WILLOWS ON THE LANDSCAPE

A deep dive into Willow Identification, ecology, and re-establishing native willows on arid, high-desert landscapes.

WORKSHOP RESOURCES

June 20th and 26th, 2024

Ochoco Creek 1911

Presented by

WESTERN BEAVERS COOPERATIVE

sunriver nature center & observatory

INTRODUCTION

Thank you for your participation in this Willows Workshop 2024. We offer this workshop to those interested in the growing practice of beaver biomimicry - widely promoted through PBR (Process Based Restoration) solutions - for a return of the beaver to Western landscapes.

PBR as conceived and promoted seems to have many strengths and potential for advancing riverscape resilience, yet as currently practiced and popularized through media, significant gaps exist between PBR project design and implementation, ***and what beavers actually need to be a long term, successful participant in all of this.***

It's our hope for this workshop to start **bridging this gap** by offering practical, field-deployed solutions, and information for understanding of what willows and beavers both need to succeed, flourish and *persist* on 'Beaver Managed Floodplains (BMFPs)'.

We offer this workshop as **the beginning of a conversation**, 'failing forward' as a practitioner community to share what's working (or not) in pursuit of vegetation establishment and healthy, resilient riverscapes (and beavers) where it's possible for the precious arid, western landscapes that we love.

We look forward to learning with you!

Reese Mercer
Western Beavers

Kelli Neumann
Sunriver Nature Center

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Key to Willows (*Salix*) of Low Elevations East of the Cascades emphasizing vegetative traits 2024

-- Barbara Wilson
Carex Working Group

This key identifies willows with mature leaves, even if they lack catkins. However, some catkin traits are mentioned if they seem helpful when catkins happen to be present.

Tree or shrub? Trees have one or very few main stems; shrubs have several. Our native willows that can become trees are also seen growing as shrubs. They can be found under either lead in the key. The introduced trees usually look like trees even when young, so they are keyed only as trees.

Leaf traits (especially shape and size) should be assessed onl on the *largest medial preformed leaves*. What does that mean? Last year's branches have buds that overwintered. These overwintering buds produce preformed branchlets that produce catkins and preformed leaves. These preformed branchlets soon produce buds that will produce additional branchlets, the neoformed branchlets. Therefore, the preformed leaves are on the oldest leafy branches. Neoformed branchlets don't have catkins (except sometimes in *S. exigua*). Leaf shape and size are much more variable on neoformed than on preformed branchlets. Therefore, you need to assess these traits only on preformed branches (the ones that also produced catkins, which have probably fallen, leaving bare nodes along the branchlet). Note that the neoformed branchlets are often more conspicuous because they're closer to the end of the branch (as we see it in mid-summer) and often larger. The lowest leaves on any one branchlet and those by the tip are often smaller and may differ in shape, so only assess the largest ones in the middle of the preformed branchlet.

Watershoots are big, vigorous shoots that come up out of the ground this year. They can be very conspicuous but avoid using them for identification. Their leaves are often atypical in shape and much larger than the preformed leaves.

Some leads in this key are long. If you feel confident in the identification after reading the first two or three traits, you don't need to read the whole thing. The additional information is intended to be helpful but sometimes it's just intimidating.

1a. **Trees**; petioles usually with wart-like glands at base of leaf blade; stamens 2-7 per flower; floral bracts usually tawny or greenish; pistillate floral bracts persistent or deciduous after flowering

2a. Leaves obovate, tip rounded to obtuse; petiole glands usually lacking or small and flat; floral bracts dark, persistent ..... ***S. scouleriana,*** **Scouler's Willow**

2b. Leaves elliptic, lanceolate, or oblanceolate, tip acute to acuminate; petiole glands usually present, usually wart-like; floral bracts tawny or greenish

3a. Branches long and hanging down, usually yellow; largest medial leaves 5.5-10.5 times as long as wide; stamens 2; pistillate flower bracts persistent; planted and only rarely spreading by fragmentation; introduced ..... ***S. sepulcralis*** (or maybe *S. pendulina*), **Weeping Willow**

3b. Branches erect to spreading, sometimes nodding near the tip; largest medial leaves 3.5-7(-9.8) times as long as wide; stamens 2-7 per flower; pistillate flower bracts deciduous

4a. Youngest (distal) branches very slender, nodding near the tips; bud scale margins free and overlapping, not fused, one margin evident on the bud surface adjacent to the branch (best viewed at 10×), bud apex usually pointed; stamens 3-7; pistillate floral bracts deciduous; in and north of Deschutes County ..... ***S. amygdaloides,*** **Peach-leaf Willow**

4b. Youngest (distal) branches not so slender, erect to spreading; bud scale margins fused, the line of fusion not evident, bud apex usually blunt to rounded, sometimes appearing duckbill-shaped; stamens 2-6

5a. Stipules absent; leaves glaucous below; hairs of juvenile leaves white; branches very brittle at base; branchlets of pistillate catkins 5–15(25) mm; stipes 0.3-0.5(0.8) mm; introduced tree to 20(–25) m; stamens 2; pistillate floral bracts persistent; lowlands; introduced ..... **S. × fragilis (= *S.* × *euxina,* = *S.* × *rubens*), Brittle Willow**

5b. Stipules present, often prominent; leaves glaucous below or not; hairs of juvenile leaves usually both white and rusty-red; branches flexible to very brittle at base; branchlets of pistillate catkins 6–30(–56) mm; stipes (0.5–)0.8–2(–4) mm; shrub or small tree to 6(–11) m; stamens 3-6; pistillate floral bracts deciduous; lowlands to midmontane; common..... ***S. lasiandra***

6a. Mature leaves not glaucous below; more common east of Cascades ..... ***S. lasiandra*** var. ***caudata***, **Shining Willow, Whiplash Willow**

6b. Mature leaves glaucous below; more common west of Cascades ..... ***S. lasiandra*** var. ***lasiandra***, **Pacific Willow**

1b. **Shrubs**; stamens 2 per flower (1 in *S. sitchensis*); floral bracts tawny, greenish, brown, or black; pistillate floral bracts persistent or deciduous

7a. **Clonal shrubs** (branches sprout from roots and do not all point back to a central origin); floral bracts tawny or greenish; pistillate floral bracts deciduous; catkins sometimes more than 1 per catkin branchlet; sometimes additional catkins produced after the first spring flowering ..... ***S. exigua***

8b. Petioles hairy; mature leaf blades persistently hairy to glabrate; capsules hairy or glabrous; stipes 0–0.9 mm; widespread east of Cascades ..... ***S. exigua*** **var. *exigua,* Coyote Willow**

8a. Petioles glabrous to very sparsely hairy; mature leaf blades glabrous to very sparsely hairy; capsules hairy; stipes 0–0.2 mm; lower Willamette Valley and Columbia River west of the Deschutes River ..... ***S. e.*** **var. *columbiana,* Columbia River Willow**

7a. **Shrubs**, not clonal, all branches pointing toward a central origin; floral bracts tawny, greenis, dark brown to black (tawny in *S. lutea*, a Great Basin species with pale branches); pistillate floral bracts persistent or deciduous; catkin branchlets each with 1 catkin; all catkins produced in the same spring flowering

9a. Some leaves opposite or nearly so (paired at a node); largest medial leaves 2.8-9.2 times as long as wide (usually long and narrow); leaves glaucous below, dull dark green above; introduced ..... ***S. purpurea,*** **Basket Willow, Purple Osier**

9b. All leaves alternate (only one at a node); leaves various

10a. Large warty glands (best viewed at 10×) present at distal end of petiole or on base of blade itself on at least some leaves; pistillate floral bracts usually tan and lacerate, deciduous after flowering

11a. Youngest (distal) branches very slender, nodding near the tips; bud scale margins free and overlapping, not fused, one margin evident on the bud surface adjacent to the branch (best viewed at 10×), bud apex usually pointed; in and north of Deschutes County ..... ***S. amygdaloides,*** **Peach-leaf Willow**

11b. Youngest (distal) branches not so slender, erect to spreading; bud scale margins fused, the line of fusion not evident, bud apex usually blunt to rounded, sometimes appearing duckbill-shaped; widespread ..... ***S. lasiandra***

12a. Mature leaves not glaucous below; more common east of Cascades ..... ***S. lasiandra*** var. ***caudata,*** **Shining Willow, Whiplash Willow**

12b. Mature leaves glaucous below; more common west of Cascades

..... ***S. lasiandra*** var. ***lasiandra***, **Pacific Willow**

10b. Glands absent or minute on tips of petioles and base of blades; floral bracts usually black to tan or bicolor, (tawny in *S. lutea*), entire to lacerate; pistillate floral bracts persistent; typical shrub willows

[lead shifted toward left margin]

13a. **Mature leaves green below**, not glaucous below, if hairy, the hairs not obscuring the lower surface; shrubs

14a. Leaf margins entire (check base of largest medial leaves, stipules, and small leaves toward the base of leafy shoots), blades persistently hairy on both surfaces; mostly alpine (note: Some Grant Co. plants may key here but are probably *S. eastwoodiae* with nearly entire leaf margins; more research is needed) ..... ***S. wolfii*** var. ***idahoensis*****, Wolf's Willow**

14b. Leaf margins serrate, serrulate, or entire, blades glabrous or hairy on one or both surfaces; elevation and range various

15a. Mature leaves hairy on one or both surfaces; usually montane to alpine

16a. Capsules glabrous; leaves usually 1.5–3(–3.5) × longer than wide ..... ***S. commutata,*** **Undergreen Willow**

16b. Capsules hairy; leaves usually 2–5 × longer than wide, montane to alpine ..... ***S. eastwoodiae*****, Eastwood's Willow**

15b Mature leaves glabrous or glabrate; usually lowlands to montane

17a. At least some leaf blade bases abruptly contracted to the petiole, cordate, truncate, or broadly rounded; stipules usually persistent; blade margins finely serrate; capsules glabrous; lowlands to montane; northern Deschutes County and north and east of there ..... ***S. monochroma,*** **One-color Willow**

17b. Leaf blade bases tapered to the petiole or rounded; stipules rudimentary or eventually deciduous; blade margins serrulate or entire; capsules glabrous or hairy; lowlands to alpine

18a. Mature leaves thinner, glabrous or nearly so; blade margins minutely serrulate, rarely entire; capsules glabrous; shrubs 1-6 m; common in and east of Cascades, mainly at low elevations ..... ***S. boothii,*** **Booth's Willow**

18b. Mature leaves thicker, usually hairy on both surfaces, often sparsely so with age; blade margins usually entire, often with a pale thickened margin below, the margins less commonly minutely serrulate; capsules hairy; shrubs 1-2(-4) m; in and east of Cascades (though not documented north of Mt. Jefferson), mainly at high elevations ..... ***S. eastwoodiae*****, Eastwood's Willow**

13b. **Mature leaves white or grayish below**, the lower surface glaucous or obscured by dense hairs

19a. Branchlets and second-year branches strongly glaucous, (the glaucous layer sometimes persisting only behind the buds); leaves lanceolate to lance-elliptic, less often elliptic; margins entire or inconspicuously toothed; capsules hairy

20a. Largest medial leaf blades with lower surface often obscured by dense but inconspicuous hairs; branches mostly ascending to erect; branches red-brown to violet or blackish; cental Oregon and east ..... ***S. drummondiana,*** **Drummond's Willow**

20b. Largest medial leaf blades with lower surface glabrous to sparsely hairy, not obscured by hairs; branches mostly spreading to ascending; branches yellowish, yellow-brown, gray-brown, or red-brown, rarely violet

21a. Petioles 2–5(–9) mm; leaves usually 6–12 mm wide; catkins subglobose, pistillate catkins 10–15(–25) mm, subglobose; stems sometimes nearly erect, plants sometimes columnar

..... ***S. geyeriana*, Geyer's Willow**

21b. Petioles 4–10(–16) mm; leaves 6–22 mm wide; catkins cylindrical, pistillate catkins 20–50 mm; stems spreading to ascending, plants relatively broad
..... ***S. lemmonii*, Lemmon's Willow**

19b. Branchlets and second-year branches not glaucous; leaves various; capsules glabrous or hairy

22a. Mature leaves densely hairy below, the hairs usually obscuring the surface

23a. Leaves similarly hairy on both surfaces; shrubs < 1(–3) m; montane to alpine

24a. Leaves usually 1.5–3(–3.5) × longer than wide, margins entire or serrulate; capsules glabrous; in and east Cascades ..... ***S. commutata,* Undergreen Willow**

24b. Leaves usually 3–4.5 × longer than wide, margins entire; capsules more or less hairy; mostly alpine (note: Some Grant Co. plants may key here but are probably *S. eastwoodiae* with nearly entire leaf margins; more research is needed)
..... ***S. wolfii var. idahoensis*, Wolf's Willow**

23b Leaves less hairy above than below; shrubs or trees to 20 m, seldom < 2 (3) m; lowlands to montane

25a. Leaves 15-30 mm wide, densely hairy below, the hairs white or gray, appressed or spreading, curly or wavy; larger medial leaves usually with 5-15 primary veins on each side of the midvein; stamen 1 per flower; capsules hairy..... ***S. sitchensis,* Sitka Willow**

25b. Leaves 10-40(45) mm wide, glabrous or with spreading hairs below, the hairs if present frequently white and rusty, larger medial leaves usually with 5-9 primary veins on each side of the midvein; capsules hairy or glabrous
..... ***S. scouleriana*, Scouler's Willow, Fire Willow**

22b. Mature leaves glabrous to hairy below, hairs if present not obscuring the surface

26a. Shrubs or trees to 12(–20) m; petioles (2-)4--8(-10) mm; leaves usually obovate to oblanceolate, dull green or slightly shiny above, hairs if present often both white and rusty-red, leaf margins usually entire, rarely irregularly serrulate; branches flexible at base; capsules hairy; catkins before leaves; widespread, lowlands to montane, rarely subalpine; plants in and west of Cascades typically in mesic, upland forest habitats (unique among our spp.), less commonly in wet habitats, plants east of Cascades usually in seasonally wet habitats ..... ***S. scouleriana*, Scouler's Willow, Fire Willow**

26b. Shrubs to 8 m; petioles (6-)10--20(-25) mm; leaf shape various, dull green to very shiny above, hairs white or both white and rusty-red, leaf margins serrate to entire; branches flexible or breaking at the base; capsules hairy or glabrous; catkins emerging before or with leaves; plants typically in wet or seasonally wet habitats

27a. Mature leaves shorter or wider, usually < 3 × longer than wide, the blades broadly elliptic to ovate or obovate (if in doubt about leaf morphology, try both leads of couplet 25 to discover which choice is correct)

28a. Upper surface of leaves with veins +/- the same level as the rest of the surface; stipules leaf-like; lower leaf surface glabrous; pistillate catkins dense to open; ovaries glabrous, on stipes 1.3-4.2 mm, usually short ..... ***S. prolixa*, Mackenzie's Willow**

28b. Upper surface of leaves with veins pressed in; stipules rudimentary or absent on early leaves, sometimes leaf-like on later leaves; lower surface of leaves densely hairy or becoming glabrous; pistillate catkins very open; ovaries hairy, on stipes 2-6 mm
..... ***S. bebbiana,* Beaked or Bebb's Willow**

27b. Mature leaves relatively long and narrow, usually > 3 × longer than wide, the blades narrowly elliptic, oblong, lanceolate, or oblanceolate

29a. At least some leaf blade bases abruptly contracted to the petiole, cordate, truncate, or broadly rounded; leaf blade margins finely serrate, rarely entire; stipules leaf-like, usually persistent; capsules glabrous; lowlands to montane

30a. Branches pale gray to yellow-gray (ghostly); floral bracts tawny or brown; not known from Deschutes County but present to the south and east (mainly a Great Basin species) ..... ***S. lutea*, Yellow Willow**

30b. Branches usually reddish to reddish-brown; floral bracts brown; range various

31a. Leaves oblong to narrowly elliptic, usually 3–6 × as long as wide; stipes 1–2(–2.5) mm; shrub 1—6 m; central Cascades south to California, rare in Oregon ..... ***S. ligulifolia*, Strapleaf Willow**

31b. Leaves broadly lanceolate to elliptic, usually 2.5–4.5 × as long as wide; stipes 2–4(–5) mm; shrub or small tree 1-5(8) m; widespread, though not in and west of the Coast Range ..... ***S. prolixa*, Makenzie's Willow**

29b. Leaf blade bases tapered to the petiole, less often rounded; leaf blade margins entire or serrate; stipules rudimentary and deciduous, or absent; capsules hairy or glabrous; lowlands to alpine

32a. Petioles 2–5(–9) mm; leaves narrowly elliptic to lanceolate, usually 6–12 mm wide; pistillate catkins subglobose, 10–15(–25) mm..... ***S. geyeriana*, Geyer's Willow**

32b. Petioles (3–)5–16 mm; leaves elliptic or oblong, less commonly oblanceolate, 6–35 mm wide; pistillate catkins cylindric, 20–110 mm

33a. Mature leaves strap-shaped to narrowly elliptic, margins entire or evenly serrate, apex acute to acuminate, length/width ratio 3.4-12; branchlets glabrous to sparsely hairy; stems puberulent (with very short hairs) and becoming glabrous; shrub height to 4 m; well-developed buds all similar in size or some a bit larger than others; epidermal flakes of 3-4 year old twigs gray patches; montane to subalpine ..... ***S. lemmonii*, Lemmon's Willow**

33b. Mature leaves strap-shaped or elliptic to oblanceolate or obovate, margins entire or remotely or irregularly serrate, apex acute or acuminate to obtuse or rounded, length/width ratio 1.9-9.6; branchlets glabrous to densely hairy; stems glabrous, pubescent or tomentose; shrub height to 10 m; well-developed buds of two distinctly different sizes; epidermal flakes of 3-4 year old twigs yelllow-edged or gray-edged longitudinal patches; low elevations to montane ..... ***S. lasiolepis*, Arroyo Willow**

Glossary for Willow Structures

This glossary has more terms than you'll ever need, but it was originally produced by a person making a very technical study of willows. Ignore words you don't need.

Modified from *Salix* (Willows) in the New World, a Guide to the Interactive Identification of Native and Naturalized Taxa Using Intkey (Delta), by George W. Argus, 2007.

Abaxial floral nectaries: Nectaries located between the stamens or ovary and the floral bract.
Abaxial: The side away from the axis. Dorsal.
Acuminate: Margin between apex and 0.75 blade length distinctly concave basally and gradually tapering to tip apically.
Acute: Margin between apex and 0.75 blade length forming an angle less than 90° and essentially straight. Straight.
Adaxial floral nectaries: Nectaries located between the stamens or ovary and the axis (present in all our species).
Adaxial: The side of a structure toward the axis. Ventral.
Adnate: Fusion of dissimilar structures.
Adventitious roots: Roots that arise from somewhere other than other roots, usually from branches.
alba-type bud gradation. Buds are similar in size and shape along the entire branchlet length. Floral and vegetative buds cannot be distinguished by size or shape (Skvortsov 1999).
Alpine: Growing in the high elevation areas where trees cannot grow.
Amphistomatous: Stomata uniformly distributed on both leaf surfaces.
Anthers: Pollen-producing plant parts. Color is based on the external color of the mature or dehisced anthers at or soon after flowering. Yellow-colored anthers vary from golden-yellow to tawny or pale brown. Purple-colored anthers vary from dark to pale purple, or sometimes pale reddish to brown. Anthers that are red in life may dry purple. Purple anthers sometimes grade into yellow in age. Anther length is measured on dehisced (opened) anthers.
Anthesis: Flowering time.
arctica-type bud gradation: There are usually few buds. The distal two or three are the largest abruptly changing to smaller buds at proximal end. The large distal buds, which open in spring, may be floral or vegetative (Skvortsov 1999).
Branch: A shoot in at least its second year of growth.
Branchlet: The current year's shoot; bearing leaves.
Brittle (branches): Branches are considered brittle if they break when pressed forward toward the main axis by pressing on them near the base. If some but not all branches break, the branches are considered somewhat brittle.
Broadly elliptic: A plane shape, L:W 1.5:1, widest at middle.
Broadly oblong: A plane shape, L:W 1:5:1, widest in the mid-zone.
Broadly obovate: A plane shape, L:W 1.2:1, widest toward apex.
Broadly ovate: A plane shape, L:W 1.2:1, widest toward base:
Bud scale: A modified leaf or prophyll that covers a bud. In *Salix*, there is only one bud scale. It is formed from the fusion of two prophylls. In most species, the scale margins are fused on both the adaxial (ventral) side and the abaxial (dorsal) side. These scales usually look like little caps, usually rounded at the tip. The scale margins are fused only on the abaxial (dorsal) side in a few species, e.g. *S. amygdaloides, S. gooddingii,* and *S. laevigata*. On the adaxial (ventral) side, the scale margins overlap. The adaxial margin is often off-center and can be surprisingly hard to see. The margin structure may be seen best by cutting a cross section of the scale. Note that bud scales usually split as bud itself grows, so only dormant buds can be used to assess whether the bud scale margins were fused or not.
Bundle scar: Markings inside the leaf scar from where the veins of the previous leaf were connected to the twig.
Caducous: Falling off early.
Campylodromous (leaf veins): The first two secondaries arise at or close to a single point at the base of the leaf and curve toward the tip.

caprea-type bud gradation: The floral buds are strikingly different in size and shape from vegetative buds. The large floral buds are sometimes intermixed with smaller vegetative buds (Skvortsov 1999).

Capsule: Fruit that has several seeds inside and will open to release them. Fruits of willows are capsules.

Carinal: Applied to stigmas in which the lobes are associated with a single carpel; not jointed across the suture or commissure.

Cataphylls: The first tow or three bract-like leaves at the proximal end of the branchlet (Sugaya 1960). They fall early, lack axillary buds, stipules, and green coloration, and often have the hardness and ciliation of bud scales. Sometimes they fall very early, a small scar the only evidence they were ever there. On the other hand, some cataphylls are green during their brief life. Sometimes the lowest cataphyll is similar in color and texture to the inner bud scale membrane, but the inner membrane appears on the same side of the branchlet as the outer bud scale membrane, and the first cataphyll arises on the opposite (adaxial) side of the branchlet.

Catkin: Inflorescence a spike of unisexual flowers without conspicuous perianth. A catkin consists of a flowering rachis and its stalk or peduncle. Catkins may arise from the subterminal bud (e.g. *S. reticulata*) or from lateral buds (most species). It may have three to several leaves near the base. These correspond to the proximal leaves of branchlets. Branched catkins are sometimes found in *S.* section *Longifoliae.* Catkin lengths are measured at anthesis. After flowering, pistillate catkins elongate but not staminate one do not. Length of the flower-bearing part of a catkin is measured from the lowermost flower on the continuously flowered part of the catkin rachis to the distal end of the catkin. The width is measured near mid-length and goes to the tips of the spreading stamens or stigmas. The stipes of pistillate flowers elongate after anthesis. Therefore, neither length nor width should be assessed on pistillate catkins after anthesis.

Caudate: Margin between apex and 0.75 blade length distinctly concave basally and gradually tapering to a long tail-like tip apically. Subtype of acuminate.

Ciliate: With hairs along the margins.

Circular: A plane shape, L:W 1:1, widest at middle.

Clonal shrub: A shrub in which the main stems arise from the roots and do not all point back toward a common base.

Clone: An extensive plant or a series of plants that form by vegetative reproduction. A willow clone can form in several ways. (1) Shoots can arise directly from the roots (soboliferous). Root shoots are common in *S.* subgenus *Longifoliae*. (2) Branches buried in soil can sprout roots (layering). (3) Shoots can arise on rhizomes, especially in arctic and alpine plants with a prostrate growth form. (4) Brittle branches may fall from the shrub and form new plants (stem fragmentation). (5) Polycormones may form distinct shrubs if soil level is rising around the plant.

Commissural: Applied to stigmas when the lobes of one carpel are connate to those of the other carpel. Joined across the suture or commissure.

Concave: Margin between base and 0.25 blade length curves toward center of blade.

Connate: Fusion of like structures.

Convex: Margin between base and 0.25 blade length or apex and 0.75 blade length curves away from center of blade. Obtuse.

Cordate: Margin between base and 0.25 blade length with rounded projections with the sides toward petioles straight or convex. Subtype of convex.

Cotaneous: Flowering as the leaves emerge.

Crenate: Teeth of shallow, rounded notches.

Crenulate (leaf margins): Teeth of small, curved indentations.

Cuneate: Margin between base and 0.25 blade length essentially straight.

Falling seasonally.

Deciduous: Decurrent: Margin between base and 0.25 blade length concave basally and straight distally, extending along petiole. Subtype of concave.

Depressed-ovate: A plane shape, egg-shaped but broader than long.

Diamond willows: Characterized by the presence of an elliptic or diamond-shaped depression surrounding a dead branch. The branch and the surrounding cambium was killed by a fungus, usually *Valsa sordida* (Lutz 1958).

Dimorphic buds: *caprea*-type buds.

Dioecious: When some plants have male (staminate) flowers and separate plants have female (pistillate) flowers. All willows are dioecious.

Distal: Toward the tip of a structure, away from point of attachment.

Distinct: Not connate. Separate.

Dorsal: Abaxial; on the side facing away from the main axis. On leaves, the lower surface.

Dwarf shrubs: Plants 0.1 m or less, e.g. S. reticulata. The branches, or at least their tips, are usually erect. In many dwarf species, e.g. *S. rotundifolia,* the leaves and catkins are also diminutive. Other species, e.g. *S. arctica,* may have dwarf stature but leaves and catkins as large as taller shrubs.

Early leaves: Preformed leaves.

Elliptic: A plane shape, L:W 2:1, widest at middle.

Emarginate: Apex deeply notched, 5-25% leaf length.

Entire: Margin forming a smooth line, lacking teeth or undulations.

Epilaminal (of glands): On the upper surface of the blade, in from the margins.

Ferruginous: Rust-colored. Some species may have rust-colored hairs. Species that do may have individuals that lack rust-colored hairs. Other species never have them. The color may be related to the colored resin produced by cottonwoods like *Populus trichocarpa*.

Flaking (epidermis): The epidermis of 2 to 4 year old branches may flake away in three ways. (1) Flaking may occur in irregular, gray sheets which peel from the underly8ing bark. (2) The epidermis may break into a series f closely spaced, short, longitudinal splits. As a gap is formed, a narrow band of yellowish or grayish epidermis separates the bark creating a distinctive pattern. Examples include *S pseudomonticola, S. myrtillifolia,* and probably other members of *S.* section *Hastatae*. (3) The epidermis can flake in many, minute segments. Such plants at first do not appear to have a flaking epidermis, but on branches 3 to 4 years old the grayish epidermis can be seen to be minutely fractured.

Flask-shaped: With a more or less abruptly tapering neck.

Flexible (branches): Branches are considered flexible if they don't break when pressed forward toward the main axis by pressing on them near the base. If some but not all branches break, the branches are considered somewhat brittle.

Floccose: Covered with tufts of soft woolly hairs that tend to rub off.

Floral bract: A small bract subtending the flower. Pistillate floral bracts in *S.* subgenera *Protitea, Salix, and Longifoliae* are deciduous after flowering. For purposes of identifications, if any of the floral bracts on a catkin are deciduous, the sample should be considered to have deciduous bracts.

Flowering branchlet: A short, vegetative shoot which terminates in a catkin. If an abscission layer forms at the top of the flowering branchlet (the base of the peduncle), the catkin will probably fall and leave the flowering branchlets intact on the stem. In a few species in *S.* section *Chamaetia,* the flowering branchlets are the same as normal vegetative shoots except that they terminate in a catkin. The length of the flowering branchlet is measured from its point of attachment to the branch to the point of attachment of the distalmost leaf. Most precocious willows (that flower before the leaves emerge) have no flowering branchlets, though they may have a rudimentary branchlet bearing only cataphylls.

Fragmentation: Breaking apart. Willows that spread by fragmentation usually spread when broken branches take root.

Free: Not adnate. Not attached, not fused. Separate.

Glabrate: Becoming glabrous in age.

Glabrescent: The process of becoming glabrous in age but a few hairs remaining.

Glabrous: Without hairs (trichomes).

Glands – see "petiole glands" and "glands on leaf margins."

Glands (on leaf margins): Each leaf tooth has a spherical gland. Even entire leaves may have glands spaced along the margins. Glands may be right on the margin of the leaf (marginal), slightly in from the edge on the abaxial (lower) surface (submarginal), or well up on the adaxial (upper) surface of the leaf (epilaminal). Glands on entire leaves are best observed on the abaxial (lower) surface.

Glaucous: With a whitish waxy coating which may be polished or removed by rubbing or scratching. (On dried leaves, gently scratch the surface of the leaf with a probe. On plants dried with heat, the waxy coating may melt off of branchlets. Look for small amounts of wax remaining in the axils of leaves or branches or under buds.)

Globose: Solid shape in which length and width are equal; spherical.

Gourd-shaped: Lageniform.

Hairs: Filamentous epidermal outgrowths. Trichomes.

Hairy: With trichomes of some kind, the kind unspecified. Opposite of glabrous.

Height (how to measure in dwarf plants): Height for dwarf shrubs is measured in the field or estimated from herbarium specimens by measuring the portion of the plant that appeared to be above the surface of the soil, turf, or moss. For species with trailing branches, height is estimated by measuring the length of catkins and flowering branchlets.

Hemiamphistomatous: Stomata on leaf adaxial surface only at apex and scattered along veins, but uniformly distributed on abaxial surface.

Hypostomatous: Stomata uniformly distributed on abaxial leaf surface.

Indumentum: General hairiness.

Inner epidermal membrane (in a bud scale): A layer of tissue inside the bud scale. In mature, opened buds, the inner membrane may be free from the outer membrane or it may remain fused (adnate) to it. If free, it may become completely free or remain attached along the margins.

Internode: The space between nodes, on a stem

Juvenile leaves: Young unfolding leaves at distal end of branchlets. Juvenile leaf color should be observed on leaves that have just emerged and area still folded around each other.

Lanceolate: A plane shape, L:W 3:1 or more, widest toward proximal end.

Largest mature leaves, or largest medial leaves: The normal well developed leaves, usual medial on the branchlet (not the smaller leaves low on the branchlets or near the tip).

Lateral bud: a bud along the length of a twig. Compare to terminal bud.

Late leaves: Neoformed leaves.

Layering: Above ground branches root after being buried in moss or in fine wind- or water-borne material.

Leaf base shape: This should be assessed on the proximal 25% of the leaf blade length. It is best observed from the adaxial (upper) side of the leaf. More than one leaf base shape can be found on a single branchlet; nonetheless, it is of some value for identification. In convex, rounded, cordate, and subcordate leaf bases, the blade meets the petiole in a short concave arc. In cuneate leaf bases, the blade meets the petiole directly, running down the petiole a little bit. In decurrent leaf bases, the blade is concave before it joins the petiole.

Leaf scar: A structure below the bud where the previous year's leaf was attached. Compare to terminal scar.

Leaf shape: This should be assessed on the largest medial leaf blades, unless otherwise specified. There are four main classes of shapes. (1) Oblong – widest throughout a zone in the middle leaf. (2) Elliptic – widest at or near the middle of the long axis of the leaf. (3) Ovate – widest between the base and the middle of the log axis. (4) Obovate – widest between the tip and the middle of the long axis of the leaf.

Linear: A plane shape, L:W 10:1, widest in the mid-zone.

Lobate: Margin between base and 0.25 blade length with rounded projections with the sides toward petioles concave. Subtype of concave.

Long-silky: Densely covered with fine, long (0.5 mm or more long), straight, appressed, shiny hairs.

Loosely flowered (catkins): Rachis clearly visible

Lorate: A plane shape, L:W 6:1, widest in the mid-zone. Ligulate.

Low shrubs: Plants 0.15-0.5 m, e.g. *S. myrtillifolia*.

Marcescent: Leaves becoming brown and withered but persisting for 2 or more years.

Marginal (glands): Glands located right on the edge of the leaf blade.

Medial leaves: Leaves near the middle of the branchlet, not near the base or tip. The medial leaves are usually the longest leaves.

Mesic: Middle, intermediate. Mesic areas are not always wet but are not arid. Mesic may also apply to temperature, but generally not with willows.

Mid shrubs: Plants 0.6-2.0 m, e.g. *S. humilis*.

Moderately dense: Surface 50% visible.

Moderately densely flowered (catkins): Rachis partly visible.

Montane: In mountains but below the alpine zone.

Narrowly elliptic: A plane shape, L:W 3:1, widest at middle.

Narrowly oblanceolate: A plane shape, L:W 6:1 or more, widest toward apex.

Narrowly oblong nectary: A slender-rod, 4 or more times longer than wide.

Narrowly oblong: A plane shape, L:W 3:1, widest in the mid-zone.

Narrowly ovate: A plane shape, L:W 2:1, widest toward base.

Nectaries: Glands that produce nectar. They are present between the flower and the rachis (main axis) of the catkin, on the adaxial (ventral) side of the flower. Some species have a second nectary between the flower and the floral bract, on the abaxial (dorsal) side of the flower. Assess abaxial nectaries near the center or tip of the catkin, since the proximal (lowest) flowers can have abnormally shaped nectaries or may have one even if the rest of the flowers do not. Nectaries can be single undivided structures or more or less lobed. If lobed all the way to the base, they are treated as multiple nectaries. If they are connate basally, they are treated as single nectaries. The length of the abaxial nectary does not include the cup, in species that have cup-shaped nectaries. Nectary shape can be assessed on fresh or rehydrated catkins.

Neoformed: Neoformed (late) leaves were not initiated in the bud, but start growth after the branchlet has begun its growth. Neoformed leaves may differ in size and shape from preformed leaves. They may have teeth near the base even if normal leaves are entire. Avoid neoformed leaves when trying to identify the plant.

Non-glaucous: Lacking a waxy coating.

Obclavate: Broadest at proximal end. Inverse club-shaped

Oblanceolate. A plane shape, L:W 3:1, widest toward distal end.

Oblong nectary: A broad-rod, 2-3 times longer than wide.

Oblong: A plane shape, L:W 2:1, widest in the mid-zone.

Obnapiform: Broadest at proximal end. Inverse turnip-shaped.

Obovate: A plane shape, L:W 2:1, widest toward distal end. Inverse egg-shaped.

Obtriangular: A plane shape. Inverted triangle narrowest at the proximal end.

Obturbinate: broadest at proximal end. Inverse top-shaped.

Obtuse: Forming an angle of greater than 90 degrees.

Ovate: A plane shape, L:W 1.5:1, widest toward proximal end. Egg-shaped.

Ovoid: A solid shape widest toward proximal end. Egg-shaped.

Ovule: The "egg" (female gametophytes) from which a seed will form. The number of ovules in the capsule is determined by counting the funicles (little stalks where the ovules were attached) in the opened capsule.

Papillae: Soft superficial glands or protuberances.

Papillate: With papillae.

Papillose: Covered with papillae, as in stigmas.

Pear-shaped: Pyriform.

Peduncle: The naked stalk between the flower-bearing catkin axis and the flowering branchlet or the branch. It may contain one or two isolated flowers or one to several empty floral bracts. Its length is measured from the proximal flower on the main catkin cluster to the point of attachment of the distal leaf on the flowering branchlet or, if no flowering branchlet is present, to the stem. An abscission layer sometimes appears at the proximal end of the peduncle.

Persistent: Not deciduous; not falling seasonally.

Petiole glands: These glands appear as small swellings on the adaxial (ventral) surface of the petiole, usually just below the base of the leaf blade. Occasionally they have little leaf-like outgrowths. Do not confuse them with the glands on the proximal leaf teeth.

Petiole hairs: These hairs are observed on the abaxial (ventral) surface of the petiole. They may be difficult to observe in dried specimens, especially those with deeply grooved petioles.

Petiole. The stalk that holds up the leaf blade. It is part of the leaf, and falls with it. Often buds occur at the base of the petiole. Petiole length is measured from the base of the leaf blade to the point of attachment of the petiole to the branchlet. Petioles are usually flattened to strongly grooved on the adaxial (ventral) surface. Petiole hairs are assessed on the adaxial (ventral) surface.

Pilose: Very sparsely covered with long, soft, wavy or straight, spreading hairs. Shaggy.

Pinnate (leaf veins): Secondary veins arising along the primary rachis.

Pisillate: Associated with the female flower, the one with the pistil (ovary, stigma, style).

Pith: The soft tissue in the center of a twig.

Polycormone: Vegetative reproduction by sprouting at base of main stem to form a hemispheric growth form. If the soil is building up, the polycormone can produce a willow clone.

Precocious: Flowering before the leaves emerge.

Preformed: Preformed (early) leaves are formed in the bud and increase greatly in size as the branchlet grows. Compare to neoformed. The medial preformed leaves (the middle leaves on the branchlet) are most consistent in shape and size in willows, so they are used for identification.

Projections (on peeled branches): Sharp point or conical, pointed projections on peeled woods, often occurring in pairs at the bases of branches but sometimes scattered along the branch. These are apparently indicate where adventitious roots can grow.

Prophyll: A small bract or modified leaf at the base of a branch.

Proximal leaves: The first 2-4 leaves at the base (proximal end) of a branchlet or all leaves on a flowering branchlet. They should not be confused with the cataphylls, which fall early, and lack buds in the axils, and are usually not green.

Proximal: Toward the base of a structure, near point of attachment.

Puberulent: Covered with very sparse, minute, soft, straight or wavy, erect or spreading hairs, scarcely visible to the unaided eye.

Pubescent: Densely covered with short, soft, spreading hairs. Not used for general hairiness.

Pyriform: Pear-shaped

Rachis: Main axis, e.g. of a catkin.

Remotely denticulate: Widely spaced, small, slender teeth extending more or less at right angle to axis.

Remotely or irregularly serrate: Widely separated, uniform teeth with an inclined axis.

Remotely shallowly serrulate (leaf margins): Teeth very shallow, widely spaced.>/

Remotely spinulose-serrulate (leaf margins): Widely spaced elongated teeth.

Retuse: Apex slightly notched, less than 5% leaf length.

Revolute (leaves): With the margins rolled under.

Rhizomes: Underground stems.

Ring scar: The scar from the previous year's terminal bud. It completely surrounds the twig.

Root shoot: Shoots arising from roots.

Rounded: Margin between base and 0.25 blade length or apex and 0.75 blade length forming a smooth arc. Subtype of convex.

Pseudo-termianl bud: A lateral bud at the end of the twig where the branch has broken or died. It can be distinguished form a terminal bud by the present of a leaf scar.

Rudimentary: Used to describe stipules that appear as minute brownish lobes.

Rust-colored (hairs): In species may have ferruginous or rust-colored, sometimes yellowish, hairs. Species that do may have individuals that lack rust-colored hairs. Other species never have them. The color may be related to the colored resin produced by cottonwoods like *Populus trichocarpa.*

Serotinous: Flowering after the leaves have emerged.

Serrate: Uniform large teeth with their axes inclined toward the distal end.

Serrulate: Uniform small teeth with their axes inclined toward the distal end.

Short-silky: Densely covered with short (less than 0.5 mm), soft, straight, appressed, shiny hairs.

Shrub. Much branched woody plant with many main stems, usually not as tall as a tree. Often used in opposition to clonal shrub, therefore, a woody plant with main stems all pointing back to a single origin.

Silky: Densely covered with short or long, soft, straight, appressed, shiny hairs.

Silky-villous: Describes an indumentum that is a combination of appressed, straight, shiny hairs and spreading, straight, shiny hairs.

Slender: More than 4× longer than wide.

Soboliferous: Forming clones by producing shoots directly from the roots.

Sparse: Surface little obscured.

Spindle-shaped: Ellipsoidal.

Spinulose-serrulate (leaf margins): Closely spaced elongated teeth.

Sprout shoot: Vigorous shoots often arising from the basal parts of the plant. Also compensatory growth arising after defoliation, suckers or offshoots. (baseoblast)

Square: About as long as wide.

Squat flask-shaped: Ampulliform.

Stamens: The male reproductive parts of the plant, consisting of the filament (a stalk) and an anther (which produces pollen). Willows usually have 2 to 7 stamens. Filaments may be partially to completely fused. If a species has only one stamen, it may be due to fusion of two stamens (e.g. *S. purpurea*, which has a single filament with two anthers) or the loss of one stamen (e.g. *S. sitchensis*, which has a single filament with a single anther).

Staminate: Associated with the male flower, the one with the stamens.

Stem fragmentation: Branches or branchlets break off, fall to the ground, and root. Plants that regularly reproduce by stem fragmentation have brittle branches.

Stigma: The part of the female flower that receives the pollen. In willows, each stigma is a two-lobed, often U-shaped structure. The lobes are often free from neighboring lobes and are called carinal, or they may be partially or completely connate to neighboring lobes, and called commissural. Commissural stigmas are seen only on styles that are fused to the other style of that ovary. Stigma length is determined by measuring the papillate part of the stigma lobe. If each lobe has a non-papillate part, that is treated as part of the style. Stigmas are variable in length, shape, and location of the papillate, receptive surfaces and there is vocabulary for this, but there are limits to how far I want to go with this.

Stipe: The stalk of an ovary.

Stipule: Outgrowths on either size of the base of the petiole (leaf stalk). Stipules should be evaluated at the base of medial preformed leaves or of neoformed leaves, but not on the proximal leaves (lowest leaves of the branchlet). In most willows, there are no stipules at the base of the proximal leaves, but stipules are present there, they are also present at all other leaves of the plant.

Stomata: The tiny "breathing pores" on the leaf surfaces. They appear as tiny, evenly distributed whitish dots visible under magnification. They're always visible under 30 to 50X magnification, and can often be seen with a hand lens. They are always present on the undersurface of the leaf, and may be present above as well. Amphistomatous leaves have many stomata throughout the upper surface. Hemiamphistomatous leaves have the stomata on the upper surface restricted to the leaf tip or to the margins of veins. Hypostomatous leaves have stomata only on the undersurface of the leaves.

Stout: Structure less than 4× longer than wide.

Striae (on peeled branches): Raised, flat, or crested longitudinal ridges emerging from the wood, visible on branches from which the bark has been removed. Observing striae is easiest if fresh branches are removed, but can be seen by soaking and then stripping dried branches. For purposes of identification using Argus's on-line key, strip bark from a 20-cm section of a branch at least 3 to 4 years old. The branch is considered smooth if it has no more then 0 to 3 widely scattered striae. 3 to 10 striae are sparse, 11 to 30 striae are moderately dense, and more than 30 striae are very dense. The function of striae is unknown, but they may be points of origin for adventitious roots.

Strongly glaucous: Conspicuous bluish or whitish waxy coating.

Style: The stalk connecting the stigma to the ovary. Each willow flower has 2 styles, one for each carpel of the ovary. The styles may be partially to completely fused proximally, or entirely separate. Like the ovaries, styles maybe green (often drying tawny or light brown) or red (drying dark brown). Style length does not include the stigma.

Subalpine: The high elevation zone of transition, where trees are uncommon and some alpine plants can be found.

Subcircular: Length/width ratio (L:W) 1.2:1, widest at middle.

Subcordate: Margin between base and 0.25 blade length slightly lobed, grading from convex to rounded apically to concave as it meets petiole. Similar to concavo-convex.

Subglobose: Slightly longer than wide (1.3-1.1×). Subspherical.

Submarginal (glands): Glands located slightly in from the margins, as seen from the abaxial (lower) side of the leaf.

Sylleptic: Buds of the year emerging without a dormant period.

Tall shrubs: Plants greater than 2.0 m, e.g. *S. discolor*.

Tawny: Light brown.

Teeth / cm: The number of teeth per cm is counted at the midpoint a mature, medial leaf. If teeth are present only near the base or near the tip, the count starts at the lowest (proximal) tooth and runs toward the tip.

Terminal bud: The bud that forms at the end of a twig, after a full year of growth.

Timing of flowering: Catkins may flower before the leaves emerge (precocious), as the leaves emerge (cotaneous), or after the leaves have emerged (serotinous).

Tomentose: Densely covered with short, rather firm, more or less matted or intertwined, hairs erect or spreading.

Transverse lines (on peeled branches): Yellowish or brownish lines composed of closely spaced, minute points. Function unknown.

Transverse-oblong: A plane shape, L:W 2:1, widest in the mid-zone but broader than long.

Trees: Plants of "tree" stature (i.e., tall), with one or few main stems (boles). Compare to shrub.

Triangular: Broadest at proximal end.

Trichomes: Hairs.

Twig: Branchlet. A woody structure in its first year of growth.

Undulate: Wavy, up and down, in and out.

Velvety: Densely covered with short, soft, straight, erect hairs of relatively uniform length.

Ventral: Adaxial: On the side of a structure facing toward the main axis: On leaves, the upper surface:

Ventricose (of a petiole). A ventricose petiole has the base inflated and inclosing a mature floral bud: Not seen in Oregon willows:

Very broadly oblong. A plane shape, L:W 1.2:1 or less, widest in the mid-zone.

Very broadly obovate: A plane shape, L:W 1:1 or less, widest toward apex.

Very broadly ovate: A plane shape, L:W 1:1 or less, widest toward base.

Very densely flowered (catkins): Rachis not visible.

Very densely: Surface obscured.

Very narrowly elliptic: A plane shape, L:W 6:1 or more, widest at middle.

Vestiture: Whatever covers the surface, usually hairs

Villous: Somewhat densely covered with long, soft, straight or wavy, spreading hairs.

Wart-like gland: a small, raised structure, simple or branched.

Water shoots: These branches arise from a trunk or branch that is several years old, from latent buds. In willow, they often arise from low on the plant, even from under ground. Their leaves are often much bigger, more deeply serrate, with larger stipules compared to normal, preformed leaves. They should be avoided when trying to identify a plant. Often a plant represented only by water shoots cannot be identified, until normal shoots are produced in a later year.

Weakly glaucous: Wax visible only when scratched or as isolated crystals.

Woolly: Very densely covered with long, soft, spreading, wavy, more or less matted or intertwined hairs.

Salix (Willows) of Oregon

Carex Working Group
1377 NW 13th Street
Corvallis, Oregon 97330
CarexWorkingGroup.com

The better llustrations come from *Salix* (Willows) in the New World, a Guide to the Interactive Identification of Native and Naturalized Taxa Using Intkey (Delta), by George W. Argus, 2007. Use by permission

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Some Issues for Identification

Branches brittle or not? Gently move a branchlet toward the branch. Does it break at the base? It was brittle. Not? It was flexible.

Leaf traits (especially shape and size) should be assessed onl on the *largest medial preformed leaves*. What does that mean? Last year's branches have buds that overwintered. These overwintering buds produce preformed branchlets that produce catkins and preformed leaves. These preformed branchlets soon produce buds that will produce additional branchlets, the neoformed branchlets. Therefore, the preformed leaves are on the oldest leafy branches. Neoformed branchlets don't have catkins (except sometimes in *S. exigua*). Leaf shape and size are much more variable on neoformed than on preformed branchlets. Therefore, you need to assess these traits only on preformed branches (the ones that also produced catkins, which have probably fallen, leaving bare nodes along the branchlet). Note that the neoformed branchlets are often more conspicuous because they're closer to the end of the branch (as we see it in mid-summer) and often larger. The lowest leaves on any one branchlet and those by the tip are often smaller and may differ in shape, so only assess the largest ones in the middle of the preformed branchlet.

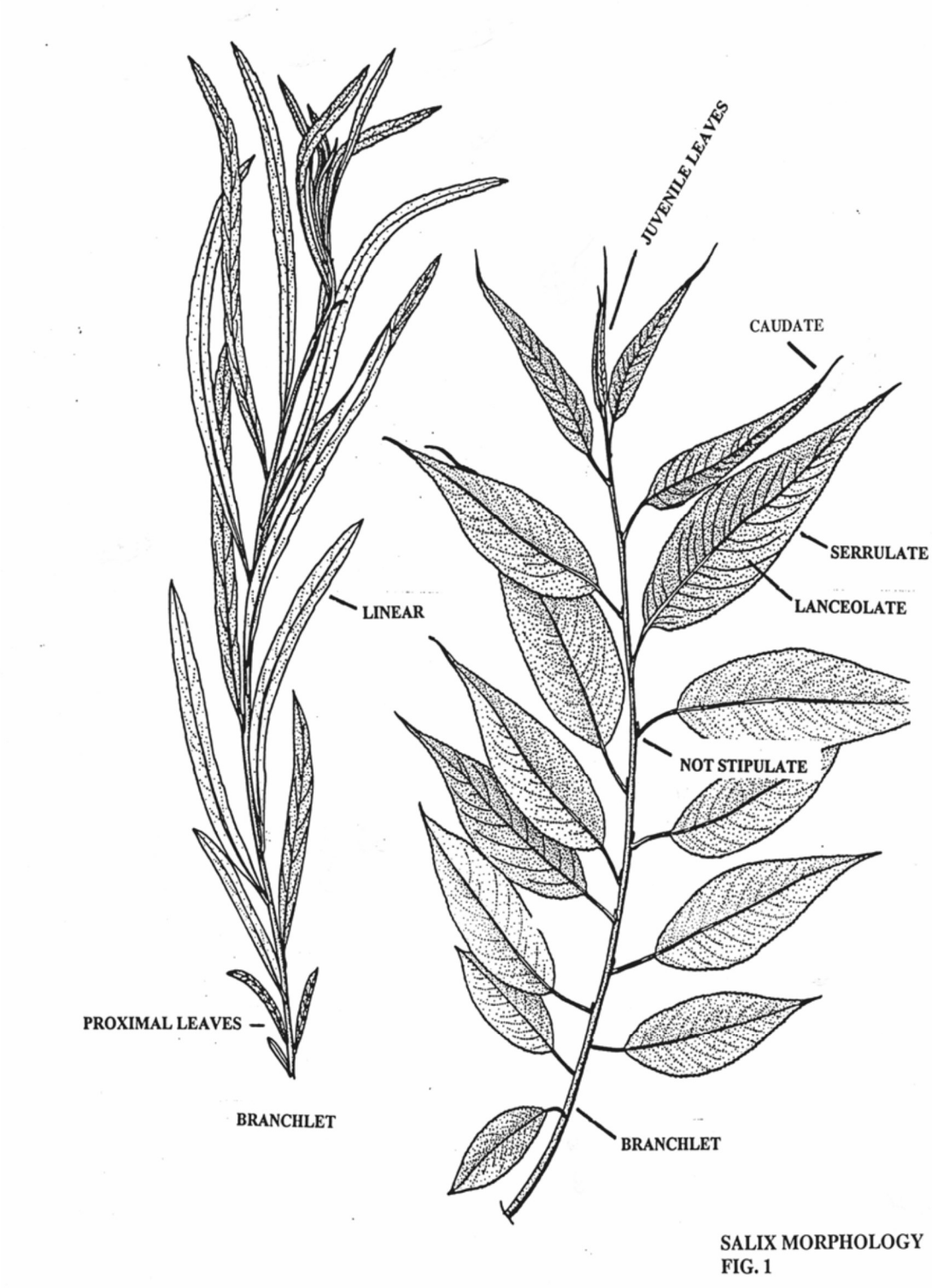
Watershoots are big, vigorous shoots that come up out of the ground this year. They can be very conspicuous but avoid using them for identification. Their leaves are often atypical in shape and much larger than the preformed leaves.

Bud margins fused or overlapping? In *Salix,* there is only one bud scale. It is formed from the fusion of two prophylls. In most species, the scale margins are fused on both the adaxial (ventral) side and the abaxial (dorsal) side. The ventral side is the one toward the stem. Bud scales usually look like little caps, usually rounded at the tip. The scale margins are fused only on the abaxial (dorsal) side in a few species, *S. amygdaloides* and *S. laevigata*. On the adaxial (ventral) side, the scale margins overlap. The adaxial margin is often off-center and can be surprisingly hard to see. The margin structure may be seen best by cutting a cross section of the scale. Note that bud scales usually split as bud itself grows, so only dormant buds can be used to assess whether the bud scale margins were fused or not.

Hybrids. Most willows that can't be identified are just hard to key, not hybrids. Suspect that your plant is actually a hybrid if it has any of these traits: (1) Capsules that have hairs in line or patches, instead of being either hairy or glabrous all over. (2) Catkins with a mix of male and female flowers (3) Plants that have both male and female catkins. (4) Some capsules are well developed while others are not. (5) None of the capsules are well developed even though the plant if obviously past flowering time.

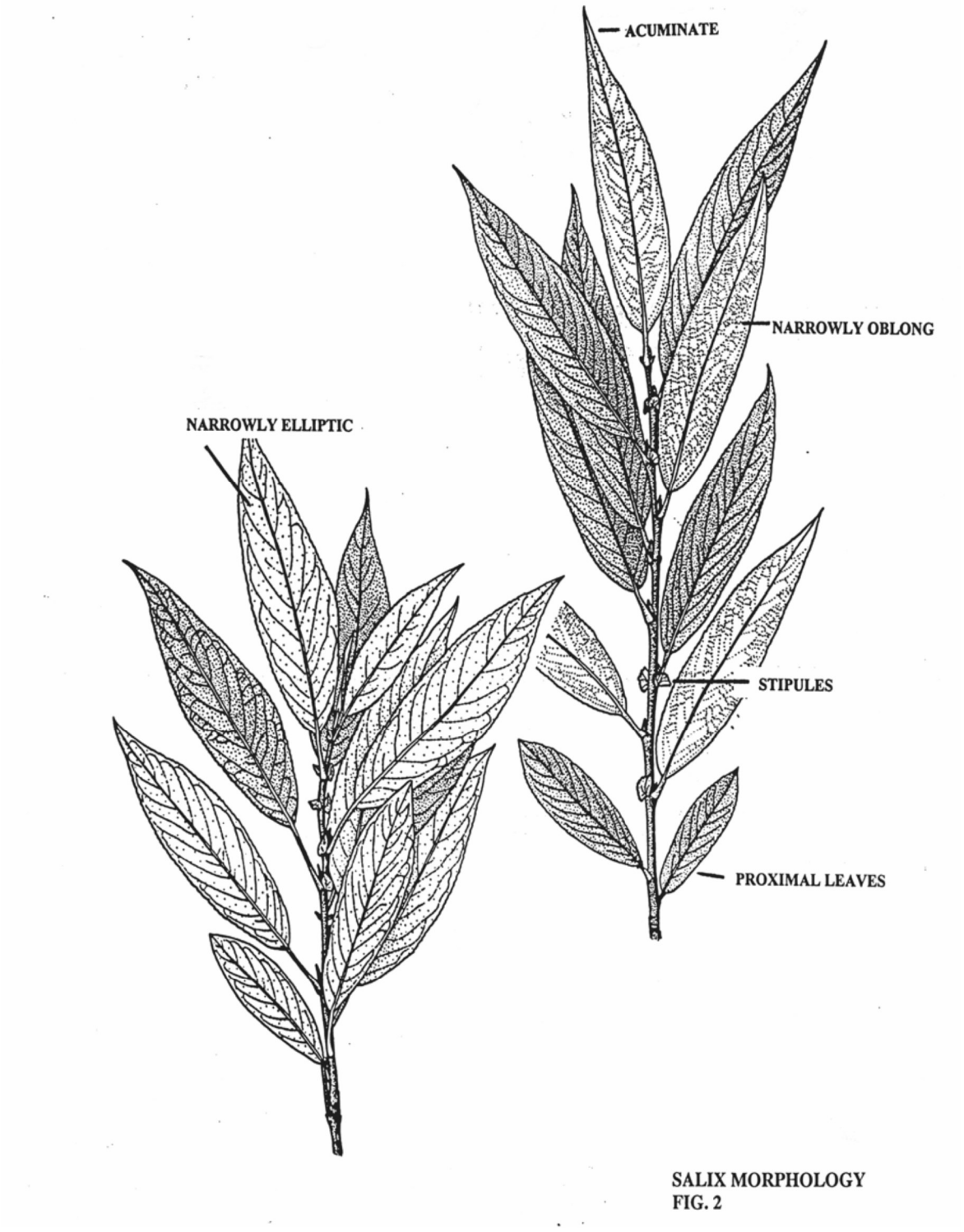
Respect sedge meadows! Wet meadows with saturated, peaty, anoxic soils are home to diverse sedge and other native species. Do not plant willows in them. If respect for plant diversity is not enough to stop you, remember that willows require looser, well-aerated soils and will die in sedge meadows. So don't plant them there.

Willow Leaf Traits



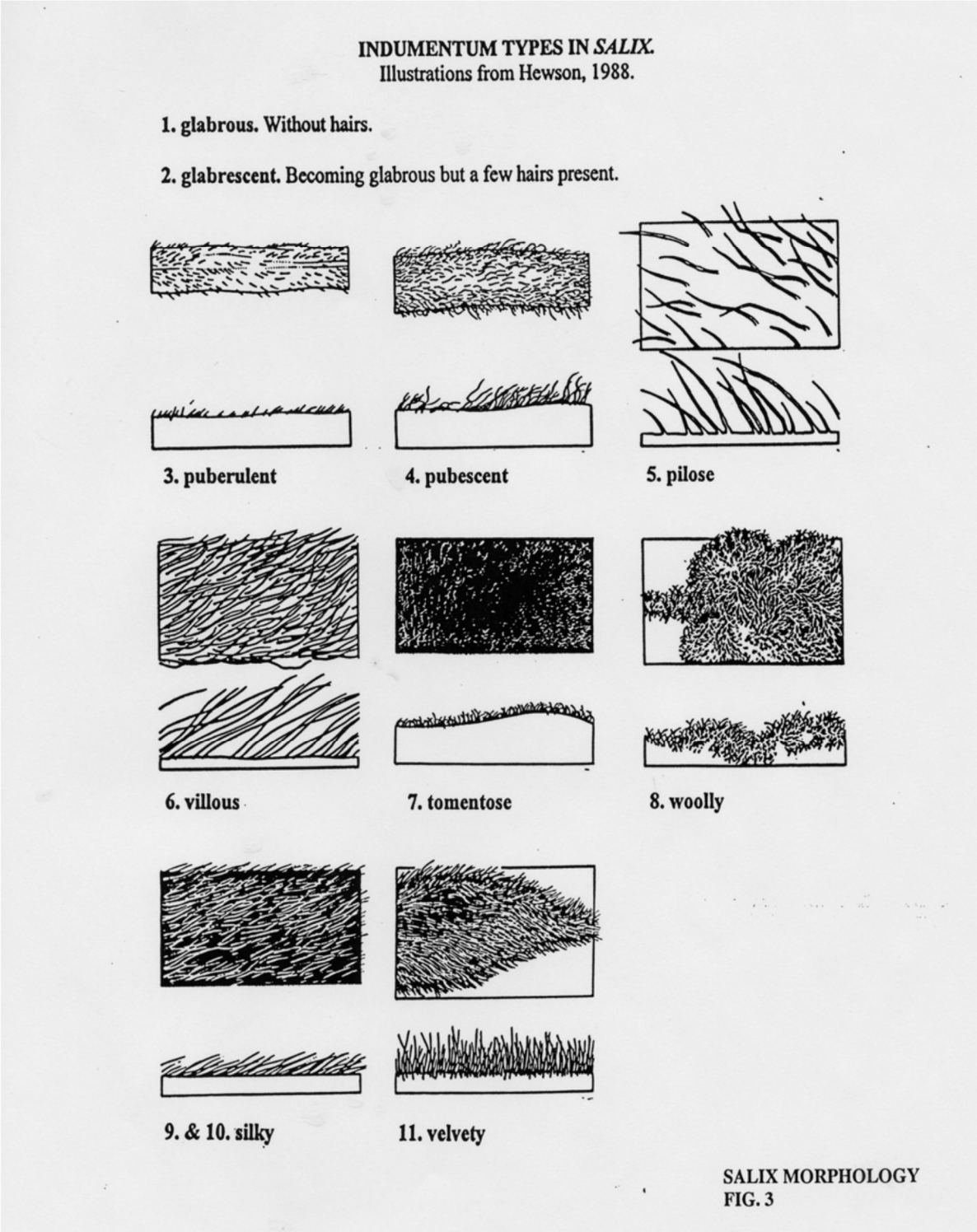
SALIX MORPHOLOGY
FIG. 1

Willow Leaf Traits

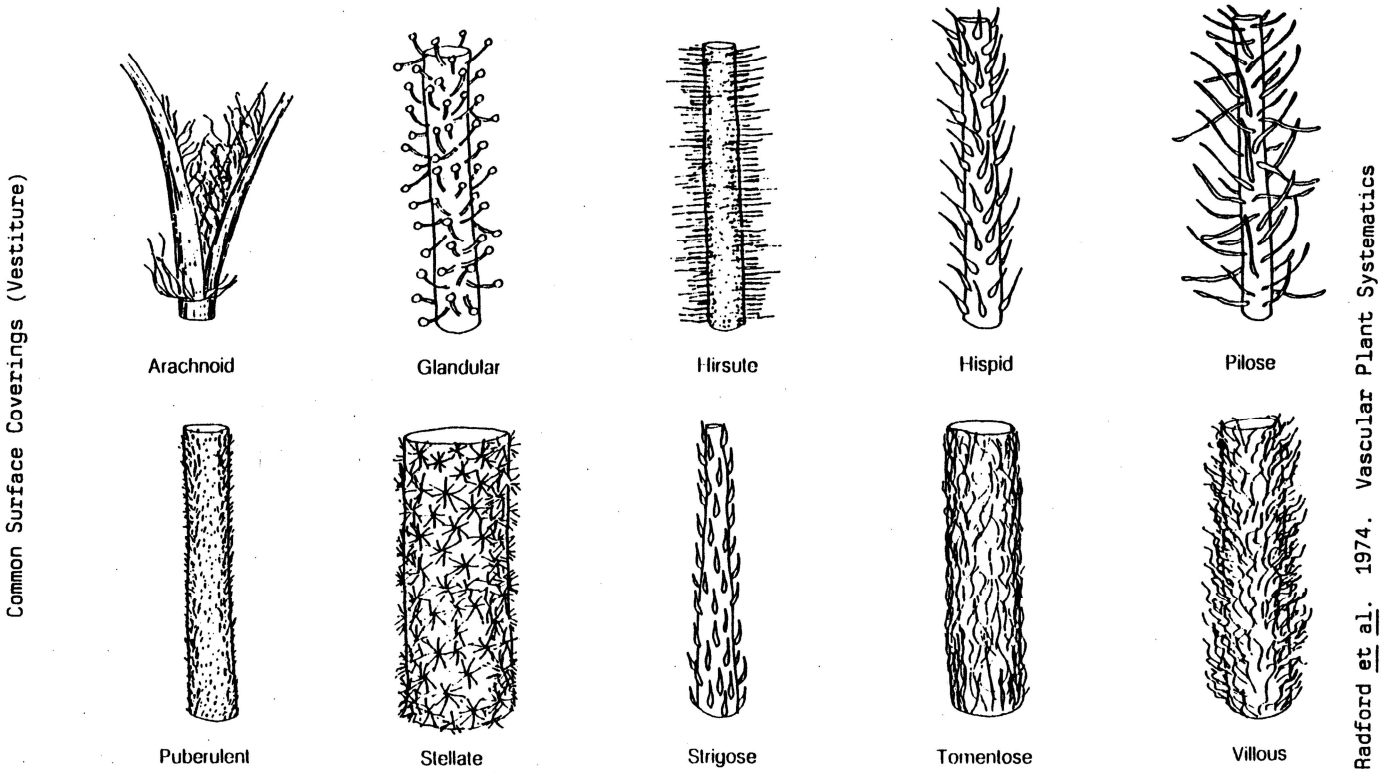


SALIX MORPHOLOGY
FIG. 2

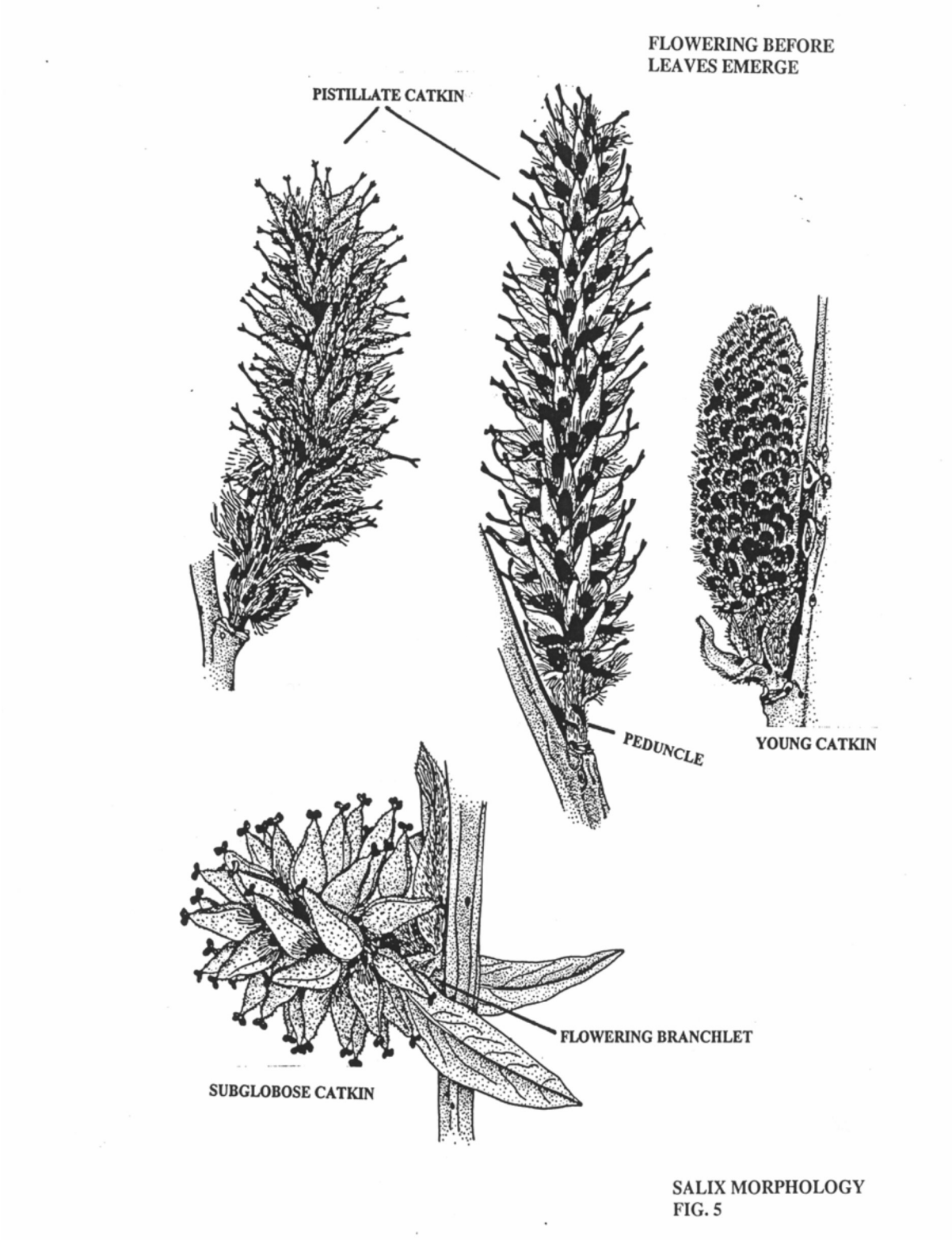
Willow Indumentum (Hair) Types



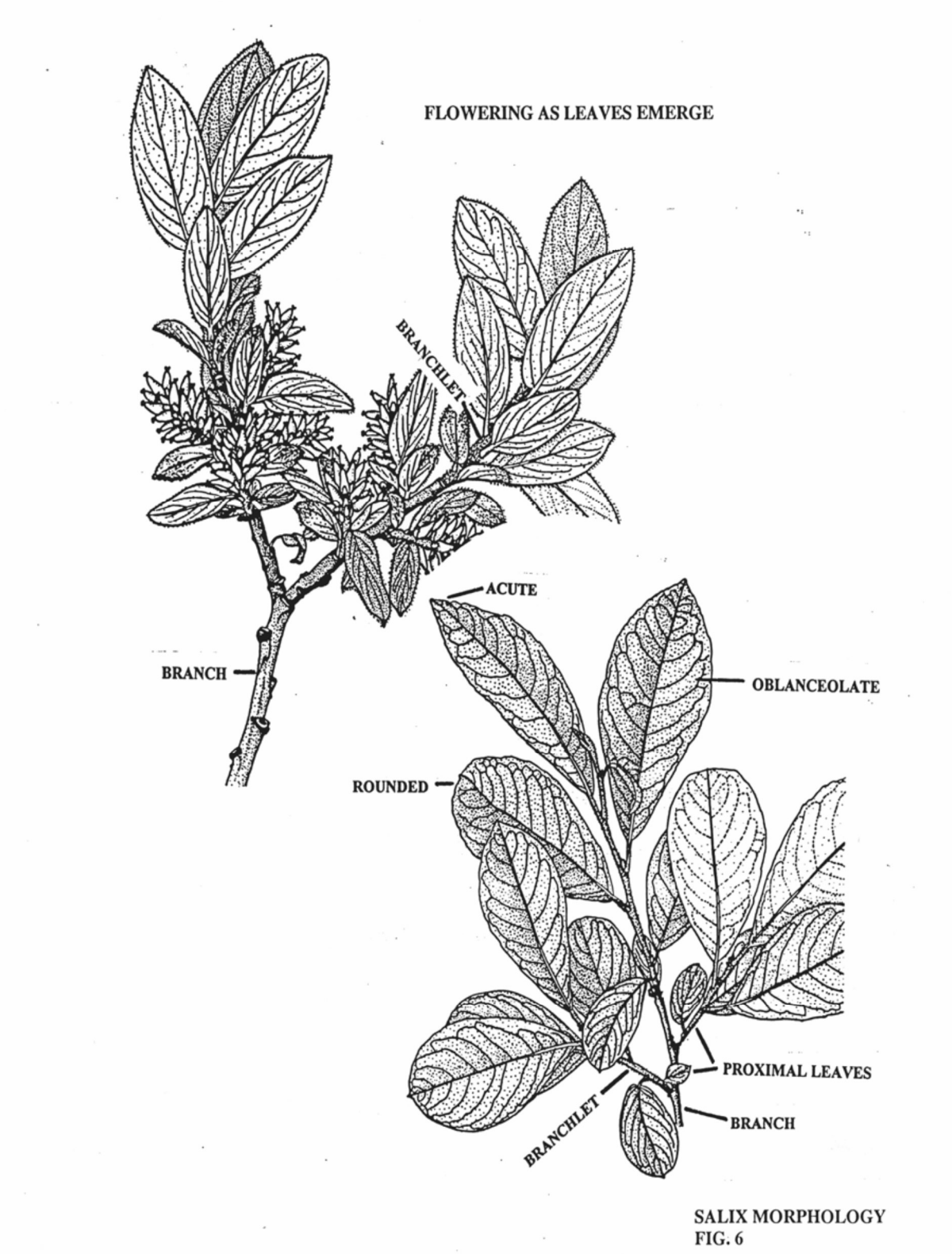
Types of hairs.



Precocious Pistillate Catkins

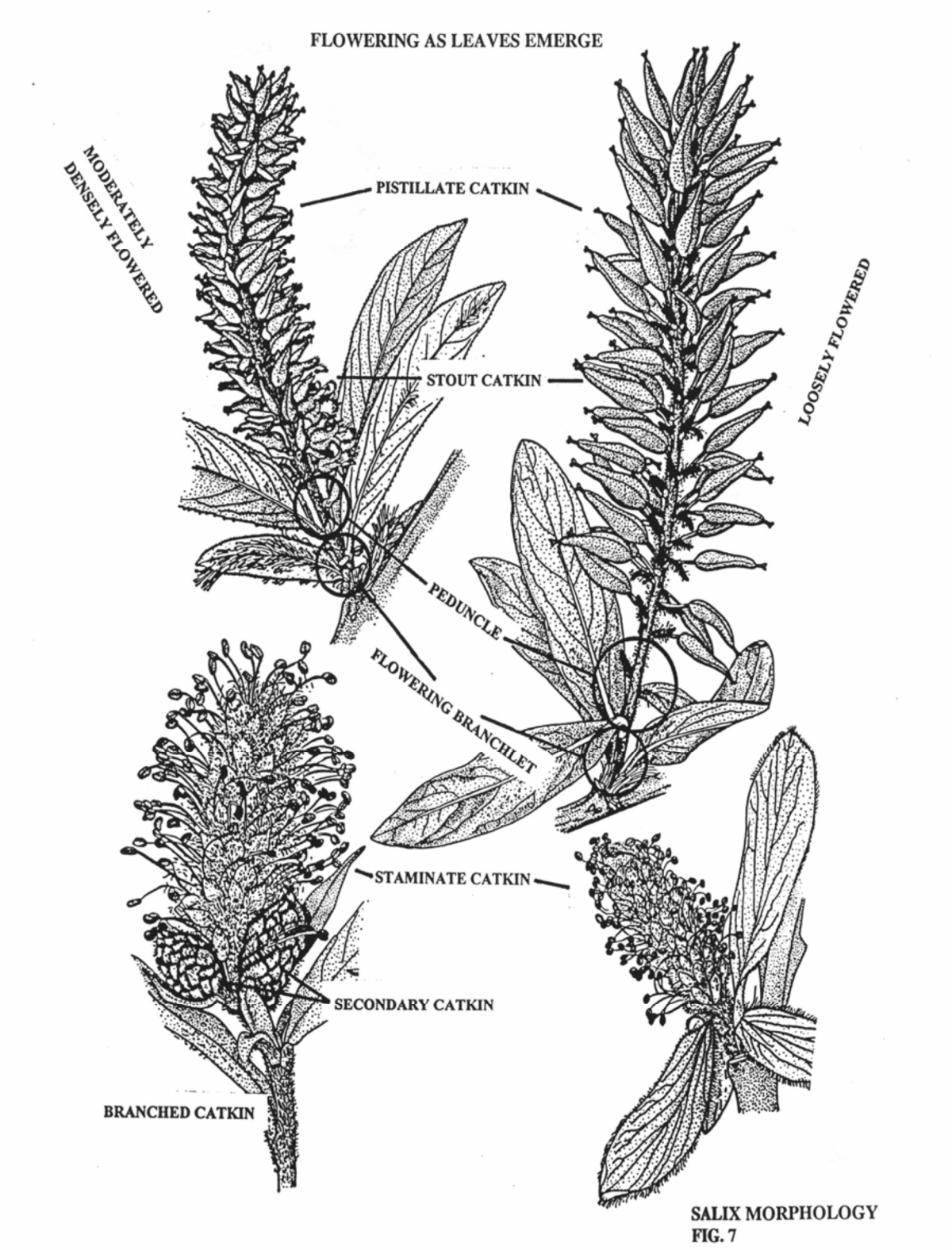


Cotaneous Pistillate Catkins



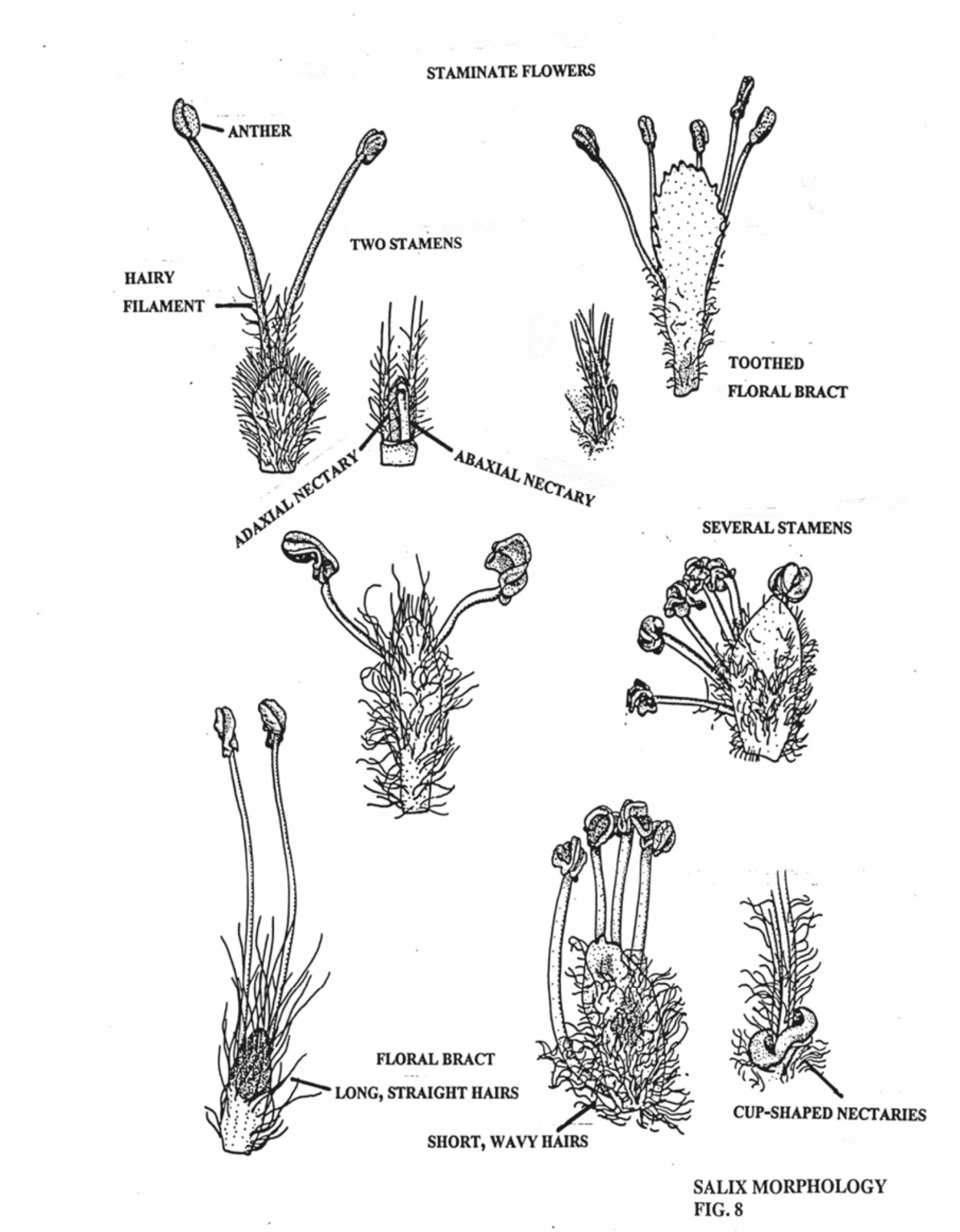
SALIX MORPHOLOGY
FIG. 6

Cotaneous Catkins, Pistillate and Staminate



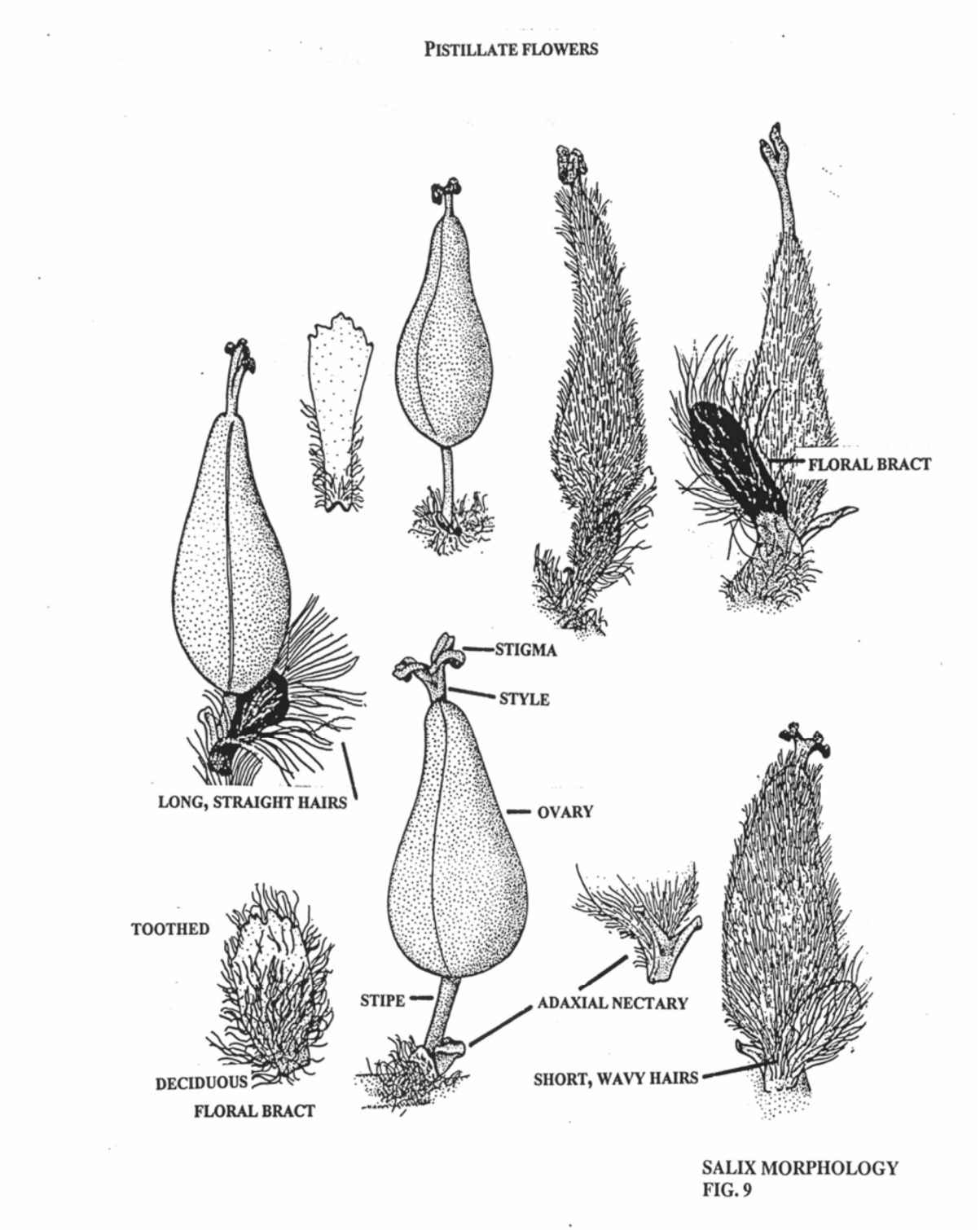
SALIX MORPHOLOGY
FIG. 7

Staminate Willow Flowers



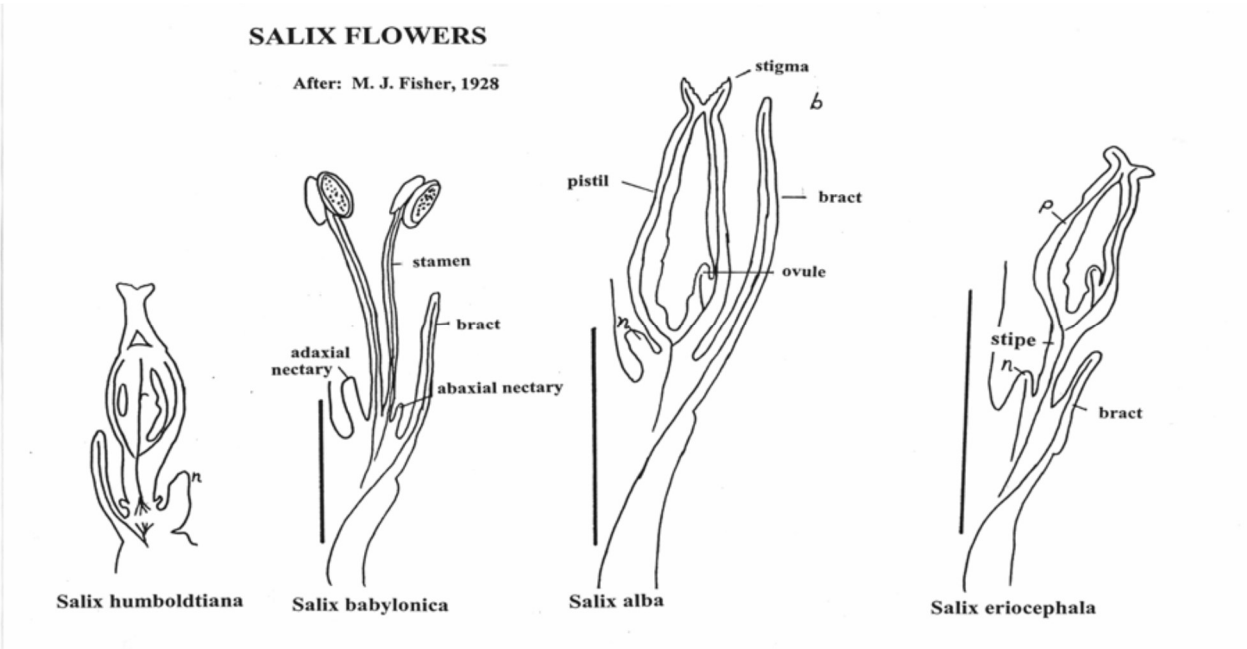
SALIX MORPHOLOGY
FIG. 8

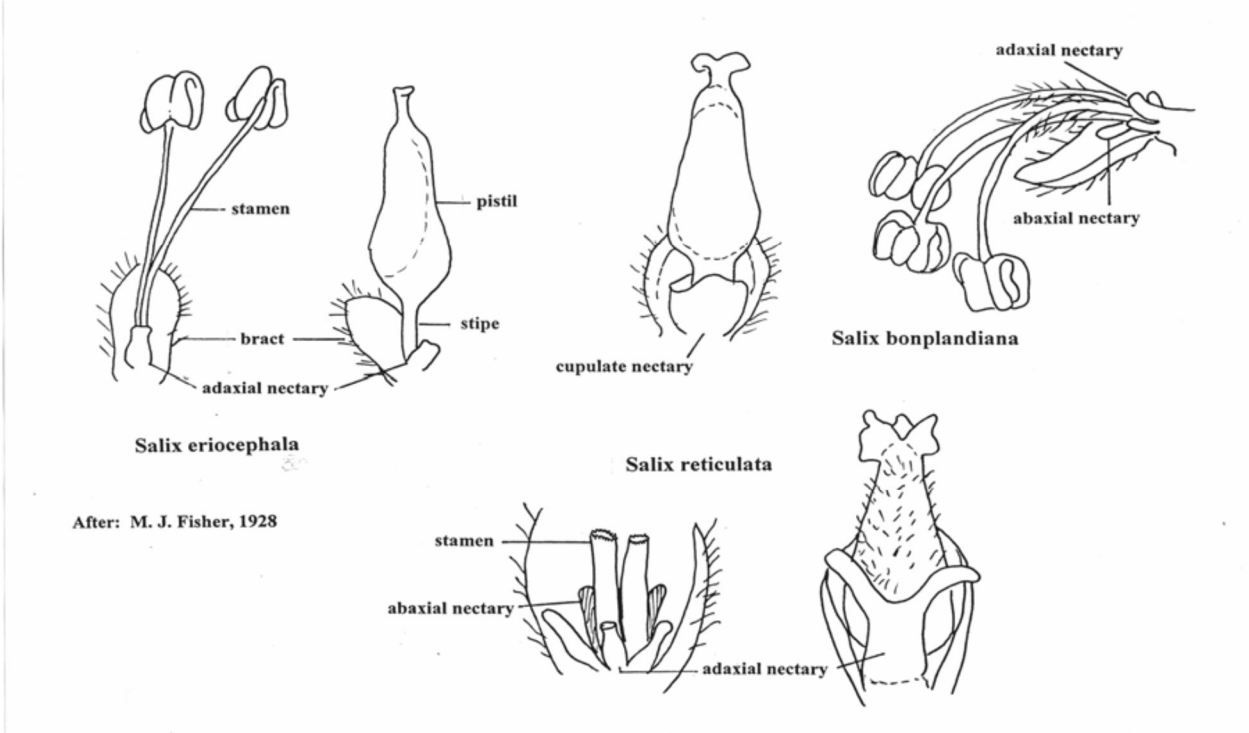
Pistillate Willow Flowers



SALIX MORPHOLOGY
FIG. 9

Willow Flowers





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Newsholme, Christopher. 1992. Willows – the Genus *Salix*. Timber Press, Portland, Oregon. (Garden emphasis. Much information, plus descriptions of many species from throughout the world, some nice illustrations. Coverage of wild species not used in the garden is limited, but some Oregon species are included.)

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Flora of Oregon, Volume 3, whenever it comes out, will have a good key to willows.

Oregon Flora project (https://oregonflora.org/) has good photos and maps and will eventually have descriptions.

Some basic on-line on restoration with willows:

https://dep.wv.gov/wwe/getinvolved/sos/documents/more/restorationusingwillows.pdf
https://www.nrcs.usda.gov/plantmaterials/mtpmctn6023.pdf
https://riversedgewest.org/sites/default/files/2022-06/WRV_Willow_Training_Manual.pdf

Oregon *Salix* Synonyms Used in Four Major Floras

Argus 2010 (FNA)	Dorn 2010	H&C 1964	Intermountain Flora	*Carex* Working Group
S. amygdaloides	*S. amygdaloides*	*S. amygdaloides*	*S. amygdaloides*	*S. amygdaloides*
S. barclayi	*S. barclayi*	*S. barclayi*	*S. barclayi*	----
S. bebbiana	*S. bebbiana*	*S. bebbiana*	*S. bebbiana*	*S. bebbiana*
S. boothii	*S. boothii*	*S. myrtillifolia*	*S. boothii*	*S. boothii*
S. brachycarpa var. *brachycarpa*	*S. brachycarpa* var. *brachycarpa*	*S. brachycarpa*	*S. brachycarpa*	*S. brachycarpa* var. *brachycarpa*
S. commutata	*S. commutata*	*S. commutata*		*S. commutata*
S. delnortensis	*S. delnortensis*	N/A	N/A	*S. delnortensis*
S. drummondiana	*S. drummondiana*	*S. drummondiana*	*S. drummondiana*	*S. drummondiana*
S. eastwoodiae	*S. eastwoodiae*		*S. eastwoodiae*	*S. eastwoodiae*
S. columbiana	*S. exigua* ssp. *exigua* var. *columbiana*	*S. fluviatilis*		*S. exigua* var. *columbiana*
S. exigua var. *exigua*	*S. exigua* ssp. *exigua* var. *exigua*	*S. exigua* ssp. *exigua*	*S. exigua*	*S. exigua* var. *exigua*
S. exigua var. *hindsiana*	*S. exigua* ssp. *exigua* var. *hindsiana*	N/A	*S. exigua*	*S. exigua* var. *hindsiana*
S. farriae	*S. farriae*			*S. farriae*
S. geyeriana	*S. geyeriana*	*S. geyeriana*	*S. geyeriana*	*S. geyeriana*
S. glauca var. *villosa*	*S. glauca* var. *villosa*	*S. glauca*	*S. glauca*	*S. glauca* var. *villosa*
S. hookeriana	*S. hookeriana*	*S. hookeriana, S. piperi*	N/A	*S. hookeriana*
S. jepsonii	*S. stichensis* var. *anguistifolia*	N/A	N/A	*S. sitchensis* var. *angustifolia*
S. laevigata	*S. bonplandiana* var. *laevigata*	N/A	*S. laevigata*	*S. laevigata*
S. lasiandra ssp. *caudata*	*S. lasiandra* ssp. *caudata*	*S. lasiandra* ssp. *caudata*	*S. lucida* var. *caudata*	*S. lasiandra* ssp. *caudata*
S. lasiandra ssp. *lasiandra*	*S. lasiandra* ssp. *lasiandra*	*S. lasiandra* ssp. *lasiandra*	*S. lucida* var. *lasiandra*	*S. lasiandra* ssp. *lasiandra*
S. lasiolepis	*S. lasiolepis*	*S. lasiolepis*	*S. lasiolepis*	*S. lasiolepis*
S. lemmonii	*S. lemmonii*	*S. lemmonii*	*S. lemmonii*	*S. lemmonii*
S. ligulifolia	*S. eriocephala* ssp. *mackenzieana* var. *ligulifolia*	N/A	*S. eriocephala* var. *ligulifolia*	*S. ligulifolia*
S. lutea	*S. eriocephala* ssp. *mackenzieana* var. *watsonii*	*S. rigida* var. *watsonii*	*S. eriocephala* var. *watsonii*	*S. lutea*
S. melanopsis	*S. melanopsis*	*S. exigua* ssp. *melanopsis*	*S. melanopsis*	*S. melanopsis*
S. monochroma	*S. eriocephala* ssp. *mackenzieana* var. *monochroma*	*S. rigida* var. *mackenzieana*	*S. eriocephala* var. *monochroma*	*S. monochroma*
S. nivalis	*S. reticulata* var. *nana*	*S. nivalis*	*S. reticulata*	*S. nivalis*
S. orestera	*S. orestera*	N/A		*S. orestera*
S. pedicellaris	*S. pedicillaris*	*S. pedicellaris*	N/A	*S. pedicellaris*

Argus 2010 (FNA)	**Dorn 2010**	**H&C 1964**	**Intermountain Flora**	***Carex* Working Group**
S. petrophila	*S. arctica* var. *petraea*	*S. arctica*	*S. arctica*	*S. petrophila*
S. planifolia	*S. planifolia*	*S. phylicifolia* var. *monica*	*S. planifolia*	*S. planifolia* var. *monica*
S. planifolia	*S. planifolia*	*S. phylicifolia* var. *pennata*	*S. planifolia*	*S. planifolia* var. *planifolia*
S. prolixa	*S. eriocephala* ssp. *mackenzieana* var. *mackenzieana*	*S. rigida* var. *macrogemma* and probably *S. rigida* var. *mackenzeiana*	*S. eriocephala* var. *mackenzieana*	*S. prolixa*
S. scouleriana	*S. scouleriana*	*S. scouleriana*	*S. scouleriana*	*S. scouleriana*
S. sessilifolia	*S. exigua* ssp. *exigua* var. *sessilifolia*	*S. sessilifolia*	N/A	*S. exigua* var. *sessilifolia*
S. sitchensis	*S. sitchensis*	*S. sitchensis*	*S. sitchensis*	*S. sitchensis* var. *sitchensis*
S. tracyi	*S. tracyi*	N/A	N/A	*S. tracyi*
S. vestita	*S. vestita*	*S. vestita*		*S. vestita*
S. wolfii var. *idahoensis*	*S. wolfii* var. *idahoensis*	*S. wolfii* var. *idahoensis*	*S. wolfii* var. *idahoensis*	*S. wolfii* var. *idahoensis*
Introduced Species				Introduced Species
S. alba	*S. alba*			*S. alba*
S. discolor	*S. discolor*			*S. discolor*
S. euxina	*S. fragilis* ?		*S. fragilis*	*S. euxina*
S. x *fragilis*	*S. fragilis*		*S.* x *rubens*	*S.* x *fragilis*
S. x *pendulina*				*S.* x *pendulina*
S. purpurea	*S. purpurea*	N/A	N/A	*S. purpurea*
S. sepulcralis	(not included)			*S.* x *sepulcralis*

Argus 2010 = Argus, George W. 2010. Salix. pp. 23 – 162 *in* Flora of North America Editorial Committee, editors. Flora of North America North of Mexico, Volume 7. Magnoliophyta: Salicaceae to Brassicaceae. Oxford University Press, New York. (Keys organized by subgenus plus descriptions, with some species illustrated with line drawings. The material is also available on line at http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=10787)

Dorn 2010 = Dorn, Robert. 2010. The Genus Salix in North America North of Mexico. http://www.lulu.com/product/ebook/the-genus-salix-in-north-america-north-of-mexico/6517733 {Free pdf file with keys organized by subgenus, plus descriptions)

H&C 1964 = Hitchcock, C. Leo, Arthur Cronquist, Marion Ownbey, and J. W. Thompson. 1964. Vascular Plants of the Pacific Northwest. Part 2: Salicaceae to Saxifragaceae. University of Washington Press, Seattle, Washington. (Keys, descriptions, illustrations, extensive synonymy.)

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Table 1. Varieties of *Salix exigua,* the clonal willow.

Trait	***S. exigua exigua***	***S. exigua hindsiana***	***S. exigua columbiana***
Juvenile leaves, hairs	long-silky	short-silky	short-silky
adult leaves	glabrescent, long-silky	short-silky	pubsecent, short-silky, long-silky
Pistillate catkins	loosely flowered	moderately to very densely flowered	moderately to very densely flowered
Pistillate catkins, abaxial nectary	present/absent	absent	present/absent
Plant height	0.5 – 5 m	1 – 17 m	2 – 6.5 m
Branches, 1 – 2 yrs old (all may have yellow branches of the year)	yellow-brown gray-brown redbrown	 gray brown red-brown	 red-brown
Petioles, length	1.5 – 8 mm	1 – 4 mm	2 – 5 mm
Leaves, length	30 – 143 mm	39 – 96 mm	5.8 – 12.5 mm
Leaves, width	2 – 8 mm	5.3 – 13.5 mm	5 – 17 mm
Leaves, length/width ratio	10 – 37.5	6.5 – 31	5.7 – 13.8
Leaves, shape	linear, lorate	linear, very narrowly elliptic, narroly elliptic	linear, very narrowly elliptic
Leaves, upper surface	shiny	shiny, dull	dull
Leavs, lower surface	glaucous or obscured by hair	not glaucous, glaucous, or obscured by hair	glaucous or obscured by hair
Ovary, stipe length	0.2 – 0.9 mm	0 – 0.2 mm	0.2 – 0.7 mm
Stigma lobe, length	0.25 – 0.5 mm	0.35 – 1 mm	0.3 – 1 mm
Ovary, hairs	glabrous or hairy	glabrescent to very hairy	hairy
Capsule, hairs	glabrous	glabrous or hairy	glabrous, hairy
Stipules, on early leaves	absent to vestigial	vestigial	absent, vestigial, foliaceous
Stipules on late leaves	vestigial to foliaceous	vestigial to foliaceous	vestigial to foliaceous
Pistillate catkin rachis length	10 – 60 mm		35 – 90 mm
Pistillate flowering branchlet	2 – 65 mm		11 – 160 mm
Pistillate flower bract	moderately dense		sparse

Table 2. Traits of wild tree willows in eastern Oregon. Pistillate flower bracts are deciduous. Weeping Willow is also a tree but rarely escapes. Its yellow branches hang down (Weeping Willow) or are contorted (Matsudana)

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Trait	**S. amygdaloides**	**S. x fragilis**	**S. lasiandra var. caudata**	**S. lasiandra var. lasiandra**
	Peach-leaf W.	**Brittle W.**	**Shining W.**	**Pacific W.**
Stems, at base	flexible to somewhat brittle	very brittle	very brittle	very brittle
Branch tips	**nodding**	spreading to erect	spreading to erect	spreading to erect
Petiole glands	present or absent	present	present (usually)	present (usually)
Leaf L/W ratio	2.8-6	4.2-7.3	3.1-9.8	3.1-9.8
Leaves	hypostomous, sometimes amphistomous	amphistomous	amphistomous	hypostomatous or hemiamphistomatous (rarely amphistomatous)
Leaf, below	glaucous	glaucous (or not glaucous -- FNA)	**green**	glaucous
Leaf hairs	white or white & rusty	**white**	white or white & rusty	white or white & rusty
Leaf tip	caudate to acuminate	acute to acuminate	caudate to acuminate	caudate to acuminate
Stamen/flower	3 to 7	**2**	3 to 6	3 to 6
Pistillate bracts	deciduous	deciduous	deciduous	deciduous
Stipe length	0.1-0.6 mm	0.3-0.5 mm	0.8-4 mm	0.8-4 mm
Ovules/ovary		6-12 (sterile)	16-30 (fertile)	16-30 (fertile)

Table 3. *Salix eastwoodiae* and *S. commutata*. Shrubs with leaves hairy on both sides. Generally at moderately high elevations, though perhaps *S. eastwoodiae* reaches fairly low elevations in central Oregon.

Trait	***S. commutata***	***S. eastwoodiae***
2x =	38	76
Ovaries	glabrous (rarely hairy)	hairy (silky, glabrescenct w/ age)
Leaf blades	sometimes amphistomatous	hypostomatous
Leaf L/W ratio	1.5 – 3.4	1.8 – 5
Leaves, teeth	0 – 19 / cm	0 – 10 / cm
Leaves, upper surfaces	glabrous or pilose to villous	tomentose or long-silky
Floral bracts	tawny to brown	brown to black
Staminate and pistillate adaxial nectaries	oblong to square	narrowly oblong to obong
Leaf blades, lower surfaces	not glaucous, moderately densely tomentose, villous, or pilose to glabrescent, hairs wavy or straight	not glaucous, pilose, short-silky, or densely woolly-tomentose to glabrescent, hairst wavy
Hairs, juvenile leaves	white	white (sometimes also yellow)

Table 4. Three shrubs with leaves green on both sides: *Salix boothii, Salix eastwoodiae,* and *S. monochroma*. *Salix eastwoodiae* is not closely related to the others. Its leaves are thicker and tend to be hairy on both sides.

Trait	***S. boothii***	***S. monochroma***	***S. eastwoodiae***
Capsules	glabrous	glabrous	hairy (sparsely to densely; sometimes glabrescent)
Branchlets	glabrous or hairy	glabrous or hairy	hairy
Twigs; hairs	absent or appressed and wavy	absent or stiff and spreading	xxxxxxxxxx
Leaf undersurface hairs	glabrous or hairy	glabrous or hairy	hairy
Branches	yellow (or red-brown)	yellow-brown, red-brown	yellow, red, violet
Leaves	thicker	thinner, translucent	thicker yet
Leaf base	tapering, usually (convext to subcordate)	cordate to truncate, usually (convex to cordate)	(convex to cordate)
Stipules	usually rudimentary	usually well developed	well developed
Leaf margins	entire to serrulate, the glands more or less paralleling the leaf margin, not prominent	serrulate, the glands more or less paralleling the leaf margin, not prominent	prominent glands on lower margins stand out at right angles to leaf margin
	glands do thick out	glands tend not to stick out	
Leaf texture	medium to thick	thin	thick
Largest leaves, L	26 – 102 mm	42 – 100 m	23 – 99 mm
Largest leaves, W	8 – 30 mm	14 – 35 mm	8 – 37 mm
Largest leaves, L/W	2 – 5.2	1.8 – 3.9	1.8 – 5
Largest leaves, teeth/cm	2 – 19	7 – 14	0 – 10
Leaf bases	not truncate (or only a few truncate); rounded to acute	often truncate; rounded to acute or convex	rounded, convex, subcordate, or cordate
Juvenile leaves	not reddish	often reddish	yellowish green
Juvenile leaves, hairiness	hairy	hairy or glabrous	hairy
Staminate catkins, fl. rachis	6 – 26 mm	21 – 52 mm	9 – 40 mm
Staminate catkin, w/ peduncle	7 – 27 mm	24 – 43 mm	9.5 – 36.5 mm
Pistillate catkins	very densely or moderately densely flowered	moderately densely or loosely flowered	very densely or moderately densely flowered
Pistillate catkins	fat, fuzzy caterpillars	starving caterpillars	
Pistillate catkin, fl rachis	10 – 70 mm	30 – 70 mm	10 – 43 mm
Pistillate catkin, w/ peduncle	12 – 62 mm	33 – 73 mm	11 – 51 mm
Pistillate fl, floral bract	hairy throughout, hairs longer	usually glabrous near the tip, hairs shorter	hairy
Pistillate fl, stipe L	0.5 – 2(-2.5) mm	(1.4-)2-3(-3.6) mm	0.18 – 1.6 mm
Pistillate fl, style L	0.2 – 1.4 mm	0.2 – 0.5 mm	0.5 – 1.5 mm
Pistillate fl, capsule L	2.5 – 6 mm	3.6 – 5.2 mm	4 – 10 mm

Table 5. Three willows with strongly glaucous young twigs: *Salix drummondiana* vs. *S. geyeriana* and *S. lemmonii*. Leaves are typically white below. Ovary hairy. Hairs white or white-and-rusty.

Trait	***S. drummondiana***	***S. geyeriana***	***S. lemmonii***
Leaf length	40-85 mm	32-89 mm	44-110 mm
Leaf width	9-26 mm	5.5-14 mm	6-22 mm
Leaf L/W ratio	3-6.2	3.6-8.4(11.3)	3.4-9.9(-12)
Lower surface	often obscured by hairs; densely short- to long-silky	glabrous to densely short- or long-silky	sparsely short- or long-silky to glabrescent
♂flowering branchlet length	0 mm	1-5 mm	1-3 mm
♂catkin length	19-40 mm	(1-)11-18 mm	(1.4-)16-28 mm
♂catkin width	8-20 mm	6-11 mm	9-17 mm
♂catkin	stout	globose	stout
♀flowering branchlet length	0-3(-6) mm	1-5 mm	1-6 mm
♀catkin length	22-87(-105 in fruit) mm	8-21 mm	(1.5-)19-44(-65 in fruit) mm
♀catkin width	8-18 mm	7-17 mm	10-18 mm
♀catkin	slender to stout	subglobose to globose	stout
Floral bract color	brown or black	tawny, brown, or black	brown or bicolor
Filaments	glabrous	glabrous or hairy in lower ½ or basally	glabrous or hairy in lower ½ or basally
Stipe length	0.3-2 mm	(0.4)1-2.8 mm	1.1-2.1 mm
Ovary	short-silky	sparsely to moderately densely short-hairy	sparsely to moderately densely short-hairy
Styles	0.5-1.5 mm	0.1-0.2(-0.6) mm	0.3-1 mm
Capsules	2.5-6 mm	(3-)4-6 mm	5-7 mm

Table 6. Willows that have been treated as subspecies of *Salix eriocephala* (*Salix* section *Cordatae*).

Trait	*S. monochroma*	*S. ligulifolia*	*S. lutea*	*S. prolixa*
Lower surface of leaf	green	glaucous	glaucous	glaucous
Leaf length	54-100 mm	60 – 133 mm	42 – 90 mm	50 – 150 mm
Leaf width	18-35 mm	12 – 30 mm	8 – 32 mm	10 – 53 mm
Leaf length/width ratio	1.8-3.6 mm	2.9 – 6.4	2.8 – 5.6	2.4 – 4.5
Leaf base	often truncate, rounded to cordate, sometimes acute	rounded, convex, or subcordate	rounded, convex, or subcordate	cordate, subcordate, rounded, or convex
Stems	yellow-brown, gray-brown, or red-brown	yellow-brown, gray-brown, or red-brown	generally gray; yellow-gray, yellow-brown, or gray-brown	gray-brown or reddish-brown

Notes on Some Willows of Central Oregon

Salix amygdaloides **(Peachleaf Willow)** – Tree or large shrub, common at low to mid elevations. Unique among our willows because the bud margins overlap. Bud tips usually sharply pointed, though sometimes the tip is blunt and the overlapping margins are hard to see. Leaves acuminate and tending to droop. (Petioles tend to twist, forming a lengthwise groove that is +/- closed by the petiole margins. This twisting causes the leaves to droop.) Flower bracts pale, deciduous. Stamens more than two per flower.

Salix bebbiana **(Bebb Willow, Long-beak Willow)** – Shrub (occasionally tree). Leaves apple-like. Leaf veins impressed on upper leaf surface and therefore pushed out on the lower surface, forming a network with green areas between them that look scooped out. Young leaves with distinctive ciliate margins. Female capsules are easy to identify because capsules are long-beaked and sit on long stipes, giving the catkin a very open look.

Salix boothii **(Booth's Willow)** –Shrub with an overall yellowish appearance. Leaves green on both sides, stipules conspicuous. Plants of Central Oregon have elliptic leaves; those of the Cascades and Wallowas may be thicker and wider. Twigs and buds yellow (or red). Leaves with big glands on the tips of the fine teeth. Leaves usually taper the same way at tip and base, though sometimes bases are more rounded. Young leaves are hairy in the Cascades and Steens Mountain, but glabrous in the Blue Mountains. Female catkins thick and dense, with the "hairy caterpillar" look. Flower bracts usually brown (not black). This is the higher elevation equivalent of *S. monochroma.*

Salix commutata **(Undergreen Willow)** – A high elevation willow with leaves green below like *S. boothii,* but with more hairs, and with glands that stick out perpendicularly from the margin of the leaves so the toothing is more obvious. Ovaries and capsules glabrous. The very similar *S. eastwoodiae,* not known from Central Oregon, is very similar but has pubescent ovaries and capsules.

Salix drummondiana **(Drummond's Willow)** – Uncommon shrubs of the mountains. Leaves are densely hairy with shiny, velvety hairs somewhat like those of *S. sitchensis* but inconspicuous. Leaves always narrow; those of *S. sitchensis* can be narrow or wide. Distinctive twigs are glossy red-brown or blackish and strongly glaucous when young.

Salix eastwoodiae **(Mountain, Eastwood's Willow).** Leaves green on both sides, +/- hairy on both sides though some plants in the population may be nearly glabrous. Leaf margins with glands that stick out. These may be limited to the bases of the leaf blades and the stipules, especially on plants growing in relatively low elevation fens (e.g. Williams Prairie, Logan Valley). Such plants are hard to distinguish from *S. wolfii.*

Salix exigua **ssp.** ***exigua*** **(Coyote Willow, Narrowleaf Willow)** – Abundant along rivers and creeks at low elevations, often forming extensive thickets. Clonal by root sprouts; many shoots that usually arise vertically (not spreading from one point), though occasionally isolated plants look almost like "normal" shrubs. Leaves linear to lanceolate. May bloom all summer long.

Salix geyeriana **(Geyer's Willow)** – Common; shrub with glaucous undersurface of leaves and (usually) glaucous twigs. Very like *S. lemmonii* and often not distinguishable, but distinctive catkins subglobose. Leaves average shorter and thinner than those of *S. lemmonii* with even tiny veins visible, "like a road map of Georgia." Shrubs sometimes columnar.

Salix lasiandra **ssp.** ***caudata*** **(Greenleaf Willow, Shining Willow, Whiplash Willow)** – Common; shrub or tree with both sides of leaf green. Leaves large, shiny, tapering from near middle to long "drip tips." Leaves usually widest in lower third. Petioles with raised glands at or near base of leaf blade. Tiny whitish or grayish stomata pepper upper surface of leaves. When collected, plants rot in the press, turning black.

***Salix lasiandra* ssp. *lasiandra* (Pacific Willow, Shining Willow, Whiplash Willow)** – Large shrub or tree, like *S. lasiandra* ssp. *caudata* but with leaves +/- glaucous below and stomata absent on upper leaf surface. Common west of the Cascades, rarely found on the east side.

***Salix lasiolepis* (Arroyo Willow)** – Common shrub. Habitat mostly hot, low elevation canyons. Leaves generally elliptic to obovate, shiny green above and glaucous below, shape and toothing are highly variable. Leaves tend to be almost unnaturally free of defects. Twigs brittle. Challenging. If this species didn't have the well established name of Arroyo Willow, we'd call it the Chameleon Willow.

***Salix lemmonii* (Lemmon's Willow)** – Very common; shrub with glaucous lower leaf surface and (usually) glaucous twigs. Very much like *S. geyeri* and often not distinguishable but catkins longer and more cylindrical, leaves average longer and thicker with tiniest veins not readily visible so the green areas between the veins are larger; "like a road map of Nebraska."

***Salix lutea* (Yellow Willow)** –A common Great Basin shrub that occurs in southern Oregon. Leaves glaucous below but not conspicuously so – shrubs look green from a distance. Young twigs tend to be yellowish. Older branches pale gray, skeletal. Stipules obvious. Most similar to *S. prolixa.*

***Salix melanopsis* (Dusky Willow)** – Like *S. exigua* but with somewhat wider leaves that become glabrous, and longer petioles. Common west of the Cascades, also found in the Columbia Gorge and the Wallowas.

***Salix monochroma* (One-color Willow)** – Shrub with overall green appearance, common at low to moderate elevations. Leaves green on both sides, stipules conspicuous. Most leaves with truncate or subcordate base. Leaves kind of squarish, with a short drip tip. Similar to *S. boothii,* which grows at higher elevations; there is a broad elevational area where the two overlap. The lower elevation version of *S. boothii* with thinner leaves and usually truncate to subcordate leaf bases.

***Salix prolixa* (Mackenzie's Willow)** – Leaves glaucous below (sometimes faintly so), stipules foliaceous, buds large, twigs often red. Like *S. boothii* or *S. monochroma* except for glaucous lower leaf surfaces and often redder twigs. Compare with *S. lutea,* which is a more southern species.

***Salix scouleriana* (Scouler's Willow)** – Shrub on mesic to dry sites, rarely in wetlands; leaves obovate (widest in outer third); hairs usually a mix of white and rusty, so undersurface of leaf often looks dingy. "Fire Willow" that moves in following disturbances such as fire, then persists as conifers grow up around it.

***Salix sitchensis* (Sitka Willow)** – Common shrub with distinctive dense hairs on the undersurface of the leaves. The hairs are short, soft, and shiny, making a pleasant surface to touch. In central Oregon confined to mountains. Compare with *S. drummondiana.*

***Salix wolfii* (Wolf Willow)** – Small alpine willow with both sides of the leaves persistently hairy. Our plants have hairy ovaries and capsules

***Salix* X *fragilis* (or *S.* x *rubens* or *S.* x *euxina,* Hybrid White Willow)** – Uncommon. Tree (shrub-like when young) with an open crown. Glands on petiole near base of leaves, like *S. lasiandra.* Twigs usually yellow and brittle. Planted near home sites and on some habitat restoration projects. Probably not producing seed but spreading downstream from twigs that break off established trees. Taxonomists have been working on this hybrid, with conflicting results.

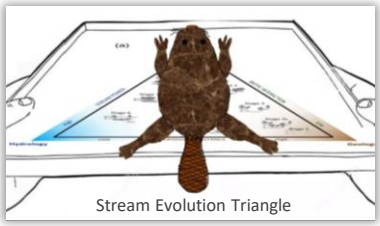
***Salix* X *sepulcralis* (or maybe *S.* x *pendulina,* Weeping Willow)** – the common "weeping" willow, with yellow twigs. Taxnomists disagree about whether our yellow-stemmed plants are *S. sepulcralis* nothovar. *chrysocoma* or *S. pendulina* and it's hard to care.

BEAVERHOODS – Planting the Seeds for Beaver Success

INTRODUCTION

This paper addresses riparian plantings on wadeable streams borne from nearly two decades of experience in planting projects on eastern Oregon landscapes.

Over the past decade, ONDA's riparian restoration strategy has developed to focus specifically on beaver as an "umbrella species"; addressing the factors limiting beavers' management of floodplains, by utilizing an in-house conceptual model referred to as "BeaverHOODs".


Stream Evolution Triangle

(Learn more at RRNW Youtube Speaker Series 3/16/21)

This beaver-based prioritization strategy was adopted because of the inherent ecological resilience and productivity achievable only from self-sustaining nature-based solutions: as opposed to relying on anthro-pogenic controls, or on actions that treat symptoms rather than root causes.

The strategy in 4 categories: BeaverHOODS helps a practitioner look at a riverscape "through a beaver's eyes": at the site's 1) hydrology, 2) vegetation, 3) morphology/topography and 4) cultural landscape.

Associated rules of thumb and guidance then help congeal these observations into a restoration design and set of expectations in an intentional and strategic way.

The Goal is to establish a "BeaverCould" - a 0.5 to 0.75-mile long reach where all four categories of the BeaverHOOD strategy (above) are addressed and beavers can then assume management by doing what they do to fulfill their own needs and drive for survival.

A lack of suitable woody riparian vegetation (size, species, location, density) is a frequently overlooked limiting factor preventing beaver long-term occupancy, and their ability to manage floodplains.

Understanding beavers as sentient creatures with their own agency, social structures, learned skills and preferences is essential.

Put your "beaver goggles" on and think like a beaver…

The BeaverHOODs Strategy encourages the establishment of 18,000 mature trunks (emanating from the ground) stems of suitable riparian plant species per ~half-mile reach: typically diverse willow species, aspen and cottonwood.

The guidance within this handout considers the intentional and repeatable suite of approaches which could meet these goals over short timelines utilizing low budget/tech tools.

Below you will find "prompts" for deeper discussions among restoration practitioners regarding just the vegetation portion of the BeaverHOOD Strategy: from "initial site assessments" to "post-implementation care".

Adapted from Jefferson Jacobs' (MS and Certified Riparian Restoration Professional) 2024 poster from River Restoration Northwest Symposium.

BEAVERHOODS – Planting the Seeds for Beaver Success

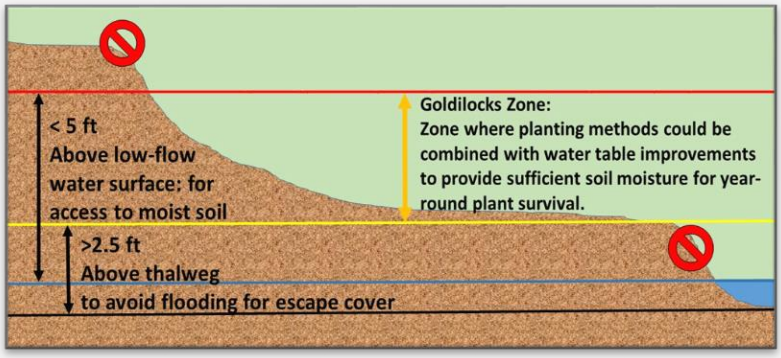
PLANNING

1 Plan for planting at least 1 year in advance!

- Potted plants often need to be ordered a year in advance.
- "Cuttings" are often harvested months before they can be planted. (Access to a walk-in cooler can keep cuttings dormant until planting)
- So need to work through steps 2-4 to have idea of how, what species, and where you will plant; informing the number and type of plants (potted/cuttings) to order or harvest.

Where to source cuttings?
Wild or nursery grown, cuttings vs. potted plants, stick length and time of year.

Species? Health? Diversity?
When cloning cuttings cut from willows or cottonwood from a wild (vs. nursery grown) source, consider the species, health of plant and harvesting from a variety of sources to improve diversity.



2 Find the Goldilocks Planting Zone

At less than 2.5 ft above the thalweg, your plantings may be flooded out over time by beaver dam building.

At less than 5 ft above surface of water of the lowest flows represents the practical upper limit where plants can be installed with low budget, low-tech techniques and *still reach suitable soil moisture*.

No more than 100 ft from the creek's current location means food is closer to escape cover where beavers feel safer and are less vulnerable to predation.

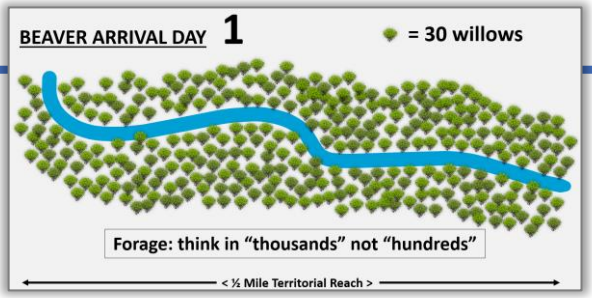
3 Of course, existing suitable vegetation counts toward the 18K stem goal

Map existing suitable beaver food in the Goldilocks zone. Suppressed vegetation might recover and spread on its own with the removal of browse pressure. Just make sure it is actually "preferred beaver food" species (willow, cottonwood, aspen highest value) and don't assume it actually exists. (p.s. *Alder* is not a preferred beaver food.)

Get acquainted with beaver signs. Beavers will maintain their teeth on, cut down, and build with, materials they don't actually eat. They will also "survive" on sub-optimal food sources. Understand what your beavers prefer to eat based on consumption vs. availability, (including aquatic vegetation like cattails) and what is not being eaten. Don't mistake occasional signs of beaver chew for beaver occupancy.

When thriving beaver families and long term beaver managed floodplains (BMFPs) is the goal, how much beaver food is needed Day 1 of occupancy to sustain long-term site persistence?

Between existing vegetation and new vegetation planted *the total size of larder should provide an average beaver family (of 5) beavers with enough food initially and also allow the willows to regenerate between beaver harvests.*



PLANNING (CONTINUED)

4 Map Soil Moisture and "Diggability" in the Goldilocks Zone

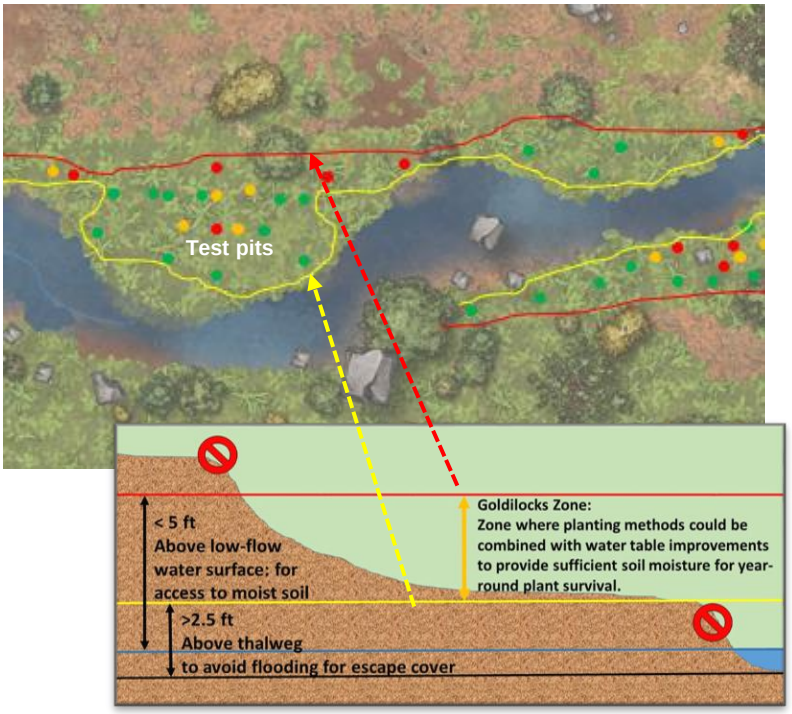
Spoiler: Plants need water year round, and you need to be able to make holes to plant them. Planting during the wet spring or fall seasons makes everywhere look suitable for planting: **you need to plan your planting locations for the dry season conditions those plants will have to survive**.

What and how you will be planting determines how near to the surface you need suitable soil moisture at the driest time of the year.

Accessibility, planting objectives and soil moisture and diggability will also determine what and how you hope to plant and where.

Consider the differences between a) deep planting "cuttings" with a mounted auger vs. b) hand-planting "cuttings" vs. c) hand-planting potted plants.

Map Soil Moisture and "Diggability" at the driest time of year using the "deepest" planting methods suitable at any given location (i.e. dig, auger or "pike" actual test holes throughout all potential planting sites).



In the Oregon high desert, planning your approach for the harshest, lowest-moisture season is key to survival and establishment

- Suitable moisture rules of thumb: Holes need the lower 75% to have soil moist enough to make a "snowball" in fine grains, or to be "visibly wet" in courser grains. A hole with more than 75% (for cuttings) or 30% (for potted plants) filled with standing water can drown out plants.
- Diggability: Gravel holes collapse, but have good water infiltration. Bedrock or embedded cobble may be undiggable, and prevent hyporheic benefits. Fine, uniform soil may be hydrophobic and prevent infiltration. Reed Canary Grass (RCG) root masses will hamper finding soil to backfill your plants. Source another soil supply away from RCG.

But what about . . .

- Beaver Dam Analogues (BDAs)? A means to an end, not an end to themselves. Temporary tool to address stream power or improve soil moisture, but thoroughly resurvey soil moisture months after install.
- Older veg as indication of soil moisture? Don't assume that older mesic or riparian vegetation present onsite is an indicator of current soil moisture. Mature plants have deeper roots and can often be present in conditions where your new veg establishment would be difficult.

BEAVERHOODS – Planting the Seeds for Beaver Success

IMPLEMENTATION

5 Planting, Finally

Timing: Potted plants after senescence in fall, cuttings as early in spring as possible. Don't store cuttings in a cooler >2 months. It is possible to soak cuttings for too long.

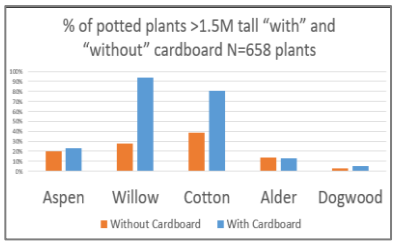
Densities 1 plant per <2.5 feet: Shades *Phalaris*. Discourages deer from jumping into exclosures.

Cardboard weed-mat for potted plants going into weedy areas, after weed whacking.

Cluster augered cuttings: 4 to 6 cuttings per 6-inch diameter hole won't compete if they are deep into moist soil.

Exclosure fence with skirt all the way around to exclude beaver, and discourage deer. Inexpensive 60" high of 2'X4' welded-wire fence balances effective with affordable and easy to handle.

Tips for planning the logistics: Soaking, staging, materials, order of operations, mental walk-through.



MONITORING / 'READY FOR OCCUPANCY'

6 The job's not over until beavers move in!

Maintain fences and BDAs: All that work is wasted if the plants get killed off before they can handle the stress of browsing and of fluctuating water levels.

Track what worked, and what didn't (and why) to better inform your next effort. Fail forward. If this is your first project, start small and learn from your mistakes. Everyone makes mistakes: They just don't publish them.

Remove exclosure fences 5 years after the last exclosure in the whole treatment reach was planted. Removing individual exclosure fences "piecemeal" will result in over-browsing of each one in turn. Established plants have more resilience to browsing and higher structural diversity and volume.

ADDITIONAL READING

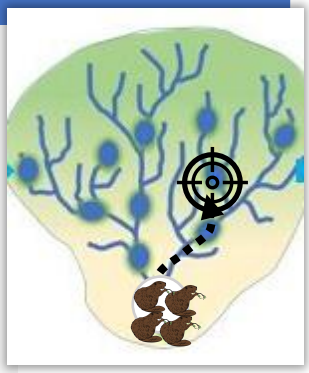
- How much veg for beaver success? www.westernbeavers.org/beaverveg
- More about BeaverHOODs: www.westernbeavers.org/beaverhoods

For consideration:

- *When might beavers arrive?*
- *Where's the nearest growing beaver family?*
- *In other words - how long might it be before beavers move in and settle?*

On connectivity:
What obstacles might exist in the distance between the nearest growing beaver family and your treatment site? For example: lack of water cover, trapping, etc.

Work to address these limiting factors to ease the path of travel and migration for dispersing 'source family' beavers to find your 'ready for occupancy' site.



Riparian Vegetation For Beaver Habitat Establishment

Where thriving beaver families and beaver managed floodplains are a goal for stream recovery, how much beaver forage is needed to sustain long-term site persistence?

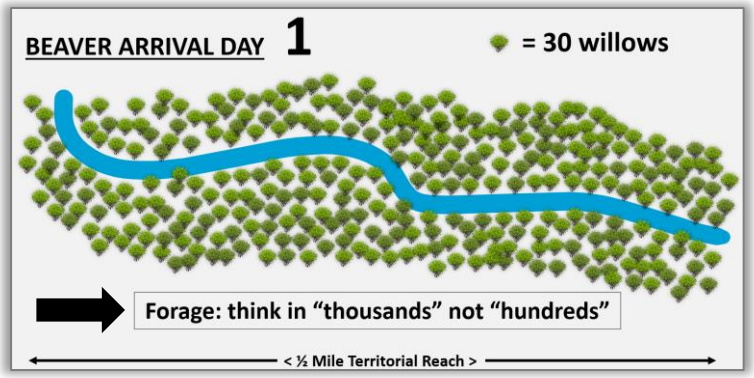
Beaver Related Restoration. As Western stream restoration agencies are recognizing the value of beaver-managed floodplains (BMFP) to watershed health and resilience it's an exciting time to work for beaver recovery in eastern Oregon!

Beaver-based restoration -- with "long term process based restoration" (LTPBR) at its core – seeks to mimic the beaver activities that created Oregon's meadowscapes over several millennia. LTPBR as practiced often relies on added structure (like BDAs and PALs) to kickstart dynamic, natural processes in a riverscape so systems can begin to heal themselves. *But structure alone won't provide what beavers need for long term site persistence.*

Beavers Need ALOT of Forage. In the arid, wadeable streams of the West, we often see stream degradation so severe that beaver food and forage establishment should be considered an essential component of this work.

Without a persistent, renewable and accessible source of forage beavers will migrate. In travel, beavers are at the most risk of predation.

Its why our stream recovery projects are striving to provide the conditions needed to keep beavers in place safely for the long run, removing reason or need to ever stray far from pond safety. Adequate food and forage on Day 1 of beavers' arrival is essential to BMFP site longevity and the well-being of beaver populations as a whole.



Informed by the research and reading provided below, good results achieved by others, and learnings through years spent monitoring beaver families throughout eastern Oregon streams, we believe every beaver habitat project should consider **these three factors**:

1 Sufficient food established Day 1 of beaver arrival for long term site longevity where the rate of beaver forage and the rate of willow regeneration are equal. We strive for riparian planting within the safest distance (30' to 50') from the water's edge, along 1/2 mile stream reaches (the length of a 'typical' territorial beaver home base) for a total of 8,000 to 12,000+ trees and shrubs established on Day 1 of beaver arrival.

This amount of forage provides food for individual fitness and dam/den construction over years, and provides the space and time needed for vegetation to regenerate between beaver harvests.

THE GOAL / DESTINATION

Persistent occupancy of thriving beaver with multigenerational residency managing riverscapes for the long term.

2 Protection from browse.
If beavers are in the system, we assume that early plantings will be eaten. To prevent this most of our plantings are caged by 2"x4" fencing during a 3 to 5 year period of tree establishment. Once enough vegetation is established, the caging is removed. Without this protection during willow establishment, vegetation doesn't get a foothold. Beavers may move in for a while, but over time they're forced to leave the site when vegetation regeneration can't keep up with beaver harvest.

3 Primary diet of native poplar species.
Though beavers will make use of many different tree, bush and herbaceous species the most nutritious and delicious beaver woody favorites generally include these riparian natives: willow, cottonwood and aspen.

As the regen rangeland philosophy goes: "Care for the land, and she will care for your livestock." We advocate for an approach to BMFPs and beavers in general that follows this same thinking: **"Care for the beavers and they'll care for your stream".**

ON BEAVER FORAGE – RECOMMENDED READING AND RESEARCH REPORTS

ARTICLE (Click to view)	CITATION	EXTRAPOLATE, FOR A FAMILY OF 5 IN 1/2 MILE TERRITORIAL REACH
1. A study of beaver colonies in Michigan. Journal of Mammalogy, Glenn Bradt, 1938	"It's estimated that one acre of poplar will support an average colony of 5 animals for 1 to 2.5 years, depending on the stand of poplar and other factors." "If we use 1500 trees per acre as a standard, and assume that one beaver will cut 216 trees per year on the average, one acre will support one beaver for about 7 years, or 7 beavers for one year."	• 216 trees of 2.1" average trunk diameter x 5 beavers x 8 years = 8,460 trees • If trees at 30' spacing = **5.8 acres of poplar**
2. Simulation modeling to understand how selective foraging by beaver can drive the structure and function of a willow community. Ecological Modeling, Raúl Peinetti, et al., 2009	Given a site where all stems were equally available, the model suggested a simulated beaver family of 2 adults, 2 yearlings, and 2 kits required a minimum of 9.9 acres of willow (stems spaced 10.7 sf) to persist in a steady state.	• **10 acres of willow** is optimal for a 'steady state' of beaver occupancy, willow forage and its regeneration.
3. Beaver Habitat Selection for 24 Yr Since Reintroduction North of Yellowstone National Park Montana State University, Scrafford, et al., 2018	Willow cover and height were positively associated with colony longevity. Numerous other influencing variables included secondary channels, sinuosity, stream depth, and sandbar width. The study found 7.5 years of colony persistence at sites with 100% of willow coverage (and other beneficial factors).	• If ½ mile (2,640') home base reach x 100' lateral safe forage zone at 100% coverage = **6 acres willow**.
4. Felling and foraging: results of the first year of beaver (Castor fiber) activity in an enclosed Scottish site Lutra, Jones, et al., 2003	Yields approximate felling rates of 0.5 trees per beaver per day at the Willow Carr Site and 0.8 trees per beaver per day at the Lake Site.	• If 365 days x 5 beavers x 8 years site longevity x (range of) 0.5 to 0.8 trees = **7,300 to 11,680 trees**
5. North American Beaver (Castor canadensis): A Technical Conservation Assessment February 6, 2007 Steve Boyle and Stephanie Owens, BIO-Logic Environmental, 2007	P.16 cited Ringelman (1991): "estimated that a colony of six beavers can be supported by 1.6 ha (3.9 Acre) of aspen, 4.9 ha (12 acre) of willow, or an intermediate combination of the two."	• **4 to 12 acres of willow or aspen** to support a colony of 6 beavers
6. Spatial and Energy Requirements of Beavers, Ohio Journal of Science, Fred Brenner 1967	One acre of aspen produces 5,840 lbs of food, which would be sufficient to sustain 10 beavers for 442 days.	• **4 acres of aspen** would sustain 5 beavers for 8 years
7. Saving the Dammed, excerpts from "About Beavers" - February Chapter, pages 26-27, Dr. Ellen Wohl, CSU, 2019	P. 27 A colony requires a minimum area of almost 10 acres of willows to persist indefinitely. This size of larder provides the beavers with enough food but also allows the willows to regenerate between beaver harvests.	• **10 acres of willow** is required for a 'colony' to persist indefinitely (no definition of colony size)
8. Beaver Carrying Capacity of Certain Streams in North Park, Colorado, Duncan MacDonald, 1956	Thesis paper with helpful references to research on beaver forage needs (captive and wild), and measurements around how much ingestible food exists on Aspen of different stem sizes.	• An adult beaver requires a range of 3 to 5 lbs of food daily; or 1/2 ton annually.