CHAPTER 2:
How does climate change affect our world?

A Project of Learning for a Sustainable Future

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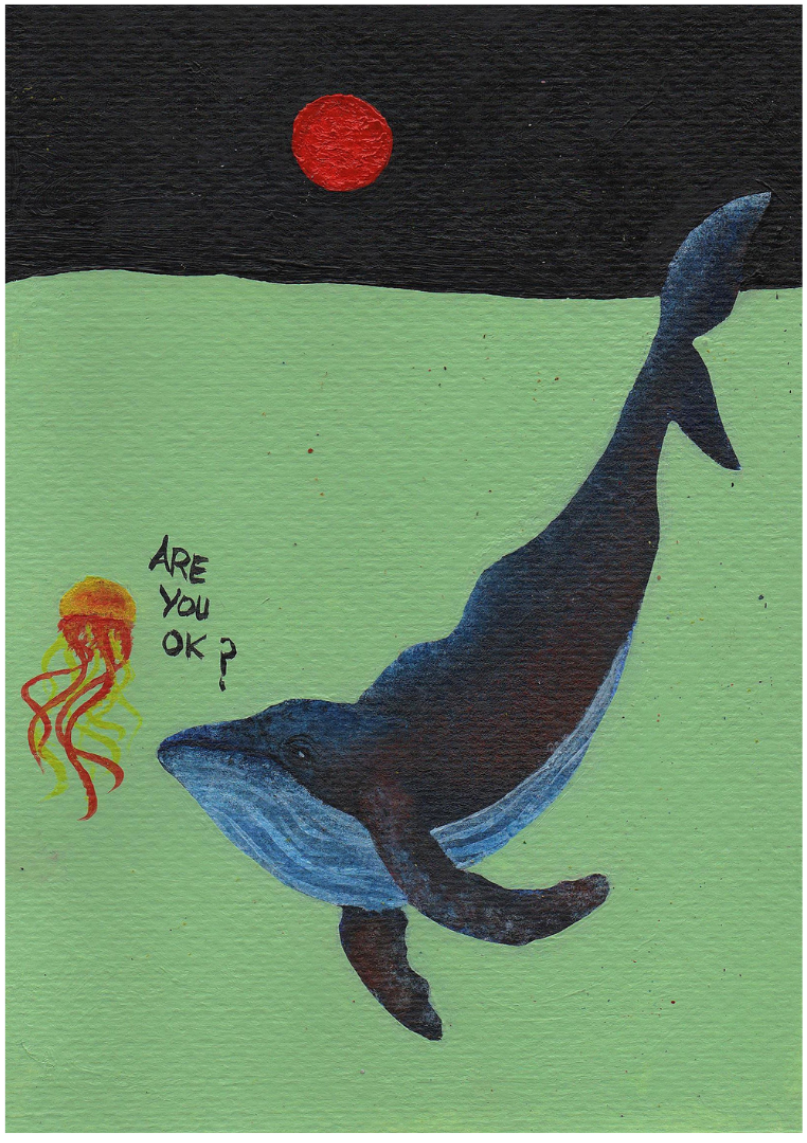

Art by Belen Gonzalez for ArtistsForClimate.org

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Chapter 2. How Does Climate Change Affect Our World?

This inquiry delves deeper into the multifaceted environmental effects of climate change. We encourage students to harness their curiosity about the local environment by examining changes to systems and through systems thinking, specifically ecosystems, biodiversity and habitat loss, or by connecting with a community expert and exploring restorative practices. We have included a multitude of external resources and guiding questions to help support and extend student research and action.

Photo by Belén González (Matitafore)

Before you Begin: Background Information for Educators

Regions across Canada are already experiencing the effects of climate change. Many ecosystems are changing rapidly, and animals' habitats are changing at a faster rate than they can adapt. The Living Planet Report shows an average decline of 60% in animal populations between 1970 and 2014. In order to conceptualize some of the major environmental effects that can be attributed to climate change and trends that could emerge in coming years, the effects have been broken down into the following sub-categories: changes in temperature and precipitation, changes to the cryosphere (portions of Earth's surface where water is in solid form, including ice caps, glaciers, sea ice, snow cover, etc.), changes to freshwater resources, changes to ocean climate, and biodiversity changes.

Changes in Temperature and Precipitation:

- In Canada, temperatures have increased by 1.5 degrees above pre-industrial levels. Canada's position in the far northern hemisphere means that we are experiencing the effects of climate change at a higher rate than many other regions in the world.
- Warmer air has the potential to absorb more surface water, resulting in both droughts and more intense precipitation events. Overall trends indicate that Canada has become wetter in the past decade, with increased rainfall and decreased snowfall across many regions of southern Canada.
- Temperature and weather extremes are expected (very hot and very cold as well as very wet and very dry) leading to a higher risk of associated environmental hazards such as floods and droughts.
- Overall temperature warming is enhanced in the northern latitudes of the country.

Changes to the Cryosphere (parts of the earth's surface characterised by the presence of frozen water)

- Permafrost temperatures in Northern Canada have been fairly consistently rising 0.2 degrees per decade over the past 20-30 years.
    - Globally between 2007 and 2016, there has been an average increase of 0.29°C ± 0.12°C in permafrost temperatures. (IPCC, 2019)
    - The effects of melting permafrost include release of harmful greenhouse gases previously trapped within the ice and reduction of structural support in regions previously covered by permafrost.
- Glaciers have been melting at an accelerated rate since the beginning of the 20th century—glaciers lost 11% and 25% of their surface area in Alberta and British Columbia, respectively, between 1985 and 2005 Columbia, respectively, between 1985 and 2005 (*Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation;* Chapter 2, 2014).

Changes to Freshwater Resources

- Changes to freshwater resources across Canada are difficult to categorize as a whole, nationally, due to the extreme regional variation that exists.
- Canadian data shows that water quality has remained stable in the vast majority of monitoring stations across the country (81%) between 2002 and 2016, improved in 10% of locations, and decreased in 9%.
- However, the levels of PBDEs (Polybrominated diphenyl ethers, persistent organic pollutants) remain above prescribed guidelines in the following locations: The Great Lakes, Pacific Coastal, and St. Lawrence.
- Excessive nutrients in both the Winnipeg River Basin and The Great Lakes area have caused detrimental algae blooms in these locations.
- Water levels across the Great Lakes (the largest surface freshwater system on Earth) broke seasonal or all-time record highs in both 2019 and 2020. These changes in water level are a wake up call that these types of extreme conditions are not a worry for the

future, but happening now. “Adaptation planning must manage uncertainty, rather than try to avoid it” (Kwakkel et al., 2016) (NRCAN National Issues Report, Chapter 4)

- “Combined changes in precipitation phase (e.g., rain or snow), earlier snowmelt, ice cover retreat and decreasing glacier mass affect Canadian river flows and lake levels. Future trends identified in Canada’s Changing Climate Report (Bush and Lemmen, 2019) and other studies, include: less water availability in southern basins, particularly in summer; increased frequency and intensity of water-related extremes; reduced water quality and more harmful algae blooms.” (NRCAN National Issues Report p. 196-197)

Changes in the Ocean Climate

- Trends in the Pacific, Atlantic and Arctic oceans indicate long-term warming of approximately 0.1 percent per decade, in both surface temperatures and bottom waters.
- Ocean temperature, acidity, and oxygen levels are affected by increasing atmospheric carbon dioxide levels.
    - Since the 1980’s the ocean has absorbed between 20-30% of total anthropogenic carbon dioxide emissions.
- The rate of ocean warming has more than doubled since 1993 (IPCC).
- Ocean levels are rising at a concerningly fast rate (in part due to the melting ice caps), which is increasing the risks of flooding and potential contamination of freshwater and groundwater, among other issues.
    - In Canada, a country surrounded by three different ocean bodies, the changes to ocean levels, temperature and composition are of paramount importance.
- “NASA measures sea level around the globe using satellites. The Jason-3 satellite uses radio waves and other instruments to measure the height of the ocean's surface – also known as sea level. It does this for the entire Earth every 10 days, studying how global sea level is changing over time.”
    - For resources explaining the effects of climate change on the oceans to young children visit NASA’s Climate Kids.

Biodiversity Changes in Canada:

- Increases in the frequency and intensity of droughts, forest fires, and insect outbreaks in combination with direct human impacts like deforestation, pollution and overharvesting are resulting in habitat loss and threatening the survival of many species (Canada and a Changing Climate).
- Changes to season lengths and times (such as earlier springs) are changing the growth and reproduction patterns of many plant species, which directly affects animals that rely on them for food and habitat.
- Physical changes in the landscape (e.g., higher water levels or human barriers such as roads, farms, and dams) can prevent animals from accessing food or breeding/rearing areas and can result in habitat loss.
- “The capacity of ecosystems and individual species to adapt to climate change through range shifts, however, is not without limits. Organisms are limited in the range of environments to which they can adapt.” (NRCnap. 284)

- “Since biodiversity is critical to ecosystem resilience and functioning, it is important to consider ecosystem services within the context of broader life support systems when investigating climate change impacts, ecosystem responses, climate change adaptation and greenhouse gas (GHG) emissions reduction (Biodiversity Adaptation Working Group, 2018).” (NRCan p. 278)

General Introduction to the Inquiries in this Chapter:

This chapter offers 3 different structured and scaffolded inquiries to support *How Climate Change Affects Our World, Our Community, and Our Natural World?* Each of the 3 inquiries begin with a provocation followed by the other steps of our inquiry model which includes many active learning strategies and activity/resource examples (see the table of contents in each inquiry for details).

These explorations can be completed in their entirety as stated, however, because we know inquiry is an organic and fluid process based on student input, educators may wish to take parts of each of the 3 ideas presented and even adapt, modify or replace what’s suggested to create their own inquiry with their class. It is therefore suggested that teachers review the whole chapter first in order to determine and plan what works best with their particular group of learners.

The following 3 inquiries are connected to curricular concepts as shown in this chart. These curricular concepts are applicable across Canada.

Curricular Connections	**Concepts**
Science	Stewardship Ecosystems Biodiversity Sustainability Protection Habitats Change Survival Action Conservation
Language	Critical literacy Text features Text forms Interencing Retelling Visual literacy Media forms Persuasion Point of view

Social Studies	Perspectives Interrelationships Cause Significance Human-environmental interaction Physical features Rights Justice
Physical Education and Health and Wellness	Fulfillment Contribution Connection Relationships
The Arts	Composition Symbolism Interpretation
Math	Data literacy

Prior to Provocations: Journaling
Encourage students to record their thinking and learning throughout the learning process. The main reason for developing a journal is for students to then be able to look back and track their growth and progression with their connection to climate change. Students scaffold their thinking throughout their learning journey. The entries can be a combination of personal reflections and assigned reflections. This can be done as illustrations, concept maps or written reflections.

Inquiry 1: How Does Climate Change Affect My World? Understanding Systems Thinking

Students will be introduced to systems and systems thinking by exploring how climate change affects their own world.

Resources:

- **Habits of a Systems Thinker** cards

Inquiry 2: How Does Climate Change Affect Our Community? What Systems are at Work in a Neighbourhood?

Students will explore their local community, through a neighbourhood walk, noting the systems at work that make it function. Students will note human impacts on the local community and explore the consequences of short-term and long-term actions.

Resources:

- Permission to go on a neighbourhood walk
- **Habits of a Systems Thinker** cards

Inquiry 3: How Does Climate Change Affect Our Natural World? How is Biodiversity Affected by Climate Change Using a Systems Thinking Approach?

Students will explore the systems at work in a local natural habitat and as an "adventure scientist" collect data to provide evidence on the health of the habitat and biodiversity within it.

Resources:

- **Poster** from Ingenium's Let's Talk Energy
- Access to a local natural habitat

Chapter 2: How Does Climate Change Affect Our World
Inquiry 1: Understanding Systems Thinking

- ***Provocations*** *–Artefact*
- ***Question Generation*** *– Creative Question Starts, Compare and Contrast*
- ***Knowledge Building*** *– Video*
- ***Determining Understanding*** *– Habits of a Systems Thinker*
- ***Pursuing learning*** *– Think Feel Care*
- ***Consolidation*** *– I Used to Think, Now I Think*
- **Assessment** *– Invent and reflect, One Minute Sentence*
- ***Take Action***

This inquiry is focused on understanding systems thinking. “To think about systems means we pay attention to interrelationships, patterns, and dynamics as well as to the parts.” (Linda Booth Sweeney, Agency By Design, Project Zero at Harvard Graduate School of Education

Prior to Provocations: Journaling
Encourage students to record their thinking and learning throughout the learning process. The main reason for developing a journal is for students to then be able to look back and track their growth and progression with their connection to climate change. Students scaffold their thinking throughout their learning journey. The entries can be a combination of personal reflections and assigned reflections. This can be done as illustrations, concept maps or written reflections.

A. Provocation

To hook student interest, introduce the provocation to initiate student thinking.

Artefact
The opportunity to handle actual **artefacts** is a unique experience. Students will inevitably be curious about the artefacts and this will naturally lead to good discussion.

Example Activity:
Bring a homemade or purchased terrarium (or a picture of a **terrarium**) to class. A terrarium is a self-sustaining plant **ecosystem** with living plants inside. It is usually made of a sealed, transparent container which contains all of the necessary parts that make up the ecosystem.

Explore all of the parts that make up the terrarium ecosystem. Consider what a plant ecosystem needs to survive (food, water and sunlight) and how all the elements (plants, soil, rocks, the container) all contribute to keeping the system working as an **ecosystem**. The plants and the soil in the terrarium release water vapour, essentially recycling water. The vapour is then collected onto the walls of the vessel and trickles down to the soil. The rocks in the bottom help to keep the soil from saturating so the water is absorbed as needed.

All of the parts of the terrarium contribute to its success, even the container. Students make connections to the idea that if something consists of many parts and functions as a **system**, the parts influence one another. If one part isn't working properly, or if a part of a system is missing, broken, worn out, mismatched or misconnected, it affects the entire system.

Explore another example of a **system**, and see if students can identify the parts that make that **system** work. For example, using a bicycle, have students brainstorm all of the parts of a bike that make it work. Ask students to make simple connections from the parts to the whole: e.g., How do the wheels connect to the pedals? How do the pedals connect to the gears? How do the gears connect to the brakes?

Now explore some other systems and how the parts contribute to the functioning of the whole system; for example:

- Systems in my kitchen
- A bicycle as a system
- Planets in a solar system

- Computer and its components
- Human body system (e.g., digestive, circulatory, etc.)

This video by Linda Booth Sweeney makes a great introduction to **systems thinking:** **What Are Systems?**

Possible Discussion Questions:

- Choose one system that we encounter in our everyday lives and list as many of its parts as you can. What would happen if one of the parts was missing or malfunctioned?
- Think about your schoolyard as an ecosystem, list all of the parts. What would happen if one of the parts was paved to make a new parking lot?
- Can you think of a system we have discussed in class in the past and reflect on its components (e.g., water cycle, human body, solar system)

B. Question Generation

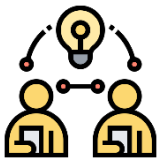
At this point in the inquiry, we want to harness students' curiosity and build off of the provocations that have captured their interest by generating meaningful questions to continue to drive the learning process. This section will outline pathways for question generation depending on the provocation(s) that your class engaged with.

Use **Creative Question Starts** to provoke student thinking and further their inquiry.

Example Activity:
Using these question starters, have students come up with a list of questions regarding a living system:

- What if...?
- What is the purpose of...?
- How would it be different if...?
- Suppose that...?
- What if we knew...?
- What would change if...?

Have students write their questions on sticky notes, one question per note. Compare and contrast these questions with those generated for another system you explored in the provocation. Sort the questions into duplicate ones, those that can be answered with some simple research and those that may lead to a deeper inquiry.



C. Knowledge Building

At this stage, students may be ready to engage in a group knowledge building activity. It will encourage students to open their minds to many alternative ways of thinking about the provocations and ideas that have been generated thus far in the inquiry process.

The **Mangrove Ecosystem Video** **by PBS's Plum Landing** explores how the parts of the ecosystem contribute to the success as a whole.

Example Activity:
Watch the video, then analyze the behaviours of the system:

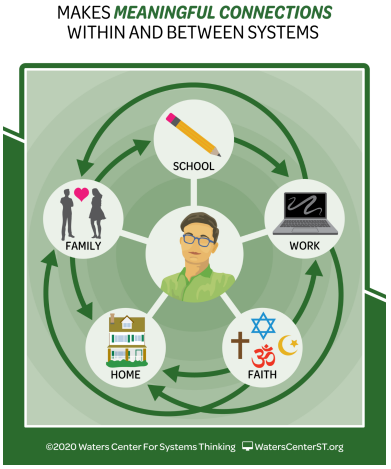
1. Identify the key parts of the mangrove as a system
2. Examine the interconnections between the parts
3. Explore how the behaviour of each part affects the behaviour of the other parts
4. Identify how the interactions of all of the parts, working together, produce the overall behaviour of the entire system.

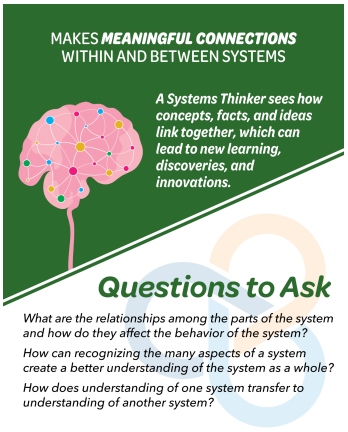
D. Determining Understanding

Use responses to inform and guide the learning process. They can provide insight into which concepts need clarity, what many students are already well informed about, and a general direction that many students want to pursue.

After viewing the Mangrove Ecosystem video(s) and participating in the provocation activities, explore this strategy to determine next steps.

From **Habits of a Systems Thinker** learning cards, address the concepts on this card to help students make some meaningful connections between systems that they have explored:





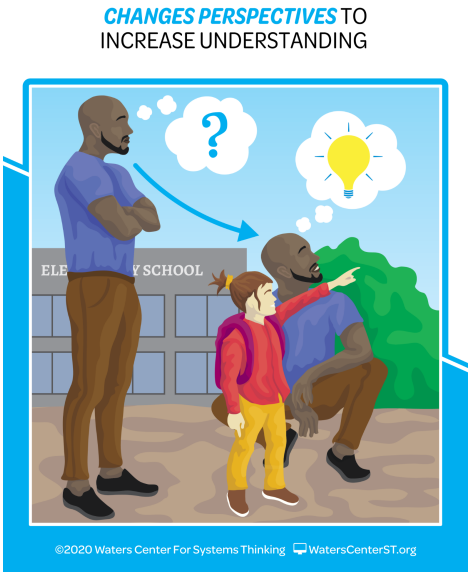
Example Activity:
Consider the systems that make our school function. Explore the parts (office runs the administration, classrooms, library, gym, schoolyards, parking lots, playgrounds, etc.) and identify other parts that contribute to making our school function. Allow students to express how these parts make the school function as a system and how this affects each students' role at home, with their friends and as a learner.

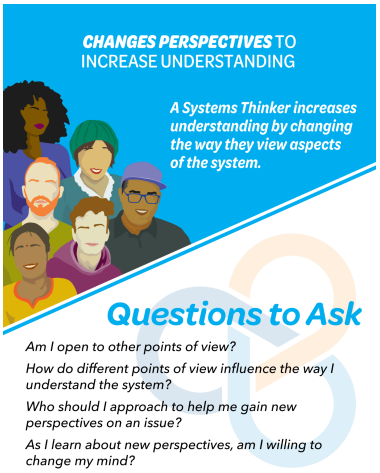
E. Pursuing Learning

At this stage, students may begin research to pursue some of their questions, or some of the following activities could be integrated into the process to ensure that students have an understanding of systems thinking. The activities listed below will enrich the understanding of climate change.

The **Think Feel Care** routine helps learners understand that people who participate in a system think, feel, and care differently about things based on their positions in the system.

Example Activity:
A system thinker changes perspectives to increase understanding. Use the **Habits of A Systems Thinker** card shown here, and the questions posed on the card to respond to Greta Thunberg and George Monbiot's **short film** highlighting the need to protect and restore nature in response to the climate crisis.





Example Activity:
Have students role-play different people in the school community that help the school function as a working system. Explore situations where decision making is necessary from different points of view. For example:

- *It is raining outside and recess is approaching. Students have proper clothing and like to play in the rain.* Make a decision on indoor recess from:
    - the principal's point of view
    - a teacher's point of view
    - the custodian's point of view
    - the students' point of view
- *The friendly class snake escaped from its tank. Students love the snake and know that it won't harm anyone who is kind to it. Some students are terrified and may try to harm it if found.* Make a decision on what to do from:
    - the principal's point of view
    - a teacher's point of view

- the custodian's point of view
- the students' point of view

F. Consolidation

This step is designed to encourage students to integrate and synthesize key ideas. When students make connections and see relationships within and across lessons, this helps them to solidify knowledge and deepen understanding.

After students have had an opportunity to do some research on everyday systems, a valuable consolidation tool is **I used to think...now I think**.

Example Activity:
Using this strategy have students work individually or in small groups and respond to any or all of these statements:

- "I used to think that my sometimes silly actions, as a student in the school, didn't matter; now I think…"
- "I used to think that not exercising my body regularly would just make me lazy; now I think…"
- "I used to think our school worked because adults made all of the decisions; now I think…"

These are just a few examples. Have students come up with other statements that demonstrate their understanding of the importance of all parts of a system needing to work together to make it function properly.

Assessment Idea

Teachers will assess learning at different points throughout the inquiry using multiple methods. The following assessment provides an alternative evaluation method to standard quizzes and tests that can be used after consolidation or at any point in the lesson to check for understanding.

Reflection:
Explain how the bicycle is a system that helps the world. It reduces carbon footprint and it is a healthy system.

Have fun with some **Rube Goldberg** machines! Invite students to invent a simple Rube Goldberg system that solves a problem in the natural world. Have students reflect on how their invention can help the world.

Here are some Rube Goldberg Lesson Ideas.

To form a concise summary, use the **One Minute Sentence** strategy.

Example Activity:

1. **List:** During a lesson, have students make a list of the most important ideas of the lesson. They can do this individually or with a partner.
2. **Compose:** Students review the important ideas they've recorded so far, then use what they've reviewed to compose one sentence to summarize the entire lesson individually.
3. **Mash Up:** Students can also get together with a partner and compare sentences, take the main points from each other and co-create one richer sentence that demonstrates their learning and understanding in this inquiry.

(Adapted from The Teacher Toolkit: One Minute Sentence)

Take Action:

These ideas for action can be utilized at any point in the learning process, whether it's now or after completing more guided inquiries. Note, the suggestions are consistent in each chapter.

Allowing time for students to take action is an essential part of the learning process on climate change, as it empowers students and eases their eco anxiety.

Choose any or all of the 4 suggested videos to view, discuss and to spark an inquiry:

- **Save Tomorrow** [Young Voices for the Planet] 7:21 minutes
  Inspired by the other Young Voices for the Planet films, three 9-year-old girls realize that they might be able to make a difference, too. These youth in Lexington, MA team up together to change a town law (with unanimous support!) to allow solar panels on public buildings. They then turn their passion towards protecting the local forest habitat.

- **How we children save the world** [Plant for the Planet]: 5:21 minutes
  The story behind Plant for the Planet—a youth perspective on how children can change the world and make a real impact in the climate crisis.

- **Canada Living Report** [World Wildlife Fund] 0:59 seconds
  WWF's 2017 living planet report brings attention to the significant wildlife loss and takes a look forward to see "what can be done?"
  - **Artivism for Nature** [World's Largest Lesson] 2:02 minutes
    Students explore what it means to be Nature Positive and design a creative image of a tree, uploading it to a virtual forest as a demonstration of their commitment to being Nature Positive and wanting others to be too.

Possible Discussion Questions:

- What is your favourite place to be outdoors?
- How are young people making their voices heard?
- How can a "nature positive" attitude help local habitats and biodiversity?
- Why is it important that all people have access to the outdoors?

- What are some outdoor spaces/places that all people and communities should have access to?
- Do all people have access to the outdoors?
- What is your favourite place outdoors?

Ideas for Taking Action:

- Plant trees
- Habitat restoration
- Collect data as citizen scientist such as local bird counts, schoolyard tree and plant surveys or participate in a **local bioblitz**
- Join student council and support initiatives and campaigns that help habitats and increase biodiversity
- Share your learning within your school and share your learning outside the class

Action Project Examples

- Ten Canadian Schools' stories of Climate Action
    - This document outlines a collection of promising practices of climate action taking place in 10 Canadian UNESCO Associated Schools. These 10 schools participated in a worldwide UNESCO pilot project to implement climate action as recommended in the UNESCO (2016) publication, *Getting Climate-Ready: A Guide for Schools on Climate Action.*
- Young Voices for the Planet
    - This website documents youth speaking out, creating solutions and leading the change. These youth solutions to the climate crisis include stories of California kids banning plastic bags, Florida students saving their school $53,000 in energy costs, an 11-year-old German boy planting millions of trees and other young people changing laws, changing minds and changing society as they reduce the carbon footprint of their homes, schools and communities.
    - Check out resources for Kids Taking Action here
- The Great Plant Hunt from Ecoschool Global
    - The campaign aims to educate students about biodiversity, its importance and encourage them to take positive action.
- Warming, Waste, Water, Watts, Wildlife (W5)
    - Through this project, thousands of students will be given opportunities to assess, design, and build innovative solutions to environmental challenges.
- Community Conversations for Climate Change
    - In this activity, students talk to members of their community about some of the environmental and climate change they have noticed since they were young.

Chapter 2: How Does Climate Change Affect Our World

Inquiry 2: What Systems are at Work in a Neighbourhood?

- ***Provocation*** *–Neighbourhood Walk, I Wonder Wall*
- ***Question Generation*** *– Concept Mapping,*
- ***Knowledge Building*** *– Parts, Perspectives, Me*
- ***Determining Understanding*** *– Back and Forth, Habits of a Systems Thinker Scenarios*
- ***Pursuing learning*** *– Habitat Exploration*
- ***Consolidation*** *– Triangle, Square, Circle*
- **Assessment** *– 30 Second-one minute sound bite*
- ***Take Action***

A. Provocation

To hook student interest, introduce the provocation to initiate student thinking.

Neighbourhood Walk

Take your class outside on a neighbourhood walk to observe the local environment. This could include both the natural and built environment. You could ask your students to look for anything from flora and fauna to evidence of adaptations to climate change.

On this walk challenge students to find three to five **"I wonders"** about how climate change is affecting or may affect the environment in your local area. Compile all of the "I wonders" into a list for students to refer back to when developing **umbrella questions**. For example, "I wonder how bees are being affected by climate change."

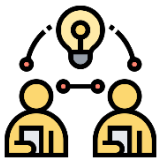
Biodiversity or species at risk modification:
Before leaving for your walk, encourage students to bring a device along to allow them to photograph their "wonderings". (Students may be able to download the free app, iNaturalist. The app allows them to take photos of plants, animals or insects for identification and will suggest probable species. Data uploaded into iNaturalist is shared with scientists to help conduct research and monitor invasive species). If students do not have the app (or data on their device), simply take photos of interest to explore further upon returning to the classroom.

B. Question Generation

At this point in the inquiry, we want to harness students' curiosity and build off of the provocation that has captured their interest by generating meaningful questions to continue to drive the learning process. This section will outline a pathway for question generation depending on the provocation(s) that your class engaged with.

Consider the neighbourhood to be another system and explore questions using **concept mapping** that can connect the different parts.

Example Activity:
Create your own concept map using the essential question, **"What are the systems in our neighbourhood?"** See Systems Thinking in the Elementary Classroom for some ideas.



C. Knowledge Building

At this stage, students may be ready to engage in a group knowledge building activity. It will encourage students to open their minds to many alternative ways of thinking about the provocations and ideas that have been generated thus far in the inquiry process.

Using the **Parts, Perspectives, Me** routine, encourage students to examine, in detail, a part of the system.

Example Activity:
Following the neighbourhood walk have students choose an object/subject of interest they discovered on their walk. In pairs or small groups have students explore the following ideas in order to build knowledge and explore alternative perspectives.

Possible Discussion Questions:

- What are the various parts or components of the object or subject of choice?
- Explore this object or subject from a different perspective such as one of the parts or components that you identified above. How do these parts or components contribute to the function of the whole?
- What personal connections can you make to this object or subject? Try also taking the perspective of the specific component or part that you identified.

D. Determining Understanding

Use responses to inform and guide the learning process. They can provide insight into which concepts need clarity, what many students are already well informed about, and a general direction that many students want to pursue.

After experiencing some of the provocations and participating in the Parts, Perspective and Me activity, explore this strategy to determine next steps and levels of understanding.

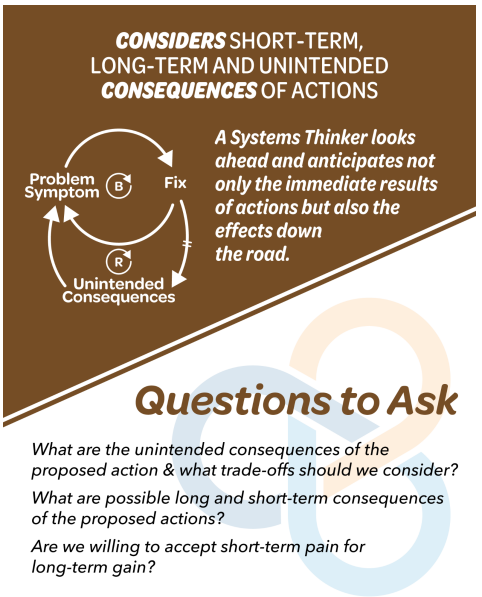
The **Back and Forth** technique allows students to explain a concept or idea and share thoughts with a partner.

Example Activity 1:

In pairs, student A explains a problem or an issue they observed on their walk (such as vandalism in the woodlot) and perhaps a potential solution to the problem. Student B writes down what they think they understood the problem to be and the potential solution and then shares what they wrote with student A. Students reverse roles and check each other's work for clarity and accuracy.

Example Activity 2:
Using the **Habits of A Systems Thinker** cards, consider "short-term, long-term, and unintended consequences of actions".

Exploring our own community through a systems thinking lens creates opportunities for us to examine our actions and the consequences of them. Allow students time to discuss these scenarios using the **Back and Forth** strategy, until they come up with a collaborative possible solution to address the scenario. Students can then present their solutions to the class for feedback.



Scenario 1:
Problem: too many cars on our roads contributing to air quality problems as they sit idling in traffic
Short-term consequence: build more roads so that cars continue to move freely, less idling
Long-term consequence: people more apt to use their cars to get around because traffic is moving more freely
Unintended consequence: more people driving, more carbon dioxide released into the air contributing to air pollution

Scenario 2:
Problem: coyotes killing and eating chickens on local farms
Short-term consequence: extend hunting season and quotas on coyotes to reduce the population
Long-term consequence: less coyotes means increase in some animal populations such as rabbits and deer; increased population of rabbits and deer means more grazing on available plants and trees, particularly in the winter months
Unintended consequences: rabbits and deer starving as their food source is limited

E. Pursuing Learning: Impacts on the Environment

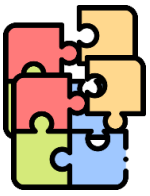
At this stage, students may begin research to pursue some of their questions, or some of the following activities could be integrated into the process to ensure that students have an understanding of foundational climate science. The activities listed below will enrich the understanding of climate change.

Students become explorers through **Habitat Exploration**.

Example Activity:
"Are you ready to go on a habitat exploration? If you took a trip around your neighbourhood, you would see an incredible variety of habitats, everything from parks to ponds. In this activity, students will be explorers who travel around their communities to observe various land and water habitats. Students will collect, record, organize, and compare data about the variety of habitats and take note (using field notes and by taking pictures) of the cleanliness of the habitat and take a survey of the biodiversity, both plants and animals, that make it their home."
(Adapted from zspace.com)

Possible Discussion Questions:

- What is the biggest environmental impact in our area? Do you see any evidence of climate change in your study area?
- From your field work, determine which species are most common in your area? Did you find any evidence that other species may also use this study area?
- Do you see any risks for any species in your study area?
- How are we, as humans, connected to any of the species you found?
- What are the best restoration actions (best ways to improve these areas) that will encourage biodiversity and maintain healthy habitats?



F. Consolidation

This step is designed to encourage students to integrate and synthesize key ideas. When students make connections and see relationships within and across lessons, this helps them to solidify knowledge and deepen understanding.

Determine three important issues identified on the neighbourhood walk using the **Triangle, Square, Circle** routine.

Example Activity:
Based on the activities that followed the neighbourhood walk, have the class, together as a group, (or in small groups for older children), use a triangle shape to determine 3 important issues, problems or discoveries they made, one for each point Use a square shape to explore things that "squared" with them or that they agree with. Finally, use a circle shape to identify what is still "circling" in their minds or questions that they still have regarding how climate change affects our local habitats.

Assessment Idea

Teachers will assess learning at different points throughout the inquiry using multiple methods. The following assessment provides an alternative evaluation method to standard quizzes and tests, that can be used after consolidation or at any point in the lesson to check for understanding.

As an assessment tool, I have students try the **30 Second - 1 Minute Sound Bite** strategy.

Example Activity:
Have students work in pairs or small groups to create a short and succinct PSA about the need to care for a specific local habitat or a species at risk within a local habitat.

Take Action:

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Possible Discussion Questions:
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- Community Conversations for Climate Change
    - In this activity, students talk to members of their community about some of the environmental and climate change they have noticed since they were young.

Chapter 2: How Does Climate Change Affect Our World

Inquiry 3: How is Biodiversity Affected by Climate Change Using a Systems Thinking Approach?

- ***Provocation*** *–Poster*
- ***Question Generation*** *– Umbrella Questions*
- ***Knowledge Building*** *– Four Corners*
- ***Determining Understanding*** *– Doodling/Sketching*
- ***Pursuing learning*** *– Adventure Scientists*
- ***Consolidation*** *–Card Sort*
- **Assessment** *– Headlines*
- ***Take Action***

A. Provocation

To hook student interest, introduce the provocation to initiate student thinking.

Poster

A good digital **poster** presents information clearly, but doesn't draw on data, as an infographic does.

Example Activity:

Share the following poster from Ingenium's Let's Talk Energy resource with your students. Explore the visuals before deconstructing the text. Notice the use of colours - grey, green, brown, and blue. Explore the different features of this poster, including the text, font, images and backgrounds and have students relay the "story" and information that this poster conveys. What questions emerge from this exercise?

Climate Change and Biodiversity

Biodiversity is about **living things** and their relationships with each other

This includes **species**, **ecosystems** and the **ecological processes** of which they are a part

The **earlier arrival** of spring changes the **life cycles** of many plants that provide food and habitat for other species

Many species won't be able to **adapt** quickly enough to changes in their **environment**

Habitat fragmentation

happens when natural landscapes are broken up by development such as river dams and highways, which can interrupt migration routes

Phenological mismatches

happen when the life cycles of dependent species change and no longer match up

E.g., migratory species arrive at a site after their prey has passed

Northern ecosystems are vulnerable to habitat loss and could see an influx of new species and diseases from the south

More CO_2 in the atmosphere and higher temperatures could lead to **longer growing seasons** for forests

Climate change can cause **Range contraction** when already limited habitats change and shrink further

Habitat destruction

In **prairie ecosystems**, more droughts will likely harm the growth of natural grasslands

Climate change can lead to competition for resources among species, as well as bigger and more frequent **infestation outbreaks**

Wolf + Coyote

Hybridization

is the mixing of different but similar species, and can drive rare species to extinction or increase adaptability

Extreme storms and **rising sea levels** can cause coastal squeeze

Climate change causes harmful algae growth in **marine ecosystems**, which are also at risk of pollution, commercial fishing and wetland drainage

Preservation through adaptation

Protect - nature reserves and marine sanctuaries
Connect - wildlife crossings, bridges and corridors
Restore - selective fishing, animal breeding programs

For the whole Canada in a Changing Climate report, visit **Adaptation.NRCan.gc.ca**

Ingenium | Let's Talk Energy | Canadian Geographic | Canada

Possible Discussion Questions:

- What is the main point of this poster?
- There are many different font types on this poster. Why do you think these different fonts are used?
- What new vocabulary is being introduced and how does the poster help us learn these new words?
- Which plant and animals in your neighbourhood/community could be further affected by climate change?
- How does the poster make you feel?
- How does the information make you feel?
- What actions do you want to take from the information you have learned from the poster?

B. Question Generation

At this point in the inquiry, we want to harness students' curiosity and build off of the provocations that have captured their interest by generating meaningful questions to continue to drive the learning process. This section will outline pathways for question generation depending on the provocation(s) that your class engaged with.

Begin by creating **Umbrella Questions** to help ground the inquiry.

In the example below, the quotes are from the infographic and the questions are possible ones that stem from the quote. These questions can be used as stated or students can be encouraged to create and ask questions based on the quotes.

Example Activity:

- How is a habitat an example of a system?
- What are some of the problems, caused by climate change, that affect the biodiversity of a habitat?
    - How do each of these problems affect the biodiversity of a habitat?
- "Climate change affects biodiversity"
    - What is biodiversity?
    - How does climate change affect plants and animals?
- "Preservation through Adaptation"
    - What does adaptation mean?
    - What are some of the ways that adaptation can be used to preserve biodiversity?

C. Knowledge Building

At this stage, students may be ready to engage in a group knowledge building activity. It will encourage students to open their minds to many alternative ways of thinking about the provocations and ideas that have been generated thus far in the inquiry process.

Use the **Four Corners** technique to promote listening, verbal communication, critical thinking, and decision-making.

Example Activity:
Generate a [controversial] statement related to the information presented in the poster or from the questions generated in the **Umbrella Questions** strategy. Place 4 choices around the room spaced in such a way that a group of students can come together for a conversation. The choices can be statements such as “strongly agree”, “agree”, “disagree” and “strongly disagree”, or other statements where students need to choose and be able to describe their feelings towards or understandings of.

Examples:

- “The mixing of different but similar species, such as wolf and coyote, will drive the species to become extinct.”
- “Warmer weather is better for birds and animals that depend on plants to survive.”
- “New roads and highways are good for nature as they keep traffic moving, causing less idling time for cars and trucks.”
- Or others...

D. Determining Understanding

Use responses to inform and guide the learning process. They can provide insight into which concepts need clarity, what many students are already well informed about, and a general direction that many students want to pursue.

After determining your umbrella questions and participating in the four corners activity, explore this strategy to determine next steps.

Doodling/sketching is a strategy for group mapping of what information is known to date. Watch this video for tips on how and why to use drawings as “powerful effects on learning”.

Example Activity:
Give each group of 3-4 students a piece of blank chart paper and some markers. Ask them to plan and sketch, together as a group, using pictures and some words, their understanding of some of the concepts introduced through the poster. The point is not the quality of the drawings but the students’ abilities to demonstrate knowledge linguistically, visually and kinesthetically.

E. Pursuing Learning: Impacts on the Environment

At this stage, students may begin research to pursue some of their questions, or some of the following activities could be integrated into the process to ensure that students have an understanding of foundational climate science. The activities listed below will enrich the understanding of climate change.

Become an **"Adventure Scientist"** who helps active science research by collecting data in the field. Scientists and adventurers, of all ages, spend time in the field collecting valuable data used to make decisions and solve real world problems. Check out their website at the above link.

In partnership with National Geographic Education and Adventure Scientist, students can participate in a schoolyard biodiversity adventure called Ring of Darhad: Mongolia Wolverine Expedition. Below is the link to the specific lesson on schoolyard biodiversity data collection.

Example Activity 1:
Lesson Overview: Become an adventure scientist by exploring the biodiversity of your schoolyard. Use a field journal to plan and prepare for your adventure, collect data in the field, and draw conclusions from your findings. The link takes you to the lesson, including background information, learning objectives and detailed instructions including a reproducible field journal and data collection tables.

Example Activity 2:
Jobs in a biotic community. Students survey a specific habitat, looking for organisms that inhabit that habitat and look for evidence of these organisms doing their "job". **Here is a link** to the lesson from Ecoliteracy.ca

F. Consolidation

This step is designed to encourage students to integrate and synthesize key ideas. When students make connections and see relationships within and across lessons, this helps them to solidify knowledge and deepen understanding.

Using the **Card Sort** strategy, teachers can check for students' understanding.

Example Activity:
Create vocabulary/concept cards, using index cards or blank card stock paper. Students, working in groups of 3, are given a stack of cards with new vocabulary, concepts and ideas on them. Have students sort cards into groups that connect with each other and have students explain their connections. For example: biodiversity - living things - ecosystems - species, these cards can all be connected with an explanation as to how they are connected.

Assessment Idea

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The **Headlines** routine ensures students summarize what they know and understand in a concise manner.

Example Activity:
Have students write headlines that capture the most important aspect of this topic/issue in this inquiry. Ask, “How does your headline differ from what you would have said yesterday?”

Take Action:

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