A Seedling Identification Guide

For Common Plants on Mt. Rainier and the North Cascades

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About this Project

Project Inspiration

This project arose from my personal interests in plant propagation, plant identification, and scientific writing during my time as an undergraduate student in plant biology at the University of Washington. After a summer fieldwork job that involved seedling identification, I gained an appreciation for this task and its challenges, including the lack of resources available. Although there are numerous identification guides for mature plants, there are remarkably few for seedlings. Yet, researchers and restoration managers need seedling identification resources to help them track seed germination and seedling mortality rates. I sought to fill this knowledge gap by creating a seedling identification guide for thirty plant species commonly found on Mt. Rainier and the North Cascades in Washington. This guide was first used to support field research conducted by the Hille Ris Lambers Lab, a plant community ecology lab at the University of Washington. However, I hope that this guide will serve as a multipurpose resource for scientists, amateur botanists, seed enthusiasts, and anyone who wishes to learn more about the beginning of a plant's life.

About this Project

A Case for Seedling Identification

Despite the importance of early life stages to the survival, growth, and development of plants, little is known about the morphology of seedlings. Most plant identification guides focus on mature plants. Seedlings are harder to identify because they are very small, lack prominent features such as flowers and fruits, and have similar leaf shapes. Of the few seedling guides available, there is a heavy focus on crop and weed seedling identification. These resources are targeted toward farmers and invasive species management programs. Seedling guides for native plants are rare, but would be useful for plant ecologists and habitat restoration projects. One notable example is *A Guide to Seedling Identification for 25 Conifers of the Pacific Northwest* by forest ecologist Jerry Franklin.[1] Nevertheless, seedling identification resources for the Pacific Northwest could be greatly improved and expanded, especially for native species that are not trees.

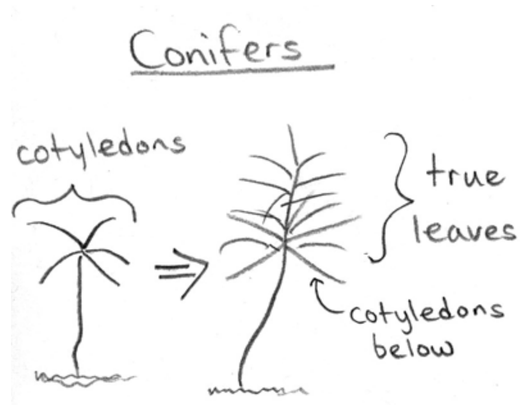
The species in this guide represent a variety of growth forms of plants native to Mt. Rainier and the North Cascades, including trees, shrubs, flowers, and sedges. Most of these species were selected by the Hille Ris Lambers Lab for field research on the effects of climate change on seed germination and seedling survival. Identifying plants is a fundamental part of ecological fieldwork and can be achieved using strategies that range from flipping through plant photographs to following a dichotomous key to performing DNA analysis. This guide provides a morphological approach to seedling identification, which can be supplemented with environmental clues such as climate and elevation.

Helpful Hints for Seedling Identification

Basic Terminology[2]

Cotyledons are the first leaves of a seedling. Unlike true leaves, cotyledons emerge from the seed. Most flowers have one or two cotyledons, while conifers usually have multiple cotyledons.

True leaves are leaves that emerge after the cotyledons. True leaves often look very different than cotyledons.

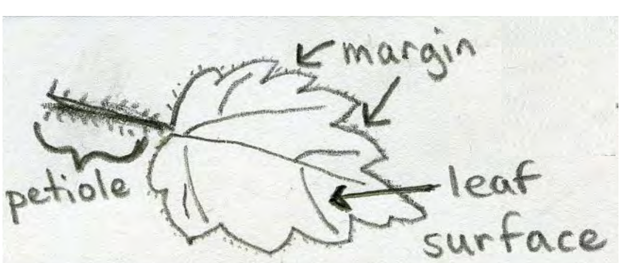


Stomata are pores that allow plants to breathe in carbon dioxide for photosynthesis and breathe out oxygen and water vapor. Most stomata are found on leaves. Conifer stomata are typically white and arranged on the needle in stripes. Different conifers have different numbers of stomatal stripes, which is useful for identification.

The *petiole* is the stem of a leaf, which attaches the leaf blade to the main stem. The petioles of cotyledons often lengthen as the cotyledons age, and may not be visible when the cotyledons first emerge. The petioles of true leaves are usually longer than the petioles of cotyledons. Some plants do not have petioles.

The *margin* of a leaf is the edge of the leaf, and may be smooth, spiny, jagged, etc.

The *surface* of a leaf is the area or blade of the leaf. The upper surface of the leaf faces the sky, and the lower surface faces the soil. Color and texture may differ between the upper and lower leaf surface.



Helpful Hints for Seedling Identification

Tools

Use a magnifying glass! It will help you identify details such as plant hairs and stomatal stripes that may be hard to see without magnification.

If you want to photograph seedlings, use a camera with a macro lens and tripod. A macro lens captures minute details that a regular lens will not. A tripod provides stability and minimizes image blur. If your seedlings are growing in a greenhouse, you may need to move your plants to better lighting to avoid yellow-tinted photographs.

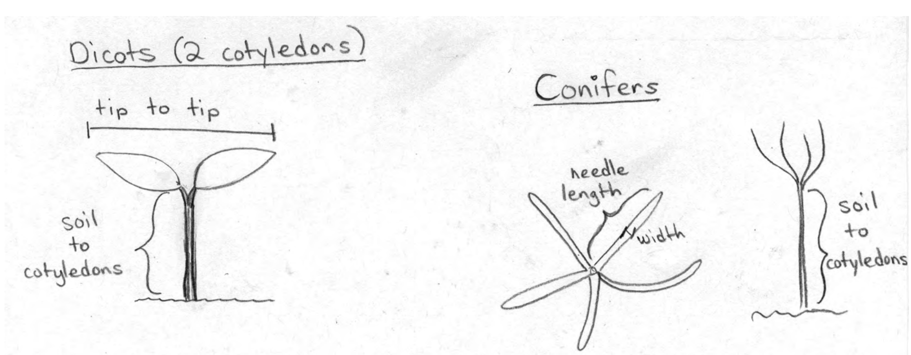
The penny in each photograph provides a visual size reference. Compare seedling dimensions to the diameter of the penny, 0.75 inches (19.05 mm).

Tips

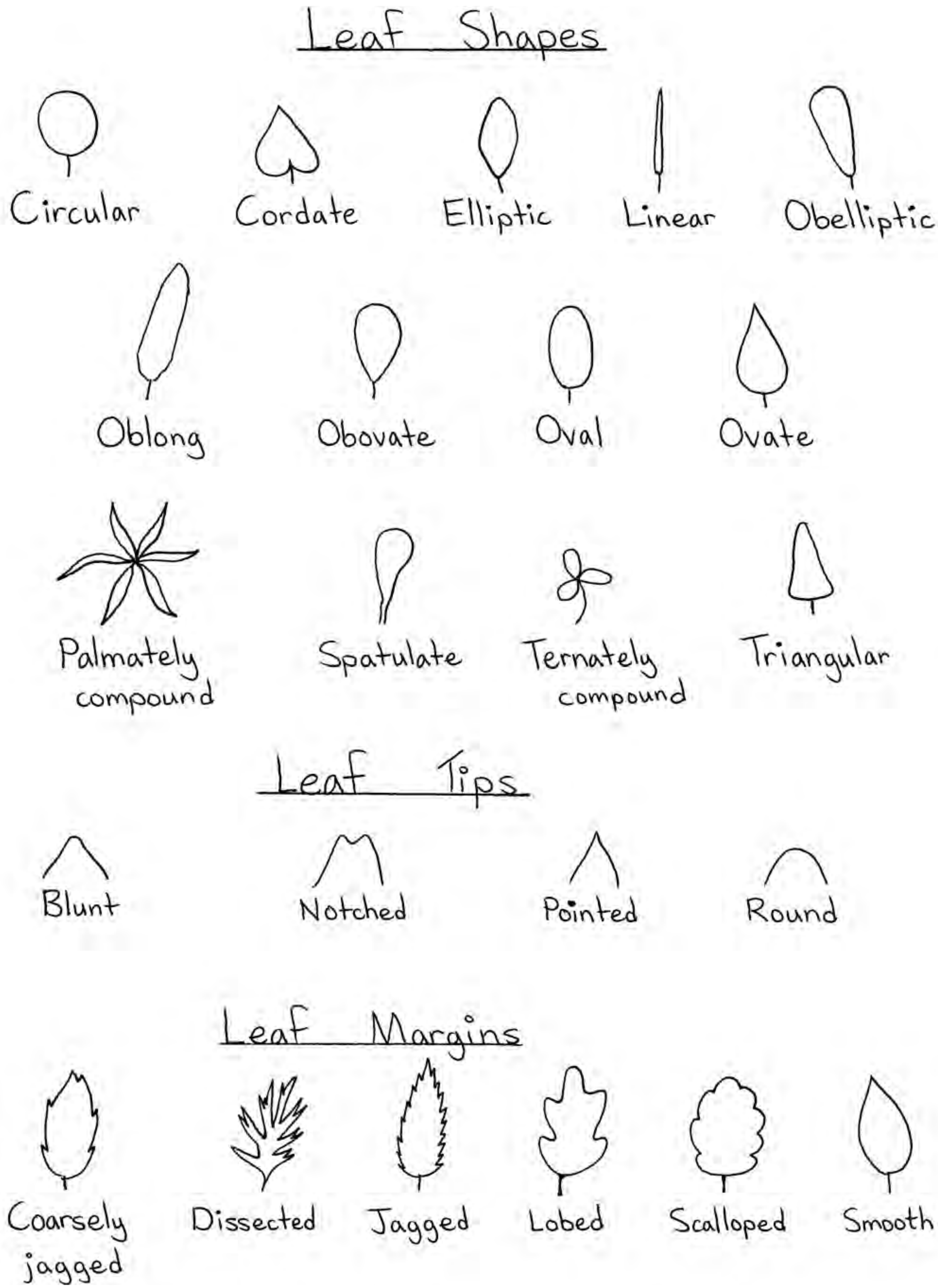
When identifying seedlings, first examine leaf shape and cotyledon number, and look for the presence of hairs. Other traits such as color can be informative but often vary between seedlings of the same species, especially when seedlings receive different amounts of light and water due to their location. Seed shells stuck to cotyledons may be useful if the seed can be identified.

If you are struggling to identify a seedling, try identifying the adult plants in the area. The seedling could have emerged from a seed produced by a nearby plant.

Measurements in this guide serve as a rough size guideline for new seedlings. For plants with two cotyledons, the cotyledon measurement from "tip to tip" is the distance between the cotyledon tips. This leaf span is analogous to the human arm span. For conifers, the length and width of an individual needle is included instead of a "tip to tip" measurement. Secondly, the stem measurement from "soil to cotyledons" describes the distance from soil level to the bottom of the cotyledon leaf blades (not the bottom of the cotyledon petioles). Note that these numbers will increase as the seedling grows.



Leaf Shape Terminology [2]



Dichotomous Key

Similar to a choose-your-own adventure book, a dichotomous key allows you to reach a conclusion by guiding you through a series of binary decisions. In this case, the conclusion is the correct identification of a seedling and decisions are made based on cotyledon traits. This key only includes the 30 species in this guide, so the seedling that you are trying to identify may not be listed. To use this key, choose between a and b for a given number and follow the directions to go to the next number. If no number is mentioned, proceed to the following line. Continue until you have reached a species or genus. For example, you might suspect that you have a *Xerophyllum tenax* seedling, but want to check. You start by reading 1a and 1b, and choose 1a because the cotyledon is leafy. You follow the directions in 1a and go to 2. After reading 2a and 2b, you select 2a because the seedling has one cotyledon. 2a has no directions, so you go to the next line, 3. Since both 3a and 3b list plant names, this is your last choice. You decide that your hunch was correct because your seedling matches the description in 3a.

1a. Cotyledons leafy, not needlelike. Go to 2.

1b. Cotyledons needlelike. Go to 16, page 11.

2a. One cotyledon.

3a. <u>Xerophyllum tenax</u>: Thick, flat cotyledon with blunt or rounded tip. Seed often attached to cotyledon tip. No sheath at base.

3b. <u>Carex</u>: Thin, flat cotyledon that tapers to a pointed tip. Round sheath at base.

2b. Two cotyledons.

4a. <u>Rubus</u>: Hairs on cotyledon margin, but not on cotyledon surface. Cotyledons elliptic or oval. Cotyledons measure 5-10 mm from tip to tip soon after emergence.

4b. No hairs on cotyledon margin OR hairs on cotyledon surface and margin.

5a. Cotyledons measure less than 5 mm from tip to tip. Very tiny! Go to 6.

5b. Cotyledons measure 5 mm or more from tip to tip. Go to 9, page 10.

6a. <u>Tellima grandiflora & Tolmiea menziesii</u>: Cotyledons rounded but slightly triangular, and widest at the base of the leaf. Cotyledon tips are slightly notched. A vein line down the center of the cotyledon is often visible. The first true leaves look like miniature adult true leaves. The first true leaves are round with a scalloped margin and tiny white hairs.

6b. Cotyledon leaf tip round and not notched.

7a. <u>Anaphalis margaritacea</u>: Cotyledons circular or slightly elliptic, and 1-1.5 times as long as wide. Cotyledon petioles lengthen as the seedling ages, drawing the cotyledons apart. Cotyledons are hairless, but true leaves have soft, white hairs.

7b. Cotyledons elliptic or oval, not circular. Cotyledons at least 1.5 times as long as wide.

Dichotomous Key

8a. *Alnus*: Cotyledons elliptic or oval, and widest at the base or middle. Cotyledons usually 1.5-2 times as long as wide. Petioles lengthen as seedling ages. The stem is often reddish. True leaves have serrate, jagged, or lobed margins.

8b. *Vaccinium*: Cotyledons elliptic or oval, and twice as long as wide. Cotyledon width is relatively constant from leaf base to tip. There is no or little space between the cotyledons since petiole length is insignificant. The stem is often reddish. The first true leaves are the size of cotyledons, but have slightly serrate or jagged margins.

9a. *Lupine*: Cotyledons thick, fleshy, and bean shaped. The stem is often reddish or purplish, while the cotyledons are dark green. Cotyledons are large, about 15-25 mm from tip to tip.

9b. Cotyledons thin or not bean shaped.

10a. *Sambucus*: Cotyledons triangular. Cotyledon tip blunt or slightly pointed. Cotyledons measure 10-20 mm from tip to tip soon after emergence, but enlarge greatly as the seedling develops.

10b. Cotyledons not triangular.

11a. *Acer*: Cotyledons oblong, at least 3 times as long as wide, and 35-45 mm from tip to tip soon after emergence. Cotyledons tough, but commonly creased and crinkled with fold lines. Waxy stem.

11b. Cotyledons soft, under 30 mm from tip to tip, or not oblong.

12a. *Anemone occidentalis:* Cotyledons and first true leaf have separate stems. The base of the cotyledon does not taper to a petiole-like structure. Cotyledons elliptic or oval. True leaves dissected.

12b. Cotyledons and first true leaves found on same stem.

13a. *Berberis*: The base of the cotyledon does not taper to a petiole-like structure. Cotyledons elliptic or oval. Stem 10 mm or longer. Spiny true leaf margin.

13b. The base of the cotyledon tapers to a petiole-like structure that is relatively long and thick, being at least 1/3 of the width and 1/4 of the length of cotyledon leaves. Seedlings germinate and grow quickly.

14a. *Erigeron peregrinus*: Cotyledons as thin as paper. Surface looks and feels smooth. Cotyledons elliptic or oval, and widest at the middle. Tips are blunt or rounded. Surface of true leaves is hairless, but margins and petioles may have small hairs.

14b. Cotyledons slightly thicker than paper. Stem base is often reddish or pinkish.

15a. *Arnica latifolia:* Cotyledons spatulate or oblong. Cotyledon apex rounded, never notched. True leaves covered in thin white hairs.

15b. *Eriophyllum lanatum*: Cotyledons various shapes, often spatulate or elliptic. Cotyledon apex notched or rounded. Cotyledon surface has visual texture, but feels smooth. True leaves covered in thick, long, white hairs, hence the common name woolly sunflower.

Dichotomous Key

16a. Needle tip pointed.

17a. Double white stomatal stripes on upper cotyledon surface, but no stomatal stripes on lower cotyledon surface. Stomatal stripes may be faint on newly emerged cotyledons, but should be visible with a magnifying glass. 4-8 cotyledons.

18a. *Pseudotsuga menziesii*: Cotyledons 5-8, most commonly 6-7. Cotyledons wider than *Picea*. 0.7 to 1.2 mm wide. Seedlings taller than *Picea*. 15 to 35 mm tall. Cotyledon length usually greater than *Picea*. 10-25 mm long. Cotyledons cupped up. Stem often deep red.

18b. *Picea*: Cotyledons narrow, less than 0.7 mm wide. Seedlings generally shorter than *Pseudotsuga menziesii*. Less than 20 mm tall soon after emergence. Cotyledon length usually shorter than *Pseudotsuga menziesii*. Less than 13 mm long.

19a. *Picea sitchensis*: Cotyledons 4-6, most commonly 5-6. Seedling height and cotyledon width and length are similar to *Picea engelmanni*.

19b. *Picea engelmanni*: Cotyledons 4-8, most commonly 5-7. Seedling height and cotyledon width and length are similar to *Picea sitchensis*.

17b. Double stomatal stripe on upper cotyledon surface not visible with a magnifying glass OR cotyledon count fewer than 4 or greater than 8.

20. *Pinus*: Cotyledons narrow, no more than 0.5 mm wide. Cotyledons flat on newly emerged seedlings, but become more triangular with age. Cotyledons usually cupped upwards.

20a. *Pinus contorta*: Cotyledons 4-6, most commonly 5. Cotyledons typically shorter than *Pinus ponderosa*, up to 30 mm long.

20b. *Pinus ponderosa:* Cotyledons 8-12, most commonly 10. Cotyledons arranged like a messy hairdo, pointed upwards in multiple directions. Cotyledons typically longer than *Pinus contorta*, up to 60 mm long.

16b. Needle tip rounded or blunt.

21. *Abies*: Cotyledons 4-7, flat, and wide. Cotyledons usually 1-2 mm in width. Double white stomatal stripes present on upper cotyledon surface, but no stomatal stripes on lower cotyledon surface. Stomatal stripes may be faint on newly emerged cotyledons, but should be visible with a magnifying glass. Stem often reddish.

21a. *Abies grandis*: Usually taller than *Abies lasiocarpa*. 20-50 mm tall. Needles often longer than *Abies lasiocarpa*. 15-35 mm long.

21b. *Abies lasiocarpa*: Usually shorter than *Abies grandis*. 10-25 mm tall. Needles often shorter than *Abies grandis*. 10-25 mm long.

Conifer cotyledon measurements included in this key were obtained from *A Guide to Seedling Identification for 25 Conifers of the Pacific Northwest* by Jerry Franklin.[1]

Conifers

Side by side comparison is useful when identifying multiple species of conifer seedlings. For conifer seedlings of the same age, pine (*Pinus*) seedlings are usually bigger than true fir (*Abies)* seedlings, which are bigger than spruce (*Picea*) seedlings. The needle and stem lengths of conifer seedlings provided in this guide were referenced from *A Guide to Seedling Identification for 25 Conifers of the Pacific Northwest* by Jerry Franklin.[1]

Height and Needle Length	Shortest	Medium	Longest
Species	Spruces (*Picea*)	True firs (*Abies*)	Pines (*Pinus*)

Note that white stomatal stripes on conifer needles may be difficult to see soon after cotyledons emerge but more visible as cotyledons age.

Grand fir (*Abies grandis*)

Cotyledons

Number: 5-7 (most commonly 5-6)

Color: Dark green

Upper needle surface: Two wide white stomatal stripes

Lower needle surface: Plain green, no stomatal stripes

Shape: Round or blunt tip, flat and wide needle

Length: 15-35 mm long, 1.0-2.2 mm wide[1]

Angle: Needles horizontal or slightly curved

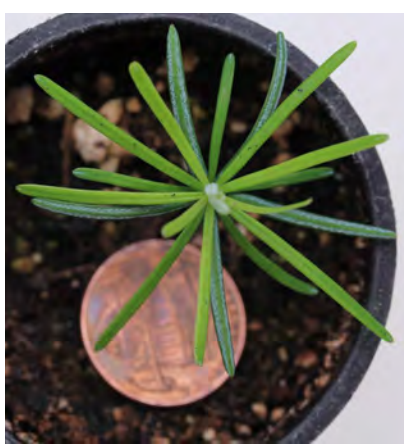
Young stem

Color: Usually red, but may be reddish green

Texture: Waxy, no hairs

Length: 20-50 mm from soil to cotyledons[1]

Left: Seedling with seed shell covering cotyledons. **Right**: Seedling with cotyledons only. Note double white stripes on each needle, which are stomata and develop with age.


Left: Note red stem. **Middle and right**: Seedlings with cotyledons and true needles. True needles develop double white stomatal stripes and a darker green color with age.

Subalpine fir (*Abies lasiocarpa*)

Cotyledons

Number: 4-7 (most commonly 5-6)

Color: Dark green

Upper needle surface: Two wide white stomatal stripes

Lower needle surface: Plain green, no stomatal stripes

Shape: Round or blunt tip, flat and wide needle

Length: 10-25 mm long, 1.0-2.2 mm wide[1]

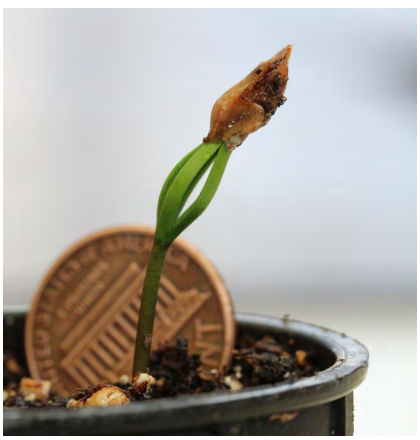
Angle: Needles pointed upward, often forming a cup

Young stem

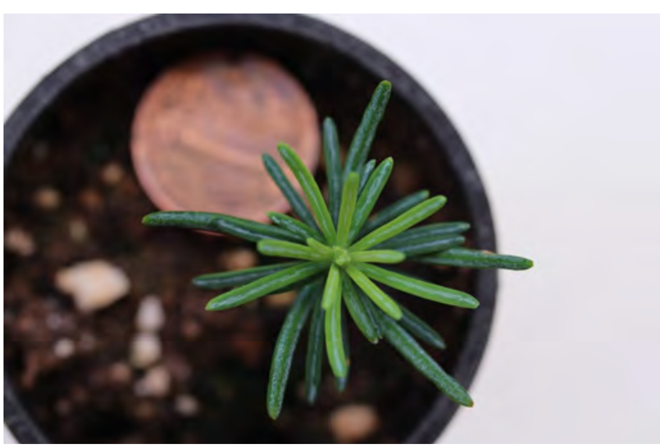
Color: Usually red, but may be reddish green or pink

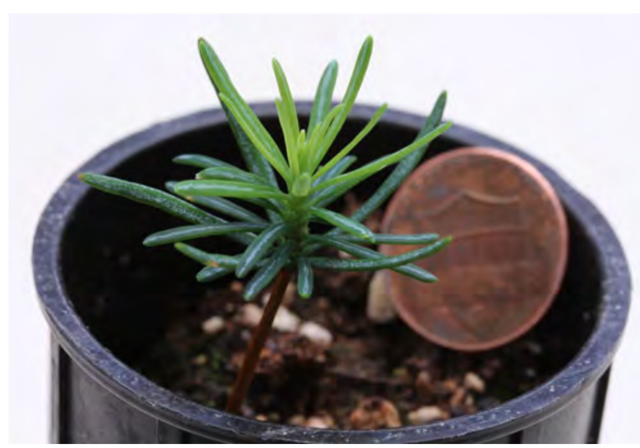
Texture: Waxy, no hairs

Length: 10-25 mm from soil to cotyledons[1]



Seedlings with cotyledons only. **Left**: Seedling with seed shell attached to cotyledon tips. **Left and right**: Note variation in stem color.





Seedlings with cotyledons and true needles. True needles develop double white stomatal stripes and a darker green color with age. Note that true needles are denser than *Abies grandis* seedlings.

Engelmann spruce (*Picea engelmanni*)

Cotyledons

Number: 4-8 (most commonly 5-7)

Color: Medium to dark green

Upper needle surface: Two white stomatal stripes, sometimes difficult to see

Lower needle surface: Plain green, no stomatal stripes

Shape: Pointed tip, flat needle that increases in thickness with age

Length: 6-13 mm long, 0.3-0.6 mm wide[1]

Angle: Needles usually cupped upward, but may point in multiple directions

Young stem

Color: Greenish white, green, greenish red, or red

Texture: Waxy, no hairs

Length: 8-18 mm from soil to cotyledons[1]

Left: Seedling with seed shell attached to cotyledon tips. **Middle and right**: Seedlings with cotyledons only. Note *Picea* needles are much shorter than *Abies* and *Pinus* needles in this guide.

Left: Seedling with cotyledons only. Note pointed *Picea* needle tips, as opposed to rounded *Abies* needle tips.
Middle and right: Seedlings with cotyledons and true needles.

Sitka spruce (*Picea sitchensis*)

Cotyledons

Number: 4-6 (most commonly 5-6)

Color: Dark green

Upper needle surface: Two white stomatal stripes, sometimes difficult to see

Lower needle surface: Plain green, no stomatal stripes

Shape: Pointed tip, flat needle that increases in thickness with age

Length: 6-11 mm long, 0.3-0.6 mm wide[1]

Angle: Needles pointed up or in multiple directions

Young stem

Color: Green or greenish red

Texture: Waxy, no hairs

Length: 7-15 mm from soil to cotyledons[1]

Left: Seedling with seed shell attached to cotyledon tips. **Middle and right**: Seedling with cotyledons only. Note pointed *Picea* needle tips, as opposed to rounded *Abies* needle tips.

Seedlings with cotyledons and true needles. True needles may have bluish tint. See how *Picea* needles are narrower than *Abies* needles.

Lodgepole pine (*Pinus contorta*)

Cotyledons

Number: 4-6 (most commonly 5)

Color: Medium green

Upper needle surface: Plain green

Lower needle surface: Plain green

Shape: Pointed tip, flat needle that becomes triangular with age

Length: 16-30 mm long, 0.4-0.5 mm wide[1]

Angle: Needles strongly pointed or cupped up, forming a V or U when viewed from the side

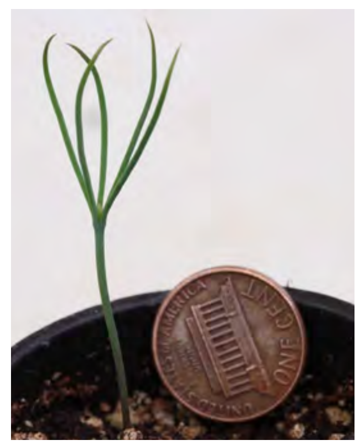
Young stem

Color: Green, reddish green, or reddish purple

Texture: Waxy, no hairs

Length: 10-25 mm from soil to cotyledons[1]





Left: Seedling with seed shell attached to cotyledon tips. **Middle and right**: Seedlings with cotyledons only. Note thinner and longer needles than *Abies*.



Left: Seedling with cotyledons surrounding central emerging true needles. **Middle and right**: Seedlings with cotyledons and true needles. Needles shorter than *Pinus ponderosa*, shown in reference to penny and edge of cone-tainer.

Ponderosa pine (*Pinus ponderosa*)

Cotyledons

Number: Many, 8-12 (most commonly 10)

Color: Dark green

Upper needle surface: Plain green

Lower needle surface: Plain green

Shape: Pointed tip, flat needle that increases in thickness and becomes triangular with age

Length: Very long needles, 25-60 mm long, 0.2-0.5 mm wide[1]

Angle: Needles arranged like a messy hairdo and strongly cupped upward

Young stem

Color: Green or reddish green

Texture: Waxy, no hairs

Length: 15-40 mm from soil to cotyledons[1]

Left: Seedling with seed shell attached to cotyledon tips. **Middle and right**: Seedlings with cotyledons. Note that the number of cotyledons is greater than *Pinus contorta*.

Left: Seedling with cotyledons surrounding central emerging true leaves. **Middle and right**: Seedlings with cotyledons and true needles. Needles longer than *Pinus contorta*, shown in reference to the penny and edge of cone-tainer.

Douglas fir (*Pseudotsuga menziesii*)

Cotyledons

Number: 5-8 (most commonly 6-7)

Color: Medium green

Upper needle surface: Two faint white stomatal stripes

Lower needle surface: Plain green

Shape: Pointed tip, flat needle that increases in thickness with age

Length: 10-25 mm long, 0.7-1.2 mm wide[1]

Angle: Needles cupped up into a bowl shape, tips often curve inward when viewed from above

Young stem

Color: Usually deep red, but may also be greenish red or whitish green

Texture: Waxy, no hairs

Length: 15-35 mm from soil to cotyledons[1]

Left: Seedling with seed shell attached to cotyledon tips. **Middle**: Note red stem. **Middle and right**: Cotyledons cup upward much more than *Abies*. **Right**: Unlike *Abies,* cotyledon tips curve inward.

Seedlings with cotyledons and true needles. **Middle**: Easy to confuse with *Abies* seedlings, which also have red stems. **Left and right**: Note pointed needle tips, as opposed to rounded *Abies* needle tips.

Other Trees & Shrubs

Whether or not a seedling will develop into a tree may not be obvious. Some trees, such as alders, invest more energy into leaf growth than stem growth when they are very young. Other trees, such as maples, grow seedlings with rapidly elongating stems. A seedling may not look like a miniature version of the adult plant that it will become.

These seedlings showed little resemblance to adult maple trees when they only bore cotyledons, visible in this photograph as the pair of long, narrow green leaves at the base of each stem. However, the identity of the seedlings became more apparent after the emergence of their true leaves, which are similar to adult maple leaves in shape.

Vine maple (*Acer circinatum*)

Two cotyledons

Shape: Oblong, width slightly greater at leaf apex, round or blunt tip, smooth margin

Color: Medium green

Texture: Hairless, tough leaves, may have fold lines due to struggle to emerge from seed

Length: 35-45 mm from tip to tip

Young stem

Color: Varies, may be light red, reddish purplish green, greenish red, or light green

Texture: Waxy

Length: 15-25 mm from soil to cotyledons

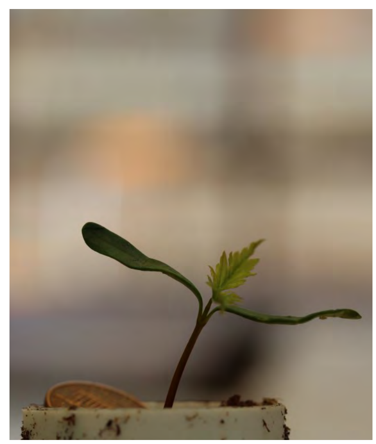
First true leaves

Shape: Resemble mature maple leaves, narrow when young

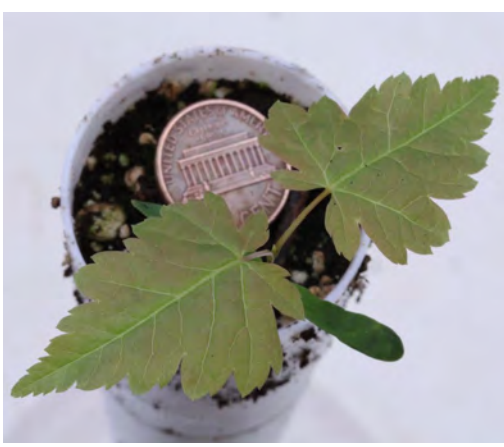
Color: Bright yellowish green, light green, greenish purple, or purplish red

Texture: Hairless





Left: Seedling emerging from seed. **Middle and right**: Seedlings with cotyledons and young true leaves.



Left: Seedling with cotyledons and first pair of true leaves. **Middle**: Close up of first true leaf. **Right**: Later true leaves have deeper lobes. **Middle and right**: Note how true leaves widen with age. Also observe variation in leaf color.

Rocky Mountain maple (*Acer glabrum*)

Two cotyledons

Shape: Oblong, width slightly greatest at leaf midpoint, round or blunt tip, smooth margin

Color: Medium green

Texture: Hairless, tough leaves, may have fold lines due to struggle to emerge from seed

Length: 35-45 mm from tip to tip

Young stem

Color: Light green, greenish red, or red

Texture: Waxy

Length: 15-20 mm from soil to cotyledons, usually shorter than *Acer circinatum*

First true leaves

Shape: Resemble elongated mature maple leaves, narrow when young

Color: Light green, may have tinges of red and yellow

Texture: Hairless

Seedlings with cotyledons only. Observe crinkled fold lines on cotyledons.

Left: Seedling with cotyledons and first true leaves. **Middle and right**: Older seedlings with true leaves. **Right:** Note first pair of true leaves is longer than later true leaves. See how leaf lobes are shallower than *Acer circinatum*.

Red alder (*Alnus rubra*)

Two cotyledons

Shape: Elliptic or oval, smooth margin, seed shell often remains attached to young cotyledons

Color: Medium green

Texture: Hairless

Length: Very small, less than 5 mm from tip to tip

Young stem

Color: Whitish green, reddish green, or reddish purple

Texture: Hairless

Length: Less than 5 mm from soil to cotyledons

First true leaves

Shape: Circular to ovate, lobing at leaf apex, also lobing along sides of margin in older seedlings

Color: Medium green or yellowish green, middle vein sometimes reddish

Texture: Small, short, sparse white hairs on leaf stem and margin

Left and middle: Seedlings with cotyledons only. **Right**: Seedling with cotyledons and first true leaves. Note red stem.

Seedlings with cotyledons and true leaves. Note that tip of leaf margin lobes are more rounded than *Alnus viridus*.
Right: See how base of leaf margin is smooth even on older true leaves, unlike *Alnus viridis*.

Green alder (*Alnus viridis*)

Two cotyledons

Shape: Elliptic or oval, smooth margin, seed shell often remains attached to young cotyledons

Color: Medium-dark green

Texture: Hairless

Length: Very small, less than 5 mm from tip to tip

Young stem

Color: White, whitish green, or red

Texture: Hairless

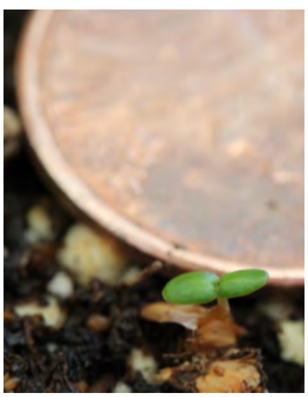
Length: Less than 5 mm from soil to cotyledons

First true leaves

Shape: Circular to ovate, jagged margin at leaf apex and later all along margin

Color: Medium green or yellowish green

Texture: Small, short, sparse white hairs on leaf stem and margin



Left: Seedling with cotyledons and seed shell remnant attached to stem. **Middle and right**: Seedlings with cotyledons and first true leaves. Observe variation in jagged margin in first true leaves.



Left: Seedling with first true leaves. **Middle and right**: Older seedlings. Note jagged leaf margin forms sharper points than *Alnus rubra* margin. See how leaf margin is jagged almost to the petiole junction on older true leaves, unlike *Alnus rubra*.

Tall Oregon grape (*Berberis aquifolium*)

<u>Two cotyledons</u>

Shape: Elliptic or oval, smooth margin

Color: Medium green, may be yellowish or reddish

Texture: Hairless

Length: 10-20 mm from tip to tip

<u>Young stem</u>

Color: Whitish green, green, greenish red, or red

Texture: Hairless

Length: 10-15 mm from soil to cotyledons

<u>First true leaves</u>

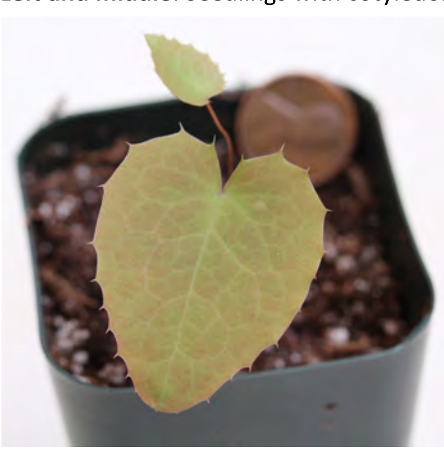
Shape: Cordate, spiny margin with spines at leaf apex pointing in same direction as leaf tip and spines below apex pointing approximately perpendicular to leaf margin

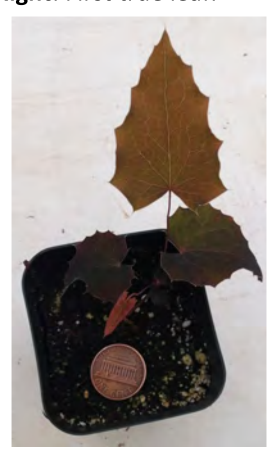
Color: Greenish red, reddish purple, or purplish green, lighter veins, white lower leaf surface

Texture: Leaves become leathery with age



Left and middle: Seedlings with cotyledons only. **Middle**: Note seed shell still attached to seedling. **Right**: First true leaf.





Left and middle: Seedlings with cotyledons and first true leaves. See how the V that makes the heart shape at the base of leaf is deeper than *Berberis nervosa*. **Right**: Older seedling with true leaves.

Dwarf Oregon grape (*Berberis nervosa*)

Two cotyledons

Shape: Elliptic or oval, smooth margin

Color: Green, reddish green, or reddish purplish green

Texture: Hairless

Length: 10-20 mm from tip to tip

Young stem

Color: Reddish purple, reddish green, or green

Texture: Hairless

Length: 10-15 mm from soil to cotyledons

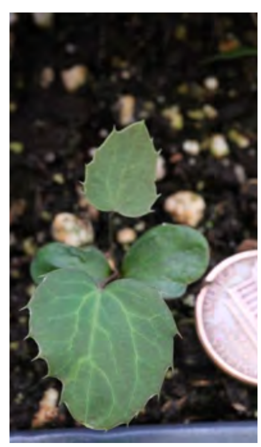
First true leaves

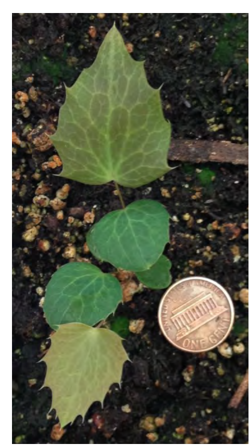
Shape: Cordate, spiny margin with spines pointing in same direction as leaf tip

Color: Green, greenish red, purplish green, or red, lighter veins, white leaf lower surface

Texture: Leaves become leathery with age

Seedlings with cotyledons and emerging pair of true leaves.





Seedlings with cotyledons and true leaves. Note spines on leaf margin point in the same general direction as the leaf tip, unlike *Berberis aquifolium*, which has spines pointing away from the leaf tip in the bottom half of the leaf.

Thimbleberry (*Rubus parviflorus*)

Two cotyledons

Shape: Elliptic or oval, smooth margin

Color: Medium green upper leaf surface, slightly lighter green lower leaf surface

Texture: Tiny hairs stick out horizontally from leaf margin, more visible with magnifying glass

Length: 5-10 mm from tip to tip

Young stem

Color: Green or greenish white, sometimes with a pink tinge

Texture: Hairs stick straight out along stem

Length: Less than 5 mm from soil to cotyledons

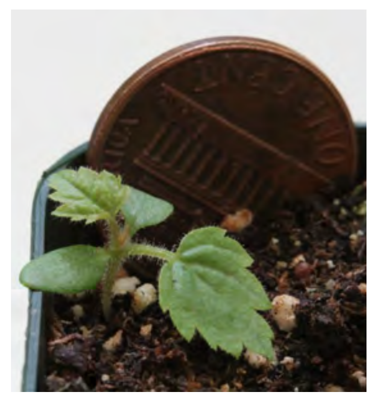
First true leaves

Shape: Triangular or cordate, coarsely jagged margin at leaf apex and sides, smooth margin at leaf base

Color: Medium green leaf surface, light green or purplish veins

Texture: White hairs on upper and lower leaf surface, leaf margins, and petiole





Left and middle: Seedlings with cotyledons only. **Left**: Note hairs on leaf margin. **Middle**: Note hairs on stem.
Right: Seedling with cotyledons and first true leaves.



Left: One of the first true leaves. **Middle and right**: Older plants with true leaves. **Right**: Mature true leaf.

Trailing blackberry (*Rubus ursinus*)

Two cotyledons

Shape: Elliptic or oval, smooth margin

Color: Medium green

Texture: White hairs on leaf margin, more visible with magnifying glass

Length: 5-10 mm from tip to tip

Young stem

Color: Light green or white

Texture: White hairs, tiny dots of red fluid secreted at hair tips in older seedlings

Length: Less than 5 mm from soil to cotyledons

First true leaves

Shape: Circular or cordate, coarsely jagged margin at leaf apex and sides, smooth leaf base margin

Color: Medium green

Texture: Dense white hairs on petiole, dark pink thorns on petiole in older seedlings, also hairs on upper and lower leaf surface and margins

Left and middle: Seedlings with cotyledons only. **Right**: Seedling with cotyledons and first true leaf. Note hairs along margin of cotyledons and true leaves.

Left: Seedling with cotyledons and first true leaf. **Middle and right:** Older plants with true leaves. **Right**: Mature true leaf.

Blue elderberry (*Sambucus cerulea*)

Two cotyledons

Shape: Triangular, blunt or slightly pointed tip, smooth margin

Color: Light to medium green

Texture: Hairless

Length: 10-20 mm from tip to tip

Young stem

Color: Light or whitish green

Texture: Hairless

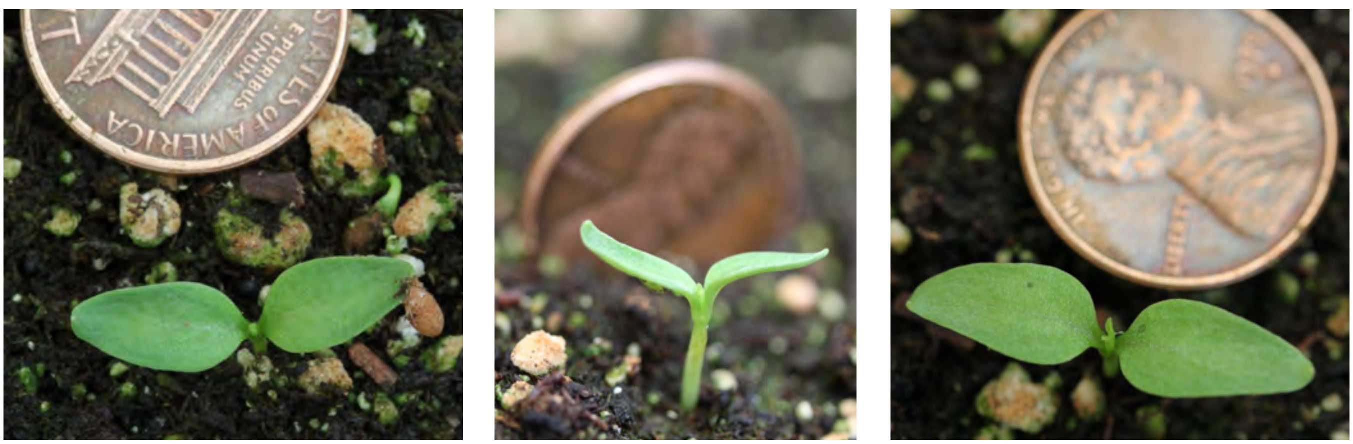
Length: 5-10 mm from soil to cotyledons

First true leaves

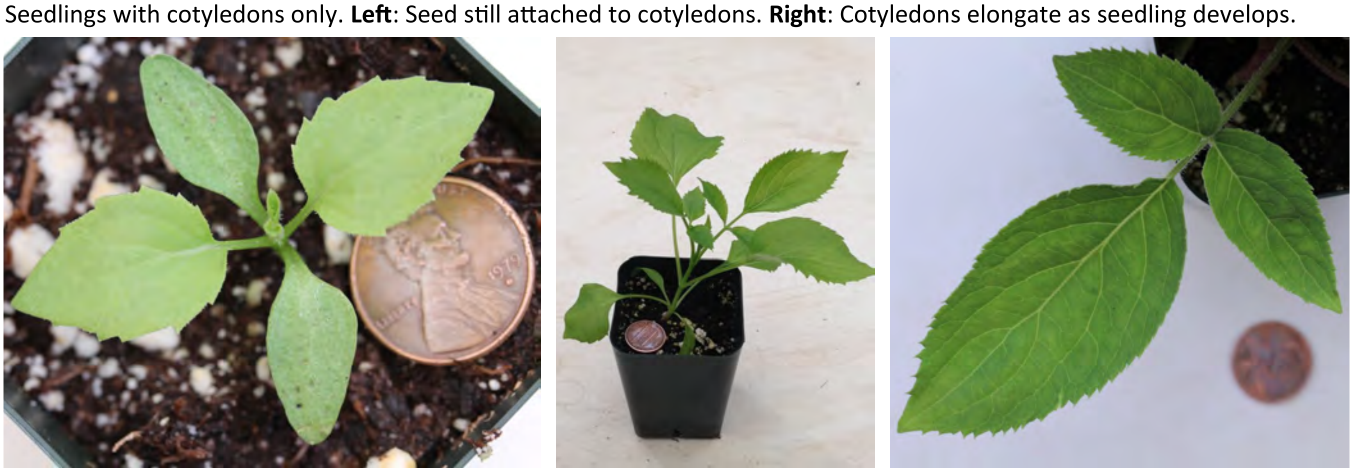
Shape: Ovate, coarsely jagged margin, pointed or slightly rounded tip

Color: Light to medium green

Texture: Small white hairs of medium density on petiole, sparse hairs on lower leaf surface



Seedlings with cotyledons only. **Left**: Seed still attached to cotyledons. **Right**: Cotyledons elongate as seedling develops.



Left: Seedling with cotyledons and first pair of true leaves. See how leaf base of first pair of true leaves is straight, lacking the inward notch found in *Sambucus racemosa*. **Middle**: Older seedling. **Right**: True leaf of older seedling.

Red elderberry (*Sambucus racemosa*)

Two cotyledons

Shape: Triangular, blunt or slightly pointed tip, smooth margin

Color: Light to medium green

Texture: Hairless

Length: 10-20 mm from tip to tip

Young stem

Color: Light or whitish green

Texture: Hairless

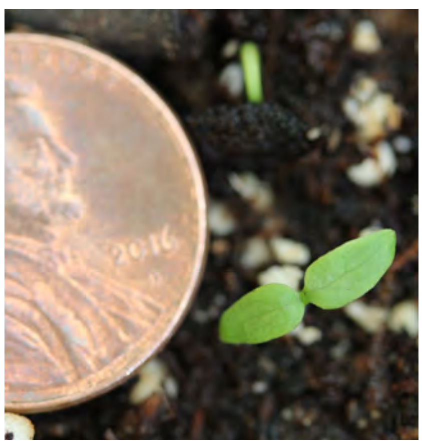
Length: 5-10 mm from soil to cotyledons

First true leaves

Shape: Cordate, coarsely jagged margin, pointed or slightly rounded tip

Color: Light to medium green

Texture: White hairs on upper leaf surface, margins, and petiole



Left and middle: Seedlings with cotyledons only. **Right**: Seedling with cotyledons and first pair of true leaves. See how first true leaves are more rounded than *Sambucus cerulea* and leaf base notches inward.

Older seedlings. Note how second pair of true leaves differs in shape from first pair of true leaves.

Cascade blueberry (*Vaccinium deliciosum*)

Two cotyledons

Shape: Elliptic or oval, twice as long as wide, smooth margin, no or little space between cotyledons

Color: Green or reddish green

Texture: Hairless

Length: Extremely small; less than 5 mm from tip to tip

Young stem

Color: Light green, reddish green, red, or reddish purple

Texture: Hairless

Length: Less than 5 mm from soil to cotyledons

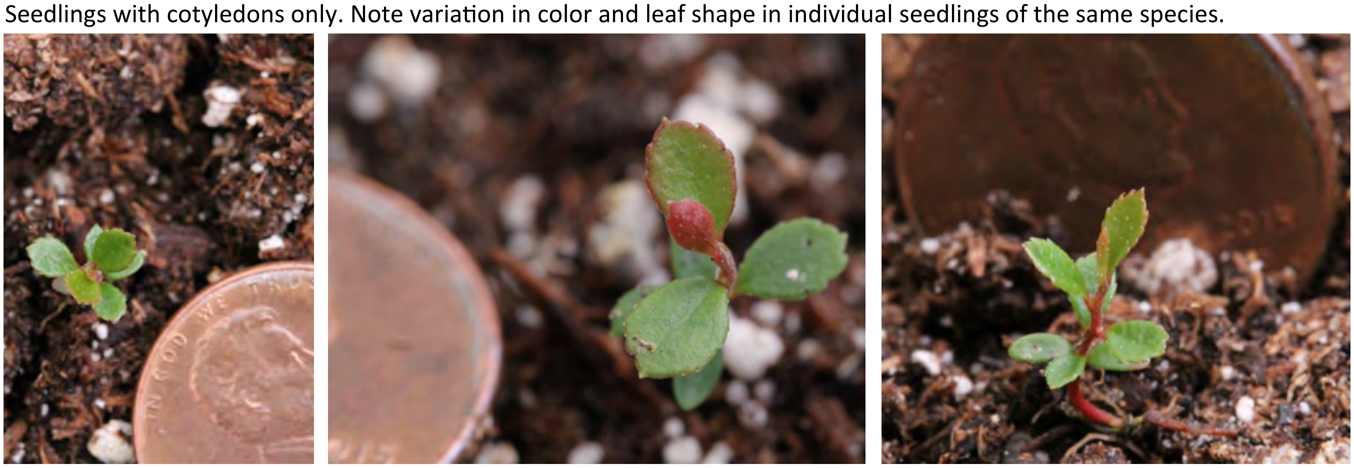
First true leaves

Shape: Obovate or oval, rounded leaf apex with blunt or slightly pointed tip, petiole absent or very short, margin slightly jagged at leaf apex, also slightly jagged on leaf sides in older seedlings

Color: Medium green, may be yellowish or reddish, sometimes with a red leaf margin

Texture: White hairs on upper leaf surface, margins, and petiole

Seedlings with cotyledons only. Note variation in color and leaf shape in individual seedlings of the same species.



Seedlings with cotyledons and true leaves. Note variation in shape of true leaves on the same plant.

Red huckleberry (*Vaccinium parviflorum*)

Two cotyledons

Shape: Elliptic or oval, twice as long as wide, smooth margin, no or little space between cotyledons

Color: Green

Texture: Hairless

Length: Extremely small; less than 5 mm from tip to tip

Young stem

Color: Light green

Texture: Hairless

Length: Less than 5 mm from soil to cotyledons

First true leaves

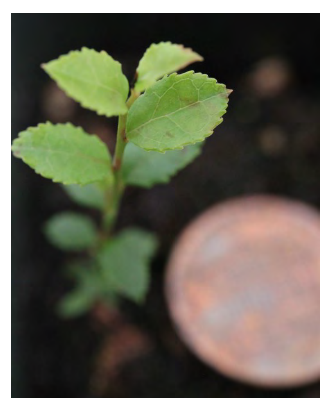
Shape: Ovate, elliptic, or obovate, slightly jagged margin, pointed tip, petiole absent or very short

Color: Light to medium green, may be yellowish or reddish, sometimes with a red leaf margin

Texture: White hairs on upper leaf surface, margins, and petiole

Left: Seedling with cotyledons and seed shell attached. **Right**: Seedling with cotyledons and first true leaves.





Left: Seedling with cotyledons and first true leaves. **Middle and right**: Older seedlings. Note that true leaf shape is usually ovate or elliptic for *Vaccinium parviflorum*, with the widest part of the leaf below the midpoint, but obovate for *Vaccinium deliciosum*, with the widest part of the leaf at or above the midpoint.

Flowers

Flowers typically germinate and grow more rapidly than trees and shrubs. This is particularly true for flowers that are native to high elevation habitats such as subalpine meadows, because the growing season is short and provides a limited window for bloom time.

Although numerous resources focus on identifying flowers in bloom, the photographs in this section illustrate that there are many stages of life besides the flower itself. The challenge in identifying flowers as seedlings lies in training the eye to recognize subtle differences in leaf traits between species, particularly leaf shape. Traits will vary slightly between individual plants of the same species, so examining more than one plant of the same species is recommended.

Pearly everlasting (*Anaphalis margaritacea*)

Two cotyledons

Shape: Circular or slightly elliptic, 1 to 1.5 times as long as wide, smooth margin

Color: Medium green

Texture: Hairless

Length: Less than 5 mm from tip to tip

Young stem

Color: Light green

Texture: Hairless when young, fuzzy white stem develops after first true leaves

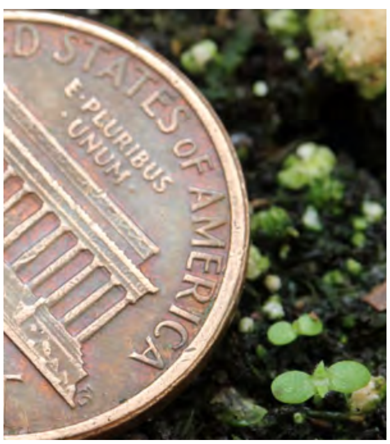
Length: Less than 5 mm from soil to cotyledons, stem not easily visible when seedling is small

First true leaves

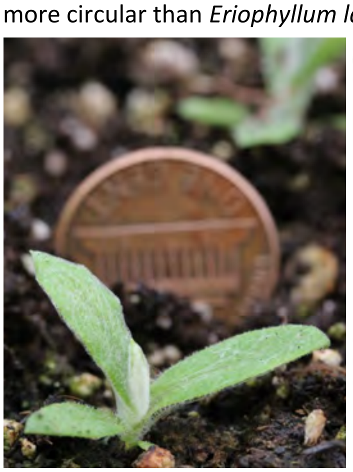
Shape: Elliptic, pointed or rounded tip, no petiole, thick and protruding vein on lower leaf surface

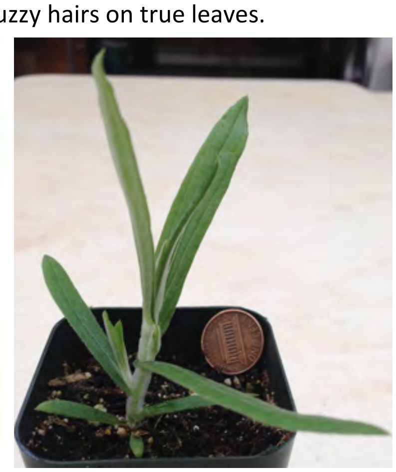
Color: Medium green, may have thin purplish vein lines on upper leaf surface

Texture: Soft, white hairs on upper and lower leaf surface




Left and middle: Seedlings with cotyledons. **Right**: Seedling with cotyledons and first true leaves. See how cotyledons are more circular than *Eriophyllum lanatum* even though first true leaves are similar. Note fuzzy hairs on true leaves.





Older plants. **Left**: First true leaves are elliptic. **Middle and right**: In contrast, older true leaves are linear.

Western pasqueflower (*Anemone occidentalis*)

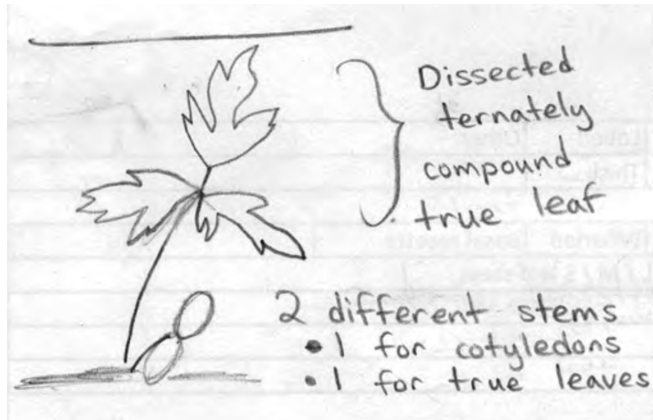
Two cotyledons

Shape: Elliptic or oval, smooth margin

Color: Light to medium green

Texture: Hairless

Length: 10-15 mm from tip to tip



Young stem

Color: Light green, whitish or pinkish at base

Texture: Hairless

Length: 5-10 mm from soil to cotyledons

First true leaves

Shape: Dissected, ternately compound (three leaflets)

Color: Lighter green on lower leaf surface, thin green branching vein lines

Texture: Hairless

Left: Seedling with cotyledons only. **Right**: Seedling with cotyledons and first true leaf. See how cotyledon and first true leaf stems are attached near soil level.

The first true leaf is formed on a second stem that is separate from the stem supporting the cotyledons. This is unusual.

Broadleaf arnica (*Arnica latifolia*)

Two cotyledons

Shape: Spatulate or oblong, smooth margin

Color: Medium green

Texture: Hairless

Length: 10-15 mm from tip to tip

Young stem

Color: Whitish green or red

Texture: Hairless, but hairs along true leaf petioles

Length: 5-10 mm from soil to cotyledons

First true leaves

Shape: Triangular, slightly jagged margin is more pronounced on older true leaves

Color: Similar to cotyledons, but prominent vein lines

Texture: White hairs on upper and lower leaf surface, leaf margin, and petiole

Left: Seedling with cotyledons only. **Middle**: Observe hairs on bud of leaf emerging between the cotyledons. **Right**: Seedling with cotyledons and pair of first true leaves. Note hairs and long petioles on true leaves.

Older plants. See how plant forms a rosette first rather than growing vertically.

Mountain daisy (*Erigeron peregrinus*)

Two cotyledons

Shape: Elliptic or oval, blunt or rounded tip, leaf as thin as paper, smooth margin

Color: Light to medium green, usually lighter than *Eriophyllum lanatum*

Texture: Surface looks and feels smooth, hairless

Length: 5-10 mm from tip to tip

Young stem

Color: Light green

Texture: Hairless

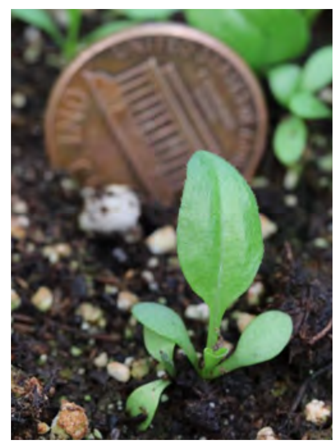
Length: 5-10 mm from soil to cotyledons

First true leaves

Shape: Elliptic or oval, curved or curled surface, smooth margin, long petiole, blunt or rounded tip

Color: Medium green

Texture: White hairs on leaf margin and petiole



Left: Seedlings with cotyledons and emerging true leaves. Note that cotyledons are rounder than *Arnica latifolia* cotyledons and smoother than *Eriophyllum lanatum* cotyledons. **Middle and right**: Seedlings with cotyledons and first true leaf.

Older plants. See how plant forms a rosette first rather than growing vertically.

Common woolly sunflower (*Eriophyllum lanatum*)

<u>Two cotyledons</u>

Shape: Spatulate, elliptic, oval, or oblong, leaf slightly thicker than paper and *Erigeron peregrinus*, smooth margin, rounded or notched apex

Color: Medium to dark green, usually darker than *Erigeron peregrinus*

Texture: Rougher surface than *Erigeron peregrinus*, hairless

Length: 5-10 mm from tip to tip

<u>Young stem</u>

Color: Often reddish green when young and light green when older

Texture: Hairless when young, fuzzy white stem develops after first true leaves

Length: 5-10 mm from soil to cotyledons

<u>First true leaves</u>

Shape: Elliptic, rounded or slightly pointed tip, smooth margin but older true leaves are dissected

Color: Medium green upper leaf surface, with whiter lower leaf surface

Texture: Long, white hairs form a dense horizontal mat on upper and lower leaf surface

Left and middle: Seedlings with cotyledons. Cotyledons have visual texture, while *Erigeron peregrinus* cotyledons appear smooth. **Right**: Seedling with cotyledons and first true leaves. See soft white hairs on true leaves, not found in *E. peregrinus*.

Left: Seedling with cotyledons and first true leaves. **Middle and right**: Older plants.

Broadleaf lupine (*Lupinus latifolius*)

Two cotyledons

Shape: Bean shaped, thick, and fleshy, smooth margin

Color: Semi-waxy, dark green upper leaf surface, with slightly lighter lower leaf surface

Texture: Hairless

Length: 5-10 mm from tip to tip

Young stem

Color: Light green, red, or purplish red, with darker red coloring at base of stem

Texture: Hairless, but true leaf stem may have hairs

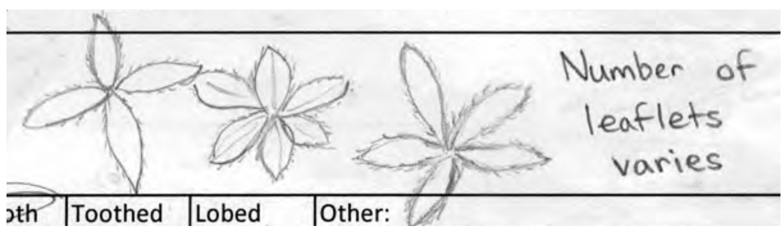
Length: 15-20 mm from soil to cotyledons

First true leaves

Shape: Palmately compound with 3-7 leaflefts (usually 4-6), leaflets elliptic or obelliptic

Color: Medium green

Texture: Hairs on margin



Seedlings with cotyledons only. See how cotyledons are bean shaped, the same shape as lupine seed.

Seedlings with cotyledons and first true leaves. Note that the number of leaflets on true leaves varies.

Fringecup (*Tellima grandiflora*)

Two cotyledons

Shape: Rounded but slightly triangular, widest at base, notched tip in older cotyledons

Color: Medium green, may have vein line down center of leaf surface

Texture: Small hairs on upper leaf surface

Length: Very tiny, less than 5 mm from tip to tip

Young stem

Color: White

Texture: Hairless when young, white hairs develop after first true leaves

Length: Very short, less than 5 mm from soil to cotyledons

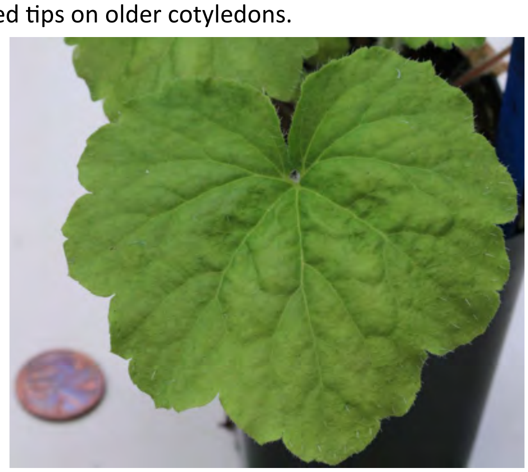
First true leaves

Shape: Round with a scalloped margin, notched base, resemble miniature adult true leaves

Color: Medium green, with purplish veins

Texture: Small white hairs on petiole, leaf margin, and sometimes upper leaf surface


Seedlings with cotyledons. **Right**: Note notched tips on older cotyledons.




Left: Note seedling in bottom right photo corner with cotyledons and first true leaf. Practically impossible to distinguish from *Tolmiea menziesii* at this stage of development. **Middle and right**: Older plants. See how plant forms a basal rosette.

Piggyback plant (*Tolmiea menziesii*)

Two cotyledons

Shape: Rounded but slightly triangular, widest at base, notched tip in older cotyledons

Color: Medium green, may have vein line down center of leaf surface

Texture: Small white hairs, not obvious without a magnifying glass

Length: Very tiny, less than 5 mm from tip to tip

Young stem

Color: White

Texture: White hairs

Length: Very short, less than 5 mm from soil to cotyledons

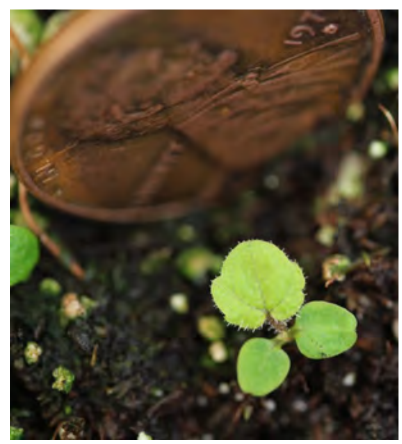
First true leaves

Shape: Round with a scalloped margin, notched base, resemble miniature adult true leaves

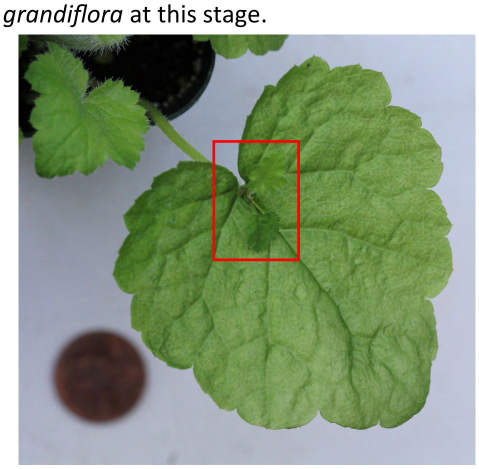
Color: Medium green, with palmate veins that are more distinct on older leaves

Texture: Dense white hairs on petiole, also hairs on margin and upper and lower leaf surface





Left and middle: Seedlings with cotyledons. **Middle:** Note notched tips on cotyledons. **Right**: Seedling with cotyledons and first true leaf. Indistinguishable from *Tellima grandiflora* at this stage.


Older plants. **Right**: Inset of middle photo. See tiny "piggyback" leaf at base of large leaf, hence the name piggyback plant.

Beargrass (*Xerophyllum tenax*)

<u>One cotyledon</u>

Shape: Linear, thick and flat, blunt or rounded tip, round cross section, seed often attached to tip

Color: Medium to dark green

Texture: Hairless

<u>First true leaves</u>

Shape: Linear, flat but substantial thickness, round or pointed tip

Color: Medium to dark green

Texture: Hairless

Left: Cotyledon with seed shell still attached. **Right**: Cotyledon after seed shell pops off cotyledon tip.

Left: Cotyledon with first true leaf. Note seed shell still attached to cotyledon tip. **Middle and right**: Older plants. Species resembles grass, despite being in the lily family.

Photographed plants grown by botanist Courtney Bobsin. Our *Xerophyllum tenax* did not germinate.

Sedges

Sedges can easily be confused with grasses and rushes, especially when young. An old rhyme can be used as a mnemonic to distinguish between these plant families. “Sedges have edges, rushes are round, grasses have knees that bend to the ground.” Grasses and rushes usually have round stems, while the stems of sedges are triangular, hence the edges.[3] However, sedge seedlings grow a round sheath at the base of their stalk before developing a triangular stem. This mnemonic is only useful for adult and older juvenile plants, after the clear development of the stem.

Another distinguishing feature of sedges is leaf arrangement. From a bird’s eye view, you can see leaves arranged in threes, with 120 degrees between each leaf.[3] This trait is visible in seedlings after the development of a few leaves.

Showy sedge (*Carex spectabilis*)

One cotyledon

Shape: Thin, flat leaf is vertical or slightly curved, round sheath at base visible with age, pointy tip

Color: Light green, whiter towards base

Texture: Hairless

Stem

Shape: Cross section is triangular when older

Color: Whitish or light green at base

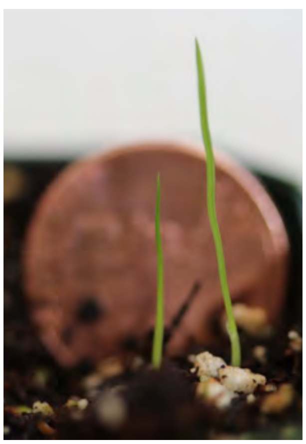
Texture: Striped pattern at base

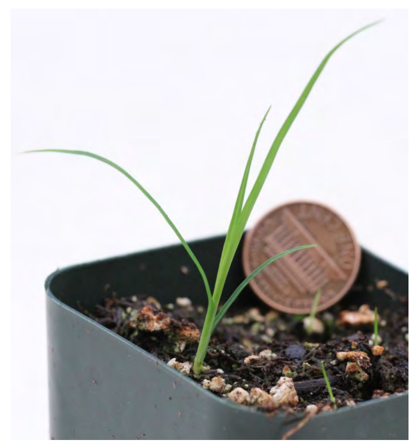
First true leaves

Shape: Linear tapering to a pointed tip, wide ridge down center of lower leaf surface develops with age, leaves narrower than *Carex stipata*

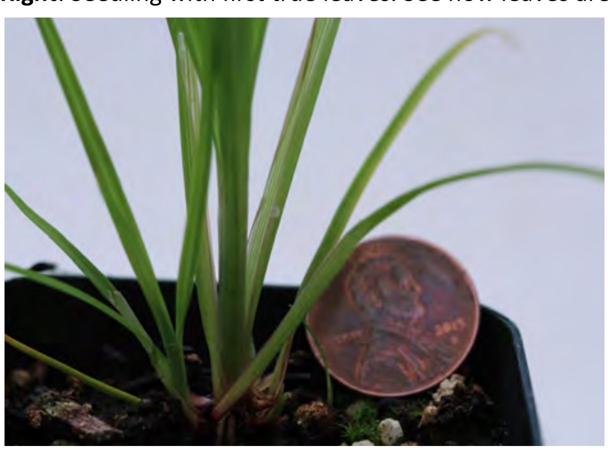
Color: Medium green

Texture: Hairless





Left and middle: Cotyledons. **Right**: Seedling with first true leaves. See how leaves are thinner than *Carex stipata*.


Left: Seedling with first true leaves. **Middle and right**: Older plants. **Middle**: Observe striped pattern on sheaths at stem base, in contrast to the cross hatched pattern in *Carex stipata*.

Awlfruit sedge (*Carex stipata*)

One cotyledon

Shape: Thin, flat leaf is vertical or slightly curved, round sheath at base visible with age, pointy tip

Color: Light green, whiter towards base

Texture: Hairless

Stem

Shape: Cross section is triangular when older

Color: Whitish or light green at base

Texture: Cross hatching pattern at base

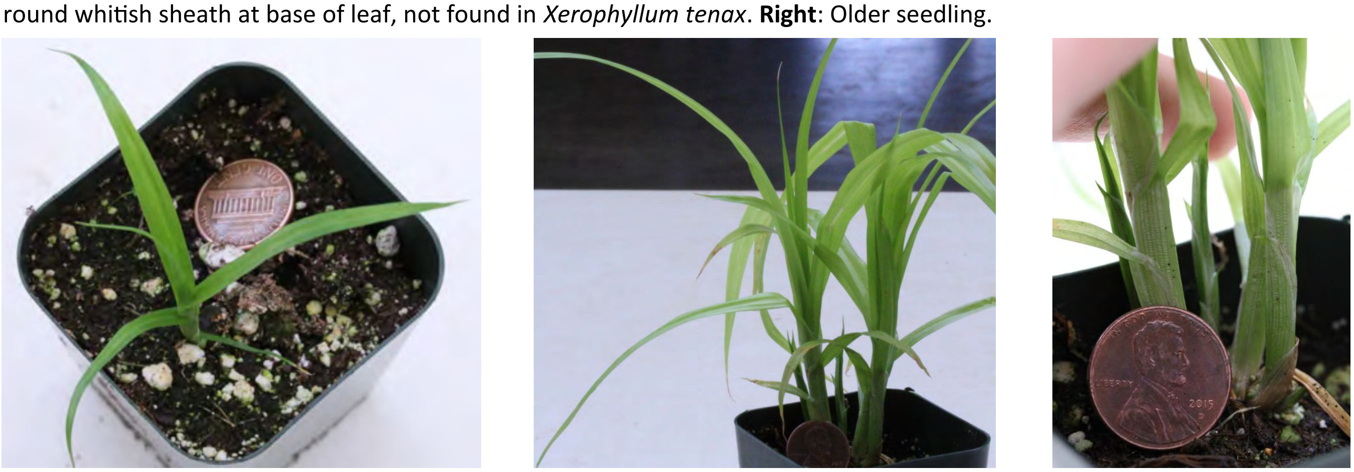
First true leaves

Shape: Linear tapering to a pointed tip, skinny ridge down center of lower leaf surface, wider leaves than *Carex spectabilis*

Color: Medium green

Texture: Hairless

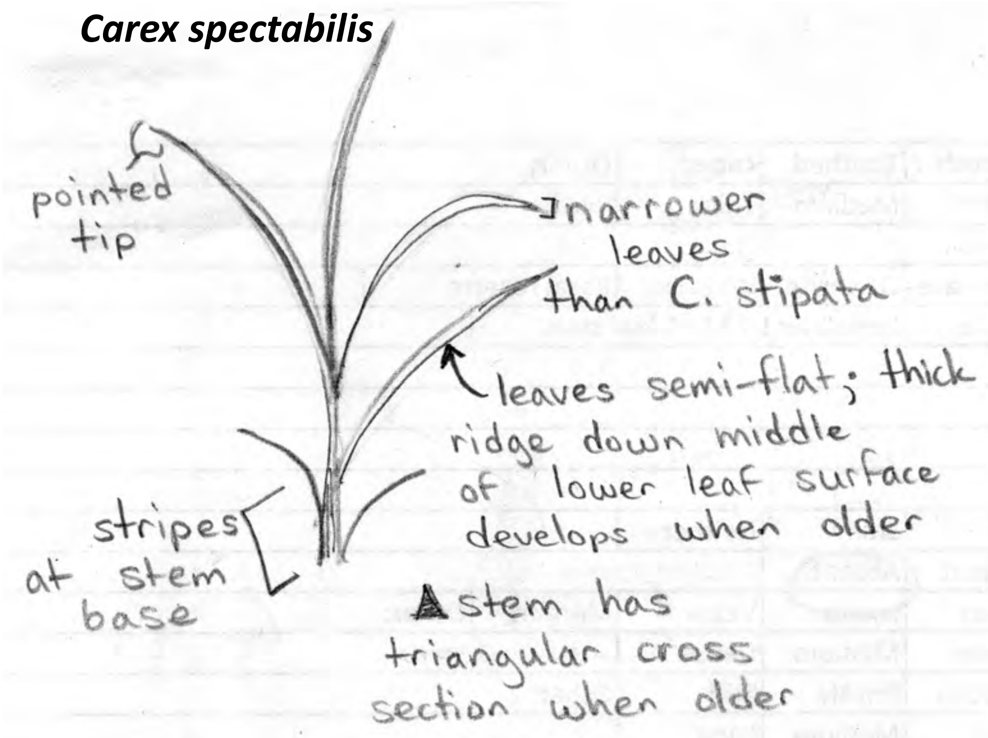
Left: Cotyledons. Visually impossible to identify at this stage of development. **Middle**: Seedlings with first true leaves. Note round whitish sheath at base of leaf, not found in *Xerophyllum tenax*. **Right**: Older seedling.



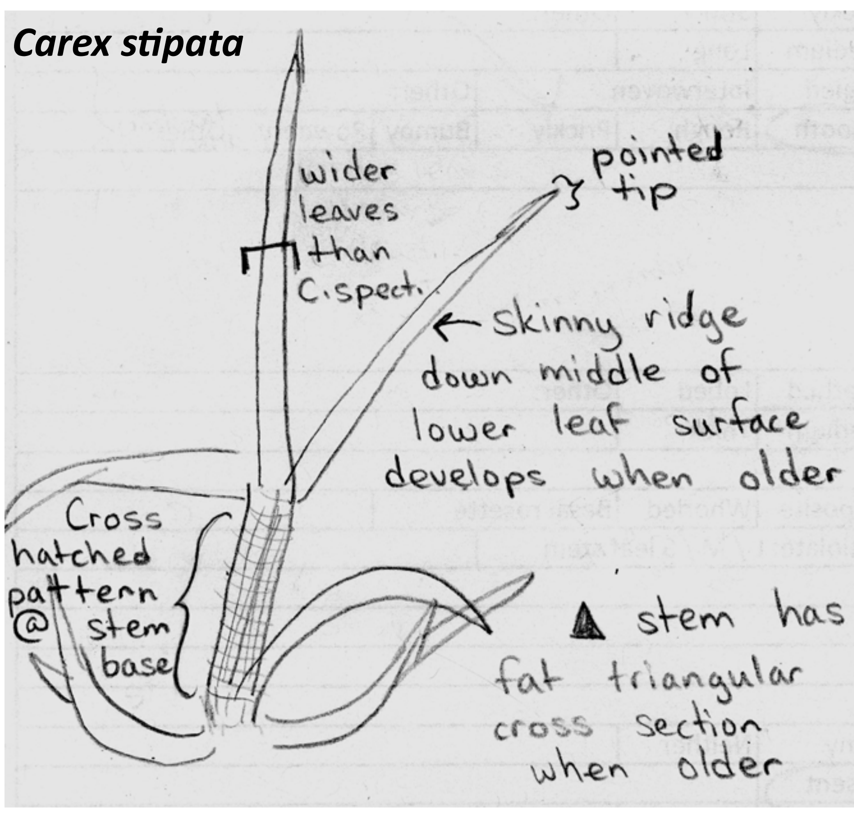
Older plants. See how leaves are wider than *Carex spectabilis*. **Right**: See cross hatched pattern on sheaths at stem base.

Sedge (*Carex*) Comparison

Carex spectabilis



Carex stipata

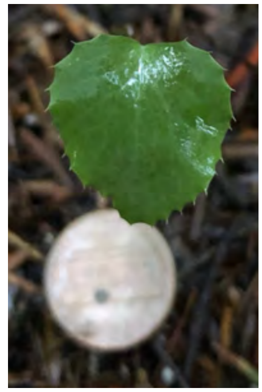


There are many more species of sedges native to Washington than just these two species.

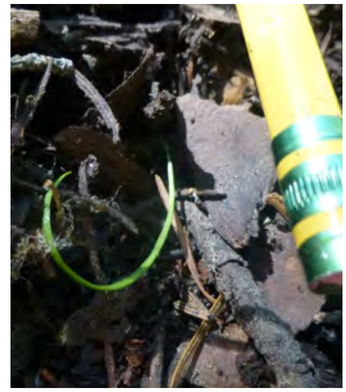
Field Specimens

Subalpine fir
(*Abies lasiocarpa)*

Western pasqueflower
(*Anemone occidentalis*)



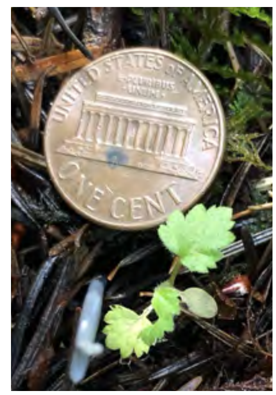
Tall Oregon grape
(*Berberis aquifolium*)



Showy sedge
(*Carex spectabilis*)

Ponderosa pine
(*Pinus ponderosa*)

Douglas fir
(*Psuedotsuga menziesii*)

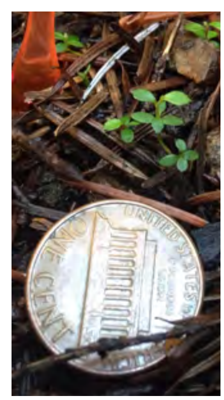


Trailing blackberry
(*Rubus ursinus*)

Blue elderberry
(*Sambucus cerulea*)

Fringecup
(*Tellima grandiflora)*

Piggyback plant
(*Tolmiea menziesii*)



Cascade blueberry
(*Vaccinium deliciosum*)

Photos from Hille Ris Lambers field crew members. Note that plants growing in the field may look slightly different than the same species growing in the greenhouse. Outdoor plants face higher levels of stress, such as drought, shading, and severe temperatures, which affect their appearance.

Growing Native Plants From Seed [4,5,6,7]

Seeds, bundled and labelled for processing.

Planning a seed propagation project. Growing plants from seed usually takes longer than expected. Many seeds will not germinate if directly buried in soil! Instead, they require several months of pretreatment prior to sowing. Therefore, I researched the growing requirements for each species first. I also found a lab partner for my project since growing plants from seed is time-intensive and working with others makes the process more manageable. I collaborated with master's student Kimberly Ertel to germinate and grow the plants in this guide. Although we were using the plants for different projects, having multiple eyes on the plants proved invaluable. We created a calendar for different tasks, including pretreating and sowing seeds, to organize our propagation efforts.

Buying and storing seeds. After preliminary research, the next step was obtaining seeds. In this case, we used seeds that the Hille Ris Lambers Lab crew collected from the North Cascades with permit permission. The rest of the seeds were purchased from seed companies, namely, Inside Passage, Silvaseed Co., L&H Seeds, and Native Seed Foundation. The seeds were temporarily stored at room temperature in paper bags in a storage cabinet before we started working with them. However, seeds should be kept in a fridge or cold room if the duration of storage is longer than a few months. Over time, seeds lose their ability to germinate, but storing them in low temperature and low relative humidity conditions lengthens their lifetime.

Sanitizing seeds. Our work began with the crucial step of pretreating the seeds. Many seeds will not germinate and survive without pretreatment. First, we sterilized the seeds using bleach to eliminate any fungal spores or bacteria on the seeds that could kill seedlings. Note that we could have used hydrogen peroxide instead of bleach. To secure the seeds before sterilization, we placed each species in a square of mesh cloth, tied the cloth into a bundle with metal wire, and used a metal tag to label each bundle with the species name and date. Then, we filled a bucket with a solution of one part

Growing Native Plants From Seed[4,5,6,7]

We soaked tiny seeds in cups (**above**) and the rest of the seeds in a tub of circulating water (**below**).

bleach to ten parts warm water, and soaked the seeds in the solution while stirring intermittently. After five minutes, the seeds were removed from the solution and rinsed with water. Secondly, we aerated the seeds in a tub of running water. This step promoted seed germination by softening the seed coats and leaching chemicals that inhibit germination from the seeds. For two days, we circulated the bundles of seeds in a tub full of water using aquarium air pumps. We placed a few species with tiny seeds, *Vaccinium deliciosum*, *Vaccinium parviflorum*, *Tellima grandiflora, and Tolmiea menziesii*, in their own cups of water, because these seeds were susceptible to escaping through the mesh cloth. The soaking water turned a yellowish color as chemicals leached from the seeds. To keep the water fresh, we dumped and refilled the water multiple times over the two days. After soaking, we rinsed the seeds again with water.

Breaking seed dormancy. Sanitizing and soaking are only the first part of pretreatment. Many species require further pretreatment to break seed dormancy, which equates to several months of patience. Seed dormancy occurs when a seed will not germinate in favorable environmental conditions. Seed dormancy is akin to hibernation in animals; basically, the seed needs to be woken up before germination can occur. In the lab, seed dormancy is broken by simulating environmental conditions that the seed would endure in nature. Dormancy breaking requirements, particularly the length of treatment, vary not only with species but sometimes with year and collection location.

Growing Native Plants From Seed[4,5,6,7]

Seeds ready to be placed in the cold room for stratification.

There are multiple types of seed dormancy. Most species in this guide display physiological dormancy, which occurs due to high levels of hormones that inhibit seed germination. Physiological dormancy can be broken by cold stratification, where seeds are exposed to cold temperatures for a duration of weeks to months. Seeds that require cold stratification are native to places with cold winters and thus are genetically programmed to avoid germination in the middle of winter. We performed cold stratification by planting the bundles of seeds in shallow containers of moist peat moss and keeping the containers in a cold room at 5°C for 1-3 months. To prevent the seeds from drying out, we sprayed water on the peat moss every few weeks.

Another common type of seed dormancy is physical dormancy, where a hard seed coat prevents the embryo, the tiny plant inside, from busting out of the seed. Physical dormancy is broken through scarification where the seed coat is worn down with hot water, acid, or rubbing. The only species that we treated for physical dormancy was *Lupinus latifolius*. We used the hot water method because acid requires safety precautions and rubbing can easily damage the embryo. We heated up a cup of water, waited for the water to stop boiling, added the seeds to the water, and kept the seeds in the cup until the water reached room temperature. Then, we stratified the lupine seeds for thirty days.

Some species had little or no information on seed pretreatment requirements in the literature, namely, *Alnus rubra, Alnus viridis, Vaccinium deliciosum, Vaccinium parviflorum, Tellima grandiflora, and Tolmiea menziesii*. This information might be absent because these species have nondormant seeds, though this was not explicitly stated. It is also possible that these species require seed pretreatment, but few people have reported their methods. We treated these species with thirty days of stratification in case of seed dormancy. On the next page is a table of pretreatment methods that we used for each species. We obtained information on pretreatment methods primarily from the Native Plant Network, an online resource sponsored by the United States Department of Agriculture that maintains a Propagation Protocol Database for native plants.[7] We supplemented propagation information from the Native Plant Network with a few other sources, which are listed in the References section.[4,5,6]

Seed Pretreatment Methods & Germination Notes[7]		
Species	**Pretreatment**	**Notes**
Conifers		
Grand fir (*Abies grandis*)	Cold strat. (30 days)	Very low germination
Subalpine fir (*Abies lasiocarpa*)	Cold strat. (30 days)	
Engelmann spruce (*Picea engelmanni*)	Cold strat. (30 days)	
Sitka spruce (*Picea sitchensis*)	Cold strat. (30 days)	
Lodgepole pine (*Pinus contorta*)	Cold strat. (30 days)	
Ponderosa pine (*Pinus ponderosa*)	Cold strat. (30 days)	
Douglas fir (*Pseudotsuga menziesii*)	Cold strat. (30 days)	
Other Trees & Shrubs		
Vine maple *(Acer circinatum*)	Cold strat. (90 days)	Very low germination
Rocky Mountain maple (*Acer glabrum*)	Cold strat. (90 days)	Very low germination
Red alder (*Alnus rubra*)	Cold strat. (30 days)	Seeds need light to germinate
Green alder (*Alnus viridis*)	Cold strat. (30 days)	Seeds need light to germinate
Tall Oregon grape (*Berberis aquifolium*)	Cold strat. (90 days)	Started germinating in strat.
Dwarf Oregon grape (*Berberis nervosa*)	Cold strat. (90 days)	
Thimbleberry (*Rubus parviflorus*)	Cold strat. (90 days)	
Trailing blackberry (*Rubus ursinus*)	Cold strat. (90 days)	
Blue elderberry (*Sambucus cerulea*)	Cold strat. (90 days)	
Red elderberry (*Sambucus racemosa*)	Cold strat. (90 days)	
Cascade blueberry (*Vaccinium deliciosum*)	Cold strat. (30 days)	
Red huckleberry (*Vaccinium parviflorum*)	Cold strat. (30 days)	Very low germination
Flowers		
Pearly everlasting (*Anaphalis margaritacea)*	Cold strat. (30 days)	Seeds need light to germinate
Western pasqueflower (*Anemone occidentalis*)	Cold strat. (90 days)	
Broadleaf arnica (*Arnica latifolia*)	Cold strat. (30 days)	
Mountain daisy (*Erigeron peregrinus*)	Cold strat. (30 days)	Seeds need light to germinate
Common woolly sunflower (*Eriophyllum lanatum*)	Cold strat. (90 days)	Started germinating in strat.
Broadleaf lupine (*Lupinus latifolius*)	Scarification, then Cold strat. (30 days)	
False lily of the valley (*Maianthemum dilatatum*)	Cold strat. (90 days)	No germination
False Solomon's seal (*Maianthemum racemosum*)	Cold strat. (90 days)	No germination
Fringecup (*Tellima grandiflora*)	Cold strat. (30 days)	
Piggyback plant (*Tolmiea menziesii*)	Cold strat. (30 days)	
Beargrass (*Xerophyllum tenax)*	Cold strat. (30 days)	No germination
Sedges		
Showy sedge (*Carex spectabilis*)	Cold strat. (90 days)	
Awlfruit sedge (*Carex stipata*)	Cold strat. (30 days)	

Note: For species with poor germination, longer stratification might yield higher germination results.

Growing Native Plants From Seed[4,5,6,7]

Avoiding problems during stratification. Some of our seeds molded during stratification. In retrospect, peat moss was not the best medium choice. An inorganic medium such as sterilized sand, as opposed to an organic medium such as peat moss, might have reduced our mold problems. Additionally, it would have been better to keep the medium lightly moist, rather than heavily so. Fortunately, we were able to mitigate mold problems by regularly checking on the seeds. Once a week, we opened the mesh bags, rubbed mold off the seeds, and discarded the squishy seeds. We also soaked the seeds in a 1:10 diluted bleach solution during the middle of stratification, which temporarily reduced the amount of mold. If we had not closely monitored the seeds, they probably would not have survived.

Additionally, a few species started germinating in stratification before we were ready to sow seeds. Some of these seedlings died because they were held too long in stratification. When scheduling planting, remember that some species may need to be planted earlier than anticipated. Frequently monitoring the health and stage of development of the seeds is critical to stratification success!

Every week, we checked seeds in stratification for seed mold (**left**) and early germination (**right**).

Planting seeds and transplanting seedlings. To streamline our planting process, we scheduled stratification such that all seeds were ready to be planted at approximately the same time. We followed the general rule of thumb for seed sowing, that is, planting seeds as deep as their length. For example, we covered Douglas fir seeds with about 3/4 cm of soil, estimated by eye, because these seeds are about 3/4 cm long. All seeds were covered with soil except species with photodormant seeds, which need light to germinate. We planted the seeds in Sunshine 4 mix, but any seedling mix should do. We sowed tree seeds in cone-tainers, with a few seeds per cone-tainer, and sprinkled flower, sedge, and shrub seeds over flats. To speed up germination and seedling growth, the soil was covered with plastic lids to create miniature terrariums that maintained high humidity levels. After germination, we thinned tree seedlings to one per cone-tainer. We transplanted the rest of the seedlings from flats to 4-inch rose pots after they developed their first true leaves. Transplanting was time consuming, but starting non-tree seeds in flats conserved space. Note that we started the tree seedlings in cone-tainers rather than flats since they transplant poorly and develop long roots quickly.

Growing Native Plants From Seed [4,5,6,7]

Layout on the greenhouse bench.

Germination and growing conditions. We grew our plants in spring in the greenhouse at the Center for Urban Horticulture at the University of Washington, where temperatures ranged from 68-75°F and the lights were on from 7 am to 5 pm daily. Germination took place over a span of a few days to weeks, with most germination occurring 1-2 weeks after planting. Trees and other large seeded plants typically took longer to germinate than herbs but had larger seedlings. After the plants were large enough, the greenhouse staff started watering our plants with diluted Dyna-Gro fertilizer instead of regular water. Fertilizing is important because most seedling soil mixes contain low levels of nutrients that cannot sustain a rapidly growing plant. Ideally, you should begin fertilizing after the first set of true leaves have emerged. We learned this the hard way and had to rescue our plants after their leaves started to change color due to nutrient deficiencies. Other dangers to seedling survival include overwatering, which causes yellow leaves and root rot, and underwatering, which causes drooping leaves. Seedlings need to be monitored closely since they are more sensitive to their environment than mature plants.

Records. I kept records so I could remember my propagation process, avoid making the same mistakes twice, and share knowledge with people interested in growing the same species. Along the way, I recorded pretreatment and planting methods, germination results, and observations. On the following page is a table of the identification traits that I recorded in my observation datasheets.

We thinned seedlings to avoid crowding (**left**). We sowed tree seeds in cone-tainers since seedlings grow long roots (**right**).

Observation Datasheet for Seedling Identification Traits			
Observation Date:		Species:	
Plant Organ	**Trait**	**Classification**	**Definitions**
Leaves (Cotyledons, True Leaves)	Number	Monocot	One cotyledon
		Dicot	Two cotyledons
		Polycot	More than two cotyledons
	Shape	Leaf outline	Circular, cordate, elliptic, linear, obelliptic, oblong, obovate, oval, ovate, palmately compound, spatulate, ternately compound, triangular… also note shape of leaf tips and base
		Leaf margin	Coarse or finely jagged, dissected, lobed, scalloped, smooth...
		Leaf thickness	Thin, medium, thick
		Leaf angle	Needles horizontal or cupped up, or leaf tilted up or down
	Color	Leaf surface	Note color and any difference between upper and lower leaf surface; note if color is uniform, striped, or another pattern
		Leaf vein	Note if different color than leaf surface
		Leaf hairs	Note if different color than leaf surface
		Leaf shine	Dull, shiny, or regular leaf surface
	Texture	Leaf hairs	Present or absent
		Location of hairs	May be present on upper or lower leaf surface, vein, margin, petiole
		Density of hairs	Sparse, medium, dense
		Quality of hairs	Smooth, prickly, stiff; may secrete sticky substance from tip
		Length of hairs	Short, medium, long
		Arrangement	Stick straight up, angled, form interwoven mat
		Surface quality	Waxy, smooth, rough, prickly, powdery, or bumpy surface; note any difference between upper and lower leaf surface
	Attachment	Sessile	No petiole
		Petiolate	Long, medium, or short petiole
Stem	Shape	Cross section	Round, flat, or triangular stem
	Color	Stem	Note color and if color pattern is uniform, striped, or other
	Texture	Stem hairs	Look for same traits as leaf hairs
Overall	Size		Length and width of cotyledons, seedling height
	Growth habit		Upright, sprawling, semi-sprawling, basal rosette
Notes			Additional information

I made a datasheet for efficiently collecting observations of the cotyledons, young stem, and true leaves of each species. Above is a condensed version of my datasheet, which I created after examining the traits included in the seedling identification guides listed under the References section. For the seedling photographs, I used a Canon EOS Rebel T6 DSLR camera with an EF-S 60mm f/2.8 fixed macro lens and a tripod for stabilization. I took photographs of each species from multiple angles, particularly top-down and side views, to capture both stem and leaf traits. I also photographed sequential stages of development over the course of several months in order to showcase the transition from cotyledons to first true leaves to older seedlings. While reviewing, reorganizing, and consolidating my notes, I selected photographs to emphasize the key traits of each species in my guide. Plant identification is a science and an art, and I hope that my guide will be appreciated as both.

Elevation and Climate

Elevation matters to plants, mainly because the temperature drops as elevation increases. Since each plant species tolerates a limited temperature range, species will only be found in their native habitat at certain elevations. It is uncommon to discover high elevation species at low elevations, or low elevation species at high elevations. Furthermore, each species prefers different levels of rainfall and soil moisture. Some species are more drought tolerant than others. Any houseplant owner has observed this fact; certain species are more likely to survive if insufficiently watered. Thus, both elevation and climate can serve as a clue to the identity of a species. Additionally, species grown outdoors will perform poorly if planted outside of their preferred elevation range and climate. This is a word of caution to those who might otherwise be enticed into growing pretty alpine wildflowers at low elevations! On the following page is a table of the general elevation and climate preferences of species in this guide. This table is an oversimplification since species preferences are often nuanced.

Elevation and Climate Preferences[8,9,10,11]

	Lower Elevations	Higher Elevations	Low & High Elevations
Moist Climate	**Vine maple** *(Acer circinatum)* **Red alder** *(Alnus rubra)* **Dwarf Oregon grape** *(Berberis nervosa)* **Showy sedge** *(Carex stipata)* **Sitka spruce** *(Picea sitchensis)* **Thimbleberry** *(Rubus parviflorus)* **Red elderberry** *(Sambucus racemosa)* **Fringecup** *(Tellima grandiflora)* **Piggyback plant** *(Tolmiea menziesii)* **Red huckleberry** *(Vaccinium parvifolium)*	**Broadleaf arnica** *(Arnica latifolia)* **Awlfruit sedge** *(Carex spectabilis)* **Engelmann spruce** *(Picea engelmannii)*	
Dry Climate	**Pearly everlasting** *(Anaphalis margaritacea)* **Common wooly sunflower** *(Eriophyllum lanatum)* **Ponderosa pine** *(Pinus ponderosa)* **Blue elderberry** *(Sambucus cerulea)*	**Subalpine fir** *(Abies lasiocarpa)* **Western pasqueflower** *(Anemone occidentalis)* **Mountain daisy** *(Erigeron peregrinus)*	
Moist & Dry Climates	**Grand fir** *(Abies grandis)* **Rocky Mountain maple** *(Acer glabrum)* **Green alder** *(Alnus viridis)* **Tall Oregon grape** *(Berberis aquifolium)* **Douglas fir** *(Pseudotsuga menziesii)*	**Cascade blueberry** *(Vaccinium deliciosum)*	**Broadleaf lupine** *(Lupinus latifolius)* **Lodgepole pine** *(Pinus contorta)* **Beargrass** *(Xerophyllum tenax)*

Most of the species in this guide were grown to support field research conducted on Mt. Rainier and North Cascades by the Hille Ris Lambers Lab. To study the effects of climate change on plant communities, the lab selected pairs of native species in the same genus with different elevation and/or climate preferences.

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Plant Propagation Protocols

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Other Helpful Resources

How to Identify Plants

Mangold, Jane, and Hilary Parkinson. *Plant Identification Basics*. Montana State University Extension, 2013. http://msuextension.org/publications/AgandNaturalResources/MT201304AG.pdf.

More Seedling Guides

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By Kyra Kaiser, 2019