Public Health Benefits of Urban Trees

Increasingly tree plantings and urban forestry programs are used not only for aesthetic and environmental reasons but also to provide health benefits to urban and suburban communities. The public health benefits of trees are direct and indirect. Direct benefits include clean air, clean water, protection form harmful UV rays, and the positive psychological effects associated with the proximity of natural environments. Indirect benefits include a more active lifestyle linked to increased outdoor activity. A growing body of local, national and international research suggests that a lack of near proximity to nature may be associated with numerous deleterious conditions such as asthma, childhood obesity, and childhood diabetes. Research also indicates possible association with behavior disorders, depression, and a diminished sense of place and community. Heightened health problems, higher stress, higher aggression, reduced cognitive and creative capacities, lower school achievement, blighted sense of efficacy, and diminished productivity are among the possible associated negative impacts.

Section A presents a selection of academic papers which conclusions support the link between trees and individual and public health. Section B and C present currently available data on the benefits of trees in Palo Alto and East Palo Alto, CA, two communities that Canopy serves. Section D lists a selection of hyperlinks to additional resources.

A. Academic research presenting evidence on the benefits of urban trees on public health

1. Clean air

Air pollution is a serious health threat to many people living in cities, causing asthma, coughing, headaches, respiratory heart disease, and cancer. Air pollution is caused by elevated levels of ozone (O3), dust and other small particulate matter (PM10) as well as other toxic gases. Locally, San Mateo, and Santa Clara Counties have been designated 'nonattainment areas for the 8-hour O3' as they exceed O3 safe levels, and East Palo Alto has the highest rate of asthma-related hospitalization in San Mateo County.

In San Mateo County, East Palo Alto's children suffer disproportionately from asthma. According to the Stanford University Medical Center's Department of Emergency Services, in 2004, 10.9% of East Palo Alto children five years old or younger and 9.8% of children from six to eighteen years old were diagnosed with asthma. A 2005 community survey found that 14% of respondents suffered from asthma, compared to 6.7% in San Mateo County. According to kidsdata.org, just 7.1% of seventh-grade students in East Palo Alto met six of ten fitness standards, compared to 37.3% for San Mateo County as a whole. About 17.5% of families and 19.2% of the population were below the poverty line, including 18.6% of those under age 18.

The U.S. Environmental Protection Agency (EPA) recognizes tree planting as a measure for reducing O3. Air quality management districts in California have funded tree planting projects to control PM10 and other air pollutants. These policy decisions are creating new opportunities to plant and care for trees as a method for controlling air pollution. Urban forests provide multiple air quality benefits, including, but not limited to:

- Absorbing gaseous pollutants (e.g., O3, nitrogen dioxide [NO2], and sulfur dioxide [SO2]) through leaf surfaces
  - Gina Schellenbaum Lovasi, James W Quinn, Kathryn M Neckerman, Matthew S Perzanowski, and Andrew Rundle. Columbia University. 2007. Children living in areas with more street trees have lower asthma prevalence. J Epidemiol Community Health. 0: jech.2007.071894v1.
  - Nowak, D.J.; Civerolo, K.L.; Rao, S.T.; Sistla, G.; Luley, C.J.; Crane, D.E. 2000. A modeling study of the impact of urban trees on ozone. Atmospheric Environment. 34: 1601–1613.
- Intercepting PM10 (e.g., dust, ash, pollen, smoke)
  - Nowak, D.J.; Crane, D.E.; Stevens, J.C. 2006. Air pollution removal by urban trees and shrubs in the United States. *Urban Forestry and Urban Greening*. 4: 115–123.
  - Smith, W.H.; Dochinger, L.S. 1976. Capability of metropolitan trees to reduce atmospheric contaminants. In: Santamour, F.S.; Gerhold, H.D.; Little, S., eds. Better trees for metropolitan landscapes. Gen. Tech. Rep. NE-22. Upper Darby [Newtown Square], PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 49–60.
- Releasing oxygen through photosynthesis
  - McPherson, E.G. 1997. Airing it out. Spring Update. Davis, CA: U.S. Department of Agriculture Forest Service, Pacific Southwest Research Station, Center for Urban Forest Research. 4 p.

2. Shading and cooling

When school campuses are devoid of trees, the temperature of buildings and playgrounds rises rapidly. A sea of black top under our climate causes an exacerbated heat island effect. Recess and lunchtime are uncomfortable when temperatures are high, there is no place to hide from the sun, and play equipment too hot to touch. Trees play a simple but essential role by cooling the atmosphere through shade and evapo-transpiration.

Over-exposure to ultra violet radiation (UVR), especially in childhood, leads on to cancer. In fact, one blistering sunburn during childhood can double the risk of cancer.[1] UVR has also been linked to cataracts, suppression of the body's immune system and the development of allergies.[2]

Children and youth are particularly vulnerable because they rarely demonstrate 'shade seeking' behavior. At school, children can spend up to 25% of their time outdoors, typically during the period of highest UVR exposure — between 10 a.m. and 4 p.m. One of the most effective means of protecting students from UVR is to plant shade trees where they play and congregate - around playground equipment, near asphalt play areas, and along sports fields. Citations in five related categories include:

- Shade, cooling and protection form UV rays
  - Heisler, G.M.; Grant, R.H.; Grimmond, S.; Souch, C. 1995. Urban forests—cooling our communities? Kollin, C.; Barratt, M., eds. Proceedings: 7th national urban forest conference. Washington, DC: American Forests: 31-34.
  - Akbari, H.; Davis, S.; Dorsano, S.; Huang, J.; Winnett, S., eds. 1992. Cooling our communities: a guidebook on tree planting and light-colored surfacing. Washington, DC: U.S. Department of the Interior, Environmental Protection Agency. 217 p
- Urban heat island effect
  - Rosenzweig, C.; Solecki, W.D.; Slosberg, R.B. 2006. Mitigating New York City's heat island with urban forestry, living roofs, and light surfaces; final report for New York State Energy Research and Development Authority; contract 6681. New York, NY: Columbia University Center for Climate Systems Research & National Aeronautics and Space Administration/Goddard Institute for Space Studies. 156 p

3. Individual and community well being

There is growing interest in the public health benefits from the presence of nature and trees in the urban environment. Research is being conducted on several aspects of these benefits including creating environments conducive to an active lifestyle, reducing stress and violence, and positively affecting behavior.

- Create spaces fit for active and passive recreation to combat obesity
  - Fielding, J.E. M.D., Increasing Physical Activity: A Report on Recommendations of the Task Force on Community Preventive Services, Centers for Disease Control and Prevention, October 26, 2001, p.1.

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1 S. Graham, J. Marshall, B. Haughey et al., "An inquiry into the epidemiology of melanoma," *American Journal of Epidemiolog*y 1985.122:606-19.

2 World Health Organization Fact Sheet # 261, Protecting Children from UVR (July 2001). Available at www.who.int/mediacentre/factsheets/fs261/en/

        - Katz, D. L. MD. Public Health Strategies for Preventing and Controlling Overweight and Obesity in School and Worksite Settings: A Report on Recommendations of the Task Force on Community Preventive Services. , Centers for Disease Control and Prevention, October 7, 2005, p.2
    - Decrease physical and emotional stress
        - Dwyer, J.F.; Nowak, D.J.; Noble, M.H.; Sisinni, S. 2000. Connecting people with ecosystems in the 21st century: an assessment of our nation's urban forests. PNW-GTR-490. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 483 p.
        - Ulrich, R.S. 1984. View through a window may influence recovery from surgery. Science. 224: 420-421.
    - Reduce violence
        - Kuo, F.E., & Sullivan, W.C. (2002).Environment and crime in the inner city: Does vegetation reduce crime? Environment & Behavior, 33(3), 343-367: Residents living in greener surroundings report lower levels of fear, fewer incivilities and less violent behavior. The study also found that the greener a building's surrounding, the fewer reported crimes.
        - Kuo, F.E. & Sullivan W.C. (2001). Aggression and violence in the inner city: Impacts of environment via mental fatigue. Environment & Behavior, 33(4), 543-571. Women who lived in apartment buildings with trees and greenery immediately outside reported committing fewer aggressive and violent acts against their partners in the preceding year than those living in barren but otherwise identical buildings. Exposure to green surroundings reduces mental fatigue and the feelings of irritability that come with it. The ability to concentrate is refreshed by green views, along with the ability and willingness to deal with problems thoughtfully and less aggressively.
    - Effect on girls decision making
        - Faber Taylor, A., Kuo, F.E., & Sullivan, W.C. (2002). "Views of Nature and Self-Discipline: Evidence from Inner City Children." Journal of Environmental Psychology, 22, 49-63. Girls who lived in apartments with greener, more natural views scored better on tests of self-discipline than those living in more barren but otherwise identical housing. Girls who grew up with greener views showed better concentration, exhibited less impulsive behavior, and were better able to postpone immediate gratification. In turn, self discipline also help girls make thoughtful choices and perform better in school.
    - Effect of green settings on ADD:
        - Faber Taylor, A., Kuo, F.E., & Sullivan, W.C. (2001). "Coping with ADD: The surprising connection to green play settings." Environment and Behavior, 33(1), 54-77. Human-Environment Research Laboratory at the University of Illinois, Urbana-Champaign. Results indicate that children function better than usual after activities in green settings and that the "greener" a child's play area, the less severe his or her attention deficit symptoms.

- Kuo, F.E. (2001). Coping with poverty: Impacts of environment and attention in the inner city. *Environment & Behavior*, 33(1), 5-34. Exposure to green surroundings refreshes the ability to concentrate, leading to greater effectiveness at coping with major life issues. And, in this study, even small amounts of greenery—a few trees and a patch of grass—helped inner city residents to feel and do better.

B. Benefits of the Canopy East Palo alto Tree Initiative plantings

In 2006 Canopy launched the East Palo Alto Tree Initiative to plant 1,000 trees in East Palo Alto before 2010. The goal was achieve in 2008. The table below models the expected benefits of these trees over 40 years. These were calculated by the U.S. Forest Service Urban Forest Research Center at UC Davis for the initial 961 trees.

Tree Species for Use in East Palo Alto

Tree Numbers	487 Small		303 Med		112 Large		59 Conifer		961 Total	
Benefit Type	RU	$	RU	$	RU	$	RU	$	RU	$
Cooling (kWh)	1,519,440	323,173	1,090,800	231,371	654,080	138,925	398,840	85,243	3,663,160	778,712
Heating (kBtu)	3,155,760	54,349	2,230,080	38,420	1,227,520	21,190	1,158,760	20,013	7,772,120	133,973
Net Energy	18,311,200	377,522	13,089,600	269,912	7,745,920	160,115	5,158,960	105,256	44,305,680	912,806
Net CO2 (lb)	623,360	2,143	921,120	3,030	286,720	941	276,120	920	2,107,320	7,034
O3	3,117	3,117	1,939	1,818	1,165	1,165	873	873	7,094	6,973
NO2	1,558	1,558	848	848	538	538	496	496	3,440	3,440
SO2	195	390	121	242	90	179	71	142	476	953
PM10	6,623	11,104	1,697	2,788	1,478	2,509	755	1,251	10,554	17,651
VOC	0	0	0	0	0	0	0	0	0	0
BVOC	0	0	0	0	0	0	-802	-307	-802	-307
Net Air Quality	11,493	16,168	4,606	5,818	3,270	4,346	1,416	2,454	20,785	28,786
Interception (gal)	8,181,600	44,999	4,472,280	24,604	3,015,040	16,576	3,948,280	21,712	19,617,200	107,890
Aesthetics/Other		453,105		489,527		392,090		281,477		1,616,198
Total Benefit ($)		893,937		792,890		574,067		411,820		2,672,715
Assumes 35% mortality rate over 40 year period										
Total 40-yr benefit	$ 2,672,715									
$/tree planted	$ 2,781.18									
$/year/tree	$ 69.53									

C. Benefits of the Palo Alto urban forest

It is estimated that the Palo Alto urban forest (urban areas only, no open space) is composed of approximately 164,000 trees. Calculations prepared by Canopy based on available data from the U.S. Forest Service Urban Forest Research Centers indicate that: Palo Alto's urban forest neutralizes the CO_2 emissions of about 2,000 cars a year

Palo Alto's canopy ensures that summer temperatures are at least 6 to 8 degrees lower than in comparable neighborhoods without trees
Palo Alto's urban forest provides enough oxygen to fulfill the needs of all Palo Alto residents

D. Additional resources

U.S. Department of Agriculture Forest Service Urban and Community Forestry – Trees for People:
http://www.fs.fed.us/ucf/treesforpeople.html
Warwick District Council: The Benefits of urban Trees: A summary of the benefits of urban trees accompanied by a selection of research papers and pamphlets:
http://www.naturewithin.info/UF/TreeBenefitsUK.pdf

The Outdoor Foundation: Research studies links:
http://www.outdoorfoundation.org/youth.toolkit.research.html

University of Washington Human Dimensions of Urban Forestry and Urban Greening: Research Studies Links:
http://www.naturewithin.info/urban.html

Colorado Tree Coalition Air Quality Tree Benefits in Urban Areas
http://www.coloradotrees.org/benefits.htm#Air Quality and Trees