



# Best Practices for Root Pruning

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## Learning Objectives

- Review the two styles of root pruning and how to execute each with minimal harm.
- Understand the long-term effects of root pruning and how they can negatively affect tree health and stability.
- Learn how to properly care for root-pruned trees to increase their chances for full recovery.

CEUs: A, U, M, T, L, Bm, Bp

## Root Pruning

Ideally, tree roots should not be cut when there are other options for management. Roots are typically pruned when they interfere with existing or proposed infrastructure, to limit the spread of vascular disease, or to correct defects that affect tree health or stability. Infrastructure damage includes lifting of sidewalks, creating tripping hazards or limiting access; damaging building or wall foundations; plugging sewer pipes; and disrupting underground utilities. Much root cutting occurs on construction sites during excavation for foundations, installation of underground utilities, and changes to the grade. The spread of vascular diseases, such as oak wilt and Dutch elm disease, can be limited when root connections between adjacent trees are cut. Tree health and stability concerns include assessment of root decay, stem girdling roots, and circling roots.

The consequences of root pruning have not been well studied. Small-diameter root cuts and damage that is limited to root sapwood are thought to compartmentalize well and do not usually lead to extensive decay. When larger roots are cut and heartwood is exposed, decay is more likely to develop. The resulting decay can affect root strength years or decades later in temperate climates. Other factors that can affect decay spread are tree and fungus species, the distance of root cuts from the trunk, and soil moisture and temperature.

There are two general methods used for cutting roots. First is selective root pruning, which involves locating and exposing roots, then making targeted pruning cuts.

The second is nonselective root cutting, which involves mechanical excavating or trenching the soil along a pre-determined line and indiscriminately severing the roots.

Both selective root pruning and nonselective cutting can cause great harm to a tree, especially if key structural roots are affected. Damage may reduce tree health and/or structural stability. To minimize tree health impacts, when roots must be pruned, they should be cut as far from the trunk as is practical.

In some situations, an alternative to cutting through the entire root may be to shave the top of the root. While not a preferred option, root shaving is occasionally done when roots are lifting pavement and new pavement needs to be installed above the offending roots. If roots are to be shaved, the amount of wood removed should be kept to a minimum to achieve the goal, but no more than one-third of the diameter of the root should be removed. Shaving into heartwood and creating sharp angle cuts should be avoided. Root shaving is not a permanent solution to pavement lifting. Future radial growth of the root and woundwood can result in the reoccurrence of lifting. A layer of foam may be installed over the top of the shaved root to increase the time before lifting reoccurs. While root shaving may be less damaging than root cutting, decay fungi may infect these wounds.

Objectives of root pruning or nonselective cutting should be determined with the client and stated in the scope of work or contract. Common objectives include mitigation of root defects (e.g., stem girdling roots), preparing for soil excavation, and removing roots to minimize infrastructure damage.

## Selective Root Pruning vs. Nonselective Root Cutting

Selective root pruning starts with soil excavation and root exposure, followed by the cutting of individual roots. Excavation prior to root pruning allows the arborist to examine the roots and determine the best location to make pruning cuts, preferably beyond (distal to) sinker roots or outside root branch unions (Figure 1). This can make it possible to cut fewer roots or to make several

smaller cuts instead of a single larger-diameter cut. Tools used should be selected based on the root diameter and location. They include hand pruners (secateurs), chisels, loppers, hand saws, reciprocating saws, oscillating saws, and small chain saws.

Just as flush cutting branches is not an acceptable practice, a pruning cut that removes a root at its point of origin should not cut into the parent root. Root pruning cuts should be made cleanly using a sharp tool appropriate for the root diameter, leaving a clean cut that is perpendicular to the direction of growth, with the bark intact.

Nonselective root cutting is less targeted than selective root pruning. Usually, root cutting is the result of trenching or soil excavation that does not intentionally target tree roots. Rather, it is done to install pipes or wires in a trench, to change soil grade for construction, or for sidewalk or pavement removal or replacement. Unfortunately, most equipment operators are not aware of the tree damage being inflicted during these operations. However, once trained, a capable excavator operator can minimize root damage.

Regardless of the reason for nonselective root cutting, it is better to use specifically designed mechanical root-pruning tools (e.g., Vermeer, Imants, or Dosko root pruners) to provide moderately clean root cuts. When tools not specifically designed for root cutting, such as trenchers, excavators, and backhoes, are used, they result in torn, splintered, and crushed roots; thus, they are the least preferred. Cutting a line with a root pruner on the tree side of the excavation line prior to excavation can limit this type of damage.

If roots are not cut prior to excavation, any exposed root ends over 1 in (2.5 cm) in diameter should be pruned beyond the damaged area rather than left torn or crushed. The final root cut should result in a flat surface with the adjacent bark firmly attached. Exposed roots should be shaded and kept moist, such as by using moist burlap.

### Stem Girdling Roots

Stem girdling roots (SGRs) are roots that grow around or across the base of the trunk (Figure 2). They often originate inside a nursery container when the stem is buried and roots grow to the container wall, then turn and continue growing in a circular orientation. If not eliminated at planting, these roots often persist after installation in the landscape. SGRs have also been associated with excessive soil over the root system in the root collar area. SGRs can originate as existing nearly perpendicular branches of radial lateral roots whose growth increases after the radial root is cut (similar to a lateral branch growth increasing when the terminal is cut). Certain species seem to be naturally prone to developing girdling roots (e.g., maples



Figure 1. Selective root pruning consists of soil excavation prior to root pruning to determine the best places to make cuts (right). Nonselective root cutting is less targeted, usually causing root damage as the result of trenching or soil excavation that does not intentionally target tree roots (left).

[*Acer* spp.], hackberry [*Celtis* spp.], linden [*Tilia* spp.], elms [*Ulmus* spp.], and *Zelkovas* spp.). SGRs are so common on Norway maples (*Acer platanoides*) that fewer are being planted.

SGRs will typically cause a gradual decline in health, though they can lead to sudden failures during wind-loading events. Aboveground decline symptoms of SGRs include small leaves, early autumn color, gradual reduction of terminal growth, dieback of branches in sections of the canopy, and partial or total absence of a root flare. SGRs can restrict vascular transport by constricting phloem tissue and sapwood.

The treatment for SGRs is selective pruning of the offending roots. Some amount of root collar excavation (RCX) may be necessary to expose the SGRs. Pruning is commonly done with loppers, chisels, oscillating saws, hand saws, or small chain saws. Roots should be cut on both sides of the area being girdled. Roots that encircle or fully girdle the trunk should be removed before they are engulfed by trunk tissue if possible. Grafting between roots and trunk tissue is rare because the bark on both root and trunk creates a barrier between the cambium layers. When pruning a girdling root, care should be taken not to damage trunk tissue.

Removal of SGRs results in the loss of a portion of the root system and a corresponding reduction of water and nutrient supply to the crown. As a general rule, if the girdling root is more than one-third of the diameter of the stem, its removal will impact tree health and can even result in whole tree mortality. Therefore, if one or more large girdling roots are present, consider progressive root



Figure 2. Girdling is the term used to describe roots that encircle, confine, or limit the growth of the trunk or other root. Stem girdling roots (SGRs) are roots that girdle the base of the trunk.

pruning over a specified period of time. This may involve starting with a notch cut one-third to one-half of the way through a girdling root to slow its growth and to relieve the pressure on stem tissues. After a year or more, the notch may be enlarged to further slow the root growth or the root can be entirely severed.

Although there is the potential for SGR removal to induce temporary physiological stress, the condition of the tree can improve over time as the vascular constriction is overcome with the addition of new tissue. Fertilization and crown pruning are not substitutes for SGR removal. If stem tissue remains in contact with soil after SGR removal, SGRs can recur. Maintaining a soil- and mulch-free root collar area will minimize the growth of a new SGR.

### Long-Term Effects of Root Pruning

Root pruning reduces the root system's capacity to absorb water and nutrients, which can create water stress and initiate tree decline. Root loss can impact tree vitality due to a loss of stored energy and hormone synthesis. The crown can respond with less growth or, in more severe cases, branch mortality. Older trees may be more severely affected than established younger trees.

Root loss can be considered temporary when cut roots are able to regenerate and eventually replace lost root function. However, species vary in their ability to recover from such temporary root loss. For instance, post oaks (*Quercus stellata*) are notorious for their poor recovery from this type of injury, while many species of *Ulmus*, *Platanus*, and *Robinia* can respond well to root injury.

If root space is permanently lost (e.g., from lowering the grade or construction of a structure or nonporous pavement in the root zone) after root pruning, then the

root system cannot be replaced in that area, and stress and stability concerns may never be overcome.

### Consequences of Root Pruning on Tree Health and Stability

When root cuts are necessary, they should be as far from the trunk as possible. Tree response to root cuts is dependent on tree species, age, condition, root configuration, and soil characteristics, including the presence of underground root obstructions.

Cutting roots closer than six times diameter at breast height (DBH) on one side of the tree can cause sustained and chronic water-stress symptoms in some species (Figure 3). This stress in turn can lead to other tree health problems, such as increased susceptibility to pests and diseases, drought, or other environmental pressures.

When cuts are made closer to the trunk, stability and health may be compromised and should therefore be avoided. Tree stability has been found to be compromised on some species when cuts are made within three times the trunk diameter from the trunk.

For most species, when roots are cut closer than one- to one-and-a-half times the DBH distance from the trunk, a serious reduction in stability can occur and long-term health and survival will be impacted. Should large roots be cut that close to the trunk, it may be better to remove the tree rather than preserve it. If the tree is retained, monitor the structural stability, and maintain a safe zone around the tree. Maintain tree health with good arboricultural practices, such as additional watering and soil amending, to improve root health.

### New Root Growth

When woody roots are cut, numerous adventitious roots may be initiated at, or just behind, the cut surface. In unrestricted areas, these roots typically elongate in the same direction as the original root. The rate of growth is affected by the environment and available resources from the tree. Annual root extension depends on species, soil moisture, soil density, and temperature. For example, in the upper midwestern United States (USDA Hardiness Zone 5, min. temperatures to  $-20^{\circ}\text{F}/-29^{\circ}\text{C}$ ), with moderate summers and frozen soils in winter, typical annual root elongation is about 18 in (45 cm), and in a subtropical climate (USDA Hardiness Zone 9, min. temperatures to  $20^{\circ}\text{F}/-7^{\circ}\text{C}$ ), annual root growth is 6 ft (2 m) or more. Root growth rates can also depend on tree species. The number of years required to replace lost roots can be calculated as the estimated length of roots lost divided by the estimated annual growth extension in that hardiness zone. Trees with damaged root systems usually benefit from supplemental irrigation and mulch over the remaining roots during periods of drought, until the lost root function is replaced.

Cut palm roots frequently sprout and branch into a network of roots. In tropical regions where temperatures, humidity, and moisture are not limiting, palm roots emerge and grow year-round, sometimes in distinct flushes. For example, in regions with distinct growing seasons, such as the southwestern United States, roots grow mostly during the warmer months and when there is adequate rain or irrigation water.

### Root Growth Stimulants

Many kinds of root-stimulating products have been marketed over the years. Possible treatments include vitamin compounds, seaweed extracts, growth hormones, plant growth regulators, auxin, carbohydrates, and mycorrhizal fungi.

The effectiveness of many of these products in stimulating root growth has not been consistently shown in landscape situations or by research. If testing the products on your own, be sure to include untreated plants for a comparison to judge whether they are really effective. Usually, other cultural treatments, such as mulching, organic-matter incorporation, and fertilization, can provide greater benefits.

### Care of Root Pruned Trees

Trees that have sustained root loss should be monitored regularly for symptoms of stress, insects, pathogens, and decline. Monitoring should continue for up to five years because visible symptoms of stress may not develop right away. If root loss occurs while the tree is in leaf, signs of water stress, such as early seasonal leaf color change, defoliation, dull or drooping leaves and branch tips, and scorched leaf margins, may develop in the same season. Other symptoms of stress, such as reduced twig elongation and leaf size, will not be evident until the next growing season. Trees responding to root loss will often leaf out late, develop open and sparse canopies, have atypically sized leaves, and may show premature leaf loss.

Following root pruning, cultural practices that minimize stress should be implemented to avoid secondary problems and promote root development. Most importantly, soil should be kept moist (but not saturated) throughout the root zone. More frequent irrigation might be needed during hot, dry periods. Eliminating turfgrass and applying a 2 to 4 in (5 to 10 cm) layer of organic mulch will help to reduce competition for soil moisture and minimize evaporative water loss.

If a nutrient deficiency is suspected, a soil or foliar sample should be collected and analyzed before fertilizer is applied (Smiley et al. 2020). In the absence of a deficiency, fertilization will not substantially increase root development.

In cases of extreme root loss, tree removal or tree height reduction may reduce the likelihood of root-related

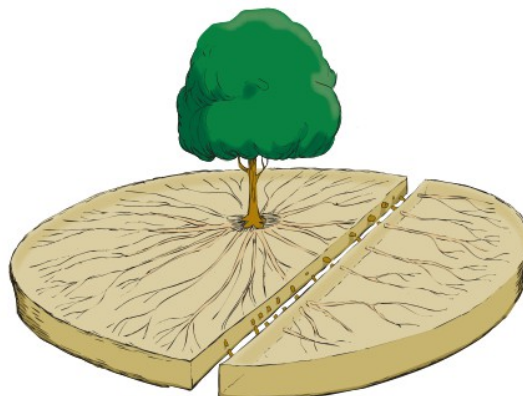


Figure 3. Root loss can affect tree health and stability. Cutting roots at a distance greater than six times the trunk diameter (DBH) minimizes the likelihood of affecting both health and stability. At this distance, approximately 25% of the root system would be lost. Since many landscape trees do not have the even distribution of roots shown in this illustration, the percentage cut at this distance may be more or less than calculated.

whole tree failure. If branch dieback is evident, pruning may be required. Advanced root or stability assessment should be recommended when appropriate.

### Literature Cited

Smiley ET, Werner L, Lilly SJ, Brantley B. 2020. *Tree and shrub fertilization*. 4th Ed. Best Management Practices. Atlanta (GA, USA): International Society of Arboriculture. 57 p.

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A passing score for this quiz, **Best Practices for Root Pruning**, requires sixteen correct answers. Quiz results will display immediately upon quiz completion. CEU(s) are processed immediately. You may take the quiz as often as is necessary to pass.

CEUs: A, U, M, T, L, Bm, Bp

- Factors that can affect the spread of decay in roots that have been cut include:
  - Tree species
  - Exposed heartwood
  - Soil temperature
  - All of the above
- Nonselective root pruning indiscriminately severs roots along a predetermined line and can cause great harm to a tree, whereas selective root pruning is a safe method because it targets specific roots for pruning.
  - True
  - False
- Root damage that is limited to the \_\_\_\_\_ generally compartmentalizes well.
  - taproot
  - heartwood
  - sapwood
  - fine feeder roots
- When shaving roots, what is the maximum amount of wood that should be removed?
  - 1/4 of the root diameter
  - 1/3 of the root diameter
  - 1/2 of the root diameter
  - 1/5 of the root diameter
- Root shaving is a \_\_\_\_\_ solution to pavement lifting.
  - permanent
  - non-damaging
  - temporary
  - long-term
- How should a pruning cut be made to remove a root?
  - The cut should be flush to the point of origin.
  - The cut should be perpendicular to the direction of growth.
  - The cut should be made using whatever tools the arborist has on hand.
  - The cut should be made at a slight angle.
- When cutting roots, it is better to avoid tools not specifically designed for the task, such as:
  - Trenchers
  - Backhoes
  - Root pruners
  - Both a and b
- It is important to keep any exposed roots \_\_\_\_\_.
  - dry
  - shaded
  - moist
  - Both b and c
- Stem girdling roots (SGRs) are often associated with \_\_\_\_\_.
  - circular root growth inside a nursery container
  - excessive soil in the root collar area
  - Acer platanoides*
  - All of the above
- The negative symptoms of an SGR cannot be mitigated by \_\_\_\_\_.
  - fertilization
  - removal of the SGR
  - progressive pruning of the SGR
  - None of the above
- It is not possible for SGRs to recur after their removal.
  - True
  - False
- Root cuts should be made \_\_\_\_\_.
  - at least two times DBH from the trunk
  - as far from the trunk as possible
  - at least three times DBH from the trunk
  - as close to the trunk as possible
- About \_\_\_\_\_ of a tree's root system can be lost if cuts are made within six times the trunk's DBH.
  - 15%
  - 25%
  - 30%
  - 45%
- Adventitious roots typically grow \_\_\_\_\_ the root from which they originate.
  - perpendicular to
  - straight down from
  - in the same direction as
  - around
- How many years would it take for a tree growing in a subtropical climate to replace 25 ft (7.5 m) of roots?
  - Approximately 4 years
  - Approximately 6 years
  - Approximately 10 years
  - Approximately 15 years
- Which of the following treatments does NOT usually provide greater benefits for root growth?
  - irrigation
  - mulching
  - fertilization
  - root stimulants
- Trees should be monitored for up to \_\_\_\_\_ following root loss.
  - 1 year
  - 3 years
  - 5 years
  - 10 years
- Symptoms of stress from root loss can occur during \_\_\_\_\_.
  - the same season
  - the dormant season
  - the following growing season
  - Both a and c
- Fertilization will NOT substantially increase root development in cases where \_\_\_\_\_.
  - the tree is not experiencing a nutrient deficiency
  - the tree is deficient in more than one nutrient
  - the tree is already showing signs of stress
  - the tree is receiving supplemental irrigation
- Symptoms of root loss include:
  - Atypical leaf size
  - Sudden new growth
  - Dense and crowded canopies
  - Development of SGRs