



Paula J. Peper Historical Environmental Research
3790 Las Pajas Way, Sacramento, CA 95864 Phone: 916-359-8003 Email: ppeper@surewest.net

August 10, 2017

To: Richard Cowan, PE, Chair
California Historic State Capitol Commission

Re: Capitol Park Tree Ecosystem Service Assessment and Recommendations

At the request of the Historic State Capitol Commission, I conducted a two-fold assessment of the Capitol Park tree population from January 18 through May 31, 2017 with recommended actions to insure both the continued tree canopy cover and the historic basis of the park. The requested assessment components were as follows:

1. Conduct a park tree resource analysis to include:
 - a. Species richness, composition and diversity
 - b. Age structure and overall tree condition
 - c. Ecosystem services provided by the trees
 - d. Replacement value
2. Recommendations to insure continued canopy cover and unique historic species diversity

My credentials for conducting this work include over 20 years as an urban ecologist and biometrician for the US Forest Service Pacific Southwest Research Station's Center for Urban Forest Research conducting municipal forest resources analyses and management recommendations for cities across the United States from Hilo, Hawaii to New York City and Orlando, Florida. Published reports from some of this work may be accessed at

https://www.treearch.fs.fed.us/search.php?in_words_phrases=&in_author=Peper&in_title=&filterByDate=1&in_pub_year_start=1993&in_pub_year_end=2017.

Key recommendations are listed first, with support data and individual resource analyses following. These recommendations are based on the assumption that the State Legislature wishes to insure the historic, arboretum quality of the park for future generations.

Key Recommendations:

- Current asset value of the trees is \$5.8 million (cost to replace). However, based on tree ages, 30% of population is senescent, 30% of population is conifer and highly impacted by drought, park is likely to lose 25-30% of trees within next 20 years. Over 10% have been lost in the past 4 years. A 50-year Tree Management Plan should be developed to insure tree canopy.
- Note that a management plan does NOT limit building or development in park, but provides resources and guidance for systematic tree preservation, removal, and care. At a minimum, this plan should include:
 - 50-year removal and replacement plan with propagation resources for unique and rare species
 - Public safety section to insure long-term, consistent funding for biannual tree risk inspections and 3-person tree crew dedicated to the park
 - Hiring and funding freezes through the decades have detrimentally affected the trees due to lack of appropriate and timely care

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- Employ ANSI Standard best management practices for structural pruning of newly planted and young trees (greatly reduces future costs)
- Analysis by California experts on effects of reclaimed water on aged, historic and rare species (a very limited and general analysis was conducted by Stantec for DGS)
- Recommended grouping of new plantings by water needs
 - Removal of some members of the 10 dominant species that are high water users and replace with low-to-medium water use trees
- Purchase and train employees in use of a 21st century tree inventory and care database capable of tracking individual tree risk assessments, work conducted on each tree, and prioritizing daily tree work schedules

Note that California is home to many internationally known urban tree experts, specialists in common and rare species, propagation, effects of reclaimed water, ecosystem service assessment, and tree management plan development. Their expertise would be invaluable in developing a management plan.

Park Resource Analysis Components

Species Richness, Composition and Diversity

These 849 trees represent a rare diversity for a small 40 acre park. There are 210 unique species. However, 97 of these species are represented by only one specimen and many of these are over-mature, needing constant care. Another 67 species are have only 2 specimens.

The table below shows current number of trees in each size class for the 10 dominant species present in the park. These 10 species account for 33% of the trees in the park

Species	Diameter-at-breast height (inches)									Total
	0 - 3	3 - 6	6 - 12	12 - 18	18 - 24	24 - 30	30 - 36	36 - 42	> 42	
Coast redwood	0	0	1	14	9	4	3	6	23	60
Southern magnolia	0	0	4	5	2	2	6	11	7	37
California palm	0	0	0	0	0	2	25	1	0	28
Flowering dogwood	5	20	2	0	0	0	0	0	0	27
Japanese maple	4	9	8	1	0	1	0	0	0	23
Yew pine	0	8	6	1	4	2	0	0	0	21
European fan palm	0	0	20	0	1	0	0	0	0	21
Valencia orange	0	2	6	4	5	2	0	0	0	19
American elm	0	3	10	3	1	1	0	0	0	18
European white birch	0	0	1	13	0	0	1	0	3	18
% of Park Total	2.83	15.67	23.32	14.61	7.66	6.24	8.36	7.18	14.13	272

Assessment:

- Species diversity indicates park is of arboretum quality with many of the older specimens currently rare and endangered in their native lands
- This is a fragile resource where species richness and diversity can easily be compromised
 - Many of the unique species are senescent and have no replacement on hand
- A removal and replacement plan should be developed to cover the next 25 years (50 is recommended)
- Trees from some of the dominant species that are also water-hungry can be removed to make room for replacements of more unique species that will be lost within the next two decades

Age Structure and Condition

Because ages were not available for all trees, diameter-at-breast height (dbh) of trees is commonly used as an indicator of relative age. Key points:

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- About 30% of trees are greater than a 30-in dbh, indicating mature to senescent condition and the need for biannual (or more) risk assessment and pruning
 - These are the trees that form the major canopy cover over the park and also potentially pose the most risk to the hundreds of thousands of park visitors annually should there be more limb or tree failures
- Walk-through assessment of the population indicates inconsistent care over the lifespan of these trees, but significant improvement in care over the past few years
- Tree crew today is working to correct many structural issues caused by prior periods of inconsistent care and the past 5 years of drought followed by a very wet winter
- Approximately 42% of the trees are small-statured, commonly understory trees beneath larger canopied specimens
- Young trees have lacked early structural pruning that would greatly reduce future care needs and associated costs while insuring longer lifespans
- Over 10% of trees have failed and been removed due to drought impact in the past 4 years
- Conifers continue to suffer most from the effects of drought and associated water reduction
 - Nearly 30% of the park tree population is conifer

Assessment:

- Continued biannual risk assessment with follow-up pruning is a must
 - Consistent care has been limited due to budget restrictions and hiring freezes
- Due to tree age, condition and the compounding effects of drought it is likely that 20-30% of trees will fail or require removal over the next 30 years

Table below provides number of trees in each dbh size class for each tree type as well as percent of total population by size class:

Species Type	Diameter-at-breast height class (inches)									Total
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42	
Broadleaf Deciduous Large (BDL)	2	7	17	15	7	9	13	13	10	93
Broadleaf Deciduous Med (BDM)	0	16	19	29	1	8	4	1	4	82
Broadleaf Deciduous Sm (BDS)	15	54	44	8	2	2	0	2	2	129
Broadleaf Evergreen Large (BEL)	0	10	10	6	4	7	3	2	7	49
Broadleaf Evergreen Med (BEM)	0	1	13	9	7	2	7	15	20	74
Broadleaf Evergreen Sm (BES)	4	30	31	10	6	6	0	2	1	90
Conifer Evergreen Large (CEL)	3	5	16	25	24	17	17	24	70	201
Conifer Evergreen Med (CEM)	0	1	1	1	0	0	1	0	4	8
Conifer Evergreen Sm (CES)	0	0	8	1	0	2	26	2	1	40
Palm Large (PEL)	0	7	11	13	1	0	0	0	1	33
Palm Med (PEM)	0	2	4	0	0	0	0	0	0	6
Palm Sm (PES)	0	0	24	7	13	0	0	0	0	44
Totals	24	133	198	124	65	53	71	61	120	849
% of total population	2.8	15.7	23.3	14.6	7.7	6.2	8.4	7.2	14.1	100.0

Ecosystem Services Provide by Capitol Park Trees

Analysis was conducted using i-Tree Streets (<http://www.itreetools.org/streets/>). This is a free, downloadable software tool developed by the US Forest Service. Although the title is misleading, it covers trees in parks as well. The most recent Capitol Park tree survey was supplied by DGS contractor ECORP Consulting, Inc. on January 18, 2017. The inventory included 864 trees of 210 unique species. After omitting non-trees (bamboo, groves not listing individual trees), the data run included 849 trees representing 197 unique species.

- Carbon stored: 4.1 million lbs/yr

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- Carbon dioxide removed from atmosphere: 203,000 lbs/yr
- Energy savings: 135 Mega-watt hours/yr
- Stormwater reduction: 1.3 million gal of rain intercepted/yr
- Air pollutant removal: 655 lbs/yr
- Natural gas use reduction: 548 therms/yr
- Property value increase: \$83,905/yr
- Economic benefit of all savings: \$159, 210/yr

The table below provides detail of resource units saved by trees by park zone:

Zone	Total Electricity (MWh)	Total Natural Gas (Therms)	Total rainfall interception (Gal)	Total stored carbon (lbs)	CO₂ Net Total (lb)	Air Pollutant Total (lb)
1 South	6	23	80,070	228,860	9,240	79
2 North East	9	52	89,345	265,358	17,270	61
4 North	12	37	96,957	261,685	18,170	102
3 North	15	39	106,202	347,424	18,614	- 40
4 South	14	38	138,751	405,886	18,786	157
5 South	15	65	146,106	478,550	23,712	113
3 South	16	76	133,364	438,047	22,371	134
2 South West	9	39	87,038	307,932	15,108	- 63
2 North West	7	40	70,425	257,750	11,063	- 64
2 South East	11	54	102,343	360,922	18,529	25
5 North	12	39	119,981	431,024	15,347	41
1 North	9	46	114,289	342,334	14,404	110
Total	135	548	1,284,872	4,125,771	202,613	655

Assessment:

This is a significant underestimation the services provided by the Capitol Park trees for these reasons:

- At least 30% of Capitol Park trees are larger than the growth equations allow in iTree, so values are capped far below what actual tree size would allow
- No adjustment available in iTree for significance of historic trees
- No adjustment available in iTree for rare species
- No adjustment available in iTree for social/health benefits to park visitors/users

Replacement Value

Replacement value accounts for the long-term investment in trees now reflected in their number, stature, placement and condition. Based on the trunk formula method, this is the cost of replacing existing trees with trees of similar size, species and condition if all were destroyed, for example, by a catastrophic storm or a decision to remove trees for construction of buildings.

The table below shows replacement value by park zone. Two zones highlighted represent those areas that could be impacted by construction/expansion of the East Wing. Those two zones represent nearly one-quarter (25%) of the replacement value for all trees in the park.

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Replacement Value		
Zone	Total (\$)	% of Total
1 South	287,694	5.0
1 North	437,690	7.5
2 North East	335,736	5.8
2 North West	361,996	6.2
2 South East	456,038	7.9
2 South West	384,223	6.6
3 North	691,744	11.9
3 South	699,535	12.0
4 North	459,606	7.9
4 South	614,835	10.6
5 North	532,581	9.2
5 South	546,625	9.4
Park-wide Total	5,808,301	100.0

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Additional details and results from my analyses are available upon request along with the slide presentations of results shown to the Commission in April and DGS Park Grounds employees in May.

Sincerely,

Paula J. Peper