www.PlantWatch.ca

PlantWatch

Teacher's Guide

by Elisabeth Beaubien

PlantWatch
Nature CANADA
Environment Canada
Environnement Canada
Canada

PlantWatch Teacher's Guide

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Introduction to PlantWatch

HOW TO USE THIS TEACHER GUIDE:

1. Read the introduction.
2. Select a likely plant species for observation (see list of indicator plants following).

   This will ideally be a plant species that can be found within a 5-10 minute walk of the school, so that it can be checked at least every 2 days by students.
3. Read the plant description.
4. See the key activities and the observation form to get ready for blooming season.
5. Check the activities and select which ones may suit the students' level/ interests.

YEAR AT A GLANCE

(all the following can be done in springtime, but it is better to spread the stages out)

In the fall:

1. select a plant to observe
2. select activities to work on with the class
3. print the species' description and review with students
4. locate plants near school and tag up to 5 numbered individuals (e.g. 5 saskatoon or lilac shrubs, or 5 patches of dandelions)

In late winter:

1. for poplar, test branches in water to ensure trees are males, not females
2. determine latitude/ longitude for the tagged plants, and record other environmental details concerning their position
3. register for PlantWatch, and record your observer number

In spring:

1. check plants every 2 days once flower buds start swelling
2. become familiar with the definitions of first and mid bloom (and for some plants, leafing) for your selected plant
3. *optional:* do sketches, or take photos of the same plant or branch before, during and after bloom
4. check your chosen plants: when first bloom happens, note date, weather for week before flowering, etc. (see the observation form in Key Activities, page 22) and report on the web observation form using your registration number
5. do the same when mid bloom occurs
6. check the web to see your school's data posted in tables and maps, as well as other observers' data
7. know that your contributions to this environmental monitoring network are greatly appreciated!

WHAT IS PLANTWATCH?

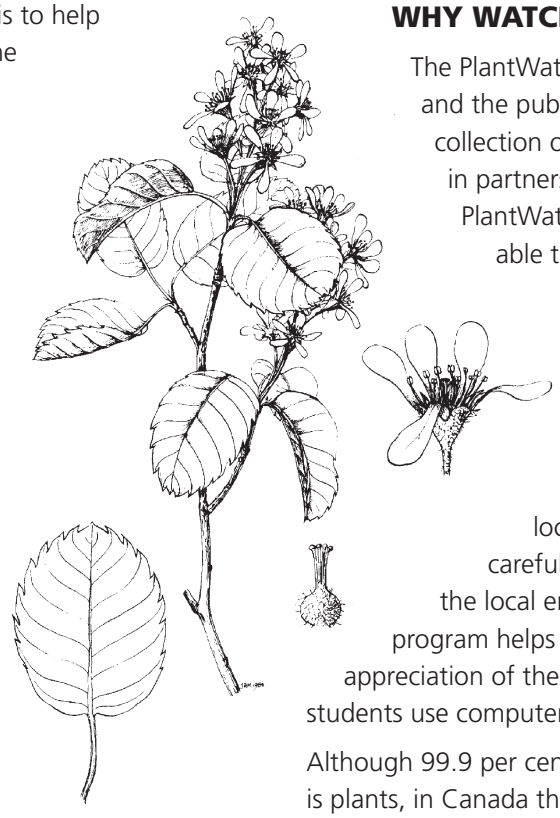
PlantWatch is a phenology program.

Phenology is the study of the seasonal timing of events in the lives of plants and animals. This program links students and the public as "eyes of science," tracking the green wave of spring. Observers select one or more of the key indicator plants and report their bloom times using the Internet. These flowering dates are posted in tables and maps on the PlantWatch website.

The purpose of this Teacher Guide is to help teachers involve their students in the PlantWatch program. Most of the contents have been written for teachers, but can be used directly in class. This guide provides information on how to observe and report flowering dates. Curriculum connections for each activity for every province and territory for science and math are described in an appended chart on page 98.

ABOUT PLANTWATCH

The PlantWatch program began in 1995, based at the Devonian Botanic Garden, a research and educational facility of the University of Alberta. This internet citizen science program was an offshoot of a longer-running phenology program, the Alberta Wildflower Survey, which began in 1987. The Alberta survey has been renamed "Alberta PlantWatch".



Saskatoon
DEVONIAN BOTANIC GARDEN, UNIVERSITY OF ALBERTA

The program has expanded rapidly. In 2001, Environment Canada, Nature Canada, and E. Beaubien partnered to develop a national PlantWatch program. Most provinces and territories now have volunteer coordinators. Common plant species that are useful indicators across much of Canada have been identified as well as regionally-relevant plant species. This teacher guide was written over the years 1996-2001 for PlantWatch, then updated to better help classes across Canada in 2009.

WHY WATCH PLANTS?

The PlantWatch program engages students and the public as active participants in the collection of scientific data. By working in partnership with research scientists, PlantWatch students and teachers are able to contribute their observations to the development of new scientific knowledge.

The process of scientific inquiry here is linked to an important real-life issue: the effect of climate change on local plant life. By encouraging careful observation of plants within the local environment, the PlantWatch program helps students develop a lifelong appreciation of the natural world. It also helps students use computers in a meaningful way.

Although 99.9 per cent of all living material on earth is plants, in Canada there are very few people who specialize in studying native plants. We need to show more students the excitement of plant biology to encourage future work on the challenges facing our forests, prairies, and tundra!

To be useful as key indicator species for spring phenology, selected plants must have certain qualities. These include: perennial growth, widespread distribution, ease of recognition by the public, lack of look-alike species and a short spring bloom period.

There are 38 species tracked through the PlantWatch program. For this teacher guide we have included information on 16 plant species. Two species below (lilac and dandelion) are plants introduced to North America when settlers from Europe arrived. The others are native[1] (or wild) plant species, which means they were here long before the settlers arrived.

[1] Many terms or words in this guide are defined in the glossary (Appendix 2).

We suggest that a teacher and class begin PlantWatch by selecting one of the following plants, or other PlantWatch species, for observation. Check the map or text on distribution with each plant description on the PlantWatch website (www.plantwatch.ca) to see which indicator plants are observed in your province or territory. A full list of PlantWatch species and the provinces/territories in which they are monitored is shown in Appendix 1.

The Indicator Plants

Aspen poplar (*Populus tremuloides*)
tree, widespread across Canada. Flowers very early in spring.

Bearberry (*Arctostaphylos uva-ursi*)
low shrub, across Canada, prefers sunny sites on infertile dry soils. Flowers early.

Bunchberry/Crackerberry (*Cornus canadensis*)
herb, found in boreal or broad-leafed forests. Flowers later.

Cloudberry/Bakeapple (*Rubus chamaemorus*)
herb, low arctic, moist tundra

Cranberry/Partridgeberry/Lingonberry (*Vaccinium vitis-idaea*)
herb, distributed across Northern Canada.

Dandelion (*Taraxacum officinale*)
introduced herb, common in lawns, disturbed areas

Dryad, white/White mountain avens (*Dryas octopetala/integrifolia*)
mat-forming low shrub, arctic and alpine tundra. White dryad prefers open sunny areas.

Labrador tea (*Rhododendron groenlandicum, Ledum groenlandicum*)
shrub, grows in damp areas in boreal forest.

Larch/Tamarack (*Larix laricina*)
tree, across Canada, common in wet muskegs and forests. Flowers early, but after aspen.

Lilac, Common Purple (*Syringa vulgaris*)
cultivated shrub, common in gardens

Prairie Crocus (*Anemone patens*)
herb, occurs in sandy soils in the west and northwestern parts of the continent, often in open pasture that has never been ploughed. It is a harbinger of spring, often starting bloom the same time as the aspen.

Saskatoon/Serviceberry (*Amelanchier spp.*)
tall shrub, across North America, often found along the sunny edges of forest

Saxifrage, purple (*Saxifraga oppositifolia*)
herb, arctic-alpine, found high in the mountains or arctic tundra. Purple saxifrage is it is one of the earliest blooms to appear after the snow.

Starflower (*Trientalis borealis*)
herb, common in Eastern Canada. Found on the coniferous forest floor.

Strawberry, Wild (*Fragaria virginiana/vesca*)
herb, across Canada

Trillium, White (*Trillium grandiflorum*)
herb, deciduous forests in eastern North America

Participants can observe those natives plants in their gardens or wherever they occur.

HOW IS THE DATA USED?

The timing of flowering and leafing in spring is largely in response to how warm the weather has been before these events. Studies have been started to see how much warmth (measured in heat units) is needed to get different plant species to flower. Spring phenology data for plants is essential to help answer the question, "With the predicted global warming, is spring arriving earlier?" Some exciting trends have already been discovered. In Edmonton, Alberta the flowering of aspen poplar trees is happening about a month earlier now than it did a century ago!

By collecting long-term phenology data, we can track plant responses to changes in climate.

Phenology can also help farmers more accurately time their activities. As plants and insects are both

developing in response to spring temperatures, it will be very useful to use bloom times to predict the best timing for control of pests. By treating weeds or insect pests at their most vulnerable stage, farmers can be more effective and boost their profits while minimizing environmental impacts. Research scientists have begun to look at the link between flowering times and the appearance of agricultural pests such as woolly elm aphids (which infest the roots of saskatoon plants) and grasshoppers (which consume cereal crops and rangeland).

PlantWatch's flowering information can also help ranchers protect rangeland and maintain maximum plant growth. For example, the best time in southern Saskatchewan to put cattle on the range is when wild rose starts to flower, usually 50 days after prairie crocus appears.

In addition, foresters can use the data to correctly time seed-collection field trips, or to treat insects with a biological control. Spring flowering dates can help wildlife managers by answering such questions as, "Will the deer population increase this year?" We know that in the aspen parkland, more deer fawns survive in years with early springs. In the field of human health, pollen warnings can help those with allergies prepare in advance. For tourism and parks departments, these flowering dates can be used to predict the best times to photograph flowers, or to predict the behaviour of bears and other animals whose movements depend on the growth stage of their plant food. Because plant and insect development are linked, bloom times can even provide information on when to go fly-fishing!

PARTICIPATION IS FREE

There is no charge to participate in PlantWatch. The PlantWatch website has all the basic information on how to participate, register, recognize plants and flowering stages, and how to report when the plants bloom. New flowering dates are posted in tables and maps.

Interested teachers please visit: www.plantwatch.ca

There you will find contact details for your territorial or provincial coordinator, who can provide more information.

JOIN US FOR PLANTWATCH! ANYONE IS WELCOME TO PARTICIPATE.

Grasshopper
ISTOCKPHOTO.COM

As plants and insects are both developing in response to spring temperatures, it will be very useful to use bloom times to predict the best timing for control of pests.

Quick Reference Table to Curriculum Links by Activity and Grade

	NWT/ NUNAVUT	BC/YUKON	ALBERTA	SASK.	MANITOBA	ONTARIO	QUEBEC	ATLANTIC
Activity	**Grades with Curriculum Links (of Gr. 6, 7, 8)**							
Key Activity 1	None	None	None	None	6, 7	7	None	6
Key Activity 2	7	None	7	6, 7, 8	6, 7	6, 7, 8	Cycle 3, Sec. I	6, 7
Key Activity 3	6, 7	7	7	6, 7, 8	6, 7	6, 7,	Cycle 3, Sec. I	6, 7
Key Activity 4	6, 7	6	6, 7, 8	6, 8	6, 7, 8	6, 7	Cycle 3, Sec. I, Sec. II	6, 7
Key Activity 5	6, 7	8	7	8	None	6.7, 8	Cycle 3, Sec. I, Sec. II	6, 7, 8
Key Activity 6	7	6	7, 8	6, 8	6, 7	6, 7, 8	Cycle 3	6, 7, 8
Science 1	6, 7	6, 7	7	6, 8	6, 7	6, 7	Cycle 3, Sec. I	7, 8
Science 2	6, 7	6, 7, 8	6, 7, 8	6, 8	6, 7, 8	6, 7	Cycle 3, Sec. I	6, 7, 8
Science 3	None	None	None	6, 7	None	None	None	None
Science 4	7	6, 7, 8	6, 7	6, 8	7	6, 7	None	7
Science 5	6	6, 7, 8	None	Ga	None	6, 7	Cycle 3, Sec. I	6, 7
Math 1	6, 7, 8	6, 7, 8	6, 7, 8	6, 7, 8	6, 7, 8	6, 7	Cycle 3, Sec. I	6, 7, 8
Math 2	7	7	7	6, 7, 8	6, 7	6, 7, 8	Cycle 3	6, 7, 8
Math 3	6, 7, 8	6, 8	6, 7, 8	6, 8	6, 7, 8	6, 7, 8	Cycle 3, Sec. I, Sec. II	6, 7, 8
Math 4	7	7, 8	7	6, 7	6, 7	7, 8	Cycle 3	6, 7, 8
Social Studies 1	7	7, 8	7	6, 7, 8	6, 7	6, 7	Cycle 3, Sec. I	6, 7, 8
Social Studies 2	7	None	7	None	6, 7, 8	6	None	6, 7
Social Studies 3	None	8	6	6, 7, 8	6, 7, 8	None	Cycle 3, Sec. I	6, 7
Lanuage Arts 1	6, 7	6, 8	6, 7	6, 7, 8	6, 7, 8	6, 7, 8	Cycle 3, Sec. I	6, 7, 8
Lanuage Arts 2	7	None	6, 7	6, 7	6, 7	6	Cycle 3, Sec. I	6

Notes

Key Activities

Start here »

www.PlantWatch.ca

Activity 1

Signs of Spring and PlantWatch

overview

The students discuss signs of spring's arrival and are introduced to the PlantWatch program. Use Activity 1 in conjunction with Activity 2 to introduce your students to the concept of phenology and PlantWatch.

Prairie Crocus LINDA KERSHAW

SKILLS

Inferring, communicating

MATERIALS

1. Illustrations of the plants. (see website www.plantwatch.ca and select "Plant Descriptions")
2. Letter to students from research scientist, and Alberta PlantWatch Coordinator, Elisabeth Beaubien. (page 10)

PREPARATION

1. Read Introduction to PlantWatch.
2. Assemble the illustrations and letter to students. (page 10)

FOCUS

What outdoor signs suggest that spring is coming?

PROCEDURE

1. Discuss the signs of spring known by the students.
2. Introduce the PlantWatch program to the students.
3. Review the illustrations.
4. Question: Do you think any of these plants or shrubs might be found in our community? Select a species to observe.
5. Have the students ask their families and neighbours if they know where this species can be found locally.
6. Give the letter from Elisabeth Beaubien to the students and ask them to share it with their families.

SUGGESTED CONNECTIONS

Key Activity 2, *Predicting Seasonal Occurrences* (page 11)

Science Activity 5, *Developing a Phenology Calendar* (Connections - Science, page 43)

Language Arts Activity 2, *Celebrating Spring* (Connections - Language Arts, page 77)

RENEWABLE RESOURCES
751 General Services, University of Alberta
Edmonton, Alberta, Canada, T6G 2H1

Dear Student,

I would like to introduce myself and the PlantWatch program to you.

My name is Elisabeth Beaubien. I've been keen on plants and animals since I was young, so it was a simple choice for me to study biology and then botany. My main jobs have been as a naturalist and environmental educator. I launched PlantWatch in 1995 and now there are coordinators in most provinces and territories! PlantWatch is part of the national NatureWatch series of volunteer monitoring programs designed to help identify ecological changes that may be affecting our environment. NatureWatch is a joint venture between the Nature Canada and Environment Canada.

If you enjoy being outdoors, using a computer, and want to help society understand the effects of climate change, this program is for you! There is lots of fun to be had, tracking plant changes in spring and writing down what you see. It is amazing to see the differences from year to year, and from place to place! While participating in PlantWatch, you will be acting as the "eyes of science" by observing the flowering of one or more of the indicator plants. Information on the PlantWatch species is available on the website: www.plantwatch.ca

On the PlantWatch website, your class will report the calendar dates when your plants start to bloom and reach mid bloom. They may track when certain trees leaf out. We post the dates received from all the PlantWatch observers on Internet maps.. Your regional coordinator will be delighted to see your reports!

This information is useful for many reasons. Because plants flower in response to warmth, flowering dates can help us track the results of a warm or cold winter and spring. It will help us learn more about weather's variability and changes in climate. *Did you know that plants have been flowering earlier in recent decades in western Canada?* We can also use your plant observations to provide farmers with advice about good times to plant their crops, to fertilize and to control pests. Foresters can use the information to correctly time seed-collection trips, or to manage insects. In the field of human health, pollen warnings can help those with allergies prepare in advance.

Thank you for joining the PlantWatch team! Your help and participation are greatly appreciated.

Cheers,

Elisabeth Beaubien,
Phenology researcher
Science Advisor, PlantWatch Canada

Activity 2

overview

Students are introduced to seasonal change and the concept of phenology by surveying others about the signs of spring and making their own predictions. Use this activity in the fall or late winter to introduce phenology to your students and get them thinking about seasonal change.

Predicting Seasonal Events

SKILLS

Predicting, communicating

MATERIALS

Survey questions, survey sheets and pencils.

PREPARATION

Prepare survey sheets.

Read Science Activity 5, *Developing a Phenology Calendar* (Connections - Science, page 43)

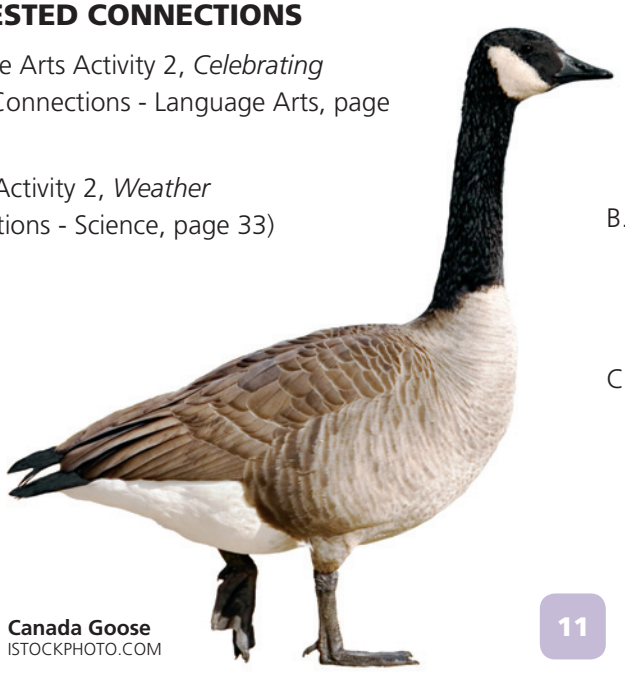
FOCUS

Introduction to phenology

SUGGESTED CONNECTIONS

Language Arts Activity 2, *Celebrating Spring* (Connections - Language Arts, page 77)

Science Activity 2, *Weather* (Connections - Science, page 33)



Canada Goose
ISTOCKPHOTO.COM

PROCEDURE

A. Choose several local signs of spring that can be easily observed, and have the students predict when those events will occur. These signs may involve the arrival of migratory birds, changes in weather, the appearance of leaves and flowers, or changes in human behaviour (changes in clothing, seasonal sports, farming practices, etc.) For example, some migratory birds may be easily identified (e.g., Canada geese, mallard ducks, common loons, swallows, robins), and students can be asked to predict when the first spring migrants will be sighted. When will the last snow on the school grounds melt? When will the first mosquito appear? When will soccer season begin? When will farmers plant the first spring crops? When will ice on lakes and rivers disappear? Record the students' predictions on a calendar and encourage the students to report any sightings or observations of the predicted events.

B. Have the students conduct a survey of their parents, grandparents or other students to learn about local signs of spring (see the survey on the following page).

C. Climate is the general pattern of weather in a region, based on a minimum of 30 years of records. Because seasonal weather patterns tend to be similar over a long period of time, we are able to

predict, with some accuracy, when certain changes in nature will take place in different locations. You may wish to invite a local naturalist to talk with the class about how people are able to make predictions about when certain signs of spring will appear. Have him/her introduce students to local sources of information on bird migrations and bloom times. Contact your local naturalists' club for names of resource people. As well, look for First Nations Peoples' calendars –these often make reference to the seasonal changes in plants and animals that occur at different times of year.

PHENOLOGY IS THE STUDY OF THE SEASONAL TIMING OF LIFE CYCLE EVENTS IN PLANTS AND ANIMALS. HISTORICAL PHENOLOGY RECORDS CAN PROVIDE EVIDENCE OF THE EFFECTS OF CLIMATE CHANGES OVER TIME.

SIGNS OF SPRING SURVEY QUESTIONNAIRE

Purpose: To find out how local people identify the arrival of spring and to discover when local people expect seasonal events will occur.

1. Please complete this sentence as many times as you wish.
   "I know that winter is over when…"
2. Please complete this sentence as many times as you wish.
   "I know that spring is here when…"
3. What are the signs of spring here in April?
4. What are the signs of spring here in May?
5. What things do you do in the spring, and how do you know when to do them?

Have students share the results of their survey with the class. In discussing the results of the survey, be sure to point out how some events can be predicted with great accuracy (e.g., the spring equinox, the next full moon, the last day of school before summer vacation). The timing of other events (e.g., bird migrations, frog calling, flowering dates, planting times) may vary from year to year, often depending on the weather. Weather conditions include such things as air temperature, precipitation and wind.

Goose family BRIAN KOTAK

Activity 3

Locating and Tagging the Plants

overview

Students go outdoors to identify and mark the plants they will observe for PlantWatch. Students make qualitative observations by describing, in words or pictures, the plants and their habitats. If a woody plant is chosen for this PlantWatch study, students can bring a branch into the warm classroom in late winter, to observe the buds developing indoors.

SKILLS

Observing, identifying plants, sketching and map-making

MATERIALS

PlantWatch species information (see www.plantwatch.ca)

Make your own tags to label the trees and shrubs, or ask a nursery for flexible plastic tags. Embossable aluminum tags work very well.

Permanent markers (for plastic tags)

PlantWatch Observation Forms (download the form from the PlantWatch website: www.plantwatch.ca or refer to page 22).

PREPARATION

Determine which species can be found in your area and select a species to report on.

Read Background Information on your chosen plant at www.plantwatch.ca

FOCUS

Where can we find these plants?

SUGGESTED CONNECTIONS

Science Activity 1, *Plants and Ecology: All My Relations* (Connections - Science, page 31)

Strawberries ROWENA HOPKINS

Language Arts Activity 1, *Descriptions* (Connections - Language Arts, page 75)

PROCEDURE

1. Take the students on a walk to locate PlantWatch plants in the area of the school. You may want to ask a local naturalist or gardener to help with identifying the species or bring a field guide to local wild plants. Tag up to 5 individuals of your selected woody plant species (trees or shrubs) or mark up to 5 patches of your selected smaller plant. Make a sketch map of the area showing your tagged plant locations.

2. Assign a group of students to each tagged woody plant or patch of plants. These students will be responsible for checking on their plants at least every 2 to 3 days when the time for flowering nears, and reporting any changes they observe to the class.
3. Have your students write descriptions of the plants' habitats and/or make sketches of the plant (e.g. sketch flower buds every few days as they grow larger) in their logbooks or on their observation sheets.
4. You may wish to clip a few short branches of your selected shrub or tree for observation in the classroom. Clip branches when the plant is dormant (i.e., before the leaves/flowers appear, January to April). Place the clipped branches in water in the classroom. Change the water and cut off a small portion of the wet end of the branches weekly. Students can observe the early development of leaves and flowers. For example, aspen poplar will flower quickly; saskatoon may take a few weeks to flower; and lilac will probably just produce leaves and flower buds before withering.

BACKGROUND INFORMATION

When to Observe

Aspen poplar can expand its catkins and release pollen very soon after snowmelt, if the weather is warm! Start watching catkins in very early spring.

Bearberry is one of the earliest flowers: look under leaves to see the 'hot pink lips' open on these small white and pink bells.

Bunchberry flowers after all the above flowers: in May or June.

Cloudberry/bakeapple/salmonberry starts to bloom in June in most of Canada (later in the north).

Cranberry/partridgeberry/lingonberry starts to flower in May (later in the North).

Dandelion appears in April or May (make sure you observe well away from warm building walls, so that your date reflects the average time for dandelion in that area)

Labrador tea usually flowers in late May or June.

Larch has small male and female cones that develop very early: watch for pollen shed and then needles emerging. In some years no cones may be produced; in other years: abundant cones.

Lilac generally starts to bloom in May in most of Canada, but keep a sharp eye on your bush starting at the end of April. Here's one example of relative timing: in central Alberta, lilac flowering generally starts a few days after full bloom of saskatoon.

Prairie crocus buds poke through the ground in early spring. Visits to locations where crocus plants grow should be scheduled soon after the snow disappears. The time from first flowering to full flowering usually lasts 7-10 days, depending on the weather (faster flowering in hot weather, slower in cold weather).

Purple saxifrage, is a "harbinger of spring" in the north and in the mountains, flowering soon after the snow melts.

Saskatoon usually flowers in May (later in the north).

Starflower begins blooming in May in eastern Canada

Strawberry starts to flower in April in warm parts of Canada.

White dryad/White mountain avens, starts flowering shortly after purple saxifrage in the arctic or in mountains.

White trillium is one of the first forest wildflowers to bloom.

Where to Observe

1. PlantWatch needs flowering dates of plants that are somewhat "average" in bloom time for your area. If your chosen plant flowers much earlier or later than others in the area, simply note this under the "Comments" section of the PlantWatch Observation

Form and tag a different plant (or group of plants) next year.

2. For the native plants, (i.e., any PlantWatch species except lilac and dandelion) select a natural setting away from buildings and other heat sources. For lilac, if possible, select a plant in the open, preferably away from any wall (with closest branch tips at least 2 m [6 ft.] away). For dandelion, select a patch on a flat area, if possible, and at least 10 m from a south or west-facing wall or fence.

   Please note the details of your plants' habitats on the PlantWatch Observation form to help PlantWatch assess the possible effects of location on your flowering dates.

Saskatoon flowers E. BEAUBIEN

3. It is important, where possible, to observe plants growing in a relatively flat area. Why? Plants on hills will get more or less sun depending on which way their slope faces. Plants on east, south, and west-facing slopes receive more warmth from the sun and may flower earlier than the same species on colder north-facing slopes. If you are limited to watching plants on slopes or hillsides, please use a compass to see which way your slope faces, and note this direction on the Observation Form.

How to Tag

Larger woody plants: e.g. lilac, aspen poplar, larch or saskatoon: Locate **up to five** plants per class to observe, and assign a number to each plant. When you report flowering on the PlantWatch Observation Form, put this number in the **Name of Plant:** section.

Make your own tags by cutting up plastic yogurt/dairy containers, or by using masking tape, or find tags at a plant nursery or forestry supply store. Mark the tag with a plant number (see box below). Wrap the tag around a solid branch of your tree or shrub (at least 2-3 cm or 1 in. diameter). Try to put the tag on a branch where students can find it easily even when the bush has leaves. If plant or label vandalism is a potential problem, you may wish to select plants away from public view, or place the tag so it is not visible from a main trail or public area.

Tagging smaller plants:

Search for a good patch of plants, i.e. in spring, one that has buds or flowers; or in summer, fall, or winter, one that has evidence of present or past fruit (empty flower stem, berries, seeds, capsules from the previous year). If the plants are very abundant, select a square

Permanent Markings on Labels

Because even permanent pen markings can fade after two months' exposure to spring sunshine, consider a more permanent marking method. Find a plastic labelmaker to add your plant's number and name to the plastic tag. Nurseries or forestry supply stores often sell embossable aluminum tags for shrubs or trees. Be sure to make and keep a sketched map of plant locations and numbers in case your label is removed, and to help relocate the plant the next spring. It is best to leave the label on a tree or shrub, and to observe the same plant in subsequent years.

patch of 1 m x 1 m (3 ft. x 3 ft.). Mark the corners of the patch using small rocks or sticks. Adding a yellow plastic tent peg, or a metal tent peg with orange flagging tape tied on, will make it simple to relocate your site. Make sure the patch has a number — use a plastic or aluminum label.

How Many to Mark or Tag

Reporting on **one** shrub or patch is fine, and more is even better! Please report on a **maximum** per class of

- five woody plants of one of the larger plants (e.g., lilac, aspen poplar, larch or saskatoon),

  or

- five patches of one of the smaller plants (e.g., dandelion, starflower, prairie crocus, bearberry, trillium, bunchberry, Labrador tea, dryad or saxifrage).

Put the number on the tag for that plant or patch.

Create a school PlantWatch garden using the species that naturally occur in your area. Then students can easily observe the plants at all stages of their life cycle! There are a few ethical issues to consider, however, when obtaining native plants. These plants should be grown from locally-collected seed, or purchased from a reputable nursery that propagates the plants and does not simply dig up plants in the wild and sell them. For information on collecting and purchasing native plants and growing native plants from seed in an ethical manner visit www.anpc.ab.ca/assets/gardener_guidelines.pdf

Activity 4

Reporting to the Class

overview

Students report back to the class any changes they may have observed in their plant(s). Encourage your students to use a variety of means to communicate their observations to the rest of the class. This activity can be used effectively in conjunction with Language Arts Activity 1 and Mathematics Activities 1 to 3.

SKILLS

Observing, recording, communicating

MATERIALS

Illustrations and colour photos of PlantWatch species from the website. (See www.plantwatch.ca, or find more photos by typing in the plant's latin name at 'Google images' on the web.)

Student logbooks

PREPARATION

Read Background Information with its definitions of first and mid flowering for the PlantWatch species your class is observing.

FOCUS

What is happening to your plant?

SUGGESTED CONNECTIONS

Language Arts Activity 1, *Descriptions* (Connections - Language Arts, page 75)

Mathematics Activity 1, *Growing Degree Summation* (Connections - Math, page 51)

Mathematics Activity 3, *Graphing and Mapping* (Connections - Math, page 55)

PROCEDURE

1. Have your students periodically report on their plants to the class. When the flower buds begin to swell, students should visit the plants at least every 2-3 days, and take particular care to observe the changes in their plants. They can regularly report these findings. Have the students sketch the changes they are observing.
2. List the bloom dates for each of the observed plants/patch of plants.
3. Report the dates to PlantWatch (see next lesson). Reporting can be done as soon as the plants start to reach first bloom, and can continue as more dates are observed.
4. Have the students make graphs of their results.

BACKGROUND INFORMATION

Before the students can start to report signs of flowering on their selected plant, they need to know how to recognize these flowering stages. Only then can accurate dates for these phases can be recorded.

See www.plantwatch.ca and click on "Plant Descriptions" for growth stage definitions to observe, and photos:

Flowering times (first bloom, mid bloom) are observed for all the species. Leafing time is noted for only 3 species: lilac, poplar and larch.

R. HOPKINS


Aspen poplar
(Populus tremuloides)
tree, across Canada (report flowering and leafing times)

E. BEAUBIEN


Bearberry
(Arctostaphylos uva-ursi);
low shrub, across Canada

E. BEAUBIEN


Bunchberry, crackerberry
(Cornus canadensis)
herb, boreal zone

L. KERSHAW


Cloudberry/Bakeapple
(Rubus chamaemorus)
herb, low arctic, moist tundra

M. BISHOP


Cranberry/Partridgeberry/ Lingonberry
(Vaccinium vitis-idaea)
herb, distributed across Northern Canada.

M. BISHOP


Dandelion
(Taraxacum officinale)
introduced herb, common in lawns, disturbed areas

R. HOPKINS


Labrador tea
(Rhododendron groenlandicum,
formerly ***Ledum groenlandicum)***
shrub, boreal

M. PRIESNITZ


Larch, tamarack
(Larix laricina)
tree, across Canada (report flowering and leafing times)

E. BEAUBIEN


Lilac, common purple
(Syringa vulgaris)
cultivated shrub, common in gardens

L. KERSHAW


Prairie crocus
(Anemone patens)
herb, prairie and northern North America

L. KERSHAW


Purple saxifrage
(Saxifraga oppositifolia)
herb, arctic-alpine

E. BEAUBIEN


Saskatoon, serviceberry
(Amelanchier spp.)
tall shrub, across North America

R. HOPKINS


Starflower
(Trientalis borealis)
herb, common in Eastern Canada. Found on the coniferous forest floor.

R. HOPKINS


Strawberry, Wild
(Fragaria virginiana/vesca)
herb, across Canada

L. KERSHAW


White dryad, white mountain avens
(Dryas octopetala/integrifolia)
mat-forming low shrub, arctic and alpine tundra

J. BRANT


White trillium
(Trillium grandiflorum)
herb, eastern deciduous forest

Activity 5

Reporting your Data

overview

The teacher registers the class and reports its data to PlantWatch.

SKILLS

Calculations, completing observation forms

MATERIALS

PlantWatch Observation Forms (page 22)

PREPARATION

1. Examine the PlantWatch Observer Form or the PlantWatch website "Submit Observations" section
2. Read Background Information on Observer Form
3. Complete Mathematics Activity 4, *Latitude and Longitude: How to Calculate Your Global Address* (Connections - Math, page 59)

PROCEDURE

Send the data to PlantWatch as soon as one of the tagged plants reaches first flowering. Keep sending data as the plants all reach first and mid bloom. Complete one form for each tree (i.e., aspen poplar, larch), bush (i.e., saskatoon, lilac) or patch (i.e., starflower, prairie crocus, trillium, etc.) observed. Just press "send" after completing your report on a plant and a confirmation page will appear. Complete another observation form if you have a date to report for another plant. To contact PlantWatch by e-mail: eman@ec.gc.ca

BACKGROUND INFORMATION
on the PlantWatch Observation Form

Filling in the Observation Form

A. Observer

Fill out the contact information.

B. Plant Observed

The PlantWatch Observation Form is used to report observations on one plant (or patch) of one species. Name the plant species you observed.

C. Flowering Phase

Fill in the date of one phase, or both phases (i.e., first bloom/mid bloom), on the same sheet. If first bloom for your plant was April 15, 2010, record 04/15/2010; if mid bloom was April 21, 2010, record 04/21/ 2010. If you are reporting on lilac or aspen poplar, leafing is the day when, in at least three places on your observed plant, the first leaves have unfolded. For larch, the tufts of needles have just started loosening and spreading.

D. Plant Location

PlantWatch scientists can use and map students' flowering observations only if they have accurate location information for the plants. To determine plant locations you could use the Latitude/ Longitude exercise (Mathematics Activity 4).

Accuracy of latitude and longitude: please provide decimal degrees with 4 decimal points (eg. 54.9211 minutes latitude, or -115.2166 minutes longitude). Use the formula given in Activity 4, the "dms" button on a calculator, or an on-line converter (e.g. www.fcc.gov/mb/audio/bickel/DDDMMSS-decimal.html) to convert degrees, minutes and seconds to decimal degrees (e.g., 54° 55' 16" = 54.9211°), which are the most useful for mapping. Note that in Canada longitude is entered as a (-) value.

The Submit Observation section of the PlantWatch website has tools which allows you to look up your latitude and longitude. Google Earth is an excellent tool to find latitude and longitude (http://earth.google.com/).

A topographic map at a scale of 1:50,000 is very useful to get accurate locations of plants.

Map Ordering

A 1:50,000 scale map is very helpful.

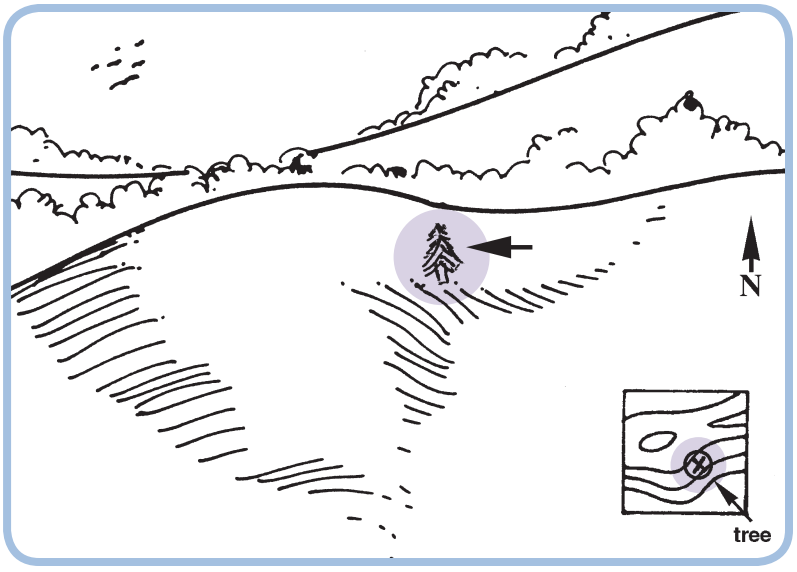
Many people now have a "GPS" (Global Positioning System: a small, hand-held instrument that calculates your latitude/longitude using satellite signals) for geo-caching, hiking, etc. They may be able to help by giving you the location of your sites. If you cannot figure out the latitude/ longitude of your site, then just report at the bottom of the form under the *Comments* section of *Optional Details*, the distance and direction of the plants from the nearest highway or town.

Elevation, taken from a map, is also useful information for research on plant flowering times. Because air cools when altitude increases, flowering in higher places is often later than at low altitudes. This effect can often be seen by hikers on a mountain trail — plants of a species may be in full bloom at the start of the trail but only in bud higher up.

E. Optional Details

Information on a plant's exposure to sun (shading, angle of slope and aspect of slope — the direction the slope faces) and weather before flowering helps us understand how plants may have been affected by their location or this year's weather. To find which direction the slope or forest edge faces, hold a compass, stand with your back to the plant and face directly downhill or at 90 degrees to the forest edge. The direction you are facing is the direction to record.

Try this exercise: This is a sketch of a hill with a single larch tree on one side. In the bottom right of the sketch is a small inset contour map of the same hill, with the tree location shown by the "x". If north is at the top of the map, which direction does the hill with the tree, face? (the answer is beneath the sketch)



ANSWER: SOUTHEAST

In the *Comments* section, students could contribute

- details about the locations of plants
- notes on any interesting insects observed on the plants (e.g., butterflies, caterpillars, ants, beetles, etc.)
- weather observations (or the calculated growing degree days to flowering: see Math Activity 1 [Connections - Math, page 51])
- whether some flower buds were lost to hungry deer or other animals
- the average flowering times for first or mid flowering for all the plants of one species (if they are all within the same area: i.e. within a circle of 100 meters diameter and within 50 meters of each other in elevation)
- any other comments or suggestions

Submitting information on the PlantWatch website

A. Registration

Go to the "Submit Observations" page of the PlantWatch website. If it is your first time submitting observations, you first need to register. Fill in all fields (School name can be entered in Last Name field). Define an Observer number. Keep track of this number and use it when sending data and locations for your observations.

If you registered previously and forgot your Observer number, just enter your email into the password retrieval system on-line and it will be automatically emailed to you.

You can edit your profile information by clicking "edit profile".

B. Add a location

Once you have registered, you will need to add a location for each individual plant observed. Enter unique latitude and longitudes for each watched plant, along with as much other data as possible.

To access the on-line tools for latitude and longitude click on "Click here to enter latitude and longitude coordinates". This will launch a pop-up screen where you can search for your location either by (a) entering the latitude and longitude directly, (b) by searching from a nearest named place or (c) by zooming in from a map of Canada. Each option will allow you to visualize the plant location on a map. Use this to verify your location. Once you are satisfied you have identified the site, click "Confirm Location". This will automatically fill in the latitude and longitude section of the page. Using Google Earth, a GPS or other tool will help to identify the latitude and longitude more specifically.

Once you have saved a location, it will appear as an option under "Location" for future entries. If you have made an error in your location information, you can edit it by clicking "edit location"

C. Submit a PlantWatch Observation

Select from the drop down menus provided all of the blooming event information about the specific plant you have monitored. You will need to repeat this for each individual watched plant.

You can edit your observation after it has been submitted by clicking "view/edit" under the "Observations" section. You can also download all of your data to a spreadsheet by clicking "download" and following the instructions.

Monarch butterfly J. GREALEY

Plantwatch Observation Form

Observer

Name: _____

Address: _____

City/Town: _____

Province/Territory: _____ Postal Code: _____

Phone: _____ E-mail: _____

Age: ○ 5-10 ○ 11-15 ○ 16-20 ○ 21-30 ○ 31-55 ○ 56 and over

Plant Observed

Name of Plant:

Flowering Phase

See **www.plantwatch.ca** for details on recognizing these stages.

First Bloom _____ / _____ / _____
MONTH DAY YEAR

Mid Bloom _____ / _____ / _____
MONTH DAY YEAR

Leafing

Leafing _____ / _____ / _____
MONTH DAY YEAR

Plant Location

Location Name: _____

Closest City or Town: _____ Province/Territory: _____

Latitude (in decimal form, e.g. 53.6812 degrees): _____ ° N Longitude (e.g. -112.9295°): _____ ° W

Elevation (if known): _____ (metres)

Habitat Type

○ Deciduous forest
○ Coniferous forest
○ Mixed forest
○ Tundra/barren
○ Grassland
○ Marsh, bog, wetland
○ Farmland
○ Residential garden/lawn
○ Schoolyard

Optional Details

Sun Exposure: ○ sunny and open area ○ in half shade ○ shaded all day

Plant is located on: ○ flat area ○ gentle slope ○ steep slope

Slope faces (select one): ○ N ○ NE ○ E ○ SE ○ S ○ SW ○ W ○ NW

Comments

_____

_____

_____

_____

Activity 6

overview

Students discuss the flowering dates of their plants and those of other PlantWatch observers. They examine data and maps provided on the Internet and interpret them in ways that fit with their other studies.

Looking Back

SKILLS

Interpreting data, comparing, inferring, communicating

MATERIALS

Student observation sheets or log books; maps of flowering dates (see website <www.plantwatch.ca>)

FOCUS

What do these flowering times mean?

SUGGESTED CONNECTIONS

Science Activity 2, *Weather*
(Connections - Science, page 33)

Science Activity 3, *Reading About Climate Change*
(Connections - Science, page 35)

Mathematics Activity 1, *Growing Degree Summation*
(Connections - Math, page 51)

Mathematics Activity 2, *Calculating Averages*
(Connections - Math, page 53)

Mathematics Activity 3, *Graphing and Mapping*
(Connections - Math, page 55)

Mathematics Activity 4, *Latitude and Longitude: How to Calculate Your Global Address*
(Connections - Math, page 59)

PREPARATION

Read Science Activity 2, *Weather* (Connections - Science, page 33)

PROCEDURE

1. Depending on the class' focus while engaged in the PlantWatch program, consider the following questions:
   - Do the data (maps, flowering dates) available on the PlantWatch website show the northern movement of a "flowering wave"? Encourage your students to explain why or why not this "wave" might be happening. See Science Activities 2 and 3.
   - How many days difference did the students find in the flowering dates between their observed plants? Did the variation differ between species? For example, say your class observed four saskatoon plants with first bloom dates May 10, 12, 12, 13. The range in bloom times is May 10 to 13, or four days. But your three observed lilacs had first bloom on May 20, 24, 26 with a range of seven days. The lilacs showed more variation in bloom time than the saskatoons. In this situation the saskatoons may have all been close to each

other on the top of a hill, sharing a similar microclimate. The lilacs may have been spread out over the neighbourhood, in sun or shade, hills or hollows.

Encourage your students to try to explain the level of variation they found. If your class reported on more than one species, did the variation differ between species? Why or why not? See Science Activities 2 and 3 and Mathematics Activities 1 to 4.

- How does your area differ from others nearby — is flowering earlier, about the same, or later? Use the PlantWatch maps and ask your students to predict flowering times on regions of the map where there is no data. Ask them to explain their predictions. (See Science Activity 2.)
- If you've recorded flowering dates in previous years, how does this year compare — is flowering earlier or later? Encourage your students to explain differences or similarities. How could they test their explanations? (See Science Activities 2 and 3 and Mathematics Activities 1 to 4.)
- What would we do differently next year? How could data collection be improved?

2. Log books — A final entry might include a student description of the PlantWatch Program: "What We Did and What We Found Out."
3. Students could share their PlantWatch observations and data with parents, other classes or others.

www.PlantWatch.ca

Connections and **Activity Suggestions**

PAGE **30** Science

PAGE **42** Mathematics

PAGE **56** Social Studies

PAGE **70** Language Arts

www.PlantWatch.ca

Connections and Activity Suggestions

Science

PlantWatch provides opportunities to explore science from elementary school to university levels. By integrating science activities (such as biology, ecology, weather and climate) with geography, mathematics, computer skills, language arts, social studies and fine arts, PlantWatch can form the basis for an integrated thematic study.

Relationships between the indicator plants, people, and wildlife (including herbivores and pollinators) are explored, as well as the plants' adaptations to cope with changes in light, water or temperature. As blooming occurs largely in response to heat, weather calculations can permit predictions of bloom timing. Shifts to earlier bloom in some areas have been noted, and tracking this spring timing can provide a focus for studies of climate change issues.

SCIENCE CONCEPT ONE — Plants

All words highlighted in ***blue*** can be found in the glossary (Appendix 2).

PlantWatch is complementary to a number of elementary school science topics. The following concepts are expanded using some of the PlantWatch species as examples.

1. **Plants are important to humans**
   - Lilac is a beautiful garden shrub. Of all the horticultural woody plants, lilac has the most ***cultivars***.
   - Aspen poplar bark was used as famine food by First Nations people and aspen leaves were used to relieve the itch of insect stings. Canoe paddles and teepee poles were commonly made from aspen wood.
   - Saskatoon berries were the most important plant food for the Blackfoot, a prairie First Nations people.
   - Saskatoon berries are now used both commercially and by individuals for pies, jams, syrups and wines.
   - The roots of starflower were used by Aboriginal hunters to make a smoke mixture to attract deer.
   - Some Aboriginal Peoples used cranberry juice to dye the porcupine quills often found in their beadwork; the berries, too, were used as beads
2. **Plants are an important part of the natural environment**
   - Plants make oxygen. All green plants, when exposed to light, produce oxygen while consuming carbon dioxide in a process called

photosynthesis. At night when the light is gone, they use oxygen to respire (see *Respiration* in glossary). However, plants produce a lot more oxygen than they consume, providing all living things on Earth with the oxygen they need to live.

- Plants play an important role in preventing soil erosion. Plants such as prairie crocus, saskatoon, and purple saxifrage have deep roots to ensure that even in dry years they can find enough moisture. If a forest or grass fire sweeps through and kills the part of the plant above the ground, the roots push up new buds in prairie crocus or new ***suckers*** in saskatoon and aspen poplar. These roots do a good job of holding the soil together and absorbing water in times of heavy rain.
- ***Pollination***

Plant flowers are important to insects such as bees both as a source of ***nectar*** (sugar) and ***pollen*** (rich in protein and fat). In turn, the insects move pollen to different flowers. Watch bees and look for yellow or orange balls of pollen being carried on their legs. This ***cross-pollination*** is necessary in some plant species for seeds to develop. Pollination is an example of a way that plants and insects help each other. How are the PlantWatch species pollinated? Lilacs are often visited by swallowtail butterflies. Bees love dandelions. Small flies likely pollinate bunchberry (though tiny insects can be damaged by the explosive pollination!). Wind moves the pollen on aspen and larch trees.

Most flowers have male and female parts. In at least two of our PlantWatch species, prairie crocus and purple saxifrage, the female parts (***stigmas***) of the flowers are ready for action first. If the stigmas receive pollen from another flower (cross-pollination), the ***stamens*** (male parts) will still ripen and release pollen, which can fertilize another flower. However, if pollination by insects does not occur, the flower can fertilize itself. In poplars, the male trees can start to release pollen before many female trees' catkins are receptive or ready for pollination.

In ***self-fertilization***, no mixing of genes occurs. Therefore, self-fertilization results in less genetic variability in the population and a decreased ability to withstand more extreme conditions (less ***hybrid vigour***). However, it does ensure continuation of a species when conditions are not favourable for cross-pollination.

If you are interested in learning more about pollinating species and how to track their diversity, visit Pollination Canada at www.pollinationcanada.ca.

3. Plants have special parts and adaptations that help them survive and thrive in certain habitats

- The PlantWatch species have unique characteristics that students can observe, identify and discuss. For example, you may wish to ask the students the following questions:

Why is the bark of aspen poplar green inside?

ANSWER: The thin layer of green tissue just under the bark allows the tree to convert light to food or sugar by the process of photosynthesis. Even before the leaves emerge, the tree can take advantage of spring warmth and light. To protect the bark from sun scald, the south-facing side of the tree often has a white powder on it that acts as a sunscreen.

Why is the prairie crocus so furry?

ANSWER: The hairs protect the plant from insects (e.g., caterpillars, beetles) and some larger herbivores (e.g. deer, elk) that might eat the plant. The hairs contain a stinging substance that can be irritating. However, perhaps because prairie crocus is one of the earliest-appearing plants after

the long winter, some animals (e.g. elk, ground squirrels) eat the crocus flower, ignoring the stinging hairs.

Hairs also provide a heat trap for rays of sunshine, and provide protection from moisture loss in the dry, spring winds. You could compare the prairie crocus to a camel-riding, nomadic person who travels the desert well wrapped in robes.

White trillium JOYCE BRANT

Why do prairie crocus and white dryad flowers turn to face the sun?

ANSWER: The prairie crocus blooms in the early spring, a cold time of year. White dryad blooms in mountains and the north where temperatures are low. The cup shaped flowers resemble satellite dishes and act as solar collectors, concentrating the sun's warm rays on the centre of the flower. Heat is necessary to help the flower parts develop (for example, for stamens to grow; for pollen grains to mature and be released) and for pollination to occur. Inside a prairie crocus flower it is often 10°C warmer than outside, making it a cozy place for spring pollinators (e.g., bees, flies) to visit. Some insects spend cold nights and stormy days inside the flower, protected from the wind and predators.

Why do trilliums flower so early?

ANSWER: In eastern North America, trilliums grow early in the spring before maples, beech, and other leafy trees unfurl their leaves. They take advantage of the bright, sunny spring to put on a spurt of growth, forming leaves and flowers. Once the leaf canopy above closes, the forest floor becomes very shady. The fully grown trilliums persist for a few months, ripening their fruits and storing nutrients for next year's growth.

Why do purple saxifrage and white dryad plants stay so small?

ANSWER: These plants rarely grow higher than 5 cm (2 in.) above the ground surface. Their small size allows them to hide from the cold, drying wind that is so common in arctic and mountain landscapes.

How does bearberry make the most of the sun?

ANSWER: Bearberry has small clear windows around the top of each hanging flower which function much like the panes of glass in a greenhouse. Sunshine enters the flower and strikes the dark purple reproductive organs. The purple pigments convert the light to heat and speed up the development of pollen and later, seeds.

What is so special about the bunchberry?

It has the distinction of being the fastest plant on earth due to the explosive opening of pollen sacs within bunchberry flowers, triggered by insects. In less than half a millisecond, pollen is ejected with an acceleration 800 times the force experienced by astronauts during launch!

4. **Plants have essential requirements that need to be satisfied in order for them to grow and thrive**
   - Plants need space

     How close together do you find the individuals of aspen poplar, prairie crocus, saskatoon, bunchberry, trillium, etc.?
   - Each plant has a temperature range in which it grows best

     Spring flowering perennials need a certain amount of heat to bloom. How does temperature seem to affect these plants? (Students could calculate the heat necessary to get their chosen plants to bloom using the growing degree summation exercise described in Mathematics Activity 1, Connections - Math, Page 51).
   - What are the local conditions (the habitats) where the plants are growing? (e.g., flat/hilly, sandy/clay soil, open/ wooded, sunny/shaded?)
   - Are the plants like others in the same area? How are they different?

5. **Plants use different techniques to make sure their seeds are moved to good growing sites**
   - Compare the seed dispersal of aspen poplar, dandelion, prairie crocus or white dryad (seeds travel on the wind) to that of saskatoon, bunchberry, bearberry, or trillium (seeds are eaten/ transported by birds, mammals or insects.)

6. **Plants go through different growth stages. A complete sequence of growth stages is called a life cycle.**
   - Observe and describe (in words and/or drawings) the growth stages of a PlantWatch plant.

Activity 1

overview

One of the fundamental principles of ecology is that everything is connected to everything else. Every plant, animal and person is connected to other living things and to other parts of the natural environment. As people, we depend upon the air we breathe, the water we drink, and the plants and animals that provide us with food. We use plants for building materials, medicines and a variety of other useful products. Our actions have an impact on the environment and other living things. We are a part of the "web of life."

Plants and Ecology: All My Relations

SKILLS/KNOWLEDGE

Identifying ecological connections.

MATERIALS

Chalk and chalkboard or flip chart and markers, paper and pencils

PREPARATION

Review Background Information in this activity.

Review other resources such as plant guides if possible.

Invite an aboriginal elder, ecologist or wildlife officer to join the class.

FOCUS

How are we connected to other living and non-living things?

SUGGESTED CONNECTIONS

Key Activity 3, *Locating and Tagging the Plants* (page 13)

Science Activity 5, *Developing a Phenology Calendar* (page 43)

Social Studies Activity 2, *People and History* (page 70)

PROCEDURE

1. Create large web diagrams on the chalkboard to show some of the connections or relationships between the plants featured in PlantWatch and other organisms or parts of the natural environment. The teacher can encourage students to identify some connections and can provide additional examples using the following two PlantWatch species: prairie crocus and saskatoon. See page 32 for Background Information.
2. Have the students look for evidence of these connections or relationships when they visit their plants.
3. Have the students create drawings that illustrate some of the relationships that their PlantWatch plants have with other parts of the natural environment (e.g., the soil, air, water, sunlight, other plants, insects, birds, mammals).
4. Introduce students to local First Nations peoples' perspectives on nature and traditional uses of native plants. There are several useful background resources for teachers on this subject. You might share some short readings or, if possible, invite an elder to visit your class to talk about the relationships that First Nations peoples have with the land, plants and animals in your area.

BACKGROUND INFORMATION

Prairie Crocus

Relationships with Other Parts of the Web of Life

The prairie crocus is a member of the buttercup family along with other flowers like the Canada anemone or the prairie buttercup.

Bees and other insects ***pollinate*** the flowers of the prairie crocus.

Ground squirrels, deer, elk, pocket gophers and voles eat the flowers, roots and/or leaves of the prairie crocus.

The prairie crocus sometimes grows in large patches in pastures that have been overgrazed by cattle.

People often enjoy the blossoms of the prairie crocus as one of the first signs of spring. Some First Nations peoples used parts of the prairie crocus to stop bleeding or treat rheumatism. The prairie crocus flower turns slowly to keep facing the sun as it moves across the sky. This movement helps the flower capture the most heat energy possible.

As moisture levels change, the seed of the prairie crocus twists and turns its way deeper into the soil, thus improving its chances of survival.

The prairie crocus blooms when the air temperature becomes warm in the spring.

Saskatoon

Relationships with Other Parts of the Web of Life

The saskatoon is a member of the rose family. People often enjoy the fruit of this plant in jams, muffins and pies. For the Blackfoot First Nation, this fruit was the most important plant food. Some First Nations peoples used the wood of this plant to make arrows, pipe stems and basket rims.

Mule deer and elk often browse on the twigs of saskatoon bushes in the winter.

Saskatoon bushes often grow alongside clumps of aspen poplar trees.

Many birds and animals eat Saskatoon berries and scatter the seeds in their droppings.

Saskatoon bushes provide protection for small animals like rabbits. The bushes provide places to hide from predators, as well as shade in summer and shelter from the wind in winter.

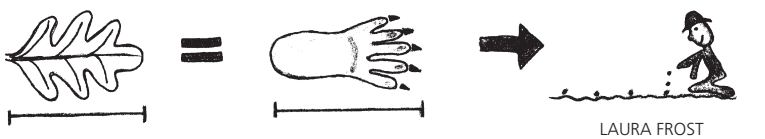
Bear
GEOFF HOLROYD

The saskatoon plant is pollinated by insects. Saskatoons bloom when the air turns warm in the spring.

Definition of Phenology

The study of the seasonal timing of life cycle events.

Phenology was common knowledge for First Nations peoples whose daily activities were closely tied to the natural rhythms of the land. When Samuel de Champlain landed at Cape Cod in 1605, he was told by the First Nations people he met that corn should be planted when the white oak leaves were the size of a red squirrel's footprint.



LAURA FROST

Activity 2

Weather

overview

Weather conditions such as temperature, day length, and precipitation affect the amount of heat available to a plant as winter gives way to spring. Collecting weather data to track the progress of spring in a particular location can be useful for predicting the flowering time of plants in that area and for choosing which crops will be best suited to that particular location.

SKILLS

Outdoor measurement of temperature and precipitation

MATERIALS

Thermometers (maximum/minimum is best type), compass to determine slope aspect (i.e. direction the slope faces), daily newspaper.

PREPARATION

Review Mathematics Activity 1, *Growing Degree Summation* (Connections - Math, page 51)

FOCUS

What variables affect when plants bloom?

SUGGESTED CONNECTIONS

Key Activity 2, *Predicting Seasonal Occurrences* (page 11)

Key Activity 6, *Looking Back* (page 23)

Mathematics Activity 1: *Growing Degree Summation* (page 51)

PROCEDURE

1. **Weather data measurement, recording and Interpretation**

   Have students measure and record temperature, day length and precipitation in order to investigate how each of these conditions affects flowering times. Spring plants flower mainly in response to temperature. If a winter has been milder than average and the spring warm, then flowering will happen earlier than usual. The amount of precipitation does not seem to change the timing of the beginning of bloom, although the time between the start of flowering and mid bloom tends to be shorter in drought periods. Day length becomes a more important factor after midsummer in determining when summer flowering plants will bloom and fruits will ripen, as well as when leaves turn colour and fall to the ground. Day length also affects how much of the sun's warmth a plant is exposed to during the day.

   Time of sunrise and sunset, and daily high and low temperatures can be found in most newspapers.

Use the verified temperature records given for the previous day, rather than the predicted values for the current day. Weather data submitted under Comments on the PlantWatch Observation Form gives a research scientist additional valuable information about flowering conditions.

2. **Predicting the timing of bloom in warmer and colder locations**

   PlantWatch scientists request that, if possible, observers report dates for plants growing in a relatively flat area. However, comparing the flowering times of one type of plant growing under different conditions can provide a concrete example of the effect of temperature on plant growth. For a ***microclimate*** study, the class could also tag individual plants of one species (e.g. saskatoon bushes) in a variety of locations. Locations could include the top of a hill, a valley bottom and slopes facing opposite directions such as north and south, or northwest and southeast.

   Plants located in a warmer site should bloom earlier than the same species in a colder site. If maximum/minimum thermometers are available, install one in each location in the shade (e.g., on the north-facing side of a tree or shrub, about 1 m [3 ft.] above the ground) and take daily readings. If using standard thermometers, take temperatures in the early morning and in the late afternoon during the two weeks before blooming. In what areas is the temperature the highest? The lowest? Where do you expect flowering will be earliest? In the northern hemisphere, the sun rises in the east, swings through the southern sky, and sets in the west. Therefore, south-facing slopes collect the most intense solar energy and should have the highest temperatures. North-facing slopes should be the coolest. But after the winter, you may notice in urban areas that east-facing, grassy slopes seem to green up first. They show earlier plant growth because they are the first areas to catch the warm morning sunshine after cold spring nights, and enjoy high temperatures for more hours than west-facing slopes. The flowering of plants at the base of valleys is often several days later than flowering on slopes or hilltops because cold air drains down the slopes at night and collects at the valley bottom.

3. **Students can use their temperature data to calculate heat units** (see Mathematics Activity 1, page 51).

   Growing degree summation (GDS) is very useful in agriculture to describe how much warmth (measured in heat units) a particular crop ***variety*** needs to develop. For example, two types of canola available for seeding on the prairies have different requirements. The Argentine variety needs 1040-1100 heat units to grow, and the Polish variety only needs 860-920 units. Knowing the current spring's progress in heat units can potentially assist a farmer in selecting the right variety of a crop for a certain location; in predicting planting dates for wheat, canola, barley and forage crops; in predicting the rate of water consumption of different crops; and in predicting the ripening times for crops. For instance, alfalfa needs 500 heat units before the first cut. In central Alberta this usually occurs the last week in June, but the timing varies depending on the weather conditions. Because plant flowering happens in response to how much heat the plants have been exposed to, bloom dates could also be used for all the above predictions. How many heat units does it take for your observed plant to flower? (See Mathematics Activity 1 for calculations.)

Activity 3

Reading about Climate Change

overview

Climate change is a shift in long-term average weather patterns, which can include changes in temperature and in precipitation amounts.

Climate change will touch the lives of all Canadians. Changes in sea levels, storm patterns and average temperatures may alter the environment that we live in and depend on. Decisions that are made today will have an impact on the communities of today and on future generations. Everyone has a role to play to ensure that the planet is hospitable to life, and the time for action is now. Early action is similar to an insurance policy that may protect us from negative effects in the future. The benefits of responding quickly include reduced pollution, increased air quality, a more efficient economy and job creation from the implementation of new technologies.

SKILLS

Reading, comprehension, analysis, critical thinking.

MATERIALS

The readings in this activity, and further readings if desired (see websites at the end of this activity).

PREPARATION

Review this activity.

FOCUS

What is climate change and what are its effects?

SUGGESTED CONNECTIONS

Key Activity 6: *Looking Back* (page 23)

Science Activity 2, *Weather* (page 33)

Mathematics Activity 1, *Growing Degree Summation* (page 51)

Mathematics Activity 2, *Calculating Averages* (page 53)

Mathematics Activity 3, *Graphing and Mapping* (page 55)

PROCEDURE

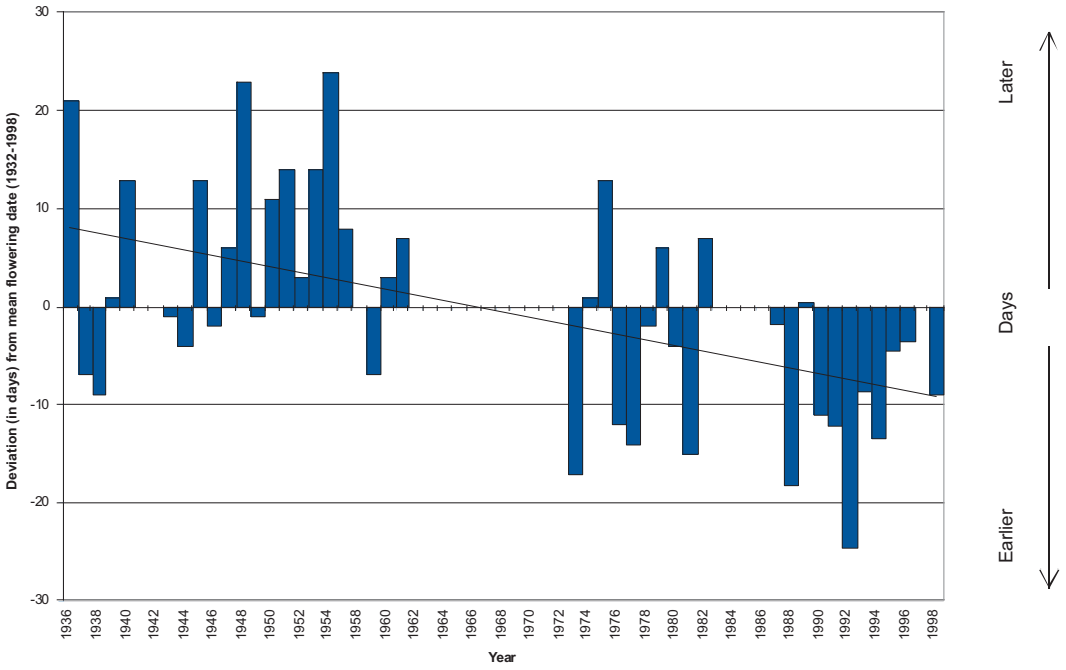
1. Read the readings in this activity.
2. Discuss them as a class.

BACKGROUND INFORMATION

PlantWatch and Climate Change

In the temperate parts of the world where there are strong seasonal changes, temperature is the main factor controlling the timing of spring development. Warmer temperatures in the winter and spring lead to earlier spring flowering and leafing of perennial plants. The plant phenology data for Edmonton, Alberta shows a dramatic shift towards the earlier development and flowering of aspen poplar trees over the last 45 years by about 0.2 days per year. Overall, by 2000, spring was arriving about a week earlier than it was in the 1950s.

Figure 1. **Flowering time of aspen poplar (*Populus tremuloides*) 1938-1998**



Long term trend towards earlier first flowering of trembling aspen (Populus tremuloides) in the area of Edmonton, Alberta (1936-1998).

Figure 1 (based on data from Edmonton, Alberta) shows that over 60 years, the first bloom of aspen became earlier. The average bloom date is shown on this graph as 0 on the y axis or the line running horizontally in the middle of the graph. The length of the bars indicates how many days earlier (towards the bottom) or later (towards the top) flowering has been in a given year. Recent analysis shows that over the last century, aspen poplar bloom in Edmonton, Alberta became earlier by almost a month. Part of this trend may be due to the 'heat island' effect of the city being warmer than the surrounding rural area. (See Beaubien and Freeland 2002, http://www.springerlink.com/content/vl4wtubu49kl575h/fulltext.pdf, see Figure 3.)

Other phenology surveys also show trends to earlier flowering. To see more information on these trends to earliness, look for assessments on the PlantWatch website and check out other phenological monitoring network websites at www.usanpn.org/?q=node/3.

Here is something that you and your students can do to help with the problem of climate change: join PlantWatch! Have your students track how plants are responding to the weather and climate. Their data would be a precious contribution to monitoring environmental changes.

What is Climate Change?

Over time the Earth has experienced much variation in climate. There have been extremely hot periods, when large areas of the planet were like deserts, as well as ice ages, when much of the globe was covered in large sheets of ice. When dinosaurs were in their prime (during the Jurassic) there was very little ice at the north and south poles, the oceans were much higher, and it was extremely hot. Less than 20,000 years ago, most of North America (probably including the area where your school is today) was covered in a large sheet of ice called the Laurentide Glacier. These different conditions are produced by natural cycles in the earth's climate.

Scientists refer to these cycles in climate as climate change.

Today, scientists believe that the planet's temperature is rising in response to increased human pollution of the atmosphere. Such an increase in temperature is called "global warming." Scientists believe that this pollution is causing an increase in the naturally occurring greenhouse effect (see below). Predictions of global warming worry many people because of the effects rising temperatures are having on the natural environment.

What is the Greenhouse Effect?

The greenhouse effect is a naturally occurring process that regulates the Earth's temperature. The Earth is warmed by light energy that comes from the sun. When the energy in the sun's rays reaches the planet, some of it is reflected away from the ground. As this energy (heat) travels

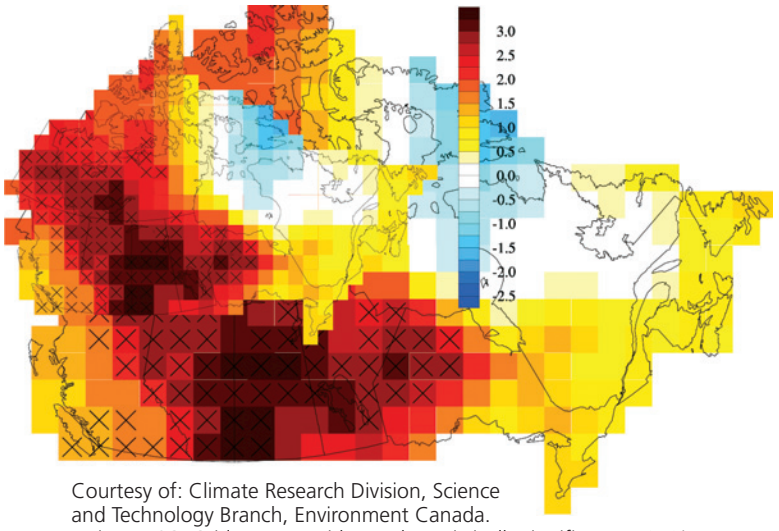
back towards space it is absorbed by gases in the atmosphere and by clouds. This absorption keeps the planet at an average temperature of around 15°C (59°F). If this energy was all reflected back into space, the planet would be about 30°C (86°F) colder, and life would be impossible.

Greenhouse gases (gases in the Earth's atmosphere that absorb heat) such as water vapour, carbon dioxide, methane, ozone, chlorofluorocarbons (CFCs) and nitrous oxide, act something like the insulation in a house. By absorbing the sun's reflected energy as heat, they keep the planet at a temperature that allows plants to grow.

As you have probably heard, we have been increasing the amount of greenhouse gases in our atmosphere for about 150 years. For example, burning fossil fuels (in cars, home furnaces, coal-fired electrical plants and factories) releases carbon dioxide into the atmosphere. The amount of carbon dioxide in the atmosphere has increased substantially, especially since 1900. Scientists measure the amount of carbon dioxide in the past atmosphere by examining the amount of carbon dioxide in dated layers of glacier ice cores. More recently, atmospheric carbon dioxide levels have been measured directly.

Refrigerators and spray cans both increase the amount of CFCs in the atmosphere. (However, many uses of these gases are being phased out). Methane, much of which comes from decomposing garbage, is also rising in concentration. Scientists believe that the increase in these greenhouse gases will magnify the amount of heat from the sun trapped by the atmosphere. This additional heat will affect the climate by raising the Earth's temperature and, thereby, changing the planet's weather patterns. Analyses by Environment Canada scientists have shown that annual temperatures across Canada have risen by an average of 1°C since 1950 (see Figure 2).

Figure 2. Change in spring mean temperature for Canada, 1948-2003



Courtesy of: Climate Research Division, Science and Technology Branch, Environment Canada.
Units are °C. Grid squares with trends statistically significant at 95% are marked by crosses.

Graphs showing changes in Canadian and global greenhouse gas emissions and temperatures are available on-line at:

www.ec.gc.ca/pdb/ghg/inventory_report/2006/som-sum_eng.cfm

www.ec.gc.ca/soer-ree/English/Indicator_series/

www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf

www.earth-policy.org/Indicators/Temp/2008.htm

The Effects of Global Warming

The consequences of a rise in global temperature will not be fully known at a local or regional level until the change actually occurs. The overall consequences of global warming are anticipated to include the following: rising sea levels, an increase in the severity of extreme weather events including thunderstorms and tornadoes, changes in the quantity and quality of available water, etc.[2] We are already seeing in Canada melting of permafrost in the Arctic and loss of Arctic sea ice leading to a variety of impacts both on ecosystems and communities. One of the possibilities is that global warming will be so rapid that many plant and animal species will not be able to adjust quickly enough to survive.

So...Has It Been Warmer Lately?

When they hear about global warming, many people wonder if a long-term warming trend will affect the weather they will know in their lifetime. Although there is a great deal of year to- year variation, recently, the weather has been hotter than usual. Studies and interpretation by the Earth Policy Institute based on NASA data showed the eight hottest years on record occurred between 1998 and 2007, with the two hottest in 2005 and 2007[3].

Conclusion

As you can see, the current warming trend we are experiencing has some serious implications for the future of life on earth. Although there are varying opinions about the exact effects of this warming, it is clear that the current warming is real and that it will have some negative effects on us all. Climate change is a reality.

Action that is taken today will have a profound impact on the climate of the future, and acting now is the only way to begin to slow climate change. PlantWatch (in addition to activities that can be found at many of the following websites), is an excellent way to contribute valuable data to monitor the effects of climate change.

Websites

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
www.ipcc.ch/
The IPCC was established to provide the decision-makers and others interested in climate change with an objective source of information about climate change.

ENVIRONMENT CANADA
The Green Line Climate Change Website
www.ec.gc.ca/climate/home-e.html
This site offers background on climate change, Canadian scientific research and information on what governments are doing to address the climate challenge.

Take Action for the Environment
www.ec.gc.ca/education/default.asp?lang=En&n=050049D2-1
This site offers suggestion as to what you can do to reduce Greenhouse Gas Emissions as well as links to educational resources.
www.ec.gc.ca/education/default.asp?lang=En&n=D3D10112-1

GOVERNMENT OF CANADA
ecoACTION
www.ecoaction.gc.ca/
This site describes efforts by the Government of Canada to reduce climate emissions and contains information on climate change activities, grants, programs, resources and events.

NATIONAL ROUND TABLE ON THE ENVIRONMENT AND THE ECONOMY
www.nrtee-trnee.com/eng/issues/climate.php
Research into climate change policy approaches.

NATURAL RESOURCES CANADA
www.adaptation.nrcan.gc.ca/index_e.php
Information on Climate Change Impacts and Adaptation.

THE PEMBINA INSTITUTE
www.pembina.org
In addition to climate protection solutions and practical information on how to reduce greenhouse gas emissions, this site contains information on how to obtain the Pembina Institute's climate change teaching resource package. This amazing package contains 14 student activities on climate change in both French and English.

WORLD WILDLIFE FUND CLIMATE CHANGE SITE
www.panda.org/about_wwf/what_we_do/climate_change/index.cfm
Climate change issues around the world are discussed on this site.

Other websites to consider:

www.greenfacts.org
www.davidsuzuki.org
www.environmentalsociety.ca

[2] www.ec.gc.ca/climat-climate/default.asp?lang=En&n=4630D154-1
[3] www.earth-policy.org/Indicators/Temp/2008.htm

SCIENCE CONCEPT TWO — Trees & Forests: the basics

1. **Our PlantWatch tree and shrub species are valuable!**
   - As habitats for a variety of living things

     Two thirds of Canada's estimated 300,000 wildlife species live in the forest. Saskatoons provide food and shelter for species such as birds, hares, mice and mushrooms.

     Aspen poplar bark and leaves are the preferred food of beavers, and these animals often use the branches to construct their dams and lodges. Aspen poplar winter buds are eaten by grouse. Young aspen twigs and leaves are browsed by hoofed animals such as deer, moose and elk. These animals can also use aspen poplar groves as shelter to hide from wind and predators.

   - For recreation

     Saskatoon berries are fun to pick and turn into pies, jams and syrup. Saskatoon bushes provide a good habitat for numerous nesting birds, and mixed poplar/conifer forests are home to more kinds of nesting birds than any other forest type in Canada. Birdwatchers know this and appreciate it!

Beaver ISTOCKPHOTO.COM

   - As part of a life-supporting environment

     Maintaining biodiversity (total variety of living things) keeps our planet's ***ecological*** systems strong and healthy and more able to withstand the stresses imposed by people and our changing climate. Forests play a key role in moderating our climate, regulating our water systems, preventing erosion, and alleviating air pollution.

2. **A variety of plants and animals live under, on and among trees. Trees affect and are affected by these other living species.** Some examples from PlantWatch species are as follows:

   Beavers cut aspen poplar trees down to get branches to build their dams and lodges. Aspen bark also is an important winter food for hoofed animals such as elk, moose and deer.

   Saskatoon provides food (berries) for birds as well as mammals such as mice and squirrels. The winter buds are a preferred food for sharp-tailed grouse, and deer, elk and moose eat the branches in winter. Saskatoon also provides a sheltering habitat for these animals and others, such as the snowshoe hare. Because saskatoon is a native shrub found throughout much of temperate North America, and has been evolving here over thousands of

years, many insects and fungi have adapted to use it as a food source. Insects (and fungi) feed on its roots, stems, leaves, flowers and/or fruit. There are nineteen species of moths/butterflies whose caterpillars (larvae) eat saskatoon. The insects in turn are valuable food for birds!

A healthy forest depends on complex relationships between tree species and other organisms. All wild or native plants have important partnerships with some soil ***fungi***. For example, fungal partners are known to give saskatoon shrubs great drought hardiness. The saskatoon's roots are connected to fine fungal strands through which plant and fungus trade nutrients. The plants provide sugars to the fungi (or mushrooms) and receive water and minerals in exchange. By greatly increasing the saskatoon roots' ability to absorb water, fungi help the shrub survive drought. The growth and survival of forest plants is dependent on these fungi, which protect them from infection and enable them to absorb water and nutrients from the soil. Without this partnership, neither green plant nor fungus would do well, which is why native plants need undisturbed prairie or forest soils where their ***fungal partners*** live and why some native plants can be hard to grow in domestic gardens.

Helping Songbirds

LISA GRBINICEK

Studies show that there have been significant and rapid declines in some forest songbird populations in the past decade. The main causes of this decline appear to be forest fragmentation (large areas of forest becoming small patches of forest) and the loss of habitat along bird migration routes due to agriculture and urban development. If we can retain hedgerows and other areas of native bushes and trees, birds will have needed shelter and food-rich habitat in their migration and nesting seasons.

3. **Trees play an important role in nutrient cycles**

In the fall, aspen poplar leaves turn yellow and saskatoon leaves turn bright orange, red or purple. The leaves then fall off and pile up on the ground. Then an army of decomposers (insects, worms, bacteria and fungi), all assisted by rain and warmth, begins to turn the leaves into nourishing soil.

Some leaves don't go through the decomposition process, but are directly consumed. For example, freshly fallen aspen poplar leaves (which look like gold coins) are a very popular food for deer and elk. The fallen leaves also provide insulated hiding places for many overwintering adult insects such as beetles, as well as butterfly, moth and spider eggs.

Trees are defined as perennial plants with a single woody stem over 5 cm (2 in.) in diameter.

A shrub (or bush) has two or more main woody stems, each less than 5 cm (2 in.) in diameter coming up from the ground. However, what grows as a shrub in some parts of Canada, grows as a tree in other areas. For example, in rich soil in British Columbia, a saskatoon can develop a single trunk and grow up to 10 m (30 ft.) tall.

Activity 4

overview

Forests offer a number of benefits to humans and wildlife. Canadian forests are dynamic and their characteristics change over time. Forest fires are an integral part of the life cycle of Canadian forests. In this activity students will be introduced to, think critically about, and research the impacts of fires on our forests.

Forests: Discussion and Investigation

SKILLS

Debating, critical thinking, problem analysis, research and information gathering

MATERIALS

The readings in this activity.

The internet or a library so students can find supplementary resources to help them answer their questions.

PREPARATION

Review this activity.

FOCUS

Forest characteristics and the issue of forest fires.

Oak leaves CREDIT VALLEY CONSERVATION

SUGGESTED CONNECTION

Social Studies Activity 2, *People in History* (page 70)

PROCEDURE

1. Begin a class discussion/debate around the following questions (introduce the information in this activity as you go along to inform your discussion):

   a) For what are forests used?

   b) What is the difference between an old forest and a young forest? Is one better than the other?

   c) Are forest fires helpful or harmful for forests?

2. Have your students research the issue further (via the internet or the school library) to try to answer the above questions and the following questions: Would putting out all fires be good or bad for our forests? Which impact leads to a healthier regrown forest, a hot forest fire or clear-cutting?

BACKGROUND INFORMATION

1. Forests are used for

- logging trees for lumber and pulp
- preserving the environment (plants and animals, biodiversity, ecosystems)

- preserving cultural heritage (the land and culture of Canada's First Nations people)
- recreation (camping, hiking, hunting, fishing)

2. Different animal and plant species live in young forests and in older forests

- In younger forest we see birds such as yellow warblers and American redstarts, as well as many shrubs and young trees, including aspen poplar and saskatoon.
- In older forests we see larger trees; thick carpets of lichen, mosses and horsetails; cavity-dwelling birds such as woodpeckers and some ducks; warblers such as the Blackburnian, Cape May and blackthroated green; and predators such as goshawks and barred owls.
- If all the older forests disappeared, we would lose the many plants and animals that need this habitat to survive. As old forests are often fairly open to walk through, with trees spaced far apart, a significant recreational resource would be lost. If all the forest was gone and converted to agricultural land, then precipitation falling on the land would no longer be stored by mosses, tree roots, etc. but would run off causing erosion of the soil. Heavy rains could easily cause floods.

3. Fire can be helpful to many forests

Fires have burned our forests for thousands of years, and they have helped build the healthy, diverse forests we have today. Would putting out all fires be good or bad for our forests? How can we find out? Which impact leads to a healthier regrown forest, a hot forest fire or clear-cutting?

- Plants, fungi, lichens and insects have adapted over thousands of years to fire conditions — seeds can persist and germinate after a fire and often plant roots survive (e.g. aspen poplar and Saskatoon sprout vigourously after a fire). The cones of the jack pine and lodgepole pine trees require heat from a fire to open the cone scales and release the seeds. Other benefits are as follows:
  - wood lilies (*Lilium philadelphicum*) produce more bulbs, flowers and seeds after a fire, and the blooms can then turn the forest floor bright orange
  - mountain bluebirds prefer to nest in holes in burned trees or snags
  - nighthawks nest on the ground in burned areas
  - woodpeckers become very numerous after a fire, as they use burnt trees for food and shelter
  - some birds that need to perch high above the ground (flycatchers, hawks, owls) use the dead trunks left by a fire
- Another benefit is that weedy, invasive, introduced plants are often eliminated.
- Fires often kill trees but the dead trunks stay standing for many years, whereas clearcut logging removes all the tree trunks to a pulp mill or saw mill. Can you think of any plants or animals that could live in a recently burned forest but could not live in a clearcut forest?

Activity 5

Developing a Phenology Calendar

overview

Students can build on the observation skills developed through PlantWatch by expanding the focus of observation to other seasonal events that occur throughout the school year.

PlantWatch is part of the NatureWatch suite of citizen science monitoring programs. NatureWatch also includes IceWatch where participants track the freeze and thaw dates of local water bodies. The other programs are FrogWatch, which monitors the abundance and diversity and call timing of amphibians, and WormWatch, which monitors the abundance and diversity of worms. Log on to www.naturewatch.ca to learn more and participate!

In the following article, reproduced (with permission) from the *Green Teacher*, grade 7 teacher Larry Weber describes his innovative approach to studying the environment, exploring the natural world and fostering respect for native habitats. By following the seasons in his area (Minnesota, USA), Larry Weber has developed a science curriculum based on local phenology. Each month, Larry and his students examine a new topic that explores what is happening outside the door to their classroom.

You may wish to develop a similar list of events for your area. Consult with a local naturalist to help develop a list of monthly events. Make a class 'phenology calendar' by filling in the dates when these events occur!

SUGGESTED CONNECTIONS

Key Activity 1, *Signs of Spring* (page 9)

Key Activity 2, *Predicting Seasonal Occurrences* (page 11)

Key Activity 3, *Locating and Tagging the Plants* (page 13)

Science Activity 1, *Plants and Ecology: All My Relations* (page 31)

LARRY WEBER

Teaching with the Seasons

Nature's daily and seasonal drama provides the textbook for this grade seven natural science course based on phenology.

by **Larry Weber**

Those of us involved in environmental education in the late 20th century face a formidable challenge. Environmental degradation continues even as we try to tell the next generation how unwise this is. Preaching the wrongs of environmental sins does not work. Nor do environmental scare tactics or blaming the students for the lifestyle enjoyed by their families. And merely describing environmental problems and possible solutions is a boring way to teach and to learn.

Underlying the difficulty of finding ways to foster concern for the environment is the fact that the majority of the youth we are trying to reach have less interaction with and awareness of the natural world than any previous generation. Over my thirty-year teaching career I have seen a dramatic decline in the amount of time students spend outdoors exploring on their own. Pick up an interesting insect, leaf or seed pod from your schoolyard and chances are that most of your students — and many of your colleagues — will be completely unfamiliar with it. "I never saw that before!" they will exclaim. Ask your students to name ten animals and most will name animals from other parts of the world. Given how little many of our students see or know of the natural world right outside the window, how can we expect them to care about

environmental problems? Is it reasonable to hope that they will work to protect what they do not see?

I believe that part of our task as environmental educators is to fill in this gap in students' education and awareness, to give students a positive, healthy view of the planet, starting with the abundance and variety of nature nearby. For the past 15 years I have been teaching a Natural Science course to seventh graders that seeks to do just that. The curriculum I developed is based on phenology, or as Webster explains, "the study of natural phenomena that recur periodically, such as migration or blossoming, and their relation to climate and changes in season." The students learn about local flora and fauna, track the weather, and closely monitor the progression of the seasons. Through the year, they develop skills of observation and prediction, experience the excitement of recognizing trees, wildflowers and animal tracks, and become attuned to the environment generally. They come to see that nature is not "somewhere else" but a dynamic presence in their daily lives.

Design of the Course

The phenology natural science course operates around three conditions that together make it unique: We do not use a textbook; we regularly use the outdoors as a classroom; and we follow the seasons' phenology as the curriculum. Instead of using my alloted money to buy textbooks, I buy classroom sets of reference books (mostly the Golden Zim guides) which students use to research the weekly topics of study, to verify observations and to identify finds. Students bring two notebooks to class. One stays indoors, while the other becomes a field journal in which students take copious notes and make sketches on our outdoor forays.

We go outdoors on a weekly basis and, with the exception of two short bus trips, we make use of the school campus and nearby property for the entire year. The purpose of the outdoor walks is to find examples or evidence of the phenology topic we are exploring that week. However, students are encouraged to look for other interesting things along the way and these add an element of spontaneity and excitement. Students observe and make notes on some of these unanticipated finds, as well as on weather and ground conditions, and the phenology topic of the walk. While always rewarding, going outdoors weekly is not without its difficulties. Students do not always come properly prepared for weather conditions, and their energy levels outdoors can be very taxing on the teacher. For these reasons it is important to maintain a semblance of classroom structure. I have found that taking students outdoors regularly from the beginning of the school year helps to establish a routine. And, as in the indoor classroom, we have a strict code of conduct involving how we act towards each other and how we treat organisms that we find. Knowing what to expect from me and what is expected of them allows us to build a pleasant working rapport. Most students find that they enjoy the walks even when the weather may be undesirable.

Class Procedure

Regular class procedure revolves around the following five main components of the course:

Weather: Temperatures and precipitation are recorded regularly, and each day we plot the high and low temperatures. Being near Lake Superior, we often find huge variations in temperature within very short distances.

As a result, we obtain the official weather from a local weather station, but we also check our instruments. We compare monthly weather statistics to the norm, and measure and mark snowfall totals on a "snowboard" on the wall. For students who are unaccustomed to noticing or remembering the weather from one day to the next, this constant weatherwatching fosters an awareness of the newness of each day, of recurring patterns, and of links between weather and wildlife. Recalling the weather during the past week often enables us to predict what we are likely to find on our outdoor walks.

Months: At the beginning of each month, we list and discuss what will happen in nature during the coming month, including the timing of the full moon and other

astronomical events. We also talk about the names of the months and try to come up with more meaningful ones that reflect events in the natural world, such as The Dark Month (December) or The Crusty Snow Month (March).

Fall and spring phenology charts: Each year, the class plots the dates of the last sighting in fall and the first appearance in the spring of common flora and fauna. Similar data is kept for weather happenings such as freezing, thawing, snows, etc. The phenology charts are extremely valuable in documenting the change of seasons and the consistency of events from one year to the next. Kept over a long period time, such charts can even aid in detecting long-term trends such as global warming.

Students' discoveries: Students are regularly given time to share their own findings, either sights (critter news) or specimens caught and brought to class and examined. All collected organisms are returned to the wild within a day of being caught.

Phenology topics: I have developed a sequence of 30 phenology topics, each of which is explored for a week or two, not more. This means that the current topic is always pertinent to what is happening in nature at that time of year.

A typical week

Monday: Discussion of present phenology; critter news, sharing of students' discoveries; weather news; introduction to the week's phenology topic

Tuesday: Discussion of the week's topic, using classroom references and other sources as well as 35 mm slides

Wednesday: Outdoor walk to look for examples or evidence of the present phenological topic. Students take notes and make sketches as we go along.

Thursday: Go over the findings from the walk and continue discussion of the topic.

Friday: Students hand in a written report summarizing the walk and our findings; students take a quiz on the topic, often done in cooperative groups.

LARRY WEBER

Phenology Topics by Month

The following 30 phenology topics are covered during the course of the school year. Their timing may vary some years, but this is the desired sequence. Teachers attempting to use phenology-based methods will need to become aware of their own local weather and phenology. This may be challenging, but it is a terrific learning experience and offers the joy of learning along with the students.

SEPTEMBER: THE COOLING MONTH

Mushrooms and other fungi: Mushrooms and other fungi abound nearly every fall near the school, often on the school lawn. They are easy to find and lead into good discussions and activities.

Fall migration - raptors: Hawks and other raptors are the focus of the bird migration in the fall. We visit Hawk Ridge, about 15 minutes away by bus.

Fall wildflowers: At this time of year, the meadows are filled with asters, goldenrods, sunflowers, clovers, and many other wildflowers. We go among and learn about these often overlooked plants.

Deciduous trees: We learn trees by their leaves, fruits and berries. In our region, deciduous trees spend more of the year without leaves than with leaves.

OCTOBER: THE LEAF-DROP MONTH

Insects: During the warm mild days of October, insects are very common in the meadows. Here we catch, observe, and release many. We also find galls and leaf miners.

Spiders: Mild autumn days are excellent for observing spiders in meadows, lawns, and ballooning in the bare trees. We catch and release.

The pond in fall: Now before the freezing, a visit to a nearby pond reveals the diversity of aquatic life. Many organisms are observed and released.

Small mammals: With the leaves dropping from trees, small mammals are getting ready for winter. We look for signs of nearby residents and live-trap a few.

NOVEMBER: THE CLOUDY FREEZE-UP MONTH

Non-flowering plants: Now with the leaves off trees and before snow, small plants such as mosses, clubmosses and ferns are easy to see. We learn about them before they are covered.

Animal signs: November is a good time to see nests, gnawings, caches, droppings, and other indications of animal presence. This topic can also be done in the snow.

Animal tracks: In the early light wet snows, many mammals are active and their stories are left in the lawns, meadows and woods.

DECEMBER: THE DARK MONTH

Large mammals: Introduced to animal signs and tracks last month, students now take a closer look at large mammals. We usually do not see many large mammals but we recognize their signs and tracks.

Winter birds: With the advent of cold weather and the snows of December, bird feeders become active. We observe the birds at the feeders as well as other birds that winter with us.

Natural lights: During the darkest week of the year, in anticipation of the coming solstice, we look more closely at natural lights around us and discuss the color of sky, ice, snow, etc.

JANUARY: THE COLD MONTH

Wildlife in winter weather: In the cold and snow of January, we take time to look at how wildlife is able to cope with these conditions and survive.

The pond in winter: Using ice augers, we drill through the ice covering the pond and sample the water beneath, examining it for pond critters. This is a good time to introduce the use of microscopes.

Conifers: Staying green all winter, the evergreens are now easy to see. We learn different kinds of conifers and how they use their leaves and shape to deal with winter.

FEBRUARY: THE DRY MONTH

Humans in winter weather: With a little planning and understanding of winter conditions, we learn how to be outside safely. Wind chill, hypothermia, frostbite, etc. are discussed.

Winter wildflowers: Often looking dead and stick-like, the perennial "weeds" persist throughout the winter. We learn different ones and how they differ in their methods of seed dispersal.

Deciduous trees in winter: The trees are bare, but can be identified by their shapes, colors and various twig conditions. We make and use a simple dichotomous key.

MARCH: THE CRUSTY-SNOW MONTH

The sap flow: Quietly, the trees respond to the warmer and longer days of early March. We tap sugar maple trees for sap and make syrup enough for everyone to taste.

Fish and streams in early spring: Streams break up before ponds and lakes. Several fish are quick to spawn. We go to a nearby small stream to look for fish and other stream fauna.

Early spring things: March is the time of micro-environments. We wander around the school, searching for the first dandelions, earthworms, flies, jumping spiders, etc.

Tree flowers: Responding to the longer days, trees flower early. We see pussy willow and aspen start the catkin season and several others quick to follow.

APRIL: THE THAWING MONTH

Spring migration - waterbirds: Rivers now hold many early migrants, the waterbirds. We learn common waterfowl and visit the St. Louis River to see them, a twenty minute trip off campus.

Frogs and other amphibians: With the thaw, ponds are the location of calling and mating frogs. We listen and look for common species. No egg collecting is done.

The pond in spring: The water is still cold, but the spring pond is filled with life. The eggs and larvae of many organisms are different from the adults we saw on earlier visits.

MAY: THE GREENING MONTH

Spring wildflowers: Since the leaves are still not on the trees, sunlight penetrates to the forest floor. We seek out and learn many of the ephemeral wildflowers.

Spring and summer songbirds: Spring migration is at its peak in May. Warmer weather brings myriad insects, and the songbirds, many of which nest here, return. We listen and look for them.

Lesser-loved critters: As the school year comes to an end, we go outside more often and are more likely to come in contact with wood ticks, mosquitoes, black flies, etc. We learn about these.

The phenology-based Natural Science course has been very successful and has been adapted by colleagues for use with elementary, middle and secondary classes. Both students and parents have shared with me how observant they have become as a result of this class. They report that family outings are now enriched with comments about local plants and animals, and most remark that they never knew so much was so close by.

As we leave the 20th century, we and our students are living in a world of shrinking natural habitat and diminishing opportunities for interacting with nature. The phenology-based approach to Natural Science helps to counter this trend. By putting students in touch with nature on a daily basis, by familiarizing them with local flora and fauna, and by teaching and reinforcing the skills of observation, we can help them build the foundation of a lifelong appreciation of the richness of the natural world around them. Only then can we expect young people to care enough about the environment to make the effort that will be needed to save it from the demise that may now appear inevitable.

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Mathematics

The PlantWatch program engages students as active participants in the collection and analysis of scientific data. It provides an opportunity for students to practice using their observation skills and to make accurate records, as well as to report findings in a scientific manner. Scientists must be able to portray their information in graphs that are easy for others to understand. The skills listed below all involve mathematics and are transferrable to other fields of study.

SKILLS USED IN PLANTWATCH:

- ✓ measuring temperature
- ✓ addition
- ✓ subtraction
- ✓ division
- ✓ graphing
- ✓ calculating averages
- ✓ linear measurement
- ✓ data management
- ✓ latitude and longitude calculations

Mathematics

Activity 1

Growing Degree Summation (GDS)

overview

After being exposed to a certain amount of heat, a spring wildflower will bloom. The concept of ***growing degree summation*** (GDS) provides a way to add up how much warmth, or how many ***heat units***, a plant has been exposed to as winter changes to spring and temperatures increase. Some people refer to these units as "growing degree-days." Although growth in Canada's wild plants probably begins as soon as temperatures are above zero, we will use 5°C as a base temperature (the minimum temperature at which growth starts)[4]. This temperature is the standard used in agriculture.

SKILLS

Addition, division, graphing, use of Centigrade temperature scale

MATERIALS

daily newspaper with temperature records, if available

graph paper

calculator (optional)

FOCUS

How much heat does it take for plants to begin to bloom?

SUGGESTED CONNECTIONS:

Key Activity 2, *Predicting Seasonal Occurrences* (page 11)

Key Activity 4, *Reporting to the Class* (page 17)

Key Activity 6, *Looking Back* (page 23)

Science Activity 2, *Weather* (page 33)

PREPARATION

Review this activity (Mathematics Activity 1, *Growing Degree Summation,* page 51)

PROCEDURE

1. Calculate the growing degree summation (GDS) for a spring day. This can be done using temperatures published in a local newspaper, and some simple math. Graph average daily temperatures to see how temperatures fluctuate over a short period of time (i.e. week, month). See Background Information.

2. Calculate the accumulated GDS for the first bloom of your observed plants. Use your daily GDS calculations from #1 above, to determine accumulated GDS.

See Background Information.

BACKGROUND INFORMATION

How to calculate GDS for a spring day

In your area, determine in which spring month the daily high temperatures generally start to go above 10°C. Start your daily calculations on the first of that month.

[4] Note: The calculation is done using Centigrade degrees.

If you are observing plants in a city, the daily high and low temperatures are generally published in daily newspapers. Use the confirmed temperatures listed for the previous day.

Determine the daily average (mean) temperature in a location by adding the daytime high (usually occurs in day) and the daytime low temperature (occurs at night) and dividing by 2. Then subtract 5 degrees to determine the GDS (heat units) for that day. If the weather was cool and the average temperature was less than 5°C, then that day had no GDS and does not count in your GDS calculations. (Do not add a negative GDS in your calculations; simply count these as zero GDS.)

Example

High or maximum temperature	15°C
Low or minimum temperature	3°C
Average temperature	15°C + 3°C = 18°C ÷ 2 = 9°C
Degree summation above 5°C	9°C- 5°C = 4 GDS on this date

The daily average temperatures can be graphed as in the example shown below. Note that on May 9 and May 21 the average temperature was below zero.

Calculate the accumulated GDS for first bloom of your observed plant(s):

The accumulated GDS will tell students how much heat it takes that year for a particular plant to flower.

Example

If there were 70 GDS for the location charted below up to May 1, and the plant first flowered on the evening of May 3, what was the total GDS (heat units) needed for first flowering?

ANSWER:	GDS
heat units from days before May 1 (i.e., April):	70
plus GDS above 5°C on May 1:	5
plus GDS above 5°C on May 2:	4
plus GDS above 5°C on May 3:	7
Total GDS:	**86**

QUESTION: The plant was in full bloom late on May 7th. What was the total GDS needed to reach full flowering?

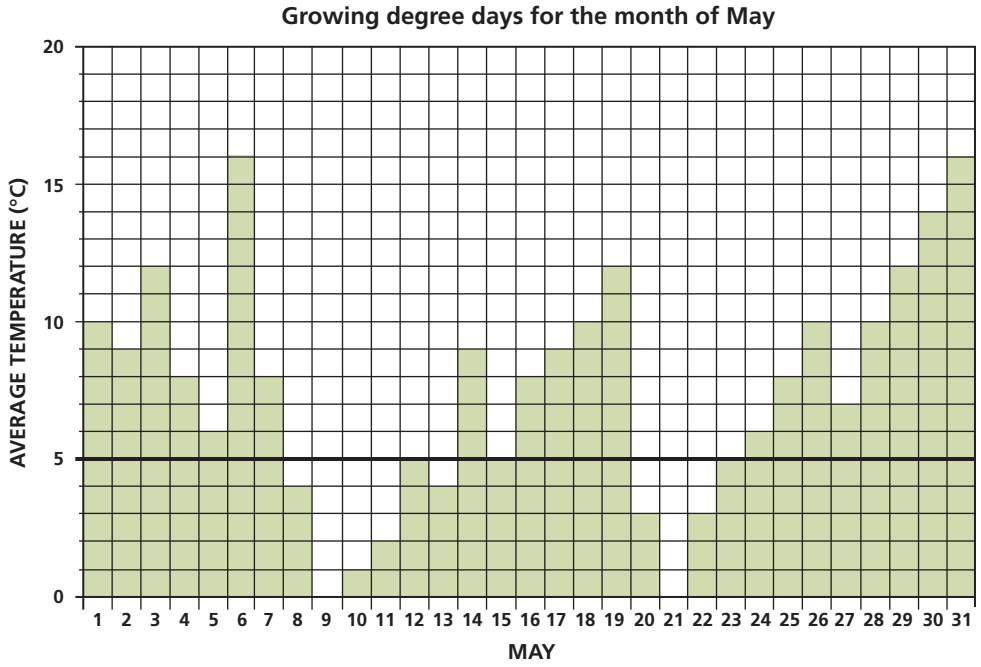


Figure 3. A sample chart of average daily temperatures in a month

Activity 2

Calculating Averages

overview

To get a good idea of this year's bloom times in your area, it is best to observe several plants of your selected species. Bloom times vary between individual plants, and it is most accurate to report an average or mean of these flowering dates. In this exercise you can create a Julian calendar and use the Julian dates to easily average your dates. Report this average to PlantWatch!

SKILLS

Addition, Division

MATERIALS

Paper/pencils or computer with a spreadsheet program

PREPARATION:

Review the Background Information for this activity.

FOCUS

What is the average flowering date for your PlantWatch species?

SUGGESTED CONNECTIONS

Key Activity 6, *Looking Back* (page 23)

Science Activity 2, *Weather* (page 33)

Mathematics Activity 3, *Graphing and Mapping* (page 55)

PROCEDURE

1. Calculate an average first flowering date for plants that all flowered during one month.
2. Calculate the average date of a flowering stage (for example, first flowering) for plants, using a Julian calendar.
3. Report your calculations when you send PlantWatch your results! When reporting bloom dates, students should put the average date of the same plant species under the Comments section on the Observation form (e.g., "The average date of flowering for our five lilacs was May 31.")

BACKGROUND INFORMATION

Calculate an average flowering date...

1. For plants that all flower during one month

If the observed plants all flower during one month, your students can find an average using the days of the month. For example, supposing there are five "first flowering" dates in May. The calculation is done as follows:

May (15+16+16+17+19) / 5 = 16.6.

This number is rounded off and May 17 is reported as the average first flowering date.

2. Using a Julian calendar

To easily calculate the average date of a flowering stage (for example, first flowering) for plants, the **Julian calendar** is often used.

Have your students create their own Julian calendar for this year.

In the Julian calendar, each day of the year has a number, starting as follows:

January 1 = Julian day 1
February 1 = day 32
March 1 = day 60
December 31 = day 365

This way of calculating dates is very useful when the dates to be averaged span two months.

For example, April 29, May 2 and May 3 converted to Julian dates make averaging a simple mathematical problem. In a leap year (e.g. 2004, 2008, 2012), when we have an extra day, February 29, you need to alter the calendar so that March 1= day 61, and so on, up to December 31= day 366.

Determine the Julian day for each of your plants' first flowering date that you recorded. Find the average of these numbers by adding them together and dividing by the number of dates added.

Refer back to your Julian calendar to determine the month and day of this average Julian date.

Example: If the class observed five common purple lilacs in the year 2000 (a leap year), with first flowering dates of May 28, 30 and 31, and June 2, then the Julian day calculation would be as follows:

May 28 = Julian day 149
May 30 = Julian day 151
May 31 = Julian day 152
June 2 = Julian day 154
June 2 = Julian day 154

Total of Julian dates: (149 + 151 + 152 + 154 + 154) = 760 divided by 5 days = day 152.

Therefore, May 31 is the average first flowering date for these five common purple lilac shrubs.

Activity 3

overview

Use your own data or PlantWatch data posted on the Internet to produce graphs and maps of temperatures and bloom dates. Interpret graphs of bloom data from Nova Scotia, Canada and Sucany, Slovakia.

Graphing and Mapping

SKILLS

- Data management (students find PlantWatch and weather data on the web, and organize and map data)
- Graphing (students interpret provided graphs, or graphs and maps on the web)

MATERIALS

graph paper or computer, Internet acces

PREPARATION

Review this activity and Mathematics Activity 1.

FOCUS

How to create, read and interpret graphs.

SUGGESTED CONNECTIONS:

Key Activity 4, *Reporting to the Class* (page 17)

Science Activity 2: *Weather* (page 33)

Mathematics Activity 1: *Growing Degree Summation* (page 51)

PROCEDURE

1. Make your own graphs and maps (see page 56)
2. Interpret graphs (see page 57)
3. Read graphs (see page 58)

MAKE YOUR OWN GRAPHS AND MAPS

A. **Growing degree summation** — See Mathematics Activity 1 (page 51) which includes graphing average daily temperatures.

B. **Flowering dates** — For each PlantWatch species that your students observed create a graph with calendar date and Julian date (see Mathematics Activity 2, page 53) on the x axis and plant number on the y axis. You can graph both first and full bloom on the same graph by using different symbols.

C. **Temperatures** — Chart the daily high and low temperatures and calculate the mean temperature.

D. **Use data on the PlantWatch website** — Have students look up the PlantWatch website (www.plantwatch.ca). Log on under "Submit Observations" To download data click on the purple floppy disk icon on the top right hand side of the screen. Select a province or territory. The data table lists location, species name, stage (first or mid bloom, or leafing), date, notes, etc.

Have your students do the following exercises:

Exercise (i) — Select a plant species, and a growth stage (e.g. first, or mid bloom) and using the location information, plot the most recent year's observations as dots on a map.

Exercise (ii) — Using the archived data from previous years, map all available data for your selected plant for your area, making a separate map for each year. Make a prediction of bloom times for next spring.

The following is an example of how flowering dates can be graphed from north to south to see the influence of latitude. This data is from the PlantWatch program in western Canada, 1996, for common purple lilac. If many dates were received for some areas, a mean date was calculated for graphing. Why do you think these British Columbia dates are so much earlier? Why might it be that northern areas (like Edmonton) sometimes have earlier first bloom than areas farther south (like Calgary)? (Consider the effects of altitude/weather patterns.)

Compare temperature records by seeing the - 1971- 2000 Canadian climate normals [www.climate.weatheroffice.ec.gc.ca/climate_normals/index_e.html] for two cities in your province or territory. (Normals are the average temperatures and precipitation over a 30 year period)

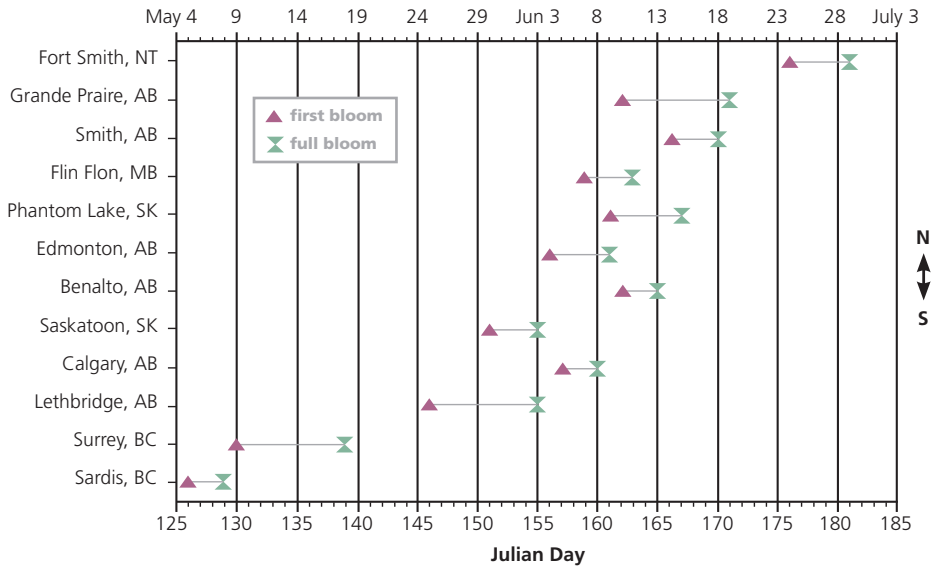


Figure 4. First and full bloom dates of Common Purple Lilac (Syringa vulgaris) for western Canada.

Based on 1996 PlantWatch data (Feb 4, 1997) University of Alberta

INTERPRET GRAPHS

Nova Scotia student phenology reports, 1910-1923 (an Internet activity)

The Nova Scotia Museum of Natural History has posted a fascinating database of phenology information from eastern Canada in the first quarter of this century. Alexander H. MacKay was secretary for the Botanical Club of Canada, as well as superintendent of Education for Nova Scotia. He coordinated a phenology survey for that province from 1891-1927. Students and teachers recorded the dates when the flowers of many native and cultivated plants were first seen and becoming common. Many of the plants that were surveyed in this early Nova Scotia study are now also used by PlantWatch!

Find the website:
https://thousandeyes.ca/english_en/graphing.php for the following exercises.

Exercise (i)

- Under "Time series" select Trembling Aspen (*Populus tremuloides*). Select the county "Annapolis". Select the belt: "Low inlands". Click "Show me". Scroll over the top left hand corner of the graph image. A pop up will allow you to save or print the image or, right click on the image and click "Save picture as" and select where you would like to save the image to your computer.
  - Change the subject to Common purple lilac (*Syringa vulgaris*). Follow the instructions to save or print the image.
  - Repeat for Indian Pear (*Amelanchier spp.*), which is the Nova Scotia name for saskatoon or serviceberry.
- Use the graphs to answer the following question:

  Which graphs show more variability in flowering time reported within a single year (ie which shows the most large blue bars)?

  ANSWER: Trembling aspen has the least years of data, and the largest bars (most variability between minimum and maximum flowering dates reported that year). In some cases the error bars are small because there is only one site for that date. Lilac dates have short and large error bars. Indian pear has very short bars demonstrating a small amount of variability in first bloom dates from the various schools participating in the survey.

Exercise (ii)

This exercise shows users "first bloom" for key PlantWatch species.

- Go back to https://thousandeyes.ca/english_en/graphing.php
- Under "Interspecies plots", select "Indian pear" as Subject 1. Select "Dandelion" as Subject 2. Select "Lunenburg" as the county, and press "Show me".
- Change the belt to "Coast". It is important the belt is listed as "Coast". The default is "Low Inlands" and will show a different graph.

  Use the graph to answer the following questions.

  A. Which graphs shows more variability in flowering time (the difference between the earliest and latest flowering date recorded) between different years, Indian pear or dandelion?

  ANSWER: The Julian Day of first flowering for Indian pear ranges from Julian Day 121 in 1901 to 144 in 1917 (23 days difference), whereas dandelion ranges from 108 in 1914 to 135 in 1923, (27 days difference). Therefore, the dandelion shows more variability in flowering time between years than the wild pear.

  B. Which of these 2 species blooms earliest? (ANSWER; dandelion) Is the trend similar between years for the 2 species? (ANSWER; yes, their lines follow each other).

  For which year is the trend very different between these 2 species? (ANSWER; from 1916 to 1917, dandelion bloom earlier in 1917, but Indian pear later) Knowing that plants bloom in response to how warm the weather is, what weather event might have happened in 1917, after dandelion bloomed and before Indian pear bloomed? (ANSWER; snowstorm or cold snap)

READING A GRAPH

Lilac flowering dates in Slovakia

Flowering in shrubs and trees occurs in response to the air temperatures at the height of their branches. Many countries in Europe have a long history of recording the timing of plant development, with several centuries of data. The following graph of lilac flowering times and temperature was kindly provided by Dr. Olga Braslavska, former phenologist for the Slovak Hydrometeorological Institute. (In Canada, we have several phenology data sets going back to the 1890s.)

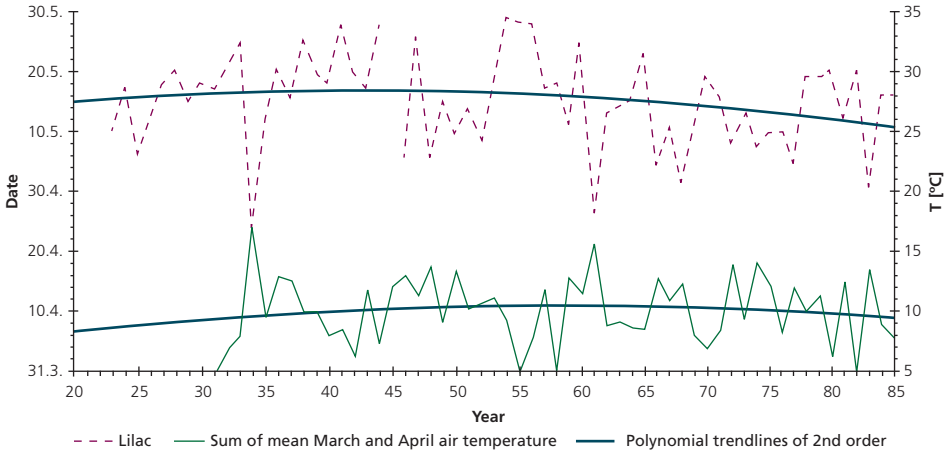


Figure 5. Courses and trends of the air temperature at Bystrička and the beginning of flowering of Lilac (*Syringa vulgaris*) at Sučany in Slovak Republic.

Explanation of the Graph

- The x axis (horizontal axis at bottom) shows the years from 1920 to 1985.
- The y axis (vertical line on left of graph) shows the flowering date for common purple lilac (note that 20.4 means the 20th day of the 4th month = April 20th, and 10.5 means May 10th).
- The y axis on the right shows the temperature, in degrees Centigrade.
- The dotted line shows the annual date when first flowering occurred for common purple lilac in the town of Sučany in Slovakia.
- The solid line shows the temperature in degrees Centigrade, calculated as the sum of the mean March and April temperatures.

Questions to ask students:

1. What were the two earliest flowering years?
2. What was the latest flowering year?
3. In these years were the temperatures unusually low or high?
4. How much variation is there between the earliest flowering date and the latest, on this graph?
5. How much does the temperature vary? (Notice that there are fewer years of temperature data.)
6. Does there appear to be a trend over time in the flowering data?
7. Is flowering getting earlier or later? Why might this change be occurring?

NOTE: If answers are not to appear on student handouts, please cover Answer area before photocopying.

Answers:

1. 1934 and 1961 are the two earliest flowering years.
2. 1954 is the latest flowering year.
3. Warmer temperatures match earlier flowering dates.
4. About 34 days.
5. The spring temperature (sum of the mean air temperatures for March and April) varies by about 13°C.
6. There is a slight trend to earlier bloom since the 1950s. A temperature trend is not so evident.
7. Flowering of lilac in Sučany is getting earlier. This change is most likely due to an increase over time in the air temperature before flowering. There is also a global trend to higher temperatures.

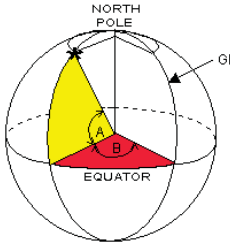
Activity 4

Latitude and Longitude: How to Calgulate our Global Address

overview

In order to use your students' flowering dates, PlantWatch research scientists need to know the location of all the PlantWatch plants in latitude and longitude. If all the plants are within 100 m and 50 m elevation of one another, one location can be reported for all your students' observations. Using a GPS (Global Positioning System) instrument to determine the location of the plants is a quick method of getting a location.

The following introductory exercise will help your students use a map to determine the precise location of their plants and convert their location in degrees and minutes to decimal form, the form most useful to PlantWatch scientists. This straightforward exercise, which takes 15-30 minutes to complete, is an excellent way to introduce the concepts of latitude and longitude to your students.



The latitude of point * is A degrees North. The longitude is B degrees West.

Access to a website where students can double check their locations. (See '*To Check Calculations*' in this activity for more details).

PREPARATION

Review this activity.

Order maps if necessary.

FOCUS

What is the global address of your observed plants?

SKILLS

Addition, division, using decimals, finding points on a map using grid co-ordinates, identifiying latitude and longitude

MATERIALS

Photocopies of the figure and tables from this activity for your class.

Detailed map of your PlantWatch area with both latitude and longitude and degrees and minutes (see '*Finding the Latitude and Longitude of a Particular Place*' in this activity for more details on maps and where to get them).

SUGGESTED CONNECTIONS

Key Activity 3, *Locating and Tagging the Plants* (page 13)

Key Activity 4, *Reporting to the Class* (page 17)

Key Activity 6, *Looking Back* (page 23)

Mathematics Activity 3, *Graphing and Mapping* (page 55)

Social Studies Activity 1, *Geography and People* (page 69)

PROCEDURE

1. Find the Latitude and Longitude of a particular place.
2. Using the figure and instructions in this activity, have your students complete the latitude and longitude exercise.
3. Check Calculations.

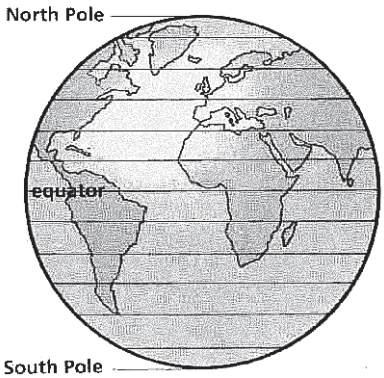
BACKGROUND INFORMATION

What is Latitude and Longitude?

A simple activity, using an orange to represent the Earth, is available at Orange Globe <http://octopus.gma.org/space1/orange.html>. In the same way that a street and an avenue specify a particular intersection in a city or town, latitude and longitude can be used as grid coordinates to locate any point on Earth. By using degrees and minutes of latitude and longitude, your students can describe the location of their plants within about 1.5 kilometres, or about 1 mile.

LATITUDE

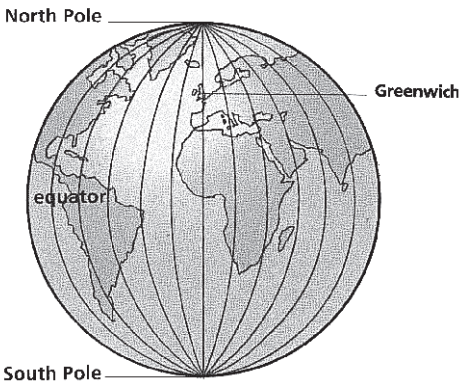
Latitude is the distance north or south of the equator. Latitude lines run east and west along the surface of the earth.



The latitude of a location is expressed as a degree of the angle (A) formed at the centre of the earth by two lines, one drawn from the equator to the earth's centre, and the other drawn from the location to the earth's centre. Thus any point on the equator has a latitude of 0°, and the Poles are at 90 degrees north and south. Each degree of latitude (also longitude) is divided into 60 equal parts called minutes, and each minute can be further divided into 60 seconds. On the surface of earth, one degree of latitude is about 110 kilometers (68 miles). However, because the earth is not quite a perfect sphere, the distances get slightly greater toward the poles, where there is a slight flattening.

LONGITUDE

Longitude lines run north and south along the surface of the earth. The earth is divided into two parts, or hemispheres, of east and west longitude. Each hemisphere has 180 degrees.



The Universal standard is to start counting longitude east and west from an imaginary line running through Greenwich (pronounced "gren-itch"), a suburb of London, which is assigned a longitude of 0 degrees. Mapmakers think of the earth as a huge globe that is divided into 360 equal slices (180 west and 180 east of Greenwich). The lines of longitude between the slices on the outside of the globe are called meridians.

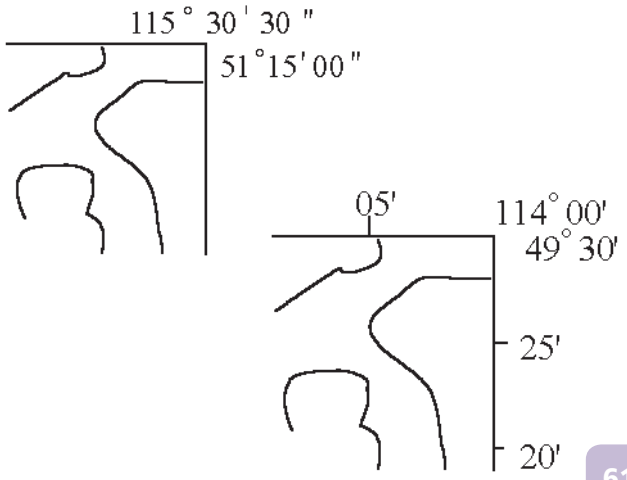
So, meridians are the main lines of longitude on maps. North, South and Central America have longitudes described as west of Greenwich, whereas most of Europe, Russia, India and China are east of Greenwich. The space between two meridians is greatest at the equator — about 110 kilometers (68 miles). This space narrows as the meridians approach the North and South poles. For example, a degree of longitude at New Orleans, Louisiana, U.S.A., is about 97 kilometers (60 miles) wide, whereas at Winnipeg, Manitoba, Canada, which lies nearer the North Pole, a degree of longitude is less than 72 kilometers (45 miles) wide.

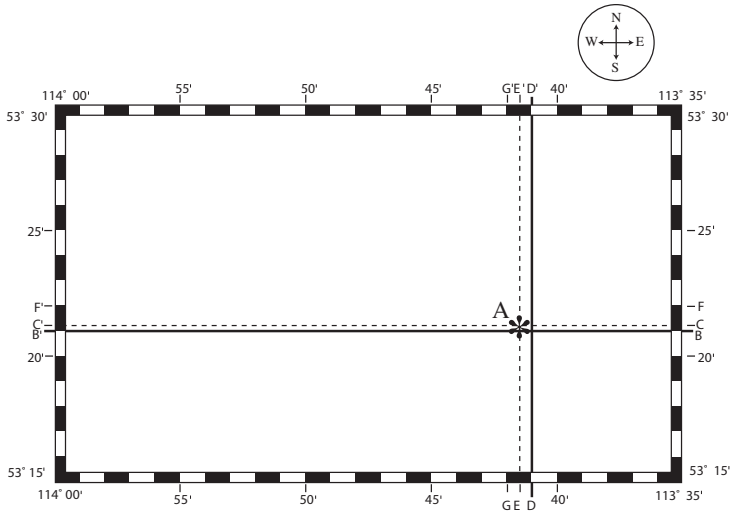
Finding the Latitude and Longitude of a Particular Place

To complete this part of the exercise, your students will need to obtain a detailed map that has latitude and

longitude in both degrees and minutes. On a small-scale map (like those found in many atlases, where the scale may be 1:1,000,000), which covers a large area of the Northern Hemisphere, too much detail is lost to provide enough accuracy for this work. 1:50,000 maps are available from provincial or federal map offices and private map retailers. See Appendix 3 for the website to locate these offices and businesses. Most universities also maintain an extensive map library.

1. **Have your students see what is already marked on their maps:**
   - On many maps you will find the latitude and longitude in the margin at each corner (see below).
   - These grid coordinates are marked in degrees (°), minutes ('), and seconds ("). For instance, a corner may be marked 115° 30' 30" and 51° 15' 00"
   - The figures at the top of the map corner represent longitude (115° 30' 30").
   - The figures below the longitude give the latitude (51°15' 00")
   - If you have a 1:50,000 scale map, your students will probably find points along the border marked in minutes, as illustrated here.
   - The border of the map may look like the map shown below.
   - Latitude and longitude lines might not exist





across your map – if not, have your students put a straight edge across the map and lightly pencil straight lines between the matching border marks (see dotted line within figure on page 62).

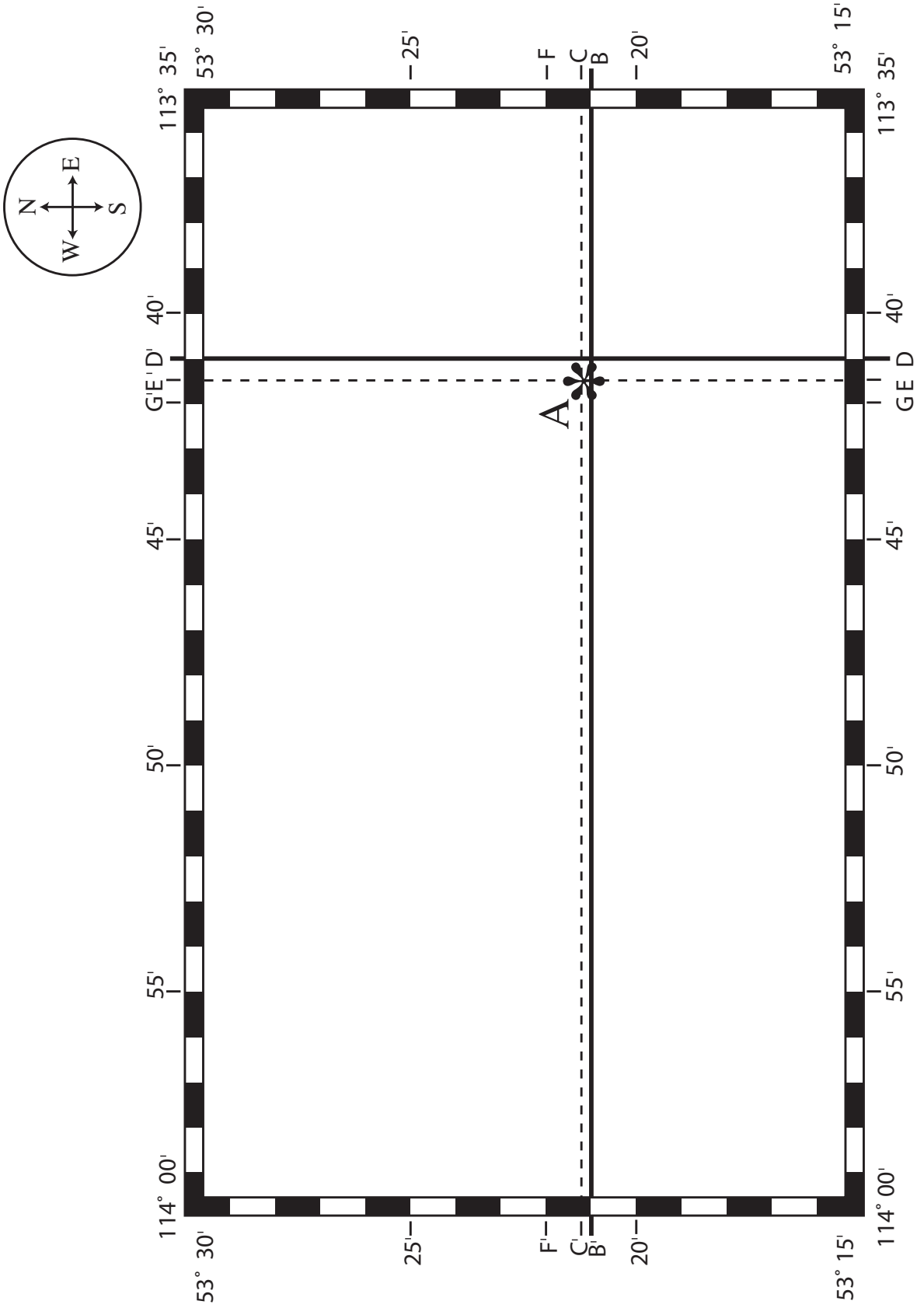
- Please remember that

  1 degree = 60 minutes

  1 minute = 60 seconds

2. **Photocopy the following three pages for students. Then, using the figure and instructions on the following pages, have your students complete the latitude and longitude exercise.**

   In the right hand column of the instructions page have your students input the measurements from their own maps. Using a 1:50,000 scale map is recommended – on a map of this scale, students will be able to locate their plants precisely.


N
E
S
W
113° 35'
53° 30'
25'
F
C
B
20'
53° 15'
40'
D'
E'
G'
A
D
E
G
45'
50'
55'
114° 00'
F'
C'
B'

Note; This exercise looks scary, but it's really easy!

IDENTIFYING LATITUDE FOR NORTHERN AND WESTERN HEMISPHERES

	EXAMPLE	INPUT YOUR VALUES HERE
Locate your plant's position on your map and mark it with an asterisk (* — point A on the example map). Draw a horizontal line through this point, parallel to the nearest line of latitude (line C→C' on the example map).	Point A Line C→C'	
Find the nearest latitude point above (north) or below (south) of point C (= point B on the example map)	Point B	
Join B to the same latitude point on the other side of the map (line B-B' on the example map) by drawing a straight line between. On a large map, use a metre stick or a straight edge. Read the latitude of this line in degrees and minutes and note it in the box to the right. Note: (N) means latitude north of the equator. Please remember to tell us if you are North or South of the equator by specifying N or S (all North America is N).	Line B'–B is 53° 21' N	_____° _____'N
Convert the latitude in degrees and minutes to decimal form (see next page). Put the exact latitude of POINT A in decimal form to the nearest minute in the box to the right.	53° 21'= 53 + 21/60 = 53 + 0.35 = 53.35	_____°

IDENTIFYING LONGITUDE FOR NORTHERN AND WESTERN HEMISPHERES

	EXAMPLE	INPUT YOUR VALUES HERE
Find your plant's position on the map and mark it with an asterisk (* — point A on the example map). Draw a vertical line through A and parallel to the nearest line of longitude (line E→E' on the example map).	Point A Line E→E'	
Find the nearest longitude point to the right (east) or to the left (west) of your line (E-E' on the example map). On this map, G or D at the bottom of the map are equally close so we select D.	Point D	
Join D to the same longitude point D' on the other side of the map. Read this longitude in degrees and minutes and note it in the box to the right. Please remember to tell us if you are in the Western or Eastern hemisphere by specifying W or E (all North America is W).	Line D'-D is 113° 41' W	_____° _____'W
Convert the longitude in degrees and minutes to decimal form (see next page). Put the exact longitude of POINT A, in decimal form, in the box to the right.	113° 41' = 113 + 41/60 = 113 + 0.6833 = 113.68°	_____°

TO CONVERT DEGREES AND MINUTES TO THE DECIMAL FORM

PlantWatch can most easily use your latitude and longitude if it is in decimal form (to at least two decimal places). To obtain a decimal version of degrees and minutes, you have to convert the minutes, which are normally expressed as a fraction of one degree, into a decimal, and add this figure to the number of degrees. In one degree there are 60 minutes.

Example (using latitude only):

1. Start with degrees and minutes — 53° 21'
2. Divide the minutes by 60 — 21 / 60 = 0.35
3. Add decimal minutes to degrees — 53 + 0.35 = 53.35 degrees N latitude

Example

The University of Alberta Devonian Botanic Garden is located about 30 km southwest of the city of Edmonton, Alberta, Canada at 53° 21' N latitude.

LATITUDE

1. Start with	2. Convert to decimal form	
53 degrees 21 minutes N latitude	= 21 minutes ÷ 60 minutes	= 53.00 degrees + 0.35 degrees = 53.35 degrees N latitude

Now, lets do the same for your location

LATITUDE

1. Start with	2. Convert to decimal form	
_____ degrees _____ minutes _____ latitude*	= _____ minutes ÷ 60 minutes	= _____ degrees + _____ degrees = _____ degrees ____ latitude

LONGITUDE

1. Start with	2. Convert to decimal form	
_____ degrees _____ minutes _____ longitude**	= _____ minutes ÷ 60 minutes	= _____ degrees + _____ degrees = _____ degrees ____ longitude

* Please specify, for the latitude: **N**, if the location is north of the Equator (Canada); **S**, if the location is south of the Equator.

** Please specify, for the longitude: **E**, if the location is within 180° east of Greenwich; **W**, if the location is within 180° west of Greenwich (Canada).

3. To Check Calculations

There are many references and websites where students may be able to find their locations. If possible find the locations using degrees, minutes and seconds, or decimal degrees with 2-4 decimal places.

Try some of the following websites to check your students' calculations.

- Google Earth: http://earth.google.com/
- Lat/long look up tool in PlantWatch "submit observations page" (see instructions in Key Activity 5)
- Query Canadian Geographical Names — search tool provided by Natural Resources Canada to identify lat/longs for Canadian towns and cities http://geonames.nrcan.gc.ca/index_e.php

When you get the results of the search, click on "info" to see more information including latitude and longitude.

USING A GLOBAL POSITIONING SYSTEM

A description of GPS and how they work can be found at www.ec.gc.ca/geocache/default.asp?lang=en&n=1BC7DC7B. This is an excellent site on Geocaching which invites schools to participate. High schools throughout Canada are encouraged to research their watershed and develop reports or stories to build geocaches. The students then hide these for the "geocacher" community to discover – passing along their knowledge for others to find.

CONGRATULATIONS!

Students now can send PlantWatch research scientists their plant locations. They can use the location form (see 'register a new location' once logged in) on the webpage www.plantwatch.ca.

Notes

Social Studies

TOPICS AND IDEAS:

- ✓ Geography and People
- ✓ People in History
- ✓ Kids Can Make a Difference

Social Studies

Activity 1

Geography and People

SUGGESTED CONNECTIONS:

Key Activity 4, *Reporting your Data* (page 19)

Mathematics Activity 4, *Latitude and Longitude* (page 59)

CONCEPTS AND SKILLS DEVELOPED THROUGH PLANTWATCH:

- Use latitude and longitude to calculate the Global Address of your community (see Mathematics Activity 4, *Latitude and Longitude: How to Calculate Your Global Address*, Connections - Math, page 59).
- Select a native plant from the PlantWatch species, and list all the provinces/states where it is found, using the plant distribution maps found by entering the plant's latin name at this website: http://plants.usda.gov
- From which areas in Canada has flowering been reported? Log on to www.plantwatch.ca under "Submit Observations" and download data by clicking on the purple floppy disk icon on the top right hand side of the screen.)
- Locate other PlantWatch sites for your chosen plant species on a large map.
- Make an outline map for the above use. Make an overhead transparency of the map of your students' choice. Project the map onto a large sheet of paper. Have the students trace the outline of the map and any other desired features onto the paper.
- Interpret the geographical features which could affect the flowering dates. For example, mountains and higher altitudes are cooler and, thus, flowering is later in these areas. Large lakes warm slowly in spring and keep local areas cool, leading to later flowering. Large towns produce a "heat island" effect: the sun's heat absorbed by roofs, asphalt roads and concrete sidewalks and the furnace heat or air conditioning exhaust from buildings, produce an environment warmer than the surrounding countryside.

For interesting maps of phenology data, see www.naturescalendar.org.uk/map/ from the 'Nature's Calendar' program in Britain.

Also see www.ncdc.noaa.gov/paleo/phenology.html; under "other sources" click "map of the first leaf date", to see a map of modelled first leaf timing for common purple lilac across North America.

Journey North is a student program in North America that tracks blooming time of tulips, leaf out on trees, etc. Learn more about their phenology program and see click on maps at www.learner.org/jnorth/pde/News.html

Activity 2

People in History

SUGGESTED CONNECTIONS:

Key Activity 3, *Locating and Tagging the Plants* (page 13)

Science Activity 1, *Plants and Ecology: All my Relations* (page 31)

Science Activity 4, *Forests: Discussion and Investigation* (page 41)

CONCEPTS AND SKILLS DEVELOPED THROUGH PLANTWATCH:

1. First Nations People made extensive use of native plants. Plants supplied these people with food, fuel, fiber, clothing, shelter, utensils, transportation and medicine. First Nations People knew a lot about the plants in their environment. They knew which plants were safe to eat and which were toxic, what part of a plant could be used as medicine, and what part could be used as food. They crushed plant parts and made dyes to decorate personal articles. Seeds were sewn onto clothes or made into necklaces, and perfumes and oils were made from plants. They used all the edible fruits, and cloudberries were said to be the 'best fruit' of all! In the north, white dryad was used to recognize the correct time for hunting expeditions: when the seeds started to untwist, it was time to get caribou skins for summer clothing.

   Have students research plants that were or are important to the First Nations People.

2. Early settlers made use of native plants. Many settlers became "root and herb doctors" who used First Nations Peoples' remedies to cure ailments. They wrote out their medicine mixes in recipe books and passed them on to their children and grandchildren. Settlers also used many native plants as food sources, such as saskatoon berries. The berries were collected and made into jams, pies, and other foods, or were eaten straight from the bushes. Labrador tea leaves were brewed into a relaxing beverage. In the east, early boat builders used the wood from Larch trees to make the keel, as it was strong and resisted rot. Early settlers introduced dandelion as a spring vegetable, and protected the plants from hares and ground squirrels with chicken wire. In Ontario, some settlers showed local First Nations People how to make a tasty 'coffee' beverage from dandelion roots.

3. Native plants are still used today by many people. Saskatoon berries are used in a variety of recipes and wild strawberries continue to be popular across Canada. The wood from poplar trees is now being used by forestry companies to make pulp, waferboard and chopsticks.

Activity 3

Kids Can Make a Difference

SUGGESTED CONNECTIONS:

Science Activity 3, *Reading About Climate Change* (page 35)

CONCEPTS AND SKILLS DEVELOPED THROUGH PLANTWATCH:

- If you are using the PlantWatch program in conjunction with a study of Climate Change (see Science Activity 3, *Reading About Climate Change*, Connections - Science, page 35), provide students with information about government policies that will help control the level of emissions of the greenhouse gases that are contributing to climate change.
- Scientists agree that even if all greenhouse gas emissions were greatly reduced, some additional degree of climate change is unavoidable. We will all need to adapt to these changes.

  Describe the concept of adaptation to climate change to students. Ask students what kinds of adaptation might be necessary where they live. Ask students what kinds of adaptation might be necessary for communities in the Far North or in tropical areas. Discuss possible positive and negative impacts in those areas.

  The adaptation 101 section of this website has some useful background. www.adaptation.nrcan.gc.ca/101/index_e.php

- Information on what the Canadian government is doing to regulate and reduce emissions can be found on the website www.ecoaction.gc.ca/index-eng.cfm. Information on what students can do to reduce greenhouse gas emissions and combat global warming are available from the Environment Canada website www.ec.gc.ca/education/default.asp?lang=En&n=050049D2-1

  Have students discuss what they can do at their homes and schools to reduce greenhouse gas emissions.

  There are many websites available to teachers to address the subject of climate change. (see Science Activity 3, *Reading About Climate Change*, Connections - Science, page 35 for a list of websites)

Notes

Language Arts

TOPICS AND IDEAS:

- ✓Descriptions
- ✓Celebrating Spring

Language Arts

Activity 1

Descriptions

SUGGESTED CONNECTIONS:

Key Activity 3, *Locating and Tagging the Plants* (page 13)

Key Activity 4, *Reporting to the Class* (page 17)

Science Activity 1, *Plants and Ecology: All My Relations* (page 31)

Science Activity 2, *Weather* (page 33)

Mathematics Activity 3, *Graphing and Mapping* (page 55)

Social Studies Activity 2, *People in History* (page 70)

CONCEPTS AND SKILLS DEVELOPED THROUGH PLANTWATCH:

While engaged in the PlantWatch program, you could have students:

Read the native legend of the prairie crocus "How the Prairie Anemone got its Fur Coat" (located on the web page <http://plantwatch.fanweb.ca/plant-information/prairie-crocus/prairie-crocus-information#a-blackfoot-legend>). According to this legend the furry coat was given to the flower to protect it on chilly spring nights. The Blackfoot First Nations word "Napi," the "old man" central to the Blackfoot creation story, also refers to the grayish seed heads of prairie crocus, which appear in early summer.

The class could also read other legends, and students could then write their own legends to explain natural phenomena.

- Write poetry about the plant or flower they are observing, or about its environment.
- Research information about uses of native plants by First Nations peoples, and write a paragraph or essay on the topic.
- Write exact descriptions of the habitats of their plants in order to help research scientists understand local growing conditions.
- Create, read and interpret non-prose forms of communicating information (e.g. graphs, maps, charts) related to PlantWatch data. (For example, students could write paragraphs to explain the information contained on a graph.)
- Report orally to other classes the purpose and results of their PlantWatch project.
- Write an account of the weather just prior to and during flowering. Both exact and figurative language could be encouraged.
- Suggestion: Find sketches of your chosen plant in field guides or on the web, to provide ideas for covers for student observations/projects.
- Use the following field observation sheet to record information on each plant, for each visit to the plants. The form is only a model; you may wish to use only the column headings and expand the space provided for sketches, for example.

PLANT SPECIES	NUMBER OR NAME	GROWTH STAGE FLOWERS	LEAVES	FLOWER/ LEAF SKETCHES	OTHER COMMENTS
Saskatoon	#4	Buds now have some white showing	Just starting to unfurl		

PlantWatch Plantwatch Observation Sheet

Date:	Observer's Name:
Location:	Description of Habitat:

PLANT SPECIES	NUMBER OR NAME	GROWTH STAGE FLOWERS	LEAVES	FLOWER/ LEAF SKETCHES	OTHER COMMENTS

Activity 2

Celebrating Spring

SUGGESTED CONNECTIONS:

Key Activity 1, *Signs of Spring* (page 9)

Key Activity 2, *Predicting Seasonal Occurrences* (page 11)

Science Activity 2, *Weather* (page 33)

Science Activity 5, *Developing a Phenology Calendar* (page 43)

CONCEPTS AND SKILLS DEVELOPED THROUGH PLANTWATCH:

Engage the students with a recording of "Spring on the Prairies" from Connie Kaldor's *Wood River* album. Read aloud the poems "In Just- Spring" by e.e. Cummings and "April Rain Song" by Langston Hughes. Invite your students to help create a Celebration of Spring that recognizes and incorporates images and experiences from their local environment. Introduce them to seasonal celebrations of various cultures by encouraging them to research their own, or others' cultural traditions.

Share other examples of music, poetry, photography, and painting that celebrate the arrival of spring.

Provide students with an opportunity to immerse themselves in a natural environment and observe the sights, sounds and smells around them. Ask them to describe the land, the air, the water and the sun. Encourage them to pay close attention to the colours and shapes of plants. Give them quiet time to reflect and record their observations, thoughts and feelings in a personal journal.

Encourage students to create their own poems, songs, photographs or artwork based on the signs of spring that they have observed in their natural environment.

Encourage them to create their own word combinations (like e.e. Cummings' "mudluscious") or express their feelings about signs of spring (like Langston Hughes' "I love the rain.") Invite a class of younger students to participate in a Celebration of Spring, by having your students accompany them on a "spring flower" nature walk and share with the younger students the poems, songs and artwork created by your students.

Notes

Appendices

www.PlantWatch.ca

Appendix 1

PlantWatch Species

Latin name	Common name	NL	NS	PEI	NB	QC	ON	MB	SK	AB	BC	YK	NWT	NU
Populus tremuloides	Aspen Poplar	●	●	●	●	●	●	●	●	●	●	●	●	
Arctostaphylos uva-ursi	Bearberry		●	●	●	●	●	●	●	●	●	●	●	●
Galium boreale	Bedstraw, northern					●			●	●				
Betula papyrifera/neoalaskana	Birch, paper	●								●			●	
Houstonia caerulea	Bluets		●			●								
Cornus canadensis	Bunchberry	●	●	●	●	●	●	●	●	●	●	●	●	
Ranunculus glaberrimus	Buttercup, sagebrush										●			
Prunus virginiana	Choke cherry					●	●		●	●				
Clintonia borealis	Clintonia, blue-bead lily	●	●	●	●	●	●							
Rubus chamaemorus	Cloudberry, bakeapple	●				●		●	●	●		●	●	●
Tussilago farfara	Coltsfoot	●	●		●	●	●							
Vaccinium vitis-idaea	Cranberry (partridge berry, lingonberry)	●				●		●	●	●		●	●	●
Taraxacum officinale	Dandelion	●	●	●	●	●	●	●	●	●	●	●	●	
Forsythia suspensa	Forsythia, weeping	●	●				●							
Thermopsis rhombifolia	Golden bean									●				
Ledum/Rhododendron groenlandicum/decumbens	Labrador Tea	●	●	●	●	●	●	●	●	●	●	●	●	●
Syringa vulgaris	Lilac, Common Purple	●	●	●	●	●	●	●	●	●	●	●	●	
Lupinus arcticus	Lupine, arctic											●	●	
Acer rubrum	Maple, red	●	●	●	●	●	●							
Epigaea repens	Mayflower		●			●	●							
Pinus contorta	Pine, lodgepole									●	●			
Anemone patens	Prairie Crocus							●	●	●		●	●	
Clintonia uniflora	Queen's cup										●			
Rhododendron canadense	Rhodora	●	●	●	●	●								

Latin name	Common name	NL	NS	PEI	NB	QC	ON	MB	SK	AB	BC	YK	NWT	NU
Amelanchier	Saskatoon, serviceberry					●		●	●	●	●	●	●	
Saxifaga tricuspidata	Saxifrage, prickly					●		●	●			●	●	●
Saxifraga oppositifolia	Saxifrage, purple					●	●	●		●	●	●	●	●
Maianthemum stellatum	Solomon's seal, star-flowered					●	●		●	●				
Trientalis borealis	Star-flower	●	●	●	●	●	●	●	●	●				
Fragaria virginiana/vesca	Strawberry, wild	●	●	●	●	●	●	●	●	●	●	●	●	
Myrica gale	Sweetgale	●				●			●					
Larix laricina	Tamarack/Larch	●	●	●	●	●	●	●	●	●	●	●	●	
Trillium grandiflorum	Trillium, white					●	●							
Linnaea borealis	Twinflower	●				●	●	●	●	●	●			
Viola adunca	Violet, early blue					●				●				●
Nymphaea odorata	Water lily					●	●							
Dryas integrifolia/octopetala	White Dryad, Mountain avens					●	●	●		●	●	●	●	●
Elaeagnus commutata	Wolf willow					●			●	●				
Achillea millefolium	Yarrow					●	●			●				

Appendix 2

Glossary

Adaptation (to climate change) – Adaptation to climate change is any activity that reduces the negative impacts of climate change and/or takes advantage of new opportunities that may be presented

Alpine – High mountain regions, above the tree line

Alternate – Arrangement of leaves in which successive leaves arise at different levels on opposite sides of the stem (see also: "Opposite")

Ament – See "Catkin"

Anther – The pollen-producing structures, borne at the tip of a filament in male flower parts (stamens) (See flower diagram on page 87.)

Basal – Located at the base of a plant or plant organ

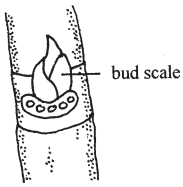
Beaked – Ending in a prolonged tip that resembles a beak

Blade – The whole green leaf, without the petiole or leaf stalk

Boreal Forest – The mainly coniferous or evergreen forest that covers much of Canada's northern regions

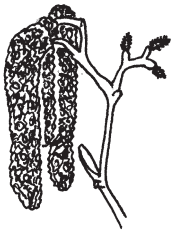
Bract – A small leaf beneath a flower or another plant organ

Bud Scale – A small, modified leaf that covers the bud



Capsule – A dry fruit that releases seed through slits or pores

Carpel – The leaf-like organ of a flower that encloses one or more ovules (see "Pistil")



Catkin – A highly condensed cluster of (usually) unisexual flowers that lack petals

Circumpolar – A large region around either the North or South Pole; can refer to a plant that is distributed around the globe in northern regions

Clone – A stand or group of plants of one type (all have identical genetic material)

Cluster – A tightly packed group of flowers

Colony – A group of plants that all have the same genetic material

Conifer – Belonging to the order Coniferales, these plants are mostly evergreen with cones and narrow, pointed, often needle-like leaves. Pine, larch, spruce, fir and cedar are all conifers. Larch is the only one which is not evergreen; it sheds its needles annually.

Creeping – Growing along or near the surface of the ground

Cross-pollination – The process by which pollen is carried from the stamens of one plant to the stigmatic surface of another plant (compare with Self-fertilization)

Crown Division – Propagation technique where the base of a plant is divided into sections

Cultivar – A uniform group of cultivated plants obtained by breeding or selection, and propagated as a pure line

Day Neutral – When a plant's seasonal changes do not depend on how many hours of sunlight the plant receives

Deciduous – Falling off at the end of the growing season

Dormancy – Lack of plant growth during unfavourable environmental conditions

Dormant – For cells, buds, seeds, etc., the period before growth begins

Ecology – The science of the interrelationship of organisms and their environment

Elaiosome – Oily appendage of a seed (can be an "ant-snack")

Ethnobotany – The study of the relationships between plants and people

Evergreen – Plants whose leaves remain green throughout the winter

Female Tree – Trees that produce only female flowers (these flowers are imperfect since they have one sex only; pistillate)

Filament – The stalk on which anthers are borne; anthers plus filament forms a stamen, the male part of a flower (See flower diagram on page 87.)

Fire-successional – Plants that are adapted to the environments present after wildfire

Floret – Individual flower in a cluster

Flower Bud – Undeveloped flower

Flower Stem – The stalk by which a flower is attached to the rest of the plant (also called a peduncle)

Flowering Sac – See "Pollen Sac"

Foliage – Leaves

Forb – A term used in botany to refer to plants – many wildflowers, for example – that do not fit into other classes like trees, shrubs or grasses. Generally, a forb is a broad-leaved, non-woody plant that dies back to the ground at the end of every growing season.

Fungi – A group of non-photosynthetic organisms with chitinous walls that feed on organic matter (includes mushrooms)

Fungal Partners – Many plants have an important underground relationship with fungi; these organisms are known as fungal partners (symbionts)

Genetic Mutations – Changes in the hereditary information carried by an organism

Genetic Variation – The genetic differences between individuals of the same species

Germination – The first stage in the growth of a seed into a seedling

Glandular – A plant organ (e.g. leaf, stem) that possess specialized cells that secrete chemical substances

Graft(ed) – The joining of two separate plant parts, like root and stem, or a branch from one plant to a branch from another, so that they can regenerate and grow as one plant

Growing Degree Summation (GDS) – A way to measure the warmth to which a plant has been exposed. The GDS is calculated by summing average daily temperatures for a given time period.

Habitat – The natural home of an organism

Hair – Hair-like structures, also known as trichomes, that are attached to many plant parts

Hardwood Cuttings – Cuttings taken from older woody tissues of hardwood trees, used for plant propagation. Cuttings are usually taken in the winter from dormant plant parts (see "Dormant").

Hardy – Plants adapted to cold or otherwise adverse conditions

Heat Unit – Temperature affects the rate of plant growth. The amount of accumulated temperature a plant has been exposed to in spring time can be measured in heat units. It is measured through growing degree summation.

Hermaphroditic – Plants that have flowers with male and female parts (see "Perfect Flowers")

Horticulture – The science of garden cultivation

Hybrid Vigour – The condition of a hybrid that is fitter than either of its parents

Hybridize – The process by which two plants with different genetic material produce offspring

Hydratode – Pore in the surface of a leaf through which minerals are extruded

Indicator Plant – In phenology studies, a plant useful as a "biological measuring stick," i.e. its growth occurs in response to a combination of weather and environmental factors, and certain growth phases are easily defined and recognized

ITEX – International Tundra Experiment

Julian Calendar – Calendar that marks the days from January 1st onwards; i.e. January 30 = day 30 and February 28 = day 59

Leaf Pore – Small opening on the leaf surface

Lenticel – Small dot or spot on the bark of a young twig that allows gas exchange between the stem and the atmosphere

Life Cycle -The entire sequence of phases in the growth and development of any organism from birth to reproduction, maturity and death

Loam – Soil that has about equal proportions of sand, silt and clay

Male Tree – Trees that bear only male flowers

Matted – Plants that grow in a very dense and flat cluster, or mat

Microclimate – The climate of a small or limited space, e.g. the surface of the soil, or under the canopy of a small patch of forest.

Native plant – A plant that occurred in a particular area before the arrival of European settlers in North America (i.e. not introduced by settlers)

Nectar – A sugary liquid secreted by a flower's nectaries

Node – The point on a stem from which a leaf grows; nodes are spaced along stems with internodes between them

Nodules (of a root) – Swollen areas of the root that contain a bacterial symbiont

Open Pollination – Pollination in which the source of pollen is unknown

Opposite – Arrangement of leaves in which each pair is at right angles to the pair above and below (see also "Alternate)

Ovary – Part of the female flower parts, located at the base of the pistil and containing ovules which can become seeds (See flower diagram on page 87.)

Ovule – Structure within the ovary containing an egg cell

Parkland – In the Canadian Prairie Provinces, Parkland is a transitional natural region between the prairies to the south and the boreal forest to the north. Patches of open meadows alternate with forest of largely poplar trees, with spruce trees on cool, north-facing slopes.

Perennial – Plants which grow and reproduce for many years, from the same roots. Perennial plants are usually woody.

Perfect Flowers – Flowers with male and female reproductive organs

Petals – Modified leaves, usually the conspicuous, brightly coloured structures above the sepals in a flower (See flower diagram on page 87.)

Petiole – Stalk of a leaf

Phenology – Study of the seasonal timing of life cycle events, i.e. growth stages or changes in plants and animals

Photoperiod – the number of hours of light that a plant receives in a day.

Photosynthetic – An organism that uses light energy to produce food

Photosynthesis – The process by which plants, algae and some bacteria convert light energy into the chemical energy stored in sugars

Phyllody – Process in which petals and sepals revert to leaves

Pistil – A collective term for all the female flower parts: stigma, style and ovary (See flower diagram on page 87.)

Pollen – Powdery contents of the anthers; a single pollen grain produces a pollen tube and sperm, and fertilizes ovules contained in a plant's ovary

Pollen Sac – The pollen-containing sac of the anthers

Pollination – Process by which pollen is transferred from the male parts (stamen) to the female parts (stigma) of a flower

Polyploid – An organism with three or more sets of chromosomes

Ramets – A large number of clonal shoots

Respiration – Physiological process in plants and animals in which oxygen is consumed in the final step of metabolizing sugars

Rhizome – A stem which grows horizontally in the soil, bearing buds from which shoots grow

Rootstock – Plant roots onto which shoots are grafted, in propagation

Root Cutting – Cutting taken from the roots, used in plant propagation

Runner – A long, slender branch that runs along the ground rooting at the nodes or tip (see "Node")

Scale – Any small, thin flat structure of a plant; a small outgrowth

Scree Slope – Mountain slope of small loose stones

Seed Capsule – Dry fruit that releases seed by way of pores or slits

Seed Head – A cluster of fruit or seeds

Seed Pod – General term for any dry fruit that opens to release seeds

Self-fertilize – Fertilization in which the pollen (sperm) and the ovary (egg) belong to the same individual. Compare with Cross-pollination.

Sepals – Modified petal-like leaves, below the petals in a flower, often green and leaf-like (See flower diagram on page 87.)

Softwood Cutting – Cutting taken from emerging woody plant parts of softwood trees, used for propagation

Stamen – Collective term for male flower parts; includes filaments and anthers (See flower diagram on page 87.)

Stigma – The receptive area of the pistil (top of the female flower part) where pollen lands or is deposited (See flower diagram on page 87.)

Stratification – Process in which seed is placed in moist, cool soil to break dormancy

Stratification Period – The amount of time required to break seed dormancy and start germination

Style – Central, tube-like region of the female flower parts (See flower diagram on page 87.)

Subalpine – Area in the higher mountain slopes just below the tree line and the alpine region

Succession – The process of development of vegetation involving changes of species and communities with time

Suckers – Shoots that arise from underground plant parts

Symbiont – An organism living in a relationship with another organism, where these two organisms live closely together for much or all of their lives, e.g. the fungi and algae in lichens

Tap Root – A large, vertical root arising from the main axis of the plant

Terminal – Applies to position of a structure borne at the tip of a plant stalk, leaf, etc.

Tundra – A treeless region of the Arctic or subarctic

Variety – A taxonomic group within a species or subspecies, i.e., a uniform group of plants that differs slightly from another group within the same species

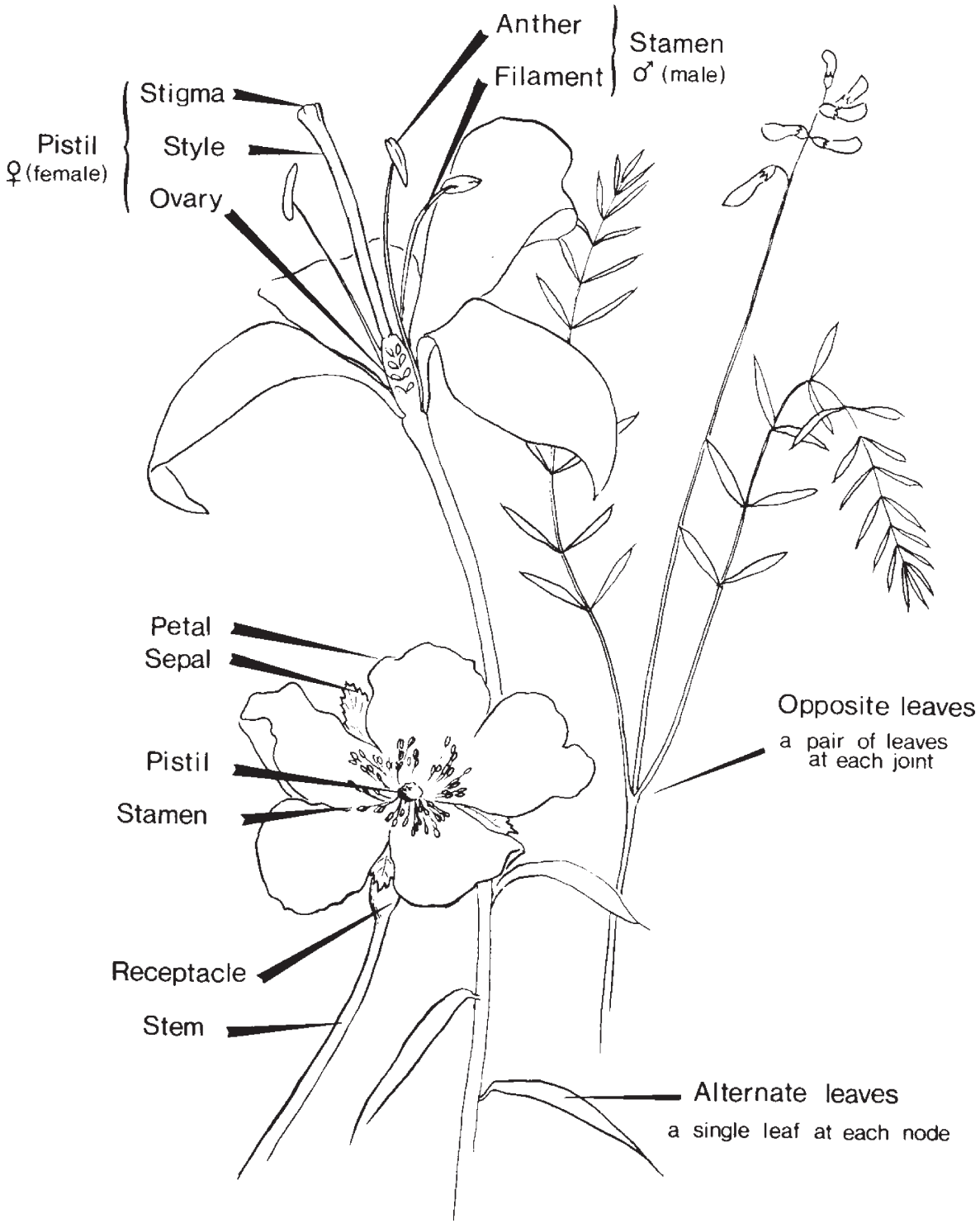
Vegetative Reproduction – Process through which plants increase in number without fertilization

Whorl – A group of three or more plant parts arising from the same region (node) of the stem

Winged – Structure with a membranous expansion

Winter Buds – Buds present in winter

PARTS OF A TYPICAL FLOWER



Appendix 3

Map Sources for Canada

For a regularly updated list of map sources for your territory or province, check the federal website:

maps.nrcan.gc.ca

and select *Canadian topographic maps*, *map distributors*, and then, *regional distribution centres*.

Appendix 4

Horticultural

All words highlighted in ***blue*** can be found in the glossary (Appendix 2).

ESTABLISHING A PLANTWATCH GARDEN

Introduction

This guide will serve as a resource to teachers in the Plantwatch Program who are interested in learning more about the cultivation and growth requirements of these key indicator plants. Some participants may find that their access to the plants in the wild state is limited (e.g., urban classrooms may find it hard to find white trilliums (eastern Canada) or prairie crocus (western Canada). One solution is for schools to create their own garden areas, using plants from the Plantwatch program and others that are native to their area. This approach not only provides special places in which to observe and record the timing of natural phenomenon such as plant flowering, but also gives opportunities for creating wildlife habitat (for birds, butterflies, etc.) and increasing local biodiversity.

Students are able to observe daily the changes in the Plantwatch species and accurately report the flowering stages. They will see first hand the effect of weather events such as spring snow storms or frosts on their plants. Temperature records from the site or nearby will provide highly useful information on the amount of heat needed for flowering. If students have access to the school grounds over the summer, they will see all stages of growth — from first buds, to flowers, to ripe fruit, as well as leaf colouring, and discover some of the insect partners that these plants attract.

Creating garden spaces in communities need not be an overwhelming task, if all the factors are considered. The benefits of such a project go far beyond the project itself, as communities become involved with the land, its rhythms and its diversity. Natural areas offer a rich learning environment that can lead directly to a stronger environmental ethic for all who become involved.

Creating Garden Spaces

Individuals, communities or schools considering the creation of school garden spaces need to ask themselves some important questions. Assistance in answering these questions can be obtained from many sources individuals, organizations and printed materials.

1. What is the purpose of the garden space? Are you going to just plant certain Plantwatch species for observation, or are you going to expand your garden area to include other native plant species?
2. Is there a plan in place? Does the plan include a budget, a realistic time line, use of the expertise of other people who have initiated such garden spaces, and opportunities for learning about the plants and their requirements?
3. Has an appropriate site been located, taking into account the soils, topography and present condition of the land, along with the requirements of the plant communities you'd like to establish? If possible, sites should be located at least 3 m-5 m (10 - 15 ft.) away from buildings (to avoid hot microclimates that will affect bloom timing), and away from sidewalks or roads. Consideration

should also be given to ease of watering, and ways in which the site can be protected from students' outdoor play activities.

4. What kind of site preparation considerations are there? Proper cultivation of an area, to control weed growth, is necessary prior to the planting of a garden. The soil should be well packed with rollers before seeding, and have appropriate soil amendments added before planting live plants. Because native plants are well adapted to low fertility, they do not require heavy fertilization (which may only encourage the growth of weedy, non-native species). Avoid using herbicides as they pose a threat to valuable soil organisms and also threaten the health of children, pets, and living things in nearby rivers and lakes.
5. What species are you going to plant? For certain Plantwatch species, see section B following: "How to Grow the Plantwatch Species."
6. What planting methods are you going to use? The methods will vary, depending on whether you are working with seeds or live plant material. Things to consider would include best dates for planting and any special techniques for specific plants.
7. What kinds of long-term management strategies do you need to consider? Young shrubs of saskatoon and lilac may take three to four years before they begin flowering. How will you maintain weed control – by hand or mowing? Keep in mind that drought-adapted species such as saskatoon, prairie crocus, or white dryad should not be overwatered once established. How will the garden space be protected from unwanted intrusions?
8. How will you achieve public involvement and support? Can you involve a variety of people (principal, school staff, grounds crew, local business people, local gardeners for summer weeding and watering)? How will you educate others about your project? Finding funding for school gardens is relatively simple because these projects have so many benefits. Sources that we know have funded similar projects include The Evergreen Foundation and Shell (see resource list for addresses).

HOW TO GROW SOME OF THE PLANTWATCH SPECIES

(lilac, prairie crocus, saskatoon, white dryad, and white trillium)

Common Purple Lilac

For those who want to plant new lilacs to observe, a recommended ***cultivar*** for Plantwatch observers is the early-flowering and popular *Syringa vulgaris* "Charles Joly", originally developed in 1896 in France by Lemoine. The flowers of this species are reddish-purple, slightly redder in colour than most common purple lilacs, but suitable for Plantwatch because they are early blooming and many nurseries have them for sale. Make sure your lilac is growing on its own roots, not ***rootstocks***.

Common purple lilac (*Syringa vulgaris*) can be planted individually or in a line to form an unclipped hedge. Lilacs should be grown in fertile, moisture-retentive soil that is neutral to alkaline, not acidic. They will thrive in sun or partial shade but grow best in full sun. In a new garden be careful not to plant any trees in the vicinity of your lilacs. Over the years these trees will grow and eventually shade the lilacs, which then will produce fewer and fewer flowers. If your lilacs do get shaded, transplant them to a sunnier site. During dry spells, lilacs benefit from regular watering, particularly young or recently transplanted plants. This shrub is relatively free from major pests, but watch out for leaf miner and lilac borer.

Pruning

Lilacs should be pruned every five to ten years to maintain a good shape. Lilacs flower on the previous year's growth, so they should not be pruned in any way until after the flowers have died. The spent blossoms should be removed every year, to prevent wasting energy on seed formation and to stimulate flower bud formation. Prune immediately after flowering occurs

in spring because next year's buds will form on the new wood that grows after flowering. Don't prune in autumn as it will remove next year's flower buds. One or more of the older main stems at the base of a plant may be removed in pruning and some of the remaining stems trimmed back to maintain the size and shape desired. Remember, never remove more than one third of a lilac bush at any one time. Cut a branch back only to the first ***node***, where new buds can be seen. If branches are cut back beyond this point, next year's flowers will be lost. After being transplanted, it may take several years for some lilacs to produce flowers.

Occasionally, a lilac may bloom the first year after being transplanted because the buds were set up in the nursery before the plant was bought. Usually, such a plant will not flower again for about three or four years, assuming the plant is growing in the full sun, and has a good supply of nutrients and moisture. Once a plant does begin to flower, it will continue to do so for many years.

The ultimate size of a mature lilac is one factor limiting the number of lilacs that any garden can satisfactorily hold. Because under ideal conditions common purple lilacs can reach a height of 2.5 m to 4 m (8-13 ft.), and have a spread of 6 m to 7 m (20-23 ft.), one has to be careful not to plant too many lilacs in a small, city garden.

Growing lilacs from seed

Lilacs can be grown from seed. If ***open pollinated seed*** is used there is no way of knowing if the new plant will be similar or quite different from the parent plant. Seed can be collected in the autumn, then dried, and the seed stored in a cool, dry place until February. Lilac seed requires a wet/cold ***stratification*** period to break the seed's natural ***dormancy***. Seed may also be sown directly in the garden in the autumn. After the first freeze, the bed should be covered with a light mulch. In the spring, this mulch should be removed, and the bed should be shaded as the seedlings appear because these seedlings scorch very easily in direct sun.

Prairie Crocus

This welcome little sign of spring is sometimes difficult to grow in a garden. It can be started from seed collected from the wild, or purchased from nurseries specializing in native plants and seeds. Please do not attempt to transplant plants from the wild to the garden. This usually fails, and it contributes to loss of biodiversity in our remaining natural habitats! Growing prairie crocus from seed requires patience because not all the seeds will germinate the first year and because the plants are deep-rooted and slow to mature. Native plant seeds usually require ***stratification*** before planting, to break their natural ***dormancy***; that is, they must be exposed to a cold and damp period prior to planting. To stratify prairie crocus seed, place the seed in a clean zip-loc bag or film container with a little sterilized dampened sand and refrigerate it from one to three weeks. Then plant the seeds in flats — they do not compete very well with other plants. Ideally, these plants should be grown in nursery conditions for the first year or two, and then transplanted to a garden in late fall or early spring.

Habitat Requirements

Prairie crocus likes a sandy soil that is never wet for more than a few hours. Once the plant has a well-established root system, do not water it during the summer unless the soil becomes very dry.

This plant needs to be planted in an open area with full sun. After a year or two, like other wild plants, it becomes dependent on ***fungal partners*** in the soil. Seedlings will flower in three or four years.

Note: In central Alberta, seed is best collected from the wild in June, when it is ripe.

Saskatoon/Serviceberry

Saskatoon is an excellent ornamental shrub for the garden. It is ***hardy***, that is, it can withstand cold winters and drought, and is easily propagated, with fragrant showy flowers, edible fruit and attractive fall ***foliage***. It also attracts birds! Many different varieties have been produced by horticulturalists for commercial

and garden use. If you'd like one in your own garden, saskatoon plants are available from many plant nurseries, in several different sizes and varieties. Plants that are old enough to produce flowers are, of course, more useful for the Plantwatch project.

Saskatoons can be started in several different ways including from seed, ***suckers***, ***root cuttings***, ***softwood cuttings***, ***hardwood cuttings***, and ***crown division***. Saskatoon twigs can also be ***grafted*** onto other trees like apples and pears. When seeds are used, some of the plants grown from a batch of seed will be different from the parent stock.

When choosing a saskatoon for your garden, Plantwatch recommends the cultivar, "Smoky", as this ***variety*** blooms early. Choose plants that are not ***grafted***. When plants arrive, remove them from the root trainer, and completely cover the root plug with soil. Firm soil around roots. Water as soon as possible, making sure that roots do not become exposed in the process. It usually takes the first year for the plants to establish their roots, so good care (e.g. occasional watering, effective weeding) at this time will ensure healthy plants for the future. Shallow cultivation is important, to protect the fragile roots, and to keep competing weeds from gaining a foothold.

Growing Saskatoons From Seed

Saskatoons can also be grown from seed. For guidelines on plant collection for the horiticultural use of native plants visit http://www.anpc.ab.ca/assets/gardener_guidelines.pdf. Collect the fruit when it is ripe and freeze it. In the fall, or when you are ready, extract the seed from the fruit pulp (add the fruit to water in blender, use a few brief pulses to avoid damaging the seed, then pass the liquid through a sieve). Don't allow seed to dry as deep ***dormancy*** may result. Soak the seed 24 hours, then place it in small zip-lock bags with moist sand (four parts sand to one part seed) and place the bags in a refrigerator for four to five months. Occasionally examine the bags for germinating seeds. Plant when a seed germinates and the first root is seen. When potting new plants handle the plant very gently to avoid breaking growing tips. Alternatively, cleaned seed can be sown in the fall and pots placed outside to take advantage of natural stratification. ***Germination*** will occur the following spring.

White Dryad, (White Mountain Avens, or Arctic and Alpine Dryad)

White dryads are attractive as garden plants because of the neat, trim leaves, abundant and long-lasting flowers and interesting seed heads. Several different commercial varieties are available. To minimize human impact on natural habitats, please do not attempt to move plants from the wild. Adult plants are hard to transplant anyway because of their large branching ***taproot*** system.

Growing White Dryad From Seed

For most success, sow ripe seed in seed pans filled with sandy, well-drained soil. If you have older seed, this seed will need to be stratified. Put the seed in sealable plastic bags, and put them in a refrigerator for two months at 4°C. After ***germination***, transfer the seedlings to individual pots. Because white dryad has a long tap root, letting the plants grow a while in pots will reduce the amount of damage that can occur when the plant is being transplanted into a garden. Plants grown from seed take many years to flower.

Habitat Requirements

The dryad grows in ***alpine*** and in northern regions, so it is adapted to cool, dry places. It can tolerate moderate drought, and alkaline soils. If you want to grow white dryad in more southern, warmer places you must try to duplicate its favoured growing conditions as much as possible.

First, you need to ensure that your soil is quite coarse in texture so it has adequate drainage. Dryads like to be slightly dry, which can be facilitated if you add pebbles with a little peat moss to your soil. Or, you can plant white dryad in a rock garden among pebbles where there is good drainage but enough moisture to keep the soil from becoming too dry.

Second, your plants need to be protected from the

hot afternoon sun, so pick a spot that is shaded in the afternoon but will expose the plants to sun in the evening and/or morning.

Third, these plants do not thrive in conditions of shade or competition with other plants. These plants have a long branching ***tap root***.

White Trillium

Trilliums can be grown in your garden; the problem is to get them started in the first place.

Do not try to transplant trilliums from the forest to the garden. It is very important to protect these species in the wild!

Forest wildflowers can take up to 15 years to flower and therefore are not economical for commercial greenhouses to grow from seeds or cuttings. For this reason some nurseries dig plants from the wild for resale, a practice that is a great threat to the biodiversity and health of our forests. FloraQuebeca, a Quebec conservation group, therefore recommends no selling or buying of forest flowers such as trillium, ladies' slipper orchid, dog-tooth violet, or spring beauty.

Growing Trilliums From Seed

If you still wish to grow trilliums and are very patient, they can be started from seed. Seeds should be harvested as soon as the capsules are ripe, and immediately planted. Germination is more likely if the seeds have experienced a frost, so it is better to sow in the fall. For germination to be successful, it is important that the seed be kept damp. Trilliums can take 15 years to flower after the seed germinates. Seedlings survive best in open soil away from plant competition, and away from heavy leaf mould.

Habitat Requirements

This plant is suitable for the shade garden, planted with other species that like cool damp conditions, such as primroses. Trilliums require a semi-shady location with good drainage, in neutral to slightly acid soils with some well rotted leaf mould (avoid heavy clay or sandy soils). The protection provided by nearby trees or shrubs and a constantly moist soil will produce a healthier plant.

For more information on native plants and seed sources, visit the following websites.

NATIONAL

Evergreen Native Plant Database
www.evergreen.ca/nativeplants/index.php

Canadian Botanical Conservation Network
c/o Royal Botanical Gardens
Attention: David Galbraith
P.O. Box 399
Hamilton, Ontario L8N 3H8
www.rbg.ca/cbcn/en/index.html

BRITISH COLUMBIA

Native Plant Society of British Columbia
2012 William Street
Vancouver, British Columbia V5L 2X6
Tel: 604.255.5719
Fax: 604.258.0201
www.npsbc.org

ALBERTA

Alberta Native Plant Council Native Plant Source List.
www.anpc.ab.ca/assets/2007SourceList.pdf

SASKATCHEWAN

Saskatchewan Native Plant Society list of native plant sources.
www.npss.sk.ca/nps.php

MANITOBA

Prairie Habitats
www.prairiehabitats.com/

Manitoba Naturalists Society
401 - 63 Albert Street
Winnipeg, Manitoba R3B 1G4
www.manitobanature.ca

ONTARIO

Native Plant Resource Guide for Ontario
www.serontario.org/publications.htm

Acorus Restoration
722 6th Concession Road, R.R. #1
Walsingham, Ontario N0E 1X0
Phone: 519.586.2603
Fax: 519.586.2447
Email: info@ecologyyart.com
www.ecologyart.com

QUEBEC

Montréal Botanical Garden
4101 Sherbrooke East
Montréal, Quebec H1X 2B2
www2.ville.montreal.qc.ca/jardin/en/menu.htm

NEW BRUNSWICK

New Brunswick Botany Club
www.macbe.com/botanyclub/home.html

Save a Plant
16 Fletcher Court, Fredericton, New Brunswick E3A 4T4
Tel.: 506.474.0801
Email: saveaplant@nb.aibn.com

NOVA SCOTIA

Harriet Irving Botanical Gardens - Acadia University
Acadia University
Wolfville, Nova Scotia B4P 2R6
http://botanicalgardens.acadiau.ca
Nova Scotia Wild Flora Society
c/o Nova Scotia Museum of Natural History
1747 Summer Street
Halifax, Nova Scotia B3H 3A6
www.nswildflora.ca/

NEWFOUNDLAND AND LABRADOR

Dr. K. Wilf Nicholls
Garden Director
MUN Botanical Garden
Memorial University
St. John's, NL A1C 5S7
709-737-3326
709-737-8596 (fax)
wnicholl@mun.ca

YUKON

Environment Yukon
www.environmentyukon.gov.yk.ca/wildlifebiodiversity/plants.php

Yellowstone to Yukon Conservation Initiative
www.y2y.net/

Appendix 5

Canadian Curriculum Links

For the PlantWatch Teachers' Guide

USING THE CURRICULUM LINKS TABLES

Appendix 4 identifies the specific curriculum connection for science and math for each activity in the PlantWatch Teacher's Guide. The table is organized by province/territory. The following table will help you to find the pages where you can locate the specific curriculum connections for each activity by code.

	Grade 6	Grade7	Grade 8
Atlantic	pages 99	pages 101	pages 103
Quebec	pages 105	pages 107	pages 108
Ontario	pages 109	pages 112	pages 114
Manitoba	pages 116	pages 118	pages 122
Saskatchewan	pages 123	pages 125	pages 126
Alberta	pages 129	pages 131	pages 134
BC/Yukon	pages 136	pages 137	pages 138
NT/NU	pages 139	pages 141	pages 145

The following Quick Reference Tables have been developed to help you locate the appropriate curriculum connections by grade or by subject.

Quick Reference Guide to Activity by Grade and Subject

K = Key Activity **S** = Science **M** = Math **So** = Social Studies **L** = Language Arts

		NWT/NUN.	BC/YUKON	ALBERTA	SASK.	MANITOBA	ONTARIO	QUEBEC	ATLANTIC
Grade	**Subject**	**Activities**							
6 (Cycle 3 in Quebec)	**Science**	K3, K4, K5, S1, S5	K2, K6, S1, S4, S5	S4, So3, L1, L2	S1, S3, S4, S5, M3, So1, So3	K1, K3, S1, M3, So2, So3, L1, L2	K3, K4, K5, K6, S1, S2, S4, S5, M3, So1, So2, L1, L2	K2, K3, K4, K5, K6, S1, S2, S5, M2, M3, MSo3, L1, L2	K1, K2, K3, K4, K5, K6, S2, S5, M3, So1, So2, So3, L1, L2
	Math	K4, K5, S2, S5, M1, M3, L1	K2, K4, S2, S5, M1, M3, L1	K4, S2, M1, M3, L1	K2, K3, K4, K6, S2, M1, M2, M3, M4, So1, L1	K2, K4, K6, S2, M1, M3, M4, So1, L1	K2, K4, K6, S2, M1, M2, M3, L1	K2, K4, S2, S5, M1, M4, So1	K4, K5, K6, S2, M1, M2, M4, So1
7 (Section I in Quebec)	**Science**	K2, K3, K4, K5, K6, S1, S2, S4, M1, M3, So1, So2, L1, L2	K3, S1, S4, S5	K2, K3, K4, K5, K6, S1, S2, S4, M1, M3, So1, So2, L1, L2	K2, K3, S3, M1, So3, L1	K1, K2, K3, K4, K6, S1, S4, M3, So2, So3, L1, L2	K1, K3, K4, K5, K6, S1, S4, S5, M3, L1	K2, K3, S1, S2, S5, M3, So1, So3, L1, L2	K2, K3, K4, K5, K6, S1, S2, S4, S5, M3, So2, So3, L1
	Math	S2, M1, M2, M4	S2, M1, M2, M4, S2, M1	K4, S2, M1, M2, M4, So1	M1, M2, M4, So1	K4, S2, M1, M2, M4, So1	K2, K4, K6, S2, M1, M2, M3, M4, So1, L1	K2, K4, K5, S2, M1, M3, L1	K4, K5, K6, S2, M1, M2, M4MSo1
8 (Section II in Quebec)	**Science**	M3	K5, S2, S4, S5, M3, So3, L1	M3	K3, K5, K6, S1, S4, S5, M3, So1, So3, L1	M3, So2, So3, L1	M3	None	K3, K4, K5, K6, S1, M3
	Math	S2.M1	S2, M1	K4, K6, S2, M1	K2, K5, K6, S2, M1, M2, M3, L1	K4, S2, M1	K2, K4, K5, K6, M2, M3, M4, L1	K4, K5, M3	K4, K5, K6, S2, M1, M2, M3, M4, So1, L1

Quick Reference Table to Curriculum Links by Activity and Grade

	NWT/ NUNAVUT	BC/YUKON	ALBERTA	SASK.	MANITOBA	ONTARIO	QUEBEC	ATLANTIC
Activity	**Grades with Curriculum Links (of Gr. 6, 7, 8)**							
Key Activity 1	None	None	None	None	6, 7	7	None	6
Key Activity 2	7	None	7	6, 7, 8	6, 7	6, 7, 8	Cycle 3, Sec. I	6, 7
Key Activity 3	6, 7	7	7	6, 7, 8	6, 7	6, 7,	Cycle 3, Sec. I	6, 7
Key Activity 4	6, 7	6	6, 7, 8	6, 8	6, 7, 8	6, 7	Cycle 3, Sec. I, Sec. II	6, 7
Key Activity 5	6, 7	8	7	8	None	6.7, 8	Cycle 3, Sec. I, Sec. II	6, 7, 8
Key Activity 6	7	6	7, 8	6, 8	6, 7	6, 7, 8	Cycle 3	6, 7, 8
Science 1	6, 7	6, 7	7	6, 8	6, 7	6, 7	Cycle 3, Sec. I	7, 8
Science 2	6, 7	6, 7, 8	6, 7, 8	6, 8	6, 7, 8	6, 7	Cycle 3, Sec. I	6, 7, 8
Science 3	None	None	None	6, 7	None	None	None	None
Science 4	7	6, 7, 8	6, 7	6, 8	7	6, 7	None	7
Science 5	6	6, 7, 8	None	Ga	None	6, 7	Cycle 3, Sec. I	6, 7
Math 1	6, 7, 8	6, 7, 8	6, 7, 8	6, 7, 8	6, 7, 8	6, 7	Cycle 3, Sec. I	6, 7, 8
Math 2	7	7	7	6, 7, 8	6, 7	6, 7, 8	Cycle 3	6, 7, 8
Math 3	6, 7, 8	6, 8	6, 7, 8	6, 8	6, 7, 8	6, 7, 8	Cycle 3, Sec. I, Sec. II	6, 7, 8
Math 4	7	7, 8	7	6, 7	6, 7	7, 8	Cycle 3	6, 7, 8
Social Studies 1	7	7, 8	7	6, 7, 8	6, 7	6, 7	Cycle 3, Sec. I	6, 7, 8
Social Studies 2	7	None	7	None	6, 7, 8	6	None	6, 7
Social Studies 3	None	8	6	6, 7, 8	6, 7, 8	None	Cycle 3, Sec. I	6, 7
Lanuage Arts 1	6, 7	6, 8	6, 7	6, 7, 8	6, 7, 8	6, 7, 8	Cycle 3, Sec. I	6, 7, 8
Lanuage Arts 2	7	None	6, 7	6, 7	6, 7	6	Cycle 3, Sec. I	6

Quick Reference Table to Curriculum Links by Activity and Subject

	NWT/ NUNAVUT	BC/YUKON	ALBERTA	SASK.	MANITOBA	ONTARIO	QUEBEC	ATLANTIC
Activity	**Subjects with Curriculum Links for Grades 6, 7 and 8 (of Science and Math)**							
Key Activity 1	Science		Science		Science	Science		Science
Key Activity 2	Science	Science, Math	Science	Science, Math	Science, Math	Math	Science, Math	Science
Key Activity 3	Science, Math	Science	Science, Math	Science, Math	Science	Science	Science	Science
Key Activity 4	Science, Math	Math	Science, Math	Math	Science, Math	Science, Math	Science, Math	Science, Math
Key Activity 5	Science, Math	Science	Science	Science, Math		Science, Math	Science, Math	Science, Math
Key Activity 6	Science	Science	Science, Math	Science, Math	Science, Math	Science, Math	Science	Science, Math
Science 1	Science	Science, Math	Science	Science	Science	Science	Science	Science
Science 2	Science, Math	Science, Math	Science, Math	Math	Math	Science, Math	Science, Math	Science, Math
Science 3				Science				
Science 4	Science	Science	Science	Science	Science	Science		Science
Science 5	Science, Math	Science, Math		Science		Science	Science, Math	Science
Math 1	Science, Math	Math	Science, Math	Science, Math	Math	Math	Math	Math
Math 2	Math	Math	Math	Math	Math	Math	Science	Math
Math 3	Science, Math	Science, Math	Science, Math	Science, Math	Science, Math	Science, Math	Science, Math	Science, Math
Math 4	Math	Science, Math	Math	Math	Math	Math	Math	Science, Math
Social Studies 1	Science, Math	Math	Science, Math	Science, Math	Math	Science, Math	Math	Science, Math
Social Studies 2	Science		Science		Science	Science		Science
Social Studies 3		Science	Science	Science	Science		Science	Science
Lanuage Arts 1	Science, Math	Science, Math	Science, Math	Science, Math	Science, Math	Science, Math	Science, Math	Science, Math
Lanuage Arts 2	Science, Math		Science		Science	Science	Science	Science

CHART OF PROVINCIAL/TERRITORIAL CURRICULUM CONNECTIONS FOR SCIENCE AND MATH FOR GRADES 6-8

LEGEND: **K** - Key activity SUBJECT-SPECIFIC ACTIVITIES: **S** - Science **M** - Math **So** - Social Studies **L** - Language Arts

ATLANTIC PROVINCES

NOTE: The math and science curriculum for the Atlantic Provinces is a result of a collaborative effort of the education departments of the four provinces, coordinated through the Atlantic Provinces Education Foundation/Council of Atlantic Ministers of Education and Training. Please refer to any of the Atlantic Provinces as a reference to the detailed curriculum learning outcomes. The following documents were used:

- Atlantic Canada Elementary Science Curriculum Guide (2002)
- Atlantic Canada Intermediate Science Curriculum Guide
- Grade 6 Mathematics Curriculum Guide (Interim Edition 2005)
- Grade 7 Mathematics Curriculum Guide (Interim Edition 2008)
- Grade 8 Mathematics Curriculum Guide (Interim Edition 2002)

NEWFOUNDLAND

www.ed.gov.nl.ca/edu/sp/pcdbs.htm

PRINCE EDWARD ISLAND

www.gov.pe.ca/educ/index.php3?number=74897&lang=E

NOVA SCOTIA

https://sapps.ednet.ns.ca/Cart/index.php?UID=2009011516322024.222.131.202

NEW BRUNSWICK

www.gnb.ca/0000/anglophone-e.asp#cd

LEGEND: **K** - Key activity SUBJECT-SPECIFIC ACTIVITIES: **S** - Science **M** - Math **So** - Social Studies **L** - Language Arts

ATLANTIC PROVINCES (GRADE 6) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	104-8 demonstrate the importance of using the languages of science and technology to compare and communicate ideas, processes, and results	N/A
K2	204-1 propose questions to investigate and practical problems to solve 207-2 communicate procedures and results, using lists, notes in point form, sentences, charts, graphs, drawing, and oral language	N/A
K3	104-8 demonstrate the importance of using the languages of science and technology to compare and communicate ideas, processes, and results 205-7 record observations using a single work, notes in point form, sentences and simple diagrams and charts	N/A
K4	205-7 record observations using a single work, notes in point form, sentences and simple diagrams and chart 207-2 communicate procedures and results, using lists, notes in point form, sentences, charts, graphs, drawing, and oral language	GCO F KSCO: iii) represent mathematical patterns and relationships in a variety of ways (including rules, tables and one- and two-dimensional graphs) SCO F4 use bar graphs, double bar graphs and stem-and-leaf plots to display data
K5	205-7 record observations using a single work, notes in point form, sentences and simple diagrams and chart 207-2 communicate procedures and results, using lists, notes in point form, sentences, charts, graphs, drawing, and oral language	GCO F: Students will solve problems involving the collection, display and analysis of data. SCO F1 choose and evaluate appropriate samples for data collection F2 identify various types of data sources KSCO: ii) construct a variety of data displays (including tables, charts and graphs) and consider their relative appropriateness
K6	206-9 identify new questions or problems that arise from what was learned	GCO F SCO: F9 explore relevant issues for which data collection assists in reaching conclusions
Other Activity		
S1	N/A	N/A
S2	204-8 identify appropriate tools, instruments, and materials to complete their investigations 205-7 record observations using a single work, notes in point form, sentences and simple diagrams and chart 207-2 communicate procedures and results, using lists, notes in point form, sentences, charts, graphs, drawing, and oral language	SCO: A6 demonstrate an understanding of the meaning of a negative integer B7 solve and create relevant addition, subtraction, multiplication and division problems involving whole numbers B11 calculate sums and differences in relevant contexts by using the most appropriate method KSCO: By the end of grade 6, students will have achieved the outcomes for entry-grade 3 and will also be expected to develop and apply measures of central tendency (mean, [median and mode])

ATLANTIC PROVINCES (GRADE 6) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
S3	N/A	N/A
S4	N/A	N/A
S5	205-7 record observations using a single work, notes in point form, sentences and simple diagrams and chart 207-2 communicate procedures and results, using lists, notes in point form, sentences, charts, graphs, drawing, and oral language	N/A
M1	N/A	SCO: A6 demonstrate an understanding of the meaning of a negative integer B7 solve and create relevant addition, subtraction, multiplication and division problems involving whole numbers B11 calculate sums and differences in relevant contexts by using the most appropriate method KSCO: By the end of grade 6, students will have achieved the outcomes for entry-grade 3 and will also be expected to develop and apply measures of central tendency (mean, [median and mode])
M2	N/A	KSCO: By the end of grade 6, students will have achieved the outcomes for entry-grade 3 and will also be expected to develop and apply measures of central tendency (mean, [median and mode])
M3	Communication and Teamwork 207-2 communicate procedures and results, using lists, notes in point form, sentences, charts, graphs, drawing, and oral language	N/A
M4	N/A	B3 compute quotients of whole numbers and decimals using up to 2- digit whole number divisors
So1	Life Science: Diversity of Life: Adaptations and Natural Selection propose questions about the relationship between the structural features of organisms and their environment, and use a variety of sources to gather information about this relationship (204-1, 205-8)	Refer to M4
So2	STSE: Nature of Science and Technology 105-5 identify examples of scientific knowledge that have developed as a result of the gradual accumulation of evidence	N/A
So3	Life Science: Diversity of Life: Adaptations and Natural Selection propose questions about the relationship between the structural features of organisms and their environment, and use a variety of sources to gather information about this relationship (204-1, 205-8) Relationships Between Science and Technology 205-8 identify and use a variety of sources and technologies to gather pertinent information STSE 108-5 describe how personal actions help conserve natural resources and protect the environment in their region Refer to S3	N/A

ATLANTIC PROVINCES (GRADE 6) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
L1	Performing and Recording 205-7 record observations using a single work, notes in point form, sentences and simple diagrams and charts Communication and Teamwork 207-2 communicate procedures and results, using lists, notes in point form, sentences, charts, graphs, drawing, and oral language	N/A
L2	Performing and Recording 205-7 record observations using a single work, notes in point form, sentences and simple diagrams and charts	N/A

ATLANTIC PROVINCES (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	N/A	N/A
K2	208-5 state a prediction and a hypothesis based on background information or an observed pattern 1.04 List examples of organisms that live in each ecosystem Organize and record information collected in an investigation of an ecosystem using instruments effectively and accurately. (209-3, 209-4)	N/A
K3	210-2 compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs, line graphs, and scatter plots.	N/A
K4	210-2 compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs, line graphs, and scatter plots.	Strand: Statistics and Probability (Data Analysis) General Outcome: Collect, display and analyze data to solve problems.
K5	210-2 compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs, line graphs, and scatter plots.	Strand: Statistics and Probability (Data Analysis) General Outcome: Collect, display and analyze data to solve problems.
K6	211-2 communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language, and other means.	Strand: Statistics and Probability (Data Analysis) General Outcome: Collect, display and analyze data to solve problems.
Other Activity		
S1	Unit 1: Interactions within Ecosystems 306-3 describe interactions between biotic and abiotic factors in an ecosystem.	N/A

ATLANTIC PROVINCES (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
S2	209-3 use instruments effectively and accurately for collecting data. 208-5 state a prediction and a hypothesis based on background information or an observed pattern	General Outcome: Use patterns to describe the world and to solve patterns. Specific Outcome 7PR2 Create a table of values from a linear relation, graph the table of values, and analyze the graph to draw conclusions and solve problems. 7N6. Demonstrate an understanding of addition and subtraction of integers, [concretely, pictorially and] symbolically. 7SP1. Demonstrate an understanding of central tendency and range by: • determining the measures of central tendency (mean, median, mode) and range data with a single meaningful number.
S3	N/A	N/A
S4	113-9 make informed decisions about applications of science and technology, taking into account environmental and social advantages and disadvantages. 1.56 Make informed decisions about forest harvesting techniques taking into account the environmental advantages and disadvantages. (113-9)	N/A
S5	209-3 use instruments effectively and accurately for collecting data. 210-2 compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs, line graphs, and scatter plots.	N/A
M1	N/A	7N6. Demonstrate an understanding of addition and subtraction of integers, [concretely, pictorially and] symbolically. 7SP1. Demonstrate an understanding of central tendency and range by: • determining the measures of central tendency (mean, median, mode) and range data with a single meaningful number.
M2	N/A	7SP1. Demonstrate an understanding of central tendency and range by: • determining the measures of central tendency (mean, median, mode) and range data with a single meaningful number.
M3	210-2 compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs, line graphs, and scatter plots.	N/A
M4	N/A	7SS3. Perform geometric constructions, including parallel line segments
So1	N/A	Refer to M4

ATLANTIC PROVINCES (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
So2	304-3 describe conditions essential to the growth and reproduction of plants [and microorganisms] in an ecosystem and relate these conditions to various aspects of the human food supply.	N/A
So3	Social and Environmental Contexts of Science and Technology 113-11 propose a course of action on social issues related to science and technology, taking into account personal needs. Refer to S3	N/A
L1	Performing and Recording 209-4 organize data using a format that is appropriate to the task or experiment. Analyzing and Interpreting 210-2 compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs, line graphs, and scatter plots. Communication and Teamwork 211-2 communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language, and other means.	N/A
L2	N/A	N/A

ATLANTIC PROVINCES (GRADE 8) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	N/A	N/A
K2	N/A	N/A
K3	209-4 organize data using a format that is appropriate to the task or experiment	N/A
K4	209-4 organize data using a format that is appropriate to the task or experiment	GCO (C): Students will explore, recognize, represent, and apply patterns and relationships, both informally and formally. SCO: C1 represent patterns and relationships in a variety of formats and use these representations to predict unknown values
K5	209-4 organize data using a format that is appropriate to the task or experiment climates	GCO (C): Students will explore, recognize, represent, and apply patterns and relationships, both informally and formally. SCO: C1 represent patterns and relationships in a variety of formats and use these representations to predict unknown values
K6	N/A	GCO (C): Students will explore, recognize, represent, and apply patterns and relationships, both informally and formally. SCO: C1 represent patterns and relationships in a variety of formats and use these representations to predict unknown values C2 interpret graphs that represent linear and non-linear data

LEGEND: **K** - Key activity SUBJECT-SPECIFIC ACTIVITIES: **S** - Science **M** - Math **So** - Social Studies **L** - Language Arts

ATLANTIC PROVINCES (GRADE 8) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
Other Activity		
S1	306-3 describe interactions between biotic and abiotic factors in an ecosystem	N/A
S2	N/A	B12 add, subtract, multiply, and divide positive and negative decimal numbers with and without the calculator B13 solve and create problems involving addition, subtraction, multiplication, and division of positive and negative decimal numbers
S3	N/A	N/A
S4	N/A	N/A
S5	N/A	N/A
M1	N/A	B12 add, subtract, multiply, and divide positive and negative decimal numbers with and without the calculator B13 solve and create problems involving addition, subtraction, multiplication, and division of positive and negative decimal numbers
M2	N/A	B12 add, subtract, multiply, and divide positive and negative decimal numbers with and without the calculator B13 solve and create problems involving addition, subtraction, multiplication, and division of positive and negative decimal numbers
M3	Performing and Recording 209-4 organize data using a format that is appropriate to the task or experiment Analyzing and Interpreting 210-2 compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs, line graphs, and scatter plots 210-6 interpret patterns and trends in data, and infer and explain relationships among the variables	C1 represent patterns and relationships in a variety of formats and use these representations to predict unknown values C2 interpret graphs that represent linear and non-linear data F4 construct and interpret scatter plots [and determine a line of best fit by inspection]
M4	N/A	B12 add, subtract, multiply, and divide positive and negative decimal numbers with and without the calculator B13 solve and create problems involving addition, subtraction, multiplication, and division of positive and negative decimal numbers
So1	N/A	Refer to M4
So2	N/A	N/A
So3	Refer to S3	N/A
L1	N/A	C2 interpret graphs that represent linear and non-linear data
L2	N/A	N/A

QUÉBEC (CYCLE 3) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	N/A	N/A
K2	Strategies: Exploration Strategies Putting forward hypothesis Anticipating the results of his or her approach	Measurement: Probability Predicting the likelihood of an event (certainty, possibility or impossibility)
K3	Living Things: Appropriate Language Drawings, sketches Strategies: Strategies for recording, using and interpreting information Using a variety of observational techniques and tools	N/A
K4	Living Things: Matter Reproduction of Plants and Animals Living Things: Appropriate Language Graphs Strategies: Communication Strategies Using tools to display information in tables and graphs or to draw a diagram	Measurement: Statistics Collecting, describing and organizing data using tables
K5	Strategies: Strategies for recording, using and interpreting information Using a variety of observational techniques and tools	
K6	Strategies: Exploration Strategies Studying a problem or phenomena from different points of view Formulating questions Putting forward hypothesis Exploring various ways of solving the problem	N/A
Other Activity		
S1	Living Things: Energy • Transformation of energy in living things (ecological pyramids) Appropriate Language • Drawings, sketches	N/A
S2	Energy: Techniques and instrumentation Use of simple measuring instruments Strategies: Exploration Strategies Putting forward hypothesis Anticipating the results of his or her approach	Integers: reading, writing, comparison, order, representation Natural numbers: -operation sense
S3	N/A	N/A
S4	N/A	N/A
S5	Energy: Techniques and instrumentation Use of simple measuring instruments Strategies: Exploration Strategies Formulating questions Putting forward hypothesis Living Things: Appropriate Language Terminology related to an understanding of living things Tables Drawings, sketches	Measurement: Temperatures, estimating and measuring Conventional units (C) Measurement: Probability Predicting the likelihood of an event (certainty, possibility or impossibility Measurement: Statistics Collecting, describing and organizing data using tables

LEGEND: **K** - Key activity SUBJECT-SPECIFIC ACTIVITIES: **S** - Science **M** - Math **So** - Social Studies **L** - Language Arts

QUÉBEC (CYCLE 3) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
M1	N/A	Integers: reading, writing, comparison, order, representation Natural numbers: -operation sense
M2	Living Things: Matter: Characteristics of Living Things • reproduction of plants and animals	N/A
M3	Living Things: Appropriate Language: Graphs Strategies Using different tools for recording information Using tools to display information in tables and graphs or to draw a diagram	N/A
M4	N/A	Geometry: Geometric figures and spatial sense constructing parallel Measurement: Lengths: estimating and measuring • relationships between units of measure
So1		Refer to M4
So2		N/A
So3	Living Things: Systems and Interaction Interaction between living organisms and their environment • adaptation Refer to S3	N/A
L1	Earth and Space Science: Systems and Interaction Meteorological systems and climates Living Things: Systems and Interaction Interaction between living organisms and their environment • living things and their habitats Living Things: Appropriate Language: • Terminology related to an understanding of living things Graphs Strategies Using different tools for recording information Using tools to display information in tables and graphs or to draw a diagram	N/A
L2	Living Things: Appropriate Language: Terminology related to an understanding of living things Strategies Using different tools for recording information Using a variety of observational techniques and tools	N/A

Québec Education Program Chapter 6.2: Mathematics, Science and Technology. www.mels.gouv.qc.ca/DGFJ/dp/programme_de_formation/primaire/pdf/educprg2001/educprg2001-062.pdf

QUÉBEC (SEC I) PROVINCIAL CURRICULUM OUTCOMES (CONCEPTS AND PROCESSES)

Activity	Science	Mathematics
Key Activity		
K1	N/A	N/A
K2	The Living World: Diversity of Life Forms Physical and behavioural adaptations Taxonomy	Statistics and Probability: Random Experiment: Event Certain, probable and impossible events Processing data from statistical reports Conducting a survey or a census Determining the population of a sample Gathering data
K3	The Living World: Diversity of Life Forms Habitat Species Physical and behavioural adaptations Taxonomy	N/A
K4	N/A	Statistics and Probability:Processing data from statistical report Organizing and choosing certain tools to present data constructing tables 'constructing graphs: bar graphs, broken line graphs, circle graphs highlighting some of the information that can be derived from a table or graphs
K5	N/A	Statistics and Probability:Processing data from statistical reports Conducting a survey or a census determining the population of a sample gathering data
K6	N/A	N/A
Other Activity		
S1	The Living World: Diversity of Life Forms Habitat Ecological niche Species Physical and behavioural adaptations Taxonomy Ecology T.O. 0.3 To identify the members of the living part of the environment. T.O. 1.1 To distinguish the different types of interactions that occur in the environment. T.O. 1.5 To identify, from examples, phenomena of living/living relationships. T.O. 1.6 To identify, from examples, phenomena of nonliving/living relationships. T.O. 1.7 To identify, from examples, phenomena of living/nonliving relationships.	N/A
S2	The Living World: Diversity of Life Forms Physical and behavioural adaptations Taxonomy	IO 2.2 To perform the following operations on integers: addition, subtraction, multiplication, division and exponentiation (exponents should be limited to the positive integers).
S3	N/A	N/A

QUÉBEC (SEC I) PROVINCIAL CURRICULUM OUTCOMES (CONCEPTS AND PROCESSES)...CONTINUED

Activity	Science	Mathematics
S4	N/A	N/A
S5	The Living World: Diversity of Life Forms Habitat Ecological niche Species Physical and behavioural adaptations Taxonomy	N/A
M1	N/A	Arithmetic and Algebra • Inverse operations: addition and subtraction, multiplication and division
M2	N/A	N/A
M3	The Living World: Diversity of Life Forms • Habitat	Arithmetic and Algebra (Processes): Different Ways of Writing and Representing Numbers • Using a variety of representations (e.g. Numerical, graphic)
M4	N/A	N/A
So1	The Living World: Diversity of Life Forms • Habitat	Refer to M4
So2	N/A	N/A
So3	The Living World: Diversity of Life Forms • Adaptation • Habitat Refer to S3	N/A
L1	The Living World: Diversity of Life Forms • Habitat	Arithmetic and Algebra (Processes): Different Ways of Writing and Representing Numbers • Using a variety of representations (e.g. Numerical, graphic)
L2	The Living World: Diversity of Life Forms • Habitat	N/A

Secondary Education: Ecology. www.mels.gouv.qc.ca/DGFJ/dp/programmes_etudes/secondaire/ecology.htm
Mathematics 116, Secondary I www.mels.gouv.qc.ca/GR-PUB/menu-curricu-a.htm

QUÉBEC (SEC II) PROVINCIAL CURRICULUM OUTCOMES (CONCEPTS AND PROCESSES)

Activity	Science	Mathematics
Key Activity		
K1	N/A	N/A
K2	N/A	N/A
K3	N/A	N/A
K4	N/A	1.1 Intermediate Objectives To give a comprehensive description of a situation represented by a graph.
K5	N/A	1.1 Intermediate Objectives To give a comprehensive description of a situation represented by a table of values.
K6	N/A	N/A

QUÉBEC (SEC II) PROVINCIAL CURRICULUM OUTCOMES (CONCEPTS AND PROCESSES)...CONTINUED

Activity	Science	Mathematics
Other Activity		
S1	N/A	N/A
S2	N/A	N/A
S3	N/A	N/A
S4	N/A	N/A
S5	N/A	N/A
M1	N/A	N/A
M2	N/A	N/A
M3	N/A	TO 1.1 To translate one representation of a situation into another
M4	N/A	N/A
So1	N/A	Refer to M4
So2	N/A	N/A
So3	Refer to S3	N/A
L1	N/A	N/A
L2	N/A	N/A

Mathematics 216, Secondary II http://www.mels.gouv.qc.ca/GR-PUB/menu-curricu-a.htm/science/programs.aspx

ONTARIO (GRADE 6) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	N/A	N/A
K2	N/A	Data Management and Probability collect data by conducting a survey (e.g., use an Internet survey tool) or an experiment to do with themselves,their environment, issues in their school or community, or content from another subject, and record observations or measurements;
K3	Understanding Life Systems: Biodiversity 1.2 assess the benefits that human societies derive from biodiversity (e.g., thousands of products such as food, clothing, medicine, and building use a variety of forms (e.g., oral, written, graphic, multimedia) to communicate with different audiences and for a variety of purposes (e.g., use a graphic organizer to show comparisons between organisms in various communities)	N/A
K4	2.5 use a variety of forms (e.g., oral, written, graphic, multimedia) to communicate with different audiences and for a variety of purposes (e.g., use a graphic organizer to show comparisons between organisms in various communities)	Data Management and Probability collect and organize discrete or continuous primary data and secondary data (e.g., electronic data from websites such as E-Stat or Census At Schools) and display the data in charts, tables, and graphs (including continuous line graphs) that have appropriate titles, labels (e.g., appropriate units marked on the axes), and scales (e.g., with appropriate increments) that suit the range and distribution of the data, using a variety of tools (e.g., graph paper, spreadsheets, dynamic statistical software)

ONTARIO (GRADE 6) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
K5	2.5 use a variety of forms (e.g., oral, written, graphic, multimedia) to communicate with different audiences and for a variety of purposes (e.g., use a graphic organizer to show comparisons between organisms in various communities) (Optional activity complements one additional outcome) 3.1 identify and describe the distinguishing characteristics of different groups of plants and animals	N/A
K6	2.5use a variety of forms (e.g., oral, written, graphic, multimedia) to communicate with different audiences and for a variety of purposes (e.g., use a graphic organizer to show comparisons between organisms in various communities)	Data Management and Probability Read, interpret, and draw conclusions from primary data (e.g., survey results, measurements, observations) and from secondary data (e.g., sports data in the newspaper, data from the Internet about movies), presented in charts, tables, and graphs (including continuous line graphs);
Other Activity		
S1	3.5 describe interrelationships within species, between species within each species of plant and between species [and explain how these interrelationships sustain biodiversity.]	N/A
S2	2.5 use a variety of forms (e.g., oral, written, graphic, multimedia) to communicate with different audiences and for a variety of purposes (e.g., use a graphic organizer to show comparisons between organisms in various communities)	Data management and Probability: Data Relationships demonstrate an understanding of mean, and use the mean to compare two sets of related data, with and without the use of technology
S3	N/A	N/A
S4	1.1 analyse a local issue related to biodiversity (e.g., the effects of human activities on urban biodiversity, flooding of traditional Aboriginal hunting and gathering areas as a result of dam construction), taking different points of view into consideration (e.g., the points of view of members of the local community, business owners, people concerned about the environment, mine owners, local First Nations, Métis, Inuit), propose action that can be taken to preserve biodiversity, and act on the proposal.	N/A
S5	2.5 use a variety of forms (e.g., oral, written, graphic, multimedia) to communicate with different audiences and for a variety of purposes (e.g., use a graphic organizer to show comparisons between organisms in various communities)	N/A
M1	N/A	Data management and Probability: Data Relationships demonstrate an understanding of mean, and use the mean to compare two sets of related data, with and without the use of technology
M2	N/A	Data management and Probability: Data Relationships demonstrate an understanding of mean, and use the mean to compare two sets of related data, with and without the use of technology

LEGEND: **K** - Key activity SUBJECT-SPECIFIC ACTIVITIES: **S** - Science **M** - Math **So** - Social Studies **L** - Language Arts

ONTARIO (GRADE 6) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
M3	Developing Investigation and Communication Skills 2.5 use a variety of forms (e.g., oral, written, graphic, multimedia) to communicate with different audiences and for a variety of purposes (e.g., use a graphic organizer to show comparisons between organisms in various communities)	Data management and Probability: Collection and Organization of Data - collect and organize discrete or continuous primary data and secondary data (e.g., electronic data from websites such as E-Stat or Census At Schools) and display the data in charts, tables, and graphs (including continuous line graphs) that have appropriate titles, labels (e.g., appropriate units marked on the axes), and scales (e.g., with appropriate increments) that suit the range and distribution of the data, using a variety of tools (e.g., graph paper, spreadsheets, dynamic statistical software); Data Relationships –read, interpret, and draw conclusions from primary data (e.g., survey results, measurements, observations) and from secondary data (e.g., sports data in the newspaper, data from the Internet about movies), presented in charts, tables, and graphs (including continuous line graphs);
M4	N/A	N/A
So1	3.2 demonstrate an understanding of biodiversity as the variety of life on earth, including variety within each species of plant and animal, among species of plants and animals in communities, and among communities and the physical landscapes that support them	Refer to M4
So2	Relating Science and Technology to Society and the Environment 1.2 assess the benefits that human societies derive from biodiversity audiences and for a variety of purposes 3.6 identify everyday products that come from a diversity of organisms (e.g., traditional pain relievers are derived from the bark of the white willow tree; tofu is made from soybeans; silk is made from silkworm cocoons; nutritional supplements, shampoos, toothpastes, and deodorants contain pollen collected by bees)	N/A
So3	Refer to S3	N/A
L1	Relating Science and Technology to Society and the Environment 1.2 assess the benefits that human societies derive from biodiversity audiences and for a variety of purposes Developing Investigation and Communication Skills 2.5 use a variety of forms (e.g., oral, written, graphic, multimedia) to communicate with different audiences and for a variety of purposes (e.g., use a graphic organizer to show comparisons between organisms in various communities)	Data management and Probability: Collection and Organization of Data - collect and organize discrete or continuous primary data and secondary data (e.g., electronic data from websites such as E-Stat or Census At Schools) and display the data in charts, tables, and graphs (including continuous line graphs) that have appropriate titles, labels (e.g., appropriate units marked on the axes), and scales (e.g., with appropriate increments) that suit the range and distribution of the data, using a variety of tools (e.g., graph paper, spreadsheets, dynamic statistical software); Data Relationships – read, interpret, and draw conclusions from primary data (e.g., survey results, measurements, observations) and from secondary data (e.g., sports data in the newspaper, data from the Internet about movies), presented in charts, tables, and graphs (including continuous line graphs);
L2	3.2 demonstrate an understanding of biodiversity as the variety of life on earth, including variety within each species of plant and animal, among species of plants and animals in communities, and among communities and the physical landscapes that support them	N/A

The Ontario Curriculum Grades 1-8: Science and Technology, 2007 www.edu.gov.on.ca/eng/curriculum/elementary/scientec.html
The Ontario Curriculum Grades 1-8: Mathematics, 2005 www.edu.gov.on.ca/eng/curriculum/elementary/math18curr.pdf

ONTARIO (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	Understanding Life Systems, Interactions in the Environment 3.2 identify biotic and abiotic elements in an ecosystem, and describe the interactions between them (e.g., between hours of sunlight and the growth of plants in a pond; between a termite colony and a decaying log; between the soil, plants, and animals in a forest)	N/A
K2	N/A	Data Management and Probability – collect data by conducting a survey or an experiment to do with themselves their environment, issues in their school or content from another subject and record observations or measurements;
K3	2.5 use a variety of forms (e.g., oral, written, graphic, multimedia) to communicate with different audiences and for a variety of purposes (e.g., design a multimedia presentation explaining the interrelationships between biotic and abiotic components in a specific ecosystem)	N/A
K4	2.5 use a variety of forms (e.g., oral, written, graphic, multimedia) to communicate with different audiences and for a variety of purposes (e.g., design a multimedia presentation explaining the interrelationships between biotic and abiotic components in a specific ecosystem)	Data Management and Probability – collect and organize categorical, discrete, or continuous primary data and secondary data (e.g., electronic data from websites such as E-Stat or Census At Schools) and display the data in charts, tables, and graphs (including relative frequency tables and circle graphs) that have appropriate titles, labels (e.g., appropriate units marked on the axes), and scales (e.g., with appropriate increments) that suit the range and distribution of the data, using a variety of tools (e.g., graph paper, spreadsheets, dynamic statistical software)
K5	2.5 use a variety of forms (e.g., oral, written, graphic, multimedia) to communicate with different audiences and for a variety of purposes (e.g., design a multimedia presentation explaining the interrelationships between biotic and abiotic components in a specific ecosystem)	N/A
K6	3.2 identify biotic and abiotic elements in an ecosystem, and describe the interactions between them (e.g., between hours of sunlight and the growth of plants in a pond; between a termite colony and a decaying log; between the soil, plants, and animals in a forest)	Data Management and Probability – read, interpret, and draw conclusions from primary data (e.g., survey results, measurements, observations) and from secondary data (e.g., temperature data or community data in the newspaper, data from the Internet about populations) presented in charts, tables, and graphs (including relative frequency tables and circle graphs);
Other Activity		
S1	3.1 demonstrate an understanding of an ecosystem (e.g., a log, a pond, a forest) as a system of interactions between living organisms and their environment 3.2 [identify biotic and abiotic elements in an Ecosystem, and] describe the interactions between them 3.9 describe Aboriginal perspectives on sustainability and describe ways in which they can be used in habitat and wildlife management	N/A
S2	N/A	Number Sense and Numeration–identify and compare integers found in real-life contexts (e.g.,–10°C is much colder than +5°C);
S3	N/A	N/A

LEGEND: **K** - Key activity SUBJECT-SPECIFIC ACTIVITIES: **S** - Science **M** - Math **So** - Social Studies **L** - Language Arts

ONTARIO (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
S4	3.2 identify biotic and abiotic elements in an ecosystem, and describe the interactions between them (e.g., between hours of sunlight and the growth of plants in a pond; between a termite colony and a decaying log; between the soil, plants, and animals in a forest)	N/A
S5	3.8 describe ways in which human activities and technologies alter balances and interactions in the environment (e.g., clear-cutting a forest, overusing motorized water vehicles, managing wolf-killings in Yukon	N/A
M1	N/A	Number Sense and Numeration–identify and compare integers found in real-life contexts (e.g.,–10°C is much colder than +5°C);
M2	N/A	Operational Sense–solve multi-step problems arising from real-life contexts and involving whole numbers and decimals, using a variety of tools (e.g., concrete materials, drawings, calculators) and strategies (e.g., estimation, algorithms);
M3	Developing Investigation and Communication Skills 2.7 use a variety of forms to communicate with different audiences and for a variety of purposes	Collection and Organization of Data–collect and organize categorical, discrete, or continuous primary data and secondary data (e.g., electronic data from websites such as E-Stat or Census At Schools) and display the data in charts, tables, and graphs (including relative frequency tables and circle graphs) that have appropriate titles, labels (e.g., appropriate units marked on the axes), and scales (e.g., with appropriate increments) that suit the range and distribution of the data, using a variety of tools (e.g., graph paper, spreadsheets, dynamic statistical software); in charts, tables, and graphs (including relative frequency tables and circle graphs); Data Relationships –read, interpret, and draw conclusions from primary data (e.g., survey results, measurements, observations) and from secondary data (e.g., temperature data or community data in the newspaper, data from the Internet about populations) presented in charts, tables, and graphs (including relative frequency tables and circle graphs); –identify and describe trends, based on the distribution of the data presented in tables and graphs, using informal language; –make inferences and convincing arguments that are based on the analysis of charts, tables, and graphs
M4	N/A	Operational Sense –solve multi-step problems arising from real-life contexts and involving whole numbers and decimals, using a variety of tools (e.g., concrete materials, drawings, calculators) and strategies (e.g., estimation, algorithms); Geometric Properties –construct related lines (i.e., parallel; [perpendicular; intersecting at 30°,45°,and 60°]),using angle properties and a variety of tools
So1	N/A	Refer to M4
So2	N/A	N/A
So3	Refer to S3	N/A

ONTARIO (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
L1	Developing Investigation and Communication Skills 2.4 use appropriate science and technology vocabulary, [including sustainability, biotic, ecosystem, community, population, and producer] in oral and written communication 2.7 use a variety of forms to communicate with different audiences and for a variety of purposes	Collection and Organization of Data –collect and organize categorical, discrete, or continuous primary data and secondary data (e.g., electronic data from websites such as E-Stat or Census At Schools) and display the data in charts, tables, and graphs (including relative frequency tables and circle graphs) that have appropriate titles, labels (e.g., appropriate units marked on the axes), and scales (e.g., with appropriate increments) that suit the range and distribution of the data, using a variety of tools (e.g., graph paper, spreadsheets, dynamic statistical software); in charts, tables, and graphs (including relative frequency tables and circle graphs); Data Relationships –read, interpret, and draw conclusions from primary data (e.g., survey results, measurements, observations) and from secondary data (e.g., temperature data or community data in the newspaper, data from the Internet about populations) presented in charts, tables, and graphs (including relative frequency tables and circle graphs); –identify and describe trends, based on the distribution of the data presented in tables and graphs, using informal language; –make inferences and convincing arguments that are based on the analysis of charts, tables, and graphs
L2	N/A	N/A

The Ontario Curriculum Grades 1-8: Science and Technology, 2007 www.edu.gov.on.ca/eng/curriculum/elementary/scientec.html
The Ontario Curriculum Grades 1-8: Mathematics, 2005 www.edu.gov.on.ca/eng/curriculum/elementary/math18curr.pdf

ONTARIO (GRADE 8) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	N/A	
K2	N/A	Data Management and Probability collect data by conducting a survey or an experiment to do with themselves, their environment, issues in their school or community, or content from another subject, and record observations or measurements;
K3	N/A	N/A
K4	N/A	Data Management and Probability select an appropriate type of graph to represent a set of data, graph the data using technology, and justify the choice of graph (i.e., from types of graphs already studied, including histograms and scatter plots)
K5	N/A	Operational Sense –solve multi-step problems arising from real-life on texts and involving whole numbers and decimals, using a variety of tools (e.g., graphs, calculators) and strategies (e.g., estimation, algorithms);

LEGEND: **K** - Key activity SUBJECT-SPECIFIC ACTIVITIES: **S** - Science **M** - Math **So** - Social Studies **L** - Language Arts

ONTARIO (GRADE 8) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
K6	N/A	Data Management and Probability read, interpret, and draw conclusions from primary data (e.g., survey results, measurements, observations) and from secondary data (e.g., election data or temperature data from the newspaper, data from the Internet about lifestyles), presented in charts, tables, and graphs (including frequency tables with intervals, histograms, and scatter plots);
Other Activity		
S1	N/A	N/A
S2	N/A	N/A
S3	N/A	N/A
S4	N/A	N/A
S5	N/A	N/A
M1	N/A	N/A
M2	N/A	Operational Sense –solve multi-step problems arising from real-life contexts and involving whole numbers and decimals, using a variety of tools (e.g., graphs, calculators) and strategies (e.g., estimation, algorithms);
M3	Developing Investigation and Communication Skills 2.6 use a variety of forms to communicate with different audiences and for a variety of purposes	Data Management and Probability Data Relationships –collect and organize categorical, discrete, or continuous primary data and secondary data (e.g., electronic data from websites such as E-Stat or Census At Schools), and display the data in charts, tables, and graphs (including histograms and scatter plots) that have appropriate titles, labels (e.g., appropriate units marked on the axes), and scales (e.g., with appropriate increments) that suit the range and distribution of the data, using a variety of tools (e.g., graph paper, spreadsheets, dynamic statistical software); charts, tables, and graphs (including frequency tables with intervals, histograms, and scatter plots); –read, interpret, and draw conclusions from primary data (e.g., survey results, measurements, observations) and from secondary data (e.g., election data or temperature data from the newspaper, data from the Internet about lifestyles), presented in charts, tables, and graphs (including frequency tables with intervals, histograms, and scatter plots); –make inferences and convincing arguments that are based on the analysis of charts, tables, and graphs
M4	N/A	Operational Sense –solve multi-step problems arising from real-life contexts and involving whole numbers and decimals, using a variety of tools (e.g., graphs, calculators) and strategies (e.g., estimation, algorithms);
So1	N/A	N/A
So2	N/A	N/A
So3	N/A	N/A

ONTARIO (GRADE 8) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
L1	N/A	Data Management and Probability Data Relationships –collect and organize categorical, discrete, or continuous primary data and secondary data (e.g., electronic data from websites such as E-Stat or Census At Schools), and display the data in charts, tables, and graphs (including histograms and scatter plots) that have appropriate titles, labels (e.g., appropriate units marked on the axes), and scales (e.g., with appropriate increments) that suit the range and distribution of the data, using a variety of tools (e.g., graph paper, spreadsheets, dynamic statistical software); charts, tables, and graphs (including frequency tables with intervals, histograms, and scatter plots); –read, interpret, and draw conclusions from primary data (e.g., survey results, measurements, observations) and from secondary data (e.g., election data or temperature data from the newspaper, data from the Internet about lifestyles), presented in charts, tables, and graphs (including frequency tables with intervals, histograms, and scatter plots); –make inferences and convincing arguments that are based on the analysis of charts, tables, and graphs
L2	N/A	N/A

The Ontario Curriculum Grades 1-8: Science and Technology, 2007 www.edu.gov.on.ca/eng/curriculum/elementary/scientec.html
The Ontario Curriculum Grades 1-8: Mathematics, 2005 www.edu.gov.on.ca/eng/curriculum/elementary/math18curr.pdf

MANITOBA (GRADE 6) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	6-1-08 Observe and describe the diversity of living things within the local environment. GLO: A1, C2, D1, E1	N/A
K2	N/A	6.SP.2 Select, justify and use appropriate methods of collecting data including questionnaires, experiments, databases, electronic media. [C, PS, T]
K3	6-1-08 Observe and describe the diversity of living things within the local environment. GLO: A1, C2, D1, E1	N/A
K4	N/A	6.SP.3 Graph collected data and analyze the graph to solve problems.[C, CN, PS]
K5	N/A	N/A
K6	N/A	6.SP.3 Graph collected data and analyze the graph to solve problems.[C, CN, PS]

LEGEND: **K** - Key activity SUBJECT-SPECIFIC ACTIVITIES: **S** - Science **M** - Math **So** - Social Studies **L** - Language Arts

MANITOBA (GRADE 6) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
Other Activity		
S1	6-1-08 Observe and describe the diversity of living things within the local environment. GLO: A1, C2, D1, E1	N/A
S2	N/A	Number 6.N.7. Demonstrate an understanding of integers, concretely, pictorially, and symbolically. [C, CN, R, V]
S3	N/A	N/A
S4	N/A	N/A
S5	N/A	N/A
M1	N/A	Number 6.N.7. Demonstrate an understanding of integers, concretely, pictorially, and symbolically. [C, CN, R, V]
M2	N/A	N/A
M3	Analysing and interpreting 6-0-6A. Construct graphs to display data, and interpret and evaluate these and other graphs. 6-0-6C. Identify and suggest explanations for patterns and discrepancies in data. Scientific and Technological Skills and Attitudes C6. employ effective communication skills and utilize information technology to gather and share scientific and technological ideas and data	Patterns and Relations 6.PR.2. Represent and describe patterns and relationships using graphs and tables. [C, CN, ME, PS, R, V] Statistics and Probability 6.SP.1. Create, label, and interpret line graphs to draw conclusions. [C, CN, PS, R, V] 6.SP.3. Graph collected data and analyze the graph to solve problems. [C, CN, PS]
M4	N/A	Number 6.N.8. Demonstrate an understanding of multiplication and division of decimals involving 1-digit whole-number multipliers
So1	N/A	Refer to M4
So2	Nature of Science and Technology (General Learning Outcomes) A4. identify and appreciate contributions made by women and men from many societies and cultural backgrounds towards increasing our understanding of the world and in bringing about technological innovations Science, Technology, Society and the Environment (General Learning Outcomes) B2. recognize that scientific and technological endeavors have been and continue to be influenced by human needs and the societal context of the time Diversity of Living Things 6-1-15 Identify and describe the contributions of scientists and naturalists who have increased our understanding of the diversity of living things.	N/A

MANITOBA (GRADE 6) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
So3	Science, Technology, Society and the Environment (General Learning Outcomes) B5. identify and demonstrate actions that promote a sustainable environment, society and economy, both locally and globally Scientific and Technological Skills and Attitudes (General Learning Outcomes) C6. employ effective communication skills and utilize information technology to gather and share scientific and technological ideas and data Researching 6-0-2A. Access information using a variety of sources. 6-0-2C. Make notes on a topic, combining information from more than one source and reference sources appropriately. 6-0-9F. Frequently and thoughtfully evaluate the potential consequences of their actions. Refer to S3	N/A
L1	Nature of Science and Technology (General Learning Outcomes) A4. identify and appreciate contributions made by women and men from many societies and cultural backgrounds towards increasing our understanding of the world and in bringing about technological innovations Observing, Measuring, Recording 6-0-5A. Make observations that are relevant to a specific question. 6-0-5F. Record and organize observations in a variety of ways.	Patterns and Relations 6.PR.2. Represent and describe patterns and relationships using graphs and tables. [C, CN, ME, PS, R, V]
L2	Observing, Measuring, Recording 6-0-5A. Make observations that are relevant to a specific question. 6-0-5F. Record and organize observations in a variety of ways. Diversity of Living Things 6-1-08 Observe and describe the diversity of living things within the local environment.	N/A

K-8 Mathematics Manitoba Curriculum Framework of Outcomes. 2008. www.edu.gov.mb.ca/k12/cur/math/framework_k-8/index.html
Grades 5 to 8 Science: Manitoba Curriculum Framework of Outcomes www.edu.gov.mb.ca/k12/cur/science/scicurr.html

MANITOBA (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	7-1-01 Use appropriate vocabulary related to their investigations of interactions within ecosystems. Include: ecosystem, biosphere, abiotic, biotic, organisms, ecological succession, photosynthesis, cellular respiration, ecological pyramid, bioaccumulation, scavengers, decomposers, micro-organisms GLO: C6, D2	N/A

LEGEND: **K** - Key activity SUBJECT-SPECIFIC ACTIVITIES: **S** - Science **M** - Math **So** - Social Studies **L** - Language Arts

MANITOBA (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
K2	7-1-01 Use appropriate vocabulary related to their investigations of interactions within ecosystems. Include: ecosystem, biosphere, abiotic, biotic, organisms, ecological succession, photosynthesis, cellular respiration, ecological pyramid, bioaccumulation, scavengers, decomposers, micro-organisms GLO: C6, D2	N/A
K3	7-1-01 Use appropriate vocabulary related to their investigations of interactions within ecosystems. Include: ecosystem, biosphere, abiotic, biotic, organisms, ecological succession, photosynthesis, cellular respiration, ecological pyramid, bioaccumulation, scavengers, decomposers, micro-organisms GLO: C6, D2 1-03 Identify abiotic and biotic components of ecosystems that allow particular organisms to survive. GLO: D1, D2, E2	N/A
K4	7-1-01 Use appropriate vocabulary related to their investigations of interactions within ecosystems. Include: ecosystem, biosphere, abiotic, biotic, organisms, ecological succession, photosynthesis, cellular respiration, ecological pyramid, bioaccumulation, scavengers, decomposers, micro-organisms GLO: C6, D2	General Outcome Collect, display, and analyze data to solve problems
K5	N/A	N/A
K6	7-1-01 Use appropriate vocabulary related to their investigations of interactions within ecosystems. Include: ecosystem, biosphere, abiotic, biotic, organisms, ecological succession, photosynthesis, cellular respiration, ecological pyramid, bioaccumulation, scavengers, decomposers, micro-organisms GLO: C6, D2	N/A
Other Activity		
S1	-1-03 Identify abiotic and biotic components of ecosystems that allow particular organisms to survive. GLO: D1, D2, E2	N/A
S2	N/A	Number 7.N.2. Demonstrate an understanding of the addition, subtraction, multiplication, and division of decimals to solve problems (for more than 1-digit divisors or 2-digit multipliers, the use of technology is expected). [ME, PS, T] 7.N.6. Demonstrate an understanding of addition and subtraction of integers, concretely, pictorially, and symbolically. [C, CN, PS, R, V] Statistics and Probability 7.SP.1. Demonstrate an understanding of central tendency and range by determining the measures of central tendency (mean, median, mode) and range [C, PS, R, T]
S3	N/A	N/A

MANITOBA (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
S4	7-1-05 Identify and describe positive and negative examples of human interventions that have an impact on ecological succession or the makeup of ecosystems. Examples: positive - protecting habitats, reintroducing species; negative - preventing natural fires, introducing non-indigenous species, draining wetlands for agriculture or housing GLO: B5, D2, E2, E3 7-1-06 Identify environmental, social, and economic factors that should be considered in the management and preservation of ecosystems. Examples: habitat preservation, recreation, employment, industrial growth, resource development GLO: B1, B5, D2, E2 7-1-12 Provide examples of scavengers and decomposers, and describe their role in cycling matter in an ecosystem. Include: micro-organism GLO: D2, E1, E2, E3	N/A
S5	N/A	N/A
M1	N/A	Number 7.N.2. Demonstrate an understanding of the addition, subtraction, multiplication, and division of decimals to solve problems (for more than 1-digit divisors or 2-digit multipliers, the use of technology is expected). [ME, PS, T] 7.N.6. Demonstrate an understanding of addition and subtraction of integers, concretely, pictorially, and symbolically. [C, CN, PS, R, V] Statistics and Probability 7.SP.1. Demonstrate an understanding of central tendency and range by determining the measures of central tendency (mean, median, mode) and range [C, PS, R, T]
M2	N/A	Statistics and Probability 7.SP.1. Demonstrate an understanding of central tendency and range by determining the measures of central tendency (mean, median, mode) and range [C, PS, R, T]
M3	Analysing and Interpreting 7-0-6A. Construct graphs to display data, and interpret and evaluate these and other graphs.	N/A
M4	N/A	Space and Shape 7.SS.3. Perform geometric constructions, including parallel line segments [CN, R, V] .
So1	N/A	Refer to M4

MANITOBA (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
So2	Nature of Science and Technology (General Learning Outcomes) A4. identify and appreciate contributions made by women and men from many societies and cultural backgrounds towards increasing our understanding of the world and in bringing about technological innovations Science, Technology, Society and the Environment (General Learning Outcomes) B2. recognize that scientific and technological endeavors have been and continue to be influenced by human needs and the societal context of the time Demonstrating Scientific and Technological Attitudes 7-0-9A. Appreciate and respect that science has evolved from different views held by women and men from a variety of societies and cultural backgrounds.	N/A
So3	Science, Technology, Society and the Environment (General Learning Outcomes) B5. identify and demonstrate actions that promote a sustainable environment, society and economy, both locally and globally Scientific and Technological Skills and Attitudes (General Learning Outcomes) C6. employ effective communication skills and utilize information technology to gather and share scientific and technological ideas and data Researching 7-0-2A. Access information using a variety of sources. Reflecting on Science and Technology 7-0-8G. Discuss societal, environmental, and economic impacts of scientific and technological endeavours.	N/A
L1	Nature of Science and Technology (General Learning Outcomes) A4. identify and appreciate contributions made by women and men from many societies and cultural backgrounds towards increasing our understanding of the world and in bringing about technological innovations Observing, Measuring, Recording 7-0-5A. Make observations that are relevant to a specific question. Analysing and Interpreting 7-0-6A. Construct graphs to display data, and interpret and evaluate these and other graphs. Demonstrating Scientific and Technological Attitudes 7-0-9A. Appreciate and respect that science has evolved from different views held by women and men from a variety of societies and cultural backgrounds.	N/A
L2	Observing, Measuring, Recording 7-0-5A. Make observations that are relevant to a specific question.	N/A

K-8 Mathematics Manitoba Curriculum Framework of Outcomes. 2008. www.edu.gov.mb.ca/k12/cur/math/framework_k-8/index.html
Grades 5 to 8 Science: Manitoba Curriculum Framework of Outcomes www.edu.gov.mb.ca/k12/cur/science/scicurr.html

MANITOBA (GRADE 8) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	N/A	N/A
K2	N/A	N/A
K3	N/A	N/A
K4	N/A	General Outcome: Collect and analyze data to solve problems
K5	N/A	N/A
K6	N/A	N/A
Other Activity		
S1	N/A	N/A
S2	N/A	Number 8.N.7. Demonstrate an understanding of multiplication and division of integers, concretely, pictorially, and symbolically. [C, CN, PS, R, V]
S3	N/A	N/A
S4	N/A	N/A
S5	N/A	N/A
M1	N/A	Number 8.N.7. Demonstrate an understanding of multiplication and division of integers, concretely, pictorially, and symbolically. [C, CN, PS, R, V]
M2	N/A	N/A
M3	8-0-6A. Construct graphs to display data, and interpret and evaluate these and other graphs.	N/A
M4	N/A	N/A
So1	N/A	Refer to M4
So2	Nature of Science and Technology (General Learning Outcomes) A4. identify and appreciate contributions made by women and men from many societies and cultural backgrounds towards increasing our understanding of the world and in bringing about technological innovations Science, Technology, Society and the Environment (General Learning Outcomes) B2. recognize that scientific and technological endeavors have been and continue to be influenced by human needs and the societal context of the time	N/A
So3	Science, Technology, Society and the Environment (General Learning Outcomes) B5. identify and demonstrate actions that promote a sustainable environment, society and economy, both locally and globally Scientific and Technological Skills and Attitudes (General Learning Outcomes) C6. employ effective communication skills and utilize information technology to gather and share scientific and technological ideas and data Also: Refer to S3	N/A

MANITOBA (GRADE 8) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
L1	Nature of Science and Technology (General Learning Outcomes) A4. identify and appreciate contributions made by women and men from many societies and cultural backgrounds towards increasing our understanding of the world and in bringing about technological innovations	N/A
L2	N/A	N/A

K-8 Mathematics Manitoba Curriculum Framework of Outcomes. 2008. http://www.edu.gov.mb.ca/k12/cur/math/framework_k-8/index.html

SASKATCHEWAN (GRADE 6) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	N/A	
K2	N/A	Data Management: Collecting D-1 acquire data through a. surveys, questionnaires b. experiments c. observation d. published information
K3	N/A	Data Management: Collecting D-1 acquire data through a. surveys, questionnaires b. experiments c. observation d. published information
K4	N/A	Data Management: Collecting D-1 acquire data through a. surveys, questionnaires b. experiments c. observation d. published information Organizing and Displaying D-9 display data using a. histograms, line graphs (broken) b. frequency diagrams, tally c. circle graphs (fractional)
K5	N/A	
K6	N/A	Data Management: Summarizing and Interpreting D-14 discuss, interpret, and ascribe meaning to the organized data
Other Activity		
S1	Ecosystems 1.2 Identify interrelationships among the biotic and abiotic components of an ecosystem 1.4 Appreciate the importance of food webs in conveying information about interrelationships in the local community 2.4 Explain how living organisms cooperatively share an environment.	N/A

LEGEND: **K** - Key activity SUBJECT-SPECIFIC ACTIVITIES: **S** - Science **M** - Math **So** - Social Studies **L** - Language Arts

SASKATCHEWAN (GRADE 6) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
S2	N/A	To be filled in with M1
S3	Earth's Climate 3.1 Recognize that climatic change can take place over prolonged periods of time 3.3 Evaluate theories of climatic change.	N/A
S4	Inquire into the effects of change in an ecosystem. 1. Identify some events that cause change. 2. Examine an ecosystem that has experienced change. 3. Appreciate the fragile nature of ecosystems. 4. Explain how living organisms cooperatively share an environment.	N/A
S5	1.Investigate factors which influence an ecosystem . 1.Recognize abiotic and biotic components of an ecosystem . 2.Identify interrelationships among the biotic and abiotic components of an ecosystem. 3.Acquire skills in estimating the population of an area. 4.Appreciate the importance of food webs in conveying information about interrelationships in the local community. 2.Inquire into the effects of change in an ecosystem. 1.Identify some events that cause change. 2.Examine an ecosystem that has experienced change. 3.Appreciate the fragile nature of ecosystems. 4.Explain how living oganisms cooperatively share an environment. 5.Illustrate ways that change cascades through an ecosystem. 6.Identify changes that have global implications. 7.Assess pressures on various populations. 3.Develop a sense of responsibility for the preservation of the ecosphere. 1.Identify direct personal links to the local ecosystem. 2.Investigate the impact that humans have on ecosystems. 3.Recognize the role that humans play in protecting or destroying ecosystems. 4.Demonstrate actions that will ensure the health of the local ecosystem.	N/A
M1	N/A	Problem Solving: Understanding P-1 establish and/or demonstrate an understanding of a problem by b: interpreting tables, charts, and graphs Numbers and Operations Analysis: Whole Numbers N-16 recognize and solve a variety of problems involving a. addition, subtraction, multiplication, or division more than one operation Numbers and Operations Analysis: Integers: N-33 represent integers by using objects, pictures, words, and symbols N-34 recognize uses of integers in the real world Numbers and Operations Analysis: Rational Numbers: Decimal Numbers N-59 recognize and solve problems involving operations with decimal numbers

SASKATCHEWAN (GRADE 6) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
M2	N/A	Numbers and Operations Analysis: N-16 recognize and solve a variety of problems involving a. addition, subtraction, multiplication, or division more than one operation Numbers and Operations Analysis: Rational Numbers: Decimal Numbers N-59 recognize and solve problems involving operations with decimal numbers
M3	Earth's Climate 1. Describe the Saskatchewan climate Recognize long-term climatic patterns. Develop a positive disposition towards lifelong learning.	Problem Solving: Reflecting: P-11 display the results using a variety of means such as graphs, charts, or statements
M4	N/A	Geometry/Measurement : Angles, Lines and Line Segments G/M-1 recognize, draw, name, and describe or define a. parallel lines, perpendicular lines
So1	Earth's Climate 1. Describe the Saskatchewan climate. Recognize long-term climatic patterns.	Refer to M4
So2	N/A	N/A
So3	Earth's Climate 1. Describe the Saskatchewan climate Recognize long-term climatic patterns. Develop a positive disposition towards lifelong learning.	N/A
L1	N/A	Problem Solving: Reflecting: P-11 display the results using a variety of means such as graphs, charts, or statements
L2	N/A	N/A

Science: A Curriculum Guide for the Middle Level www.sasked.gov.sk.ca/docs/midlsci/midlsci.html September 1993
Mathematics: A Curriculum Guide for the Middle Level www.sasklearning.gov.sk.ca/docs/midlmath/midmath.html 1996

SASKATCHEWAN (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	N/A	N/A
K2	Basics of Life 1.4 Observe and describe attributes of life in macro-organisms, both those kept in captivity and those in their natural habitats.	N/A
K3	Basics of Life 2.3 Observe and describe the reactions of organisms in their natural environment.	N/A
K4	N/A	N/A
K5	N/A	N/A
K6	N/A	N/A
Other Activity		
S1	N/A	N/A
S2	N/A	N/A

SASKATCHEWAN (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
S3	Basics of Life 2.4 Examine how natural and human-related alterations to the local environments during the past two hundred years have changed the ability of organisms to survive.	N/A
S4	N/A	N/A
S5	N/A	N/A
M1	3. Temperature and Heat Recognize differences between heat and temperature.	N7.6. Demonstrate an understanding of addition and subtraction of integers, [concretely, pictorially and] symbolically. SP7.1. Demonstrate an understanding of central tendency and range for sets of data.
M2	N/A	N7.2 Expand and demonstrate understanding of the addition, subtraction, multiplication, and division of decimals to greater numbers of decimal places, and the order of operations. SP7.1. Demonstrate an understanding of central tendency and range for sets of data.
M3	N/A	N/A
M4	N/A	SS7.3 Demonstrate an understanding of 2-D relationships involving lines and angles.
So1	N/A	Refer to M4
So2	N/A	N/A
So3	Refer to S3	N/A
L1	Saskatchewan: The Land Understand and use the vocabulary and forms of expression which ecologists and geographers use to describe the environment.	N/A
L2	N/A	N/A

Grade 7 Mathematics Curriculum (2007) www.sasked.gov.sk.ca/docs/math_curricula/g7_math_curr_2007.pdf
Science: A Curriculum Guide for the Middle Level www.sasked.gov.sk.ca/docs/midlsci/midlsci.html September 1993

SASKATCHEWAN (GRADE 8) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	N/A	N/A
K2	N/A	Data Management: Collecting D-1 acquire data through a.surveys, questionnaires b.research c.interviews D-2 recognize that the data collected are affected by a.the nature of the sample b.the method of collection c.the sample size d.biases

LEGEND: **K** - Key activity SUBJECT-SPECIFIC ACTIVITIES: **S** - Science **M** - Math **So** - Social Studies **L** - Language Arts

SASKATCHEWAN (GRADE 8) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
K3	Optional Unit: Plant Growth 1.1 Identify factors important for plant growth.	N/A
K4		N/A
K5	Adaptation and Succession 1.6 Examine the behaviours and mechanisms by which organisms make use of and coexist with the abiotic components of the ecosystem.	Data Management: Collecting D-14 discuss, interpret, and ascribe meaning to the organized data
K6	Optional Unit: Plant Growth 1.1 Identify factors important for plant growth.	Data Management: Collecting D-14 discuss, interpret, and ascribe meaning to the organized data
Other Activity		
S1	Adaptation and Succession 1.4 Recognize energy sources and energy flows in the ecosystem. 1.6 Examine the behaviours and mechanisms by which organisms make use of and coexist with the abiotic components of the ecosystem. 1.7 Explore the behaviours and mechanisms by which organisms make use of and coexist with other biotic components of the ecosystem.	N/A
S2	N/A	Math Activity 1
S3	N/A	N/A
S4	Adaptation and Succession 2 Examine how living things alter their environment. 2.1. Find examples of succession in the ecosystems of your area. 2.2 . Observe and describe the rate of environmental change. 2.3. Assess how living organisms contribute to environmental change. 2.4 .Evaluate the effect of succession on ecosystems.	N/A
S5	Adaptation and Succession 1.5 Appreciate how abiotic factors influence how populations which develop. 1.6. Examine the behaviours and mechanisms by which organisms make use of, and coexist with, the abiotic components of the ecosystem. 1.7. Explore the behaviours and mechanisms by which organisms make use of and coexist with other biotic components of the ecosystem. 2.0 Examine how living things alter their environment. 2.1.Find examples of succession in the ecosystems of your area. 2.2 Observe and describe the rate of environmental change. 2.3. Assess how living organisms contribute to environmental change. Optional Unit: Plant Growth 1.1 Identify factors important for plant growth.	N/A

LEGEND: **K** - Key activity SUBJECT-SPECIFIC ACTIVITIES: **S** - Science **M** - Math **So** - Social Studies **L** - Language Arts

SASKATCHEWAN (GRADE 8) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
M1	N/A	Numbers and Operations: Place Value: N-1 read, write the symbols for, read words for, and express orally any decimal number Numbers and Operations and Analysis: Whole Numbers N-16 recognize and solve a variety of problems involving a. more than one operation Numbers and Operations and Analysis: Integers N-32 recognize and solve a variety of problems involving positive and negative integers Numbers and Operations and Analysis: Decimal Numbers N-59 recognize and solve problems involving operations with decimal numbers
M2	N/A	Numbers and Operations: Place Value: N-1 read, write the symbols for, read words for, and express orally any decimal number N-5 round a number to the nearest a. hundred or tenth
M3	Plant Growth 1. Explore the factors which influence plant growth.	Problem Solving: Reflecting: P-11 display the results using a variety of means such as graphs, charts, or statements Data Management: Summarizing and Interpreting D18 read various charts and schedules and use the information gained to solve problems
M4	N/A	N/A
So1	Plant Growth 1. Explore the factors which influence plant growth.	Refer to M4
So2	N/A	N/A
So3	Adaptation and Succession 1. Recognize how abiotic components of an ecosystem support and influence life Plant Growth 1. Explore the factors which influence plant growth. Refer to S3	N/A
L1	Plant Growth 1. Explore the factors which influence plant growth.	Problem Solving: Reflecting: P-11 display the results using a variety of means such as graphs, charts, or statements Data Management: Summarizing and Interpreting D18 read various charts and schedules and use the information gained to solve problems
L2	N/A	N/A

Science: A Curriculum Guide for the Middle Level www.sasked.gov.sk.ca/docs/midlsci/midlsci.html September 1993
Mathematics: A Curriculum Guide for the Middle Level www.sasklearning.gov.sk.ca/docs/midlmath/midmath.html 1996

ALBERTA (GRADE 6) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	N/A	N/A
K2	N/A	N/A
K3	N/A	N/A
K4	N/A	Statistics and Probability (Data Analysis) General Outcome Collect, display and analyze data to solve problems. Specific Outcomes 1. Create, label and interpret line graphs to draw conclusions. [C, CN, PS, R, V]
K5	N/A	N/A
K6	N/A	N/A
Other Activity		
S1	N/A	N/A
S2	N/A	Number 2. Solve problems involving whole numbers and decimal numbers. [ME, PS, T] [ICT: C6–2.4] 7. Demonstrate an understanding of integers, concretely, pictorially and symbolically. [C, CN, R, V]
S3	N/A	N/A
S4	General Learner Expectations Students will: 6–10 Describe characteristics of trees and the interaction of trees with other living things in the local environment. Identify reasons why trees and forests are valued. Students meeting this expectation should be aware that forests serve as habitat for a variety of living things and are important to human needs for recreation, for raw materials and for a life-supporting environment. Describe kinds of plants and animals found living on, under and among trees; and identify how trees affect and are affected by those living things. Identify human actions that enhance or threaten the existence of forests. Identify an issue regarding forest use, identify different perspectives on that issue, and identify actions that might be taken.	N/A
S5	N/A	N/A

LEGEND: **K** - Key activity SUBJECT-SPECIFIC ACTIVITIES: **S** - Science **M** - Math **So** - Social Studies **L** - Language Arts

ALBERTA (GRADE 6) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
M1	N/A	Number 2. Solve problems involving whole numbers and decimal numbers. [ME, PS, T] [ICT: C6–2.4] 7. Demonstrate an understanding of integers, concretely, pictorially and symbolically. [C, CN, R, V]
M2	N/A	N/A
M3	N/A	Patterns and Relations 1. Represent and describe patterns and relationships, using graphs and tables. [C, CN, ME, PS, R, V] [ICT: C6–2.3] Statistics and Probability 1. Create, label and interpret line graphs to draw conclusions. [C, CN, PS, R, V] 3. Graph collected data, and analyze the graph to solve problems. [C, CN, PS, R, T] [ICT: C6–2.5, C7–2.1, P2–2.1, P2–2.2] 7. Read and interpret graphs that are provided. [C, E, PS, R]
M4	N/A	N/A
So1	N/A	Refer to M4
So2		N/A
So3	Science Inquiry: Explore and Investigate identify sources of information and ideas and demonstrate skill in accessing them. Sources may include library, classroom, community and computer-based resources Attitudes a sense of personal and shared responsibility for actions taken Refer to S3	N/A
L1	Science Inquiry: Reflect and Interpret • record observations and measurements accurately, using a chart format where appropriate. Computer resources may be used for record keeping and for display and interpretation of data progress	Patterns and Relations 1. Represent and describe patterns and relationships, using graphs and tables. [C, CN, ME, PS, R, V] [ICT: C6–2.3] Statistics and Probability 7. Read and interpret graphs that are provided. [C, E, PS, R]
L2	Science Inquiry: Reflect and Interpret • record observations and measurements accurately, using a chart format where appropriate. Computer resources may be used for record keeping and for display and interpretation of data progress	N/A

Mathematics Kindergarten to Grade 9 Program of Studies (2007) http://education.alberta.ca/teachers/program/math/programs.aspx
Elementary Science. 1996 http://education.alberta.ca/teachers/program/science/programs.aspx
Junior High Science 7–8–9. 2003 http://education.alberta.ca/teachers/program/science/programs.aspx

ALBERTA (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	N/A	N/A
K2	Interactions and Ecosystems, STSE investigate and interpret evidence of interaction and change (e.g., population fluctuations, changes in weather, availability of food or introduction of new species into an ecosystem) Skills Outcome: state a prediction and a hypothesis based on back ground information or an observed pattern of events	N/A
K3	Interactions and Ecosystems, STSE investigate a variety of habitats, and describe and interpret distribution patterns of living things found in those habitats (e.g., describe and compare two areas within the school grounds—a relatively undisturbed site and a site that has been affected by heavy use; describe and compare a wetland and a dry land area in a local parkland)	N/A
K4	Interactions and Ecosystems Analyzing and interpreting compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs and line graphs (e.g., illustrate a food web, based on observations made within a given environment)	Statistics and Probability General Outcome Collect, display and analyze data to solve problems.
K5	Interactions and Ecosystems, Performing and Recording use tools and apparatus effectively and accurately for collecting data (e.g., measure factors, such as temperature, moisture, light, shelter and potential sources of food, that might affect the survival and distribution of different organisms within a local environment)	N/A
K6	Interactions and Ecosystems, Analyzing and Interpreting identify strengths and weaknesses of different methods of collecting and displaying data (e.g., compare two different approaches to measuring the amount of moisture in an environment; analyze information presented by proponents on two sides of an environmental issue)	N/A
Other Activity		
S1	Interactions and Ecosystems, STSE investigate and interpret evidence of interaction and change (e.g., population fluctuations, changes in weather, availability of food or introduction of new species into an ecosystem)	N/A

ALBERTA (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
S2	Performing and Recording: use tools and apparatus effectively and accurately for collecting data (e.g., measure factors, such as temperature, moisture, light, shelter and potential sources of food, that might affect the survival and distribution of different organisms within a local environment)	Number 2. Solve problems involving whole numbers and decimal numbers. [ME, PS, T] [ICT: C6–2.4] 7. Demonstrate an understanding of integers, concretely, pictorially and symbolically. [C, CN, R, V] 8. Demonstrate an understanding of multiplication and division of decimals (1-digit whole number multipliers and 1-digit natural number divisors). [C, CN, ME, PS, R, V] Statistics and Probability (Data Analysis) 1. Demonstrate an understanding of central tendency and range by: • determining the measures of central tendency (mean, median, mode) and range
S3	N/A	N/A
S4	Interactions and Ecosystems, STSE describe human uses of plants as sources of food and raw materials, and give examples of other uses (e.g., identify uses of plants as herbs or medicines; describe plant products, and identify plant sources on which they depend) • investigate the extent of natural and managed living resources in agricultural, horticultural, forest and grassland environments; and identify examples of local and global change (e.g., describe changes in the size of forested areas; describe changes in the characteristics of forested areas) • investigate practical problems and issues in maintaining productive plants within sustainable environments, and identify questions for further study (e.g., investigate the long-term effects of irrigation practices or fertilizer use)	N/A
S5	N/A	N/A
M1	2. Investigate life processes and structures of plants, and interpret related characteristics and needs of plants in a local environment • investigate and interpret variations in plant structure, and relate these to different ways that plants are adapted to their environment (e.g., distinguish between plants with shallow spreading roots and those with deep taproots; describe and interpret differences in flower form and in the timing of flower production)	Number 2. Solve problems involving whole numbers and decimal numbers. [ME, PS, T] [ICT: C6–2.4] 7. Demonstrate an understanding of integers, concretely, pictorially and symbolically. [C, CN, R, V] 8. Demonstrate an understanding of multiplication and division of decimals (1-digit whole number multipliers and 1-digit natural number divisors). [C, CN, ME, PS, R, V] Statistics and Probability (Data Analysis) 1. Demonstrate an understanding of central tendency and range by: • determining the measures of central tendency (mean, median, mode) and range

LEGEND: **K** - Key activity SUBJECT-SPECIFIC ACTIVITIES: **S** - Science **M** - Math **So** - Social Studies **L** - Language Arts

ALBERTA (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
M2	N/A	Statistics and Probability (Data Analysis) 1. Demonstrate an understanding of central tendency and range by: • determining the measures of central tendency (mean, median, mode) and range
M3	Analyzing and Interpreting Analyze qualitative and quantitative data, and develop and assess possible explanations Compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs and line graphs Communication and Teamwork Communicate questions, ideas, intentions, plans and results, using [lists, notes in point form, sentences, data tables,] graphs, [drawings], oral language and other means Plants for Food and Fibre • investigate and interpret variations in plant structure, and relate these to different ways that plants are adapted to their environment (e.g., distinguish between plants with shallow spreading roots and those with deep taproots; describe and interpret differences in flower form and in the timing of flower production)	N/A
M4	N/A	Shape and Space 3. Perform geometric constructions, including: • perpendicular line segments • parallel line segments • perpendicular bisectors • angle bisectors. [CN, R, V]
So1	Analyze qualitative and quantitative data, and develop and assess possible explanations	Refer to M4
So2	Plants for Food and Fibre: STS and Knowledge • describe human uses of plants as sources of food and raw materials, and give examples of other uses (e.g., identify uses of plants as herbs or medicines; describe plant products, and identify plant sources on which they depend) Mutual Respect Appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds	N/A
So3	Refer to S3	N/A

ALBERTA (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
L1	Analyzing and Interpreting Compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs and line graphs Communication and Teamwork Communicate questions, ideas, intentions, plans and results, using [lists, notes in point form, sentences, data tables,] graphs, [drawings], oral language and other means Plants for Food and Fibre: STS and Knowledge • describe human uses of plants as sources of food and raw materials, and give examples of other uses (e.g., identify uses of plants as herbs or medicines; describe plant products, and identify plant sources on which they depend) Performing and Recording • observe and record data, [and create simple line drawings] Mutual Respect Appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds	N/A
L2	Performing and Recording • observe and record data, [and create simple line drawings]	N/A

Mathematics Kindergarten to Grade 9 Program of Studies (2007) http://education.alberta.ca/teachers/program/math/programs.aspx
Elementary Science. 1996 http://education.alberta.ca/teachers/program/science/programs.aspx
Junior High Science 7–8–9. 2003 http://education.alberta.ca/teachers/program/science/programs.aspx

ALBERTA (GRADE 8) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	N/A	N/A
K2	N/A	N/A
K3	N/A	N/A
K4	N/A	Statistics and Probability (Data Analysis) General Outcome Collect, display and analyze data to solve problems.
K5	N/A	N/A
K6	N/A	Statistics and Probability (Data Analysis) General Outcome Collect, display and analyze data to solve problems.
Other Activity		
S1	N/A	N/A

LEGEND: **K** - Key activity SUBJECT-SPECIFIC ACTIVITIES: **S** - Science **M** - Math **So** - Social Studies **L** - Language Arts

ALBERTA (GRADE 8) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
S2	N/A	Number 2. Demonstrate an understanding of the addition, subtraction, multiplication and division of decimals to solve problems (for more than 1-digit divisors or 2-digit multipliers, the use of technology is expected). [ME, PS, T] [ICT: P2–3.4] 7. Demonstrate an understanding of multiplication and division of integers, concretely, pictorially and symbolically. [C, CN, PS, R, V]
S3	N/A	N/A
S4	N/A	N/A
S5	N/A	N/A
M1	N/A	Number 2. Demonstrate an understanding of the addition, subtraction, multiplication and division of decimals to solve problems (for more than 1-digit divisors or 2-digit multipliers, the use of technology is expected). [ME, PS, T] [ICT: P2–3.4] 7. Demonstrate an understanding of multiplication and division of integers, concretely, pictorially and symbolically. [C, CN, PS, R, V]
M2	N/A	N/A
M3	Communication and Teamwork Communicate questions, ideas, intentions, plans and results, using [lists, notes in point form, sentences, data tables,] graphs, [drawings], oral language and other means	N/A
M4	N/A	N/A
So1	N/A	Refer to M4
So2	N/A	N/A
So3	Refer to S3	N/A
L1	N/A	N/A
L2	N/A	N/A

Mathematics Kindergarten to Grade 9 Program of Studies (2007) http://education.alberta.ca/teachers/program/math/programs.aspx
Elementary Science. 1996 http://education.alberta.ca/teachers/program/science/programs.aspx
Junior High Science 7–8–9. 2003 http://education.alberta.ca/teachers/program/science/programs.aspx

BRITISH COLUMBIA / YUKON (GRADE 6) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	N/A	N/A
K2	Life Science: Diversity of Life analyse how different organisms adapt to their environments	Statistics and Probability: Data Analysis D2 select, justify, and use appropriate methods of collecting data, including questionnaires experiments databases electronic media [C, PS, T]
K3	N/A	N/A
K4	N/A	Statistics and Probability: Data Analysis D3 graph collected data and analyze the graph to solve problems [C, CN, PS]
K5	N/A	N/A
K6	Life Science: Diversity of Life analyse how different organisms adapt to their environments N/A	N/A
Other Activity		
S1	Life Science: Diversity of Life analyse how different organisms adapt to their environments	N/A
S2	N/A	Number A7 demonstrate an understanding of integers, concretely, pictorially, and symbolically [C, CN, R, V] A8 demonstrate an understanding of multiplication and division of decimals (1-digit whole number multipliers and 1-digit natural number divisors) [C, CN, ME ,PS, R, V]
S3	N/A	N/A
S4	Life Science: Diversity of Life analyse how different organisms adapt to their environments	N/A
S5	Life Science: Diversity of Life analyse how different organisms adapt to their environments	Statistics and Probability: Data Analysis D2 select, justify, and use appropriate methods of collecting data, including questionnaires experiments databases electronic media [C, PS, T]
M1	N/A	Number A7 demonstrate an understanding of integers, concretely, pictorially, and symbolically [C, CN, R, V] A8 demonstrate an understanding of multiplication and division of decimals (1-digit whole number multipliers and 1-digit natural number divisors) [C, CN, ME ,PS, R, V]
M2	N/A	N/A
M3	N/A	Patterns and Relations B2 represent and describe patterns and relationships using graphs and tables [C, CN, ME, PS, R, V] Statistics and Probability (Data Analysis) D1 create, label, and interpret line graphs to draw conclusions [C, CN, PS, R, V] D3 graph collected data and analyze the graph to solve problems [C, CN, PS]

BRITISH COLUMBIA / YUKON (GRADE 6) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
M4	N/A	N/A
So1	N/A	Refer to M4
So2	N/A	N/A
So3	Refer to S3	N/A
L1	N/A	Patterns and Relations B2 represent and describe patterns and relationships using graphs and tables [C, CN, ME, PS, R, V] Statistics and Probability (Data Analysis) D1 create, label, and interpret line graphs to draw conclusions [C, CN, PS, R, V]
L2	N/A	N/A

Mathematics K to 7 (2007) - Mathematics Integrated Resource Packages www.bced.gov.bc.ca/irp/irp_math.htm
Sciences Integrated Resource Packages Science K to 7 (2005) www.bced.gov.bc.ca/irp/irp_sci.htm
Sciences Integrated Resource Packages Science 8 (2006) www.bced.gov.bc.ca/irp/irp_sci.htm

BRITISH COLUMBIA / YUKON (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	N/A	N/A
K2	N/A	N/A
K3	Life Science: Ecosystems Analyze the roles of organisms as part of interconnected food webs, communities and ecosystems	N/A
K4	N/A	N/A
K5	N/A	N/A
K6	N/A	N/A
Other Activity		
S1	Life Science: Ecosystems Assess survival needs and interactions between organisms and the environment Assess the requirements for sustaining healthy local ecosystems	N/A
S2	N/A	Number A2 demonstrate an understanding of the addition, subtraction, multiplication, and division of decimals (for more than 1-digit divisors or 2-digit multipliers, the use of technology is expected) to solve problems [ME, PS, T] A6 demonstrate an understanding of addition and subtraction of integers, concretely, pictorially, and symbolically [C, CN, PS, R, V] Statistics and Probability (Data Analysis) D1 demonstrate an understanding of central tendency and range by determining the measures of central tendency (mean, median, mode) and range

BRITISH COLUMBIA / YUKON (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
S3	N/A	N/A
S4	Life Science: Ecosystems evaluate human impacts on local ecosystems	N/A
S5	Life Science: Ecosystems Assess survival needs and interactions between organisms and the environment Assess the requirements for sustaining healthy local ecosystems	N/A
M1	N/A	Number A2 demonstrate an understanding of the addition, subtraction, multiplication, and division of decimals (for more than 1-digit divisors or 2-digit multipliers, the use of technology is expected) to solve problems [ME, PS, T] A6 demonstrate an understanding of addition and subtraction of integers, concretely, pictorially, and symbolically [C, CN, PS, R, V] Statistics and Probability (Data Analysis) D1 demonstrate an understanding of central tendency and range by determining the measures of central tendency (mean, median, mode) and range
M2	N/A	Statistics and Probability (Data Analysis) D1 demonstrate an understanding of central tendency and range by determining the measures of central tendency (mean, median, mode) and range
M3	N/A	N/A
M4	N/A	3-D Objects and 2-D Shapes C3 perform geometric constructions, including parallel line segments
So1	N/A	Refer to M4
So2	N/A	N/A
So3	Refer to S3	N/A
L1	N/A	N/A
L2	N/A	N/A

Mathematics K to 7 (2007) - Mathematics Integrated Resource Packages www.bced.gov.bc.ca/irp/irp_math.htm

BRITISH COLUMBIA / YUKON (GRADE 8) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	N/A	N/A
K2	N/A	N/A
K3	N/A	N/A
K4	N/A	N/A
K5	Processes of Science A8 demonstrate competence in the use of technologies specific to investigative procedures and research	N/A
K6	N/A	N/A

BRITISH COLUMBIA / YUKON (GRADE 8) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
Other Activity		
S1	N/A	N/A
S2	Processes of Science A8 demonstrate competence in the use of technologies specific to investigative procedures and research	A7 demonstrate an understanding of multiplication and division of integers, concretely, pictorially, and symbolically [C, CN, PS, R, V]
S3	N/A	N/A
S4	Processes of Science A3 represent and interpret information in graphic form	N/A
S5	Processes of Science A3 represent and interpret information in graphic form A8 demonstrate competence in the use of technologies specific to investigative procedures and research	N/A
M1	N/A	A7 demonstrate an understanding of multiplication and division of integers, concretely, pictorially, and symbolically [C, CN, PS, R, V]
M2	N/A	N/A
M3	Processes of Science A3 represent and interpret information in graphic form A8 demonstrate competence in the use of technologies specific to investigative procedures and research	N/A
M4	A8 demonstrate competence in the use of technologies specific to investigative procedures and research	N/A
So1	N/A	Refer to M4
So2	N/A	N/A
So3	A8 demonstrate competence in the use of technologies specific to investigative procedures and research Refer to S3	N/A
L1	Processes of Science A3 represent and interpret information in graphic form	N/A
L2	N/A	N/A

Mathematics 8 and 9 (2008) - Mathematics Integrated Resource Packages www.bced.gov.bc.ca/irp/irp_math.htm

NORTHWEST TERRITORIES / NUNAVUT (GRADE 6) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	N/A	N/A
K2	N/A	N/A
K3	Diversity of Living Things Compile data gathered through investigation in order to record and present results, using charts, tables and labeled graphs produced by hand or with a computer (e.g., make an inventory of animals found in a specific location)	N/A

LEGEND: **K** - Key activity SUBJECT-SPECIFIC ACTIVITIES: **S** - Science **M** - Math **So** - Social Studies **L** - Language Arts

NORTHWEST TERRITORIES / NUNAVUT (GRADE 6) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
K4	Diversity of Living Things Compile data gathered through investigation in order to record and present results, using charts, tables and labeled graphs produced by hand or with a computer (e.g., make an inventory of animals found in a specific location)	Graph collected data and analyze the graph to solve problems. [C, CN, PS]
K5	Diversity of Living Things Communicate the procedures and results of investigations for specific purposes and to specific audiences, using electronic media, oral presentations, written notes and descriptions, charts, graphs, and drawings (e.g., create a clearly labeled chart of organisms observed and identified during a pond study).	Statistics and Probability: Data Analysis Select, justify and use appropriate methods of collecting data, including: • questionnaires • experiments • databases • electronic media. [C, PS, T]
K6	N/A	N/A
Other Activity		
S1	Diversity of Living Things Communicate the procedures and results of investigations for specific purposes and to specific audiences, using electronic media, oral presentations, written notes and descriptions, charts, graphs, and drawings (e.g., create a clearly labeled chart of organisms observed and identified during a pond study)	N/A
S2	N/A	Number 2. Solve problems involving whole numbers and decimal numbers. [ME, PS, T] [ICT: C6–2.4] 7. Demonstrate an understanding of integers, concretely, pictorially and symbolically. [C, CN, R, V]
S3	N/A	N/A
S4	N/A	N/A
S5	Diversity of Living Things Compile data gathered through investigation in order to record and present results, using charts, tables and labeled graphs produced by hand or with a computer (e.g., make an inventory of animals found in a specific location)	Statistics and Probability: Data Analysis Select, justify and use appropriate methods of collecting data, including: • questionnaires • experiments • databases • electronic media. [C, PS, T]
M1	N/A	Number 2. Solve problems involving whole numbers and decimal numbers. [ME, PS, T] [ICT: C6–2.4] 7. Demonstrate an understanding of integers, concretely, pictorially and symbolically. [C, CN, R, V]
M2	N/A	N/A

NORTHWEST TERRITORIES / NUNAVUT (GRADE 6) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
M3	N/A	Patterns and Relations 1. Represent and describe patterns and relationships, using graphs and tables. [C, CN, ME, PS, R, V] [ICT: C6–2.3] Statistics and Probability 1. Create, label and interpret line graphs to draw conclusions. [C, CN, PS, R, V] 3. Graph collected data, and analyze the graph to solve problems. [C, CN, PS, R, T] [ICT: C6–2.5, C7–2.1, P2–2.1, P2–2.2] 7. Read and interpret graphs that are provided. [C, E, PS, R]
M4	N/A	N/A
So1	N/A	Refer to M4
So2	N/A	N/A
So3	Refer to S3	N/A
L1	N/A	Patterns and Relations 1. Represent and describe patterns and relationships, using graphs and tables. [C, CN, ME, PS, R, V] [ICT: C6–2.3] Statistics and Probability 7. Read and interpret graphs that are provided. [C, E, PS, R]
L2	N/A	N/A

The Northwest Territories and Nunavut use the Western Canadian Protocol (WCP) Mathematics, Kindergarten to Grade 12 - Lead: Alberta: The Common Curriculum Framework for K–9 Mathematics, May 2006 www.wncp.ca/english/subjectarea/mathematics/ccf.aspx

NORTHWEST TERRITORIES / NUNAVUT (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	N/A	N/A
K2	Interactions and Ecosystems, STSE investigate and interpret evidence of interaction and change (e.g., population fluctuations, changes in weather, availability of food or introduction of new species into an ecosystem) Skills Outcome: state a prediction and a hypothesis based on back ground information or an observed pattern of events	N/A
K3	Interactions and Ecosystems, STSE investigate a variety of habitats, and describe and interpret distribution patterns of living things found in those habitats (e.g., describe and compare two areas within the school grounds—a relatively undisturbed site and a site that has been affected by heavy use; describe and compare a wetland and a dry land area in a local parkland)	N/A

NORTHWEST TERRITORIES / NUNAVUT (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
K4	Interactions and Ecosystems Analyzing and Interpreting compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs and line graphs (e.g., illustrate a food web, based on observations made within a given environment)	N/A
K5	Interactions and Ecosystems, Performing and Recording use tools and apparatus effectively and accurately for collecting data (e.g., measure factors, such as temperature, moisture, light, shelter and potential sources of food, that might affect the survival and distribution of different organisms within a local environment)	N/A
K6	Interactions and Ecosystems, Analyzing and Interpreting identify strengths and weaknesses of different methods of collecting and displaying data (e.g., compare two different approaches to measuring the amount of moisture in an environment; analyze information presented by proponents on two sides of an environmental issue)	N/A
Other Activity		
S1	Interactions and Ecosystems, STSE investigate and interpret evidence of interaction and change (e.g., population fluctuations, changes in weather, availability of food or introduction of new species into an ecosystem)	N/A
S2	Performing and Recording: use tools and apparatus effectively and accurately for collecting data (e.g., measure factors, such as temperature, moisture, light, shelter and potential sources of food, that might affect the survival and distribution of different organisms within a local environment)	Number 2. Solve problems involving whole numbers and decimal numbers. [ME, PS, T] [ICT: C6–2.4] 7. Demonstrate an understanding of integers, concretely, pictorially and symbolically. [C, CN, R, V] 8. Demonstrate an understanding of multiplication and division of decimals (1-digit whole number multipliers and 1-digit natural number divisors). [C, CN, ME, PS, R, V] Statistics and Probability (Data Analysis) 1. Demonstrate an understanding of central tendency and range by: • determining the measures of central tendency (mean, median, mode) and range
S3	N/A	N/A
S4	Interactions and Ecosystems, STSE describe human uses of plants as sources of food and raw materials, and give examples of other uses (e.g., identify uses of plants as herbs or medicines; describe plant products, and identify plant sources on which they depend) • investigate the extent of natural and managed living resources in agricultural, horticultural, forest and grassland environments; and identify examples of local and global change (e.g., describe changes in the size of forested areas; describe changes in the characteristics of forested areas) • investigate practical problems and issues in maintaining productive plants within sustainable environments, and identify questions for further study (e.g., investigate the long-term effects of irrigation practices or fertilizer use)	N/A

NORTHWEST TERRITORIES / NUNAVUT (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
S5	N/A	N/A
M1	2. Investigate life processes and structures of plants, and interpret related characteristics and needs of plants in a local environment • investigate and interpret variations in plant structure, and relate these to different ways that plants are adapted to their environment (e.g., distinguish between plants with shallow spreading roots and those with deep taproots; describe and interpret differences in flower form and in the timing of flower production)	Number 2. Solve problems involving whole numbers and decimal numbers. [ME, PS, T] [ICT: C6–2.4] 7. Demonstrate an understanding of integers, concretely, pictorially and symbolically. [C, CN, R, V] 8. Demonstrate an understanding of multiplication and division of decimals (1-digit whole number multipliers and 1-digit natural number divisors). [C, CN, ME, PS, R, V] Statistics and Probability (Data Analysis) 1. Demonstrate an understanding of central tendency and range by: • determining the measures of central tendency (mean, median, mode) and range
M2	N/A	Statistics and Probability (Data Analysis) 1. Demonstrate an understanding of central tendency and range by: • determining the measures of central tendency (mean, median, mode) and range
M3	Analyzing and Interpreting Analyze qualitative and quantitative data, and develop and assess possible explanations Compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs and line graphs Communication and Teamwork Communicate questions, ideas, intentions, plans and results, using [lists, notes in point form, sentences, data tables,] graphs, [drawings], oral language and other means Plants for Food and Fibre • investigate and interpret variations in plant structure, and relate these to different ways that plants are adapted to their environment (e.g., distinguish between plants with shallow spreading roots and those with deep taproots; describe and interpret differences in flower form and in the timing of flower production)	N/A
M4	N/A	Shape and Space 3. Perform geometric constructions, including: • perpendicular line segments • parallel line segments • perpendicular bisectors • angle bisectors. [CN, R, V]
So1	Analyze qualitative and quantitative data, and develop and assess possible explanations	Refer to M4

LEGEND: **K** - Key activity SUBJECT-SPECIFIC ACTIVITIES: **S** - Science **M** - Math **So** - Social Studies **L** - Language Arts

NORTHWEST TERRITORIES / NUNAVUT (GRADE 7) PROVINCIAL CURRICULUM OUTCOMES...CONTINUED

Activity	Science	Mathematics
So2	Plants for Food and Fibre: STS and Knowledge • describe human uses of plants as sources of food and raw materials, and give examples of other uses (e.g., identify uses of plants as herbs or medicines; describe plant products, and identify plant sources on which they depend) Mutual Respect Appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds	N/A
So3	Refer to S3	N/A
L1	Analyzing and Interpreting Compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs and line graphs Communication and Teamwork Communicate questions, ideas, intentions, plans and results, using [lists, notes in point form, sentences, data tables,] graphs, [drawings], oral language and other means Plants for Food and Fibre: STS and Knowledge • describe human uses of plants as sources of food and raw materials, and give examples of other uses (e.g., identify uses of plants as herbs or medicines; describe plant products, and identify plant sources on which they depend) Performing and Recording • observe and record data, [and create simple line drawings] Mutual Respect Appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds	N/A
L2	Performing and Recording • observe and record data, [and create simple line drawings]	N/A

The Northwest Territories and Nunavut use the Western Canadian Protocol (WCP) Mathematics, Kindergarten to Grade 12 - Lead: Alberta: The Common Curriculum Framework for K–9 Mathematics, May 2006 www.wncp.ca/english/subjectarea/mathematics/ccf.aspx
Alberta Junior High Science 7–8–9. 2003 http://education.alberta.ca/teachers/program/science/programs.aspx

NORTHWEST TERRITORIES / NUNAVUT (GRADE 8) PROVINCIAL CURRICULUM OUTCOMES

Activity	Science	Mathematics
Key Activity		
K1	N/A	N/A
K2	N/A	N/A
K3	N/A	N/A
K4	N/A	N/A
K5	N/A	N/A
K6	N/A	N/A
Other Activity		
S1	N/A	N/A
S2	N/A	Number 2. Demonstrate an understanding of the addition, subtraction, multiplication and division of decimals to solve problems (for more than 1-digit divisors or 2-digit multipliers, the use of technology is expected). [ME, PS, T] [ICT: P2–3.4] 7. Demonstrate an understanding of multiplication and division of integers, concretely, pictorially and symbolically. [C, CN, PS, R, V]
S3	N/A	N/A
S4	N/A	N/A
S5	N/A	N/A
M1	N/A	Number 2. Demonstrate an understanding of the addition, subtraction, multiplication and division of decimals to solve problems (for more than 1-digit divisors or 2-digit multipliers, the use of technology is expected). [ME, PS, T] [ICT: P2–3.4] 7. Demonstrate an understanding of multiplication and division of integers, concretely, pictorially and symbolically. [C, CN, PS, R, V]
M2	N/A	N/A
M3	Communication and Teamwork Communicate questions, ideas, intentions, plans and results, using [lists, notes in point form, sentences, data tables,] graphs, [drawings], oral language and other means	N/A
M4	N/A	N/A
So1	N/A	Refer to M4
So2	N/A	N/A
So3	Refer to S3	N/A
L1	N/A	N/A
L2	N/A	N/A

The Northwest Territories and Nunavut use the Western Canadian Protocol (WCP) Mathematics, Kindergarten to Grade 12 - Lead: Alberta: The Common Curriculum Framework for K–9 Mathematics, May 2006 www.wncp.ca/english/subjectarea/mathematics/ccf.aspx
Alberta Junior High Science 7–8–9. 2003 http://education.alberta.ca/teachers/program/science/programs.aspx

Notes

Notes

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Teacher's Guide

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