Contents

Acknowledgement

This resource has been funded in part by The George Lunan Foundation and made possible through the generous donations of private individuals, other foundations and corporations who support The Curriculum Foundation, the charitable arm of Curriculum Services Canada. For more details please see www.curriculum.org and click on “Grants for Teachers.”

Introduction

Population Dynamics Watershed Field Study invites students to gain a deeper understanding and appreciation of our aquatic ecosystems. The resource is intended to challenge students in Grades 7-12 to explore, research, and report on watershed population dynamics and on indicators of watershed health. There are four main characteristics of good indicators. They:

- must be related to the main objective and the key question: What is the overall health of the watershed?
- must accurately reflect the condition and health of the watershed.
- should help students develop an understanding of how the ecosystem functions in the watershed study area.
- should allow students to connect the results of the labs to the health of the watershed.

Teacher Notes

- As watersheds differ across Canada, you may need to modify the lab explorations.
- Special attention is given to safety, use of equipment, and use of technology.
- Time permitting, students should complete all labs.
- A full day field trip can easily accommodate the time requirements for each lab.
- Applications of these explorations can be made to elementary ecology studies and to advanced population dynamics studies in senior biology courses.

Lab Activities

The resource package has three main lab activities.

- Lab 1: Watershed Assessment*****
  - Watershed Factor A: Temperature
  - Watershed Factor B: Bank Vegetation
  - Watershed Factor C: Water Turbidity
  - Watershed Factor D: Aquatic Substrates
- Lab 2: Invertebrate Collection
- Lab 3: Soil Study

The lab activities are described on reproducible sheets for students to use during the study.

*****Lab 1: Watershed Assessment has an overall task sheet and individual task sheets for each of the four watershed factors.

Safety

The safety and well being of the students during lab activities is the first priority. Each lab has specific safety protocols that should be in place when conducting this field study.

Overview of Labs

Lab 1: Watershed Assessment

The initial watershed assessment sets the stage for further population dynamics field work.

Aim To assess the condition and health of the watershed being studied.

Safety

- Consider weather conditions.
- Be aware of water dangers (depth of water, flow of water, temperature of water).
- Always bring a first aid kit.
- Bring garbage bags for waste disposal and rubberized tote bags to carry equipment
- Wear proper clothing, e.g., boots.
- Use a sanitizing or antibacterial gel/wipe to clean hands.
- Do not study polluted watersheds that present toxic hazards.

Lab Equipment

- measuring tape
- metre stick
- string
- white plastic lids
- metal screening
- clip boards for recording information
- thermometers (use alcohol and not mercury based thermometers)
- a sieve or small screen
- graph paper
- ruler
- metal washer
- hand sanitizer

Lab 2: Invertebrate Collection

Invertebrate identification is carried out using an identification key created prior to the field study. Invertebrates must be released to their environment after being collected and catalogued.

Aim To carry out a benthic macroinvertebrate collection for a given watershed study area and to use these organisms as indicators of watershed water quality.

Safety

- Choose areas that are shallow enough for wading.
- Do not carry out invertebrate collections in fast flowing water.
- Be aware of water hazard dangers - define specific areas for carrying out the lab.
- Consider water temperature and inclement weather, e.g., time of the year.
- Wear rubber gloves when collecting samples.
- Use a sanitizing or antibacterial gel/wipe to clean hands.

Lab Equipment

- collection nets
- visual invertebrate key – instructor- or student-generated
- small hand nets (aquarium size)
- clip boards
- digital camera (to photograph samples)
- plastic collection basins
- hip waders or rubber boots
- rubber gloves
- hand sanitizer
- tally sheet
- hand magnifiers
- forceps or lab tweezers

Lab 3: Soil Study

The health and condition of a watershed is revealed by the conditions of the water and the conditions of the soil that surrounds the water itself.

Aim To investigate the components of soil from four different locations in a given watershed area.

Safety

- Wear non-latex gloves when working with soil.
- Take disposable equipment, e.g., towels, gloves, plastic bags back to school to be disposed of safely.
- Do not handle materials that may cut or puncture the skin, e.g., nails, glass.
- Test plastic containers for proper lid sealing.
- Use a sanitizing or antibacterial gel/wipe to cleans hands.

Lab Equipment

- 4 plastic containers with lids or zipper sealed bags per group
- garden trowels
- magnifying glasses
- microscope (in class)
- glass slides/cover slip (for microscope work)
- hand sanitizer
- paper towels
- 4 jars or beakers with lids

Lab 1: Watershed Assessment – Task Sheet

Background

A **watershed** is all of the land drained by a river and its tributaries into a body of water such as a lake or ocean. Watersheds can be found in streams, rivers, wetlands forest, lakes, and aquifers.

A **population** is a group of organisms of the same species. **Population dynamics** refers to the different types of organisms that exist together in a given area. The characteristics of a watershed determine the populations of organisms, both plants and animals that exist in it.

Four **factors** have a direct bearing on the types of plant and animal populations that might be found - water temperature, bank vegetation, water appearance, aquatic substrates.

Aim

To evaluate the quality of a given watershed habitat and to apply a generalized rating scale to the observations.

Key Question

What are the key characteristics of the watershed area that you are studying?

Task

- Evaluate the watershed area using the criteria outlined for each factor.
- Read and follow the procedures for each short lab.
- Design a table to compare and summarize your data after completing all four of the labs.

Show what you learned …

Complete a report for your study, using the following as a guide:

- The population dynamics of the watershed area that you are studying begins with an overview of the study area. What rating would be given to the study area based upon the four factors that were presented in this lab?
- Justify the conclusions based upon the results of the lab observations.

Watershed Assessment
Watershed Factor A: Temperature

Background

Temperature is a major factor in determining the types of organisms that live in a watershed. Water temperatures are regulated by underground springs, shading from plants, and water depth.

Temperature affects many aspects of watershed health, including:

- Solubility of oxygen in water – The warmer the water, the less oxygen will be present. When water has a temperature greater than 22°C, oxygen content is quite low. A greater amount of oxygen can be dissolved in cold water than in warm water.
- Rate of photosynthesis by algae and higher plants – Warm water increases algae growth and photosynthesis.
- Sensitivity of organisms to toxic wastes, parasites and diseases – The higher the temperature of the water, the greater the sensitivity of organisms to these environmental stresses.
- Life cycle rates of aquatic insects – Many insect species cannot survive in warm water due to low oxygen content.
- Whether cold water species or warm water species are present.

Aim

To research and report on the water temperature of a given watershed and to apply a generalized rating scale to the results.

Materials

- thermometer
- graph paper
- ruler (marked at 20 cm)
- hand sanitizer

Safety

- Do not take water temperature readings in fast/deep water.
- Be aware of rocks and plant growth that can cause you to slip or fall.
- Use a sanitizing or antibacterial gel/wipe to clean hands.

Procedure

- Identify five areas on the selected watershed where water temperatures can be safely obtained.
- Record the temperature of the water at a depth of 20 cm for the five areas.
- Divide the final results by five to obtain the average temperature assessment.
- Apply the rating scale.

Average of temperature observations: _____

Rating Scale

This water temperature rating is based on conditions that are ideal for fish.

A – Excellent	B – Good	C – Fair	D – Poor
Water temperature is less than 12°C	Water temperature is 12 °C to 19°C.	Water temperature is 20°C to 22°C.	Water temperature is greater than 22°C

Show what you learned …

- Produce a bar graph with the temperature on the *y*-axis and the location of the temperature observation on the *x*-axis. Was there a variation in the temperature observations? Why or why not?
- Conduct research to respond to the question: How does water temperature affect plant and animal life? Identify some questions to guide your research. Discuss these questions with your teacher before you begin your research to answer the questions.

Watershed Assessment
Watershed Factor B: Bank Vegetation

Background

Bank vegetation affects watershed health. Bank vegetation secures soil against erosion, absorbs and filters out sediment that is found in the water, and provides living habitats for many different organisms. Water quality is connected to the presence and health of vegetation surrounding the watershed.

Healthy plant vegetation that is found on the banks of rivers, streams, and lakes represents a barrier to erosion and sediments from run-off during a rainstorm. The minimum distance for a healthy watershed area for vegetation growth is six metres. Healthy plant vegetation maintains the integrity of the banks and provides a barrier to run off from snow and rain.

Aim

To research and report on bank vegetation for a given watershed area and to apply a generalized rating scale to the results.

Materials

- measuring tape
- hand sanitizer

Safety

- Be aware of dangerous water conditions.
- Wear appropriate equipment (rubber boots).
- Use a sanitizing or antibacterial gel/wipe to clean hands.

Procedure

- Identify five different areas on the selected watershed where bank vegetation observations can safely be made.
- Record these areas using a sketch of the location.
- Use the measuring tape to mark off a distance of six metres from the water's edge.
- Apply the rating scale and record your observations.

Rating Scale

A – Excellent	B – Good	C – Fair	D – Poor
Natural bank vegetation is found for the entire six metres from the bank of the watershed.	Natural bank vegetation is found for three metres.	Natural bank vegetation is found for two metres before bare ground or man-made plants are found	No natural vegetation is found on the banks.

Note: Grass is not considered to be "natural" vegetation.

Show what you learned …

- Explain the results of your study.
- Use your findings to respond to the questions:
  - What could be done to improve the watershed area with regards to natural bank vegetation?
  - How might bank vegetation provide habitats for living things?
  - Consider the bank vegetation as habitats for animals and suggest what might live here. Explain why you have identified these animals.
  - How might bank vegetation prevent erosion from run-off?
- Bank vegetation can absorb and filter out nutrients. Explain how bank vegetation could accomplish this by referring to the process of photosynthesis and transpiration.

Watershed Assessment
Watershed Factor C: Water Turbidity

Background

Water clarity is an indicator of watershed health. The deeper an object can be seen in the water, the greater the clarity.

Turbidity is a measurement of the amount of suspended solids that are present in a water sample. The health of an ecosystem can be measured by the turbidity of the water. There are many causes of water turbidity – run-off during rain storms, erosion, and silt washing in from the soil surrounding the watershed, sewage and industrial waste, and algae growth.

Aim

To research and report on the turbidity of the water in the watershed being studied and to apply a generalized rating scale to the results.

Materials

- white plastic lid
- string (tie a knot or mark the string with insoluble ink to indicate depths)
- metre stick
- metal washer
- hand sanitizer

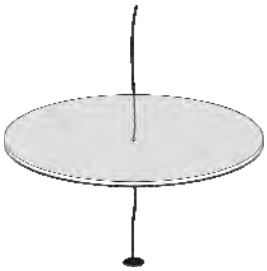
Safety

- Follow safety precautions carefully when working in very turbid water. The depth of the water will not be known with highly turbid water.
- Use a sanitizing or antibacterial gel/wipe to clean hands.

Procedure

Before the Field Study

- Thread a string through the middle of a white plastic lid. Tie a weight (a metal washer) on the string. Make sure that the white side of the lid is facing upwards as you look down on it.



During the Field Study

- Find five different areas to measure the clarity of the water.
  Note: Deep water measurements require the teacher's assistance.
- Use the metre stick to determine the distance at which you can no longer see the lid.
- Apply the rating scale to each area and record the results in a chart.

Rating Scale

A – Excellent	B – Good	C – Fair	D – Poor
Water is very clear. Objects are visible at a depth of 1 m. Rocks are free of film or algae.	Water may be cloudy. Objects are visible at a depth of 0.75 m. Water may have a slight green colour.	Water has considerable cloudiness. Visibility of objects is limited to 0.5 m. Rocks may be covered with green film.	Water is muddy. Objects are not visible below 0.25 m. Pollutants and film on rocks may be present. Floating algal mats may be present.

Overall water turbidity rating: _____

Show what you learned …

- Explain the overall rating for water turbidity. Use the observations from the lab to justify the rating.
- If pollution was present, identify the probable sources.
- Identify possible causes of turbid water in the watershed study area being tested.
- Why does high turbidity often result in an increase in water temperature?
- Soil erosion is often a cause of water turbidity. How could it be reduced or eliminated?
- Algal growth can increase turbidity. How can the growth of algae be reduced or eliminated in a watershed?

Watershed Assessment
Watershed Factor D: Aquatic Substrates

Background

Differing **substrate types** in a watershed provide different habitats for different organisms to survive. The greater the number of substrates there are in the study area, the greater the diversity of plant and animal populations that may be present.

Healthy substrates that support a variety of plant and animal life could include gravel, large stones, submerged logs, fine woody debris, sand, and leaf packs. The best substrate for fish and aquatic invertebrates is a mixture of gravel, rocks, boulders, and sunken trees/branches.

Aim

To research and report on the substrates found in the aquatic study area and to apply a generalized rating scale to the results.

Materials

- a sieve or small screen
- hand sanitizer

Safety

- Be aware of water dangers when collecting substrate samples. If the water is beyond 50 cm deep, do not attempt to collect substrate samples.
- Wear appropriate equipment when collecting substrate samples.
- Use a sanitizing or antibacterial gel/wipe to clean hands.

Procedure

- Identify a small study area to observe the substrates.
- Count the substrates. Apply the rating scale to the study area and record your findings.
- Repeat this process with two other areas.
- Assign an average rating for aquatic substrates to the study area.
- Return substrate samples to the study area after they have been analyzed and recorded.

Rating Scale

A – Excellent	B – Good	C – Fair	D – Poor
A minimum of five different substrates are observed.	Three to four different substrates are observed.	Two different substrates are observed.	Only one type of substrate is observed in the study area.

Average rating for aquatic substrate _____

Show what you learned …

- Would the study area support a large variety of aquatic life in both plant and animal form? Why or why not?
- Identify three populations of plants or animals that might exist in the study area. Explain why they might be present.
- Why would a silt substrate in a watershed be the worst type of substrate for living things?
- Draw a sketch of the substrates found in the study area. Make your drawings in pencil and label them.
- Why might the substrate of a watershed be changed or modified?

Lab 2: Invertebrate Collection

Background

Aquatic invertebrates are common populations that are found throughout Canada's freshwater ecosystems. They are often referred to as *benthic macroinvertebrates*.

benthic = bottom *macro* = large *invertebrate* = creature that lacks a backbone or spine

Benthic macroinvertebrates are excellent indicators of watershed health as they are easy to collect, differ in their tolerance to pollution and oxygen levels, are easy to identify, and live in the water for the greater part of their lives.

The study area (stream, river, reservoir, lake, pond) determines how invertebrates are collected.

Aim

To carry out a benthic macroinvertebrate collection for a given watershed study area and to use these organisms as indicators of watershed water quality.

Materials

- plastic collection basins (2 minimum)
- collection net
- hip waders or rubber boots
- digital camera – optional
- visual invertebrate key
- tally sheet for invertebrate number recording
- small hand net (aquarium size)
- hand magnifiers
- forceps or lab tweezers
- hand sanitizer

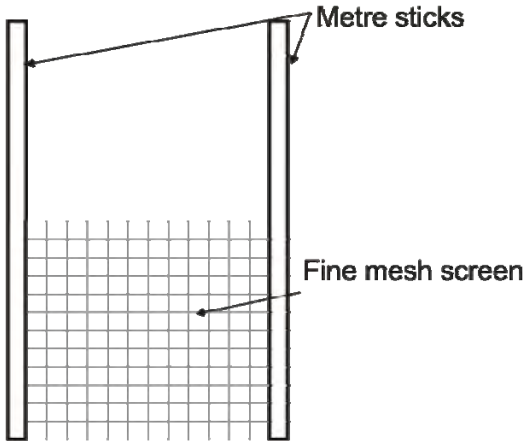
Safety

- Invertebrates should only be collected in safe water areas. Do not attempt to collect invertebrates in fast flowing or deep water.
- Some invertebrates can pinch! Do not handle invertebrates unless necessary.
- Use a sanitizing or antibacterial gel/wipe to clean hands.

Procedure

Before the Field Study

- Construct a collection net, using fine mesh screen and metre sticks. Staple or tack 50 × 30 cm piece of screen to the metre sticks.



- Obtain images of invertebrates and create a visual identification key to help you identify the samples you collect during the field study. Include these invertebrates in your key:

  Clean Water Indicators
  - Caddisfly Larvae
  - Mayfly Larvae
  - Water Boatman

  Clean to Medium Water Quality Indicators
  - Dragonfly Nymph
  - Damselfly Nymph
  - Crayfish
  - Stone fly
  - Helgrammite
  - Clams

  Poor Water Quality Indicators
  - Aquatic Worms
  - Blackfly Larvae
  - Leeches
  - Blood Worms
  - Snails

- Design a table to record the types and numbers of invertebrates you found in three different areas of the watershed.

During the Field Study

<u>For Streams and Rivers</u>

- Identify an area of study where current is flowing.
- Hold the net against the floor of the stream or river bed while your lab partner stands approximately one metre in front of the screen and gently stirs up the substrates at the bottom. Invertebrates found in the rocks will be dislodged and caught in the fine mesh screen of the collecting net.
- Transfer the invertebrates to a collection basin that has water in it. Handle them gently to avoid crushing or maiming them.
- Transfer the invertebrates to a second basin as you identify and count them.
- Return the invertebrates to the study area.

<u>For Lakes, Reservoirs, and Ponds</u>

- Identify an area of study and use the collection net to scoop down into the substrate and lift upwards.
- Transfer the invertebrates to a collection basin that has water in it. Handle them gently to avoid crushing or maiming them.
- Transfer the invertebrates to a second basin as you identify and count them.
- Return the invertebrates to the study area.

Show what you learned …

- Invertebrates are indicators of water quality. What was the dominant invertebrate species found in the study area?
- Produce a bar graph with number of invertebrates on the *y*-axis and type of invertebrates on the *x*-axis **or** compile the data on a spreadsheet.
- What can be concluded about the water quality of the study area based upon the invertebrates collected?

Lab 3: Soil Study

Background

Soil is important for plant growth and provides habitat for terrestrial organisms.

Soil characteristics include: colour, particle size, evidence of plant and animal life, texture of soil (rough/smooth, odour of soil (musty/odourless), moisture (wet/dry), effect of settling, soil percolation.

The quality and type of soil that surrounds a watershed indicates the quality and type of healthy plant growth. Healthy plant growth prevents erosion, provides shade for cooling the water, and provides a barrier to run-off.

Aim

To investigate the components of soil from four different areas in a given watershed area.

Materials

- 4 plastic containers with lids or zipper seal bags
- garden trowel
- magnifying glass
- microscope (in class)
- 4 jars or beakers with lids
- glass slides/cover slip (for microscope work)

Safety

- Wear disposable gloves when carrying out this lab.
- Clean up the study area after you complete the lab.
- Use a sanitizing or antibacterial gel/wipe to clean hands.

Procedure

- Find four different areas where soil can be collected from the study area. Include a variety of places such as a wooded area, mud flat, flat plain, hill.
- At each location, fill a container half full with the soil and the surface-level components. Take care not to take too much soil so that the study area remains relatively undisturbed.
- Label the containers with the location of the samples.
- Bring the samples back to school and analyze them with both a magnifying glass and a microscope.
- Complete the chart with your findings.

Settling Test

- Transfer the soil samples to clear jars and fill with water. Stir the contents and replace the lids. Let the jars stand over night.
- Examine the contents of each jar carefully.
- Describe what you see.
  - Has the soil settled in layers?
  - Are some materials floating on the surface of the water?

Soil Characteristic	Site 1	Site 2	Site 3	Site 4
Colour				
Particle Size				
Evidence of Plant and Animal Life				
Texture of Soil (rough/smooth)				
Odour of Soil (musty/ odourless)				
Moisture (wet/dry)				
Effect of Settling				
Soil Percolation				

Show what you learned …

- How are the four samples different? How are they similar?
- Describe the evidence of living things in the soil samples.
- Compare the composition of each sample. Describe the kind of non-living things that were found in the soil. Account for the variations.