This project was undertaken with the financial support of the Government of Canada.

Canada

discovery centre

KELP is on its Way!

Origin Story:

How did the Carbon Sink get its Name?

Toads, plants, and humans. What do we all have in common? For one, our bodies contain carbon, an important building block for life on Earth. Carbon also plays a major role in driving climate change. Why is this?

Well, when living things died millions of years ago, their carbon-rich, fossilized remains built up in the Earth's crust. Over time, the carbon turned into coal, oil, and natural gas; fuels we know today as fossil fuels. When we burn fossil fuels for energy, they release carbon dioxide gas into the atmosphere, contributing to climate change.

Keeping carbon in the ground is crucial to preventing more climate change. This is where carbon sinks come in. A carbon sink is something that stores a lot of carbon, keeping it out of the atmosphere. Plants and algae are examples of carbon sinks, because they breathe in carbon dioxide and store the carbon in their cells. Kelp, an alga, and seagrass, a plant, are two seaweeds that are exceptionally good at storing carbon, making them super carbon sinks!

Map Making:

Satellite Imaging of Seaweeds

Climate change is warming the oceans, making it harder for kelp and seagrass to grow and store carbon. Scientists are racing to map where they grow now, to help figure out how that many change in the future with continued warming. But seaweeds grow under dark, choppy waters, making photos hard to analyze and the mapping of large areas difficult. Scientists studying kelp and seagrass on Nova Scotia's Eastern Shore looked all the way to space for a solution. Could satellite images and some coding help them map these important carbon sinks more efficiently? Here is what they tried.

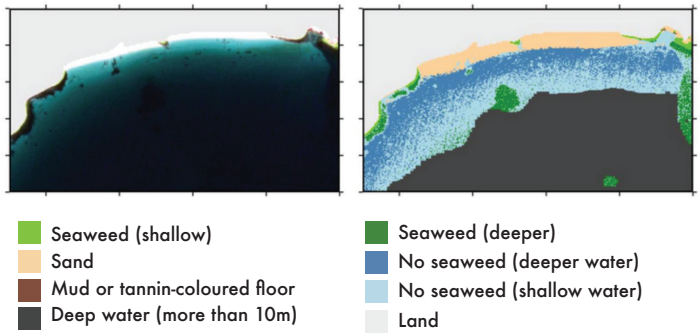
STEP ONE:
A field survey. The scientists went to the islands and dropped waterproof cameras into the ocean to record what was growing and where. This will help the scientists compare how accurately their mapping program relates to what is actually underwater.

STEP TWO:
Satellites. The scientists searched through all recent images of the Eastern Shore Islands taken by two powerful satellites (Sentinel-2), to find the clearest photo.

These special satellites capture the slight differences between light reflecting off plants and seaweeds and light reflecting off other surfaces like water or sand. The team wanted to create a computer program that could detect these differences automatically and map where seaweed is likely growing, all from images taken hundreds of kilometres above Earth. But first, they had to edit the image to remove things that could confuse their program and give messy results. It ended up being a five-step process.

1. Hide plants on land.
2. Hide freshwater.
3. Apply filters and changes to make the photo cleaner.
4. Hide areas of water deeper than ten metres (10m).
5. Hide areas with too much reflection from the sun.

Building the computer program to study the image pixel by pixel, they had it classify and map each area by category (seaweeds, sand, water, etc.) based on how it reflected light. Here is an example of what they made: first the original satellite image with just the land hidden, then the processed and mapped image.



Kristen Wilson, Melisa Wong, and Emmanuel Devred, *Branching Algorithm to Identify Bottom Habitat in the Optically Complex Coastal Waters of Atlantic Canada Using Sentinel-2 Satellite Imagery* (Frontiers in Environmental Science, 2020), 12, fig. 5a.

They made fifty different maps and models based on the satellite image information. They checked their results against their underwater photos from step one, teaching their program to be more accurate each time until they could be sure it was finding the areas that had seaweed, and which ones did not.

Success! They now have a formula for using satellites to spot these seaweeds from space, without ever having to go out on the rough seas! This is crucial for mapping other large areas more efficiently, allowing scientists to keep track of these important natural carbon sinks as our climate changes.

TIME FOR GENACTION!

Try this at Home: CITIZEN SCIENCE

Citizen science is a fantastic way for all of us to help climate scientists to track changes over a much bigger amount of land than they could manage on their own. Zooniverse is a website with lots of different citizen science projects that you can help with.

You can even help find kelp forests in satellite photos with the project Floating Forests. It is fun and easy! Check Zooniverse website for more details.

Climate Action: COMPOSTING

If plant life can store carbon, that means our food waste does too. When you send food waste to the landfill, it often decomposes anaerobically (without oxygen), which means the carbon in the food is released as methane, a greenhouse gas over twenty-five times more powerful than carbon dioxide. Consider starting a compost bin or pile at home!

This can help ensure your food scraps decompose naturally, and reduce the release of more methane. Check out your municipal website to learn what you can compost in your neighbourhood. Make a list, keep it in the kitchen, and see how much waste you can save!

This Science Spotlight was written based on Wilson, Kristen, Melisa Wong, and Emmanuel Devred. 2020. "Branching Algorithm to Identify Bottom Habitat in the Optically Complex Coastal Waters of Atlantic Canada Using Sentinel-2 Satellite Imagery." *Frontiers in Environmental Science*, 8: 1-19. https://doi.org/10.3389/fenvs.2020.579856.

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.