

## ECOS Inquiry

1. CONTRIBUTOR'S NAME: ALISON PERKINS

2. NAME OF INQUIRY: FORAGING AND FINDING FOOD IN MY FIELD

3. GOALS AND OBJECTIVES:

a. **Inquiry Questions:** What does an Orchard Mason Bee eat? Are all flowers available at the same time? How does flower availability affect Orchard Mason Bees? What does a map of Orchard Mason Bee habitat on your schoolyard look like? How suitable is the schoolyard to the life cycle of Orchard Mason Bees?

b. **Ecological Theme(s):** Different plants flower at different times of the season. Flower availability affects species of pollinators that rely on nectar and pollen for food. The Orchard Mason Bee breeding cycle is highly dependent on the availability of flowers; females need access to nectar for their own maintenance, and to pollen to provision their eggs. Quality habitat may depend on a diversity of flowers juxtaposed so that food is available throughout the breeding season.

c. **General Goal:** To learn to map habitat in the schoolyard.

d. **Specific Objectives:**

*Academic:* Habitat management for pollinators requires knowledge of plants, the effects of diversity, and phenology of flowering.

*Experimental:*

*Procedural/technical:* Good habitat maps are dependent on scale and accuracy.

*Social:* Students work as a team to develop maps of their schoolyard and present ideas about flower availability.

*Communication:* Students have the opportunity to share their ideas about pollination and flowering with the rest of the class.

e. **Grade Level:** 5-6

f. **Duration/Time Required:** two class periods

4. ECOLOGICAL AND SCIENCE CONTEXT:

**Background (for Teachers):**

Insect life cycle review:

Insects have different life cycles depending on whether they are **holometabolous** (insects that undergo complete metamorphosis, like butterflies) or **hemimetabolous** (insects that undergo incomplete metamorphosis, like “stink bugs”). As a result, a holometabolous species’ life cycle will move from **eggs** to **larvae** to **pupae** to **adults**, whereas a hemimetabolous species’ life cycle will move from **eggs** to **nymphs** to **adults**. Larvae tend to look completely different than adults; it is during the pupal stage that metamorphosis occurs resulting in the transformation.

Orchard Mason Bees are holometabolous insects. They complete their entire life cycle in the nest hole where the adult females laid the eggs. Females build a nest cell using mud as mortar, provision the cell with pollen, lay the egg in the cell, and then close the cell within another mud wall. The egg hatches and the larva eats the pollen. In Orchard Mason Bees, the

larva spins a cocoon, pupates inside the cocoon, and as an adult, remains in the cocoon in a state of dormancy (**diapause**) throughout winter. The adults chew their way out of the cocoons and the mud cells in the spring. Males emerge first, followed in a few days to a week, by females.

In Montana, Orchard Mason Bees may be highly dependent on food availability when the adults emerge. Adults seek nectar soon after they have emerged from the nest chamber. Pollen also is an important source of food for reproduction. Therefore, availability of nectar and then pollen within a short distance of the nest site may be important depending on the **phenology** (the timing of events) of the Orchard Mason Bee life cycle (that is whether males are emerging, females are emerging, or females are provisioning nest cells). Plants and flowers vary in their phenology, too; different species flower at different times of the year, and flowers provide nectar and pollen for different lengths of time (hours, days, weeks) and even at different times of the day (morning v. afternoon). As a result, Orchard Mason Bees may be more or less successful in their breeding attempts depending on the diversity and juxtaposition of flowering plants within a short distance from their nest sites (perhaps around 500 meters).

This is a good activity for the fall. Although some annual flowering plants may be difficult to locate or identify, many flowering plants will be bearing fruits in the fall. In fact, fruit trees may be particularly good for Orchard Mason Bees (and Orchard Mason Bees may in turn be particularly good for humans that rely on fruit trees) because they tend to flower early in the spring.

#### **5. MOTIVATION AND INCENTIVE FOR LEARNING:**

Students get to go outside, learn about the plants in their schoolyards, and prepare a map of where they think flowers offering pollen and nectar to insects can be found.

#### **6. VOCABULARY:**

**Larva (singular)/larvae (plural)** – life cycle stage right after the egg stage

**Pupa (singular)/pupae (plural)** – life cycle stage after the larval stage where metamorphosis occurs

**Diapause** – a resting period or period of dormancy similar to hibernation in mammals

**Holometabolous insects** – species that undergo complete metamorphosis, like butterflies

**Hemimetabolous insects** – species that undergo incomplete metamorphosis, like “stink bugs”

**Phenology** – the study of the timing of life cycle events in plants and animals

**Accuracy** – the closeness of the measures to that being measured

**Precision** – the closeness of the measures to each other

#### **7. SAFETY INFORMATION:**

None.

#### **8. MATERIALS LIST (including any handouts or transparency masters):**

- Handout 1: Phenology of Orchard Mason Bees
- Google Earth Map of your schoolyard
- Paper – the kind with squares for making an accurate scale – what is it called???
- Pencils
- Rulers

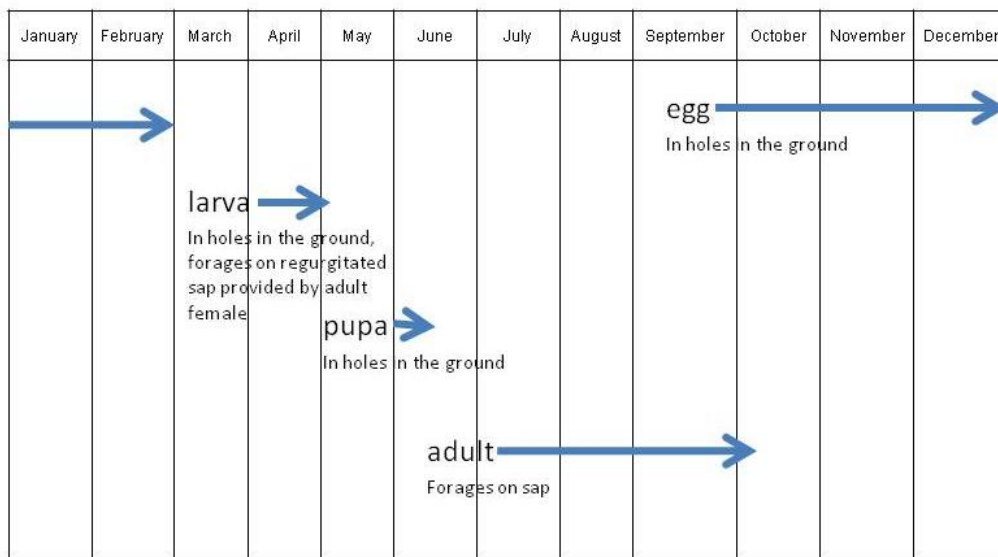
- 100 m measuring tape(s)
- Colored pencils or markers

**9. METHODS/PROCEDURE FOR STUDENTS:**

**a. Pre-investigation work (Period 1, 20-30 minutes):**

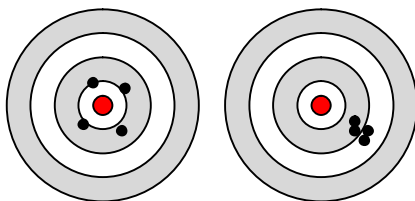
Students need to be familiar with the life cycle and timing of events in the Orchard Mason Bee life cycle. Have them gather information from available resources on the life cycle and plot the information on the Phenology of Orchard Mason Bees Handout. Have students be as specific as possible about where the animal spends that stage of its life and what it needs to forage on if appropriate. Below is an example of what the life cycle of a pollinator might look like.

*Life Cycles of Pollinators Example Chart*



**b. Investigation work (end of Period 1 and all of Period 2):**

If accurate and detailed maps are available, this part can be eliminated, although it can still be used for a discussion of accuracy v. precision. Accuracy describes whether measurements reflect what is being measured, and precision describes how repeatable the measurements were.



For example the bull's eye on the left has high accuracy (but low precision) – points close to the center are considered more accurate. The bull's eye on the right has high precision (but low accuracy) – the points are consistently in the same spot.

Pacing is an adequate means of determining distances for habitat mapping as long as it is done consistently (measuring tapes often suffer from both low accuracy and low precision, but they give the user confidence because measurements can be recorded to the nearest millimeter!).

Determine each student's pace length by having the student walk the length of a known distance several times counting the number of paces required to reach the end, and calculate the

average length of each pace. For example, if a student walked 100m with an average of 124 paces, their average pace length would be 1.24 paces/m or 1 pace = 0.81m.

Students should work in small groups. Each group should start by making a rough map of the school yard that they can take outdoors and add notes and distances. Google Earth is a good source for these rough maps – images can be saved and the outlines of important features in the school yard can be traced.

Students locate areas where plants are flowering (or predict where they will be flowering using evidence such as fruits or knowledge of plants). On the rough map, students should sketch the location of the flowers they think will be available as carefully as possible. They can determine straight-line distances of flower patches from visible landmarks using pacing. Once the school yard has been carefully examined for potential sources of foods for pollinators, students should return to the classroom and redraw their map as carefully as they can from their measurements and observations.

Using keys to identifying flowers, students should color-code patches of flowers to reflect their predictions about when plants will flower in the spring (e.g., March can be green, April can be red, June can be orange, July can be purple, etc.). A list of flowers early spring-flowering plants can be found at the end of this inquiry. Students can use the plant search option in the ECOS Guide to Ecology of the Northern Rockies to find plants by their flowering months. Students can then compare flowering dates of the plants in their school yard with the life cycle needs of Orchard Mason Bees (e.g., if most plants are flowering in June after Orchard Mason Bees are finished nesting, the school yard does not provide good habitat for these pollinators – but other pollinators will benefit).

Have students decide where to put a new block of Orchard Mason Bees in the spring. Adults emerging from the nesting block in March will need to find nectar and then pollen to begin nesting. Using the maps, have students think about distances from the nest block to food sources (bee enthusiasts suggest 150 meters). They should write up a summary of how well their school yard provides for the needs of Orchard Mason Bees.

## **10. ASSESSMENT:**

The detail and effort put into maps, in terms of the description and location of the plants available to Orchard Mason Bees, can be assessed using a relative rubric. Written summaries of the habitat the school yard provides also can be assessed. Students can even turn the summary into a story of how and where a female emerging from her nest hole will find food.

## **11. EXTENSION IDEAS:**

Maps can be made more accurately using compasses in conjunction with pacing all landmarks in the school yard.

Students can think about the timing of flower availability and make predictions about the best areas on their schoolyard for different pollinators by week. Comparisons can be made for different species of bees:

For example, species that are introduced and managed for agriculture: Honey Bees (*Apis mellifera*) and Alfalfa Leafcutting Bees (*Megachile rotundata*)  
different species of butterflies:

For example,  
species that migrate: Painted Ladies, *Vanessa cardui*

species that over-winter as caterpillars: Great Basin Fritillary, *Speyeria egleis*  
species that over-winter as chrysalids: Two-Tailed Swallowtail, *Papilio multicaudata*

## **12. SCALABILITY:**

This activity can be scaled to younger students by going on a “field trip” through their schoolyard, finding flowers that are out, and trying to infer what plants might flower later in the season.

## **13. REFERENCES AND SOURCES FOR ADDITIONAL INFORMATION:**

The ECOS Guide to the Ecology of the Northern Rockies is a great source for information about plants (<http://www.bioed.org/nhguide>).

More plant information can be found at the USDA Plant Database website (<http://plants.usda.gov/index.html>). If you know the common or scientific name of a plant, you can use this site to find more detailed information about its range and taxonomy, as well as a host of great images and sources for additional images.

Project BudBurst is a citizen science project designed to use the phenology of plants to track climate change. Their website offers information about phenology of plants, as well as several Montana species to watch ([http://www.windows.ucar.edu/citizen\\_science/budburst/](http://www.windows.ucar.edu/citizen_science/budburst/)).

Montana State University Extension Service provides broad information about pollinators important to Montanan (<http://diagnostics.montana.edu/Insect/Pollinators/>)

A great source of information about butterflies:  
<http://www.thebutterflysite.com/montana-butterflies.shtml>

## **14. LIST OF EXPERTS AND CONSULTANTS**

Jen Marangelo, insect ecologist

Paul Alaback, an expert on local plants and their phenology

## **15. EVALUATION/REFLECTION BY FELLOWS AND TEACHERS OF HOW IT WENT**



An example of a Google Earth Map of the Target Range School yard.



An example of the Lewis and Clark Elementary school yard with some areas color coded to reflect flowering plants.



Flowering plants that may be important to breeding Orchard Mason Bees in western Montana from the **ECOS Guide to the Ecology of the Northern Rockies** (<http://www.bioed.org/nhguide/>):

**Trees and shrubs**

common name	scientific name	flowering time
alder, gray	<a href="#"><i>Alnus incana</i></a>	April-May
ash, green	<a href="#"><i>Fraxinus pennsylvanica</i></a>	April-May
bitterbrush, antelope	<i>Purshia tridentate</i>	April-June
boxelder	<a href="#"><i>Acer negundo</i></a>	April-May



[BudBurst species](#)

chokecherry

[\*Prunus virginiana\*](#)



April-July

[BudBurst species](#)

currant, wax

[\*Ribes cereum\*](#)



April-May

dogwood, red osier

*Cornus sericea*



May-July

[BudBurst species](#)

elderberry, black

*Sambucus niger*



May

hawthorn, black

[\*Crataegus douglasii\*](#)



May

locust, black

*Robinia  
pseudoacacia*



May

[BudBurst species](#)

mahogany,  
curl-leaf  
mountain

*Cercocarpus  
ledifolius*



April

[BudBurst species](#)

maple, Norway

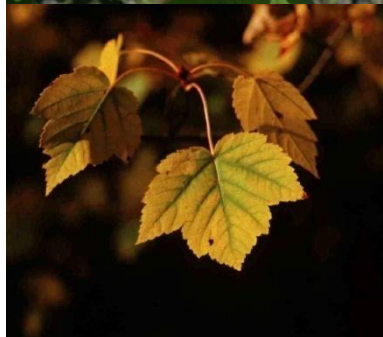
[Acer  
platanooides](#)



May

maple, Rocky  
Mountain

[Acer glabrum](#)



April-July

[BudBurst species](#)

mock orange,  
Lewis'

[\*Philadelphus  
lewisii\*](#)



May

ninebark,  
Eastern

[\*Physocarpus  
opulifolius\*](#)



May

ninebark,  
mallow

[\*Physocarpus  
malvaceus\*](#)



May

serviceberry,  
Saskatoon

[\*Amelanchier  
alnifolia\*](#)



May

**Other flowering  
plants**

flowering

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common name	scientific name	time
arnica, twin	<a href="#"><u>Arnica sororia</u></a>	May
barberry, creeping	<a href="#"><u>Mahonia repens</u></a>	April-June
beardtongue, Alberta	<a href="#"><u>Penstemon albertinus</u></a>	May
besseya, Wyoming	<a href="#"><u>Besseya wyomingensis</u></a>	May



[BudBurst species](#)

bindweed, field

[\*Convolvulus arvensis\*](#)



May

bindweed, hedge false

[\*Calystegia sepium\*](#)



May

biscuitroot, bigseed

[\*Lomatium macrocarpum\*](#)



April-May

biscuitroot, cous

[\*Lomatium cous\*](#)



April-May

biscuitroot, fernleaf

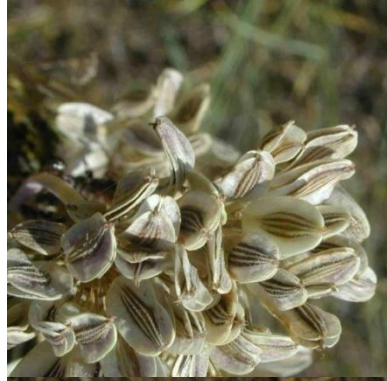
[\*Lomatium dissectum\*](#)



April-May

biscuitroot, nineleaf

[\*Lomatium\*](#)  
[\*tritematum\*](#)



May

biscuitroot, Wyeth

[\*Lomatium\*](#)  
[\*ambiguum\*](#)



April-May

bitter root

[\*Lewisia\*](#)  
[\*rediviva\*](#)



March-June

[BudBurst](#)  
[species](#)

bluebells, oblongleaf

[\*Mertensia\*](#)  
[\*oblongifolia\*](#)



May

buckwheat, cushion

[\*Eriogonum\*](#)  
[\*ovalifolium\*](#)



May

buttercup, sagebrush

[\*Ranunculus glaberrimus\*](#)



April-May

chickweed, common

[\*Stellaria media\*](#)



April-May

chickweed, common  
mouse-ear

[\*Cerastium fontanum\*](#)



April-May

chickweed, field

[\*Cerastium arvense\*](#)



April-May

clematis, western  
white

[\*Clematis\*  
\*ligusticifolia\*](#)



May

clover, white

*Trifolium repens*



April-July

[BudBurst  
species](#)

columbine, Colorado  
blue

*Aquilegia coerulea*



May

[BudBurst  
species](#)

daisy, cutleaf

[\*Erigeron compositus\*](#)



April-May

dames rocket

[\*Hesperis matronalis\*](#)



May

dandelion, common

[\*Taraxacum officinale\*](#)



April-May

deathcamas, meadow

[\*Zigadenus venenosus\*](#)



May

deerhorn

[\*Clarkia pulchella\*](#)



May

fairybells, roughfruit

[\*Disporum\*](#)  
[\*trachycarpum\*](#)



April-May

fireweed

[\*Chamerion\*](#)  
[\*angustifolium\*](#)



May

fleabane, shaggy

[\*Erigeron\*](#)  
[\*pumilus\*](#)



May

forget-me-not, small

[\*Myosotis stricta\*](#)



April-May

fritillary, yellow

[\*Fritillaria pudica\*](#)



April-May

gilia, scarlet

*Ipomopsis  
aggregata*



April-June

[BudBurst  
species](#)

honeysuckle, Tatarian

[\*Lonicera tatarica\*](#)



May

Hound's tongue

[\*Cynoglossum officinale\*](#)



May

Indian paintbrush,  
harsh

[\*Castilleja hispida\*](#)



April-May

Indian paintbrush,  
giant red

[\*Castilleja miniata\*](#)



May

larkspur, little

[\*Delphinium bicolor\*](#)



April-May

lily, pointedtip  
mariposa

[\*Calochortus  
apiculatus\*](#)



May

lupine, silky

[\*Lupinus sericeus\*](#)



April-May

kinnikinnick

[\*Arctostaphylos uva-  
ursi\*](#)



May

medick, black

[\*Medicago lupulina\*](#)

April-May



mustard, field

*Brassica rapa*

March-May



[BudBurst species](#)

mustard, tall tumble

[\*Sisymbrium altissimum\*](#)

April-May



mustard, small  
tumbleweed

[\*Sisymbrium loeselii\*](#)

April-May



old man's whiskers

[\*Geum triflorum\*](#)



April-May

pasqueflower,  
American

[\*Pulsatilla patens\*](#)



March-May

[BudBurst  
species](#)

pepperweed, common

[\*Lepidium  
densiflorum\*](#)

April-May

pepperweed, Virginia

[\*Lepidium virginicum\*](#)

May

pennycress, field

[\*Thlaspi arvense\*](#)

April-May

phacelia, silverleaf

[\*Phacelia hastata\*](#)

May

phacelia, threadleaf

[\*Phacelia linearis\*](#)

April-May



pussytoes, umber

[\*Antennaria umbrinella\*](#)



April-May

rockcress, Nuttall's

[\*Arabis nuttallii\*](#)



April-May

salsify, yellow

[\*Traopogon dubius\*](#)



May

saxifrage, wholeleaf

[\*Saxifraga integrifolia\*](#)



May

shepherd's purse

[\*Capsella bursa-pastoris\*](#)



April. May

shooting star,  
Bonnevillie

[\*Dodecatheon  
conjugens\*](#)



April-May

sorrel, common sheep

[\*Rumex acetosella\*](#)



April-May

springbeauty, lanceleaf

*Claytonia lanceolata*

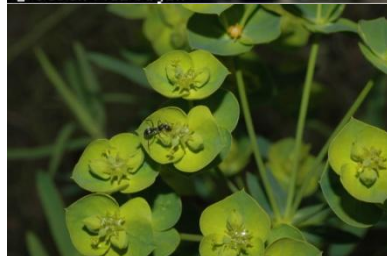


April-July

[BudBurst  
species](#)

spurge, leafy

[\*Euphorbia esula\*](#)



May

stoneseed, western

[\*Lithospermum  
ruderale\*](#)



April-May

strawberry, broadpetal  
(woods)

[\*Fragaria virginiana\*](#)



May

strawberry, woodland

[\*Fragaria vesca\*](#)



May

sweetclover, yellow

[\*Melilotus officinalis\*](#)



May

tiny trumpet

[\*Collomia linearis\*](#)



May

toadflax, bastard

[\*Comandra umbellata\*](#)



April-May

trillium, Pacific

*Trillium ovatum*



March-May

[BudBurst species](#)

violet, Nuttall's

[\*Viola nuttallii\*](#)



May

waterleaf, ballhead

[\*Hydrophyllum capitatum\*](#)



April-May

yarrow, common

[\*Achillea millefolium\*](#)



May

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