CREDIT VALLEY CONSERVATION

Bringing Back the Brook Trout

Climate Change Solutions for the Credit River

Teacher Guide

Overview

What are Brook Trout and how are they being affected by climate change? Watch a video to learn how high school students are working alongside Credit Valley Conservation (CVC) scientists to restore Brook Trout habitat and prepare the river for climate change. Then use maps and real data from the Credit River to identify high priority areas for the next habitat rehabilitation project. The focus of this activity will be to create resiliency in the Credit River in the face of climate change.

Contents

I. Learning Objectives

Students will realize that climate change is not only happening in the arctic or coastal communities but where they live as well. Students will learn that there are actions that they can take to help with climate change mitigation and adaptation locally.

Learning Objectives:
1. Factors that influence water temperature
2. Difference between native and non-native species
3. By looking at maps and water samples, scientists discover changes in water quality and identify areas for restoration
4. Implications of rising water temperatures on Brook Trout survival

II. Teacher Background

Climate Change and Conservation in our watershed

Instead of working inside a political boundary (within city or provincial limits) CVC works inside a *watershed* boundary. A watershed is an area of land that drains into a river - we live in the Credit River watershed. CVC is responsible for the land and water that surrounds the Credit River, including areas of Mississauga, Brampton, Georgetown, Caledon and Orangeville.

A major focus of CVC is to help the river and communities surrounding it prepare for climate change.

Vocabulary:

1. **Watershed:** area of land that drains into a river.

2. **Tributary:** a river or stream flowing into a larger river.

3. **Real-time Monitoring Station:** CVC operates a network of 57 environmental monitoring stations, strategically placed throughout the Credit River watershed. Stations send vital information in real time on current environmental conditions. This allows us to better understand, predict and warn about flooding, threats to water quality and low water levels.

4. **Ecological Restoration:** human action to renew, rehabilitate or restore degraded, damaged, or destroyed ecosystems and habitats in the environment.

5. **Sediment Trap:** The Christmas trees used in the river restoration project rebuild the stream bank by trapping and holding soil, vegetation and other organic matter as it washes downstream. When enough soil is trapped, plants can start to regrow along the river's edge.

III. Before Viewing this Video

This video is meant to be watched after students have a basic understanding of climate change and global warming.

IV. Student Activities

Materials

Activity 1:
- Bringing Back Brook Trout Video
- Computer and projector (if showing video in class)
- Student Activity Guide

Activity 2:
- Student Activity Guide
- Map of Real-Time Water Quality Stations
- Daily Maximum Water Temperature Graph

Instructions for Activity # 1: (To be completed by students at home or in class)

Watch 'Bringing Back the Brook Trout' and answer the viewing guide questions

Students may either watch the video at home prior to doing the in-class activity or the video can be watched together as a class. Provide the students with the link to the video (https://youtu.be/sHbwV1q4N6k) and the Viewing Guide Questions from Activity #1 in the Student Guide. The students will answer the questions while watching the video.

Answer Sheet for Activity # 1: Viewing Guide Questions:

1. Name three ways climate change is affecting the Credit River.

- *Water temperature is increasing due to the increase in air temperature*
- *Increased drought affects water quantity and quality*
- *Flood events are more frequent, which cause erosion and change the shape of the river*

2. What species of animal are we concerned about in this video and why is this species important?

Brook Trout
- *It is the only native species of trout in the Credit River*
- *It is very sensitive and prefers cool water*
- *With the increase in water temperatures, it is important for us to try to protect their habitat*

3. What are the students doing to restore the river? How is this project helping the river adapt to climate change?

- *Fastening Christmas trees (sediment traps) along the banks*
- *This narrows the river, which will decreases the surface area of the water and deepens the water to help it stay cooler*

Instructions for Activity # 2: (To be done in class)

Identifying Priority Areas for Rehabilitation

1. **Review** video viewing guide questions in small groups (2 to 4 students). Using shared information from the discussion, students may rewrite their answers to hand in.

2. **Tell the students**:

"We are going to be Water Monitoring Specialists and use water monitoring data collected by Credit Valley Conservation (CVC) to identify high priority areas to rehabilitate for Brook Trout habitat. Restoration helps to create resiliency in the Credit River in the face of Climate Change.

3. **Have the students read** through both the background information sections in Activity # 2 - *Identifying High Priority Areas for Rehabilitation* and *Brook Trout Health is Linked to Water Temperature*. **This can be done in groups or out loud for the class**. (see **Appendix 1** for more information)

4. When students are done reading the background information, they may **start the activity** – *Your Turn To Be the Scientist* **and follow the provided instructions** in the Student Guide to use the map and graph to answer the questionnaire. (see **Appendix 2** for more information)

5. The class will **discuss and defend** their answers for question # 4.

Teacher's note: The data from CVC's environmental monitoring stations is available to the public and you may use it to look at current conditions anywhere in the watershed – see suggestions for extended learning on page 6.

Answer Sheet for Activity #2: Your Turn to Be the Scientist Questions

1. Locate the monitoring stations listed on the graph for the station map. What do you notice happens to the water temperature as the water moves from the northern part of the watershed into the southern part?

    - The water is warmer in more populated areas – Orangeville has warmer water than the surrounding countryside at Cataract and Belfountain. The water really heats up in the southern watershed which is much more developed.

2. Which areas had the lowest temperatures? And the highest temperatures? Why do you think that is (refer to Stream Temperature Influences) and what are some contributing factors?

    - Belfountain and Cataract have the lowest temperatures and Old Derry and MGCC have the highest
    - Belfountain and Cataract are in the northern watershed which is less developed – more trees to shade the water and less runoff from hot pavement mean the water is colder.
    - Old Derry and MGCC are in the southern watershed meaning that water running through the urban areas of Georgetown, Brampton and Mississauga has reached these stations. Less vegetation near the water's edge and more runoff from hot pavement have heated the water.

3. Based on the water temperature, which areas of the Credit River could host Brook Trout during the month of August 2016?

    - Belfountain and Cataract could both host Brook Trout during August 2016, although Belfountain is better due to having a consistently lower temperature.

4. If you were an aquatic biologist, which areas would you identify to rehabilitate for Brook Trout habitat? Why these areas? What are some possible solutions for prevention/rehabilitation?

    - For this question, Students will be allowed to defend their choices, see # 5 below.

- Teacher Prompts - *Will you choose areas with only slightly elevated temperatures because they would be easier? Will you choose areas adjacent to or connected to "good" habitat? Will you choose areas in terrible condition because they need the most help? How will your choices affect the amount of work that needs to be put into the rehabilitation project?*

5. Pairs or teams can discuss with the class why they chose the areas they did for rehabilitation in question # 4.

VI. Evaluation

Students hand in questions (viewing and in-class) and participate in discussions.

Suggestions for extended learning:
1. Visit CVC's Real-time Monitoring site and locate the station closest to your school. Have a look at what the current water conditions are.
2. Research the different ways native animals are affected by climate change. Explain why a non-native species might be better adapted to climate change in our area.
3. Research and present how climate change is affecting water globally.
4. Take a hike to a water feature in your area, record your observations and have a class discussion.
5. Book a water testing program with Credit Valley Conservation. Contact mspiller@creditvalleyca.ca for more information.

VII. Curriculum Connections

D. Earth and Space Science: Climate Change

D1.1 - Analyse current and/or potential effects, both positive and negative, of climate change on human activity and natural systems (e.g. loss of habitat for Arctic mammals such as polar bears and loss of traditional lifestyles for Inuit as Arctic ice shrinks; famine as arable land is lost to desertification; an increase in water-borne disease and human resettlement as coastal lands are flooded; and expansion of the growing season in some regions).

D1.2 - Assess, on the basis of research, the effectiveness of some current individual, regional, national or international initiatives that address the issue of climate change (e.g. community tree-planting programs and propose a further course of action related to one of these initiatives.

D2.1 - Use appropriate terminology related to climate change, including, but not limited to: albedo, anthropogenic, atmosphere, cycles, heat sinks and hydrosphere [C].

D2.3 - Analyse different sources of scientific data (e.g., lake cores, tree rings, fossils and preserved organisms, ice cores) for evidence of natural climate change and climate change influenced by human activity.

D2.4 - Investigate a popular hypothesis on a cause and-effect relationship having to do with climate change (e.g., the combustion of fossil fuels is responsible for rising global temperatures;

the concentration of atmospheric CO2 is responsible for rising global temperatures; global temperatures have been on the increase since the industrial revolution; the severity of cyclones, hurricanes, and tornadoes increases as atmospheric temperatures increase), using simulations and/or time-trend data that model climate profiles (e.g. data from Statistics Canada and Environment Canada) [PR, AI, C].

D3.8 - Identify and describe indicators of global climate change (e.g. changes in glacial and polar ice, sea levels, wind patterns and global carbon budget assessments).

A. Scientific Investigation Skills and Career Exploration

A1.1 - Formulate scientific questions about observed relationships, ideas, problems, and/or issues, make predictions, and/or formulate hypotheses to focus inquiries or research.

A1.5 - Conduct inquiries, controlling some variables, adapting or extending procedures as required, and using standard equipment and materials safely, accurately and effectively to collect observations and data.

A1.7 - Select, organize and record relevant information on research topics from various sources, including electronic, print and/or human sources (e.g. websites for public health organizations, federal and provincial government publications, reference books, personal interviews), using recommended formats and an accepted form of academic documentation.

A1.8 - Analyse and interpret qualitative and/or quantitative data to determine whether the evidence supports or refutes the initial prediction or hypothesis, identifying possible sources of error, bias or uncertainty.

A1.10 - Draw conclusions based on inquiry results and research findings and justify their conclusions.

A1.11 - Communicate ideas, plans, procedures, results and conclusions orally, in writing and/or in electronic presentations, using appropriate language and a variety of formats (e.g. data tables, laboratory reports, presentations, debates, simulations and models).

A1.12 - Use appropriate numeric, symbolic and graphic modes of representation and appropriate units of measurement (e.g., SI and imperial units).

A2.1 – Identify and describe a variety of careers related to the fields of science under study (e.g. meteorologist, medical illustrator, geochemist and optical physicist) and the education and training necessary for these careers.

Appendix 1: Background information for student Activity # 2 (from the student guide)

Activity # 2 - Identifying High Priority Areas for Rehabilitation

Step 1: Read this background information to learn about water monitoring, Brook Trout ecology, and river restoration

We are going to be Water Monitoring Specialists and use water monitoring data collected by Credit Valley Conservation (CVC) to identify high priority areas in the watershed for rehabilitation projects for Brook Trout habitat.

CVC's water resource technicians regularly visit various locations across the watershed to gather data about the river including water temperature, turbidity, dissolved oxygen, chloride concentration and other things that can affect the health of the river and the animals living there.

CVC also has 57 environmental monitoring stations across the watershed that send information in real-time to the head office via Wi-Fi. Because of these stations, staff can predict and respond to events like flooding, droughts and threats to water quality.

Brook Trout Health is Linked to Water Temperature

Brook Trout are the only native trout in the Credit River and need clean, cold water to live. They prefer temperatures between 11-16°C and can't live for long periods in water temperatures above 23°C. The cooler water is also needed for spawning (egg laying) and embryo survival.

Brook Trout

Warm water contains less oxygen than cold water. When water levels are low and the water is warm during the summer, low oxygen levels stress fish. Some trout are able to survive in temperatures up to and exceeding 24°C but stop growing at 23°C. In the upper limits of the temperature range, trout that are otherwise unstressed (by pollution, fishing etc.) will die should those conditions persist for 24 to 48 hours.

All three major trout species (brook, brown and rainbow) begin to experience stress at approximately 20°C, with stress increasing rapidly as the temperature rises further. For Brook Trout, these limits are generally accepted to be a few degrees lower.

What influences stream temperature?

- ***Air temperature**:* is the only parameter in this list that does not directly change with watershed development (although big cities are warmer than the suburbs).
- ***The amount of light hitting the water***: clearing streamside (riparian) vegetation allows more sunlight to reach the stream, warming the water.
- ***Water depth***: more volume leads to cooler habitats at depth.
- ***Turbidity***: turbid (cloudy) water absorbs more heat from the sun. Erosion causes the water to become turbid with suspended sediment. More frequent, stronger storms equal more erosion, which equals more turbidity.
- ***Runoff***: rain falling on hot asphalt or other warm surfaces will warm up dramatically (on a typical 27°C summer day, pavement temperatures can be well above 38°C) and as this water drains into our streams, the streams warm up as well.

One of the purposes of stream restoration is to help cool the water. As seen in the video, the stream restoration project at Upper Credit Conservation Area involved attaching Christmas trees to the stream bank to act as sediment traps. This rebuilding of the bank resulted in a deeper, colder stream. Other restoration projects include planting trees to shade the water and the establishment of gravel beds for spawning.

Appendix 2: Instructions (from the Student Guide) on how to use the map and graph to answer the questionnaire

Step 2: Read the activity instructions. Using the attached map and graph, answer the questions below.

Your Turn to be the Scientist

Now that you know how streams heat up and how important it is to keep them cool, we are going to identify areas on the Credit River that need rehabilitation in order to make good Brook Trout habitat.

How to use the resources

Look at the **map of Real-time Monitoring stations** on the Credit River. The coloured area represents the watershed boundary – every drop of rain that falls within this area eventually makes its way to the Credit River (the bold blue line). Smaller blue lines are tributaries – streams that run either into the main Credit River or directly into Lake Ontario. Each of the green dots represents a permanent station that records data and sends it via Wi-Fi directly to scientists at CVC. Water in the Credit River runs from the headwaters in Orangeville, through Caledon, Georgetown, Brampton and Mississauga and finally into Lake Ontario in Port Credit.

The **Daily Maximum Water Temperature graph** contains data that was collected at the Real-time Monitoring Stations for the period of June to August 2016. Each line represents data from one monitoring station.