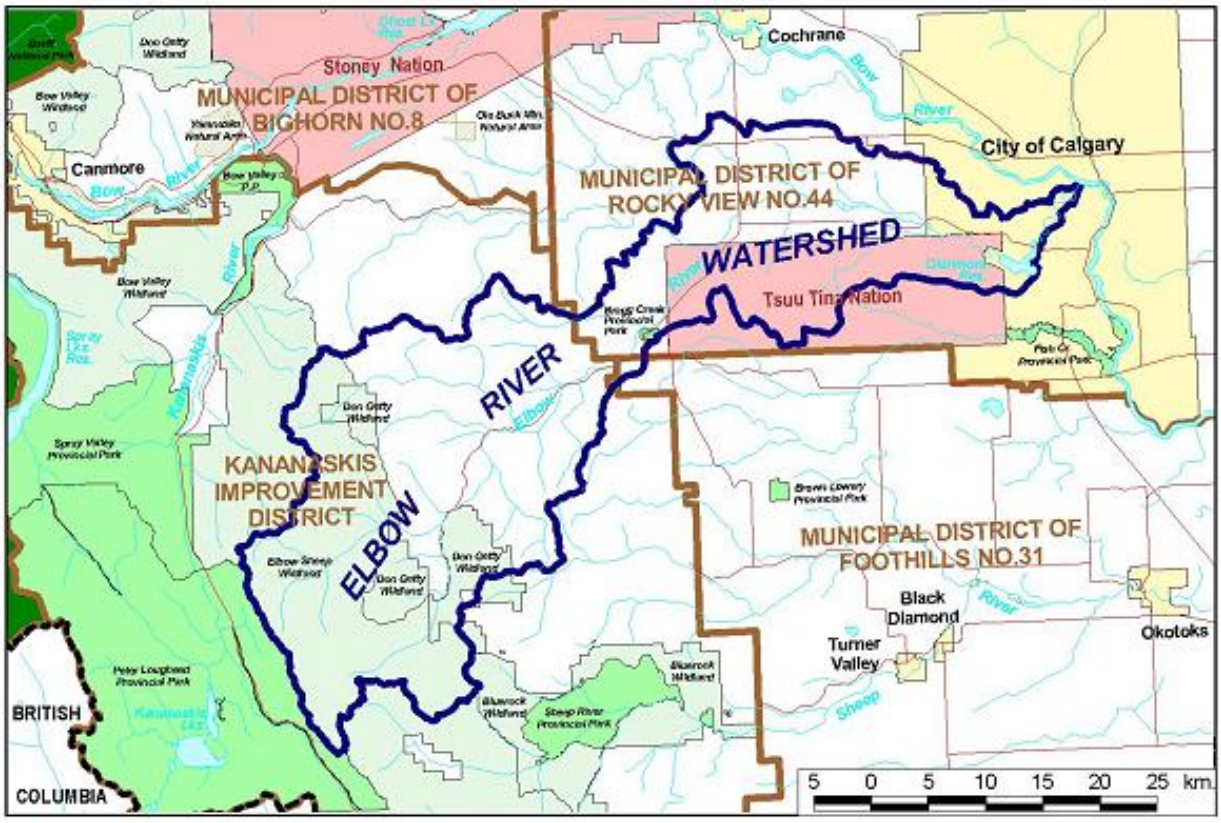
Aquatic Ecosystems: The Elbow River

An Educational Field Study for Biology-20 Students



Bow River Basin Council

Alberta Government

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Acknowledgements

The development of this field study program was made possible through a partnership between Alberta Tourism, Parks and Recreation, the Friends of Kananaskis Country, and the Elbow River Watershed Partnership. The program was written and compiled by the Environmental Education Program in Kananaskis Country and the field study equipment and programming staff were made possible through the Friends of Kananaskis Country with financial support from the Elbow River Watershed Partnership, Alberta Ecotrust, the City of Calgary, and Lafarge Canada. The Elbow River Watershed Partnership also provided technical support and expertise.

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This program is made possible through efforts of the following sponsors both past and present:

Aquatic Ecosystems – The Elbow River

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 PROGRAM AT A GLANCE

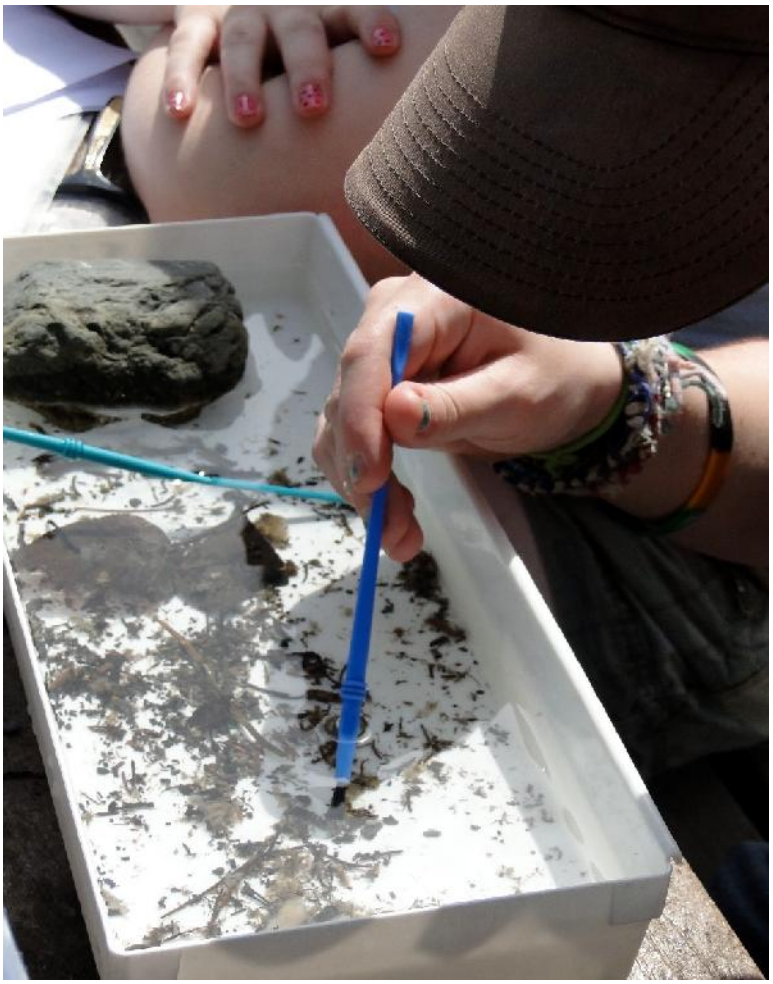
Curriculum Connections: Biology 20: Ecosystems and Population Change

Time Required: Preparatory Activities: approximately 5 classes (hours)
Field Study Activities: Full Day
Post-Program Activities: approximately 3-4 classes (hours)

Adult Recommendations: 1 Environmental Educator (program facilitator)
1 Teacher / Educator
1 Volunteer for each group of 5-6 students (3 minimum)

Ideal Season: Spring (May and June)
Fall (September and October)

Location: The program is designed for the Elbow River Watershed; however, adaptations can be made for other watersheds in Alberta



1.2 PROGRAM OVERVIEW

Welcome to ***Aquatic Ecosystems: The Elbow River***, a field study designed for Bio-20 students.

This is a curriculum-connected full-day study of the Elbow River with multidisciplinary post-activity support. The intent of this program is to provide a hands-on, engaging outdoor component, which adheres to the requirements of the Alberta Programs of Studies, which include for Biology-20 students *Unit B: Ecosystems and Population Change*. This program is also written to achieve the mandate of the Alberta Tourism, Parks, and Recreation division, and also addresses the four program goals of preservation, outdoor recreation, heritage appreciation, and heritage tourism.

The following preparatory activities are designed to prepare students for an off-site visit to the Elbow River. These activities focus on introducing students to the watershed monitoring area, related vocabulary, water testing procedures, and the expectations of safe and appropriate behaviour within a protected area. They will also attempt to further the students' ability to make predictions, and encourage them to develop a non-biased awareness of the various human impacts affecting the watershed.

The field study strongly incorporates the idea that the "rivers are an expression of our landscape." Students are challenged to predict and discover what is occurring not only in the river, but in the surrounding environment as well. Students will have the opportunity to monitor the Elbow River from the pristine waters of Elbow Falls in Kananaskis all the way to the city limits of Calgary. Traveling by bus, students will stop at key locations and test the water for various biotic and abiotic factors including dissolved oxygen levels, the presence of nitrates and phosphates, pH levels, turbidity, temperature, as well as the presence of invertebrate species. They will also have an opportunity to observe and discuss different types of both land uses and human activity occurring in the area.

Post program activities are intended to bring the program to a close for the students. Students will compile all the data collected during the field study and discuss reasons for any variations observed. Activities are prepared for students to explore the dynamics of water allocations and to discuss their personal role in water protection with the promotion of student action and stewardship.

2.0 PREPARATORY ACTIVITIES *(FOR STUDENTS)*

2.1 FIELD STUDY INTRODUCTION

Objectives:

- To introduce the concept of watersheds to students and to discuss where water is located in Alberta.
- To introduce the Elbow River watershed and the field study to students

Materials:

- "Mean Annual Discharge" visual
- "Where Alberta's Water Ends Up" visual
- "Map of the Elbow river watershed" visual
- "What do the water tests mean?" visual
- Whiteboard and projector or SMART board

Time Required:

Approximately 30 to 45 minutes

Instructions:

1. Class Review of Watersheds

- "Water on the Brain"– As a class, brainstorm words associated with watersheds and write those on the board, then have the class devise a possible definition for a watershed.
    - One definition is: *A watershed is an area of land that drains into a body of water.*
    - Another definition is: "*The land catches water just like a big bowl or basin"…* which is why a watershed is often called a drainage basin.
- The Watersheds in Alberta
    - Mount the "Mean Annual Discharge" visual onto a projector/SMART Board and discuss the major water arteries in Alberta. Compare where the majority of the water is in Alberta (60% is in the north) and where most of Alberta's population is (90% is within 100 km of the Canada / US border).
    - Discuss what implications this might have for water management and conservation.
    - Show the visual "Where Alberta's Water Ends Up" to further highlight where the river water in Alberta goes (water from the Elbow River ends up in Hudson's Bay).

2. Examine Elbow River Watershed

- Allow students to familiarize themselves with the area they will be studying. Introduce a variety of land uses in the Elbow River Watershed.

3. **(Optional) "Kananaskis Education Freshwater Field Study Equipment" Video**
    - Search YouTube for the video mentioned above. Alternatively, the link can be found here at
    - https://www.youtube.com/watch?v=U5fK7nbRwAE
    - The above video discusses how to use and care for the equipment and it gives an example of each water quality test in order to give students a baseline to make predictions for their results.
    - (Pausing the video to work on the focusing questions which appear after the demonstration of each test is another option)
    - Discuss the "What do the Water Tests Mean?" handout with the students, and/or allow them to read it before or after the video

Focusing Questions

Nutrient test

- Where would the river have a higher amount of nutrients in the water? Where would it have less?

Dissolved Oxygen

- Why is dissolved oxygen important? Where do you predict the dissolved oxygen reading to be the highest?

Invertebrates

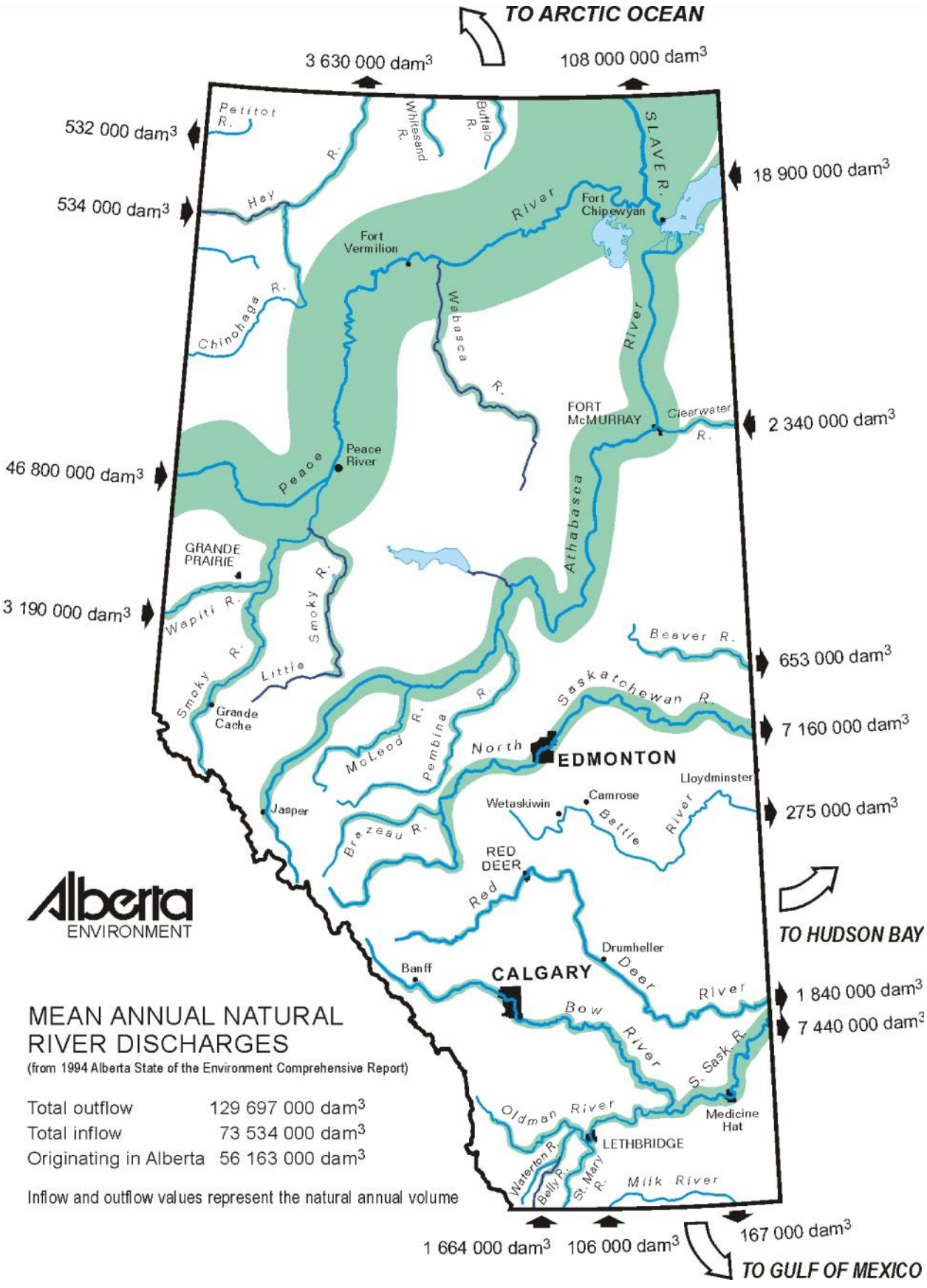
- How many invertebrates do you expect to find? How big do you think they might be?

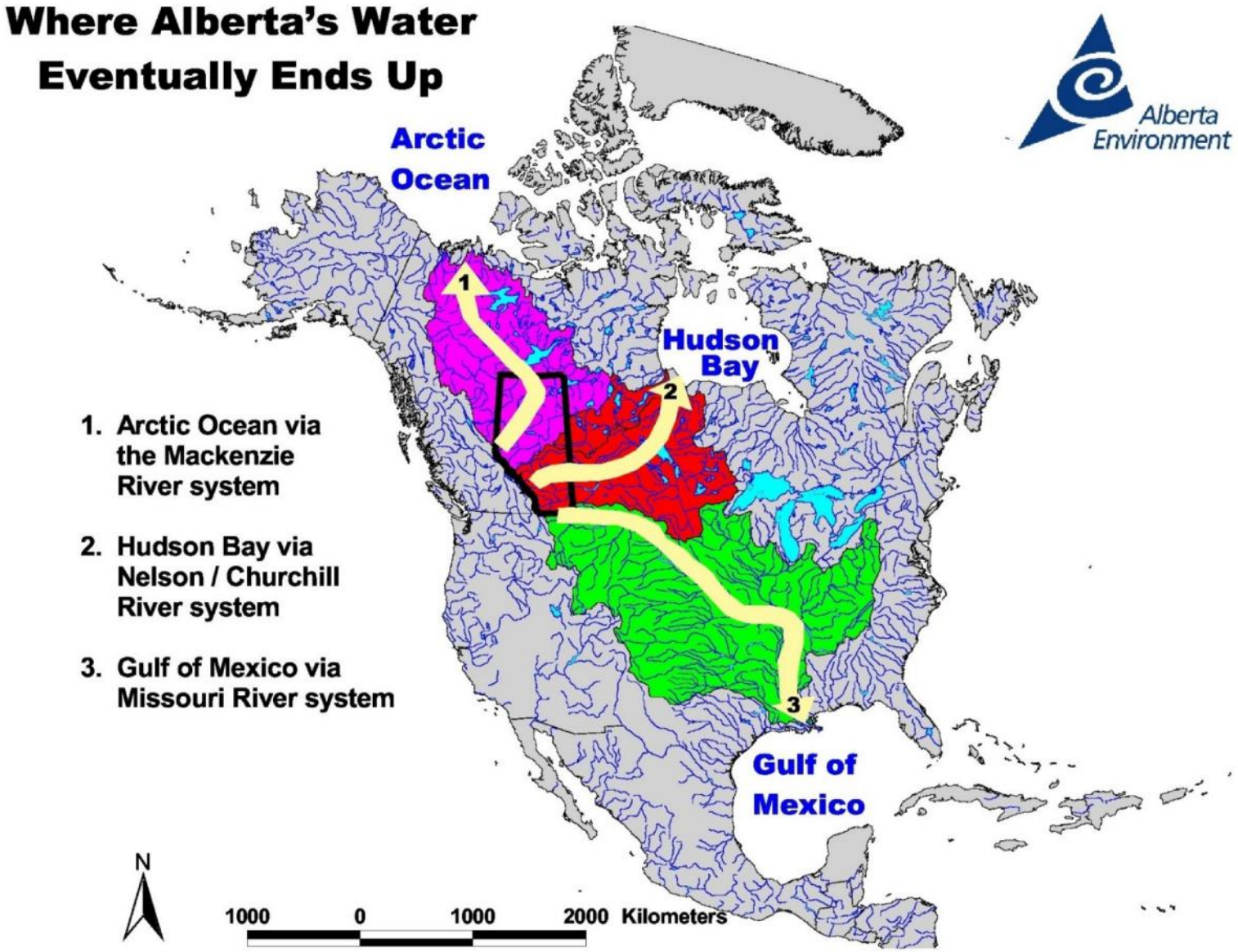
Turbidity

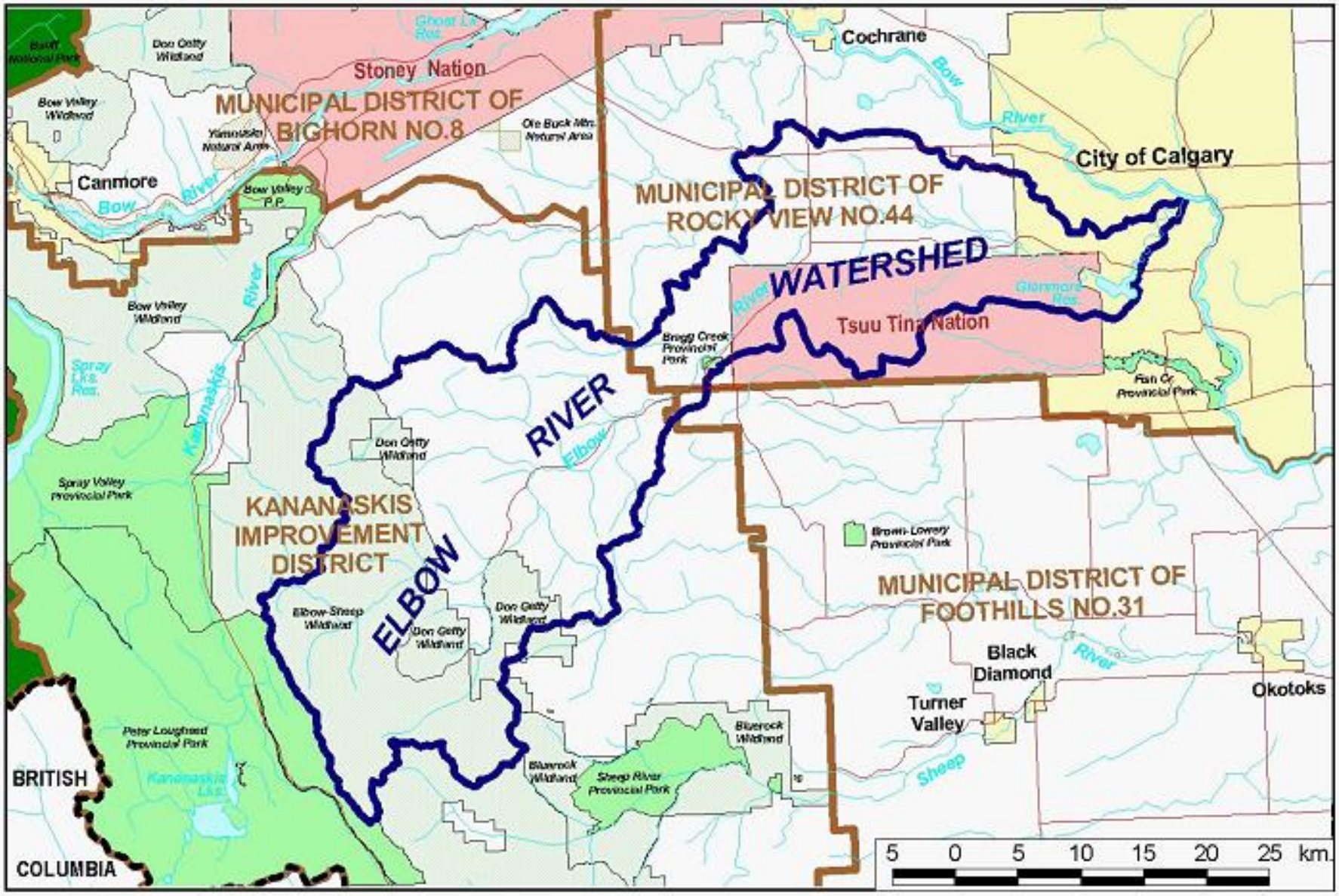
- Where do you predict the river to be more turbid?

pH and Temperature

- What factors could be affecting temperature? What factors could affect pH levels?

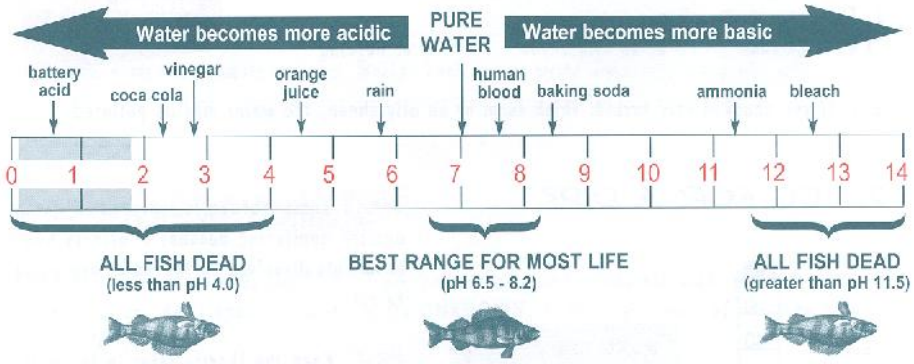

TO ARCTIC OCEAN
3 630 000 dam3
108 000 000 dam3
532 000 dam3
534 000 dam3
18 900 000 dam3
46 800 000 dam3
3 190 000 dam3
2 340 000 dam3
653 000 dam3
7 160 000 dam3
275 000 dam3
1 840 000 dam3
7 440 000 dam3
167 000 dam3
1 664 000 dam3
106 000 dam3
TO HUDSON BAY
TO GULF OF MEXICO
Petitot R.
Whitesand R.
Buffalo R.
Hay R.
SLAVE R.
Fort Chipewyan
Fort Vermilion
River
Chinchaga R.
Wabasca R.
River
FORT McMURRAY
Clearwater R.
Peace River
Peace
Athabasca
GRANDE PRAIRIE
Wapiti R.
Smoky R.
Little Smoky R.
Beaver R.
Saskatchewan R.
Grande Cache
McLeod R.
Pembina R.
North EDMONTON
Lloydminster
Jasper
Wetaskiwin
Camrose
Battle River
Brazeau R.
RED DEER
Red Deer River
Drumheller
Banff
CALGARY
Bow River
S. Sask. R.
Medicine Hat
Oldman River
LETHBRIDGE
Waterton R.
Belly R.
St. Mary R.
Milk River
Alberta
ENVIRONMENT
MEAN ANNUAL NATURAL RIVER DISCHARGES
(from 1994 Alberta State of the Environment Comprehensive Report)
Total outflow 129 697 000 dam3
Total inflow 73 534 000 dam3
Originating in Alberta 56 163 000 dam3
Inflow and outflow values represent the natural annual volume


Where Alberta's Water Eventually Ends Up
Alberta Environment
Arctic Ocean
Hudson Bay
Gulf of Mexico
1. Arctic Ocean via the Mackenzie River system
2. Hudson Bay via Nelson / Churchill River system
3. Gulf of Mexico via Missouri River system
1
2
3
N
1000 0 1000 2000 Kilometers


Stoney Nation
MUNICIPAL DISTRICT OF BIGHORN NO.8
Cochrane
City of Calgary
MUNICIPAL DISTRICT OF ROCKY VIEW NO.44
WATERSHED
Tsuu Tina Nation
RIVER
ELBOW
KANANASKIS IMPROVEMENT DISTRICT
MUNICIPAL DISTRICT OF FOOTHILLS NO.31
Canmore
Bow River
Black Diamond
Turner Valley
Okotoks
BRITISH
COLUMBIA
5 0 5 10 15 20 25 km

What do the Water Tests Mean?

pH



Source: Water Watchdogs (Saskatchewan River Basin)

Temperature	Temperature is monitored because it affects how chemicals dissolve in the water and affects the amount of dissolved oxygen in the water. An increase in temperature indicates there is heat coming from: • An input source (e.g. effluent from a factory) • Loss of the riparian area (trees) surrounding the river, which means the sun is heating up the water more than it would with trees around it.
Turbidity	Increased turbidity or lack of clarity means there is a large amount of sediment in the water. An increase in turbidity results in: • Decreased fish egg survival. • Predators that rely on their eyes to hunt are ineffective. • Chemicals can attach to dirt and be dissolved in the river. • "A fish in turbid water is like a human in a smoke-filled room."
Dissolved Oxygen	• High oxygen content = many invertebrates • Low oxygen (eutrophication) = a dying ecosystem • As temperature decreases, dissolved oxygen increases.
Nitrates	• Nitrates (which are nutrients) occur naturally in small amounts from decomposition in the atmosphere. • Other sources come from pesticides, fertilizers, and manure. • Excess nitrates can cause too much plant and algae to grow in the water, which reduces oxygen and could cause death in some aquatic animals.
Phosphates	• Phosphates (also nutrients) occur naturally in small amounts from soils and rock that leach into the water. • Phosphates are also from detergents occurring in some soap, pesticides which are toxic to invertebrates, and fertilizers.
Invertebrates	• Invertebrates are environmental indicators (something that tells you whether the environment is healthy). • The presence of those invertebrates, which are only able to live in pristine conditions, indicates a high water quality. Examples of these invertebrates include: stonefly, mayfly, and caddisfly larvae. Examples of invertebrates that can tolerate low oxygen levels and high nutrient levels are: blackfly larvae, leech, bristleworm

2.2 SCIENTIFIC ROLES

Objective:

- To familiarize students with the group structure and students' roles during the field study.

Materials:

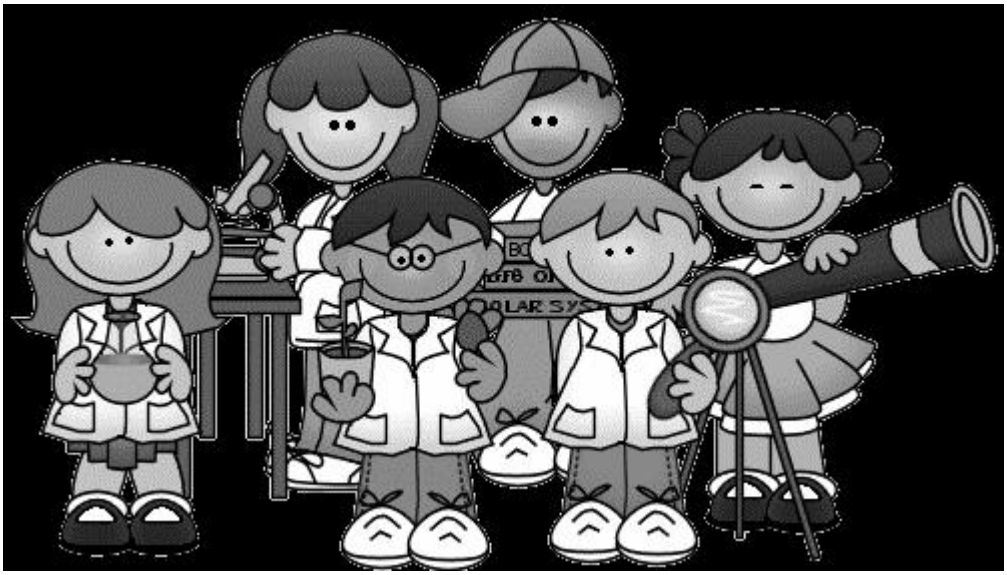
- Scientific team roles (visual)

Time Required:

- 20 minutes

Instructions:

- Divide students into 5 or 6 scientific research groups with approximately 5 or 6 students in each group (this may have already been done with previous activities)
- Assign or have student's pick a *scientific role* (see below) to ensure they know their responsibilities.



Scientific Team Roles:

Recorder (1 person):

- **Records all data** found by testers onto a chart.
- Also assists with identifying invertebrates
- **Sketches** the sampling sites (Elbow Falls, Redwood Meadows, and Twin Bridges)

Phosphate/Nitrate Test and Turbidity Test (2 people):

- Responsible for **Phosphate** or **Nitrate** test (each group will only be assigned one of the two)
- Also responsible for **Turbidity** test during the 10 minute wait period for the previous test
- Responsible for interpreting the results of these tests

PH, Temperature, Dissolved Oxygen (1 person):

- Responsible for **PH, Temperature** and **Dissolved Oxygen** tests
- Responsible for interpreting the results of these tests

Invertebrate Collector (1 or 2 people):

- Collects **Invertebrates** using net and bucket (must wear rubber boots, which are supplied)
- Assists recorder in identifying invertebrates.
- Properly **returns invertebrates** to river by gently pouring the contents of the bucket back into the river.

Once a group member has completed his/her role they must work together with other group members to complete any outstanding tests and reflect on the land use impacts up river from the sampling site.

All students are responsible for RIVER SAFETY and EQUIPMENT CARE

2.3 VOCABULARY

Abdomen: The rear region of an invertebrate. See Figure 1.

Abiotic: Non-living characteristics of an ecosystem. In aquatic ecosystems this includes temperature, pH, turbidity and nutrients.

Anterior: The head end of an organism. See Figure 2.

Benthic Zone: The lowest level of an aquatic ecosystem, the sediment surface as well as within the sediment. In a freshwater system it is the region in the bottom of the river or lake. See Figure 3.

Biotic: Living characteristics of an ecosystem; the organisms living within an ecosystem.

Cerci: Appendages on the rear-most (abdominal) section of an invertebrate. See Figure 1.

Collector: Invertebrates that feed on small bits of organic matter (less than 1mm) by filtering them from passing water or gathering them from the stream bottom.

Community: The living organisms within an ecosystem that interact with each other.

Competition: Interaction between organisms that are attempting to use the same limited resource. This can take the form of many factors including: nutrients, oxygen, or space.

Dichotomous Key: Reference tool for identifying organism by choosing between two characteristics (usually presence/absence) in a sequence.

Diversity: Measure of the number of species and their abundance (or richness) in a community or ecosystem.

Dorsal: Refers to the back of the organism. See Figure 2.

Ecosystem: The interaction between biotic communities and their abiotic environment.

Grazer: Invertebrates that feed on algae attached to rocks or logs. Example: caddis fly.

Habitat: The area where an organism or community lives.

Invasive species: A non-native species that has been introduced into an area outside of its range where it has been able to out-compete native species and has had a negative impact on their ability to survive. Example: dandelions.

Limiting Factor: An abiotic characteristic that limits growth, distribution, or diversity of organisms within an ecosystem. The limiting factor is the resource that is in shortest supply in an ecosystem.

Limnetic Zone: Layer of open water in an aquatic ecosystem that is not influenced by the shore. This layer extends from the surface to the profundal zone. Light penetrates this layer so photosynthesis can occur here. Also known as the *pelagic zone*. See Figure 3.

Littoral Zone: This is the vegetated region of an aquatic ecosystem. It extends from the shore to where light is no longer sufficient to support rooted plants. This zone borders the limnetic zone. See Figure 3.

Niche: The role of an organism in an ecosystem.

Posterior: The hind end of an organism. See Figure 2

Predator: Invertebrates that feed on other animals in the stream.

Profundal Zone: The layer of water just above the benthic layer in an aquatic ecosystem. The light levels in this layer are too low to support photosynthesis. See Figure 3.

Shredder: Invertebrates that feed on large pieces of organic matter, such as leaves, that fall into the stream.

Tarsal: Referring to the last section of the legs. See Figure 1.

Thorax: The middle region of an invertebrate, between the head and abdomen. This region bears the wings and legs. See Figure 1

Ventral: Refers to the front or belly of the organism. See Figure 2.

Figure 1: General Anatomy of an Invertebrate

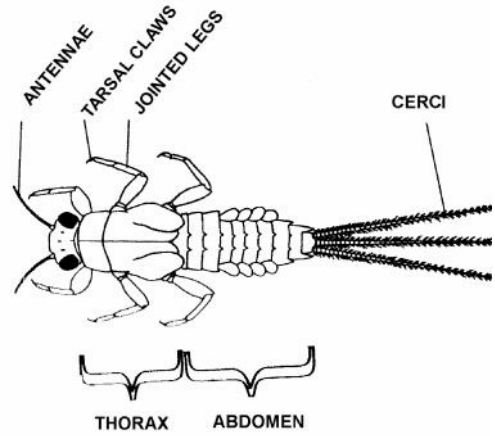


Figure 2: Dorsal-Ventral and Anterior-Posterior Orientation of an Invertebrate

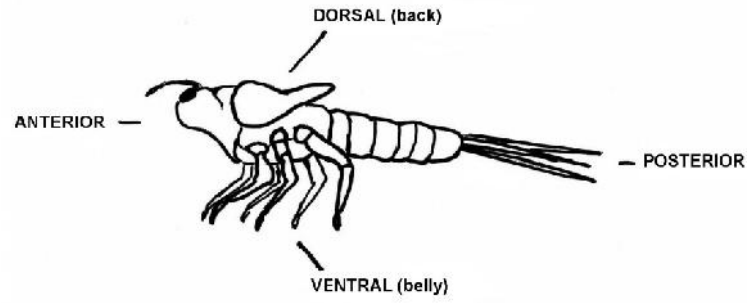
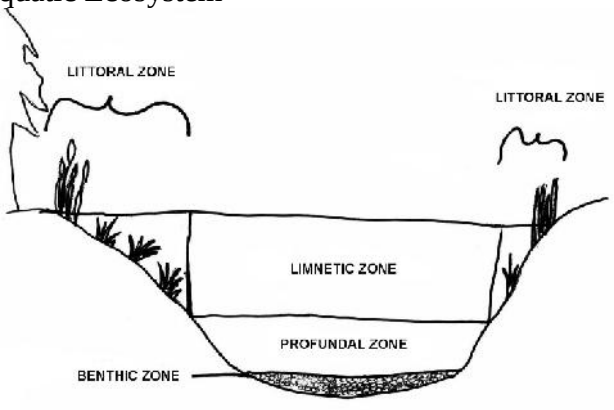


Figure 3: Zones of an Aquatic Ecosystem



2.4 CLASS DISCUSSION ABOUT THE FIELD STUDY

Objective:

- To conduct a class discussion focusing on the specifics of the actual field study day

Time Required:

- 30 minutes

Instructions:

Discuss the following checklist of items in class prior to the field study day:

1. **Behavioral expectations on the field study and important park rules**.
   The intent of parks and protected areas is to protect and preserve the natural environment. Have the class make a list of behaviours on the field study that would show respect for living things and a commitment to their care. An initial list could include:
   - Leaving nests, rotting logs and ant hills alone and intact. These are homes for small animals.
   - Staying on the trails.
   - Litter should be placed in a garbage can or in your pocket.
   - Walking carefully, watching each step to avoid crushing small plants and trees.
   - Cutting, defacing, picking, or removal of any plant, fossil, rock, or other park material is prohibited.
   - Observing wildlife from afar without disturbance (or feeding). This includes decomposable food such as orange peels and other commonly disposed of items such as sunflower seed shells.
   - Brainstorm others with the class…with emphasis on 'why' this rule is in place.

2. **Parks and protected areas have four main program objectives.**
   Initiate a conversation with the students regarding how these objectives could be balanced:
   - **Preservation**: to preserve in perpetuity a network of parks and protected areas that represent the diversity of the province's natural heritage, as well as related cultural heritage
   - **Heritage Appreciation**: to provide opportunities to explore, understand and appreciate the natural heritage of Alberta, as well as to enhance public awareness and our relationship to it
   - **Outdoor Recreation**: to provide a variety of outdoor recreation opportunities dependent on natural landscapes, as well as related facilities and services.
   - **Heritage Tourism**: to encourage residents and visitors to the province in order to discover and enjoy Alberta's natural heritage through a variety of outdoor recreation and nature-based tourism opportunities, facilities, and accommodation services.

3. **Litter-free lunch concept**
   Using reusable containers and cloth bags during lunch can significantly reduce litter. (ie. Why an orange peel, while biodegradable, is still considered litter that should be packed or properly disposed of. ("If it didn't grow there, it can't stay there.")
4. **Water safety**:
   The following chart identifies some potential hazards to consider around water and the discussion that could take place on how to minimize these hazards:

Potential Hazards	Minimizing Hazards
Slippery Rocks	Step carefully Avoid algae-covered rocks
Falling into river	Be with a partner when by the bank Watch footing and water level depth
Getting wet and cold	Bring proper wet boots Bring extra clothes or hand towel
Getting lost	Always stay with a partner and by the group
Sunburn	Wear sunglasses, sunscreen and a hat
Broken Glass	Always wear shoes and be watchful Notify teacher if glass is found Pick up and keep your garbage with you Avoid bringing glass containers in your lunch
Discussing other hazards…	

NOTE: The above hazards can be added to school board forms.

5. **Appropriate clothing**
   Students should be appropriately dressed for the season and the activities of the day. Students should wear several layers of clothing, including a water resistant layer and a hat or hood. Boots provide more protection than sandals or canvas runners. Rubber boots will be provided for the stream study. If it's warm and sunny, students should have sunscreen, hats, and insect repellent (if sensitive to bites).

3.0 PREPARATORY ACTIVITIES *(FOR TEACHERS)*

3.1 CHECKLIST FOR FIELD STUDY DAY

Logistical Notes:

- Confirm departure and pick up times and dates for transportation. Some bus companies may also be reluctant to travel into the Elbow valley area (Highway 66).
- Sample itinerary (this will be adjusted based on your school's schedule, bussing, and available time). Five hours is the approximate time required to run an optimal program.

8:45 a.m.– depart from school	→	*9:30 a.m.– arrive at Elbow Valley Visitor Centre*
9:45 a.m.– arrive at Elbow Falls	→	*11:00 a.m.– depart Elbow Falls*
11:05 a.m. – arrive at Boat Launch	→	*11:35 a.m.– depart Boat Launch*
11:45 p.m.-arrive at McLean Creek	→	*12:15p.m - depart McLean Creek*
12:35 p.m.– arrive at Red Wood Meadows	→	*1:10 p.m. – depart Red Wood Meadows*
1:30 arrive at Twin Bridges	→	*2:15 p.m. – depart for school*

- Schedule the field study day with the Kananaskis Environmental Educator. Have a cheque prepared for field trip and deliver it to your parks programmer on the day of the trip.

- This program runs more efficiently if there is at least one adult with each group of students (average is 5-6 groups) while conducting tests on the river. *Any volunteers will also require the following information:*
  - All activities planned and the schedule for the day
  - A map and/or directions (if they are driving their own vehicle and planning to meet you there)
  - Health concerns, discipline issues, and expectations for students.

- Ensure all students are dressed appropriately; check the weather prior to your field study http://www.theweathernetwork.com. Remember, rain gear for all students is essential.

- Discussion with class (previous section) prior to the trip to review park rules, litter-free lunch, and behavioural expectations.

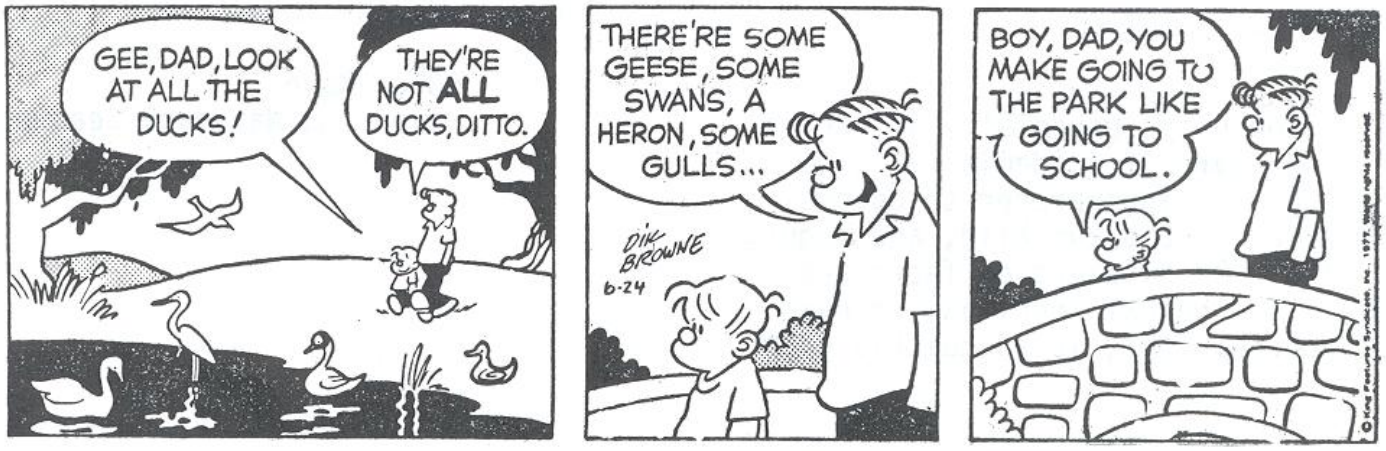
- Please see sample permission forms below

Photocopies required for the field study
- Field study data sheets (one for each group)
- Evaluation forms
  - Teacher evaluation of program
  - Student evaluation of field trip
  - Group work evaluation

Additional items to bring on the field study:
- Class list and list of students with health/allergy concerns.
- First Aid kit.
- Spare clothing for students.

3.2 SAMPLE PARENT/GUARDIAN PERMISSION FORM

The following pages contain sample parent permission forms with specific information of the field study for your students and their parents. Feel free to change or add any information required, or use as is.



Date: _____

Aquatic Ecosystems: The Elbow River
Biology-20 Field Study

Dear Parents / Guardians:

As part of this year's science unit on *Ecosystems and Population Change*, we are currently planning a class field trip to the Elbow valley. The students will be monitoring the water quality of the Elbow River using scientific testing equipment. This one-day field experience begins near the headwaters of the Elbow River within Kananaskis Country. The students will then follow the flow of the Elbow River, testing the water quality at various locations, and analyzing how it may change as it enters the city of Calgary.

Field Study Date: _____

Field Study Location: _____

Departure time from School: _____

Arrival time back at School: _____

Cost: _____

The cost of this program includes transportation, service provided (Kananaskis Country Environmental Education staff), field study equipment, and program development expenses. Please contact the teacher in charge of the field trip if there are any concerns about the cost of this field study.
Please make cheques payable to: _____

Volunteers are required. The students will be organized into groups of approximately 5 students. Each group will have a parent volunteer to assist and facilitate student efforts in completing the field study activities. The environmental education staff and the teacher will provide all field study instruction. There is no cost for volunteers. If you are interested in participating as a volunteer, please complete the lower portion of this sheet.

Complete and return the lower portion of this form on or before: _____

I _____ give permission for _____ to
(parent /.guardian) (student name)

attend the field study on _____ at _____
(date) (location)

_____ Yes, I am interested in volunteering for the field study

_____ No, I am not able to volunteer on the field study

_____
Signature

4.0 FIELD STUDY DATA SHEET

AQUATIC ECOSYSTEMS:
The Elbow River

Biology-20

Data Sheet

4.1 FIELD STUDY ITINERARY

(Including locations, discussion topics, and activities. May be subject to change)

Stop #1: Elbow Falls

- What is an ecosystem?
- Discuss the protection of the headwaters and the role of Parks and Protected areas in the Elbow River watershed
- Discuss significance of tests
- Conduct sampling of abiotic and biotic characteristics of the testing site
- Sketch the field study site and make visual observations of the site
- Predict variations in the abiotic and biotic characteristics as we travel downstream

Stop #2: Elbow River Boat Launch

- Introduction to Oil & Gas impacts on water
- Introduction to Forestry impacts on water
- Introduction to Agricultural impacts on water
- Discuss mitigation efforts and/or activity in relation to these land uses

Stop #3: McLean Creek

- Discuss and observe off highway vehicle use and potential impact on the ecosystem
- Discuss mitigation efforts
- Initiate land use debate OR Take a Stand activity OR turbidity activity
- Washroom break (lunches to be eaten during travel time)

Stop #4: Redwood Meadows

- Discuss municipal development's impact on the watershed
- Conduct sampling of abiotic and biotic characteristics of the testing site.
- Sketch the field study site and make visual observations of the site.
- Predict variations in the abiotic and biotic characteristics as we travel downstream.
- Discuss the variation in results of the tests conducted from the first testing site to the second and the possible impacts of land uses previously discussed
- Discuss scientific/human error as well as equipment limitations.

Stop #5: Twin Bridges - Calgary City Limits

- Conduct sampling of abiotic and biotic characteristics of the testing site.
- Determine the diversity index for the site.
- Sketch the field study site and make visual observations of the site.
- Discuss the changes in the abiotic and biotic characteristics of the Elbow River from the beginning of the study to the end and hypothesize about the causes of these variations.

Final Activity

- Wrap up with comparisons of group predictions and results
- Activity to instill a sense of stewardship towards water and protected areas (time permitting)

4.2 FIELD STUDY DATA SHEET

Group Members: _____ _____

_____ _____

_____ _____

Information

Date: _____ **Time:** _____

Weather: _____

Important Student Reminders:

- Fill out all the required data at each sampling location, as well as any necessary calculations.
- A group member must complete a sketch at each sampling site.
- As a group, discuss the *visually observable characteristics* of each site, any upstream land uses, and predictions and record your conclusions in the observation section of your data sheet.
- **Use care and attention when handling all sample equipment – your school will be charged for lost or broken items!**
- Enjoy the day outdoors!

Student Task Reminder

Scientific Team Roles:

Recorder (1 person):

- **Records all data** found by testers onto a chart.
- Also assists with identifying invertebrates
- **Sketches** the sampling sites (Elbow Falls, Redwood Meadows, and Twin Bridges)

Phosphate/Nitrate Test and Turbidity Test (2 people):

- Responsible for **Phosphate** or **Nitrate** test (each group will only be assigned one of the two)
- Also responsible for **Turbidity** test during the 10 minute wait period for the previous test
- Responsible for interpreting the results of these tests

PH, Temperature, Dissolved Oxygen (1 person):

- Responsible for **PH, Temperature** and **Dissolved Oxygen** tests
- Responsible for interpreting the results of these tests

Invertebrate Collector (1 or 2 people):

- Collects **Invertebrates** using net and bucket (must wear rubber boots, which are supplied)
- Assists recorder in identifying invertebrates.
- Properly **returns invertebrates** to river by gently pouring the contents of the bucket back into the river.

Once a group member has completed his/her role they must work together with other group members to complete any outstanding tests and reflect on the land use impacts up river from the sampling site.

All students are responsible for RIVER SAFETY and EQUIPMENT CARE

TESTS FOR ABIOTIC CHARACTERISTICS IN THE ELBOW RIVER				
		HEADWATERS Elbow Falls	**MID-RIVER Red Wood Meadows**	**STUDY END Twin Bridges**
ABIOTIC CHARACTERISTICS	**pH**			
	Temperature (ºC)			
	Turbidity (cm)			
	Dissolved Oxygen (mg/L)			
	Nitrates (mg/L)			
	Phosphates (mg/L)			

*** REMEMBER to write down your *observed characteristics* for each testing site.**

TESTS FOR BIOTIC CHARACTERISTICS IN THE ELBOW RIVER

HEADWATERS - Elbow Falls

SAMPLE #1 - HEADWATERS				
Common Name	**Family Name**	**Ecological Role** (collector, grazer, predator, shredder, etc.)	**Number of Individuals**	**Average Length (cm)** Note very small or large individuals
Total Number of Individuals in Sample:				**N/A**

If you have time, do a second sample. Use the additional tables on the last page to record your results.

Once samples have been taken at this testing site, calculate the biodiversity index:

1. Record the number of families you identified
2. Count the total number of individuals you found
3. Divide the number of families by the number of individuals

Biodiversity Index -Headwaters	
Number of Families:	
Total Number of Individuals for Site:	
Diversity Index: $\frac{\text{\# of families}}{\text{\# of individuals}}$	

Testing Site #1: HEADWATERS – Elbow Falls Study Site

Sketch a cross section of the river at this site:

List any observable characteristics at this site:

List the land use impacts upstream from the study site:

What are your predictions for the next site regarding the abiotic and biotic characteristics tested?

What are some possible errors that influenced the test results at this site?

TESTS FOR BIOTIC CHARACTERISTICS IN THE ELBOW RIVER

MID-RIVER - Red Wood Meadows

SAMPLE #1 – MID-RIVER				
Common Name	**Family Name**	**Ecological Role** (collector, grazer, predator, shredder, etc.)	**Number of Individuals**	**Average Length (cm)** Note very small or large individuals
Total Number of Individuals in Sample:				**N/A**

If you have time, do a second sample. Use the additional tables on the last page to record your results.

Once samples have been taken at this testing site, calculate the biodiversity index:

1. Record the number of families you identified
2. Count the total number of individuals you found
3. Divide the number of families by the number of individuals

Biodiversity Index – Mid-River	
Number of Families:	
Total Number of Individuals for Site:	
Diversity Index: # of families___ # of individuals	

Testing Site #2: MID-RIVER – Red Wood Meadows Study Site

Sketch a cross section of the river at this site:

List any observable characteristics at this site:

List the land use impacts upstream from the study site:

What are your predictions for the next site regarding the abiotic and biotic characteristics tested?

What are some possible errors that influenced test results at this site?

TESTS FOR BIOTIC CHARACTERISTICS IN THE ELBOW RIVER

STUDY END – Twin Bridges: Calgary City Limits

SAMPLE #1 – STUDY END				
Common Name	**Family Name**	**Ecological Role** (collector, grazer, predator, shredder)	**Number of Individuals**	**Average Length (cm)** Note very small or large individuals
Total Number of Individuals in Sample:				**N/A**

If you have time, do a second sample. Use the additional tables on the last page to record your results.

Once samples have been taken at this testing site, calculate the biodiversity index:

1. Record the number of families you identified
2. Count the total number of individuals you found
3. Divide the number of families by the number of individuals

Biodiversity Index – Study End	
Number of Families:	
Total Number of Individuals for Site:	
Diversity Index: $\frac{\text{\# of families}}{\text{\# of individuals}}$	

Testing Site #3: STUDY END - Twin Bridges: Calgary City Limits Study Site

Sketch a cross section of the river at this site:

List any observable characteristics at this site:

List the land use impacts upstream from the study site:

What are some possible errors that influenced test results at this site?

This is your last stop, however, if you were to test the Bow River as it was leaving Calgary, what would you predict your test results would be? Explain your reasoning.

TESTS FOR BIOTIC CHARACTERISTICS IN THE ELBOW RIVER

ADDITIONAL TABLES FOR SECOND SAMPLE

SAMPLE #2 LOCATION:				
Common Name	**Family Name**	**Ecological Role (collector, grazer, predator, shredder)**	**Number of Individuals**	**Average Length (cm) Note very small or large individuals**
Total Number of Individuals in Sample:				**N/A**

SAMPLE #2 LOCATION:				
Common Name	**Family Name**	**Ecological Role (collector, grazer, predator, shredder)**	**Number of Individuals**	**Average Length (cm) Note very small or large individuals**
Total Number of Individuals in Sample:				**N/A**

VOCABULARY

Abdomen: The rear region of an invertebrate. See Figure 1.

Abiotic: Non-living characteristics of an ecosystem. In aquatic ecosystems this includes temperature, pH, turbidity and nutrients.

Anterior: The head end of an organism. See Figure 2.

Benthic Zone: The lowest level of an aquatic ecosystem, the sediment surface as well as within the sediment. In a freshwater system it is the region in the bottom of the river or lake. See Figure 3.

Biotic: Living characteristics of an ecosystem; the organisms living within an ecosystem.

Cerci: Appendages on the rear-most (abdominal) section of an invertebrate. See Figure 1.

Collector: Invertebrates that feed on small bits of organic matter (less than 1mm) by filtering them from passing water or gathering them from the stream bottom.

Community: The living organisms within an ecosystem that interact with each other.

Competition: Interaction between organisms that are attempting to use the same limited resource. This can take the form of many factors including: nutrients, oxygen, or space.

Dichotomous Key: Reference tool for identifying organism by choosing between two characteristics (usually presence/absence) in a sequence.

Diversity: Measure of the number of species and their abundance (or richness) in a community or ecosystem.

Dorsal: Refers to the back of the organism. See Figure 2.

Ecosystem: The interaction between biotic communities and their abiotic environment.

Grazer: Invertebrates that feed on algae attached to rocks or logs. Example: caddis fly.

Habitat: The area where an organism or community lives.

Invasive species: A non-native species that has been introduced into an area outside of its range where it has been able to out-compete native species and has had a negative impact on their ability to survive. Example: dandelions.

Limiting Factor: An abiotic characteristic that limits growth, distribution, or diversity of organisms within an ecosystem. The limiting factor is the resource that is in shortest supply in an ecosystem.

Limnetic Zone: Layer of open water in an aquatic ecosystem that is not influenced by the shore. This layer extends from the surface to the profundal zone. Light penetrates this layer so photosynthesis can occur here. Also known as the *pelagic zone*. See Figure 3.

Littoral Zone: This is the vegetated region of an aquatic ecosystem. It extends from the shore to where light is no longer sufficient to support rooted plants. This zone borders the limnetic zone. See Figure 3.

Niche: The role of an organism in an ecosystem.

Posterior: The hind end of an organism. See Figure 2

Predator: Invertebrates that feed on other animals in the stream.

Profundal Zone: The layer of water just above the benthic layer in an aquatic ecosystem. The light levels in this layer are too low to support photosynthesis. See Figure 3.

Shredder: Invertebrates that feed on large pieces of organic matter, such as leaves, that fall into the stream.

Tarsal: Referring to the last section of the legs. See Figure 1.

Thorax: The middle region of an invertebrate, between the head and abdomen. This region bears the wings and legs. See Figure 1

Ventral: Refers to the front or belly of the organism. See Figure 2.

Figure 1: General Anatomy of an Invertebrate

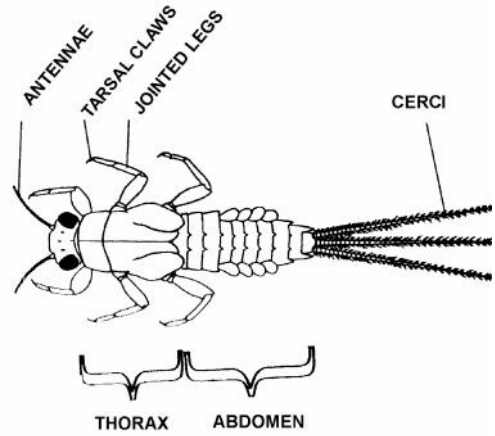


Figure 2: Dorsal-Ventral and Anterior-Posterior Orientation of an Invertebrate

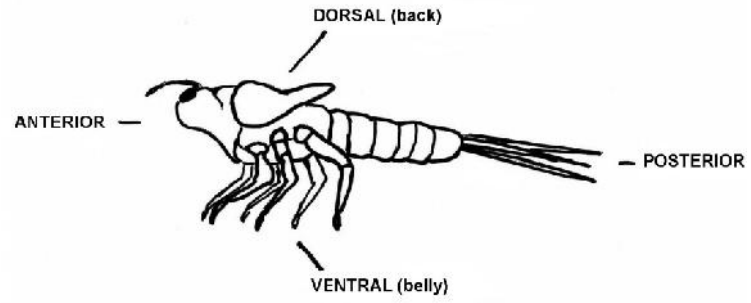
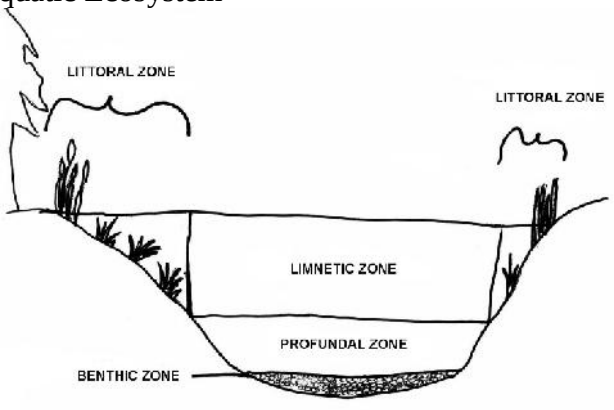


Figure 3: Zones of an Aquatic Ecosystem



5.0 POST FIELD STUDY ACTIVITIES

5.1 CONSOLIDATING CLASS DATA: PREDICTIONS VS. RESULTS

Objective:

- To make use of the data collected during the field study (consolidating, tabulating means and medians, etc.).
- To compare the predictions made with the observed and recorded results.

Materials: Consolidation chart (as visual or Excel spreadsheet)

Time Required:

- 45 minutes (or more)

Instructions:

- Compile data from all groups onto the consolidation chart.
- Create averages of all data, review consistencies and differences in measurements.
- Discuss why there is variation in scientific data (ie.) scientific error, testing anomalies
- Direct each group to discuss the differences between their pre-field study predictions and the actual results, or together as a class. What are the possible reasons for the differences?

  Examples
  - Time of day, week, or year
  - Changes in water quality due to procedures by industry, municipalities, and recreation
  - Sampling error (how would you determine if this was the case?)
    - Alberta Environment measurements
    - Repeating the tests (using the entire class's data compared to one group)
  - Compare class data to that of a single group

***Note:** this activity can precede the graphing activity (5.2) or students can be given this data to consolidate on their own during that activity.

If possible, please share this class data with the Environmental Educators of the field study program so they can provide this consolidated information to future classes.

CONSOLIDATED DATA FROM THE ELBOW RIVER FIELD STUDY				
		HEADWATERS Elbow Falls	**MID-RIVER Bragg Creek**	**STUDY END Calgary City Limits**
TESTS FOR ABIOTIC CHARACTERISTICS				
pH	Group 1			
	Group 2			
	Group 3			
	Group 4			
	Group 5			
	Group 6			
SITE AVERAGE				
Temperature (ºC)	Group 1			
	Group 2			
	Group 3			
	Group 4			
	Group 5			
	Group 6			
SITE AVERAGE				
Turbidity (cm)	Group 1			
	Group 2			
	Group 3			
	Group 4			
	Group 5			
	Group 6			
SITE AVERAGE				
Dissolved Oxygen (mg/L)	Group 1			
	Group 2			
	Group 3			
	Group 4			
	Group 5			
	Group 6			
SITE AVERAGE				
Nitrates (mg/L)	Group 1			
	Group 2			
	Group 3			
	Group 4			
	Group 5			
	Group 6			
SITE AVERAGE				

CONSOLIDATED DATA FROM THE ELBOW RIVER FIELD STUDY				
		HEADWATERS Elbow Falls	**MID-RIVER Bragg Creek**	**STUDY END Calgary City Limits**
Phosphates (mg/L)	Group 1			
	Group 2			
	Group 3			
	Group 4			
	Group 5			
	Group 6			
SITE AVERAGE				
TESTS FOR BIOTIC CHARACTERISTICS				
Total Number of Families Identified	Group 1			
	Group 2			
	Group 3			
	Group 4			
	Group 5			
	Group 6			
SITE AVERAGE				
Average Length	Group 1			
	Group 2			
	Group 3			
	Group 4			
	Group 5			
	Group 6			
SITE AVERAGE				
Total # of Individuals	Group 1			
	Group 2			
	Group 3			
	Group 4			
	Group 5			
	Group 6			
SITE AVERAGE				
Diversity Index	Group 1			
	Group 2			
	Group 3			
	Group 4			
	Group 5			
	Group 6			
SITE AVERAGE				

5.2 GRAPHING FIELD STUDY RESULTS FOR ANALYSIS

Objective:

- To build on students' existing graphing and analysis skills.
- To formulate hypotheses about observed relationships between abiotic and biotic characteristics of the aquatic environment as well as examining the impacts of human activities on these characteristics.
- To understand adaptations and variations in organisms in response to their aquatic habitat.

Materials: Consolidated class data.

Instructions:

- Each group or individual will graph their results for each variable as well as the compiled or average data for the class (see: Consolidating the Data for information on a related classroom activity) in order to consider the differences between class data and data from an individual group.
- Alternatively, if time is a constraint, students could graph either the class or group data, with an in-class demonstration of the alternative data set to show the differences.
- Examine correlations between the abiotic and biotic factors tested during the field study.
- Using a spreadsheet program could facilitate the testing of several graphing methods if desired (e.g.) average data or scatter plotting. If only one graphing method is used, a line graph is recommended.
- In groups or as a class, have the students discuss their graphing results.

The following page contains a possible hand-out for the students; it can also be used as an in-class discussion guide.

Data Analysis for the Elbow River Field Study

Graph your results for each variable tested versus each of the 3 testing sites (it may not be necessary to graph all factors if some did not vary between the testing sites):

pH	Number of Families of Invertebrate
Temperature	% of Invertebrate in Each Ecological Role
Turbidity	Number of Individuals
Dissolved Oxygen	Average Length of Invertebrates
Nitrates	Diversity Index
Phosphates	

***Reminder:** label your graphs with the date your data was collected, as well as the variables on each axis.

Discussion Questions:

1) Based on your results and observations, what are your general conclusions about the health of the aquatic ecosystem studied as you travelled from the headwaters to the study's end?
2) Do any of the abiotic and biotic variables appear to be linked or correlated? If you do see correlations, what could be causing these interactions? How is one characteristic affecting another?
3) Do your results match any predictions you made before or during the field study? If they do not match, why not?
4) What outside pressures do you think affected the abiotic and biotic characteristics in the Elbow River?
5) For the invertebrates, what variations did you see in response to the abiotic characteristics of the river as you travelled downstream? What do you think are the most important limiting factors for organisms living in the Elbow River?
6) Did you notice variations in adaptations for invertebrates in different ecological roles or niches? Think about how this relates to what they eat or where they live in the river.
7) What zone or niche of the aquatic ecosystem were the invertebrates sampled from? Why does their ecological role make them ideal biological indicators for aquatic health?
8) When the Department of Fisheries and Oceans tests for aquatic health, they base the results on the diversity of invertebrate species identified at various sites. What does the biodiversity index you calculated tell you about the health of the Elbow River in the three test sites? What predictions can you draw from the diversity of invertebrates with regards to other species living in the Elbow River?

5.3 INVASISVE SPECIES CASE STUDY

Brook Trout in the Elbow River Drainage Basin

Objectives:

Examine how an ecosystem functions by studying invasive species in the Elbow River. Use a real-life example of competition to flesh-out the concepts of niche, habitat, and limiting factors. Define invasive species and examine their impact on aquatic ecosystems.

Instructions:

Discuss the concept of invasive species with the students and introduce the case study of Brook trout in the Elbow River. Have the students do a brief research project in groups or partners with to find information about native and non-native fish species in Alberta's rivers (suggested websites are listed below). Once students have collected their information, give them the background information provided. Then lead a discussion on the impacts suggested by their research and the information provided, as well as any other impacts that they can predict based on their knowledge of the interaction of biotic and abiotic characteristics of an ecosystem.

Background Information:

The introduction of species that are not native to Alberta can upset the balance of an ecosystem. When a non-native species is introduced to a new ecosystem which may not contain a natural predator, it is often the case that it can become an invasive species. **Invasive species** are those that can out-compete native species and may actually inhibit the ability of native species to survive in an ecosystem.

In 1940, brook trout (*Salvelinus fontinalis*), a species of fish native to Ontario, were introduced into the Elbow River drainage basin as stocked fish for sport-fishing. According to Trout Unlimited Canada, a non-governmental conservation organization, non-native fish species, brook trout in particular, are out-competing the native species of bull trout (*Salvelinus confluentis*) and westslope cutthroat trout (*Oncorhynchus clarkii lewisii*) in Quirk Creek, a major tributary of the Elbow River. In 1996, 94% of fish collected in Quirk Creek were brook trout. Few brook trout are seen in the Elbow River itself above Bragg Creek. This may be due to the cold temperatures in the Elbow River limiting their activity, but brook trout do much better in the shallower and warmer tributaries such as Quirk Creek, where native species have been adversely affected.

Brook trout reproduce at the same time and place as bull trout, so both species are attempting to occupy the same **niche** within their **habitat**, putting them in direct **competition** with each other. One of the reasons brook trout are able to out-compete native species is because they are able to reproduce as early as 18 months old, while slower growing bull trout rarely reach sexual maturity before 5 years of age. Earlier maturity may result in populations of brook trout overcrowding a habitat, resulting in a population of individuals that is stunted in size.

Elbow Lake, the headwaters for the Elbow, was historically stocked with brook trout by humans. Currently the biomass in Elbow Lake has been skewed from a few large individuals to many small individuals; what has been observed there is that there are no large size fish (stunting). Often in historically fishless high mountain lakes the addition of a fish species changes the dynamic of the **ecosystem**. An introduction of a top predator can lead to the removal the native predator insects that are present, because they are being consumed by the introduced species. This can cause a trophic cascade: take out the large bugs, then the medium, and so on until it takes out the grazer bugs. Essentially there is a large population feeding on a very small resource and to compensate the population will stunt their growth so they can maintain a large population size. Now algal blooms are being seen, which is uncommon in high mountain lakes, which could be due to the removal of grazer insects that may be a **limiting factor** for the algae. The ecosystem may be "out of balance" because the brook trout that have been introduced there.

Organizations, such as Trout Unlimited Canada, can undertake programs to help suppress invasive populations. In Quirk Creek, for example, TUC is trying to ease the demand on capacity of the river through intensive electro-fishing and angling.

Background Information was adapted from:

Alberta Sustainable Resource Development Website
http://esrd.alberta.ca/fish-wildlife/fisheries-management/default.aspx

Conversations with Brian Meagher, Provincial Biologist with Trout Unlimited Canada
www.tucanada.org

Suggested websites for researching non-native fish Species in Alberta and their effect on native fish populations and the aquatic ecosystem:

Alberta Sustainable Resource Development – Fish Identification
http://esrd.alberta.ca/recreation-public-use/invasive-species/fish.aspx

Alberta Sustainable Resource Development – Species at Risk Information
http://esrd.alberta.ca/fish-wildlife/species-at-risk/

Trout Unlimited Canada
www.tucanada.org

Trout Unlimited Canada National Projects – Brook Trout Suppression in Quirk Creek (a tributary of the Elbow River)
Search for "Quirk Creek"
http://www.tucanada.org

Suggested Discussion Questions (with suggested topics to cover):

1. What resources are brook and bull trout competing for in the Elbow River? What are the limiting factors in the Elbow River ecosystem?
   - food, space, a place to reproduce

2. How do biotic factors and abiotic factors create competition?
   - finite nature of abiotic and biotic factors

3. How can populations affect each other?
   - competition
   - predation

4. What impacts might a large population of an invasive fish species have on the aquatic ecosystem?
   - change in the size or number of individuals in the ecosystem (e.g.) stunted growth
   - loss of biodiversity
   - hybridization between invasive and native species
   - changes in the food chain can lead to imbalances (e.g.) algal blooms

5. What is the difference between introduced populations of brook trout in the Elbow River versus Elbow Lake?
   - in the Elbow River there have always been fish and the populations are now competing
   - in Elbow Lake there historically were no fish, so new pressures have been added to the insect species in that habitat, so predator insects that once occupied the highest trophic level have been displaced

6. Algal blooms have been noticed in some high mountain lakes in Alberta's protected areas that have always been fishless. If the introduction of brook trout isn't causing algal blooms in Elbow lake, what other changes to the abiotic and biotic characteristics could be causing them?
   - variations in temperature or pH due to global issues such as climate change or acid rain could be affecting the ecological balance in these lakes

7. What measures might be taken to limit or monitor non-native populations? How effective do you think these measures are?
   - electro-fishing or angling to remove invasive species
   - control of fishing licences by the province as well as catch and release of threatened native fish species
   - citizen-based water quality monitoring programs
   - monitoring of native species and updating species at risk information

8. How might incorrect identification of fish species by fishermen impact populations?
   - removal of native species, especially if they are larger or more vulnerable to being caught

5.4 STEWARDSHIP PROJECT CHALLENGE

Now that students have had a chance to collect data and draw conclusions about the impacts of human activities on the abiotic and biotic characteristics of the Elbow River aquatic ecosystem, they should now be able to design and initiate a stewardship project based on their findings. This project could take the form of:

- Designing and producing pamphlets to promote awareness of issues affecting the aquatic ecosystem in your area or a river closer to your school
- Designing and creating a website
- An article in a local newspaper or a "State of the Elbow" Report
- Planning and conducting a river clean-up or a garbage pick-up at your school
- Filming a commercial to inform others of impacts on the aquatic ecosystem
- A campaign for zero pesticide use at your school or a phosphate free classroom challenge

Encourage the students to brainstorm as a class or in their individual groups about what they believe the most significant impacts on the Elbow River were. Discuss what possible mitigation efforts could be undertaken to address these issues. From this discussion, have each group create a proposal for a stewardship project that includes the issue they want to address as well as their approach, including what logistics need to be considered in undertaking the project and how they would organize it. Each group will then create a presentation for the class and the class can vote on what project they would like to take on as the Stewardship Project Challenge.

For an information-based project, encourage the students to use the data they collected during their field study to convey the information; graphs would be particularly useful. This will make the field study even more meaningful. Also discuss who their intended audience is and whether they want the tone of the information they present to be scientific or whether they want to personalize the information for a different response from the recipients.

For a more action-based project, have the students consider creating signs or posters to inform others observing their project about why they are taking on this project. This can increase their effect by spreading the knowledge they have acquired on the Elbow River field study.

***Note**: the proposal chosen could be for an individual projects to be completed by each group. For example, if designing information pamphlets is chosen, each group could create their own pamphlet with a different theme, so the result is an entire information package created by the class. Example: land use impacts on the aquatic environment: each group will design a pamphlet based on a different land use.

Sample Resources:

- Alberta Water Quality Awareness Day (www.awqa.ca). Register your class for AWQA day, send in your results for the province-wide monitoring program, and potentially win free water testing kits for your class!
- Yellow Fish Road (www.yellowfishroad.org). Trout Unlimited Canada has a great storm drain painting program and teacher's resources.
- Elbow River Watershed Partnership (www.erwp.org) has river cleanup days, tree planting projects, and other community events. Contact the partnership for inspiration on initiating your own project.
- Build your own aquifer at (http://www.epa.gov/ogwdw/kids/flash/flash_aquifer.html)

5.5 BUILD A "BETTER" FIELD STUDY CHALLENGE

Objectives:

The purpose of this activity is to think critically about the field study that was conducted and to examine the necessary factors for a successful field study. Students are to work cooperatively to choose a specific issue they want to examine in relation to aquatic ecosystems and create a set of testing parameters to meet their goal. This activity encourages students to find out what they personally want to know about an aquatic ecosystem.

Discussion Questions:

1. What did you learn from the field study on the Elbow River? What were the key conclusions you were able to make?
2. What were the limitations of the field study on the Elbow River?
3. What is the purpose of your study (i.e.) what do you want to know? This could take the form of a hypothesis or a statement of intent, in addition to some focusing questions.
4. How many testing sites will you visit? Are you doing an in-depth study in one spot or will you visit many frequent testing sites down the length of the river?
5. What is the time frame of your study? Will it be one day of testing or several throughout the year?
6. What equipment would you need to conduct your study successfully? What are the limitations of your equipment?
7. Do you have a baseline or control included in your study to compare your results to? How will you determine if your results are accurate?
8. Consider the budget you have for your study. How much might your time, travel, and equipment cost?

6.0 PROGRAM EVALUATIONS

6.1 PROGRAM EVALUATION - TEACHER

*Thank you for participating in the **Aquatic Ecosystems: Elbow River Field Study**. Your feedback is greatly appreciated and will help to improve future programs. Please use the back of the evaluation form if you require more space.*

In-Class Presentation

	not at all		*neutral*		*yes*
1. Did the presentation help to prepare the students for the field study day?	1	2	3	4	5
2. Did you find the presentation materials and activities valuable?	1	2	3	4	5
3. Was the presentation conducted at an appropriate time and duration?	1	2	3	4	5
4. Was the presentation delivery/technique effective?	1	2	3	4	5

Any additional comments about the in-class presentation? _____

_____

Did you use any **preparatory activities** with your students? If so, please describe

_____

Field Study

	not at all		*neutral*		*yes*
5. The water testing stops were educational and engaging for the students	1	2	3	4	5
6. The land use stops were educational and engaging for the students	1	2	3	4	5
7. The data sheet was a simple and effective teaching tool	1	2	3	4	5
8. The field study met and exceeded curriculum needs	1	2	3	4	5
9. The field study left students with meaningful, though-provoking questions	1	2	3	4	5

Any additional comments about the field study?

_____

_____

Which **post-program activities** did you complete with your class?

- ❑ Data consolidation
- ❑ Graphing Field Study Results
- ❑ Invasive Species Case Study
- ❑ Build a Better Field Study
- ❑ Stewardship Project Challenge

Did you use any **additional post-program activities**? If so, please describe _____

_____

Did you find the additional resources and contacts valuable? **YES** **NO**

Please list any additional resources and/or contacts you feel may benefit the program

_____

Send completed evaluation forms to: Kananaskis Country Environmental Education (403) 678-5505

6.2 FIELD STUDY EVALUATION - STUDENT

During the Water Field Study, **I learned** the following:

_____

_____

_____

I now have the following **new questions** about water and watersheds:

_____

_____

_____

I did **not understand** this part of the field trip and/or water unit:

_____

_____

_____

Assess the following:

	not at all		***neutral***		***yes***
1. *Did you find the scientific data collection useful for your study?*	1	2	3	4	5
2. *Was invertebrate collecting and identifying a valuable experience?*	1	2	3	4	5
3. *Overall, did you learn more about water and water related issues?*	1	2	3	4	5
4. *Will you help to educate others about water and water issues?*	1	2	3	4	5

Any additional comments about the water field study or your water unit? _____

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7.0 TEACHER'S RESOURCES

7.1 RESOURCE LIST

- Kananaskis Country Environmental Education
  - Field trip bookings, information, and educational resources
  - 403-678-5500 Ext. 284
  - www.kananaskis-country.ca

- Elbow River Watershed Partnership
  - Resources, data, technical information, and stewardship possibilities
  - www.erwp.org

- Alberta Parks and Protected Areas
  - Information about the parks and protected areas system
  - www.AlbertaParks.ca

- Trout Unlimited Canada
  - Yellow Fish Road Program – paint storm drains with fish!
  - www.yellowfishroad.org

- Riverwatch
  - Rafting field trips for students on various rivers in Alberta.
  - http://www.riverwatch.ab.ca/

- South Saskatchewan River Basin
  - Water Watchdog program and resources
  - www.saskriverbasin.ca/

- Alberta Watersheds
  - Watershed Maps and information on watersheds. Highlights Alberta Watershed Awareness Day
  - http://www.waterforlife.gov.ab.ca

- Cows and Fish: Alberta Riparian Habitat Management Society
  - Great information about riparian areas and about water stewardship and protection.
  - www.cowsandfish.org

- Ducks Unlimited
  - Teacher's resources, wetland connections
  - www.ducks.ca/

- What's happening to Alberta's water?
  - Information, maps, climate change research, connected with the University of Alberta
  - http://www.ualberta.ca/~ersc/water/

- Alberta Environment (water web page)
  - Research, technical findings, resources, data, policies, manuals, and more

  http://esrd.alberta.ca/

- Fisheries and Oceans Canada**:**
  - http://www.dfo-mpo.gc.ca/index.htm

- Agriculture and Agrifood Canada (search for "Robocow")
  - http://www.agr.gc.ca/eng/home/?id=1395690825741

- United States Environmental Protection Agency for students
  - http://www.epa.gov/students/index.html

- International Year of Freshwater 2003: "Water for Life" decade
  - http://www.wateryear2003.org/

- Parks Foundation Calgary
  - http://www.parksfdn.com/

- City of Calgary Water use Education programs
  - http://www.calgary.ca/UEP/Water/Pages/Youth-education/Youth-Education.aspx

- Glencoe Golf and Country Club
  - http://glencoegolf.org/

- Tsuu T'ina Nation and Ecotourism
  - http://www.tsuutina.ca/

- Living by Water
  - Landowner projects to protect water
  - http://www.livingbywater.ca/

- SEEDS – Alberta Centennial Water Challenge
  - Water challenge
  - www.seedsfoundation.ca

- Bow River Basin Council
  - www.brbc.ab.ca

- Stream of Dreams
  - Water education through community art
  - http://www.streamofdreams.org/

- Canada's Aquatic Environment
  - Provides a wealth of information on Canada's lakes, rivers, wetlands, and oceans; aquatic research in Canada; and human interactions on aquatic environments
  - http://www.aquatic.uoguelph.ca