CONNECTING BIODIVERSITY TO THE SCIENCE 10 CURRICULUM THROUGH INQUIRY







Learning for a Sustainable Future Many regions across Canada are already experiencing the effects of climate change. Ecosystems, such as the Cape Breton Highlands National Park, are changing rapidly, and animals' habitats are changing faster than they can adapt. Without intervention, vital species will become extinct through habitat loss, climate change, and the introduction of invasive species. Understanding the causes and consequences of biodiversity loss and how climate change alters ecosystems allows students to relate their understanding of local ecosystems and the need to sustain ecosystem health. Each learning experience intends to support students in understanding how the biodiversity of an ecosystem contributes to its sustainability, how our individual and collective behaviour affects the environment, and how environmentally responsible choices can contribute to healthy, sustainable ecosystems.

Learning through inquiries and experiences stemming from questions generated by students makes it authentic and meaningful. These learning experiences highlight instructional strategies that allow for students' perspectives and voice. Each inquiry is designed to stand alone, addressing different angles and lenses through which biodiversity and the sustainability of ecosystems can be explored. The resources, activities, and species at risk information ultimately provide the groundwork to engage in action and environmental stewardship opportunities.

Connecting Biodiversity to the Curriculum through Inquiry

1. **Impacts of Climate Change on Biodiversity** - This inquiry focuses on the physical impacts climate change has on the environment and the consequences of these impacts on biodiversity. The provocation activities convey the interconnectiveness of biodiversity, climate change, human impacts, mitigation and adaptation. This generates discussions on human actions, how climate change impacts ecosystems, and if humans are an invasive species to the Earth's Biodiversity.

Science 10 Curriculum connections for this inquiry:

- question and analyze how a paradigm shift in sustainability can change society's views (114-1)
- distinguish between biotic and abiotic factors, determining the impact on the consumers at all trophic levels due to bioaccumulation, variability, and diversity (318-2, 318-5)
- predict and analyze the impact of external factors on the sustainability of an ecosystem, using a variety of formats (212-4, 214-3, 331-6)
- describe how different geographical locations can sustain similar ecosystems (331-7, 318-3)

2. **Climate Adaptation for Biodiversity and Ecosystems** - This inquiry focuses on the driving question, "How does the loss of biodiversity change the stability of the forest ecosystem? The activities in the inquiry encourage students to examine the critical factors causing changes in the ecosystems in Nova Scotia. Clear-cutting, deforestation and the effects of climate change are changing ecosystems and their biodiversity. Students explore how this is affecting their local ecosystem by assessing the species richness of a local area within their community.

Science 10 Curriculum connections for this inquiry:

- question and analyze how a paradigm shift in sustainability can change society's views (114-1
- distinguish between biotic and abiotic factors, determining the impact on the consumers at all trophic levels due to bioaccumulation, variability, and diversity (318-2, 318-5)
- describe how the classification involved in the biodiversity of an ecosystem is responsible for its sustainability (214-1, 318-6)

• *describe how different geographical locations can sustain similar ecosystems (331-7, 318-3)*

3. **Changing Biodiversity in Nova Scotia – Species at Risk** – This inquiry invites students to explore various species at risk and invasive species through a case study approach. Students review suggested articles, videos and infographics to identify key issues and potential solutions. They can compare their findings to further expand their growing understanding of interconnectiveness, biodiversity and impacts on individual species.

Science 10 Curriculum connections for this inquiry:

- question and analyze how a paradigm shift in sustainability can change society's views (114-1
- predict and analyze the impact of external factors on the sustainability of an ecosystem, using a variety of formats (212-4, 214-3, 331-6)
- describe how the classification involved in the biodiversity of an ecosystem is responsible for its sustainability (214-1, 318-6)
- diagnose and report the ecosystem's response to short-term stress and long-term change (213-7, 215-1, 318-4)

This resource highlights learning opportunities that engage students in choice. Choice and action help make the concept of the loss of habitat, climate change, and the introduction of invasive species more relevant and meaningful to the student. In the culminating task, the students apply what they have learned in the inquiry to create an action plan for an environmental stewardship project of their choice. An environmental stewardship project aims to have students connect responsibility and choice and fosters the development of important competencies. The action plan meaningfully engages students throughout the process, from choosing an issue to how students will carry it out. The best way to showcase action is by getting involved in helping combat biodiversity loss and climate change.

IMPACTS OF CLIMATE CHANGE ON BIODIVERSITY







To hook student interest, complete the learning experiences as a class to initiate student thinking

Bring Back the Boreal: A story about Cape Breton Highlands National Park 3:18 mins

Bring Back the Boreal was a five-year forest restoration project focusing on two areas within Cape Breton Highlands National Park: Skyline trail and North Mountain. Parks Canada tested different techniques in each area to find the most effective approaches to restoring forest health.

Climate Connections

Use the climate connection picture cards to generate questions regarding the connections between human actions and changes in nature. The cards in Climate Connections depict specific situations, but they may be interpreted in numerous ways by the students.

<u>Tipping Point Activity</u> – a team-building activity modified to convey the interconnectiveness of biodiversity, climate change, human impacts, mitigation, and adaptation. Students represent components of an ecosystem and will be challenged to keep that system in equilibrium throughout a series of positive and negative influences on the system's resilience. (p.7 of the resource)





QUESTION GENERATION

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.

Below are some guiding questions to help frame inquiry questions. Use the <u>QFT technique</u> with



students to help them dig deeper, remove hesitation and allows the students to dive right into the questioning process.

Begin by brainstorming about some impacts of climate change and the consequences these impacts have on biodiversity.

- How does biodiversity affect the sustainability of an ecosystem?
- How can an ecosystem be transformed by climate change?
- What are some human activities that have reduced biodiversity?
- What actions do we take that contribute to the impacts of climate change?
- What can we do to mitigate the impacts of climate change?
- How does the introduction of invasive species like animals, plants or other organisms into places outside their natural range impact biodiversity and the ecosystem?



At this stage, students may be ready to engage in a group knowledge-building activity. <u>Concept Mapping</u> – Have students link together the physical impacts climate change has on the environment and the consequences these impacts have on biodiversity.

Climate change can cause extreme weather events, plant and animal extinction and has many other effects that can impact ecosystems directly and indirectly. Create a concept map that represents how climate change impacts an ecosystem, be sure to include direct and indirect impacts on living beings in the ecosystem.

To concept map a dimension of climate change, model how to create a concept map. A concept map is comprised of key ideas or concepts (enclosed in shapes such as circles, boxes, triangles, etc.) and then a directional arrow is drawn to denote the relationship between the ideas. Along the line of the directional arrow, a preposition statement is included that explains the relationship.

Students can work individually or in small groups to show what they think are the important elements/concepts of climate change and the impacts on biodiversity. The concept map can be drawn on a large piece of chart paper with markers. Ask students to present their conceptual maps to the class. Encourage dialogue by asking students with similar concepts to add their interpretations to the discussion.

Students may use these informative websites to gather more information for their concept maps.

- <u>Chapter 5 Ecosystems Services</u> Natural Issues Report by Natural Resource Canada (Case Study 5.5 Restoring tidal wetlands and their ecosystem service in Truro, N.S.)
- <u>Climate Change and Biodiversity</u> Convention on Biological Diversity
- <u>Biodiversity and Climate Change</u> Making use of the findings of the IPCC's Fifth Assessment Report
- Forests and Climate Change Climate Atlas of Canada
- <u>Why is Biodiversity Important?</u> Parks Canada
- <u>Climate Change and Biodiversity Infographic</u> Canada in a Changing Climate Report





DETERMINING UNDERSTANDING

Uses responses to inform and guide the learning process.

To determine understanding with your students

- Have students present their concepts maps to determine how well they have understood the topic
- The concept map provides an opportunity to offer immediate feedback as teachers can identify any misconceptions or knowledge gaps that students have. The concept map can also be iterative and students can come back to their concepts maps to expand or modify them as they learn.



PURSUING LEARNING: Biodiversity-related Concepts

At this stage, students may begin research to pursue their questions. The following activities could be integrated into the process to ensure that students can apply biodiversity-related concepts.

1. Have students identify new impacts of climate change on biodiversity that they may have learned during this inquiry, such as:

- changes in the flowering times of native plants
- changes in the arrival and departure times of some bird species during migration
- a decline in trees and plants due to lack of water
- a decrease in fish species in Nova Scotia and a greater spread of invasive plants and insects
- others signs such as disappearing wetlands and greater coastal erosion

2. Have students identify and investigate some local environmental issues and suggest strategies to address the problems.



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.

Have students participate in an <u>accountable discussion</u> where they are held accountable to give reasons and evidence for their opinions regarding the following question:

Are Humans an <u>Invasive Species</u> to Earth's Biodiversity?



Take Action - Environmental Stewardship

Allow 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.



Ideas for Taking Action

- Have students be environmental stewards in their communities. Have them educate their community about the risks posed by climate change
- In the schoolyard or nearby area remove an introduced plant species to give native species of plants and animals a chance to reclaim their former habitat.
- Investigate the impacts of invasive species in your area, and then host a display for your school and community through a newsletters, posters, flyers and presentations.
- Do a school waste audit, survey the school's waste and document the results.
- Organize a presentation to showcase climate change risk information in an engaging manner
- Engage your students in a learning experience that is hands-on, real-world, memorable and impactful. Learning for a Sustainable Future provides funding for student-led climate change/sustainability Action Project. Apply for a LSF grant
- <u>CLEAN Climate Action Grants</u> empower youth to design and execute climate action projects to create positive environmental change in their communities
- <u>Our Canada Project</u> inspires youth to be responsible citizens and gives them a platform to share their voices. Check out some of the latest projects from coast to coast

CLIMATE ADAPTATION FOR BIODIVERSITY AND ECOSYSTEMS







To hook student interest, complete the learning experiences as a class to initiate student thinking

Use this driving question to create an authentic learning experience for students: <u>How does the loss of</u> <u>biodiversity change the stability of the forest ecosystem?</u>

Activity 1 – <u>Maps of Dramatic Changes in Nova Scotia Forests</u> – Have students view the maps that reveal the dramatic changes of clear-cutting which has taken place in the Nova Scotia Forests during the last three decades. In Nova Scotia, clear-cutting is a leading cause of habitat and biodiversity loss.

Activity 2 – <u>Canadian Biodiversity: ecosystem status and trends 2010</u> – At a national level, the extent of forests has changed little since 1990; at a regional level, loss of forest extent is significant in some places. The structure of some Canadian forests, including species composition, age classes, and size of intact patches of forest, has changed over longer time frames. This report assesses progress towards the framework's goal of "Healthy and Diverse Ecosystems" and the two desired conservation outcomes, i) productive, resilient, diverse ecosystems with the capacity to recover and adapt, and ii) damaged ecosystems restored.

Activity 2 – <u>Flying Over a Clear Cut</u> – After viewing, discuss the environmental effects of a clear-cut forest and how clear-cutting impacts wildlife and biodiversity, threatens watersheds and causes habitat loss. Clear cutting is only one method which contributes to deforestation; can you identify others.



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.

The <u>Q-Chart</u> is designed to help students generate deep, relevant inquiry questions. The goal is to ask the questions at the bottom right corner of the matrix. These questions require higher thinking and produce more profound and more complex answers.

- What are the most critical factors causing ecosystem changes?
- How do ecosystems change over time?
- How is biodiversity important for the forest ecosystem and its sustainability?
- What are some factors that make it hard for ecosystems to adapt?
- How does climate impact biodiversity?

- How does climate change affect the components of a forest ecosystem?
- How can we detect and measure the impacts of climate change on ecosystems?





At this stage, students may be ready to engage in a group knowledge-building activity.

Engage students in the <u>Climate Change in your Ecological Area</u> experience. Use this outdoor learning experience to help students build knowledge about the effects of climate change on their local ecosystem and its biodiversity and explore how this might affect the local community.





DETERMINING UNDERSTANDING

Uses responses to inform and guide the learning process.

Cause and Effect Analysis

To determine understanding with your students, students can complete a Cause-and-Effect Analysis of climate change for their local area. Using the <u>cause-and-effect flow chart tool</u> can help students understand and further investigate implications of changes.



PURSUING LEARNING: Biodiversity-related Concepts

At this stage, students may begin research to pursue their questions. The following activities could be integrated into the process to ensure that students can apply biodiversity-related concepts.

The biodiversity index provides scientists with an accurate and consistent way to compare the biodiversity of different areas. Each species plays a vital role in maintaining an ecological balance. High biodiversity makes the world's ecosystems more resistant to environmental changes and keeps ecosystems healthy by creating sustainability. Teach students how to <u>calculate a biodiversity index</u> indoors before taking the learning outside.

Students can complete the <u>Biodiversity in your</u> <u>Neighbourhood</u> outdoor activity. This activity teaches students how to measure the biodiversity of an area in their surrounding neighbourhood using the most



common measurement approach, Species Richness, combined with Abundance to calculate the Biodiversity Index.

In <u>Populations Dynamics</u> students will conduct a model population census by taking advantage of species present in their local environment. Students will analyze and compare results to develop an understanding of the complexities associated with species and ecosystem management. They will explore different variables and factors contributing to population dynamics.

Students can review Nova Scotia's Adapting to Climate Change website. Review the <u>Climate Impacts and</u> <u>Adaptation</u> for Forests, Terrestrial Ecosystems and Coastal areas. Discuss whether these adaptations are sufficient to protect those areas to ensure biodiversity conservation. Use the <u>Claim Support Question</u> thinking routine to form interpretations based on what you have read and support them with the evidence you have learned during this inquiry.



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.

To encourage students to integrate and synthesize key ideas, configure the class into a circular seating formation and facilitate a <u>Knowledge Building Circle</u>

Here are some reflective questions suggestions:

- What are some climate impacts in that you have identified in your local community?
- How can we reduce the impact of climate change on biodiversity in your local area?
- How is climate change affecting plants and animals in your community?
- How is climate change affecting the people in your community?



Allow 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.



Ideas for Taking Action

- Have students be environmental stewards in their communities. Have them educate their community about the risks posed by climate change
- In the schoolyard or nearby area, remove an introduced plant species to give native species of plants and animals a chance to reclaim their former habitat.
- Investigate the impacts of invasive species in your area, and then host a display for your school and community through a newsletter, posters, flyers and presentations.
- Do a school waste audit, survey the school's waste and document the results.
- Organize a presentation to showcase climate change risk information in an engaging manner
- Engage your students in a learning experience that is hands-on, real-world, memorable and impactful. Learning for a Sustainable Future provides funding for student-led climate change/sustainability Action Project. <u>Apply for a LSF grant</u>
- <u>CLEAN Climate Action Grants</u> empower youth to design and execute climate action projects to create positive environmental change in their communities
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Changing Biodiversity in Nova Scotia – Species at Risk







To hook student interest and initiate student thinking

A case study approach to exploring the changing biodiversity in Nova Scotia will help make these concepts more concrete for students. Exploring specific impacts and relevant factors related to Atlantic Salmon, as an example, can help students explore interconnectiveness in local ecosystems. Students can explore various species at risk and invasive species in Nova Scotia using the resources listed below. Have students review the suggested articles, videos and infographics individually or in groups to identify key issues and potential



solutions. Students can compare their findings to further expand their growing understanding of interconnectiveness, biodiversity and impacts on individual species. For example, a discussion relating to the <u>recent study</u> which reveals that the chain pickerel – an invasive species - is a potentially devastating threat to Atlantic salmon – a species at risk - by invading the salmon habitat would help students appreciate the relevance of interconnectiveness of various species in a local ecosystem.

Suggested resources:

<u>Atlantic Salmon Information Card</u> – Species identification and information card for the Atlantic Salmon, a species at risk in Nova Scotia

<u>Fundy Salmon Recovery</u> 6:21 minutes - Fundy Salmon Recovery is a diverse group of partners from the provincial and federal governments, the aquaculture industry, First Nations and academia. They are united and inspired by a common goal - to restore the historic wild Atlantic salmon populations to the inner Bay of Fundy for generations to come.

Too Hot to Handle? Salmon and Climate

Other species at Risk in Nova Scotia

<u>Species at Risk in Atlantic Canada</u> – The Atlantic Wolffish 2:44 - Wolffish are considered a species at risk of becoming endangered in Canada. This video highlights the 3 wolffish species found in waters around Atlantic Canada, explaining their habitat, diet, unique biology, and what is threatening them

Species at Risk in Atlantic Canada videos

- White Shark 3:10
- North Atlantic Right Whale 3:34
- Blue Whale 3:40
- Leather Back Turtles 2:58

Infographic of Marine Species at Risk in Canadian Waters

- North Atlantic Right Whale
- <u>Leatherback Sea Turtle</u>
- White Shark

Links about the invasive species the Chain Pickerel

- Invasive species in Nova Scotia Chain Pickerel
- Freshwater Ecosystem conservation
- Targeting Invasives: The Chain Pickerel of Nova Scotia

Investigating the Hemlock Woolly Adelgid

- Hemlock Woolly Adelgid in Nova Scotia
- Protecting Kejimkujik's hemlock legacy
- Hemlock Woolly Adegid Management Plan for Canada
- <u>Nova Scotia Hemlock Initiative</u>



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.

Question generation can begin with a discussion about the diversity of living things and how everything is interconnective within ecosystems, focusing on the sustainability of those ecosystems.

• Students can be invited to explore questions such as: What are some of the critical factors necessary to ensure the sustainability of ecosystems? What role does climate change play in the sustainability of an ecosystem? How is biodiversity connected to the sustainability of an ecosystem? What role do humans have in that sustainability?

Students can then further explore the notion of species at risk. Ask students why some species are at risk while others are not. Have them generate questions they may have regarding species at risk and/or invasive species. What are the key factors that put them at risk (e.g., habitat loss, invasive species) and what role do humans play in this?

Some examples of questions include:

- What is the impact of climate change on species at risk?
- How is Climate Change endangering the future of Atlantic Salmon, and what can be done to protect this species at risk?
- How does introducing invasive species like animals, plants or other organisms into places outside their natural range impact biodiversity or ecosystems as a whole?
- What lessons can we learn from studying how the chain pickerel is transported from one ecosystem to another and how they spread?





At this stage, students may be ready to engage in a group knowledge-building activity.

Engage students in the <u>Accidental Travelers</u> activity to learn how invasive species are transported from one ecosystem to another and how they spread once they have arrived.

Students can extend their knowledge building by following through on a line of inquiry that resulted from the question generation above. Students can gather information about what local organizations are doing to protect species at risk and to preserve local biodiversity. Students can also engage in research and data collection.



At this stage, students may begin research to pursue their questions. The following activities could be integrated into the process to ensure that students can apply biodiversity-related concepts.

At this stage, students may begin investigating a specific species at risk or invasive species in Nova Scotia in more depth for their inquiries. Allow students the choice of species they want to research by visiting the species at risk



or invasive species websites below. Students may wish to complete their research in the form of a fact sheet about their chosen species, a letter campaign, informational poster, a podcast, a town-hall meeting, etc....

Potential topic areas for student inquiry into a specific species at risk or invasive species might include:

Natural history and habitat components, significance, at-risk status, statistics, recovery efforts, legislation, prediction for the future, connection to climate change, etc.

- Invasive Alien Species in Nova Scotia
- <u>Nova Scotia Invasive Species Council</u>
- Biodiversity Species at Risk in Nova Scotia
- Species at Risk in Nova Scotia Identification and Information Guide
- Salmon and Climate Change Fish in Hot Water



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

- Student-Created Questions For this consolidation exercise, students will work in pairs. Each person will generate several thought-provoking consolidation questions for their partner. The questions should be based on the learning from this inquiry and could address their gaps in understanding or aim to deepen understanding and exploration of biodiversity and species at risk. Each partner will have an opportunity share their thinking with their partner.
- Another way for students to consolidate some of their learning would be to return to the initial questions provided at the beginning of this inquiry. These questions could initiate a small group discussion, written reflections, or a whole-class discussion and would be a good way for students to reflect on their learning process and synthesize some of the knowledge and skills gathered throughout the inquiry. This could occur through note-taking or <u>doodling/sketching</u> a creative visual that depicts the key information that students have learned throughout this inquiry.



Allow 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.

Ideas for Taking Action

- Find out if there is an ongoing species at risk recovery effort in your community, and ask how you can support and learn more about those activities.
- Invite foresters and biologists into your classroom to talk about their work in protecting species at risk.
- In the schoolyard or nearby area, remove an introduced plant species to give native species of plants and animals a chance to reclaim their former habitat.
- Investigate the impacts of invasive species in your area, and then host a display for your school and community through a newsletter, posters, flyers and presentations.
- Organize a presentation to showcase climate change and species at risk information in an engaging manner
- Engage your students in a learning experience that is hands-on, real-world, memorable and impactful. Learning for a Sustainable Future provides funding for student-led climate change/sustainability Action Project. <u>Apply for a LSF grant</u>
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