SCIENCE SPOTLIGHT

Food Chain Reactions:

HOW CLIMATE CHANGE IS IMPACTING CANADA'S LAKES

GEN ACTION

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Food Chain Reactions: How Climate Change Is Impacting Canada's Lakes

Origin Story: WHO-EATS-WHO IN AN ECOSYSTEM?

We have all heard the term **food chain**. In case you need a quick refresher, the food chain shows the transfer of energy within a part of an ecosystem - basically, it shows you who-eats-who. In addition to the food chain, there is something called a **food web**. A food web describes how the different linear food chains are interconnected within an ecosystem, making them much more complex.

Some species have a bigger impact on the health of ecological communities than others – these are called **keystone species**. If the keystone species within an ecosystem is taken away, it can lead to an unbalanced number of predators and prey and can impact the entire ecosystem. This is known as a trophic cascade, a series of chain reactions brought on by removing or changing a link in the food chain. A well-known example of a **trophic cascade** happened after sea otters were overhunted off the coast of Alaska. With fewer sea otters to feast on the sea urchins, the sea urchin population grew out of control. They ate up the kelp forests and left the ecosystem barren. Why does this matter? Kelp absorbs carbon dioxide from the water, which keeps the ocean acidity level stable. Without the kelp, the extra carbon dioxide makes the water more acidic which leads to even more negative impacts on the ecosystem. As scientists, we want to understand food chains and food webs so that we can protect the keystone species and prevent trophic cascades.

CHAIN REACTIONS IN CANADIAN LAKES

We are starting to see more changes in food webs as climate change is impacting entire ecosystems.

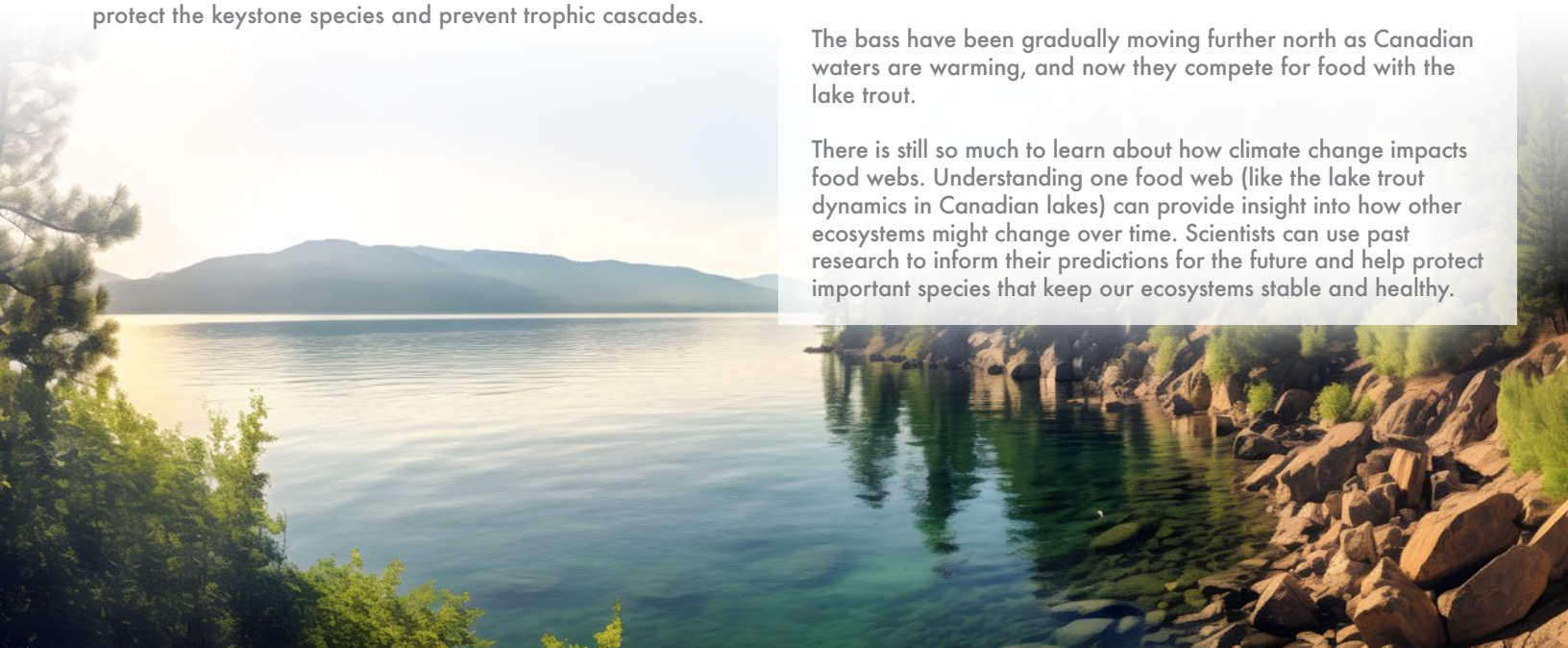
Scientists need to prepare for the long-term impacts of climate change and can try to gather important information by studying different ecosystems. The Canadian North is just one example of the scope of ecosystem impacts caused by climate change, and Canada's lakes are no exception. They too are experiencing accelerated rates of change from the warmer and shorter winters, meaning there is an overall loss of ice cover.

A team of researchers has been studying native lake trout in lakes across Canada. They knew that climate change could change Canadian ecosystems drastically. To support the study, the scientists looked for data on lake geography, their physical characteristics, and even the fish communities living within them. Eventually, they assembled a dataset of almost twenty-two thousand Canadian lakes and could draw conclusions about how the lakes are impacted by climate change.

The researchers quickly found that lake trout – a keystone species in many lakes – are moving away from their native habitats. The lakes are warming with the changing climate, which makes them less hospitable for lake trout. Warmer waters have less oxygen in them (which stresses out the lake trout) and are more appealing to other fish species like the smallmouth bass.

The bass have been gradually moving further north as Canadian waters are warming, and now they compete for food with the lake trout.

There is still so much to learn about how climate change impacts food webs. Understanding one food web (like the lake trout dynamics in Canadian lakes) can provide insight into how other ecosystems might change over time. Scientists can use past research to inform their predictions for the future and help protect important species that keep our ecosystems stable and healthy.



Try This at Home:
WEB WEAVERS

Choose a habitat and think about the species that live there. Let's think about a pond, for example. It is home to so many organisms: algae, insects, fish, frogs, turtles, snakes, and even birds. On a whiteboard or a piece of paper, write down the names (or draw a picture) of each species that might live in your habitat. Now, use arrows to draw connections between the different species. Who is a predator and who is their prey? Looking back at the pond for example, would a heron eat algae? Does a snake eat a frog?

The arrows will help you see how complex food webs really are. You can see just how many relationships there are between species of plants and animals within one ecosystem.

Climate Action:
PROTECTING OUR POLLINATORS

You can help maintain food webs in your ecosystem by helping insects! Insects are important for every ecosystem, but some species play a key role in keeping the plants happy and healthy: Pollinators! Pollinators are essential for making sure the basal species—plants—can produce the food that is consumed by other animals in the ecosystem. Here are three ways that you can help pollinators in your own backyard:

1. **Make a bee watering station!**
   Bees and other pollinators need water just like we do. Wouldn't you be thirsty after a long day of hard work? Bee watering stations make sure that bees can stay hydrated and cool off while working hard to pollinate the nearby plants.

2. **Plant bee-friendly native plants in your garden!**
   Just like humans, bees need proper nutrition to fuel their long days of flying. Bees can normally get all of their nutrients from local flowering plants. It is important to plant native species for bees to have access to their nectar and pollen to keep them healthy and strong.

3. **Leave the leaves!**
   If you have a green space at home (like a backyard or garden), leave the flowers, leaves, and stems outside over winter. The left-over foliage can be used by the rest of the ecosystem and improve its health year-round. They will decompose and keep your soil nutrient-rich, and they can provide protection from the harsh elements for insects and small animals during the cold winter months.

MEET OUR LOCAL SCIENCE HERO:

Dr. Sapna Sharma teaches biology at York University in Toronto. She is an expert on lakes in Canada. Dr. Sharma's research examines the impacts of environmental stressors on our lakes and the organisms that live within them. She leads international teams that conduct their own research, and she also collects data from Citizen Scientists (everyday people who want to volunteer their time to help with research, you can become one too!).

All of these scientists are working together to help understand how climate change is impacting lake ice cover, water temperatures, water quality, and fish communities.

Dr. Sharma's goal is to find out how climate change affects the environment's living beings (like the fish) and their physical features (like ice cover in winter). Dr. Sharma's research can help us all better understand how our environment works and find new ways to fight climate change to keep our lakes healthy.

This Science Spotlight was written based on Sharma, S., Jackson, D., & Minns, C. (2009). Quantifying the potential effects of climate change and the invasion of smallmouth bass on native lake trout populations across Canadian lakes. *Ecography: A Journal of Space and Time in Ecology*, 32(3), 517-525. DOI:10.1111/j.1600-0587.2008.05544.x.

Climate Change
Past, Present, and Future

Earth is the only planet in the solar system known to support life. What makes our home so special? Earth has an atmosphere, a layer of gases between our planet and space. Some of these gases, like carbon dioxide, are called **greenhouse gases**. They are crucial parts of our atmosphere; they trap in the heat of the sun, similar to how heat is trapped in a greenhouse, or in a car on a hot day. This process, called the **greenhouse effect**, keeps Earth's temperature warm enough for living things to thrive.

The sun's rays hit our round, tilted planet unevenly. This uneven heating of Earth's surface leads to differences in temperature, which drives weather patterns. We call the patterns in temperature and weather over long periods of time **climate**. Different parts of the world have vastly different climates; it depends on how much heat they receive, as well as what landscape features are nearby. Water, mountains, ocean currents, and forests all impact our climate. In turn, living things around the world have adapted to the climate they live in.

Something, though, is changing. Over the past two hundred years, humans have been burning fossil fuels, such as coal and oil, to make energy to power our daily lives. Fossil fuels are made from decomposed plant matter and microscopic life millions of years old. This matter is full of carbon, and, burning it releases, or emits, billions of tonnes of **carbon dioxide** gas into the atmosphere every year. When too much carbon dioxide is emitted, the delicate balance of greenhouse gases maintaining

Earth's climate is upset. More and more heat is trapped, causing the planet to warm. Weather patterns change, water levels rise, storms get worse.

Climate has changed many times throughout Earth's history, from ice ages to periods much hotter than today. So why is this time any different? Scientists agree on two things. One, temperatures are rising faster than they ever have in documented climate history. Two, this climate change is driven by human activities, due primarily to greenhouse gas emissions.
Climate change is already impacting people's ways of life all over the world. Powerful storms, droughts, forest fires, and floods are threatening people's access to food, water, and safe homes.

The most important step we can take to prevent serious climate change is to reduce greenhouse gas emissions. Incredibly brave and caring people around the world are finding new ways to reduce emissions and make our communities climate resilient every single day. And you can join them! These Science Spotlights are here to help us learn more about climate change and how you can take action.

Our Commitment to the Decolonization of Science

Institutions of GenAction initiative respect and affirm the inherent and Treaty Rights of all Indigenous Peoples across what we now know as Canada. We give thanks to the Indigenous Peoples who care for this land since time immemorial and pay respect to their traditions and ways of knowing. We acknowledge their many contributions to innovations in Science, Technology, Engineering, and Mathematics, past and present, and are committed to deepening engagement and collaborating with Indigenous Peoples as partners in order to advance truth and reconciliation and the decolonization of science.

Climate Change: Past, Present, and Future is based on...Delmotte, Masson, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, et al. 2021. "Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change." Intergovernmental Panel on Climate Change. Cambridge University Press. In Press.