MASTER GARDENER
COLORADO STATE UNIVERSITY
EXTENSION

CMG GardenNotes #610-617

The Science of Pruning

Red Handled Pruners
Artwork by Melissa Schreiner © 2023

This Science of Pruning curriculum was developed by David Whiting, CSU Extension, retired; Alison O'Connor, PhD, CSU Extension; and Eric Hammond, CSU Extension. Cover art by Melissa Schreiner. Used with permission.

Updated 2023

MASTER GARDENER
COLORADO STATE UNIVERSITY
EXTENSION

CMG GardenNotes #610

The Science of Pruning

References and Review Material

Reading/Reference Materials

CSU GardenNotes

- https://cmg.extension.colostate.edu/volunteer-information/cmg-gardennotes-class-handouts/.
- #611, *Tree Growth and Decay.*
- #612, *Pruning Cuts*.
- #613, *Structural Training of Young Shade Trees*.
- #615, *Pruning Mature Shade Trees*.
- #616, *Pruning Flowering Shrubs*.
- #617, *Pruning Evergreens*.

CSU Extension Fact Sheets

- https://extension.colostate.edu/topic-areas/yard-garden/.
- #7.003, *Training and Pruning Fruit Trees*.

Plant*talk* Colorado™

- https://planttalk.colostate.edu/.
- #1210, *Pruning Mature Fruit Trees*.
- #1713, *Pruning Shrubs*.

Other

- *An Illustrated Guide to Pruning,* Third Edition. Edward F. Gilman. 2012. Available from the International Society of Arboriculture, https://wwv.isa-arbor.com/store/product/24.
- *Best Management Practices – Pruning,* Third Edition. Sharon J. Lilly, and E. Thomas Smiley. 2019. Available from the International Society of Arboriculture, https://wwv.isa-arbor.com/store/product/58/.
- *ANSI A300 Pruning Standards, Part 1*. American National Standards Institute. 2017. Available from TCIA, https://treecareindustryassociation.org/business-support/ansi-a300-standards/.
- *Structural Pruning, A Guide for the Green Industry*. Dr. Edward F. Gilman, Brian Kempf, Nelda Matheny, and Jim Clark. 2013. Available from the International Society of Arboriculture, https://wwv.isa-arbor.com/store/product/500/.
- Find an Arborist (ISA), https://www.treesaregood.org/findanarborist.
- The Urban Tree Foundation, http://www.urbantree.org/.

Learning Objectives

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

- Explain how trees grow, describe their tissues, and understand decay.
- Know the three different types of pruning cuts (removal cuts, reduction cuts, and heading cuts) and be able to explain their uses and how to execute them.
- Structurally prune a young shade tree.
- Describe pruning of maturing shade trees, including objectives and methods.
- Prune flowering shrubs.
- Prune evergreen shrubs.

Review Questions

Tree Growth and Decay

1. What is a branch collar?
2. Explain how a branch collar develops.
3. Explain the size relationship between the side branch and trunk/parent branch necessary for a branch collar to develop.
4. Define the following terms:
    - Phloem.
    - Xylem.
    - Sapwood.
    - Heartwood.
    - Ray cells.
    - Compartmentalization.
5. How do trees respond to decay?
6. Describe the four 'walls' of CODIT (Compartmentalization of Decay in Trees).
7. What are some visual indicators of decay?

Pruning Cuts

8. Identify/define the following:
    - Branch collar.
    - Branch bark ridge.
    - Branch defense zone.
    - Reaction zone.
    - Wound wood.
9. Answer the following questions about removal cuts:
    - In what situation would you use a removal cut?
    - What are the advantages of a removal cut?
    - When the branch bark ridge is visible, where is the removal cut made?
    - If the branch collar is not easy to identify, where is the removal cut made?
    - If the branch has no branch collar, where is the removal cut made?
    - What happens when the branch collar is injured or removed?
10. Answer the following questions about reduction cuts:
    - In what situation would you use a reduction cut?
    - What are the uses and limitations of reduction cuts?
    - What is the proper angle for a reduction cut?
    - In a reduction cut, what is the proper size relationship of the branch being removed to the branch pruned back to? Is it important?
11. Answer the following questions about heading cuts:
    - In what situation would you use a heading cut?
    - How does it influence regrowth of the plant?
    - What are the effects of using heading cuts on larger branches?
12. Explain the three-step method for pruning large branches. Why is it needed? When is it needed?
13. Ideally, what time of year should major pruning of shade trees or larger evergreens be undertaken?

Structural Training of Young Shade Trees

14. 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 is the dosage range adjusted for the specific tree?
15. What are the pruning objectives for young trees.
16. Define codominant trunks. Why do arborists have zero tolerance for codominant trunks?
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.

Pruning Mature Trees

23. List the objectives for pruning a mature tree.
24. List the methods of pruning to achieve purposes.
25. Describe key elements in writing specifications for general pruning of maturing trees.
26. 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?
27. Describe subordinate pruning. What factors should be considered when deciding where to make a subordinate pruning cut?
28. Describe how to subordinate prune a medium-aged tree with the following situations:
    - Codominant trunks.
    - Rounded off.
    - Choked-out central leader.
    - Too many upright-growing branches.
29. Describe key elements in writing specifications for structural pruning of medium-aged trees.
30. Define cleaning. In cleaning, how much of the live wood should be removed? Why?
31. When is it important to remove dead branches? At what size and height does dead branch removal become an important management issue?
32. When removing a dead branch, where is the final cut made?
33. Describe key elements in writing specifications for cleaning.
34. Describe thinning.
    - What are the purposes of thinning the crown?
    - In thinning the crown, what types of cuts are made?
    - What is the general maximum size of branches to be removed?
    - What is the long-term effectiveness in overall crown thinning to reduce storm damage potential? What pruning method would be more effective?
35. Describe the key elements in writing specifications for thinning.
36. What is lion-tailing? How does it differ from thinning the crown? What are the problems associated with lion-tailing?
37. What is the rule of thumb on dealing with excessive sucker growth?
38. In raising, what is the minimum live crown ratio?
39. In raising, what options may be workable other than removal of lower branches? Why may removal of lower branches cause problems?
40. Describe the key elements in writing specifications for crown raising.
41. Describe the reasons for crown reduction. Describe the limitations of crown reduction.
42. List pointers on crown reduction, as given in chapter.
43. What is the long-term effectiveness in overall crown reduction to reduce storm damage potential? What pruning method would be more effective?

44. How does topping a tree impact its structural integrity and internal decay potential?
45. Describe the key elements in writing specifications for crown reduction.

Flowering Shrubs

46. What is the difference between spring-flowering shrubs and summer-flowering shrubs? How does this affect pruning?
47. Many gardeners prune flowering shrubs by topping or shearing them. Describe the impact on growth and flowering.
48. Explain the pros of, and limitations for, shrub pruning by:
    - Shearing to shape.
    - Thinning old wood.
    - Pruning to the ground.
    - Replacement.
49. What types of shrubs are successfully renewed by pruning to the ground? List situations where this approach may not work.

Evergreens

50. Why should you avoid pruning the evergreen tree back further than where it has foliage?
51. A large evergreen tree is overgrowing the space. Explain options to prune back the bottom branches for spruce, fir, and Douglas-fir and pines.
52. Explain what happens when a gardener shears a pine shrub. What is another technique to keep a young pine shorter and bushier?
53. On junipers and arborvitae, explain the pros and cons of:
    - Shearing.
    - Thinning.
54. Explain the problems associated with trying to prune back a severely overgrown juniper or arborvitae.

MASTER GARDENER
COLORADO STATE UNIVERSITY
EXTENSION

CMG GardenNotes #611

Tree Growth and Decay

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. For additional information, see CMG GardenNotes #610-617 on *The Science of Pruning*.

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.

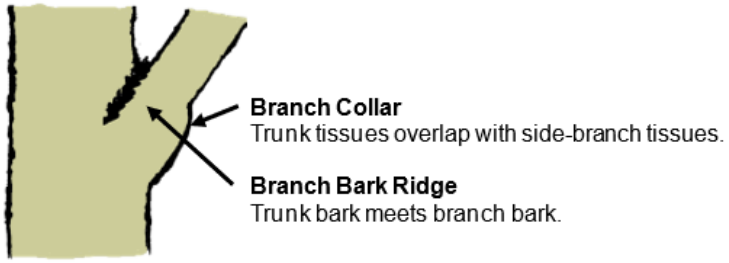
Developing a Strong Branch Union

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 account for the majority of storm damage in Colorado landscapes.

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



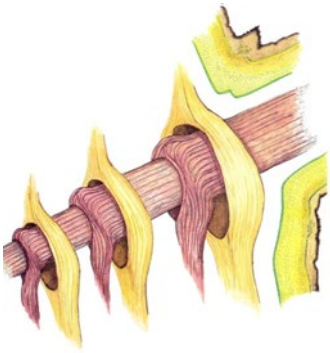


Figure 3. The branch collar is where annual growth rings of the trunk overlap the annual growth rings of the side branch, like shuffling a deck of cards. This creates a very solid section of wood, known as the "knot" in lumber. Line drawing: U.S.D.A.

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 one-third to two-thirds to slow growth or remove the branch entirely. Over a period of years, a branch collar will develop. [**Figure 4**]

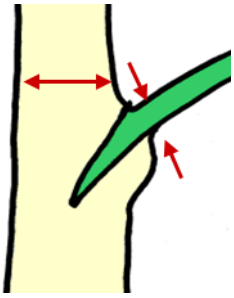


Figure 4. As the branch collar develops, side branch tissues connect into the trunk in a wedge shape making a structurally strong unit. For the branch collar to develop, the diameter of the side branch must be less than half the diameter of the adjacent trunk. Less than one-third is preferred.

The size relationship between the trunk and side branch is called ***aspect ratio***. A branch union with high aspect ratio, like one-to-one (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 one-to-three (side branch is one-third 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, such as 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**] Choosing structurally correct trees or fixing when young is ideal. Refer to CMG GardenNotes #632, *Tree Selection: Right Plant, Right Place*.

Figure 5.
Left: A branch collar does not develop on co-dominant trunks, making the branch union structurally weak. Tight angled V-shaped branch unions are more prone to decay and storm damage.
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, prune to develop branch collars. The side branch must be less than half the diameter of the adjacent trunk. Also select branch unions with a wide angle of attachment. In pruning, remove codominant trunks and narrow branch unions while young (smaller than two inches). If the branch is larger, a heading cut can be made one year, and removal can happen the following year to reduce the percentage of removal as needed. [**Figure 6**]

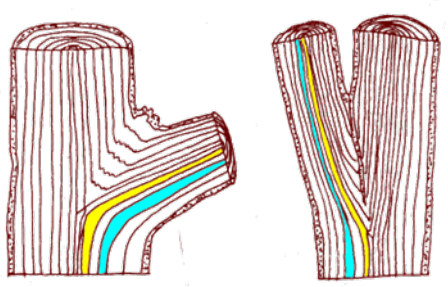


Figure 6. Branch unions that form a right angle are more resistant to decay. A branch union with codominant trunks and a narrow angle of attachment is highly prone to the spread of decay.

How Trees Grow

Xylem Tissues. Each year a tree puts 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**]

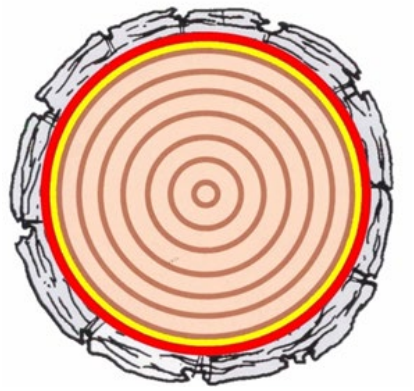


Figure 7. Cross section of a tree.
Bark is the outer protective covering.
Phloem (red in drawing) is the inner bark tissue. Photosynthates (sugars and carbohydrates produced in the leaves by photosynthesis) move throughout the tree in the phloem tissues, including down to feed the roots.
Cambial Zone (yellow in drawing) is the layer of active cell division between bark and xylem.
Xylem (brown layers in drawing) shows each year that 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 organisms. Due to chemical changes in these non-living cells, heartwood is often darker in color. [**Figure 9**]

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 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.

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. [**Figures 11** and **12**]

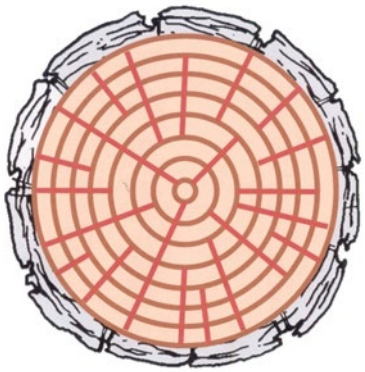


Figure 11. The xylem tissue (wood) is a series of compartments or boxes created by the annual growth rings and ray cells.

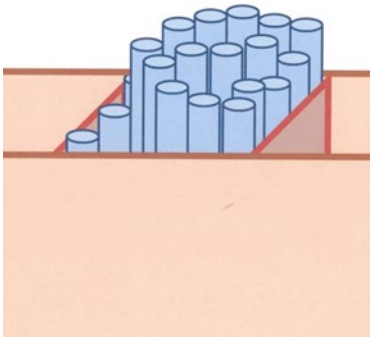


Figure 12. Each compartment or box framed by the annual growth rings and ray cells is filled with xylem tubes. Water moves in the xylem tubes up from the roots.

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

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. [**Figure 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 twenty 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. [**Figures 13** and **14**]

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

Figure 13. The heartwood has completely decayed away.

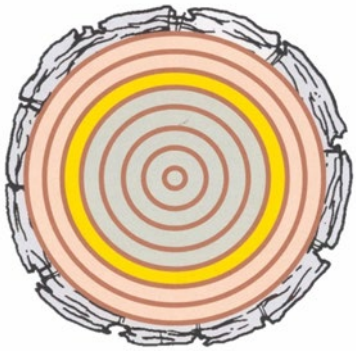


Figure 14. Decay in a tree creates a pipe-like structure with a hollow center. The light colored wood represents new annual growth rings that grew after the year of injury. The darker colored ring is a reaction zone created in the sapwood. The heartwood has completely decayed away.

In the drawing, an 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.

Evaluating Decay

Evaluation of decay and if a tree is hazardous must be done by a **TRAQ (Tree Risk Assessment Qualification) certified arborist**. A commercial arborist or arborists with the Colorado State Forest Service with this TRAQ certification should be the only ones discussing risk! When evaluating risk of the tree, arborists look at tree history, tree vigor, species, crown density, potential targets, consequences of failure, and if there are mitigation steps that can be taken. The following is for knowledge only.

Percent Decay or Hollowness

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

In evaluating potential hazards, arborists (tree care professionals) calculate 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). This healthy wood is sometimes called holding wood and mainly consists of sapwood. A tree with a 33% healthy wood is labelled high risk potential. A tree with a 20% healthy wood is labeled as critical risk potential.

The cottonwood branch above [**Figure 13**] has 25% healthy wood, putting it at “high risk” for potential failure. This *calculation* is valid only when the decay column is centered in the trunk/branch. Other factors are used to evaluate the tree’s health and risk.

On older mature trees, percent holding wood or sapwood (healthy wood) 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. Arborists that have specific training in Tree Risk Assessment Qualification (TRAQ) use a Basic Tree Risk Assessment form and certain tools to assess trees. These trained arborists are the ones that should address any question of risk. The following are procedures with limited potential to evaluate the internal structure of trees.

Visual Indicators for Decay

Large pruning wounds suggest the potential for internal decay. Often decay may be observed within the pruning wound. [**Figure 15**]

Figure 15. 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 may spread decay since the core is taken through healthy and decayed layers of the wood, so it is only used when evaluating risk potential. Coring devices only indicate the decay potential at the point of drilling and do not represent the entire trunk or branch.

The tools used to measure risk based on decay and health of trees can include an increment borer tool, a drill with a small bit, a Resistograph, digital microprobe, sonic tomograph, electrical impedance tomograph, sonic hammer, tree motion sensors, or chlorophyll fluorimeter.

Listening and Radar Devices

Various methods are used today to predict the risk potential of trees. These methods may include using instruments to measure sound to determine internal decay, visualizing sound waves, measuring the electric field of the wood, or using radar. Some of these methods are financially prohibitive tools for arborists.

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 16**]

Figure 16. 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 one-third 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 or heading cuts.

Authors: David Whiting, CSU Extension, retired, and Carol O'Meara, CSU Extension, retired. Artwork by David Whiting. Used with permission. Reviewed May 2018. Reviewed May 2023 by Susan Carter, CSU Extension.

Reviewed May 2023

MASTER GARDENER
COLORADO STATE UNIVERSITY
EXTENSION

CMG GardenNotes #612

Pruning Cuts

A pruning cut is a controlled wounding of a tree. Pruning a tree has potential negative consequences for its health, including reduced production of photosynthates, lower vigor, and creating pathways into the tree for decay organisms. To mitigate the risk pruning poses, a tree should only be pruned when needed (when there is a beneficial objective) and pruning cuts should be executed properly. For details on tree growth and decay, refer to CMG GardenNotes #611, *Tree Growth and Decay*.

There are three types of pruning cuts: **removal cuts**, **reduction cuts**, and **heading cuts**, each of which is executed and used differently.

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 branches.

Maximum Diameter of Pruning Cuts

Ideally all pruning cuts would be made on branches two inches or less in diameter. Smaller cuts are more quickly covered with wound wood and avoid exposing large amounts of heartwood. ***Sapwood*** is the newer xylem rings. It is active in water transport and storage of photosynthates and is composed of both living and dead cells. Because it contains living cells it can actively resist the spread of decay organisms. On branches two inches and less in diameter, sapwood dominates the branch structure and in many cases is the only type of wood present.

Heartwood, the older xylem rings no longer active in water transport, has no way to actively resist 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. [**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.

Sometimes larger diameter cuts are needed to achieve critical pruning objectives. Any pruning cut larger than four inches needs to take into account the increased risk of decay organisms colonizing the tree's wood through the cut.

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 diameter growth of interior branches. 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**]

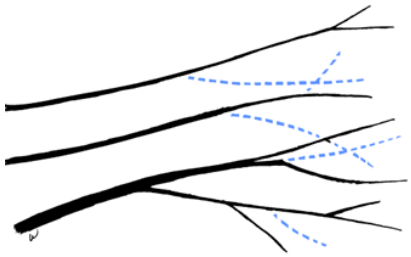
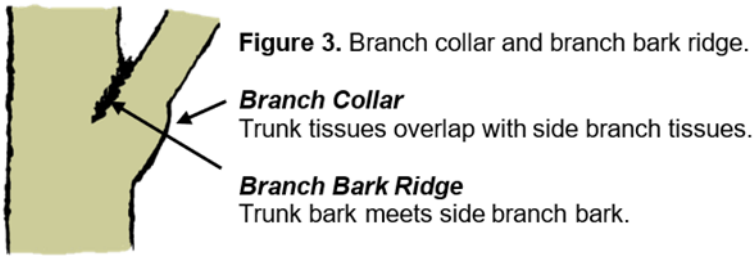


Figure 2. Removal cuts eliminate a side branch back to the trunk or parent branch.

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 overlap with 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 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. Where they meet, the bark rises into a ridge. It mirrors the angle of attachment of the side branch.
[**Figure 3**]



Within the branch collar is a narrow cone of cells called the branch defense zone. [**Figure 4**] This area plays an important role by inhibiting the spread of decay organisms into the trunk. If the branch collar is injured or removed during pruning, the tree will be predisposed to decay organisms entering through the cut.

A primary objective in a correct removal cut is to preserve the branch collar.

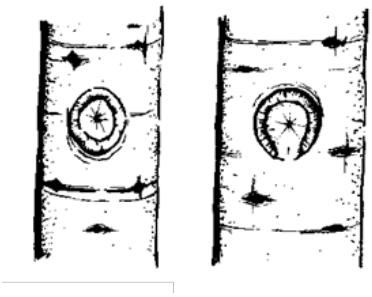


Figure 4. Branch Defense Zone
Within the branch collar is the branch defense zone, a narrow ring of cells that effectively initiates a strong reaction in which chemical changes protect the trunk from decay. If the branch collar is cut or nicked in pruning, the defense zone may fail, predisposing the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

With a *removal cut*, the final cut should be just beyond the branch collar. [**Figure 5**]

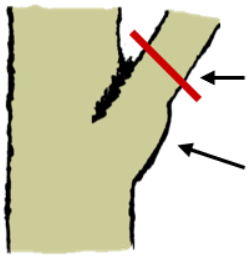


Figure 5. Removal Cut

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**]

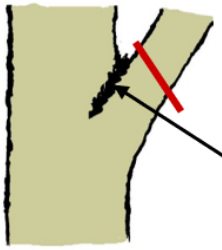


Figure 6. When the branch collar is not clearly identifiable, make the final *thinning cut* at the angle that mirrors the angle of the *branch bark ridge*.

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. [**Figure 7**]

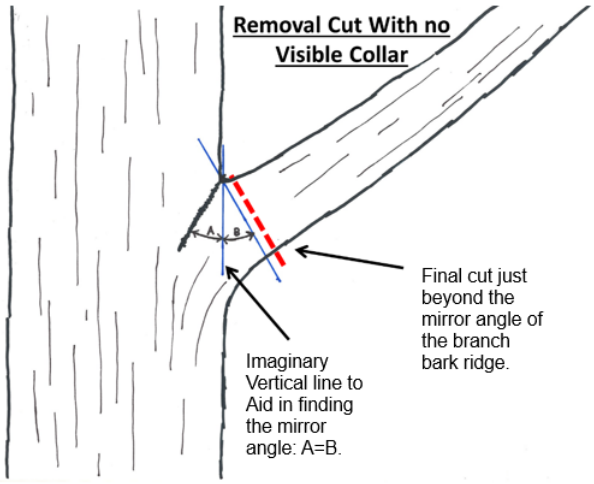


Figure 7. Correct angle for a removal cut with no visible collar.

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 tissue. [**Figure 8**]

Figure 8. Do not cut into or otherwise damage the branch collar or woundwood growing around the dead branch.

Reduction Cuts

Reduction cuts remove a larger 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.

The branch removed with a reduction cut does not have a branch defense zone. This means that reduction cuts have a high risk of leading to decay, especially when they are 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 straight across at the base of the branch being removed. If the branch is vertical add a slight angle to the cut to help with drainage. 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 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 9** and **10**]

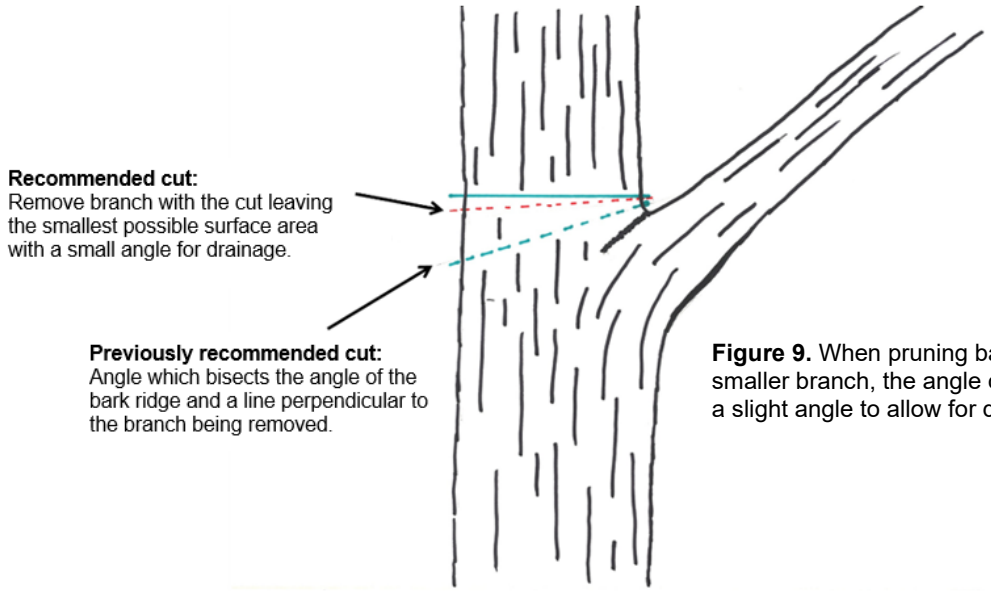


Figure 9. When pruning back a larger branch to a smaller branch, the angle of the final cut should have a slight angle to allow for drainage of rainwater.

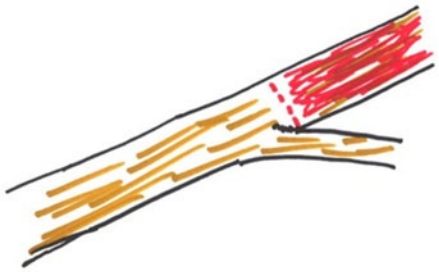


Figure 10. To prevent excessive suckering, the branch which is left should be at least 1/3 the diameter of the larger branch being removed (shown in red).

Heading Cuts

Heading cuts are made at a node (location where there is a bud) instead of at a union of branches. These cuts should be avoided in most landscape situations. These types of cuts remove the terminal bud which releases lateral buds below the cut allowing them to grow. This creates undesirable structure and necessitates that the resulting branches be thinned and/or suppressed. [**Figure 11**]

Figure 11. Heading cuts remove the growing tips of branches, releasing side buds to grow.

Another type of 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. This type of heading cut is very undesirable for most landscape trees. [**Figure 12**]

Figure 12. 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.

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 13**]

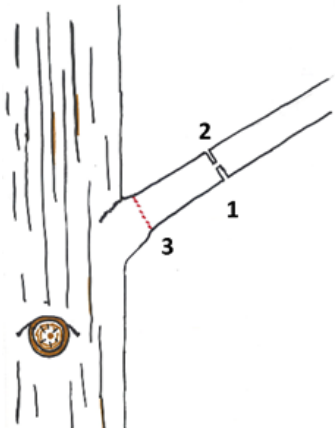


Figure 13. Three-cut method for any branch larger than one inch.

Cut One
Twelve to fifteen inches from the branch union (crotch), make an undercut approximately one-third to halfway through the branch.

Cut Two
Directly above the undercut make a second downward cut. The branch will break as you are making the second cut removing most of its weight. This double-cut method prevents the weight of the branch from tearing the bark below the collar.

Cut Three
Make the third and final cut at the correct pruning point. For example, on a removal cut, just outside the branch collar.

Alternate Three-Cut Method [**Figure 14**]

Cut One
Twelve to fifteen inches from the branch union (crotch), make an undercut approximately one-third to halfway through the branch.

Cut Two
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 Three
Make the third and final cut at the correct pruning point. For example, on a removal cut, just outside the branch collar.

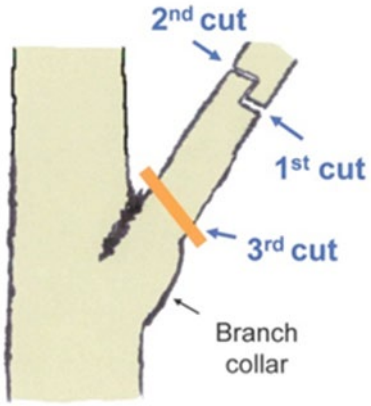


Figure 14. Alternate three-cut method for any branch larger than one inch. Fine for non-chainsaw work.

Wound Dressings

Generally wound dressings do not benefit a tree and in some cases they can be harmful. They can interfere with normal wound closure, may trap moisture in dead wood (compartmentalized wood or heartwood) and some dressings may harm plant tissue (i.e., they kill living plant cells).

Wound dressings can be used as part of a management plan for specific disease and insect issues which are not major factors in Colorado landscapes.

Time of Year to Prune

Dead, diseased, and damaged wood can be removed any time of year. Likewise, minor pruning of live wood (less than 10% of the foliage and/or only small diameter branches are removed) can be done any time of year on healthy trees. From a plant health perspective it is safer to prune a tree from late winter until late summer while the tree is not dormant.

Late winter: Pruning in the late dormant season (before buds swell) is a good time of year to prune most trees from a plant health perspective. Some species are prone to “bleeding” sap if pruned

during this time of year. This is a cosmetic issue, but it can be avoided by pruning after the spring flush of growth is done. [**Table 1**]

Table 1. Examples of Trees Prone to Spring Bleeding	
• Birch • Black locust • Elms • Golden chain tree • Hackberry • Japanese pagoda tree	• Kentucky coffeetree • Maple • Mulberry • Poplar • Walnut • Willow

Spring to summer, following growth flush (as leaves reach full size, harden, and turn dark green) is considered a good time to prune.

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

Late fall to mid-winter is generally considered an undesirable time to prune. Cold temperatures can lead to cracking and damage wood exposed by pruning.

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 two inches in diameter but should be used with caution as they can crush branches and damage tissues.

Pole pruners are used to cut small branches which cannot be reached from the ground. Making good pruning cuts with pole pruners can be difficult.

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 one 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; Alison O'Connor, PhD, CSU Extension; and Eric Hammond, CSU Extension. Artwork by Scott Johnson, David Whiting, and Eric Hammond. Used with permission. Revised May 2018. Revised September 2023 by Eric Hammond, CSU Extension and Micaela Truslove, CSU Extension.

Revised September 2023

MASTER GARDENER
COLORADO STATE UNIVERSITY
EXTENSION

CMG GardenNotes #613

Structural Pruning of Young Shade Trees

Outline:

Structural Pruning Basics

Structural pruning of trees is undertaken with the broad objective of developing and maintaining a branch structure which is less prone to failure. It can be conducted on trees of any age; however, it is most effective, and mostly undertaken, on young-to-middle-aged trees as their branch structure can be more easily changed. A mature tree's structure can be changed to some extent using the principles of structural pruning. Doing so may take many years, especially in cool, dry climates such as Colorado's where trees grow relatively slowly.

Landscapes are fundamentally different than the forests where most trees evolved. In a forest setting, trees compete with their neighbors for light. This incentivizes them to have a single tall trunk, be relatively narrow, and have fewer and smaller lateral branches in their lower canopy. In a landscape setting, there is less competition for light. Trees in landscapes tend to be wider, have multiple competing leaders, and have larger and longer lateral branches. Trees evolved to support their forest form and are at a higher risk of failure in landscapes without structural pruning.

Determining Good Structure

Trees are less likely to fail if:

1) They have a single dominant leader.
2) Lateral branches have a strong attachment to their parent branch which means:
    a. Lateral branches are less than half the size of their parent branch, so they form a branch collar. [**Figure 1**]
    b. They have wider branch unions and more horizontal branching.
    c. Branch unions are free of ***bark inclusions*** (bark pressed against bark rather than connected by sound wood).
3) Scaffold branches are spaced with 3% or more of the expected mature height of the tree between them.
4) They have a live crown ratio (the proportion of tree which is canopy versus bare trunk below the canopy) of 60% or greater.

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

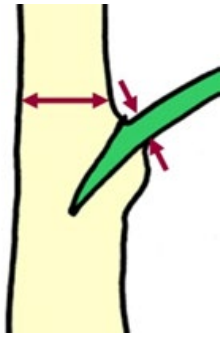


Figure 1. For a branch collar to develop, the side branch must be less than one-half the diameter of the adjacent trunk. See GardenNotes #611.

Time of Year to Prune

Structural pruning is typically done in late winter before trees break dormancy. This is a good time to prune from a tree health perspective as wounds will close quicker and the tree generally has a high amount of stored energy from the previous growing season. It is also easier to evaluate the tree's branch structure and make decisions about where to prune before the tree leafs out. Pruning is generally avoided during the spring growth flush as tissues in branches can easily separate at this time. Mid-summer is also a good time for pruning. Major pruning should not be done from early fall to mid-winter due to the risk of frost cracks and the fact that trees are dormant during this time and cannot actively respond to recovery from pruning. Minor pruning (branches two inches or less in diameter and less than 10% of the trees foliage removed) can be done anytime.

Acceptable Size of Pruning Cuts

If possible, all pruning cuts should be two inches in diameter and smaller. Pruning cuts larger than four inches in diameter should be made only in cases where there are no other options to achieve a critical pruning objective. Large pruning cuts increase the potential for decay.

Pruning Dose (Percent of Live Foliage Removed)

The amount of foliage which can be removed in a given pruning is referred to as the "pruning dose." Until a newly planted tree becomes established, pruning should be limited to dead and broken branches and correcting major structural defects. Once a tree has established following transplant, the amount of live foliage or number of live buds that can be removed depends on the tree's age and health and the pruning cycle (frequency) for the tree.

The American National Standards Institute (ANSI) standards state that 25% of a healthy tree's foliage is the maximum that can be removed each year. This is a good starting point and is useful in forming specifications for pruning. Mature trees are less tolerant of pruning. However, from a plant health perspective, no more than 10% of a mature tree's foliage should be removed annually. Young trees can tolerate more pruning. Up to 50% of a young tree's foliage can be removed annually if needed. These percentage guidelines are maximums. In situations where trees are pruned annually, the appropriate pruning dose would be lighter. However, if a tree goes several years between pruning cycles, the appropriate dose might be higher. Remove as little foliage as possible while still completing your pruning objectives. Trees that are in poor health or under stress should be pruned more lightly. Trees that are under persistent drought stress should not be pruned.

Terms Used to Describe Branches

Permanent Branch – A branch selected to be part of the permanent structure of the tree. This means it will never intentionally be removed. Also referred to as scaffold branches.

Temporary Branch – A branch that will be removed at some point as the tree grows, usually before it reaches two inches in diameter. Normally these are low branches below the permanent crown, or branches located between permanent scaffold branches.

Dominant Trunk/Central Leader – The main trunk of a tree from which primary scaffold branches originate.

Codominant Trunks/Leaders – When trees have two or more upright competing leaders of near equal size. This condition is a major structural defect as the unions between codominant leaders do not develop a branch collar and are prone to having included bark. Trees with codominant trunks are more likely to suffer damage or fail from snow and wind loading. [**Figure 2**]

Figure 2. 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.

Parent Branch – A larger branch that smaller lateral branches originate from.

Structural Pruning Objectives for Young Shade Trees

1) Remove dead, damaged, crossing, or rubbing branches.
2) Maintain a single dominant leader to near the top of a tree’s canopy.
3) Keep temporary branches less than half the size of their parent branch and remove them before they grow larger than two inches.
4) Choose well-spaced permanent branches and maintain them at less than half the size of their parent branch.
5) Maintain a live crown ratio of 60% or greater.

To achieve these objectives, structural pruning manages the growth rate of a tree’s branches through pruning. If part of a branch is removed, it will have fewer leaves to perform photosynthesis and will grow slower than if it had not been pruned. This also means that over time it may become relatively smaller compared to its parent branch.

Strategies for Structural Pruning of Young Shade Trees

Here are general strategies to achieve structural pruning objectives (adapted from *An Illustrated Guide to Pruning,* 3rd Edition, Dr. Edward Gilman).

Before Beginning Structural Pruning: Remove Dead and Damaged Branches

Start by removing dead, damaged, crossing, or rubbing branches from the tree. Any dead material removed does not count toward your pruning dose. However, live branches removed at this point should be considered part of your pruning dose. [**Figure 3**]

Figure 3. Rubbing branches.

Strategy 1 – Select and maintain a single dominant central leader.

Select a trunk to be the tree's dominant leader and remove or shorten all competing leaders. Generally select an upright growing branch that has the best combination of larger size and more vertical growth near the center of the tree's canopy.

Structural Pruning in Practice, Strategy 1:

A tree has two competing leaders. One of the two, normally the most vertical or tallest, is selected to be the dominant leader. The other is shortened with a reduction cut. It will grow more slowly as it will have less leaves going forward. Additionally, shortening the competing leader may allow the main leader to get more sunlight and thus grow more rapidly. Shortening the competing leader subordinates it to the unpruned leader which is now the central or dominant leader. Another possibility is that the competing leader could be removed completely to achieve our objective of having one dominant leader.

The correct choice to shorten or remove the competing leader in this example is based on several factors including: the relative and absolute sizes of the branches involved, how much of the pruning dose for the tree we can afford to use, and the branching structure of the tree. If the competing leader is approaching two inches in diameter it might be best to remove it before it gets larger and develops heartwood. On the other hand, if it is larger than four inches in diameter, it is probably best to shorten it rather than risk exposing heartwood by removing it. If the branches are less than two inches in diameter and equal in size so a branch collar has not developed, it might be better to shorten the branch so that it can develop a collar over time. However, if the branches are equal in size but are approaching a size that makes them too large to remove without an increased risk of decay, it might be best to remove the branch regardless of whether there is a collar. There are a lot of factors that go into making this sort of pruning decision, and it takes knowledge and experience to be comfortable making them.

Strategy 2 – Select the lowest permanent branch.

It is often desirable to raise the canopy (remove lower branches) to provide clearance for human and vehicle traffic. For shade trees in lawns, patios, and along sidewalks, the lowest permanent branch is normally seven to ten feet above ground level. On smaller ornamental trees, lower branching may be preferred. Over streets, the lowest branches should be 14 feet or higher. In wooded settings, the

canopy is raised to 10 feet as a fire prevention technique. Many newly planted trees are short enough that they have no permanent lateral branches at the time of planting, meaning most or all the branches present at planting will be strategically removed over time.

Strategy 3 – Keep branches below the permanent crown from growing too large and remove them over time.

Once the lowest permanent branch has been selected, it is easier to identify how to manage other branches. All branches below this branch are temporary and should be kept relatively small through pruning. They should be kept less than half the size of their parent branch (which is normally the tree's trunk). They should be removed over time before they reach two inches in diameter. The growth rate of branches can be managed by using removal and reduction cuts to remove foliage from them, which in turn will reduce their growth rate.

At least 60% of a tree's height should be canopy as opposed to bare trunk (the live crown ratio should be 60% or greater). Do not raise a tree too high or too rapidly. Lower limbs provide energy to support the development of proper trunk taper (i.e., proper diameter growth of the main trunk) and help distribute wind load placed on the tree. This means lower branches should be kept short by pruning and be removed gradually over time. Temporary branches are often reduced by pruning and retained for many years before being removed. [**Figure 4**]

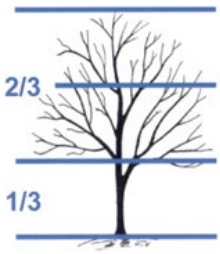


Figure 4. Temporary branches below the lowest permanent branches will be removed over time.

If lower branches grow larger than four inches in diameter, shortening them with proper pruning cuts may be a safer option than removing them.

Strategy 4 – Develop branch structure in the tree's permanent canopy by selecting well-placed permanent branches.

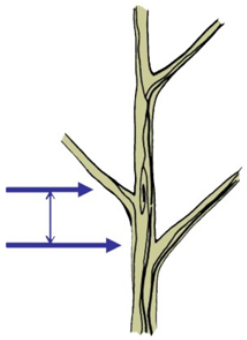
Above the lowest permanent branch there is a mix of temporary and permanent branches. The permanent branches are often referred to as scaffold branches. When selecting scaffold branches, look for branches that are well spaced with branch unions that have desirable traits (e.g., wide branch angles, a well-developed branch collar, and no included bark).

Spacing of Scaffold Branches – When selecting scaffold branches, space branches so the space between permanent branches equals approximately 3%-5% of the tree's expected mature height. **Table 1** shows spacing based on 5% of a tree's expected mature height.

Table 1. Scaffold Branch Spacing Based on 5% of Mature Tree Height	
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 an even radial distribution around the tree's trunk. Try not to select branches on the same side of the tree which are directly above or below other nearby scaffold branches. [**Figure 5**]

Figure 5. 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.



Poorly spaced or clustered branches can negatively impact the way a tree responds to wind and snow loading by concentrating the load placed on the tree at one point on the trunk, increasing the risk of failure. Additionally, clustered branches are less likely to form proper branch collars. [**Figure 6**]

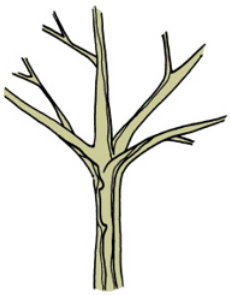


Figure 6. Multiple branches originating from the same location are structurally weak. An objective in structural training is to space scaffold branches.

Selecting Branches with Strong Unions

When selecting scaffold branches, try to select outward growing branches with a wide angle of attachment rather than upward growing branches. Narrow unions are prone to having included bark (bark pressed against bark rather than connected by sound wood). The presence of included bark is a critical defect. Branches growing closer to horizontal continually bear a greater gravitational load and thus develop more reaction wood (additional wood which is anatomically stronger) on the tops or bottoms of branches, making them stronger and more resistant to wind and snow loading.

Strategy 5 – Remove temporary branches in the tree's permanent crown before they get too large.

Temporary branches in a tree's permanent crown are branches growing between permanent scaffold branches. They should be managed in the same way as temporary branches below the permanent crown. They should be kept relatively small through pruning (less than half the size of their parent branch) and be removed before they grow larger than two inches in diameter.

Strategy 6 – Maintain all scaffold branches at half the diameter of the trunk or less in size.

Branches that are half the diameter of their parent branch have a stronger connection due to the development of a branch collar. Scaffold branches that are growing too large relative to the trunk can have their growth slowed with proper removal and reduction cuts.

Another way to think about this strategy is to keep all branches less than one-half the diameter of their parent branch so they develop a branch collar. Temporary branches also benefit from having a collar as it can help prevent decay from entering the tree. In this document, management of temporary branches is covered in Strategies 3 and 4.

Strategy 7 – Remove or shorten branches whose unions have bark inclusions.

Bark being included within the union between branches makes the union much weaker and prone to failure. Branches with inclusions should be shortened with reduction cuts or removed.

Bark inclusions can be identified by looking for bark which rolls smoothly into the union rather than creating a rough ridge where the branches meet (the branch bark ridge). Old inclusions develop an "elephant ear" appearance as the tree tries to grow over them. Included bark is also more common on upright growing branches. Some species of trees are more prone to forming bark inclusions than others (e.g., trees in the genus *Tilia*).

Authors: David Whiting, CSU Extension, retired; Alison O'Connor, PhD, CSU Extension; and Eric Hammond, CSU Extension. Artwork by David Whiting. Used with permission. Revised May 2018. Revised September 2023 by Eric Hammond, CSU Extension; Micaela Truslove, CSU Extension; and Alison O'Connor, PhD, CSU Extension

Revised September 2023

MASTER GARDENER
COLORADO STATE UNIVERSITY
EXTENSION

CMG GardenNotes #615

Pruning Mature Shade Trees

Outline:

Mature Trees and Pruning

Mature trees contribute a tremendous amount of aesthetic and financial value to a property. Trees take decades to reach maturity and cannot be easily replaced, so, caring for them correctly is critical. One important aspect of tree care is pruning. Proper pruning can prevent structural issues, mitigate hazards, improve a tree's appearance, and generally ensure a tree remains healthy and structurally sound.

Mature trees are less tolerant of pruning than young trees and incorrectly pruning them can also have major consequences for their health and stability. This means mature trees should not be pruned unless there is a reason to do so. Common acceptable reasons to prune mature trees include removal of dead or diseased wood, removing or managing water sprouts, improving light penetration into, and air movement through the canopy, reducing the size of the crown in order to prevent interference with other landscape features, and mitigating their risk of failing.

Pruning larger trees is extremely dangerous work. Hundreds of arborists are severely injured or killed every year. It is important to know your limitations; mature tree pruning is best left to professional arborists. Never remove large limbs while on a ladder.

Finding a Good Arborist

A professional arborist is licensed and insured. Your local city forester may maintain a list of arborists that are licensed to work in your municipality.

Industry groups, such as the International Society of Arboriculture, administer arborist certification programs that train arborists and require them to adhere to a code of ethics. Accreditation is based on experience and demonstrated knowledge, and arborists must maintain accreditation by completing continuing education units. This continuing education requirement ensures they always

have the most up-to-date training on proper tree care. Industry groups maintain searchable databases of certified arborists to aid the public in hiring a trained and certified professional. Not all tree care workers are certified arborists. It is a good idea to make sure any tree care company you hire has a certified arborist on staff and ideally, that one will be on site when your tree is pruned.

Pruning Specifications

A pruning specification is a document that describes how a tree or group of trees will be pruned. Having a good pruning specification or similar document agreed upon by the property owner and arborist limits the opportunities for misunderstanding and poor pruning. A good specification should state at a minimum which trees on the site will be pruned, the type of pruning the trees will receive, the objective of the pruning, the maximum percentage of a tree's canopy that will be removed and the maximum diameter of live branches that will be removed. It may also specify that the tree will not be topped or "lion tailed." An arborist may have a general set of specifications they use, or it may be provided by the property owner in some cases.

General Pruning Guidelines

Limitations on Diameter of Cut

Ideally all pruning cuts are made on branches two inches or less in diameter. Smaller cuts are more quickly covered with wound wood and avoid exposing large amounts of heartwood. ***Sapwood*** is the newer xylem rings. It is active in water transport and storage of photosynthates and is composed of both living and dead cells. Because it contains living cells it can actively resist the spread of decay organisms. On branches two inches and less in diameter, sapwood dominates the branch structure and in many cases is the only type of wood present.

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

Heartwood, the older xylem rings no longer active in water transport, has no way to actively resist 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. [**Figure 1**]

If decay organisms successfully colonize a tree's heartwood, over time they can spread to all the heartwood in the tree, creating large columns of decay. When a pruning cut or other injury opens a branch to decay, the decay organisms will potentially affect the current season of xylem rings and everything older over time. 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. Cutaway showing new annual growth rings resistant to decay with a pruning cut made this season.

Proper Pruning Cuts

For information on making proper pruning cuts, refer to CMG GardenNotes #612, *Pruning Cuts*.

Pruning Dosage: Maximum Amount of Live Wood/Foliage to Remove

Mature trees are less tolerant of pruning than younger trees. When pruning them you should remove the least amount of foliage required to meet your pruning objectives. From a plant health perspective, a maximum of 10% of a mature tree's foliage should be removed during each pruning cycle. However, to meet your pruning objectives a larger pruning dose—or amount of live tissue removed during a single pruning cycle—may be necessary and is acceptable if the tree is in good health.

In situations where trees are pruned annually, the appropriate pruning dose will normally be smaller. However, trees are often pruned only once every several years. Here the appropriate pruning dose may be larger. In situations where heavy pruning is needed, complete the work over a period of years.

Excessive pruning can lead to ***water sprouts*** (sucker-like shoots on the trunk or branches). Water sprouts are structurally unsound because they are superficially attached to the tree. In contrast, structurally sound branches contain overlapping branch and trunk wood. This means branch wood is enveloped with trunk wood, and each year a new layer of branch and trunk wood form at the branch collar in a ball-and-socket fashion ensuring a strong branch attachment.

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 cycle, resulting in a multi-year decline in canopy growth.

Removal of dead wood does not count toward your dosage.

Pruning Objectives

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

Table 1. Objectives and Methods for Pruning Maturing Trees

Objectives (Why)	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	-	-
Influence Flowering and Fruiting	-	-

Pruning Methods

Structural Pruning

Structural pruning centers around developing a dominant trunk with subordinate and properly spaced side branches and secondary limbs. To be most effective, it requires annual pruning over a period of years. It is a proactive practice that seeks to establish a resilient structure and prevent

major structural defects in a tree. It is mostly carried out on younger trees as mature trees have already developed their structure.

Some of the principles of structural pruning can be applied to mature trees to reduce the risk of branches failing due to wind or snow loading. For more information, see the section on reduction pruning later in this document. [**Figure 3**]

Figure 3. Codominant trunks (adjacent trunks of similar size) account for the majority of storm damage in Colorado landscapes.

Cleaning

Cleaning is the most common type of pruning mature trees need and the most common type of pruning performed on them.

The objective of cleaning is to improve the tree's health and reduce the risk posed to people and property by removing dead, broken, cracked or diseased wood, rubbing branches, and weakly attached branches. Examples of weakly attached branches include branch unions with included bark, unions where the branches are equal in size (codominant branches), and water sprouts.

If a mature tree has many water sprouts, leaving some is considered good practice. They are a stress response and attempt by the tree to produce more energy. If water sprouts are abundant or associated with a wound, prune out approximately one third of them such that remaining sprouts are spaced evenly along branches. If there are only a few water sprouts and they are not associated with a wound, they should be removed. Water sprouts below the canopy and suckers from a tree's root system should be removed. [**Figure 4**]

Figure 4. This old cottonwood needs cleaning to remove dead branches and reduce the risks associated with branch failure.

Removing Dead Branches

To minimize risk if the branch were to fail, it is advisable to remove any dead branch larger than two inches in diameter and higher than thirty 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 result in a high potential for decay to spread into the trunk. If live wood has begun 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 even with the trunk. Always cut outside of the branch bark ridge and branch collar. [**Figure 5**]

Figure 5. 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, *"Remove dead branches one inch in diameter and larger"* or *"Remove dead 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.

Thinning

In properly executed thinning, some small branches are removed from a tree's canopy, primarily from its outer edge, with the objective of increasing light penetration into, and airflow through, the canopy. [**Figure 6**] The potential benefits of this include a reduced risk of failure due to a reduction of branch weight and decrease in load placed on branches from wind or snow, better taper (increased diameter growth) of interior branches due to increased sunlight in the inner canopy and a reduction of foliar diseases.

The benefits of thinning are short lived as the tree continues to grow and replaces removed branches in future years. Thinning is frequently executed incorrectly with too many branches being removed from the interior of a tree's canopy. Results of improper thinning can be similar to "lion tailing." Thinning is most appropriate for trees that have a confined or reduced rooting area, are in windy sites to reduce wind loading, or for mitigating a specific hazard.

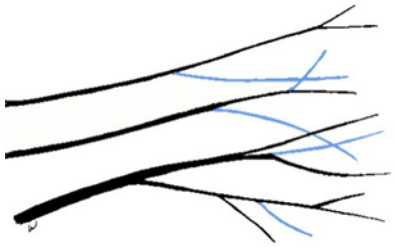


Figure 6. Thinning is the selective removal of small branches, growing parallel to each other, in the leafy upper/outer tree canopy.

Potential Benefits of Thinning

- Thinning can reduce limb weight in order to compensate for structural defects.
- Thinning increases light penetration into the tree's interior. This can invigorate the tree and help retain the tree's natural shape. Thinning may adequately reduce shade for shade tolerant understory plants below the tree. However, thinning middle-aged and mature trees will not adequately promote growth of sun loving plants like Kentucky bluegrass growing in the tree's shade.
- Thinning is a technique to partially open a view without removing or structurally influencing a tree. This is often referred to as *vista pruning*.

Limitations of Thinning

- 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.
- In most situations the benefits of thinning will be short-lived as the tree puts on new growth. This makes it most relevant to higher value trees which have a known hazard.

Improper Thinning

- *Thinning* should be carried out on relatively small branches in the outer canopy. Thinning should not remove large branches or many interior branches. Doing so can have results similar to lion tailing which reduces the tree's vigor and increases the risk of damage from wind. [**Figures 7** and **8**]

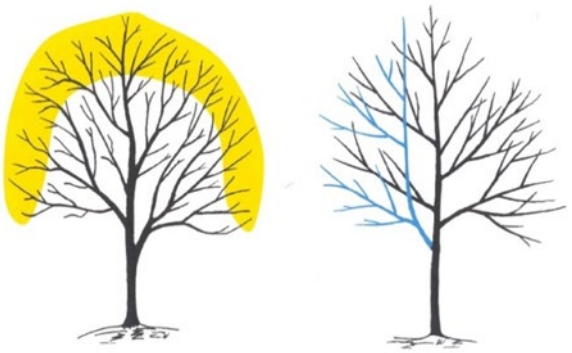


Figure 7.
Left: Thinning focuses on small branches in the upper/outer tree canopy.
Right: Thinning does NOT remove large branches, creating a gap in the tree canopy.

Figure 8. Do not "lion-tail" trees as in the photo. Removal of the smaller twiggy wood in the inner tree canopy decreases vigor, reduces the development of taper, and increases potential for wind damage by reducing the tree's ability to dampen what wind is distributed.

Written specifications for a thinning job should specify the following:

- Clarify the dosage (percent of the tree's canopy that 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 two 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 (live crown ratio). [**Figure 9**]

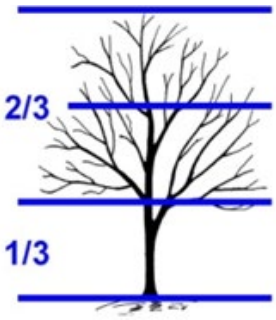


Figure 9. When removing lower branches, maintain at least one-half of the foliage in the bottom two-thirds of the tree. The lowest branch should originate in the lower one-third of the tree.

Raising should be part of the tree's structural training while young. Ideally raising would be done before branches to be removed exceed two inches in 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. Removing branches greater than half the diameter of the adjacent trunk leaves 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 10**]

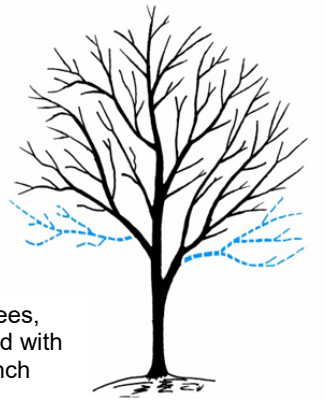


Figure 10. In raising branches on maturing trees, consider if required clearance can be achieved with removal and reduction cuts out along the branch rather than removing large branches entirely.

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 upper crown, increasing wind loading.

Written specifications 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

The objective of reduction pruning is to reduce the size of the tree's canopy. Normally it is undertaken to provide clearance for a structure, power lines, or other element in a landscape. It can also be used to reduce the risk of tree failure.

Reduction pruning is best done before a tree outgrows its space and begins to interfere with structures or power lines. This allows for the use of smaller pruning cuts and for the natural shape of the tree to be preserved. Improper reduction pruning can quickly become topping. [**Figure 11**]

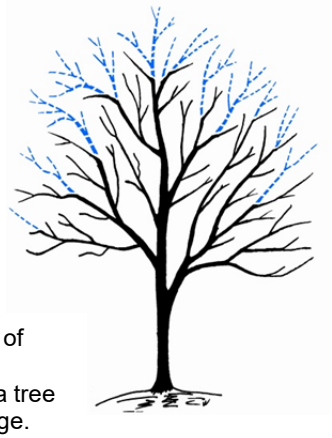


Figure 11. Reducing is the selective removal of branches to decrease a tree's height and/or spread. Just being tall does not indicate that a tree is structurally weak and prone to storm damage.

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 remaining branch or trunk to internal decay. On older trees showing stress or decline, heading cuts can accelerate decline and death. The need for reduction pruning can be reduced by selecting a tree with an appropriate mature size for a site and by performing proper structural pruning as the tree grows.
[**Figure 12**]

Figure 12. Not every tree should be reduced. Notice the dieback associated with previous reduction pruning 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 remaining after the cut 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, *Structural Pruning of Young Shade Trees*.

It is very time intensive to use crown reducing to permanently maintain a tree at a small size without causing tree decline. Ideally, trees should be selected with adequate space to accommodate their mature size. Where size control is necessary, it is best to begin reduction pruning as the tree reaches an 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.
[**Figure 13**]

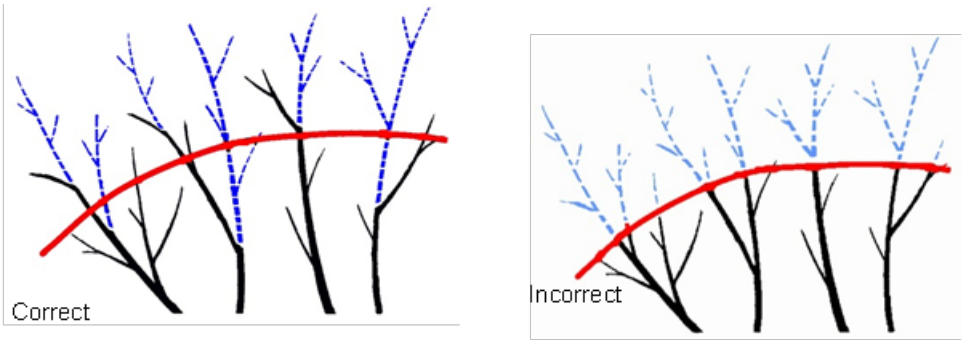


Figure 13.
Left: In reduction, visualize the new outer edge of the smaller canopy. Prune back to branch unions that make proper reduction and thinning cuts. Some branches will be taller than the new outer edge, some shorter.
Right: This tree is incorrectly rounded off with heading cuts.

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 14**]

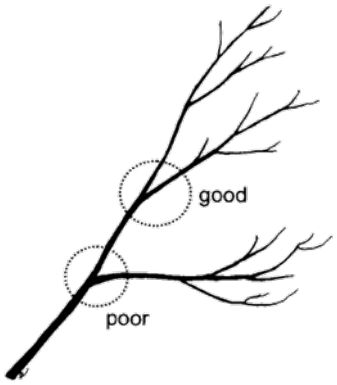


Figure 14. In shortening a main upward growing branch, pruning back to a narrow branch union may be stronger than a wide branch union.

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 remaining lateral branch 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 pruning is an advanced type of pruning which has the objective of helping a tree recover from storm damage or prior improper pruning. It seeks to manage the remaining branches and any water sprouts which result from the damage to restore a sound branch structure.

Before a storm damaged tree undergoes restoration pruning it is important to first decide if the tree can be saved. The loss of leaves or broken branches are both conditions a tree can recover from. Cracks or other significant damage to the main trunk often are not.

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

Types of Pruning to Avoid

There are several types of pruning that should be avoided for mature landscape trees. These include, topping, rounding-over and lion tailing. Always have a reason to prune, do not just prune for the sake of pruning.

a) Topping or Rounding Over:
    I. Topping is the arbitrary shortening of a tree's branches or trunks during pruning without regard for tree anatomy or biology. It may produce an abundance of water sprouts which are vigorous and structurally unsound. In some cases, topped trees will decline and die. Topping often occurs when trees are planted in spaces that are too small for their mature size, such as under powerlines, or to give a tree a rounded shape. When planting a tree make sure that its mature size will fit the space and that

it is a cultivar that has the shape you desire. Properly executed reduction cuts can be used to reduce the height of the tree while minimizing negative impacts on the health of the tree.

b) Lion Tailing:

II. Lion tailing is the practice of limbing up a tree taken to an extreme. In the worse cases of lion tailing, all the lower branches of the tree are removed leaving only a few leaves at the ends of long bare branches (like the puff of fur at the end of a lion's tail). In less extreme cases only interior branches are removed creating a shell of foliage around a hollow center. To avoid lion tailing be sure that at least two thirds of a tree's height is left as canopy with no more than the lower one third being bare trunk. Raise the canopy of trees slowly and only as far as needed based on the planting site. Interior branches are important to proper diameter growth of major limbs and trunks and should not be over thinned.

Frequently Asked Questions About Pruning Mature Shade Trees

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.

How Should Storm-Damaged Trees be Pruned?

First, assess if the tree is safe to work on or around. Look for cracked or hanging branches that might fall, downed power lines and other hazards. Once you are sure the area is safe, focus on cleaning (removing broken and damaged limbs), keeping in mind the structural integrity of the tree.

Next, focus on structural pruning to restore the tree's structural integrity and shape to the extent possible. Re-establishing good structure 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 as a result of storm damage. When too much live wood/foliage is lost to storm damage, limit pruning to cleaning.

On 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 performing any pruning other than cleaning. This may take several years.

Figure 15. Keep storm-damaged trees when they can be pruned back to structurally sound wood and have an acceptable appearance.

Keep the tree if it can be pruned back to structurally sound wood and will be esthetically pleasing. Often when more than half the tree is lost to storm damage, the best option is to remove the entire tree. [**Figure 15**]

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 three to twelve 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.

Authors: David Whiting, CSU Extension, retired; Alison O'Connor, PhD, CSU Extension; and Eric Hammond, CSU Extension. Artwork by David Whiting. Used with permission. Revised May 2018. Revised September 2023 by Eric Hammond, CSU Extension; Micaela Truslove, CSU Extension; and Chris Hilgert, CSU Extension.

Revised September 2023

MASTER GARDENER
COLORADO STATE UNIVERSITY
EXTENSION

CMG GardenNotes #616

Pruning Flowering Shrubs

Outline:

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 (new twigs that grew the previous summer). The flower buds develop from midsummer through fall, overwinter, and bloom the following spring. In the early spring, flowering shrubs can be thinned before flowering or growth starts. [**Figure 1**] Thinning or rejuvenation pruning can also be done right after blooming to maximize the next season's flowers. Pruning in the fall and winter will remove wood containing the flower buds, reducing blooms the following spring. [**Figure 2**]

Spring-flowering shrubs include forsythia (*Forsythia* spp.), Nanking cherry (*Prunus tomentosa*), quince (*Chaenomeles* spp.), bridal wreath and Vanhoutte spireas (*Spiraea prunifolia*, *S. pleniflora* '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.).

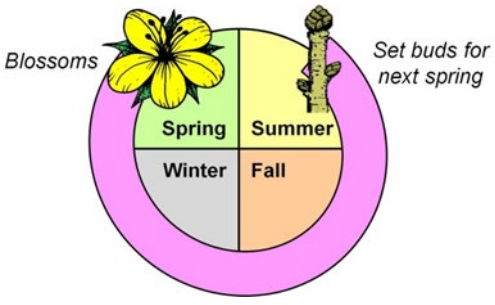


Figure 1. Spring-flowering shrubs bloom from buds that developed on new wood the previous summer.

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

For 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. For many flowering shrubs, the spent flowers and seedpods are not attractive and can be removed for aesthetic reasons (lilacs).

Summer-flowering shrubs bloom on new wood that grew earlier in the current growing season. Summer-flowering shrubs can be pruned by thinning or rejuvenation pruning 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’), mock orange (*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.).

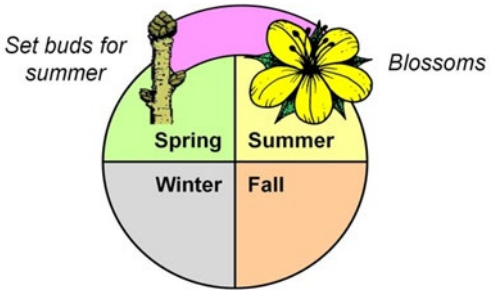


Figure 3. Summer-flowering shrubs bloom from buds which developed on new wood that grew earlier in the current growing season.

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

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

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**]

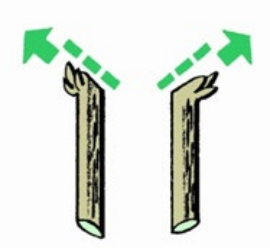


Figure 4. Shape can be managed to some extent by pruning to buds and branches growing in the desired direction of growth.

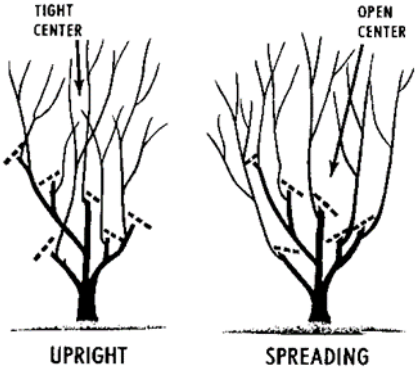


Figure 5. Pruning to inward growing buds or branches results in narrower shrubs. Pruning to outward-growing buds or branches results in wider shrubs. [Line drawing by USDA]

Prune to Manage Pests

Pruning is a management technique for some insect or disease problems. For example, removing the older wood in lilac can reduce 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 when 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**]

Branch-by-branch shaping is a slow process, but this method maintains a more naturally shaped shrub and does not significantly encourage new growth.

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. In addition, frequent shearing does not encourage new growth from the base, which is needed to promote flowering.

With frequent shearing, the plant becomes thicker and bushier toward 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 that are sheared 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** through **11**]

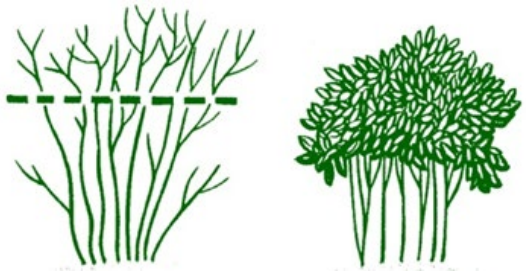


Figure 7. Flowering shrubs pruned by topping or shearing become woody at the base. [Line drawing by USDA]

Figure 8. Over time, sheared shrubs become woody and contain 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.

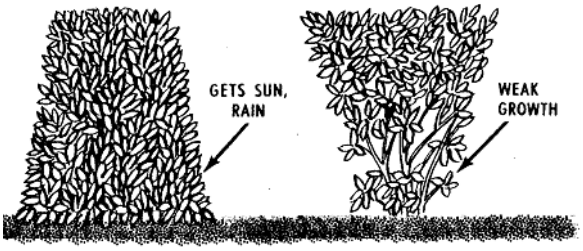


Figure 10. In shearing hedges, maintain the natural shape of the plant. A common mistake is to shape shrubs with a wide top and narrow base. Lack of sunlight shades out lower interior growth, resulting in a woody base. [Line drawing by USDA.]

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 before growth starts using leafless branches in early spring but can also be done in summer if necessary. This method can be 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 annual thinning is better for overgrown shrubs.

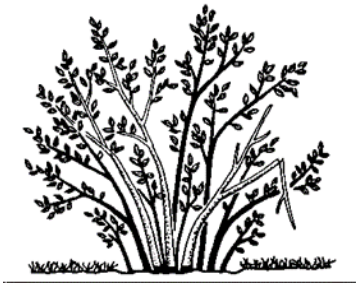


Figure 12. Annual thinning removes one-third of the oldest wood to the base each spring. This encourages new growth from the base, keeping the shrub youthful looking. [Line drawing by USDA.]

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 (*Spiraea* spp.), blue mist spirea (*Caryopteris*), *Potentilla*, red-twig dogwood, sumac (*Rhus* spp.), and

hydrangea. (Note: *Caryopteris* flowers best if renewed each spring.) Also use this method to rejuvenate lilac, privet (*Ligustrum* spp.), barberry (*Berberis* spp.), forsythia, flowering quince, honeysuckle, mock orange, 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 general rule, if more than one-third of the branches are woody and, without healthy foliage, the shrub will probably not respond. Some shrubs are structurally similar to small trees, with only one or a few primary trunks, including 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 grafted onto common lilac rootstocks should not be cut to the ground. Regrowth will be of the common lilac rather than the selected cultivar.

Replacement

Shrubs that have been neglected or repeatedly sheared often become woody with many dead twigs. The best option may be to replace them.

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, CSU Extension; Carol O'Meara, CSU Extension, retired; and Carl Wilson, CSU Extension, retired. Artwork by David Whiting and USDA. Used with permission. Revised May 2018. Reviewed May 2023 by Amy Lentz, CSU Extension.

Reviewed May 2023

MASTER GARDENER
COLORADO STATE UNIVERSITY
EXTENSION

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 the 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 the 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. This is similar to a heading or reduction cut in deciduous trees.

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; this is removing the collar and cutting flat to the trunk. Remove the branch using a three-cut method. [**Figure 1**]

Cut One. Coming out twelve to fifteen inches from the trunk, make an undercut a third to halfway through the branch.

Cut Two. 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 Three. 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. This cut should be perpendicular to the branch that is being removed. A good cut will make a circular shape.

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

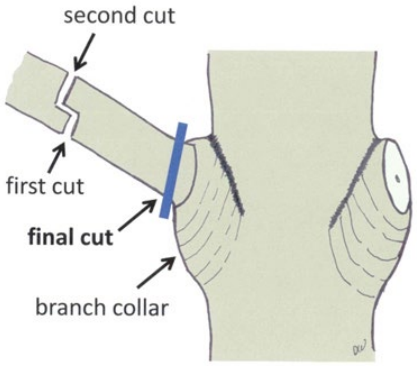


Figure 1. On evergreen trees, remove large branches back to the trunk using a three-cut method. Make the final cut just outside the branch collar. Needles only grow from the growing tips out and will not develop on the interior branch wood without needles.

Pruning Spruce, Fir, and Douglas Fir

Spruce (*Picea* spp.), fir (*Abies* spp.), and Douglas fir (*Pseudotsuga menziesii*) generally need little to no pruning when planted in the right place.

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 if 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 and elongated but needles not expanding). Avoid using pruners or a knife, as it will cut the remaining needles, giving a brown tip appearance. [**Figure 3**]

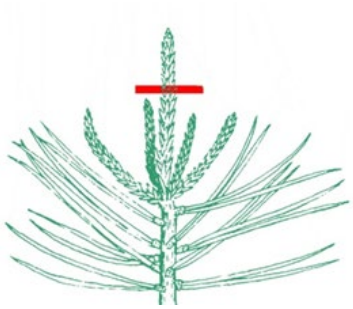


Figure 3. On pines, for bushier new growth “pinch” growing tips by snapping off one-third of the “candle” tips with the fingers. Because pines produce few side buds, they are intolerant of more extensive pruning. Line drawing by CSU Extension.

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. (Cut needles will stay cut and not grow back.)

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 must be pruned back for space issues, remove it back to the trunk. Mugho pine shrubs are a good candidate for pinching needles to keep them short and bushy.

Pruning Juniper and Arborvitae

Juniper and arborvitae generally need little to no pruning.

They may be pruned at any time except during subzero weather or late summer. Needles form a waxy layer in summer that prevents sunburn of the needles. 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; and Carol O'Meara, CSU Extension, retired. Artwork by David Whiting and CSU Extension. Used with permission. Revised May 2018. Reviewed May 2023 by Susan Carter, CSU Extension.

Reviewed May 2023