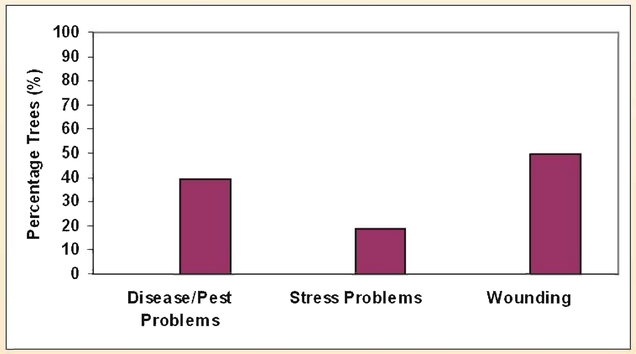
Long–term Monitoring of Tree Size and Condition Across Non-Residential Patch Types in Phoenix, Arizona

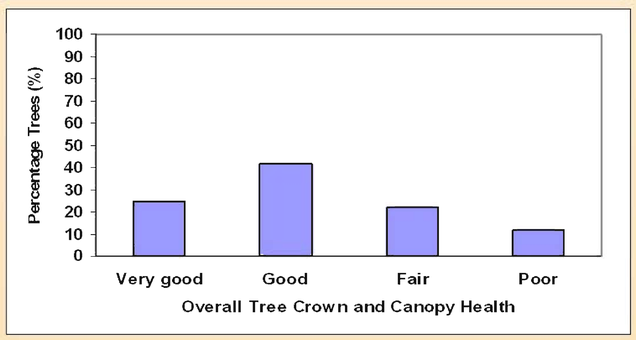
Chris A. Martin and Jean C. Stutz
Department of Applied Biological Sciences, Arizona State University at the Polytechnic Campus
Mesa, Arizona 85212

Introduction

Cities are now recognized by ecologist as planned and managed system.s with ecological processes like primary production that merit investigation and understanding. Little is known about how the urban environment affects annual rates of change in urban tree size or tree health. This is a first report of a continuing long-term assessment of changes in tree size, and measures of tree health and mortality within the CAP LTER study region. Phoenix, Arizona, (33°26'N, 112°1'W) is situated within the lower Salt River basin on the northeastern edge of the Sonoran Desert in the southwestern United States.

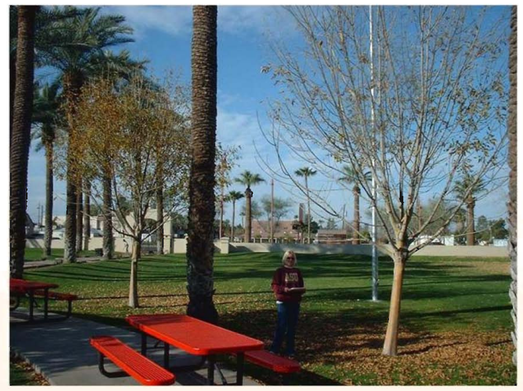
Though previous researchers like Szarek and Woodhouse (1978) have quantified primary productivity of Sonoran Desert vegetation, only recently was primary productivity in Phoenix residential landscapes within estimated to be about 2.8 times higher than that of surrounding Sonoran Desert vegetation (Martin and Stabler, 2002). Though these data were the first to elucidate the potential effects of urbanization in an arid Southwest climate, they were limited both spatially and temporally. More extensive studies are needed to understand long-term changes in tree size and health.





Figures above. Assessments of the percentage of health problems and overall crown and canopy health of nonresidential trees in Phoenix, Arizona.

Multiple tree taxa at a mixed commercial extensive site in Tempe, AZ.



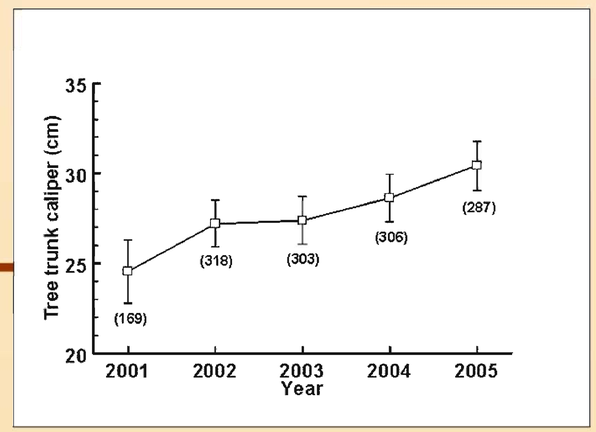
Multiple tree taxa at an institutional (school) extensive in Phoenix, AZ.

Methodologies

Plant scientists with the Central Arizona - Phoenix (CAP) LTER have established a multi-faceted approach for measuring ecosystem function that includes use of controlled experiments, and intensive and extensive monitoring programs. Whereas controlled experiments and intensive monitoring programs typically involve the accrual of research data for either the testing of ecological theory or the monitoring of ecosystem function over relatively short temporal and/or spatial scales, extensive monitoring programs focus on repeated measurements of ecosystem processes or functions over relatively greater spatial and temporal scales and may ultimately serve as the cornerstone for our understanding hierarchical scalar interactions of urban ecology in the CAP research area.

Thirty two sites across a gradient of seven zones from urban core to fringe in Phoenix, AZ, were selected in 2001 to begin monitoring long term changes in tree trunk cross sectional area. Eighteen additional sites were added in 2002. Gradient zones were based on a preliminary study of near surface atmospheric CO_2 concentrations and air temperatures across an urban core to fringe gradient (Stabler and Martin, 2000). The 50 sites encompassed a variety of non residential land use types (commercial, industrial, institutional, transportation, and desert) that were replicated within each of the seven gradient zones. Only trees in non-residential patch types were selected because of concerns about long-term researcher access. The number of trees (single to multiple taxa) at each site ranges from 3 to 10 and encapsulate a range of common Phoenix landscape tree taxa and disparate habits ranging from palms to winter deciduous (see Table). In January of each year, a standard suite of size measurements are made for trees at all sites.

In spring 2006, studies of tree health and condition were made. Tree canopy health was visually assessed on all trees by considering branch dieback, density of foliage (species dependent) and discolored foliage. Based on this assessment, each tree was placed into one of four categories (very good, good, fair or poor). Wounding damage was assessed by examining each tree and noting physical/mechanical injury to roots, stem or main scaffold branches. Each tree was examined for any evidence of wood decay, nutrient deficiencies, stress (water, salt or sunburn), disease or insect pests. All data collected is maintained on the CAP LTER web server.



Figures side. Tree trunk caliper (diameter at breast height) of non-residential trees in Phoenix, Arizona. Data are means ± SE. Numbers in parentheses are number of trees sampled each year.

Findings of Tree Size

Mean trunk caliper was the best single indicator of overall changes in tree size. Greatest increases in trunk caliper for all non-residential trees sampled within the Phoenix metropolitan area occurred during 2002, 2004 and 2005. Mean trunk caliper showed little to no increase in 2003. Increased numbers of trees sampled in 2002 (169 to 318) reflect the addition of 18 sampling sites. Declines in the number of trees sampled at the 50 sites from 2002-2005 relate incidences of urban tree mortality. Tree mortality was a result of either tree death or removal.

Table. Listing of tree taxa that are measured semi-annually across 50 extensive monitoring sites in the Phoenix, Arizona metropolitan area.

Scientific name	Common name
Acacia salicina	Weeping acacia
Acacia stenophylla	Shoestring acacia
Brachychiton populneus	Bottle tree
Carya illinoisis	Pecan
Ceratonia siliqua	Carob tree
Citrus aurantium	Sour orange
Cupressus sempervirens	Italian cypress
Dalbergia sissoo	Indian rosewood
Ebenopsis ebano	Texas ebony
Eucalyptus camaldulensis	Red gum
Eucalyptus microtheca	Coolibah
Fraxinus uhdei	Shamel ash
Fraxinus velutina	Arizona ash
Gleditsia triacanthos	Honey locust
Jacaranda mimosifolia	Jacaranda
Lysiloma watsonii	Fern of the desert
Melia azadarach	Umbrella tree
Morus alba	Mulberry
Olea europaea	Olive
Parkinsonia hybrid	Palo verde
Parkinsonia praecox	Palo brea
Parkinsonia florida	Blue palo verde
Parkinsonia microphylla	Foothills palo verde
Quercus virginiana	Southern live oak
Phoenix canariensis	Canary island pine
Pinus eldarica	Afghan pine
Pinus halepensis	Aleppo pine
Pinus roxburgii	Chir pine
Pistacia chinensis	Chinese pistache
Prosopis alba	Argentine mesquite
Prosopis chilensis	Chilean mesquite
Rhus lancea	African sumac
Salix laevigatum	Red willow
Ulmus parvifolia	Chinese elm
Washingtonia filifera	California fan palm
Washingtonia robusta	Mexican fan palm

Findings of Tree Health

Tree canopy health was assessed as very good or good for 66% of trees. Diseases and pests had a significant impact on tree canopy health with 55% of trees rated fair and 80% of trees rated poor having disease/pest problems. Diseases and pests detected included aphids, wood decay, Verticillium wilt, sooty canker and ash decline. Physical/mechanical injury to roots, stem or main scaffold branches was detected in half of the trees assessed and stress problems in approximately 20% of trees. The most common stress problem was sunburn damage to bark of the main trunk which occurred in 10% of trees

Literature Cited

Martin, CA and LB Stabler. 2002. Plant gas exchange and water status in urban desert landscapes. Journal of Arid Environments 51:235-254.

Stabler, LB and CA Martin. 2000. Temporal and spatial patterns of air temperature and CO_2 concentration in metropolitan Phoenix. Third Symposium on the Urban Environment 3:201-202.

Szarek, SR and RM Woodhouse. 1978. Ecophysiological studies of Sonoran Desert plants IV. seasonal photosynthetic capacities of *Acacia greggii* and *Cercidium microphyllum.* Oecolgia 37: 221-229.

This material is based upon work supported by the National Science Foundation under Grant No. DEB-0423704, Central Arizona - Phoenix Long-Term Ecological Research (CAP LTER). Any opinions, findings and conclusions or recommendation expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation (NSF).