Name: _____ Section: _____

Water Quality Lab

Introduction

The purpose of this lab is to introduce you to:
1) the scientific process within the geosciences;
2) basics of water quality and watershed concepts;
3) equipment you will use during your semester-long research projects; and
4) methods for recording data and observations.

Part 1

The first three lab exercises of the semester will help you prepare for your team's research project. Your task for today, as a geoscientist, is to consider the various metrics of water quality in preparation for field data collection in a future lab. We will also explore how confounding variables are introduced into a scientific study and may affect measurements and results.

First, let's consider the following question:
How do various water quality metrics indicate whether water is uncontaminated and safe to drink?

Nitrite (NO_2) and Nitrate (NO_3)

Nitrite: ≤ 1 mg/L (EPA drinking water standard)
Nitrate: ≤ 10 mg/L (EPA drinking water standard); 5.8 mg/L (Iowa stream average).
Note: Nitrite has a short lifespan in surface water and will quickly oxidize into nitrate. Noticeable amounts of nitrite usually means water was sampled near a local source of contamination.
Potential Health Effects: Potentially fatal blood disorder in infants if left untreated.
Common sources of nitrite/nitrate:
Runoff from fertilizer use; leaking from septic tanks, sewage; and erosion of natural deposits.

pH

6.5 – 8.5 (EPA secondary standard); 8.2 (Iowa stream average)
Common anthropogenic effects on water pH:
acid precipitation, agricultural runoff, wastewater discharge or industrial runoff.

Chloride (Cl)

≤ 250 mg/L (EPA secondary standard); 22 mg/L (Iowa stream average)
Common anthropogenic sources: Wastewater discharge, road salting, or agricultural runoff.

Water Hardness

Water hardness is a function of the amount of dissolved calcium (Ca) and magnesium (Mg). There are no known harmful health impacts of hard water. The United States Geological Survey recognizes hardness values ≥ 120 mg/L as being "hard" or "very hard".

Hardness is due water dissolving rocks and sediment. Consequently, groundwater has a higher hardness than surface runoff.

Phosphate (PO_4)

0.10 mg/L (EPA recommendation for freshwater environments); 0.2 mg/L (Iowa stream average)
Potential Health Effects: High concentrations hinder removal of microorganisms from drinking water
Common anthropogenic sources: agricultural runoff or wastewater discharge.

Part 2

Imagine that your team forms a research question regarding the size of a **watershed** and water chemistry within that watershed based on the following observations:

A) Water chemistry is affected by agricultural runoff and waste runoff (e.g., sewage).

B) Ioway Creek watershed drains both farmland and urban areas.

C) The size of a watershed can be quantified by the area (km2) of its catchment (i.e., the area of land that collects precipitation in the watershed).

Your team suspects that as more and more farmland and urban areas are drained by Ioway Creek and its tributaries, the quality of that water should decrease.

These observations lead your team to form a more general hypothesis:
As the catchment area of a stream and its tributaries increases, water quality decreases, too.

One member of your team has taken water samples from five locations in the Ioway Creek watershed and has measured the catchment area of all streams that occur upstream from each of the sampling locations.

Please see the sheet provided by your TA for his/her field notes regarding each water sample. A map of the sample collections site is shown at the end of the lab handout.

Questions

1. Assuming that the hypothesis is true, what are specific predictions you can make about how pH, nitrite/nitrate, chloride, water hardness, and phosphate measurements will change as stream length increases?

pH:

Nitrite/Nitrate:

Chloride:

Water hardness:

Phosphate:

2. Assuming that the hypothesis is true, which sample(s) do you think will be the most different from the others? Explain your reasoning.

3. Besides catchment area from each of the localities, how do the samples differ from each other based on the field notes? How could these differences affect the results of your water chemistry tests?

4. It is time to measure the water chemistry of each sample! You will only need ~75 mL of each sample.

Follow your TA's instructions and the instructions on your water testing kits to complete the following table:

Sample Name					
Catchment area (km^2)					
pH					
Nitrite (mg/L)					
Nitrate (mg/L)					
Chloride (mg/L)					
Hardness (mg/L)					
Phosphate (mg/L)					
Notes					

5. Were all of your predictions correct based on your measurements? If not, briefly describe any differences between your predictions and the results of your measurements.

6. What could be potential reasons for the differences between your predictions and your results?

7. Confounding variables are variables that a researcher failed to control for during an experiment or study. When a researcher fails to remove such confounding variables, measurements and analyses can be affected, leading one to incorrectly accept or reject a hypothesis. Consistent sampling and measurement techniques are a good first step in removing confounding variables. How could consistency in sampling and measuring be improved in this activity?

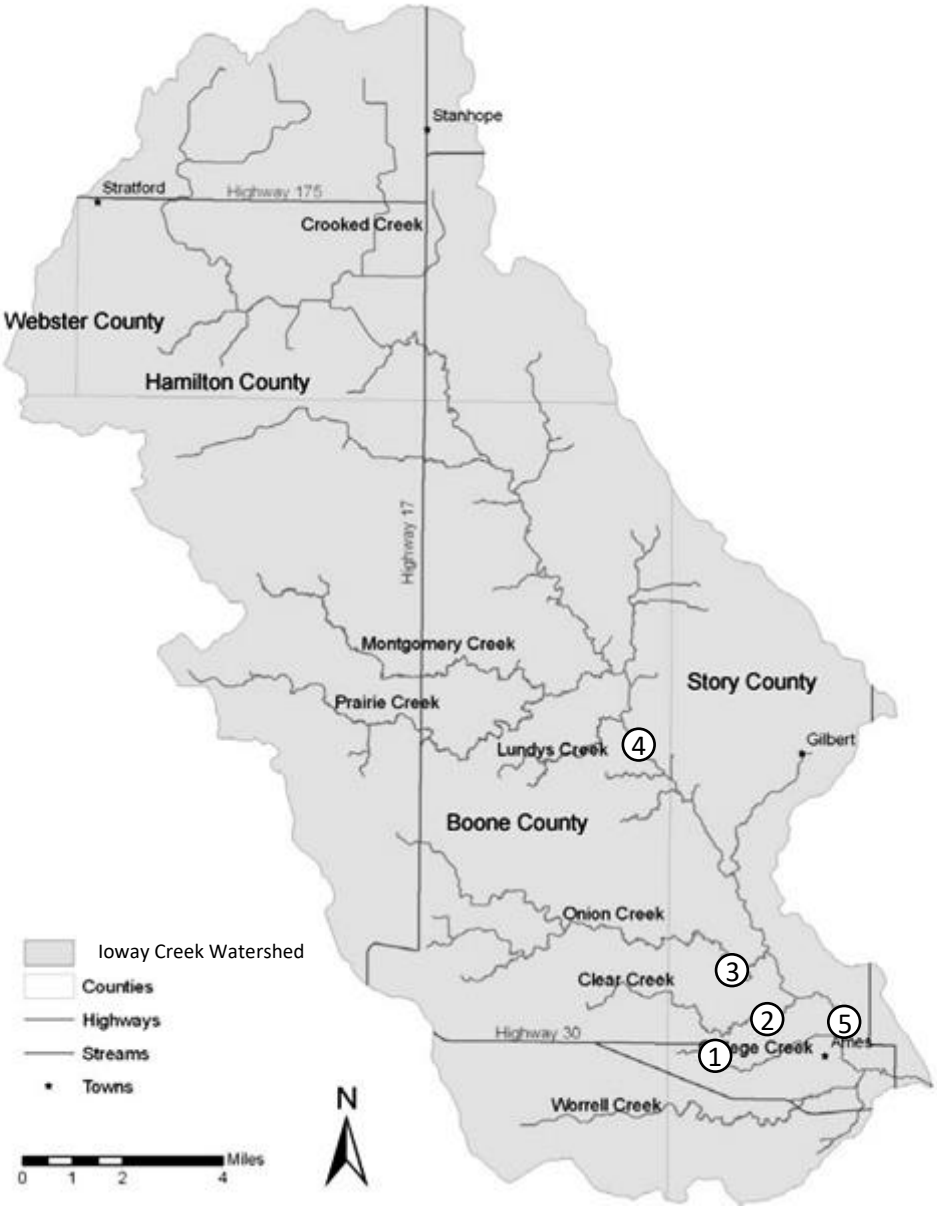

Figure 1. The Ioway Creek watershed and major tributaries in Boone, Hamilton, Story and Webster Counties. Water sampling localities are marked by circles. 1 = College Creek, 2 = Clear Creek, 3 = Onion Creek, 4 = Zenorsville, and 5 = Brookside Park. Map from Wendt (2007).

Field notes associated with water samples

Locality 1: College Creek at Daley Park, Ames, IA
Date: 08/16/2021 Time: 1:10 pm

Catchment area: 7 km²

Air Temperature: 22.9°C Water Temperature: 19.8°C
Weather: Sunny, clear skies

Stream conditions: No flow, disconnected pools in streambed. Water depth < 30 cm. Clear water with abundant minnows, frogs, insects. Pools in shade. Trees and residential neighborhood nearby.

Comments: Collected directly from pool using sample bottle. Sediment in streambed was not disturbed. Minimal sediment gathered with sample. Sample was transported by car and stored in the dark at room temperature for ~1 week.

Locality 2: Clear Creek at Emma McCarthy Lee Park, Ames, IA
Date: 08/16/2021 Time: 1:30 pm

Catchment area: 18 km²

Air Temperature: 22.8°C Water Temperature: 21.5°C
Weather: Sunny, clear skies

Stream conditions: No flow, disconnected pools in streambed. Water depth < 30 cm. Clear water with abundant minnows, frogs, insects. Pools in shade. Trees and residential neighborhood nearby.

Comments: Collected directly from pool using sample bottle. Sediment in streambed was not disturbed. Minimal sediment gathered with sample. Sample was transported by car and stored in the dark at room temperature for ~1 week.

Locality 3: Onion Creek at N. Dakota Ave., Ames, IA
Date: 08/16/2021 Time: 12:53 pm

Catchment area: 49 km²

Air Temperature: 27.0 °C Water Temperature: 24.4°C
Weather: Sunny, clear skies, but sampled in shade

Stream conditions: No flow, disconnected pools in streambed. Water depth < 30 cm. Somewhat brown, turbid water with abundant algae, frogs, insects. Pools in shade. Trees and cornfields nearby.

Comments: Collected directly from pool using sample bottle. Sediment in streambed was not disturbed. Minimal sediment gathered with sample. Sample was transported by car and stored in the dark at room temperature for ~1 week.

Locality 4: Ioway Creek (upstream site) near Zenorsville, IA
Date: 08/16/2021 Time: 12:35 pm

Catchment area: 385 km²

Air Temperature: 30.1°C Water Temperature: 24.0°C
Weather: Sunny, clear skies

Stream conditions: Low flow velocity (< 1 m/s). Water depth ~60 cm. Brown, turbid water. Stream in direct sunlight with trees and horse pastures nearby.

Comments: Collected using bailer from bridge. Sediment in streambed was disturbed. Significant amount of sediment gathered with sample. Sample was transported by car and stored in the dark at room temperature for ~1 week.

Locality 5: Ioway Creek at Brookside Park, Ames, IA
Date: 08/16/2021 Time: 1:48 pm

Catchment area: 528 km²

Air Temperature: 29.4°C Water Temperature: 24.8°C
Weather: Sunny, clear skies

Stream conditions: Low flow velocity (< 1 m/s). Water depth ~60 cm. Brown, turbid water. Stream in direct sunlight with trees and residential neighborhood nearby.

Comments: Collected using bailer from bridge. Sediment in streambed was disturbed. Significant amount of sediment gathered with sample. Sample was transported by car and stored in the dark at room temperature for ~1 week.