Severing Subterranean Stranglers: A Protocol for Managing Stem-Girdling Roots

Guy Meilleur

Modern nursery practices using containers and field production result in a substantial number of stem-girdling roots. These defects are seldom corrected before or during installation. Once the trees are established in the landscape, the root defects expand in size and severity. By reviewing the origin of these problems and the options for managing them, arborists can more successfully maintain tree health and stability.

"Root pruning is hard, dirty work, and the results are not always obvious, so it is usually discussed more than it is practiced" (Harris et al. 2004). After reading these discouraging-but-true words, it is no surprise that managing stem-girdling roots (SGRs) is not a popular topic. Nevertheless, arborists must identify and correct SGRs because they are the cause of many tree problems today. This article will address the what, why, who, where, when and how of managing stem-girdling roots, with the purpose of making the work easier, if not cleaner.

What Are Stem-girdling Roots?

Many SGR's were once small roots that hit the wall of a small container and elongated alongside it, innocent in appearance to most observers. If these roots are not straightened or cut in the nursery when trees are "stepped up"–transplanted into larger containers—this can result in a "multiple corkscrew" effect (Urban 2008). As both stem and root increase in diameter they come in contact, and the root constricts circulation as it girdles the stem (Figure 1). In field production, the European nursery standards specify root pruning at every step, 10–20 cm (4–8 in) further out each time (Watson and Himelick 2005).

Many North American nurseries also encourage a well-branched root system this way in both field and container production. The American Standard for Nursery Stock (anonymous 2004) currently does not discuss root pruning, but it does require that

Figure 1. When the severity of the problem is made visible, it is easier to understand the importance of inspection and correction of roots at planting time. Image Courtesy Nathaniel Sperry.

Guy Meilleur, Better Tree Care Associates.

the flare be the starting point for measuring both the height of the trunk (Section 1.1.1.2) and the depth of the root ball, and recommends that the soil above the flare be removed (1.6.3).

If the tree leaves the nursery with the flare buried, the transplanting standard calls for correction at planting time. ANSI A300 (Part 6)-2005 confirms that the rootball must be "measured from the bottom of the trunk flare to the bottom of the ball" (Section 63.6.1.2) and requires that "The bottom of the trunk flare SHALL be at or above finished grade" (Section 63.6.2.3, emphasis added)

Many tree planters do not find the flare, instead matching the soil line to grade and adding more soil and mulch to the stem. This practice may serve to guide roots upward and inward into nursery soil where oxygen and fertility levels may be higher than they are outside the prepared planting pit. These roots can girdle the stem as they elongate, with disastrous consequences. Trunk tissue is compressed, weakening the tree's structure at the tree's fulcrum (Figure 2). Nutrient flow through the phloem is slowed, weakening the tree's overall health (Costello et al. 2003; Urban 2008). There is currently nothing in either the Z60.1 or the A300 standard about the making sure major roots are growing away from the stem, although A300 standards on tree root care are being developed.

Figure 2. Compression over two buttress roots was relieved by severing one girdling root. Air excavation can dry out roots that are not threatening the stem. Soil should be replaced immediately after inspection.

Where Do They Grow?

On very young trees, the trunk flare is not yet formed, so the topmost roots can be located by probing into the soil with a finger, a surveyor's pin or a similar device. Always check to see that the first roots emerge from the stem near the soil surface (Watson and Himelick 1997). Future inspections will be needed to ensure that the roots are developing normally. If the origin of the buttress roots on field-dug trees is kept visible, roots cannot girdle stems. In this way, radial root development can be maintained, for tree health and safety. Removing soil must be done with caution, to ensure that fine roots are not exposed.

When inspecting stems of established trees that are compressed by stem-girdling roots, resonance testing with a rubber mallet can yield a hollow sound. This may indicate dead tissue and the need for a closer inspection. If there are signs that tissue under the bark is dead, lightly scraping the outer bark can reveal moist and bright-colored tissue, indicating living cells. If the tissue inside the bark is brown and dry it is dead. If disease (dead, yellow to dark brown phloem) or decay is found, its extent should be measured and assessed for risk. Diseased tissue should be left open and exposed (Britton 1998).

Aside from nursery- and landscaping-caused defects, SGR's can form from several locations on the tree. When roots are cut by harvesting in the nursery or damaged by construction activity (Figure 3), small lateral roots emerging near the stem girdle it as they enlarge and elongate (Watson and Neely 1993). This is typical on maples (*Acer spp.*). A root tip also can turn sharply where it hits the hard interface in a poorly prepared planting pit, or any other hard object.

Why Do They Need to Be Dealt With?

Let's talk about safety first. After Hurricane Fran hit Raleigh, North Carolina in 1996, Director J.C. Raulston and the author inspected 87 trees that were toppled at the North Carolina State

University Arboretum. Sixty-three of these trees, or almost 75%, had moderate to severe SGR's. They appeared to have one condition in common: they had stayed too long in a container, so their roots circled around the stem instead of radiating away from it. At a nearby private school ten years later, a tree failed near a classroom. Excess soil was excavated from over 400 trees with an air tool. Over 75% of these trees, many of them high-dollar specimens, had moderate to severe SGR's (Meilleur 2007).

In Minnesota, 73% of linden (*Tilia* spp.) that failed completely in storms broke at the point where SGR's strangled the stems. In related storm damage research conducted since 1997, 30% of trees that failed completely and were not located in storm centers but at the edge, broke at SGR compression points (Johnson and Hauer 2000). This is why Dr. Ed Gilman of the University of Florida (Gilman 2008) reminds us to "Examine the root collar (the place below ground where main roots meet trunk) carefully as part of a regular tree maintenance program near buildings, parks, streets, and other places where people live, play, and work" (Figure 4).

Roots that circle the trunk instead of growing away from the trunk injure the tree by reducing transport of water, minerals and sugars where the root presses against the trunk. The injury increases with time, often leading to tree decline. When a root collar examination (RCX) is done, the number of SGR's associated with tree decline and/or sudden failure is amazing. In Kentucky, consulting arborist Dave Leonard uncovered SGR's as contributing to the death of a sugar maple, *Acer saccharum*. After the property owner witnessed what the tree looked like underground, he wanted his other 39 struggling sugar maples assessed. Leonard found only two with "normal" root systems, free of significant SGR's (Meilleur 2007).

Figure 3. Underneath the first stem-girdling root there are often more. All the roots crossing the stem and buttress should be removed.

It's not just sugar maples—no species is immune to this condition. Underground landscapes across North America—municipal, residential, institutional—are full of root disorders, and millions more are in the nursery pipeline. Early decline and destabilization caused by girdling roots is a widespread problem. Removing these roots when they are encountered in the landscape seems like a reasonable and worthwhile step toward restoring a healthy urban forest.

Who Should Deal With Stem-girdling Roots?

Many arborists who are paid to assess tree condition do not get to the bottom of tree problems. Less than half of the arborists who responded to a 1997 survey performed an RCX when they were called to look at trees. In that same survey, SGR's were found 52% of the time a competent inspection took place (Johnson and Hauer 2000). Most practitioners may have assumed that these examinations take too much of their higher-priced time, so their clients would not be willing to pay for them. However, if the consultant is working alone, the client may want to do some preliminary earth moving to save time and money. Once SGR's are exposed and examined, it is often reasonable to conclude that "As young girdling roots are noted later in the life of the tree, they should be cut" (Shigo 1986).

If a crew is present, most of the work can be done by entry-level employees, making the service more easily affordable. With a little training and the proper equipment, all but the most

Figure 4. A buttress root was damaged by construction 18 years previous, and a girdling root grew. One year after pruning, callus forms all around the wound, and more new orange tissue bulges over the girdled area. By sight and touch, this area appears relatively unchanged, indicating that severely compressed tissue is slow to recover."

delicate surgery can be done by crewmembers. Many workers enjoy working with the lower part of the tree for a change, and also being trusted with increasingly technical procedures. Dave Leonard's 2-person root crew alternates between the air excavation tool and hand tools, which makes sense for reasons of ergonomics and morale.

Close supervision is required during training, however, to ensure the job is done carefully. Once a trainee was left alone with hammer and chisel in hand, and soon a swatch of bark had been cleanly trimmed off the stem. This experience was instructive in two ways. First, it's important to keep one eye on the job until the worker is proven to handle it. Second, the speed at which young trees seal injuries can provide a great sense of relief (Figure 3).

When is the Best Time to Do the Work?

The season during which SGR's are removed might influence the success of the treatment. Pruning branches is typically avoided in spring and fall, when leaves are forming or falling, because these are times of increased sap flow and hormonal activity. Midsummer is a good time to prune deciduous trees, in part because the wound response may be more active than in winter. For all these reasons, midsummer may be the best time to prune roots. For red maple trees under an irrigation system, scientists at the Bartlett Tree Research Laboratories found that summer removal of SGR's resulted in better diameter growth over two years than did fall removal or a combination of summer and fall removal (Smiley 1993).

Drought can complicate recovery from root pruning, so mulch and extra water in lieu of rain are strongly recommended. Even without extra care, a study in the late 1970's on Norway maple (*Acer platanoides)* showed that "The amount of foliage dieback after two years was less on girdled trees with roots cut compared to girdled trees with uncut roots… Girdled trees with roots cut grew slightly more than non-girdled normal trees" (Tate 1980).

Many sources echo Dr. Alex Shigo's concern: "On older trees… it is best to leave the girdling roots alone. More harm than good can be done in attempts to remove large girdling roots" (Shigo 1986b). While strictly speaking this is true, it does not seem to consider the widespread problem that SGR's have become, or the technical expertise of today's arborist. Even some very large and embedded SGR's can be removed without damaging the trunk. Pruning roots relieves compression stress, but may cause stress from root loss. The arborist must decide whether eliminating stress by removing the defect outweighs the risk from root removal. Pruning large branches is a routine activity that most trees survive, so pruning large roots may also be tolerated (Figure 5).

Treating Defects Related to Stem-girdling Roots

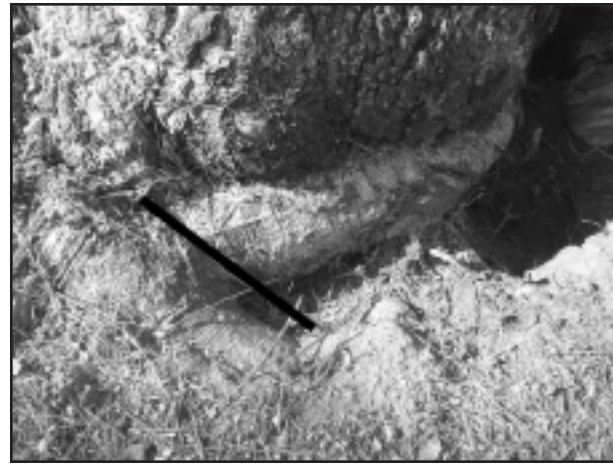

Figure 5. Directional Pruning: The cut was made back to the lateral that grows radially, removing most of the stem-girdling portion.

The first step in an RCX to clear away the misplaced mulch and soil from the trunk flare so the sides of the buttress roots are exposed. Surplus soil should be set aside for future use. Smaller roots growing upward and inward should be snipped out of the way to find the flare. If young roots are found growing out of the stem before the flare is found, the arborist is faced with a difficult decision. These adventitious roots were formed from stem tissue in response to darkness and moisture. If they are large or numerous, they may be forming a secondary support system for the tree. Some species such as *Fraxinus pennsylvanica* and *Taxus baccata* have demonstrated the capacity to form secondary root systems. A survey of observations might help guide future work in this area.

Conks, the fruiting bodies of fungus, can indicate wood decay around stem-girdling roots. "…diseased trees have sometimes been saved by removing soil from around the root buttresses and root collar. The pathogen ceases growth in tissues thus exposed" (Sinclair 2005). In all these cases, dead tissue should be removed so the damage can be assessed and contained. "…include a round-edged chisel in your tool kit…It is possible to cut out cankers on trees" (Shigo 1986b). If the dead areas are extensive, strength loss should be assessed and removing or reducing the tree considered. After all the soil that contacts the infected stem and roots is removed, beneficial microbes such as *Trichoderma* and *Gliocladium* can be inoculated into the surrounding soil and outcompete the decay fungi that are still and always present (Schwarze 2008).

If SGR's are found, the earth is cleared away from them as much as is practical. "Girdling roots should be cut where they attach to the trunk or to another root and then again beyond the point of the girdle" (Costello 2003). Making clean cuts at the origins promotes wound closure. Loppers or secateurs work well for cuts where the entire target area is exposed, while a well-balanced chainsaw can make "plunge cuts" cleanly, especially with a small-width carving bar. Hammer and chisels are often needed to finish the work, with minimal damage outside the scope of work (Figure 6).

Figure 6. A chainsaw with a narrow bar can rapidly "plunge cut" girdling roots. Following standard safety techniques, the operator can make the cut gradually. Sensing the root's release, the operator can pull back in time to avoid damaging stem tissue.

If the root diameter is over 10% of the stem diameter and girdles less than 10% of the stem

before growing away, it may be best to leave it alone, depending on tree vitality and other factors. On roots that are overgrown by stem tissue, several cuts and gentle prying can free the root. If it does not move, sever both ends and chisel off as much of it as possible so it will be pushed off as the trunk and buttress roots expand. It is rare for root tissue to graft to stem tissue, but more common for roots to graft to other roots. Therefore, only those root-girdling roots that constrain buttress roots severely are pruned. If they have already grafted, there seems to be little benefit from pruning them.

Aftercare

To minimize the potential for decay and to facilitate monitoring, pruning wounds should not be covered with soil or mulch. Restoring the grade with smooth stones can add aesthetic appeal and allow air and light to penetration. (Ken Six, pers. comm.) (Figure 7). The aged mulch, soil and pruned roots that were around the trunk flare can be inserted into holes near the dripline. In light of the root loss, adequate irrigation away from the trunk is especially important. Standard arboricultural treatments such as mulching and pest control are, as always, recommended. Cleaning the crown of dead and dying branches will make it easier to see if root pruning causes further dieback. Wounds should be monitored periodically for rates of closure and decay.

An ounce of prevention in the nursery, or four ounces of inspection at buying time, or eight ounces of correction at planting time can prevent a ton of work. In the end, it falls to the arborist to find the flare, examine the root crown, and prune stem-girdling roots. It may be hard, dirty work, but the results become obvious over time. Pruning defective roots grows healthier trees, so it's time to stop discussing and start practicing this simple yet important procedure.

Figure 7. Root crown examinations can expose sensitive tissues, but replacing soil can infect wounds and trap excess moisture. Restoring the grade with smooth stones can add aesthetic appeal while allowing air and light penetration.

Literature Cited

Anonymous. 2004. American Standard for Nursery Stock ANSI Z60.1. http://www.anla.org/applications/Documents/Docs/ANLAStandard2004.pdf

Britton, John, 1998. Root Collar Examinations for Disease and Decay, Handout for annual meeting, American Society of Consulting Arborists.

Costello, L., E. Perry, N. Matheny, J.M. Henry. 2003. Abiotic Disorders of Landscape Plants. pp. 177–180. University of California Agriculture & Natural Resources, Oakland, CA. 242 pp.

Gilman, E. 2007. Landscape Plants. Environmental Horticulture Department, IFAS, University of Florida. Gainsville, FL. http://hort.ifas.ufl.edu/woody/

Harris, R., N. Matheny and J. Clark. 2004. Arboriculture: Integrated Management of Landscape Tree, Shrubs and Vines. p 338. Prentice Hall, Davis, CA. 592 pp.

Johnson, G. and R. Hauer. 2000. A Practitioner's Guide to Stem-Girdling Roots of Trees. Regents of the University of Minnesota, St. Paul, MN. http://www.extension.umn.edu/distribution/naturalresources//DD7501.html

Meilleur, G. 2007. Root Pruning: Severing Subterranean Stranglers. Tree Care Industry magazine July: 8–14.

Schwarze, Francis W.M.R. 2008. Diagnosis and Prognosis of the Development of Wood Decay in Urban Trees, 122-3 Enspec Environment and Risk, Rowville, VIC. 336 pp.

Shigo, A., 1986a. A New Tree Biology Dictionary: Shigo & Trees Associates. Durham, NH. 132 pp.

Shigo, A. 1986b. A New Tree Biology. Shigo & Trees Associates. Durham, NH. 618 pp.

Sinclair, W. and H.H. Lyon. 2005. Diseases of Trees and Shrubs. pp. 329-330. Cornell University Press, Ithica, NY. 680 pp.

Smiley, E.T. 1999. Personal Communication. Bartlett Tree Research Laboratories, Charlotte, NC.

Tate, R.L. 1980. Detection, description and treatment of girdling roots on urban Norway maple trees. 'Metro. Tree Impr. Alliance (METRIA) Proc. 3:83–87.

Urban, J. 2008. Up by Roots: Healthy Trees and Soils in the Built Environment. International Society of Arboriculture: pp. 91, 343, 404.

Watson G., and E. Himelick. 1997. Principles and Practices of Planting Trees and Shrubs. pp. 69–72, 107–113. International Society of Arboriculture. 200 pp.

Watson, G.W., S. Clark, and K. Johnson 1990. Formation of Girdling Roots. *Journal of Arboriculture* 16:197–2002, International Society of Arboriculture

Watson, G.W. and E.B. Himelick. 2005. Best Management Practices, Tree Planting, International Society of Arboriculture: 5–6. 41 pp.