Results from Water Quality Monitoring Conducted during Project AWARE 2012 on the Iowa River in Central Iowa

Lynette Seigley
Iowa Department of Natural Resources
Watershed Monitoring and Assessment Program
109 Trowbridge Hall
Iowa City, IA 52242-1319
(319) 335-1598; Lynette.Seigley@dnr.iowa.gov

Jim Urban and Bailey Bergthold
Project AWARE 2012 Volunteers

August 2012

Abstract: From July 7-14, 2012, 387 volunteers participated in Project AWARE 2012, a weeklong river cleanup which was held this year on the Iowa River in central Iowa. Project AWARE, which stands for A Watershed Awareness River Expedition is a 7-day, 7-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, and 2012 represented the tenth year of the event. A total of 387 volunteers participated throughout the week, and a record total of 60.36 tons of trash was removed from the 85 miles of the Iowa River through Wright, Franklin, Hardin, and Marshall counties. A total of 86% of the trash was recycled, which included 1,371 tires; 823 were dredged directly from the river and another 548 were part of a locally-led land-based cleanup of the riverbank held in conjunction with Project AWARE. Project AWARE is an initiative of the Iowa Department of Natural Resources IOWATER and Water Trails programs, and 2012 represented the tenth year of the event. The event was made possible through the financial and in-kind support of 105 sponsors.

In addition to trash removal, 28 stream sites along the canoe route and at overnight camping locations were monitored for a variety of water quality parameters using IOWATER methods. IOWATER is Iowa's volunteer water monitoring program. The Project AWARE event occurred during drought conditions in Iowa and under extremely low flow conditions for the Iowa River. Stream flow conditions for the Iowa River varied from 5 to 12% of normal for this time of year. While the low water levels made it easy for volunteers to locate trash in the river, it also resulted in volunteers having to push, pull, drag, or walk their canoes filled with trash along several stretches of the river. On a few days, the distance paddled was shortened due to the low water conditions.

The extremely dry conditions and low water prior to and during Project AWARE impacted the water quality results. Dissolved oxygen and nitrate-N concentrations were the lowest reported during the 10 years of monitoring on Project AWARE. For most of the parameters, concentrations at these sites during Project AWARE varied from levels measured in streams statewide for July 2012. Results from the Project AWARE sites showed that water temperatures, dissolved oxygen, and nitrate concentrations were lower for the Project AWARE sites compared to streams statewide; phosphate concentrations were higher; and pH and chloride levels for Project AWARE sites were similar to concentrations statewide.

This report summarizes the water quality results for sites monitored during Project AWARE 2012. For more information on Project AWARE, go to *www.iowaprojectaware.com*.

Introduction

Project AWARE, which stands for **A W**atershed **A**wareness **R**iver **E**xpedition, is the Iowa Department of Natural Resources' weeklong volunteer river cleanup event during which hundreds of Iowans spend anywhere from a day to an entire week 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 2012 represents the 10th 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; and the Little Turkey, Turkey, and Volga rivers in northeast Iowa. In 2012, 387 people participated in Project AWARE. Volunteers ranged in age from 3 to 78 with an average of 146 volunteers per day. A total of 49% of the volunteers were first year participants, while 20% had been on Project AWARE 5 or more years.

Project AWARE 2012 began on the Iowa River at Dows and continued down river for the next 85 miles. Portages occurred around low-head dams at Alden, Iowa Falls, and Steamboat Rock. Some of the sites initially identified as monitoring sites were not sampled, as some days were shortened due to low water conditions.

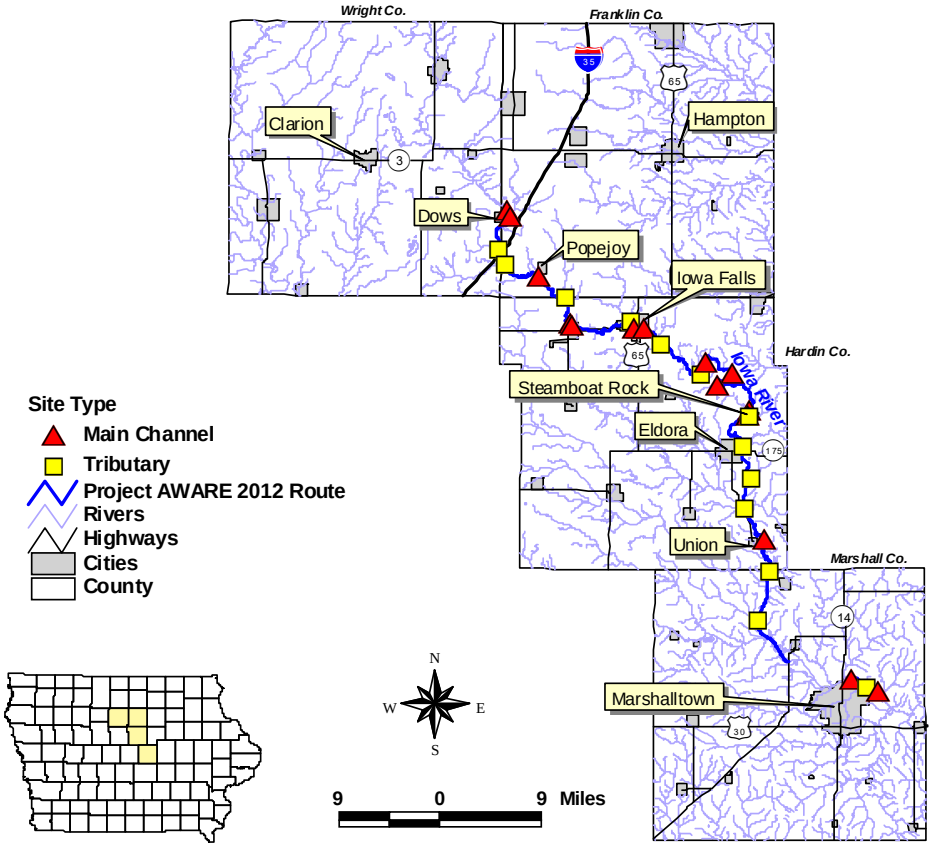

Figure 1. Location of sites sampled as part of Project AWARE 2012 on the Iowa River in central Iowa.

For each day of Project AWARE, Jim Urban and Bailey Bergthold, Project AWARE volunteers, conducted water testing at pre-determined sampling locations both along the route and at overnight camping locations. 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 Iowa River; and other locations of interest. A total of 28 sites were sampled (Figure 1), including 15 on the Iowa River and 13 tributaries. Bailey and Jim have been conducting the water monitoring as part of Project AWARE for the past 3 years and share the results with volunteers throughout the week.

For all sites sampled during Project AWARE 2012, 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 2012 sampling of 28 sites (Figure 1), and includes chemical and physical results (Table 1).

Where possible, water quality results from Project AWARE were compared to a network of 76 streams statewide that is monitored on a monthly basis as part of the Iowa Department of Natural Resources' (DNR) Watershed 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, January 2012). In this report, this statewide stream network will be referred to as the DNR statewide stream network. The July 2012 data from the DNR statewide stream network were also compared to Project AWARE results to determine relative concentrations for streams statewide during the same time period.

Table 1. Monitoring results from Project AWARE 2012.

	Unit	Method	# of samples	Min Value	Percentiles			Max Value
					25th	50th	75th	
Chloride	mg/L	IOWATER test strip	27	<32	<32	<32	<32	38
Dissolved Oxygen	mg/L	IOWATER field kit	27	4	4	5	6	6
Nitrite-N	mg/L	IOWATER test strip	28	0	0	0	0	1.5
Nitrate-N	mg/L	IOWATER test strip	28	0	0	0	2	10
Phosphate	mg/L	IOWATER field kit	28	0.1	0.3	0.4	0.6	0.8
pH	pH units	IOWATER test strip	28	6	8	8	9	9
Temperature, Air	degrees F	Thermometer - Field	28	69	74	80	85	95
Temperature, Water	degrees F	Thermometer - Field	28	65	73	77	80	91
Transparency	centimeters	IOWATER transparency tube	28	11	35	44	60	60

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

Precipitation and Stream Flow Conditions

Precipitation and stream flow conditions affect water quality, and in 2012, the extended period of no rain across Iowa caused river levels in the Iowa River to be at or below normal for most of the summer (Figure 2). (The low levels in the Iowa River were a continuation of low levels during the fall of 2011. In previous years, Project AWARE personnel conduct a pre-scout of the route, but the pre-scout that had been planned for the fall of 2011 had to be canceled due to low water. In 2012, rainfall totals for the months of June and July for Iowa Falls were 1.82 inches and 1.18 inches, respectively, and 0.85 inches and 0.72 inches for Marshalltown (source: Iowa Environmental Mesonet, http://mesonet.agron.iastate.edu/COOP/), which were below the long-term normal for both months and both cities. Based on stream flow data from the U.S. Geological Survey (www.usgs.gov), water levels for the Iowa River were at or below the long-term normal levels for these rivers during the summer of 2012 (Figure 2). For the week of Project AWARE, flow for the Iowa River at Rowan ranged from 18 to 25 cubic feet per second (CFS) and 90 to 139 CFS for the Iowa River at Marshalltown. A CFS equates to roughly the volume of a

basketball. Throughout the week of Project AWARE, flow declined 7 CFS at the Rowan gaging station and 43 CFS at Marshalltown. Flow for the Iowa River at Rowan varied from 5 to 7% of normal during the week of Project AWARE, while the flow for the Iowa River at Marshalltown varied from 7 to 12% of normal. Along the stretch of the Iowa River that was cleaned, the largest tributary to the Iowa River is the South Fork of the Iowa River which empties into the Iowa River near the community of Gifford. The South Fork of the Iowa River contributed 72 to 130 CFS to the Iowa River during the week.

Climatically, July 2012 was an unusual month. Statewide, air temperatures for July averaged 6.1 degrees above normal while rainfall ranged from 1.16 inches to 3.34 inches below normal (Harry Hillaker, Iowa Department of Agriculture, Climatology Bureau - http://www.iowaagriculture.gov/climatology/weatherSummary.asp). July 2012 was the third warmest July on record and the fifth driest. In most of the Iowa River watershed, the maximum daily temperature exceeded 90 degrees only two of the seven days that volunteers were on the river for Project AWARE. The highest maximum daily temperature was 93 degrees in Marshalltown on July 7. Rain fell late in the week, with rain occurring on Friday, July 13, and Saturday, July 14, in Marshalltown. Rainfall amounts for the week ranged from 0.01 inches in Iowa Falls to 0.11 inches in Marshalltown (source: Iowa Environmental Mesonet, http://mesonet.agron.iastate.edu/COOP/). While low water levels posed challenges in removing the trash, event organizers and volunteers were fortunate that Project AWARE occurred during the coolest week of July (July 7-14).

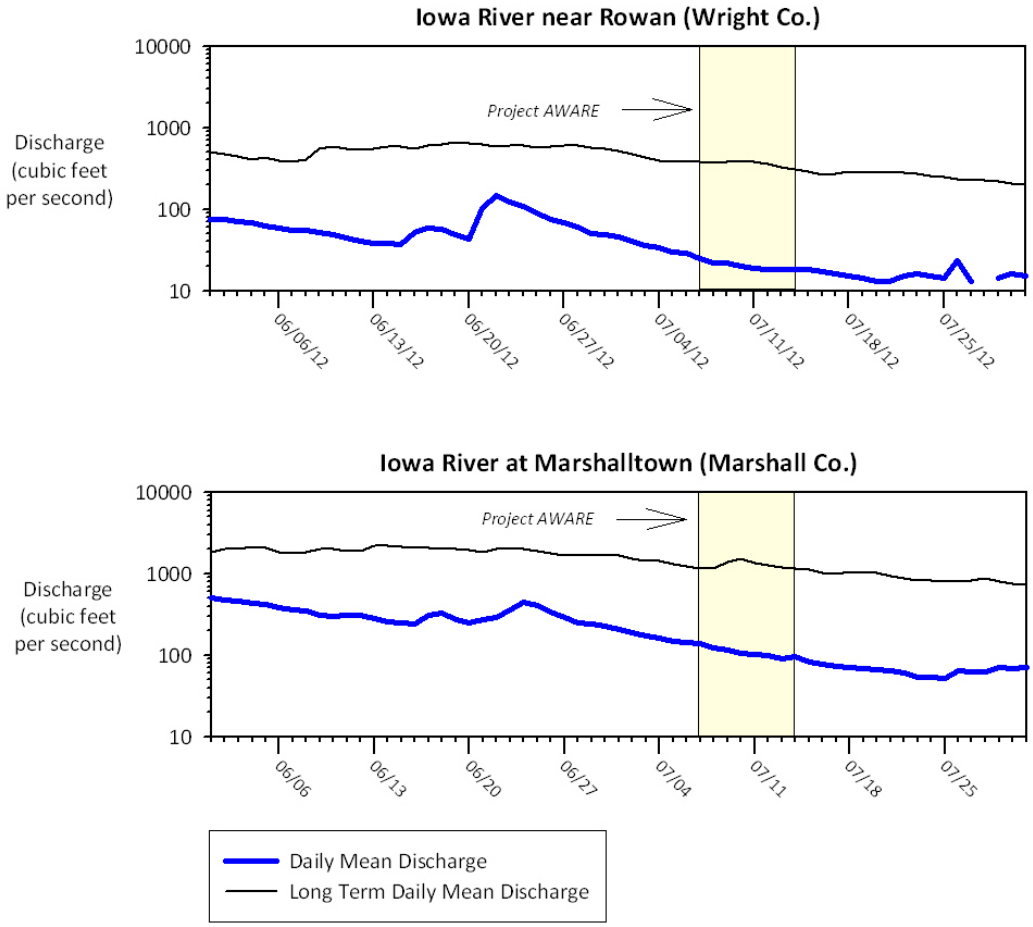

Figure 2. Discharge for the Iowa River for June 2012 through July 2012. The yellow shaded area represents when Project AWARE occurred from July 7-14, 2012. Data from http://ia.water.usgs.gov.

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 28 sites during Project AWARE 2012 and temperatures varied from 65 to 91 degrees Fahrenheit (F) (Table 1; Figure 3). Overall warmer water temperatures occurred on the main channel sites, with temperatures ranging from 72 to 87 degrees with a median of 78 degrees. Temperatures for the tributary sites ranged from 65 to 91 degrees with a median of 74 degrees. Pine Creek, a tributary to the Iowa River in Hardin County, had the highest water temperature.

Figure 4 compares the results of selected parameters from Project AWARE to the DNR statewide stream network. Water temperatures for sites monitored on Project AWARE had a similar range to those measured statewide, however, Project AWARE temperatures overall were lower than those statewide. The median water temperature for Project AWARE sites was 77 degrees versus 82 degrees for streams statewide. A maximum water temperature of 91 degrees was reported for both sets of data. July 2012 was one of the warmest July on record. Statewide stream water temperatures were the highest ever recorded for July based on 13 years of monitoring by the Iowa Department of Natural Resources.

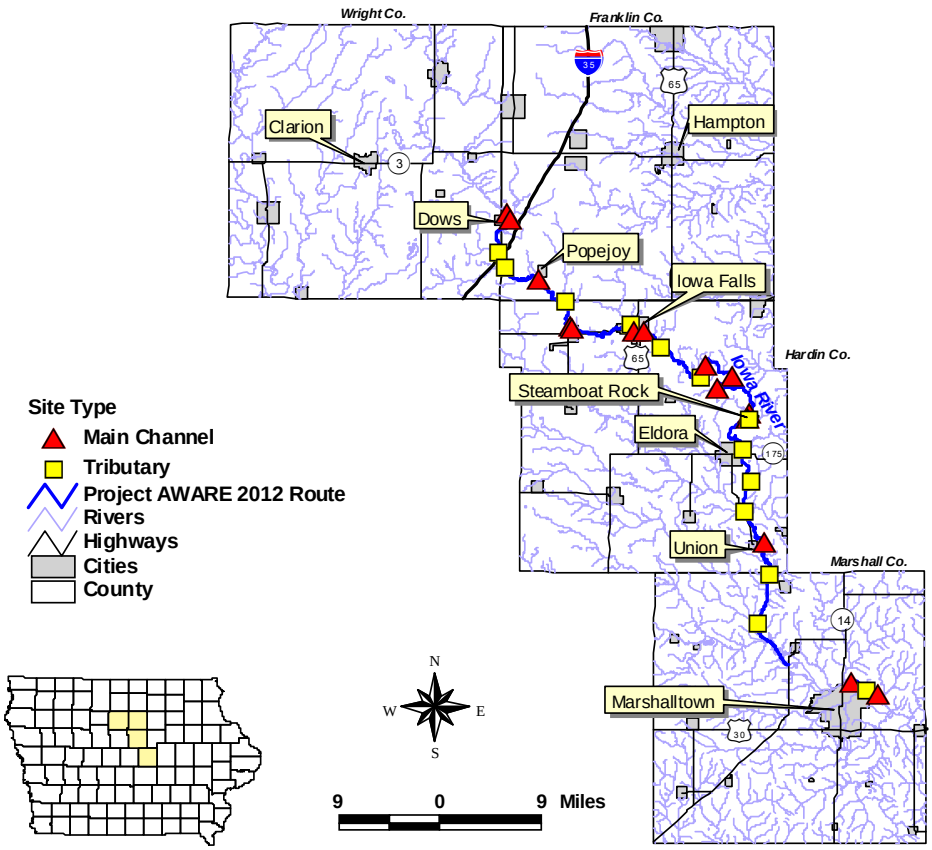

Figure 3. Water temperature (IOWATER method) for sites sampled as part of Project AWARE 2012 on the Iowa River.

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 6 to 9 using the IOWATER test strip (Table 1; Figure 5). A pH of 6 was recorded for the Iowa River at Eagle City Park in Hardin County. pH for most of the other sites located on the Iowa River was 8 or 9.

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 2012. The overall difference in pH values most likely has to do with the method used to measure pH. 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 that measure in tenths are used.

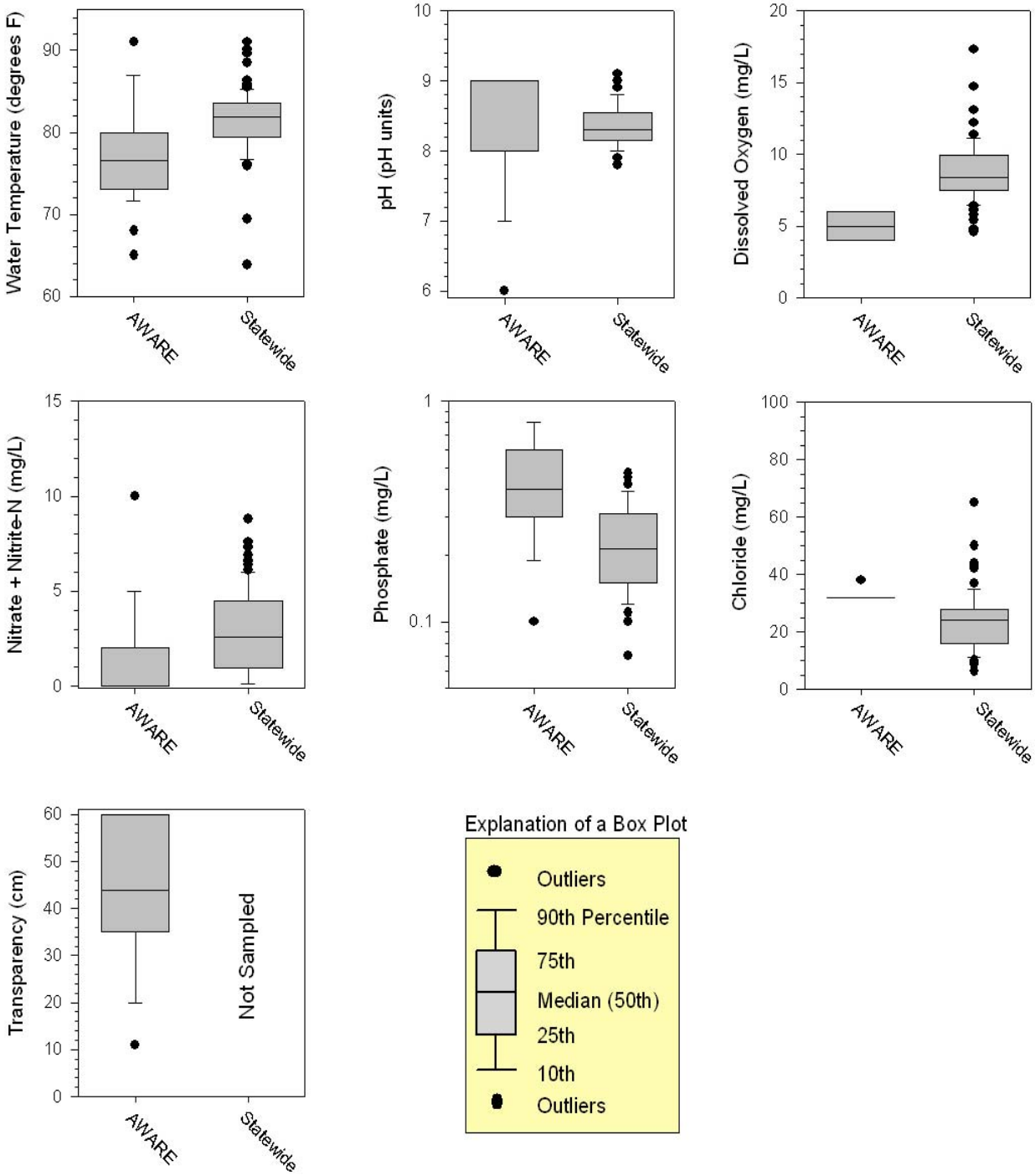

Figure 4. Box plots comparing water quality results for sites sampled during Project AWARE 2012 to the DNR statewide stream network for July 2012.

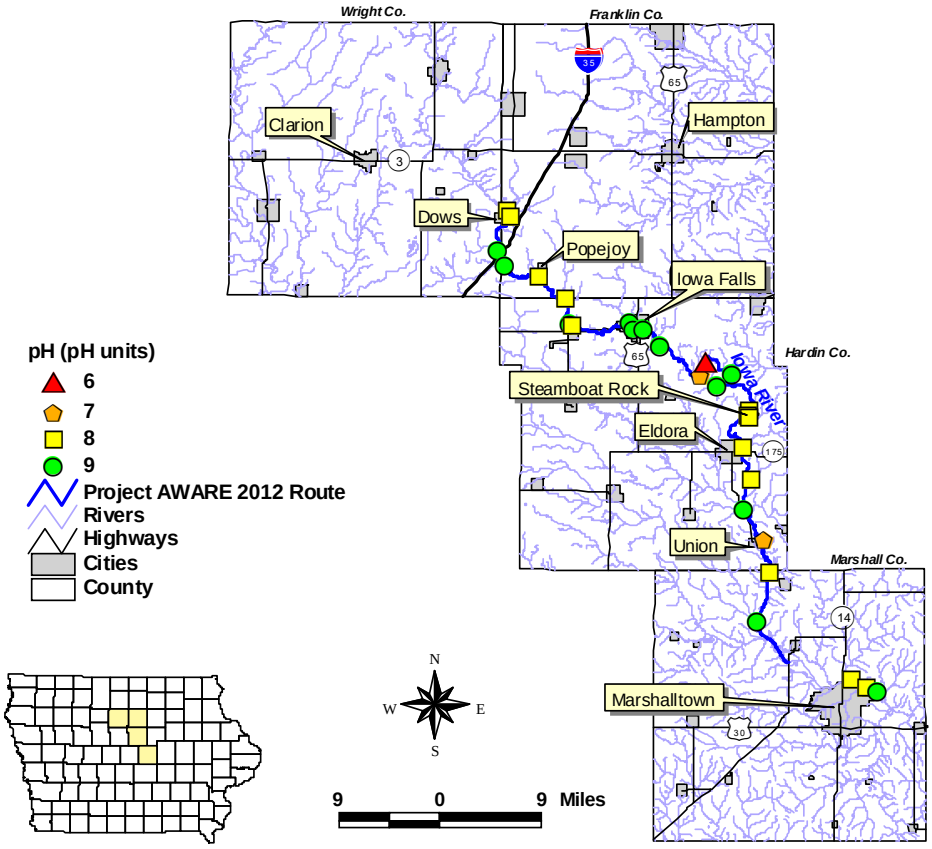

Figure 5. pH (IOWATER method) for sites sampled as part of Project AWARE 2012 on the Iowa River.

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 11 to 60 centimeters (cm) for all Project AWARE sites (Table 1; Figure 6). Overall, transparency levels were relatively high and similar to levels measured in 2008 when Project AWARE occurred on the Winnebago, Shell Rock, and Cedar rivers. The highest transparency levels measured on Project AWARE are still associated with the 2011 event on the Little Turkey, Turkey, and Volga rivers when 76% of the sites had a transparency of 50 cm or greater. The overall median transparency for sites sampled for Project AWARE 2012 was 44 cm. The generally high transparency combined with extremely low water levels helped volunteers in their search for trash. Water was more transparent (or clear) on the tributary streams compared to the main stem of the Iowa River (median of 50 mg/L versus 40 mg/L).

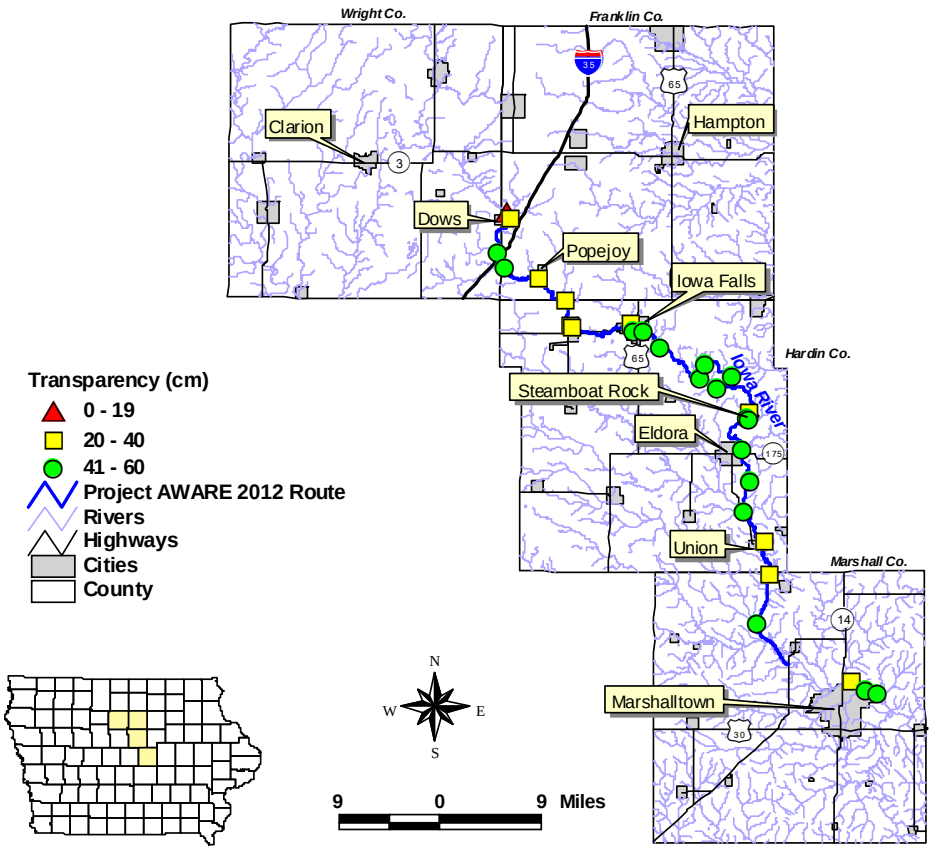

Figure 6. Water transparency (IOWATER method) for sites sampled as part of Project AWARE 2012 on the Iowa River.

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 4 to 6 mg/L (Table 1; Figure 7), with a median of 5 mg/L. Eight sites (29%) had dissolved oxygen levels of 4 mg/L which is less that Iowa's statewide standard for warm water streams of 5 mg/L. All of the sites monitored were warm water streams. Six of the sites with low dissolved oxygen were located on the Iowa River while the other two were on Pine Creek and an unnamed tributary to the Iowa River, and both located in Hardin County. Monitoring occurred upstream and downstream of a couple of the low-head dams along this year's route. Higher dissolved oxygen occurred downstream of the Alden dam versus upstream (6 versus 4 mg/L, respectively) while levels above and below the dam in Iowa Falls were the same (5 mg/L). The two sites in Iowa Falls were not sampled on the same day.

Dissolved oxygen concentrations measured during Project AWARE were lower than levels measured in streams statewide for July 2012 (Figure 4) and showed little variability, ranging from 4 to 6 mg/L. The low dissolved oxygen levels measured during Project AWARE can be attributed to the low water levels and warm water temperatures. Low water levels and slower moving water tend to have lower dissolved oxygen. Warm water temperatures also contribute to low oxygen, as warm water holds less oxygen than colder water. While the ambient stream sites had higher water temperatures compared to the Project AWARE sites, the ambient sites are located on larger river sites which also have greater stream flow than occurred with the Project AWARE sites.

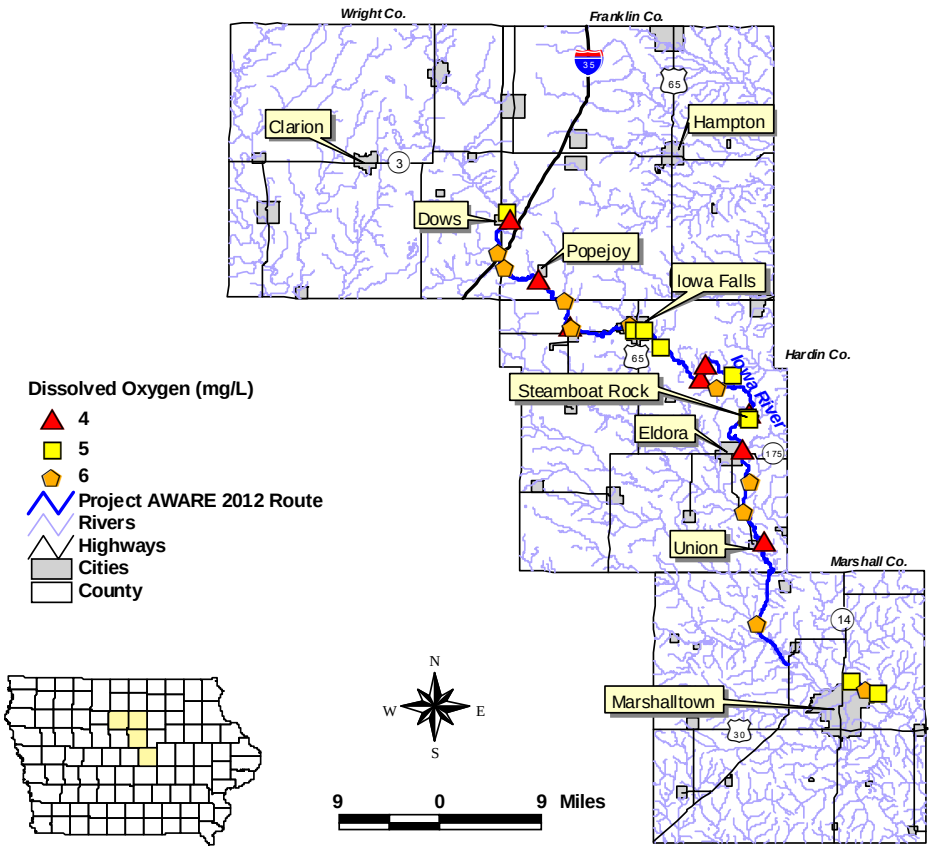

Figure 7. Dissolved oxygen (IOWATER method) for sites sampled as part of Project AWARE 2012 on the Iowa River.

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 2.9 to 8.7 mg/L, 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 as nitrate+nitrite-N.

Nitrite-N was measured at Project AWARE sites using the IOWATER method (Table 1; Figure 8). Concentrations ranged from 0 to 1.5 mg/L. Only 5 of the 28 sites had measurable levels of nitrite-N of 0.15 or 1.5 mg/L. The site with the nitrite-N value of 1.5 mg/L was an unnamed tributary to the Iowa River located just upstream of Eagle City Park in Hardin County. On the field data sheet, the water monitoring team noted that the water had a petroleum/plastic odor to it. This site had a nitrate-N concentration of 10 mg/L, the highest of any of the sites sampled; it also had one of the lowest dissolved oxygen concentrations (4 mg/L). The water monitoring team noted that on the day this site was sampled (July 10), crop dusting was occurring in the area. It is unclear why the nitrite-N was elevated at this site.

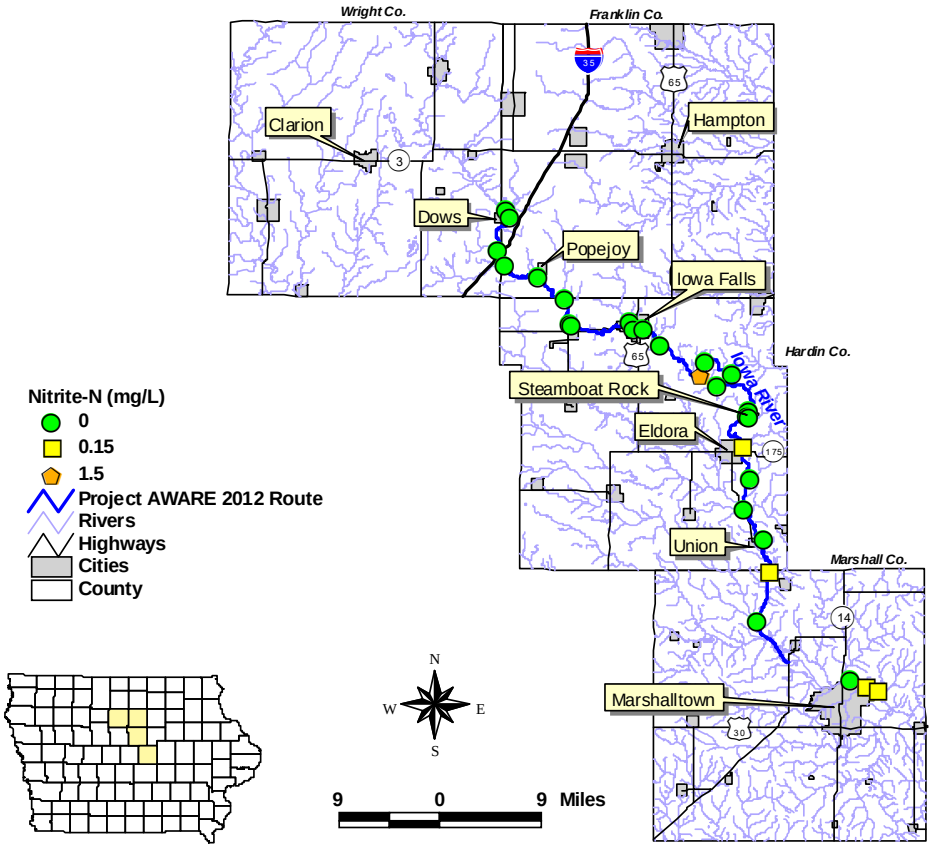

Figure 8. Nitrite-N (IOWATER method) for sites sampled as part of Project AWARE 2012 on the Iowa River.

Nitrate-N for sites sampled as part of Project AWARE ranged from 0 to 10 mg/L (median of 0 mg/L; Table 1; Figure 9). The site with the highest nitrate-N (10 mg/L) was an unnamed tributary to the Iowa River just upstream of Eagle City Park. Nitrate-N concentrations overall were very low (61% of samples were 0 mg/L). Sites located on the main stem of the Iowa River showed a slight increase in nitrate-N concentrations from 0 mg/L in Franklin County and most of Hardin County before increasing to 2 mg/L and then 5 mg/L at Furrows Access in Marshall County, the end point for the event. Overall, nitrate-N concentrations were the lowest that have been measured during the ten years of Project AWARE.

Nitrate-N concentrations varied from 0 to 10 mg/L for the tributary sites and 0 to 5 mg/L for sites on the main stem of the Iowa River. The overall median concentration for all sites was 0 mg/L. Based on monthly data collected from DNR's statewide stream network, the median nitrate+nitrite-N concentration for July 2012 was 2.6 mg/L. The July 2012 nitrate+nitrite N concentrations statewide are the lowest for any July since the ambient stream monitoring began in 2000. Typically nitrate+nitrite-N concentrations remain elevated during the month of July before declining in August, however, due to the drought conditions combined with the fact that nitrate is water soluble, lower nitrate+nitrite-N concentrations occurred a month earlier than normal.

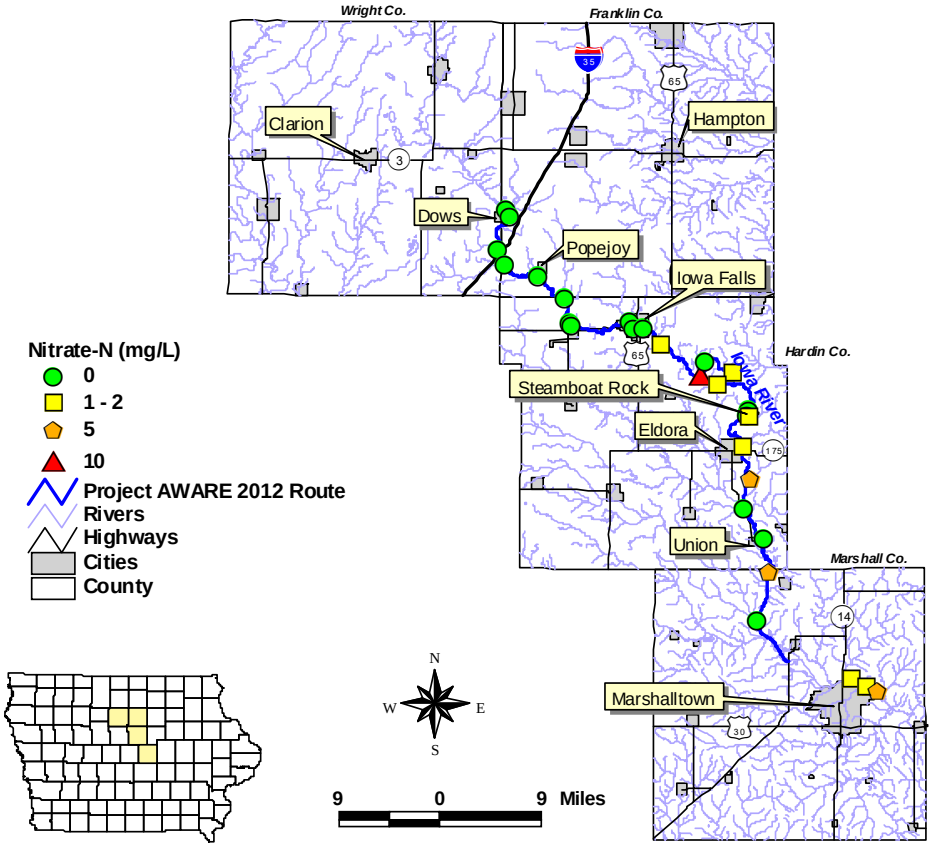

Figure 9. Nitrate-N (IOWATER method) for sites sampled as part of Project AWARE 2012 on the Iowa River.

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 0.33 mg/L, with a median of 0.20 mg/L.

IOWATER phosphate results for the Project AWARE sites ranged from 0.1 to 0.8 mg/L, with a median of 0.4 mg/L (Table 1; Figure 10). The highest phosphate level (0.8 mg/L) occurred at four sites, including two sites on the main stem of the Iowa River in the Marshalltown area and two tributaries in Hardin County. None of the other water quality parameters measured for these four sites were unusual. Phosphate concentrations for the Project AWARE sites were elevated compared to concentrations measured as part of the DNR statewide stream network (Figure 4).

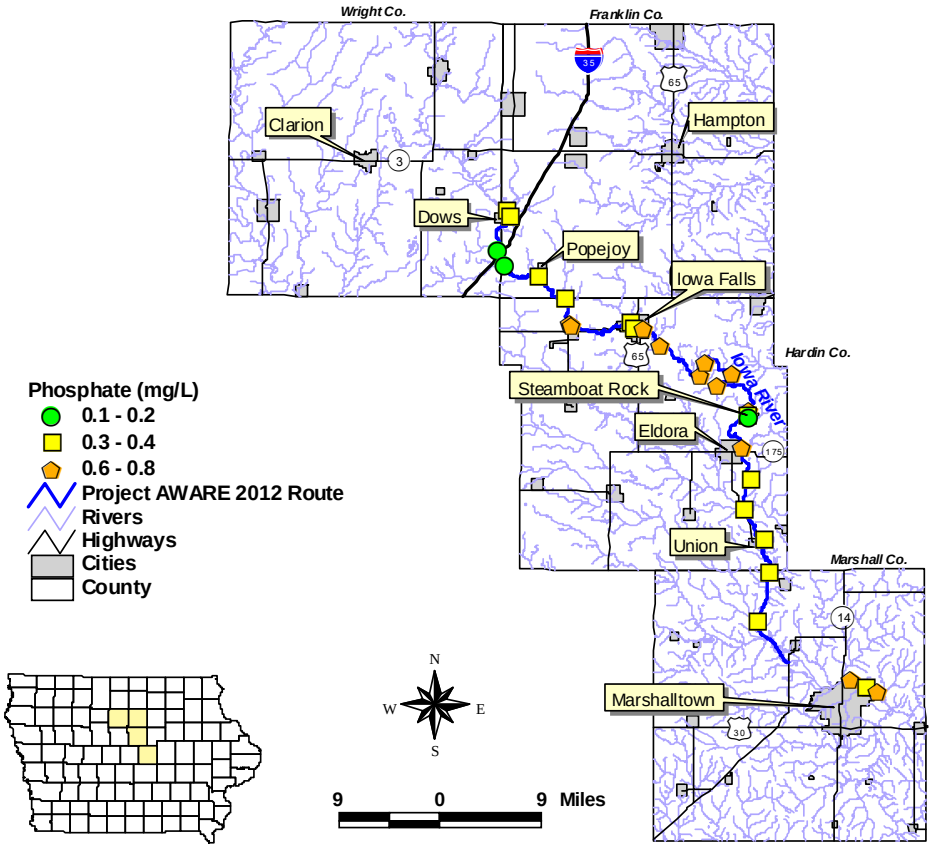

Figure 10. Phosphate (IOWATER method) for sites sampled as part of Project AWARE 2012 on the Iowa River.

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.

For Project AWARE sites, the majority of chloride concentrations were below the test strip detection limit of 32 mg/L (Table 1; Figure 11). The highest chloride measured was 38 mg/L, which is very low. Given the low water levels, if point sources had been present (i.e., discharge from wastewater treatment facilities or discharge from septic systems), inputs from point sources would have been indicated by elevated chloride concentrations. However, no elevated chloride concentrations were measured.

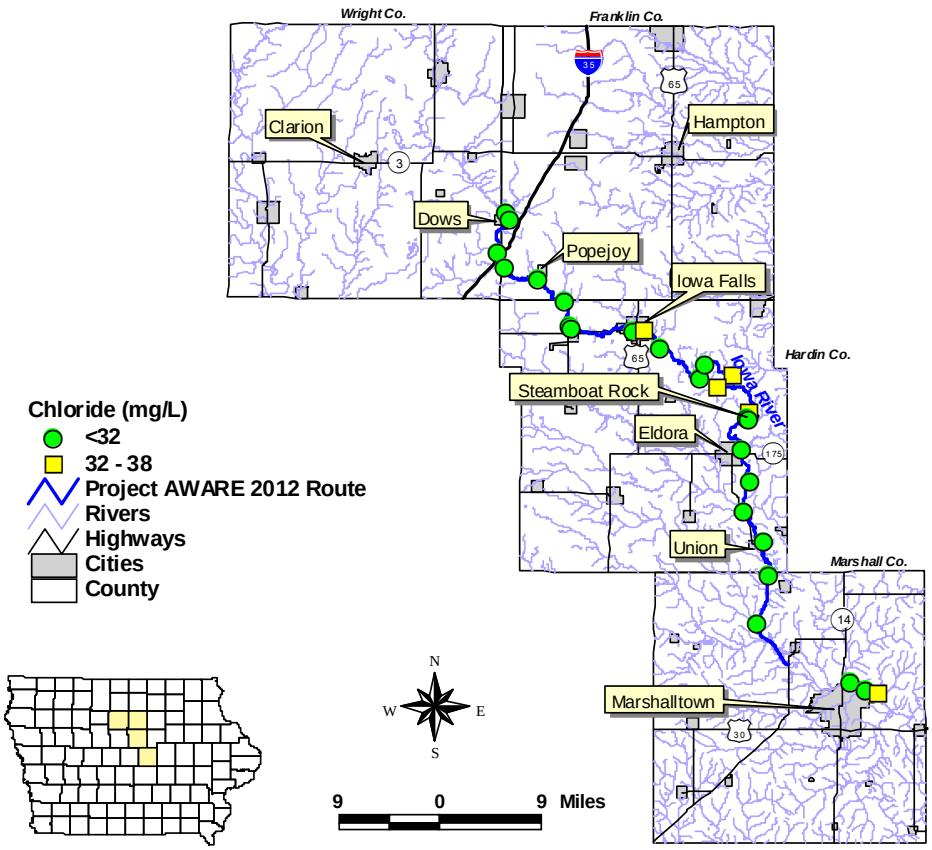

Figure 11. Chloride (IOWATER method) for sites sampled as part of Project AWARE 2012 on the Iowa River.

Summary

Through the efforts of 387 volunteers, more than 60 tons of trash was removed from the Iowa River as part of Project AWARE. One of the educational events during Project AWARE was water monitoring of sites along the route and sharing of the results. For the third year in a row, the team of Bailey Bergthold and Jim Urban conducted the monitoring. A total of 28 sites were monitored for a variety of field parameters using IOWATER methods. Below are some observations from the data.

- Project AWARE occurred from July 7-14, 2012, during extremely low stream flow conditions. Flow for the Iowa River at Rowan varied from 5 to 7% of normal during the week of Project AWARE, while the Iowa River at Marshalltown ranged from 7 to 12% of normal. River levels this year were the lowest ever during the ten year history of Project AWARE. While July 2012 was the third warmest July on record, fortunately Project AWARE occurred during the coolest week of the month. The only rain that fell during Project AWARE occurred did so at the end of the week, with Iowa Falls receiving 0.01 inches and Marshalltown 0.11 inches. Rain fell in Marshalltown as the event ended.
- Water temperature for Project AWARE sites sampled ranged from 65 to 91 degrees Fahrenheit. Sites located on the main stem of the Iowa River exhibited higher temperatures than tributary streams. Overall, water temperatures for sites sampled as part of Project AWARE were lower than levels seen statewide for July. Statewide stream water temperatures were the highest ever recorded for July based on 13 years of monitoring by the Iowa Department of Natural Resources.
- pH ranged from 6 to 9, with the majority of sites having a pH of 8 or 9 which is typical for Iowa streams.

- Transparency ranged from 11 to 60 centimeters with a median of 44 cm. While the transparency was not as high as measured in 2011 on Project AWARE on the Little Turkey, Turkey, and Volga rivers in northeast Iowa (median of 60 cm), overall, the high transparency and low water helped volunteers in their search for trash.
- Dissolved oxygen concentrations varied from 4 to 6 mg/L with a median of 5 mg/L. A total of 29% of the sites had concentrations below Iowa's statewide standard for warm water streams of 5 mg/L. Low dissolved oxygen levels are attributed to warm water temperatures and extremely low flow conditions.
- Nitrite-N concentrations ranged from 0 to 1.5 mg/L with 5 of the 28 sites having detectable levels of nitrite-N. The site with the nitrite-N (1.5 mg/L) also had the highest nitrate-N (10 mg/L).
- Nitrate-N concentrations ranged from 0 to 10 mg/L. Nitrate-N concentrations were the lowest measured in ten years of Project AWARE. Nitrate-N concentrations on the main stem of the Iowa River increased from 0 mg/L along the upper sites in Franklin and Hardin counties to 5 mg/L for sites along the lower stretch from southern Hardin County into Marshall County. Not only were nitrate-N concentrations an all-time low for Project AWARE, but streams statewide showed the lowest levels ever for July since the DNR began monitoring began in 2000.
- Phosphate ranged from 0.1 to 0.8 mg/L, with a median concentration of 0.2 mg/L. Levels were elevated compared to levels reported for streams statewide for July 2012.
- The majority of chloride concentrations were below the test strip detection limit of 32 mg/L. The low chloride suggests that the sites monitored were not directly impacted by any point source inputs. An exception may have been the tributary located upstream of Eagle City Park which may have been affected by a potential point source. While this site did not have chloride detected, the nitrite-N and nitrate-N were the highest of the sites sampled; a petroleum odor was reported; and the site had a low dissolved oxygen (4 mg/L).

Acknowledgements

A sincere thanks to Bailey Bergthold and Jim Urban for conducting the water quality monitoring throughout the week of Project AWARE. IOWATER staff provided review of the report.

References

Iowa Department of Natural Resources, Water Quality Summary 2000-2011, Water Fact Sheet 2012-1, January 2012, 2 p, ftp://ftp.igsb.uiowa.edu/igspubs/pdf/WFS-2012-01.pdf.

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