Results from Water Quality Monitoring Conducted during Project AWARE 2017 on the upper Cedar River in North-Central Iowa

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Abstract: From July 10-14, 2017, 469 volunteers participated in Project AWARE 2017, the Iowa Department of Natural Resources volunteer river cleanup. The 2017 event was held on the upper Cedar River in Mitchell and Floyd counties in north-central Iowa. Project AWARE, which stands for **A W**atershed **A**wareness **R**iver **E**xpedition, is a five-day, four-night canoe trip down an Iowa river that allows volunteers to participate in a river cleanup, water quality monitoring, and on-river and evening educational programs. This was the fifteenth year of the event. A total of 28 tons of trash was removed from 55 miles of the upper Cedar River. Eighty-eight percent of the trash was recycled, which included 14.9 tons of scrap metal and 7.3 tons of tires (n = 368). Project AWARE is an initiative of the Iowa Department of Natural Resources IOWATER and Water Trails programs. The event was made possible through the financial and in-kind support of the Iowa Department of Natural Resources and 90 sponsors.

In addition to trash removal, 16 stream sites along the canoe route were monitored for a variety of water quality parameters using IOWATER methods. IOWATER was Iowa's volunteer water monitoring program. This report summarizes the water quality results for sites monitored during Project AWARE 2017. For more information on Project AWARE, go to *www.iowadnr.gov/aware*.

Introduction

Project AWARE, which stands for **A W**atershed **A**wareness **R**iver **E**xpedition, is the Iowa Department of Natural Resources' volunteer river cleanup event during which hundreds of Iowans spend anywhere from a day to several days improving Iowa's waterways by removing trash. While the main goal of Project AWARE is to bring Iowans together in a civic engagement project that provides them with an opportunity to experience and enhance their state's rivers from the seat of a canoe, Project AWARE volunteers also have opportunities to participate in educational opportunities, collect and analyze water quality monitoring data, and develop healthy behaviors that help benefit the environment.

Project AWARE 2017 represents the 15th year of this annual event. Previous Project AWARE events have paddled and cleaned up stretches of the Maquoketa River in northeast Iowa; the Des Moines River watershed in north-central Iowa; the Little Sioux River in northwest Iowa; the Iowa and English rivers in southeast Iowa; the Middle and North Raccoon rivers in west-central Iowa; the Winnebago, Shell Rock, and the upper Cedar rivers in north-central Iowa; the middle Cedar River in eastern Iowa; the East and West Nishnabotna rivers in southwest Iowa; the Little Turkey, Turkey, and Volga rivers in northeast Iowa; the Iowa River in north-central Iowa; the Des Moines River and Boone River in north-central Iowa; the Big Sioux River in northwest Iowa; the Wapsipinicon River in east-central Iowa; and the lower Des Moines River in southeast Iowa (Figure 1).

In 2017, 469 people participated in Project AWARE. Volunteers ranged in age from 2 to 77 and an average of 250 volunteers were on the water each day. In 2017, 50% of the volunteers were first-year participants, while 25% had been on Project AWARE five or more years. A total of fifteen volunteers were recognized for being on Project AWARE ten years, and one individual was recognized for participating in all 15 events. In addition to Iowa, volunteers were from Illinois, Arkansas, Colorado, Illinois, Kansas, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, Ohio, South Dakota, Texas, Utah, and Wisconsin.

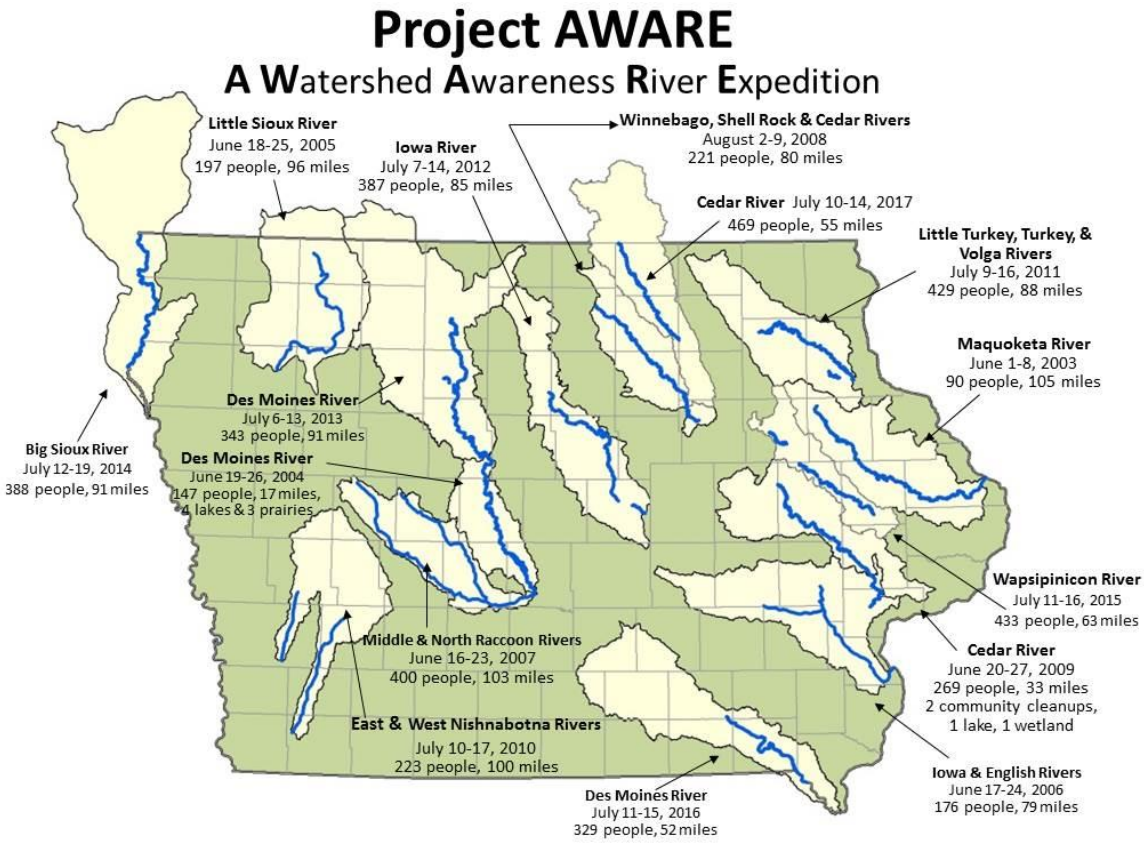

Figure 1. Location of Project AWARE events from 2003 through 2017.

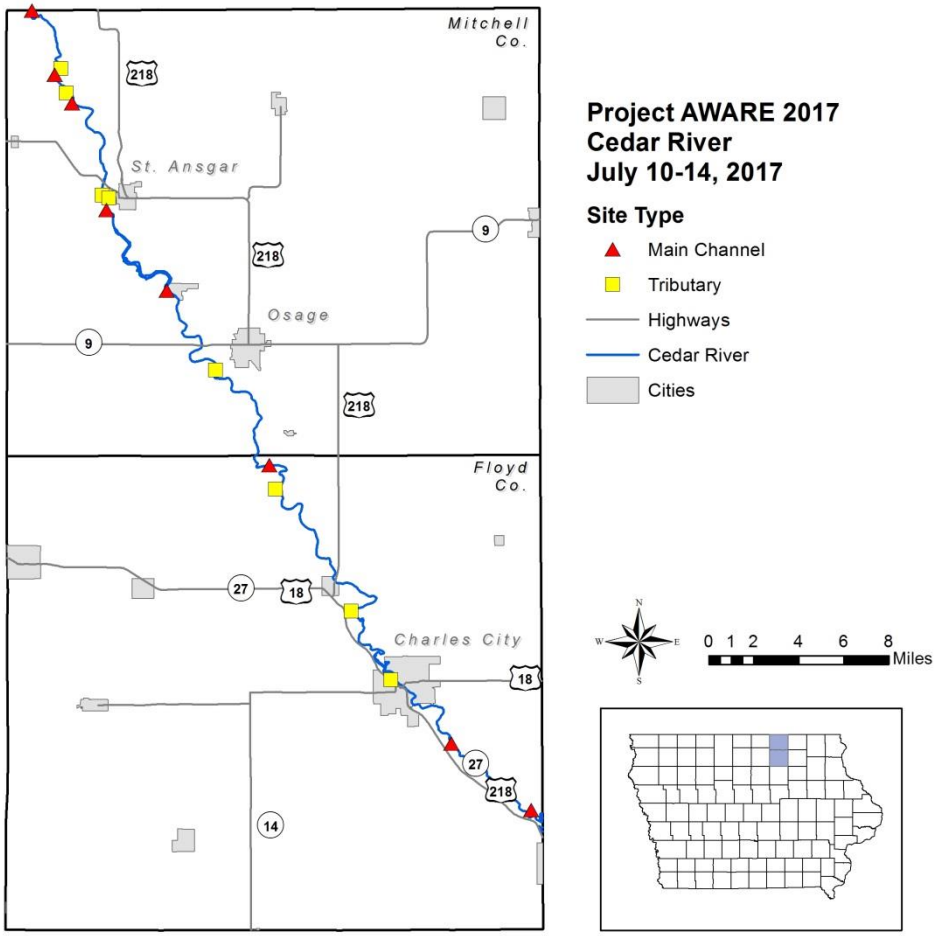

Figure 2. Location of sites sampled as part of Project AWARE 2017 on the Cedar River in north-central Iowa.

Project AWARE water quality monitoring was conducted by the following volunteers – Caden, Chuck, Joe, and Tiffanie Tonelli on July 10; Kata McCarville and Jason Jaeger on Tuesday July 11; Liz Queathem on Wednesday July 12; Jane Shuttleworth and Anne Lullie on Thursday July 13; and Angie Reid and Heather Gamm on Friday July 14. Prior to the event, potential monitoring sites were identified by Project AWARE staff. Sites were selected based on start, half-way, and take-out points for each day of Project AWARE, location of major tributaries entering the Cedar River, and other locations of interest. A total of 16 sites were sampled (Figure 2). Eight of the sites were on the main stem of the Cedar River while the remaining 8 were tributary sites. Results are available in Appendix A.

For all sites sampled during Project AWARE 2017, water quality data were collected using IOWATER field methods as described in the IOWATER Quality Assurance Project Plan (2010). Field data were recorded on waterproof paper field sheets. This report summarizes the water quality from the Project AWARE 2017 sampling of 16 sites (Figure 2) and includes the chemical and physical results (Table 1).

Where possible, water quality results from Project AWARE were compared to a network of 60 streams statewide that is monitored on a monthly basis as part of the Iowa Department of Natural Resources' (DNR) Water Quality Monitoring and Assessment Ambient Stream Monitoring Program. Data from this network have been collected since 2000 and provide perspective on typical stream concentrations statewide for the various parameters (Iowa DNR, March 2017). In this report, this statewide stream network will be referred to as the DNR statewide stream network. The July 2017 data from the DNR statewide stream network were compared to Project AWARE results to give an idea of the relative concentrations of various parameters in streams statewide during the same time period.

Table 1. Monitoring results from Project AWARE 2017.

Parameter	Unit	Method	# of samples	Min Value	Percentiles			Max Value
					25th	50th	75th	
Chloride	mg/L	IOWATER test strip	14	<31	<31	<31	<31	<31
Dissolved Oxygen	mg/L	IOWATER field kit	16	5	6	8	8	10
Nitrite-N	mg/L	IOWATER test strip	16	0	0	0	0	0
Nitrate-N	mg/L	IOWATER test strip	16	2	5	5	10	10
pH	pH units	IOWATER test strip	16	7	8	8	9	9
Phosphate	mg/L	IOWATER field kit	16	0.2	0.4	0.4	0.8	1
Temperature, Air	degrees F	Thermometer - Field	16	59	75	76	79	87
Temperature, Water	degrees F	Thermometer - Field	16	64	72	75	76	80
Transparency	centimeters	IOWATER transparency tube	16	28	32	50	60	60

mg/L = milligrams per liter (or parts per million - ppm)
F = Fahrenheit

Precipitation and Stream Flow Conditions

For the days of Project AWARE, water levels for the Cedar River at Charles City were slightly lower than the long-term normal conditions based on U.S. Geological Survey data (Figure 3). The drainage area for the Cedar River at Charles City, Iowa, is 1,054 mi^2. Stream flow for the Cedar River at Charles City varied from 549 to 691 cubic feet per second (cfs) during Project AWARE. Stream flow levels were highest on July 12 and lowest on July 14. Water levels for the Cedar River at Charles City were 61 to 76% of the long-term normal for this time of year.

Air temperatures for the week of Project AWARE were near normal. Temperatures ranged from highs of 74 to 89 degrees Fahrenheit to lows of 55 to 73 based on the Charles City, Iowa, climate station (https://mesonet.agron.iastate.edu/). Normal high for this time of year is 83 degrees Fahrenheit with a normal low of 61 (https://mesonet.agron.iastate.edu/). Rain occurred during Project AWARE. The Charles City climate station recorded 1.16 inches of rain on July 10, 0.01 inches on July 12, and a trace on July 13 (https://mesonet.agron.iastate.edu/).

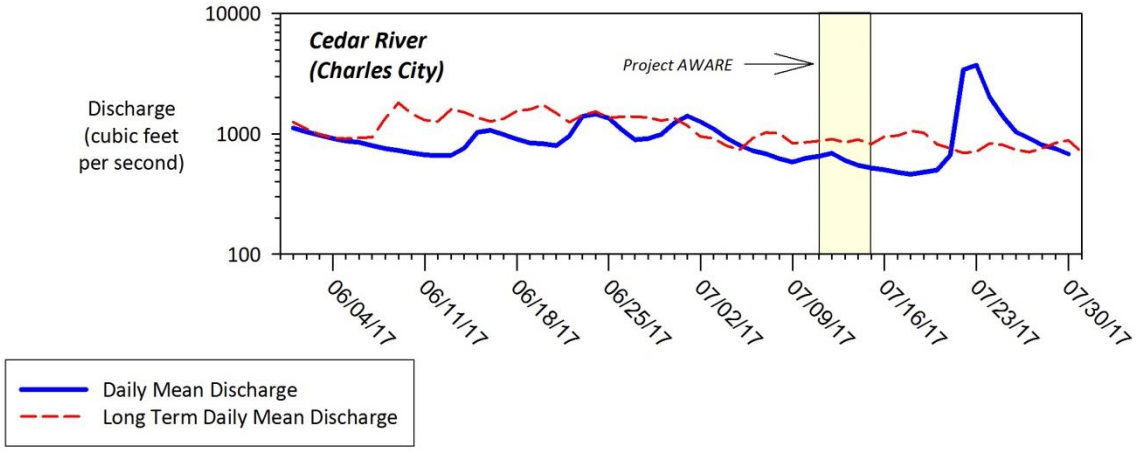

Figure 3. Discharge for the Cedar River at Charles City for June 1, 2017 through July 31, 2017. The yellow shaded area represents when Project AWARE occurred July 10-14, 2017. Data are from http://ia.water.usgs.gov.

Chemical and Physical Parameters

Water Temperature

Water temperature affects many of the biological, chemical, and physical processes in a stream, including the amount of oxygen gas that can dissolve in water, the rate of photosynthesis by algae and plants, as well as the metabolic rate of aquatic animals.

Water temperature was measured at 16 sites and temperatures varied from 64 to 80 degrees Fahrenheit (F) (Table 1; Figure 4). Water temperatures for main stem Cedar River sites were similar to the tributary sites (median of 74 for the tributary sites as well as for the main stem sites). Water temperatures for the tributary sites were more variable than the main stem sites. While the Cedar River is a warm water stream, the tributary sites monitored included both warm water as well as a few cold water streams.

Figure 5 compares the results of selected parameters from Project AWARE to the DNR statewide stream network. The median water temperature for sites monitored on Project AWARE was cooler (75 degrees F) than streams statewide (78 degrees F).

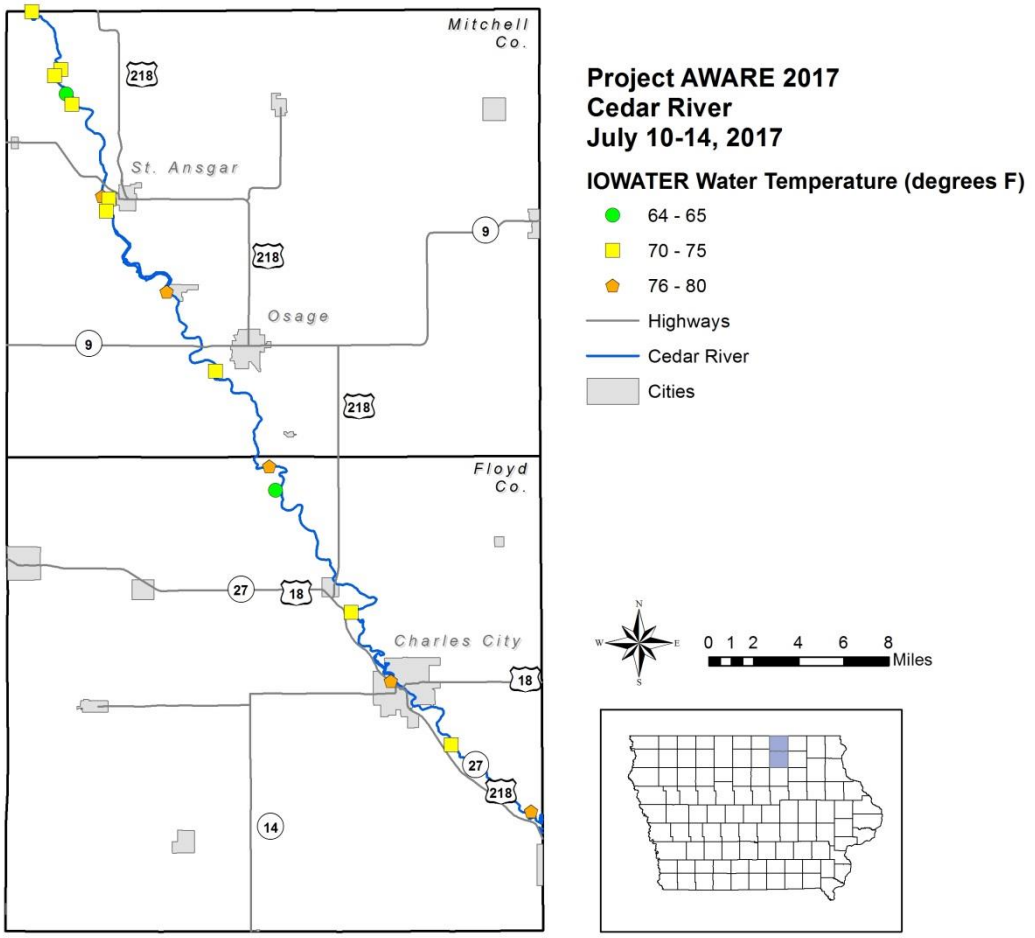

Figure 4. Water temperature (IOWATER method) for sites sampled as part of Project AWARE 2017 on the Cedar River in north-central Iowa.

pH

pH is a measure of water's acid/base content. Changes in pH can be caused by atmospheric deposition of acid rain, the types of soils and bedrock that the water comes in contact with, wastewater discharges, and acid mine drainage. A pH of 7 is neutral; pH values greater than 7 are alkaline or basic, while a pH less than 7 is acidic.

pH levels for sites sampled during Project AWARE ranged from 7 to 9 using the IOWATER test strip (Table 1; Figure 6). The median pH for the main stem and tributary sites was 8. The pH levels measured at sites sampled as part of Project AWARE were more variable than those measured as part of the DNR statewide stream network for July 2017 (Figure 5). The overall difference in pH values most likely has to do with a difference in pH methods. For Project AWARE, pH test strips were used which measure pH in whole number increments whereas for the DNR statewide stream network, calibrated pH meters were used that measure in tenths.

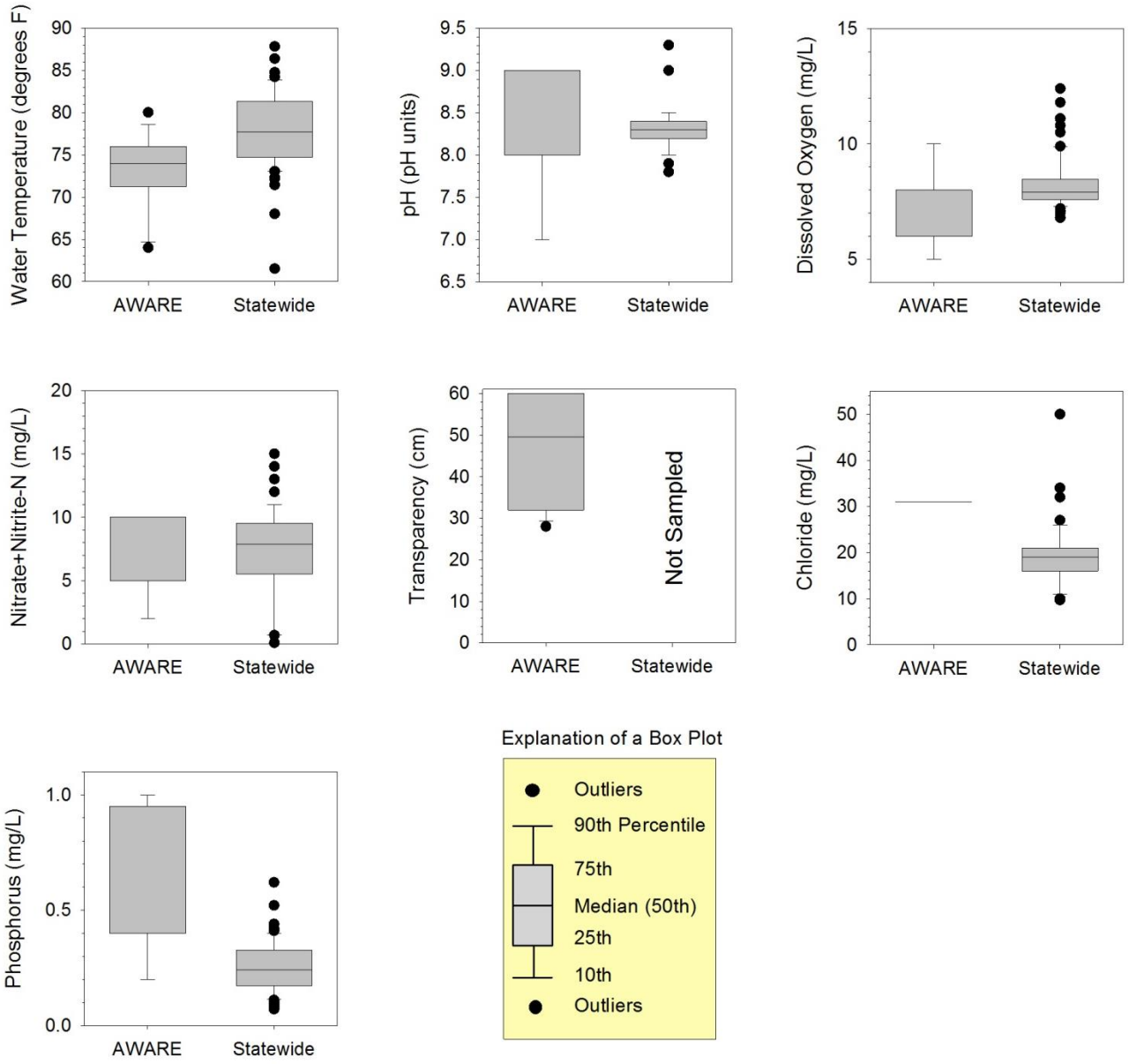

Figure 5. Box plots comparing water quality results for sites sampled during Project AWARE 2017 to the DNR statewide stream network for July 2017.

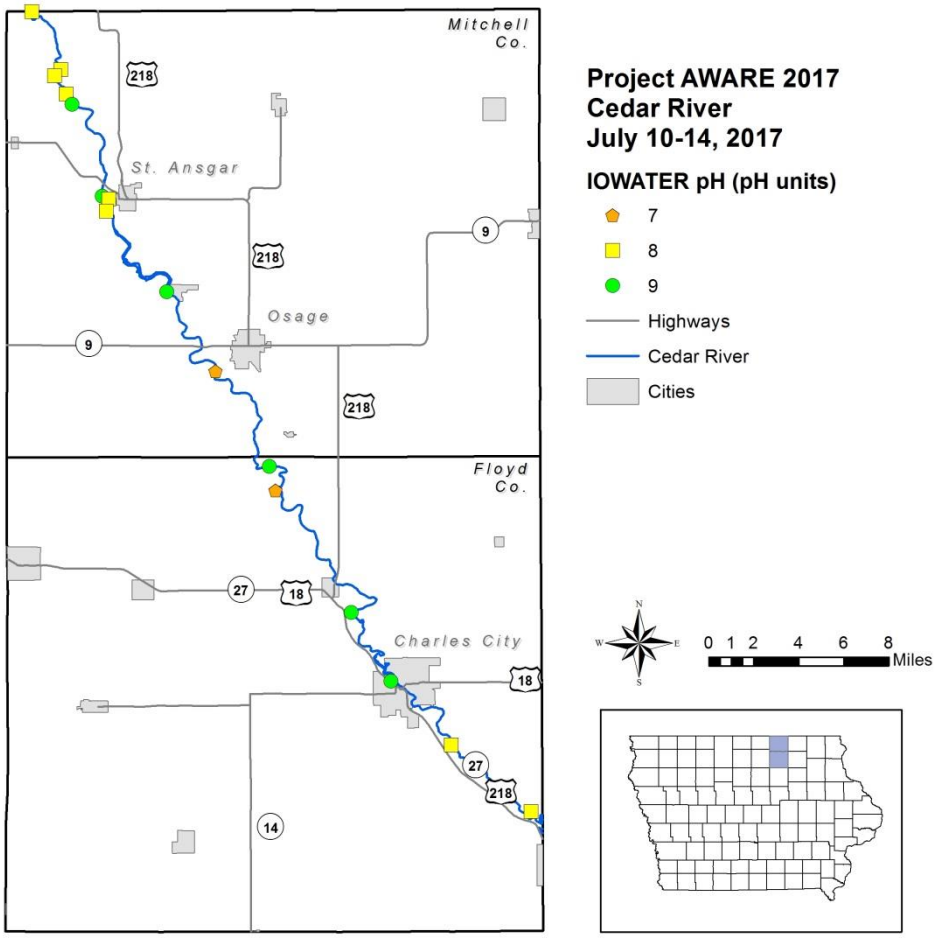

Figure 6. pH (IOWATER method) for sites sampled as part of Project AWARE 2017 on the Cedar River in north-central Iowa.

Transparency

Transparency is a measure of water clarity and is affected by the amount of material suspended in water. As more material is suspended in water, less light can pass through the water, making it less transparent (or more turbid). These materials include soil, algae, plankton, and microbes.

Transparency ranged from 28 to 60 centimeters (cm) for all Project AWARE sites with a median of 50 (Table 1; Figure 7). Transparency was lower for the main stem sites on the Cedar River (median of 39 cm) relative to the tributary sites (median of 56 cm). Two of the main stem and four of the tributary sites had transparency readings of 60 centimeters, the upper limit.

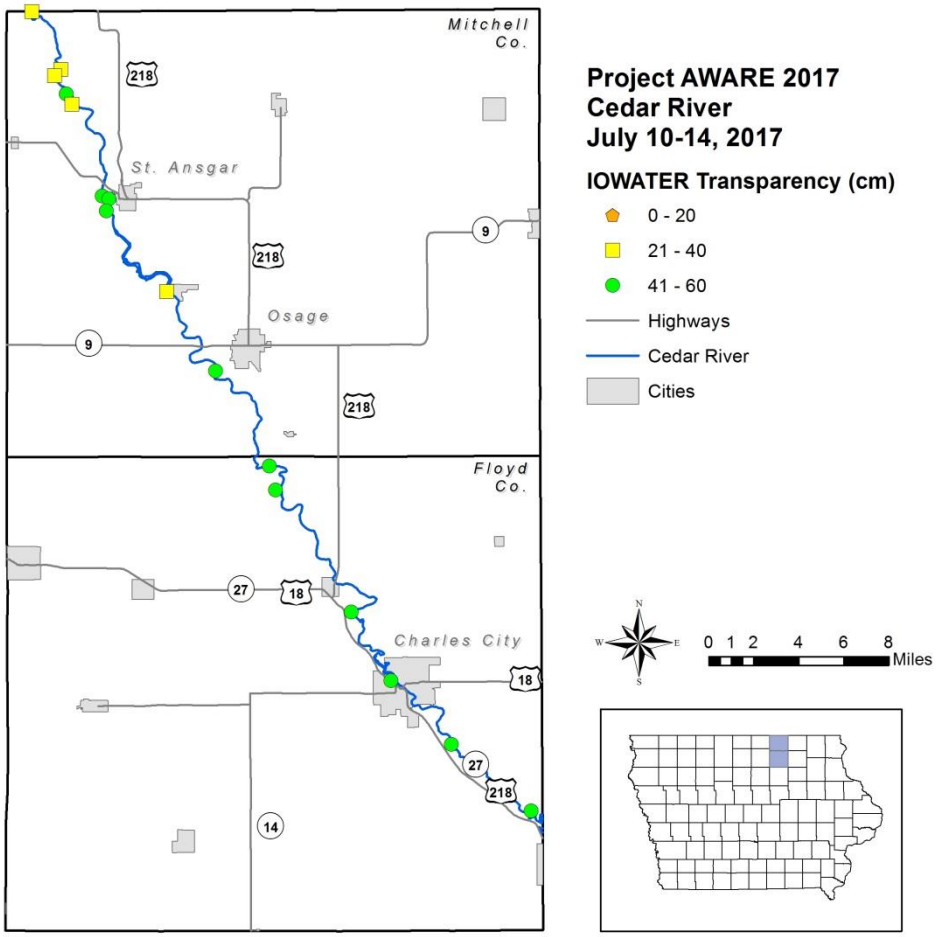

Figure 7. Water transparency (IOWATER method) for sites sampled as part of Project AWARE 2017 on the Cedar River in north-central Iowa.

Dissolved Oxygen

Dissolved oxygen levels in a stream can be affected by a number of variables, including water temperature, season of the year, time of day, stream flow, presence of aquatic plants, dissolved or suspended solids, and human impacts. Oxygen enters a stream through diffusion from the surrounding air and as a product of photosynthesis from aquatic plants. Oxygen in a stream can be consumed through respiration by aquatic plants and animals, and by the decomposition of organic matter. Iowa has a water quality standard minimum of 5 mg/L of dissolved oxygen for warm water streams.

For Project AWARE sites, dissolved oxygen ranged from 5 to 10 mg/L (Table 1; Figure 8) with a median of 8 mg/L. None of the sites had dissolved oxygen levels less than Iowa's statewide standard for warm water streams of 5 mg/L. Median dissolved oxygen concentrations were similar between the main stem sites on the Cedar River and tributary sites. Dissolved oxygen concentration medians were similar between Project AWARE sites and streams monitored statewide for July 2017 (Figure 5).

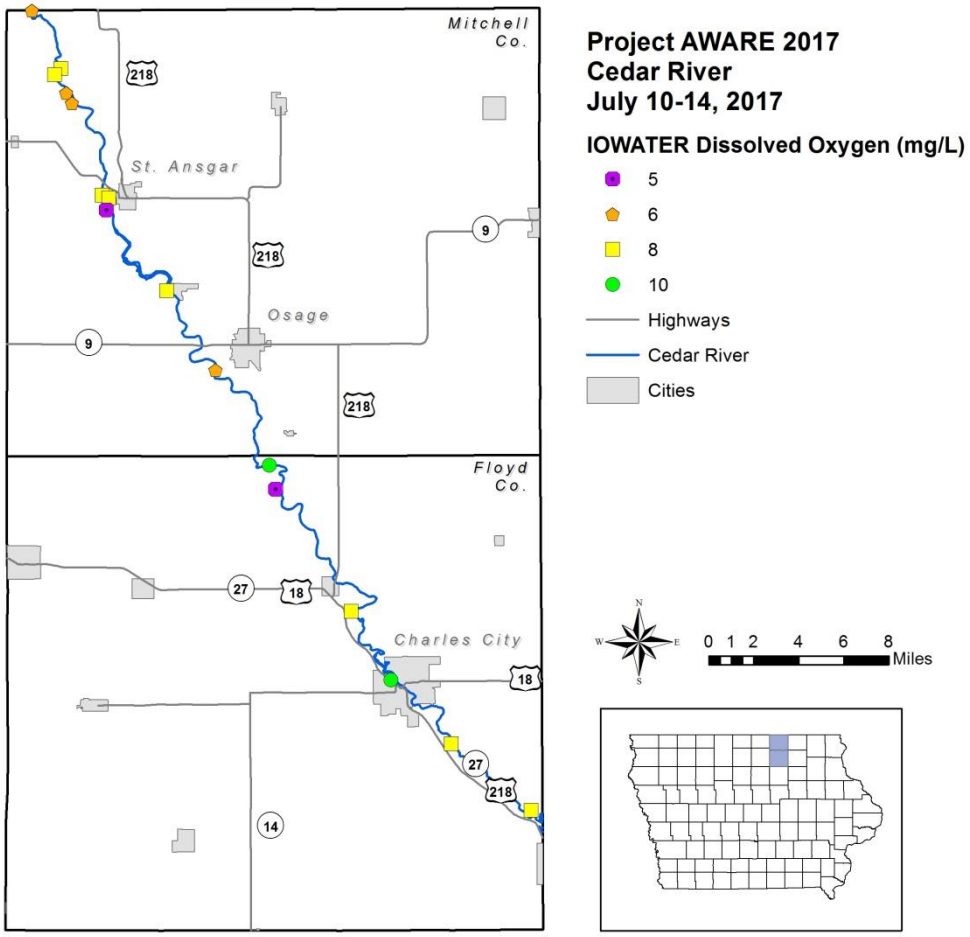

Figure 8. Dissolved oxygen (IOWATER method) for sites sampled as part of Project AWARE 2017 on the Cedar River in north-central Iowa.

Nitrite-N and Nitrate-N

Nitrogen is a necessary nutrient for plant growth, and includes both nitrite- and nitrate-nitrogen. Too much nitrogen in surface waters, however, can cause nutrient enrichment, increasing aquatic plant growth and changing the types of plants and animals that live in a stream. Sources of nitrogen include soils; human and animal wastes; decomposing plants; and fertilizer runoff from golf courses, lawns, and cropland. Typical nitrate+nitrite-N concentrations for Iowa streams range from 2.6 to 8.2 mg/L (Iowa DNR, 2017), with higher concentrations generally occurring in the late spring/early summer. Nitrite-N and nitrate-N are not measured separately as part of the DNR statewide stream network, rather it is measured and reported as nitrate+nitrite-N.

Nitrite-N was measured at Project AWARE sites using the IOWATER method (Table 1; Figure 9). All nitrite-N concentrations were 0 mg/L.

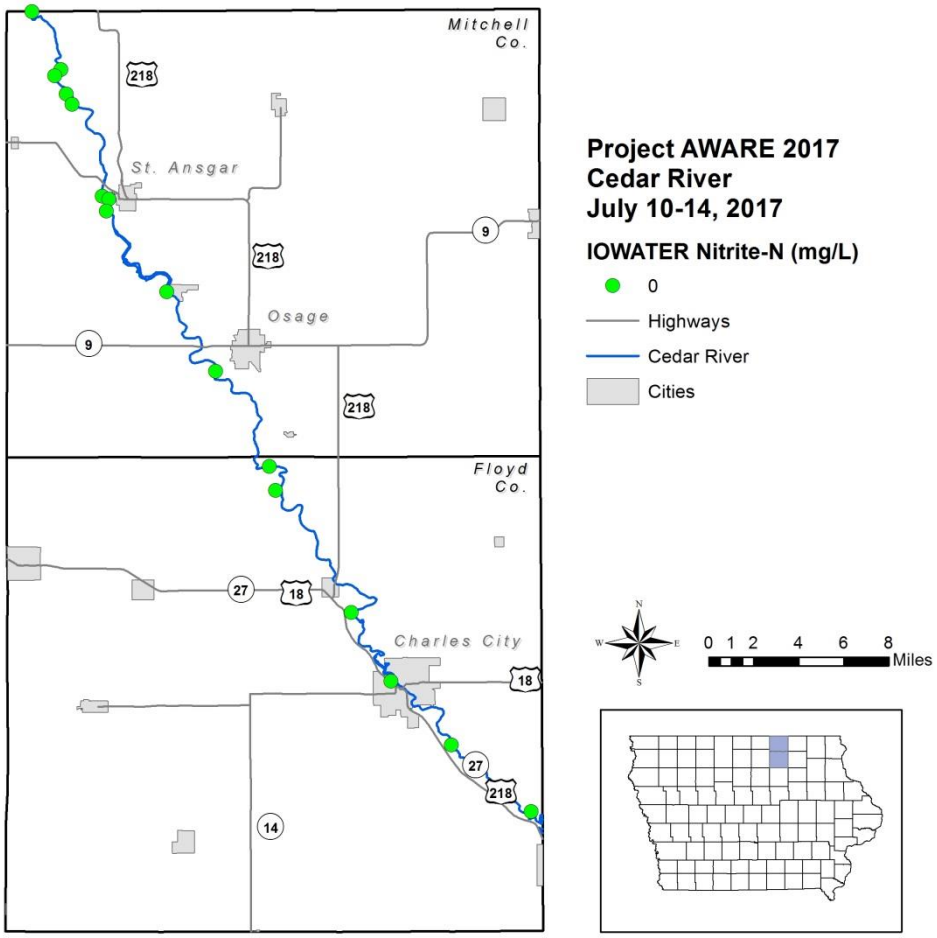

Figure 9. Nitrite-N (IOWATER method) for sites sampled as part of Project AWARE 2017 on the Cedar River in north-central Iowa.

Nitrate-N for Project AWARE sites ranged from 2 to 10 mg/L (median of 5 mg/L; Table 1; Figure 10). The median nitrate-N for tributary sites was slightly higher (8 mg/L) compared to sites on the Cedar River (5 mg/L). Forty-four percent of the sites had nitrate-N concentrations of 10 mg/L. Nitrate-N results from Project AWARE sites showed a lower median concentration (2 mg/L) than streams statewide (6.9 mg/L) as well as a smaller range in concentration (Figure 5).

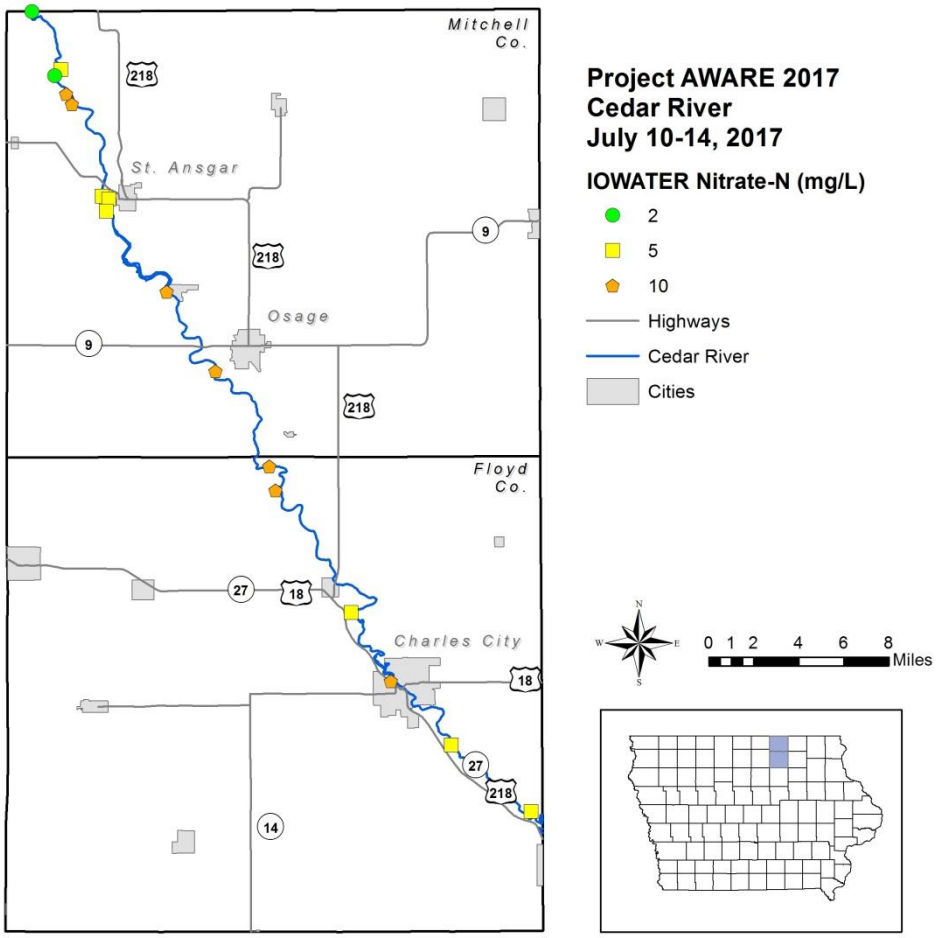

Figure 10. Nitrate-N (IOWATER method) for sites sampled as part of Project AWARE 2017 on the Cedar River in north-central Iowa.

Chloride

Chloride is a component of salt and is a measure of human or animal waste inputs to a stream. Potential sources of chloride to a stream include direct input from livestock, septic system inputs, and/or discharge from municipal wastewater facilities. During winter months, elevated chloride levels in streams may occur as a result of road salt runoff to nearby streams. Typical concentrations of chloride in Iowa streams range from 16 to 28 mg/L, with a median of 21 mg/L, with higher concentrations occurring during winter months (Iowa DNR, 2017).

For Project AWARE sites, all chloride results were below the test strip detection limit of 31 mg/L (Table 1; Figure 11). Chloride concentrations for the DNR statewide stream network were more variable than the Project AWARE sites, ranging in concentration from 9.7 to 50 mg/L. These samples were analyzed in the lab allowing lower detection values than possible with the IOWATER chloride test strip.

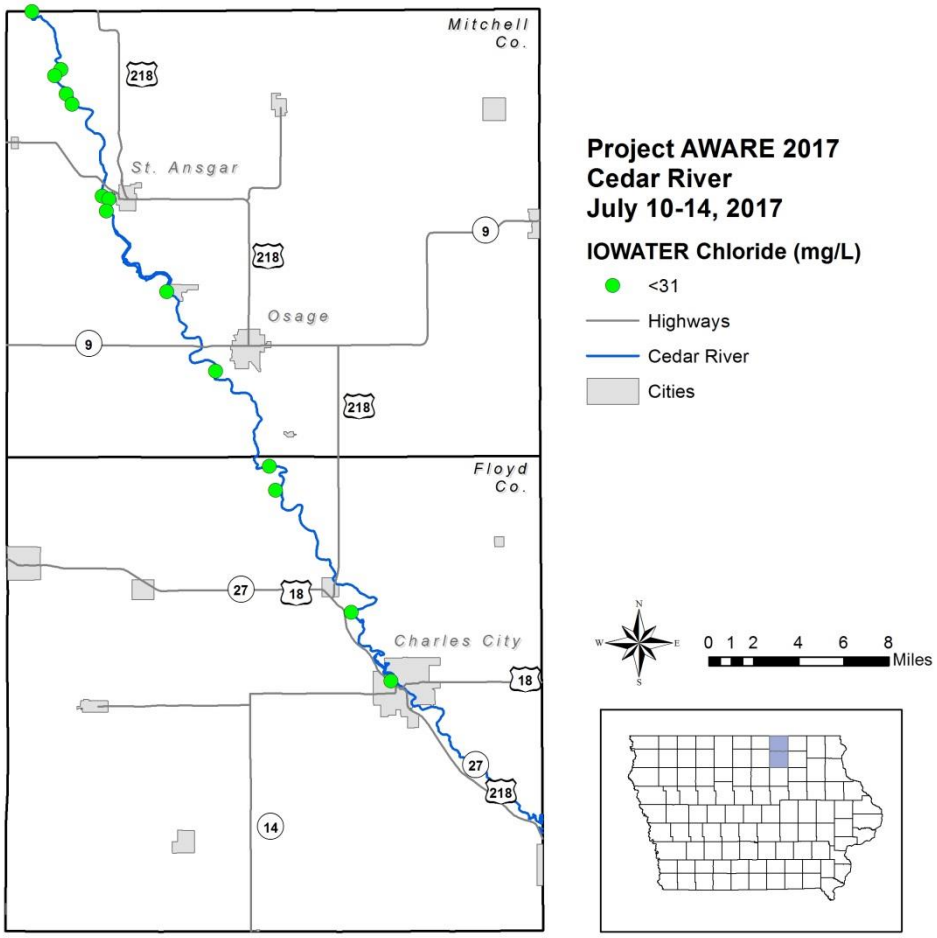

Figure 11. Chloride (IOWATER method) for sites sampled as part of Project AWARE 2017 on the Cedar River in north-central Iowa.

Phosphorus

Phosphorus is a necessary nutrient for plant growth. Too much phosphorus in surface waters, however, can cause nutrient enrichment, increasing aquatic plant growth, and changing the types of plants and animals that live in a stream. Sources of phosphorus include certain soils and bedrock; human and animal wastes; detergents; decomposing plants; and runoff from fertilized lawns and cropland. Typical concentrations of phosphate in streams statewide vary from 0.11 to 0.32 mg/L, with a median of 0.19 mg/L (Iowa DNR, 2017).

IOWATER phosphate results for the Project AWARE sites ranged from 0.2 to 1.0 mg/L, with a median of 0.4 mg/L (Table 1; Figure 11). The highest phosphate level (1.0 mg/L) occurred at three locations on the Cedar River and Otter Creek, a tributary in Mitchell County. Phosphate concentrations for sites monitored as part of Project AWARE were higher compared to the DNR statewide stream network (Figure 5).

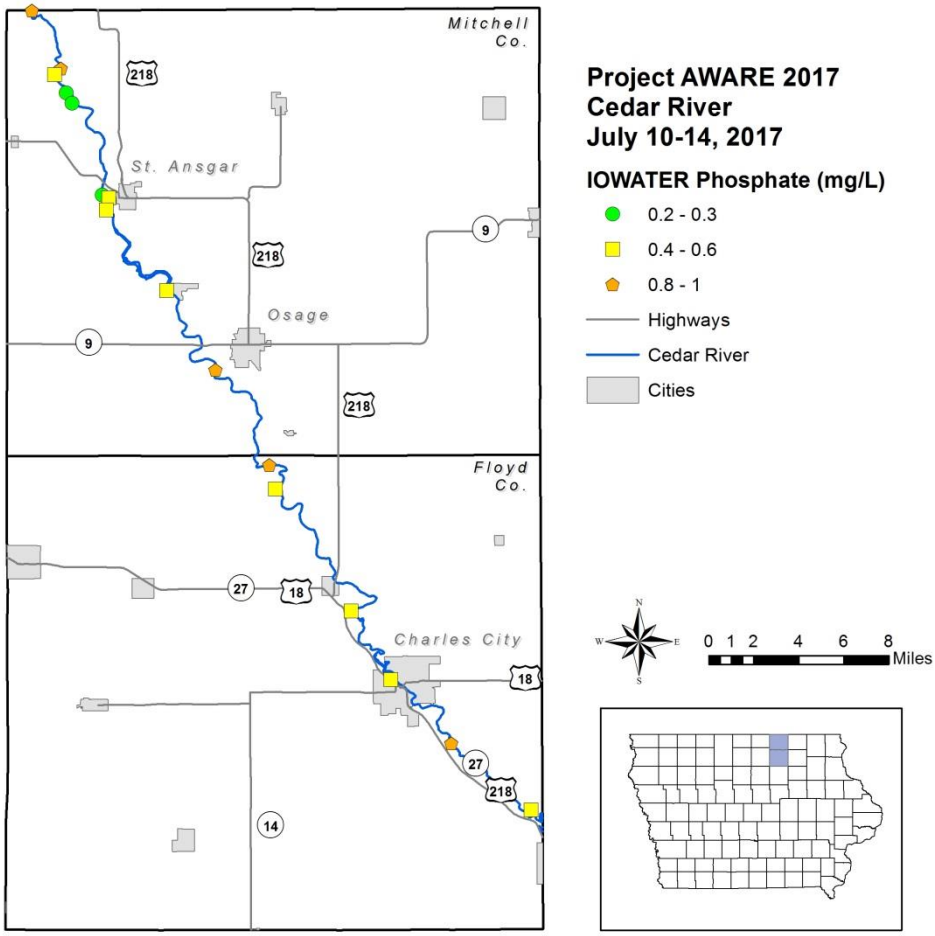

Figure 12. Phosphate (IOWATER method) for sites sampled as part of Project AWARE 2017 on the Cedar River in north-central Iowa.

Summary

Through the efforts of 469 volunteers, a total of 28 tons of trash was removed from the upper Cedar River as part of Project AWARE 2017. The water quality of 16 sites was monitored for a variety of field parameters using IOWATER methods. Below are some observations from the data.

- Project AWARE occurred July 10-14, 2017, as Cedar River stream levels were slightly below normal for this time of year. During the Project AWARE event, stream flows were 61 to 76% of normal for the Cedar River at Charles City.
- Water temperature for Project AWARE sites sampled ranged from 64 to 80 degrees Fahrenheit. Water temperatures on the main stem of the Cedar River were similar to the tributary sites (median of 74 for the tributary sites and 74 for the main stem). Water temperatures for the tributary sites were more variable than the main stem sites. While the Cedar River is a warm water stream, the tributary sites monitored included both warm water as well as a few cold water streams. The median water temperature for the Project AWARE sites was warmer (81 degrees Fahrenheit) compared to the network of streams monitored statewide (75 degrees Fahrenheit).
- pH for the Project AWARE sites ranged from 7 to 9. The median pH for the main stem and tributary sites was the same (8). pH values for Project AWARE were more variable than levels measured for streams statewide and likely are caused by a difference in how pH was measured.

- Transparency ranged from 28 to 60 centimeters with a median of 50 cm. Transparency was lower for the main stem sites on the Cedar River (median of 39 cm) relative to the tributary sites (median of 56 cm).
- Dissolved oxygen concentrations varied from 5 to 10 mg/L with a median of 8 mg/L. None of the sites had dissolved oxygen levels less than Iowa's statewide standard for warm water streams of 5 mg/L. Median dissolved oxygen concentrations were similar between the main stem sites on the Cedar River and tributary sites. While the median for the Project AWARE sites was similar to the median for the DNR statewide stream network, the standard deviation was greater for the Project AWARE sites.
- All nitrite-N concentrations were 0 mg/L.
- Nitrate-N concentrations ranged from 2 to 10 mg/L. The median nitrate-N for tributary sites was slightly higher (8 mg/L) compared to sites on the Cedar River (5 mg/L). Forty-four percent of the sites had nitrate-N concentrations of 10 mg/L.
- All chloride results were below the test strip detection limit of 31 mg/L.

Acknowledgements

Sincere thanks to the Tonelli family (Caden, Chuck, Joe, and Tiffanie), Kata McCarville, Jason Jaeger, Liz Queathem, Jane Shuttleworth, Anne Lullie, Angie Reid, and Heather Gamm for conducting the water quality monitoring throughout the week of Project AWARE 2017. The Project AWARE monitoring and site selection efforts were coordinated by Rebecca Kauten. Project AWARE staff provided review of the report.

References

Iowa Department of Natural Resources, Stream Water Quality Summary 2000-2016, March 2017, 7 p.

IOWATER Quality Assurance Project Plan. 2010. Iowa Department of Natural Resources. QA/WM/01-02. 94 p.

September 2017

Appendix A. Water quality results.

Number	Stream	Site_Type	UTM_X	UTM_Y	County	Date	Time	Sampled by	Water Temperature (degrees F)	Transparency (cm)	pH (pH units)	Nitrite-N (mg/L)	Nitrate-N (mg/L)	Dissolved Oxygen (mg/L)	Phosphate (mg/L)	Chloride (mg/L)
1	Iowa-Minnesota St	Main Channel	499850	4816313	Mitchell	7/10/2017	14:30	Tonelli Family	75	32	8	0	2	6	1	<31
2	Otter Creek	Tributary	501924	4812163	Mitchell	7/10/2017	15:54	Tonelli Family	75	32	8	0	5	8	1	<31
3	Cedar River Otrant	Main Channel	501481	4811730	Mitchell	7/10/2017	16:30	Tonelli Family	74	32	8	0	2	8	0.4	<31
4	Unnamed Creek	Tributary	502304	4810428	Mitchell	7/11/2017	9:31	Kata McCarville, Jason Jaeger	64	47	8	0	10	6	0.3	<31
5	Cedar River	Main Channel	502729	4809678	Mitchell	7/11/2017	10:00	Kata McCarville, Jason Jaeger	72	30	9	0	10	6	0.2	<31
6	Deer Creek	Tributary	504893	4803120	Mitchell	7/11/2017	12:00	Kata McCarville, Jason Jaeger	76	60	9	0	5	8	0.2	<31
7	Turtle Creek	Tributary	505346	4802897	Mitchell	7/11/2017	12:30	Kata McCarville, Jason Jaeger	74	52	8	0	5	8	0.6	<31
8	Cedar River DS Klei	Main Channel	505180	4802031	Mitchell	7/11/2017	13:15	Kata McCarville, Jason Jaeger	73	45	8	0	5	5	0.6	<31
9	Cedar River Interst	Main Channel	509502	4796272	Mitchell	7/11/2017	15:00	Kata McCarville, Jason Jaeger	78	28	9	0	10	8	0.4	<31
10	Sugar Creek	Tributary	512995	4790586	Mitchell	7/12/2017	10:57	Liz Queathem	74	60	7	0	10	6	0.8	<31
11	Cedar River at Sete	Main Channel	516831	4783801	Floyd	7/12/2017	14:04	Liz Queathem	80	60	9	0	10	10	1	<31
12	Skunk Creek	Tributary	517269	4782074	Floyd	7/13/2017	9:54	Jane Shuttleworth, Anne Lullie	65	46	7	0	10	5	0.4	<31
13	Stewart Creek	Tributary	522694	4773353	Floyd	7/13/2017	14:10	Jane Shuttleworth, Anne Lullie	70	60	9	0	5	8	0.4	<31
14	Drainage Ditch 3	Tributary	525542	4768421	Floyd	7/13/2017	16:30	Jane Shuttleworth, Anne Lullie	76	60	9	0	10	10	0.4	<31
15	Cedar River at laun	Main Channel	529839	4763887	Floyd	7/14/2017	9:00	Angie Reid, Heather Gamm	71	60	8	0	5	8	1	---
16	Cedar River at How	Main Channel	535561	4759108	Floyd	7/14/2017	11:55	Angie Reid, Heather Gamm	76	55	8	0	5	8	0.4	---