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# Arid Zone Times

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## Shade Trees and Parking Lots

Parking lots occupy about 10 percent of the land in our cities and can be significant sources of heat, air pollutants, water pollutants, and visual blight. Because they are often located along the most heavily traveled streets, their landscaping influences scenic quality and community sense of place. Mature trees relieve the stark, barrenness of parking areas, and soften the architecture of large commercial buildings. Well-treed parking lots reflect a community's commitment to promoting quality of life for residents and visitors alike.

**Arid Zone Trees**

***Dedicated to providing quality trees to the landscape industry, that are appropriate to the desert Southwest.***

Parking lot tree shading provides environmental, as well as aesthetic benefits. Peak summer air temperatures can be 4-8 F cooler in lots that are well-shaded compared to those with no shade. Mini-urban heat islands that form over unshaded lots (i.e., the "dome" of elevated temperature) can adversely affect human health. Excessive heat aggravates respiratory illnesses, induces heat- strokes, and by reducing thermal comfort can increase stress and anti-social behaviors.

Additionally, as the air temperature heats up over the city there is an increase in photochemical smog and other pollutants, which lead to a degradation in air quality. By shading asphalt surfaces trees reduce air temperatures and the rate at which smog forms. By shading parked vehicles, trees reduce the emission of hydrocarbons that come from fuel tanks and hoses as gasoline evaporates. These evaporative emissions are a principal component of smog and parked vehicles are a primary source. Trees in parking lots provide other air quality benefits by intercepting particulate matter and absorbing ozone, nitrogen dioxide, and sulphur dioxide gases. The average annual value of all air quality benefits are estimated to be about $25-35 for a healthy parking lot tree in Sacramento, California.

By significantly reducing the amount of heat generated in unshaded lots, shade trees reduce energy used for cooling in urban areas. Elevated temperatures associated with unshaded lots can influence air temperatures in neighborhoods up to one-quarter mile downwind. Hence, parking lot tree shade can conserve air conditioning energy usage by on-site buildings and, to a lesser extent, in surrounding neighborhoods. By sequestering carbon dioxide ($CO_2$) as they grow and reducing $CO_2$ emissions from power plants through energy conservation, parking lot trees contribute to global efforts to reduce greenhouse gas emissions and mitigate climate change. Atmospheric $CO_2$ removal and cooling savings provided by a healthy parking lot tree in Sacramento is valued at $10-15 per year.

Parking lots exert a greater water quality impact than most other land surfaces. They accumulate pollutants deposited from the atmosphere and produce greater levels of petroleum hydrocarbons and trace metals (e.g., cadmium, copper, lead, zinc) than most other urban land uses. Trees intercept rainfall and store it in their crowns, thereby reducing runoff volume. Planting islands and perimeter landscaping can capture and treat runoff if designed as concave-shaped swales instead of convex- shaped berms. Through bioremediation of runoff, vegetation is one of the most cost-effective best management practices for controlling water pollution from parking areas.

### Davis Parking Lot Shade Study

In 1977 the City of Davis Parking Lot Shading Ordinance was established requiring that 50% of paved parking lot surfaces be shaded by tree canopies within 15 years of development. The primary intent of the ordinance was to lower air temperatures and improve the lots' visual and aesthetic characteristics. The Davis ordinance served as a model for other Central Valley cities such as Sacramento, Woodland, and Modesto. The objective of this study was to quantify whether a sample of lots in Davis complied with the ordinance.

### Methods and Results

Five parking lots were selected to include public and privately owned lots and based on availability of information on their landscape. Property owners and landscape managers were surveyed to determine each lots' age, design, and management characteristics. All trees were inventoried to identify species, size, condition, and management needs. Color infrared photographs taken August 18, 1995 were digitized and classified to obtain the percentage of paved area shaded by existing tree canopy cover. Area shaded was projected at year 15 for two lots less than 15 years old using a typical growth rate of 0.35 m crown spread per year. An overlay was created based on original landscape plans to show the



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planned mature size of trees. Compliance was assessed as the difference between the percentage of area shaded after 15 years and the 50% target stated in the ordinance.

Current shade coverage ranged from 8 to 45% of paved area with none of the parking lots meeting the 50% target. In fact, none of the original designs showed 50% shading (18-47%). Our analysis of the ordinance indicates that compliance could be increased if the following issues are addressed: **1)** More precise definition of "paved area" and "shaded paved areas" in relation to shade from surrounding structures, street trees, and planters within the lot; **2)** More specific guidelines in the ordinance to insure that appropriate tree species are selected (e.g., high branching, strong-wood, little litter,and tolerant to drought, diseases, and pests,) and tree spacing realistically reflects growth rates given site conditions and management soil environment supports healthy and vigorous tree growth (e.g., adequate soil volume, permeability, and irrigation) tree maintenance is geared towards achieving compliance (e.g., dead trees are replaced, removal of ties and stakes, trees are not topped but rather pruned for safety and shade, regular mulching, irrigation, fertilization) **3)** Incentives for compliance or punishment for noncompliance are clearly stated in the ordinance; **4)** Responsibility for ordinance enforcement is formally identified within city government and stipulated in the ordinance. **5)** Educational programs inform property owners and landscape managers about rationale for the ordinance and specifics of its implementation.

In September, 1997 the Davis Planning Commission approved changes to the ordinance that clarify computation of shaded area, improve tree root environments, and update the tree list. Planning staff and scientists at the Center are developing a more comprehensive list of changes for future consideration.

**Effects of Tree Shade on Evaporative Hydrocarbon Emissions from Parked Cars**

Smog is a summertime health hazard in Sacramento and motor vehicles are the primary source of smog-forming chemicals (over 65%). Hydrocarbons escape from worn components of the fuel delivery system such as cracked hoses and saturated canisters in parked cars. Like any volatile liquid, gasoline evaporates as temperatures rise, and on a sizzling summer day temperatures on unshaded asphalt can reach 160 F. Parked cars account for nearly 20% of the hydrocarbon emissions from vehicles. In turn, vehicles make up roughly 30% of total hydrocarbon emissions in the atmosphere. On any given summer day, thousands of motor vehicles sit in poorly shaded parking lots, creating pollutant "hot spots." Through direct shading and transpirational cooling, a healthy tree canopy can cool parking lots and reduce evaporative hydrocarbon emissions from parked vehicles. Initial calculations indicate that planting trees in parking lots throughout the region could reduce hydrocarbon emissions comparable to the levels achieved through the clean fuels program (e.g., compressed natural gas buses, low emission fleets). This pilot study is the first to examine relations between shade tree impacts on parking lot microclimate and evaporative hydrocarbon emissions from parked vehicles.

Measured microclimate data from parking lots with contrasting amounts of shade tree cover are used as inputs to a motor vehicle emissions model. Model runs will quantify vehicle hydrocarbon evaporative emissions under contrasting shade regimes. Model results will be used to evaluate the potential for parking lot trees to improve air quality. By understanding the relations between tree canopy cover, parking lot microclimate, and hydrocarbon evaporative emissions, results will help to (1) augment ordinances and strategies to reduce air pollutant emissions and (2) foster new partnerships between air quality agencies, local government, business, landscape professionals, and NGOs.

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