

Resources Related to Determining Critical Root Zone/Tree Protection Zone

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This is a list of resources related to determining critical root zone for trees. This is not a comprehensive list, but gives an idea of some of the resources available.

Researchers responded to this email:

"I often get calls from communities who are writing or revising their tree ordinance and they want to incorporate a critical root zone/tree protection zone into the ordinance but are not sure what formula or criteria to use. I've been trying to track down research on this topic and I'm not finding very much. It seems like there are formulas/criteria floating around but they are not substantiated with research. Do you have any leads for me on this topic? Thanks for your help."

***Nina Bassuk, Cornell University, nlb2@cornell.edu**

"Our soil volume calculations suggest that for most of the US except for the desert Southwest, 2 cubic feet of soil volume per square foot of crown projection should be a reasonable amount. This is an overestimate if the tree is in the East where there is more rainfall, but covers dryer areas of the Mid West and West and I'd rather err on the side of more root protection rather than less. Knowing that the crown projection is the area under the drip line, we would end up with 1 and a half times the radius of the crown projection as being the area to stay out of. This is also assuming that the tree roots are growing symmetrically, another big assumption. Here's an example of how to figure it out.

Take a tree with a 20' crown diameter. Find the area under the drip line(crown projection) using the formula for the area of a circle, ($\text{Pi} \times \text{radius squared}$). The radius in this case would be 10'. So the area under the drip line would be 314 square feet. Now we double that number to get the volume of soil we need to protect =628 cubic feet. We divide 628 by $\text{Pi}(3.14)$ and get 200. Find the square root of 200 and you get 14.1 feet. This is the

radius from the tree trunk out to the end of the zone of protection. Conveniently, this is nearly 1 and a half times the original tree radius(10'). This is based on the research Pat Lindsey and I did as published in the J. of Arboriculture:

Lindsey, P. and Bassuk, N. 1991. Specifying Soil Volumes to Meet the Water Needs of Mature Urban Street Trees and Trees in Containers. Journal of Arboriculture. 17(6)141-149."

***Jim Clark, HortScience, jim@hortscience.com**

"First, there is no real research. Any guidelines, indices and the like are anecdotal. That doesn't make them bad just not as quantitative as we might like. If you want some background, Nelda put a good discussion together in Trees and Development. See page 72.... But this is the optimum root zone.....more how far away should we be" and less "how close can we get." Having said that, we also talk about (page 104) what will happen if you can't provide the optimum. If this sounds confusing, it is, mostly because our knowledge of how individual species respond is qualified by site conditions and the nature of the construction impact. The effect of fill is different than root pruning. There is another aspect to this.....Claus Mattheck talks about the size of the root plate. You may see this called the critical root zone or something similar. Claus' is really interested in failure due to wind, where on construction sites we're concerned about survival! Don't let these two mess you up....!"

***Ed Gilman, University of Florida, efg@gnv.ifas.ufl.edu**

"This is a tough one because any living organism is affected incrementally by changes in its environment. What I mean is that taking a quarter of the roots off stresses the tree, taking half the roots off stresses it more, and taking three quarters applies even more stress. There is no magic cut off for survival as I see it, although cutting into large roots close to the trunk (use Bartlett's formula for example) can have significant stability implications. What we know is that with proper management following injury, we can lose a great deal of the root length and keep the tree alive. If proper management continues, the trees could flourish once again. I have no formula to enter the fray with so I will defer to others who might work more closely with big trees everyday, like Bruce and Tom Smiley. We have to start some place and then refine as we learn more. This will take a long time."

***Jason Grabosky, University of Florida**

"The numbers that I have seen float around are from some work by Burger at UC Davis in the 80s with dimensions of trees and sidewalks with a minimum distance to prevent damage. The British have codified some distances based on work from Cutler in Kew. Some data based on wind storms and clay shrinkage rates are listed and further referenced in ISAs Landscape Belowground or Trees and Buildings proceedings. The British have their standards (BS 5837) for trees and construction, an approximation of which was superimposed onto Mattheck's VTA windthrow diagram (which is really only a failure analysis. This is listed as figure 111 in Mattheck's Body Language of Trees. The Germans, based on research in various German institutions I hope, is a constant 2.5 meters for a root plate radius. I tend to like the British system which is more generous, and acknowledges differences in tree vigor over their age span."

***Kim Coder, University of Georgia, kcoder@uga.edu**

"...There are a number of critical root area formulae based upon research with some used successfully for almost a decade here in Georgia, and used as a part of training professionals across the South and nation. In particular, one is based upon a basal area stocking rule (NC State) and one is based upon soil resource volumes (Cornell). Other formula or methods exist that were developed by consultants (Clark) and used to successfully preserve trees..."

***Don Ham, Clemson University, dham@clemson.edu**

(I asked him if he had a copy of the British Standards that Jason mentioned in his email) He replied that he does have a copy of the British standards. He also said that in the Clemson publication "Landscape Design for Energy Efficiency" that the protection distances used on page 45 in that publication were adapted from the British standards, but they did not incorporate the age aspect that Jason mentioned.

***Gary Watson, Morton Arboretum, gwatson@mortonarb.org**

"You are correct, there isn't much data to support any of the methods. I have seen them based on dripline, tree height, trunk caliper, and maybe a few other things I don't remember. Dripline is a good visual marker and will protect a substantial portion of the roots, but when a large tree is involved, prohibiting disturbance out to the dripline would probably be impossible. Life is full of compromises."

***Susan Day, Virginia Tech**

"There are formulas floating around, and they are not substantiated by research. To my knowledge there is no research that directly addresses this. There have been a few things looking at trenching on one side, two sides, etc. and there is research with that in apple orchards--but these results haven't been very informative for this issue. I think the recommendations in the latest edition of Harris' Arboriculture text book are as good as any. These say 1 foot radius per inch of dbh with some adjustments for species and age. My personal opinion is that the impact is so heavily affected by soil conditions and maintenance before and after the event that these zones are only guidelines. Also, many sites do not have enough space for these protection zones to be installed at the "recommended size". What disturbs me sometimes is when I meet with people who say that they tell clients to just give up on trees where they can't protect at least two-thirds (or another amount) of the root zone. Certainly younger trees can easily handle more damage if they have good soil conditions and proper after care. Trees in marginal conditions with no aftercare, can usually handle only very minor damage to roots. I would suggest an ordinance specify certain aftercare procedures (watering, and mulching in non-woodland cases) in addition to protection zones. Also, the timing of the installation of the protection zone is as important as the size. It needs to be installed before any kind of activity, brush clearing, etc., occurs. Hope this helps you. I often recommend the book by Nelda Matheny and Jim Clark that the ISA publishes. I don't agree 100% with everything they say, but overall it is excellent. Good luck. Susan Day

***Davis Sydnor, Ohio State**

"I suspect that the research you seek does not exist and is unlikely to be funded or undertaken for a variety of reasons. That does not mean that we do not have an obligation to provide assistance. I prefer the guidelines detailed by Matheny and Clark and referenced on page 12 in the publication I sent to you by snail mail. They acknowledge species and maturity differences. While not supported by research, they do add the weight of a published standard."

Greg McPherson, USDA Forest Service, gmcpherson@fs.fed.us

"I don't have any specific info on this Ingrid. We use the dripline but provide flexibility based on the city arborist's discretion. It is very site specific so not surprising that there is no one-size fits all answer. Perhaps Jim Clark or Nelda Matheny have more technical info."

Example Definitions of Critical Root Zone/Tree Protection Zone

Abbey, B. 1998. U.S. Landscape ordinances: an annotated reference handbook. New York: John Wiley & Sons. 438 pages.

- 1) CRZ definition from Alpharetta, GA ordinance: The minimum area beneath a tree that must be left undisturbed in order to preserve a sufficient root mass to give a tree a reasonable chance of survival. The critical root zone is typically represented by a concentric circle centering on the tree trunk with a radius equal in feet to one 1) times the number of inches of the trunk diameter: (CRZ in ft = 1 x D in.)
- 2) CRZ definition from Raleigh, NC ordinance. Generally, a circular area surrounding a tree, the center of which is the center of the tree trunk and the radius is the distance from the outside of the trunk to any point twelve (12) times the diameter, as measured at four and one-half (4 ½) feet from the ground on the low side of the trunk, which points constitute the circumference of the critical root zone.
- 3) TPZ definition from Hilton Head Island, SC: The area around a tree corresponding to the drip line or ten (10) feet in all directions from the trunk.

Johnson, G. R. 1997. Tree preservation during construction: a guide to estimating costs. Minnesota Extension Service, University of Minnesota.

CRZ definition: A way to define the protection zone for an individual tree. It is commonly calculated as the roots and soil within 1) the dripline, or 2) an area defined by a circle with a diameter 24 - 36 times the d.b.h. of the tree (1 to 1.5 feet of radius for each d.b.h.)

Publications

Coder, K. 1996. Construction damage assessments: trees and sites. Athens, GA: University of Georgia, School of Forest Resources.
<http://www.forestry.uga.edu/warnell/service/library/index.php3?docID=125&docHistory%5B%5D=2>

Coder, K. 1996. Relative tolerance of tree species to construction damage. Athens, GA: University of Georgia, School of Forest Resources.
<http://www.forestry.uga.edu/warnell/service/library/index.php3?docID=118&docHistory%5B%5D=2>

Coder, K. 1996. Tree root growth requirements. Athens, GA: University of Georgia, School of Forest Resources.
<http://www.forestry.uga.edu/warnell/service/library/index.php3?docID=393&docHistory%5B%5D=2&docHistory%5B%5D=412>

Matheny, N.; Clark, J.R. 1998. Trees and development: A technical guide to preservation of trees during land development. Champaign, IL: International Society of Arboriculture.

Neely, D.; Watson, G., eds. 1998. The Landscape below ground II: Proceedings of an International Workshop on Tree Root Development in Urban Soils; 1998 March 5-6; San Francisco, CA. Savoy, IL: International Society of Arboriculture.

Watson, G.; Neely, D., eds. 1993. The Landscape below ground: Proceedings of an International Workshop on Tree Root Development in Urban Soils; 1993 September 30 - October 1; Lisle, IL. Savoy, IL: International Society of Arboriculture.

Watson, G.; Neely, D., eds. 1995. Trees and building sites. Proceedings of an International Conference; 1995 May 31 - June 2; Lisle, IL. Savoy, IL: International Society of Arboriculture.

Miscellaneous Information

The National Arborist Association has identified priority topics for research. One of those topics is "Tree Preservation - critical root zone, including biological and structural parameters," Feb 28, 02