**A Day in the Life of the Buffalo River**
**Staff/Volunteer/Partner Instructions**

1. **Preparation** (~9:30 AM)
    a. Set out tarp on ground.
    b. Establish boundaries for the sample site. Look for potential hazards.
    c. Set up activity stations with cones/flags and appropriate equipment.
    d. Set out extra equipment on tarp.
    e. Meet the bus at the designated area.
2. **Introduction** (10:00 AM)
    a. Explain purpose of event/what a watershed is/sample site location. Resources:
    - "Event Overview" (laminated)
        - Introduction and talking points – purpose of event, what is investigated, what's a watershed, timeline: history of Buffalo River, pollution and cleanup efforts; Area of Concern map; "10 Cool Facts About the Buffalo River Watershed".
    - "Buffalo River Watershed", "Historic Industries/Buffalo River & Tributaries" maps (laminated)
        - Shows the entire watershed, historic industries along the Buffalo River, and the main river plus the three tributaries.
    - "A Day in the Life of the Buffalo River – Sample Sites" map (laminated)
        - Small- and large-scale views of where all the sample sites are in relation to each other; names each sample site and waterway it is on; general facts about the Buffalo River.
3. **The Activities** (10:00 AM – 1:00 PM)
    a. Hand out equipment, assist students with understanding activity, using equipment, and interpreting data.
        i. Equipment is organized in bags marked with the Activity number. Some items are used in multiple activities and are not in the bags.
        ii. Each activity comes with a laminated instruction sheet.
    b. There is 15 minute time limit for each activity. Keep time and signal when to switch. Have students leave all equipment at each station.
4. **Miscellaneous Event Details**
    a. Staff should take pictures.
    b. Participants may take a lunch break.
    c. Locations of restrooms are indicated on the Site Description.
5. **Time Fillers**
    a. Activity 6: "Bioassessment" can be done continuously throughout the day.
    b. Have each group take turns sharing their data results with the class. Ask the students questions about their results to encourage discussion.
    c. Discuss any of the following topics: aquatic flora and fauna, water chemistry, history of the Buffalo River, pollution, restoration efforts, Great Lakes issues, invasive species, or anything else in your area of expertise.
    d. Do additional testing with any equipment brought by the partners.
    e. Explore the area near the sample site and identify plants and animals.
    f. Resource: laminated sheet "10 Cool Facts about the Buffalo River."
6. **End of Event** (~1:00 PM)
    a. Students should return all equipment and help look around the site to ensure it is clean. Students should help rinse out nets, waders, and buckets.
    b. Gather all the equipment back in the storage bin. Put any wet or muddy items in trash bags.
        i. There is an equipment checklist on the inside lid of the bin.
    c. Have students share something they learned or a way to protect the river.
    d. Return all equipment to Reinstein Woods.

## Activities Overview

**Activity 1. Turbidity**

Students measure the turbidity, or cloudiness, or the water.

Significance: High turbidity levels can decrease how much oxygen fish can use from the water (dissolved oxygen). Turbidity can also prevent light from reaching plants beneath the surface.

**Activity 2. Weather and Wind**

Students measure air temperature, observe current weather conditions, and determine how recent weather conditions could affect their data.

Significance: Wind and weather can affect oxygen levels, pollution, and aquatic life in the river.

**Activity 3. The Environment at the Sampling Site**

Students observe, describe, and measure the river and the area around their sampling site.

Significance: Elements of the surrounding environment can positively or negatively affect water quality (i.e. avenues of pollution, buffer zones against erosion, industrial waste discharge, etc.)

**Activity 4. Sketch a Map of the Sampling Site**

Students explore and draw their sampling site, taking note of significant landmarks and specific sampling locations.

Significance: Maps help to put the data in context and show the unique features of each site.

**Activity 5. Water Temperature**

Students measure the water temperature at different locations and depths, and compare temperatures changes over the course of the day.

Significance: Water temperature determines how much oxygen is in the water and therefore what organisms can live in the river.

**Activity 6. Bioassessment**

Students collect, identify, and record the aquatic creatures they catch at their site. They then use their results to determine water quality.

Significance: Certain creatures cannot tolerate pollution. Which organisms are found at the site can offer clues as to the quality of the water.

**Activity 7. Chemical Analysis**

Students measure pH and Dissolved Oxygen levels to determine water quality and livability.

Significance: Most organisms cannot tolerate changes in pH. Dissolved oxygen is essential to the survival of aquatic organisms. Many factors can affect these levels and therefore aquatic life.

## A Brief Look at the Buffalo River

The Buffalo River has played a major role in the development of the city of Buffalo. It has been, and still is, used for industrial, recreational, commercial, and economical purposes. The freshwater river is 8.7 miles long and flows west, emptying into Lake Erie. It is fed by three tributaries: Cayuga Creek, Buffalo Creek, and Cazenovia Creek. All tributaries join together at various points to form the Buffalo River.

During the Industrial Revolution, wetlands around the Buffalo River were destroyed to build oil refineries, factories, grain elevators, and chemical industries. The river was used as a waste receptacle for heated water, toxic contaminants, and raw sewage. It became so polluted that the river actually caught on fire in 1968! In 1987, the Buffalo River was listed as an Area of Concern by the Environmental Protection Agency (EPA). An Area of Concern, or AOC, is a geographic location that has experienced environmental degradation.

To address these issues, the Department of Environmental Conservation, the U.S. Army Corps of Engineers, Buffalo Niagara Riverkeeper, Honeywell, and the EPA formed the Buffalo River Restoration Partnership. A $75 million cleanup and restoration effort is underway. Project goals include decreasing pollution, restoring and establishing new habitats, improving soil and water quality, and increasing public access to the river. Accomplishing these goals will in turn benefit wildlife, the environment, our economy, and human health. No longer is the Buffalo River "devoid of life."

**Note: The following pages are similar to the instruction sheets the students will see on the day of the event. More background information is provided here for instructors.**

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# Activity 1: Turbidity

**Equipment:** turbidity tube, measuring cup, waders, life jacket

**Vocabulary:**

**Secchi disk:** a black and white disk that is lowered into water to the depth at which it vanishes from sight to measure turbidity.

**turbidity**: the cloudiness of water.

**Turbidity** is the cloudiness of water. Turbidity is caused by things suspended in the water, like small plants, animals, sand, mud, and pollutants. High turbidity levels can decrease how much oxygen fish can use from the water. Turbidity can also stop light from reaching plants beneath the surface. A **Secchi disk** is that black and white disk inside the **turbidity tube** that used to measure turbidity.

1. Put on waders, go into the river, and fill the measuring cup with water. Don't kick up too much mud, as this will throw off your results.
2. Fill the turbidity tube to the top with water. Get another cup full of river water if needed.
3. Place the turbidity tube near the edge of the water with the bottom valve facing the water (this way, when you spill the water out, it doesn't get the whole site wet). As one student looks through the top of the turbidity tube, another slowly lets water out of the tube through the valve at the bottom.
4. The student looking through the top says "Stop" as soon as they can see the black and white circle (Secchi disk). The other student closes the water valve as soon as they hear "Stop."
5. Record the height of the remaining water in the tube as "Reading 1."
6. Empty the tube. Repeat steps 1-4 to obtain "Reading 2."
7. Take the average of your two readings to get your turbidity measurement.

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# Activity 2: Weather and Wind

**Equipment**: air thermometer, compass

**Vocabulary:**

**dissolved oxygen (DO)**: the amount of oxygen gas in the water.

**habitat**: The area or natural environment in which an organism or population normally lives. A habitat is made up of factors such as soil, temperature, light, availability of food and the presence of predators.

**runoff*:*** the flow of water, from rain, snow melt, or other sources, over land.

Weather and wind tell us about the physical conditions around the river. Weather includes what the weather is today and what the weather was like during the past few days. Weather conditions can affect water quality. Heavy rains might flush pollution into the river. High winds can mix extra oxygen from the air into the water and increase dissolved oxygen levels (see Activity 7).

1. **Weather**
    1. Hold the air thermometer upright and out of direct sunlight. Allow several minutes for the thermometer to give an accurate reading.
    2. Record air temperature, cloud cover and precipitation.
2. **Wind**
    1. Use the compass to determine wind direction. Remember, winds are named for the direction the wind is coming *from*.
    2. Refer to the "The Beaufort Scale: Effects on Land" figure to estimate wind speed. Record the figure number and wind speed.
    3. Describe the wind's effect on the river surface.

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## Activity 3: The Environment at the Sample Site

**Equipment**: measuring tape, meter stick, waders, life jacket, field guides (optional)
**Vocabulary:**
**biodiversity:** the variety of species found in an area.
**bulkhead**: a barrier of wood timber, concrete or metal, holding the shore in place along the water's edge
**ecosystem**: a community of organisms together with their physical environment, viewed as a system of interacting and interdependent relationships
**habitat**: The area or natural environment in which an organism or population normally lives. A habitat is made up of factors such as soil, temperature, light, availability of food, and the presence of predators.
**marsh**: an area of shallow water with many plants growing through the water's surface.
**riprap**: large rocks that are piled up along a shoreline to protect it from strong waves and erosion.

Each sample site is unique, ranging from old industrial sites to rural nature preserves. Some sites may show heavy human involvement, such as industries or houses near the river. Other sites will have many **ecosystems**, such as forests and marshes. An area with more **habitats** usually has a greater variety of living things (**biodiversity**). Every environment has features that can potentially help or harm water quality.

1. Explore and observe the area around your sample site, using the numbered list as a guide. Record data.
2. Put on waders, choose a location, and use the meter stick to measure the water depth. Do not go in water deeper than your knees.
3. Complete the "Field Observations" boxes. Use field guides to identify plants (optional).

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## Activity 4: Sketch a Map of the Sample Site

**Equipment:** colored pencils, camera (optional)
**Note:** There is no Datasheet or Instructions sheet for this activity.

**Procedure:** Include a compass rose (N, S, E, W) and rough scale. Indicate specific locations where you sampled. Label landmarks, waterways and other notable features. If possible, take pictures of the site and activities.

Some students may want to be as accurate as possible and include scales, measurements, and labels. Others might be more creative and abstract (one group of students smeared mud and crushed plants on their map to draw different features!)

# Activity 5: Water Temperature

**Equipment:** water thermometer, meter stick, waders, life jacket
**Vocabulary:**
**dissolved oxygen (DO)**: the amount of oxygen gas in the water.
**saturation**: the point at which a solution of a substance can dissolve no more of that substance.
**thermal pollution**: discharge of heated water into a water source that can cause a dangerous rise in temperature.

**Water temperature** can determine which animals survive in the river. It affects their feeding habits and other bodily functions. Water temperature also determines how much oxygen the water has in it. Oxygen that is mixed into water is called "dissolved oxygen." Warm water holds less oxygen than cold water, which means there's less oxygen for fish and other animals to breathe.

One factor that can change water temperature in a river is **thermal pollution**. Thermal pollution occurs when heated water flows into a waterway. Industries and power plants may draw in cold river water to cool machines, and then return warmer water to the river. Buildings and sidewalks can trap heat and warm up rainwater, which then runs off into the river.

1. Put on waders. Do not go in water deeper than your knees.
2. Choose a location and measure the water depth with the meter stick. Record water depth.
3. Submerge the water thermometer for 2 to 4 minutes at your chosen location. Record the water temperature as "Reading 1."
4. Repeat steps 2-3 to obtain "Reading 2."
5. Average the two readings.

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# Activity 6: Bioassessment

**Equipment:** waders, life jackets, scoop nets, viewers, Cool Whip containers, shallow tubs, macroinvertebrate ID sheets, field guides (optional), seine net (optional)
**Vocabulary:**
**adaptation**: a feature that allows an organism to adjust to differing environmental conditions.
**aquatic:** living in fresh water, as opposed to marine (salt water).
**bioassessment**: a survey of living systems that measures presence, condition and number of organisms to evaluate the overall health of aquatic ecosystems.
**biodiversity:** the variety of species found in an area.
**ecosystem**: a community of organisms together with their physical environment, viewed as a system of interacting and interdependent relationships.
**invertebrate:** an animal without a backbone.
**macroinvertebrate:** an animal without a backbone that is visible without a microscope.
**metamorphosis:** A change in the form of a living thing as it matures.
**vertebrate:** an animal with a backbone. Includes fish, reptiles, amphibians, birds, and mammals.

**Macroinvertebrates** ("macro" = big, "invertebrates" = animals without backbones) are animals visible to the naked eye, such as insects, worms, and spiders. Some macroinvertebrates spend their entire life in the water. Others, such as dragonflies and damselflies, begin life in the water and take to the air as adults. Just like frogs, macroinvertebrates go through **metamorphosis**, where their bodies change from egg, to juvenile, to adult. They also have special **adaptations** that help them survive in the water, such as oar-shaped legs, snorkel-like breathing tubes, and hairs that trap air like a scuba tank.

A **bioassessment** ("bio" = life, "assessment" = study) looks at the health of an **ecosystem**, like a river. It uses living things in the ecosystem, like macroinvertebrates, as clues to its health. Species that can live in polluted waters are "tolerant." Species that can't handle pollution are "intolerant." If you find pollution-intolerant animals, it means you have good water quality!

1. Put on the waders. Grab a small net and Cool Whip container. Scoop for macroinvertebrates along the river's edge, under rocks, along the river bottom, or on aquatic plants.
2. Use the bigger nets to scoop in deeper water. Do not go in water deeper than your knees. To use the seine net: stretch the net between two people. Make sure the sinkers are on the bottom and the foam rollers are on top. Walk upstream (against the current) and see if anything swims into the net.
3. Place macroinvertebrates in the pond viewers and shallow tubs. Identify and record each species.
4. Complete the Pollution Tolerance Index and the Field Observations boxes.
5. You may keep macroinvertebrates in the tubs for other students to see. Release all animals back to the river at the end of the event.

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**Pollution Tolerance Index**

1. Place a check next to each macroinvertebrate species you caught. For example, whether you found one mayfly or 50 mayflies, place one check next to the mayfly line in Group 1.
2. Complete the chart for all of the marcoinvertebrate groups.
3. Calculate each group's score using the formulas provided.
4. Add all of the group scores together for your Total Score.
5. Compare your Total Score with the Water Quality Assessment scores. Record the quality rating.

## Example

| **Group 1 Macroinvertebrates: Very Intolerant** | **Group 2 Macroinvertebrates: Intolerant** | **Group 3 Macroinvertebrates: Tolerant** | **Group 4 Macroinvertebrates: Very Tolerant** |
|---|---|---|---|
| _x_ Stonefly | _x_ Dragonfly | _x_ Water Strider | ____ Pouch Snail |
| _x_ Mayfly | ____ Damselfly | ____ Water Mite | _x_ Aquatic Worm |
| ____ Caddisfly | ____ Scud | _x_ Crayfish | ____ Water Boatman |
| ____ Dobsonfly | | | |
| # of checks _2_ x 4 | # of checks _1_ x 3 | # of checks _2_ x 2 | # of checks _1_ x 1 |
| Group Score = 8 | Group Score = 3 | Group Score = 4 | Group Score = 1 |

**Total Score =** 16

**Water Quality Assessment** (*circle one*):
23 or more = Potentially Excellent Water Quality
17-22 = Potentially Good Water Quality
11-16 = Potentially Fair Water Quality
10 or less = Potentially Poor Water Quality

**Intolerant** = animal can't live in polluted water.

**Tolerant** = animal can live in polluted water.

*Adapted from Project WET, 2011*

# Activity 7: Chemical Analysis

**Equipment:** water chemistry kit, waders, water thermometer, container for waste chemicals, ruler (optional)

**Vocabulary:**
**acid rain:** precipitation that is unusually acidic due to atmospheric pollution and harmful to the environment.
**concentration**: the amount of an ingredient in a given volume of liquid or other substance.
**decomposition**: the process of breaking down organic material, such as dead plant or animal tissue, into smaller molecules that are available for use by organisms.
**dissolved oxygen (DO)**: the amount of oxygen gas in water.
**pH**: a number used to express acidity or alkalinity on a scale with values from 0 (acidic) to 14 (alkaline).
**photosynthesis**: the process by which plants that contain chlorophyll make carbohydrates from water and from carbon dioxide in the air in the presence of light.
**saturation**: the point at which a solution of a substance can dissolve no more of that substance.

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1. **DISSOLVED OXYGEN**: Oxygen that is mixed into water is called "dissolved oxygen" (DO). It is a measure of how much oxygen is in the water for fish and other organisms to use. It is measured in parts per million (ppm). One ppm is like one cent in $10,000.

   DO increases when wind mixes up the water or when river plants make oxygen during **photosynthesis**. DO decreases when it is used by river animals to breathe, when photosynthesis stops during the night, or when the water is polluted. **A healthy stream DO range is 5 – 11 ppm.**

   1. Fill the small glass vial to overflowing with river water.
   2. Add **two** Dissolved Oxygen TesTabs to the vial.
   3. Cap the vial. Mix until the tablets have dissolved (about 4 minutes).
   4. Wait 5 minutes. **You may complete the pH test while you wait.**
   5. Hold the vial against the white area of the Dissolved Oxygen Color Chart.
   6. Compare the color of the sample to the DO color chart. Record the result in the table.
   7. Complete the Field Observations box and the Extra Activity (optional).

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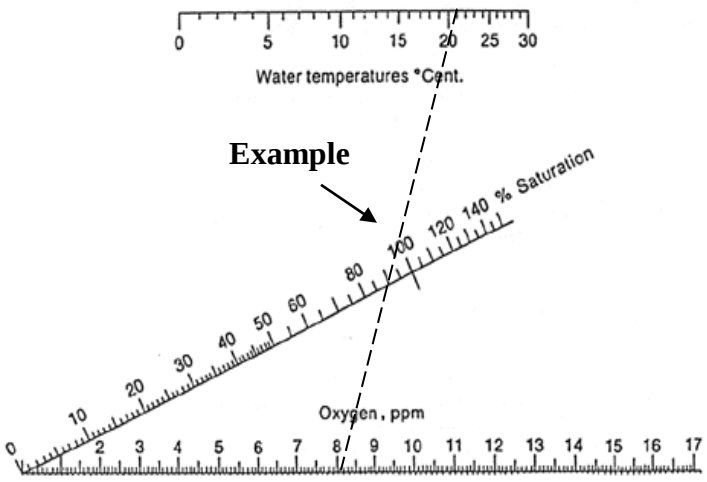
**EXTRA ACTIVITY - Determining percent saturation:** Percent saturation is a measure of how much dissolved oxygen is in the water and available for aquatic life to use. Waterways with a saturation value of **90% or greater** are considered healthy.

1. Measure the water temperature with the water thermometer. Record in the table.
   On the graph in your packet, pair up your DO (ppm) result with the water temperature ($^{o}$ C) with a ruler. Draw a straight line between the two values. The percent saturation is the value where your drawn line intercepts the angled saturation scale.

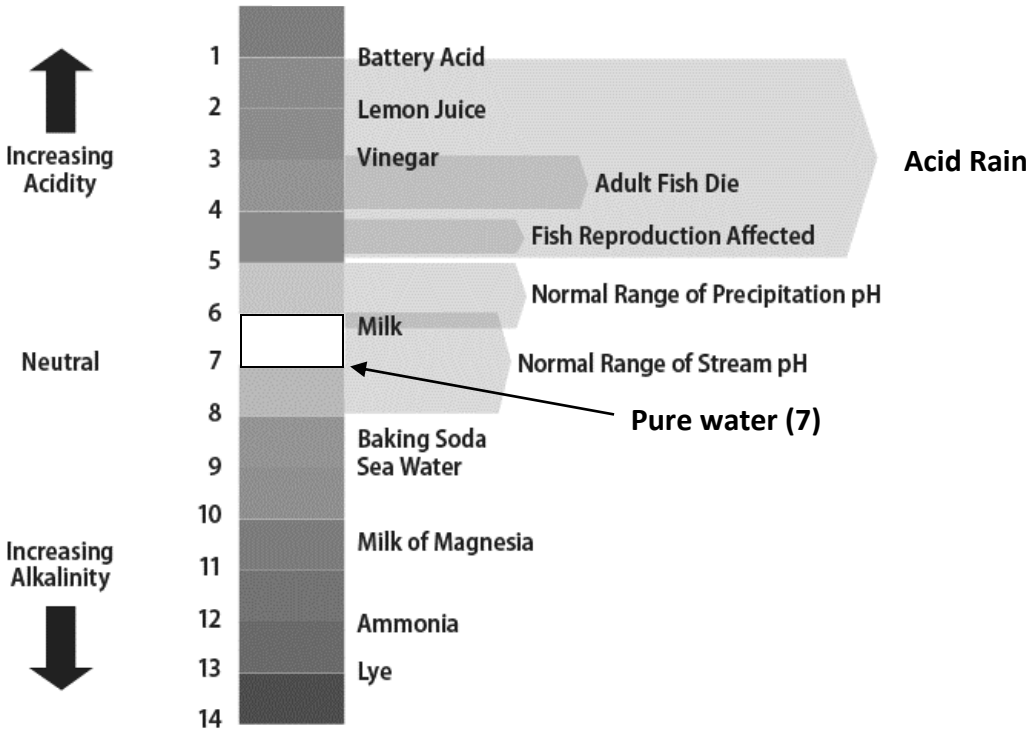
**Dissolved Oxygen - % Saturation**



2. **pH**: The pH scale measures how acidic or basic (alkaline) a solution is on a scale of 0 to 14. It is a measure of hydrogen ion **concentration**. A pH of 7.0 is neutral. A pH less than 7.0 is acidic, and a pH greater than 7.0 is basic. Most organisms are very sensitive to pH changes, and may die if the pH falls outside of the healthy range. A healthy stream pH range is 6.5 – 8.2.

Normal precipitation is slightly acidic, with a pH range of 5.0-6.3. **Acid rain** has a pH below 5.0, and is caused by car and industrial emissions. Acid rain can lower the pH of lakes and rivers and kill off resident plants and animals.

**pH Scale**




Source: Recreated from Environment Canada. 2008. The pH scale. www.ec.gc.ca/eau-water/default.asp?lang=En&n=FDF30C16-1.

*****Actual instructions may vary; consult your specific chemical testing kit. *****

| **General Instructions for tablets** | **General Instructions for test strips** |
|---|---|
| 1. Fill a test tube with river water to the 10 mL line.<br>2. Add one pH Wide Range TesTab.<br>3. Cap the tube and mix until the tablet has dissolved.<br>4 Hold the tube against the white area of the pH Color Chart (#59-18CC).<br>5. Match the color of the sample to the pH color chart. Record the result in the table.<br>6. Dispose of sample water in the waste container.<br>7. Complete the Field Observations box. | 1. Fill a test tube with river water to the 10 mL line.<br>2. Dip one pH strip in the sample water for 10 seconds. Hold the strip as still as possible.<br>3. Remove strip.<br>4. Immediately match the strip to the corresponding pH color chart. Record the result in the table.<br>5. Dispose of sample water and test strip in the waste container.<br>6. Complete the Field Observations box. |