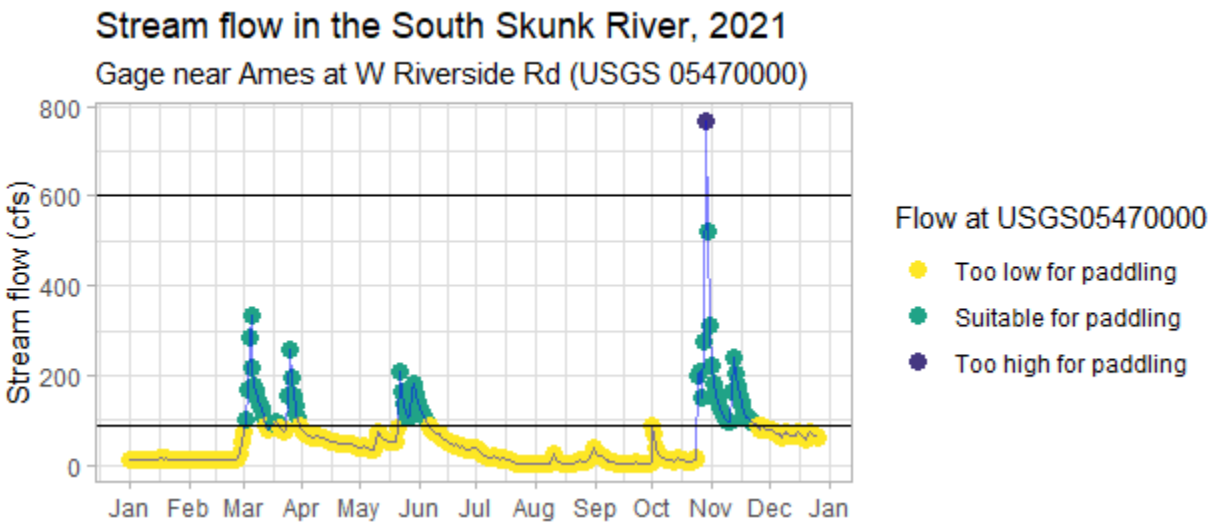
As the graph below shows, in 2021, there was enough water in the South Skunk River to float a canoe on only 66 out of 365 days (18% of the time). Only one day had average flows too high for paddling.

744 cfs
Too high for paddling
(For most people)

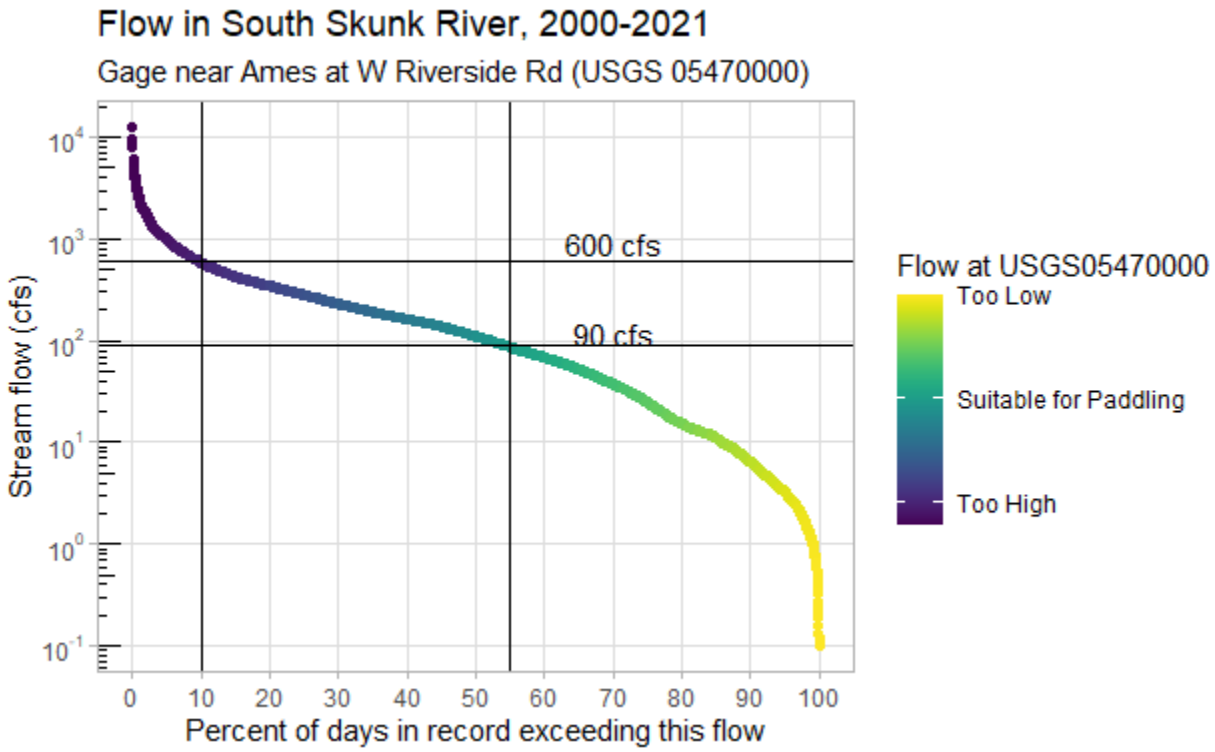
180 cfs
Suitable for paddling

9 cfs
Too low for paddling

Examples of different flow conditions in the South Skunk River. Photos taken at River Valley Park in Ames, flow measurements at upstream USGS gage (05470000).



That's not typical of the past 21 years, during which flows were at least 90 cfs at this gage 55% of the time, at least 160 cfs about 40% of the time, and at least 600 cfs about 10% of the time.



This will be a challenge when analyzing trends. Moving forward at newly established sites, it's likely that the next few years will be wetter than 2020-2021, which will certainly affect water quality. Looking back to historic data (the South Skunk River at W Riverside Rd was monitored from 2000-2014) it's certain that 2020-2021 is drier. There are two ways overcome this challenge.

1. Collect another year or two of data, so that each group includes a mix of wet and dry years.
2. Break out water quality data by streamflow, so that we can compare dry conditions this year to comparable conditions in previous years.

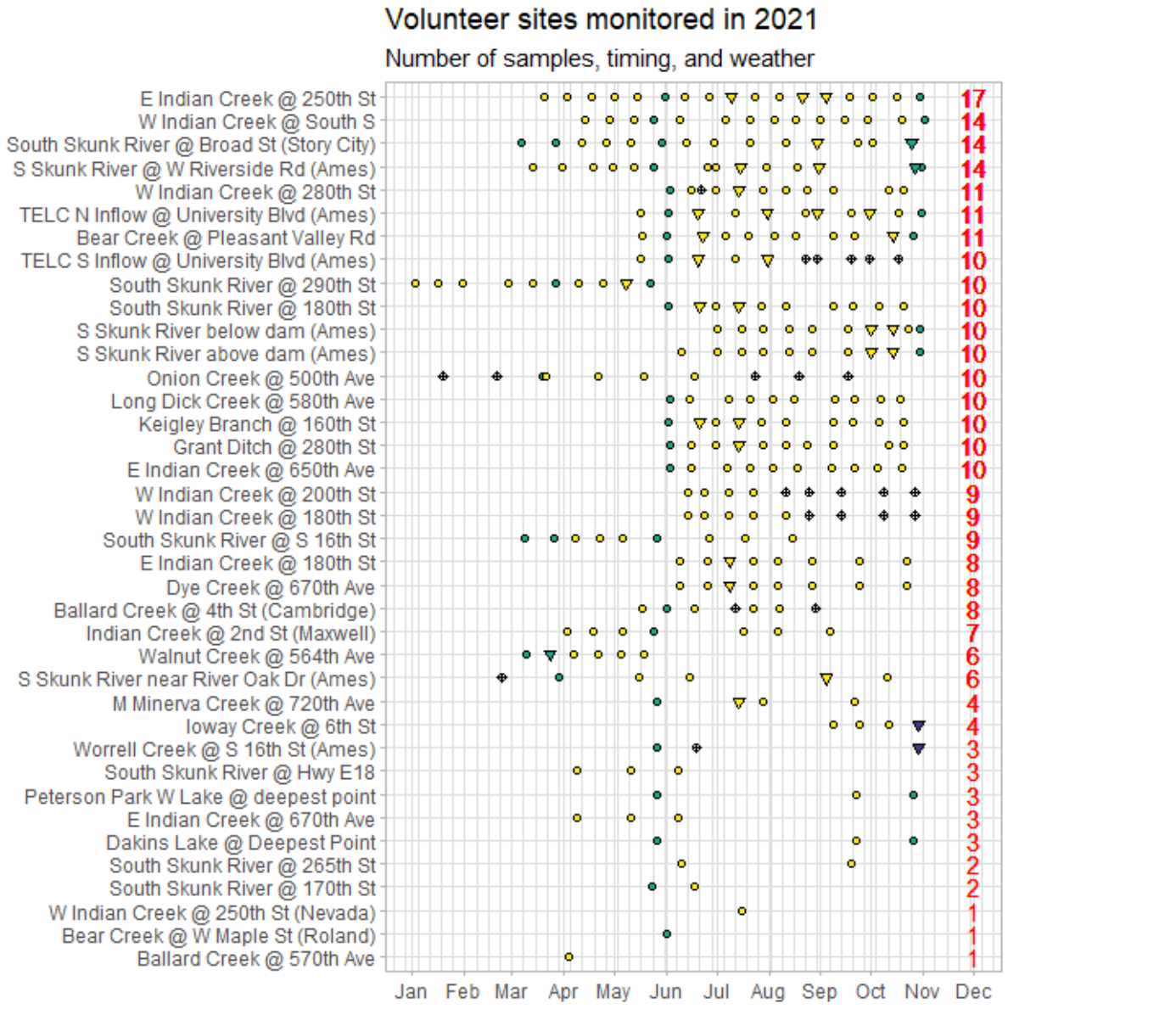
This report is an introduction to the second approach, sometimes bringing in data from other years to show how water quality differs when river levels are high enough for paddling. Flow in the South Skunk River may not be relevant for all the sites presented here (i.e. lakes) but our hope is that consistent categories and color coding makes this report easier to follow.

Monitoring Sites and Activity in 2021

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

Water quality testing in the field by volunteers

In 2021, volunteers monitored 25 stream sites with kits and oversight from **Story County Conservation**. Story County Conservation staff monitored another 11 streams and 2 lakes with the same approach. This graph shows when each site was monitored, and the weather conditions in the South Skunk River during monitoring. The red number at the right indicates the number of times each stream was monitored in 2021, while the color and symbol indicates the weather conditions in the South Skunk River at the time of monitoring.



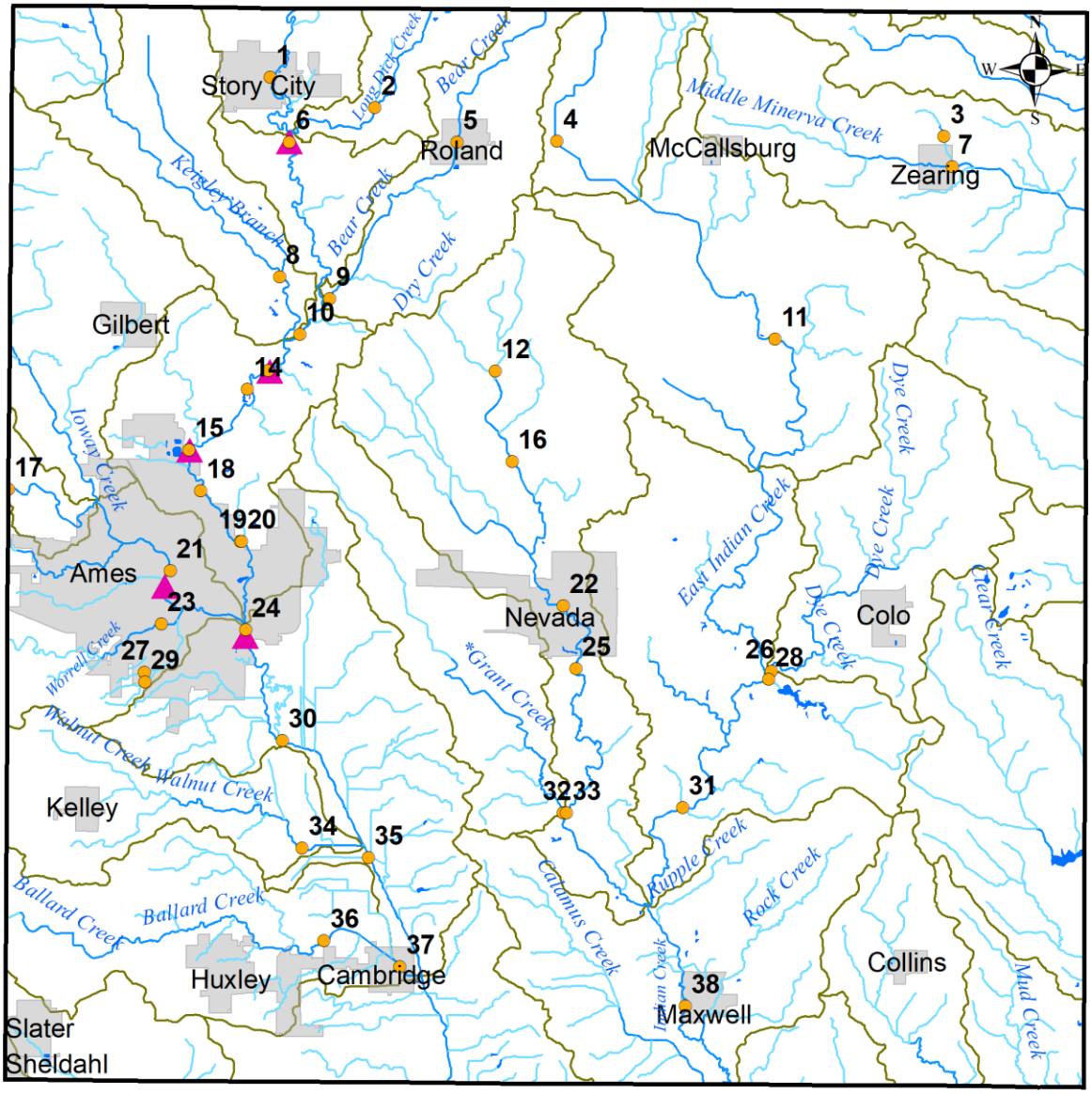
Story County Conservation recommended that sites be monitored on the first and third week of each month, but encouraged volunteers to participate as they were able. Many new volunteers joined the program this year. This means there is some inconsistency in timing that should be considered when interpreting results. Water quality averages for some sites may reflect seasonal differences.

Staff and volunteers follow the protocols of the Izaak Walton League's Save Our Streams program and enter data in the Clean Water Hub. 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 Izaak Walton League and Story County Conservation hosted a training workshop on April 18, attended by 6 people.

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.

This map shows sites actively monitored by volunteers in 2021. Site names have been edited for length and consistency, so site identification numbers used in the Clean Water Hub are included for reference.



0 1 2 4 Miles

Legend

- Monitoring Sites (Volunteer)
- Gage (flow)
- Lakes (NHD)
- Headwater streams
- Larger streams
- Municipal boundaries
- Watershed boundaries (HUC12)

On Map	Site Name	ID in Hub			
1	South Skunk River @ Broad St (Story City)	11578	20	S Skunk River below dam (Ames)	11870
2	Long Dick Creek @ 580th Ave	10931	21	Ioway Creek @ 6th St	11975
3	Dakins Lake @ Deepest Point	10968	22	W Indian Creek @ 250th St (Nevada)	10241
4	E Indian Creek @ 670th Ave	10744	23	Worrell Creek @ S 16th St (Ames)	11823
5	Bear Creek @ W Maple St (Roland)	10932	24	South Skunk River @ S 16th St	10981
6	South Skunk River @ Hwy E18	10723	25	W Indian Creek @ South S	11573
7	M Minerva Creek @ 720th Ave	10970	26	Dye Creek @ 670th Ave	10967
8	Keigley Branch @ 160th St	10939	27	TELC N Inflow @ University Blvd (Ames)	11780
9	Bear Creek @ Pleasant Valley Rd	10937	28	E Indian Creek @ 180th St	10942
10	South Skunk River @ 170th St	10980	29	TELC S Inflow @ University Blvd (Ames)	11781
11	E Indian Creek @ 250th St	11581	30	South Skunk River @ 265th St	11577
12	W Indian Creek @ 180th St	10973	31	E Indian Creek @ 650th Ave	10940
13	South Skunk River @ 180th St	10971	32	Grant Ditch @ 280th St	10195
14	Peterson Park W Lake @ deepest point	10969	33	W Indian Creek @ 280th St	561
15	S Skunk River @ W Riverside Rd (Ames)	11515	34	Walnut Creek @ 564th Ave	11575
16	W Indian Creek @ 200th St	10972	35	South Skunk River @ 290th St	11583
17	Onion Creek @ 500th Ave	10977	36	Ballard Creek @ 570th Ave	11598
18	S Skunk River near River Oak Dr (Ames)	11584	37	Ballard Creek @ 4th St (Cambridge)	11826
19	S Skunk River above dam (Ames)	11777	38	Indian Creek @ 2nd St (Maxwell)	10975

Prairie Rivers of Iowa organized volunteer "snapshot" events in May and October, testing multiple sites in the Ioway Creek watershed. These watershed events are a tradition going back to 2006, formerly organized by the Ioway Creek Watershed Coalition with the support of Iowa DNR. The materials and methods formerly used in the IOWATER program are almost identical to those used by the Save Our Streams program.

Volunteers Rick Dietz and Reed Riskedahl test orthophosphate in a tributary of Ioway Creek at the spring snapshot event.

May 15, 2021: Twenty-five sites were monitored and 15 volunteers participated.

Oct 23, 2021: Due to dry conditions, it was not possible to monitor the usual sites. The event included practice water monitoring, a presentation by Dan Haug on how to interpret water quality data, setting up storm samplers, and biological monitoring led by Susan Heathcote, which allowed several volunteers to complete the field portion of their Save Our Streams training course. Fifteen volunteers participated.

Biological monitoring

In 2021, volunteers surveyed benthic macroinvertebrates at two sites using Save Our Streams protocols:

- S Skunk River @ N River Valley Park, Oct 23
- W Indian Creek @ 280th St (Jennett Heritage Area), Oct 20

Story County contracted the State Hygienic Lab to survey both fish and benthic macroinvertebrates using a more rigorous methodology.

- W Indian Creek @ 280th St[1] (Jennett Heritage Area), July 23

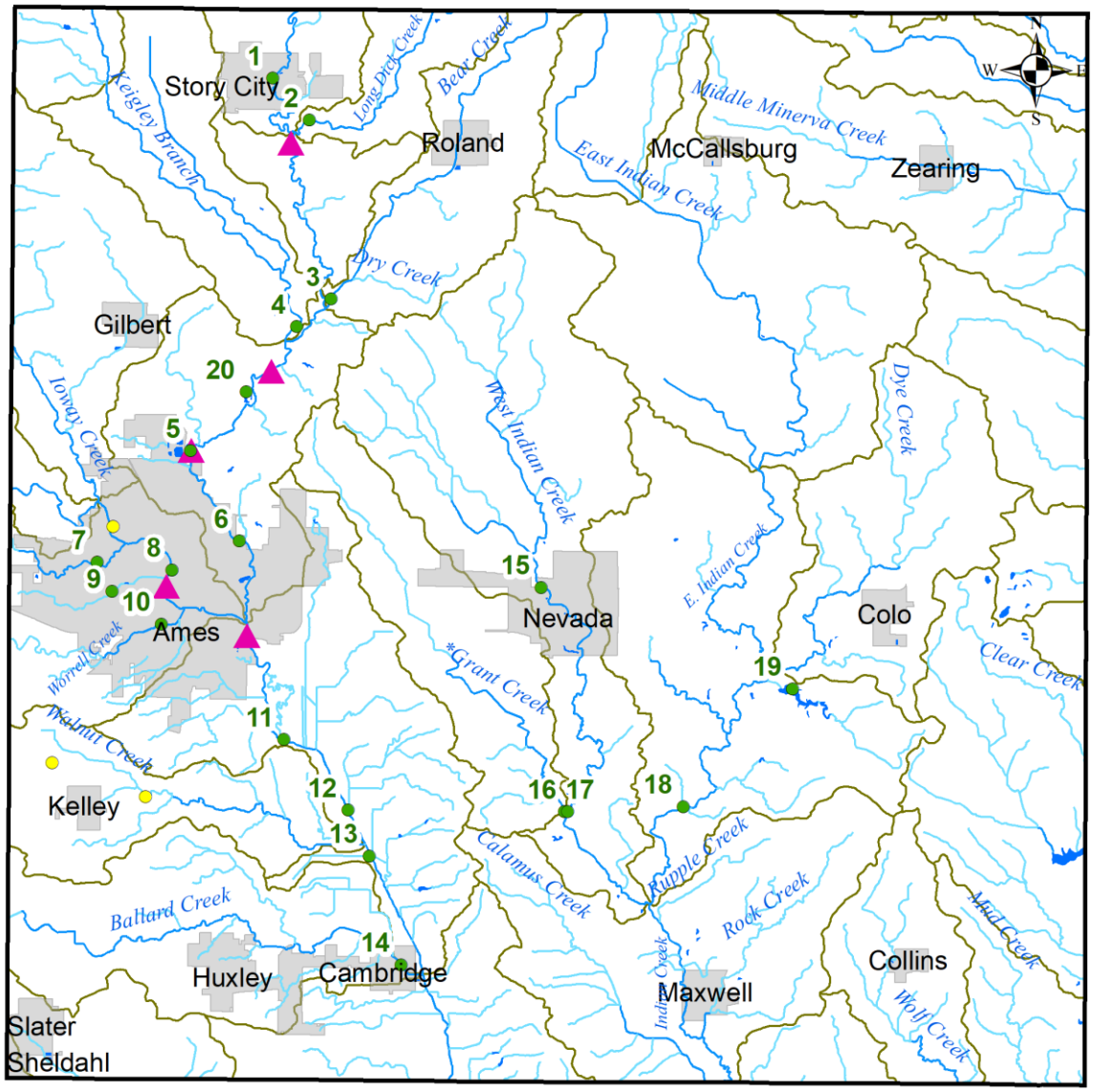
Biological surveys complement water quality monitoring. If sensitive species are absent or diversity is low where suitable habitat exists, this is an indication of a problem with water quality. More information about these monitoring events is located in Findings: Aquatic Life.

Volunteers identify aquatic invertebrates at the fall snapshot event.

[1] https://programs.iowadnr.gov/bionet/Sites/1311

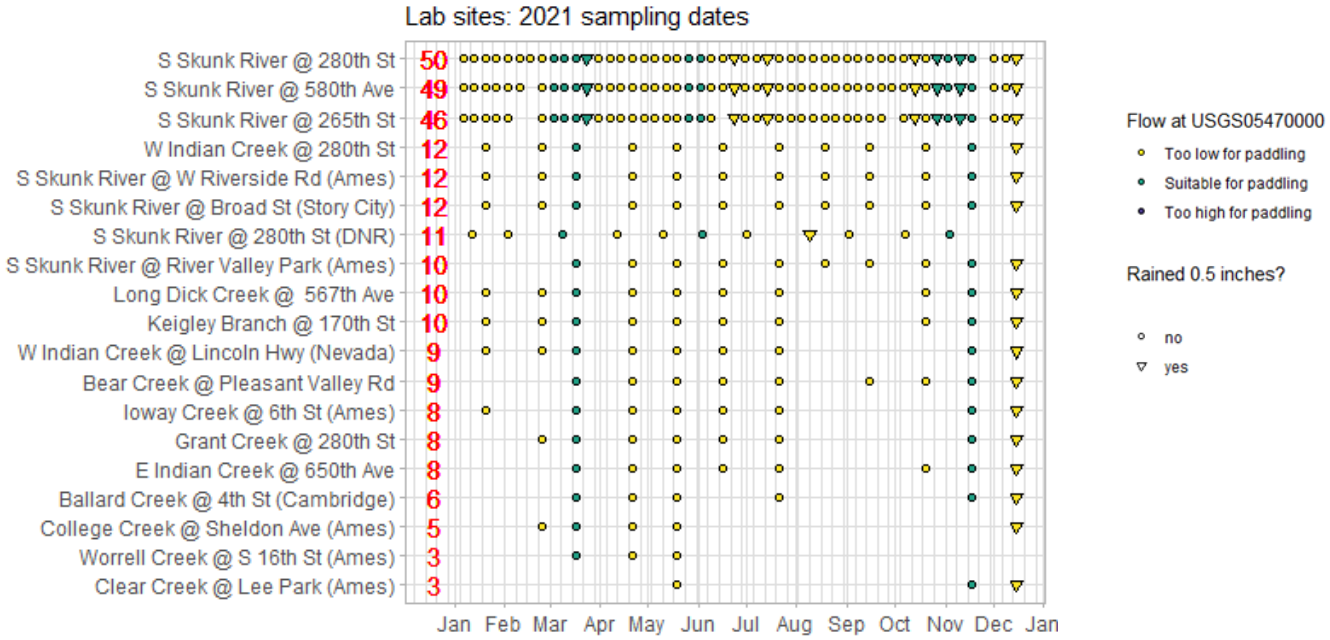
Laboratory testing of water samples

This map shows surface water sites regularly sampled in 2021 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, thick ice cover during the winter, construction on Bear Creek and Clear Creek, and equipment malfunctions.



As part of the Ambient Stream Monitoring Network, Iowa DNR continued monthly testing of the South Skunk River near Cambridge. The site is located at 280th St, below the outfall of the Ames Wastewater Treatment Plant. It is 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 comparing the South Skunk River to other sites in the network.*

- South Skunk River @ 280th St (Site #10850002)

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. We are also pulling monthly subsets out of this dataset to illustrate sampling error and evaluate different monitoring strategies (see Recommendations).*

- 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. This year, smaller creeks (especially Worrell and Clear Creek) were frequently dry or stagnant, and sometimes other issues prevented a sample from being collected.

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 partnered 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.*[2]

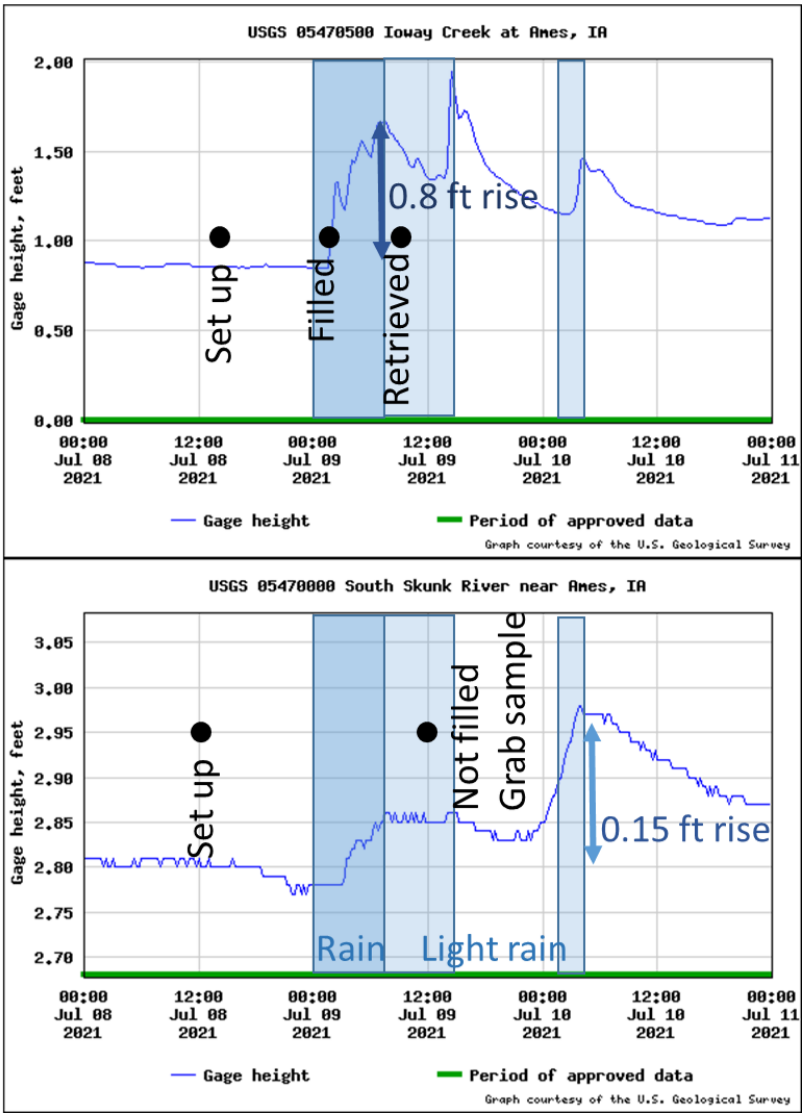
Beachgoers at West Peterson Park Lake

[2] 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

Special monitoring projects

With funding from the **Leopold Center for Sustainable Agriculture**, Dr. Jake Petrich (a chemistry professor at Iowa State University) used spectroscopy to test two rounds of 10-12 samples provided by **Prairie Rivers of Iowa** for optical brighteners, a chemical found in laundry detergent. *This method could be used in combination with E. coli testing as a low-cost way to identify likely sewer or septic issues and narrow down their location.* Dr. Petrich's lab is now exploring ways to distinguish the optical brighteners found in laundry detergent from other chemicals in the environment. At present, it is not clear whether the signals in water samples are coming from laundry detergent, since some pesticides and chlorophyll glow (fluoresce) in the same range of wavelengths, and optical brighteners are also present in paper litter.

Because of the drought, water samples were collected during storm events in order to include a wider variety of sites: larger streams likely to contain brighteners from treated effluent, small streams likely to be affected by wastewater leaks, and small streams unlikely to be affected by wastewater. With the help of volunteers, **Prairie Rivers of Iowa** collected samples of stormwater runoff from creeks, ditches, and storm sewers using Nalgene storm samplers and mounting hardware. These bottles fill and seal shut when the water level in a creek rises above the intake, ideally capturing the dirtiest "first flush" of runoff that comes off paved surfaces and bare soil. Samples can be retrieved the next day, without venturing out in a thunderstorm.



The figure to the right shows how storm samplers fill (or don't) as water levels change. Prairie Rivers of Iowa set up storm samplers in several creeks on Sunday July 8 in anticipation of rain, positioning the intake 2-4 inches above the water surface. Ioway Creek had risen 0.8 ft (9 inches) and was falling again by the time the full bottle was retrieved the next morning. However, the South Skunk River had not risen even an inch, and the water was still relatively clear.

Drought this year limited our ability to test runoff in rural creeks—rain tended to soak into dry soils without generating much runoff or causing drainage tiles to flow. The site list will continue to change as we work out the logistics.

Mounting hardware for a Nalgene storm sampler, installed in a stream. A crest-stage recorder measures the rise in water level.

Storm samples were collected during the following events.

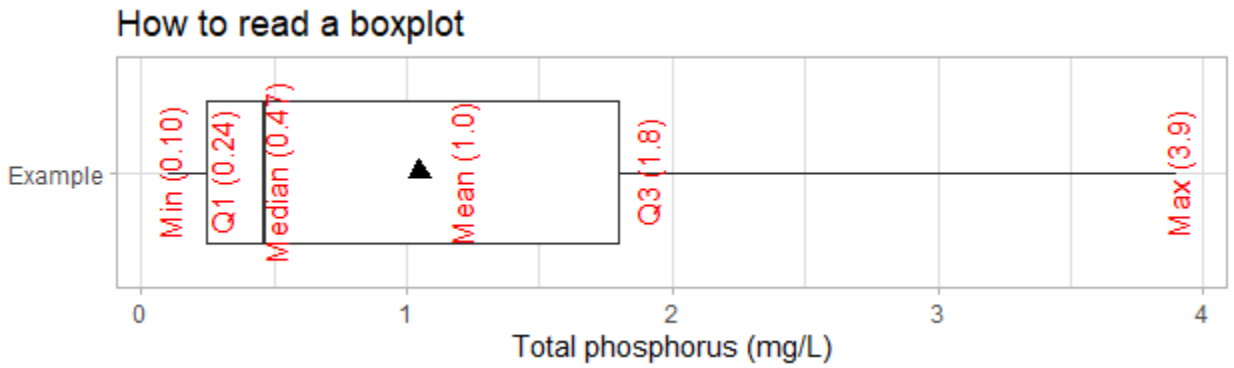
- **May 21:** 0.74 inches at Ames Airport. Five samples, tested with field kits. This should be treated as a practice round, since samples were held too long without refrigeration.
- **June 20**: 0.60 inches of rain at the Ames Airport. Five samples, tested by the Ames WPC Lab for *E. coli*, nitrate, total phosphorus, and total suspended solids.
- **July 9**: 1.45 inches of rain at the Ames Airport. Collected 12 samples, tested at the ISU Water Quality Research Lab (WRQL) for *E. coli*, nitrate, total phosphorus, and total suspended solids.
- **August 30-31:** 1.27 inches of rain overnight at the Ames Airport. Collected 8 storm samples, tested by ISU WQRL for *E. coli*. These samples plus 3 controls were also tested by Dr. Jake Petrich for optical brighteners.
- **October 24:** 3.19 inches of rain at Ames Airport. Collected 11 storm samples, tested by ISU WQRL for *E. coli*. These samples plus 3 controls were also tested by Dr. Jake Petrich for optical brighteners.

This type of data can help identify which streams are most affected by pollutants in stormwater runoff, and can check what is being missed by more regular sampling.

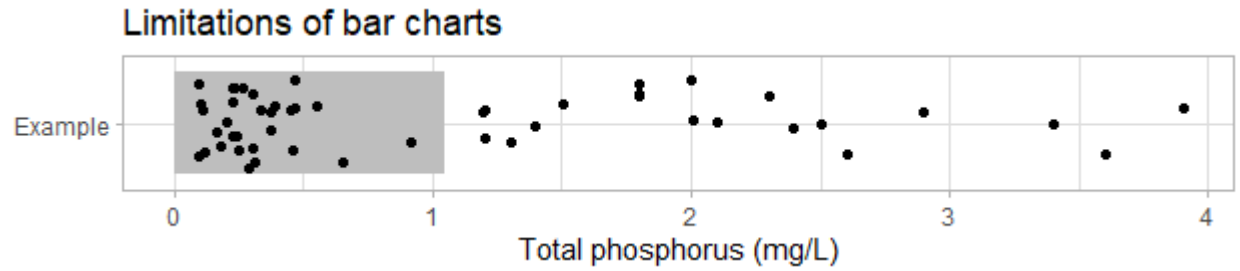
Findings

The graphs used to present our findings from the 2021 monitoring season require some explanation.

A box and whiskers plot (or boxplot) is a good way to summarize data from sites with 5 or more samples. The box extends from the 25th percentile to the 75th percentile, and is split at the 50th percentile (median). In the style used here, the "whiskers" (horizontal lines) extend to the minimum and maximum measurements, and the triangle indicates the mean (average) for the group.

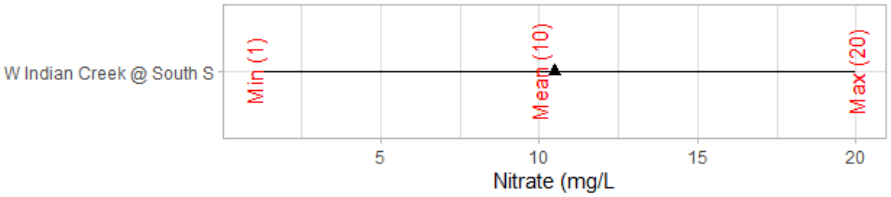


It would have been simpler to calculate an average for each site and present that as a bar graph or table. For the South Skunk River at 280th St, the mean phosphorus concentrations in 2021 was 1 mg/L. However, that number doesn't tell us the whole story. If we superimpose individual data points over the bar graph, we can see that most of the samples had phosphorus much lower than 1 mg/L, and some had phosphorus concentrations as much as four times higher.



Depending on the water quality issue, we might be interested in the low end (i.e. how often dissolved oxygen falls low enough to harm fish), the high end (how often *E. coli* exceed the recreational standard), or the middle. Boxplots take a bit more effort to read, but pack in a lot more information into a small space.

Boxplots do not work as well for test strip data with coarse measurement scales, so for volunteer data, we've used a simplified version that shows the minimum, maximum, and an average (a triangle for the mean, or a square for the median).



Bacteria and Recreation

Issue: Recreation and waterborne illnesses

Metric: *Escherichia coli (E. coli)* bacteria

Findings: *E. coli* was usually low at swimming beaches and parts of the South Skunk River, but high in most creeks. We can narrow down likely sources of contamination by checking whether bacteria is highest during low flows or high flows.

E. coli bacteria is an easy-to-measure indicator of fecal contamination from warm-blooded animals. Water contaminated with waste from humans, livestock, or wildlife might contain pathogens that could make someone sick if they accidentally swallow some water.

A lowhead dam modification project at River Valley Park in Ames has improved paddling on the South Skunk River Water Trail.

For lakes and rivers to fully support primary contact recreation or children's play, the state standard has two parts:

- Individual samples should not exceed 235 colonies/100mL
- The geometric mean for the season should not exceed 126 colonies/100mL.

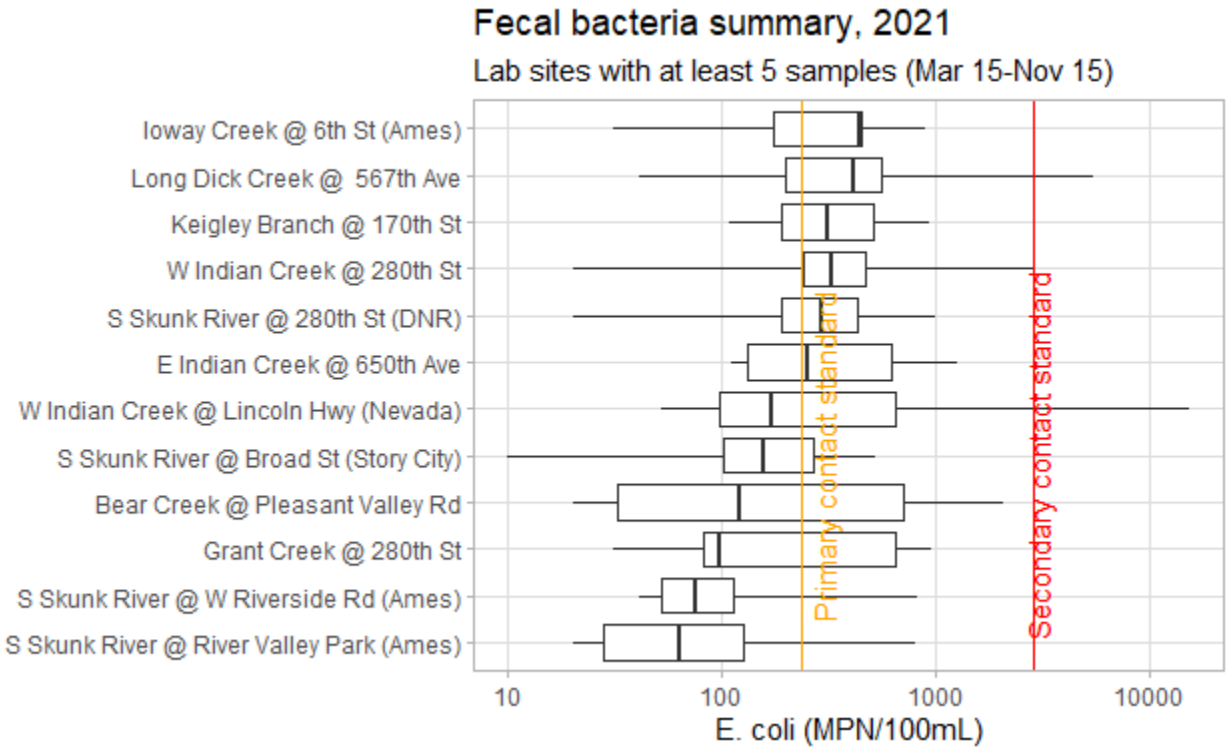
The standard is only applied during the recreational season of March 15-November 15, and generally requires 7 or more samples in a season. This year, smaller creeks were often dry, so we had enough data to evaluate only five stream sites. Lakes at Hickory Grove Park and West Peterson Park were monitored weekly, but Hickory Grove Lake was only at 15-30% of its normal volume and the beach was not usable for swimming. Note that *E. coli* counts may be reported as MPN (Most Probable Number) or CFU (Colony Forming Units), depending on the laboratory method.

In 2021, swimming beaches at Story County lakes met the primary contact recreation standard (*E. coli* geomean), as did two sites on the South Skunk River. Three stream sites exceeded the standard.

Site	Number of samples (need 7)	Samples exceeding *E. coli* standard	*E.coli* geomean (MPN/100mL)
West Peterson Park Lake (beach)	15	2	17
Hickory Grove Lake	15	3	58
S. Skunk River @ N River Valley Park	8	1	72
S Skunk River @ W Riverside Rd (Ames)	8	1	98
S. Skunk River @ Broad St, Story City	8	3	**134**
Bear Creek @ Pleasant Valley Road	7	3	**159**
West Indian Creek @ 280th St (Nevada)	8	7	**315**

Iowa DNR is unable to use our data for regulatory decisions, but it could still be submitted for inclusion in the 2024 integrated report. We have submitted data from 2020 for inclusion in the 2022 assessment cycle, recommending four additional stream segments for inclusion in the list of "Waters in Need of Further Investigation."

The boxplot below shows stream sites where we were able to collect at least 5 monthly samples. All had at least one sample exceeding the primary contact standard of 235 colonies/100mL. Six sites exceeded this threshold at least half the time. Long Dick Creek and West Indian Creek also exceeded the secondary contact recreation standard of 2880 colonies/100mL.

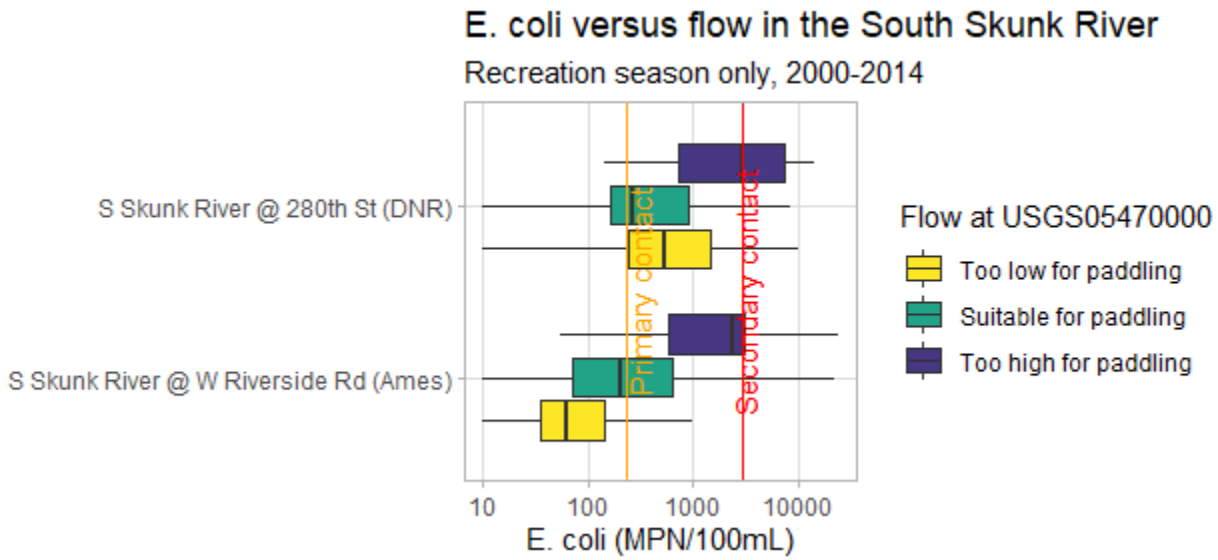


Most of our *E. coli* samples in 2021 were collected when streams were low and it hadn't rained for a while, so we can rule out dog and raccoon manure in urban stormwater and swine manure in runoff from farm fields as major sources of fecal bacteria. More likely sources include animals wading in streams (including cattle and geese), leaking sewer lines, and illegally discharging septic systems. Treated effluent from wastewater treatment plants can also be a source of bacteria. We know of some wastewater treatment plants in Story County that recently installed UV disinfection systems (City of Ames, City of Gilbert, and Squaw Valley HOA) but do not know the status of others in the county and watershed.

Cows cool off in a tributary of Ioway Creek.

"Primary contact recreation" means activities where people may get fully submerged in water—sometimes deliberately (i.e. swimming and tubing) and sometimes accidentally (i.e. canoeing and kayaking). **We do not have much recent data collected when the South Skunk River was high enough and warm enough for swimming and paddling. Another year of monitoring may tell us more.**

We do have plenty of older data, collected by Iowa DNR at two sites on the South Skunk River across a wide range of flows. This graph shows how individual samples compare the primary and secondary contact recreation standards (235 MPN/100mL and 2,880 MPN/100mL) plotted on a logarithmic scale. At W Riverside Rd (upstream of the confluence with Ioway Creek) *E. coli* usually met the standard when flows were suitable for paddling, and was even lower when conditions were too dry to paddle. At 280th St (downstream of the confluence with Ioway Creek), E. *coli* usually exceeded the standard when the river was high enough for paddling, and was even higher when the river was too low for paddling.



This preliminary analysis suggests a prioritization scheme that would benefit recreation on the water trail. *E. coli* reduction efforts should begin with the Ioway Creek watershed, focusing on dry-weather sources of contamination.

The Headwaters of the South Skunk River watershed could be set at a lower priority and focus on wet-weather sources of contamination—this could include runoff from fields receiving manure application and septic systems that back up in wet weather.

Paddlers on Ioway Creek on a day when E. coli exceeded the recreation standard.

Nutrients and Agriculture

Issue: Gulf Hypoxia and nutrient losses

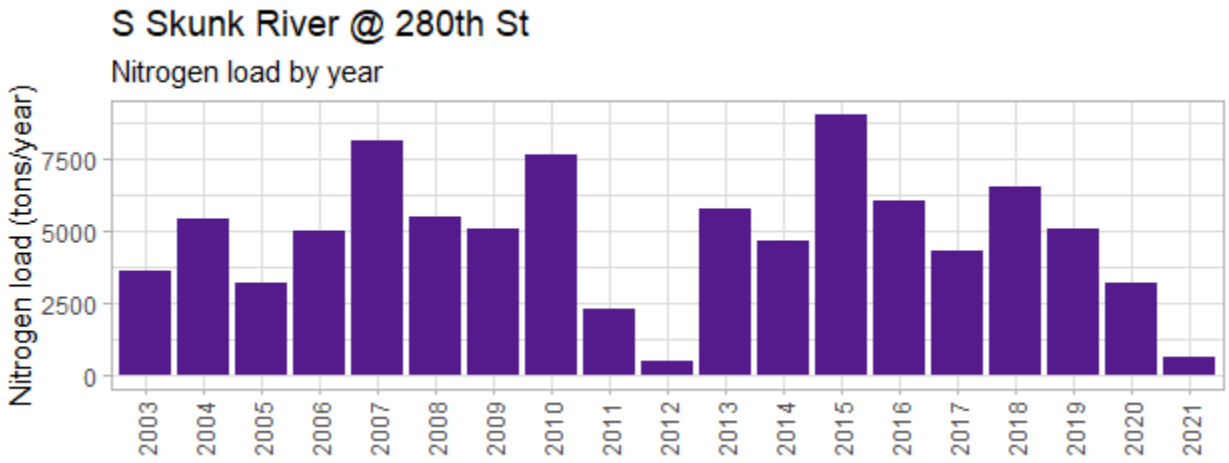
Metrics: Nitrate and phosphorus load

Findings: This year was too dry to have much influence on Gulf Hypoxia. Focusing on normal-to-wet periods will help us to identify hot spots where conservation practices are needed and evaluate whether conservation practices are working.

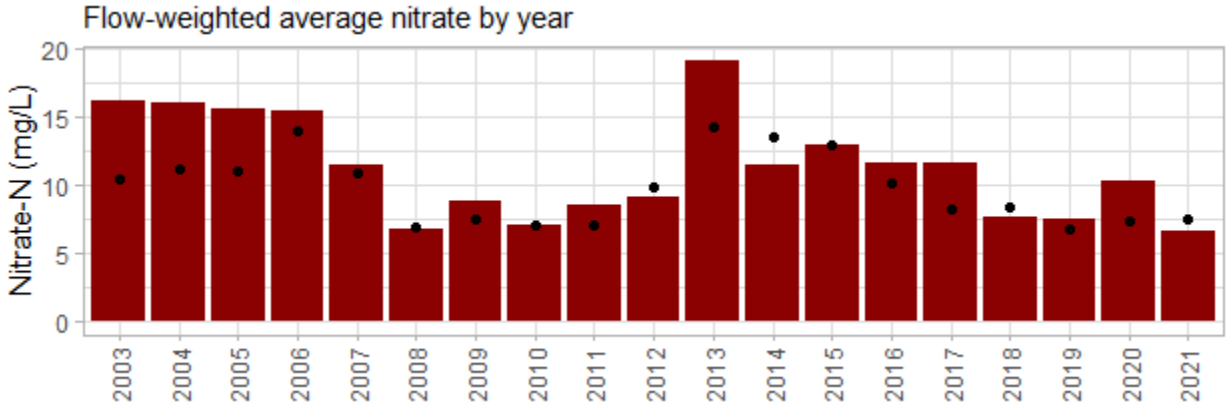
Cover crops near Nevada, IA.

Local partners have been involved in watershed projects aimed at preventing nitrogen and phosphorus from reaching the Gulf of Mexico through practices like cover crops, wetlands, and saturated buffers. The Iowa Nutrient Reduction strategy calls for a 41% reduction in nitrogen load and a 29% reduction in phosphorus load for non-point sources, relative to a 1980-1996 baseline period, in order to meet goals set by the Hypoxia Action Task Force.

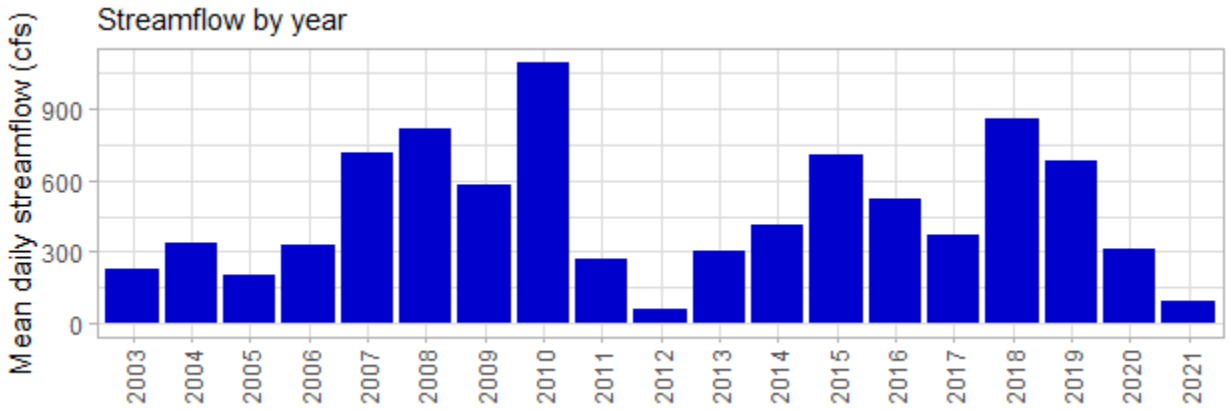
We can estimate nitrogen load carried by the South Skunk River by multiplying the nitrate concentration in a given year (measured weekly at 280th St by Ames W&PC) by average streamflow (measured continuously at Hwy 30 by the USGS). Good news: the nitrate load in 2021 was the second lowest in the past 18 years.



However nitrate concentrations were not especially low compared to previous years. The metric used in this calculation is a flow-weighted average (shown as red bars), which is usually higher than the mean (shown as dots).

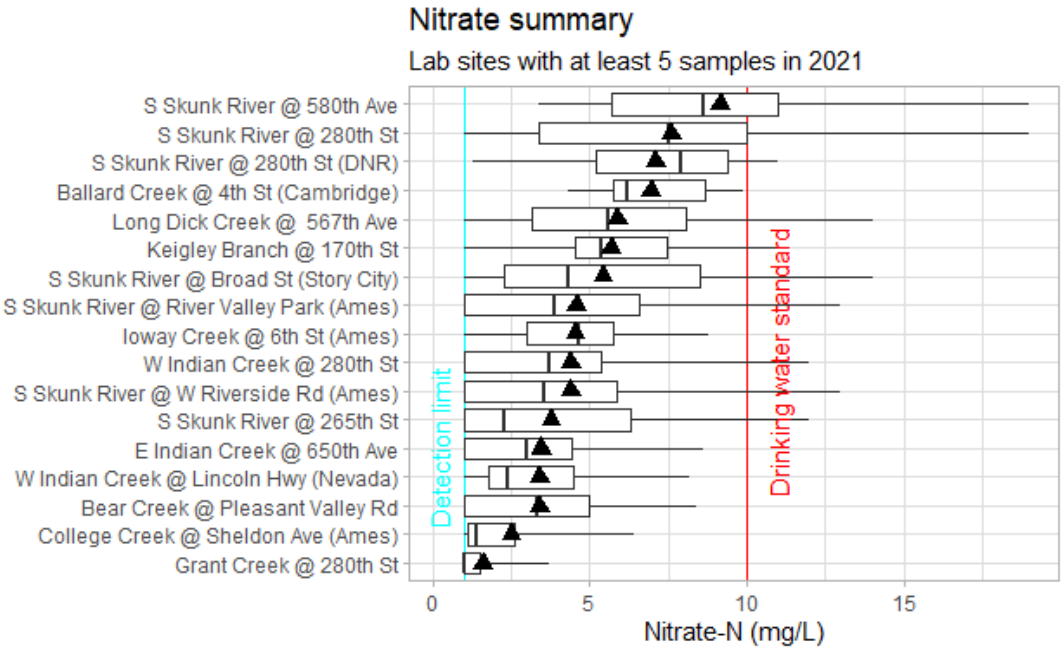


Streamflow in the South Skunk River (measured a few miles upstream from the water quality station at USGS gage #05471000) varies much more from year-to-year than nitrate concentrations, and seems to be the bigger influence on nutrient loads. **The years with the lowest nitrogen loads (2012 and 2021) were drought years with very little water in the river.**

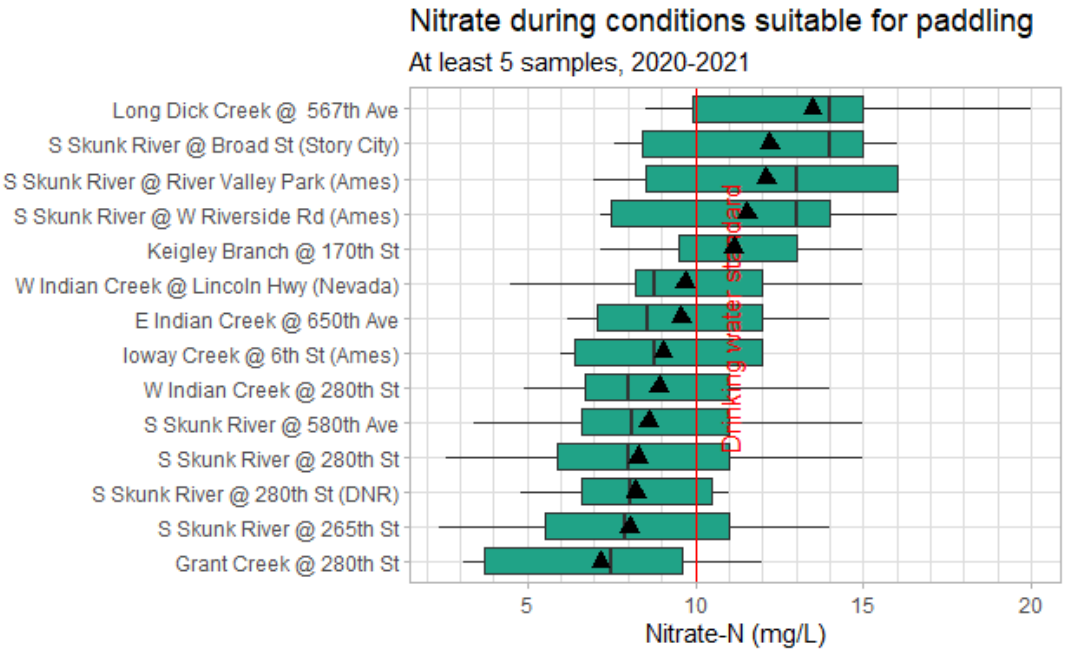


Even though nutrient reduction goals are expressed in terms of nutrient loads (pounds or tons), annual nutrient loads may not be the best metric for evaluating conservation efforts, at least at the local level.

We can also use nitrate data to make comparisons across sites in the same year. In 2021, the highest nitrate concentrations were observed in the South Skunk River below the Ames WPCF and in Ballard Creek near Cambridge.



However, these "hot spots" are not where the nitrogen is coming from during the wetter conditions that deliver most of the load to the Gulf. If we look at days in the past two years when streams were high enough for paddling, the pattern changes (refer to the graph on the next page). Nitrate is highest in the Headwaters of the South Skunk River and tributaries like Long Dick Creek and Keigley Branch. The drinking water standard is included for reference; these are not drinking water sources.



If we want to understand how farming practices are affecting water quality, it would make sense to focus on the wetter periods when nitrate is transported. This is further discussed in the Recommendations section. In addition to helping us identify "hot spots" where conservation practices are most needed, nitrate monitoring during wetter conditions may help us reduce the uncertainty associated with trends, providing an early indication of whether conservation efforts are working.

Phosphorus loads are not shown here, but were also especially low in 2012 and 2021.

Nutrients and Wastewater

Issue: Nutrient enrichment and algae blooms in lakes and streams

Metrics: Total phosphorus, orthophosphate, nitrate

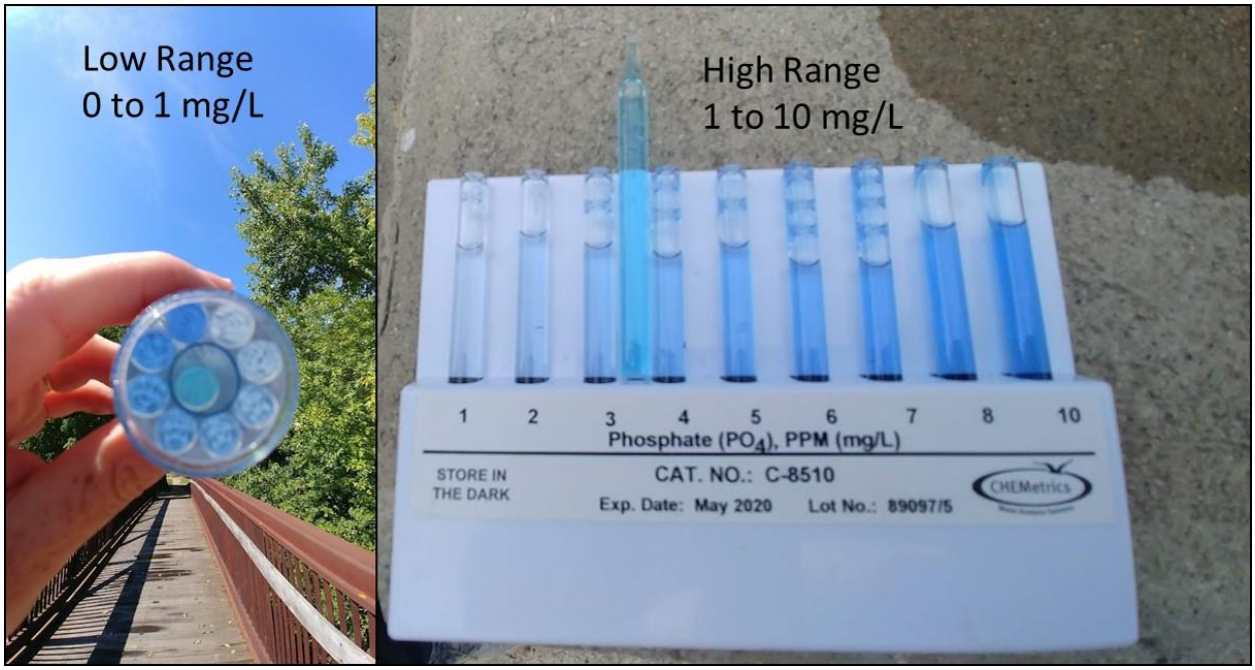
Findings: During dry conditions, the highest nutrient levels are below wastewater treatment plants.

In a dry year, little water and thus little nitrogen or phosphorus reaches the Gulf of Mexico. However, high nutrient concentrations can stimulate algae blooms in local lakes and rivers, some of which can be harmful to fish, pets, or people. The phosphorus and nitrogen monitoring could identify streams where the risk of algae blooms is greater.

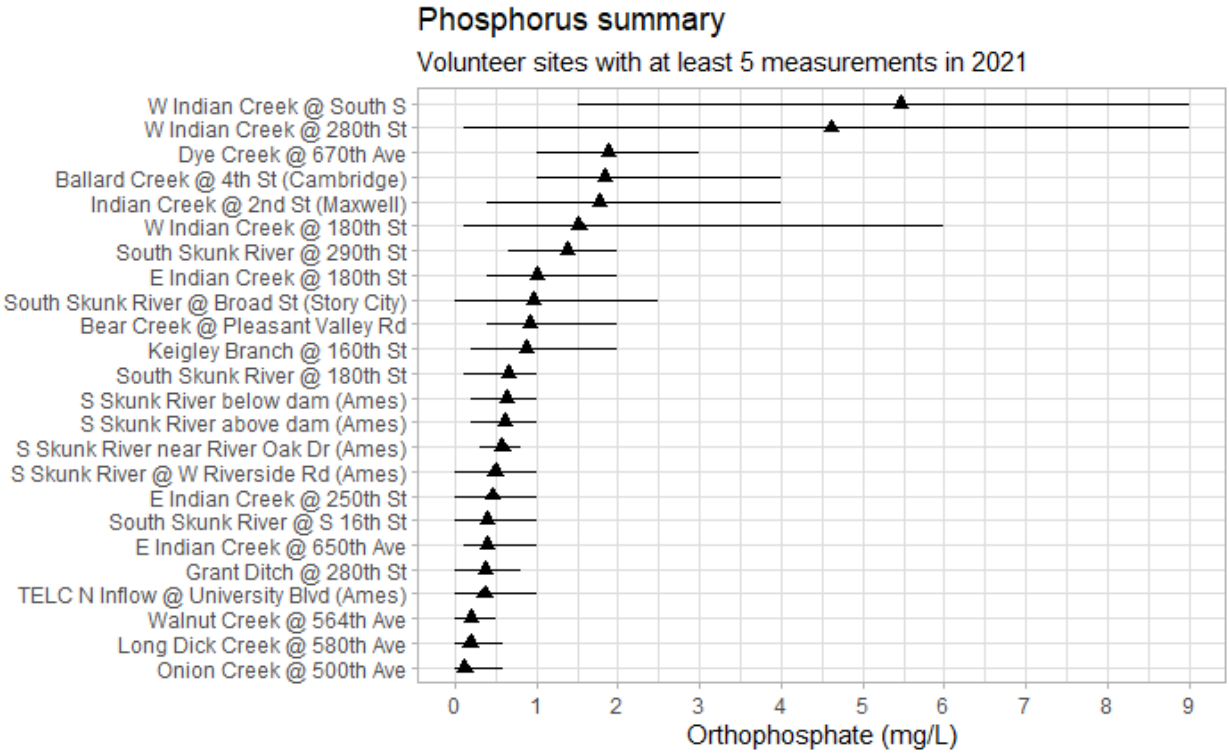
Algae in West Indian Creek at Jennett Heritage Area

However, this year, we also noticed mats of algae in streams like Ioway Creek with relatively low phosphorus concentrations. The challenges of interpreting nitrogen and phosphorus data in streams are discussed in the 10-year plan.

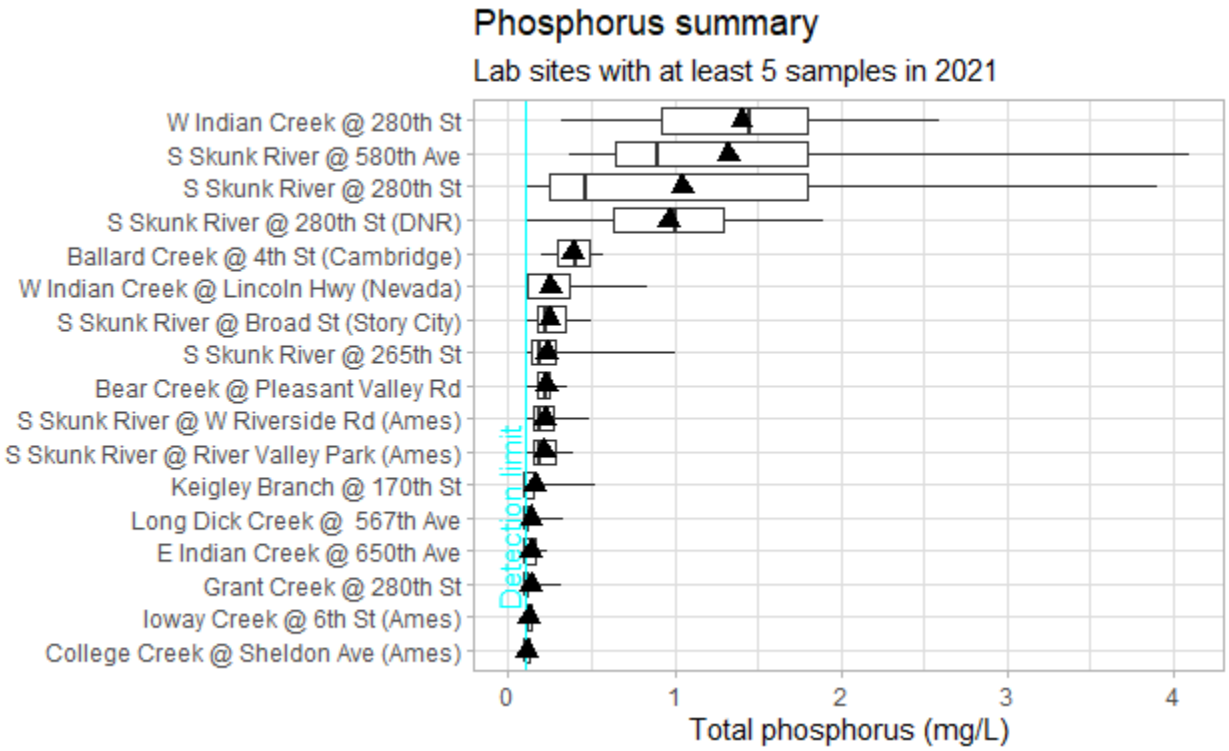
Most volunteers testing orthophosphate (the dissolved form of phosphorus) in Iowa streams will use the low-range vials for comparison, with measurements of 0.1 or 0.2 mg/L being typical. However, this year, the volunteers testing West Indian Creek had to break out the high range comparison vials, measuring orthophosphate as high as 9 mg/L!



Examples of low and high range orthophosphate measurements.

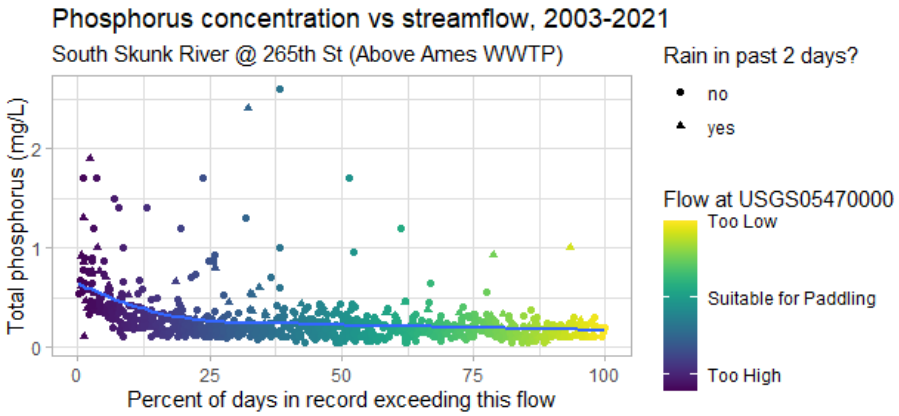


This pattern was also observed with lab testing of total phosphorus, which includes both the dissolved form and forms bound to soil. Total phosphorus at some sites on West Indian Creek and the South Skunk River exceeded 1 mg/L and went as high as 4 mg/L.

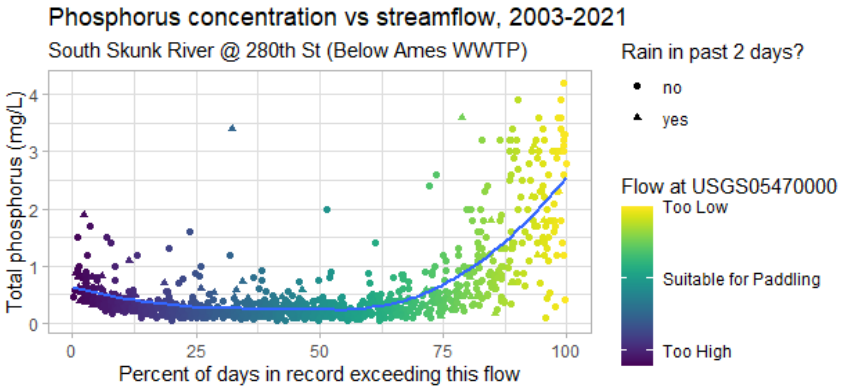


Keeping in mind that this is an unusually dry year, what do these hot spots have in common? **They are below wastewater treatment plants.** We have a wealth of data from the South Skunk River above and below the Ames WPCF to illustrate what is happening. Over the long-term, wastewater accounts for only 15% of phosphorus load and 4% of nitrogen load in the South Skunk River but in a dry year they have an outsized influence.

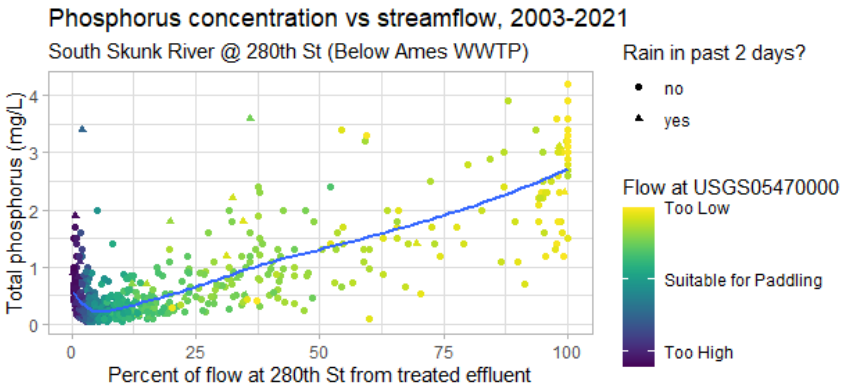
Above the Water Pollution Control Facility, phosphorus concentrations are at their highest when the river is too high to paddle. This makes sense because faster flowing water can carry more sediment, and phosphorus is often bound to sediment.



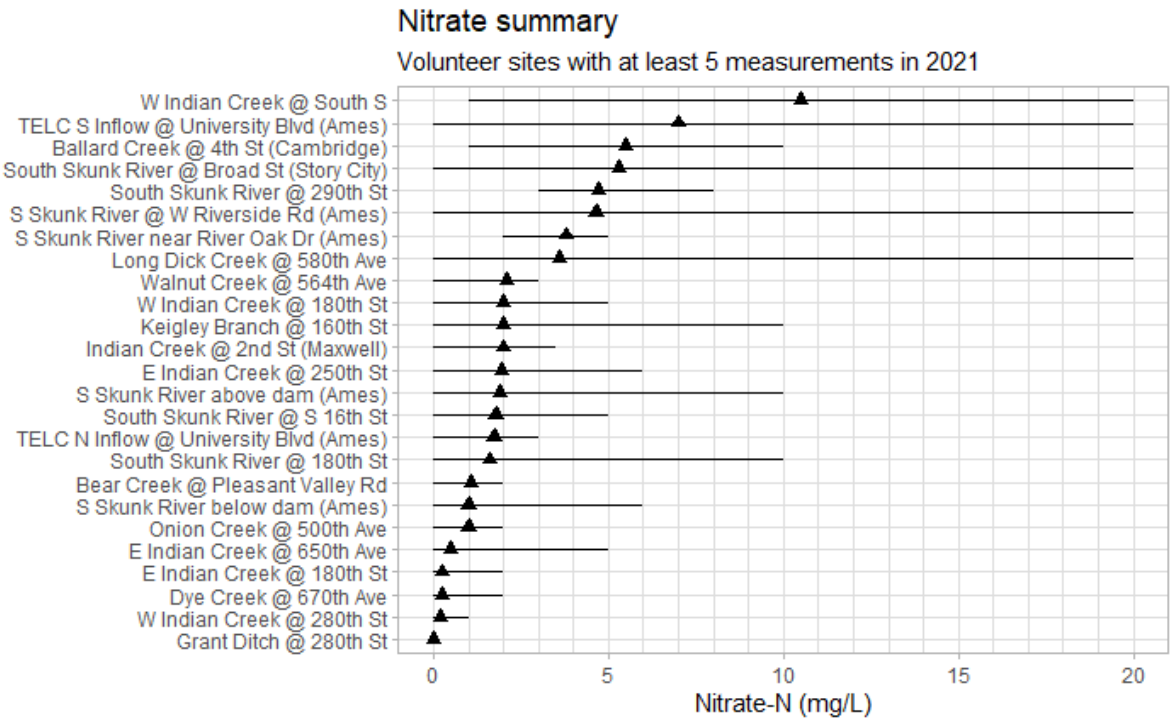
Below the Water Pollution Control Facility, the pattern is reversed. Phosphorus is highest when rivers are too low for paddling.

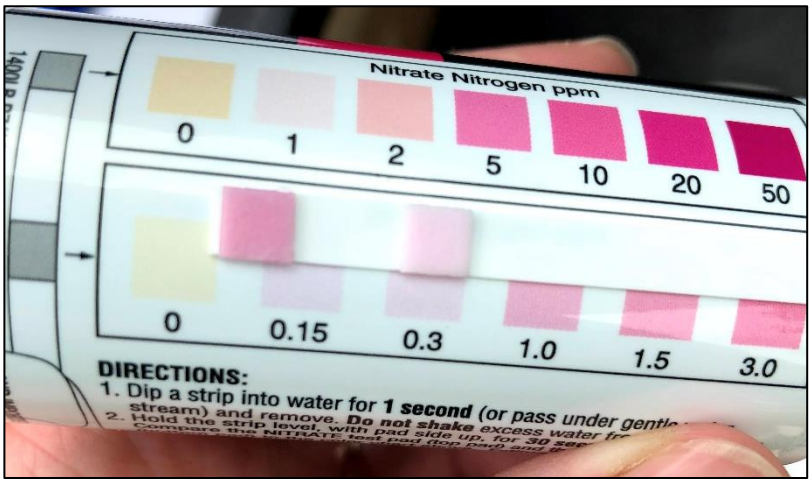


The Ames Water Pollution Control Facility was constructed in 1988. It was designed to primarily remove ammonia-nitrogen and Biochemical Oxygen Demand (BOD). Over the next 20 years, improvements will be implemented at the facility to meet the goals of the Iowa Nutrient Reduction Strategy. Under current conditions, the treated effluent has higher levels of nitrate and phosphorus than is typically encountered in the South Skunk River. In dry conditions, this effluent is less diluted.



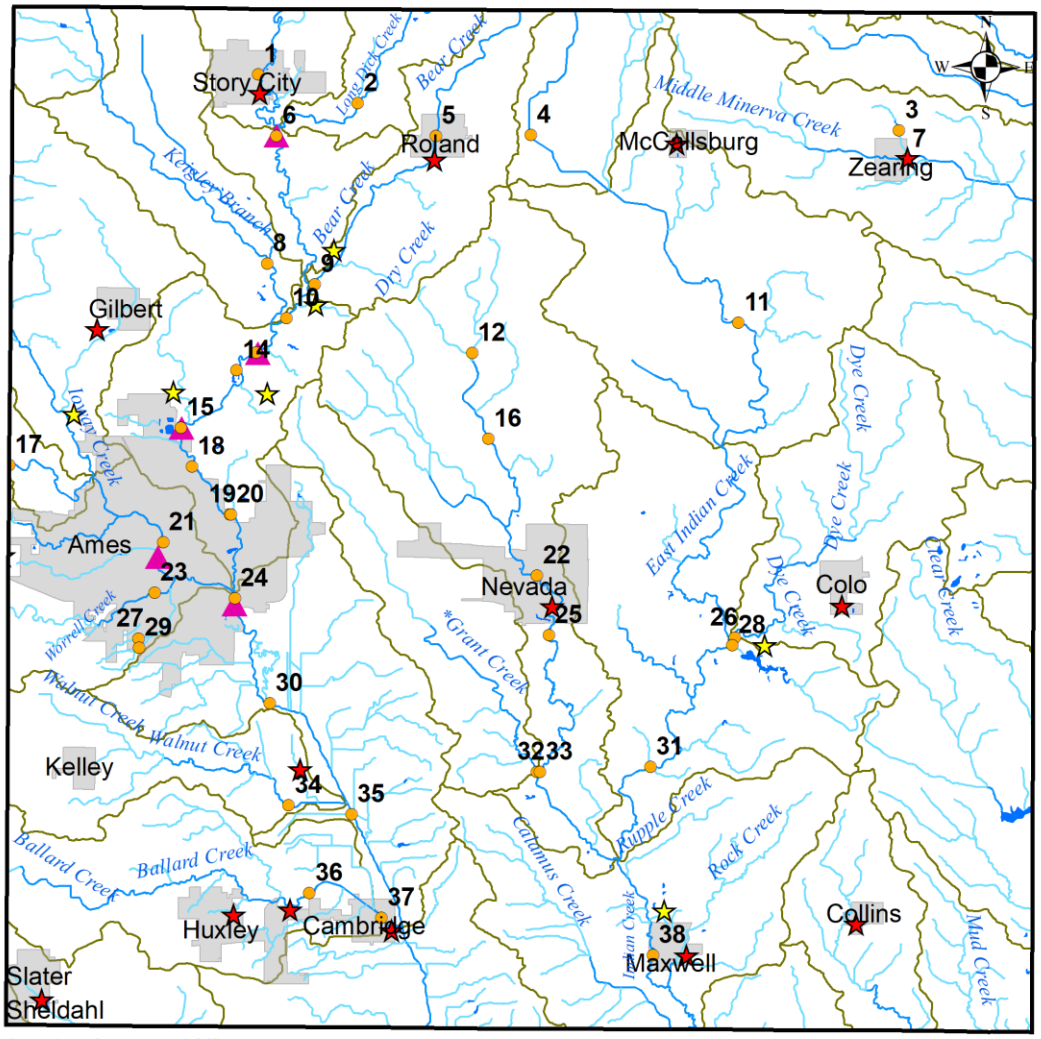
Nitrate is the most easily dissolved form of nitrogen. The highest average nitrate concentrations of any volunteer site was measured at West Indian Creek at South S Ave, one mile below the Nevada Wastewater Treatment Plant (WWTP). Interestingly, nitrate concentrations are very low five miles below the plant at 280th St. This could be due to denitrifying bacteria in the stream bottom, which can have a large influence when water levels are low and weather is warm. Many conservation practices like constructed wetlands and woodchip bioreactors work by providing suitable conditions for the growth of these bacteria, which remove nitrate in the water by converting it into nitrogen gas.





Nitrate and nitrite, measured with a test strip.

Once you know what to look for, it's apparent that most streams with moderate to high phosphorus this year have a wastewater treatment plant located somewhere upstream. Nitrate levels at these sites are sometimes high as well.



On Map	Site Name	ID in Hub			
1	South Skunk River @ Broad St (Story City)	11578	20	S Skunk River below dam (Ames)	11870
2	Long Dick Creek @ 580th Ave	10931	21	Ioway Creek @ 6th St	11975
3	Dakins Lake @ Deepest Point	10968	22	W Indian Creek @ 250th St (Nevada)	10241
4	E Indian Creek @ 670th Ave	10744	23	Worrell Creek @ S 16th St (Ames)	11823
5	Bear Creek @ W Maple St (Roland)	10932	24	South Skunk River @ S 16th St	10981
6	South Skunk River @ Hwy E18	10723	25	W Indian Creek @ South S	11573
7	M Minerva Creek @ 720th Ave	10970	26	Dye Creek @ 670th Ave	10967
8	Keigley Branch @ 160th St	10939	27	TELC N Inflow @ University Blvd (Ames)	11780
9	Bear Creek @ Pleasant Valley Rd	10937	28	E Indian Creek @ 180th St	10942
10	South Skunk River @ 170th St	10980	29	TELC S Inflow @ University Blvd (Ames)	11781
11	E Indian Creek @ 250th St	11581	30	South Skunk River @ 265th St	11577
12	W Indian Creek @ 180th St	10973	31	E Indian Creek @ 650th Ave	10940
13	South Skunk River @ 180th St	10971	32	Grant Ditch @ 280th St	10195
14	Peterson Park W Lake @ deepest point	10969	33	W Indian Creek @ 280th St	561
15	S Skunk River @ W Riverside Rd (Ames)	11515	34	Walnut Creek @ 564th Ave	11575
16	W Indian Creek @ 200th St	10972	35	South Skunk River @ 290th St	11583
17	Onion Creek @ 500th Ave	10977	36	Ballard Creek @ 570th Ave	11598
18	S Skunk River near River Oak Dr (Ames)	11584	37	Ballard Creek @ 4th St (Cambridge)	11826
19	S Skunk River above dam (Ames)	11777	38	Indian Creek @ 2nd St (Maxwell)	10975

The City of Ames, Nevada, and many other communities have completed feasibility studies and budgeted for nutrient removal systems as a condition of their wastewater permits. **We can expect water quality to improve below these plants over the next decade as capital improvements are phased in.**

Aquatic Life

Issue: Fish and the insects they eat, stream and lake ecology

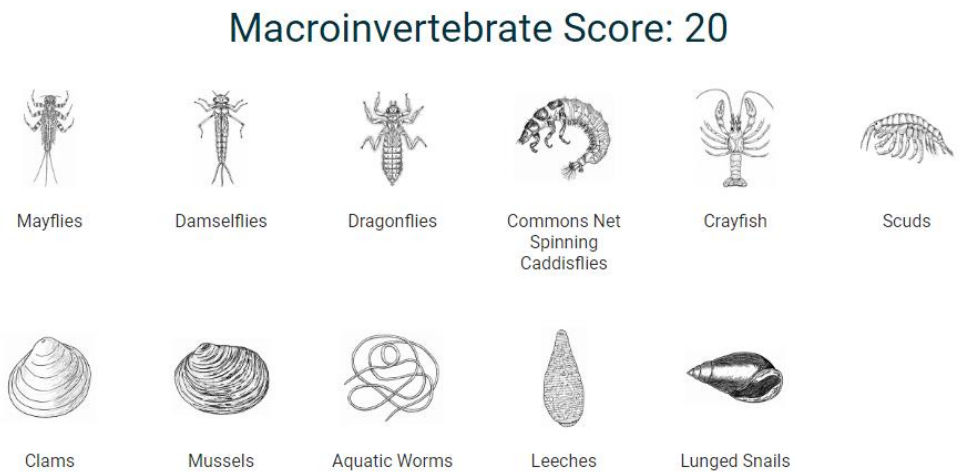
Metrics: Index of benthic macroinvertebrates, dissolved oxygen, chloride

Findings: Low dissolved oxygen is harming invertebrates in some streams. Effluent from wastewater treatment plants could be a factor, but some patterns are still unexplained.

In order to have good fishing in a stream, there must be insects for the fish to eat. A healthy aquatic ecosystem includes a variety of invertebrate species, filling different roles: scrapers, filter feeders, predators, etc.

Some invertebrates like mayflies and stoneflies have external gills and need high levels of dissolved oxygen to survive. Some species are especially sensitive to salts (chloride) or pesticides. Like the proverbial canary in the coal mine, the invertebrates that are present or missing in a stream are a clue to water quality. **In this section, we have included results of biological surveys as well as dissolved oxygen and chloride data which may help explain these results.**

During the fall "snapshot" water monitoring event on October 23, volunteers surveyed benthic macroinvertebrates in the South Skunk River at North River Valley Park in Ames, just below the rapids. They found representatives of several different groups, including sensitive mayflies. Overall, the score was "Good." It was encouraging to see that the ecosystem was recovering after construction on the low-head dam.

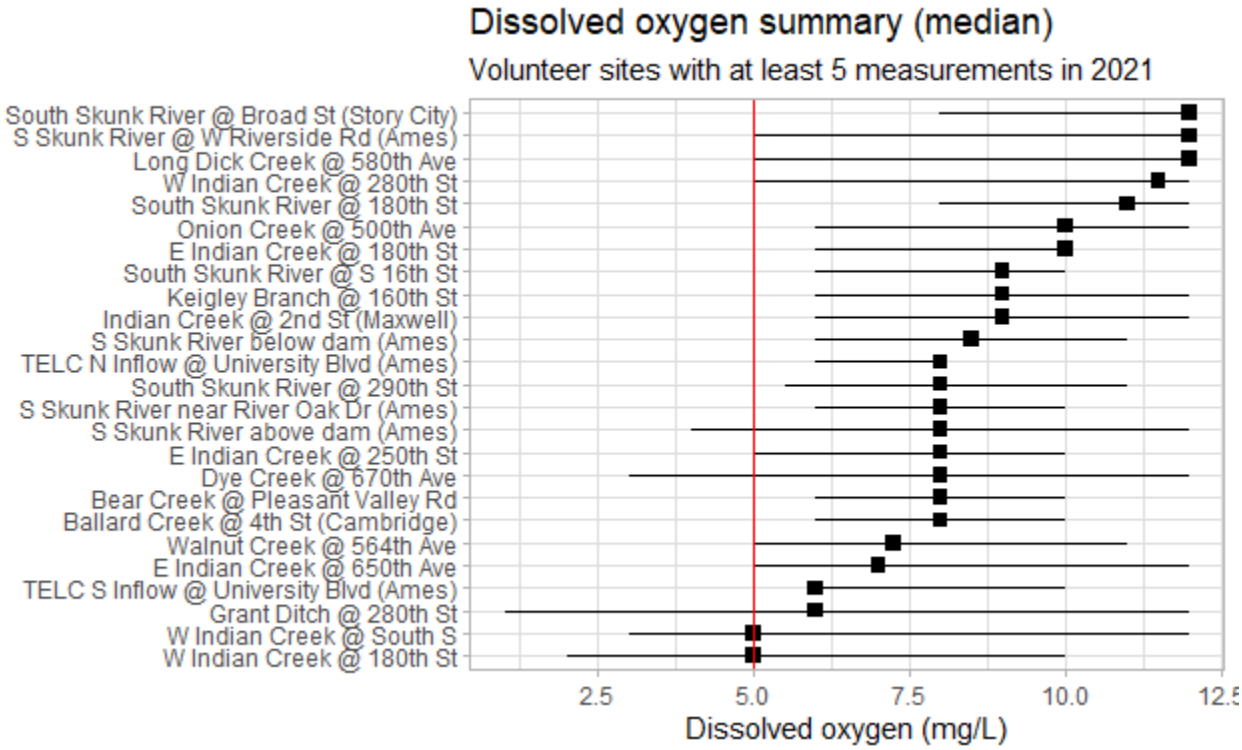


Another site—West Indian Creek at 280th Street (Jennett Heritage Area)—was sampled the week before. Only four groups of invertebrates were found, and the score was "Poor." Sensitive mayflies, which had been found in small numbers at this site in 2019, were absent this year.

Following up on a volunteer survey from the previous year, Story County contracted the Iowa State Hygienic Lab to perform a biological survey of Grant Creek at Jennett Heritage Area[3]. The scoring for these surveys is more complicated than in the Save Our Streams program, and identification is done to the species or genus level where possible, but the principle is the same. The invertebrate score was "Poor." Fish were collected using backpack shockers and 13 species were identified. The fish score was "Fair."

All three sites have good habitat for invertebrates. The results can be explained by differences in dissolved oxygen. Water quality was tested regularly by volunteers at the same locations that biological surveys were done. Both sites with "Poor" invertebrate scores (West Indian Creek @ 280th St and Grant Creek at 280th St) sometimes had dissolved oxygen levels as low as 5 mg/L (shown as a red line), which is the threshold at which aquatic life can be harmed. Low dissolved oxygen levels were not observed at the South Skunk River below the dam, which had a "Good" invertebrate score.

Volunteers found crayfish and dragonfly nymphs in the South Skunk River.

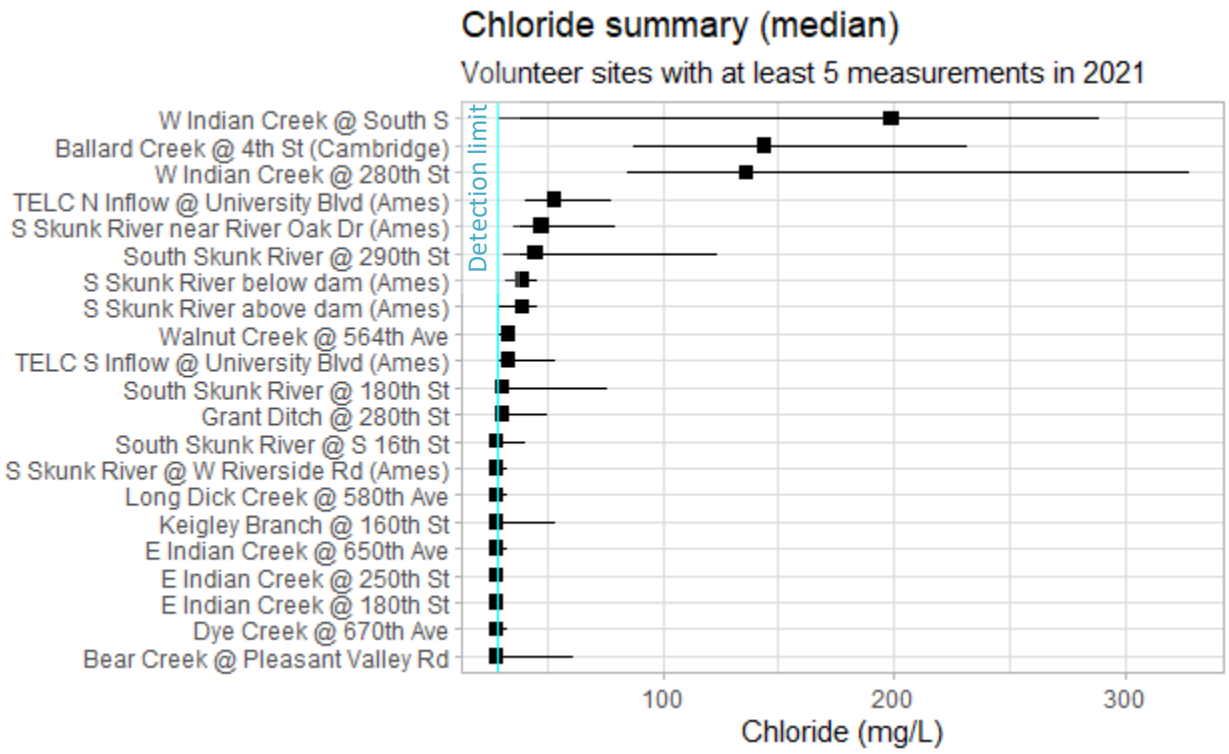


[3] https://programs.iowadnr.gov/bionet/Sites/1311

Excess nutrients in streams can stimulate algae blooms. Algae blooms can cause overnight drops in dissolved oxygen. This dynamic could be at play in West Indian Creek at South S Ave. This site is 1 mile downstream from the Nevada WWTP and had consistently low dissolved oxygen (median 5.0 mg/L) and consistently high orthophosphate (median 6 mg/L) and nitrate (10 mg/L).

Effluent from wastewater treatment plants can contain other chemicals that can harm aquatic life. For example, salts from water softeners can end up in wastewater, and cannot be easily removed by treatment systems. None of the creeks that were tested had chloride levels high enough to be toxic to aquatic life—389 mg/L is the standard for chronic exposure. However, higher chloride levels were observed in West Indian Creek (the sites downstream from the Nevada WWTP) and Ballard Creek (downstream from the Huxley WWTP), during times of year when road salt would not be a major factor.

Frog in final stages of metamorphosis, found in the South Skunk River.



In 2021, both biological and chemical monitoring made us aware of the influence that treated wastewater can have on streams during dry conditions. However, there is much more to learn before we can say what local actions will protect fish and aquatic life. We still do not have an explanation for the low dissolved oxygen and poor biological indices at Grant Creek. Patterns in dissolved oxygen between sites may become more clear once we can control for seasonal and daily cycles; either through more consistent monitoring schedules, or additional analysis.

Sediment and Stormwater

Issue: Erosion and sediment impacts on aquatic life

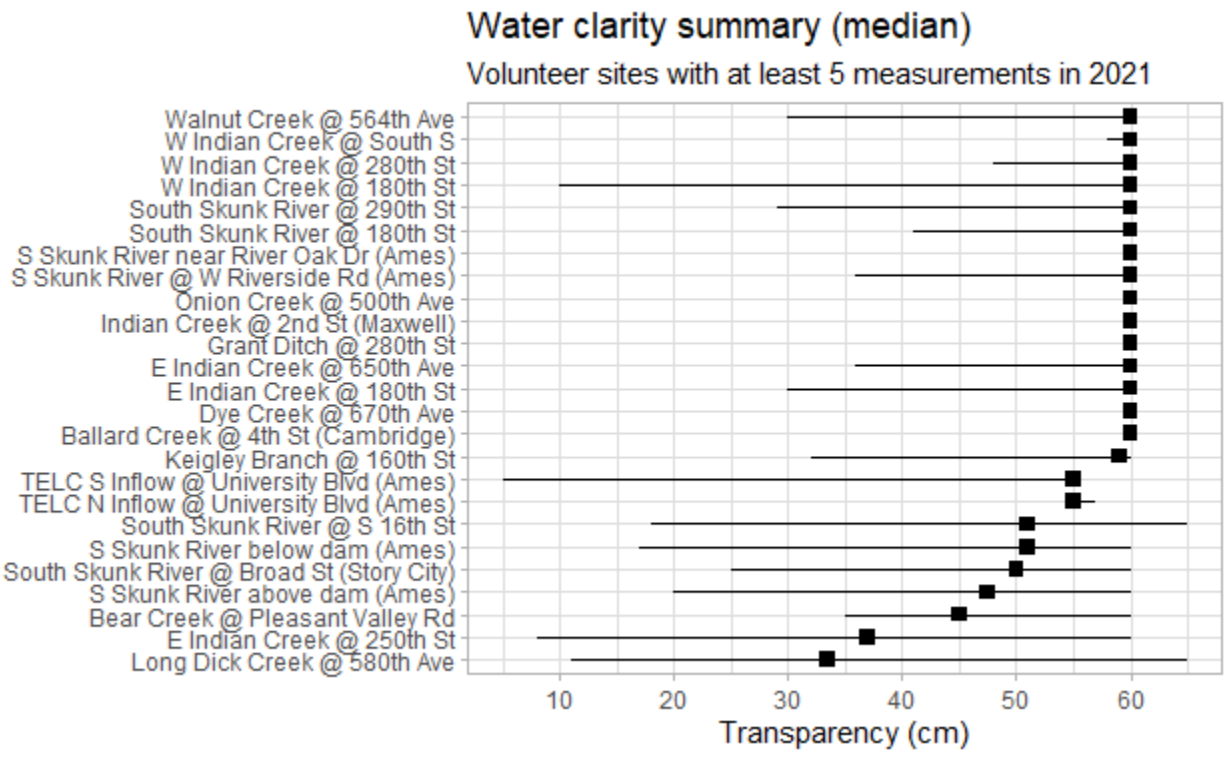
Metrics: Total suspended solids, transparency

Findings: Untreated stormwater from older neighborhoods can have extremely high levels of sediment, phosphorus, and bacteria.

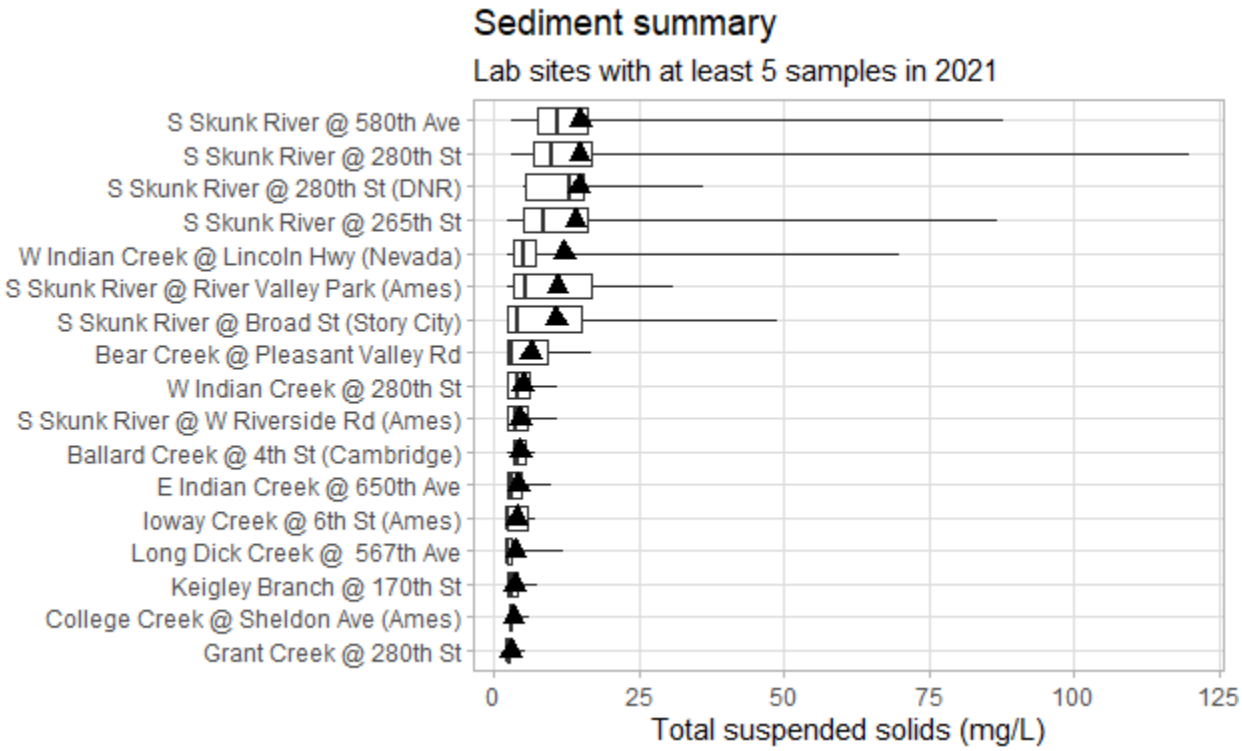
After a storm in May, some creeks had very high sediment levels.

Too much sediment in the water can harm fish and other aquatic life by reducing visibility and covering up rocks needed for habitat. Sediment in the water can come from farm fields and bare soil, or from stream banks, both of which are economic and environmental concerns in their own right. Other pollutants, including phosphorus and bacteria, are often attached to the sediment.

There are several ways to measure the amount sediment in the water. Muddy water is hard to see through. The scattering of light can be measured with a sensor, in turbidity units. Volunteers using the Save Our Streams protocol use a transparency tube to measure the depth (in centimeters) at which a pattern is visible. A secchi disk on a rope is used to measure clarity in lakes. A single low transparency measurement could be a fluke (a storm, a cow wading upstream, or a volunteer accidentally stirring up the bottom before sampling) but East Indian Creek and Long Dick Creek frequently had transparency readings in the range that Save Our Streams classifies as "fair" (15-35 cm).



Laboratories measure total suspended solids, in milligrams per liter. This is the dry weight of sediment removed from a water sample.



The amount of sediment a river can carry depends on how fast the water is moving, and the speed of water depends on the flow of water and channel shape. Not surprisingly, with little water in the creeks, total suspended solids were low in most samples collected this year. **The exceptions to this were the samples that were collected during rain events with Nalgene storm samplers. These often had Total Suspended Solids (TSS), *E. coli*, and phosphorus concentrations at least 10 times higher than other samples collected in the same month.**

Ioway Creek @ 6th St	TSS (mg/L)	*E. coli* (CFU/100 mL)	Nitrate-N (mg/L)	Total Phosphorus (mg/L)
July 9, storm event	1,316	25,200	0.60	1.42
July 21, baseflow	7	441	1.00	0.17
June 16, baseflow	7	904	5.50	0.14

Ordinances in Ames and Story County require new developments to include stormwater retention ponds in order to reduce flooding and negative water quality impacts. A properly designed retention pond is expected to remove 80% of the total suspended solids that would otherwise reach lakes or streams, as well as much of the bacteria, phosphorus, and other pollutants bound to the sediment. However, many older neighborhoods predate these ordinances and allow untreated stormwater to reach streams.

This is most clearly seen in data from the July 9 storm, during which we tested many sites for TSS. Very little sediment would reach Ioway Creek from the retention pond on Carver Ave, but untreated runoff reaches Ioway Creek at several locations between Stange Rd and 6th St (sites indicated in red), raising the levels of TSS, E. coli, and phosphorus.

Stormwater runoff in this ditch near Stange Rd contained high levels of sediment and E. coli bacteria.

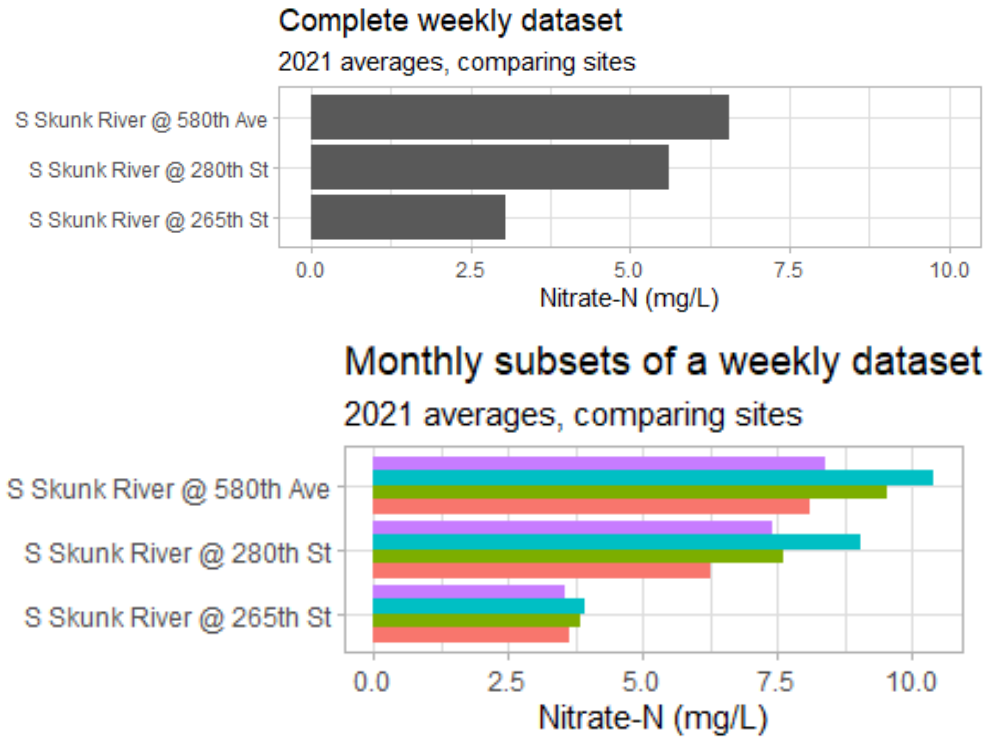
If it is possible to retrofit older neighborhoods with stormwater treatment practices, this could have water quality benefits.

ID #	Site Location	TSS (mg/L)	*E. coli* (CFU/ 100 mL)	Nitrate-N (mg/L)	Total Phosphorus (mg/L)
ST-12	Pond overflow @ Carver Ave	1	20	0.01	0.02
ST-04	Ioway Creek @ Stange Rd	5	**12,600**	0.28	0.16
ST-01	S Skunk River @ W Riverside Rd	7	**650**	0.26	0.24
ST-02	S. Skunk R. at N. River Valley Park	16	**13,700**	0.27	0.26
ST-06	Ioway Creek @ 6th St	130	**57,200**	0.25	0.20
ST-13	Outfall to S Skunk River @ 13th St	244	**6,700**	1.14	0.27
ST-10	Ditch near Stange Rd	1,006	**53,200**	1.54	0.79
ST-11	Tributary to Ioway Creek @ Ames High School	1,090	**25,800**	0.81	1.37
ST-03	S Skunk River @ 265th St	1,292	**20,200**	0.58	1.14
ST-05	Ioway Creek @ 13th St	1,316	**25,200**	0.60	1.42
ST-08	College Creek @ University Ave	5,820	**21,200**	0.50	2.70
ST-09	Storm sewer outfall to Ioway Creek near Stange Rd	15,318	**22,500**	0.70	2.87

Recommendations for improving monitoring in 2022

#1. Whenever possible, coordinate sampling schedules

Comparisons between nearby water bodies are more reliable if the sites are sampled on the same schedule. We can illustrate this by pulling once-a-month subsets from the once-a-week dataset collected by Ames Water & Pollution Control. Sampling always introduces some error and uncertainty. By chance, some of our highest nitrate readings fell on the third week of the month. Compared to the complete dataset, nitrate averages based on monthly sampling range from 1 to 3 mg/L too high, depending on which week of the month we happened to sample.



If the 580th St site was sampled on the 1st week and 280th St was sampled on the 3rd week, we would incorrectly conclude that nitrate was slightly higher at 280th St. If we sampled on the same day, our estimates for the two lower sites would be off by about the same amount, so we would at least get the ranking correct.

As shown in the table below, water quality can also vary dramatically within the span of a week if there is a rain storm. However, if same-day sampling is not possible, same-week sampling is the next best thing.

College Creek @ University Ave, tested with volunteer kits	May 14, 2021 (volunteer event, baseflow)	May 20, 2021 (After 0.7 inch rain, collected with Nalgene storm samplers)
Transparency	60+ cm	**32 cm**
Phosphate	0.2 mg/L	**0.6 mg/L**
Nitrite-N	0	**0.15 mg/L**
Nitrate-N	1 mg/L	1 mg/L
Chloride	**125 mg/L**	69 mg/L

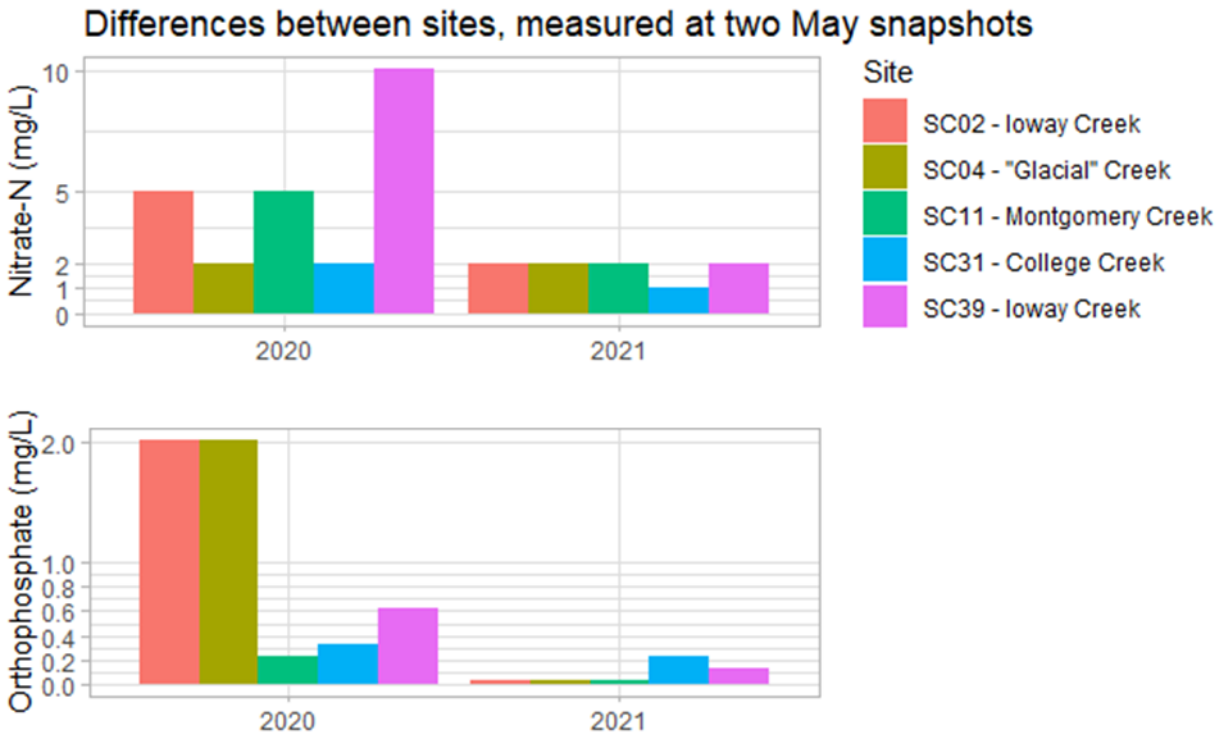
Same-day sampling is less important if differences between sites are very large (as they are between 265th St and the other sites), if day-to-day variation in water quality is small, or if streams are far enough away from each other that they experience different weather patterns.

Prairie Rivers of Iowa and City of Ames are currently coordinating lab sampling to occur the third Wednesday of the month at 15 sites, or every Wednesday at 3 sites near the Ames WPCF. We considered trying to match the schedule when Iowa DNR tests the South River at 280th St, but they do not test on a consistent day of the week.

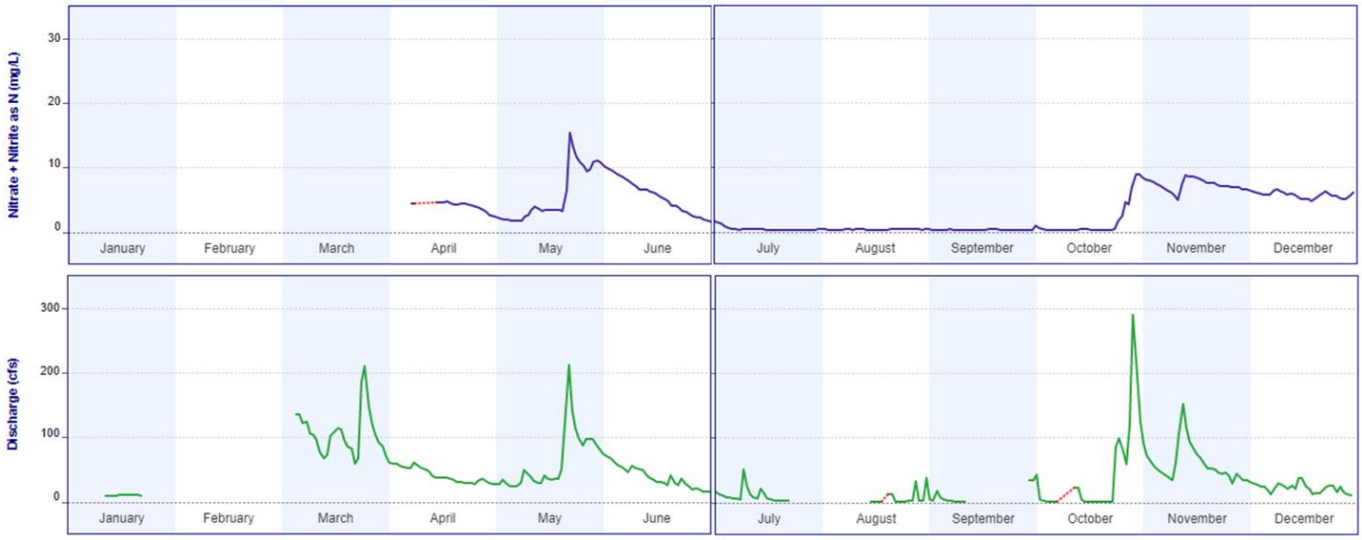
Story County Conservation is recommending that volunteers test on the first and third weeks of each month. Next year, we hope to have more sites that are monitored on this schedule, for a larger portion of the year. These sites can be analyzed separately, giving us greater confidence that differences in water quality averages between sites reflect differences in land use rather than seasonal patterns or weather. However, the main goals of the volunteer program are to engage and educate the public and to collect baseline data for streams and lakes around the county. Some flexibility in scheduling is necessary to achieve these goals.

#2. Consider focusing laboratory and snapshot sampling efforts on conditions most relevant for pollutants of interest

In central Iowa, drainage tiles are the main avenue by which nitrate gets from farm fields to streams. Edge of field practices like wetlands and bioreactors can intercept drainage water and remove nitrogen. Glacial Creek, a tributary of Ioway Creek in Boone County, is downstream of CREP wetland. At previous "snapshot" monitoring events held every May, we have noticed a big difference in nitrate concentrations between Glacial Creek and Ioway Creek. However, during the 2021 "snapshot" event, tiles were not flowing and water quality was the same at most sites we tested.



Even during a dry year, there are wetter periods where pollutants like nitrate are more concentrated. Real-time data from the nitrate sensor in Ioway Creek helped us track these changes, as shown below (purple is nitrate concentrations, green is stream flow). On May 21st, a week after the "snapshot" event, nitrate in Ioway Creek rose from 3 mg/L to 16 mg/L in response to much needed rain. Nitrate levels stayed high, gradually declining over the next few weeks until soils dried out and drain tiles stopped flowing again. We saw the same pattern in October and November.



These periods are not representative of 2021, but they are representative of the conditions when nitrogen is being lost from farmland. We know that a large portion of the phosphorus and sediment load in a given year is transported during the wettest conditions. However, there is a point at which soils become saturated and practices like ponds, wetlands, and bioreactors overflow and no longer provide any water quality treatment. Somewhere in between is a range of weather conditions under which conservation practices could make the most difference for water quality.

Several graphs in this report make comparisons between sites during "conditions suitable for paddling." If this is a useful way of looking at things, it could be helpful to collect more data points under these conditions. At most of our monthly sites, we only had 5 such samples in the last 2 years to work with.

The implications for volunteer snapshot events are clear: be prepared to reschedule if water levels are abnormal. The "spring snapshot" can best identify hot spots for nutrient losses if drainage tiles are flowing. The "fall snapshot" can best identify conditions that are healthy or stressful for aquatic life if most streams are low, but not completely dry.

It may be premature to change the sampling plan for regular lab testing. Further analysis or literature review is needed to understand how data collected during certain seasons or flow conditions relates to the year as a whole, and how conditions in smaller streams relate to conditions at downstream gages. Dr. Matt Helmers and colleagues at Iowa State University are monitoring nitrate losses from small paired watersheds with and without cover crops, including one site in Story County. Reviewing data from this kind of study would be helpful to understand the conditions and times of year when land management has the most influence.

#3. Balance geographic coverage with timing

Story County Conservation identified volunteer monitoring sites in each HUC12 watershed in the county, prioritizing creeks that feed directly into the South Skunk River. All but four of the high priority sites are being actively monitored by staff or volunteers. As more volunteers join the program, additional creeks in the NE and SW parts of the county can be monitored.

A woodchuck on the banks of Ioway Creek in Ames.

New volunteers could also support additional testing in and around lakes. The Friends of Ada Hayden have expressed interest in regular volunteer monitoring of wetlands, storm sewers, and groundwater feeding into the Ada Hayden Lake. A volunteer effort would supplement the more rigorous studies commissioned by the City of Ames, which do not occur every year. However, new volunteers could also be asked to help cover existing sites, acting as an alternate or "float". This would reduce gaps during the year when a site is not monitored, making data analysis more straightforward and conclusions more reliable.

Sites for monthly sampling and lab testing were chosen to prioritize creeks in town or in public parks where people come into contact with the water and *E. coli* data would be most relevant. Additional locations for lab testing could include Indian Creek in Maxwell and Middle Minerva Creek in Zearing. However, it will be important to plan routes carefully so that we can continue to cover all sites on the same day of the month.

The South Skunk River near Story City.

Overall, monitoring in Story County is proceeding well; it is important to ensure that volunteers and staff are able to sustain the effort.