As featured in American Nurseryman

Training Young Trees

Like humans, trees need special care during their infancy. An environmental horticulture advisor says adhering to a five-step process is essential to young trees becoming attractive, long-lasting adults.

It's been known for some time that trees should be trained when they're young. The development of strong structure at an early stage in the life of a tree has lasting benefits. Richard Harris, author of *Arboriculture: Integrated Management of Landscape Trees, Shrubs and Vines* (1992), stated, "Training young trees provides the greatest benefit of any cultural practice in influencing the future structure, appearance and maintenance costs of landscape trees." In spite of this clear message regarding the importance of this practice, many — if not most — young trees are not trained, and the ones that are pruned are often not pruned correctly. This is the case in cities across the US and abroad.

Why aren't young trees trained? Typically, it's for two reasons. First, for municipal trees, the refrain "we can't afford to train young trees" is often heard. It is reasoned that this is an additional practice that requires additional labor and cities simply don't have the money. Although this lack of budget support response seems understandable, it is also shortsighted. Cities can't afford *not* to train young trees. Training provides too much of a return on investment to be ignored. It is a critically important practice that should be integrated into all tree management programs.

Text and photos by Laurence R. Costello

Second, many young public and private trees are not trained because there hasn't been a systematic method in place that guides horticulture professionals through the training process. We've known certain elements of the training process, such as removing injured branches and codominant stems, but there hasn't been a stepwise system that leads professionals through it from beginning to end. As a result, young trees are either ignored or they're pruned improperly.

In this article, both the why and the how of training young trees are addressed. The key benefits of training are discussed, and a five-step process for pruning young trees is outlined. With this information, nursery, landscape and arboriculture professionals can produce attractive and long-lasting trees.

Key benefits of training. It is vital to understand the key benefits of training. With this understanding comes the rationale and motivation needed to establish formative pruning as an essential practice in tree management programs. Without it, the pruning needs of many young trees will continue to be ignored.

Three benefits are: improved structural strength, reduced maintenance costs and increased tree longevity. Individually, each benefit can be viewed as providing sufficient basis to initiate a training program. Collectively, they make a compelling case.

Improved structural strength. By removing defects, such as weak branch attachments and codominant stems, trained trees will be structurally stronger than untrained trees; they will have a lower failure potential, lower hazard potential and lower liability risk (photo, below). Many juvenile and mature trees fail simply because structural defects were not removed when the tree was young. In the training process, structural defects are remediated or removed. As a result, trained trees are stronger and safer than untrained trees.

Reduced maintenance costs. Mature, trained trees will require less maintenance than untrained trees because they have fewer branches to prune, their branch spacing permits easier access for arborists and they will not need corrective structural work.

Trained trees will be structurally stronger than untrained trees. The stem that broke off of this elm should have been removed when the tree was young. Now, the tree needs to be removed.

If there is more than one leader, then the strongest and most vertical stem should be selected as the central leader. Codominant stems have developed on this young oak and one needs to be removed. Removal of the stem on the left established the stem on the right as the central leader.

Trained trees typically have fewer branches than untrained trees, which means less pruning. For example, instead of having 20 scaffold branches that are poorly spaced and uneven in weight distribution, a trained tree may have 10 scaffolds that are well-spaced and balanced. This translates into a reduced pruning requirement with proportionate cost savings.

Well-spaced branches in a trained tree allow pruning to be accomplished in a relatively short period of time. Scaffolds that are well-spaced both vertically and radially facilitate climber entry into the crown and movement around the crown. On untrained trees, multiple branches extending from the same area on the trunk and uneven branch distribution make access and movement more difficult, leading to longer time requirements for pruning and increased costs.

Finally, costs associated with structural defect correction can be avoided. When structural defects remain in trees, they frequently become hazards. To mitigate the hazard, corrective work is needed, such as cabling, bracing, canopy thinning and codominant stem removal. This work is time-consuming and often very costly. Such costs can be avoided simply by correcting defects when the tree is young. It takes a few seconds and little equipment to remove a codominant stem on a young tree, but many hours and heavy equipment when the tree is mature. These costs can be avoided by training.

Increased tree longevity. With structural strength, trained trees are likely to remain a part of the urban forest for a longer period of time than untrained trees. Trees that have sustained partial failure, such as to limbs or stems, often need to be removed because they are hazardous or unsightly.

Collectively, these benefits are substantial, and they can be achieved with a relatively small investment of time and some basic equipment: hand pruner, lopper, pole pruner, handsaw and ladder. When considering the benefits relative to the costs, it is clear that we can't afford *not* to train young trees.

How to train young trees. The five-step process for producing well-trained trees applies to most deciduous and broadleaf evergreen trees, regardless of species or use (park, street, residential area and so on). Conifers are addressed separately. They do not apply to trees that are specialty-pruned: espaliered, pollarded or multitrunk trees.

Training should begin in the nursery and continue for several years after planting. As trees develop structure, their pruning requirement will diminish. The five steps should be followed in sequence.

Step 1: Remove broken, diseased, damaged or dying branches. Look around the tree, and if you see any broken, diseased, damaged or dying branches, remove them behind the point of injury. In some cases, the whole branch may need to be removed. In other cases, just the injured part can be cut off. This is a "cleanup" step — it is an opportunity to rid the tree of branches that should not be retained as part of its structural framework.

Step 2: Select a leader and remove competing leaders. The leader is the central stem of the tree. Carefully follow the trunk of the tree from bottom to top. The trunk should narrow into a single stem that is in a vertical position. This is the leader. There should be only one leader.

If there is more than one leader, or a competing leader, then the strongest and most vertical stem should be selected as the central leader (photo, page 23) and other stems should be removed, cut back or possibly selected as permanent branches (see Step 4). This is a critical step that will minimize the potential for codominant stem development in mature trees (photos, above). Do not wait to establish a central leader; as the competing stems grow in diameter, it becomes more problematic to cut one back or remove it.

In some cases, nursery stock may be headed to produce lateral branches. If this happens, then a central leader needs to be re-established. This should be done in the nursery. Avoid planting trees that have been headed in the nursery and do not have a central leader re-established.

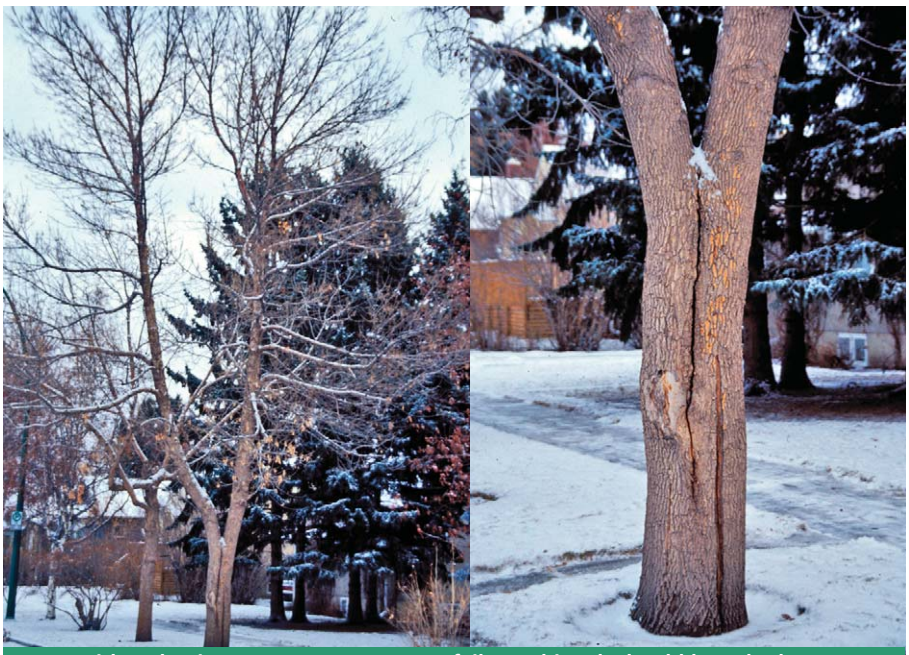
Step 3: Select the lowest permanent branch. The lowest permanent branch, or lowest scaffold branch, is the lowest branch attached to the trunk that will remain on the tree throughout its lifetime. The position, or height, of the lowest permanent branch is determined by the location and use of the tree. For street trees, the lowest permanent branch over the sidewalk may be 8 feet, while it should be at least 14 feet over the street. Branch heights for street trees are often mandated by local ordinance.

For trees in parking strips, the lowest permanent branch may be 6 or 7 feet if it is positioned parallel to the parking strip. The lowest permanent branch for trees in parks or yards often will be lower than that of street trees, but this will depend on the specific use and maintenance considerations.

Look for a vigorous branch with a strong attachment that meets the height requirement. Its stem diameter should be one-half or less of the trunk diameter where the branch attaches to the trunk. You may want to label or tie a piece of string on this branch so you know that it has been selected as the lowest permanent branch for identifying it later. If the tree is too short to select a branch at the desired height, then you'll have to wait until the tree grows taller (see Step 5).

Smaller "temporary" branches should be left close to the lowest permanent branch. Larger temporary branches should be pruned back to one or two buds.

Step 4: Select scaffold branches and cut back or remove competing branches. Scaffold branches are the permanent branches of the tree that constitute much of its framework. Scaffolds are lo-



Trees with codominant stems are prone to failure. This ash should have had one stem removed when it was young.

The leader is the central stem of the tree. When following the trunk from the ground to the top, only one leader should be found. If codominant stems are found, one stem should be cut back or removed.

Temporary branches are not trivial

Temporary branches remain on the tree during the first few years of its life and are then removed. These branches are important because they provide photosynthate for trunk growth and taper development, shade the trunk (particularly on the afternoon equator side) and reduce the risk of tree damage due to vandalism.

When possible, leave temporary branches on the trunk and between scaffolds. In many cases, it is useful to shorten their length to two to four buds and keep them cut back during the growing season. Less vigorous twigs are preferred as temporaries rather than more vigorous branches. However, if more vigorous branches remain as temporaries, prune them to within 1 foot of the trunk.

When assessing whether branches should remain as temporaries or be removed, keep in mind that when training is complete, approximately one-half of the foliage should be on the branch extending from the lower two-thirds of the tree's height. In order to achieve this distribution, it may be important to leave certain branches as temporaries, particularly lower ones.

cated above the lowest permanent branch and are selected based on spacing and size. Remove branches that have weak attachments, such as those with included bark (photo, page 26). These should not be used as scaffolds.

Vertical spacing between scaffolds should be 15 inches or more for trees that are expected to achieve a trunk diameter of 12 inches or more at maturity. For smaller trees with trunk diameters less than 12 inches at maturity, scaffold spacing of 12 inches or more is recommended.

Scaffold branches also should be spaced radially around the trunk, like spokes in a wheel. This vertical and radial spacing of the scaffolds gives the tree good balance and form. Select scaffold branches starting with the lowest permanent branch and proceed up around the trunk. If the selection of scaffolds is made difficult because of the selection of the lowest permanent branch, then it may be better to see which vertical and radial selection will give the best total arrangement. In some cases, it will be necessary to go back to Step 3 and reselect the lowest permanent branch based on the best combination of scaffolds.

Selected scaffolds should have strong attachments. Branch diameter should be no more than one-half the diameter of the trunk at the point of attachment. Remove branches that are close to the scaffolds — within 4 inches — and are of equivalent size. If competing branches are needed to maintain canopy size, reduce their size by 50 percent or more. Leave small diameter branches as temporaries (see Step 5).

Keep in mind that, as the tree grows, branch size and the space it occupies changes, and you may find some branches are no longer suitable as scaffolds. In this event, a scaffold may need to be removed; for example, it has grown too large and is crowding other branches, or a new scaffold may need to be selected. Be prepared to re-evaluate scaffold selection as the tree develops.

Step 5: Select temporary branches below the lowest permanent branch. Some or all of the branches located below the lowest permanent branch can be retained as temporary branches. Remove branches that have a diameter greater than one-third the diameter of the trunk at the point of attachment. Shorten the length of temporaries to two to four buds (sidebar, page 24).

How much to prune. Generally, no more than 25 percent of a young tree's canopy should be removed in any one year. In many cases, removing only 5 or 10 percent of the canopy will be sufficient to develop good structure and form, such as for trees with an excurrent form like *Liquidambar styraciflua* (sweet gum). In other cases, the removal of more than 25 percent may be necessary. For instance, if significant defects have occurred, such as codominant stems or weak attachments, a large branch or stems representing more than 25 percent of the canopy may need to be removed. Particularly vigorous trees, such as species of elm, maple or acacia, may require more aggressive pruning to achieve branch spacing recommendations.

Suggested remedies for common problems

Leader

Problem: The leader is broken or cut.
Remedy: Avoid nursery stock that has been headed and has not had a central leader re-established. If the leader was cut or broken after being planted, then a new leader should be established. Select the most vertical branch that is large enough to develop as a leader. The new leader may need to be held in a vertical position. If this is the case, tape the leader to an adjacent branch or tie it to a nursery stake. If the leader is broken, you may be able to cut the remaining portion back to an upright-directed bud.

Problem: Two stems are in the leader position. One is more vigorous, while the other is straighter (more vertical).
Remedy: This is a difficult choice. Select the more vigorous stem if it looks like it will grow in an upright position (when the other stem is removed). Otherwise, choose the straighter stem.

Problem: The leader is bent.
Remedy: If the bend is not severe, leave it alone and the stem will probably straighten itself. If it needs to be straightened, use two stakes placed on either side of the tree and tie the leader in an upright position between the stakes. Ties should allow the leader to move in the wind. In some cases, a single, lightweight stake, such as bamboo, can be tied to the central leader to hold it in a vertical position (photo, page 26). If staking will not straighten the leader, cut it back to a bud that will develop in an upright position. Prune in the summer to direct new growth.

Lowest permanent branch

Problem: The tree has not developed branches above the minimum height, such as at 8 feet for the lowest permanent branch over a sidewalk.
Remedy: Wait until next year or the year after for the tree to grow taller. Be sure the central leader is well-established; it will give rise to the lowest permanent branch. Keep lateral branches (temporaries) that are below the minimum height pruned back to encourage height growth.

Problem: Several branches of equivalent diameter occur at the position selected for the lowest permanent branch.
Remedy: Select the most vigorous branch that is growing in the desired direction. It should have a strong attachment and a diameter that is no more than one-half the trunk diameter. Remove competing branches, or reduce their length by 50 percent or more to use as temporaries.

Scaffold branches

Problem: The best scaffold branches are on one side of the tree.
Remedy: Try to invigorate smaller branches on the other side by removing or reducing the size of existing branches. Develop the leader to encourage branch development on the desired side. Remove or cut back competing branches.

Problem: Potential scaffold branches are spaced closely on the trunk and leader.
Remedy: Select a vigorous branch that has a strong attachment and is in a desirable position. Remove competing branches, or reduce their length by 50 percent or more and use as temporaries.

Temporary branches

Problem: It's difficult to decide whether a branch should be left on as a temporary or be removed.
Remedy: Remove the branch if it is greater than one-third the diameter of the trunk at the point of attachment and is located close to a permanent branch. If it is not too large and is not interfering with the development of permanent branches, then retain it as a temporary. Cut it back to slow growth. It may need to be removed the next year or later.

When to prune. Both deciduous and broadleaf evergreen trees should be trained primarily in the winter months when the trees are dormant. This is a time when minimal physiological activity and pruning will have the least impact on subsequent growth and development.

However, dormancy periods change with location and species. For instance, the dormancy period in much of California is from December to February for most species. In Maine, many species are dormant from November to March. At the earliest, wait until the leaves have fallen to prune deciduous trees. At the latest, prune well before buds swell and new leaves begin to develop in the spring for both deciduous and broadleaf evergreens.

Pruning during the growing season may be needed to direct growth, to control watersprouts or suckers, or to remove diseased wood, insect-infested wood or growth obstructing signs, windows or passageways. This pruning should be kept to a minimum so as not to unnecessarily reduce tree growth and development. In some cases, pruning during the growing season should be avoided entirely for pest management reasons, such as to avoid attracting bark beetles.

For trees with a tendency to develop suckers, it will be important to remove the suckers during the growing season, particularly those within 6 inches of the ground.

During the first year after planting, the amount of pruning can vary with nursery stock: container, bareroot and B&B. For all types, it is recommended that steps 1 and 2 be applied. For container stock, steps 3 and 4 can be applied if tree size is sufficiently large. For bareroot and B&B stock, minimal pruning is recommended, and steps 3 and 4 can be delayed to the following year. For all stock types, temporary branches along the trunk should be retained and cut back (Step 5).

The five steps can be applied to conifers, but with some modifications. Steps 1 and 2 are important. Damaged branches and competing leaders need to be removed. Step 3 will be important depending on tree location. If clearance is needed for vehicles, equipment or people, then Step 3 should be applied. Step 4 is not as important for conifers as for hardwood species. In many cases, this step can be bypassed entirely. However, look for and remove branches with weak attachments. Step 5 will be needed if a lowest permanent branch is established.

A single, lightweight stake can be used to straighten a bent leader. Bamboo is being tied to the central leader of a young oak.

Avoid branches with weak attachments, such as those with included bark. The branch on the left should be removed.

Species and conditions vary considerably, and you will always need to use good judgment. Understand the rationale for each of the five steps and make reasonable adjustments in the field.

What to do next year. You probably won't be able to develop the tree's permanent framework (central leader and scaffold branches) in the first year. You may not even be able to select the lowest permanent branch or the scaffolds. Pruning in subsequent years will be needed in almost all cases. This pruning simply involves applying the five steps as done in the first year. Plan to go through the steps each year until good structure and form are achieved.

Field practice. It is very important to practice the five steps before applying them. Review each step with a coworker before making cuts. Tie a string or ribbon around the leader, the lowest permanent branch and the scaffolds. Discuss reasons for your selections and step back to evaluate potential impacts on tree form and size. After you are confident in your selections, make your cuts. Again, step back from time to time to assess changes in canopy size and form.

Remember that species and conditions vary considerably, and you will always need to use good judgment. Understand the rationale for each of the five steps and make reasonable adjustments in the field.

Laurence R. Costello is the environmental horticulture advisor for the University of California Cooperative Extension, San Mateo-San Francisco Counties.

References.

ANSI A300 (Part 1). 2001. "American National Standard for Tree Care Operations — Tree, Shrub and Other Woody Plant Maintenance — Standard Practices (Pruning)." American National Standards Institute.

Costello, Laurence R. 1999. "Training Young Trees for Structure and Form." University of California Agriculture and Natural Resources Video V99A.

Gilman, Edward F. 1997. "Trees for Urban and Suburban Landscapes: An Illustrated Guide to Pruning." Delmar Publishers.

Harris, Richard W. 1992. "Arboriculture: Integrated Management of Landscape Trees, Shrubs and Vines." 2nd Edition. Prentice Hall.

Harris, Richard W.; James R. Clark; and Nelda P. Matheny. 2004. "Arboriculture: Integrated Management of Landscape Trees, Shrubs and Vines." 4th Edition. Prentice Hall.

Shigo, Alex L. 1989. "Tree Pruning: A Worldwide Photo Guide." Shigo and Trees.