

Life Linked to Spring



Leader's Manual



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GLOSSARY

- hibernate** Animals that hibernate go into a dormant state and remain there for the winter. During hibernation the body temperature drops close to freezing, and metabolic activities in the body slow down so much they're nearly stopped.
- migrate** Animals that migrate move seasonally from one habitat, or region, to another. Migration may occur to access breeding grounds, food sources, protection from predators or specific climate variables. Migration is undertaken by birds, fish, mammals, and insects.
- reproduction** Reproduction is the process of producing offspring, such as young animals, larval insects or plants. This may be a sexual or asexual process.
- productivity** Ecologists use the term productivity to describe the growth rate of the organisms living in an ecosystem. A very productive ecosystem will have a very high volume of plant and animal biomass produced within it. Productivity is dependent on the availability of resources needed for photosynthesis, and on the diversity of the ecosystem.
- bioblitz** A biodiversity blitz, or bioblitz, is a tool used to assess the biodiversity of an area and get an idea of what species are present.
- citizen science** Scientific study and data collection conducted by laypeople, rather than scientists.
- baseline** Information that is used as a starting point from which to compare other information.

1 Introduction

Background to the Project

In May 2013, the Conservation of Arctic Flora and Fauna (CAFF), the biodiversity working group of the Arctic Council, released the *Arctic Biodiversity Assessment* (ABA). The ABA contains the best available science—informed by traditional ecological knowledge—on the status and trends of Arctic biodiversity during a time of rapid social, economic and environmental change. While much of the report is aimed at Arctic policy makers, the information it contains is important to all Arctic residents and to many people outside the Arctic.

In order to make that information more easily available, particularly to young people, CAFF is developing a set of educational kits about Arctic ecosystems and Arctic biodiversity. Each kit includes a pocket field guide that can be used on its own or together with additional material available on the CAFF website (www.caff.is). Accompanying each pocket field guide is a Leader's Manual to help teachers, youth groups and community leaders make use of the field guides in their educational programming.

For a complete list of available pocket field guides and manuals, and for downloadable and printable versions, go to the CAFF website at www.caff.is.

Life Linked to Spring: Pocket Guide and Leader's Manual

This manual and its associated pocket field guide look at the processes and some of the organisms closely linked with spring. Since spring itself is a process of change over a fairly short period of time, the field guide focuses on the broad categories of spring changes, with examples (plants, birds, animals) that help students see and understand the details of those changes. The leader's manual provides background information about the processes, the organisms and some of the changes and threats that could affect Arctic ecosystems and biodiversity as they are linked to spring. In addition, the manual includes a number of challenges and projects designed to get young people—either individually or in groups—out on the land and actively investigating the natural world around them. Appendix A provides more detailed information about the organisms in the pocket field guide. Appendix B provides printable worksheets for some of the suggested activities.

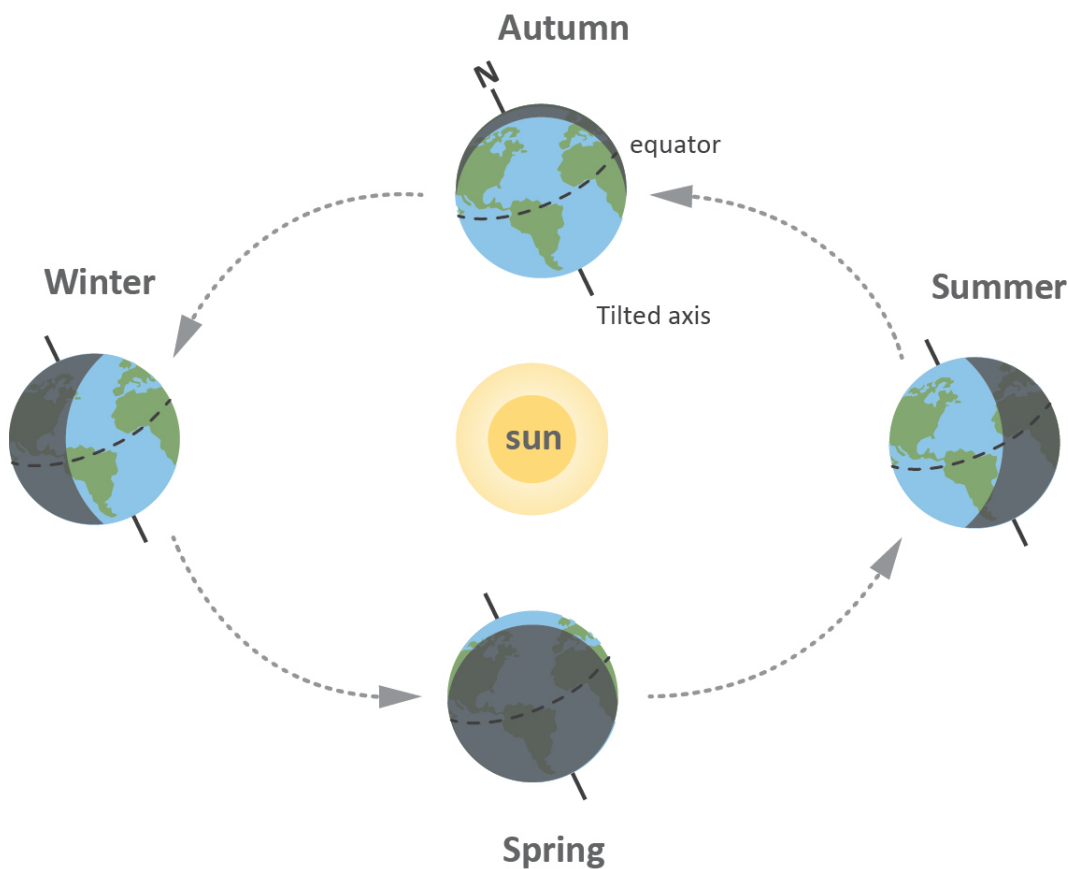
2 Spring Processes

Spring is not just a time of year. It's a process—and, in the Arctic, it's a fast process. Once the sun starts coming back and temperatures begin to creep upward, the land changes quickly. New plants pop up almost daily, flowers seem to bloom within a few hours, and migratory birds appear overnight. The landscape is suddenly alive with the scurrying, buzzing and fluttering of small creatures. To think about spring, you have to think about change. To observe spring and understand it, you have to observe it over time. In the Arctic, that time is short, but full of action.

Spring Starts in Space

The first process—the process that triggers all the other processes of spring—starts in space. All year long, Earth twirls through space, circling the sun and leaning a bit as it twirls. Earth is tilted slightly on its axis, with the result that the polar regions don't get equal amounts of sunlight year-round. In winter, the north leans away from the sun, so it doesn't get much sunlight. In fact, parts of the Arctic are in Earth's shadow for weeks at a time and the sun never appears above the horizon.

Eventually, Earth circles around to a point in its orbit where the north leans toward the sun. The sun rises, even at the top of the world. And the Arctic spring begins.



Spring Starts on Earth

The spring days get longer very quickly in the Arctic. The sun feels warmer, even if the thermometer still reads below freezing. In fact, the sunlight really is warmer. In winter, when the sun is low in the sky, sunlight (which is both light and heat) meets the atmosphere almost sideways, which means it passes through a lot of atmosphere before reaching the ground. Much of its heat is absorbed by the atmosphere. As the sun climbs higher in the sky, its light passes through less atmosphere, and more heat reaches the ground.

With the longer days and warmer temperatures, snow and ice shrink and melt, and green begins to appear—in the warm shallows of ocean and lakes, on south-facing hillsides, in sheltered crannies among sun-warmed rocks. That green is important. It's the colour of food.

Spring Green-up

The green comes from chlorophyll, the substance plants use to manufacture energy from sunlight, in a process called photosynthesis. When the sunlight returns in the spring, the chlorophyll starts working, and the plants turn green. For the plant-eaters in the Arctic food web, that means, essentially, that dinner is served.

The process of spring green-up drives all the other spring processes in the Arctic. The first plants to emerge, including such simple plants as mosses and algae, feed small mammals and insects on land, microscopic browsers in freshwater, and small filter-feeding organisms in the sea. Those creatures, in turn, become prey to larger animals—and onward through the food webs of land and water.

In spring, birds flock to the Arctic in huge numbers to breed, relying on these early plants and plant-eaters for food along the journey and upon arrival. The timing is often very tightly orchestrated. Migration happens at just the right time for food to be available. In turn, having the proper food to eat along the journey and on the breeding grounds is key to the birds' breeding success. If there is a timing mismatch, body condition during migration and reproduction might not be ideal, which could affect individual animals' health and productivity and the health and even survival of populations as a whole.

Birds aren't the only animals that rely on the timing of green-up. Caribou and reindeer are famous for the long migrations they undertake. In early spring, the pregnant cows start leaving winter pastures for the herd's traditional calving grounds. Their migration is timed so that they arrive on the calving grounds at a time when the vegetation is green and lush and full of the nutrients they need to feed themselves and provide milk for their calves. If green-up comes early or late, both cows and calves are at risk.

Monitoring Green-up

Green-up is so important to life in the Arctic that scientists go to great lengths—and heights—to study it. Since the early 1980s, they've been using satellite imagery to track changes in vegetation across the Arctic and around the world.

Their most common tool is the normalized difference vegetation index, commonly called NDVI. It's simply a way of turning the data collected from the images into a measurement of the concentration of green leaf vegetation, essentially how green and dense the plant growth is. Using this technique, scientists have been able to track and date green-up around the Arctic.

What they have seen is a lot of change. During the period 2000-2010, the NDVI showed that the growing season increased in much of the Arctic and sub-Arctic, particularly in Eurasia. Spring green-up in Eurasia occurred on average 15.2 days earlier than green-up in North America, and the end of the growing season in Eurasia occurred on average 13.6 days later than in North America. Those changes appear to be linked to generally increasing temperatures in May and September, due to global climate change.

Animals in Spring

Some Arctic animals are active all year, but most life kicks into high gear in the spring. Small animals emerge from beneath the snow, and larger animals wander back from the ice or struggle out of their dens. Birds that flew south months ago fill the skies again, and fish return to the rivers. Insects creep and crawl and buzz.

Some animals emerge from hiding in spring. Most insects spend the winter as eggs or cocoons, but a few survive as adults, including the big, slow-moving mosquitoes that appear early in spring. They are all females. In fall, they store up fat—about 10 times as much as usual—and hide in crevices or old burrows to wait out the cold. Their body processes slow down, and they simply don't move until temperatures rise again in spring. Then they crawl out of their hiding places and buzz around early flowers in search of nectar. They also buzz around mammals in search of a blood meal to nourish their eggs.

Spring tempts some very different animals out of hiding: polar bear families. Most polar bears roam the ice all winter, but not pregnant females. They dig dens in snowdrifts near or even on the sea. That's where their cubs are born in the den and spend their first few months. Mother and cubs emerge from the den in March or April, and the mother goes in search of fresh food for her growing family. Polar bears eat roots and vegetation in the spring, as well as meat.

A few animals do more than hide themselves away for the winter. They **hibernate**. And hibernation is much stranger than just going to sleep. It involves an extreme physiological change.

The Arctic ground squirrel is one of the Arctic's few true hibernators. It hibernates for up to eight months of every year, curled up in its snow-covered burrow. During that time, its body temperature—normally about the same as a human's—drops to

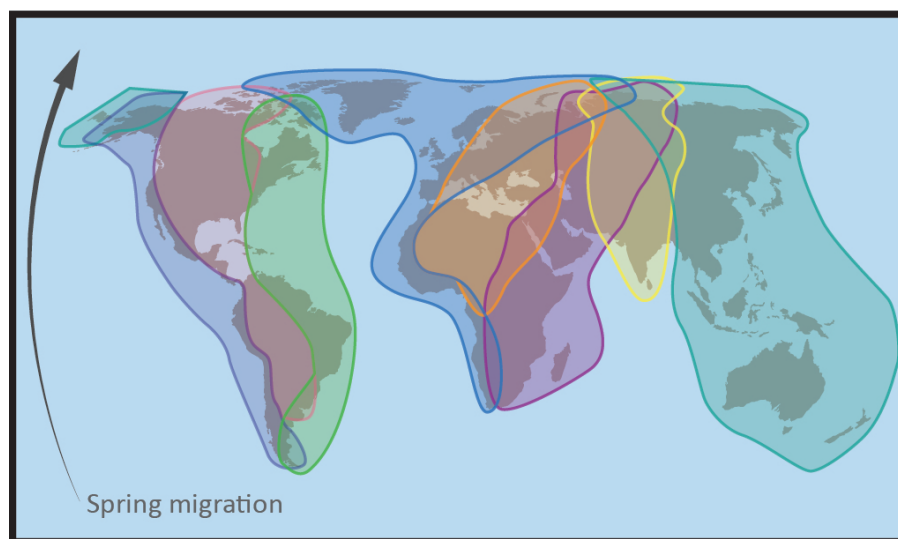
just below freezing. But the squirrel doesn't freeze. Every couple of weeks, it shivers for more than half a day to reheat its body. Then, it settles down, without ever waking up, and its temperature drops again.

Ground squirrels start waking up in late April—first the males and then, a week or two later, the females. Scientists aren't sure what wakes them up, but one possibility is that they sense the return of sunlight, even in their underground and under-snow burrows. At first, they eat the vegetation they stored in their burrows in the fall. As soon as the snow melts, though, they head in search of the fresh green leaves and seeds of spring, and in search of a mate.

Instead of hiding away during the Arctic winter, some animals just head south. Then, in spring, they **migrate** back north to feast on spring food and raise their young.

Migratory Bird Flyways

- | | |
|-----------------|-----------------------------|
| ■ Pacific | ■ Mediterranean / Black Sea |
| ■ Mississippi | ■ West Asia / Africa |
| ■ West Atlantic | ■ Central Asia / India |
| ■ East Atlantic | ■ East Asia / Australasia |



Millions of birds migrate north to the Arctic each spring. Some even travel from the other end of Earth. And every year, they take the same route their parents and grandparents took, following one of the great migration flyways shown on this map.

The Arctic tern is the world champion of migration. It flies from one end of Earth to the other, twice a year. Arctic terns spend the northern winter in Antarctica and the summer in the Arctic. That's a round trip of more than 70,000 km, on average. Over a lifetime, each bird flies a distance equal to three return trips to the moon.

Another long-distance traveler is a rusty-colored little shorebird, the red knot. After spending the winter in Africa or as far as the southern tip of South America, red knots fly about 15,000 km to nest in the Arctic. They travel in large flocks, stopping roughly every 1,500 km to feed and store up energy for the rest of their long journey.

Not every migrating animal goes south for the winter. Beluga whales live in Arctic waters all year round, but spring is migration time for some of them too. The whales spend the winter in patches of open water near the pack ice. As the ice melts in spring and summer, opening up shallower waters, many belugas move to summer feeding grounds along the coast and in estuaries. Some belugas even swim up rivers, chasing migrating fish. Rivers are also a safe place for beluga calves, out of reach of the killer whales that would love to eat them. A few belugas have been found hundreds or even thousands of kilometers from the ocean.

Spring is the season of new life, of **reproduction**. Arctic terns and red knots, Arctic ground squirrels and mosquitoes—all of them are in a hurry to meet, mate and produce young.

The thick-billed murre doesn't migrate as many birds do. And, unlike most birds, it doesn't even bother with a nest. Thick-billed murres are diving birds that spend their whole lives in the Arctic, mainly on the open ocean. They can dive as deep as 200 m and stay underwater for more than three minutes. In spring, they travel fairly short distances to seaside cliffs. There they settle in huge colonies to lay their eggs and raise their chicks. They lay the eggs directly on narrow ledges above the sea, with no more protection than—sometimes—a few pebbles arranged to keep the egg from rolling off the ledge.

The Arctic's reindeer and caribou spend their whole lives in the north too, but they migrate across large territories, especially to reproduce. Their calves are born over a short period in May or June, but before they're born, their mothers make a long journey to their herd's traditional calving grounds. All across northern North America and Europe, the pregnant cows start their journey as soon as the snow starts to melt. They might travel 20 km a day on a journey that might be hundreds of kilometers long. They go back to the same place year after year because it provides what their calves need for a good start in life: fresh green vegetation so their mothers can produce plenty of milk, not too many predators, and fresh breezes to blow away the clouds of biting insects.

People in Spring

Spring is a time of change for people too. Long hours of sunlight and the new warmth in the air tempt people outside. Indoor games give way to outdoor games. Snow machines give way to cars, bicycles, and boats. The ice is no longer safe for travel, and snowy roads turn to mud. You can fish from land or from a boat, instead of from the ice. Animals migrate and aggregate, bringing changes in hunting availability and opening up hunting grounds. Foraging for fresh foods can begin, after a winter of eating store-bought or preserved foods. Just like other animals, human activities are linked to each of the processes of spring.

Spring and Environmental Change

Spring in the Arctic is changing because of climate change. And those changes themselves are having further impacts on the global climate.

Earlier snow-melt means more of the sun's radiation is absorbed by the bare, dark ground, rather than bouncing back off the white snow. This is a consequence of increasing temperatures, but it also adds to the temperature increase. This feedback effect is one of the contributing factors to the acceleration of climate change.

One of the consequences of a longer growing season, due to climate change, is an increase in shrub cover. An earlier spring gives the dwarf trees and shrubs of the Arctic longer to grow. As a result, shrubs are getting taller and more dense across much of the Arctic and sub-Arctic. This has consequences for the mix of plant life, as some plants get crowded out or shaded by the shrubs. It also creates another feedback effect, as the dark branches of the shrubs stick up above the snow in winter and absorb more heat, reducing the reflectivity of the snow.

Changes in the timing of green-up can have profound impacts on many species that emerge or migrate in the spring.

The emergence of the Arctic woolly bear caterpillar (see *Life Linked to Tundra*, another guide in this series) is timed to the greening of Arctic willow. What happens if the willow leaves and buds emerge weeks earlier than in the past?

Many migratory birds depend on specific plants or insects to feed them during migration and at their nesting sites. If the timing of the availability of those plants and insects changes, will the birds be able to adapt?

Many caribou and wild reindeer herds around the Arctic are in decline. Historically, caribou and reindeer numbers have fluctuated, but this broad decline has been linked by researchers to both climate change and industrial disturbance from resource extraction operations. Further, with the development of roads to service industrial development, the herds have become more accessible resident and non-resident hunters alike, increasing the hunting pressure on already-struggling populations. Will they be able to adapt sufficiently to survive?

3 Equipment for Exploring Spring

If you want to make the most of a spring field trip to a pond, here's a general list of useful equipment. Any special equipment needed for the activities in the next section of this manual is listed with the activity.

Basic gear

- **Notebook and pen or pencil:** Record field trip date, time of day, weather conditions, location. The notebook can be used to record details of a specific project or activity, but it can also be used to make notes and sketches of things you observe. If you want to identify a plant or animal later, a few notes about its features and a quick sketch will make that a lot easier.
- **Short ruler:** When photographing a small thing, such as a caddisfly larva case, place it beside a small ruler with clearly visible markings. That way you will know exactly how big it is.
- **Magnifying lens:** Any kind of magnifying glass will make it easier to see the details of plants and small pond animals.
- **Water:** For thirsty explorers.

Optional

- **Binoculars:** Can be heavy and expensive, but they make it much easier to observe and identify birds and animals without disturbing them. That's especially important during nesting season. On a field trip, several people can share one set of binoculars.
- **Meter stick:** To measure snow or water depth. Make sure it's one that can survive getting wet and muddy.
- **Thermometer:** To measure water and air temperature.
- **String and 4 tent pegs or short sticks:** Helpful to mark out plot areas to examine in detail.
- **Compass:** Direction is often an important factor in where and how vegetation grows or where birds arrive from, so it's useful to be able to tell directions, even on an overcast day. It also helps you avoid getting lost!
- **Field guide** (a book or a person): A portable collection of expert information. Usually we think of a field guide as a book, but it could just as easily be a person who knows about pond life (a scientist, an elder, someone who works on the land) and is willing to join the field trip.
- **Camera:** Useful for recording species to identify later.
- **Snack:** For hungry explorers

4 Activities for Individuals and Small Groups

4.1 EXPLORING TRADITIONAL ECOLOGICAL KNOWLEDGE

Goal: To gather knowledge from within the community about spring in your area.

Location: In the community.

Background information:

Traditional ecological knowledge is a way of knowing about the natural world that does not come from scientific studies. Traditional ecological knowledge is collected from users of the land within your community such as elders, hunters, naturalists, teachers, grandparents and any other community member that has a knowledge of the ecosystem around you.

The climate is changing in the Arctic, much faster than elsewhere on the planet. These changes mean that different species are able to live in the Arctic than used to, and some species that have always lived there are now having a hard time. Changing ocean currents mean that some types of fish are coming further north. Plant communities are changing, with different plants and plants coming up earlier. Changes in sea ice are forcing some marine mammals to go where they didn't have to before.

Questions to consider:

Go out in the community and ask the following questions to learn about how this is affecting your area:

- What are the first signs of spring in this area?
- What plants and animal species do you remember being the first to appear in spring?
- Have you noticed any changes lately in the species that come north for the summer?
- What are your favorite things about spring?

4.2 SPRING FORAGING

Goal: To discover the wild foods that were important in your area as the seasons changed.

Location: In the field and in the community.

Background information:

Spring is a time when the first fresh foods were available after a long winter of eating stored foods. Are there people in your community that live off the land, or used to when they were children? What did spring mean to them?

Instructions:

Ask community elders, grandparents or hunters about what local foods they associate with spring. Look for local history books and guides to edible plants in your library. Find someone who knows about local wild foods and can act as a guide, and go on a spring foraging expedition. (But be careful not to overharvest and spoil the foraging for others, including animals.)

Questions to consider:

- What are the first fresh foods to be found in the wild after the winter?
- How does hunting and fishing change in the spring?
- What plants can you eat that come up in the spring?
- Have you noticed any changes in spring foods that are available at this time of year?
- Do you have any recipes to cook wild spring foods?

Write the questions and answers in your spring journal. If there are people in the community that can share their wild food recipes, try organizing a pot luck dinner so everyone in your class or group can sample these foods!

4.3 SPRING BIRD WATCH AND BIRD COUNT

Goal: Go on a birdwatching expedition.

Location: Field

Equipment:

- Spring journal
- Binoculars (can share a pair)
- Bird identification book
- Expert human guide, if possible
- *Life Linked to Spring Field Guide*

Instructions:

Head out for a walk. As you go, take note of each bird you hear or see, counting each individual. Take care not to count the same bird several times. You might want, also, to make note of where you saw the bird. In town? Near the water? In open country?

Along the way, stop frequently to listen. Avid birdwatchers and bird counters learn to identify birds by their song. If you hear a song make note of it in your journal. If it's a bird you know, write its name. If you don't know what bird it is, write a creative description of the song—maybe something like “sounds like Tra-le DA” or perhaps “loud screech.” Then when you hear another bird making that sound, you can put a tick next to it to count another of that species.

Any birds that you see can be counted and identified with the help of your human guide or a bird guidebook. When it's time to head back or stop for a snack, count your birds and how many you found of each species. If you do this activity again in a few weeks, you might find completely different species!

Questions to consider:

- Where did you find the greatest number of birds?
- Where did you find the greatest variety of birds?
- What kind of terrain seems to attract the most birds, and why?
- Could you tell what the birds were eating?
- Could you tell if there might be nests nearby?

4.4 HUNTING FOR SIGNS OF SPRING WITH THE SENSES

Goal: Experience spring with all the senses.

Location: Field

Equipment:

- Spring journal
- Pen and/or pencil
- *Life Linked to Ponds* Field Guide

Instructions:

When you see the first signs of spring, you know the long days of winter are coming to a close. Do you see it yet in your neighborhood? Go out for a slow walk, and bring your journal. Take frequent breaks; maybe even sit down. Close your eyes. What do you hear? Take a deep breath. What do you smell? Gently touch and feel the plants that are emerging. Do they have hairs on their leaves or stems? Are they soft or rough? Are their edges sharp or smooth?

In your journal make a section for each of the following senses: Look, Touch, Smell and Sound. Then write at least two things under each category. You might lay it out in a table like the one below.

Look	
Listen	
Touch	
Smell	
My favourite sign of spring is:	

Questions to consider:

- Do you notice different things when you use different senses?
- Ask your friends and family what their favorite spring things are. Are they the same as yours?

5 Activities for Larger Groups and Classes

These activities can be used on their own as stand-alone activities if you are short on time, or they can be used to structure a full-day or half-day field trip. Pick the activities that appeal to you, and that you think will work best for the age and size of group you are working with. Some activities can be done as a follow-up in the classroom, after returning from the field trip. As always, ensure your group is dressed appropriately for the weather, and that they have snacks or a lunch with them if you to eat in the field.

These activities are meant to be a fun way to get children outside and interacting with the natural world. Get outside, get active and get exploring!

5.1 EXPLORE TRADITIONAL AND LOCAL ECOLOGICAL KNOWLEDGE

Note: This activity is equally suitable for individuals and small groups. It is included here because it lends itself well to classroom use, where a variety of learning areas (language skills, writing, art, co-operative group work, mathematics, etc.) can be combined in a single project.

Goal: To record observations of the progress of spring.

Location: In the field, in the classroom, at home.

Background information:

Keeping a nature journal is a great way to track your discovery of spring in the Arctic. There are many ways of knowing that spring has come to the Arctic. Snow and ice begin to melt, the sun gets warmer, flies come out, small flowers bloom, birds fly up from the south, plankton and algae bloom in the water and mammals, such as polar bears, whales and caribou, are seen near human habitations.

Scientists use field journals to take notes of anything interesting they see on expeditions. Your journal is a chance to draw, identify and write about interesting plants and animals that you encounter as you explore what spring looks like in your area. You can use art, pictures, words and more to show what spring means to you and to your region.

Equipment:

- An empty journal, notebook or sketchbook
- Pencils (coloured are nice to have for drawings)
- Binoculars, magnifying lens, guidebooks, camera (option)

Instructions:

The first thing to do is to get outside! A nature walk is the best way to begin your nature journal and get inspired. Make it a goal to slow down. You will see more this way. Pay attention to shapes, textures, movement and colors. Close your eyes and listen. Do you hear birds, or the buzzing of insects? Take a deep breath. What does

spring smell like? Find something that catches your eye and study it. You can start sketching and recording right then, or take photos to examine later.

You might want to take some samples of plants to dry and stick in your book, but ask a grown up first to make sure they are not delicate or rare species that would be harmed by collecting them. If you do take samples, just take a small one and make sure people in your group take things from different plants and different places, not all in the same area.

Write notes about where you walked, what the weather was like and any birds, insects and animals you saw. Get creative! Other things you might want to add to your journal include:

- Flowers: you can press them, sketch them, glue your own photos into the journal, and draw a diagram of them with the help of a botany book.
- Leaves: you can collect a few leaves of different shapes, textures and sizes to show the diversity of plant life.
- Rubbings and stampings: You can get crafty with leaf rubbings and stamping using rocks, sticks, bark and flowers.
- Writing: You can write observations, poetry or even short stories based on what you have found.

Every person will notice and be inspired by different things when they are out in nature. There is no wrong way to create a spring nature journal! If beautiful pebbles and plants peeking through the snow catch your eye, include them. If you see an interesting bird or beetle, draw it or write a poem about it. If you want to know more about something you saw, find a guidebook to learn more about it and write some of that information in your journal. Or find someone in your community who can tell you more about the thing that interests you. Get creative and get exploring!

Questions to consider:

- When you slowed down and listened, did you notice more living things than on your usual walks?
- In what ways are the organisms you saw connected to each other?
- In what way are you connected to the ecosystem you were in?
- Are there other places in your area you would like to explore with your nature journal?

5.2 SPRING BIOBLITZ!

Goal: To assess the springtime biodiversity in your area by collecting data in a consistent manner.

Location: Classroom and field.

What is Bioblitz?

A biodiversity blitz, or **bioblitz**, is a tool used to assess the biodiversity of an area and get an idea of the species present. Biodiversity is the variability among living organisms, including the diversity within species, between species and of ecosystems. A simple measure of biodiversity is the number of species occupying an area—which is what you'll be discovering in your spring bioblitz.

A bioblitz is a form of **citizen science**. Citizen science is based on the principle that many eyes are better than only a few. So, rather than having one or two employees gather data, it uses a whole community to collect more data, while encouraging citizens to learn about and care for their natural spaces. You can organize your spring bioblitz as a whole-community event or just with your group.

During a bioblitz, participants record every species they encounter and the number of organisms in each species. This data can be used to compare two different areas, or to monitor change in one area over time. Depending on the size of your group, you may choose to divide the bioblitz groups up by organism type. In smaller groups, students can be assigned one of the following organism types to bioblitz: birds, mammals and signs of mammals (including birds), plants, fungi and lichens, and insects.

A bioblitz is a great way to get people involved and aware of local ecosystems, but it is also serious and valuable science. Governments, environmental managers and conservation organizations often use bioblitz data. When done consistently every couple of years, bioblitzing provides a basis to measure change. If there are any rare or endangered species, it provides a way to keep track of changes in their populations.

Background information:

Spring in the Arctic is a special time of year. After the long dark winter, species are emerging and returning to the north. The blanket of snow and ice slowly melts, revealing early plants that provide the first fresh foods after herbivores have subsisted on dried or dead plants, wood and lichens all winter. These nutrient-dense plants bring migrating birds huge distances up to the Arctic to feed and breed. An area that, a few months ago, supported only a handful of animal species might now be playing host to a surprising amount of life. Doing a spring bioblitz will challenge students to discover just what organisms are using your area as their spring home.

The Arctic region is currently undergoing significant and rapid environmental change due to pollution, mining, oil and gas activities, changes in climate, human use of freshwater and invasive introduced species. There is a big gap in knowledge about many Arctic species and ecosystems. Without **baseline** knowledge of your area, you won't know how or when it is changing. An activity like a bioblitz provides that

reference information. You will learn what lives in area, what species are present and in what concentrations. This knowledge can be used to monitor change over time and to give you an idea of the health of your local ecosystems.

Equipment:

For each working group, approximately four students

- Jars, containers or plastic baggies for samples
- Binoculars
- Magnifying glass
- *Life Linked to Spring* Field Guide
- Field guides to plants, animals, insects and fungi (or a knowledgeable person as a guide)
- Activity sheets in Appendix B

Instructions:

By giving students a time limit, the bioblitz becomes an exciting challenge to find as many life forms as possible in the time allotted. Depending on the age of the group, you may want to have them scouring the area for anywhere from 30 to 90 minutes. Be sure to explain to the group that Arctic ecosystems are very slow to recover from disturbances, and that being careful not to damage plants will help maintain the health of the ecosystem. If they wish to collect samples to examine and identify later, make sure it is one small part of a plant, and that students collect samples from different areas rather than in one concentrated area. This will help to minimize the impact on local vegetation.

Choose an area for your bioblitz study. More diversity in life is likely to be found in areas where there is some variation in habitat. Divide students into small groups, ideally of four or fewer. Ask each group to scour the chosen study area for every living thing they can find and record the information on their data sheets. If they start with one small section of land, they can try to find as many different kinds of plants as possible in their chosen area before moving on. Using binoculars if necessary, students record all the birds seen and heard. Even signs of small animals, such as tracks or droppings, can be recorded. Make sure to stress that notes and drawings should be made if a student doesn't know what a plant, animal or animal sign is. They can be checked later and possibly identified. Have guidebooks and/or experts on hand to answer questions and help in identification. At the end of the time limit, gather all of the data sheets for later discussion.

Using the data:

If you can enter the data into a computer program or spreadsheet, it will be easier to see patterns and it will help classes in future years to see if changes are happening. But no matter how you look at the results of the bioblitz, the records will reveal a lot about your local area. Students may be surprised to learn just how many different organisms are there when you look closely. You can lead a discussion with your group about what they found, what they were surprised to find and what they expected. Students can also try to predict what changes might take place in the future.

Questions to consider:

- Were there more or fewer different species than you expected?
- People think of the Arctic as barren compared to most areas in the world. Do your results show otherwise?
- Were there any organisms that were new to you?
- In what kind of location or situation might it be useful for scientists to have data collected this way? Is the Arctic a good place for citizen science?
- Do you think your group got a good 'snapshot' of what is living in the area? Were there some things you could have worked harder to find, or things that were difficult to identify?

5.3 BIODIVERSITY BINGO

Goal: To document the range of living things in your study area.

Location: Field

Background Information

Biodiversity is the variety of living things found in a given place. It is important because it takes a variety of life forms, big and small, to create a healthy ecosystem. In spring the variety of life that is active and visible in the Arctic increases hugely. Animals and plants that may have been hibernating, dormant or living beneath the snow emerge. Many species migrate north to feed and reproduce. This fun activity explores the biodiversity of life in the local area.

Equipment:

- Biodiversity Bingo activity sheet
- Pen or pencil
- Clipboard or other hard surface to write on
- Field journal
- Magnifying lens (if available)

Instructions:

Discuss the plants and animals you think might be living in the area. What species from the *Life Linked to Spring* Field Guide live in your part of the Arctic? What other species can you think of?

Go over the items on the bingo board. Ask students for examples of animals with 8, 6, 4, and 2 legs. If necessary, explain that spiders have 8 legs, insects such as flies and beetles have 6 legs, and birds and people both have 2 legs.

Explain the rules of bingo: cross off items when you see them, and shout out "Bingo!" when you have crossed off a row of five. Each time the students find something to cross off, ask them to make a note of what they saw in their field journals. Then when someone gets a Bingo!, they can tell everyone what they found to make a line.

Students don't need to pick plants or pick up insects to prove that they've found them. They can just observe and check them off the bingo board. They may find things like insects or worms hidden in cracks, in the grass or in the soil. It's okay to dig around and get dirty!

When the game is over, lead a discussion about what was found.

Questions to consider:

- Which items were easiest to find? Which ones were hardest?
- How many plants and animals did you name before the game? How many different living things did you find during the game? Was what you found a surprise?

Did you know there was so much biodiversity in this area before you played Biodiversity Bingo?

Appendix A: Species Information

This section provides further information about the principal species mentioned in the *Life Linked to Spring* field guide. The information is presented in the same order that it appears in the field guide.



Arctic Poppy

(Scientific name: *Papaver radicum*)

Arctic poppies are common across the Arctic, and their bright flowers stand out on the tundra. They are one of the first green plants to pop up in the spring because they stay green all year, even under the snow in the winter! Their flowers are on long stems that turn so the flowers face the sun. They look very similar to Iceland poppies and other garden poppies, so they are easy for most people to recognize.

Physical description:

- Cup-shaped white or yellow flowers with four petals.
- Flowers on a long thin stem, up to 10 cm long.
- Each flower has an oval-shaped seed capsule with radiating “spokes” on top.
- Leaves and stem are covered in dark hairs.
- Long, thin, lobed leaves grow in a dense rosette pattern around the flower stems.

Habitat: Prefer areas where vegetation cover is open, such as rocky slopes. Grow in almost all High Arctic habitats except wetlands.

Range: Circumpolar distribution in Arctic and alpine climates. One of the northernmost flowering plants in the world, Arctic poppies can be found north of the 82nd parallel.

Reproduction: Bloom in June and July. Self-pollinating flowers bear thousands of fertilized seeds with a low germination rate.

Life span: Perennial plants that return each year.

Ecosystem functions:

- Dense plant cluster provides shelter for small mammals and insects in Arctic tundra.
- Parabolic flower shape creates heat-absorbing center that attracts insects to the warmth.

Impacts of climate change:

- The Arctic poppy is vulnerable to temperature increases, so the plant and its habitat could be threatened by global climate change.

Interesting facts:

- Poppy flowers do not produce nectar, but are visited by many pollinating insects searching for nectar.
- Arctic poppy flowers always turn to face the sun. In the summer, when the sun is out 24 hours a day in the Arctic, poppies follow the sun around the clock.
- Arctic poppies have what is known as “wintergreen” leaves. These are semi-evergreen leaves that develop in late summer and survive through winter without withering. They remain green and can start photosynthesis as soon as temperatures begin to warm in spring. They wither and die once the new spring leaves grow and take over.
- Because Arctic poppy flowers are shaped like a bowl, when the sun shines on them, the air inside the flower becomes several degrees warmer than outside. Insects take advantage of this by basking inside the flower.
- There is another species also known as Arctic poppy: *Papaver laestadianum*. It is found only in northern Scandinavia and is extremely rare.



Dwarf Birch

(Scientific name: *Betula nana*)

One of the most common and useful Arctic shrubs is dwarf birch. Ptarmigan eat its buds and catkins (fruiting bodies). Insects swarm to it for nectar, and small birds eat the insects. People use dwarf birch for firewood, bedding and tent flooring. A bundle of birch twigs also makes a handy broom.

Physical description:

- Leathery, round to egg-shaped leaves with rounded teeth on the margins.
- Leaves are darker green on upper surface, and become red in autumn.
- Bark is smooth dark brown to gray and may have fine hairs on new growth. Older growth may have warty resinous glands.
- Male flowers are drooping yellow-green catkins 2.5 to 5 cm long.
- Female flowers are upright reddish-green catkins 2.5 to 5 cm long and become cone-like as they mature.
- Plants grow up to 1 m in height, but can be much smaller, depending on environment.

Habitat: Arctic and alpine tundra, acidic rocky slopes and barrens, muskegs, peat bogs, stream banks and open subalpine summits. Dwarf birch prefers wet, well-drained sites with nutrient-poor and acidic soils.

Range: Arctic and cool-temperate regions of Greenland, Iceland, northern Europe, northern Asia and northern North America. Also found in high-elevation alpine sites in Scotland and the European Alps.

Reproduction: Plants have both male and female parts on one plant. The male and female parts are called catkins. Tiny seeds with crescent-shaped wings are wind-dispersed. Dwarf birch can also reproduce vegetatively, with new shoots growing from underground roots.

Ecosystem functions:

- Ptarmigan eat dwarf birch buds and catkins almost exclusively.
- Many species of insects rely on dwarf birch for food and shelter.
- Eaten by mammals such as caribou, Arctic hare and Arctic ground squirrel.

Impacts of climate change:

- Dwarf birch can take advantage of warmer temperatures and increased nutrient availability by increasing the height and density of their canopy. This may reduce the growth potential of competing plants as they have less access to sunlight.

Interesting facts:

- Just-unfolded birch leaves are sticky on the underside, and Inuit children have been known to stick them on their ears to make “earrings.”
- Young leaves can be added to salads for flavoring.
- A tea made of dwarf birch leaves was traditionally used to relieve stomachache.



Purple Saxifrage

(Scientific name: *Saxifraga oppositifolia*)

This tufted, cushion-forming plant brings a welcome splash of color to the Arctic tundra in early spring. It is often the first plant to flower in the spring and is a sure sign of the changing seasons. This pretty plant has edible purple flowers that can be used by people as well as animals.

Physical description:

- Tiny, overlapping gray-green leaves look like scales.
- Small lilac-to-magenta-colored flowers with five petals. Occasionally a white flower is seen amongst the patch of purple flowers.
- Solitary flowers grow on short, trailing stalks.
- Plant growth form is usually a low, rounded cushion, but can also be sprawling or trailing and less compact.
- Low-growing plants up to 5 cm tall are well adapted to harsh Arctic conditions.

Habitat: Can tolerate extreme conditions in the high Arctic where few other plants can survive. Likes to grow on rocks, in crevices on cliffs and in gravelly areas.

Range: Circumpolar across the Arctic, as well as high-elevation mountain habitats as far south as the European Alps and Pyrenees, Rocky Mountains and northern Britain.

Reproduction: Purple saxifrage requires less than two months from first flowering until seeds ripen. This allows them to grow in the High Arctic despite short summers. Flowers can cross-fertilize or self-fertilize. Insects such as flies, bees, moths and butterflies assist cross-fertilization. If no insects pollinate a flower, the male flower parts will turn inward to pollinate itself. This produces fewer and less viable seeds than cross-pollination.

Ecosystem functions:

- Purple saxifrage grows in often harsh conditions, in environments that are particularly sensitive to disturbance.
- The flowers are high in vitamin C and provide an early spring food source for small herbivores, insects and people.

Impacts of climate change:

- Experiments done to simulate climate warming suggest that saxifrage will not be able to effectively compete with plants that flower earlier in response to more heat. As a result, purple saxifrage populations in the Arctic may be negatively affected by climate change.

Interesting facts:

- Purple saxifrage, along with Arctic poppy and a few species of mosses, liverworts and lichens, can be found on Greenland's Kaffeklubben Island, the most northerly location plants are found on Earth.
- In Inuit culture, the full blooming of the plants was an indication that the caribou were calving out on the land.
- As a good source of vitamin C, the sweet flowers are used by people in villages where berry picking is not prevalent.



Mosquito

(Scientific name: Family *Culicidae*, more than 3,000 species)

When we think of mosquitoes, we think of itchy, red mosquito bites. These little flies are an annoyance most people on earth are familiar with, and the Arctic is no exception. In fact the Arctic has higher concentrations of mosquitoes than most places in the world. This is because there are so many small ponds in the Arctic—perfect habitat for the aquatic mosquito larvae. As irritating as they may be to us, mosquitoes play an important role in Arctic ecosystems. They are an important food source for many organisms. However, we aren't the only ones that might prefer not to have mosquitoes around. Caribou herds congregate on windy mountaintops and in coastal areas in mosquito season to get away from

them. They can be bad news for large mammals like muskoxen and caribou, forcing them away from food and causing the animals extreme stress.

Physical description:

- Mosquito bodies have three segments, the head, thorax and abdomen.
- The aquatic larvae have a well-developed head with bristle-like mouth parts for feeding. They have a large thorax, no legs, and a segmented abdomen.
- Adults have compound eyes and long, segmented antennae. They have a long proboscis, the mouth part used for feeding.
- Adults have three sets of legs and one set of wings attached to the thorax.
- The abdomen, which is used for food digestion and egg development, can expand considerably.
- Adult mosquitoes vary greatly in size, with the largest females measuring up to 16 mm in length.

Habitat: Larvae live in shallow still water. Adults are terrestrial flies.

Range: Extremely widespread around the world, with many species in the Arctic. There are more than two dozen species in Alaska alone.

Food: Larvae filter-feed particles (algae, bacteria, other microbes) out of the water. Adults drink nectar from flowers. Only females drink blood, which they use as a source of protein to develop their eggs. Females can develop eggs without a blood meal, but fewer eggs are produced.

Reproduction: Females lay eggs near the margins of lakes, ponds or puddles.

Life span: Varies by species and geography. Larval stage usually lasts a few days to a couple of weeks. Adults can live from weeks to several months. Adult females of some species overwinter.

Ecosystem functions:

- Larvae are food for other pond insects.
- Many fish eat mosquito larvae.
- Migrating birds eat the adult mosquitoes that gather in thick clouds in the Arctic.
- Mosquitoes pollinate plants, just as bees do—including rare Arctic orchids.
- Mosquitoes sometimes transmit diseases to the animals they bite.
- Mosquitoes can affect the seasonal movements of some Arctic species, such as caribou, which congregate on windy hilltops or in coastal areas to escape harassment during insect season.

Impacts of climate change:

- Warmer water allows the larvae to grow faster and hatch sooner, so it could lead to an increase in mosquito numbers and a longer mosquito season.
- Some species will be able to move farther north as the climate warms, potentially bringing blood-borne diseases with them.

Interesting facts:

- Female mosquitoes can consume 1-5 times their body weight in blood, which they use as a source of protein to develop their eggs.
- The mosquito's buzzing sound is made by their wings. Female mosquitoes are larger, so they flap their wings slower, changing the sound. Males can follow the sound of a female's buzzing in order to mate.
- The itchy bump of a mosquito bite is caused by an allergic reaction to the mosquito's saliva.
- There are no mosquitoes in Iceland or the Faroe Islands.



Polar Bear

(Scientific name: *Ursus maritimus*)

The iconic Arctic species, polar bears, are well known for their reliance on Arctic sea ice. This unique white bear is a marine mammal that spends time on land, on ice and in the water. They rely on sea ice to hunt their favorite food – seals. Polar bears are born in snow caves and don't see daylight until they are a few months old. The mother goes all winter without eating, using her fat stores to feed her cubs and keep herself alive. Polar bears are very vulnerable to changes in sea ice, and climate change is predicted to have devastating impacts on their populations.

Physical description:

- Heavy-set, bob-tailed mammals with five clawed toes on each foot.
- Long body and neck with a long, narrow head.
- Very small ears.
- Thick, long creamy white fur, yellowish white in summer.
- Coarse, hollow hairs for insulation. Black skin absorbs heat.
- Males are one-fourth to one-third larger than females.
- Average length of a male polar bear is 2 to 3 m.
- Average weight of a male polar bear is between 420 and 500 kg.

Habitat: Preferred habitat is the southern, broken edge of the Arctic pack ice. They avoid solidly frozen sea ice and the open sea. Changing ice conditions and lack of ice are driving polar bears onto land more frequently in recent years.

Range: Circumpolar distribution, inhabiting all the Arctic seas and coastlines. Most common in northern Canada, Alaska, Greenland and along the Eurasian Arctic coast from Spitzbergen to Wrangell Island. Occasionally, rare stragglers have reached Iceland.

Food: Polar bears are the most carnivorous of bear family. Seals and walrus are the most common food, when available. In summer, foods often include fish, mussels, crabs, starfish, carrion, and the eggs and nestlings of waterfowl and cliff-dwelling

seabirds. Stranded whale carcasses attract polar bears, who will group together to feast on the rich blubber and meat.

Reproduction: Breeding season is from April to May. Gestation lasts 228 to 254 days. Cubs are birthed in winter dens dug into snow banks and ice ridges. Average litter size is two cubs, and ranges from one to four. Cubs remain with their mother until after the start of their third year of life.

Life cycle: Average of 15 to 18 years.

Ecosystem functions:

- A top, apex predator in the Arctic marine and terrestrial ecosystems.
- Regulate prey populations, such as seals.
- Increased predation on seabirds is having a detrimental effect on those populations.
- Hunted for food and fur in North America and Greenland.

Impacts of climate change:

- Polar bears rely on sea ice for their survival.
- Sea ice is currently projected to decrease in the Arctic by 50-100% in the summer. Annual ice is projected to decline 10-50%.
- Lack of sea ice removes polar bears' access to their primary prey source, seals.
- Polar bears need to eat the dense, energy-rich seal blubber to replenish fat stores and survive. While on land in the summer, they primarily fast and cannot survive solely on the foods they do find on land.
- Some polar bear populations are already in decline due to a lack of sea ice. Current estimates predict that in 100 years the global population of polar bears will be at less than 30% of what it is today. Others have speculated that polar bears will be extinct 100 years from now.

Interesting facts:

- Polar bears do not hibernate. Only pregnant females den for a long period in winter.
- Polar bears have black skin, which absorbs heat.
- Polar bears can go days or even weeks without eating, living on fat reserves.



Arctic Ground Squirrel

(Scientific name: *Spermophilus parryi*)

The Arctic ground squirrel is the largest of all of the American ground squirrels. It is well adapted for life in extreme conditions, and that has allowed it to survive very far north. Unlike its close relatives, the Arctic ground squirrel will not defend a territory. Instead, it lives

in a number of different burrows over its lifetime. The Arctic ground squirrel will also live in large colonies. These colonies construct large systems of burrows that can reach a length of 20 m with approximately 50 to 60 separate entrances.

Physical description:

- Mid-sized rodent with a dark, bushy-tipped tail.
- Short face with small ears.
- Reddish cinnamon cheeks, head and shoulders, with white around eyes.
- Body is tan in color with a white-spotted back.
- Head and body length ranges from 22 to 35 cm. Arctic ground squirrels farther north are generally larger than their southern counterparts.

Habitat: Raised, dry habitats where they are able to dig extensive tunnel systems and hibernation chambers. Colonies are restricted to areas free of permafrost.

Range: In Eurasia, in northeastern Siberia, with its range expanding. In North America, from the western shores of Hudson Bay to western Alaska, in mainland Arctic tundra and in open habitats of the subarctic boreal forest.

Food: Arctic ground squirrels eat a wide variety of native tundra vegetation, such as seeds, leaves, flowers, berries, leaf buds, catkins and mushrooms. They will also eat carrion. One squirrel was seen to carry a kilogram of caribou flesh to its den.

Reproduction: Mating season is in May. After a 25-day gestation period, young are born mid-June. Litter size varies from 5 to 10. The young grow rapidly and move to their own burrow by late summer of their first year.

Life span: Up to nine years.

Ecosystem functions:

- Main predators are raptors, wolverine, Arctic fox and ermine.
- Old tunnels provide habitat and refuge for other species.

Impacts of climate change:

- Resilient species with a fast reproduction rate and flexibility in food choices. Arctic ground squirrels will likely be able to adapt to climate change overall.

Interesting facts:

- The Inuit name for Arctic ground squirrels is siksik. The name comes from the short, piercing whistle the animals make.
- There are populations of melanistic Arctic ground squirrels that are all black.
- Arctic ground squirrels are true hibernators. They winter in dens up to 1 m below ground for seven to eight months of the year. Their body temperature drops to just below freezing, with their heart and lungs slowing down drastically.



Arctic Tern

(Scientific name: *Sterna paradisaea*)

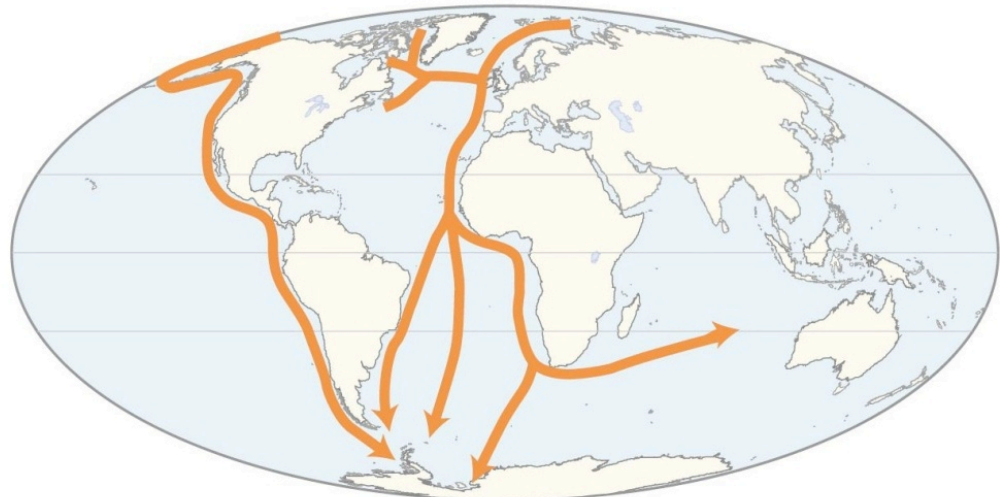
The Arctic tern is a small, slender white bird with a black cap. It is well known for its long annual migration, the longest of any animal on earth. Arctic terns small size and forked tails have earned them the nickname of “sea swallow.”

Physical description:

- Medium-sized tern.
- White, with a black cap on the top of its head.
- Long tail with a deep fork.
- Wings white with some dark coloring at the tips.
- Juveniles have brown or gray bars across the back.
- Dark red bill.
- Body feathers darken in autumn and winter, to a gray or brown color.
- Average wingspan of 65-75 cm.

Habitat: Arctic terns breed in open tundra, boreal forest or on rocky islands and beaches. They migrate far offshore, and winter on the edges of pack ice.

Range: Circumpolar, breeding in the Arctic and sub-Arctic of North America, Greenland and Eurasia. Migration routes down the west coast of North America and the west coast of Europe and Africa. Overwinter in the oceans of the southern hemisphere, generally along the coast of Antarctica.



Migration routes of the arctic tern
(Source: CAFFs Arctic Flora & Fauna - 2001)

Food: Small fish, crustaceans and insects.

Reproduction: Nests in colonies and sometimes single pairs near salt or fresh water. Nests are frequently unlined depressions in ground, rock or moss, but sometimes lined with grass. Clutches of one to two eggs are incubated for 21 to 22 days, by

both sexes. Eggs are buff to olive in color, with dark brown spots and splotches. Hatchlings remain with the parents for 21-28 days, with both parents bringing them small fish to eat.

Life span: Can live to be over 30 years old, with an average of about 20 years.

Ecosystem functions:

- Large nesting colonies have large feeding needs during breeding season, impacting localized fish populations.
- When accessible, Arctic fox feed on eggs.

Impacts of climate change:

- Warmer climate can disrupt migration patterns of migratory birds, such as Arctic terns. Spring migration occurs earlier and fall migration later in many species. This can lead to a mismatch in timing for food availability and habitat suitability along migration routes. Shifts in timing also make birds more vulnerable to heat waves, droughts and cold snaps.
- Changes in critical habitat can put birds at risk. Migratory birds are particularly sensitive to any fluctuations in climate, as timing-specific foods provide the energy necessary for long migrations. Changes in habitat, such as increased shrubbiness, could also force birds to travel farther in search of suitable nesting areas.
- Warmer weather and increased ice melt could reduce access to Arctic tern nests by Arctic foxes. The foxes often access nests by traveling across ice to colonies nesting on islands. The reduced predation could have a positive impact on Arctic tern populations.

Interesting facts:

- Arctic terns follow the sun and the summer. They likely see more sunlight than any other organism on earth.
- It takes around 90 days for Arctic terns to migrate between summer and winter grounds, a round trip of between 59,500 and 81,600 km.
- Arctic terns that live over 30 years could travel more than 2.4 million kilometers in their lives. That is the equivalent of three return trips to the moon!



Red Knot

(Scientific name: *Calidris canutus*)

Red knots, a type of sandpiper, are an example of a long-distance migratory shorebird. They rely on very specific habitats and food sources to make their long annual journey, the second-longest bird migration in the world. They are heavily studied as an indicator species for high Arctic shorebirds.

Physical description:

- Large, stocky sandpiper.
- Head and breast are an unmarked robin-red in breeding season. Red knots are gray the rest of the year. Some white markings and darker bars on belly and under tail.
- Straight, black bill is slightly longer than the head.
- Dark green, short and thick legs.
- Average of 24 cm in length, with a wingspan up to 51 cm.

Habitat: Outside of breeding season, red knots are found primarily in intertidal, marine habitats near coastal inlets, estuaries and bays. Their preferred breeding sites are in dry upland tundra. Red knots make very few stops during migration, but often congregate in habitats, such as bays or estuaries, with high concentrations of food to fuel the long journey.

Range: Circumpolar distribution, breeding in the High Arctic areas of North America, Greenland and Eurasia. In winter they migrate to marine wintering habitats in southern latitudes of South America, Africa, Europe, Australia and New Zealand.

Food: During the breeding season, red knots feed predominantly on insects, usually larval or adult flies, caddisflies, beetles, butterflies, moths and bees. They also feed on spiders, small crustaceans and worms. On arrival at the breeding grounds, few insects are available, and they will eat vegetation until insects emerge. Outside of the breeding season, they eat primarily clams, mussels and snails.

Reproduction: Eggs are laid in June and July, on dry rocky tundra at high elevations. Solitary pairs protect their nesting territory, usually nesting at least 1 km away from other breeding pairs. Nests are open, shallow depressions lined with grasses, lichens and leaves. Eggs are light olive in color, with an average of four per nest. Both parents incubate the eggs, which hatch in 21 to 22 days. The young leave the nest right away, and are able to fly by 18 days old.

Life span: Up to 13 years, but varies greatly depending on conditions.

Ecosystem functions:

- Apart from June and July when they are breeding, red knots form large colonies. These flocks can be made up of hundreds or even thousands of birds. The food demands of these large flocks may limit populations of prey species, such as clams and mussels.
- Red knots are subject to predation throughout their range. In the Arctic, Arctic fox and raptors are their most common predators.

Impacts of climate change:

- Changes in Arctic tundra ecosystem could shift food availability and reduce nesting habitat.
- Coastal habitats are likely to be impacted by sea level rise.
- Food sources and timing of food availability could be impacted, resulting in timing mismatch during migration periods.

- Severity, timing and location of storm and weather patterns are changing, potentially endangering red knots during their long migration.

Interesting fact:

- The North American subpopulation of *Rufa* red knots relies on horseshoe crab eggs found on a migratory pit stop in Delaware Bay. A past commercial fishery reduced horseshoe crab stocks, and this population of red knots is in decline.
- Red knots eat clams, mussels and snails whole. The shells are crushed in their muscular stomachs. The shells left in the scat can tell scientists what the birds have been eating.



Beluga

(Scientific name: *Delphinapterus leucas*)

Beluga whales are also called white whales, and their unusual color makes them an easily identifiable and memorable Arctic species. They are social animals, living in pods of as few as 10 or as many as several hundred. Many subpopulations of beluga whale undertake annual migration to preferred feeding and breeding grounds and away from the pack ice in the winter.

Physical description:

- Small, white toothed whale.
- Rounded foreheads, lacking a dorsal fin.
- Calves are born gray or brown, and fade to white as they become sexually mature around five years of age.
- Belugas are covered with a thick layer of blubber that can account for as much as 40% of their body mass.
- Average length is around 4 m, but can be up to 6 m long.
- Adult males average 1,500 kg while adult females weigh an average of 1,300 kg.

Habitat: Generally found in shallow, coastal waters but also venture into the deep ocean. Often found among icebergs and ice floes in the Arctic and sub-Arctic. Also found in estuaries and river basins.

Range: Circumpolar distribution, inhabiting the Arctic and sub-Arctic regions of Russia, Greenland and North America. Belugas inhabit the Arctic Ocean, the Sea of Okhotsk, the Bering Sea, Gulf of Alaska, Beaufort Sea, Baffin Bay, Hudson Bay and the Gulf of St. Lawrence. They may also be found up large rivers, such as the Yukon.

Food: Opportunistic feeders that subsist on octopus, squid, crabs, shrimp, clams, mussels, snails, sandworms and fishes. Fish species preyed on include eulachon, salmon, capelin, cod, herring, smelt, flounder, sole, sculpin, lampreys and lingcod.

Reproduction: Mating occurs in spring, usually March or April, and occurs in small bays or estuaries. Gestation lasts 14 to 15 months, with calves born primarily between May and July. Females usually give birth to one calf or, occasionally, twins. Calves nurse exclusively for at least 12 to 18 months, at which point they begin to supplement their diet with shrimp and small fishes. They continue to nurse for another year after beginning to eat solid foods.

Life span: 30 to 35 years.

Ecosystem functions:

- Beluga whales are prey for polar bears and killer whales.
- Belugas are hunted by indigenous peoples and by commercial fisheries.

Impacts of climate change:

- Climate change is predicted to impact beluga whales directly through ecosystem changes and indirectly through changes in human behavior.
- Ecological changes that might affect belugas are changes in prey populations, changes in ice conditions and more frequent predation by killer whales.
- With increased access to Arctic waters as ice melts, human marine traffic is expected to increase. This will lead to more ship strikes, disturbance from industrial and vessel noise, and exposure to pollutants.

Interesting facts:

- Belugas are known as the “canaries of the sea” because of the vast range of sounds they produce, including whistles, squeals, moos, chirps and clicks.
- Unlike most other whales, Belugas have flexible necks, allowing them to move their heads up and down and side to side separately from their bodies. It is thought that this is an adaptation to maneuver and catch prey in muddy areas and beneath ice floes.
- The name beluga comes from the Russian word “bielo,” which means white.



Thick-billed Murre

(Scientific name: *Uria lomvia*)

The thick-billed murre is also called Brünnich's guillemot. It is a colony-nesting seabird in the Auk family, and one of the most numerous marine birds in the Northern Hemisphere. Colonies can contain as many as 1 million birds nesting in high densities on sea cliffs.

The murre is medium-sized waterbird, stout, with a pointed bill. It has a white throat in non-breeding plumage. This marine bird uses its wings to swim underwater to find fish and invertebrate prey.

Physical description:

- Large and stocky member of the Auk family.
- Black and white plumage, with a long and pointed black bill. Often has a white to gray streak on bill in summer.
- Summer plumage has head, upper breast and upperparts turning brownish black to dark brown. Underparts white. Nonbreeding birds have white extending to the sides of the face and just below eyes.
- Very powerful breast muscles with a deep keel. Short, narrow wings.
- Rounded tail

Habitat: An exclusively marine bird, ranging along sea coasts and offshore on the ice edge and in open-water polynyas. During breeding season they congregate on high cliff sites.

Range: Circumpolar distribution in the Arctic and high Arctic regions of North America, Greenland and Eurasia. Breeds as far south as the Kuril Islands in Russia, Newfoundland and Labrador in Canada, and also winters off the coast of central Japan. Found in coastal waters and offshore as far as the continental shelf.

Food: Feed primarily on fish, shrimps, squid and crustaceans. They can dive over 200 m in depth foraging for food, and commute as much as 170 km from breeding colony to feed. Primary prey species varies by region.

Reproduction: Colonies aggregate in spring on sea cliffs, nesting on narrow ledges. No nest is constructed; eggs are laid on bare cliff edges and sometimes in crevices or caves. Females scrape the site to form a slight depression prior to laying, thought to prevent eggs from rolling off the cliff. Females always lay just one egg. Eggs are laid side-by-side in high density. Parents may recognize eggs by color variations. Eggs range from white to bright turquoise, with dark spots, streaks or blotches. Both parents incubate eggs and participate in the initial care of chicks.

Life span: Up to 30 years.

Ecosystem functions:

- Adults and chicks are occasionally preyed on by gyrfalcon, peregrine falcon, snowy owl, Arctic fox, and red fox. Walruses and polar bears also prey on them in the water.
- Eggs are eaten by ravens and gulls.
- Thick-billed murrelets are hunted by subsistence hunters in Greenland and northern North America. Eggs are also collected.
- Large nesting colonies require large amounts of fish. Thick-billed murrelets predate very heavily on local fish populations around nesting areas.

Impacts of climate change:

- In recent years, a lack of sea ice has led to an increase in predation on thick-billed murres by polar bears. Hungry bears have been observed climbing cliffs to get to the eggs and newly hatched chicks.
- A decrease in sea ice means an increase in ocean traffic in the Arctic. This includes traffic for the purposes of oil extraction and fisheries. This may lead to increased mortality as thick-billed murres are extremely vulnerable to oil slicks and get caught in fishing nets.

Interesting facts:

- Chicks are still flightless when they leave the nest at three weeks old. They undertake a swimming migration of up to 1000 km before their flight feathers develop. Adults often moult at the same time, leaving them flightless as well.

Once they leave the nest, only the males remain with the chicks. They continue to provide parental care for four to eight weeks after leaving the nest.



Caribou and Reindeer

(Scientific name: *Rangifer tarandus*)

Caribou and reindeer are among the largest plant-eaters on the tundra. They both belong to the same species – *Rangifer tarandus*. Generally, caribou live in North America, while reindeer live in the Arctic regions of Europe and Asia. Caribou are wild animals, but many reindeer are domesticated. There are seven subspecies of *Rangifer tarandus*: reindeer (*R. tarandus tarandus*), wild forest reindeer (*R. tarandus fennicus*) and Svalbard reindeer (*R. tarandus platyrhynchus*) in Eurasia; and barren-ground caribou (*R. tarandus groenlandicus*), Alaskan caribou (*R. tarandus granti*), Peary caribou (*R. tarandus pearyi*), and woodland caribou (*R. tarandus caribou*) in North America.

Physical description:

- Ungulates, meaning they have cloven hooves and chew cud
- Only members of the deer family in which both the males and females have antlers; bull antlers can reach 1.2 m in width
- Short, stocky body that conserves heat, and long lean legs to help them move through deep snow.
- Large, concave hooves adapted for travel through snow and for use as a scoop when looking for lichens under the snow
- Average male (across all subspecies) 167-298 cm long, 87-158 cm shoulder height, 66-300 kg; average female (across all subspecies) 105.4-234 cm long, 80-139 cm shoulder height, 51-156 kg

- Across all subspecies, male caribou larger than females by 10-50%
- North American caribou larger than Eurasian reindeer

Habitat: Most Arctic caribou and wild reindeer undertake long migrations each year, up to 5,000 km. Some, such as the Peary caribou on the islands of the Canadian Arctic Archipelago, do not migrate. Nor do the Svalbard reindeer, which live on Norway's Svalbard Archipelago.

Range: *Rangifer tarandus* are native to Arctic, subarctic, tundra, boreal and mountainous regions of northern Europe, Siberia and North America.

Food: Caribou/reindeer diet changes with the seasons. In summer, they eat a variety of tundra plants, including willow and birch leaves, sedges and grasses. In winter, the diet consists primarily of lichen, especially reindeer lichens.

Reproduction: Breeding season occurs in October. Caribou males will fight each other for the right to breed and will attempt to breed several females. Males breed with the females in best condition before breeding younger or older females. Females generally do not reach sexual maturity until they are 2.5 years old. Gestation is anywhere from 225 to 235 days, and calves are born in late May or early June.

Life span: Average of 4.5 years.

Ecosystem functions:

- Primary food source for wolves; important food source for some bears and smaller predators
- Major source of food and materials for many Arctic peoples.
- Caribou droppings spread nutrients and seeds across the tundra, playing a significant role in the growth and diversity of tundra vegetation.

Impacts of climate change:

- Climate change is causing an increase in freeze-thaw events, which lead to layers of ice encasing the animals' primary winter food, lichens. This leads to more energy expenditure to access winter foods and can reduce winter food availability.
- Encroachment of shrubs into tundra environments as climate warms creates competition for the vital lichen food source.
- Earlier spring break-up affects some herds that migrate across rivers to reach their calving grounds. The result can be that calving occurs in less desirable areas and the calves are forced to cross streams and rivers while still young and weak.

Interesting facts:

- The antlers of the *Rangifer* female are smaller than those of the male, but they are carried for a longer period of time. Caribou start growing their antlers each spring and are normally done the process by August. Male caribou shed their antlers in November or December, after mating, while females will often carry them until June, after they have given birth. Usually

only the pregnant caribou keep the antlers that late. They allow the cows to defend their feed and displace large caribou from favored sites while nourishing their babies.

- Reindeer were imported into Canada in the 1930s. A shortage of caribou in the Northwest Territories led the government to bring a herd of domesticated Russian reindeer into Canada. After travelling to North America by boat, they were herded from Alaska to the Mackenzie Delta, a five-year journey. Today the herd numbers over 3000 animals.
- Young caribou can outrun an Olympic sprinter when only a day old.
- Reindeer were domesticated in Eurasia 2000 years ago.

Further Information

General Information

The most comprehensive and up-to-date source of information about Arctic biodiversity, including sections on freshwater, marine and terrestrial organisms and ecosystems, is the Arctic Biodiversity Assessment (ABA). The reports that make up the ABA, along with a variety of associated materials and information, are all available online at www.arcticbiodiversity.is/.

For even more information, go to the main website of the Arctic Council's biodiversity working group, Conservation of Arctic Flora and Fauna (CAFF): www.caff.is/.

For a visually appealing and informative look at organisms and ecosystems associated with Arctic sea ice, look at CAFF's publication Life Linked to Ice: A guide to sea-ice associated biodiversity in this time of rapid change: <http://www.caff.is/assessment-series/254-life-linked-to-ice-a-guide-to-sea-ice-associated-biodiversity-in-this-time-of-ra>

For an in depth look at increased greening in the Arctic, see the CAFF expert series on Arctic Biodiversity Trends and the Greening of the Arctic: www.caff.is/expert-groups-series/114-arctic-biodiversity-trends-2010-indicator-11-greening-of-the-arctic or, see this article published by the University of Alaska Fairbanks on why green is increasing in the Arctic: news.uaf.edu/greening-arctic-2/

Species Information websites

(Listed alphabetically.)

Arctic ground squirrel

Environment Yukon, Arctic Ground Squirrel:

www.env.gov.yk.ca/animals-habitat/mammals/agsquirrel.php

U.S. Department of the Interior, National Park Service. Arctic Ground Squirrel:

www.nps.gov/dena/learn/nature/arcticgroundsquirrel.htm

Frontier Scientists, Sharing the Arctic's Newest Discoveries. The Abundantly Peculiar Arctic Ground Squirrel:
frontierscientists.com/2014/09/abundantly-peculiar-arctic-ground-squirrel/

Arctic poppy

Canadian Museum of Nature, Expedition Arctic. Arctic Poppy:
www.expeditionarctic.ca/site/specimen/pavot_islande-arctic_poppy/

Arkive. Arctic Poppy:
<http://www.arkive.org/arctic-poppy/papaver-laestadianum/>

Arctic tern

The Cornell Lab of Ornithology. All About Birds. Arctic Tern:
www.allaboutbirds.org/guide/Arctic_Tern/id

The Arctic Tern Migration Project:
www.arctictern.info/

Beluga

The IUCN Red List for Threatened Species. Beluga, White Whale:
www.iucnredlist.org/details/6335/0

National Oceanic and Atmospheric Administration (NOAA) Fisheries. Beluga Whale:
www.fisheries.noaa.gov/pr/species/mammals/whales/beluga-whale.html

Dwarf birch

NatureGate, Plants. Dwarf Birch:
www.luontoportti.com/suomi/en/puut/dwarf-birch

The IUCN Red List of Threatened Species. Betula nana:
www.iucnredlist.org/details/194495/0

Mosquito

National Geographic Animals. Mosquito:
animals.nationalgeographic.com/animals/bugs/mosquito/

All About Mosquitoes. Mosquitoes Overwintering:
www.allmosquitos.com/mosquitos/mosquito-overwintering.html

Arthropolis Facts, Cold, Icy and Arctic. Attack Of The Buzzing Hordes!:
www.arthropolis.ca/arctic-facts/fact-mosquito.htm

Polar bear

The IUCN Red List of Threatened Species. Polar Bear:
www.iucnredlist.org/details/22823/0

Polar Bears International, Polar Bear Facts and Information. Hibernating and Denning:

www.polarbearsinternational.org/about-polar-bears/essentials/hibernating-and-denning

Purple saxifrage

Plantwatch. Purple saxifrage:

www.naturewatch.ca/plantwatch/purple-saxifrage/

Legislative Assembly of Nunavut. The Official Flower of Nunavut, Purple Saxifrage:

www.assembly.nu.ca/about-legislative-assembly/official-flower-nunavut

Red knot

The Cornell Lab of Ornithology, All About Birds. Red Knot:

www.allaboutbirds.org/guide/red_knot/lifehistory

Smithsonian Research Station at Fort Pierce. Red Knot:

www.sms.si.edu/irlspec/Calidr_canutu_rufa.htm

NatureGate. Red Knot:

www.luontoportti.com/suomi/en/linnut/knot

Reindeer/caribou

Large Herbivore Network. Reindeer, *Rangifer tarandus*:

www.lhnet.org/reindeer

The IUCN Red List of Threatened Species. *Rangifer tarandus*:

www.iucnredlist.org/details/29742/0

Thick-billed murre

The Cornell Lab of Ornithology. All About Birds.

www.allaboutbirds.org/guide/Thick-billed_Murre/id

Audubon Guide to North American Birds. Thick-billed Murre:

www.audubon.org/field-guide/bird/thick-billed-murre

CAFF Expert Series, CBird. Arctic Biodiversity Trends 2010: Indicator #04, Seabirds – Murres, Guillemots:

www.caff.is/seabirds-cbird/cbird-publications/107-arctic-biodiversity-trends-2010-indicator-04-seabirds-murres-guillemots

Appendix B: Activity Sheets

Biodiversity Bingo

The following page is designed for use with the large-group activity, “Biodiversity Bingo” The activity is set out in detail in Section 5 of this manual. The student worksheet is attached here, separately, for ease of printing.

Biodiversity Bingo

Instructions: Draw an 'X' over the square when you find one of the objects listed within. If you get five squares in a row, yell 'BINGO!!!!' and bring your sheet to a leader to check over. Show your classmates what you found and compare their finds with yours. Were you surprised at what some of your friends thought of? Which ones were hard, and which ones were easy?

If you have time, you can try and get a 'Blackout'. Can you fill in every square on the sheet?

A leaf with a smooth edge	A bird flying	Three purple flowers	An omnivore	An animal with six legs
An animal that lives far away in the winter	A fungus	Something living on a rock	An animal making a noise	A flower with four petals
A plant with hairs on it	An animal eating something	FREE	A plant that looks like grass, but has a triangular stem	An organism that looks different in summer and winter
A leaf with a toothed edge	A herbivore	A tree that is tiny	Something caribou and reindeer might eat	A carnivore
A lichen	An animal that sleeps all winter	An animal with two legs	A yellow flower	Scat, also known as poop