USA National Phenology Network

Plant and Animal Phenophase Definitions Version 2.1

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Updates to standardized plant and animal observation protocols of the USA National Phenology Network

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USA National Phenology Network (2014) Plant and Animal Phenophase Definitions. University of Arizona Research Data Repository.
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REVISION RECORD

Date	Version	Revision Description
8/2013	Original	
4/2021	2.0	Plants: 1. Addition of "Forb (semi-evergreen)" functional group 2. Minor change to phenophases for "Tree/Shrub (drought deciduous)" functional group 3. Minor changes to phenophase definitions for: a. Initial growth (Grass/Sedge) b. Young leaves (Tree/Shrub) c. Leaves (Tree/Shrub) d. Colored leaves (Tree/Shrub) e. Falling leaves (Tree/Shrub) f. Flowers or flower buds (Cactus/Forb/Rush/Tree/Shrub) g. Flower heads (Grass/Sedge) h. Colored needles (Deciduous conifer) 4. Minor changes to intensity questions for: a. Leaves (Tree/Shrub) b. Colored leaves (Tree/Shrub) c. Emerging needles (Pine) d. Young needles (Pine) e. Needles (Deciduous conifer) f. Colored needles (Deciduous conifer) 5. Addition of FAQ #12 Animals: 1. Addition of many new insect groups 2. Major updates to insect protocols to include more phenophases for reproductive and juvenile stages 3. Major updates to bird protocols to include more phenophases for reproductive and juvenile stages 4. Minor changes to phenophase definitions for: a. Live individuals (Mammal) b. Dead individuals (Mammal) 5. Addition of FAQ section
3/2023	2.1	Plants: 1. Updates to Introduction 2. Minor changes to footnotes in summary table for angiosperms and gymnosperms 3. Minor changes to phenophase definitions for: a. Breaking leaf buds (Tree/Shrub) b. Young leaves (Tree/Shrub) c. Leaves (Tree/Shrub) d. Falling needles (Tree/Shrub) Animals:

		1. Updates to Introduction 2. Minor change to phenophases for beetles to include egg laying in soil 3. Minor changes to phenophase definitions for: a. Mating (Fly) 4. Change to abundance measure for: a. Eggs (Scale/True Bug/Beetle/Moth/Butterfly/Bee) b. Cast-off skins (Cicada) c. Fresh eggs (Salamander/Toad/Frog) d. Occupied nest (Bird)

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PLANTS

INTRODUCTION

The USA National Phenology Network's (USA-NPN) standardized phenology monitoring protocols were designed to capture the seasonal life cycle stages of plants and animals across polar, temperate, tropical, and water-limited ecosystems. The protocols can be tailored to any sampling density or frequency and can be used either within the *Nature's Notebook* observation program, or independently. The resulting data can be used to answer a variety of scientific and management questions from local to continental scales. (For more information, see Denny et al. 2014.)

The protocols are specific to major taxonomic groups and consist of a suite of "phenophases". A phenophase is an observable stage or phase in the annual life cycle of a plant or animal that can be defined by a start and end point. For plants, phenophases identify the presence or absence of structures such as leaves, flowers, and fruits on an individual plant that is observed repeatedly over the course of one or more growing seasons.

Plant "functional groups" were defined by the USA-NPN to organize species by phenological similarities. The major functional groups include Cactus, Conifer, Forb, Grass/Sedge/Rush, Tree/Shrub and are further divided according to leaf retention characteristics (e.g. deciduous, evergreen). See this link for a description of each USA-NPN plant functional group.

Phenophases in use for each plant functional group are summarized in the tables, and written definitions are included in the following sections. Each phenophase is posed to the observer as the question "Do you see [phenophase]?" to which the observer records "yes", "no" or "uncertain" for each date and time of observation. Several of the phenophases are nested such that if one is occurring the other must also be occurring. For example, if "Open flowers" are visible on a plant, "Flowers or flower buds" are also visible by definition. Note that phenophases are listed in the order of leafing, flowering and fruiting for all plants, but they will not necessarily occur in that order during the calendar year for each species.

Intensity or abundance measures for each phenophase are included below each definition. These represent either an estimate of the number of plant structures (e.g., buds, flowers, fruits) as one of several quantitative classes (<3, 3-10, 11-100, 101-1,000, 1,001-10,000, >10,000), or an estimate of the percentage of plant structures in a phenophase as one of six percentage ranges (<5%, 5-24%, 25-49%, 50-74%, 75-95%, >95%). The quantitative classes were chosen to represent increasing orders of magnitude, and they can be used to track exponential increases and decreases in visible structures (e.g., breaking leaf buds) as plants develop during a growing season, as well as to track year-to-year variability in the total number of structures that are produced during a season (e.g., fruit masting). The six percentage ranges were chosen to represent quartiles (i.e. 25%, 50%, 75%, 100%) as well as the tails of a normal distribution (i.e. 0-5% and 95-100%). Reporting in discrete quantitative classes or percentage ranges is favored over reporting continuous variables or finer-scale percentages (e.g., reporting a bin of "101-1000" instead of "652", or a range of "5-25%" instead of "16%") to simplify observation for observers who might be uncomfortable with or unable to provide such precise estimates, and to optimize observation time for all observers (e.g., given the limited resource of observer time,

ten plants with a quick, coarse estimate of intensity are more useful than a single plant with a time-consuming, precise estimate of intensity). Note that some phenophases do not include an intensity or abundance measure.

The phenophases and intensity/abundance measures are designed to be applied to an individual plant (or a delineated patch of clonal or small individual plants of the same species growing en masse). Several individuals (or patches) of the same species can be evaluated separately at a single location for replication.

A major challenge to standardization is the fact that different observers can interpret the meanings of definitions differently. We have made every effort to make the definitions as clear and complete as possible in order to minimize variation in interpretation. To this end, observers should interpret definitions literally in all situations and resist trying to second guess alternative meanings for unanticipated situations they believe the creators of the definitions might have implied but did not clearly state.

Please see the permanent landing page at https://doi.org/10.25422/azu.data.20736700 (USA National Phenology Network 2014) for future updates to these Plant and Animal Phenophase Definitions. Also visit the *Nature's Notebook* website (www.usanpn.org/natures_notebook) to find the specific phenophases recommended for each of over 1000 plant species, including some clarifying species-specific descriptions added to phenophase definitions, most notably for fruit phenophases.

Two primers developed for *Nature's Notebook* observers may be of help in understanding and evaluating plant phenophases. Our *Botany Primer* and *Phenophase Primer for Plants* can both be found on the *Nature's Notebook* website (www.usanpn.org/natures_notebook). Our self-directed *Observer Certification Course* may also be helpful and is available at learning.usanpn.org after creating a user account on the *Nature's Notebook* website.

SUMMARY TABLES

Angiosperms and Gymnosperms

	Phenophase title	**Cactus**	**Conifer** (general)	**Conifer** (pine)	**Conifer** (deciduous)	**Forb** (general)	**Forb** (semi-evergreen)	**Forb** (evergreen)	**Grass/Sedge/Rush**	**Tree/Shrub** (deciduous)	**Tree/Shrub** (drought deciduous)	**Tree/Shrub** (semi-evergreen)	**Tree/Shrub** (broadleaf evergreen)
Vegetative phenophases	Initial growth[a]					X	X		X				
	Breaking leaf buds[b]									X		X	X
	Young leaves[c]						X	X			X	X	X
	Leaves[d]					X	X		X	X	X	X	
	Increasing leaf size									X		X	
	Colored leaves									X	X	X	
	Falling leaves									X	X	X	
	Breaking needle buds		X		X								
	Emerging needles[e]			X									
	Young needles		X	X									
	Needles				X								
	Colored needles				X								
	Falling needles				X								
Reproductive phenophases	Flowers or flower buds[f]	X				X	X	X	X	X	X	X	X
	Open flowers[g]	X				X	X	X	X	X	X	X	X
	Pollen release[h]	X	X	X	X	X	X	X	X	X	X	X	X
	Pollen cones		X	X	X								
	Open pollen cones		X	X	X								
Fruit/seed phenophases	Fruits	X				X	X	X	X	X	X	X	X
	Ripe fruits	X				X	X	X	X	X	X	X	X
	Recent fruit or seed drop	X				X	X	X	X	X	X	X	X
	Unripe seed cones		X	X	X								
	Ripe seed cones		X	X	X								
	Recent cone or seed drop		X	X	X								

[a] excluded for forbs where initial growth is difficult to discern

[b] excluded for evergreen and semi-evergreen species where leaf buds are absent or too small to see

[c] excluded for evergreen species where young leaves are difficult to discern from mature leaves

[d] excluded for saprophytic plants where leaves are absent or too small to notice

[e] "Emerging needles" is included for pines instead of "Breaking needle buds" in order to capture the period when needles unfold from their fascicle sheaths after the bud has broken and the candle has elongated

[f] entitled "Flower heads" for grasses and sedges

[g] excluded for species where individual flowers can only be observed by destroying an enclosing structure in which they are hidden

[h] in angiosperms, only included for allergen species in *Nature's Notebook*

Historical Cloned and Common Lilac

	Phenophase title
Vegetative phenophases	Breaking leaf buds (previously “First leaf”)
	All leaf buds broken (previously “Full leaf out”)
Reproductive phenophases	Open flowers (previously “First bloom”)
	Full flowering (previously “Full bloom”)
	End of flowering (previously “Last bloom”)

Phenological monitoring of lilacs starting in the 1950s preceded the development of the current USA-NPN protocols. To maintain consistency in the lilac observation record, these original phenophases are still used (with some minor changes) for the common lilac (*Syringa vulgaris*) and the cloned Red Rothomagensis lilac (*Syringa* x *chinensis* ‘Red Rothomagensis’).

ANGIOSPERM PHENOPHASE DEFINITIONS

Leaf Phenophases

Initial growth

(***Forb***) New growth of the plant is visible after a period of no growth (winter or drought), either from above-ground buds with green tips, or new green or white shoots breaking through the soil surface. Growth is considered "initial" on each bud or shoot until the first leaf has fully unfolded. For seedlings, "initial" growth includes the presence of the one or two small, round or elongated leaves (cotyledons) before the first true leaf has unfolded.

(***Grass/Sedge***) New growth of the plant is visible after a period of no growth (winter or drought), either as new green shoots sprouting from nodes on existing stems, new green shoots breaking through the soil surface, or re-greening of dried stems and leaves. For each shoot, growth is considered "initial" until the first leaf has unfolded or has fully re-greened.

(***Rush***) New growth of the plant is visible after a period of no growth (winter or drought) as new green shoots breaking through the soil surface. For each shoot, growth is considered "initial" until the exposed, green portion of the shoot has reached approximately 2 inches (5 cm) in length.

Breaking leaf buds

(***Tree/Shrub***) One or more breaking leaf buds are visible on the plant. A leaf bud is considered "breaking" once a green leaf tip is visible at the end of the bud, but before the first leaf from the bud has unfolded to expose the leaf base at its point of attachment to the leaf stalk (petiole) or stem.

How many buds are breaking?
Less than 3; 3 to 10; 11 to 100; 101 to 1,000; 1,001 to 10,000; More than 10,000

Young leaves

(***Forb***) One or more young leaves are visible on the plant. A leaf is considered "young" before it has reached full size or turned the darker green color or tougher texture of mature leaves on the plant. Do not include fully dried or dead leaves.

(***Tree/Shrub***) One or more young, unfolded leaves are visible on the plant. A leaf is considered "young" and "unfolded" once its entire length has emerged from the breaking bud, stem node or growing stem tip, so that the leaf base is visible at its point of attachment to the leaf stalk (petiole) or stem, but before the leaf has reached full size or turned the darker green color or tougher texture of mature leaves on the plant. Do not include fully dried or dead leaves.

How many young leaves are present?
Less than 3; 3 to 10; 11 to 100; 101 to 1,000; 1,001 to 10,000; More than 10,000

Leaves

(***Forb***) One or more live, fully unfolded leaves are visible on the plant. For seedlings, consider only true leaves and do not count the one or two small, round or elongated leaves (cotyledons) that are found on the stem almost immediately after the seedling germinates. Do not include fully dried or dead leaves.

(***Grass***) One or more live, green, unfolded leaves are visible on the plant. A leaf is considered "unfolded" once it unrolls slightly from around the stem and begins to fall away at an angle from the stem. Do not include fully dried or dead leaves.

What percentage of the plant is green?
Less than 5%; 5-24%; 25-49%; 50-74%; 75-94%; 95% or more

(***Sedge***) One or more live, green, unfolded leaves are visible on the plant. A leaf is considered "unfolded" once it has grown long enough that the two halves of the leaf blade have begun to spread apart like an open book. Do not include fully dried or dead leaves.

What percentage of the plant is green?
Less than 5%; 5-24%; 25-49%; 50-74%; 75-94%; 95% or more

(***Rush***) One or more live, green, unfolded leaves are visible on the plant. A leaf is considered "unfolded" once the exposed, green portion of the leaf (or shoot) has reached approximately 2 inches (5 cm) in length. Do not include fully dried or dead leaves.

What percentage of the plant is green?
Less than 5%; 5-24%; 25-49%; 50-74%; 75-94%; 95% or more

(***Tree/Shrub***) One or more live, unfolded leaves are visible on the plant. A leaf is considered "unfolded" once its entire length has emerged from the breaking bud, stem node or growing stem tip, so that the leaf base is visible at its point of attachment to the leaf stalk (petiole) or stem. Do not include fully dried or dead leaves.

What percentage of the potential canopy space is full with leaves? Ignore dead branches in your estimate of potential canopy space.
Less than 5%; 5-24%; 25-49%; 50-74%; 75-94%; 95% or more

Increasing leaf size

(***Tree/Shrub***) A majority of leaves on the plant have not yet reached their full size and are still growing larger. Do not include new leaves that continue to emerge at the ends of elongating stems throughout the growing season.

What percentage of full size are most leaves?
Less than 25%; 25-49%; 50-74%; 75-94%; 95% or more

Colored leaves

(***Tree/Shrub***) One or more leaves show some of their typical late-season color, or yellow or brown due to drought or other stresses. Do not include small spots of color due to minor leaf damage, or dieback on branches that have broken. Do not include fully dried or dead leaves that remain on the plant.

What percentage of the potential canopy space is full with non-green leaf color? Ignore dead branches in your estimate of potential canopy space.
Less than 5%; 5-24%; 25-49%; 50-74%; 75-94%; 95% or more

Falling leaves

(***Tree/Shrub***) One or more leaves with typical late-season color, or yellow or brown due to other stresses, are falling or have recently fallen from the plant. Do not include fully dried or dead leaves that remain on the plant for many days before falling.

Flower Phenophases

Flowers or flower buds

(***Cactus/Forb/Rush/Tree/Shrub***) One or more fresh open or unopened flowers or flower buds are visible on the plant. Include flower buds or inflorescences that are swelling or expanding, but do not include those that are tightly closed and not actively growing (dormant). Also do not include wilted or dried flowers.

How many flowers and flower buds are present? For species in which individual flowers are clustered in flower heads, spikes or catkins (inflorescences), simply estimate the number of flower heads, spikes or catkins and not the number of individual flowers.

(*Cactus/Forb/Rush*) Less than 3; 3 to 10; 11 to 100; 101 to 1,000; More than 1,000
(*Tree/Shrub*) Less than 3; 3 to 10; 11 to 100; 101 to 1,000; 1,001 to 10,000; More than 10,000

Flower heads

(***Grass/Sedge***) One or more fresh flower heads (inflorescences) are visible on the plant. Flower heads, which include many small flowers arranged in spikelets, emerge from inside the stem and gradually grow taller. Include flower heads with unopened or open flowers, but do not include heads whose flowers have all wilted or dried or begun to develop into fruits (grains).

How many fresh flower heads are present?

Less than 3; 3 to 10; 11 to 100; 101 to 1,000; More than 1,000

Open flowers

(***Cactus/Forb/Rush/Tree/Shrub***) One or more open, fresh flowers are visible on the plant. Flowers are considered "open" when the reproductive parts (male stamens or female pistils) are visible between or within unfolded or open flower parts (petals, floral tubes or sepals). Do not include wilted or dried flowers.

What percentage of all fresh flowers (buds plus unopened plus open) on the plant are open? For species in which individual flowers are clustered in flower heads, spikes or catkins (inflorescences), estimate the percentage of all individual flowers that are open.

Less than 5%; 5-24%; 25-49%; 50-74%; 75-94%; 95% or more

(***Grass/Sedge***) One or more open, fresh flowers are visible on the plant. A flower is considered "open" when reproductive parts (male anthers or female stigmata) can be seen protruding from the spikelet. Do not include flowers with wilted or dried reproductive parts.

What percentage of all fresh flowers (unopened plus open) on the plant are open?

Less than 5%; 5-24%; 25-49%; 50-74%; 75-94%; 95% or more

Pollen release

(***Cactus/Forb/Grass/Sedge/Rush/Tree/Shrub***) One or more flowers on the plant release visible pollen grains when gently shaken or blown into your palm or onto a dark surface.

How much pollen is released?
Little: *Only a few grains are released.*; **Some:** *Many grains are released.*; **Lots:** *A layer of pollen covers your palm, or a cloud of pollen can be seen in the air when the wind blows.*

Fruit Phenophases

Fruits

(***Cactus/Forb/Grass/Sedge/Rush/Tree/Shrub***) One or more fruits are visible on the plant. *Species-specific description included here.*

How many fruits are present?
(*Cactus/Forb/Grass/Sedge/Rush*) Less than 3; 3 to 10; 11 to 100; 101 to 1,000; More than 1,000
(*Tree/Shrub*) Less than 3; 3 to 10; 11 to 100; 101 to 1,000; 1,001 to 10,000; More than 10,000

Ripe fruits

(***Cactus/Forb/Grass/Sedge/Rush/Tree/Shrub***) One or more ripe fruits are visible on the plant. *Species-specific description included here.*

What percentage of all fruits (unripe plus ripe) on the plant are ripe?
Less than 5%; 5-24%; 25-49%; 50-74%; 75-94%; 95% or more

Recent fruit or seed drop

(***Cactus/Forb/Grass/Sedge/Rush/Tree/Shrub***) One or more mature fruits or seeds have dropped or been removed from the plant since your last visit. 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.

How many mature fruits have dropped seeds or have completely dropped or been removed from the plant since your last visit?
(*Cactus/Forb/Grass/Sedge/Rush*) Less than 3; 3 to 10; 11 to 100; 101 to 1,000; More than 1,000
(*Tree/Shrub*) Less than 3; 3 to 10; 11 to 100; 101 to 1,000; 1,001 to 10,000; More than 10,000

CONIFER PHENOPHASE DEFINITIONS

Needle Phenophases

Breaking needle buds

(***Evergreen Conifer, excluding Pines***) One or more breaking needle buds are visible on the plant. A needle bud is considered "breaking" once a green needle tip is visible at the end of the bud, but before the first needle from the bud has unfolded and spread away at an angle from the developing stem.

How many buds are breaking?
Less than 3; 3 to 10; 11 to 100; 101 to 1,000; 1,001 to 10,000; More than 10,000

(***Deciduous Conifer***) One or more breaking needle buds are visible on the plant. A needle bud is considered "breaking" once a green needle tip is visible at the end of the bud, but before the first needle from the bud has unfolded and spread away at an angle from the developing stem, or from other needles in a bundle.

How many buds are breaking?
Less than 3; 3 to 10; 11 to 100; 101 to 1,000; 1,001 to 10,000; More than 10,000

Emerging needles

(***Pine***) One or more emerging needles or needle bundles (fascicles) are visible on the plant. A needle or needle bundle is considered "emerging" once the green tip is visible along the newly developing stem (candle), but before the needles have begun to unfold and spread away at an angle from others in the bundle.

How many needle bundles are emerging?
Less than 3; 3 to 10; 11 to 100; 101 to 1,000; 1,001 to 10,000; More than 10,000

Young needles

(***Evergreen Conifer, excluding Pines***) One or more young, unfolded needles are visible on the plant. A needle is considered "young" and "unfolded" once it has spread away from the developing stem enough that its point of attachment to the stem is visible, but before it has reached full size or turned the darker green color or tougher texture of mature needles on the plant.

How many young needles are present?
Less than 3; 3 to 10; 11 to 100; 101 to 1,000; 1,001 to 10,000; More than 10,000

(***Pine***) One or more young, unfolded needles are visible on the plant. A needle is considered "young" and "unfolded" once it begins to spread away at an angle from other needles in the bundle (and is no longer pressed flat against them), but before it has reached full size or turned the darker green color or tougher texture of mature needles on the plant.

How many bundles with young needles are present?
Less than 3; 3 to 10; 11 to 100; 101 to 1,000; 1,001 to 10,000; More than 10,000

Needles

(***Deciduous Conifer***) One or more live, unfolded needles are visible on the plant. A needle is considered "unfolded" once it begins to spread away at an angle from the developing stem enough that its point of attachment to the stem is visible, or from other needles in a bundle so that it is no longer pressed flat against them. Do not include fully dried or dead needles.

What percentage of the potential canopy space is full with needles? Ignore dead branches in your estimate of potential canopy space.
Less than 5%; 5-24%; 25-49%; 50-74%; 75-94%; 95% or more

Colored needles

(***Deciduous Conifer***) One or more needles show some of their typical late-season color, or yellow or brown due to drought or other stresses. Do not include small spots of color due to minor needle damage, or dieback on branches that have broken. Do not include fully dried or dead needles that remain on the plant.

What percentage of the potential canopy space is full with non-green needle color? Ignore dead branches in your estimate of potential canopy space.
Less than 5%; 5-24%; 25-49%; 50-74%; 75-94%; 95% or more

Falling needles

(***Deciduous Conifer***) One or more needles with typical late-season color, or yellow or brown due to other stresses, are falling or have recently fallen from the plant. Do not include fully dried or dead needles that remain on the plant for many days before falling.

Pollen Cone Phenophases

Pollen cones

(***All Conifers***) One or more fresh, male pollen cones (strobili) are visible on the plant. Cones have overlapping scales that are initially tightly closed, then spread apart to open the cone and release pollen. Include cones that are unopened or open, but do not include wilted or dried cones that have already released all of their pollen.

How many fresh pollen cones are present?
Less than 3; 3 to 10; 11 to 100; 101 to 1,000; 1,001 to 10,000; More than 10,000

Open pollen cones

(***All Conifers***) One or more open, fresh, male pollen cones (strobili) are visible on the plant. Cones are considered "open" when the scales have spread apart to release pollen. Do not include wilted or dried cones that have already released all of their pollen.

What percentage of all fresh pollen cones (unopened plus open) on the plant are open?
Less than 5%; 5-24%; 25-49%; 50-74%; 75-94%; 95% or more

Pollen release

(***All Conifers***) One or more male cones (strobili) on the plant release visible pollen grains when gently shaken or blown into your palm or onto a dark surface.

How much pollen is released?
Little: *Only a few grains are released.*; **Some:** *Many grains are released.*; **Lots:** *A layer of pollen covers your palm, or a cloud of pollen can be seen in the air when the wind blows.*

Seed Cone Phenophases

Unripe seed cones

(***All Conifers***) One or more unripe, female seed cones are visible on the plant. *Species-specific description included here.*

How many seed cones are unripe?
Less than 3; 3 to 10; 11 to 100; 101 to 1,000; 1,001 to 10,000; More than 10,000

Ripe seed cones

(***All Conifers***) One or more ripe, female seed cones are visible on the plant. *Species-specific description included here.*

How many seed cones are ripe?
Less than 3; 3 to 10; 11 to 100; 101 to 1,000; 1,001 to 10,000; More than 10,000

Recent cone or seed drop

(***All Conifers***) One or more seed cones or seeds have dropped or been removed from the plant since your last visit. Do not include empty seed cones that had long ago dropped all of their seeds but remained on the plant.

How many seed cones have dropped seeds or have completely dropped or been removed from the plant since your last visit?
Less than 3; 3 to 10; 11 to 100; 101 to 1,000; 1,001 to 10,000; More than 10,000

HISTORICAL CLONED AND COMMON LILAC PHENOPHASE DEFINITIONS

Leaf Phenophases

Breaking leaf buds

(***Lilac***) In at least 3 locations on the plant, a breaking leaf bud is visible. A leaf bud is considered "breaking" once the widest part of the newly emerging leaf has grown beyond the ends of its opening winter bud scales, but before it has fully emerged to expose the leaf stalk (petiole) or leaf base. The leaf is distinguished by its prominent midrib and veins. (*This phenophase was previously called "First leaf".*)

All leaf buds broken

(***Lilac***) For the whole plant, the widest part of a new leaf has emerged from virtually all (95-100%) of the actively growing leaf buds. (*This phenophase was previously called "Full leaf out".*)

Flower Phenophases

Open flowers

(***Lilac***) For the whole plant, at least half (50%) of the flower clusters have at least one open fresh flower. The lilac flower cluster is a grouping of many, small individual flowers. (*This phenophase was previously called "First bloom".*)

Full flowering

(***Lilac***) For the whole plant, virtually all (95-100%) of the flower clusters no longer have any unopened flowers, but many of the flowers are still fresh and have not withered. (*This phenophase was previously called "Full bloom".*)

End of flowering

(***Lilac***) For the whole plant, virtually all (95-100%) of the flowers have withered or dried up and the floral display has ended. (*This phenophase was previously called "End of bloom".*)

FREQUENTLY ASKED QUESTIONS ABOUT PLANT PHENOPHASES

1. Can I still report "Breaking leaf/needle buds" (trees and shrubs), "Emerging needles" (pines), or "Initial growth" (forbs and grasses) once I see "Leaves/Needles" or "Young leaves/needles" on the plant?

Yes, you should judge each leaf bud, needle bud, or shoot separately. As long as some buds or shoots on the plant are still breaking or initiating growth and have not yet produced an unfolded leaf or needle, you are seeing "Breaking leaf/needle buds", "Emerging needles", or "Initial growth". For plants that have more than one bud or shoot, in most cases you will still be seeing "Breaking leaf/needle buds", "Emerging needles", or "Initial growth" in some buds or shoots for many days after you first begin seeing "Leaves/Needles" or "Young leaves/needles" from other buds or shoots. It is also possible to see multiple episodes of leaf/needle bud break or initial growth within a season. This might occur after a period of frost, drought, or after a plant is defoliated by insects. However, once ALL the active leaf/needle buds or shoots on the plant have at least one unfolded leaf/needle, you should be reporting that you no longer see "Breaking leaf/needle buds", "Emerging needles", or "Initial growth".

2. How do I judge whether or not a leaf or needle is "young"?

Young leaves or needles on an evergreen or drought-deciduous plant can be distinguished from older leaves or needles because they are smaller, a lighter shade of green, and/or thinner than mature leaves or needles. As the young leaf matures and approaches the size, color and thickness of older leaves on the plant, it can be difficult to determine when to no longer consider it "young". This is particularly true for drought-deciduous species where new leaf growth is often initiated by rain events. If water becomes unavailable after growth is initiated, leaf expansion may stop, resulting in many small leaves on the plant. If this is the case, you will need to stop reporting that you see "Young leaves/needles" when it appears that the leaves or needles have stopped changing in size, color and thickness (or report that you are "Uncertain" of whether or not you see "Young leaves/needles"). With experience, it will become easier to determine when a leaf or needle is still growing and young.

3. Why is there a phenophase for "Emerging needles" for pine species but not for other conifer species?

In most conifers, breaking needle buds reveal new needles unfolding, then lengthening of the stem, and the unfolding of more needles until the stem stops growing for the season. In pines, growth of the stem (or "candle") occurs first, before the needles appear. Once the stem has grown, the needle bundles begin to emerge and unfold from protective papery sheaths along the newly elongated stem. We have decided that "Breaking needle buds" should be an advanced phenophase for pine species, and thus do not include it in the protocols at this time. Instead, observation of pine species begins with the search for emerging needles along the new stem.

4. When should I report I no longer see "Leaves/Needles"?

You should continue to report seeing "Leaves/Needles" as long as fresh green or colored leaves/needles remain on the plant. Do not include dried, dead leaves or dead, brown needles that remain on the plant, such as occurs with some species throughout the dormant season (e.g., winter or dry season). In some cases, green leaves will remain on the plant in a frozen condition for part or all of the winter. If more than about 5% of the leaves have remained on the plant in this condition, you should continue to report seeing "Leaves" until they fall off or appear wilted.

5. How do I judge what percentage of the plant is green in grasses, sedges and rushes?

For grass, sedge and rush species where new growth is from new stems, the plant will probably be 100% green until it begins to turn brown in the late summer or fall. For species where existing stems can turn brown and then re-green, the percentage may start low at the beginning of the growing season, become higher in the middle of the growing season, and then decline again as the plant turns brown again. In dryland environments where conditions are extreme, it can be particularly difficult to judge what portion of a grass plant is truly dead and what portion has the potential to re-green. If this is the case for your plant, you may want to ignore this intensity question and just report on whether or not you see green leaves.

6. How do I judge what percentage of the canopy is full with leaves or needles?

To be able to do this requires knowing what a full canopy looks like for any given deciduous or semi-deciduous species. We plan to eventually provide photos for each species to help illustrate this, but in the meantime you will need to make note of the fullness of the canopy once the leaves or needles have grown to full size, but before they begin to fall off towards the end of the growing season. This will be what the canopy looks like at 100%. During your first year of observing, you may want to avoid estimating canopy fullness until you know what it looks like at 100% fullness.

Once you know what the canopy looks like at 100% fullness, you should estimate the changing percentage of fullness as the leaves grow larger at the beginning of the growing season (starting at 0% with bare branches before any leaves appear and increasing to 100% when the leaves become full size), and as leaves fall off and the canopy thins at the end of the growing season (starting at 100% and decreasing to 0% once all the leaves have fallen off). One trick is to estimate the percentage of sky seen through the tree canopy. If no sky is visible at 100%, then when you see half sky and half leaves within the area of the canopy, it is 50% full. A similar trick can be used for smaller plants by estimating the amount of ground you see through the canopy while looking down on a plant.

We are aware that estimates of canopy fullness by the human eye is a somewhat subjective measure, but combined with more precise measurements made from camera images, it can provide very useful information about the duration of the year over which a plant is photosynthesizing, which in turn affects the amount of CO_2 in the atmosphere.

For semi-deciduous species, the canopy fullness will not necessarily drop to 0% every year, and may not even get up to 100% every year if the environmental conditions have been extreme (for example, an extreme drought that delays leaf bud break). For these species, the extent of the canopy in a good year should be considered 100% fullness, and 0% would be the plant with all leaves dropped off.

If your plant has a dead section that never grows leaves, you can ignore that portion of the plant in estimating canopy fullness so that the plant canopy is 100% full when the live portions of the plant are fully leafed out.

7. How can I judge the percentage of full leaf size while leaves are still increasing in size?

This is a little difficult the first year you try it, but gets easier with practice. If you are in doubt, you can use a ruler to measure full size (length and/or width) of a typical leaf during summer of the first year, and then use that measure to better judge the percentage of full leaf size during the period of leaf growth in subsequent years. We are asking observers to note when leaves are less than 25%, 25-49%, 50-74%, 75-94% or 95% or more of full leaf size in order to create an estimate of the time it takes for leaves to grow to full size. Including this measure allows scientists to keep track of the length of the "green-up" period which is an important aspect of a plant's response to climate change.

8. How do I judge what percentage of the canopy is full with colored leaves or needles?

To answer this question, use the principle explained in FAQ #6, above, but consider only the colored portions of leaves and needles that are left on the plant and do not include the green portions. For instance, if the plant canopy is 100% full with leaves but about half of them are green and half are colored, you would report that 100% of the canopy is full with leaves, and 50% of the canopy is full with colored leaves. If it is windy the next day, and half of the colored leaves fall off (but none of the green leaves fall off), you would now report that 75% of the canopy is full with leaves and 25% of the canopy is full with colored leaves. As the days go on, more of the leaves change color and some fall off, and you might eventually find that only half of the leaves remain on the plant and there is no green left in them. At this point you would report that 50% of the canopy is full with leaves and 50% of the canopy is full with colored leaves. Note that the percentage of the canopy full with leaves or needles (green plus colored) should steadily decline from 100% to 0% as leaves or needles fall off. However, the percentage of the canopy full with colored leaves or needles may go up and down during this time of leaf/needle fall.

9. Why are there no intensity options provided for “Falling leaves/needles”?

There are no intensity options for this phenophase because the percentage of leaves or needles that have fallen from your deciduous plant can be calculated from the percentage of leaves or needles that remain on the plant. This is already captured in the value you reported for "What percentage of the canopy is full with leaves/needles?" for the “Leaves/needles” phenophase. See FAQ #6 above for more information.

10. How are the phenophases "Flowers or flower buds", "Flower heads" (grasses), or "Pollen cones" (conifers) different from "Open flowers" or "Open pollen cones"?

The "Flowers or flower buds", "Flower heads" (grasses), and "Pollen cones" (conifers) phenophases give you the opportunity to report developing flowers, flower heads, or pollen cones before you see any of the flowers or pollen cones open on your plant (flowers are not considered "open" until reproductive parts are visible). Report "Yes" for this phenophase when you see any developing flower or flower bud, fresh (unwithered) flowers, or pollen cones on your plant, ***whether they are open or closed*** (however do not include dormant flower buds enclosed in bud scales until that bud begins to break, as occurs in many northern tree and shrub species, such as forsythia). This means that whenever you report you see "Open flowers" or "Open pollen cones", you should also be reporting that you see "Flowers or flower buds", "Flower heads" or "Pollen cones". For some species, flowers or pollen cones can open on sunny days and stay closed on cloudy days, in which case you should continue to report you see "Flowers or flower buds", "Flower heads" or "Pollen cones" even when you are reporting that you do not see "Open flowers" or "Open pollen cones". However, once all flowers or pollen cones on the plant have withered, do not report this phenophase even if the dried or withered petals or cones remain on the plant. Note that any given flowering plant species will either have single flowers that sit directly on a woody twig or at the end of a short or long stalk, or it will have many flowers on a single stalk (a flower head, flower spike, catkin or inflorescence). Report "Yes" for "Flowers or flower buds" as soon as you see something that is recognizable as a flower structure, whether it is a developing flower in the process of emerging from a twig on a tree, or a developing flower stalk emerging from the base of a wildflower.

11. How do I judge what percentage of flowers are open on a species with inflorescences?

For species where tiny individual flowers are clustered in inflorescences (flower heads, spikes or catkins), it may seem difficult to estimate the percentage of these individual flowers that are open over the entire plant. However, oftentimes the percentage of individual flowers open on a single inflorescence will be the same for all inflorescences on the plant. If this is the case, you can choose a single inflorescence, estimate the percentage of open flowers on it, and use that value to represent the entire plant. For larger plants, it is generally a good idea to check a few inflorescences (for example, one towards the bottom of the plant, one in the middle and one towards the top), and average the percentage of open flowers on each of these inflorescences to represent the entire plant.

12. Why do some species have a phenophase for "Pollen release" and others do not?

While you should be able to see pollen release from almost all plant species when the mature male or bisexual flowers are shaken or blown, we have only included this phenophase for species that are considered moderate or severe allergens. "Pollen release" should be reported only if you can actually see pollen dust upon blowing or shaking a flower or pollen cone. Do not try to observe this phenophase if you cannot get close enough to a flower or pollen cone to blow or shake it to see if pollen falls into your hand.

13. How is the phenophase "Fruits" different from "Ripe fruits"?

The "Fruits" phenophase gives you the opportunity to report the presence of developing fruits before you see any of them mature or ripen on your plant. Report "Yes" for this phenophase as long as you see fruits on your plant at any stage of maturity, whether unripe and in the process of developing, or mature and ripe. This means that whenever you report you see "Ripe fruits", you should also be reporting that you see "Fruits". Often some fruits will ripen and be eaten or drop from the plant, while unripe fruits still remain, so you may see fruits for a long period of time with ripe fruits present on the plant during some observation days and no ripe fruits present on other observation days. Sometimes it is hard to tell when fruits first appear. Technically they are present as soon as the flower's ovary is fertilized, but often the ovary does not swell into something resembling a fruit for several weeks. Do not worry about missing this early stage and simply report fruits when you see the fruit as it begins to enlarge. However, once all of the fruits drop all of their seeds, do not report this phenophase even if the pods, capsules, or husks of the fruits remain (or "persist") on the plant.

14. In counting fruits, should I count all fruits on a single inflorescence as a single unit, as is done for flowers?

No, you should count individual fruits. Often not all flowers in an inflorescence will be fertilized and develop into fruit or substantial fruit abortion will occur within an inflorescence after the flowers have been fertilized. For this reason the number of fruits in an inflorescence can be highly variable. However, for some species an inflorescence will result in hundreds of tiny fruits (for example, sunflowers) and you may need to estimate the number of fruits on a plant by trying to roughly count them on a single inflorescence and multiplying by the total number of inflorescences on the plant.

Fruit structures in the plant world are very diverse and it can be difficult to identify fruits and determine ripeness. For this reason we have added a species-specific description to the fruit phenophase definitions for each species included in *Nature's Notebook* to ensure all observers are evaluating the same thing. In some cases what is described as a fruit in these definitions does not fit the botanical definition of "fruit", but you should follow the guidelines in the definition for the purposes of counting to insure consistency across all observers. Please visit the website (www.usanpn.org/natures_notebook) to find this information for each species.

15. Can I report seeing both "Unripe seed cones" and "Ripe seed cones" on the same plant at the same time?

Yes, absolutely. There are many times when you will see both unripe and ripe seed cones on the same plant at the same time. In some species, seed cones take more than a full year to mature and you could be seeing ripe seed cones from a previous year's crop at the same time you see unripe seed cones from this year's crop. Or you may even see unripe cones from the previous AND current year's crop at the same time. Just be careful not to count as "ripe" any empty cones that have already dropped all of their seeds but remain on the plant. This occurs quite frequently for some conifer species, but these empty seed cones should be ignored.

16. Why should I look for "Recent fruit or seed drop" or "Recent cone or seed drop" (conifers), and how can I tell if mature fruits or seed cones have dropped from my plant since my last visit?

Sometimes a fruit or seed cone is not ripe very long before it drops from the plant. This phenophase allows you to report that one or more fruits or seed cones ripened and dropped from the plant since your last visit. Evidence of "Recent fruit or seed drop" or "Recent cone or seed drop" may include mature fruits or seed cones on the ground below the plant that were not there on your last visit, or fruits or seed cones missing from the plant which were present on your last visit. For this phenophase, do not include the dropping of fruits or seed cones that are clearly immature and unripe, as often happens in a heavy rain or wind storm. You should also not include fruit pods, capsules, husks, or empty seed cones that long ago dropped all of their seeds and are only now falling from the plant.

ANIMALS

INTRODUCTION

The USA National Phenology Network (USA-NPN) standardized phenology monitoring protocols were designed to capture the seasonal life cycle stages of plants and animals across polar, temperate, tropical, and water-limited ecosystems. The protocols can be tailored to any sampling density or frequency and can be used either within the *Nature's Notebook* observation program, or independently. The resulting data can be used to answer a variety of scientific and management questions from local to continental scales. (For more information, see Denny et al. 2014.)

The protocols are specific to major taxonomic groups and consist of a suite of "phenophases". A phenophase is an observable stage or phase in the annual life cycle of a plant or animal that can be defined by a start and end point. For animals, phenophases identify the presence or absence of behaviors such as breeding, migration, and use of food resources. Individual animals are not tracked, but rather the species as a whole is observed repeatedly at a site over the course of one or more years.

Phenophases in use for each animal group are summarized in the tables, and written definitions are included in the following sections. Each phenophase is posed to the observer as the question "Do you see/hear [phenophase]?" to which the observer records "yes", "no" or "uncertain" for each date and time of observation. Note that more than one phenophase may be occurring in a single, individual animal at the same time. For example, if a bird is seen in the "Fruit/seed consumption" phenophase, it is also in the "Live individuals" and "Feeding" phenophases.

Intensity or abundance measures for each phenophase are included below each definition. In most cases this represents an estimated count of the number of individual animals of a given species at a given site that are observed in the phenophase of interest at the time of observation. "Vocalizing" in frogs and toads, "Courtship calling" in some insects, and emergence in some mayflies are exceptions, where a series of categorical qualitative options for intensity are provided in lieu of asking observers to count the number of individuals.

Phenophases that indicate bait or capture methods are included to indicate when the likelihood of detecting the animal was increased beyond a chance sighting. These include "Individuals at a feeding station", "Individuals at a light", "Individuals in a net", and "Individuals in a trap".

A major challenge to standardization is the fact that different observers can interpret the meanings of definitions differently. We have made every effort to make the definitions as clear and complete as possible in order to minimize variation in interpretation. To this end, observers should interpret definitions literally in all situations and resist trying to second guess alternative meanings for unanticipated situations they believe the creators of the definitions might have implied but did not clearly state.

These phenophases are designed for an audience that is not trained in handling wild animals, and only phenophases that are relatively easy to observe and/or evaluate are included.

Phenophases for which evaluation could potentially endanger an observer (e.g., trying to catch bees in a net), or disturb an animal or its habitat (e.g., cutting into a tree trunk or digging into soil to search for insect larvae) are not included. Note that there are many animal groups for which phenophases have not yet been developed (e.g., bats, ticks, intertidal invertebrates, etc.). Please see the permanent landing page at https://doi.org/10.25422/azu.data.20736700 (USA National Phenology Network 2014) for future updates to these Plant and Animal Phenophase Definitions. Also visit the *Nature's Notebook* website (www.usanpn.org/natures_notebook) to find the specific phenophases recommended for each of over 300 animal species, including some clarifying species-specific descriptions added to phenophase definitions.

A self-directed, online course developed for *Nature's Notebook* observers may be of help in understanding and evaluating animal phenophases. Our *Observer Certification Course* is available at learning.usanpn.org after creating a user account on the *Nature's Notebook* website (www.usanpn.org/natures_notebook).

SUMMARY TABLES

Insects

Phenophase title	Mayfly	Stonefly	Dragonfly/Damselfly	Grasshopper	Cicada	Aphid	Scale	Ture Bug	Beetle	Moth	Butterfly	Ant	Bee	Fly
Adults	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Male adults[a]							X						X	
Feeding							X							
Adults feeding[a]			X	X	X	X		X	X	X	X			X
Flower visitation											X		X	
Winged adults						X						X		
Migrating adults[a]			X								X			
Courtship calling[a]				X	X									
Mating[a]	X	X	X	X	X		X	X	X	X	X	X	X	X
Nest building												X	X	
Drone cells[a]													X	
Nest provisioning[a]												X	X	
Egg laying[a]	X	X	X	X				X	X	X	X			X
Recent egg laying					X									
Eggs[a]							X	X	X	X	X		X	
Nymphs/Crawlers/Larvae/Caterpillars[a]			X	X	X	X	X	X	X	X	X		X	X
Dormant nymphs[a]							X							
Caterpillars in tent[a]										X				
Post-dormant nymphs[a]							X							
Nymphs/Larvae/Caterpillars feeding[a]				X		X		X	X	X	X			X
Pupae[a]									X	X	X		X	
Cast-off skins					X									
Subadults	X													
Recently emerged adults		X	X											
Dead adults	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dead nymphs/larvae/caterpillars[a]			X	X	X	X		X	X	X	X			X
Individuals at a feeding station[a]										X	X			
Individuals at a light[a]	X	X	X	X					X	X				
Individuals in a net	X	X	X	X					X	X	X			
Individuals in a trap	X	X	X	X	X	X	X	X	X	X	X	X	X	X

[a] excluded for species where this stage or behavior is never exhibited, is difficult to observe, or requires destructive sampling to observe

Fishes, Amphibians and Reptiles

Phenophase title	**Fish** (saltwater)	**Fish** (anadromous)	**Fish** (freshwater)	**Eel**	**Salamander**	**Toad/Frog**	**Alligator**	**Turtle**	**Lizard/Snake**
Individuals on land							X	X	X
Adults on land					X	X			
Individuals in water[a]							X	X	X
Adults in water[a]					X	X			
Adults in freshwater		X	X	X					
Adults in saltwater	X	X		X					
Feeding							X	X	X
Adults feeding	X	X	X	X	X	X			
Adults migrating upstream		X							
Adults migrating downstream[b]		X	X	X					
Juveniles in saltwater	X								
Juveniles moving upstream				X					
Vocalizing[c]						X			
Adults vocalizing							X		
Mating					X	X			
Nesting								X	
Fresh eggs					X	X			
Young individuals							X	X	X
Dead individuals							X	X	X
Dead adults					X	X			
Dead or dying adults	X	X	X	X					
Individuals on a hook	X	X	X	X					
Individuals in a net	X	X	X	X					

[a] excluded for species that are solely terrestrial
[b] excluded for species that do not migrate or migrate only once, then spawn and die upstream
[c] excluded for species that do not vocalize

Birds and Mammals

Phenophase title	**Bird** (altricial)	**Bird** (altricial with song)	**Bird** (precocial)	**Bird** (precocial with song)	**Mammal** (general)	**Pinniped**	**Squirrel/Chipmunk**	**Deer/Sheep**
Live individuals	X	X	X	X	X		X	X
Individuals on land						X		
Individuals in water						X		
Feeding[a]	X	X	X	X	X	X	X	X
Fruit/seed consumption[b]	X	X	X	X			X	
Insect consumption[b]	X	X	X	X				
Nut gathering[b]	X	X					X	
Flower visitation[b]	X	X						
Calls or song	X	X	X	X				
Singing individuals		X		X				
Territorial individuals	X	X	X	X				
Males vocalizing[a]								X
Male combat[a]						X		X
Courtship	X	X	X	X				
Mating[a]	X	X	X	X	X	X		X
Nest building[c]	X	X	X	X				
Occupied nest[c]	X	X	X	X				
Nestlings	X	X						
Downy young			X	X				
Partially-fledged young			X	X				
Fledged young	X	X	X	X				
Young individuals					X	X	X	X
Summer coat[a]					X			
Winter coat[a]					X			
Dead individuals	X	X	X	X	X	X	X	X
Dead nestlings or young	X	X	X	X				
Individuals at a feeding station	X	X	X	X				

[a] excluded for species where this stage or behavior is never exhibited or is very difficult to observe

[b] excluded for species where this feeding behavior is never exhibited or exhibited year-round regardless of season

[c] excluded for brood parasite species which lay their eggs in the nests of other bird species

INSECT PHENOPHASE DEFINITIONS

Adults

(***Mayfly/Stonefly/Dragonfly/Damselfly/Grasshopper/Cicada/Aphid/Scale/True Bug/Beetle/Moth/Butterfly/Ant/Bee/Fly***) One or more adults are seen or heard moving about or at rest. *Species-specific description sometimes included here.*

For abundance, record the number of individual animals observed in this phenophase.

In Hexagenia mayflies--instead of recording the number of individuals, use this intensity question:*

What is the intensity of emergence?

Slight: *Less than 100 individuals are seen within the immediate observation area (approximately 5 feet in any direction).;* ***Light:*** *Between 100 and 500 individuals are seen within the immediate observation area (approximately 5 feet in any direction).;* ***Moderate:*** *Consistent coverage of surfaces is seen (ground, building walls and windows, vegetation, etc.), or small groups of individuals are seen under lights.;* ***Heavy:*** *Thick coverage of surfaces is seen, or very noticeable groups of individuals, including small to medium piles, are seen under lights.;* ***Very heavy:*** *Very thick coverage of surfaces is seen (with minimal surface area exposed), or large groups of individuals, including large piles, are seen under lights.*

Male adults

(***Scale/Bee***) One or more adult males are seen moving about or at rest. *Species-specific description included here.*

For abundance, record the number of individual animals observed in this phenophase.

Feeding

(***Scale***) One or more individuals are seen feeding. If possible, record the name of the species or substance being eaten or describe it in the comments field. *Species-specific description sometimes included here.*

For abundance, record the number of individual animals observed in this phenophase.

Adults feeding

(***Dragonfly/Damselfly/Grasshopper/Cicada/Aphid/True Bug/Beetle***) One or more adults are seen feeding. If possible, record the name of the species or substance being eaten or describe it in the comments field. *Species-specific description sometimes included here.*

For abundance, record the number of individual animals observed in this phenophase.

(***Moth/Butterfly/Fly***) One or more adults are seen feeding with their straw-like tongue (proboscis). If possible, record the substance and species on which they are feeding (for example, nectar, sap, dung, or moist soil) in the comments field. *Species-specific description sometimes included here.*

For abundance, record the number of individual animals observed in this phenophase.

Flower visitation

(***Butterfly/Bee***) One or more individuals are seen visiting flowers or flying from flower to flower. If possible, record the name of the plant or describe it in the comments field.

For abundance, record the number of individual animals observed in this phenophase.

Winged adults

(***Aphid/Ant***) One or more adults bearing wings are seen moving about or at rest.

For abundance, record the number of individual animals observed in this phenophase.

Migrating adults

(***Dragonfly/Damselfly***) A swarm of adults of mostly the same species is seen flying overhead.

For abundance, record the number of individual animals observed in this phenophase.

(***Butterfly***) Multiple adults of the same species are seen flying steadily in a uniform direction without stopping.

For abundance, record the number of individual animals observed in this phenophase.

Courtship calling

(***Grasshopper/Cicada***) Courtship sounds produced by an adult are heard. *Species-specific description included here.*

What is the intensity of calling?
Single calls: *There is space between calls and individuals can be counted*.; **Overlapping calls:** *Calls of individuals can be distinguished but there is some overlapping of calls*.; **Full chorus:** *Calls are constant and overlapping.*

Mating

(***Mayfly/Stonefly***) A male and female are seen coupled in a mating position, usually one on top of the other.

For abundance, record the number of individual animals observed in this phenophase.

(***Dragonfly/Damselfly***) A male and female are seen coupled in a mating position, usually forming what looks like a circle with their bodies. This can be at rest or in flight.

For abundance, record the number of individual animals observed in this phenophase.

(***Grasshopper/Cicada/Aphid/Scale/True Bug/Beetle/Ant/Bee***) A male and female are seen coupled in a mating position, usually with the male on top of the female.

For abundance, record the number of individual animals observed in this phenophase.

(***Moth/Butterfly***) A male and female are seen coupled in a mating position, usually end to end. This can occur at rest or in flight.

For abundance, record the number of individual animals observed in this phenophase.

(***Fly***) A male and female are seen coupled in a mating position, usually one on top of the other or end to end.

For abundance, record the number of individual animals observed in this phenophase.

Nest building

(***Bee, general***) One or more adults are seen building a nest or hive. *Species-specific description sometimes included here.*

For abundance, record the number of individual animals observed in this phenophase.

(***Ant/Bee, ground-nesting***) One or more adults are seen digging into soil to construct a nest. *Species-specific description sometimes included here.*

For abundance, record the number of individual animals observed in this phenophase.

(***Ant/Bee, wood-nesting***) One or more adults are seen (or heard) chewing into wood to construct a nest. *Species-specific description sometimes included here.*

For abundance, record the number of individual animals observed in this phenophase.

Drone cells

(***Bee***) One or more drone cells are seen in a hive. *Species-specific description included here.*

For abundance, record the number of individual animals observed in this phenophase.

Nest provisioning

(***Ant***) One or more adults are seen entering the nest with insects or seeds. If possible, record the name of the species or substance being carried or describe it in the comments field. *Species-specific description sometimes included here.*

For abundance, record the number of individual animals observed in this phenophase.

(***Bee***) One or more adults are seen entering the nest with pollen. *Species-specific description sometimes included here.*

For abundance, record the number of individual animals observed in this phenophase.

Egg laying

(***Mayfly/Stonefly/Dragonfly/Damselfly***) A female is seen laying eggs directly onto the water surface, or attached to aquatic plants.

For abundance, record the number of individual animals observed in this phenophase.

(***Grasshopper/Beetle, soil-laying***) A female is seen laying eggs on or below the soil surface.

For abundance, record the number of individual animals observed in this phenophase.

(***True Bug/Beetle, plant-laying/Moth/Butterfly****)* A female is seen laying eggs on a plant or other surface. If possible, record the name of the plant or describe it in the comments field. *Species-specific description sometimes included here.*

For abundance, record the number of individual animals observed in this phenophase.

(***Fly****)* A female is seen laying eggs. If possible, record the name of the species or substance on which the eggs are being deposited or describe it in the comments field. *Species-specific description sometimes included here.*

For abundance, record the number of individual animals observed in this phenophase.

Recent egg laying

(***Cicada***) A female is seen depositing eggs, or evidence of recent egg laying is seen on a plant or other surface. If possible, record the name of the plant or describe it in the comments field. *Species-specific description sometimes included here.*

For abundance, record the number of individual animals observed in this phenophase.

Eggs

(***Scale/True Bug***) One or more eggs are seen. *Species-specific description included here.*

For abundance, record the number of eggs observed.

(***Beetle/Moth/Butterfly***) One or more eggs are seen on a plant or other surface. If possible, record the name of the plant or describe it in the comments field. *Species-specific description included here.*

For abundance, record the number of eggs observed.

(***Bee***) One or more eggs are seen in a nest or hive. *Species-specific description included here.*

For abundance, record the number of eggs observed.

Nymphs

(***Dragonfly/Damselfly/Grasshopper/Cicada/Aphid/True Bug***) One or more nymphs are seen moving about or at rest. *Species-specific description included here.*

For abundance, record the number of individual animals observed in this phenophase.

Crawlers

(***Scale***) One or more crawlers are seen moving about or at rest. *Species-specific description included here.*

For abundance, record the number of individual animals observed in this phenophase.

Larvae

(***Beetle/Bee/Fly***) One or more larvae are seen moving about or at rest. *Species-specific description included here.*

For abundance, record the number of individual animals observed in this phenophase.

Caterpillars

(***Moth/Butterfly***) One or more caterpillars (larvae) are seen moving about or at rest. When seen on a plant, if possible, record the name of the plant or describe it in the comments field. *Species-specific description included here.*

For abundance, record the number of individual animals observed in this phenophase.

Dormant nymphs

(***Scale***) One or more nymphs are seen in a dormant state. *Species-specific description included here.*

For abundance, record the number of individual animals observed in this phenophase.

Caterpillars in tent

(***Moth***) Caterpillars are seen in their tent. If possible, record the name of the plant on which the tent is built or describe it in the comments field.

For abundance, record the number of individual animals observed in this phenophase.

Post-dormant nymphs

(***Scale***) One or more nymphs have come out of their dormant state. *Species-specific description included here.*

For abundance, record the number of individual animals observed in this phenophase.

Nymphs feeding

(***Grasshopper/Aphid/True Bug***) One or more nymphs are seen feeding. If possible, record the name of the species or substance being eaten or describe it in the comments field. *Species-specific description sometimes included here.*

For abundance, record the number of individual animals observed in this phenophase.

Larvae feeding

(***Beetle/Fly***) One or more larvae are seen feeding. If possible, record the name of the species or substance being eaten or describe it in the comments field. *Species-specific description sometimes included here.*

For abundance, record the number of individual animals observed in this phenophase.

Caterpillars feeding

(***Moth/Butterfly***) One or more caterpillars are seen feeding. If possible, record the name of the species or substance being eaten or describe it in the comments field. *Species-specific description sometimes included here.*

For abundance, record the number of individual animals observed in this phenophase.

Pupae

(***Beetle/Moth/Butterfly/Bee***) One or more pupae are seen in a cocoon or shell (puparium). *Species-specific description included here.*

For abundance, record the number of individual animals observed in this phenophase.

Cast-off skins

(***Cicada***) One or more cast-off skins or exoskeletons shed during transformation from nymph to adult are seen. These may be difficult to identify to species level.

For abundance, record the number of cast-off skins observed.

Subadults

(***Mayfly***) One or more subadults are seen moving about or at rest. *Species-specific description included here.*

For abundance, record the number of individual animals observed in this phenophase.

In Hexagenia mayflies--instead of recording the number of individuals, use this intensity question:*

What is the intensity of emergence?

Slight: *Less than 100 individuals are seen within the immediate observation area (approximately 5 feet in any direction).;* ***Light:*** *Between 100 and 500 individuals are seen within the immediate observation area (approximately 5 feet in any direction).;* ***Moderate:*** *Consistent coverage of surfaces is seen (ground, building walls and windows, vegetation, etc.), or small groups of individuals are seen under lights.;* ***Heavy:*** *Thick coverage of surfaces is seen, or very noticeable groups of individuals, including small to medium piles, are seen under lights.;* ***Very heavy:*** *Very thick coverage of surfaces is seen (with minimal surface area exposed), or large groups of individuals, including large piles, are seen under lights.*

Recently emerged adults

(***Stonefly/Dragonfly/Damselfly***) One or more adults (teneral adults) are seen just following emergence from the larval stage. They have a soft exoskeleton and a pale appearance.

For abundance, record the number of individual animals observed in this phenophase.

Dead adults

(***Mayfly/Stonefly/Dragonfly/Damselfly/Grasshopper/Cicada/Aphid/Scale/True Bug/Beetle/Moth/Butterfly/Ant/Bee/Fly***) One or more dead adults are seen.

For abundance, record the number of individual animals observed in this phenophase.

In Hexagenia mayflies--instead of recording the number of individuals, use this intensity question:*

What is the intensity of death?

Slight: *Less than 100 individuals are seen within the immediate observation area (approximately 5 feet in any direction).;* ***Light:*** *Between 100 and 500 individuals are seen within the immediate observation area (approximately 5 feet in any direction).;* ***Moderate:*** *Consistent coverage of surfaces is seen (ground, building walls and windows, vegetation, etc.), or small groups of individuals are seen under lights.;* ***Heavy:*** *Thick coverage of surfaces is seen, or very noticeable groups of individuals, including small to medium piles, are seen under lights.;* ***Very heavy:*** *Very thick coverage of surfaces is seen (with minimal surface area exposed), or large groups of individuals, including large piles, are seen under lights.*

Dead nymphs

(***Dragonfly/Damselfly/Grasshopper/Cicada/Aphid/True Bug***) One or more dead nymphs are seen.

For abundance, record the number of individual animals observed in this phenophase.

Dead larvae

(***Beetle/Fly***) One or more dead larvae are seen.

For abundance, record the number of individual animals observed in this phenophase.

Dead caterpillars

(***Moth/Butterfly***) One or more dead caterpillars are seen.

For abundance, record the number of individual animals observed in this phenophase.

Individuals at a feeding station

(***Moth/Butterfly***) One or more individuals are seen visiting a feeder, feeding station, or food placed by a person.

For abundance, record the number of individual animals observed in this phenophase.

Individuals at a light

(***Mayfly/Stonefly/Dragonfly/Damselfly/Grasshopper/Beetle/Moth***) One or more individuals are seen at a light, whether flying or at rest.

For abundance, record the number of individual animals observed in this phenophase.

Individuals in a net

(***Mayfly/Stonefly/Dragonfly/Damselfly/Grasshopper/Beetle/Moth/Butterfly***) One or more individuals are seen caught in a net.

For abundance, record the number of individual animals observed in this phenophase.

Individuals in a trap

(***Mayfly/Stonefly/Dragonfly/Damselfly/Grasshopper/Cicada/Aphid/Scale/True Bug/Beetle/Moth/Butterfly/Ant/Bee/Fly***) One or more individuals are seen caught in a trap.

For abundance, record the number of individual animals observed in this phenophase.

* Intensity categories for mayflies are based on the Johnson scale, an unofficial five-point scale developed by Kent Johnson, who worked for the Metropolitan Council Environmental Services in St. Paul, MN until 2017, and Mark Steingraeber, a fisheries biologist who worked for the U.S. Fish and Wildlife Service until 2016.

FISH PHENOPHASE DEFINITIONS

Adults in freshwater

(***Anadromous/Freshwater/Eel***) One or more adults are seen in a freshwater stream, lake, or pond.

For abundance, record the number of individual animals observed in this phenophase.

Adults in saltwater

(***Saltwater/Anadromous/Eel***) One or more adults are seen in an ocean, an estuary, a saltwater or brackish wetland, or other body of saltwater.

For abundance, record the number of individual animals observed in this phenophase.

Adults feeding

(***Saltwater/Anadromous/Freshwater/Eel***) One or more adults are seen feeding. If possible, record the name of the species or substance being eaten or describe it in the comments field.

For abundance, record the number of individual animals observed in this phenophase.

Adults migrating upstream

(***Anadromous***) One or more adults are seen moving upstream, for example, in a river or fish ladder.

For abundance, record the number of individual animals observed in this phenophase.

Adults migrating downstream

(***Anadromous/Freshwater/Eel***) One or more adults are seen moving downstream.

For abundance, record the number of individual animals observed in this phenophase.

Juveniles in saltwater

(***Saltwater***) One or more juveniles are seen in a bay, an estuary, or other near-shore habitat.

For abundance, record the number of individual animals observed in this phenophase.

Juveniles moving upstream

(***Eel***) One or more immature individuals are in or entering a river mouth, moving from salt water or brackish water to freshwater stream habitat, or are moving upstream, for example, through a fish ladder, a counting station, or around a dam relatively near the mouth of a river.

For abundance, record the number of individual animals observed in this phenophase.

Dead or dying adults

(***Saltwater/Anadromous/Freshwater/Eel***) One or more dead or dying adults are seen.

For abundance, record the number of individual animals observed in this phenophase.

Individuals on a hook

(***Saltwater/Anadromous/Freshwater/Eel***) One or more individuals are seen caught on a hook.

For abundance, record the number of individual animals observed in this phenophase.

Individuals in a net

(***Saltwater/Anadromous/Freshwater/Eel***) One or more individuals are seen caught in a net.

For abundance, record the number of individual animals observed in this phenophase.

AMPHIBIAN PHENOPHASE DEFINITIONS

Adults on land

(***Salamander/Toad/Frog***) One or more adults are seen at rest or active on land.

For abundance, record the number of individual animals observed in this phenophase.

Adults in water

(***Salamander/Toad/Frog***) One or more adults are seen at rest or active in water.

For abundance, record the number of individual animals observed in this phenophase.

Adults feeding

(***Salamander/Toad/Frog***) One or more adults are seen feeding. If possible, record the name of the species or substance being eaten or describe it in the comments field.

For abundance, record the number of individual animals observed in this phenophase.

Vocalizing

(***Toad/Frog***) One or more individuals are heard vocalizing.

What is the intensity of vocalizing?
Single calls: *There is space between calls and individuals can be counted.*; **Overlapping calls:** *Calls of individuals can be distinguished but there is some overlapping of calls.*; **Full chorus:** *Calls are constant and overlapping.*

Mating

(***Salamander/Toad/Frog***) A female is seen grasped and held by a male.

For abundance, record the number of individual animals observed in this phenophase.

Fresh eggs

(***Salamander/Toad/Frog***) Eggs are seen being extruded, an egg mass is seen with jelly not expanded to full size, or embryos that are more or less spherical are seen.

For abundance, record the number of eggs observed .

Dead adults

(***Salamander/Toad/Frog***) One or more dead adults are seen.

For abundance, record the number of individual animals observed in this phenophase.

REPTILE PHENOPHASE DEFINITIONS

Individuals on land

(***Alligator/Turtle/Lizard/Snake***) One or more individuals are seen active or at rest on land, including individuals found under cover of a rock, log, or burrow.

For abundance, record the number of individual animals observed in this phenophase.

Individuals in water

(***Alligator/Turtle/Lizard/Snake***) One or more individuals are seen active or at rest in water, including individuals basking on a log or rock in the water.

For abundance, record the number of individual animals observed in this phenophase.

Feeding

(***Alligator/Turtle/Lizard/Snake***) One or more individuals are seen feeding. If possible, record the name of the species or substance being eaten or describe it in the comments field.

For abundance, record the number of individual animals observed in this phenophase.

Adults vocalizing

(***Alligator***) Vocal sounds produced by an adult are heard.

For abundance, record the number of individual animals observed in this phenophase.

Nesting

(***Turtle***) One or more adult females are seen nesting. This includes actual laying of eggs or excavating the nest cavity. It does not include turtles that are likely engaged only in basking.

For abundance, record the number of individual animals observed in this phenophase.

Young individuals

(***Alligator/Turtle/Egg-laying Lizard/Snake***) One or more recently hatched or young individuals are seen, living or dead, including those individuals found dead on a road.

For abundance, record the number of individual animals observed in this phenophase.

(***Lizard/Snake with live birth***) One or more recently born or young individuals are seen, living or dead, including those individuals found dead on a road.

For abundance, record the number of individual animals observed in this phenophase.

Dead individuals

(***Alligator/Turtle/Lizard/Snake***) One or more dead individuals are seen.

For abundance, record the number of individual animals observed in this phenophase.

BIRD PHENOPHASE DEFINITIONS

Live individuals

(***Bird***) One or more individuals are seen or heard moving about or at rest.

For abundance, record the number of individual animals observed in this phenophase.

Feeding

(***Bird***) One or more individuals are seen feeding or foraging. If possible, record the name of the species or substance being eaten or describe it in the comments field.

For abundance, record the number of individual animals observed in this phenophase.

Fruit/seed consumption

(***Bird***) One or more individuals are seen eating the fleshy fruits, seeds, or cones of a plant. If possible, record the name of the plant or describe it in the comments field.

For abundance, record the number of individual animals observed in this phenophase.

Insect consumption

(***Bird***) One or more individuals are seen eating insects. If possible, record the name of the insect or describe it in the comments field.

For abundance, record the number of individual animals observed in this phenophase.

Nut gathering

(***Bird***) One or more individuals are seen taking acorns or other nuts from a plant or from on the ground. If possible, record the name of the plant or describe it in the comments field.

For abundance, record the number of individual animals observed in this phenophase.

Flower visitation

(***Bird***) One or more individuals are seen visiting flowers or flying from flower to flower. If possible, record the name of the plant or describe it in the comments field.

For abundance, record the number of individual animals observed in this phenophase.

Calls or song

(***Bird***) One or more individuals are heard calling or singing.

For abundance, record the number of individual animals observed in this phenophase.

Singing individuals

(***Bird***) One or more individuals are heard singing. Singing refers to stereotypical, simple or elaborate vocalizations (most commonly by males) used as part of territorial proclamation or defense, or mate attraction. It does not include relatively simple calls used for other forms of communication.

For abundance, record the number of individual animals observed in this phenophase.

Territorial individuals

(***Bird***) One or more individuals are seen or heard defending a territory. This may be indicated by calls or song used as part of a territorial proclamation, chasing of an individual of the same species from a breeding area (but do not confuse this with courtship behavior, which in some species may involve chasing), or calls or displays directed at individuals of the same or a different species to defend a feeding area.

For abundance, record the number of individual animals observed in this phenophase.

Courtship

(***Bird***) A male and female are seen near one another and are engaged in courtship behavior. Do not include male displays in the absence of a female.

For abundance, record the number of individual animals observed in this phenophase.

Mating

(***Bird***) A male and female are seen coupled in a mating position, usually with the male on top of the female.

For abundance, record the number of individual animals observed in this phenophase.

Nest building

(***Bird***) One or more adults are seen constructing a nest or carrying nesting material.

For abundance, record the number of individual animals observed in this phenophase.

Occupied nest

(***Bird***) One or more adults are seen sitting on a nest, entering or leaving a nest site under circumstances indicating its use for nesting (including nest defense behavior), or live eggs or nestlings are seen in a nest.

For abundance, record the number of occupied nests observed.

Nestlings

(***Altricial Bird***) One or more young are seen or heard in a nest.

For abundance, record the number of individual animals observed in this phenophase.

Downy young

(***Precocial Bird***) One or more young are seen covered with fluffy down feathers and not yet any smooth contour feathers.

For abundance, record the number of individual animals observed in this phenophase.

Partially-fledged young

(***Precocial Bird***) One or more young are seen with a mix of fluffy down and smooth contour feathers, and often have an unkempt or ragged appearance.

For abundance, record the number of individual animals observed in this phenophase.

Fledged young

(***Altricial Bird***) One or more young are seen recently departed from the nest. This includes young incapable of sustained flight and young which are still dependent on adults.

For abundance, record the number of individual animals observed in this phenophase.

(***Precocial Bird***) One or more young are seen covered with smooth contour feathers and no longer any fluffy, natal down feathers. This includes young incapable of sustained flight and young which are still dependent on adults.

For abundance, record the number of individual animals observed in this phenophase.

Dead individuals

(***Bird***) One or more dead individuals are seen.

For abundance, record the number of individual animals observed in this phenophase.

Dead nestlings or young

(***Bird***) One or more dead nestlings or young are seen.

For abundance, record the number of individual animals observed in this phenophase.

Individuals at a feeding station

(***Bird***) One or more individuals are seen visiting a feeder, feeding station, or food placed by a person.

For abundance, record the number of individual animals observed in this phenophase.

MAMMAL PHENOPHASE DEFINITIONS

Live individuals

(***Mammal/Squirrel/Chipmunk/Deer/Sheep***) One or more individuals are seen or heard moving about or at rest.

For abundance, record the number of individual animals observed in this phenophase.

Individuals on land

(***Pinniped***) One or more individuals are seen active or at rest on land.

For abundance, record the number of individual animals observed in this phenophase.

Individuals in water

(***Pinniped***) One or more individuals are seen active or at rest in water.

For abundance, record the number of individual animals observed in this phenophase.

Feeding

(***Mammal/Pinniped/Squirrel/Chipmunk/Deer/Sheep***) One or more individuals are seen feeding. If possible, record the name of the species or substance being eaten or describe it in the comments field.

For abundance, record the number of individual animals observed in this phenophase.

Fruit/seed consumption

(***Squirrel/Chipmunk***) One or more individuals are seen eating the fleshy fruits, seeds, or cones of a plant. If possible, record the name of the plant or describe it in the comments field.

For abundance, record the number of individual animals observed in this phenophase.

Nut gathering

(***Squirrel/Chipmunk***) One or more individuals are seen taking acorns or other nuts from a plant or from on the ground. If possible, record the name of the plant or describe it in the comments field.

For abundance, record the number of individual animals observed in this phenophase.

Males vocalizing

(***Deer/Sheep***) Vocal sounds produced by an adult male are heard.

For abundance, record the number of individual animals observed in this phenophase.

Male combat

(***Pinniped***) Two or more adult males are seen wrestling or biting, or one male is seen chasing another.

For abundance, record the number of individual animals observed in this phenophase.

(***Deer/Sheep***) Two or more adult males are seen touching antlers or horns or butting heads, or one male is seen chasing another.

For abundance, record the number of individual animals observed in this phenophase.

Mating

(***Mammal/Pinniped/Deer/Sheep***) A male and female are seen coupled in a mating position.

For abundance, record the number of individual animals observed in this phenophase.

Young individuals

(***Mammal/Pinniped/Squirrel/Chipmunk/Deer/Sheep***) One or more recently born or young individuals are seen, living or dead, including those individuals found dead on a road.

For abundance, record the number of individual animals observed in this phenophase.

Summer coat

(***Mammal***) One or more individuals are seen with more than half of their coat consisting of dark hairs.

For abundance, record the number of individual animals observed in this phenophase.

Winter coat

(***Mammal***) One or more individuals are seen with more than half of their coat consisting of white hairs.

For abundance, record the number of individual animals observed in this phenophase.

Dead individuals

(***Mammal/Pinniped/Squirrel/Chipmunk/Deer/Sheep***) One or more dead individuals are seen.

For abundance, record the number of individual animals observed in this phenophase.

FREQUENTLY ASKED QUESTIONS ABOUT ANIMAL PHENOPHASES

1. Can I still report seeing "Live individuals", "Adults", or "Individuals/Adults on Land/Water" if I also report seeing another more specific phenophase?

Yes, you should report "Yes" for **ALL** the phenophases you see occurring on a given date. For animals, if you see a specific activity, like nest building, you are also seeing one or more live individuals, and should be reporting "Yes" to both of those phenophases for that species.

2. How can I estimate the number of individuals in a large group of animals

If you are looking at large groups of animals, such as a colony of black-tailed prairie dogs, a migrating flock of robins, or a school of salmon, you may have a hard time estimating the total number of individuals you are seeing. Here are two ways to make an estimate of the total number of individual animals:

If you can see the whole group at once (such as a far away flock, or a relatively stationary herd of animals), try counting a small section of the total group (anywhere from 10 to 50 individuals). Then estimate the space those individuals take up. For example, 30 robins in a far away flock take up an area the size of my fist when I hold it in front of my face. I will then see how many of these fist-sized areas (or blocks) it takes to visually cover the whole flock. Let's say there are 22 blocks. My estimate is then 30 individuals per block, multiplied by 22 blocks, for a total of 660 individuals. You might also consider taking a picture of the group of animals and estimating or counting the number of individuals later.

If you are watching a large group of animals pass by (such as a herd of elk, a school of fish, or a swarm of insects), you will not be able to use the spatial method above to estimate the total number. Instead, you will need to calculate a rate and the time is takes the group to pass. To do this, select a landmark, like a fencepost or a rock in a stream, and count how many animals pass by the landmark in a given amount of time. Then time how long it takes for the whole group to pass completely. For example, if I am watching a monarch migration and I see 30 individuals pass by a fencepost in one minute, and the butterflies continue passing for 11 minutes, then my estimate would be 330 individuals.

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