LOST LANDSCAPES
Teacher Resource Guide

Program Overview

TOPIC: Reconstructing Palaeoenvironments

THEME: How Alberta's environment has changed, and why.
What does this mean for humans and our future?

PROGRAM DESCRIPTION: Students work in groups to examine a variety of evidence, including fossils collected from sites across Alberta. Looking at ancient temperature and CO_2 levels at their site, they will discover how Alberta's environment has changed over time, before using this information to draw evidence-inspired illustrations. The program concludes with a discussion on how learning about the past can help us prepare for the future, and how scientists can communicate these ideas using different mediums such as art, writing, and social media.

AUDIENCE: Grades 7 – 11

DURATION: 60 minutes

LOCATION: Learning Centre

GROUP SIZE: 15 – 32

Curriculum Connections

Fine arts, mathematics, science

Grade 7 **Science**: Interactions and Ecosystems; Planet Earth

Grade 8 **Science**: Freshwater and Saltwater Systems

Grade 9 **Science**: Biological Diversity; Matter and Chemical Change

Grade 10 **Science**: Energy Flow in Global Systems

Grade 11 **Science 20**: The Changing Earth
Biology 20: Ecosystems and Population Change

CTS Environmental Stewardship

IMPORTANT NOTE: Students are encouraged to use their cellphones and other electronic devices. This program discusses social media as a means of sharing scientific information and (if in agreement with a school's social media policy) students will be given opportunities to take individual and group selfies with program materials.

Learning Objectives

Students will understand that Alberta's environment has changed over time:

- They will understand that environments can change due to biotic and abiotic factors.
- They will be able to identify biotic and abiotic factors within the ancient environment they investigate during the program, and explain how these factors affected that ecosystem.
- They will explore how species in the past have adapted (or failed to adapt) to a changing environment, and what circumstances are more likely to lead to adaption or extinction.

Students will identify different methods of dating a fossil site:

- They will understand that scientists use different methods to date fossil sites.
- They will be introduced to absolute and relative dating methods such as radiometric dating and biostratigraphy (complexity of explanation will vary by grade).

Students will better understand how scientists communicate their findings:

- They will create a piece of research-inspired palaeoart.
- They will consider the pros and cons of social media for science communication.
- They will better understand the research scientists must carry out before making claims.

Suggested Pre-Visit Activities

1. TERMINOLOGY

Here are some terms to introduce to your class before your program at the Royal Tyrrell Museum. These terms will prepare the students so that they will get the full benefit of the program.

GENERAL PROGRAM TERMINOLOGY:

Abiotic vs. Biotic: Biotic factors in an environment include living things, like plants, animals, and you! Abiotic factors are not alive. Examples include soil, water, and rocks.

Climate Adaptation: Reducing vulnerability to the harmful effects of climate change by designing projects with the expected consequences of future climate change in mind.

Climate Mitigation: Working to prevent human-caused climate change by either reducing production of greenhouse gases or enhancing carbon 'sinks' through activities, like tree planting.

Climate Resilience: Preparing for, and responding to, climate-related hazards such as floods and fires.

Climate vs. Weather: Weather is the day-to-day state of the atmosphere and its short-term variations on a daily to weekly basis. Climate is a trend formed by a place's weather, averaged over a period of years. Snow is weather; winter is climate.

Geologic Time: A system of measuring time on a scale of hundreds of thousands, millions, or billions of years. Scientists use this scale to understand the timing and relationships between processes that have changed the Earth, such as evolution of life, extinction events, continental drift, and climate changes.

Matrix: The rock and soil removed while excavating a fossil site. Sorting through matrix can yield small fossils from various creatures (i.e., fishes, turtles, crocodiles, etc.) that help build a more detailed picture of the ancient past.

Palaeoart: Artwork that uses palaeontological evidence to depict extinct animals and ancient environments.

Parts per million: The measurement system of how much of a certain gas, such as carbon dioxide, is present in the atmosphere. For instance, 1 part per million (ppm) means that out of every million air molecules, one is a CO_2 molecule.

FOSSIL DATING TERMINOLOGY:

Absolute dating: Methods for establishing the exact age of a fossil, rock layer, or other object.

Relative dating: Methods for establishing the age of a fossil, rock layer or other object in comparison to something else. For example, if a sandstone layer is underneath a mudstone layer, the sandstone is older, though in relative dating the exact age may not be known.

Biostratigraphy: The study of the placement of fossils within rock layers. Scientists can use changes in the fossils between rock layers to determine the age of the rocks, and detect major changes in life on Earth, like mass extinctions. Certain kinds of fossils can also indicate the presence of natural resources, such as natural gas. Since it reveals a range of time a species existed, but not the exact date, this is a form of relative dating.

Isotopes: Sub-types of chemical elements whose atoms have a different number of neutrons in their nucleus. Some chemical elements have several different isotopes that can be stable or unstable. Unstable isotopes will naturally transform or decay into new isotopes over time. When an unstable isotope changes into a new isotope, the original isotope is called the Parent and the new isotope is called the Daughter. For example, Uranium-235, the element used to power nuclear reactors, is a Parent isotope, and it decays into its Daughter isotope, Thorium-231.

Half-life: The amount of time it takes for half of a chemical element's unstable isotopes to decay from Parent isotopes to Daughter isotopes. Depending on the element, this can take anywhere from seconds to billions of years.

Radiometric dating: A method that calculates the rate decay of unstable isotopes to find the age of a fossil, geological formation, or artifact. Since it provides a very precise date, this is a form of absolute dating.

Post-Visit Activities

1. ADAPTING FOR THE FUTURE

If possible, have students go outside, either before, or while, answering these questions.

- Look at the environment where you live. List some biotic (living) and abiotic (non-living) factors that make your area unique.
- How do you think the environment in your area may look different in the future?
- How might humans, plants, and animals adapt to those changes?

Additional Resources:

- NASA: Climate Adaptation and Mitigation
- Ecosystems and Impacts in Fish Creek Provincial Park – a field study developed by Alberta Parks for Biology 20, Unit B

2. SCIENCE COMMUNICATION AND SOCIAL MEDIA

- Explore the different formats scientists can use to share their discoveries with the public, like print and online news, documentaries, and social media platforms like YouTube or Twitter. What are the advantages and disadvantages of these different formats? Discuss.
- Take what you've learned about Alberta's past environments and try turning it into a presentation in the style of Hashtags Through History: Fun Bonus Activity, a template by a teacher for formatting historical events in a modern social media lens (could be adapted to natural history).

3. PALAEOART

- Palaeontologists use many different channels to communicate with the public and with other scientists. They often enlist the help of artists to communicate how extinct species may have looked or behaved. Do you think that art is a good way for scientists to communicate with the public? Discuss.
- Research-based artwork that depicts extinct animals or ancient environments is called **palaeoart**. Continue working on the palaeoart you created during the program, or create a new piece of artwork based on the evidence provided in the **Site Information & Further Discussion** section below.

4. SITE INFORMATION & FURTHER DISCUSSION

Continue the discussion about the Alberta fossil sites studied during the program or use this information as a springboard for further research. Teachers can also use this section to mark answers on the worksheets completed by students during the program if they wish.

A. Luscar Mountain: Devonian

Age: 380 Mya (determined by biostratigraphy/fossil evidence)

CO_2: 400 ppm (global climate similar to today, local climate warmer)

Environment: Shallow, coastal, reef environment

Flora & Fauna: Brachiopods (early shelled ocean animals), crinoids (anemone-like ocean animals), coral, conodonts (extinct fish), trilobites, *Tiktaalik* (extinct lobe-finned fish), placoderms (extinct armoured fish), *Manticoceras* (shelled, squid-like animal or nautiloid), foraminifera (single-celled saltwater organisms), ostracods & bryozoan (tiny, hard-shelled saltwater animals)

Further Discussion:

- During the Devonian, the world had a relatively cool average temperate. However, due to shifting tectonic plates, Alberta was closer to the equator at this time, and therefore warmer. How does this demonstrate the difference between global versus local climate trends?
- Much of the oil produced in Alberta originates from the compressed remains of marine organisms, which lived during the Devonian. What are other ways events from the distant past can affect the present?

B. Lethbridge: Late Cretaceous

Age: 73 Mya (determined by radiometric dating)

CO_2: 580 ppm (global and local climate warmer than today)

Environment: Warm, shallow, inland sea

Flora & Fauna: Ammonites (shelled, squid-like animals), sharks, oysters, clams, dinoflagellates (microscopic saltwater organisms), foraminifera (single-celled saltwater organisms), sea turtles, ferns, angiosperms (flowering plants), driftwood

Further Discussion:

- The Bearpaw Sea formed partially because of higher sea levels due

to a warmer global climate (no ice caps), but also because the middle of North America was at a lower elevation in the Cretaceous than it is today. How might future sea level changes potentially impact humanity? How can we respond to this?

C. Dry Island Buffalo Jump: Late Cretaceous

Age: 66.5 Mya (determined by soil stratigraphy/rock formations)

CO_2: 570 ppm (global and local climate warmer than today)

Environment: Wet, swampy forests; slow, deep rivers

Flora & Fauna: Turtles, crocodiles, champsosaurs, clams, oysters, *Tyrannosaurus rex*, duckbill dinosaurs, *Didelphodon* (small, marsupial mammal), gar fish, ferns, angiosperm (flowering) plants, coniferous trees

Further Discussion:

- This site represents the end of the age of dinosaurs. What can we learn from mass extinction events in the fossil record?
- Unlike the dinosaurs, we have the ability to detect incoming threats, such as asteroids. If such a threat were detected, what would be the best way to prepare?
- Livescience: What should we do if a 'planet-killer' asteroid takes aim at Earth?

D. North Calgary: Palaeogene

Age: 61.7 Mya (determined by biostratigraphy/fossil evidence)

CO_2: 311 ppm (global and local climate cooler than today)

Environment: Dry shrubland with shallow, seasonal rivers

Flora & Fauna: Champsosaurs, early primates, angiosperm (flowering) plants, ferns, algae

Further Discussion:

- This site represents the world immediately after the mass extinction that killed off the dinosaurs, except for birds. What do you notice about the plants and animals?
- This site has been built over by urban development and no longer exists. How can we balance protecting irreplaceable fossil sites or present-day natural environments with necessary construction for housing, industry, or roadwork?
- CBC News: Renewal at fire-ravage Waterton Park

E. Wally's Beach: Pleistocene

Age: 13,500 (determined by radiometric dating)

CO_2: 203 ppm (global and local climate cooler than today)

Environment: Grasslands, shrubbery, small trees, some rivers

Flora & Fauna: Horses, camels, mammoths, grass, sage, birch

Further Discussion:

- Humans were present on every continent by the time of this site. What impact did humans have on the ecosystems and environments we encountered as we spread around the world?
- During the Pleistocene, the ancestors of many domesticated plant and animal species first appeared, but most of these species were not domesticated until after the end of the last ice age. How does domestication change a species' ability to adapt to new environments?

F. Drumheller: Quaternary

Age: 1968 – Present Day (determined by archaeological evidence)

CO_2: 400 ppm (modern global and local climate)

Environment: Semi-arid badlands, cultivated prairie

Flora & Fauna: Bison, coyote, mule deer, Richardson's ground squirrel, common starling, grass, silver sagebrush, brittle prickly pear cactus, canola

Further Discussion:

- Many of the plant and animal species at this site were introduced to North America relatively recently. How did these impact the landscape?
- Bison remains are present at this site. The last wild bison vanished from the Drumheller area sometime between 1820 and 1884. How does the presence or absence of certain plants and animals effect the environment?
- The evidence at this site can be used to reconstruct Alberta's past over the last 200 years, but the same site also contains evidence stretching back over 72 million years. What is the best way to proceed at locations where there is evidence from multiple eras (and it may be necessary to destroy one set of evidence to study another)?

5. ADDITIONAL RESOURCES

- Alberta Council for Environmental Education: Road Map to Excellent Climate Change Education poster
- Alberta Council for Environmental Education: Talking Climate Tip Sheet
- Alberta Council for Environmental Education: What is Excellent Climate Change Education? A thorough guide for teachers, expanding on the two links above.
- NASA: the Effects of Climate Change Facts
- NASA: Climate Change: How Do We Know?
- Alberta Council for Environmental Education: Leap into Action: Environmental Action Guide - a BC guide for classroom activism, including case studies of successful campaigns.

Note: Links were last accessed January 2022.