Urban Forest Research

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Center for Urban Forest Research • Pacific Southwest Research Station • USDA Forest Service

What Are Your Trees Relative Performance Index?

Annual performance evaluations are not something we all look forward to. But at least you know where you stand after they are over. And your boss knows how you are performing relative to the other employees.

A performance evaluation for trees?

What if you could evaluate the performance of tree species in your community? You can. The measure is called a Relative Performance Index (RPI). All you need is a basic inventory. Even a sample inventory will work. After a simple calculation you would know how well each tree species is performing. And most importantly, how species perform relative to each other. An RPI could provide you with a good case for "firing" some species and keeping others. Here's how it works.

SPECIES	CONDITION INDEX	SPECIES	CONDITION INDEX
Acer saccharinum	1.1	*Melia azedarach*	1.2
Albizia julibrissin	1.2	*Morus alba*	1.6
Alnus rhombifolia	0.6	*Pinus canariensis*	1.5
Betula pendula	0.4	*Pistacia chinensis*	1.3
Carpinus betulus	1.6	*Pinus halapensis*	1.4
Casurina cunninghamia	1.2	*Pinus pinea*	1.5
Celtis australis	1.4	*Platanus acerifolia*	0.8
Cercis occidentalis	1.6	*Platanus racemosa*	1.0
Celtis sinensis	1.1	*Prunus cerasifera*	0.5
Fraxinus holotricha Moraine	0.8	*Pyrus calleryana*	0.5
Fraxinus oxycarpa Raywood	1.0	*Pyrus calleryana Aristocrat*	1.2
Fraxinus spp.	0.6	*Pyrus calleryana Bradford*	0.9
Fraxinus velutina	0.1	*Quercus agrifolia*	1.3
Fraxinus velutina Modesto	0.4	*Quercus ilex*	1.4
Ginkgo biloba	1.4	*Quercus lobata*	1.0
Gleditisia triancanthos	0.7	*Quercus suber*	1.4
Juglans hindsii	0.4	*Quercus virginiana*	1.6
Juglans regia	1.3	*Rhus lancea*	1.1
Koelreuteria paniculata	1.4	*Robinia ambigua*	1.2
Lagerstroemia indica	0.8	*Salix babylonica*	1.7
Laurus nobilis	1.1	*Sapium sebiferum*	1.0
Liquidambar styraciflua	1.2	*Sequoia sempervirens*	1.3
Liriodendron tulipifera	0.8	*Sophora japonica*	0.7
Malus floribunda	1.2	*Zelkova serrata*	1.1
Magnolia grandiflora	1.5		

Table 1. Relative Performance Index for public tree species in Davis, CA representing over 0.5% of the total population.

The Davis, CA case

The Davis case started as a master's thesis for Scott Maco, urban forester for our Center. Using a stratified random sampling technique, he conducted an inventory of street trees that included typical parameters such as species, height, diameter, age, and condition. His subsequent analysis of the inventory data produced a clear picture of the urban forest. But one particular aspect of the analysis involved a seldom used way of looking at street tree condition data—the RPI.

Relative performance index (RPI)

Relative Performance Index is based on the proportion of each public tree species classified as "good"

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(condition class) divided by the proportion of the total population classified as "good" (Table 1). In Davis, an index value of '1' indicates that 60% of that particular species are in "good" condition, reflecting the average condition of all species in the city. A value higher than '1' indicates that there is proportionately more individuals classified as 'good'. And an index value below '1' indicates that that species has a below average condition rating when compared with other street trees.

Condition is the key

Recent pruning and stand age may be factors, but a tree's condition is the overriding indicator of well-adapted and appropriate trees. This was the key, and Scott wanted a simple way to compare species. Thus, relative performance index was born.

Functional life

While a relative performance index can be used to indicate trees well suited to your city's environmental condition, it is important to remember that some species with low values may have an age distribution that represents a senescing population. An example would be many of the ash and black walnut in Davis (Figure 1). Though most of these trees' functional lives are past, they have served the city well throughout their long lives. And to not replant these species based on current condition of these senescing individuals may be shortsighted.

On the other hand, the fact that some of the species currently being heavily planted have values less than '1' suggests one of two things: 1) the city is either putting faith in species unlikely to provide stability or cost-effective functionality, or 2) proper maintenance is not being provided, or it was not provided when the trees were young. These species—plum, Bradford pear, crape myrtle, and plane—are exhibiting relatively poor condition at young ages, suggesting that it will be difficult for them to age gracefully.

Here are some additional factors to consider when using an RPI:

❦ ***Looking at planting trends***
Be sure to ask the question: what's happening at the small end—the small diameter classes? What are you planting? This will directly

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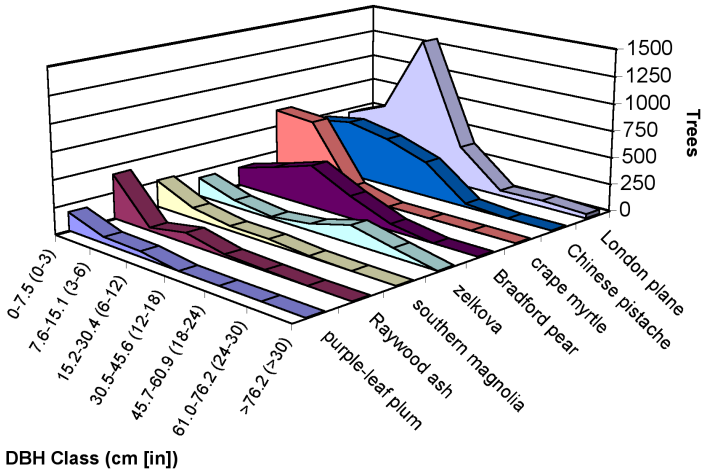

Figure 2. Top trees currently planted by numbers and DBH classes in Davis, CA.

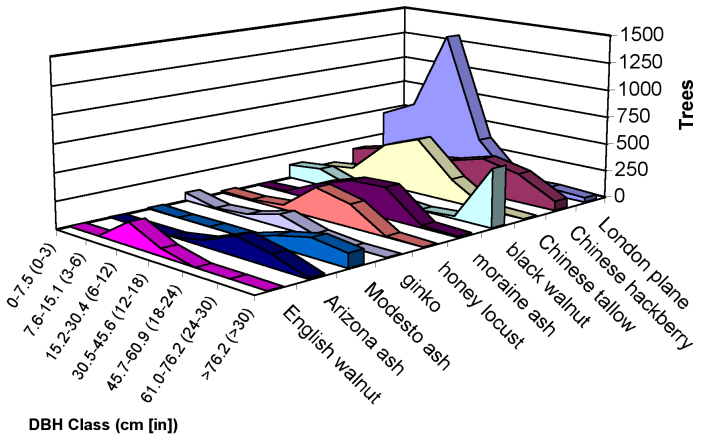

Figure 1. Age distribution of trees in Davis, CA that are currently producing the largest average annual benefits on a per tree basis.

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The shift towards planting small-stature and untested species has the potential to dramatically disrupt the current level of benefits a community enjoys.

affect what becomes larger over time. For example, in Figure 2 you can see that recent plantings have tended toward trees such as London plane, Chinese pistache, crape myrtle, Raywood ash and to a lesser extent Bradford pear, zelkova, southern magnolia, and purple leaf plum. Zelkova and perhaps London plane and Chinese pistache are the only species with a significant number of individuals present in functionally large DBH classes (>12 in.).

❦ ***Performance related to benefits***

RPI starts with understanding age distribution for each of your species. As Scott discovered in Davis, population stability, and ultimately stand performance, requires more than simply planting "other trees" when a single species is planted beyond a set threshold (10% of total population). To our way of thinking, tree performance is directly related to a tree's ability to produce benefits. Therefore, the more healthy, large-stature trees that "grow" into the larger diameter classes while maintaining an ideal age distribution (see Figure 3), the more benefits the urban forest will provide to the community.

❦ ***Functional size***

Functional size is critical too, because this is when trees are capable of producing the most benefits with the least amount of care. As is evident in Figure 1, large, long-lived deciduous trees are those that reach functional size. Substantial tree numbers in large DBH classes represent proven adaptability. The shift towards planting small-stature and untested species has the potential to dramatically disrupt the current level of benefits that a community enjoys.

The city of Davis stopped planting the majority of species represented in Figure 1—ash, walnut and locust—due to perceived problems, whether it was infrastructure or pest related. It is important, however, to continue to evaluate how well they, as well as other species, are aging in comparison with each other.

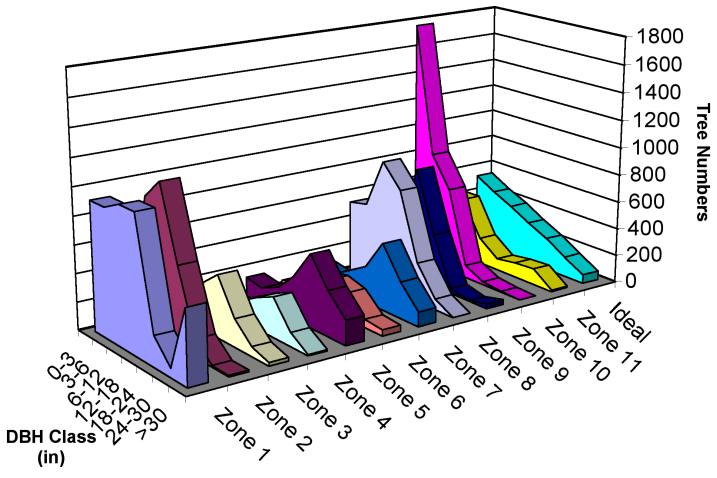

Figure 3. Comparative age distribution to the ideal in Davis, CA.

USDA Forest Service launches *Treesearch*

Treesearch is an online system for locating publications by USDA Forest Service Research and Development scientists. Publications in the collection include research by the Forest Service, as well as papers written by Forest Service scientists, but published by other organizations in their journals, conference proceedings, or books. This website provides you with an additional way to find our research documents. Only peer-reviewed publications will be housed on *Treesearch*. All of our other publications and products are still available on our website.

Treesearch lets you search listings by author, keyword, originating Station, or date. You can find Treesearch at: http://216.48.37.142/

The bottom line

The RPI may be a completely new way of looking at your city street trees, but it provides another glimpse of what is really going on underneath the canopy. Try it out. See if it works for you. And if you end up "firing" some species and justifying keeping others you thought were "over the hill," our urban forests will be that much better off. Let us know how many species you "fired" and which ones you "promoted."

—*Jim Geiger*

How does your tree program "stack up"?

Despite a harsh climate, the city of Cheyenne, Wyoming has been able to create an urban forest that has withstood the test of time. We recently went to Cheyenne to conduct a benefit-cost analysis of their community trees using their 1992 citywide inventory. Check out the city's achievements.

- They have 17,010 municipal trees—48% are publicly managed and 52% are privately cared for.
- 41% (6300) of all street tree planting sites are unplanted. Conversely, the parks are fully stocked.
- There are 58 different tree species. Because many species are newer introductions, and few in number, overall diversity is low.
- Cottonwood and Siberian elm are the dominant street tree species, contributing over 50% of the total tree leaf area and 60% of the total canopy cover. Ponderosa/Austrian pine, blue spruce, and cottonwood dominate parks.
- The average small or young trees produce $19/tree in benefits, maturing medium-sized trees produce $38/tree, mature large trees produce $66/tree, and large old trees produce annual benefits of $80/tree.
- Municipal trees provide approximately $686 thousand ($40/tree) in total annual benefits. The city currently spends about $19/tree on their care. Citizens are now receiving a relatively large return on that investment—$2.09 in benefits for every $1 spent on tree care.

Cheyenne, Wyoming

Future Needs

1. More species diversity. Continued replacement of senescent cottonwood and Siberian elm with a variety of long-lived medium and large-stature broadleaf deciduous tree species will improve diversity.

2. Improved distribution of benefits. By focusing planting efforts along streets where stocking levels are lowest, benefits will be more evenly distributed.

3. Better management of privately-cared-for trees. Extensive education on appropriate pruning and irrigation could establish a more consistent management program for street trees.

Cheyenne is faced with a fragile resource that needs constant care to maximize and sustain benefits through the foreseeable future. In a city where the climate poses a constant challenge to tree growth and health, this is no easy task. The challenge will be to maximize net benefits over the long-term, providing a resource that is both functional and sustainable.

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