SCIENCE FOCUS

Engaging NWT youth and teachers
for grades 6-12 in environmental science

Lesson plans for grades 6-12 in environmental science.

ECOLOGY NORTH

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Introduction

Welcome to our Science Focus document in which Ecology North's environmental education team have provided a variety of Environmental Science lesson plans for grades 6-12. The objective of this resource is to help educators get students engaged in science.

Our goal for this project is to provide interactive, hands-on, science-based lesson plans and activities for youth across the NWT. Our focus is on grades 6-12 with lesson plans based on five different themes (waste, water, climate change, energy and animals). We are particularly interested in reaching out to small remote communities where it can be a challenge for teachers to encourage students to become engaged in scientific activities.

Our hope is to inspire an interest in studying and pursuing the sciences for northern students. In addition, we are keen to connect with classrooms from across the NWT and support citizen science observations. Students can get engaged in Plantwatch and Icewatch activities to help collect data and relate their observations to changes associated with climate change. Scientists are in need of real data from NWT communities to track the impacts of climate change. For example, some predicted impacts of climate change are that as temperatures get warmer, spring arrives earlier. Warming temperatures causes the ice on local bodies of water to melt faster than before, meaning that our rivers and lakes will be clear of ice earlier in the season. The effects of shorter ice road season will have a great impact on people in a number of NWT communities, in addition to affecting animals that use ice during migration. These warmer temperatures also result in plants blooming earlier, which affects the animals who relies on these plants as source of food.

These lesson plans are just a guideline and you are encouraged to follow them or make changes that best suit your particular group of students. Each lesson plan provides curriculum connections as we feel it is important to make them meaningful and aligned with the curriculum goals for each science unit. They also include a suggested list of supplies, which include materials that should be easily found in your classroom or science lab. Each lesson plan also includes several activities for you to complete with your students to help them get engaged in the topic area. As always we encourage you to provide guiding questions throughout the lesson to gauge what you students know and what information they are still missing to support learning.

We hope that you enjoy this resource and find it helpful as you plan and prepare to teach environmental science to your students. Our most important goal is to get students engaged in meaningful experiences that get them excited about learning more about their natural environment and support the foundation for lifelong learning!

Biology 20 – lesson 1

Composting Biology

Objective: To explore the conditions and ecology of composting

Introduction: While it may look like a pile of dirt and other organic materials, the compost pile is an area of considerable biological activity. This lesson will help students explore some of the cycles, organisms and interactions present in the compost pile.

Curriculum Connections:

Unit A: 1.1-1.4k, 1.2s, 1.3s, 2.1-2.2k, 2.1sts

Unit B: 1.1-1.4k, 1.1sts,

Unit C: 2.3k, 2.1-2.2sts

Supplies / Materials:

- Compost and soil samples
- Pictures of / words representing components and products of composting (resource 1)
- Microscopes
- Food web of compost pile (resource 2)
- Computers to look up other **resources** or print-outs from **resources** 3 and 4

Hook: Put out small dishes of soil and compost samples to be shared by small groups of students. Have them feel, smell and describe differences of the samples

Intro Activity: Ask the students which they thought was garden soil and which was compost. Fill out a KWL chart for composting (encourage them to think about the microbiology, heat and cycling)

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Lesson Subject

Biology 20

Topic

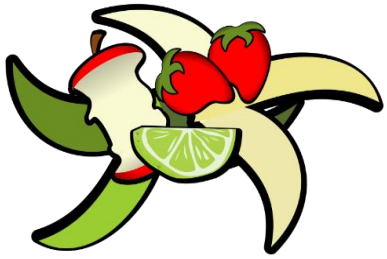
Compost Ecology and Energy

Location

Classroom

Length

60-80 mins



Main Activity:

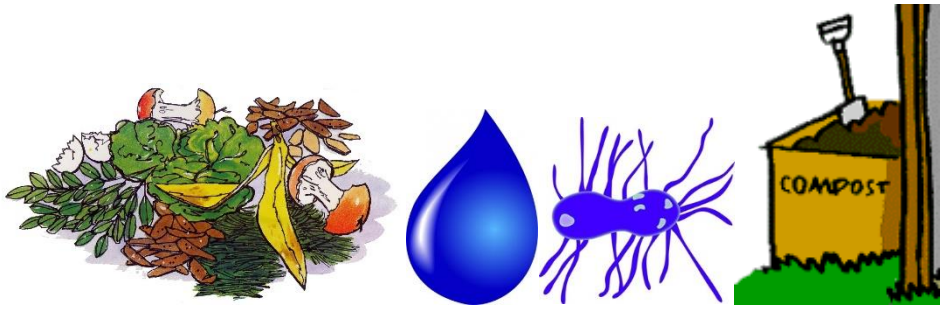
1) Have students create a flow chart of inputs/outputs for the compost process using the words/pictures.
2) Have them look at their samples under microscopes to compare microbiology, trying to find the organisms in the food web. Note this will not work if you have sterilized compost. See extension for creating your own compost
3) Divide students into groups: (Use **resources** 3-7)
    a) To research and discuss the roles of oxygen in composting. (Anaerobic vs aerobic processes)
    b) To research the role of water in composting. How does it promote anaerobic vs aerobic processes?
    c) To research the nutrient cycles in composting. Give some examples of carbon and nitrogen sources and discuss the ratios of these in effective composting.

Conclusion / Review: Review what was learned about compost ecosystems – what are the organisms, their niches, and abiotic and biotic factors? Review biogeochemical cycles.

Homework: Have students plan an experiment to explore compost variables (see extensions); investigate vermicomposting or determine the best composting for their home waste.

Resources:

1) Overview: http://home.howstuffworks.com/composting1.htm



2) Compost food web: http://www.cas.miamioh.edu/scienceforohio/Composting/images/CoFoodWb.pdf

3) Compost fundamentals: http://whatcom.wsu.edu/ag/compost/fundamentals/index.htm (includes information about aerobic vs. anaerobic, microbes, nutrients, moisture, T etc.).

4) The Science of Composting: http://web.extension.illinois.edu/homecompost/science.cfm

5) The decomposition process: http://aggie-horticulture.tamu.edu/earthkind/landscape/dont-bag-it/chapter-1-the-decomposition-process/

6) The N cycle: http://www.the-compost-gardener.com/nitrogen-cycle.html

7) The P cycle: http://www.gardenmyths.com/rock-phosphate-fertilizer/

Answer Guide to Question #3.

a) Role of oxygen:

- Allows respiration of aerobic decomposers, carbon oxidized for energy – no smell
- Lack of oxygen results in fermentation, aerobic organisms release of CH4 and H2S = smell

b) Role of water

- Survival of microorganisms
- Solvent for organic molecules
- Some microorganisms use water to move
- Too much displaces oxygen

c) Nutrients and nutrient cycles

C: becomes CO2 as respired; CO2 will be taken up in photosynthesis

N: combined with C in living cells, used for cell protoplasm and amino acids, produce ammonium

P: important for cellular growth – builds cell protoplasm

- When these microorganisms die, other organisms can take up the nitrogen and phosphorus and respire the carbon

Biology 20 – lesson 2

Shrubs of the NWT

Objective: To investigate some NWT shrubs and their specific characteristics

Introduction: Plants are important providers of food and medicine, gas exchange and water cycling. While there may be fewer plant species in the North, those that thrive here can be found in abundant quantities. In addition, knowledge of their identification and value is becoming less common. This lesson plan aims to introduce students to some northern plant species and get them excited about plant watch.

Curriculum Connections:

Unit B – 1.1-1.4k, 1.1-1.3s,

Unit C – 1.1-1.3s. 2.1s

Supplies / Materials:

- An area with 2 of the following plants: bearberry, cranberry, saxifrage or mountain avens
- PlantWatch Book or computers to access Plant Watch plant descriptions online
- 4m long strings (1 per group of students)
- Cameras and/or sketch books
- Spade or soil sampling kit
- Small Ziploc bags
- Nature journals, worksheet or blank paper for taking notes
- Pencils or writing materials to make notes

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Lesson Subject

Biology 20

Topic

Ecosystems, Photosynthesis

Location

Field (possibly start in classroom)

Length

100 mins

plantwatch
ENGAGING CITIZENS IN SCIENCE

Hook: Ask students to reflect on the value of plants to humans and to ecosystems.

Intro Activity: Introduce students to the plants they will use. They will need to learn to identify their plants so have them make sketches and write down important information based upon the plant watch book (branching pattern, leaf identification). This can be done through a simple worksheet with a variety of pictures of plants found in their community or can be done through collecting a sample of plants outside and letting them examine them hands on in the classroom, depending on the weather and time of year.

Main Activity:

1) Have each student choose a plant that interests them, or get them to choose a plant in a small group of 2-3 students, depending on class size and the number of plants you provide.

2) Have them go outside to collect several samples of their chosen plant. For example, if they choose a pinecone, get them to gather 2-3 pinecones. Remind them that each sample should be different in some way (size, colour, age).

3) Have students look at their samples closely and with a magnifying glass if possible for more detail. Get them to try and identify different parts of their plant and make notes on their sketch.

Independent Student Work: Have students create a write-up about their plant either in a worksheet or in their plant journals. They can use data collected from their observations and plant watch book. Their write up should include a sketch, a few identified parts of the plant and a reflection about the activity. Perhaps they could outline a description with explaining all the features of the plant and then end with a "Who Am I"? See if the students can guess the identity of the plant. This might work for your class!

Conclusion / Review: Ask students to share a bit about what they have learned. Is there anything to add to the functions of plants? How do they think ecosystem factors are interacting?

Homework: Finish the plant write-up and be prepared to share what they have learned about their plant with other students who examined other species.

Resources:

1. http://www.saps.org.uk/secondary/teaching-resources/157-measuring-the-rate-of-photosynthesis

2. http://www.isa-arbor.com/events/conference/proceedings/2013/FINI_ISA2013_shrubs_paper.pdf

Extensions:

1. Participate in Plant Watch: https://www.naturewatch.ca/plantwatch/

2. Have students estimate the carbon dioxide uptake of an area of shrubs or plants using the data from their photosynthesis measure or an average from resource 2 and the number of growing days in your community.

3.Have students compare and contrast the similarities and differences in the characteristics of plants that live in the Northwest Territories. Is there a pattern or common thread to the adaptations of these plants? If so, what are they?

Biology 20 – lesson 3

NWT Caribou

Objective: To introduce students to the challenges for NWT caribou.

Introduction: Caribou herds have been declining in the NWT over the past decades in response to human activity including resource exploration and extraction, industrial development and climate change. This lesson aims to introduce students to some of the challenges caribou face and potential solutions for mitigating those challenges.

Curriculum Connections:

Unit B – 1.1k, 1.4k, 1.1sts, 1.4s, 2.2k, 2.3s

Supplies / Materials:

- Large tarp/sheet, sets of coloured cards (5 cards per student)
- Newspaper
- Construction paper
- Ribbons
- Barren-Grounds population graph

Hook: Have students create a mind map for what they know about caribou (can be a class or smaller group activity). Brainstorm potential pressures on caribou populations (roads, town sites, mines, oil and gas, fires, hunting, climate change, predation, illness etc.)

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Lesson Subject

Biology 20

Topic

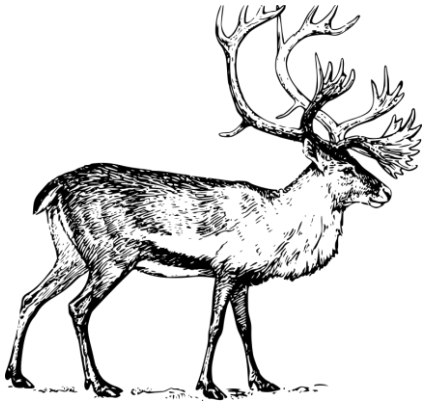
Ecosystems and Population Change

Location

Classroom

Length

1 period



Intro Activity: Caribou habitat pressures game (See "Bears of Banff" game described below).

Main Activity:

Project resource 2 on a screen. Have students break into small groups to talk about what information and/or conclusions they feel they can gather from this data and what questions they have of the data. Have them brainstorm what we can do as humans to protect vulnerable populations.

Conclusion / Review: Revisit the mind map and add in details.

Homework: Assign students to 3 groups to read and summarize one of the three reports in **resources** 2-4. Have them determine if there are other things to add to the mind map.

Resources:

1. Bears of Banff Game: http://cpaws-southernalberta.org/upload/Bears_of_Banff.pdf

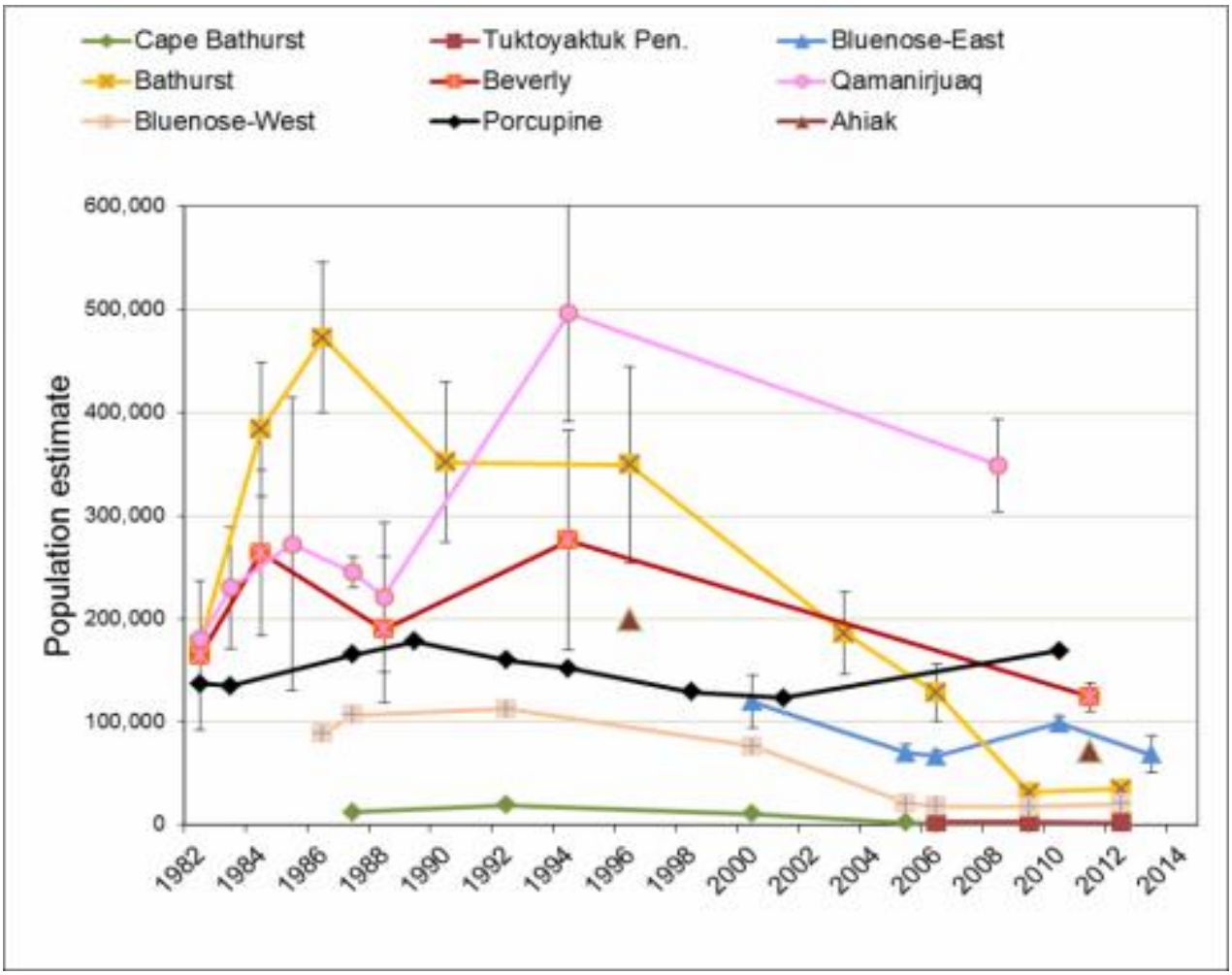
   Play this game as described above **except:**

   a) Substitute an area of the NWT for Banff (habitat of threatened species can be found at: http://www.nwtspeciesatrisk.ca)

   b) Substitute caribou for bears – may want to add limits on movement due to prey behavior being different than predator behavior e.g. movement as a herd, novelty fear, presence of wolves in an area etc.) Alternatively discuss this difference post-game.

   c) Substitute Banff pressures for NWT pressures (see **resource** 2)

2. ENR depiction of Barren-Grounds Caribou Herds (http://www.enr.gov.nt.ca/fr/node/3167)



3. Article about caribou responses to human activity (BC): http://www.env.gov.bc.ca/cariboo/env_stewardship/wildlife/inventory/caribou/mtncar/harass/impacts.pdf

4. CPAWS boreal caribou information and articles: http://cpawsnwt.org/campaigns/boreal-caribou

Extensions: Find your school's copy of or contact you local ENR for the *Caribou and People: A Shared Future*. Follow those activities to learn more or assign some as homework.

Biology 30 – lesson 1

Bison Management

Objective: To analyze / study a population of NWT Bison and its management

Introduction: The MacKenzie Bison Population was established to protect the genetics and health of Wood Bison as a species. This population started with a limited number of healthy individuals, grew exponentially and now is fluctuating. The purpose of this study is to create understanding about population change and species management in the NWT.

Curriculum Connections:

Unit D - 1.1 sts, 30 2.1k, 2.1sts, 2.1s, 3.1-3.3k, 3.1s, 3.3s

Supplies / Materials:

- Data from ENR – see below
- Student questions – see below

Hook: Wolf and bison video:

https://www.youtube.com/watch?v=tCG1I-Ssgww

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Lesson Subject

Biology 30

Topic

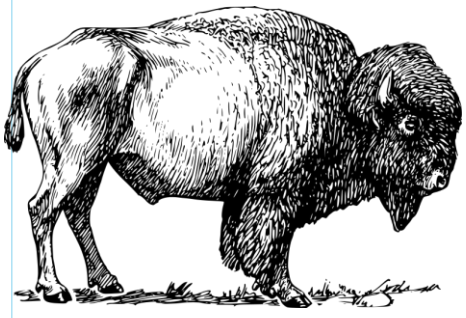
Population and Community Dynamics

Location

Classroom

Length

50 minutes for initial activity, 50-100 minutes for group investigation



Intro Activity:

1) Let the students know they are going to investigate the MacKenzie Bison Population, which started with 16 human-introduced individuals in 1963 as an attempt to protect Wood Bison genetically - avoiding interbreeding with Plains Bison. A map of the range of this population can be found in **Resource 1**.

2) Have students look at population estimate chart and see what information they can glean from the data. Sample questions to help guide them can be found below.

Main Activity:

1. Have students work in a group to investigate Wood Bison further (**Resources 1 and 2**).
2. Ask students to either brainstorm ideas of how to manage this population, especially considering the limited genetics, and/or design experiments that could be done with this population. Some ideas are given below.

Independent Student Work: Have your students write a journal entry about what they have learned about bison populations and management.

Conclusion / Review: What responsibilities do we have in managing populations and what are some of the challenges of reintroducing species in an area?

Homework: Do some online research on Wood Bison and/or other managed species in the NWT (e.g. Whooping Cranes, Caribou, Wood Frog etc.) E-mail links to interesting news stories to your teacher.

Resources:

1. Wood buffalo management strategy:

http://www.enr.gov.nt.ca/sites/default/files/strategies/wood_bison_management_strategy.pdf

2. Wood Bison information: http://www.nwtspeciesatrisk.ca/species/wood-bison

3. Sample Student Questions:

Review this data from ENR found at:
(http://www.enr.gov.nt.ca/sites/default/files/strategies/wood_bison_management_strategy.pdf)

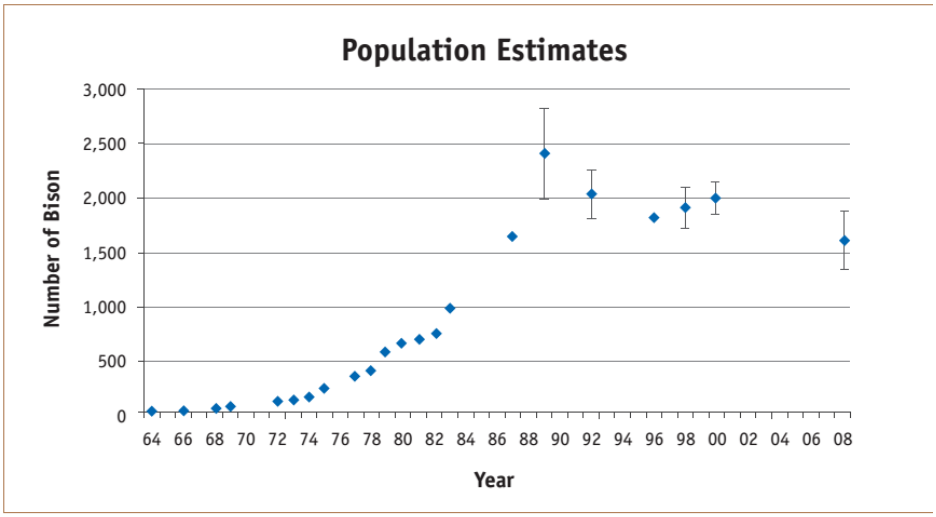


Figure 3: Mackenzie wood bison population size estimates, 1964 to 2008. Error bars are 95 percent Confidence Limits.

1. What is a population?
2. How do you think these estimates are made (especially larger numbers)?
3. What type of growth do we see between 1964 and 1989? (Linear vs Exponential)?
4. What factors might influence population growth? (Predators, hunting, habitat limitations, human control measures, disease).
5. Would you assume buffalo offspring are r- or k- type? Could this graph support your assumption? (may expect more variability in population numbers in an r-based population) What other data would help confirm your assumptions?
6. At what point in this graph do you think the Hardy-Weinberg principle might apply?
7. (when might the assumptions hold true).
8. Why might we want to keep Wood Bison genetics pure? What are potential genetic challenges for this population?

In the summer of 2012, the Mackenzie wood bison population experienced the worst anthrax outbreak known in northern Canada when at least 440 bison died over an 8 week period.

1. If anthrax resistance is hereditary as it is in humans[1] do we expect the remaining population to be more or less resistant? Why?
2. How would we expect the population of predators (wolves) to respond to this loss?
3. What control measures might be put in place to limit the spread of disease in populations?

[1] *Anthrax susceptibility and heredity (in humans): http://www.upmc-cbn.org/report_archive/2012/cbnreport_02172012.html*

Experimental Ideas:

1. Investigate intraspecific competition for mates / prime habitat
2. Investigate anthrax resistance by looking for resistant proteins

   Pimental, RA; Christensen, KA; Krantz, BA; Collier, RJ (September 2004). "Anthrax toxin complexes: heptametrical protective antigen can bind lethal factor and edema factor simultaneously". Biochemical and Biophysical Research Communications 322 (1): 258–62. doi:10.1016/j.bbrc.2004.07.105. PMID 15313199.
3. Investigate the effect of human activities such as logging on distribution and population levels
4. Investigate predator/prey relationships
5. Predict population change over the next 10-20 years

Extension Ideas:

1) Use this lesson as a springboard into Frog Watch: https://www.naturewatch.ca/frogwatch/ Please note, Lesson Plan Biology 30-1 has more detail on NWT Frog Populations.

2) If possible, use this topic (managed species in the NWT) to be the focus for a student project. The projects can be part of a small group or large group focus depending on your goals as an educator.

Biology 30 – lesson 2

NWT Frog Populations

Objective: To introduce students to populations by using NWT frogs as a model

Introduction: As frogs are an indicator species, the monitoring of frog populations can help in the evaluation of ecosystem health. In this lesson plan students will investigate the reasons for, methodology of and data from frog population monitoring in NWT and Canada.

Curriculum Connections:

Unit D 1.1sts, 2.1sts, 2.4, 3.1s, 3.2S

Supplies / Materials:

- Map of frog/toad distribution in NWT
- Data collected in frog watch
- Student journals / blank paper

Hook: Watch frog video e.g. http://ed.ted.com/lessons/disappearing-frogs-kerry-m-kriger

"*Frogs and toads can be used as indicator species, because they are vulnerable to changes in the atmosphere, the land, or the water." source Frogwatch Canada.*

Intro Activity:

1. Discuss the term **indicator species** and determine which NWT species are considered **indicator species**. Discuss how monitoring their populations may be an important tool to track environmental change / human impact.

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Lesson Subject

Biology 30

Topic

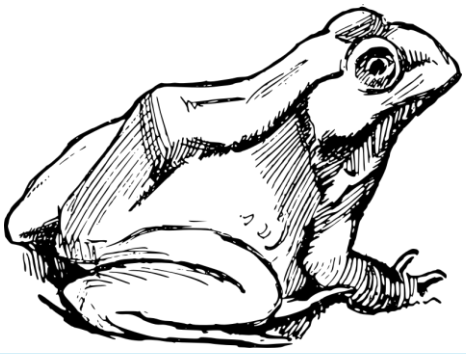
Human Impacts and Monitoring

Location

Classroom

Length

50 – 100 minutes (depending on optional activities included)



2. In the NWT there is a lot of discussion regarding monitoring large animals, like bison, caribou and musk ox but there is less attention to smaller and lesser-known species. Ask the students how they think frog populations could be monitored (visually, auditory – on calls, physically – e.g. catch and release). Have them brainstorm the pros and cons for each of these monitoring techniques. Provide time to do some online research, as the concept of studying frogs will be a usual topic of conversation.

Main Activities:

1. (Optional) In the senior guide for Frogwatch **(Resource 1)** there are several activities to help students understand Canadian frog populations in general. You may want to choose one or more of these activities.

2. Have students assess data from Frogwatch for the NWT. What does this (limited) data set tell us about NWT frogs? What else would they want to know and how might they research this?

3. (Optional) Compare NWT data with data from another province. Can those data be used to form trends? Have students think about (in pairs) and then be prepared to comment (to the class) on what amount of data is needed to be confident in making conclusions (i.e. is the population trend indicating a decline or an increase in population?).

4. Compare NWT data to visual sightings data found in **Resource 1** below. Is the Frogwatch data supported by the map? (**Resource 2**) What are some questions/assumptions they have about how data was collected by these researchers? Are their frogs/toads in your community? Has anyone seen them?

5. Traditional Knowledge should be shared with the class. Invite the school elder, or a an elder from the community to visit the class and explain what they know about frogs. Have they seen them in the community in their lifetime?

Conclusion / Review: What is the value of observations and data in helping us monitor our wetland health? What is good data? How much do we need? How can we contribute?

Homework:

1) Have students do one of the optional activities above.

2) Have students research which frog/toad's range (spread) includes your community and learn its call.

Resources:

1. Frogwatch: https://www.naturewatch.ca/frogwatch/northwest-territories/

https://www.naturewatch.ca/wp-content/biguploads/senior_guide_712.pdf

http://www.nwtspeciesatrisk.ca/sites/default/files/northern_leopard_frog_nwt_status_report_dec_2013_final2_0.pdf

2. Map: http://www.nwtpas.ca/maps/map-sf-amphibians-pas-areas.pdf

Extension:

1. Take the students on short field trips in the spring and fall to observe for Frog Watch. In the spring, you will be more likely to hear the mating calls of any resident species in your area. Please be sure to submit those observations to Nature Canada. www.naturewatch.ca/frogwatch

2. Have students research what scientists have learned about human health through studying frogs. For example, researchers are examining the wood frog for it's freeze tolerance in the hopes of being able to apply that knowledge to the world of medicine. This knowledge will have implications for human organs – being able to freeze them safely would allow for a greater success in human organ transplant surgeries.

Biology 30 – lesson 3

Endocrine Disrupters

Objective: To learn the effect of household chemicals on the human body

Introduction: Common household chemicals found in cosmetics or cleaners may have significant biological effects in the human body but companies are not forced to disclose them. This lesson aims to introduce students to some of those potential effects and their mechanisms of action.

Curriculum Connections:

Unit A

Unit B

Unit C – human activity leading to mutations and cancer

Supplies / Materials:

- Bottles of cleaning supplies and cosmetics or pictures of labels of these things

Hook: "The Dirty Dozen"
https://www.youtube.com/watch?v=Eju1KqipMyc

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Lesson Subject

Biology 30

Topic

Endocrine and Nervous Systems

Location

Classroom

Length

60 mins for initial activities + time for individual student work or projects (10 – 50 mins)

Intro Activity: Have students look at the ingredient lists on cosmetic products or cleaning supplies. Alternatively, if you don't have products or labels available divide the information from "the dirt on toxic chemicals" article below into sections and assign to groups of students to look over. Ask them to look for vocabulary that describes the effect of these chemicals on our health (e.g. carcinogen, endocrine disruptor, irritant etc.)

Main Activity:

1. Review what the students know about endocrine function. What are some of the hormones they know about? How do these hormones affect the human body?
2. Let students know they will focus on endocrine disruption for this lesson. Brainstorm what they think the term "disruption" could mean to a cell, organ or human body.
3. Have students work in small groups to create an image for how they think endocrine disruptors work or look at an image and describe what is happening. What do they think having endocrine disruptors in cleaners and/or cosmetics could be doing to human health?

Independent Student Work: (assign one or more as in-class work or as a project)

1) Have students define terms related to human health in science notebooks. The terms can include *carcinogen*, *endocrine/hormone disruptor*, *reproductive toxins* and *neurotoxicity*. (These terms were selected from the David Suzuki Foundation articles, your class may brainstorm more terms they wish to have defined).
2) Have students come up with their own schematic for endocrine disruption
3) Have students brainstorm which products in their own homes could lead to endocrine disruption
4) Have students research specific endocrine disruptors and the systems they effect

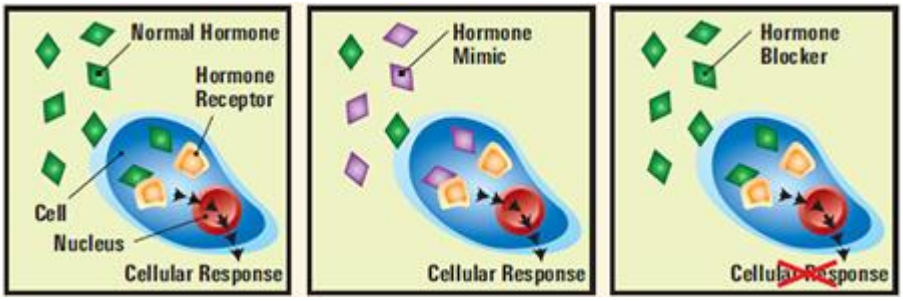
Conclusion / Review: Ask if students were surprised by what they learned. Ask them why they think these chemicals may be allowed and whether they think they are a problem / how big of a problem.

Homework: Have students write a letter to federal politicians requesting better labeling systems, citing scientific evidence for the need based on endocrine function. See CESD petition below for examples.

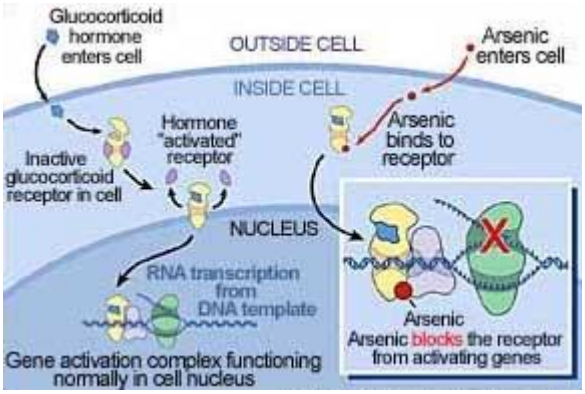
Resources:

1) http://www.davidsuzuki.org/issues/health/science/toxics/the-dirt-on-toxic-chemicals-in-household-cleaning-products/
2) http://www.davidsuzuki.org/media/news/downloads/2011/CESD-petition-cosmetics-2011-01-18.pdf
3) http://davidsuzuki.org/issues/health/science/toxics/dirty-dozen-cosmetic-chemicals/

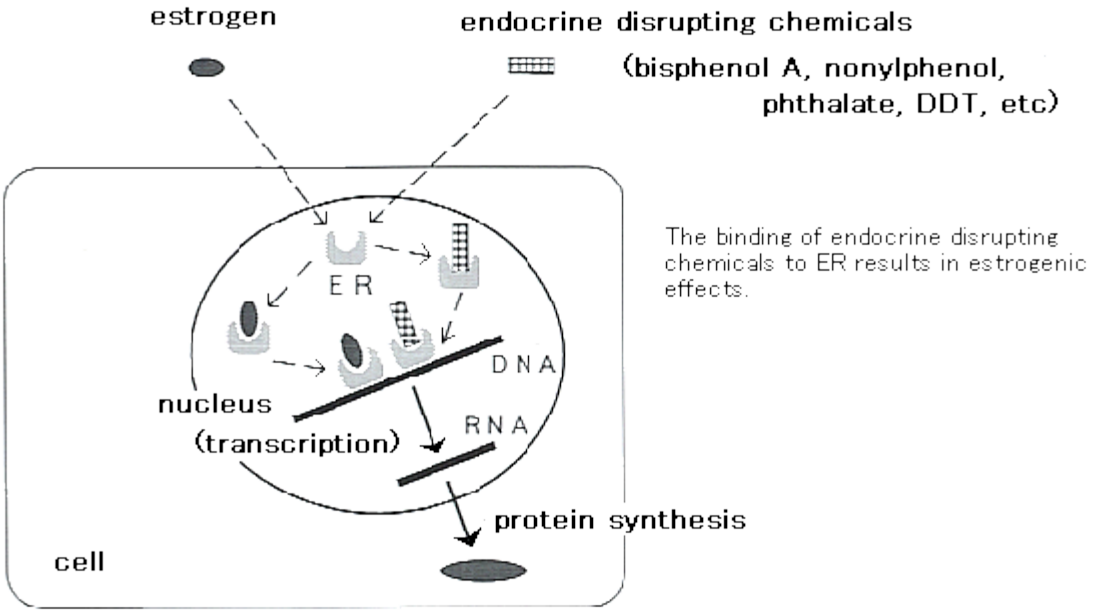
Sample Images:



From: http://www.niehs.nih.gov/health/topics/agents/endocrine/



From: http://www.mindfully.org/Pesticide/Arsenic-ED-Heavy-Metal.htm



From: http://www.env.go.jp/en/chemi/ed/speed98/sp98f3a.gif

Extension:

1. Have students research the dirty dozen of cosmetics (see resources) and try to determine which products they use may contain chemicals and if there are healthier alternatives
2. Discuss/research the effect of endocrine disruption on wildlife – link to unit D e.g. http://www.ncbi.nlm.nih.gov/pubmed/10680769
3. Have students compare conventional and alternative cleaners using agar plates and bacterial swabs.

Chemistry 20 – lesson 1

pH of Water

Objective: To discover the pH scale and why it is used by scientists

Introduction: The quality of our drinking water is tested all over Canada. Each community has a water treatment plant where employers conduct a variety of tests to ensure that our drinking water is clear and safe to drink. Contaminated water can pose a number of risks to our health, and it is important we ensure the safety of drinking water and obtain water testing that meets all regulator requirements and quality standards in Canada. One of the tests that are done at local water treatment plant is the pH test. A simple pH test determines the acidity of the water, with the goal of it being as close to neutral as possible. A neutral pH ensures that the water is safe to travel through pipes (minimizes corrosion) and to drink.

Curriculum Connections:

- Students will conduct investigations into relationships among observable variables and use a broad range of tools and technique to gather and record data.
- Students will compare changes in pH with changes in concentration for acids and bases

Supplies / Materials:

- Water samples
- Sample bags
- Straws
- pH scale handout
- pH tablets
- Vinegar, baking soda, soap
- Computers

SCIENCE FOCUS

Lesson Subject

Chemistry 20

Topic

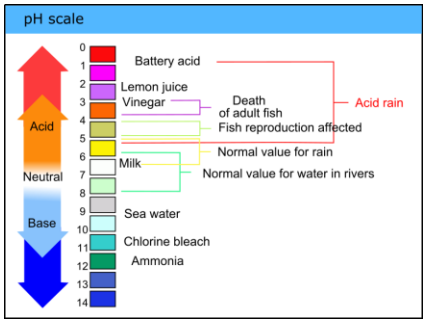
Acids and Bases

Location

Classroom

Length

50 mins



Hook: Students go online to watch the pH scale video and take the quiz to test their knowledge.

Link: http://study.com/academy/lesson/the-ph-scale-calculating-the-ph-or-poh-of-a-solution.html

Intro Activity: Teacher leads a discussion about water quality testing, why it is important that the city tests for the quality of our water. Water quality is defined by analyzing it in terms of its chemical content, physical content and biological content. Lead an example of testing water for pH using the testing kit.

-Add a sample of water to the yellow sampling bag, shake in a pH tablet and check the scale for the corresponding color. (Neutral distilled water)

Main Activity:

Students test a variety of samples of water using the PH scale to determine if they are neutral, an acid or a base. Students are encouraged to sample water from a variety of sources (bottled, tap, local bodies of water, etc.). Some samples can have ingredients added such as vinegar, baking soda and lemon juice.

Conclusion / Review: Collect results as a class and go over findings. Ask guided questions:

1) Did anything surprise you about your findings?

2) Why do we want drinking water to have a neutral pH level?

Homework: Have your students try the *Red Cabbage Chemistry* experiment at home. Red cabbage can be used as an indicator that will test the pH or the acidity or alkalinity of certain liquids. Get students to take pictures and record their method, observations and results. They can bring their findings to the next Chemistry 20 class for discussion. You can also try this experiment as a class. **Step by step instructions and a video can be found at SICK Science under resource 3.**

Resources:

1. Acids and Bases lesson plans**:** http://study.com/academy/course/high-school-chemistry-syllabus-resource-lesson-plans.html

2. Alberta Program of Studies: Chemistry

3. Sick Science: Red Cabbage Chemistry
http://www.stevespanglerscience.com/lab/experiments/red-cabbage-chemistry/

Chemistry 20 - 2

Science in the Natural World

Objective: Explain the goal of science is knowledge about the natural world

Introduction: Although many gases in the atmosphere have little effect on weather patterns there are some that have a significant effect on the weather that we experience. Carbon dioxide is one of the gases that do affect weather. This gas has the unique characteristic of absorbing the heat sent to the Earth from the Sun. This helps keeps the Earth warm for life to exist. Carbon dioxide occurs naturally causing the greenhouse effect. The problem starts when humans artificially add higher amounts of carbon dioxide and other greenhouse gases into the atmosphere than is needed to maintain a natural balance. This happens through the burning of fossil fuels (or greenhouse gases), and is causing the Earth's temperature to rise in an enhanced greenhouse effect.

Quick Fact: The Greenhouse gases (GHGs) include water vapor (H20), carbon dioxide (CO2, methane (CH4), nitrous oxide (N20), halocarbons (HC), ozone (O3). Source climatechangeconnection.org

Curriculum Connections:

Students will describe examples of natural phenomena and processes such as weather that illustrate the properties of gases.

Supplies / Materials:

- Properties of Gases video
- Erlenmeyer 250 mL flasks
- Balloons
- Ice water
- Hot plate

SCIENCE FOCUS

Lesson Subject

Chemistry 20

Topic

Gases

Location

Classroom

Length

50 minutes

Hook: As a class go online and look up the weather of your community on different sites such as *The Weather Network* and *Environment Canada*. What can you gather from this data collection?

Intro Activity: In the computer lab, or on laptops access the "properties of gases video" watch through and take notes. After watching the video complete the quiz.

Link: http://study.com/academy/lesson/the-kinetic-molecular-theory-properties-of-gases.html

Main Activity: **Balloon and Flask Experiment**

Key concept: When the temperature of a gas is increased, its volume will increase.

Place 10 mLs of water in an Erlenmeyer flask. Stretch an un-inflated balloon over the mouth of the flask (250 mL flask). Place the flask next to a hot plate with a thermal oven glove so that students can move the flask easily from the hot plate to the ice water. Students will see how an increase in temperature can case an increase in the volume of a gas.

Place the flask on a hot plate and let the water boil.

Conclusion / Review:

1) What happens to the balloon? Why?

2) What happens to the balloon when you put the flask in a beaker of ice and let it cool? Why?

Homework: In your science lab journal review our experiment. How does a temperature increase in a hot air balloon relate to increased temperature in our community?

Resources:

1) http://study.com/academy/lesson/the-kinetic-molecular-theory-properties-of-gases.html
2) http://www.arborsci.com/cool/chemistry-gas-laws-smorgasborg
3) Environment Canada https://weather.gc.ca/city/pages/nt-8_metric_e.html
4) The weather network https://www.theweathernetwork.com/ca

Chemistry 20 - 3

Composting Chemistry

Objective: To explore the chemistry of composting

Introduction: In the process of breaking down compostable materials, a number of chemical reactions occur. The goal of this lesson is to familiarize students with some of the chemistry that occurs in the compost pile, allowing for the cycling of nutrients.

Curriculum Connections:

Students will learn the process of breaking down compostable materials.

Supplies / Materials:

- Compost samples (ask a gardener friend!)
- Computers and/or handouts with chemical molecules
- Paper and writing utensils
- Magnifying glasses
- Paper towel (for small compost sample)

Hook: Give students compost samples to smell, feel and observe. How did we go from dead plant/organic material to this? (For simplification we will focus on plant material only)

SCIENCE FOCUS

Lesson Subject

Chemistry 20

Topic

Compost chemistry

Location

Classroom

Length

50 mins

Intro Activity: Have students list and sketch out an example of these biological macromolecules (**Resource** 1) that make up the majority of plant biomass

a) Proteins (amino acid polymers)

b) Carbohydrates (sugar polymers)

Main Activity:

The ideal compost process is the breakdown of molecules in plants (and animals) by aerobic microorganisms. We want the end result of the composting process to produce a result that is within an ideal range on the spectrum of toxicity. If it is too toxic that we can't sell our compost to be used in landscaping or gardening. Soil sample results are used to analyze toxicity levels among other components. They oxidize C for energy and break down N (and other nutrients) for cellular construction.

1) Have students write out an equation and/or draw out the molecular structure for the breakdown of cellulose (reduction into sugars). Which end is the reducing end (single hydroxide) and which is the non-reducing end – if molecule is drawn?
    a. (C6H1205)n + nH20 --- (H+)--- nC6H12O6
    b. Reducing end is the one with the single OH-
2) Have students write out the equation for cellular respiration:
    a. C6H12O6 + 6O2 ----- 6CO2 + 6H2O + ATP (energy)
    b. This is why a compost pile needs sufficient oxygen
3) Plant proteins are broken down by decomposers and then incorporated into cellular structures. Have students look into the Nitrogen cycle in **Resource** 2. Have students draw out the molecules in the cycle and/or research equations in Nitrogen cycling.
4) When there is limited oxygen present in the compost pile fermentation happens instead. One of the products is methane. Have students try to figure out what happens to the glucose molecule in this case. C6H12O6 --- 3CO2 + X X = 3CH4
5) Ammonia (NH3) is another by-product of aerobic fermentation. How is ammonia formed? 00C-NH2 +H+ --- NH3. What type of equation is this? (Reduction)

Conclusion / Review: How can humans manipulate the compost process? How can we use technology to create the products we want? There are new machines that are used to manage the chemical process of these compost piles. Anaerobic digesters can be added to take oxygen out to speed up the process, and machines can be used to turn compost piles to add more air if needed.

Homework: Have students research how water is important to compost chemistry, why would we need to water our compost piles? What happens when our piles have too much moisture?

Resources:

1. The Molecules that Make Plant Cells Different: http://www.bio.miami.edu/dana/226/226F08_2print.html
2. Compost Gardener – the Nitrogen Cycle: http://www.the-compost-gardener.com/nitrogen-cycle.html#bacteria\
3. Compost Facility Operator Manual: a compost facility operator training course reference and guide. John Paul and Dieter Geesing

Extension: Have student's design aerobic and anaerobic composters. Have them measure different variables such as temperature, moisture levels, smell, colour changes, production of gases (oxygen), and pH levels. You can also get your students to compare the two processes of aerobic and anaerobic composting.

A sample experiment is outlined here: https://www.acs.org/content/dam/acsorg/greenchemistry/education/resources/chemistry-and-compost.pdf

Chemistry 30 – lesson 1

Hydrocarbons in NWT Water

Objective: To interpret data on hydrocarbons in NWT water

Introduction: Polycyclic Aromatic Hydrocarbons (PAHs) are released into the environment by any number of processes including incomplete combustion, waste disposal and petroleum products. These compounds have implications for human and ecological health and therefore, should be monitored. This lesson plan helps students to learn about PAHs and monitoring of water in the NWT for them.

Curriculum Connections:

Unit C – 1.1k, 1.3k, 1.3s, 2.3k

Supplies / Materials:

- Class set of computers

Hook: Watch Video on PAHs:
https://www.youtube.com/watch?v=gJlnmG51Pyo

Intro Activity: Draw the structure of benzene on the board – PAHs have at lease 2 benzene rings. What makes them an organic compound? Have students copy the drawing in science notebook or journal.

SCIENCE FOCUS

Lesson Subject

Chemistry 30

Topic

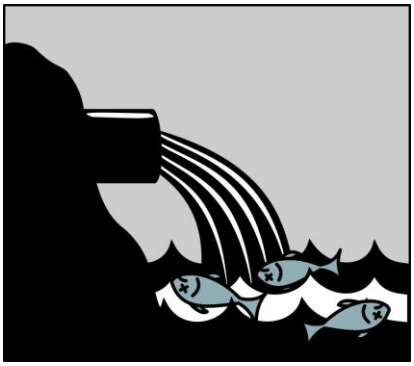
Organic Compounds

Location

Classroom

Length

50 mins



Main Activity:

1. Let the students know they will be looking at a dataset that evaluates PAHs in water in different NWT communities. Ask them where they think the PAHs come from (industry, fossil fuels etc.) Why might we be concerned if they are in water? (Potential for drinking water contamination, ecological disturbances).
2. Have students choose a sampling site near your community and choose 3 compounds found in the water.
3. Ask them to research the chemical structure of the 3 compounds chosen and any guidelines for human and/or ecological health (**Resource 2**).

Conclusion / Review: What are the sources and concerns around PAHs? Why would we monitor them in water? Do we have any concerns?

Homework: Research if water treatment plants in your area deal with PAHs.

Resources:

1. MacKenzie Data stream – hydrocarbon data: http://www.mackenziedatastream.org/#/themes/pmd/aba937d2-d759-44be-81eb-73ceb161cec9

2. Canadian Water Quality Guidelines for the protection of aquatic life; PAHs: http://ceqg-rcqe.ccme.ca/download/en/201

Soluble Salt and Electrical Conductivity

Objective: To explore toxicities that may occur in compost piles

Introduction: Compost piles that contain a higher concentration of plant nutrients will also have a higher "salt" level, or electrical conductivity (EC). EC is a measure of the soluble nutrients in the compost and can be measured with an EC meter. Although specific toxicities may occur due to a high concentration of certain minerals, soluble nutrients may reduce plant growth by osmotic effect.

Curriculum Connections:

Unit B – 1.1-1.4k, 1.1-1.2sts

Unit C – 1.1-1.4k, 2.1-2.4k, 2.3s

Supplies / Materials:

- Compost samples (classroom composter or local compost from a farm, compost facility or greenhouse)
- Magnifying glasses
- An EC meter (if you have access to one!)
- Science notebook or loose leaf paper
- Writing utensils
- Computers and/or handouts with chart an chemical equations

SCIENCE FOCUS

Lesson Subject

Chemistry 30

Topic

Compost Chemistry

Location

Classroom

Length

50 minutes

Hook: Give students compost samples to smell, feel and observe. How did we go from dead plant material to this? Provide students with magnifying glasses if possible to get a closer look at the sample.

Intro activity: As mentioned in the introduction, compost piles that contain a higher concentration of plant nutrients will also have a higher "salt" level, or electrical conductivity. Higher values of salt may be present with some compost that is high in food waste or animal waste content. Have students list and sketch out an example of food and animal waste that could potentially be found in a compost pile.

Main Activity:

SAR = Na / (square root of ([Ca + Mg]/2))

In this formula, sodium (Na), calcium (Ca) and magnesium (Mg) are expressed in milliquivalents per litre (meq/l) of soil solution. This is an expression of the concentration of each element in the solution.

Provide sample equations for your students,

- Solve for Mg
- Solve for Ca

Extension Activity:

If you have access to an EC meter, gather a variety of soil and compost samples, and test them with the meter. Have your students record results in chart form and discuss their findings. Just a reminder that soluble salt levels in compost can very depending on the feed stock of your compost pile and how it is processed. Back yard compost may have leaves, food waste, yard waste, etc. A school vermicomposter will have mostly carbon and food waste, and soil from the playground is harder to predict.

Sample #	Type of Soil	EC Meter number
1	Back yard compost	
2	School vermicomposter	
3	Soil from playground	

- What surprised you about your findings?
- Why would your samples have different results?

Conclusion / Review:

An SAR below 10 is acceptable and does not significantly impact soil properties, while an SAR above 25 has a severe negative impact on soil properties and will affect your potential to sell your compost product.

Homework: Have your students write a homework reflection on what they have learned about composting and the importance of checking your soil samples for or electrical conductivity. Although it may not seem important at first, quality soil in the middle of the spectrum is idea for use in personal or market gardening.

Resources:

1. The Molecules that Make Plant Cells Different: http://www.bio.miami.edu/dana/226/226F08_2print.html
2. Compost Gardener – the Nitrogen Cycle: http://www.the-compost-gardener.com/nitrogen-cycle.html#bacteria
3. **Compost Facility Operator Manual**: a compost facility operator training course reference and guide. John Paul and Dieter Geesing.

Chemistry 30 – lesson 3

Comparing Fuel Oil and Biomass Use in Heating Systems

Objective: To explore the chemical nature of 2 heating fuels

Introduction: As concerns about climate change rise, alternate fuels are being sought out to replace some of the use of fossil fuels. In the NWT fuel oil (a petroleum product) is often used as a heating source, resulting in the production of greenhouse gases. In attempts to reduce these gases, one alternative that is being explored is the uses of wood pellets, which when processed and burned efficiently are considered carbon neutral. This lesson aims to compare the use of both of these fuels as a heating source.

Curriculum Connections:

Unit A – 1.1-1.2sts, 1.1-1.2s, 2.1-2.3sts, 2.2s

Unit C – 1.1-1.2k, 2.4k, 2.3s

Supplies / Materials:

- Materials for combustion demonstration: eye protection, reaction vessel and stopper, beaker, alcohol (See **Resource 1**)
- Computers for research and/or handouts

SCIENCE FOCUS

Lesson Subject

Chemistry 30

Topic

Comparing Heating Fuels

Location

Laboratory and Classroom

Length

50 minutes

Hook: Demonstrate combustion (e.g. **Resource 1**) and/or have students do this in the lab. If not practical, watch: https://www.youtube.com/watch?v=UygUcMkRy_c. Discuss the important components of combustion – fuel, oxygen, and ignition. Guiding questions - What is produced? (Energy/heat). This is an exothermic reaction. What can we use this for?

Intro Activity: Have students look at their community energy profile (see **Resource #2** below). Guiding questions - How much energy is coming from fuel oil? What percent of greenhouse gases? What is fuel oil? (Mainly diesel oil in the NWT (1))

[1] Standing Committee on Energy, the Environment and Natural Resources. 2014. Powering Canada's Territories. Online at: http://nwtbiomassenergy.ca/wp-content/uploads/2015/11/Power-the-North.pdf

Main Activity:

1) Have students compare the energy content of biomass and fuel oil (2): How many L of heating oil is required to match 1 tonne of pellets? How can we compare tonnes to liters? If time permits ask students to look up the density (weight) of 1 L of diesel oil.

Energy content of Heating Fuels	
Wood Pellets	19,700 MJ per tonne
Heating Oil	38.4 MJ per litre

2) Have students look up the reactions for wood (focus on cellulose) and diesel combustion in **Resources 2 and 3**.

3) Have them use **Resource 4** to estimate the molar entropy of the reactions.

4) Have students determine the amount of carbon dioxide produced when comparable energy is created.

Conclusion / Review: Are wood pellets a feasible alternative to fuel oil? Why might they be considered carbon neutral?

Resources:

1. Combustion reaction: http://www.rsc.org/learn-chemistry/resource/res00000708/the-whoosh-bottle-demonstration?cmpid=CMP0000523
2. Community Energy Use Profiles – click on your community at http://aea.nt.ca/communities
3. Diesel fuel combustion: https://chembloggreen1.wordpress.com/
4. Combustion of Wood: http://chemistry.stackexchange.com/questions/1254/what-are-the-chemical-reactions-behind-fire
5. Fuel oil combustion: http://www.personal.utulsa.edu/~kenneth-weston/chapter3.pdf

Extension:

1. There are many different ways to make changes to reduce greenhouse gas emissions (GHG). Brainstorm with your students a few ideas…if you need suggestions go to the publication "Steps for Climate Friendly living" at http://climatechangeconnection.org/resources/climatechangeconnectionpublications/

2. Have students participate in NatureWatch to help contribute data to study the impacts of climate change: https://www.naturewatch.ca/

[2]Artic Energy Alliance. 2009. NWT Community Wood Pellet Study. Online at: http://aea.nt.ca/research/research-2

Experiential Science 10 – lesson 1

Response of Plants and Animals to Changing Climate

Objective: To investigate ecological responses to climate change

Introduction: The effects of climate change can be diverse. The monitoring of certain plants and animals may help us to understand the effect on ecology, especially on sensitive plants and animals. The purpose of this lesson is to introduce students to temperature change as an indicator of climate change and to the monitoring of animal and plant species in response to changing temperatures.

Curriculum Connections:

Unit 2: 1f ; 3a,b,c , e

Unit 3: 1a-e;

Homework/Extension: 2a, c-e,g; 3-5

Supplies / Materials:

- Student journals / blank paper
- A copy of the spring temperature chart printed copies and/or projected for the class (found under **resources** in this lesson)
- Chart paper for brainstorming and unanswered questions list
- Writing utensils
- Access to Nature Watch website

SCIENCE FOCUS

Lesson Subject

Experiential Science 10

Topic

Units 2 and 3

Location

Classroom

Length

100+ mins (optional activities included)

plantwatch
ENGAGING CITIZENS IN SCIENCE

frogwatch
ENGAGING CITIZENS IN SCIENCE

Hook: Have students look at the spring temperature chart (found under **resources**) and facilitate a classroom brainstorming session and discussion about what types of information they can gather about temperature change. Give your students time to ask questions they may have about the chart, temperature and the data recorded. If you are unable to answer a question, create a list of ponderings and research them later as a class. Ask your students how they think other weather parameters would fluctuate with temperature trends.

Intro Activity: Have students brainstorm what rising spring temperatures mean for the North in general and for their community in particular (flooding, change in ice, pack change in growing season, change in animal/plant communities, change of lifestyle)

Main Activities:

1. Let students know that the focus will be on plant and animal responses to change in climate. Introduce the work of Plantwatch and Frogwatch:

   The purpose of Plant and Frog Watch is to collect data across Canada about species that are sensitive to environmental changes. Plants chosen bloom in response to temperature and frogs/toads are animals that are particularly sensitive to environmental parameters. (This has been adapted from resources 2 and 3).

2. Discuss data collection techniques – Data is collected for these projects using citizen science (voluntary submissions by general citizens). What are the benefits and limitations of using this type of science?

   a. Discuss specific data collection for plant watch (recording bloom times) – what are some of the benefits and limitations? What could be other options (photography of plants)?

   b. Discuss specific data collection for frog watch (listen for auditory calls) – what are some of the benefits and limitations? Are there other possible data collection methods (e.g. visual sightings, trapping)?

3. Look at Plantwatch data for NWT found under resource number 2. Currently there are limited observations – can we deduce anything from these observations? Compare with data from the Yukon or Alberta. Are there any trends?

4. Have students assess data from Frogwatch for the NWT found under **resource** number 3. What does this (limited) data set tell us about NWT frogs? What else would they want to know and how might they research this? Compare with data from the Yukon or Alberta. Are there any trends?

5. Review/introduce the concept of ecosystems, habitat and population changes. What factors do the students believe are influencing Northern flora and fauna that may not

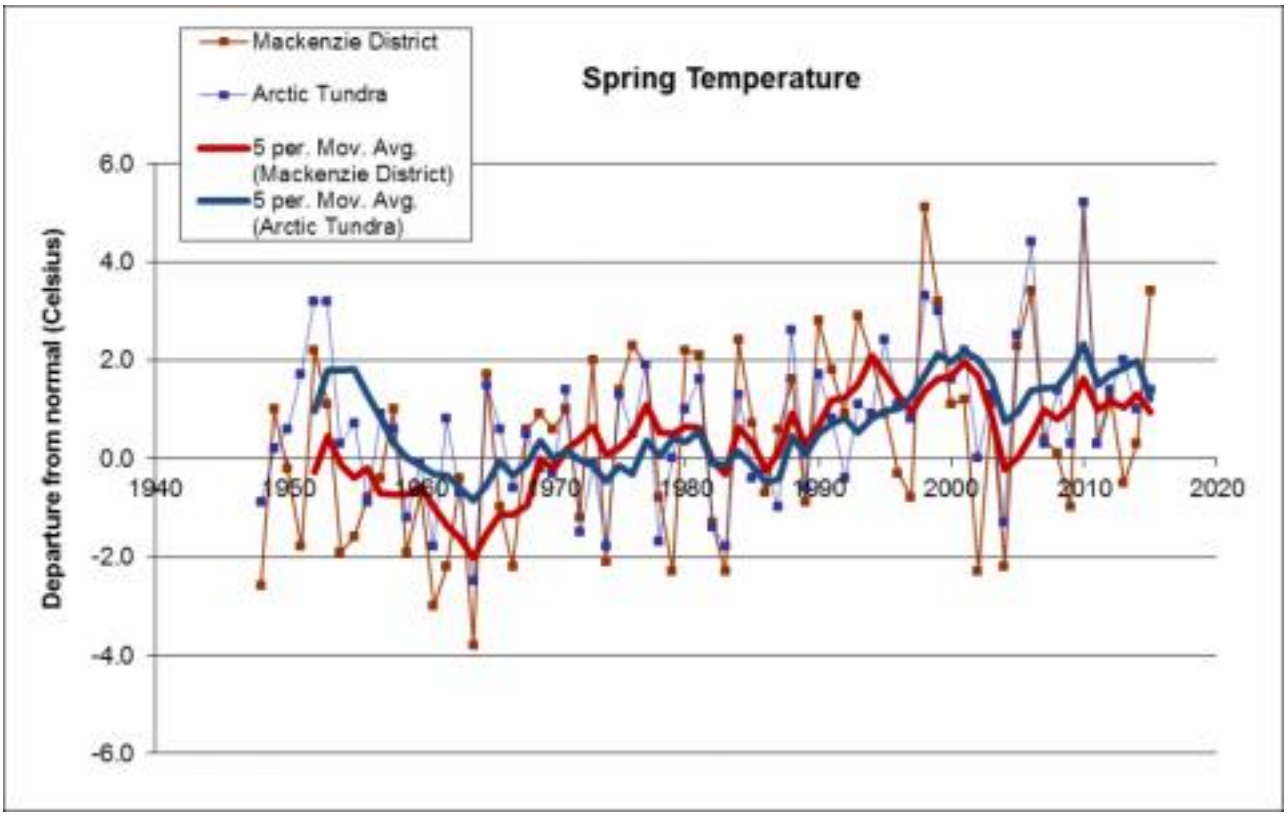
influence (or to the same extent) those in neighboring provinces? Can we come up with a hypothesis about changes in NWT populations based on the data we looked at in

Conclusion / Review: What is the value of observations and data in helping us monitor our ecosystem health in response to changing weather/climate? What is good data? How much do we need? How can we contribute?

Homework: Have students research a specific plant or animal via Plant/Frogwatch, including its recognition and habitat. Consider further research into habitat, ecology and population trends.

Resources:

1. Spring temperature chart – taken from: http://www.enr.gov.nt.ca/state-environment/31-trends-observed-seasonal-weather-compared-normal



2. Plant Watch: https://www.naturewatch.ca/plantwatch/

3. Frog watch: https://www.naturewatch.ca/frogwatch/northwest-territories/

https://www.naturewatch.ca/wp-content/biguploads/senior_guide_712.pdf

Extension Activities:

1. Have students make observations and submit to Frog/Plant Watch
2. Look into further activities at: http://www.nwtspeciesatrisk.ca/sites/default/files/northern_leopard_frog_nwt_status_report_dec_2013_final2_0.pdf

Climate Change – How will it affect us?

Objective: To introduce students to climate change and how it impacts the North.

Introduction: Melting ice and rising temperatures over the past decades suggest that climate change is happening at a noticeable rate in the North. Effects of climate change in the North are more concerning than in other parts of the country due to implications of significant ice melt and permafrost changes. This lesson aims to introduce students to the implications of climate change in Northern communities.

Curriculum Connections:

Unit 1 – 8 c, h

Unit 2 – 1b,f ; 2; 3a-c. d-e

Supplies / Materials:

- Ecology North Climate Change **Resource** Materials (see below)
- Student Journals or notebooks
- Writing utensils

Hook: Show students climate change trends in the North from: http://www.enr.gov.nt.ca/sites/default/files/page_3_nwt-climate-observations_06-13-2015_vf_1_0.pdf. What do they observe?

SCIENCE FOCUS

Lesson Subject

Experiential Science 10

Topic

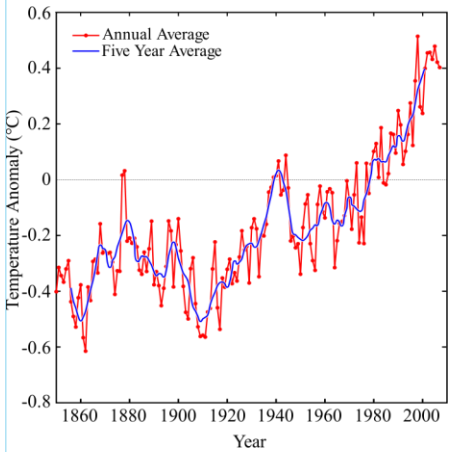
Units 1 and 2

Location

Classroom

Length

50 minutes



Intro Activity: Have students define a number of terms related to weather and climate. Definitions and an introduction to climate change (and its relationship to weather) are found under the **resources** section of this lesson.

Main Activity:

1. Have students reflect how they expect climate to affect the NWT specifically – provide them with a table of key impacts, define applicable terms and let them brainstorm secondary impacts (see below).
2. Have students work in a small group to come up with some recommendations for reducing the impacts of climate change in the North (or specifically your community)

Independent Student Work: Record terms in the science journal/notebook.

Conclusion / Review: Go over the following questions as a class either verbally, on chart paper, or on the board. These can also be used as homework reflection questions.

1. Why does climate change matter?
2. Why is it of particular concern to the North?

Homework: Have students assess nature watch data for evidence of climate change in Canada and make Northern predictions. They can go online; using the link provided below and make some point form comments, questions or conclusions based on the data.
https://www.naturewatch.ca/plantwatch/view-results/

Have students find a location in their community to watch for ice formation and ice melt as part of Ice Watch.

https://www.naturewatch.ca/icewatch/

Resources:

(Taken from: Integrating Climate Change Measures in Municipal Planning by Ecology North with the help of Pembina Institute).

1. Terminology

- **Weather** is what you see out your window
- **Climate** is the weather of an area over time
- **Climate Change** refers to any significant change in temperature, precipitation, and wind patterns occurring over an extended period of time.
- **Global Warming** is no longer used to refer to climate change, as the climate does not warm in all places at all times.
- **Greenhouse Effect** refers to the trapping of the sun's energy in the earth's atmosphere. Greenhouse gases act like the glass in a greenhouse in doing so.

2. Climate change –what does it mean?

Climate is the average pattern of weather in a given location over a period of time —from months to thousands of years. Climate change refers to any significant change in temperature, precipitation, and wind patterns occurring over an extended period of time.

Climate change is a natural process, but today's climate change is caused mostly by the increasing amounts of carbon dioxide and other greenhouse gases in the atmosphere.1

The unprecedented rapid global temperature and climate changes in the past century are primarily the result of burning fossil fuels, as well as the rapid increase in deforestation, industrial processes and some harmful agricultural practices.

Greenhouse gases in the atmosphere act like the glass in a greenhouse (hence the name greenhouse effect), allowing heat from the sun in but blocking it from leaving. Some greenhouse effect is essential for human life, but as the amount of carbon dioxide increases in the atmosphere, the changes we are seeing on earth are speeding up — with enormous impacts on the natural environment and people.

It is important to distinguish between weather (what you see out your window today) and climate, which refers to long-term average weather patterns in a given area. The most common measure of climate is temperature. While the daily temperatures that we experience vary across seasons, even a small change in average annual temperatures can have important impacts on ecosystems, on landscape features such as permafrost, and on infrastructure. Other important climate measures are precipitation (rain and snow), wind, humidity and air pressure. Seasonal changes in precipitation — like more snow in the winter — can have big impacts too.

Documented climate change varies across regions but globally includes warmer average annual temperatures, changes in the frequency and intensity of extreme weather events such as heavy rain or snowstorms with high winds, and changes in the amount of precipitation and the type of precipitation, such as rain instead of snow.

4. Climate change in the NWT

Below you will find a table of impacts from the perspective of human use / well-being.

Some key terminology to define/discuss include:

- **Permafrost:** is a permanently frozen layer of subsoil. It consists of soil, gravel, and sand, usually bound together by ice. Permafrost usually remains at or below for at least two years can range from 1 meter to more than 1,000 meters thick.
- **Turbidity:** the cloudiness/haziness of water due to suspended particles. Important to drinking water as disease-causing agents can be bound to particles and turbidity can interfere with chlorination.
- **Erosion**: the movement of rock, soil and other dissolved materials from one place to another by a mechanical process – wind, water or animals
- **Thaw slumps**: a slope failure resulting from thawing of ice-rich permafrost

Primary and secondary impacts relevant to community governments, based on a review of NWT community adaptation plans

KEY IMPACT	SECONDARY IMPACT
Permafrost degradation	Short-term and long-term damage to buildings
	Short-term and long-term damage to transportation infrastructure such as roads (e.g. potholes, sinking, heaving) and airport runways
	Damage to community infrastructure (e.g. water /wastewater lagoons and facilities)
	Ruptured oil tank fuel lines
	Large-scale landscape changes (e.g. increased size and frequency of thaw slumps)
Warmer air temperatures	Transportation disruptions from shorter ice and winter road seasons (e.g. the Fort Providence ice bridge has been reduced by 30 days in the past 40 years)[7]
	Transportation disruptions through increased risk of landslides on all-season roads
	More difficulty travelling on the land: shorter winter travel season (affecting fur trapping); more dangerous travel on sea ice; more overflow in winter (caused by thinner ice and more snow)
	Decreased heating costs
Rising ocean levels and open water in the Beaufort Sea	Increased shoreline erosion on the Beaufort Sea due to high water levels and less ice cover
Changing weather patterns	More rain on snow events and ice storms
	More extreme weather events
Increased forest fire risk	Greater risk of severe forest fires due to longer, hotter, and drier summer seasons and more lightning strikes

Extensions:

1. Participate in Ice Watch – https://www.naturewatch.ca/icewatch/

2. Review the government's strategy to mitigate the effects of GHG: http://www.enr.gov.nt.ca/sites/default/files/strategies/greenhouse_gas_strategy_final.pdf

3. Peruse the Climate Action Network with/without your class, they are doing exciting things across Canada related to Climate Change!

http://climateactionnetwork.ca

Experiential Science 20 – lesson 1

Climate Change and the Arctic Ocean

Objective: To investigate changing arctic ice

Introduction: Due to the implications of ice melt (flooding, ecosystem changes, increased warming etc.) monitoring sea ice is an important part of awareness and mitigation of climate change. This lesson aims to introduce one of the modeling techniques used in sea ice modeling and encourage students to think of local and global implications.

Curriculum Connections:

Unit 1: 6a, 8e-g

Supplies / Materials:

- Student journals / blank paper
- Data below

SCIENCE FOCUS

Lesson Subject

Experiential Science 20

Topic

Arctic Sea Ice and Climate Change

Location

Classroom

Length

50 mins

icewatch
ENGAGING CITIZENS IN SCIENCE

Hook: Watch "Arctic in your backyard" at:
http://wwf.panda.org/what_we_do/where_we_work/arctic/what_we_do/climate/

Intro Activity: Project or hand out copies of the PIOMAS Arctic Sea Ice Volume. Allow students a few minutes to look at the data and discuss with neighbours what information they can get out of it and what they think it means.

Main Activity:

1. Ask for students' observations.
    a. Make sure they are aware they are looking at volume data vs. surface area – What is the difference? Why might it matter? (thickness related to stability of ice flows, weight bearing, age etc.)
    b. Ask them about the length of data collection. Do they think this is sufficient to draw conclusions? What would skeptics suggest? Are there any ways to support claims that this trend has been happening longer than data collection? (some critics say there are 50 or 100 year cycles in climate, traditional knowledge may help to substantiate claims)
    c. If artic sea ice disappears what are the implications for the North? (flooding, food chain changes, increased warming, decreased Permafrost, possible contamination, landslides etc.)
    d. How do students think they can help? (personal decisions, contribution to science, informing others)

Independent Student Work: Have students write an article for the school newsletter/ design an info-graphic for a school bulletin board based on what they have learned.

Conclusion / Review: Share some of how students think they can help.

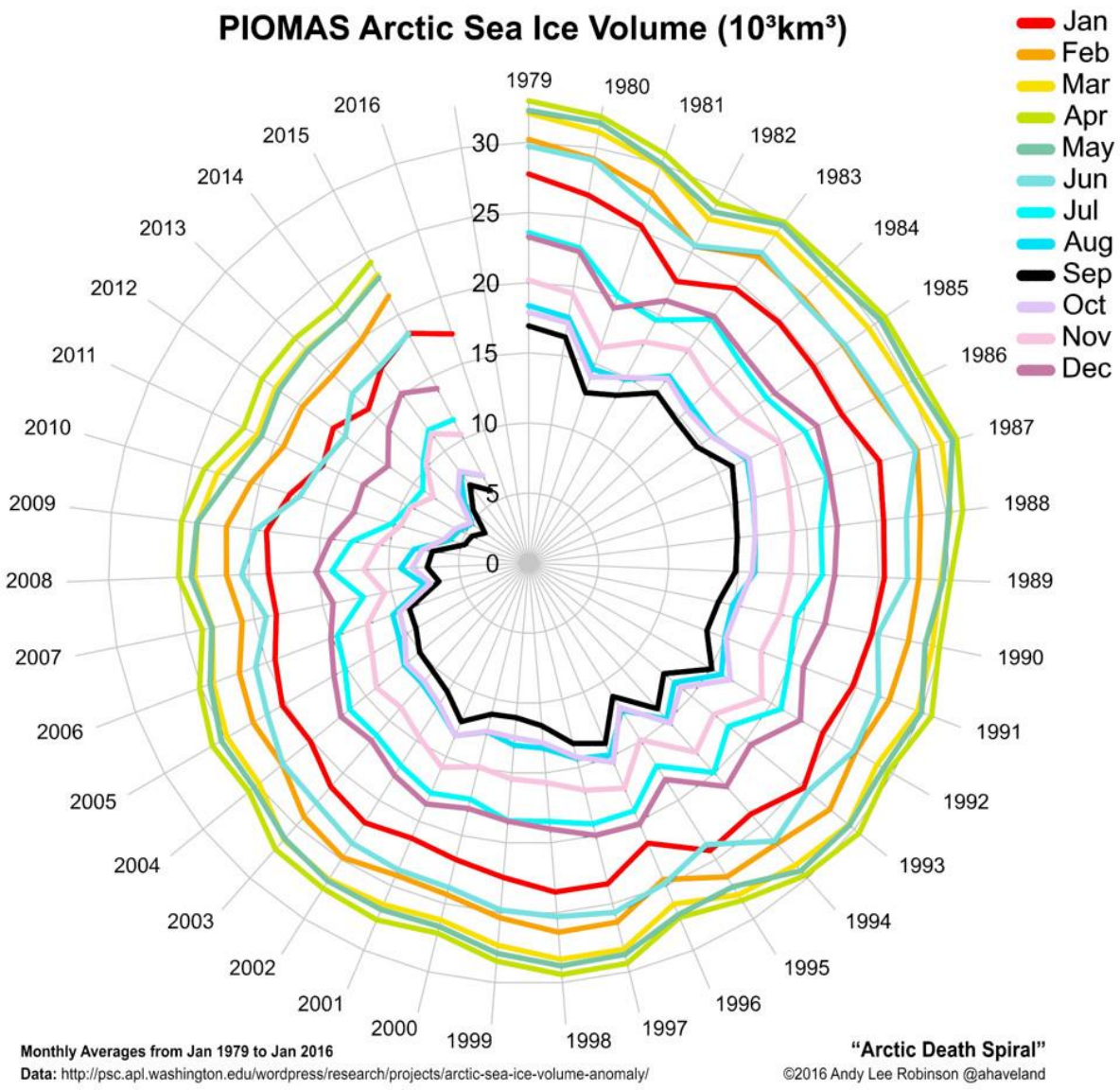
Homework: Have students find a place they can watch ice melt daily and make observations about melting in regard to weather observations (T, wind speed, humidity etc). Encourage them to submit data to Ice Watch

Resources:

Polar Science Centre (PIOMAS): http://psc.apl.uw.edu/research/projects/arctic-sea-ice-volume-anomaly/

Ice Watch: https://www.naturewatch.ca/icewatch/

Extra information found online at:
http://www.inspirationgreen.com/assets/images/Issues/2012/arctic-death-spiral.png



Experiential Science 20 – lesson 2

Plastic Waste in the Ocean

Objective: To explore the effect of plastic waste on oceans

Introduction: Plastics may end up in the oceans through a variety of means – direct dumping, wind, water or animal transport. These plastics may have significant implications for ocean health, through direct consumption and/or leaching of chemicals. This lesson allows students to evaluate media **resources** to think about these implications.

Curriculum Connections:

Unit 3 -2 d, related to Units 2&4,

Supplies / Materials:

- Picture of plastic filled seabird (resource 1)
- Copy of **resources** 1 and 2 or computer access

Hook: Show a picture of a seabird with plastic debris inside (see resource 1)

Intro Activity: Have students try to identify the products in the picture

Main Activity:

1) Have students read the websites (the class may be divided in half). Have them ask critical questions about what they are reading and evaluate whether they believe the sources are viable.

SCIENCE FOCUS

Lesson Subject

Experiential Science 20

Topic

Ocean contamination

Location

Classroom

Length

50 mins

2) Ask students to brainstorm in small groups how they think the plastic is ending up in the ocean. Ask them to think about their community in particular and how it could be connected to the ocean (what rivers flow into the ocean)? Which animals may carry stuff out to the ocean? Which means of transportation may result in wastes in the ocean? Where is the dump situated and how is waste secured from elements that may move them?)

Independent Student Work: Allow students some time to research their questions. Have them come up with an action plan to change the use of plastic in their own lives and/or other students.

Conclusion / Review: Have students share some ideas about plastic contamination.

Homework: Finish independent student work.

Resources:

1) Plastics and Ocean Health - includes picture of seabird full of plastic http://serc.carleton.edu/NAGTWorkshops/health/case_studies/plastics.html

2) Article about plastic in arctic ice: http://www.sciencemag.org/news/2014/05/trillions-plastic-pieces-may-be-trapped-arctic-ice

Experiential Science 30 – lesson 1

Changing Ice Melt of Freshwater Bodies

Objective: To explore the effect of climate on ice melt

Introduction: As climate changes, ice coverage of rivers, lakes and other freshwater sources decreases. The effect may be a change in both ecology and human utilization of these resources. This lesson plans helps students assess the monitoring of change in ice coverage and some of the implications of the changes.

Curriculum Connections:

Unit 2: 5av, 8c

Supplies / Materials:

- Location to safely monitor ice with a visual across the river/stream/lake
- Ice measurement tool – ice tool, drill with wood auger, Nordic ski pole etc (**Resource 1**) if school allows
- Clipboards, papers and pens

Hook: Inform students before going out about your plan to find a good ice spot – have them share their favourite ice spot/activity. This may help you select a spot for monitoring.

SCIENCE FOCUS

Lesson Subject

Experiential Science 30

Topic

Freshwater Ice

Location

Field and/or Classroom

Length

30-40 minutes field, 50 minutes Classroom

icewatch
ENGAGING CITIZENS IN SCIENCE

Intro Activity: Gather the students in a group and have them create rules around ice safety.

1. Have them define boundaries (based on school policy and time of year, you may or may not want to be on the ice at all).
2. Discuss emergency protocol.
3. If you are using tools, have them define the use of tools
4. Talk about keeping warm.

Field Activity:

1. Tell students their role will be to monitor ice melt of freshwater in the community. Ask them to work in groups to come up with a monitoring strategy
    a. What makes an ideal monitoring spot? Students may need to consider both visibility of the body of water but also their own safety and/or comfort
    b. What variables do you want to monitor? (Could be thickness, percent open water, reflection of light etc.)
    c. When should the variables be monitored? (When does ice melt in your community?)
    d. How do you get consistent monitoring of those variables? (Well marked observation spot, consistent observers and/or clear communication between, clear definitions etc.)
2. If possible take a few measurements of the ice.

Independent Student Work: Have students pick a monitoring spot and describe it in such a way that they themselves or someone could find the spot.

Classroom Activity:

1. Discuss monitoring procedures. Introduce the monitoring used for IceWatch and discuss merits/challenges.
2. View data from NWT and other regions of Canada. What is this telling us about the ice?

3. Have students brainstorm some of the implications of earlier ice melt / longer open water:
    a. Increased ecological activity, including great algal blooms, longer feeding seasons for fish
    b. Change in conditions for fish – T, O2, mixing
    c. Change in fishing and hunting seasons
    d. Flooding
    e. Less absorption of solar energy
4. Discuss measurements of ice thickness. Why measure? (track change, safety) How did the class measurements go? What do they feel about the accuracy? Why might sonar and radar be the measurement tools of choice (precision, data on quality, safety etc.)

Conclusion / Review: Why should we monitor ice melt/formation in our community?

Homework:

1. Read more about the effects of climate change on river ice (Ex Science 30 textbook)
2. Have students revisit their spot and submit IceWatch observations

Resources:

1) Ice measurement tools: http://lakeice.squarespace.com/testing-tools/
2) Ice watch data (note you need to create a sign-in): https://www.naturewatch.ca/download/

Experiential Science 30 – lesson 2

NWT Frog Populations

Objective: To introduce students to freshwater species populations by using NWT frogs as a model

Introduction: As frogs are an indicator species, the monitoring of frog populations can help in the evaluation of ecosystem health. In this lesson plan students will investigate the reasons for, methodology of and data from frog population monitoring in NWT and Canada.

Curriculum Connections:

Unit 3: 2-6

Supplies / Materials:

- Map of frog/toad distribution in NWT
- Data collected in frog watch
- Student journals / blank paper

Hook: Watch frog video e.g. http://ed.ted.com/lessons/disappearing-frogs-kerry-m-kriger

SCIENCE FOCUS

Lesson Subject

Experiential Science 30

Topic

Freshwater Ecology

Location

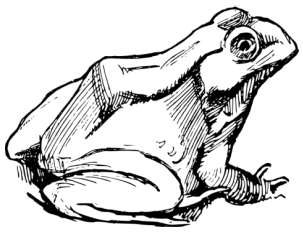
Classroom

Length

60-80 mins

Time of Year

Spring



Intro Activity:

1) Discuss indicator species and how monitoring their populations may be an important tool to track environmental change / human impact.

2) Ask the students how they think frog populations could be monitored (visually, auditory – on calls, physically – e.g. catch and release). Have them brainstorm the pros and cons for each of these monitoring techniques.

Main Activities:

1. (Optional) In the senior guide for Frogwatch (**Resource 1**) there are several activities to help students understand Canadian frog populations in general. You may want to choose one or more of these to have students do.

2. Have students assess data from Frogwatch for the NWT. What does this (limited) data set tell us about NWT frogs? What else would they want to know and how might they research this?

3. (Optional) Compare to data from another province. Can those data be used to form trends? Have students comment on trends and data needed to be comfortable to make conclusions.

4. Compare to visual sightings data found in **resource** 1 below. Ask your students if the map supports the Frogwatch data? (**Resource** 2) What are some questions/assumptions they have about how data was collected by these researchers? Are their frogs/toads in your community? Has anyone seen them?

Conclusion / Review: What is the value of observations and data in helping us monitor our wetland health? What is good data? How much do we need? How can we contribute?

Homework:

1. Have students do one of the optional activities above.

2. Have students research a frog/toad in your community and learn its call and observe for Frog Watch.

Resources:

1. Frogwatch: https://www.naturewatch.ca/frogwatch/northwest-territories/

https://www.naturewatch.ca/wp-content/biguploads/senior_guide_712.pdf

http://www.nwtspeciesatrisk.ca/sites/default/files/northern_leopard_frog_nwt_status_report_dec_2013_final2_0.pdf

2.Map: http://www.nwtpas.ca/maps/map-sf-amphibians-pas-areas.pdf

Extension:

1. Visit a local wetland in spring and listen for frog calls. Submit to Frog Watch.
2. Have students research what scientists have learned about human health through studying frogs.

Science 6- lesson 1

How Do Species Adapt to the Cold?

Objective: To familiarize students with how animals and people adapt to Northern temperatures

Introduction: Over time, animals have developed certain features that allow them to survive in harsh climates. In the North, cold Temperatures, freezing waters and winds can make it difficult to survive. Animals that live in the North have adapted by altering behavior, physiology and body chemistry. This lesson aims to introduce students to adaptations and what humans may learn from them.

Curriculum Connections:

Science Strands:

Diversity of Living Things – cold and warm-blooded animals, adaptations

Air and Flight – air in common products

Dene Kede Thematic Unit: The Land and The Sky

Supplies / Materials:

- Examples or picture of down-filled winter gear.
- Optional – Pictures of northern species in winter

SCIENCE FOCUS

Lesson Subject

Science 6

Topic

Diversity of Living Things, Air and Flight

Location

Classroom or Outdoors

Length

1 period

Hook: Watch adaptations video - https://www.youtube.com/watch?v=YX8VQIJVpTg or read *Be a Wilderness Detective* to your class (see **Resources**). Stop at page 16 and explore the winter survival section. Ask guiding questions such as "Where do you think animals go in the winter?" or "What do you know about hibernation?" Have more time? Use this **alternative hook** – set up the "blubber glove" experiment to engage your students with a hands-in experiment. https://www.stevespanglerscience.com/lab/experiments/blubber-gloves/

Intro Activity: Have students brainstorm some of the geographical and climatic factors that northern animals (including humans) have to adapt to in order to survive in the North (temp., dryness, rockiness etc).

Main Activity:

Let students know this lesson will focus mainly on adaptations to lower temperatures.

1) Show students an example of a down product and/or feather – what happens with the air that makes down warm? (Air is trapped and cannot be carried away; air itself doesn't transfer heat very well). Which animals does down come from? Why is it so light (birds-flight-hollow shafts). What are other materials animals produce to cover themselves? (fur, hair, fat). Interesting fact: caribou have hollow hair. How does snow cover work? (also traps air)

2) What about animals that don't produce their own heat (ie cold-blooded)? Some hibernate (many amphibians), some hibernate in groups (e.g. snake hibernaculum) some produce chemicals to help them tolerate lower temperatures (e.g. insects) or even freeze solid (e.g. wood frog)

3) What are other strategies to deal with winter? (Eat lots, optimize activity, good shelter, external sources of warmth (fire, taking advantage of the sun, others)

4) How do environmental changes (increasing average temperatures) affect these survival strategies? (Higher overall temperature may mean less need to produce heat but also can mean lower snow pack, shorter hibernation (more time to eat but more resources needed), less water in ponds/lakes so they are more likely to freeze solid etc.)

Independent Student Work: Have students reflect on what they can learn from animals in terms of being prepared for the winter (as this will help reduce our dependence on energy outside of us).

Conclusion / Review: Share some student reflections.

Homework: Have students explore other materials that could be used in the "blubber glove" experiment. (https://www.stevespanglerscience.com/lab/experiments/blubber-gloves/). Ask them to be creative – bringing in household items (sawdust, flour, pompoms (or other craft supplies) to compare with the natural features (down, fat, sand) that (may) have been already tried in class. (This is a fun experiment! For all ages!).

Extension: Research how different NWT frogs adapt to winter. Participate in Frog Watch to see how average warmer temperatures effect local frog populations.

Resources:

Be a Wilderness Detective: solving the mysteries of fields, woods, and coastlines. Peggy Kochanoff. Nimbus Publishing LTD. 2013. Available through the Yellowknife Public Library or Interlibrary Loan.

Adaptation, Polkadot place, YouTube. Oct 12. 2006, https://youtu.be/YX8VQIJVpTg

Science 6- lesson 2

Identifying Northern Plant Species

Objective: To familiarize students with northern plants and their classification

Introduction: Both in the past and present, recognizing plant characteristics and naming plants has helped humans to identify and communicate with others about specific plants, whether they be a food source, medicine or aesthetic. This lesson aims to introduce students to naming and recognizing some of the plants in their community.

Curriculum Connections:

Science Strand: Diversity of Life (Plant characteristics, classification, dichotomous keys)

Dene Kede Thematic Units: Animals, People

Supplies / Materials:

- Plant Watch North booklets or computers to access the website
- Area to observe plants or if not possible plant pictures or samples
- Sketch-books or cameras

Hook: Write the Latin names for some common plants in your community (distribution maps are included in the Plant Watch North Booklet). Have students work in partners to 'translate' the Latin name into a common name.

SCIENCE FOCUS

Lesson Subject

Science 6

Topic

Diversity of Life

Location

Classroom and/or Field

Length

2 periods

Date

Spring, ideally before flowing blooming

plantwatch
ENGAGING CITIZENS IN SCIENCE

Intro Activity: Ask for a few suggestions to demonstrate that people can refer to plants by many different names (imagine speaking a different language). This is why Latin names are given. Have students notice how the Latin names are written (*Genus species*). Explain that the genus is a generic name (i.e. like a last name) and species a specific name. Many plants are grouped into the same genera by flower type. Species names are usually an adjective.

Main Activity:

1) Have students pick out 4 plants in the booklets/website that live in your community or nearby (alternatively assign these plants)

2) Ask students to group plants by similar characteristics (they may choose flower colour, leaf shape, size etc.). Then have them find individual characteristics to break down their group into individuals.

3) Have a few share how they came to their groupings. Tell them that they are going to have to identify their plants in the outdoors (or from pictures/samples). Ask them how they will do so if there is no flower (leaf shape, size etc.).

4) Have them revise their groupings and individual recognition based on the above. Let them know they made a simple dichotomous key.

5) In the next class period take the students outside to observe plants and use their keys. If there are plants they cannot identify have them sketch or photograph those plants. They may want to try to use reference books or community members to help ID them.

6) If possible make repeated site visits and record bloom times for identified plants and submit to Plant Watch (see Plant Watch booklet/website for detailed instructions)

Independent Student Work: Have students sketch and make notes about the plants they identify in the field.

Conclusion / Review: Review plant names and classification. Talk about good observations of plants.

Homework: Ask students to visit site repeatedly and make their own observations if class visits are not possible.

Resources:

1. *Plant Watch North; Your Plantwatch Field Guide for Northern Canada*. https://www.naturewatch.ca/plantwatch/
2. Wild and Wacky Plants of the NWT: http://nwtarts.com/sites/default/files/wild_and_wacky_plants_of_the_nwt.pdf

3. *What's Blooming? Guide to 100+ plants of the NWT* by Alexandra Millburn

Extension:

1. View plant watch data (Resource 1 – use AB data as NWT observations are scant) and see how plant bloom times are being affected by climate change. Link this to the electricity unit and what we can do to be good energy stewards to mitigate climate change.
2. Plant an area of native plants in your schoolyard or another public area.

Science 7- lesson 1

The Environmental Impacts of Heat

Objective: Identify and evaluate different sources of heat and their environmental impact

Introduction: The climate of the whole earth is really changing and it is affecting those who live in the North somewhat faster than those who live in the south. The global climate is the average climate over the entire planet, and the planet is warming up faster than ever before in history. Scientists have discovered that we are causing the warming, and it is our job to learn what we can do to slow down the warming.

Curriculum Connections:

Students will analyze issues related to the selection and use of thermal technologies, and explain decisions in terms of advantages and disadvantages for sustainability.

Supplies / Materials:

- Science Journal
- Chart paper and markers
- Bristol board
- Paper

Hook: Watch a short video explaining climate change: https://youtu.be/Sv7OHfpIRfU

SCIENCE FOCUS

Lesson Subject

Science 7

Topic

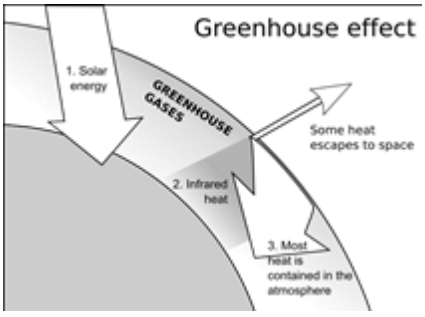
Heat and Temperature

Location

Classroom

Length

50 mins



Intro Activity: Teacher leads a discussion using a KWL chart about climate change, asking students what they know, and what they want to know about climate change.

Afterwards it would also be good to create a brain storm about what they already know about heat, temperature and climate change.

Main Activity: Students work in small groups to research information about different sources of heat and create a table listing advantages and disadvantages of each their source.

Independent Student Work: Students create an informative poster in pairs about ways we can take action on climate change. Ideas can include walking to school, wearing sweaters and turning the heat down, reducing energy consumption, planting trees, starting a recycling initiative, etc.

Conclusion / Review: Students take turn sharing their poster and ideas with the class. Students duplicate their posters and post them around the school/community.

Homework Reflection: How will climate change affect me in now and in the future? What can I do to help adapt to climate change.

Resources:

http://climatekids.nasa.gov/climate-change-meaning/

Science 7- lesson 2

Water Quality in Local Environments

Objective: Describe the distribution and characteristics of water in local environments.

Introduction: The quality of our drinking water is tested all over Canada. Each community has a water treatment plant where employers conduct a variety of tests to ensure that our drinking water is clear and safe to drink. Contaminated water can pose a number of risks to our health, and it is important we ensure the safety of drinking water and obtain water testing that meets all regulator requirements and quality standards in Canada. One of the tests that are done at local water treatment plant is the pH test. A simple pH test determines the acidity of the water, with the goal of it being as neutral as possible. A neutral pH ensures that the water is safe to travel through pipes and to drink.

Curriculum Connections:

Students will identify major factors used in determining if water is potable, and describe and demonstrate tests water quality.

Supplies / Materials:

- Science Journal
- Water testing bags
- Straws
- Water samples
- Tablets

SCIENCE FOCUS

Lesson Subject

Science 7

Topic

Water Quality

Location

Classroom

Length

50 mins

Hook: Watch a short video explaining water quality testing. Choose from one of the videos on this website. Such as "*clean your water tank*" or "*Ensure safe drinking water in the NWT*"

http://www.nwtdrinkingwater.ca/videos-links-resources/videos/

Intro Activity: Teacher leads a discussion about water quality testing, why it is important that the city tests the quality of our water, what they are looking for, how they clean water, what they add to our water to make it safe to drink.

Main Activity: Students will conduct a series of tests with samples of water to determine clear, salinity, and hardness of the water and to test for the pH level as well as the amount of chlorine in their water sample. Students are encouraged to sample water from a variety of sources (bottled, tap, local bodies of water, etc). As a class test the water quality of a a sample of water collected from the school (bathroom tap or classroom sink). Give each student a testing bag, and get him or her to fill the bag up to the first line. Add a pH tablet and shake for 1 minute, watch as the water changes color. Compare the colour of the water to the pH scale to determine the pH level of the school's water supply.

Independent Student Work: have students bring in water samples from around the community. Students should have recorded the date, time and location of the where the water sample was collected. Students will conduct a series of tests on their water sample. Some locations can include drinking water fountains, home faucets, local streams and lakes, ponds, street run off, rain, puddles, bottled water, etc.

Conclusion / Review: In your science journal write a small reflection based on your results. Did anything surprise you? Do you feel confident that the water you drink is safe? What does the city do to help ensure our drinking water is safe?

Homework Reflection: Test the water at home, and share your results in your science journal to share with the class.

Resources:

1. http://www.lifewater.ca/drill_manual/Section_16.htm
2. http://education.nationalgeographic.com/assets/file/freshwater_chapter4_v2.pdf
3. Canada Water Week: http://www.nwtwaterstewardship.ca/news/canada-water-week-march-21-27-0
4. NWT Water Stewardship: http://www.nwtwaterstewardship.ca/resources

5. NWT Drinking Water Information videos: http://www.nwtdrinkingwater.ca/videos-links-resources/videos/

Science 8 – lesson 1

Energy and Climate Change

Objective: Identify and evaluate different sources of heat and their environmental impact.

Introduction: The climate of the whole earth is really changing and it is affecting those who live in the North somewhat faster than those who live in the south. The global climate is the average climate over the entire plant, and the plant is warming up faster than ever before in history. Scientists have discovered that we are causing the warming, and it is our job to learn what we can do to slow down the warming.

Curriculum Connections:

Students will investigate and interpret linkages among landforms, water and climate.

Supplies / Materials:

- Science Journal
- Bristol board
- Markers

Hook: Watch a short video explaining climate change: https://youtu.be/Sv7OHfpIRfU

SCIENCE FOCUS

Lesson Subject

Science 8

Topic

Climate Change

Location

Classroom

Length

50 mins

Intro Activity: Teacher leads a discussion using a KWL chart about climate change, asking students what they know, and what they want to know about climate change.

Afterwards it would also be good to create a brain storm about what they already know about heat, temperature and climate change.

Main Activity:

Students work in small groups to research information about different sources of heat and create a table listing advantages and disadvantages of each their source.

Independent Student Work: Students create an informative poster in pairs about ways we can take action on climate change. Ideas can include walking to school, wearing sweaters and turning the heat down, reducing energy consumption, planting trees, starting a recycling initiative, etc.

Conclusion / Review: Students present their posters to the class and find a place in the school to hang them up.

Homework: Finish working on poster if unable to complete it during class time.

Resources:

1. http://www.climatechange.gc.ca/default.asp?lang=En&n=E18C8F2D-1

2. http://climatekids.nasa.gov/climate-change-meaning/

Science 8 – lesson 2

Water in Local Environments

Objective: Describe the distribution and characteristics of water in local environments.

Introduction: he quality of our drinking water is tested all over Canada. Each community has a water treatment plant where employers conduct a variety of tests to ensure that our drinking water is clear and safe to drink. Contaminated water can pose a number of risks to our health, and it is important we ensure the safety of drinking water and obtain water testing that meets all regulator requirements and quality standards in Canada. One of the tests that are done at local water treatment plant is the pH test. A simple pH test determines the acidity of the water, with the goal of it being as neutral as possible. A neutral pH ensures that the water is safe to travel through pipes and to drink.

Curriculum Connections:

Students will identify major factors used in determining if water is potable, and describe and demonstrate tests water quality.

Supplies / Materials:

- Science Journal
- Water testing bags
- Straws
- Water samples
- Tablets

Hook: Take your students on a tour of your local water treatment plant and observe the process the water goes through as it is

SCIENCE FOCUS

Lesson Subject

Science 8

Topic

Water Quality

Location

Classroom

Length

50 mins

testing and prepared to be safe drinking water for your community.

Intro Activity: Teacher leads a discussion about water quality testing, why it is important that the city tests the quality of our water, what they are looking for, how they clean water, what they add to our water to make it safe to drink.

Main Activity:

Students will conduct a series of tests with samples of water to determine clear, salinity, and hardness of the water and to test for the pH level as well as the amount of chlorine in their water sample. Students are encouraged to sample water from a variety of sources (bottled, tap, local bodies of water, etc).

Conclusion / Review: In your science journal write a small reflection based on your results. Did anything surprise you? Do you feel confident that the water you drink is safe? What does the city do to help ensure our drinking water is safe?

Homework: Test the water at home, and share your results in your science journal to share with the class.

Resources:

1. http://www.lifewater.ca/drill_manual/Section_16.htm

Science 8 – lesson 3

Life Processes of Plants

Objective: Investigate life processes of plants and the need of plants in our environment.

Introduction: Plant life takes on different forms that are challenging to observe and understand. Plants carry out seven processes that define life; closely observing plant life can reveal connections to our own existence.

Curriculum Connections:

Students will illustrate and explain the essential role of plants within the environment

Supplies / Materials:

- Science Journal
- Plants of the NWT book
- Samples of plants
- Magnifying glasses

Hook: Take a tour of a garden, greenhouse or farm. Observe the different plant species you see, have students make simple sketches of one or two plants they notice. Can they tell which plants are edible, and which ones are not?

Intro Activity: Teacher leads a discussion about the use of plants. Humans have always depended on plants as a source of food and to meet a variety of needs. As a class create a brainstorm of all the different ways we use plants in daily life.

SCIENCE FOCUS

Lesson Subject

Science 8

Topic

Plants for Food and Fiber

Location

Classroom

Length

50 mins

Main Activity:

Each student chooses a plant and identifies its use as food, herb, medicine or product. They have to create a model of that plant and write a report about its use in today's society.

Conclusion / Review: Class presentation of created work. Create a class PowerPoint presentation or Prezi [https://prezi.com] that serves as a collection of student work. Have students report their findings to the class.

Homework: Journal reflection: Do an inventory of the plants you can find at home, what are the uses of these plants? Does your family grow their own garden? What are some of the benefits of growing your own food?

Resources:

http://www.gardenguides.com/126002-seven-life-processes-plant.html

Science 9 – lesson 1

Sexual and Asexual Reproduction

Objective: Introduce different reproductive strategies using Northern plant examples

Introduction: Several plants have the ability to reproduce both asexually and sexually. Since they need to rely on external factors (wind, animals, water etc) for sexual reproduction, asexual reproduction allows for a more consistent local distribution. However, it doesn't have the protective and adaptive attributes of sexual reproduction. This lesson aims to introduce different methods of plant reproduction to students and encourages them to think about how the different strategies apply in Northern climates.

Curriculum Connections:

Unit A: 2 – reproductive strategies (sexual and asexual reproduction)

Supplies / Materials:

- Pictures of different reproductive methods (see **resources** below)

Hook: Show an example of a plant stolon (Resource 1). Have students guess at what they are looking and discuss why this strategy.

SCIENCE FOCUS

Lesson Subject

Science 9

Topic

Biodiversity

Location

Classroom or outdoors

Length

60-80 mins

Intro Activity: Introduce rhizomes and seeds. Have students determine whether they are sexual/asexual reproduction. Have them brainstorm pros/cons of each strategy.

Main Activity:

Discuss above activity and verify. Have students research (computer, resource books or pictures) and compare reproduction of Mountain Avens (rhizomes), Bearberry or Strawberry (stolons) and Prickly Saxifrage (seed only). Have students discuss in groups how each strategy may be affected by climate.

Independent Student Work: Define and sketch the different categories discussed today in a journal/notebook. Describe some pros/cons of each.

Conclusion / Review: Why do different strategies exist? Which may be most beneficial for human use / survival in different climates or habitats?

Homework: Choose one of the plants and continue to study for identification, habitat, human uses etc.

Or

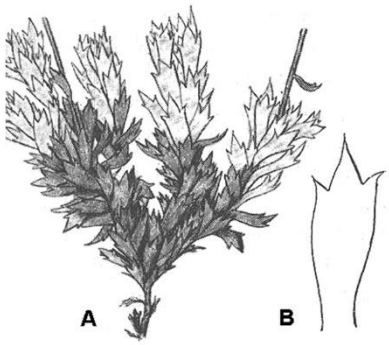
Have students go through more plant watch plants and tabulate how many plants use each reproductive strategy. Is there a predominant strategy?

Resources:

1. Stolon: http://www.sci.sdsu.edu/plants/plantsystematics/morph/vegetative/stolon.html
2. Plantwatch North: www.naturewatch.ca/plantwatch/northwest-territories.
   Contact your local representative for Plantwatch North Guidebooks
3. NBES common plants: http://nbes.ca/wp-content/uploads/2014/03/CommonPlants_Oct12-1.pdf
4. Wild and Wacky Plants of the NWT:
   http://nwtarts.com/sites/default/files/wild_and_wacky_plants_of_the_nwt.pdf
5. Images:

Bearberry (from: http://3.bp.blogspot.com/-xDm9D-s2AhY/ToXZKSR1I-I/AAAAAAAAA0s/0rMwihVmDek/s640/M1320075.jpg)

Mountain Avens (From: http://www.flora.dempstercountry.org/V.B.14.Rosaceae/Dryas.integ/Dryas.integ.drawing.jpg



Prickly saxifrage (From: http://nature.ca/aaflora/images/sxtrd1a.jpg)

Extension:

1. Discuss niche Planting – Which plants might grow well together and which might compete? Why? Observe a local plant community and see if you can verify you answers.
2. Discuss how the technology of cloning animals is similar to this? Different? What are the ethical implications?

Science 9 – lesson 2

Frogs in the NWT

Objective: Introduce different reproductive strategies using Northern plant examples

Introduction: Due to their nature as an indicator species, the monitoring of frogs is important to help humans recognize potential threats to our environment and make changes as necessary. This lesson aims to introduce the idea of indicator species and to help make students aware of local frog and toad populations and their recognition.

Curriculum Connections:

Unit A: 1&4

Supplies / Materials:

- Map of frog/toad distribution in NWT
- Student journals / blank paper

Hook: Watch frog video e.g. http://ed.ted.com/lessons/disappearing-frogs-kerry-m-kriger

Intro Activity: Discuss indicator species and their value. Look at the map of frog/toad distribution and determine which NWT frogs live closest to you. Are you aware of the existence of these frogs? Where around the community might you find them?

SCIENCE FOCUS

Lesson Subject

Science 9

Topic

Biodiversity

Location

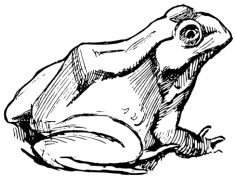
Classroom with possibility of Field Study

Date:

Spring

Length

50 mins



Main Activity:

Students choose 2 species of frogs/toads to compare. Use those in your area if applicable. Compare based upon facts provided in info sheets at naturewatch.ca and answer the following questions: How are the species similar/different? In which habitats are they primarily found – if different what would you think is the predominant species based on the landscape where you live? What are some of its adaptations to a Northern Climate?

Independent Student Work: Sketches of 2 frogs or toads including notes on how to identify species (field journal).

Conclusion / Review: Why are frogs and toads important to us? How can scientists (including ourselves) monitor levels?

Homework: Research the sensitivity of one of the species of frogs (or frogs in general) to climate change. Brainstorm strategies to minimize the impacts.

Resources:

1. Map: http://www.nwtpas.ca/maps/map-sf-amphibians-pas-areas.pdf
2. Frogwatch: https://www.naturewatch.ca/frogwatch/northwest-territories/

Extension:

1. Have students investigate reproductive strategies of a frog species. Brainstorm human activities that could detract and enhance these strategies.
2. Have students submit Frog watch observations
3. Further lessons about frogs: https://www.naturewatch.ca/wp-content/biguploads/senior_guide_712.pdf

Science 9 – lesson 3

Behind the Bottle – What's in the Bottle?

Objective: Introduce different reproductive strategies using Northern plant examples

Introduction: Many people consume bottled water due to concerns about their own water sources. Some of these perceptions may be true but others are false. This lesson helps students investigate the quality of their own communities' water and assess whether the waste of bottled water is necessary.

Curriculum Connections:

Unit C – 2: processes for monitoring water quality

Supplies / Materials:

- Computer access
- Notebook
- Student Worksheets, maps and information sheet from resource
- Flip chart and pens

Hook: Show controversial ad for Bottled Water: http://www.coloribus.com/adsarchive/prints/archipelago-bottled-water-3166605/

Intro Activity: Discuss why people buy bottled water. What are perceptions of tap water vs. bottled water? What are the sources? Do students know about water treatment in their area?

SCIENCE FOCUS

Lesson Subject

Science 9

Topic

Environmental Chemistry

Location

Classroom and Field

Length

50 mins

Main Activity: Discuss with your class if it is worth buying bottled water. Bring in a sample of different bottled water that is available in your community and get the students to guess the price of each bottle. Have stickers with the correct prices written out and play a matching game with your students. Also have a cup with tap water included in your display. Have a sticker with the cost of tap water included as well so students can get a better idea of the money they would save by drinking tap water. Bottled water usually comes to about $2.75 per litre, and tap water is about $0.01 per litre.

Independent Student Work: Have students create a poster to promote tap water in their school, home and community. This can also be done in partners or small groups depending on class size and needs. They can include some benefits from switching to NWT water included below.

Take Action:

Home:

- Get a reusable water bottle that you can fill with tap water and carry with you
- Fill a glass pitcher with tap water and place it in your home fridge, most chlorine used to treat the water will dissipate within a few hours

At School:

- Use the drinking water fountain if one is available, if not request that one be installed (get students to write and sign a petition for the principle)
- Carry a reusable water bottle around, maybe provide your class with a reusable water bottle or include it in the school supplies list at the beginning of the year, or as a note home to parents. Make sure to label water bottles to avoid mix up between students.

In your community:

- Contact your local government or band office, as how your community is implementing the NWT Association of Communities resolution to phase out the sale and use of bottled water
- Visit the water body where your community gets its drinking water and learn more about the local water treatment system.

Conclusion / Review:

- Have a discussion with your class on the following: Is it worth buying bottled water?
- Collect recycled water bottles from the school and turn it into an art project.

Homework: Have students design an educational campaign to educate schoolmates about bottled water or to take to businesses to discourage the sale of them. This can include finishing the posters they started in class.

Resources:

Ecology North: Water and #loveNWTwater campaign

http://ecologynorth.ca/our-work/water/

Extension:

1. Connect to impacts on biodiversity – what happens to plastics in the environment and what are the implications for animal species?
2. Use testing kits to compare bottled water samples to tap water samples.

Science 10 –lesson 1

The Green Clean

Objective: To introduce students to some chemicals used for cleaning and potential alternatives.

Introduction: Often chemicals are used for cleaning / maintenance in the home without further thought given to the implications on human and environmental health. This lesson aims to introduce students to the chemistry behind 2 alternative drain de-clogging agents and have them consider the challenges and benefits of using alternative cleaners.

Curriculum Connections:

Unit A – 2, 3

Supplies / Materials:

- Ingredient List for Drano (see **resources**)
- Periodic Table of the elements

Hook: Have the ingredient list for Drano on the board. Have students discuss what they know about the product and any ingredients listed.

Intro Activity: Have students write out the chemical formulas for the compounds listed using their periodic tables. Define what a surfactant is and how it works.

Main Activity: Compare ingredients of a green alternative (baking soda and white vinegar) to Drano. Show the chemical formula on the board. Have students work

SCIENCE FOCUS

Lesson Subject

Science 10

Topic

Environmental Chemistry

Location

Classroom

Length

50 – 60 mins

in small groups to determine which compounds are acidic and which are basic. Have them predict reactions and categorize them. Have them discuss some of the pros and cons of each product.

Independent Student Work: Have students work out an experiment to test the efficacy of each of the alternatives.

Conclusion / Review: What do the students predict about the efficacy of the products? When might it be beneficial to use one over the other? What are the environmental consequences of the choices?

Homework: Have students compare other cleaners and green alternatives chemically.

Resources:

1. Drano list: http://www.whatsinsidescjohnson.com/us/en/brands/drano/drano-liquid-clog-remover

2. Description of chemical reactions: http://home.howstuffworks.com/home-improvement/plumbing/drain-cleaner2.htm; https://en.wikipedia.org/wiki/Drano

3. Cleaning acids and bases: https://van.physics.illinois.edu/qa/listing.php?id=491

4. Vinegar and Baking soda chemistry: http://www.middleschoolchemistry.com/multimedia/chapter6/lesson2

Extensions:

1. In the lab test the efficacy of Drano vs the green alternative against dissolving a clot of organic matter in a piece of PVC pipe. Have them assess water solubility of the compounds and discuss how this can influence the body of water where these compounds may end up.

Science 10 – lesson 2

Climate Change – How will it affect us?

Objective: To introduce students to the greenhouse effect, climate change and challenges in the NWT.

Introduction: Melting ice and rising temperatures over the past decades suggest that climate change is happening at a noticeable rate in the North. Effects of climate change in the North are more concerning than in other parts of the country due to implications of significant ice melt and permafrost changes. This lesson aims to introduce students to climate change and the greenhouse effect and then to the specific implications for the north.

Curriculum Connections:

Unit D – SO 1-4

Supplies / Materials:

- Ecology North Climate Change Resource Materials (see below)
- Student Journals or notebooks
- Flashlights, plastic sheets or bottles and black paper

Hook: Show a brief video on Climate Change e.g. https://www.youtube.com/watch?v=9GjrS8QbHmY

SCIENCE FOCUS

Lesson Subject

Science 10

Topic

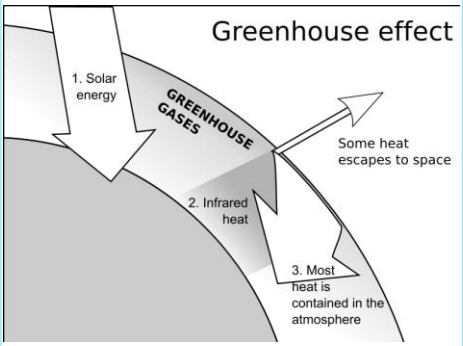
Energy Flow in Global Systems – Climate Change

Location

Classroom

Length

100 mins



Intro Activity: Have students discuss what they know about climate change. Sample discussion questions can be found below.

Main Activity:

1. Have students define the terms found in #2 below using the information found below in "Climate Change What Does it Mean".
2. Do a class demonstration or let students work in small groups to demonstrate the greenhouse effect. Shine the flashlight onto black paper and note the definition of the light. Shine it through the plastic (leaving a few cms between plastic and paper) and notice the distortion – what is happening to the light rays (scattering) and how do they come back through to our eye?. How would changing the translucency influence this? Remind students that it is not just light but heat (energy) that is reflected back to earth.
3. Show students climate change trends in the North from: http://www.enr.gov.nt.ca/sites/default/files/page_3_nwt-climate-observations_06-13-2015_vf_1_0.pdf and have them reflect on what this means for the NWT
4. Have students brainstorm how climate change will affect the NWT specifically. See below for some ideas.
5. Have students work in a small group to come up with some recommendations for reducing the impacts of climate change in the North (or specifically your community)

Independent Student Work: Record terms in science journal/notebook.

Conclusion / Review: Why does climate change matter?

Homework: Assess Nature watch data for evidence of climate change in Canada and make Northern predictions. https://www.naturewatch.ca/plantwatch/view-results/

Resources:

Material from: Integrating Climate Change Measures in Municipal Planning by Ecology North with the help of Pembina Institute.

1. Discussion
    a. When you hear the term "climate change" what does it make you think of?
    b. Why is understanding climate change important?
    c. Why is it important to have communities begin to consider the impacts of climate change?
    d. What recent events have told you, you need to learn more about climate change?

2. Terminology

- **Weather** is what you see out your window
- **Climate** is the weather of an area over time
- **Climate Change** refers to any significant change in temperature, precipitation, and wind patterns occurring over an extended period of time.
- **Global Warming** is no longer used to refer to climate change as the climate does not warm in all places at all times.
- **Greenhouse Effect** is the gases in the atmosphere acting like the glass in a greenhouse, allowing heat from the sun in but blocking it from leaving.
- **Adaptation** refers to planning for the effects of climate change. How we will adapt to the changes.
- **Mitigation** refers to how we can stop or slow down climate change.

3. Climate change –what does it mean?

Climate is the average pattern of weather in a given location over a period of time —from months to thousands of years. Climate change refers to any significant change in temperature, precipitation, and wind patterns occurring over an extended period of time.

Climate change is a natural process, but today's climate change is caused mostly by the increasing amounts of carbon dioxide and other greenhouse gases in the atmosphere.1 The unprecedented rapid global temperature and climate changes in the past century are primarily the result of burning fossil fuels, as well as the rapid increase in deforestation, industrial processes and some harmful agricultural practices.

Greenhouse gases in the atmosphere act like the glass in a greenhouse (hence the name greenhouse effect), allowing heat from the sun in but blocking it from leaving. Some greenhouse effect is essential for human life, but as the amount of carbon dioxide increases in the atmosphere, the changes we are seeing on earth are speeding up — with enormous impacts on the natural environment and people.

It is important to distinguish between weather (what you see out your window today) and climate, which refers to long-term average weather patterns in a given area. The most common measure of climate is temperature. While the daily temperatures that we experience vary across seasons, even a small change in average annual temperatures can

have important impacts on ecosystems, on landscape features such as permafrost, and on infrastructure. Other important climate measures are precipitation (rain and snow), wind, humidity and air pressure. Seasonal changes in precipitation — like more snow in the winter — can have big impacts too.

Documented climate change varies across regions but globally includes warmer average annual temperatures, changes in the frequency and intensity of extreme weather events such as heavy rain or snowstorms with high winds, and changes in the amount of precipitation and the type of precipitation, such as rain instead of snow.

4. Climate change in the NWT
Below you will find a table of impacts from the perspective of human use / well-being.

Extensions:

Participate in Nature Watch North! https://www.naturewatch.ca/plantwatch/northwest-territories/

Research how much CO2 could be sequestered by planting an area of native plants such as part of the schoolyard, an empty field etc.

Greenhouse gas pop bottle models:
http://www.paulding.k12.ga.us/cms/lib010/GA01903603/Centricity/Domain/540/Greenhouse%20Global%20Warming%20LAB.pdf

Build models of Greenhouse gases using chemistry modeling kits or foam balls (of relative size) and pipe cleaners. Which ones do we think will trap the most gases?

See the government's strategy to mitigate the effects of GHG:
http://www.enr.gov.nt.ca/sites/default/files/strategies/greenhouse_gas_strategy_final.pdf

Science 10 – lesson 3

Behind the Bottle – What's in the Bottle?

Objective: To illustrate the energetic cost of drinking bottled water.

Introduction: To get to the NWT a bottle of water must often travel thousands of kilometers. Besides the energy required for this transport, other energy is expended to create and store these bottles. As tap water quality is strictly monitored in the NWT this energy may not be of best use. The goal of this lesson is to generate awareness amongst students about the true energetic costs of bottled water.

Curriculum Connections:

Unit B – 1: existence of energy in a variety of forms; select and integrate information from various print and electronic sources or from several parts of the same source

Unit D -4: assess risks and benefits of human activity

Supplies / Materials:

- 10-15 bottles from bottled water, either brought in by students or recovered from recycling
- Calculators
- Copies of reference tables: *distance between NWT communities* and Table 1 in **resources** below or access to Google Maps; Table 2 below

SCIENCE FOCUS

Lesson Subject

Science 10

Topic

Energy Flow in Tech Systems

Location

Classroom

Length

50 mins

Hook: Show students a controversial bottled water ad. such as:

http://www.coloribus.com/adsarchive/prints/archipelago-bottled-water-3166605/. Ask students if this is truly the case (Note: if a bottle doesn't say spring or mineral water it is tap water), where energy may be being wasted in bringing it to another community (bottle manufacturing, transport, cooling, recycling). What forms of energy are involved? (Chemical, mechanical, thermal and electrical)

Intro Activity: Have students look at the bottles and determine where they came from. Ask them to make an educated guess about the modes of transport required for the bottle to make it to their community? (Rail, ship, plane, transport truck)

Main Activity:

1. Review and/or introduce the Joule. Have students hypothesize how many Joules (or Megajoules) transportation of bottled water requires.
2. Have students calculate how much energy their bottle needed for transport (1 L of water = 1 kg).
3. Either have students read the Gleik and Cooley article (Resource 3) about energy required to make water bottles or use Gleik's and Cooley's data to calculate the energy of producing bottles:
    a. Bottles weigh approx. 38 grams and lids 2 grams
    b. Resin production requires approximately 76 MJ/kg
    c. Final production (into a bottle) requires approximately 20 MJ/kg

Conclusion / Review: Were students surprised by the energy required by the process? What might make it worth it/not to use this energy?

Resources:

1.

Distances and Common Transport Methods for Bottled Water

From	To	Approximate distance (kilometres)	Most common transport method for bottled water between these locations
Within Canada			
Edmonton, AB	Yellowknife	1,500	large diesel transport truck
Edmonton , AB	Hay River	1,100	large diesel transport truck
Vancouver, BC	Edmonton	1,100	large diesel transport truck
Hope, BC	Edmonton	1,000	large diesel transport truck
Cranbrook, BC	Edmonton	700	large diesel transport truck
Toronto, ON	Edmonton	3,400	Rail
Montréal, QC	Toronto, ON	500	Rail
International			
Evian, France (Alps)	Le Havre, France (shipping port)	700	Rail
Le Havre, France	Montréal, QC	5,500	Ship
Fiji	Vancouver, BC	9,400	Ship

Notes:

- Kawkawa Springs, British Columbia (B.C.), is near Hope, B.C
- Mississauga, Ontario, is near Toronto, Ontario

(Ecology North, 2013)

2.

Energy Use by Various Transportation Methods

Transportation Method	Amount of energy (Joules) it takes this transportation method to move 1 kg a distance of 1 km (J / kg • km)
Large diesel transport truck	2,400
Medium-sized diesel transport truck	6,660
Rail	235
Ship / Barge	432
Airplane	3,100

Source: Natural Resources Canada, Office of Energy Efficiency. Freight transportation secondary energy use by energy source and transportation mode - 2007. Available at www.nrcan.gc.ca

3. Gleik, PH and Cooley, HS. 2009. Energy implications of bottled water. In: Environmental Research Letters 4:1. Online at: http://iopscience.iop.org/article/10.1088/1748-9326/4/1/014009/fulltext/;jsessionid=98982E2AFDD6B0E37F12F7C1CDB30865.c2

Extensions:

1. Have students research the energy of cooling and recycling to get a complete picture of energy costs.
2. Have students do an energy comparison for the process of bottling water to common household energy uses.
3. Have students create awareness about how much energy is required to bring bottled water to communities.

Ocean Waves

Objective: To learn about alternative technologies while studying mechanical waves

Introduction: Watching the ocean, especially on a windy day, is very suggestive of its power. Typically humans have harnessed this power for recreation or sea travel but wave power is currently being investigated as a source of electrical power generation. The aim of this lesson is help students understand ocean waves and introduce them to the potential and challenges of harnessing wave energy.

Curriculum Connections:

Unit B - 1.1 sts

Unit C - 2.3sts

Unit D – 2.1-2.4k, 2.1sts

Supplies / Materials:

- Projector and computer
- Computer access for students
- Tub of water
- Print outs of charts and **resources** provided
- Chart paper and markers

Hook: Watch a bit of the following video:
https://www.youtube.com/watch?v=gSKFqm4pIEI

SCIENCE FOCUS

Lesson Subject

Physics 20

Topic

Mechanical Waves

Location

Classroom

Length

50-80 minutes (dependent on work time allotted)

Intro Activity: Ask for student observations from the video provided above – you are looking for answers such as "a wave is powerful and rhythmic."

Main Activity:

1. Explain that the class will be investigating waves as a renewable energy source.

2. Explore the movements of particles in a wave – if possible watch the animation in **Resource** 1, it might be helpful to have the video preloaded for your class.

3. Discuss transverse and longitudinal movements of particles; provide an example of previously record information in either a table or chart.

4. Have students discuss methods in which the energy of waves may be captured – it may be helpful to have a model tub of water and some supplies so students can experiment with wave movement and energy. Make sure to put some time aside to set up, run and tear down the tub models. You can also get a student to help with this! Give students time to jot down notes of thoughts, ideas and discoveries that came up during this experiment.

5. Have students brainstorm some of the challenges to harnessing wave power. Some of the topics could include changes in wave intensity and frequency, international politics, set-up and repair of stations, transport of energy and viability in the North. Note that the students should focus on the viability of wave power in the North, and this could lead into the next lesson.

Independent Student Work: Have students research wave technology and determine whether it would be valuable for Northern Canadians to invest in. Resource 2 is a good starting place. Try to use both local **resources** from your community and or territory, and look nationally as well.

Conclusion / Review: Have students share some of their findings, and write down some of the ideas that came up during one of the brainstorming sessions from the previous main activities. Your students can either write their thoughts down or present this information pictorially or orally to the teacher or to the class.

Homework: Finish independent student work in the form of a KWL chart, a Brain Map or a short reflection piece.

Resources:

1. Mechanical energy of waves: http://www.acs.psu.edu/drussell/Demos/waves/wavemotion.html

2. Wave technology: https://hub.globalccsinstitute.com/publications/renewable-electricity-futures-study-volume-2-renewable-electricity-generation-and-storage-technologies/95-technology-characterization

Physics 20 – lesson 2

Alternative Energy

Objective: To learn about alternative energy, analyze solar data.

Introduction: Solar generation is being introduced in Northern communities as a wave to reduce reliance on diesel electricity generation. The strength of this technology is in its renewability and decrease on dependence of shipped materials, however, it is also subject to presence of sunlight. This lesson helps students research this type of solar energy and how much can be produced by a Northern array (Colville Lake).

Curriculum Connections:

B 1.1 sts, C 2.3sts, C2.3s

Supplies / Materials:

- Computer access

Hook: Watch video about solar energy – e.g. https://www.youtube.com/watch?v=x4CTceusK9I

Intro Activity: Ask students what they know about alternative energy and how feasible they think it is for their community. What are some of the benefits/challenges of living in the North?

Main Activity:

1. Have students read through the description of Colville Lake's solar energy description (Resource 1)

SCIENCE FOCUS

Lesson Subject

Physics 20

Topic

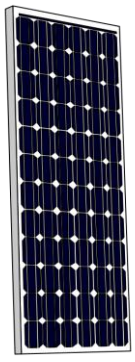
Solar Energy

Location

Classroom

Length

50 mins



2. Have students look at solar generation for different days/months in 2015 using Resource 2. When is this most efficient? How much of the potential is being reached? (Note that there is a little tab on the left hand side of the page to change between daily and monthly data)
3. Assuming diesel generators produce 1kW-hr/L of diesel (Resource 3), how much diesel is being saved?

Independent Student Work: Energy Consumption Calculator: Have students work out an energy budget for a day (**Resource 4**). How much solar would need to be generated to support their lifestyle? How big would the array and batteries have to be? Give your students lots of time to complete this activity, if they are unable to finish during class time, perhaps collect their work and extend it into the start of your next class.

Follow up lesson for next day: when students return to class with their completed energy budget lead a classroom discussion. Ask the following questions; how could they be more efficient? What sacrifices would they make? What alternatives are possible?

Conclusion / Review: Have students prepare a poster, presentation or letter to their family to share their findings. Cover questions such as what are the pros and cons of solar energy? How can we save energy overall?

Homework: Finish personal energy budget and determine ways to save energy and/or locations for solar in your community.

Resources:

1. Description of solar energy project in Colville Lake : http://www.bullfrogpower.com/wp-content/uploads/2015/09/Colville_Lake-Solar.pdf
2. Solar energy data for Colville Lake (note only 1 of 2 arrays is being monitored as of Mar 2016): https://enlighten.enphaseenergy.com/pv/public_systems/xrDs481206/overview
3. Diesel generators: http://energyeducation.ca/encyclopedia/Diesel_generator
4. Energy consumption calculator: https://www.easycalculation.com/physics/electromagnetism/energy-consumption.php

Physics 30 – lesson 1

Electromagnetic Radiation

Objective: To understand electromagnetic radiation (EMR) and the effect on ice and snow

Introduction: The North is particularly influenced by climate change as areas of ice and snow can influence the reflection of radiation and a loss of snow/ice cover can further influence snow melt. This lesson aims to introduce students to how EMR and climate change are related.

Curriculum Connections:

C.1.2k, 1.6k, 1.8k

Supplies / Materials:

- Projector and screen or handouts of pictures from resource 1
- A location to observe ice and snow melt preferably with shady areas
- Optional: prisms, polarization filters etc. to look at reflection and refraction

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Lesson Subject

Physics 30 - 1

Topic

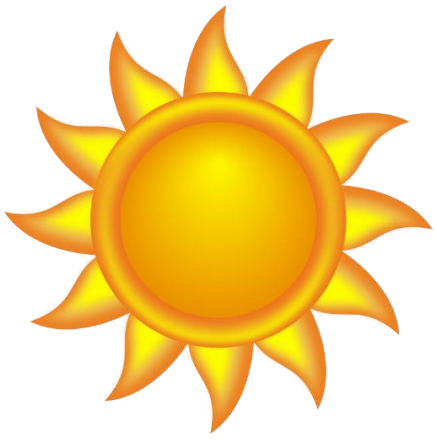
EMR and Ice/Snow

Location

Classroom Start, Field

Length

50 minutes



Hook: Break your class into smaller groups and inform each group that they will be expected to present their groups observations after studying figure 1 from **resource** two. Show or hand out a copy of figure 1 from **resource** two. Have students make observations about the relationship of wavelength and energy. Provide chart or poster paper to each group to help them present their findings to the class. This can be done pictorially, written or verbally but should include at least one example of each.

Intro Activity: Give students the statement "Fog eats snow (or ice)". Have them work in pairs or groups to explain what is happening based on figure 1. Look at absorption in Figure 4 – water (fog=water droplets) is good at absorbing long-wave radiation and reflecting it back, which causes it to melt the snow. Ask students what happens with increased reflection either by greenhouse gases or extra air moisture. Explain that this phenomenon actually makes the North more vulnerable to climate change (ie as ice melt increases there is more moisture in the atmosphere which means more reflection…)

Main Activity:

1. Go to your ice and snow observation spot. Measure different weather variables (T, wind, humidity etc.) in 2 or more spots.
2. Experiment with prisms, polar filters etc.

Independent Student Work:

1. Have students make observations about the apparent melt of snow and ice. Have them take particular notice of the quality of ice.
2. Encourage students to return and monitor a patch of ice and submit observations to IceWatch (see **resources**)

Conclusion / Review: Review EMR and the implications of climate change in the North.

Homework: Submit student and class observations to Ice Watch.

Ice watch: https://www.naturewatch.ca/icewatch/

Field Trip: Take your class for a walk around the community to witness the behavior of ice and snow melting according to several conditions such as shade, elevation, proximities and exposures. In a larger community you could always just walk around the school ground.

Resources:

1. Ice watch: https://www.naturewatch.ca/icewatch/
2. OZ coasts 'The enhanced greenhouse effects" . http://www.ozcoasts.gov.au/indicators/greenhouse_effect.jsp

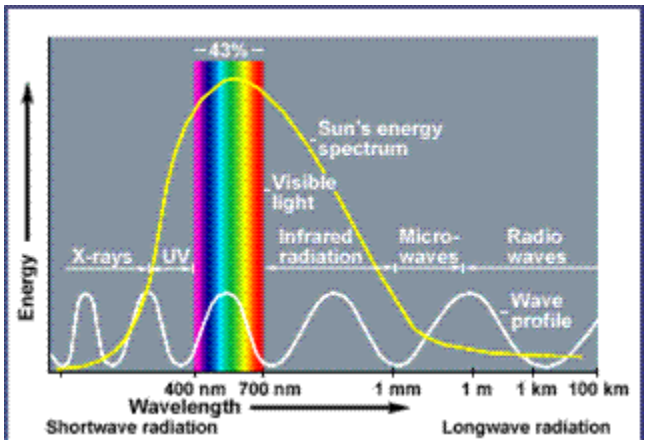


Figure 1: A schematic of the electromagnetic spectrum, showing the Sun's energy output in relation to wavelength.

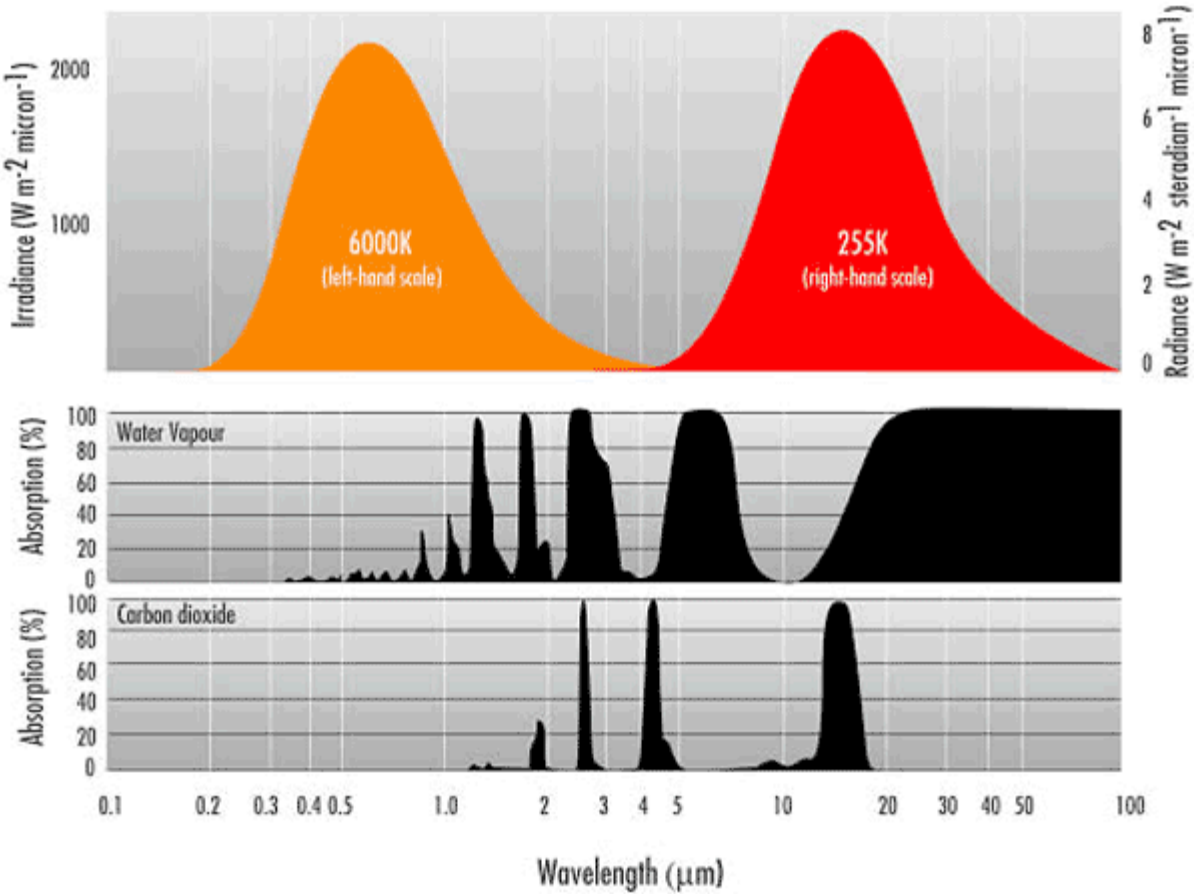


Figure 4. The radiation Absorption characteristics of Water Vapour and Carbon Dioxide. From: Bureau of Meteorology (Australia) The Greenhouse Effect and Climate Change.

Physics 30 – lesson 2

EMR and Northern Greenhouses

Objective: To understand electromagnetic radiation (EMR) and the design of Northern Greenhouses.

Introduction: Food security is a challenge for Northern communities as many are only accessible by water or ice road. Therefore, the production of food within a community is very important. To combat the cold, greenhouses may be one of the better options to at least extend a short growing season. This lesson aims to help students understand how an optimal greenhouse could be designed for their community.

Curriculum Connections:

C.1.6k, 1.8k; C1.2sts, C1.2s

Supplies / Materials:

- Computer/projector or class set of computers
- Paper and pencils for drawing
- Articles about greenhouses in the North (see **resources**) or computers to access

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Lesson Subject

Physics 30

Topic

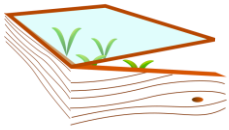
EMR and Greenhouse Design

Location

Classroom

Length

50 minutes plus project time



(cold frame)

Hook: Show students pictures of large Alaskan vegetables (Google) and ask them where they think these were grown. Reveal that they were grown in Alaska – how is this possible?

Intro Activity: Have students create a rough sketch of what they think of when they think about a greenhouse. Typically, people think of a basic rectangular structure with either a pyramidal or semi-cylindrical roof. Have students consider what angle the sun would be hitting the roof and what this means in terms of reflection and refraction of light (see resources 1 and 2 to look at these in general and to determine the elevation of the sun in your community). What are the goals of a greenhouse and how can we maximize the potential?

Main Activity: Have student read through articles about designing greenhouses for the North. See resources 3-6 as examples.

Independent Student Work: In groups, have students design an appropriate greenhouse for the schoolyard or other public space in your community. Get your students to consider location, orientation, design and what types of plants they would like to grow. If the community already has a greenhouse, consider taking your students there on a field trip. During this field trip students can be asked to evaluate the efficiency of design.

Conclusion / Review: What are some of the important features of a greenhouse and how can we effectively grow food for the North? Encourage the class to partner with a local community organization to create a small-scale green house somewhere in the community, perhaps in the school to grow vegetables, berries and herbs.

Homework: Work on design project above. Write a short reflection on how a community greenhouse could benefit their community in providing fresh and healthy food options for the local people.

Resources:

1. Reflection and refraction between glass and air: http://physics-animations.com/Physics/English/rays_txt.htm

2. A tool to look at sun angles and elevation: http://www.sunearthtools.com/dp/tools/pos_sun.php?lang=en

3. Design of a solar greenhouse for Calgary: http://vergepermaculture.ca/blog/2011/01/09/how-we-designed-our-solar-greenhouse/

4. 5 Northern Greenhouse examples: http://waldenlabs.com/5-northern-greenhouse-examples/

5. University of Saskatchewan Northern Greenhouse Guidelines: https://www.usask.ca/icngd/publications/reports/Reports-Files/Northern%20Greenhouse%20Guidelines_FINAL.pdf

6. Cold Climate prototype: http://www.greenhousecanada.com/energy/efficiency/solar-thermal-greenhouse-prototype-for-cold-climates-20292

Extensions:

Assess solar energy options in your community:

1. Optimal angle for solar panels: http://greenerenergy.ca/PDFs/Tilt%20and%20Angle%20Orientation%20of%20Solar%20Panels.pdf

2. Colville Lake solar: https://enlighten.enphaseenergy.com/pv/public_systems/xrDs481206

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Engaging NWT youth and teachers
for grades 6-12 in environmental science

Science Focus provides lesson plans for grades 6-12 that are environmentally minded to help get your students engaged in science.

The goal of these lessons is provide fun, interactive, hands-on, science-based lesson plans and activities for youth across the NWT.