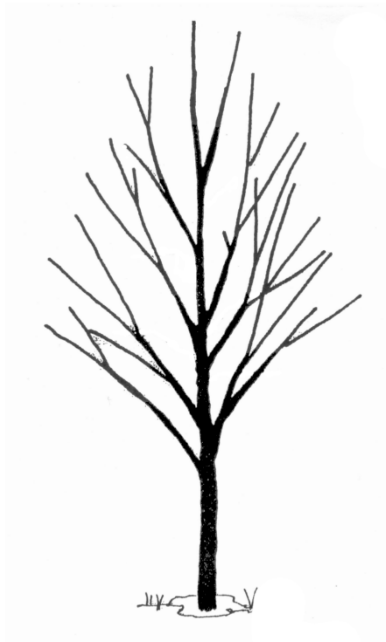
MASTER GARDENER
COLORADO STATE UNIVERSITY
EXTENSION



The Science of Pruning

Pruning Reference

Books (available from the *International Society of Arboriculture* at www.isa-arbor.com)

- ***An Illustrated Guide to Pruning, Third Edition.*** Edward F Gilman. Cengage Learning. 2011.
- ***Best Management Practices: Tree Pruning***. Edward F Gilman and Sharon J. Lilly. International Society of Arboriculture. 2008.
- ***ANSI A300 Pruning Standards, Part 1.*** American National Standards Institute. 2008.

Books (available from Urban Tree Foundation at www.urbantrees.org)

- ***Structural Pruning, A Guide for the Green Industry.*** Dr. Edward F Gilman, Brian Kempf, Nelda Matheny, and Dr, Jim Clark. Urban Tree Foundation. 2013.

Web: http://hort.ifas.ufl.edu/woody/pruning.shtml for sample pruning specifications.

Pruning curriculum develped by David Whiting (retired), Alison O'Connor, and Eric Hammond, Colorado State Univeristy Extension

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- Colorado State University, U.S. Department of Agriculture and Colorado counties cooperating.
- Extension programs are available to all without discrimination.

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Learning Objectives

At the end of this unit, the student will be able to:

- Explain how trees grow and decay, and the implications for pruning.
- Explain removal cuts, reduction cuts and heading cuts.
- Structurally prune a young shade tree.
- Describe pruning of maturing shade trees, including objectives (whys) and methods (hows).
- Prune flowering shrubs
- Prune evergreen shrubs

Review Questions

Tree Growth and Decay

1. What is the branch collar?
   a. Explain how it develops.
   b. Explain the size relationship between the side branch and trunk/parent branch necessary for a branch collar to develop.

2. Explain how trees grow, adding xylem rings each year. Define the following terms:
   a. Phloem
   b. Xylem
   c. Sapwood
   d. Heartwood
   e. Ray cells
   f. Compartmentalization

3. Explain how trees respond to wounds (i.e., CODIT).
   a. What are the roles of annual growth rings and ray cells?
   b. In CODIT, explain why trees decay with a pipe-like structure. How does a break in the pipe-like structure impact structural strength?

4. What is percent shell? What are significant about 33% and 25% shells?

5. Describe methods to evaluate decay and cracking in trees.

Pruning Cuts

6. Identify/define the following:
   a. Branch bark ridge
   b. Branch defense zone
   c. Reaction zone
   d. Woundwood

7. What is a removal cut?
   a. What are the advantages of a removal cut?
   b. When the branch bark ridge is visible, where is the removal cut made?
   c. If the branch collar is not easy to identify, where is the removal cut made?
   d. If the branch has no branch collar, where is the removal cut made?
   e. What happens when the branch collar is cut or injured?
   f. What happens when nubs or very short branches are left?
   g. With hindsight, how does one evaluate when the thinning cut was properly made?

8. What is a reduction cut?
   a. What are the uses and limitations of reduction cuts?
   b. What is the proper angle for a reduction cut?
   c. In a reduction cut, what is the proper size relationship of the branch being removed to the branch pruned back to? is it important?

9. What is a heading cut?
   a. How does it influence regrowth of the plant?
   b. What are the effects of using heading cuts on larger branches?

10. Explain the three-step method for pruning large branches. Why is it needed? When is it needed?

11. Describe the pros and cons of pruning live branches during the:
    a. Late winter (dormant)
    b. Spring (during growth flush)
    c. Midsummer (after leaves harden and turn dark green)
    d. Late summer and fall
    e. Late fall and early winter
    f. During drought

Structural Training of Young Shade Trees

12. In structural training of young shade trees, give the rule-of-thumb for dosage (i.e., the maximum amount of live wood/foliage removed per season)? How does the gardener determine the growth rates to set dosage? How is the dosage range adjusted for the specific tree?

13. Define *excurrent* and *decurrent* growth habits.

14. List the steps and pruning objectives for excurrent and decurrent trees.

15. Define codominant trunks. Why do arborists have zero tolerance for codominant trunks?

16. What are the options if multiple leaders develop? If the main leader is killed?

17. What is the standard height for the lowest permanent branch of sidewalk trees? Street tree? Trees in forest areas (fire management)?

18. What is the proper size relationship between the trunk and side branch? Why is it important? What are the options if a side branch is growing too large?

19. Define scaffold branch. What is the rule of thumb for minimum spacing of scaffold branches?

20. How do multiple branches arising at one site influence the branch collar and thus structural integrity?

21. What is the role of temporary branches on young trees?

22. Describe the management of temporary branches.

23. Given a young excurrent or decurrent tree (or a picture of a young excurrent tree), describe specific training for this tree.

24. When decurrent trees are not trained from early growth in the nursery and on the landscape site, it is often impossible to fully achieve the five training objectives. To minimize potential storm damage, what is the most important objective to pursue?

Pruning Mature Trees

25. List the <u>objectives (whys)</u> for pruning a mature tree.

26. List the <u>methods (hows)</u> of pruning to achieve purposes.

27. Describe key elements in writing specifications for general pruning of maturing trees.

28. What is the overall objective in structural pruning of medium-aged and mature trees? Why will it generally require work over a period of years? How does larger branch size influence the potential for structural pruning?

29. Describe *subordinate pruning*. What factors should be considered when deciding where to make a subordinate pruning cut?

30. Describe how to subordinate prune a medium-aged tree with the following situations:

    a. Codominant trunks
    b. Rounded off
    c. Choked-out central leader
    d. Too many upright-growing branches

31. Describe key elements in writing specifications for structural pruning of medium-aged trees.

32. Define *cleaning*. In cleaning, how much of the live wood should be removed? Why?

33. When is it important to remove dead branches? At what size and height does dead branch removal become an important management issue?

34. When woundwood is growing out along a dead branch, where is the final cut made?

35. Describe key elements in writing specifications for cleaning.

36. Describing thinning.

    a. What are the purposes of thinning the crown?
    b. Will thinning lower a tree's height?
    c. In thinning the crown, what types of cuts are made?
    d. What is the general maximum size of branches to be removed?

e. What is the long-term effectiveness in overall crown thinning to reduce storm damage potential? What pruning method would be more effective?

37. What is *lion-tailing*? How does it differ from thinning the crown? What are the problems associated with lion-tailing?

38. What is the rule of thumb on dealing with excessive sucker growth?

39. Describe the key elements in writing specifications for thinning.

40. In raising, what is live crown ratio? What is the rule of thumb on how fast a tree can be pruned up?

41. In raising, what options may be workable other than removal of lower branches? Why may removal of lower branches cause problems?

42. Describe the key elements in writing specifications for crown raising.

43. Describe the reasons for crown reduction. Describe the limitations of crown reduction.

44. List pointers on crown reduction, as given in chapter.

45. What is the long-term effectiveness in overall crown reduction to reduce storm damage potential? What pruning method would be more effective?

46. How does topping a tree impact its structural integrity and internal decay potential?

47. Describe the key elements in writing specifications for crown reduction.

48. Explain the pruning objectives for the following situations:

    a. Storm-damaged trees
    b. Old and declining trees
    c. Root-damaged trees
    d. Hazard trees

<u>Flowering Shrubs</u>

49. What's the difference in flowering habit and pruning of spring-flowering shrubs and summer-flowering shrubs?

50. Many gardeners prune flowering shrubs by topping them. Describe the impact on growth and flowering.

51. Explain the pros of, and limitations for, shrub pruning by

    a. Shearing to shape
    b. Thinning old wood
    c. Pruning to the ground
    d. Replacement

52. What types of shrubs are successfully renewed by pruning to the ground? List situations where this approach may not work.

<u>Evergreens</u>

53. How can a gardener make a young spruce, fir or Douglas-fir bushier? What about a pine?

54. A large evergreen tree is overgrowing the space. Explain options to prune back the bottom branches for spruce, fir and Douglas-fir. Explain options for pruning back bottom branches for pine. Why is pine different from spruce, fir and Douglas-fir?

55. Explain what happens when a gardener shears a mugo pine shrub.

56. On junipers and arborvitae, explain the pros and cons of

    a. Shearing
    b. Thinning

57. Explain the problems associated with trying to prune back a severely overgrown juniper or arborvitae.

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CMG GardenNotes #611

Tree Growth and Decay

Outline:

As forest scientists observed how trees respond to wounds, pruning techniques changed and pruning objectives were clarified.

This *CMG GardenNotes* provides background information on how trees grow and decay and therefore the implications of pruning cuts and structural training. Refer to other CMG GardenNotes for additional details on pruning cuts and structural training.

Note: in this publication, the term “trunk” refers to a trunk or parent branch and “side branch” refers to a side branch arising from the trunk (parent branch). The same relationship would exist between a side branch and a secondary side branch.

Developing a Strong Branch Union

In Colorado (and other snowy climates) the most common type of significant storm damage in landscape trees results from failures at the ***branch union*** (crotch), primarily with ***codominant trunks*** (adjacent trunks of similar size). Primary objectives in training young trees are to develop strong branch unions and eliminate structurally weak codominant trunks. [Figure 1]

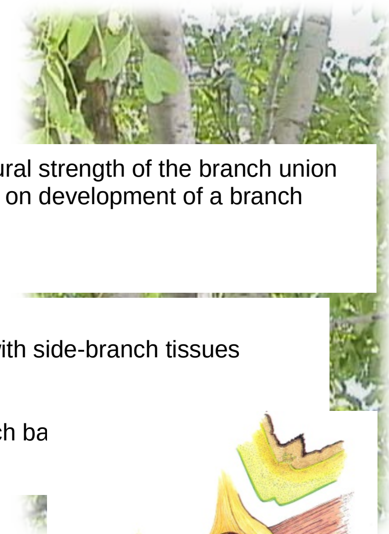
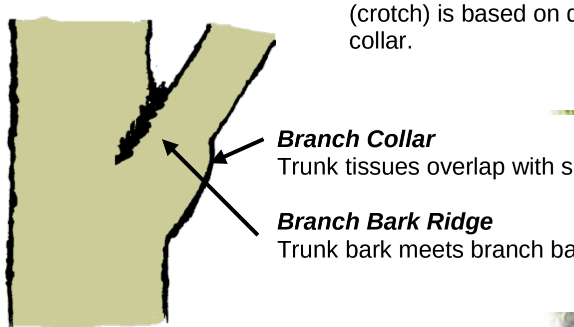


Figure 1. Codominant trunks (adjacent trunks of similar size) account for the majority of storm damage in Colorado landscapes.

Figure 2. Structural strength of the branch union (crotch) is based on development of a branch collar.



Structural strength of a branch union is based on the development of a ***branch collar***. The branch collar is where the annual growth rings of the trunk overlap the annual growth rings of the side branch, like shuffling a deck of cards. In lumber, the branch collar is called the knot. [Figures 2 and 3]

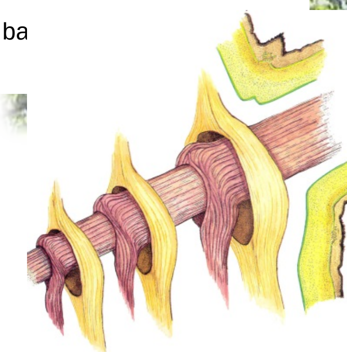


Figure 3. The branch collar is where annual growth rings of the trunk overlap the annual growth rings of the side branch, like shuffling a deck of cards. This creates a very solid section of wood, known as the “knot” in lumber. (Line drawing: U.S.D.A.)

As the branch collar develops, side branch tissues connect into the trunk in a wedge shape, making a structurally strong unit. **For the branch collar to develop, the side branch must be less than half the diameter of the adjacent trunk**. **Less than one-third is preferred.**

If the side branch is too large in diameter, prune back the side branch by 1/3 to 2/3s to slow growth (or remove the branch entirely). Over a period of years, a branch collar will develop. [Figure 4]

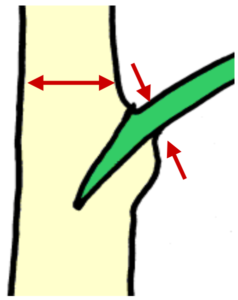


Figure 4. As the branch collar develops, side branch tissues connect into the trunk in a wedge shape making a structurally strong unit. For the branch collar to develop the diameter of the side branch must be less than half the diameter of the adjacent trunk. Less than one-third is preferred.

The size relationship between the trunk and side branch is called ***Aspect Ratio***. A branch union with high *aspect ratio*, like 1 to 1 (two trunks of the same diameter), is highly prone to failure in wind and snow loading. A branch union with a low aspect ratio, like 1 to 3 (side branch is 1/3 the diameter of the adjacent trunk), would not likely fail due to the development of the branch collar.

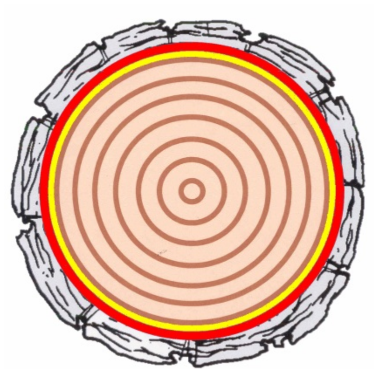
A branch collar will not develop on codominant trunks (adjoining trunks of similar size), making this branch union structurally weak. [Figure 5]

Multiple branches arising at the same location also compromise the branch collar's structural strength. Some tree species (like elm, maple, and crabapple) naturally develop multiple branches at one location. This predisposes the tree to storm damage if the situation is not corrected by structural training when the tree is young. [Figure 5]

Figure 5. (Left) A branch collar does not develop on co-dominant trunks, making the branch union structurally weak. (Right) Multiple branches arising at the same location are also structurally weak as the branch collars cannot knit together into a strong union.

Spread of decay – Due to the constriction of xylem cells where the side branch annual growth rings are overlapped by the trunk annual growth rings, the development of a branch collar significantly reduces the potential spread of decay. In addition, branch unions with a right angle of attachment are more effective in preventing the spread of decay.

To reduce the potential for decay, 1) prune to develop branch collars (the side branch must be less than half the diameter of the adjacent trunk) and 2) select branch unions with a wide angle of attachment. In pruning, remove codominant trunks and narrow branch unions while young (smaller than two inches). [Figure 6]



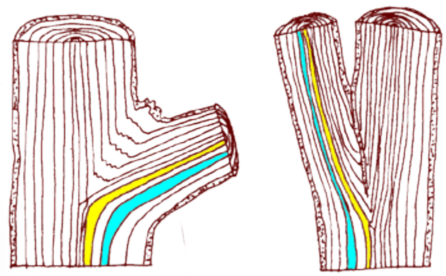


Figure 6. Branch unions that form a right angle are more resistant to decay. A branch union with codominant trunks and a narrow angle of attachment is highly prone to the spread of decay.

How Trees Grow

Xylem tissues – Each year a tree puts on a new outer ring of wood (xylem tissue) under the bark resulting in the increased diameter of a trunk or branch. The number of rings indicates the limb's age and the width of individual rings indicates that year's growing conditions. [Figures 7 and 8]

Figure 7. Tree cross section
Bark – Outer protective covering
Phloem (red in drawing) – Inner bark tissue. *Photosynthates* (sugars and carbohydrates produced in the leaves by photosynthesis) move throughout the tree in the phloem tissues, including down to feed the roots.
Cambial Zone (yellow in drawing) – Layer of active cell division between bark and xylem.
Xylem (brown layers in drawing) – Each year the cambium adds a new ring of xylem tissue just under the cambium layer, resulting in a growth in limb diameter. Xylem tissues are the technical name for the "wood".

Figure 8. The "wood" of a tree is the xylem tissue. Xylem tissues that grew in the spring and early summer enlarge and are the tubes in which water with minerals flows from the roots to the leaves. In a cross-section of the log, these are light colored rings. Xylem tissues that grew mid-summer, at the end of the growth cycle, are higher in fiber content creating a wall to the outside. In a cross-section of a log, these are the darker colored rings.

Younger ***annual growth rings*** (annual rings of xylem tissue) with their living cells active in water transport and storage of photosynthates are called ***sapwood***.

Depending on the species and vigor, sapwood comprises approximately the five youngest (outer) annual growth rings. ***Heartwood,*** the older annual xylem rings no longer active in water transport, is very susceptible to decay organism. Due to chemical changes in these non-living cells, heartwood is often darker in color. [Figure 9]

Figure 9. On this Douglas-fir log, the *sapwood* is the light colored annual growth rings active in water transport and storage of photosynthates. The darker colored *heartwood* in the center has no resistance to decay.

Ray cells grow through the annual growth rings functioning like staples or nails to hold the growth rings together. Ray cells also function as the path to move photosynthates in and out of storage in the xylem tissues. On some species, ray cells are not readily visible. On other species, ray cells create interesting patterns in the wood. [Figure 10]

Figure 10. The cracks on this willow stump show ray cells.

The wood is a series of boxes or "compartments" framed by the ***annual growth rings*** and ***ray cells***. Each compartment is filled with xylem tubes in which water with minerals moves from the roots to the leaves. [Figure 11 and 12]

CODIT: Compartmentalization of Decay in Trees (How Trees Decay)

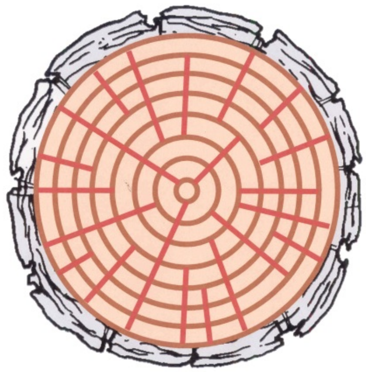


Figure 11. The xylem tissue (wood) is a serious of compartments or boxes created by the annual growth rings and ray cells.

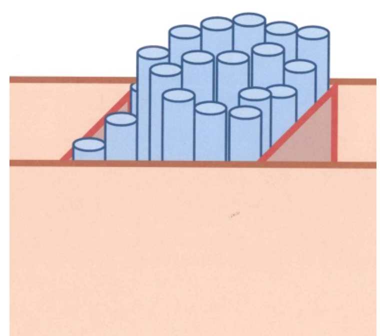


Figure 12. Each compartment or box framed by the annual growth rings and ray cells is filled with xylem tubes. Water moves in the xylem tubes up from the roots.

Unlike animals and people, trees do not replace damaged tissues. Rather, cells in the damaged area undergo a chemical change in a method to seal off or "compartmentalize" the damaged area from the spread of decay. This area of chemical change is called the ***reaction zone***. In most species, a reaction zone appears as darker colored wood.

The spread of decay is related to this compartmentalization of the xylem tubes in a box-like structure created by the annual growth rings and ray cells. In this box-like structure, the four walls differ in their resistance to the spread of decay. [Figures 11]

Wall 1 – Resistance to the spread of decay is very weak up and down inside the xylem tubes. Otherwise, the tubes would plug, stopping the flow of water, and kill the plant. From the point of injury, decay moves upwards to a small degree, but readily moves downward. The downward movement may be 20 or more feet and can include the root system.

Wall 2 – The walls into the older xylem tissues (toward the center of the tree) are also rather weak allowing decay to readily move into <u>older</u> annual growth rings.

Wall 3 – The walls created by the *ray cells* (being high in photosynthates) are somewhat resistant to decay organisms. This may help suppress the spread of decay <u>around</u> the tree.

Wall 4 – New annual growth rings that grow in years <u>after</u> the injury are highly resistant to the spread of decay.

Resistance to the spread of decay by the new annual growth ring and ray cells creates a pipe-like structure, with a decayed center. This concept of how decay spreads in a tree (as controlled by the *annual growth rings* and *ray cells*) is called CODIT, for Compartmentalization Of Decay In Trees. [Figure 13 & 14]

Figure 13. Spread of decay in trees

The spread of decay in trees is suppressed by the four walls created by compartmentalization of the annual growth rings and ray cells.

In the drawing, injury occurred three years ago when the yellow colored annual growth ring was the youngest. That year and everything older (grayed annual growth rings) are subject to a reaction zone and decay. The two new annual growth rings (brown color) that grew in years after the injury are highly resistant to decay.

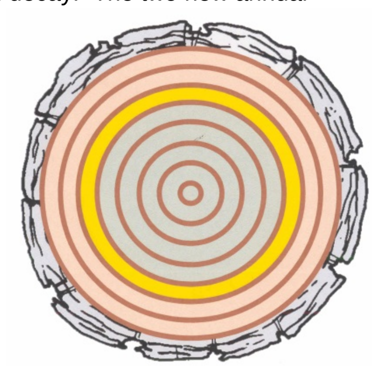


Figure 14. Decay in a tree creates a pipe-like structure with a hollow center. The light colored wood represents new annual growth rings that grew after the year of injury. The darker colored ring is a reaction zone created in the sapwood. The heartwood has completely decayed away.

Evaluating Decay

Percent Shell

A trunk or branch with some internal decay is not necessarily at risk for failure. Structural strength is based on 1) the minimum thickness of the healthy wood (xylem tissues) and 2) the structural strength of wood (tree species).

In evaluating potential hazards, arborists (tree care professionals) work with a technical term called ***percent shell***. Percent shell is calculated by dividing the thickness of the healthy wood at the thinnest point (not including bark, reaction wood, or decaying tissue) by the radius of the trunk/branch (not including bark).

Thirty three percent shell = high risk potential – Trees with a 33% shell or less are termed “high risk” with a statistically high probability of failure in a storm event. For example, a six-inch diameter (three-inch radius) trunk with only a one-inch thick ring of healthy wood would have a 33% shell with a hollow center. If injury or property damage would occur upon tree failure, corrective action (such as removal of the defective branch or removal of the tree) should be considered.

Twenty percent shell = critical risk potential – Trees with a 20% shell or less are considered a “critical risk” with a very high probability of failure in storms. For example, a tree with a ten-inch diameter (five-inch radius) trunk with only one-inch ring of healthy wood would be considered a “critical risk”. If injury or property damage would occur upon tree failure, corrective action (such as removal of the defective branch or removal of the tree) should be taken. [Figure 15]

Figure 15. This cottonwood branch has a 25% shell, putting it at “high risk” for potential failure. Percent shell is measured by dividing the thickness of the healthy wood at its narrowest point (not including the reaction wood [darker ring towards the center] and the bark) by the radius of the limb (not including bark).

The *Percent Shell Formula* is valid only when the decay column is centered in the trunk/branch. Researchers are developing other formulas to evaluate off-sided decay and open cavities, which are significantly weaker.

On older mature trees, percent shell formula standards may overstate the thickness of healthy wood needed to be structurally acceptable. Additional research is needed to better clarify this standard for older/mature trees.

Measuring Decay

So, how thick is the healthy wood in a trunk or branch? Researchers are working to address this big question. At the present time, arborists are limited in their ability to measure and evaluate the internal structure of a trunk or limb. The following are procedures with limited potential to evaluate the internal structure of trees.

Visual Indicators of Decay

Large pruning wounds suggest the potential for internal decay. Often decay may be observed within the pruning wound. [Figure 16]

Figure 16. The black material in the pruning cut is decay fungus. Notice the cracking; it also raises flags of structural integrity.

Cankers suggest the potential for internal decay. If the canker extends down into the soil, decay organisms will always be active.

Valleys, ridges, cracks, and splits along the trunk/branch suggest the potential for decay.

Wildlife living inside the tree is a sign of decay.

Abnormal swellings or shapes could be a sign that the tree is growing around a decayed area.

Coring Devices

Note: All coring devices have a small potential to spread decay, as the coring tools break the strong exterior wall of a reaction zone and bring decaying tissues out though healthy wood in the removal. Thus they are generally not used on living trees except when there is a special need to evaluate risk potential. Coring devices only indicate the decay potential at the point of drilling and do not represent the entire trunk or branch.

- An **Increment Borer** is a hand tool that removes a small core from a trunk or branch. The relative effort it takes to drill the borer through various layers of the tree and examination of the core removed gives the arborist some idea about the internal structure at this location. Increment borers are rarely used today in arboriculture.

- **Drill with small drill bit** – Drilling the trunk or branch with a 1/8 inch fully fluted drill bit is a tool used by some arborists. Pressure to push the drill through the annual growth rings and examination of the sawdust removed gives the arborist some idea about the internal structure at this location. An experienced arborist can be rather accurate in evaluation by drilling. Drilling has little value, however, for the inexperienced person. [Figure 17]

Figure 17. Examination of the sawdust and the pressure to push the drill through the annual growth rings give the experienced arborist a handle on internal decay. The yellow earplug on the drill bit helps the arborist know the depth as he works the drill bit in and out. With experience, the arborist could estimate percent shell for the spot drilled.

- A **Resistograph** is a specialized drill that graphs the pressure needed to push a small drill bit through various layers of annual growth rings. The graph gives a visual indication of internal structure at this location. Due to cost, few arborists have a resistograph. [Figure 18]

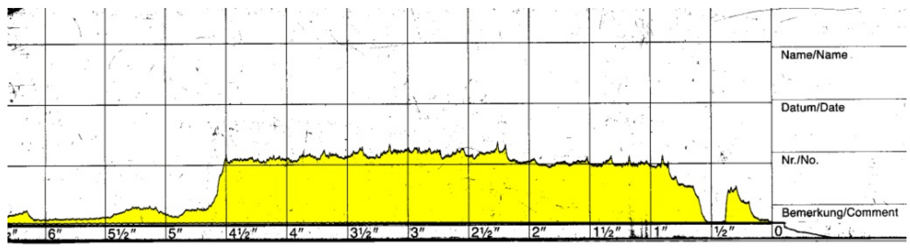


Figure 18. Sample printout of resistograph – This tree has a decayed center at 4½" from the outside bark.

- A **Digital Microprobe**, a specialized drill bit rotating at 7,000 rpm, measures the pressure needed to drill/burn its way through tissues. Data is fed into a computer database for evaluation and printout. This equipment is new to the industry and cost prohibitive for most arborists.

Listening and Radar Devices

- **Rubber mallet** – Tapping the trunk/branch with a rubber mallet and listening for a hollow sound may give some indication of critical internal decay. It will not give any percent shell to help evaluate risk potential and may not be effective on thick bark trees (like old cottonwoods). However, do not totally discount this technique, as may give clues of where to use other tools.

- **PiCUS Sonic Tomography** is a new device that listens to how sound waves move through the trunk/branch. A series of listening devices are attached around the trunk/branch and connected to a computer. When the tree is tapped with a mallet, the computer measures how the sound moves through the wood and creates a graphic cross-section of the trunk/branch interior. Measurements taken at multiple heights up the trunk can generate a three-dimensional image. This type of equipment has the potential to totally change tree care when it becomes available to arborists. Currently the cost is prohibitive for most arborists. [Figure 19]

Figure 19. PiCUS tomography listens to the movement of sound through the tree and draws a picture of the tree's internal structure.

- **Electrical Impedance Tomography** is similar to sonic tomography and measures the distortion of the electrical field by wood conditions. Electrical impedance tomography is better at detecting "Y" crevices and cracks and thus is often used in conjunction with sonic tomography.

- **Tree Radar** – A hand held radar device is run around the trunk/branch. The computer database is sent to the company for evaluation. Currently the cost is prohibitive for most arborists. [Figure 20]

Figure 20 – Tree radar taking a look at the tree's internal wood structure.

Breaks in the Pipe-Like Structure

When a wound or pruning cut breaks the pipe-like structure of a trunk/branch, the tree is especially weak at this location creating a higher potential for tree failure. [Figure 21]

Figure 21. Structural strength is significantly compromised when the pipe-like structure of a trunk has a break in the cylinder wall.

Lack of Trunk/Branch Taper

Branch failure (often breaking a few feet to 1/3 of the branch length out from the branch union) is a common type of storm damage. Branch failures often cause minimal damage to the tree. However, failure of a major branch may create holes in the tree canopy, introduce decay and cracking, and make the tree look unacceptable. ***Trunk failure*** refers to breaking of the lower trunk, above ground level (not at a branch union).

Branch and trunk failures are associated with lack of trunk/branch taper. That is the trunk/branch does not thicken adequately moving down the trunk/branch. This can be caused by pruning up the trunk too fast and by removing small branches and twigs on the lower trunk or lower interior canopy of the tree.

Very upright branches without a lot of side branches also typically fail to develop adequate taper. For structural integrity, shorten these branches with appropriate reduction cuts.

Authors: David Whiting (CSU Extension, retired), with Carol O'Meara (CSU Extension).
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- Colorado Master Gardener *GardenNotes* are available online at www.cmg.colostate.edu.
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Pruning Cuts

A pruning cut may or may not predispose the tree to internal decay and cracking, depending on the type of cut used, technical precision of the cut, size of the branch removed, species, and general health of the tree. For details on tree growth and decay, refer to *CMG GardenNotes* #611, Tree Growth and Decay.

In pruning, there are three primary types of pruning cuts, ***removal (thinning) cuts, reduction cuts*** and ***heading cuts***, each giving different results in growth and appearance.

Note: In this publication, the term "trunk" refers to the trunk or parent branch, and "side branch" refers to the adjacent side branch arising from the trunk (parent branch). The same relationship exists between a side branch and secondary side branch.

Maximum Diameter of Pruning Cuts

Sapwood, the living cells in the newer xylem rings active in water transport and storage of photosynthates, is resistant to decay. On branches two inches and less in diameter, sapwood dominates the branch structure making the branch resistant to decay. In a removal type cut, ***woundwood*** (the callus tissue that grows over pruning cuts or wounds) quickly grows over these small pruning cuts.

Heartwood, the older xylem rings no longer active in water transport, has no resistance to decay. Due to chemical changes in these nonliving cells, heartwood is often darker in color. Depending on species and growth rates, heartwood becomes significant as branches reach two to four inches in diameter. At approximately four inches, heartwood dominates the branch structure, and the branch becomes highly susceptible to decay organisms and internal cracking. [Figure 1]

Figure 1. Cross section of a Douglas-fir. The light colored outer ring of wood is the sapwood. The dark wood in the center is the heartwood.

In an ideal world, all pruning cuts would be two inches in diameter or smaller. This small size is especially important on tree prone to decay (a factor of species and tree vigor). On tree species resistant to decay, with good vigor and without growth limiting factors (such as severe soil compaction or drought stress), the two-inch or less standard may be pushed to 2-4 inches. [Table 1]

Table 1. Tree Species Prone/Resistant to Decay

Weak Compartmentalizers **Prone to Decay**	**Strong Compartmentalizers** **Resistant to Decay**
o Beech (*Fagus* spp.) o Birch (*Betula* spp.) o Cherry, Peach, Plum and other *Prunus* spp.) o Crabapple (*Malus* spp.) o Hackberry (*Celtis* spp.) o Horsechestnut and Buckeye (*Aesculus spp.*) o Maples (some *Acer* spp.): Norway, Silver o Oak (some *Quercus* spp.): Pin, Shumard o Poplar, Cottonwood, & Aspen (*Populus* spp.) o Redbud (*Cercis* spp.) o Willow (*Salix* spp.)	o Black Locust (*Robinia pseudoacacia*) o Catalpa (*Catalpa* spp.) o Elm, American (*Ulmus Americana*) o Honeylocust (*Gleditsia* spp.) o Hornbean (*Carpinus* spp.) o Maples (some *Acer* spp.): Red, Sugar o Oak (some *Quercus* spp.): Bur, English, Live, Northern Red, White o Pine (some *Pinus* spp.) o Walnut (*Juglans* spp.) o Yew (*Taxus* spp.) Note: Will lose resistance with stress factors such as severe soil compaction, drought, hardscape over rooting area, etc.

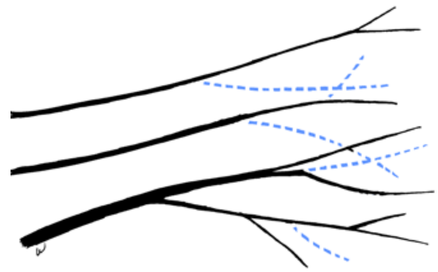
However, we don’t live in the ideal world. Sometime larger diameter cuts are needed. Any pruning cut four inches and larger needs to take into account the increased risk for failure and reduced health associated with internal decay and cracking. Cuts on large branches often create new problems with high potential for failure!

Removal Cuts

Removal cuts (also known as thinning cuts or collar cuts) remove side branches back to the larger parent branch or trunk. If the branch union has a branch collar, removal cuts have the advantage of preserving the *branch defense zone*, providing a strong defense against internal decay.

Removal cuts reduce the canopy density but have little influence on height. Thinning with removal cuts allows better light penetration into the canopy, which encourages desired growth of interior branches. This improves trunk taper and increases the general vigor of primary branches and the trunk. Removal cuts reduce the weight on large branches, giving the tree resilience to snow loading. The primary use of removal cuts is in structural pruning of small, middle-aged and older trees and on shrubs.

Figure 2. Removal cuts eliminate a side branch back to the trunk or parent branch.



Two features on the branch, the *branch collar* and the *branch bark ridge*, help identify the proper cut angle. The ***branch collar*** is the area where the annual growth rings of the trunk fold in between the annual growth rings of the side branch, in a manner similar to shuffling a deck of cards. On some species, the branch collar is readily noticeable, while on other species the branch collar is less obvious. [Figure 3]

The ***branch bark ridge*** is where the bark from the trunk joins the bark from the side branch. It looks like a dark line or small mountain range extending out from the crotch down both sides of the trunk/branch. It mirrors the angle of attachment of the side branch. [Figure 3]

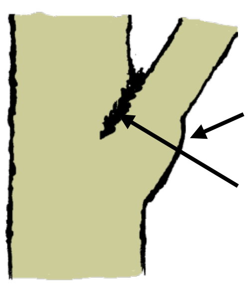


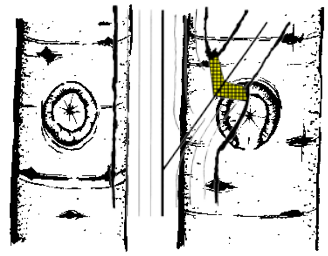
Figure 3. Branch collar and branch bark ridge.

Branch Collar
Trunk tissues overlap with side branch tissues

Branch Bark Ridge
Trunk bark meets side branch bark

Within the branch collar is a narrow cone of cells called the ***branch defense zone***. These cells activate the growth of ***woundwood***, the callus tissue that grows over the pruning cut. With a proper cut, the woundwood grows out from all sides in a donut shape over the wound. If the branch collar is nicked, the woundwood does not grow from that point. It is common to see a pruning cut where the woundwood fills in only from two sides, indicating that the top and bottom of the branch collar were injured. [Figures 4]

Figure 4. Branch Defense Zone – Within the branch collar is the branch defense zone, a narrow ring of cells that effectively initiates a strong reaction in which chemical changes protect the trunk from decay. If the branch collar is cut or nicked in pruning, the defense zone may fail, predisposing the wound to decay.



The branch defense zone also plays an important role in activating a strong reaction zone inhibiting the spread of decay organisms into the trunk. If the branch collar is injured or removed during pruning, the branch defense zone will fail, limiting the growth of woundwood and predisposing the cut to decay. Thus, a primary objective in a correct removal cut is to preserve the branch collar intact.

With a *removal cut,* the final cut should be just beyond the branch collar. Because the woundwood that grows over the pruning cut originates in the branch defense zone, <u>it is imperative that the branch collar not be cut or otherwise injured in pruning</u>. To eliminate error, cut a little beyond the collar region (i.e., 1/8 inch for small-diameter twigs and 1/4 inch for larger branches). [Figure 5]

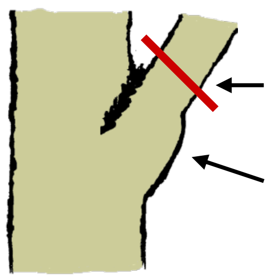


Figure5. Removal Cut

Final Cut made just outside the branch collar, taking care not to nick the branch collar.

Branch Collar
Trunk tissues overlap with side branch tissues

In species where the branch collar is not clearly identifiable, look for the branch bark ridge. Make the final cut at the angle that mirrors (lies opposite) the angle of the *branch bark ridge*. [Figure 6]

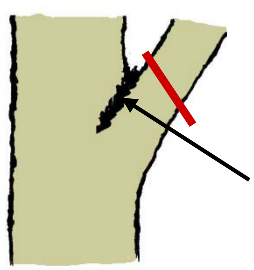


Figure 6. When the branch collar is not clearly identifiable, make the final *thinning cut* at the angle that mirrors the angle of the *branch bark ridge*.

Branch Bark Ridge

When a branch union has no branch collar (the side branch is greater than half the diameter of the adjacent trunk), tilt the angle of the final cut out a little more to minimize the size of the wound. Be aware that in the absence of a branch collar there is no branch defense zone to activate rapid woundwood growth and activate a strong reaction to suppress the potential for decay. (Fig.7.)

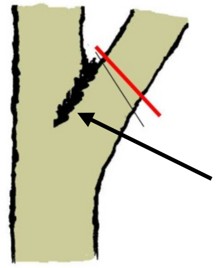


Figure 7. When the branch union has no branch collar (the side branch is greater than half the trunk diameter), tilt the cut angle out a little more to reduce the diameter of the cut wound.

When removing a dead branch, the final cut should be just outside the branch collar of live bark tissue. If a collar of live wood has begun to grow out along the dead branch, remove only the dead stub, leaving the collar intact. Do not cut into living tissues. [Figure 8]

Figure 8. When removing a dead branch, do not cut into or otherwise damage the branch collar or woundwood growing around the dead branch.

Reduction Cuts

Reduction cuts remove a <u>larger</u> branch or trunk back to a smaller-diameter side branch. Reduction cuts are commonly used in training young trees. They are also the only type of cut that will significantly lower a tree's height.

However, reduction cuts do not have a *branch defense zone*, leaving the branch with a weak defense against decay. This is not a major concern on young, actively growing branches. However, reduction cuts are discouraged on mature trees and on limbs larger than two inches in diameter. On trees under stress or in decline, avoid reduction cuts as they can accelerate the decline.

In a reduction cut, make the final cut to bisect (split the difference) between the *branch bark ridge* angle and an imaginary line perpendicular to the stem being removed. Alternatively, the angle could be tilted up a little more to perpendicular to reduce the size of the wound. The exact angle is not critical as long as it is not flat on top (water needs to readily run off). [Figure 9]

To prevent undesired suckering at this point, the diameter of the smaller side branch should be at least one-third (preferably one-half) the diameter of the larger branch being removed. If the diameter of the smaller branch is less than one-third the diameter of the larger branch being removed, the cut is considered a heading cut and is generally unacceptable in pruning standards. [Figures 10 and 11]

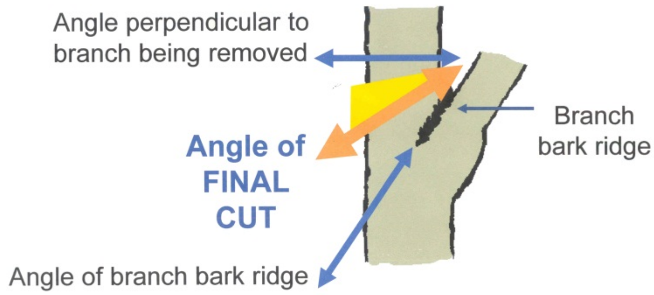


Figure 9. Reduction Cut – When pruning back a larger branch to a smaller branch, the angle of the final cut should split the difference between the angle of the *branch bark ridge* and the angle perpendicular to the branch being removed.

Figure 10. To prevent excessive suckering, the smaller branch should be at least one-third the diameter of the larger branch.

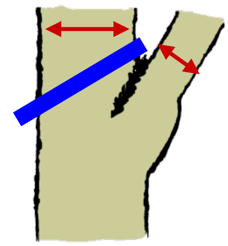
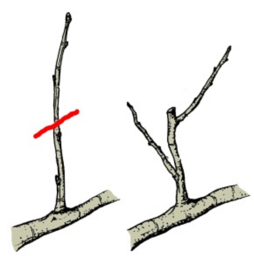


Figure 11. This adventitious sucker growth from a reduction cut is structurally unsound and prone to storm damage as it grows.

Heading Cuts

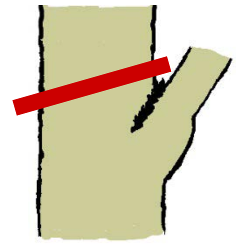
Heading cuts remove the growing tips of branches. This releases the side buds to grow, resulting in more dense growth at the point of pruning. [Figure 12]

Figure 12. Heading cuts remove the growing tips of branches, releasing side buds to grow.



Another type of undesirable heading cut is the removal of a large trunk/branch back to a smaller side branch when the side branch is less than one-third the size of the larger trunk being removed. Structurally unsound water sprouts often emerge along the branch, and the tree may become more unsound than before the pruning. [Figure 13]

Figure 13. Removing a larger trunk or branch back to a small side branch when the side branch is less than one-third the diameter of the adjacent trunk is also considered a heading cut. This leads to structurally unsound growth of water sprouts and is not considered an acceptable pruning cut.



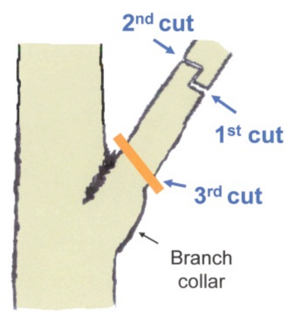
Heading cuts are undesirable for most pruning objectives on shade trees. Topping a tree with heading cuts gives a surge of new branch growth at the tree's top. The new growth is often structurally unsound and prone to storm damage. Growth in the tree's interior thins out from increased shading, decreasing the tree's overall health and vigor.

On shrubs, heading cuts or "shearing" creates a very dense upper/outer canopy that shades out the lower/inner portion, creating a woody base.

Three-Cut Method for Larger Branches

When removing any branch larger than one inch in diameter, use a three-cut method to protect the bark from tearing. [Figure 14]

Figure 14. Three-cut method for any branch larger than one inch.



Cut 1. Coming out 12 to 15 inches from the branch union (crotch), make an undercut approximately one-third to halfway through the branch.

Cut 2. Moving a couple of inches out past the first cut, make the second cut from above, removing the branch. This double-cut method prevents the weight of the branch from tearing the bark below the collar.

Cut 3. Make the third and final cut at the correct pruning point. For example, on a *removal cut*, just outside the branch collar. For *woundwood* growth, take extra caution not to cut into or otherwise injure the branch collar.

Wound Dressings

Wound dressings do not prevent decay organisms from moving in. In fact, the older, tar-type dressings actually interfere with the natural *woundwood* growth and may create conditions favorable for decay organisms. Generally, leave pruning cuts dry and untreated.

Occasionally a thin layer of water-based dressing or paint may be applied solely for aesthetic purposes. Never use an oil-based paint, tar or other materials that contain petroleum solvents. A dark-colored material over a wound may predispose the wound site to winter injury. When managing diseases such as fire blight, a fungicide/bactericide may be used as a wound dressing.

The key to good wound closure is proper pruning, making a smooth cut just beyond th*e branch collar,* and making all cuts on branches less than two inches in diameter. Trees under stress (soil compaction, drought, overly wet soils, insect or disease problems, lawnmower damage to the trunk, etc.) are less capable of fighting the invasion of decay organisms.

Time of Year to Prune

Dead, diseased, and damaged wood can be removed any time of year as needed.

When it comes to removing live wood, there are better times of year for pruning. Light pruning—up to 10% of the foliage—may generally be done any time of year on healthy trees without stress factors.

Late winter—Pruning in the late dormant season (before buds swell) is considered the routine pruning time on many tree species. However, some species are prone to bleeding if pruned in the spring. While this is more of a cosmetic issue than a health issue, most arborists avoid pruning bleeders in the late dormant season. [Table 2]

Table 2.
Examples of Trees Prone to Spring Bleeding

Birch	Kentucky coffeetree
Black locust	Maple
Elms	Mulberry
Goldenchain tree	Poplar
Hackberry	Walnut
Japanese pagodatree	Willow

Spring, during growth flush, is generally considered an undesirable time to prune trees. The bark and cambium tissues are easily damaged. Pruning may stimulate excessive watersprout growth or reduce overall vigor.

Midsummer, following growth flush (as leaves reach full size, harden and turn dark summer green) is considered an excellent time to prune. It is the preferred time for spring bleeders. It may be the best time of year to suppress decay potential.

Late summer to fall is generally considered an undesirable time to prune. It may stimulate canopy growth and interfere with winter hardiness.

Late fall to early winter is generally considered an undesirable time to prune. Extreme cold (below zero) may cause cambium damage near the pruning cut.

Drought – Do not remove live wood from trees in drought stress. This removes stored photosynthates that the tree is living on during the stress.

Pest management consideration – In some insect management programs, pruning may need to be timed before insect flight periods or avoided during insect flight periods.

Pruning Equipment

Hand pruners are used to cut small limbs up to ¼ to ½ inch in diameter (depending on the wood hardness). The bypass or scissor-type pruner (cutting as the blade crosses past the hooked anvil in a scissor action) is considered the best type. The anvil type (cutting as the blade pushes against the anvil) is more prone to tearing and mashing the tissues. The best advice on pruners is to purchase the best pair you can afford. It will last for years. Inexpensive pruners are short-lived.

In using bypass-type hand pruners, place the blade toward the tree with the anvil toward the outside. This allows for a closer cut. For bypass pruners, sharpen only the beveled edge of the blade pointing toward the anvil, never the anvil side of the blade.

Loppers are used for larger branches, generally up to ½ inch in diameter. With long handles, they make quick work of cutting up prunings on the ground.

Pole pruners make poor-quality cuts. They are used to cut small branches out of reach from the ground.

Handsaws are used for branches larger than ½ inch. There are two general types of tree saws. Tree saws with curved blades cut as the saw is pulled and are considered safer to use. Tree saws with straight blades cut as the saw is pushed. To remove the moist sawdust, tree saws have wider teeth spread than lumber saws. In a cut larger than 1 inch, a three-cut method should be used.

Chain saws are extremely dangerous. In the United States 40,000 to 90,000 people have serious injuries, and 40 to 60 are fatally injured each year from chain saw accidents. Most accidents occur to the left leg, the shoulders, and the face. Chain saws should only be used by someone specifically trained in chain saw safety. A common accident occurs when the limb kicks back as the cut is being completed. Personal protective clothing is also needed. Safety glasses and boots are required by law. Helmet, hearing protection, gloves, and leg protection are also recommended.

Authors: David Whiting (CSU Extension, retired), with Alison O'Connor and Eric Hammond (CSU Extension). Artwork by David Whiting and Scott Johnson; used by permission.

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Revised May 2018

CMG GardenNotes #613

Structural Training of Young Shade Trees

Pruning Basics

Structural training is a multi-year investment requiring evaluation and corrective pruning on an annual basis. Young trees require little pruning. However, the training a tree receives while in the early "growth phase" of its life cycle determines its structural integrity for life. Many trees become prone to wind and snow damage as they mature due to the lack of structural training while young. Proper structural training of the young tree makes it especially resilient to storm damage when mature.

In this *CMG GardenNotes*, we look at the ideal structure for a young tree making it resilient to wind and snow loading. In selecting trees at the nursery, choose trees that will not require extensive pruning to reach the desired structure (e.g., no codominant trunks, straight central leader, evening branching along all sides, etc.). In real world settings, not all trees will fit the ideal description. The objective is to set the direction of what is desirable, recognizing that some trees simply do not meet the preferred structure for storm resilience.

Note: For additional information on a tree's life cycle, refer to CMG GardenNotes #101, *Plant Health Care*. For additional information on branch collar development refer to CMG GardenNotes #611, *Tree Growth and Decay* For additional information on types of cuts, refer to CMG GardenNotes #612, *Pruning Cuts.*

Time of year

Structural pruning is typically done in late winter, before trees break dormancy. Pruning is generally avoided during the spring growth flush as bark is rather tender at this point in time. Mid-summer pruning is preferred for tree species prone to bleeding if spring pruned (including birch, black locust, elms, goldenchain tree, hackberry, Japanese pagodatree, Kentucky coffeetree, maples, mulberry, poplars, walnuts, and willows).

Size of branches

Ideally, all pruning cuts are two inches in diameter and smaller. On tree species more resistant to decay, the standard could be pushed to two to four inches, maximum (depending on actual vigor and growth of the tree).

The structural training stage basically ends when pruning cuts would be greater than this standard. Larger cuts become general pruning rather than training of the tree. Any pruning cut four inches and larger must be justified by taking into account the potential for decay.

Structural Training Steps

Structural training follows a series of steps. Considerations at each step determine the direction to take in following steps.

Step 1 – Dosage: Maximum Amount of Live Wood/Foliage to Remove

The maximum amount of foliage/live wood that can be removed per season depends on the actual growth rate of the tree. Look at six to 12 branches around the tree to assess growth rates. Look for what is the typical growth rate for most branches, rather than the fastest or slowest growing branches. [Table 1]

Growth and Annual Growth Rings – Starting at the branch tip, look at the length back to the first ***annual growth ring*** (*terminal bud scare*). This is where the growth ended the previous year. The annual growth ring looks like a small ring or crown going completely around the twig. On some trees it is easy to identify, on other trees it is only a simple ring. To avoid confusing it with a side bud, the annual growth ring goes completely around the twig. On some trees, a slight change in bark color helps identify where the annual growth rings are located. [Figure 1]

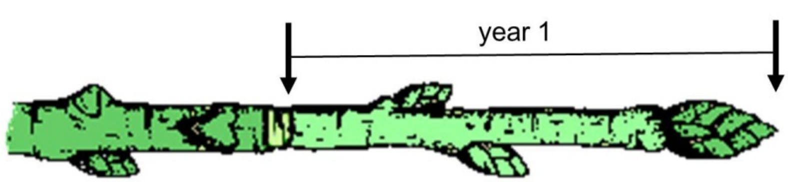


Figure 1. The annual growth rings (terminal bud scar) looks like a small ring or decorative crown going complete around the stem.

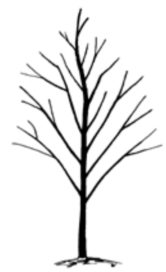
Table 1. Dosage: Maximum Amount of Live Wood/Foliage to Remove per Season on Young, Actively Growing, Trees	
Actual Annual Growth	**Estimated Maximum Amount of Live Wood/Foliage to Remove Per Season**
3 to 4+ feet.	25% to 50%
1 to 2 feet	10% to 25%
6 to 12 inches	Approximately 10%.
Little annual growth.	Limit pruning to a light dosage, correcting codominant trunks.
Tree under critical stress with minimal annual growth.	Limit pruning to cleaning (removal of dead and damaged branches).

In situations where trees are pruned annually (the ideal situation), the appropriate pruning dose would be light. However, in real world situations, trees are often pruned only once every several years. Here the appropriate pruning dose may be higher. In situations where heavy pruning is needed, complete the work over a period of years.

Excessive pruning can lead to watersprouts (upright, sucker-like shoots emerging on the trunk or branches). Waterspouts, a common response to over pruning and storm damage, are structurally unsound. Excessive pruning also creates a hormone imbalance between auxins (produced in the terminal buds) which stimulates root growth, and gibberellins (produced in the root tips) which stimulates canopy growth. Since roots have multiple regeneration periods each season, this imbalance puts the root system into a decline, resulting in a multi-year decline in canopy growth.

Step 2 – Growth Habit

The desired branching structure depends on the natural growth habit of the tree. Trees with an ***excurrent*** growth habit develop with a ***central leader*** (single trunk) to the top. Examples of excurrent trees include aspen, linden, and pines. Trees with a ***decurrent*** growth habit develop a more rounded form with multiple ***scaffold branches*** (secondary trunk-like branches) or secondary trunks originating from the trunk. Examples of decurrent trees include maple, ash, elm, and honeylocust. Table 1 shows comparisons in pruning objective of excurrent and decurrent trees. [Table 2]

Table 2 – Structural Training Objectives for Young Trees		
	 **Excurrent Trees** Single trunk to the top	 **Decurrent Trees** Scaffold branches arise from the trunk becoming the main structural system
Training Objective 1	Remove dead and damaged branches.	
Training Objective 2	Maintain single trunk to top of tree.	Maintain single dominant trunk to at least two-thirds of the tree's mature height.
Training Objective 3	Select lowest permanent branch.	Select lowest scaffold branch.
Training Objective 4	Maintain diameter of all branches less than one-half the diameter of adjacent trunk.	Select other scaffold branches.
Training Objective 5	Manage temporary branches removing them over time (before they reach a two inch diameter).	

Step 3 – Pruning Objectives

Structural training of young shade trees is based on five pruning objectives. Evaluation of all five is generally done before actual pruning occurs, as considerations are interrelated.

Objective 1 – Remove Dead and Damaged Branches

Actual pruning begins with the removal of dead, broken, and damaged branches. [Figure 2]

Competing branches (branches growing in the same space) are also a consideration. However, which one to keep and which ones to remove generally sorts out in the other steps.

Figure 2. Rubbing branches

Objective 2 – Develop Trunk

The primary pruning objective is to eliminate multiple trunks. If multiple trunks start to develop, remove all but one. If the leader is killed, select a side branch to become the new leader, removing its competition (a multi-year process). It may be helpful to loosely tie the new leader to a stick to bend it to an upward orientation.

Codominant Trunks

In training trees, arborists have zero tolerance for ***codominant trunks*** (adjacent trunks of similar diameter). Codominant trunks account for the majority of wind and snow related tree failures in Colorado and other snowy climates.

With codominant trunks, no branch collar develops to wrap the two trunks together. (The ***branch collar*** is the area where trunk wood wraps around the branch wood creating a structurally strong branch union.) The ***branch union*** (crotch) is structurally weak and prone to breakage as the trunks reach a size greater than 3-4 inches in diameter. [Figure 3]

Note: In selecting a tree, it is advisable to avoid purchasing trees with codominant trunks.

Figure 3. Codominant trunks – A branch union with two trunks of similar size is structurally weak and prone to storm damage. "Included bark" (hidden bark) between the trunks prevents the wood from growing together. Without a branch collar, wood of the two trunks does not knit together. In structural pruning, there is zero tolerance for codominant trunks.

Excurrent Trees – Maintain Single Trunk to Top of Tree

On excurrent (central leader) trees, maintain a single trunk to the top of the tree. If a side branch begins growing upright in a trunk-like fashion, prune it back to redirect the growth to an outward direction or removed it entirely. Generally, do not prune or "head back" the central leader (trunk). [Figure 4]

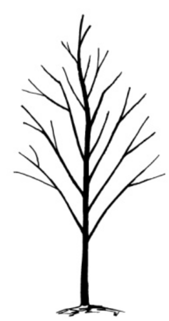


Figure 4. On excurrent trees, maintain a single trunk to the top.

Decurrent Trees – Maintain Single Dominant Trunk to at Least Two-thirds of the Tree's Mature Height

The overall objective with decurrent trees is to develop a structural system of *scaffold branches* rather than secondary trunks. ***Scaffold branches*** are the major structural, trunk-like branches that originate off of the trunk. By definition, a scaffold branch must be less than one-half the size of the adjacent trunk. Less than one-third is preferred. This allows for a branch collar to develop, creating a structurally strong branch union. In contrast, ***secondary trunks*** lack the size relationship for branch collar development, creating structurally weak branch unions.

In an open landscape setting, most decurrent trees naturally develop multiple secondary trunks often arising at the same location predisposing the tree to storm damage.

<u>On decurrent trees, maintain a single dominant trunk to at least two-thirds of the tree's mature height.</u> For example, if the mature tree height is 30 feet, a single trunk should dominate to at least 20 feet. If the mature tree reaches 60 feet, a single trunk dominates to at least 40 feet. Scaffold branches become the secondary framework of the tree. By training, secondary trunks are avoided. [Figure5]

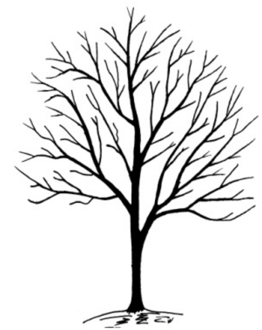


Figure 5. On decurrent trees, maintain a single dominant trunk to at least two-thirds of the tree's mature height.

If vigorously upward-growing side branches begin to compete with the central leader, prune back the branch to a more outward growing side branch. Some tree species naturally put out many upward growing secondary trunks. Heavy pruning over a period of years will be desirable to establish a dominant central leader with subordinate smaller side branches.

Generally, do not "head-back" (prune) the central leader.

<u>Objective 3 – Select Lowest Branch</u>

It is often desirable to ***raise*** the canopy (remove lower branches) so they are out of the way of human activities like mowing the lawn and lawn games. For shade trees in lawns, patios, and along sidewalks, the lowest permanent branch generally starts 7 to 10 feet above ground level. On smaller specimen trees in a garden bed, lower branching may be preferred. Over streets, the lowest branches start at 14 feet. In wooded settings, the canopy is raised to 10 feet as a fire prevention technique.

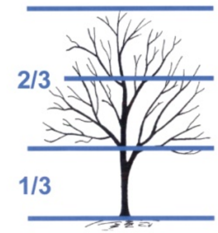
Many gardeners mistakenly plan to remove lower branches as the tree reaches a more mature size. Removing these larger branches as the tree matures opens the tree to internal decay. On decurrent trees, these lower branches typically make up a significant portion of the tree.

The objective is to identify what will be the lowest permanent branch at this early time in life, allowing the gardener to manage and remove lower branches over time. Branches below the lowest permanent branch are called ***temporary branches***. Management and removal of the temporary branches will be discussed in Objective 5.

The lowest branch on any tree should originate in the bottom one-third of the tree. In establishing the lowest branch, don't "limb-up" a young tree too early in its growth. To develop a trunk taper resilient to wind, one-half of the leafing area should be found in the lower two-thirds of the tree. Lower ***temporary branches*** should be removed only as the tree grows in height, but before they reach two-inches in diameter. (Refer to Objective 5 for details). [Figure 6]

Figure 6. To develop a strong trunk taper, at least one-half of the foliage must be in the lower two-thirds of the tree.

Temporary branches below the lowest permanent branches will be removed over time. (Refer to Objective 5.)



<u>On excurrent trees</u>, select the lowest permanent branch. Branches below this point become temporary branches.

<u>On decurrent trees</u>, select the lowest permanent branch, which will become the first *scaffold branch*. Other scaffold branches will be selected based on the location of this branch. Branches below the lowest (first) scaffold branch become temporary branches.

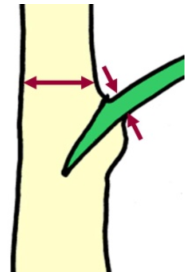
<u>Objective 4 – Developing Branching Structure</u>

In Objective 4, branches are managed differently for excurrent and decurrent trees.

Excurrent Trees: Maintain Diameter of All Branches Less Than One-Half the Trunk Diameter

For structural integrity, side branches must be less than one-half the diameter of the adjacent trunk. Less than one-third is preferred. Without this important size ratio, the branch collar fails to develop, creating a weak branch union. [Figure 7]

Figure 7. For a branch collar to develop, the side branch must be less than one-half the diameter of the adjacent trunk.



If the diameter of a branch is growing too fast compared to the trunk, prune the branch back by 1/3 to 2/3s to slow its growth rate.

Spacing of branches along the trunk is not a critical structural issue on excurrent trees, as long as the trunk to side branch ratio is within limits. Many species of excurrent trees develop branches in a whorl. This is structurally acceptable as long as the branch to trunk size ratios are within limits. On some species of trees, thinning of competing branches (branches growing in the same space with the potential to rub and damage each other) may be desirable.

Decurrent Trees: Select Other Scaffold Branches

In the structural pruning of decurrent trees, an overall intent is to guide development of the branching structure, creating *scaffold branches* and eliminating secondary trunks. The intent is to create strong branch unions with a branch collar. For the branch collar to develop, the branch must be less than one-half (less than one-third preferable) the size of the adjacent trunk. Without the branch collar, secondary trunks are structurally weak and prone to breakage as the tree matures.

The selection of other scaffold branches takes place over a period of years as the tree grows in height. Branches along the trunk not destined to become scaffold branches are managed as ***temporary branches*** being removed over time.

In selecting other scaffold branches, consider branch spacing and branch union (crotch) angles. In an open landscape setting, decurrent trees naturally develop more branches than is desirable, predisposing the tree to wind and snow damage as the tree matures. The objective of training is to correct this situation while the tree is young.

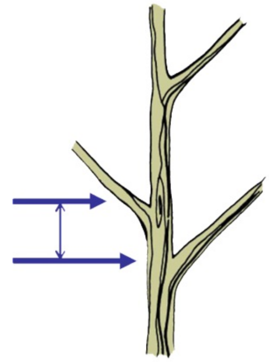
Branch spacing – Desired spacing for scaffold branches depends on the mature height of the tree. The rule of thumb is to allow at least 6 inches per 10 feet of mature tree height. Table 2 shows spacing for various mature heights. [Table 3]

Table 3 – Minimum Spacing for Scaffold Branches

Mature Tree Height	Minimum Scaffold Branch Spacing
20 feet	1 foot
30 feet	1.5 feet
40 feet	2 feet
50 feet	2.5 feet
60 feet	3 feet
70 feet	3.5 feet
80 feet	4 feet

Select scaffold branches with even distribution around the tree trunk. Where a scaffold branch is growing directly above another, vertical spacing should be at least 60 inches on trees with a mature height of 30 feet and taller, and 18 to 36 inches on smaller trees. [Figure 8]

Figure 8. Minimum scaffold branch spacing is based on the mature height of the tree at 6 inches per 10 feet of mature height. A tree that will grow to 30 feet should have scaffold branches spaced at least 18 inches apart.



<u>Multiple branching at one location</u> — When multiple scaffold branches arise from the same area, the branch collars cannot knit together into a strong branch union. These branches become vulnerable to wind and snow damage. In training a young decurrent tree, eliminate multiple branches arising at the same location. Many common shade trees, including maples, cottonwoods, poplars, and elms naturally develop multiple branching at the same location. [Figure 8]

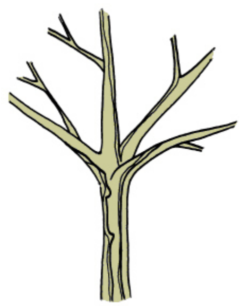


Figure 8. Multiple branches originating from the same location are structurally weak. An objective in structural training is to space scaffold branches.

Branch union angles – The problem with a narrow branch union (crotch) angle is the development of ***included bark*** (bark against bark inside the branch union) as the tree grows. With included bark, the branch collar cannot wrap the trunk wood around the side branch wood, creating a weak branch union. A branch union with a wide angle of attachment is also more resistant to the spread of decay.

In selecting scaffold branches, select outward growing branches with a wide angle of attachment rather than upward growing branches.

Objective 5 – Manage Temporary Branches, Removing Them Over Time

Temporary branches on the lower trunk are important to the tree's early growth. *Photosynthates* (carbohydrates and proteins produced by photosynthesis) produced in the lower canopy help develop the natural trunk taper giving wind resilience. Shading by the lower foliage helps reduce sunscald of the tender bark.

Manage growth on temporary branches by keeping them short and removing them over time as the tree grows in height. Ideally, temporary branches are pruned back to a few buds. On temporary branches that have grown significantly before training begins, start by cutting them back by about 50%, removing more over time.

<u>Temporary branches are removed before they reach a two inch diameter</u>. Pruning back a temporary branch slows the growth, giving more time before the branch must be removed due to size.

Keeping temporary branches short suppresses their rapid growth while encouraging the desired growth up in the scaffold branch structure. During the early training process, a young tree will have a cylinder of short temporary branches along the lower trunk (below the lowest permanent branch), with the tree's significant growth developing up in the permanent branch structure. [Figure 10]

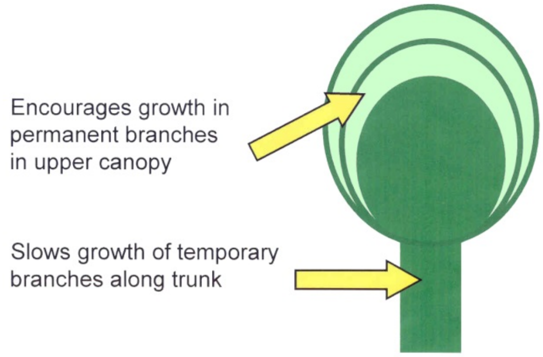


Figure 910 of a young tree: temporary branches on the lower trunk (below the lowest permanent branch) create a narrow cylinder of short branches.

Preferred vertical spacing of temporary branches is four to six inches. Thus some branches would be removed outright. On decurrent trees, no temporary branch should be within six inches of a scaffold branch. Branches between scaffold branches are also considered temporary branches. Maintain these temporary branches for one to five years, removing them before they reach a two-inch diameter.

On decurrent trees, it generally takes several years to manage and eventually remove temporary branches. Remember that the total amount of foliage that can be removed per season depends on the growth rate of the tree. In purchasing, select trees that require minimum corrective pruning to make them structurally sound.

Authors: David Whiting (CSU Extension, retired), with Alison O'Connor and Eric Hammond (CSU Extension). Photographs and line drawings by David Whiting; used by permission.

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Revised May 2018

CMG GardenNotes #614

Structural Training Summary
for Young Shade Trees

Dosage: How much to remove

The amount of live wood/foliage to remove per season depends on the growth rate of the tree. Look at 6 to 12 twigs around the tree to assess actual growth rates.

- For trees with critical stress and insignificant annual growth, limit pruning to *cleaning* (removal for dead and damaged branches).
- For trees putting on little growth, limit pruning to a light dosage correcting codominant trunks.
- For trees putting on approximately six to 12 inches of new growth per season, 10% would be an estimate.
- For trees putting on a foot or two of new growth, 25% would be an estimate.
- Trees putting on three to four plus feet of new growth may tolerate 25% to 50% of the live wood/foliage being removed.

Ideally, all pruning cuts are two inches in diameter and smaller.

Growth habit

The desired branching structure depends on the natural growth habit of the tree. Trees with an ***excurrent*** growth habit develop with a ***central leader*** (single trunk) to the top. Examples of excurrent trees include Aspen, Linden and pines. Trees with a ***decurrent*** growth habit develop a more rounded form with multiple ***scaffold branches*** (secondary trunk-like branches) or secondary trunks originating from the trunk. Examples of decurrent trees include Maple, Ash, Elm and Honeylocust.

Codominant trunks – A branch union with two trunks of similar size is structurally weak and prone to storm damage. "Included bark" (hidden bark) between the trunks prevents the wood from growing together. In structural pruning, there is zero tolerance for codominant trunks.

Developing Trunk

The primary pruning objective is to eliminate multiple secondary and codominant trunks. If multiple trunks start to develop, remove all but one. If the leader is killed, select a side branch to become the new leader, removing competition.

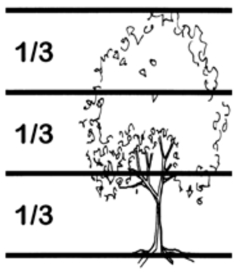
On excurrent (central leader) trees, maintain a single trunk to the top of the tree. If a side branch begins growing upright in a trunk-like fashion, prune it back, redirecting growth to an outward direction. Do not prune or "head back" the central leader (trunk).

On decurrent trees, maintain a single dominant trunk to at least 2/3s of the tree's mature height. For example, if the mature tree height is 30 feet, a single trunk should dominate to at least 20 feet. If the mature tree reaches 60 foot, a single trunk dominates to at least 40 feet. Scaffold branches become the secondary framework of the tree. Through training, secondary trunks are avoided. Do not "head-back" (prune) the central leader.

The overall objective with decurrent trees is to develop a structural system of *scaffold branches* rather than secondary trunks. ***Scaffold branches*** are the major structural, trunk-like branches that originate off of the trunk. By definition, a scaffold branch must be less than one-half the size of the adjacent trunk. Less than one-third is preferred. This allows for a branch collar to develop creating a structurally strong branch union. In contrast, "secondary trunks" lack the size relationship for branch collar development creating structurally weak branch unions. In an open landscape setting, most decurrent trees naturally develop multiple secondary trunks arising at the same location predisposing the tree to storm damage.

Managing Side Branches

Selecting lowest branch – The objective is to identify what will become the lowest permanent branch early in the tree's life, allowing the gardener to manage and remove lower branches over time. Branches below the lowest permanent branch are called ***temporary branches***.



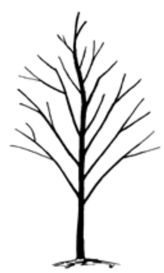
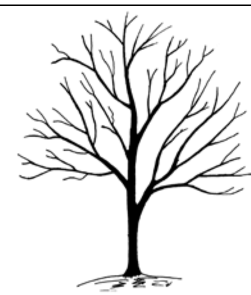
To develop a strong trunk taper, at least one-half of the foliage must be in the lower two-thirds of the tree. *Temporary branches* below the lowest permanent branches will be removed over time, as the tree grows in height.

<u>On excurrent trees</u>, select the lowest permanent branch. Branches below this point become temporary branches.

<u>On decurrent trees</u>, select the lowest (first) scaffold branch. Other scaffold branches will be selected based on the location of this branch. Branches below the lowest (first) scaffold branch become temporary branches.

Developing branching structure – For a branch collar to develop (creating a structurally strong branch union) the side branch must be less than one-half the diameter of the adjacent trunk. Less than one-third is preferred. If a side branch is growing too fast, compared to the trunk, prune back the side-branch to slow the growth.

In structural training of decurrent trees, the overall intent is to guide development of the branching structure, creating *scaffold branches* and eliminating secondary trunks. Minimum spacing on scaffold branches is based on the mature height of the tree, based on the formula of six inches per ten feet of mature height. For example, a tree with a mature height of 30 feet should have scaffold branches spaced at least 18 inches apart.

	 **Excurrent Trees** Single trunk to the top	 **Decurrent Trees** Scaffold branches arise from the trunk becoming the main structural system
Objective 1	Remove dead and damaged branches.	
Objective 2	Maintain single trunk to top of tree.	Maintain single dominant trunk to at least 2/3rds of the tree's mature height.
Objective 3	Select lowest permanent branch.	Select lowest scaffold branch.
Objective 4	Maintain diameter of all branches less than ½ the diameter of adjacent trunk.	Select other scaffold branches (Scaffold branch must be less than ½ the diameter of adjacent trunk.)
Objective 5	Manage growth on temporary branches by routinely pruning them back, and eventually removing them over time as the tree grows in height. Ideally, temporary branches are pruned back to a few buds. On temporary branches that have grown significantly before training begins, start by cutting them back by about 50%, removing more over time. <u>Temporary branches are removed before they reach a two inch diameter.</u>	

MASTER GARDENER
COLORADO STATE UNIVERSITY
EXTENSION

CMG GardenNotes #615

Pruning Mature Shade Trees

When to Hire a Professional Certified Arborist

Pruning large trees is a safety issue beyond the training and experience of home gardeners. Hiring a bonded professional is the best approach for most tree pruning jobs. Look for arborists with certification from the ***International Society of Arboriculture, ISA***. Many are listed in the phone book yellow pages and a list of ISA Certified Arborists working in the area can be found on the ISA web site at www.isa-arbor.com. Also, ask about liability insurance coverage.

This *CMG GardenNotes* is written to help the home gardener understand issues around pruning of mature trees and help with communications with their certified arborists.

General Pruning Guidelines

Limitations on Diameter of Cut

Ideally, all pruning cuts are two inches in diameter and smaller. On tree species resistant to decay, the standard could be pushed to two to four inches, maximum (depending on actual vigor and growth of the tree). These small wounds minimize the potential for internal decay. The two-inch diameter and smaller branch is primarily ***sapwood*** (newer xylem rings of living cells active in water transport and storage of photosynthates) that is not prone to decay.

Unless there is a strong justification, (taking into account the potential for a decay column and internal cracking) avoid removing branches larger than four inches in diameter. At approximately four inches, ***heartwood*** (older xylem rings of non-living cells no longer active in water transport) dominates the branch structure. The branch becomes prone to decay as heartwood has no resistance to the spread of decay and is prone to internal cracking. (Note: Due to chemical changes in the cells, heartwood is often darker in color.) [Figure 1]

Figure 1. Cross section of Douglas-fir. Light colored outer rings are sapwood. The dark wood in center is the heartwood.

When a pruning cut or other injury opens a branch to decay, the decay column will take the current season of xylem ring and everything older. Decay creates a pipe-like structure in the branch. The healthy, undecayed wood will be the xylem rings that grow in future years. [Figure 2]

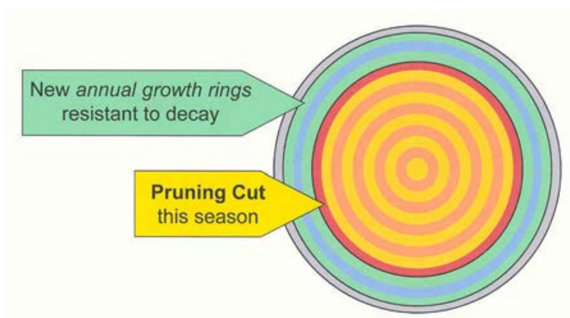


Figure 2. When injury (such as improper pruning cuts) leads to decay, it takes the current season's xylem ring and everything older (inward). New growth (xylem rings that grow in future years) will be resistant to decay. Decay creates a pipe-like structure.

For example, if a branch with eight-inch diameter xylem (wood) is pruned back to a trunk with 12-inch diameter xylem (wood) and decay results, the decay column in the trunk will be 12 inches wide (that is, the diameter of the trunk wood at the time the injury occurred). The tree would have to add six inches of healthy new growth to meet the minimum standards for structural strength (33% shell). If annual growth rings were ¼" wide, this would take 12 years! For additional information on tree decay and percent shell, refer to *CMG GardenNotes* #611, Tree Growth and Decay. [Figure 3]

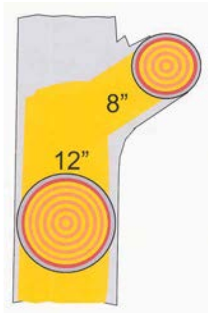
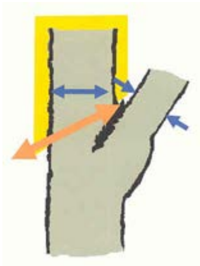


Figure 3. The diameter of the decay column will be the diameter of the current season's xylem ring for the year that injury occurred and inwards. Structural weakness from the decay is offset by the growth of new wood (xylem rings) in future years.

Limitations on Size Relationship with Reduction Cuts

Pruning often involves subordinating side branches or secondary trunks to a more dominant leader. This can only be achieved with ***reduction cuts*** (removing a larger trunk/branch back to a smaller side branch). In reduction cuts, the diameter of the side branch must be at least one-third the diameter of the trunk/parent branch removed. If the side branch is smaller, it becomes a ***heading cut***. [Figure 4]

Figure 4. In reduction cuts (removing a larger trunk/parent branch back to a smaller side branch), the side branch must be at least one-third the diameter of the trunk/parent branch removed. If the side branch is less than one-third the trunk diameter, it is a heading cut. Heading cuts are not acceptable in pruning standards.



A common mistake in lowering branch height is the use of heading cuts, which release waterspout (sucker) growth from the pruned branch. The regrowth will be structurally unsound, resulting in trees that may be more prone to storm damage than before pruning occurred. When pruning maturing trees, heading cuts are not acceptable in pruning standards!

For additional details on reduction cuts refer to *CMG GardenNotes* #612, Pruning Cuts.

Dosage: Maximum Amount of Live Wood / Foliage to Remove

Do not indiscriminately remove branches with live foliage as this can add stress to the tree. **The amount of live wood and foliage to remove per season depends on the actual growth rate of the tree.** Young, actively growing, trees are rather tolerant of a heavy pruning dose. As trees become mature, they become intolerant of heavy pruning. Look at six to 12 branches around the tree to assess growth rates. Look for what is the typical growth rate for most branches, not the fastest or slowest growing branches.

- **<u>Trees under severe stress putting on insignificant annual growth</u> –** Limit pruning to *cleaning* (removal of dead and damaged branches). Live wood should not be removed on trees under severe stress (including drought stress). Heavy pruning simply removes the stored photosynthates that the tree is living on during the stress period!

- On **<u>mature trees</u>** (greater than 75% mature size for the site), pruning dose should be limited to 5% to 10%, based on actual growth and vigor of the tree.

- On **<u>medium aged trees</u>**, the dosage really depends on actual growth. Typical range would be 10% to 25% depending on actual growth and vigor of the tree.

In situations where trees are pruned annually (the ideal situation), the appropriate pruning dose would be on the lighter side. However, in real world situations, trees are often pruned only once every several years. Here the appropriate pruning dose may be heavier. In situations where heavy pruning is needed, complete the work over a period of years.

Excessive pruning can lead to watersprouts (upright, sucker-like shoots emerging on the trunk or branches). Waterspouts, a common response to over pruning and storm damage, are structurally unsound.

Excessive pruning also creates a hormone imbalance between Auxins (produced in the terminal buds of the canopy) which stimulates root growth and Gibberellins (produced in the root tips) which stimulates canopy growth. This puts the root system into a multi-year decline, resulting in a multi-year decline in canopy growth.

Storm damage may take of excessive amounts of live wood leading to heavy canopy growth and watersprouts the first year due to high Gibberellins. The natural root generation declines the first year due to low Auxins. This decline in root regeneration leads to a multi-year decline in root and canopy growth. The storm damage counts into the dosage of life wood removed. When storm damage takes off more than the appropriate dosage for the trees actual growth, limit pruning to cleaning (removal of dead and damaged) until the tree rebalances and resumes normal growth rates.

Removal of dead wood does not count into the dosage.

<u>Other General Guidelines</u>

- To maintain trunk taper resilient to winds, at least one-half of the foliage should be in the lower two-thirds of the tree. The lowest limb should originate in the bottom one-third of the tree's height.

- Pruning should maintain the tree's natural shape.

- Avoid "lion-tailing" where the small twiggy inner foliage is cleaned-out on the lower scaffold branches and secondary trunks. This shifts weight to the ends of branches and reduces the damping effect on the branch; increasing the potential for wind damage. It reduces the taper (widening of the branch/trunk as it moves downwards) increasing the potential for branch/trunk failure. It also reduces the stored photosynthate reserves in the lower branching structure decreasing resilience to stress factors.

- Avoid topping a tree. Topping opens the tree to internal decay and cracking. Regrowth of watersprouts (adventitious shoots) is structurally unsound.

- Written specification for any pruning job should include the following:

    - Clearly state which tree(s) will be pruned.
    - Clearly indicate the objectives for pruning (why prune), such as reduce risk of failure due to wind damage or snow loading, manage health, improve aesthetics, provide clearance, improve view.
    - Specify pruning methods (how to prune) to meet the objectives, such as structural pruning, cleaning, thinning, raising, reducing, restoration pruning.
    - State the size specification for the minimum and/or maximum branch size to be removed. For example, *"Cuts should be made on branches two inches and less in diameter"* and *"In a reduction cut, the side branch pruned back to should be at least one-third the diameter of the branch removed."*
    - Specify the dosage (maximum amount, by percentage, of live wood/foliage to be removed per season). For example, *"Pruning should not remove more than 15% of the live crown."*
    - In writing pruning specifications, the word "should" refers to a practice that is routine and recommended. The word "shall" refers to a practice that is mandatory.
    - Include these generic safety statements to reduce the homeowner's and pruning crew's liability. *"All work shall be performed in accordance with American National Standards Institute A300 Pruning Standards and Z133.3 Safety Standards." "All work shall be performed under the supervision of a licensed, International Society of Arboriculture certified arborist."*

Pruning Objectives

Pruning should be based on pruning objectives (why to prune). Do not indiscriminately remove branches. Pruning objectives determine methods (how to prune) to be used, which in turn determine the type of pruning cuts made. Table 1 lists common objectives, methods and types of pruning cuts.

Table 1. Objectives and Methods for Pruning Maturing Trees

Objectives (Whys)	Methods (How)	Pruning Cuts
Reduce risk of failure (wind and snow)	Structural	Removal cut
Improve structure	Cleaning	Reduction cut
Maintain health	Thinning	Heading cut
Improve aesthetics	Raising	
Provide clearance	Reducing	
Improve view	Restoring	
Reduce shade	Pollarding	
Influence flowering and fruiting		

Pruning Methods

Structural Pruning

A common pruning objective with maturing trees is to reduce the potential risk of failure from wind and snow loading. Significant wind damage occurs on structurally weak trees with wind gusts of 60 to 75 mph. Even structurally sound trees may fail with wind gusts above 95 mph.

In Colorado (and other snowy climates), most significant storm damage is due to codominant trunks (trunks of similar size). Structural problems of this type should have been corrected while the tree was in the early growth stage. Arborists have a limited potential to correct structural defects on middle-aged and mature trees without predisposing the tree to internal decay, cracking, and creating an unsightly shaped tree. [Figure 5]

Figure 5. Codominant trunks (adjacent trunks of similar size) account for the majority of storm damage in Colorado landscapes.

Structural pruning centers around developing a dominant trunk with subordinate side branches and secondary limbs. To be most effective, it requires annual pruning over a period of years, rather than an occasional one-time pruning.

Written pruning specifications for structural pruning of maturing trees should include the following:

- Identify branches where work will be done (for example, "*codominant trunk on south side of tree*").
- Identify the methods to be used in pruning (for example, "*the secondary trunk on the south side should be reduced by 10 feet").*

Subordinate Pruning Considerations

Structural pruning of maturing trees is often referred to as ***subordinate pruning,*** where secondary trunks (and side branches) with weak branch unions are subordinated to a dominant trunk. To avoid removing too much foliage/live wood in one season, subordinate pruning generally requires work over a period of years.

In evaluating how to prune the maturing tree, take into account the following considerations:

What Is the Purpose for Pruning the Tree?

Structural pruning (subordinating weak side branches to a more dominant trunk) is more effective in reducing failure potential than general crown reduction or crown thinning. With general crown reduction or thinning, regrowth simply replaces what was pruned off in a few years.

Wind loading – To reduce potential of failure due to wind loading, the height of secondary trunks and side branches with weak branch unions must be lowered. This is done with reduction cuts, and proper reduction cuts may not be possible on many maturing trees without introducing decay and internal cracking, and structurally unsound waterspout growth.

For example, many cottonwood and popular trees will not have side branches of adequate size for proper reduction cuts (side branch prune back to must be at least 1/3 the diameter of the trunk removed).

A slight reduction in secondary trunk/branch height will not achieve the objective. To significantly reduce the risk of failure, reduction may need to be 1/3 or more of the branch length. On maturing trees, this may be into braches too larger for pruning by pruning standards. Not all branches can be effectively reduced.

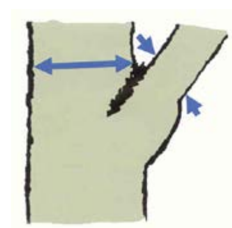
Snow loading – To reduce potential of failure due to snow loading, the snow catching volume of the branch needs to be reduced. This is best achieved with structural pruning of weak branches.

What Is the Structural Integrity of the Branch Union?

To evaluate the structural integrity of the branch union (crotch) look at the ***Aspect Ratio*** (that is the diameter of the side branch to the diameter of the trunk). Any side branch with an aspect ratio larger than 1 to 2 (diameter of side branch greater than ½ the diameter of the trunk) will be structurally weak due. For example, if the diameter of the trunk is four inches, all side branches should be less than two inches.

A structurally strong branch union has a ***branch collar*** (where the annual growth rings of the trunk wrap around the annual growth rings of the side branch). For a branch collar to develop, the side branch needs to be less than one-half the diameter of the adjacent trunk. Less than one-third is preferred. Branch unions with branch collars are also more resistant to the spread of decay. For more details on branch collars, refer to *CMG GardenNotes* #611, Tree Growth and Decay. [Figure 6]

Figure 6. To evaluate the structural strength of a branch union, compare the diameters of the trunk and side branch. A branch union is structurally strong when it has a branch collar. For the branch collar to develop, the diameter of the side branch needs to be less than one-half the diameter of the adjacent trunk.



Branch unions can also be compromised with narrow crotch angles, leading to ***included bark*** (bark against bark) and multiple branching originating in the same area.

What Is the Aesthetic Value of the Branch?

Is the branch in question important to the tree's balance and appearance? If the branch were removed, would its removal create a major gap in the canopy?

Where Should the Pruning Cut Be Made?

If the three previous questions lead to the conclusion that a secondary trunk or branch needs to be pruned, several considerations are needed to determine where to make the actual cut. Sometimes none of the options meet pruning guidelines, and the better of the bad options is chosen.

For illustration, look at the tree in Figure 7. It has three trunks. If the branch unions do not have branch collars (that is, the secondary trunks are more than half the diameter of the primary trunk), the tree is prone to storm damage.

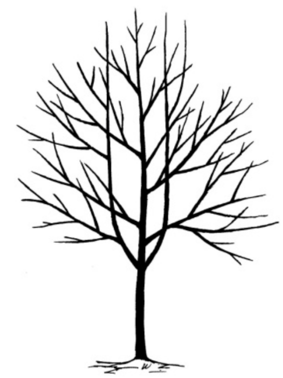


Figure 7. As drawn, the tree has three trunks. Evaluate the need for subordinate pruning by comparing the diameters of the secondary (left and right) trunks to the center trunk. To be structurally strong with branch collars, the left and right trunk need to be less than half the diameter of the center trunk.

Considerations for the Secondary Trunk on the Left

As drawn in Figure 8, there are four sites where pruning could occur to lower the height of the secondary trunk (wind loading) and reduce the snow loading potential.

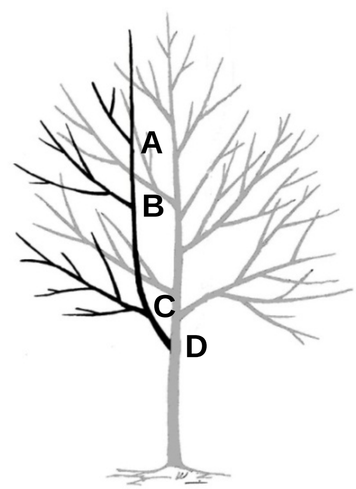


Figure 8. As drawn, there are four locations where pruning could occur.

Considerations for locations A, B and C with reduction cuts (removing a larger trunk back to a smaller side branch)

- If location A has a 2-inch trunk with a 1-inchside branch, it meets the pruning guidelines for both size (decay potential) and reduction cut (waterspout growth). However, as drawn, it may have little potential to minimize storm damage, as the height is not significantly lowered (wind loading), and the total potential for snow loading has not been significantly reduced.

- If location A has a 2-inch trunk with a half-inch side branch, it does not meet the reduction cut guideline (waterspout growth), as the side branch is one-fourth the size of the trunk being removed. Due to the size relationship, this becomes a heading cut. Watersprouts regrowth on the trunk could make it more prone to storm damage than before pruning!

- If location B has a four-inch trunk and a 3-inch side branch it violates the size (decay) guideline because the trunk is too large, predisposing the trunk to decay and internal cracking. This is typical when pruning maturing trees, as branches will be too large except in the outer canopy. The 3” side branch is within the reduction cut (waterspout) guideline, making it a reduction cut.

- If location B has a 4-inch trunk and a 1-inch side branch it violates both the size (decay) and the reduction cut (waterspout) guidelines.

- If location C has a 6-inch trunk and a 3-inch side branch it violates the size (decay) standard. The 3-inch side branch is within the reduction cut (waterspout) standard.

Considerations for location D with a removal cut (removing a smaller side branch back to a larger trunk/parent branch)

- Is the branch important to the aesthetics of the tree? As drawn, the removal of the entire branch would create a gap in the canopy.
- Removal of the left side secondary trunk plus additional pruning on the right side to aesthetically balance the tree would remove too much of the tree's foliage/live wood in a single season.
- If location D has an 8-inch trunk with a 6-inch side branch (secondary trunk), it violates the size (decay) guideline. Being a removal cut (removing a smaller side branch back to a larger trunk/parent branch); it does not have a reduction cut standard. Without a branch collar, the branch union is prone to decay.

Better of the Bad Options

In reality, it is common that none of the potential cuts meets acceptable pruning guidelines, and the arborist looks for the better of the bad options. Due to the diameter of the limbs, large trees have few acceptable options based on the size guideline (potential for internal decay and cracking). It is common that secondary trunks may not have any side branches of an acceptable size relationship for a reduction cut.

- If the tree species is prone to decay, avoid compromising on the size (decay) guideline, opening the tree to decay and internal cracking.

- If the tree is in a stressed site (including limited water or root spread potential) avoid compromising on the size (decay) guideline, as the tree is more prone to decay.

- If the tree is vigorously growing or the total amount of foliage/live wood being removed is at the maximum allowed in pruning standards, avoid compromising on the reduction cut (waterspout) guideline, as the tree is more prone to waterspout growth. With growth, the tree may become more prone to storm damage than before pruning. If the tree will be pruned each year (dealing with the waterspout growth) this becomes less of an issue.

- If tree failure would not cause injury or significant property damage, no pruning may be the better option.

- If tree failure would cause injury or significant property damage, it may be better to accept limited decay and work with resulting structural issues from regrowth than to leave the tree at high risk for storm damage.

- Storm failures are more common on young and medium-sized trees as the co-dominant and secondary trunk reach 3-4 inches in diameter. Old, mature trees are actually less prone to storm damage, having had their weakness tested in previous mega storms.

Illustrations of Subordinate Pruning Situations

Medium-Aged Tree with Codominant Trunks

With codominant trunks, one trunk is subordinated to a dominant trunk. Figure 9 illustrates this. It may require annual pruning over a period of years.

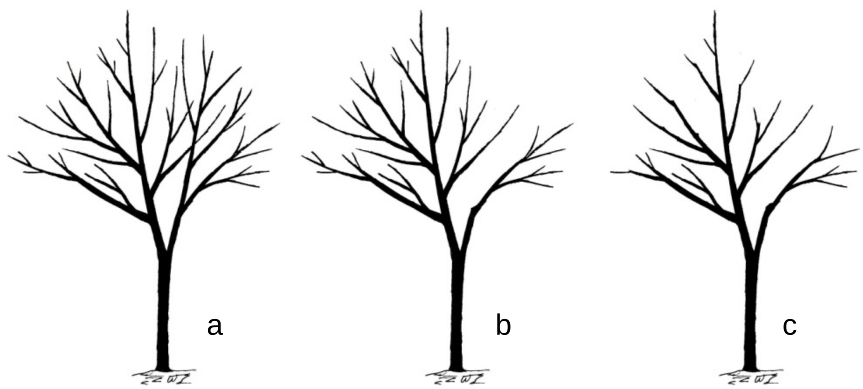


Figure 9. Before and after pruning with codominant trunks.

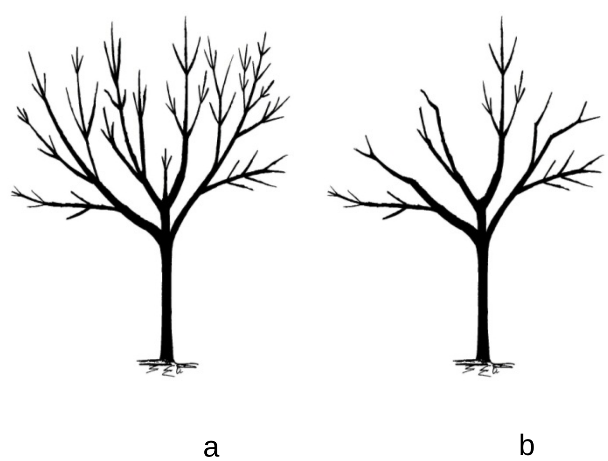
a. Tree before pruning.
b. Codominant trunk on right subordinated to trunk on left.
c. Tree balanced with other, more upright growing branches on left subordinated to the dominant trunk.

Vigorously Growing Branches Choke-Out the Central Leader

On species with opposite branching patterns, vigorously growing lower branches often choke-out the central leader. Figure 10 illustrates the pruning approach. It may require annual pruning over a period of years.

Figure 10. Before and after views of a tree who's vigorously growing branches choke-out the central leader.

a. Before pruning
b. Desired look after pruning



Young Tree Rounded with Heading Cuts

Trees should never be rounded with heading cuts. Figure 11 illustrates the pruning approach. It may require annual pruning over a period of years.

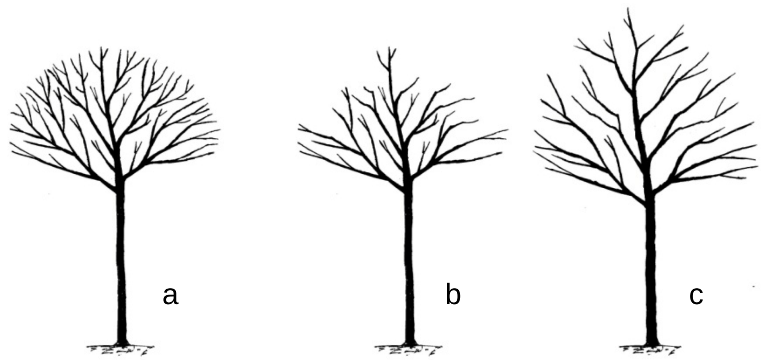


Figure 11. Before and after views of a young tree rounded with heading cuts.

a. Before pruning
b. Desired look after pruning, subordinating side branches to a dominant trunk.
c. Tree with growth.

Upright Growing Trees with Numerous Upright Growing Branches

Some species of trees (including Callery pear and some crabapple cultivars) have numerous upright growing branches. Figure 12 illustrates the pruning approach. It may require annual pruning over a period of years.

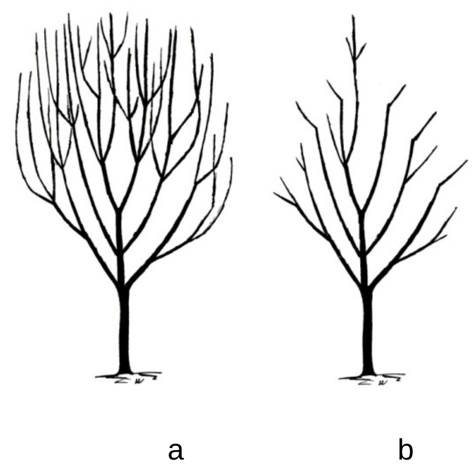


Figure 12. Before and after views of an upright growing tree with numerous upright growing branches.

a. Before pruning
b. Desired look after pruning

Cleaning

Cleaning is the removal of dead, diseased, cracked, and broken branches. This type of pruning is done to reduce the risk of branch failure, improve tree appearance, and to reduce the spread of insects and diseases. Most pruning of middle-aged and mature trees falls into this type. Trees under stress or declining trees may need cleaning every few months to ever few years. All dead wood may be removed at one time. It does not count in the total of live wood/foliage removed. In cleaning, do not remove healthy branches and live foliage. Do not clean out healthy growth in the tree's interior. [Figure 13]

Figure 13. This old cottonwood needing cleaning to remove dead branches and reduce the risks associated with branch failure.

<u>Removing dead branches</u> – To minimize risk if the branch were to fail, it is advisable to remove any dead branch larger than a two-inch diameter and higher than 30 feet. Dead branches may also become a source of insect and disease pressure in the tree.

Remove the dead branches using the three-step pruning technique. For details refer to CMG GardenNotes #612, *Pruning Cuts*. Do not cut into the branch collar, which would open a high potential for decay to spread into the trunk. If live wood has began to grow out along the dead limb, cut just beyond the live wood being cautious not to nick the live tissue. Never "flush cut" the dead branch. [Figure 14]

Figure 14. When removing dead branches, do not cut into the living tissues.

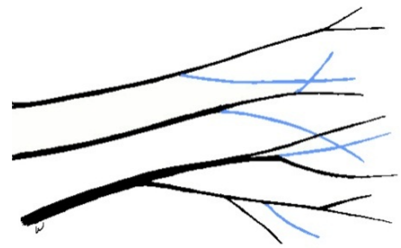
Written specifications for cleaning should specify the minimum size of dead branches to be removed. For example, *"Clean branches one inch diameter and larger"* or *"Clean branches two inches in diameter and larger that are 30 feet and higher above the ground."* The location of the branch to be removed should be specific if the entire crown is not going to be cleaned.

<u>Thinning</u>

Thinning is the selective removal of smaller branches (½ inch to 2.5 inches in diameter) to reduce crown density. Because the majority of small branches are in the outer canopy, thinning focuses in this area. Thinning should retain crown shape and size, and provide an even distribution of foliage throughout the crown. Removal cuts are primarily used. [Figure 15]

Because thinning is in the upper/outer canopy, it requires a trained arborist with a high level of skill. Thinning is expensive, often running $500 to over $1,000 per large tree when done correctly.

Figure 15. Thinning is the selective removal of small branches, growing parallel to each other, in the leafy upper/outer tree canopy.



Thinning can include removal of suckers from the base of the tree and some waterspouts on the interior. Excessive removal of watersprouts at one time often promotes growth of additional watersprouts, and should be avoided.

Benefits of Thinning

- Thinning is a method to minimize potential damage caused by snow loading, a primary situation leading to tree failures in Colorado. Thinning can reduce limb weight in order to compensate for structural defects.

- Thinning increases light penetration into the tree interior. This can invigorate the tree and help retain the tree's natural shape. Thinning may adequately reduce shade for shade tolerant under story plants below the tree. However, thinning middle-aged and mature trees will not adequately promote growth of sun loving plants like Kentucky bluegrass.

- Thinning is a technique to partially open a view without removing or structurally influencing a tree. This is often referred to as *vista pruning*.

- On a tall tree, thinning may not be an effective technique to reduce wind sail and potential for breakage in strong winds. Reducing is the most effective way to deal with wind loading issues.

Effectiveness of Thinning

- Researchers are questioning the overall effectiveness of overall tree thinning. Depending on growth rates, the tree may simply regrow the removed branches in a few years. **Current thought in reducing storm loading is that structural pruning will be more effective than general thinning.**

Clarification on Thinning

- As a point of clarification, *thinning* is done on relatively small branches in the leafy upper/outer canopy. *Thinning* is not removing large lower branches, which could create gaps in the crown and encourage watersprouts. Thinning is not removal of the small twiggy branches in the inner canopy. Thinning will not significantly lower a tree's height. [Figure 16]

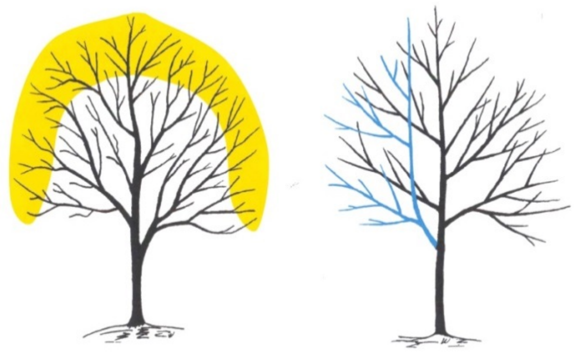


Figure 16.
Left – Thinning focuses on small branches in the upper/outer tree canopy.
Right – Thinning does NOT remove large branches, creating a gap in the tree canopy.

- Avoid ***lion-tailing*** which is the removal of the live small leafy twigs down in the tree's interior. Never clean out these lower branches and twigs on maturing trees. These small interior branches are critical to the trunk's structural integrity and vigor. They also serve to dampen tree sway in wind. Lion-tailing shifts the wind loading to the outer canopy increasing the tree's potential for wind damage. [Figure 17]

Figure 17. Do not "lion-tail" trees as in the photo. Removal of the smaller twiggy wood in the inner tree canopy decreases vigor on the major branches and trunk and shifts the weight to the top increasing the potential for wind damage.

Written specifications for a thinning job should specify the following:

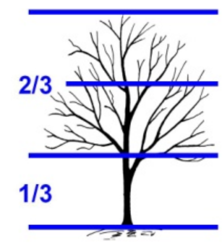
- Clarify the dosage (percent of the tree's canopy may be removed). For example, *"Pruning should not exceed 15% of the total live canopy."*
- Clarify where in the tree the pruning will occur. For example, *"Pruning should occur in the outer third of the crown."*

- Clarify size of branches to be removed. For example, *"Pruning should remove branches up to 2½ inches in diameter."*

Raising

Raising is the removal of lower branches to provide clearance for people, traffic, buildings, or a view. When removing lower branches, maintain at least one-half of the foliage in the lower two-thirds of the tree. The lowest branch should originate in the bottom one-third of the tree's height (live crown ratio). [Figure 18]

Figure 18. When removing lower branches, maintain at least one-half of the foliage in the bottom two-thirds of the tree. The lowest branch should originate in the lower one-third of the tree.



Raising should be part of the tree's structural training while young. Ideally raising would be done before branches to be removed exceed a two-inch diameter. The potential for decay is high when the branch removed is larger than four inches or when a two-inch and larger branch is greater than half the diameter of the adjacent trunk (no branch collar to suppress decay).

On many trees, lower branches make-up a significant portion of the tree's entire canopy and cannot be removed without significantly influencing tree health and appearance. When the branch to be removed is larger than two inches, consider other alternatives. Can the clearance required be achieved with removal and reduction cuts out along the branch rather than removing the entire branch? Leaving some small diameter branches on the lower trunk for a year helps close pruning wounds and lessens the potential for trunk cracking. [Figure 19]

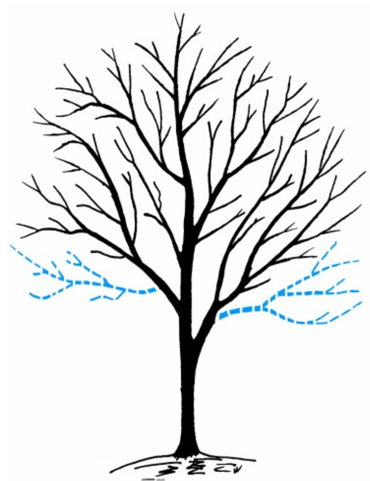


Figure 19. In raising branches on maturing trees, consider if required clearance can be achieved with removal and reduction cuts out along the branch rather than removing large branches entirely.

Excessive removal of lower branches increases the potential for tree failure by decreasing trunk taper, causing trunk cracks and decay, and transferring weight to the top.

Written specification for raising should include the following:

- Clarify the clearance required. For example, *"The tree's crown will be raised to seven feet."*

- Clarify what branch(es) will be pruned and the type of pruning cuts (removal or reduction cut) to be used. For example, *"The lowest branch on the south side shall be removed back to the trunk with a removal cut. The lowest branch on the north side will be reduced with a reduction cut at the branch five feet out from the trunk and a removal cut to the lowest side-branch."*

- Clarify what size of branches will be pruned. For examples, *"All cuts shall be two inches in diameter and smaller."*

Reduction

Reduction is the selective removal of branches to decrease the height and/or spread of a tree. It requires the use of *reduction cuts*, which remove larger branches back to smaller side branches. [Figure 20]

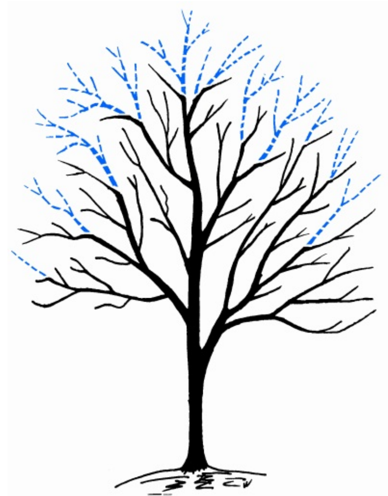


Figure 20. Reducing is the selective removal of branches to decrease a tree's height and/or spread. Just being tall does not indicate that a tree is structurally weak and prone to storm damage.

Reduction is a method to reduce potential wind loading on large trees with structural defects. Reducing and thinning both decrease potential failure from snow loading. However, researchers are questioning the effectiveness of overall tree reduction. Depending on growth rates, the tree may simply regrow the removed branches in a few years. **Current thought in reducing storm loading is that selective *structural pruning* on weak secondary trunks will be more effective than general tree reduction.**

Not all trees can be reduced without predisposing the tree to decline and death. Crown reducing requires the extensive use of *reduction cuts, which* can predispose the branch/trunk to internal decay. On older trees showing stress or decline, *heading cuts* can accelerate decline and death. [Figure 21]

Figure 21. Not every tree should be reduced. Notice the dieback associated with the previous reduction on this old cottonwood. On old trees and trees showing stress or decline, heading cuts may accelerate the decline cycle.

In a proper *reduction cut*, the side branch pruned back to will be at least one-third the diameter of the trunk/parent branch removed. Under American National Standards Institute (ANSI) pruning standards, if the side branch is less than one-third, it is considered a *heading cut*, which is generally unacceptable. For additional details on proper reduction cuts, refer to *CMG GardenNotes* #613, Pruning Cuts.

It is very difficult to use crown reducing to permanently maintain a tree at a small size without causing tree decline. Ideally, trees were selected with adequate space for their mature size. Where size control is necessary, it is best to begin reduction pruning as the tree reaches acceptable size, rather than when the tree becomes overgrown.

In crown reducing, first visualize the new outer edge of the smaller canopy. Then prune the tree back to appropriate branch unions for a proper reduction cut or removal cut. Some branches will be left taller than the visualized outer edge while others will be cut back below the visualized canopy edge. Do not make heading cuts and avoid rounding off the tree canopy. [Figure 22]

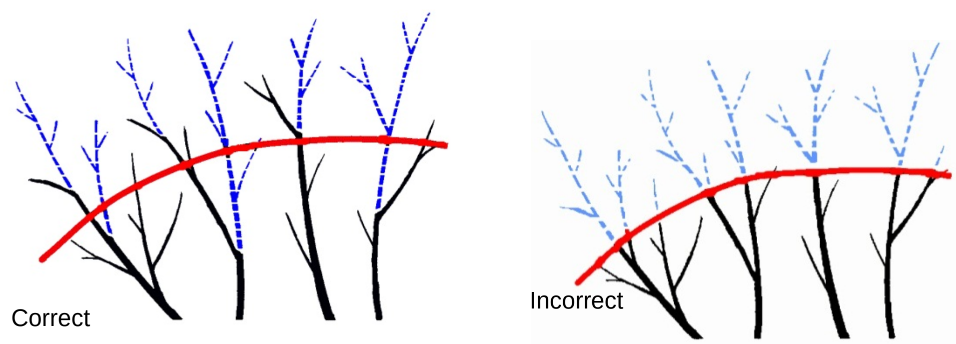


Figure 22.
Left – In reduction, visualize the new outer edge of the smaller canopy. Prune back to branch unions that make proper reduction and thinning cuts. Some branches will be taller than the new outer edge, some shorter.
Right – This tree is incorrectly rounded off with heading cuts.

In shortening primary upward growing trunks/primary branches to a lateral branch, a side branch that is somewhat upward growing with a narrow branch union angle may be stronger than a branch union with a wide angle. [Figure 23]

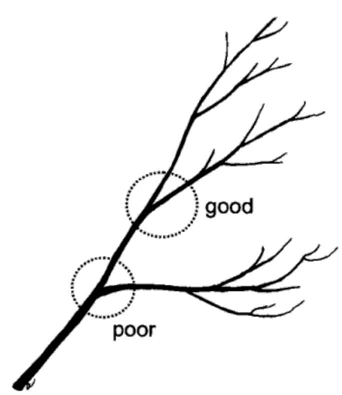


Figure 23. In shortening a main upward growing branch, pruning back to a narrow branch union may be stronger than a wide branch union.

Just because a tree is tall does not indicate that it is structurally unsound. Potential risk of failure should be evaluated by an experienced arborist based on branching structure, branch union integrity, signs of internal decay, and previous damage.

Written specifications for reduction pruning should include the following:

- Clarify the desired reduction in height/spread.
- Specify criteria for reduction cuts. For example, *"All cuts should be made on branches less than two inches in diameter. Diameter of the side branches pruned back to should be at least one-third the diameter of the branch removed."*
- Clarify the dosage (percentage of live wood/foliage to be removed). For example, *"Pruning should not exceed 10% of the total canopy."*

Restoration

Restoration is the selective removal of branches, sprouts, and stubs from trees that have been damaged by improper pruning, vandalism, and storms. The objective is to restore the trees structure, form, and appearance to the extent possible. Restoration generally requires annual pruning over a period of years.

Actual pruning procedures vary with the situation. When dealing with situations of excessive watersprouts, a rule to thumb is to remove one-third and reduce one-third with each annual pruning. Removing all of the watersprouts at one time often stimulates the growth of more watersprouts.

Pollarding

Pollarding is a training system that involves creating "heads" on secondary branches were small tertiary branches arise. The small tertiary branches are all removed back to the head every one to three years (depending on growth rates).

Pollarding started as a method to produce shoots for fuel, shelter, and products made from the young shoots. Today, it is used as an art form. Pollarding is common in some parts of Europe to keep tree small and shaped as living screens. Pollarding is not topping and should not be considered a routine method to keep large trees small. Due to annual labor involved, it is uncommon in the United States.

Frequently Asked Questions About Pruning Mature Shade Trees

What About Topping a Tree?

Shade trees should **never** be topped. The regrowth of a topped tree is structurally unsound. Topping required by utility right-of-way pruning is starkly obvious and sets an unfortunate community standard followed by others. Instead of topping, use *cleaning,* and/or proper *structural pruning* methods. [Figure 24]

Figure 24. Never top a tree, the regrowth is structurally unsound, making it very prone to wind and storm damage.

What About Utility Right-Of-Way Pruning?

Pruning for utility line clearance does not always follow desirable pruning techniques regarding appearance and health of the tree. In this situation, the needs of the utility right-of-way take priority over the tree.

When a tree under a power line requires frequent reduction, consider having the tree removed. Utility companies are generally eager to accommodate. In planting trees, selection criteria (i.e., size and placement) should be followed so that a tree's health and appearance will never be compromised by the need for utility pruning.

I Am Concerned About My Tall Tree Breaking in Storms, But I Really Do Not Want to Lose the Shade. Do I Really Need to Have the Tree Pruned or Removed?

This is a two-part question. First, does the tree show signs of being highly susceptible to storm damage, (i.e., previous storm damage, dieback or dead branches, structural problems such as codominant trunks, weak branch unions or internal decay)? This should be evaluated by an experienced ISA Certified Arborist.

Second, if yes, what would the tree or branch hit should it fail? If it would cause significant property damage or threaten life, the tree should be pruned or removed as a preventive measure.

Cleaning and ***structural pruning*** may reduce the potential storm hazard without compromising the shade. In some situations, the risk of failure cannot be reduced without removal. Remember that healthy structurally sound trees are generally windfast even when mature.

Storm damage is usually, but not always, related to structural problems that could have been addressed with proper structural training when the tree was young. Codominant trunks account for the majority of tree failures in Colorado. The hazard of wind damage is higher on the regrowth of trees that have been "topped". Consult an ISA Certified Arborist for additional details.

How Should Storm-Damaged Trees be Pruned?

First, focus on *cleaning* (removing broken and damaged limbs) keeping in mind the structural integrity of the tree. Realize that you may have to accept less than ideal pruning techniques by "Mother Nature".

Second, focus on *structural pruning* to restore the tree's structural integrity and shape to the extent possible. This may take place over a period of years.

The maximum amount of tree canopy that can be removed without putting the tree and its root system under stress includes the live wood/foliage removed by the storm. When Mother Nature removes too much live wood/foliage, limit pruning to cleaning.

On storm damaged trees where excessive live wood and foliage were removed by storm damage, wait until the roots and crown stabilize (as measured in canopy growth) before doing thinning, reducing, or other structural pruning. This may be a multi-year period.

Keep the tree if it can be pruned back to structurally sound wood and will be esthetically pleasing. Often when one side of the tree is gone, the best option is to remove the entire tree. [Figure 25]

Figure 25. Keep storm-damaged trees when they can be pruned back to structurally sound wood and has an acceptable appearance. This yard would look better if the tree was removed.

How Should Trees With Root Damage be Pruned?

Focus on *cleaning*. Avoid removing live wood and foliage as this could speed the decline. Removing live wood lowers the *auxin* content, which is the hormone that promotes root growth. Removing foliage reduces photosynthesis and levels of stored carbohydrates that the tree is living on during the recovery period. Trees in a construction site with damaged roots may require cleaning every 3-12 months for five plus years.

How Should Declining Trees be Pruned?

Focus on *cleaning*. Avoid removing live wood and foliage as this could speed the decline. Removing live wood lowers the *auxin* content, which is the hormone that promotes root growth. Removing foliage reduces photosynthesis and levels of stored carbohydrates that the tree is living on. Old declining cottonwoods and poplars may warrant cleaning every one to five years.

Authors: David Whiting (CSU Extension, retired), with Alison O'Connor and Eric Hammond (CSU Extension). Artwork by David Whiting; used by permission.

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MASTER GARDENER
COLORADO STATE UNIVERSITY
EXTENSION

CMG GardenNotes #616

Pruning Flowering Shrubs

Why Prune?

Pruning has a major influence on a shrub's flowering habit, shape, size, and pest problems.

Prune to Encourage Flowering

Pruning has a major influence on shrub flowering. Over time, an unpruned flowering shrub becomes woody, with little new growth to support flower bud development.

Spring-flowering shrubs bloom on one-year-old wood (twigs that grew new the previous summer). Buds develop in midsummer through fall for the following spring. Pruning in the fall and winter removes flowering wood with buds. Spring-flowering shrubs can be rejuvenated or thinned in early spring before flowering or growth starts [Figures 1 and 2]. Thinning can also be done right after bloom to maximize the next season's flowers.

Spring-flowering shrubs include forsythia (*Forsythia* spp.), Nanking cherry (*Prunus tomentosa*), quince (*Chaenomelea* spp.), bridalwreath and Vanhoutte spireas (*Spiraea prunifolia, S. plenaflora* 'Plena' and *S.* x *vanhouttei*), viburnum (*Viburnum* spp.), beautybush (*Kolkwitzia amabilis*), lilac (*Syringa* spp.), honeysuckle (*Lonicera* spp.), peashrub (*Caragana* spp.), deutzia (*Deutzia* spp.), *and* weigela (*Weigela* spp.).

On spring-flowering shrubs it is recommended to "deadhead" spent blooms (remove flowers after they fade). While time-consuming, deadheading conserves the plant's energy, which would otherwise be spent on seedpod and seed development. On many shrubs, the spent flowers and seedpods are not attractive (lilacs).

Figure 1. Spring-flowering shrubs bloom from buds that developed on new wood the previous summer.

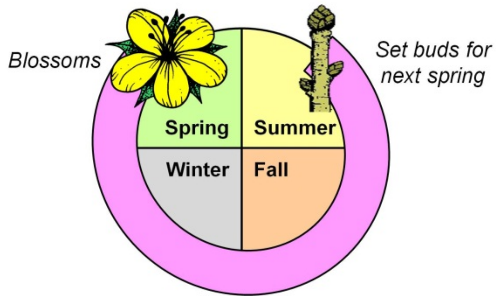


Figure 2. Fall shearing of this spring-flowering lilac removed flower buds on the lower section of the shrubs.

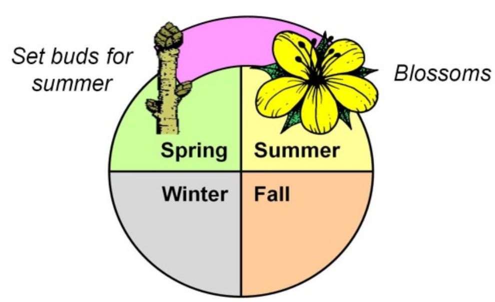
Summer-flowering shrubs bloom on new wood that grew earlier in the growing season. Summer-flowering shrubs are also pruned by thinning or rejuvenation in the early spring before growth starts. [Figure 3]

Summer-flowering shrubs include most butterfly bush (*Buddleia* spp. and *Cassia* spp.), blue mist spirea (*Caryopteris* x *clandonensis*), Hancock coralberry (*Symphoricarpos* x *chenaultii* 'Hancock'), mockorange (*Philadelphus* spp.), potentilla (*Potentilla* spp.), Bumald and Japanese spirea (*Spiraea* x *bumalda and S. japonica*), Annabelle and Peegee hydrangea (*Hydrangea arborescens* 'Annabelle' and *H. paniculata*), shrub althea or rose of Sharon (*Hibiscus syriacus*), snowberry (*Symphoricarpos albus*) *and* St. John's wort (*Hypericum* spp.).

Removing older canes of flowering shrubs also allows better sunlight penetration into the shrub. This results in better flowering throughout the shrub, instead of flowers just at the top where sunlight is sufficient.

On shrubs noted for their bark color, like red-twig dogwood (*Cornus sericea*), the new shoot growth has more brilliant color. Routine pruning at the base encourages new shoots, which have the desired red color.

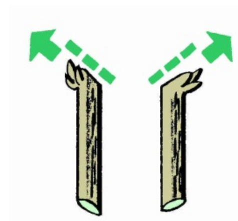
Figure 3. Summer-flowering shrubs bloom from buds that developed on new wood that grew earlier this growing season.



Prune to Direct Shape

Shaping is another reason for pruning shrubs. Shape can be managed to some degree by pruning to side buds or branches growing in the desired direction. While pruning can provide some control over size, it is not an effective method to keep a large shrub in a small space. Where shrubs have overgrown their space, consider replacing the plants with smaller cultivars or other species. [Figures 4 and 5]

Figure 4. Shape can be managed to some extent by pruning to buds and branches growing in the desired direction of growth.



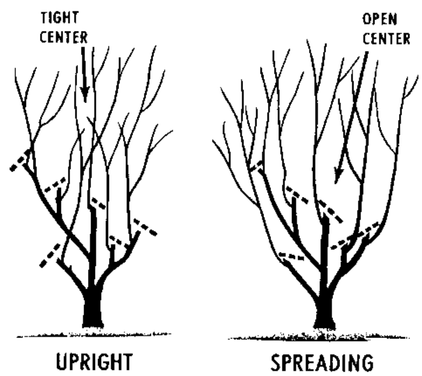


Figure 5. Pruning to inward growing buds or branches results in narrower shrubs. Pruning to outward-growing buds or branches results in wider shrubs. [Line drawing by USDA]

Prune to Manage Pests

Pruning is a management technique for some insect or disease problems. For example, removing the older wood in lilac reduces oystershell scale and borer problems. Thinning a shrub to increase air circulation reduces the incidence of powdery mildew and leaf spot diseases.

Pruning Methods for Flowering Shrubs

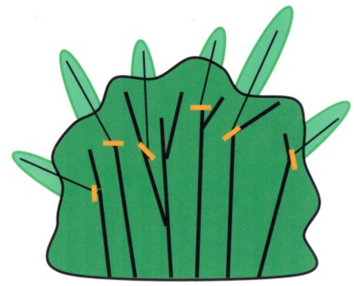
The primary objective in pruning flowering shrubs is to encourage new (flowering) growth from the base. This is best accomplished by thinning at the base, or rejuvenation.

Branch-by-Branch Shaping

Branch-by-branch shaping involves shortening the length of excessively long branches by cutting them back one-by-one. Cuts are made back in the shrub, leaving branches at varying lengths. Avoid making cuts at a uniform "edge," creating a rounded ball. Make cuts at appropriate branch unions (crotches) or buds. [Figure 6]

This method maintains a more naturally shaped shrub but does not significantly encourage new growth of flowering wood for maximum bloom. Branch-by-branch shaping is a slow process.

Figure 6. With branch-by-branch shaping, long branches are cut back into the shrub, giving a more natural shape. Avoid making cuts at a uniform "edge," creating a rounded ball.



Shearing to Shape

Shearing shrubs to round balls or other desired shapes is a common pruning technique because it is quick and easy. However, sheared shrubs lose their natural shape, and the rounded "balls" may detract from a more natural, informal landscape design. Shaping spring-flowering shrubs after midsummer removes the new wood with next year's blossoms. Frequent shearing does not encourage new growth from the base, which is needed to promote flowering.

With frequent shearing, the plant becomes bushier on the exterior. The thick outer foliage may shade out the interior and lower foliage, and the plant becomes a thin shell of foliage with a woody interior and base. The thin shell of foliage is prone to browning and burning from wind and cold weather. Over time, shrubs become woody, with lots of dead branches and few flowers. When shrubs become overly woody from routine shearing, replacement is the best option to refresh the landscape design. [Figures 7-11]

Figure 7. Flowering shrubs pruned by topping or shearing become woody at the base. [Line drawing: USDA]

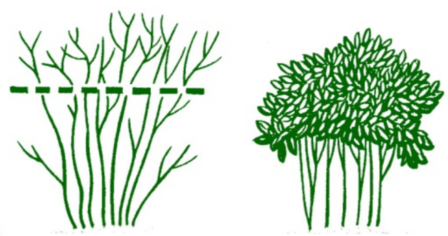


Figure 8. Over time, sheared shrubs become woody with dead sections. The only treatment at this point is to replace the shrub.

Figure 9. Sheared forsythia in full bloom. Shearing does not encourage new wood with blossoms.

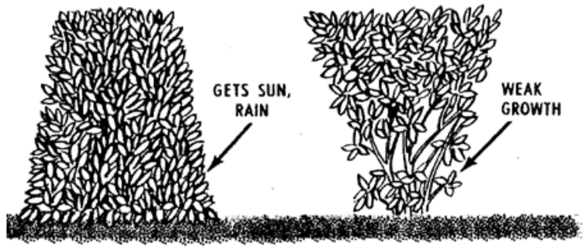


Figure 10. In shearing hedges, maintain the natural shape of the plant. A common mistake is to shape shrubs with a wide top and narrow base. Lack of sunlight shades out lower interior growth, resulting in a woody base. [Line drawing by USDA.]

Figure 11. Properly pruned hedge, wider at the base.

Thinning

One method to encourage shrub flowering is annual thinning. The objective is to **remove one-third of the oldest wood to the ground each year**, which in turn stimulates new, better-flowering growth from the base of the shrub. Thinning is more easily done with leafless branches in early spring before growth starts but can also be done in summer. This method is time-consuming and does not work well on twiggy, multi-stem shrubs, like spirea. [Figure 12]

Cutting back and thinning an overgrown shrub will not restore its natural, informal form. It will look like an overgrown shrub that has been pruned. Rejuvenation pruning followed by thinning is better for overgrown shrubs.

Figure 12. Annual thinning removes one-third of the oldest wood to the base each spring. This encourages new growth from the base, keeping the shrub youthful looking. [Line drawing by USDA.]

Rejuvenation Pruning

Many shrubs can be easily renewed with rejuvenation pruning. The shrub is cut entirely to the ground in the early spring before growth starts. The shrub regrows from roots, giving a compact, youthful plant with maximum bloom. Rejuvenation can have a major effect on size. This method is preferred for many flowering shrubs because it is quick and easy with great results. Initial rejuvenation should be followed by thinning new canes to several strong ones over the next several years. Remove weak cane growth at the base (ground level).

Rejuvenation is typically done no more than every three to five years when a shrub begins to look gangly and woody. It works very well on multi-stemmed, twiggy-type shrubs such as spirea, *Caryopteris* (blue mist spirea), *Potentilla*, red-twig dogwood, sumac (*Rhus* spp.), and hydrangea. (Note: *Caryopteris* flowers best if renewed each spring.) Also use this method to rejuvenate lilac, privets (*Ligustrum* spp.), barberry (*Berberis* spp.), forsythia, flowering quince, honeysuckle, mockorange, flowering weigela, beautybush, many viburnums, elderberry (*Sambucus* spp.), and others.

Limitations:

- Spring-flowering shrubs will not bloom the year of rejuvenation.
- On shrubs with a rock and weed fabric mulch, rejuvenation may not be successful due to decreased root vigor and interference of the mulch with growth from the base.
- Extremely overgrown shrubs with large woody bases may not respond well to rejuvenation pruning.
- Shrubs with many dead branches will not respond well to rejuvenation pruning. As a rule of thumb, if more than one-third of the branches are woody, without healthy foliage, the shrub will probably not respond.
- Some shrubs are structurally more like small trees, with only one or a few primary trunks. They include several *Viburnum* and *Euonymus* species, and shrubby forms of *Rhamnus* (buckthorn). Do not cut these shrubs to the ground. Prune by thinning branches back to side branches.
- Lilac cultivars budded onto common lilac rootstocks should not be cut to the ground. Regrowth will be common lilac rather than the selected cultivar.

Replacement

Shrubs that have been repeatedly sheared often become woody and filled with dead twigs. The best option may be to replace them. On many commercial sites, labor issues prohibit routine pruning. When shrubs become overgrown, they are simply replaced as a low-maintenance alternative.

Shrubs can also be overwhelmed by weedy invaders seeded by birds, squirrels or wind. For example: Common Buckthorn (*Rhamnus cathartica*), Walnut (*Juglans* spp.), Elm (*Ulmus* spp.). If routine clearing of these invading woody species is not done, the original shrubs may be compromised or lost. Replacement may again be needed.

Authors: David Whiting (CSU Extension, retired), with Robert Cox and Carol O'Meara (CSU Extension), and Carl Wilson (CSU Extension, retired). Artwork by David Whiting and USDA; used by permission.

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MASTER GARDENER
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CMG GardenNotes #617

Pruning Evergreens

Most types of evergreen trees and shrubs need little to no pruning. Pruning may make the new growth bushier, but will not effectively control size. Select plants based on mature size to minimize pruning needs. If frequent pruning is necessary to keep plant growth in bounds and prevent interference with a walk, driveway or view, consider replacing the plant. Evergreen trees and shrubs are pruned according to species growth characteristics.

Pruning Evergreen Trees

On evergreen trees, avoid pruning the central leader (trunk). This results in the development of multiple leaders that are prone to wind and snow damage. If the central leader is killed back, select one branch to become the new leader and remove potentially competing leaders.

Never allow codominant trunks (trunks of similar size) to develop. If multiple trunks begin to develop, select one and remove others.

For structural integrity on evergreen trees, all side branches should be less than half the diameter of the adjacent trunk (less than one-third is preferred). If the diameter of a side branch is too large, prune back part of the needled area to slow growth or remove the branch entirely back to the trunk.

Removing Large Branches on Evergreen Trees

New needles will not grow from branches without needles. When a side branch is removed on an evergreen, cut back to the trunk just outside the ***branch collar*** (the enlarged connecting area on the trunk around the limb).

Do not cut into or otherwise injure the branch collar. Do not make flush cuts. Remove the branch using a three-cut method. [Figure 1]

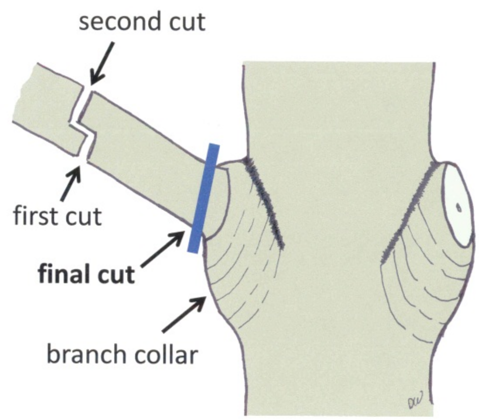
Cut 1. Coming out 12-15 inches from the trunk, make an undercut a third to halfway through the branch.

Cut 2. Moving a couple of inches out past the first cut, make the second cut from the top, removing the branch. This double- cut method prevents the weight of the branch from tearing the branch below the branch collar.

Cut 3. Make the third and final cut just outside the branch bark collar. Take extra caution to not cut into or otherwise injure the branch bark collar.

For additional details on pruning cuts, refer to *CMG GardenNotes #612,* Pruning Cuts.

Figure 1. On evergreen trees, remove large branches back to the trunk using a three-cut method. Make the final cut just outside the branch collar. Needles only grow from the growing tips out and will not develop on the interior branch wood without needles.



Pruning Spruce, Fir, and Douglas Fir

Spruce (*Picea* spp.), fir (*Abies* spp.), and Douglas fir (*Pseudotsuga menziesii*) generally need little to no pruning.

On young trees, pruning is useful in situations where bushier new growth is desired. Because these species produce some side buds, branch tips can be removed encouraging side bud growth. Prune late winter or early spring. [Figure 2]

Figure 2. Pruning spruce and fir back to a side bud or side branch will encourage growth of side branches. (Line drawing by CSU Extension.)

Spruce, fir, and Douglas fir that are over-growing their space are somewhat tolerant of being pruned back as long as they are not pruned back past the needles. However, with constant pruning the branches may begin to show needle browning and dieback. In situations where the branch must be pruned back past the needles, remove it back to the trunk.

In landscape design, small to midsize evergreen trees, with their pyramidal form, generally look best with their lowest branches allowed to drape to ground level.

On large trees, primary growth occurs at the top with minimal growth at the lower levels. Due to slow growth, pruning of the lower branches may give a "pruned look" for a long time. On large trees, limb up lower branches only if they are in the way.

Very slow-growing species, like the dwarf Alberta spruce (*Picea glauca* var. *albertiana* 'Conica'), blue nest spruce, aka dwarf black spruce (*Picea mariana* 'Nana') and bird's nest spruce (*Picea abies* 'Nidiformis') are rather intolerant of pruning.

Pruning Pine

Pines generally need little to no pruning.

On young plants, if a more compact new growth is desired, "pinching" may be helpful. Using the fingers, snap off one-third of the new growing tips while in the "candle" stage (in the spring, when young needles are in a tight cluster). Avoid using pruners or a knife, as it will cut the remaining needles, giving a brown tip appearance. [Figure 3]

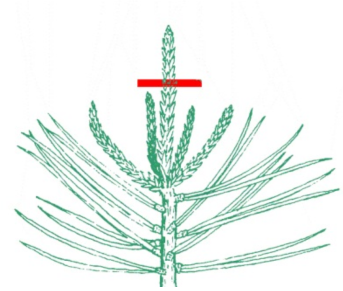


Figure 3. On pines, for bushier new growth "pinch" growing tips by snapping off one-third of the "candle" tips with the fingers. Because pines produce few side buds, they are intolerant of more extensive pruning.
(Line drawing by CSU Extension.)

Because pines produce few side buds, they are intolerant of more extensive pruning. If the terminal bud on a branch is removed, growth on that shoot is stopped, with additional growth occurring only from existing side branches. Do not shear pines.

Like other evergreen trees, small to midsize pine trees look best (from the landscape design perspective) with their lowest branches allowed to drape down near ground level. When a lower branch has to be pruned back for space issues, remove it back to the trunk.

Pruning Juniper and Arborvitae

Juniper and arborvitae generally need little to no pruning.

They may be pruned at anytime except during subzero weather. The best time is early spring, prior to new growth.

The best pruning method is to cut individual branches back to an upward growing side branch. This method of pruning is time-consuming, but keeps the plant looking young and natural. [Figure 4]

Figure 4. Pruning junipers and arborvitae back to a side shoot hides the pruning cut. (Line drawing by CSU Extension.)

While shearing is quick and easy, it is not recommended, especially after midsummer. Shearing creates a dense growth of foliage on the plant's exterior. This in turn shades out the interior growth, and the plant becomes a thin shell of foliage. Frequently sheared plants are more prone to show needle browning and dieback from winter cold and drying winds.

Any pruning that tapers in toward the bottom of the plant will lead to thinning of the lower branches due to shading. To keep the bottom full, the base of the shrub needs to be wider than the top portion.

It is common to see junipers and arborvitae that have overgrown their space. Because new growth comes ONLY from the growing tips, branches cannot be pruned back into wood without needles. If the shrub is pruned back to bare wood, it will have a permanent bare spot.

For shrubs that are getting too large, it is better to prune them back as they begin to overgrow the site. Pruning back severely overgrown shrubs generally gets into wood without needles. Consider replacing severely overgrown plants with smaller cultivars or other species.

Junipers and arborvitae growing in the shade are rather intolerant of pruning due to slow growth rates.

Authors: David Whiting (CSU Extension, retired) with Carol O'Meara (CSU Extension). Artwork by David Whiting and Colorado State University Extension; used by permission.

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