

Protocols and supplementary information for monitoring plant phenology and collecting pollinators in Alaskan National Parks

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Denali National Park and Preserve
2021

Section A

PACKING LIST

Bug vacuum

Charger for vacuum

18V Batteries for vacuum (2)

Extension tubes for vacuum (6" and 12")

Collecting tubes for vacuum with end caps (4)

Extra end caps (2)

Extra neoprene flap valves (2)

Collapsible insect net (3 pieces: net + two 12-inch extension segments (one with red grip))

Blue-capped plastic tubes for use with insect net (2)

Flexible forceps (2)

Plastic mason jars for killing insects (2)

Colored tags for marking plants (15)

Popsicle sticks for marking plants (15)

Whirl-paks for storing and transporting insects (20)

Ziploc bags (10)

Mailing boxes (6 unfolded)

PLEASE MAKE SURE TO HAVE 32 OZ. OF 70% ISOPROPYL ALCOHOL ON HAND
(available at drug or grocery stores or in the mail through Fred Meyer)



Typical sampling equipment.

Section B

Protocol for Monitoring Plant Phenology

Select focal plant species

Choose 2-3 plant species from the list below to monitor over the course of the growing season. Having accessible and relatively dense patches of plants to sample should factor into your choices (see section II below). **Include fireweed as one of your species.** Try to choose species with different flowering times (i.e., earlier and later season; there will likely be some overlap). As a third species, consider non-native dandelion if you have it nearby and haven't ripped it all out of the ground. If you have additional plants that you are especially interested in monitoring, it's okay to add species not listed below. However, the more replication we have between parks (i.e., many parks monitoring the same plants), the more powerful the phenology comparisons.

Common name	Latin name	Earlier season	Later season
Bog/Northern Labrador tea*	<i>Rhododendron groenlandicum/tomentosum</i>	x	
Lowbush cranberry/ lingonberry	<i>Vaccinium vitis-idaea</i>	x	
Prickly rose	<i>Rosa acicularis</i>	x	
Common dandelion**	<i>Taraxacum officinale</i>	x	x
Fireweed	<i>Chamerion angustifolium</i>		x
Common/northern yarrow***	<i>Achillea millefolium</i>		x

*We have two species of Labrador tea in Alaska that look similar to each other. They have undergone some taxonomic revisions recently, so there might be some confusion.

Bog Labrador tea (*Rhododendron groenlandicum*)

Marsh or Northern Labrador tea (*Rhododendron tomentosum*)

The best characters to tell them apart are: plant size (*groenlandicum* is generally taller); leaves (*groenlandicum* has larger, broader leaves); flower stalks or pedicels (*tomentosum* stalks are sharply bent at the top and have rust-colored hairs while *groenlandicum* stalks are more evenly curved and have white hairs); and number of stamens (10 for *tomentosum* vs. 8 for *groenlandicum*)

A great reference with photos is the Ecological Atlas of Denali's Flora (<http://ecologicalatlas.uaf.edu>)

If you choose Labrador tea as a focal plant, please try to determine which species you are monitoring (it is possible to have both growing side by side in some places). In Southeast parks, you are almost certain to have only *L. groenlandicum*. North of the Brooks Range, probably *L. tomentosum*. You can always send me a photo.

****Note that there are several similar-looking native dandelions in Alaska. If you plan to monitor this exotic and invasive species, look for it in disturbed areas.**

*****Common or boreal yarrow (*Achillea millefolium*, we will lump the subspecies *borealis*) could be confused with Siberian yarrow (*Achillea sibirica*). *Achillea sibirica* has toothed leaves, while *A. millefolium* has much more finely (feathery) divided leaves. *Achillea sibirica* is typically associated with wetlands, while *A. millefolium* is found in drier, and often disturbed habitats.**

Another excellent resource for images of all the focal plant species and various phenophases can be found here: www.alaskawildflowers.us

II. Site selection

Plant phenology monitoring sites should be in areas that can be accessed on a weekly basis. The goal is to have enough individuals of your focal plant species in the site that you will be able to collect 50-100 pollinators from the flowers in 20 minutes. (You may need to enlarge the size of your site once you begin pollinator sampling.) You will describe (and sketch) the sampling area on the Plant Phenology Site Description Sheet, including whether the focal plants are distributed in a linear patch (e.g. along a trail), several smaller patches, or randomly dispersed throughout the site. Choose a site with relatively uniform habitat (e.g., avoid being half in the forest and half in a meadow). Try to avoid places prone to trampling by visitors. It is fine to have overlapping (or the same) sites for different plant species. Site dimensions and total area will depend on how plants are arranged and how dense they are, but try to keep the total area at or under 100m² to start, if possible.

III. Select individual plants to monitor

For each plant species you select, you will monitor FIVE individual plants within the site you have chosen (e.g., along the trail or among the multiple patches). The individuals should be healthy reproductive plants and separated by at least 2 m from each other. Try to choose plants of different sizes. Do not monitor plants growing right next to buildings. For multi-stem plants or large shrubby plants such as prickly rose, where there are too many leaves and flowers to do full counts, select a single branch or stem for your observations (see IV below). **If it turns out that the individual plant you selected is damaged, dies, or bears no flowers, you will select a new individual to replace it (see V below).**

IV. Marking sites and plants

You will be visiting phenology monitoring sites weekly, so if there will be more than one person making observations, be sure to mark the boundaries of your site in some way (e.g. flagging corners), and/or describe it on the Plant Phenology Site Description Sheet in enough detail that another person can locate the site and identify the boundaries (especially important for insect sampling).

If your park has a preferred way to mark plants, it is fine to modify the following instructions. Each of the five plants at a site that will be monitored week to week must be marked with a unique label. The label should have park code + plant name + unique number (e.g., DENA-fireweed-1, DENA-

fireweed-2...for fireweed plants in Denali). We will supply popsicle sticks for marking the site of initial leaf emergence from the ground for forbs, and plastic tags for marking larger plants (attach to the stem or base of the branch of your plant), but use whatever works best. Additionally, you may need to flag the plant in a more visible place if the vegetation is dense.

V. Recording observations

You will be collecting data on leaf, flowering, and fruit phenology of each focal plant species once per week throughout the growing season. This means that if your 2-3 focal plant species have new leaves/buds/flowers/fruits simultaneously, then you will be monitoring 2-3 plants each week.

Data sheets

One Plant Phenology Observation Data Sheet will be used for each plant species each week. There are three versions of the observation sheet, depending on the growth form of the plant:

General: for dandelion (*Taraxacum*), prickly rose (*Rosa*), fireweed (*Chamerion*)

Evergreen: for cranberry (*Vaccinium*), Labrador tea (*Rhododendron*)

Yarrow: (*Achillea*)

Each data sheet has five columns, one for each individual plant (or stem/branch) that you are monitoring. If one of your monitoring plants is damaged, dies, or bears no flowers, make a note on the data sheet and select a new plant to monitor. Make sure to give the new plant a new number (e.g., #6) and put a tag on it.

Phenophase observations

The data sheet lists the phenophases to observe and count. Refer to the Phenophase Photo Guide for each plant species to learn how to recognize the different phenophase categories. If you are still not sure of a phenophase that you are observing, take a photo and email it to jessica_rykken@nps.gov.

Below are general guidelines for each phenophase (adapted from the National Phenology Network and Project BrownDown)

Leaves

Initial Leaf Emergence: New plant growth is visible, either from buds with green tips on existing branches (shrubs), or new shoots breaking through the soil surface (forbs). Growth is considered "initial" on each bud or shoot until the first leaf has unfolded/emerged to expose the leaf stalk (petiole) or base. Record "Yes" or "No" depending on whether or not you observe this new growth for each plant (you do not need to count anything).

New leaves (unfurling and fully open): For fireweed, prickly rose, and dandelion, count the number of leaves that are unfurling (you should be able to see the base or stalk of the leaves) as well as those that have expanded and/or flattened out. (Last year we counted unfurling and fully open leaves

separately, but in 2020 we are lumping them into one category). For cranberry, Labrador tea, and yarrow, you will not count unfurling leaves at all, just note Yes or No if you see them (as indicated on data sheet); you will count only fully open leaves.

Old leaves: For evergreen plants (Labrador tea, cranberry), you must distinguish between this year's leaves and older (previous year's) leaves. Old leaves tend to be duller in appearance. Most evergreen species produce their new leaves at the tips of branches in a flush (all at once). Old and new leaves will look more and more similar as the season progresses, so use a colored twist tie to mark the break between old and new to avoid confusion. The old leaves on a plant only need to be counted ONCE, on your first visit.

Senescing Leaves: Count the number of leaves that are senescing. Senescing leaves are generally discolored a hue of red, orange, yellow or brown. Leaves that have died or are dying from being damaged or diseased (or affected by drought) should not be counted as senescing leaves. Be careful: in evergreen plants leaves often turn red but remain alive through the winter and turn green again the following year.

Flowers and fruits

Flower buds: Count the number of flower buds that have not yet opened on the plant (or the single stem or branch that you tagged).

Flowers: Count the number of open, fresh flowers that are visible on the plant (or stem/branch). Do not include wilted or dried flowers.

Petal drop: Count the number of flowers that have wilted or dropped their petals BUT whose ovaries have not clearly swollen. If the petals are still on the flower but the ovary has clearly started to swell, count this as the next phenophase "unripe fruits or seeds." See photo guides.

Unripe fruits or seeds: Count the number of unripe fruits or seeds. For an unripe fruit, the ovary is swollen and obviously has been fertilized. See photo guides.

Ripe fruits or seeds: Count the number of ripe, mature fruits, or seeds that are visible. Be careful not to include empty capsules whose seeds have already dispersed (this is the next phenophase).

Dispersed fruits or seeds: Count the number of ripe fruits that have recently dropped or been removed from your plant since the last visit, or the number of empty capsules from which seeds have dispersed. Do not include obviously immature fruits that have dropped before ripening, such as in a heavy rain or wind, or empty fruits that had long ago dropped all of their seeds but remained on the plant.

Please add any additional observations to the data sheet that you think might be of interest. If you need to monitor a new plant, make a note and add a new plant #. Take photos if you are unsure of anything, but please label the jpg file with [park code—plant species—plant number] and note on your data sheet that you are submitting photos

New in 2020: At the bottom of the data sheet, note the least advanced and most advanced phenophases of your focal plant in the plot (refers to any plants in the plot, not just the five you are monitoring).

VI. Reporting observations

On a weekly or biweekly schedule, please either scan your Plant Phenology Observation Data Sheet(s) and e-mail to Jessica Rykken, or make a copy and then mail the originals to me at the address below. Also scan/send the Plant Phenology Site Description Sheet for each site after establishing each site.

Section C

Plant Phenology Site Description Sheet

(only need to fill out **once per site**)

1. Park Unit: _____

2. Name of observer(s): _____

3. Site name (e.g., Visitor Center, Healy Tr, Riley Cr): _____

4. Site description: sketch below (or on back of sheet); use landmarks to describe boundaries; describe how focal plant species is/are distributed across site (e.g., along trail, in scattered patches, evenly distributed)



5. Approximate dimensions of site: _____ m/ft by _____ m/ft (circle units)

6. Date of site establishment: _____.

7. GPS coordinates (in decimal degrees, e.g., 63.4756 °N)

Latitude: _____ °N Longitude: _____ °W GPS datum: _____.

8. Site elevation (meters): _____.

9. Focal plant species at this site (circle species; if site encompasses more than one species, circle each):

Chamerion angustifolium
(fireweed)

Taraxacum officinale
(common dandelion)

Vaccinium vitis-idaea
(lowbush cranberry)

Rosa acicularis
(prickly rose)

Rhododendron groenlandicum/tomentosum
(Labrador tea—choose one sp.)

Achillea millefolium
(common/boreal yarrow)

Other species: _____

10. Vegetation cover estimates in site (round each category to the nearest 10%; the total can add up to more than 100):

Focal species (if more than one species at this site, list all with cover estimate (%) for each):

_____ % _____ % _____ %

moss/lichen _____% forbs _____% grasses/sedges _____% low shrub tundra _____%

tall shrubs _____% deciduous trees _____% coniferous trees _____%

disturbed open _____%

11. Slope (circle one): flat some incline (1-5%) steep hill (> 5%)

12. Aspect (if there is a slope, which direction is it facing): _____

13. Additional comments or notes: _____

14. PLEASE TAKE PHOTOS OF SITE! (send to jessica_rykken@nps.gov, label each jpg file this way: park code-site name-unique number, e.g., DENA-Riley Cr-1)

Section D

The following 14 pages show phenophase photo guides for inflorescence and leaf development for seven focal plant species monitored in eight Alaskan national parks in 2019 and 2020. Phenophase guides are borrowed and adapted from Project BrownDown, a citizen science effort lead by K. Spellman and C. Mulder at University of Alaska Fairbanks, and used with their permission.

Phenophase Photo Guide

Common yarrow (*Achillea millefolium*)

Note that each small flower head is composed of many tiny disc and ray florets. Thus, each of the flower heads will produce many fruits. When counting buds, flowers, and fruits focus on flower heads (not individual florets or fruits)

1. Flower Buds



Lauren Odenkirk



Alfred Cook

4. Unripe Fruits or Seeds



Jouko Lehmuskallio

The fruit is very tiny and seed-like and many are crowded into one spent flower head. The seed-like fruit changes from whitish-yellow or yellow-green to tannish and drops from the plant (when ripe, see next phase). Count only spent flower heads that have not yet dropped fruits.

2. Flowers



2004 © Peter M. Dziuk



5. Ripe Fruits or Seeds



Alfred Cook

A fruit is considered ripe when it has turned tannish and readily drops from the spent flower head when touched. Do not include flower heads with unripe fruits that have not dropped nor empty flower heads that have already dropped all of their fruits.



3. Petal Drop



Lauren Odenkirk

Petals begin to droop and wither.

6. Dispersed Fruits or Seeds



Spent flower heads will often remain on the plant through the winter. Some fruits remain in the spent flower heads and provide food for seed-eating birds in winter.

Phenophase Photo Guide

Common yarrow (*Achillea millefolium*)

Common yarrow (*Achillea millefolium*, we will lump the subspecies *borealis*) could be confused with Siberian yarrow (*Achillea sibirica*). *Achillea sibirica* has toothed leaves, while *A. millefolium* has much more finely (feathery) divided leaves. *Achillea sibirica* is typically associated with wetlands, while *A. millefolium* is found in drier and often disturbed habitats.

Common yarrow

Siberian yarrow



Alfred Cook

1. Initial Leaf Emergence



Watch for tiny sprouts or feathery leaves emerging from the soil in a cluster.



Alfred Cook

3. Fully Open Leaves



Count feathery leaves growing on the vertical stem as fully open leaves. Select just one main stem.



2. Unfurling leaves



Alfred Cook

Note the leaves that grow in the initial cluster or rosette as unfurling leaves. You do not need to count individual leaves in the rosette.

4. Senescing Leaves



Alfred Cook

Leaves may turn red or brown at the end of the season

Phenophase Photo Guide

Fireweed (*Chamerion angustifolium*)

1. Flower Buds



Alfred Cook

Note that flowers lower on the stem mature earlier than those above, so there will usually be multiple phenophases occurring simultaneously on the same stem

Stem with swollen buds. The lowest buds will bloom first

4. Unripe Fruits or Seeds



Peter M. Dziuk



Alfred Cook

Developing seed pods are elongate and deep pink/red

2. Flowers



Peter M. Dziuk



Alfred Cook

Open flowers have four petals alternating with four darker, narrower sepals. More mature flowers have the stigma prominent.

5. Ripe Fruits or Seeds



Alfred Cook

Ripe seed pods split into multiple sections, beginning at their tips, and release many tiny seeds, each attached to a small tuft of white fluff

3. Petal Drop



Teun Spaans



Petals begin to droop and wither, then fall off in this phenophase

6. Dispersed Fruits or Seeds



Alfred Cook

After seeds have dispersed, the empty brown split pods remain on the stem

Phenophase Photo Guide

Fireweed (*Chamerion angustifolium*)

The long, narrow leaves of fireweed are easily identified by the pattern of their veins: parallel veins extending from the midrib curve around to form a loop, leaving a narrow border along the leaf margin.

1. Initial Leaf Emergence



Alfred Cook



Alfred Cook

Sprouting stems.

3. Fully Open Leaves



Katy Chayka



Fully open leaves are flat, or sometimes have wavy edges

2. Unfurling leaves



Katy Chayka

Unfurling leaves are leaves that are still unfolding, they have not yet flattened out. Young leaves are curled under along the edges

4. Senescing Leaves



Al Schneider



Susan Meades

Leaves turn red, yellow, and orange at the end of the season

Phenophase Photo Guide

Cow parsnip (*Heracleum maximum*)

The tiny flowers on cow parsnip are arranged into umbels. When counting flower and fruit phenophases, you will determine which umbels you are monitoring (if the plant is large, select a subset of flowers on one or a few stems). Then you will estimate whether each umbel is fully (or almost) in one phenophase or if it is 50% in one and 50% in another (see data sheet).

1. Flower Buds



4. Unripe Fruits or Seeds



The fruit is flattened and seed-like, with two tiny fruits joined tightly together, and changes from green to light-green, white, tannish or brown.

2. Flowers



Fully open flowers are organized in groups or umbels. Select the umbels you will monitor on the plant and then categorize each umbel as fully in one phenophase, OR 50% in one and 50% in another (e.g., 50% buds and 50% flowers). If flowers are not yet fully open so all petals are visible, categorize as "flower buds."



5. Ripe Fruits or Seeds



Steve Matson

The fruit is considered ripe when it has turned white, tannish or brown and has developed four conspicuous vertical purple lines

3. Petal Drop



Petals begin to droop and wither and eventually fall off.

6. Dispersed Fruits or Seeds



Fruits fall off stalks and the two seeds split apart.

Phenophase Photo Guide

Cow parsnip (*Heracleum maximum*)

Note that cow parsnip can be a biennial plant. If so, the first year there are just a cluster of basal leaves. You will want to choose plants that will flower this year.

1. Initial Leaf Emergence



Initial sprouts will unfurl into leaves.

3. Fully Open Leaves



Lower and middle leaves on the stem are compound leaves made of 3 leaflets. Count each compound leaf as ONE leaf. Upper leaves may be simple (just a single leaf)

2. Unfurling leaves



Unfurling leaves are still somewhat curled inward, they will flatten out with time. You do not need to count the unfurling leaves.

4. Senescing Leaves

No photos available yet. I think leaf turns yellow/brown? Do not count leaves from previous year in a biennial plant.

Phenophase Photo Guide

Labrador Tea (*Rhododendron groenlandicum* or *R. tomentosum*)

1. Flower Buds



Flower buds first appear as a cluster (left), and then begin to differentiate into closed white capsules (middle) which you can eventually count individually (right).



4. Unripe Fruits or Seeds



Unripe fruits are green or red and swollen in appearance.

2. Flowers



Flowers are white and open. Count each flower individually.

5. Ripe Fruits or Seeds

Ripe fruit are brown. Count each ripe fruit individually.



3. Petal Drop



The flower petals have withered and begun to fall, leaving a green or reddish ovary. If pollinated, this ovary will soon swell to become an unripe fruit.



6. Dispersed Fruits or Seeds



Seed pods split open and seeds disperse.



<https://sites.google.com/a/alaska.edu/projectbrowndown/>

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Phenophase Photo Guide

Labrador Tea (*Rhododendron groenlandicum* or *R. tomentosum*)

R. tomentosum can be distinguished from *R. groenlandicum* by smaller, narrower leaves, and it usually has 10 stamens versus 8 for *groenlandicum*

1. Initial Leaf Emergence	3. Fully Open Leaves
 Initial leaves will emerge as a bud on the tips of stems.	Fully open leaves are completely expanded and tend to be evenly spaced. Because this plant is an evergreen species, count NEW fully open leaves separately from OLD fully open leaves.  New leaves appear on the part of the stem that is light and reddish or greenish in color (red arrow), rather than old fully open leaves which are located on a fully brown stem (blue arrow).
2. Unfurling Leaves	4. Senescing Leaves
 Unfurling leaves tend to be bunched together, and will not be expanded like the fully open leaves.	 Senescing leaves may be turning yellow, orange, red or brown. A few senescing leaves may occur on your plant or none at all.

<https://sites.google.com/a/alaska.edu/projectbrowndown/>

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Phenophase Photo Guide

Wild rose (*Rosa acicularis*)

1. Flower Buds



Wild rose buds are pink. The petals have not yet unfurled.



4. Unripe Fruits or Seeds



Unripe fruit are green and will begin to develop some red coloring.



2. Flowers



Flowers are showy and pink.



5. Ripe Fruits or Seeds



Fruit become ripe when they are completely red; no green persists on the rose hip. This is not the same as what we consider ripe for picking and eating.



3. Petal Drop

The flower petals drop, leaving bracts on the plant attached to what will become the unripe fruit as it swells.



6. Dispersed Fruits or Seeds

This stage is hard to detect, but look for the pedicles of where the fruit used to be (the tiny stem that held the fruit to the branch). Also, look for fruits dropped to the ground below the plant.

<https://sites.uaf.edu/alaska.edu/projectbrowndown/>

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Phenophase Photo Guide

Wild rose (*Rosa acicularis*)

Special note on leaves for this species:

Wild rose has **COMPOUND** leaves. This means that a single leaf is made of many small leaflets. You should count each leaf, not every little leaflet.

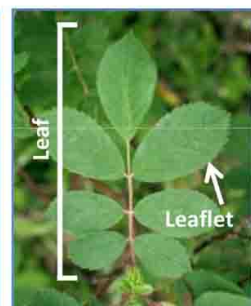


Photo by Kellr Morse

1. Initial Leaf Emergence



UAF Mulder Lab

Look for leaf buds like the one pictured to the left. Once individual leaves become differentiable, count each leaf as unfurling.

3. Fully Open Leaves

Fully open leaves are completely flattened and expanded.



UAF Mulder Lab



© Kay Winger

2. Unfurling Leaves

Unfurling leaves are leaves that are still unfolding. They tend to be creased and have not yet reached their full surface area.



Periphotography.com



UAF Mulder Lab

4. Senescing Leaves



UAF Mulder Lab



www.cdfa.us

The senescing leaves of wild rose can turn yellow, orange, red, brown and combinations of all these colors on a single leaf.

<https://sites.google.com/a/alaska.edu/projectbrowndown/>

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Phenophase Photo Guide

Common dandelion (*Taraxacum officinale*)

1. Flower Buds



A flower bud is completely closed and no yellow petals are showing. The flower buds and unripe seeds of dandelions look very similar. In order to differentiate between the two, peel back a portion of the sepals. The sepals are the outer green part surrounding the unripe seeds or flower bud. In flower buds, this will expose the yellow petals of the flower yet to form inside.

4. Unripe Fruits or Seeds



When you peel back a portion of the sepals of unripe seeds you will see green unripe seeds with white tips inside. Unripe fruit may have dried up petals appearing yellow or brown poking out from the sepals, or may have white fuzz poking out. Do not assume that just because there is yellow at the tip that there is a flower bud inside. Any leftover yellow will turn to brown and eventually fall off, exposing the white beneath.

2. Flowers



Flowers are yellow and showy. The yellow flower head is actually many small ray flowers clustered together, each with their own petal, pistil and stamens.



5. Ripe Fruits or Seeds



When the flower has reached ripe seeds stage, the sepals will reopen, and create a ball of seeds with white pappus (white hair-like structures to carry the seeds by wind). They have not yet been fully dispersed by the wind.

3. Petal Drop



During the petal drop phenopase, the flower head closes back up and the yellow petals begin to wither. If the yellow petals are completely dried up, the flower has already moved onto the next phenopase, unripe fruit.

6. Dispersed Fruits or Seeds



When the seeds have dispersed, little to no seeds remain on the flower head. Count this stage ONLY the first week that you notice no seeds remaining.



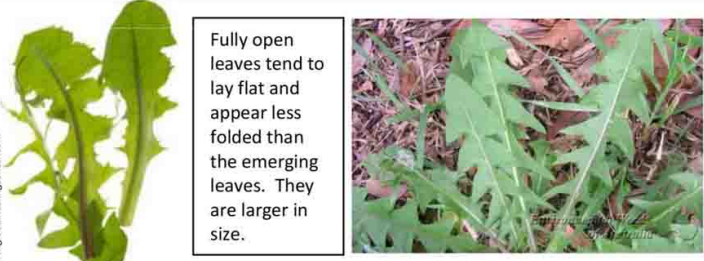
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Phenophase Photo Guide

Common Dandelion (*Taraxacum officinale*)

1. Initial Leaf Emergence	3. Fully Open Leaves
 First leaves emerging through the soil (left). Dandelion leaves will form a rosette, with new leaves emerging from the center (right).	 Fully open leaves tend to lay flat and appear less folded than the emerging leaves. They are larger in size.
2. Unfurling Leaves	4. Senescing Leaves
 Unfurling leaves are smaller than fully open leaves and appear folded. They emerge from the center of the plant and are more erect than fully open leaves.	Senescing leaves may be red, yellow, orange or brown. 

<https://sites.google.com/a/alaska.edu/projectbrowndown/>

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Phenophase Photo Guide

Lowbush Cranberry (*Vaccinium vitis-idaea*)

1. Flower Buds



Buds emerge at the tips of branches in clusters of pink buds (left). The cluster of buds elongates and the white to pink tear-shaped buds appear (center and right).

4. Unripe Fruits



The ovary swells and the sepals start to push together (left). The fruit is green (right) or beginning to redden (left). Count all fruits that still have green on them.

2. Flowers



Pink to white flowers open, with four lobes at the flower opening. The stamens and stigma are visible.

5. Ripe Fruits



The fruit is entirely red. This is the easiest phase to count! Remember, don't eat the berries on your focal plants until all your data collection is done in the fall. The plants nearby are fair game!

3. Petal Drop



Petals and stamens fall off the flower, leaving only the ovary and a prominent pistil pointing out (red arrows).

6. Dispersed Fruits

This stage is hard to detect, but look for the pedicles of where the fruit used to be (the tiny stem that held the fruit to the branch). Also, look for fruits dropped to the ground below the plant.

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Phenophase Photo Guide

Lowbush Cranberry (*Vaccinium vitis-idaea*)

Special note on leaves for this species:

Lowbush cranberry is an EVERGREEN plant. This means that it keeps its leaves for several years, sometimes making a few new leaves and losing a few old leaves in a given growing season. We ask you to count new leaves and old leaves separately. All unfurling leaves are new leaves. When they reach full size, you distinguish NEW fully open leaves from OLD fully open leaves two ways: 1) look for a difference in color and texture of the leaves. New leaves are brighter green and a little less leathery and shiny than old leaves; 2) look for a growth node along the stem. The new growth from the current growing season will be visible on the top of the stem, and the stem will look brighter, lighter green in color, and less woody than the portion of the stem bearing leaves produced during previous years. Not all lowbush cranberry plants make new leaves in a given year. If this is the case for one of your plants, mark a zero in the NEW fully open leaves section of the datasheet.



NEW leaves

Growth Node

OLD leaves

1. Initial Leaf Emergence



Leaves unfurl from a small bud at the tips of branches (left). The leaf buds can have reddish tips and green beneath, or be totally green.

3. Fully Open Leaves



Leaves are no longer bright green and have developed a more leathery texture.



2. Unfurling Leaves



New lowbush cranberry leaves unfurl from the buds. They can have a reddish hue on the edges (left), or be bright green (right).

4. Senescing Leaves



The senescing leaves turn yellow or red, then eventually turn brown and fall off. There may be only a few senescing leaves a year or none at all.

<https://sites.google.com/a/alaska.edu/projectbrownDown/>

This Phenophase guide was developed for Project BrownDown citizen science project by Katie Spellman, Christa Mulder and Katie Moeller, University of Alaska Fairbanks, and is used with permission for this NPS Pollinator Plant Phenology Project



Section E

Data sheets for plant phenology observations (next 3 pages). All data sheets adapted from University of Alaska Project BrownDown <https://sites.google.com/a/alaska.edu/projectbrowndown>

Plant Phenology Observation Data Sheet--General
 PRICKLY ROSE (*Rosa*), FIREWEED (*Chamerion*), DANDELION (*Taraxacum*)
 (fill out **one data sheet per focal plant species** each week)

In the phenophase table below, write the number of leaves, buds, flowers, fruits etc. for each category on the five individual plants (or branches) that you have selected in your site. Fill in zero if phenophase is not seen. Use the corresponding Phenophase Photo Guide to help you. If you have questions, take a photo of the plant in question and send to jessica_rykken@nps.gov

Park code: _____ Observer(s) name: _____

Focal plant species: _____ Date: _____

Site name: _____

Weather (circle one): sunny partly cloudy cloudy rain Air temp: _____ C/F

Phenophase	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5
Initial leaf emergence/buds (don't count)	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No
Count ALL green leaves (unfurling and fully open)					
Senescing leaves					
Flower buds					
Open flowers					
Petal drop					
Unripe seeds or fruit					
Ripe seeds or fruit					
Dispersed seeds or fruit					
Notes (More space on back)					

What is the LEAST ADVANCED phenophase for this plant that you see at the site? _____

What is the MOST ADVANCED phenophase for this plant that you see at the site? _____

Plant Phenology Observation Data Sheet--Evergreen
CRANBERRY (*Vaccinium*), LABRADOR TEA (*Rhododendron*)
(fill out **one data sheet per focal plant species** each week)

In the phenophase table below, write the number of leaves, buds, flowers, fruits etc. for each category on the five individual plants (or branches) that you have selected in your site. Fill in zero if phenophase is not seen. Use the corresponding Phenophase Photo Guide to help you. If you have questions, take a photo of the plant in question and send to jessica_rykken@nps.gov

Park code: _____ Observer(s) name: _____

Focal plant species: _____ Date: _____

Site name: _____

Weather (circle one): sunny partly cloudy cloudy rain Air temp: _____ C/F

Phenophase	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5
Initial leaf emergence/buds (don't count)	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No
NEW unfurling leaves (don't count)	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No
NEW fully open leaves					
OLD leaves (count on first visit only)					
Senescing leaves					
Flower buds					
Open flowers					
Petal drop					
Unripe seeds or fruit					
Ripe seeds or fruit					
Dispersed seeds or fruit					
Notes (more space on back)					

What is the LEAST ADVANCED phenophase for this plant that you see at the site? _____

What is the MOST ADVANCED phenophase for this plant that you see at the site? _____

Phenology Observation Data Sheet—Tiny flowers in dense clusters
(for *Heracleum* or very dense *Achillea*)
(fill out **one data sheet per focal plant species** each week)

In the phenophase table below, write the number of leaves, buds, flowers, fruits etc. for each category on the five individual plants (or branches) that you have selected in your site. Fill in zero if phenophase is not seen. **Note that you do not need to count each individual flower, only the number of flower clusters or umbels.** Use the corresponding phenophase photoguide to help you. If you have questions, take a photo of the plant in question and send to jessica_rykken@nps.gov

Park code: _____ Observer(s) name: _____

Focal plant species: _____ Date: _____

Site name: _____

Weather (circle one): sunny partly cloudy cloudy rain Air temp: _____ C/F

Phenophase	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5
Initial leaf emergence/buds (don't count)	YES/NO	YES/NO	YES/NO	YES/NO	YES/NO
Unfurling leaves (don't count)	YES/NO	YES/NO	YES/NO	YES/NO	YES/NO
Fully open leaves					
Senescing leaves					
Flower buds					
½ buds, ½ flowers					
Open flowers					
½ flowers, ½ petal drop					
Petal drop					
½ petal drop, ½ unripe					
Unripe seeds or fruit					
½ unripe, ½ ripe seeds/fruit					
Ripe seeds or fruit					
Dispersed seeds or fruit					

What is the LEAST ADVANCED phenophase for this plant that you see at the site? _____

What is the MOST ADVANCED phenophase for this plant that you see at the site? _____

Section F

Protocol for Insect Pollinator Collection

Things to bring for field collections:

Pollinator Collection data sheet

Bug vacuum (with two fully charged batteries)

4 collecting tubes with red end caps

2 Ziploc bags

Optional: insect net (with handle extension) and blue-capped vials filled with water and a little dish soap

Where to sample. All pollinator sampling will be done at the site(s) you have selected for plant phenology monitoring. If the site you originally designated for phenology monitoring turns out not to have enough plants for collecting an adequate number of insects, you can expand the site boundary as necessary (but note this on the back of your Pollinator Collection data sheet).

When to sample. Collect pollinators off of each target host plant species at least once every two weeks while it is in flower at your site (begin during the week when you see the first open flowers at the site). The five individual plants you are monitoring for phenology need not be in flower when you collect insects, but at least some of the plants must be in flower at the site. Ideal conditions for collecting insects are days that are sunny/dry, warm (55°F or more), and calm. If possible, plan to collect on days that meet at least some of these criteria (cold, rainy, windy days will not give you much). Note that you do not have to space consecutive samples exactly two weeks apart, it's more important to choose a good-weather day. If you want to sample more frequently (e.g., weekly) that's even better.

How to sample.

1. **Data sheet:** Once you get to the phenology site for your plant, answer parts #1-8 on the Pollinator Collection data sheet. Fill out one data sheet for each host plant species, even if they are growing in the same site.
2. **Setting up vacuum:** Slide in a fully-charged 18V battery on the end of the handle. Pull black end cap off vacuum nozzle (by stretching bands). Insert a clear collecting tube into the nozzle of the vacuum. The screen end should go in first, and the black neoprene flap valve should be at the open end (if the collecting tube has a solid red end cap on one end, make sure to remove this before inserting into nozzle). Then stretch the black end cap back in place at the end of the nozzle, and attach the six-inch clear extension tube into the hole. Note that there is a ring to adjust the strength of the suction at the bottom of the nozzle.



Insect vacuum setup.

3. **Sucking up insects.** Make sure to practice a little before your first timed collection. Turn on the vacuum, aim the extension tube at an insect and watch it disappear into the collecting tube (be sure to release any practice bugs). Once you're feeling confident, begin the official collection by noting down the time on your data sheet and then walk through your site, sucking insects off any **open flowers** of the target host plant species (i.e., not off leaves, stems, buds, or dead flowers, nor insects in flight unless you see them come directly off a flower). Avoid sampling off of the individual plants that you are monitoring for phenology (you don't want to damage them). Any insect that is sitting on an open flower of your target species is fair game, and your catch will likely include: bees, flies, beetles, true bugs, ants, wasps. **HOWEVER:** Try to **avoid collecting spiders, moths, and butterflies** (they will cover the other insects in your tube with silk or colored scales which makes things really messy later)

Give yourself a maximum of 20 minutes to collect insects at your site (write down the end time as well as the start time on data sheet). Move around to different flowers in the site. Don't run the vacuum continuously if not needed (charged battery lasts about 15 mins). Keep a rough count of how many insects you've collected, limit yourself to about 100 specimens, even if you've been there less than 20 minutes. If there is lots of insect activity on your target flowers, go for diversity of species in your collection of 100 specimens. For example, don't *only* collect bumble bees or big obvious insects, also look for smaller or more cryptic species. But remember, **collect only insects on open flowers**. If insect activity is low, then collect everything you can find on flowers in 20 minutes. If your collecting tube is getting too full with big buzzy insects, you can switch to a new empty tube mid-sample. Just follow the steps below.

4. **Completing and LABELING the sample.** Once you've finished your collection (or your first tube is full), take the collecting tube out of the vacuum nozzle, make sure to close off the neoprene flap valve with a red end cap so nothing escapes, and then store the tube with end cap in a sealed Ziploc. **MAKE SURE TO FILL OUT A LABEL** (tear from bottom of data sheet) **AND PUT IT IN THE ZIPLOC AS WELL!** If you end up using two collecting tubes at the site, put them both in the same Ziploc with that one label.
5. **Killing insects in collecting tube.** Why do we need to kill the bugs? In order to identify them, we need to examine them under a microscope, photographs aren't adequate.* The simplest way to kill the insects is to put the whole collecting tube or Ziploc into a freezer overnight until movement stops, then pour the contents of the tube into a Whirl-pak with just enough alcohol to submerge all the insects. **PUT THE LABEL INTO THE WHIRL-PAK WITH THE INSECTS AND THE ALCOHOL.** Then squeeze air out and roll down the top of the Whirl-pak and secure with yellow wire tabs (see photo below). If you don't have access to a freezer, then fill a plastic mason jar with alcohol and submerge the collecting tube (with insects inside) down in the alcohol until insects have stopped moving. You will then need to transfer insects from the collecting tube into a Whirl-pak as above (use forceps to help pick them out of tube if necessary). Don't forget to add the label!
6. **Storing and mailing specimens.** While storing the specimens in the park, make sure they are submerged in plenty of alcohol in the Whirl-paks, and keep the Whirl-paks vertical, if possible, to prevent leakage. Ideally, plan to mail specimens to Denali once or twice a month (you can send more than one sample at a time). We have provided each park with several small mailing boxes that you can use to mail specimens through the season. When you are ready to ship, open up each Whirl-pak and pour out most of the alcohol (to prevent leakage *and* because there are restrictions on mailing alcohol), leave the label in there, and reseal the Whirl-pak. Then put each Whirl-pak (can be more than one) into a Ziploc bag with some paper towel, and seal tightly. Place this in the mailing carton **WITH THE DATA SHEET** (make a copy for yourself first) and send to: Jessica Rykken, Denali National Park and Preserve, PO Box 9, Denali Park, AK 99755. Send me a quick e-mail to let me know a box is on its way (jessica_rykken@nps.gov)



*For a well-reasoned article that explains why entomologists kill so many insects:
<http://malaiseprogram.com/site/wp-content/uploads/2014/11/whywekillbugs-1.pdf>

Section G

Pollinator Collection Data Sheet

(fill out **one data sheet per host plant** each time pollinators are collected)

1. Park Unit: _____ 2. Date: _____

3. Name of collector(s): _____

4. Weather (circle one): sunny partly cloudy full cloud cover rain (not recommended!)

Air temperature: _____ F/C (circle unit)

Wind (circle one): calm breezy strong wind

5. Site name (should match site name used for plant phenology): _____

6. Name of target host plant being sampled (circle one or add other species):

Chamerion angustifolium
(fireweed)

Taraxacum officinale
(dandelion)

Vaccinium vitis-idaea
(cranberry)

Rosa acicularis
(prickly rose)

Rhododendron groenlandicum/tomentosum
(Labrador tea)

Achillea millefolium
(northern/common yarrow)

Other species: _____

7. Proportion of target host plants in site with open flowers: < 10% ~25% ~50% ~75% > 90%

8. Other plant species in site that also have open flowers (take photo if unfamiliar plant):

Species (up to five most abundant species)

Flower abundance in site compared to target plant

fewer flowers about the same many more flowers

fewer flowers about the same many more flowers

fewer flowers about the same many more flowers

fewer flowers about the same many more flowers

fewer flowers about the same many more flowers

9. Time started sample: _____ AM/PM Time stopped sample: _____ AM/PM
(you should sample for 20 minutes OR until you get ~100 insects, whichever comes first, but note time either way)

10. Estimate number insects collected: _____

11. LABEL (THIS IS THE MOST IMPORTANT STEP!) WRITE IN **PENCIL!!!** (otherwise ink will bleed in alcohol)

Fill out info in practice label on left, then copy everything you have written onto the other label below, tear it off this sheet, and make sure it goes inside the Whirl-pak with insect sample.



Park code (e.g., DENA):	Date:
Collector's name:	
Site name:	
Host plant:	

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12. Notes (e.g., Did you need to expand established site to find enough pollinators? Were insects difficult to catch? What were the most abundant pollinators? Did you take any photos?)

13. Please put this data sheet in with your insect sample when sending to Denali, OR scan the data sheet and e-mail, OR send hard copy separately to Denali (make your own copy first). Send to:

Jessica Rykken
Denali National Park & Preserve
PO Box 9
Denali Park, AK 99755
e-mail: jessica_rykken@nps.gov
phone: office 907-683-5751