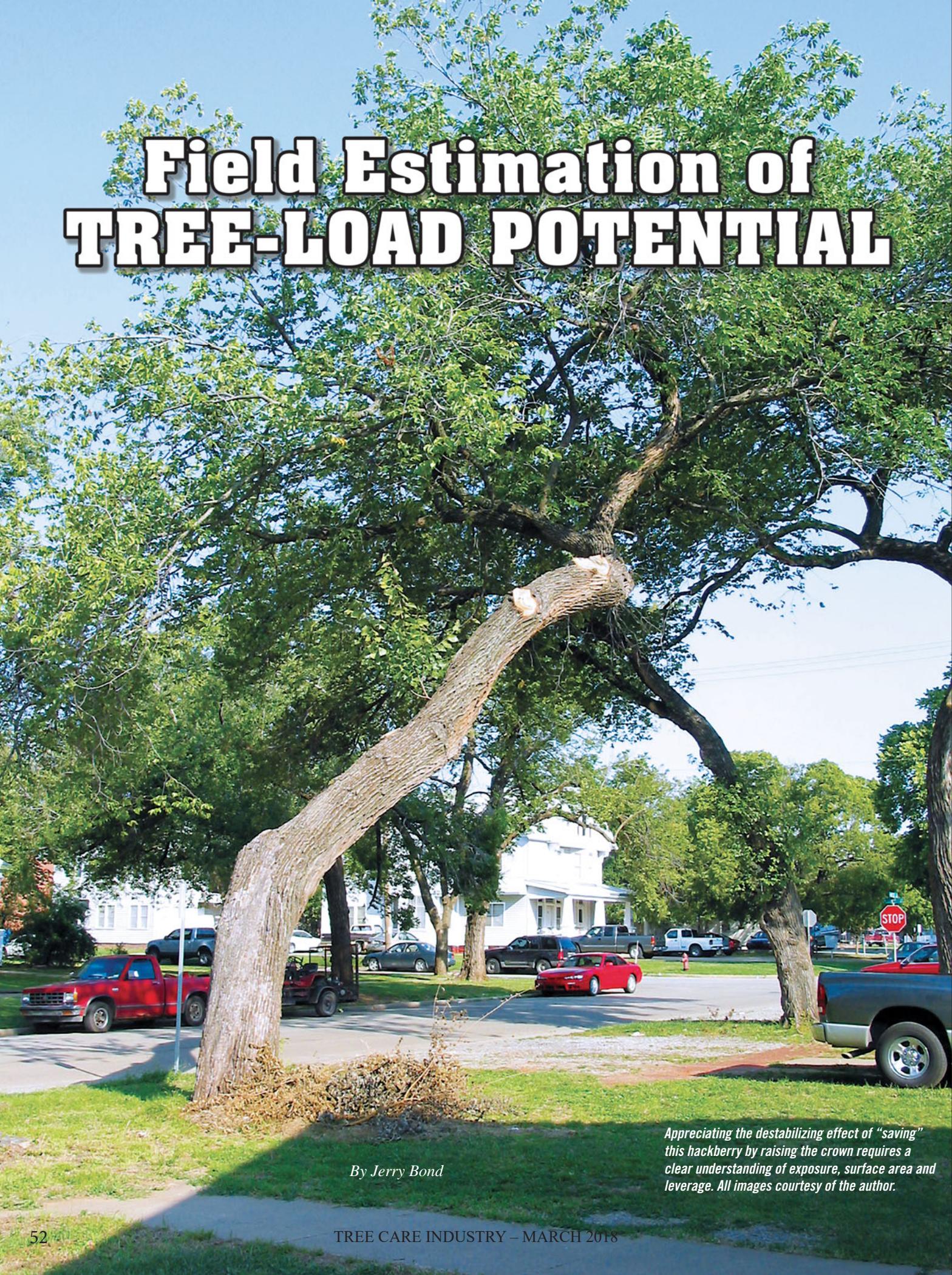


# Field Estimation of TREE-LOAD POTENTIAL



By Jerry Bond

*Appreciating the destabilizing effect of “saving” this hackberry by raising the crown requires a clear understanding of exposure, surface area and leverage. All images courtesy of the author.*

**T**here is no field protocol for simple tree-load analysis that I know of. Yet the basic principles of load analysis should be made available to arborists and tree managers everywhere as a standard tool for everyday work. It is critical that we base our evaluations on *stress* (load/area) rather than defect size, since only the first consistently relates to failure potential. Clear and quick field protocol, good documentation and, ideally, industry adoption would be required for this to happen. In this article, I address the first step only, hoping to attract serious attention to the topic from tree professionals who, like me, may have hesitated to look at this for lack of an engineering background.

Such a basic field protocol would not be a substitute for a detailed scientific analysis, and it could never be relied on for high-risk situations, for which a trained professional is required. The objective of creating a field protocol would be to make simple load analysis a standard field tool for gaining a “first approximation” of load potential. Employing it would be analogous to the use of a sounding hammer. The hammer is a simple tool often able to detect the presence of significant decay, and a positive result points to the need for advanced techniques to measure the decay’s extent and the consequent failure potential.

Ultimately, I would like to see basic load analysis incorporated into standard visual-assessment techniques. It would need two critical elements. The first requires that we consider the magnitude of the forces that can typically be expected to be exerted on the whole tree or one of its parts. For the second, we want to identify locations that will be subjected to high stress levels as the load moves through the tree. We can make this process easier by breaking down the analysis into discrete steps.

### Five questions toward a protocol

I will argue that five questions can lead the field arborist to a functional appreciation of potential load magnitude and distribution. The questions aid the arborist in following load from its origin in the application of a force to its ultimate dispersion. For ease of application, only categorical responses are required: high, medium



*A risk assessment of this green ash (*Fraxinus pennsylvanica*) with a huge canker will have to take into account the fact that it is completely surrounded by other trees, severely reducing the wind load on the crown.*

and low. Such responses are not measurements, and they are barely even estimates. Yet the set of answers is sufficient to provide a “fuzzy” portrait of potential load that will help identify and prioritize instability. Also, given the large number of uncertainties in both measurement and

interpretation during tree-risk assessment, that fuzziness can find a ready defense.

### **Q1: What is actual exposure potential to high levels of wind, ice, etc.?**

Factors:

- Weather exposure



*The extended limb of a sugar maple (*Acer saccharum*) carries a large mass of dense foliage that is completely exposed to the prevailing winds.*

- ◇ Cankers, cracks and other material defects
- ◇ Rapid and severe reduction in load-bearing surface area
- Severity level judged with standard visual techniques

**Q4: How long is the lever arm to magnify the force?**

Factors:

- Lever = distance from center of load to nearest susceptible stress raiser or base of a branch or tree
- ◇ Center of load – here, the approximate center of the foliage or branch mass
- ◇ Most susceptible stress raiser – select from responses to Q3 or use termination point



*A tall and thin black cherry (*Prunus serotina*) newly exposed on the edge of construction. The load descending from the small crown is concentrated by the obvious stress raiser half way down, resulting in an increased potential for failure at that location.*

- ◇ Frequency, type and severity of extreme events (e.g., a “Pineapple Express,”\* hurricane or ice storm)
- Site exposure
  - ◇ Neighboring vegetation or structures
  - ◇ Aspect, if on a slope (i.e., what compass direction does the slope face?)
- Individual exposure
  - ◇ Leaning-edge tree, overextended limb, etc.
  - ◇ Recent loss of protection through removal of trees, limbs, structures, etc.

**Q2: How much surface area is available to capture the force?**

Factors:

- Foliage surface area – size and density of foliage on the tree or branch. Major impact on drag
- Wood surface area – generally only a significant factor in leaf-off periods or during extreme events that escape prediction
- Lopsided foliage distribution increases torsion

**Q3: What stress raisers are present?**

Factors:

- Stress raisers concentrate load moving through the tree
- Types
  - ◇ Sharp bends, such as doglegs

- If leverage is ignored, load and safety cannot be estimated

**Q5: What is the degree of excurrent architecture?**

Factors:

- Excurrent limbs and trees have a single, dominant central axis
- They tend to maximize load transference and are more likely to resonate to dynamic loading
- A more decurrent architecture has multiple large branches that absorb force (damping)

**Conclusions**

My persuasion is that this basic field method provides a legitimate contribution to judgments about likelihood of failure that we make every day about individual trees as well as populations. But that persuasion needs to be tested by arborists and their feedback used to modify and improve the method. This question set needs to be applied to many different situations, and both process and product evaluated carefully. A simple data form can be created for data collection (e.g., Bond 2016), which adapts easily to electronic data collection. Once filled in for a specific tree, the form would constitute a kind of “load profile” that could be used for risk assessment. For example, Figure 1 might contain the result for a large lateral limb.

In general, the more questions that are answered with “High,” the more an arborist would be inclined to conduct some form of more detailed investigation.

It is important to repeat what this proposal does not claim to be:

- It does not offer a magic bullet for risk assessment;
- It is not a substitute for formal scientific analysis;

ID	Rating	Q1: Exp	Q2: Fol	Q3: Str	Q4: Lev	Q5: Exc
<Tree>	High	x	x			
	Medium				x	
	Low			x		x

Figure 1: An example of a load profile with multiple ratings of “High” that suggest a greater likelihood of failure.



The risk potential of these black locust (Robinia pseudoacacia) is increased by the very long lever arm, though the most likely point of failure may not be easy to determine.

- It does not provide easy answers; and
- It does not eliminate the need for ex-

perienced and knowledgeable interpretation of its data.

But these five questions are one effective means of estimating load analysis in the field that can be put to use without special training and mathematical ability. They also constitute a useful pedagogical tool for workshops, crew training and other settings for professional learning. With luck, such an approach may bring load analysis into everyday work situations for us non-engineers



*The many large limbs radiating from the top of this white oak (Quercus alba) are capable of absorbing a great deal of energy, relieving the stress on the lower stem and roots.*

doing risk analysis with limited time and resources.

**Additional reading**

Bond, Jerry. 2016. Data form for basic load



*Figure 2: Relation of load analysis to estimation of likelihood of failure.*

analysis. <<http://bit.ly/2DwsGgL>> (PDF)

Smiley. E. Thomas, Matheny, Nelda and Sharon Lilly. 2017. Best Management Practices: Tree Risk Assessment. 2<sup>nd</sup> ed. Champaign, IL: International Society of Arboriculture. Appendix 2: “Loads on Trees.”

\* The “Pineapple Express” is a continuous surge of tropical moisture extending from near Hawaii all the way into a West Coast storm.

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*This article, though significantly updated here, was based in part on an article by the author that first appeared in the April 2011 issue of Arborist News.* 



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