Root Problems

Root problems = inadequate anchoring by the root system, damaged roots, or stem-girdling roots.

When a tree has extensive root damage, the whole tree usually tips over and falls to the ground because the roots can no longer provide adequate anchoring. Roots can be lost due to excavation, trenching, soil compaction, grading, paving, fungal decay, or environmental stress, such as drought or flooding. See Figures 3.70 through 3.76.

Figure 3.70. *Failure of root system to anchor the tree.*

Figure 3.71 - 3.76. *Roots can be lost due to excavation, paving, soil compaction, regrading, trenching, and root decay.*

Common symptoms of root problems include: decline or dieback symptoms in the crown, dead roots, missing roots, broken roots, decayed roots, leaning trees, and presence of fungal fruiting bodies at the root collar. See Box 11: Crown decline.

BOX 11

Crown decline

Trees maintain a dynamic equilibrium between their live branches and their roots. When the equilibrium is disrupted by root disease, root decay, or root loss, decline symptoms appear in the branches. The loss of essential roots is followed by the decline and dieback of twigs and branches. If too much of the root system is lost, the crown will decline and the tree will die or it will fail. See Figure 3.77.

Figure 3.77. *Crown decline is a symptom of extensive root system loss*

Serious root problems become apparent when a tree develops a new or abnormal lean. See Figure 3.78. In these cases, a portion of the root system failed and the tree started to tip over but the tree was stabilized, at least temporarily, by the remaining root system. Newly leaning trees are often accompanied by soil mounding, soil cracking, root lifting, or root breakage near the stem on the far side of the lean. See Figures 3.79 through 3.82. A tree with a new lean may indicate a high risk of failure. Trees with an established, stabilized lean are discussed further in the section on Poor Architecture.

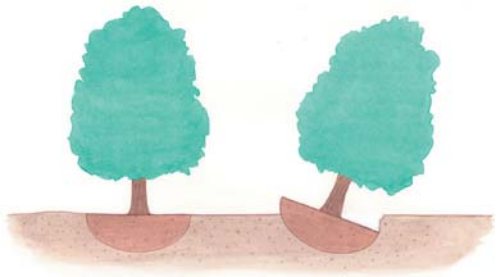
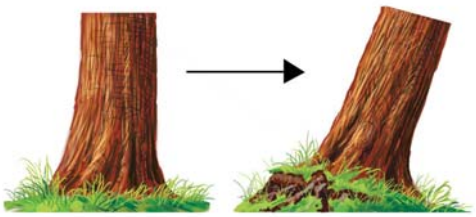


Figure 3.78. *Root system failed to anchor tree and tree developed a "new lean." Look for soil mound, soil cracking near root collar, or broken roots sticking out of the soil.*

Figure 3.81. *A leaning tree that also had advanced decay in the root collar.*

Figure 3.82. *Exposed roots on tree that failied.*



Figures 3.79-3.80. *A leaning tree with a soil mound at the base of the tree.*

Sometimes it is obvious that trenching, paving, grading, or soil compaction occurred. See Figures 3.83,3.84, and 3.85. To determine how much damage the root system did sustain, estimate how much of the critical rooting area was damaged based on the pattern of damage. Critical rooting area is defined by the Critical Root Radius (CRR). See Box 12: Critical Root Radius. The CRR is a circular area around the stem of the tree, usually larger than the area defined by the tree's dripline. A tree is adequately anchored when the roots inside the area defined by the CRR are sound and alive. Up to 40 percent of the root system can be damaged before anchoring is seriously impaired, but some tree species are more susceptible to root loss than others. See Table 3.4: Tree characteristics. You may want to consider larger CRR's for sensitive trees.

Figures 3.83-3.84. *To estimate how much root damage was sustained, determine how much of the Critical Root Radius was disturbed.*

Figure 3.85. *Recent construction on three sides of this tree reduces anchoring ability of roots.*

BOX 12

Critical root radius

The CRR is used to define the portion of the root system nearest the stem that is critical for the stability and vitality of the tree. It is a circular area defined as CRR = DBH x 1.5 foot per inch. This area is usually beyond the dripline of the tree. The CRR can be used for narrow-canopied trees as well as open-grown trees. (Miller et al 1995, Matheny and Clark 1991) See Figure 3.86.

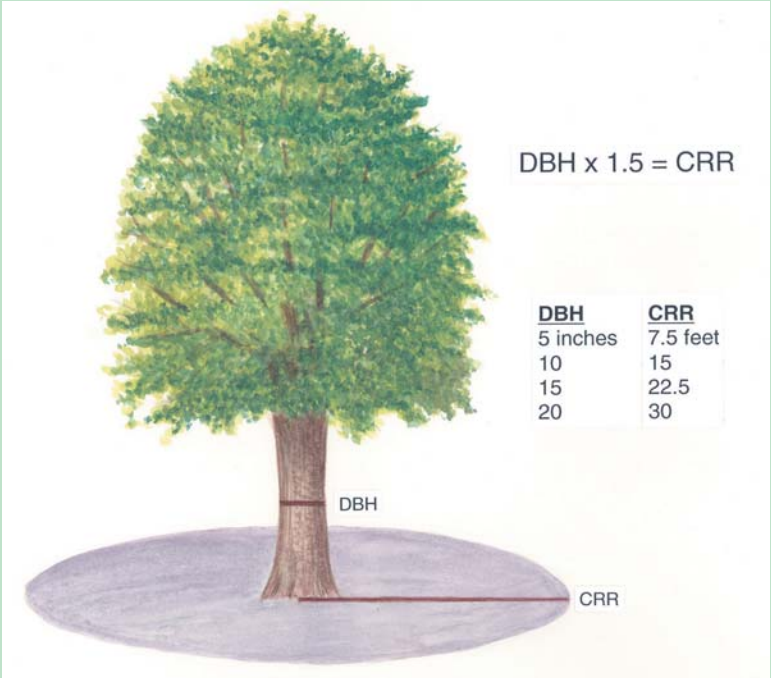


Figure 3.86. *Use the Critical Root Radius to estimate the extent of damage to a tree's root system. Up to 40 percent of the area can sustain damage before anchoring is seriously impaired.*

Table 3.4. Tree characteristics.

Species	Root severance	Soil compaction & flooding	Mature crown spread
Northern white cedar	Tolerant	Tolerant	10-20 feet
Balsam fir	Tolerant	Tolerant	20-35
White fir	Tolerant	Sensitive	10-20
Tamarack	Tolerant	Tolerant	15-25
White pine	Tolerant	Sensitive	50-80
Jack pine	Tolerant	Sensitive	20-30
Red pine	Tolerant	Sensitive	20-40
Scotch pine	(Tolerant)	(Sensitive)	30-50
Eastern redcedar	Tolerant	Sensitive	10-20
Black spruce	Tolerant	Tolerant	15-30
Colorado spruce	Intermediate	Tolerant	20-30
White spruce	Tolerant	Intermediate	20-30
Black ash	Tolerant	Tolerant	30-60
Green ash	Tolerant	Tolerant	30-50
White ash	Tolerant	Intermediate	50+
Bigtooth aspen	Tolerant	Sensitive	20-35
Quaking aspen	Tolerant	Sensitive	20-35
Blue beech	Sensitive	Sensitive	15-20
Paper birch	Intermediate	Sensitive	30-50
River birch	Tolerant	Tolerant	30-50
Yellow birch	Intermediate	Sensitive	25-50
Boxelder	Tolerant	Tolerant	35-50
Ohio buckeye	Intermediate	Intermediate	30-40
Butternut	Sensitive	Intermediate	50-60
Catalpa	Intermediate	Tolerant	30-50
Black cherry	Intermediate	Sensitive	40-50
Kentucky coffeetree	Intermediate	Intermediate	40-50
Eastern cottonwood	Tolerant	Tolerant	80-100
Red-osier dogwood	Tolerant	Intermediate	10-12
American elm	Tolerant	Intermediate	70-150
Slippery elm	(Tolerant)	(Intermediate)	40-60
Hackberry	Tolerant	Intermediate	50+
Hawthorn	Intermediate	Intermediate	20-30
Bitternut hickory	Intermediate	Intermediate	30+
Honeylocust	Tolerant	Intermediate	50-75
Ironwood	Sensitive	Sensitive	20-30
Basswood	(Intermediate)	Sensitive	50-75

Species	Root severance	Soil compaction & flooding	Mature crown spread
Black locust	Tolerant	Sensitive	20-50
Red maple	Tolerant	Tolerant	40-60
Silver maple	Tolerant	Tolerant	75-100
Sugar maple	(Intermediate)	Sensitive	60-80
Mountain ash	Tolerant	Intermediate	15-25
Black oak	Sensitive	Sensitive	50-70
Bur oak	(Tolerant)	Intermediate	40-80
Northern pin oak	Sensitive	Sensitive	30-50
Red oak	Tolerant	Sensitive	40-50
Bicolor oak	(Intermediate)	Tolerant	40-50
White oak	Sensitive	Sensitive	50-90
Wild plum	Tolerant	Sensitive	15-25
Serviceberry	Intermediate	Sensitive	6-15
Black walnut	Sensitive	Intermediate	60-100+
Black willow	Tolerant	Tolerant	20-40

In other cases, particularly for root decay, it is difficult to see the pattern of damage in the root system. Another means to assess the soundness of the main roots is to use a metal probe to locate and test them for the presence of advanced decay. See Figure 3.87. At least 60-70 percent of the buttress and main roots need to be sound in order to have the tree adequately anchored (Mattheck and Broeler, 1994).

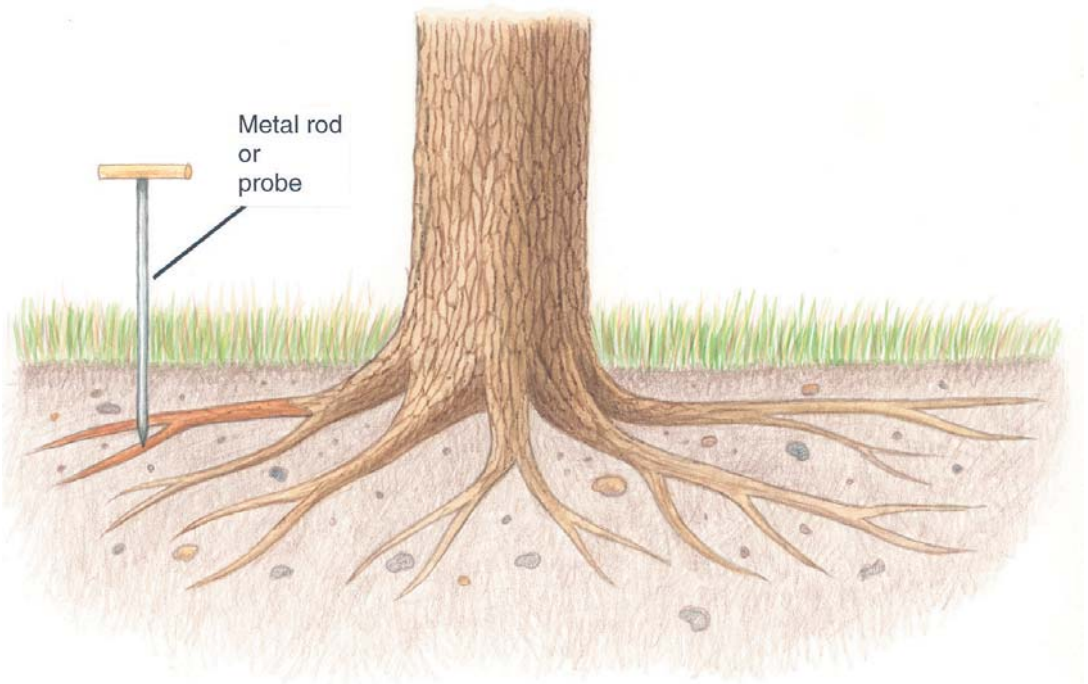


Figure 3.87. *Use a metal rod as a probe. To ensure that a tree is adequately anchored, 60-70 percent of its main roots must be sound.*

A tree may have a restricted root system which can compromise the tree's stability and vigor. Site conditions that restrict root systems are: shallow soils, compacted clay soils, saturated soils, or confined rooting areas e.g. sidewalks, buildings. See Figures 3.88 through 3.90. Due to the asymmetrical nature of restricted root systems, these trees may be at more risk than their normally-rooted counterparts. See Box 13: Restricted root systems. If new curbs or sidewalks were installed or trenches dug for utility installation, roots are more likely to be damaged or removed during the construction process. See Figures 3.91 through 3.94. Even though the trees' vitality may recover over time, the trees are highly unstable for many years due to their asymmetrical and reduced root systems. In root-restricting locations, roots are much more critical for anchoring and stability. Here, any root loss is significant. So if any of the main order roots inside the CRR are damaged or missing, the risk of tree failure is likely to be high.

Figures 3.88-3.90. *Restricted root systems will compromise the tree's stability and vitality.*

Figures 3.91-3.94. *Roots are often removed or damaged during construction.*

BOX 13

Restricted root systems

Roots of trees that have been bounded on at least two sides (e.g. by curb and sidewalk), have distinctively different growth patterns, as compared to open-grown trees. Root systems of open-grown trees are shallow (usually less than 3 feet in depth) and quite extensive (usually two to four times the height of the tree). Restricted root systems generally grow in a linear pattern, along the length of the boulevard lawn. See Figures 3.95 and 3.96. When roots grow in the direction of the sidewalks and curbs, their roots characteristically "turn" with the physical obstructions and grow parallel to them. Therefore, if a 20 inch dbh tree is growing in a boulevard site that is 5 feet wide and 60 feet long, the root system will be concentrated in that 5 foot x 60 foot rooting space.

Figures 3.95-3.96. *Root systems in restricted spaces have distinctly different growth patterns than those without barriers.*

Besides being restricted by shallow soils or concrete barriers, trees can be restricted by their own roots. See Figures 3.97 through 3.99. This condition is known as "stem girdling roots". Stem girdling roots are most commonly a human-caused problem. When a tree is planted too deeply, roots that encircle the stem can develop. Even as little as four inches of added soil can be too much. Over time, the encircling roots start compressing and killing the stem tissues below ground. Stem girdled trees most commonly break at a point just below the girdling roots. See Box 14: Stem girdling roots. Trees most commonly decline in health or suddenly fail in windstorms when stem compression reaches a point where more than 40 percent of the stem circumference is girdled. How to detect the presence of stem girdling roots is discussed later in this chapter: Tree risk inspections and use of specialized diagnostic tools.

Figures 3.97-3.98. *A tree can be restricted by its own roots when "stem girdling roots" encircle the stem.*

Figure 3.99. *Eventually trees with stem girdling roots fail due to extensive decay at the root collar.*

BOX 14

Stem girdling roots

There are probably several reasons why roots begin growing in an encircling pattern around stems: they are already present in pot-bound trees or they develop around trees planted in extremely compacted soil, trees planted too deeply or when roots hit solid obstructions in soil. See Figures 3.100. When the stem is buried, the encircling roots can survive and develop into stem girdling roots.

Figures 3.100. *Stem girdling roots develop when the tree is young and become a problem in a decade or two. If seedlings are pot-bound or planted too deeply, stem girdling roots can develop.*

Trees that are suffering from stem girdling roots exhibit some common symptoms: stunted growth, scorched foliage, abnormal leaning, lack of a characteristic trunk are, early leaf coloration and leaf fall, and vulnerability to secondary problems. See Figure 3.101. These symptoms are subtle and seemingly healthy trees can suddenly fail during windstorms. In storm damage surveys conducted in 1997-1998 by the University of Minnesota's Forest Resources Department, 30 percent of all landscape trees that failed in windstorms failed at the root collar due to stem girdling roots (Johnson 1999).

Figures 3.101. *Trees with stem girdling roots may show symptoms of crown decline, stunted growth, abnormal foliage, leaning, and lack of normal root flares.*

Root Problems

High risk of failure:

See Figures 3.102, 3.103, and 3.104.

- Leaning tree with recent evidence of root lifting, soil movement, or soil mounding.
- More than 40 percent of the roots within the CRR are damaged, decayed, severed, or dead.
- Stem girdling roots constrict more than 40 percent of the tree's circumference.

Moderate risk of failure:

- Less than 40 percent of the roots within the CRR are damaged, decayed, severed, or dead.

Figure 3.102. *High risk of failure: Leaning tree with recent evidence of root lifting, soil movement or soil mounding.*

Figure 3.103. *High risk of failure: Roots within CRR are more than 40 percent damaged, decayed, severed, or dead.*

Figure 3.104. *High risk of failure: Stem girdling roots constrict more than 40 percent of the tree's circumference.*

NOTES: