Results from Water Quality Monitoring Conducted during Project AWARE 2016 on the Lower Des Moines River in Southeast Iowa

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Abstract: From July 11-15, 2016, 329 volunteers participated in Project AWARE 2016, the Iowa Department of Natural Resources volunteer river cleanup. The 2016 event was held on the lower Des Moines River in southeast 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 fourteenth year of the event. A total of 40.0 tons of trash was removed from 52 miles of the lower Des Moines River. Seventy-seven percent of the trash was recycled, which included 20.2 tons of scrap metal and 5.8 tons of tires (n =329). 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 82 sponsors.

In addition to trash removal, 20 stream sites along the canoe route were monitored for a variety of water quality parameters using IOWATER methods. IOWATER is Iowa's volunteer water monitoring program. This report summarizes the water quality results for sites monitored during Project AWARE 2016. 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 2016 represents the 14th 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 northeastern 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; and the Wapsipinicon River in east-central Iowa (Figure 1).

In 2016, 329 people participated in Project AWARE. Volunteers ranged in age from 4 to 82 and an average of 183 volunteers was on the water per day. In 2016, 42% of the volunteers were first-year participants, while 31% had been on Project AWARE five or more years. A total of five volunteers were recognized for being on Project AWARE ten years. In addition to Iowa, volunteers were from Illinois, Maryland, Minnesota, Missouri, Nebraska, South Dakota, and Wisconsin. Also, one volunteer was from Sweden.

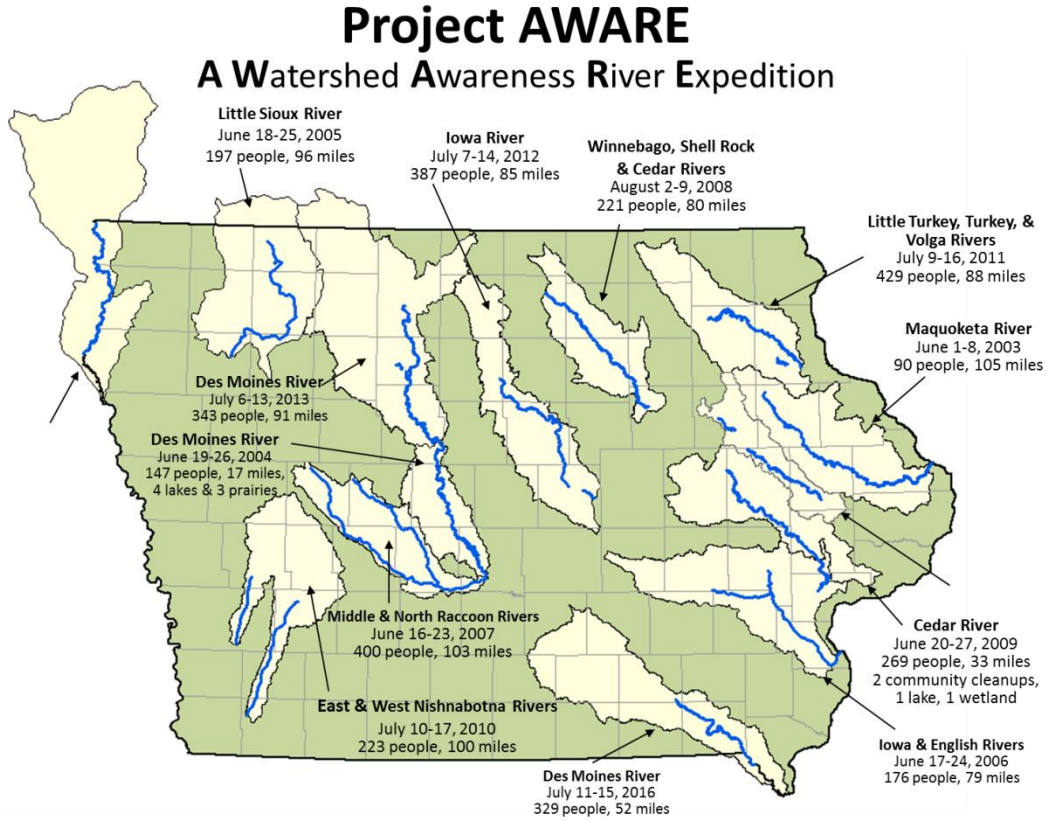

Figure 1. Location of Project AWARE events from 2003 through 2016.

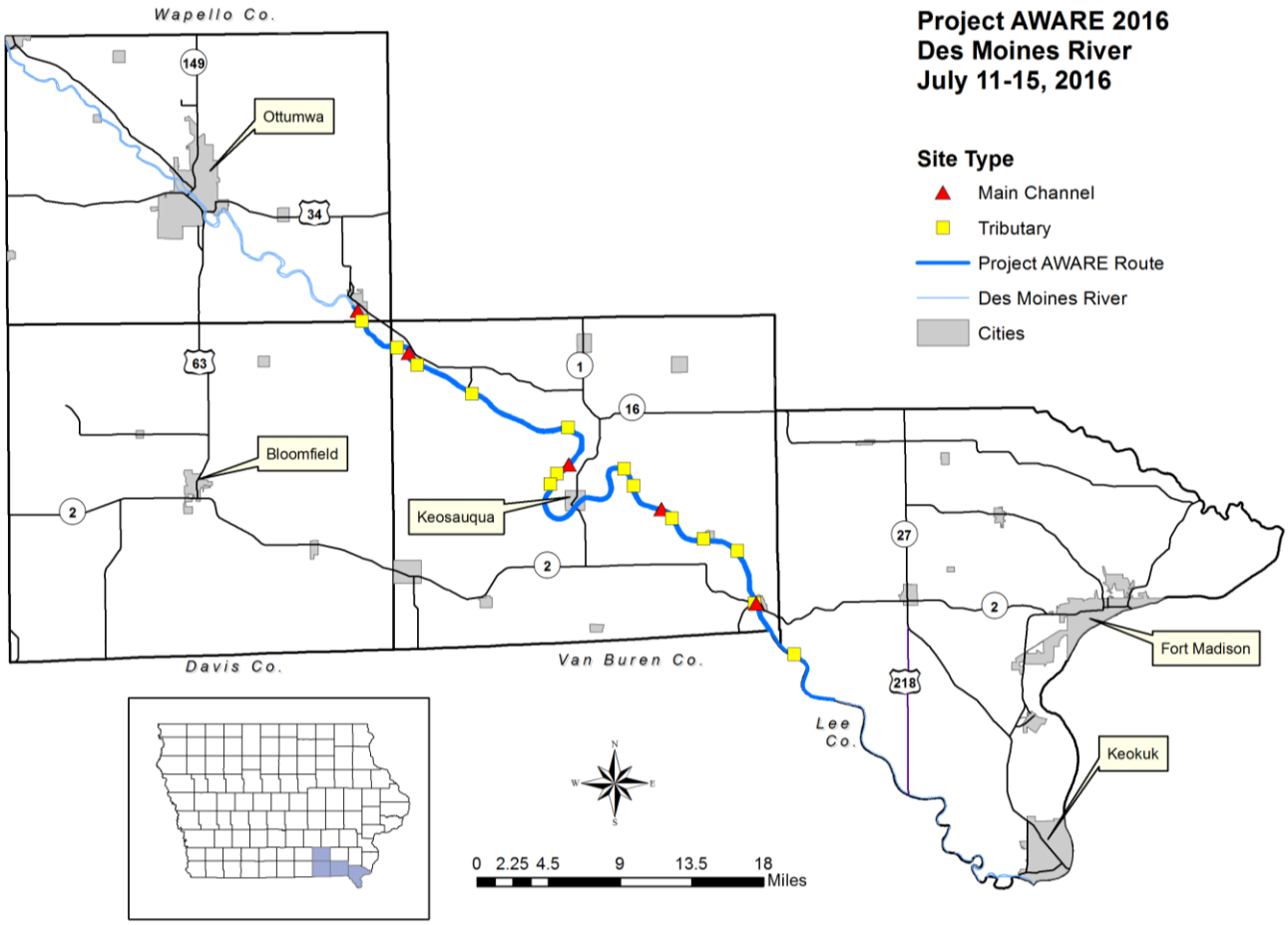

Figure 2. Location of sites sampled as part of Project AWARE 2016 on the Des Moines River in southeast Iowa.

Project AWARE water quality monitoring was conducted by the following volunteers – Robin Fortney and Molly Hanson on Monday July 11; Robin Fortney, Molly Hanson, and Jane Shuttleworth on Tuesday July 12; the Soenen family (Brian, Owen, and Toby) on Wednesday July 13; Teagan DiSalvo and Danilea McKee on Thursday July 14, and the Tonelli family on Friday July 15. Prior to the event, potential monitoring sites were identified by Project AWARE staff. Sites were selected based on starting, half-way, and take-out points for each day of Project AWARE, location of major tributaries entering the Des Moines River, and other locations of interest. A total of 20 sites were sampled (Figure 2). Five of the sites were on the main stem of the Des Moines River while the remaining 15 were tributary sites. Results are available in Appendix A.

For all sites sampled during Project AWARE 2016, 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 2016 sampling of 20 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, April 2015). In this report, this statewide stream network will be referred to as the DNR statewide stream network. The July 2016 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 2016.

	Unit	Method	# of samples	Min Value	Percentiles			Max Value
					25th	50th	75th	
Chloride	mg/L	IOWATER test strip	19	<31	<31	<31	<31	38
Dissolved Oxygen	mg/L	IOWATER field kit	20	6	8	8	10	12
Nitrite-N	mg/L	IOWATER test strip	20	0	0	0	0	0.15
Nitrate-N	mg/L	IOWATER test strip	20	0	0	2	10	10
pH	pH units	IOWATER test strip	20	7	8	8	9	9
Temperature, Air	degrees F	Thermometer - Field	19	71	80	83	89	91
Temperature, Water	degrees F	Thermometer - Field	20	75	79	81	84	91
Transparency	centimeters	IOWATER transparency tube	20	5	9	15	36	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 Des Moines River at Keosauqua were below the long-term normal conditions based on U.S. Geological Survey data (Figure 3). Stream flow for the Des Moines River at Keosauqua varied from 5,320 to 8,520 cubic feet per second (cfs) during Project AWARE. The drainage area for the Des Moines River at Keosauqua, Iowa, is 14,038 mi^2. Stream flow levels were lowest on July 11 and increased through July 15. Water levels for the Des Moines River at Keosauqua were 30 to 48% of the long-term normal for this time of year. The U.S. Army Corps of Engineers maintains water levels on Lake Red Rock which is located on the Des Moines River upstream of Keosauqua and the entire route for the 2016 Project AWARE.

Air temperatures for the week of Project AWARE were near normal. Temperatures ranged from highs of 85 to 90 degrees Fahrenheit to lows of 63 to 68 based on the Keosauqua, Iowa, climate station (https://mesonet.agron.iastate.edu/). Normal highs for this time of year are 88 degrees Fahrenheit with lows of 64 to 65. Rain occurred during Project AWARE. The Keosauqua climate station recorded 0.71 inches on July 11, 0.4 inches on July 12, 0.14 inches on July 13, and 0.07 inches on July 14 (https://mesonet.agron.iastate.edu/).

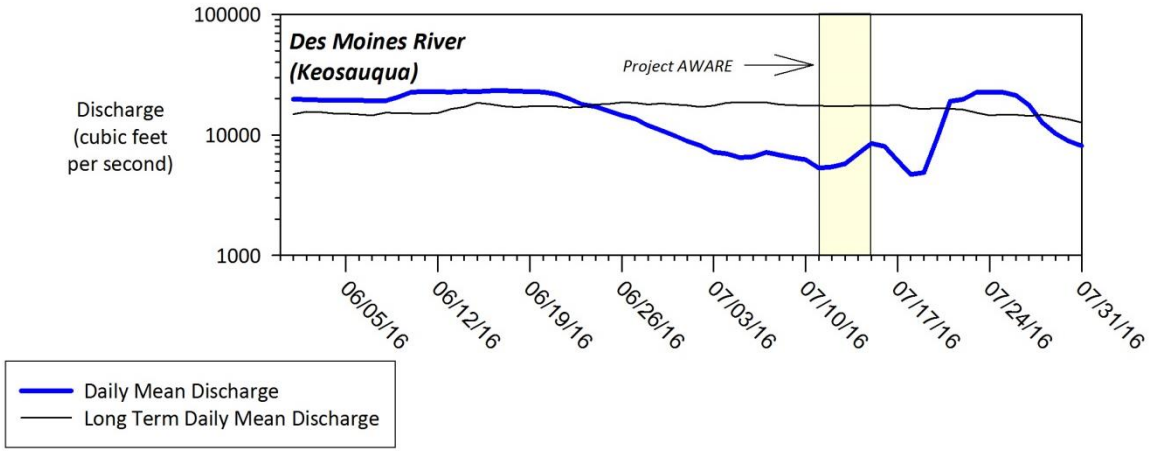

Figure 3. Discharge for the Des Moines River at Keosauqua for June 1, 2016 through July 31, 2016. The yellow shaded area represents when Project AWARE occurred July 11-15, 2016. Data are from http://ia.water.usgs.gov.

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 20 sites and temperatures varied from 75 to 91 degrees Fahrenheit (F) (Table 1; Figure 4). Water temperatures on the main stem of the Des Moines River were similar compared to the tributary sites (median of 81 for the tributary sites and 83 for the main stem). Water temperatures for the tributary sites were more variable than the main stem sites. This was likely due to more tributary sites being sampled (15 tributary compared to 5 main stem sites).

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 warmer (81 degrees F) than streams statewide (75 degrees F).

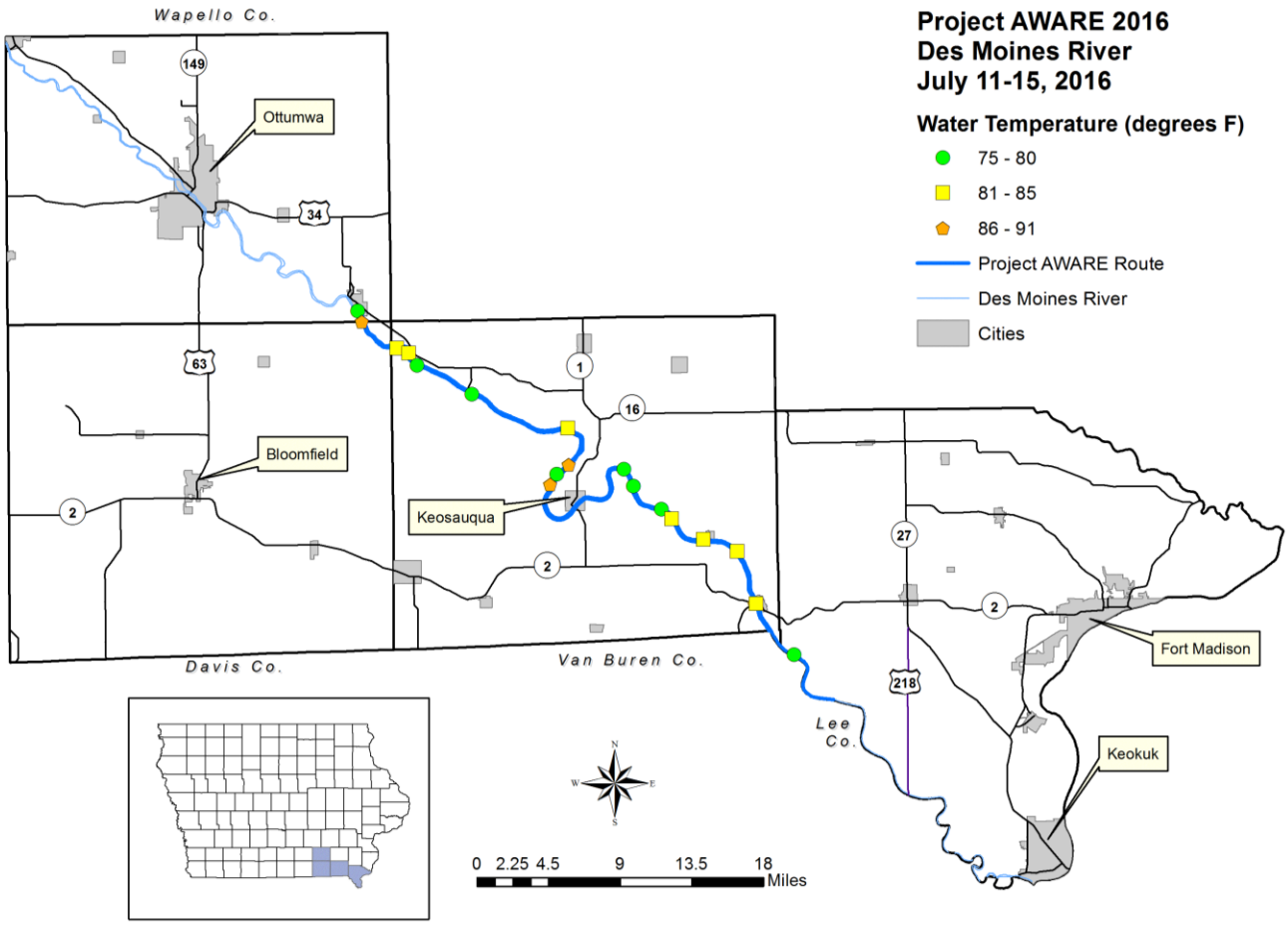

Figure 4. Water temperature (IOWATER method) for sites sampled as part of Project AWARE 2016 on the Des Moines River in southeast Iowa.

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 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 2016 (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.

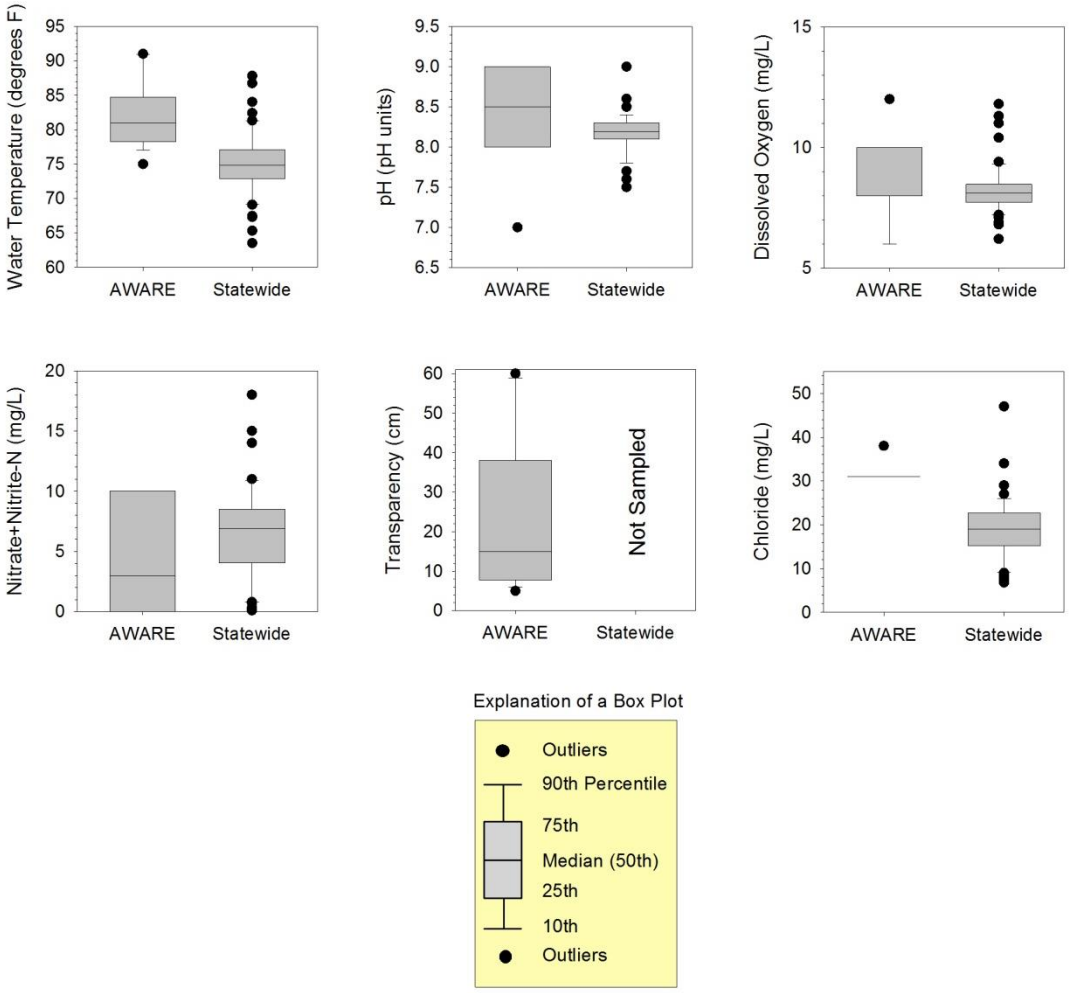

Figure 5. Box plots comparing water quality results for sites sampled during Project AWARE 2016 to the DNR statewide stream network for July 2016.

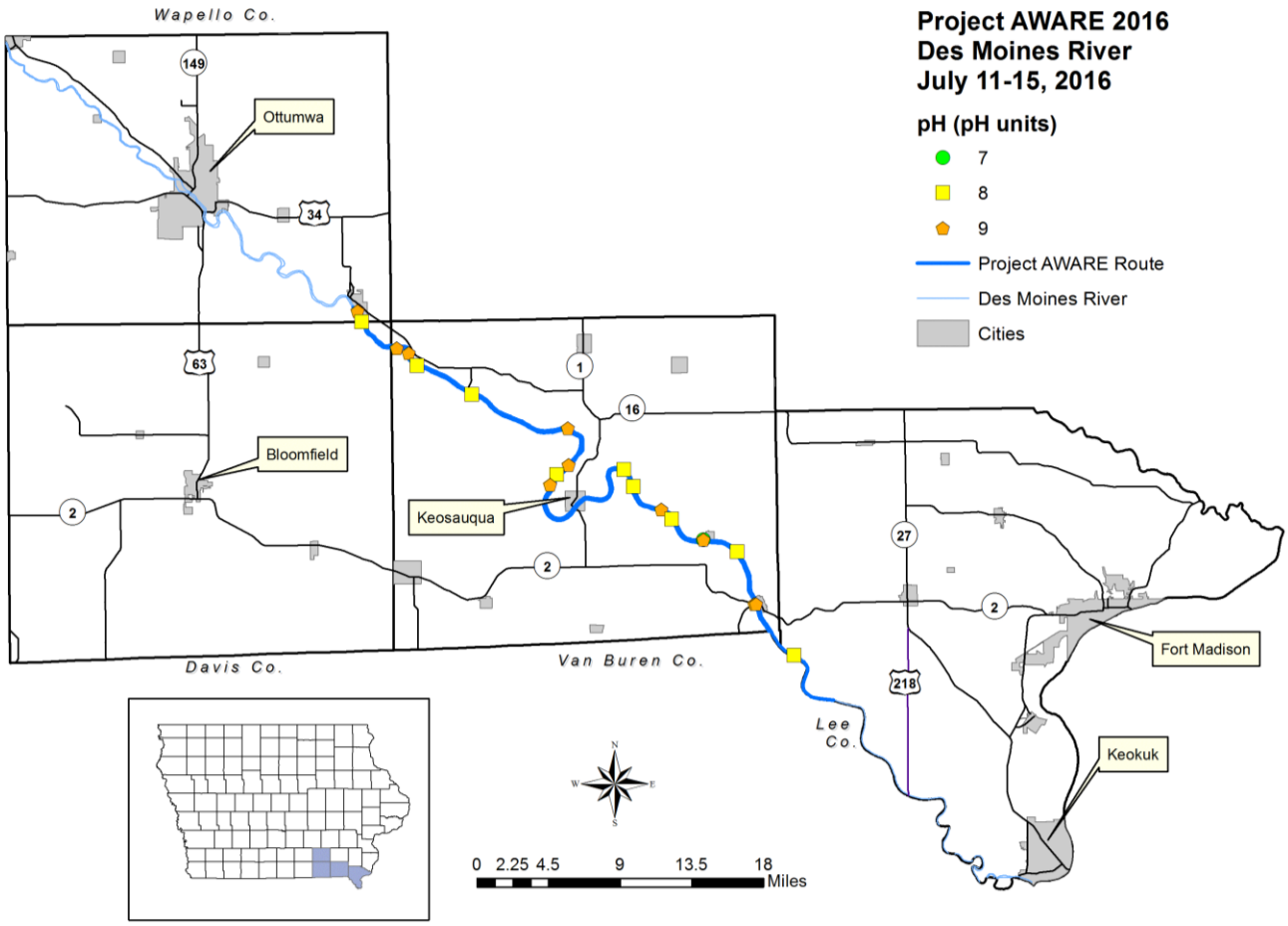

Figure 6. pH (IOWATER method) for sites sampled as part of Project AWARE 2016 on the Des Moines River in southeast Iowa.

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 5 to 60 centimeters (cm) for all Project AWARE sites with a median of 15 (Table 1; Figure 7). Transparency was lower for the tributary sites (median of 13 cm) relative to sites on the main stem of the Des Moines River (median of 16 cm). Two of the tributary sites had transparency readings of 60 centimeters, the upper limit (Honey Creek in Van Buren County near Bonaparte and Lick Creek in Lee County near Croton); none of the main stem sites on the Des Moines River was 60 centimeters.

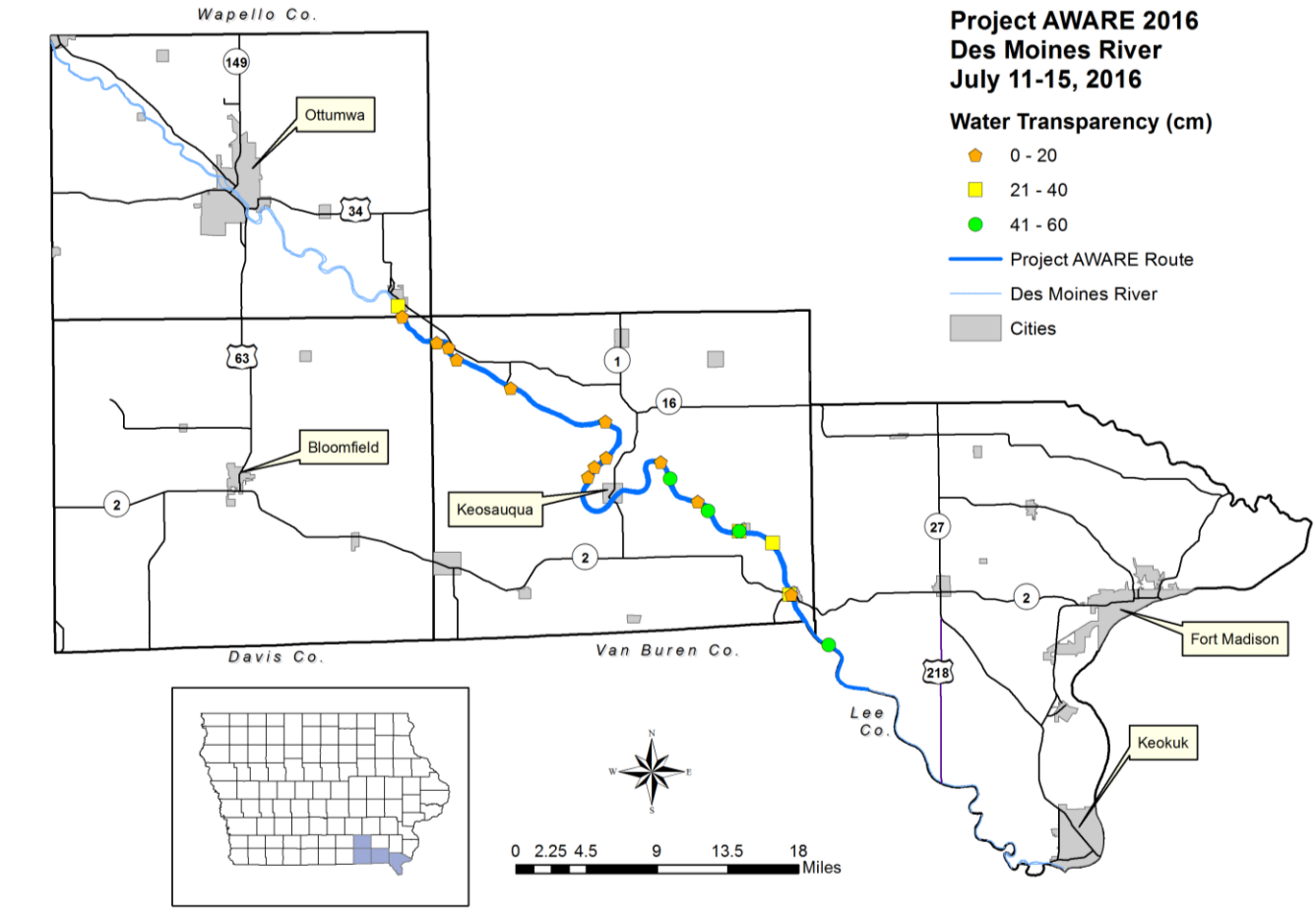

Figure 7. Water transparency (IOWATER method) for sites sampled as part of Project AWARE 2016 on the Des Moines River in southeast Iowa.

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 6 to 12 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 Des Moines River and tributary sites. Dissolved oxygen concentration median and range in values measured during Project AWARE were similar to those measured in streams statewide for July 2016 (Figure 5).

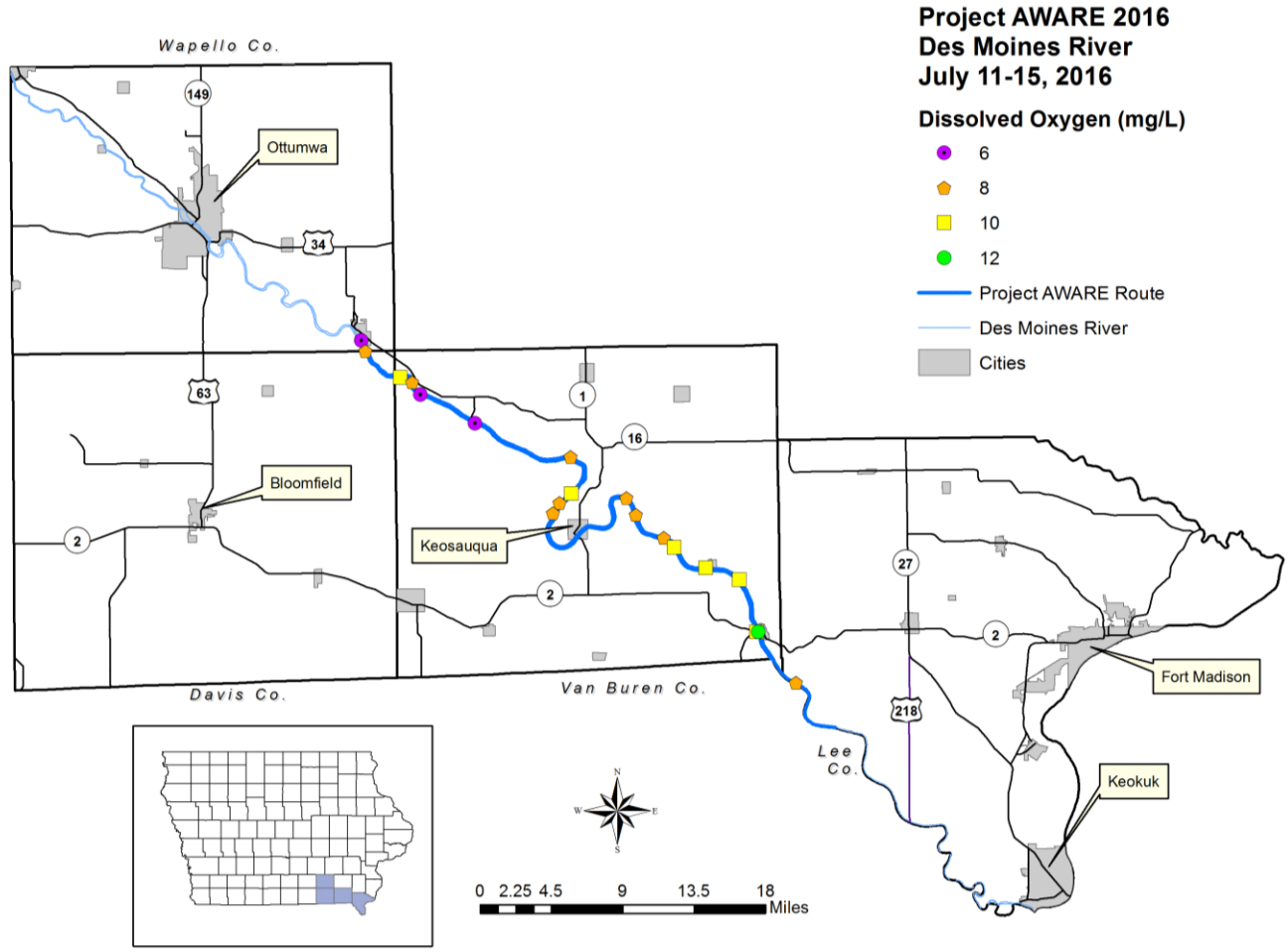

Figure 8. Dissolved oxygen (IOWATER method) for sites sampled as part of Project AWARE 2016 on the Des Moines River in southeast Iowa.

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 7.9 mg/L (Iowa DNR, 2015), 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). Concentrations ranged from 0 to 0.15 mg/L. One site, Honey Creek, a tributary to the Des Moines River near Bonaparte, had a nitrite-N detection of 0.15 mg/L.

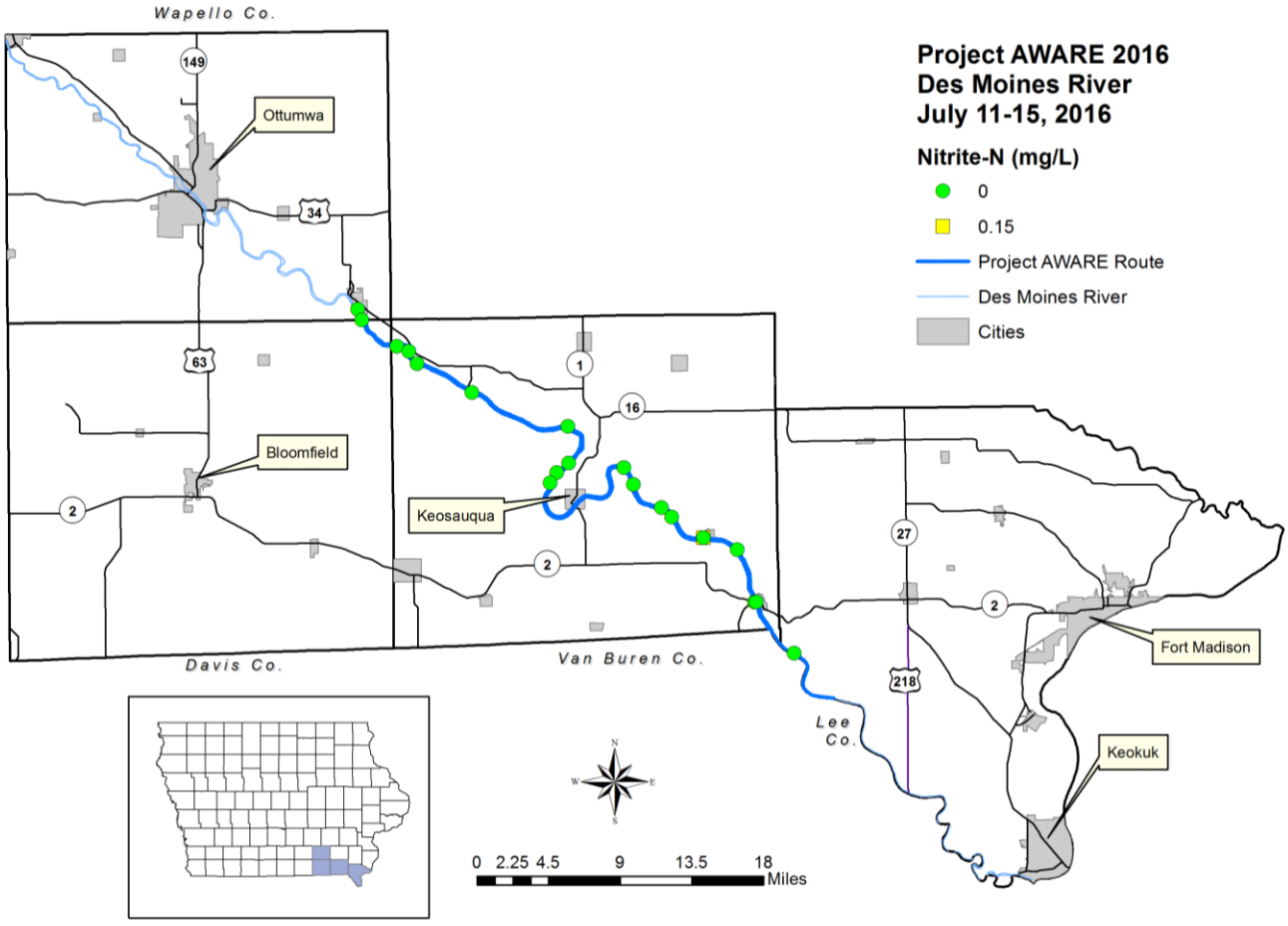

Figure 9. Nitrite-N (IOWATER method) for sites sampled as part of Project AWARE 2016 on the Des Moines River in southeast Iowa.

Nitrate-N ranged from 0 to 10 mg/L (median of 10 mg/L; Table 1; Figure 10). The median nitrate-N for tributary sites was lower (0 mg/L) compared to sites on the Des Moines River (10 mg/L). Thirty-five 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).

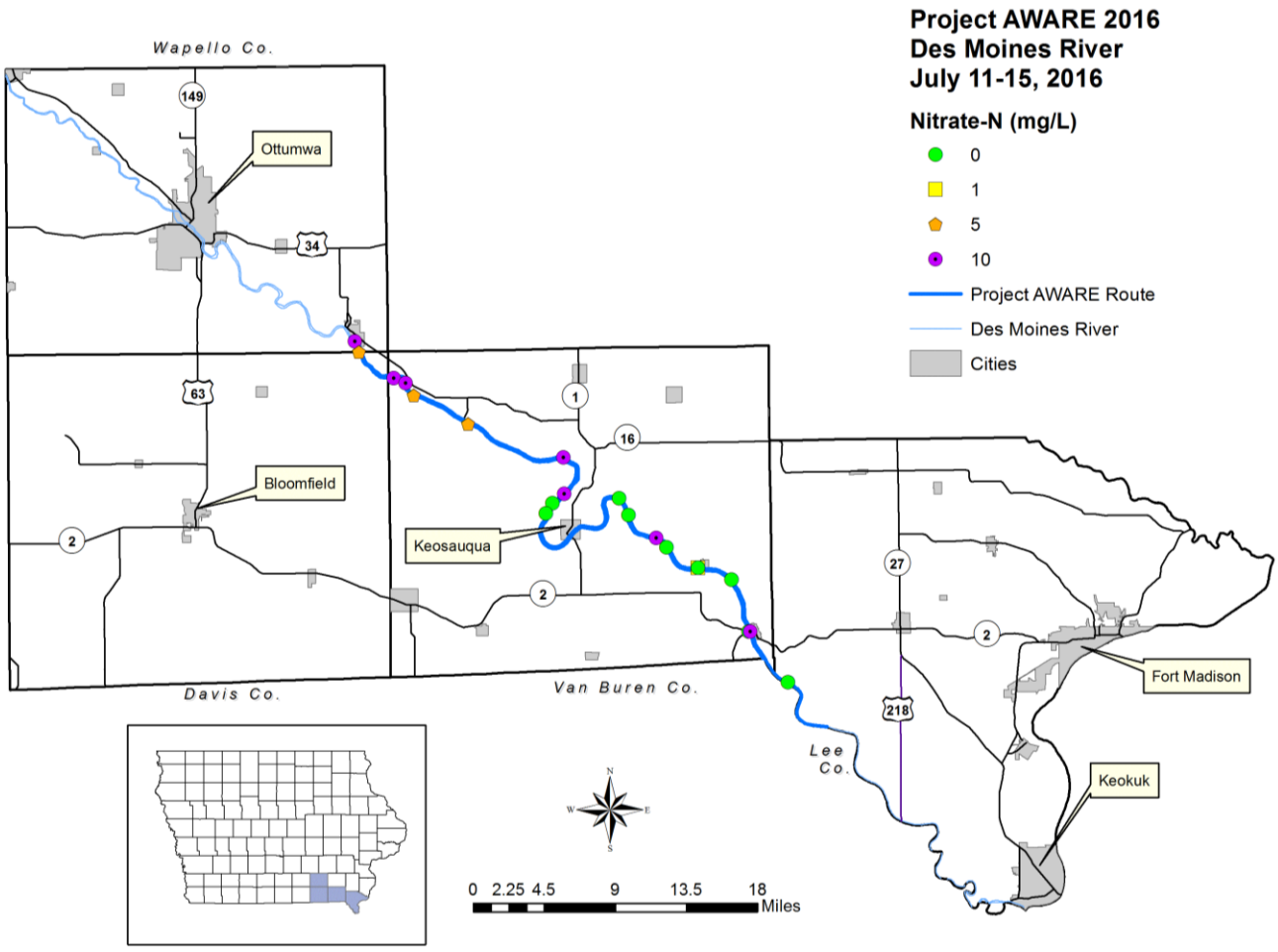

Figure 10. Nitrate-N (IOWATER method) for sites sampled as part of Project AWARE 2016 on the Des Moines River in southeast Iowa.

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 29 mg/L, with a median of 22 mg/L, with higher concentrations occurring during winter months (Iowa DNR, 2015).

For Project AWARE sites, just one chloride concentration was above test strip detection limit of 31 mg/L (Table 1; Figure 11). That chloride concentration was 38 mg/L measured at an Unnamed Creek site in Van Buren County upstream of Keosauqua.

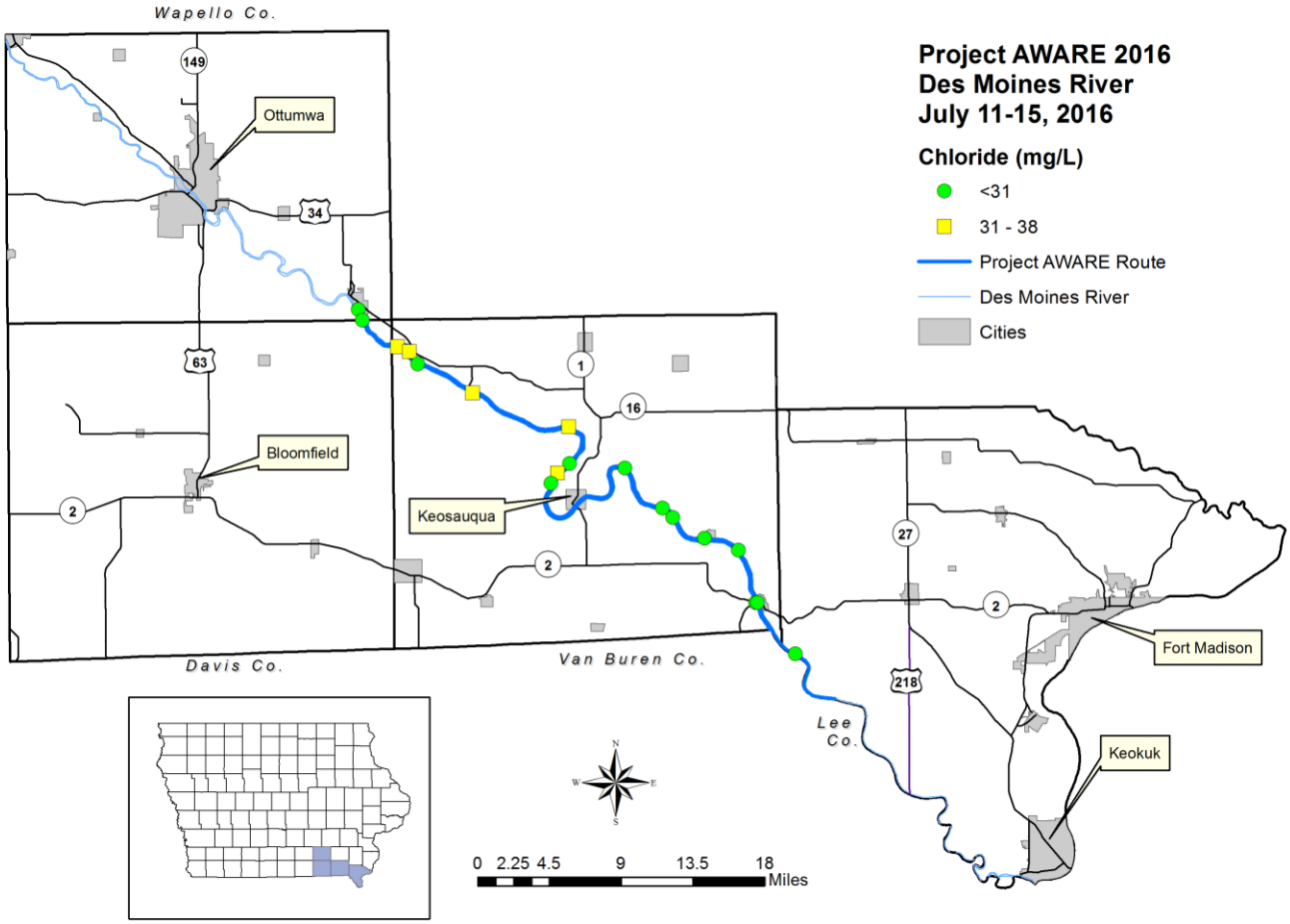

Figure 11. Chloride (IOWATER method) for sites sampled as part of Project AWARE 2016 on the Des Moines River in southeast Iowa.

Summary

Through the efforts of 329 volunteers, a total of 40 tons of trash was removed from the lower Des Moines River as part of Project AWARE 2016. The water quality of 20 sites was monitored for a variety of field parameters using IOWATER methods. Below are some observations from the data.

- Project AWARE occurred July 11-15, 2016, as Des Moines River stream levels were well below normal for this time of year. During the Project AWARE event, stream flows were 30 to 48% of normal for the Des Moines River at Keosauqua.
- Water temperature for Project AWARE sites sampled ranged from 75 to 91 degrees Fahrenheit. Water temperatures on the main stem of the Des Moines River were similar compared to the tributary sites. Water temperatures for the tributary sites were more variable than the main stem sites. This was likely due to more tributary sites being sampled (15 tributary compared to 5 main stem sites). Temperatures were higher for Project AWARE sites compared to streams statewide during the month of July (81 versus 75, respectively).
- pH ranged from 7 to 9. 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 5 to 60 centimeters with a median of 15 cm. Median transparency was lower for the tributary sites (13 cm) relative to sites on the main stem of the Des Moines River (16 cm).

- Dissolved oxygen concentrations varied from 6 to 12 mg/L with a median of 8 mg/L. All of the measured oxygen levels were above Iowa's statewide standard for warm water streams of 5 mg/L.
- Nitrite-N concentrations ranged from 0 to 0.15 mg/L with all but one site measuring no detectable level of nitrite-N.
- Nitrate-N concentrations ranged from 0 to 10 mg/L. The median nitrate-N for tributary sites was lower (0 mg/L) than for sites on the Des Moines River (10 mg/L).
- The majority of chloride concentrations (95%) were at or below the test strip detection limit of 31 mg/L. The low chloride suggests that the sites monitored were not directly impacted by any point source inputs. Chloride levels were higher for Project AWARE sites compared to the DNR statewide stream network due to a difference in the detection limit associated with the method used for each of the monitoring efforts.

Acknowledgements

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References

Iowa Department of Natural Resources, Stream Water Quality Summary 2000-2014, April 2015, 2 p.

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

September 2016

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)	Chloride (mg/L)
1	Des Moines River	Main Channel	565818	4529017	Wapello	7/11/2016	1400	Robin Fortney, Molly Hanson	80	21	9	0	10	6	<31
2	Soap Creek	Tributary	566241	4527927	Wapello	7/11/2016	1500	Robin Fortney, Molly Hanson	91	12	8	0	5	8	<31
3	Vesser Creek	Tributary	569785	4525245	Van Buren	7/11/2016	1610	Robin Fortney, Molly Hanson	84	13	9	0	10	10	31
4	Des Moines River	Main Channel	571000	4524767	Van Buren	7/11/2016	1640	Robin Fortney, Molly Hanson	83	17	9	0	10	8	31
5	Miles Branch	Tributary	571814	4523499	Van Buren	7/12/2016	900	Robin Fortney, Molly Hanson	78	5	8	0	5	6	<31
6	Holcomb Creek	Tributary	577370	4520570	Van Buren	7/12/2016	1015	Robin Fortney, Molly Hanson	77	6	8	0	5	6	31
7	Lick Creek	Tributary	587093	4517158	Van Buren	7/12/2016	1420	Robin Fortney, Jane Shuttleworth	81	10	9	0	10	8	31
8	Des Moines River	Main Channel	587183	4513435	Van Buren	7/12/2016	1526	Robin Fortney, Jane Shuttleworth	91	10	9	0	10	10	<31
9	Unnamed Creek	Tributary	585949	4512470	Van Buren	7/13/2016	900	Brian, Owen, Toby Soenen	75	6	8	0	0	8	38
10	Chesquest Creek	Tributary	585317	4511451	Van Buren	7/13/2016	950	Brian, Owen, Toby Soenen	86	7	9	0	0	8	<31
11	Rock Creek	Tributary	592782	4512980	Van Buren	7/13/2016	1305	Brian, Owen, Toby Soenen	79	7	8	0	0	8	<31
12	Coppers Creek	Tributary	593709	4511299	Van Buren	7/13/2016	1400	Brian, Owen, Toby Soenen	79	42	8	0	0	8	N.A.
13	Des Moines River	Main Channel	596553	4508933	Van Buren	7/14/2016	930	Teagan DiSalvo, Danilea McKee	80	16	9	0	10	8	<31
14	Bear Creek	Tributary	597590	4507965	Van Burean	7/14/2016	1015	Teagan DiSalvo, Danilea McKee	81	49	8	0	0	10	<31
15	Honey Creek	Tributary	600817	4505905	Van Buren	7/14/2016	1115	Teagan DiSalvo, Danilea McKee	78	39	7	0.15	1	8	<31
16	Honey Creek2	Tributary	600828	4505889	Van Buren	7/14/2016	1315	Teagan DiSalvo, Danilea McKee	81	60	9	0	0	10	<31
17	Reeds Creek	Tributary	604229	4504711	Van Buren	7/14/2016	1400	Teagan DiSalvo, Danilea McKee	82	35	8	0	0	10	<31
18	Big Indian Creek	Tributary	605969	4499417	Van Buren	7/14/2016	1500	Teagan DiSalvo, Danilea McKee	90	28	9	0	0	10	<31
19	Des Moines River	Main Channel	606147	4499405	Van Buren	7/14/2016	1530	Teagan DiSalvo, Danilea McKee	85	14	9	0	10	12	<31
20	Lick Creek	Tributary	609985	4494212	Lee	7/15/2016	1016	Brittany, Maria, and Chuck Tonelli	77	60	8	0	0	8	<31