TREE CONDITION: HEALTH

By Jerry Bond

"What's the condition of this tree?" Some variant of this question is usually the first thing tree professionals hear from owners—often before they've managed to even get a good look at the thing! Tree condition is also one of the core attributes collected for any tree inventory because it is critical for planning purposes, permitting estimation of maintenance needs, forest functionality, and life expectancy, all of which impact overall costs and benefits. Yet it is curious that for all its importance, tree condition has attracted only limited scrutiny from urban professionals outside the field of tree appraisal.

The bottom line: I am persuaded that we need to develop a new standard condition rating system that is more objective, and I hope in this article to establish a starting point for that process. I will restrict my focus here to tree health, saving tree stability for another time. After reviewing current systems in wide use, I ask questions about desirable attributes, and then conclude by examining an existing system outside of urban forestry that might serve as a useful model. My purpose is to promote professional discussion as well as to identify criteria that can be put to use immediately.

What's Out There Now?

CTLA

The only condition system actually developed by the professional community and in general use within at least some areas of arboriculture and urban forestry was developed by the Council of Tree and Landscape Appraisers (CTLA 2000). Designed to be used with methods for assigning dollar value, the system breaks condition into five factors (rated from 1-4) and combines them to obtain a final condition rating. These five factors are:

- Roots
- Trunk
- Scaffold branches
- Small branches and twigs
- Foliage

This rating system has two distinct advantages:

- The system is well-established and widely-employed.
- It has gradually evolved (Cullen 2008) to become the standard guide for tree appraisal work.

For purposes other than appraisal, however, this condition system has some serious disadvantages:

- The system relies on subjective criteria, raising problems including the non-repeatability of ratings, lack of clarity for clients/owners, and difficulties during legal disputes.

Despite losses from windstorms and pruning, the remainder of this white pine (*Pinus strobus*) displays dense dark green foliage with no dieback, indicating the tree is likely in good health at this point.

- Health and stability are conflated. This means that the ability of the tree to carry out photosynthesis, respiration, and other biological functions is evaluated alongside the ability of the tree to resist mechanical failure. This has serious consequences: anyone doing risk analysis on urban trees, for example, would be required to somehow "average out" a defective root system with a healthy crown.
- Health is treated as a spatially distributed value in that each of the five condition factors receives a separate health rating. But this approach makes limited sense in a biological organism with countless feedback loops. The word "health" refers to the overall state. We never ask, "How is your foot's health?" Here is an important illustration of why this matters: root and crown condition are tightly coupled, a fact of great utility when carrying out visual tree analysis during risk assessment. Rating them separately and then trying to combine them somehow, especially when one of them is effectively invisible, seems to make little scientific or practical sense.
- The overall score requires an evaluation of the foliage, which is impossible for a deciduous tree during its dormant period, and very hard during leaf expansion and leaf senescence, each of which can last up to two months.

i-Tree

One of the components of i-Tree, STREETS (formerly STRATUM), includes tree condition in its model, and its sound principles merit consideration. STREETS divides condition into structural (woody) and functional (foliage) areas, each of which is given one of four values: good, fair, poor, and dead/dying. The two divisions are reported separately, with two discrete values for tree condition.

Because there aren't any definitions or criteria supplied for those values—by intention—the i-Tree STREETS system represents more of a container for a condition system rather than the system itself. But it is a very good container, and is already established in software developed by USDA Forest Service personnel and distributed throughout the United States and beyond (i-Tree 2009).

Apart from these two widespread systems, tree professionals are on their own, with the result that a tree condition rating is often difficult to communicate and interpret in any detail.

What Should We Look For?

The number one priority for developing an improved system is to draw clear lines between biological and structural condition (i.e., between health and stability). It seems critically important to try to avoid confusion between these two aspects given that they cause so much difficulty when dealing with untrained observers, who are routinely blinded to professional evaluation by the simple fact that a tree "looks OK." The confusion can also cause disagreement among professionals about the exact focus of evaluation. The mechanical and biological systems that Alex Shigo called the "apoplastic" and the "symplastic" trees (e.g., Shigo 1994), interact closely in critical processes such as cell growth and wound response, of course; but the two sets of external symptoms for biological health and mechanical stability give little clear information about each other to the observer. At the extreme, in fact, some species are very good at remaining mechanically stable even when dead, while others are capable of maintaining the appearance of good health even when structural collapse is imminent.

The large amount of branch death and sparse foliage on this young honeylocust (*Gleditsia triacanthos* var. *inermis*) are typical symptoms of serious root death or loss, in this case due to planting into wet clay with heavy equipment.

A second and almost equally important issue is objectivity. If we are to have an industry standard for assessing the tree health component of tree condition, one can be used by all evaluators, it is crucial that the data collected in the field be as free of individual bias as possible. Asking that words or numbers be assigned to a tree or its part invites imprecision and misunderstanding; judgments on how well scaffold branches have been pruned (CTLA 2000), for instance, will simply lead to dispute. Less subjectivity will increase repeatability, raise integrity, facilitate quality control, and promote data sharing.

Finally, we need a well-reasoned method of determining any overall condition rating. Does it really make sense, for instance, to add factors together? Should they rather be multiplied, a required procedure when independent probabilities are involved. Or would it be most appropriate if one or two critical factors were used to create the overall condition rating (as in Nowak et al. 2008)? It is also possible that none of these options are actually justified as a universal measure to be applied to all species and life stages. For

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The intact and dark green crown of this bur oak (*Quercus macrocarpa*) disguises the extensive decay in the main trunk, which is 80 percent hollow.

example, saplings and juvenile trees might best be judged by average shoot extension, mature trees by foliage quality, and declining trees by dieback.

One Better Way

Let us look at an example of a tree health evaluation system that is more detailed, more objective, and more useful: the Forestry Inventory and Analysis Program (FIA 2009). Though all but unknown in urban forestry, its approach deserves attention for its rigorous and mature methodology, even though it is in many ways not suited for urban forestry in its current form.

FIA has established a set of seven crown indicators that are designed for use individually or combined (FIA 2007):

- Live crown ratio. The live crown ratio is the percentage of height which supports live, green foliage that is contributing to total height growth.
- Crown light exposure. The number of sides of a tree receiving light when the sun is directly above the tree.
- Crown position. The position of a tree as compared to the stand overstory canopy.
- Crown vigor class. The condition of saplings based on crown ratio, dieback, and foliage.
- Crown density. Amount of crown branches, foliage, and reproductive structures that block light visibility through the crown.
- Crown dieback. The percentage of the live crown area showing dieback.
- Crown transparency. The amount of skylight visible through the live, normally foliated portion of the crown.

The approach of the Forestry Inventory and Analysis Program displays a number of striking features:

- Each indicator is quantitative, minimizing individual bias.
- Values are defined by clear detailed documentation.
- These indicators are restricted to tree health: no direct information about tree stability is recorded.
- Neither an aggregate value nor any single crown indicator is used to indicate overall tree health.
- Required field tools are inexpensive and low-tech.
- The resulting data provide a universally communicable picture of the crown and, within limits, of the tree's health.

Because the FIA system benefits from substantial historical record and established field techniques, it provides a good example of an objective tree health evaluation method that represents a detailed and repeatable system of analysis of the functional integrity of a tree's physiological apparatus.

What About the Leaves?

Foliage quality is ignored in the FIA system, yet it figures prominently in most urban tree evaluation. Because leaves are absent or unreliable in many climates for a significant portion of the year, they cannot be used as an exclusive health indicator. When present, mature leaves open up a range of interpretative possibilities—especially on deciduous trees. An economical scale could perhaps be constructed on the percentage class of "abnormal leaves," understood to include foliage that is:

Five annual shoot extensions can be clearly seen on this silver maple (*Acer saccharinum*) twig, and the average length of about 1 in (2.5 cm) per year indicates a serious state of decline for this normally fast-growing species. In this case, where the tree is on a fairground, soil compaction is the likely cause.

The loss of a significant amount of crown due to utility pruning and decline has left this sugar maple (*Acer saccharum*) with 25-50 percent crown density, 50-75 percent crown integrity, but 75-100 percent foliage opacity.

- necrotic
- chlorotic
- abnormally small

At the same time, it is important to realize that leaves are much more subject than woody parts to short-term factors (Roloff 2001), including but not limited to:

- drought
- pests
- heavy seed set
- phenology
- frost
- herbicide/pesticide application

With appropriate restrictions and criteria, leaf quality could be added to a modified FIA system as a quantitative and repeatable attribute to collect when estimating tree health.

Conclusion

A system for evaluating tree health following these lines would establish a single objective field procedure that would set a standard for all arborists doing such work. Moreover, arborists could begin to adapt suitable categories (see *The FIA System in an Urban Context*) without waiting for the development of a complete and official new urban system, knowing their field data will be objectively ►

The FIA System in an Urban Context

Why not simply adopt the FIA system for use in urban forestry as i-Tree Eco (formerly UFORE) does? A number of obstacles obstruct a more general adoption:

- The system flirts with the fallacy of **misplaced precision**, because it frequently treats information as more precise than it really is. For example, since we have no evidence as far as I am aware that there is any actual change in tree health corresponding to the difference between any two 5% crown dieback classes, then we have no practical reason to use a scale with such fine resolution. We can obtain more precise data, but not more precise information.
- FIA data collection demands time and personnel not routinely available in the urban context. For each of the seven crown parameters, two observers must examine the crown from different viewpoints and agree on one of as many as twenty possible values for each attribute.
- It needs substantial alteration for the new work context:
  - The two parameters of **Crown position** and **Crown light exposure** should be eliminated, since they really only produce useful information about shade-intolerant species in a stand, and the effects of those position parameters are recorded by other indicators.
  - **Crown vigor class** of saplings is not applicable to most urban contexts as defined by the FIA and should be removed.
  - **Crown transparency** and **crown dieback** should have their scales inverted so that the highest value corresponds to the best health. They should also be renamed to something like "Crown Opacity" and "Crown Integrity" to reflect the change.
  - The number of classes should be restricted; 4 would be sufficient for just about any urban work situation (Roloff 2001).
- The system lacks important parameters commonly used in arboriculture and urban forestry:
  - **Average shoot extension** class provides a very useful and quick measurement that provides a reasonable measurement of any tree's general health and vigor (CTLA 2000). A rigorous field protocol and interpretative procedure needs to specified.
  - **Leaf quality** needs to be added because of its great utility in judging the health of urban trees, particularly the effects of belowground factors.

The leaf blotch disfiguring this horsechestnut (*Aesculus hippocastanum*) is primarily cosmetic in effect, but renders any attempt to read the condition of the leaves difficult.

quantified—and therefore understandable, repeatable, and uncontroversial. Once these changes were in place and detailed documentation was written for each parameter, the industry would have an excellent objective protocol for the collection of field data to evaluate tree health.

It is important to conclude by noting that the increased objectivity of numbers from such an evaluation system would not replace the work of interpretation. These numbers are oriented intentionally toward the here and now: what is the current health of the tree in front of me? Little about the site-tree-climate interaction (apart from stand location) is directly taken into account, species norms are only partially accounted for, and the tree's particular history and work context are excluded. Only a trained and experienced professional who has been on site can finally make use of these data to fulfill the twin obligations of prediction ("What's likely to happen?") and prescription ("What's the best treatment?").

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