Table 6.1. Polygons from the GAP database selected for field survey during the summer of 1999, with data for species composition, abundance and relative ranking of each polygon.

Polygon I.D.	Area (ha)	Primary, Secondary, Or Tertiary	Predicted Species Assemblage	Assemblage Cover (%)	Crown Closure (%)	Rank By Isoprene	Rank By Monoterpene
SN Iso 58 Mono 373	1380	P	*Pinus ponderosa, Quercus wislizenii, and Quercus kellogii*	60 – 70	40 – 59	58	373
		S	*Quercus wislizenii, Quercus garryana, and Cercocarpus betuloides*	30 – 40	40 – 59		
		T	None	0	0		
SN Iso 471 Mono 686	190	P	*Quercus kelloggii, Pinus ponderosa, and Abies concolor*	60 – 70	10 – 24	471	686
		S	*Quercus kelloggii, Quercus wislizenii, and Pinus ponderosa*	30 – 40	25 – 39		
		T	None	0	0		
SN Iso 737 Mono 1044	640	P	*Avena sp. and Bromus sp.*	50 – 60	25 – 39	737	1044
		S	*Quercus douglasii, and Pinus sabiniana*	30 – 40	10 – 24		
		T	*Adenostoma fasciculatum*	10 – 20	40 – 59		
SN Iso 1232 Mono 129	4460	P	*Pinus ponderosa*	80 – 90	0	1232	129
		S	*Adenostoma fasciculatum*	10 – 20	0		
		T	None	0	0		
SN Iso 1154 Mono 543	310	P	*Eriogonum fasciculatum and Yucca whipplei*	50 – 60	0	1154	543
		S	*Juniperus californica, Eriogonum fasciculatum, and Yucca whipplei*	30 – 40	0		
		T	*Artemisia tridentata, Eriogonum fasciculatum, and Chrysothamus nauseosus*	10 – 20	0		
GV Iso 15 Mono 48	151	P	*Avena sp. and Bromus sp.*	50 – 60	0	15	48
		S	*Populus fremontii, Salix sp., and Quercus lobata*	30 – 40	0		
		T	None	10 – 20	0		
GV Iso 45 Mono 84	860	P	*Distichlis spicata*	70 – 80	0	45	84
		S	*Populus fremontii and Distichlis spicata*	20 – 30	0		
		T	None	0	0		
GV Iso 64 Mono 27	260	P	*Allenrolfea occidentalis*	80 – 90	60 – 100	64	27
		S	*Eucalyptus sp., Populus fremontii, and Allenrolfea occidentalis*	10 – 20	60 – 100		
		T	None	0	0		
GV Iso 594 Mono 594	250	P	*Atriplex polycarpa, Avena sp., and Bromus sp.*	90 –100	0	594	594
		S	None	0	0		
		T	None	0	0		

Table 6.2. Polygons from the GAP database selected for field survey during the summer of 2000, with data for species composition, abundance and relative ranking of each polygon.

Polygon I.D.	Area (ha)	Primary, Secondary, Or Tertiary	Predicted Species Assemblage	Assemblage Cover (%)	Crown Closure (%)	Rank By Isoprene	Rank By Monoterpene
SN Iso 48 Mono 709	2680	P	*Quercus douglasii and Quercus kelloggii*	60 – 70	10 – 24	48	709
		S	*Quercus wislzenii, Aesculus californica, and Quercus douglasii*	30 – 40	10 – 24		
		T	None	0	0		
SN Iso 240 Mono 942	640	P	*Cercocarpus betuloides, Quercus chrysolepis, and Arctostaphylos mewukka*	90 – 100	40 – 59	240	942
		S	None	0	0		
		T	None	0	0		
SN Iso 139 Mono 154	2500	P	*Pinus ponderosa, Calocedrus decurrens, and Abies concolor*	50 – 60	40 – 59	139	154
		S	*Quercus chrysolepis, Aesculus californica, and Cercocarpus betuloides*	30 – 40	10 – 24		
		T	*Quercus chrysolepis and Pinus contorta*	10 – 20	40 – 59		
SN Iso 435 Mono 1088	340	P	*Quercus wislizenii, Quercus douglasii, and Aesculus californica*	50 – 60	25 – 39	435	1088
		S	*Quercus wislizenii, Quercus douglasii, and Pinus sabiniana*	30 – 40	10 – 24		
		T	*Avena sp., Quercus wislizenii, and Aesculus californica*	10 – 20	10 – 24		
SN Iso 1076 Mono 27	1010	P	*Pinus sabiniana, Avena sp. and Artemisia tridentata*	50 – 60	0	1076	64
		S	*Artemisia tridentata and Pinus sabiniana*	40 – 50	0		
		T	None	0	0		
SN Iso 630 Mono 1133	470	P	*Quercus douglasii*	70 – 80	25 – 39	630	1133
		S	*Adenostoma fasciculatum*	20 – 30	60 – 100		
		T	None	0			
SN Iso 315 Mono 630	640	P	*Quercus kelloggii, Pinus ponderosa, and Avena sp.*	50 – 60	10 – 24	315	630
		S	*Quercus douglasii*	40 – 50	40 – 59		
		T	None	0	0		
SN Iso 225 Mono 1194	1960	P	*Quercus douglasii*	80 – 90	40 – 59	225	1194
		S	*Quercus douglasii, Avena sp., and Bromus sp.*	10 – 20	25 – 39		
		T	None	0	0		
SN Iso 1333 Mono 1095	810	P	*Adenostoma fasciculatum*	60 – 70	0	1333	1095
		S	Unidentified chaparral shrubs	20 – 30	0		
		T	Bare exposed rocks	10 – 20	0		

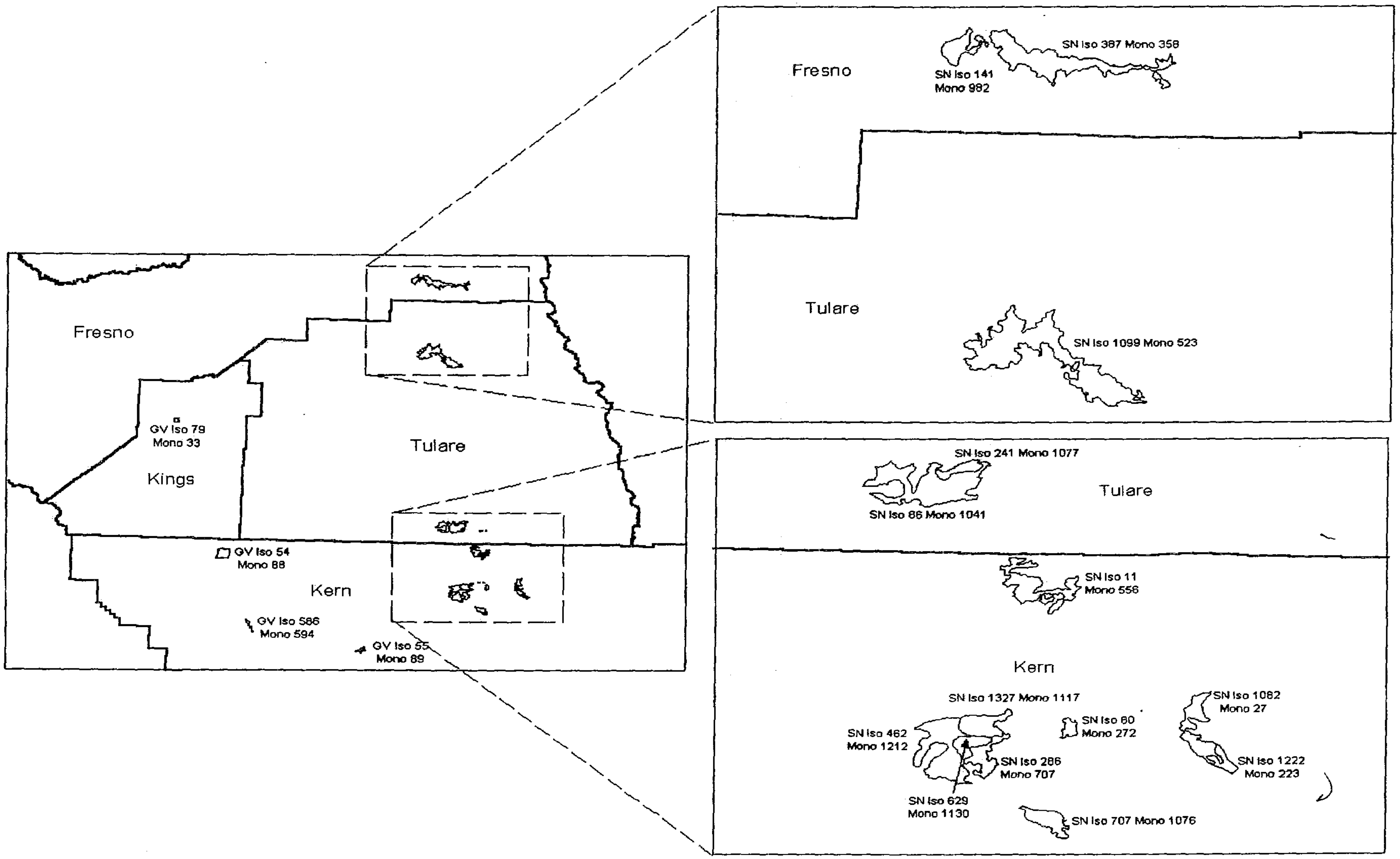

Figure 6-1. GAP polygons surveyed during 1999 and 2000 for plant species composition and dominance.

If permission was obtained to access most of a polygon, sample elements were selected by overlaying a 500 meter UTM grid on the polygon, assigning sequential numbers to every grid element within 1 km of a road, and randomly selecting the centerpoint locations for the needed number of 500 meter grid elements. The number of centerpoints and corresponding elements varied with polygon size. For polygon areas of <1000, 1000-10000, and >10000 ha, two, three, and four centerpoints were chosen, respectively. This method was similar to the one employed in the Utah GAP validation project (Edwards et al. 1995) and that of the study of Chung and Winer (1999). In several cases suitable survey sites were not available within the vicinity of a road, so hikes of up to two hours along a trail were needed to reach the desired area within the polygon.

6.3.4 Vegetation Survey Protocol

The vegetation survey protocol employed in this study was initially based on recommendations of 1 square kilometer sample units (Stoms et al. 1994). Because the GAP database is a large-area land cover map, use of a large sample element (e.g. 1 km^2) avoids quantifying heterogeneity below the intended resolution of the map. Stoms et al. (1994) noted other issues affecting vegetation surveying such as the need to obtain legal access from private landowners, safety, and proximity of sample sites to roads, but the specific shape of the vegetation survey unit was left unresolved in the guidelines. As mentioned earlier, the field survey protocol was subsequently developed and refined in an antecedent study in San Diego County (Winer et al. 1998, Chung and Winer 1999).

The survey team located the centerpoint of a particular sample element using a global positioning receiver (GPS) locked onto universal transmercator (UTM) coordinates gathered from the GAP database. A Garmin 12XL handheld GPS unit, with an accuracy of approximately ± 15 m or ± 5 m, in 1999 and 2000, respectively, was employed. Plant community and site descriptions were recorded and elevation at the centerpoint was determined using a hand-held altimeter (Model Alti Plus A2, Pretel).

In the present study, the specific survey protocol chosen depended on the type of vegetation being assessed. Within the polygons dominated by trees, surveys were performed by a team of two along 6 m wide, 500 m long belt transects orthogonal at the centerpoint in most elements. Six meter wide belt transects make the mechanics of sampling easier while not significantly compromising accuracy (Lindsey 1955). For these belt transects, the surveyors walked 250 m north, south, east, and west away from the centerpoint, using a magnetic compass to maintain course.

Within polygons dominated by scrub or chaparral, a team of two individuals performed surveys in each sample elements consisting of two 300 m line transects orthogonal at the centerpoints. Line transects have been used to estimate relative cover for chaparral (Bauer 1943) and for sage scrub (Kent and Coker 1992, Zippin and Vanderwier 1994).

6.3.5 Data Collection

For belt transects, one person of the survey team measured the crown radii and diameter at breast height of trees and the crown height of shrubs (plants with more than one stem), while another measured the crown height of trees (plants with one stem) and recorded the field data. Crown radii in trees were measured with a 10 m tape in the four cardinal directions. Two crown radii in shrubs were measured orthogonally. Measurements were made to the nearest 0.1 m. Crown height of trees greater than 8 m was obtained from a clinometer (Model PM-5/PC 66, Suunto Instruments) with a horizontal distance from the observer to the tree of approximately 10-20 meters, obtained to the nearest meter using an optical rangefinder (Model TLR 75, Ranging Bushnell), and the crown height measured as a percentage of the observer's distance away from the tree with the clinometer. For forested polygons (areas where crowns of trees interlocked), only data from plants greater than waist height (about 1 m) were recorded. For woodland polygons (areas where crowns of trees did not interlock), only plants greater than 0.6 m (about knee height) were recorded.

For line transects, one individual surveyed along the line transects using a 50 m tape noting species identity and measurements of the topmost plant species directly over the meter tape. The number of 0.1 m segments occupied by that plant species was recorded by the assistant, and the height of the crown was measured for each individual plant to the nearest 0.1 m. The crowns were envisioned as rectangular prisms and measured as such. The transects were completed using three 50 m segments in each cardinal direction. For scrub and chaparral, all plant species except understory species and grasses were recorded. Most plants were identified in the field, and samples of unidentified plants were taken to the UC Cooperative Extension laboratory for identification.

6.3.6 Data Analysis

Data analysis followed the example of Chung and Winer (1999). As noted earlier, the GAP GIS database provides semi-quantitative information on the abundance and distribution of plant species. For each polygon, the GAP database lists primary, secondary, and sometimes tertiary species assemblages and the estimated areal proportion (p) of each assemblage within a polygon. Each species in a listed assemblage is a co-dominant, providing $\geq 20\%$ relative cover within the assemblage. Therefore, the expected coverage of any species listed in the GAP database for a given polygon is then $\geq 0.2p$. For example, in polygon SN Iso 58 Mono 373, *Quercus kelloggi* is listed as a co-dominant in a primary assemblage that occupies 60-70% of the polygon. Using a mean value of 65% for p, GAP predicts *Quercus kelloggi* would cover more than 0.2 x 65% or $\geq 13\%$ of the polygon.

The polygon coverage of plant species inferred from the GAP database by this procedure was compared with the cover data gathered from the field surveys in the eighteen selected polygons. First, the coverage of each species within each sample element of a polygon was calculated. Then, from the species coverage for each sample element, the mean coverage and upper limit of the two standard error (SE) confidence intervals for the polygon were calculated, corresponding to an 85% confidence interval (McClave and Dietrich 1985).

Crown closure from the GAP database was also compared to the field data. Crown closure was equivalent to the percent coverage by all overstory plants within a polygon divided by the area of the polygon. A confidence interval within two SE was calculated from the field data and compared with the listing from the GAP database.

6.4 Results

6.4.1 Location and Description of GAP Polygons

As seen in Tables 6.3 and 6.4, and Figure 6.1, the GAP polygons studied were located in Kern, Fresno, Kings, and Tulare counties. The polygons sampled during the

Table 6.3. Locations for polygons sampled in the summer of 1999.

Approximate Location	Polygon Designation	Transect Type	Point #	UTM Coordinates	Elevation	North	South	West	East
Glennville	SN Iso 58 Mono 373	Belt	1	0354440E 3958495N	1600m 5250ft	250m	250m	250m	250m
			2	0354516E 3957515N	1500m 4920ft	250m	250m	250m	250m
			3	0353494E 3958989N	1450m 4760ft	250m	250m	250m	250m
Keysville	SN Iso 471 Mono 686	Belt	1	0356987E 3942531N	1600m 5250ft	250m	250m	250m	250m
			2	0357018E 3943505N	1570m 5150ft	250m	250m	250m	250m
			3	0357508E 3942944N	1550m 5085ft	250m	250m	250m	250m
Kern Canyon	SN Iso 737 Mono 1044	Belt	1	0354486E 3933011N	825m 2700ft	250m	250m	250m	250m
			2	0353972E 3933433N	750m 2460ft	250m	250m	250m	250m
			3	0353554E 3934047N	700m 2300ft	250m	250m	250m	250m
Sequoia National Park	SN Iso 1232 Mono 129	Belt	1	0341494E 4043484N	890m 2900ft	250m	250m	250m	250m
			2	0339496E 4048501N	1450m 4760ft	250m	250m	250m	250m
			3	0340500E 4046380N	1500m 4920ft	250m	250m	250m	250m
Bodfish	SN Iso 1154 Mono 543	Belt	1	0370487E 3938944N	1100m 3600ft	250m	250m	250m	250m
			2	0370044E 3939431N	1200m 3940ft	250m	250m	250m	250m
			3	0371522E 3938503N	1300m 4265ft	250m	250m	250m	250m
Kern National Wildlife Refuge	GV Iso 15 Mono 48	Line	1	0263605E 3958895N	66m 215ft	150m	150m	150m	150m
			2	0262995E 3957483N	64m 210ft	150m	150m	150m	150m
			3	0264010E 3957948N	66m 215ft	150m	150m	150m	150m
			4	0264494E 3956964N	68m 223ft	150m	150m	150m	150m
Yokuts Park (Kern River)	GV Iso 45 Mono 84	Belt	1	0311993E 3915512N	120m 390ft	250m	250m	250m	250m
			2	0312930E 3915997N	120m 390ft	250m		250m	
			3	0313976E 3916528N	120m 390ft	250m		250m	
Lemoore	GV Iso 64 Mono 27	Line	1	0248008E 4015490N	66m 215ft	150m	150m	150m	150m
			2	0247503E 4014995N	64m 210ft	150m	150m	150m	150m
			3	0247908E 4014491N	63m 206ft		150m	150m	50m
Buttonwillow	GV Iso 594 Mono 594	Line	1	0273875E 3925067N	83m 272ft	150m	150m	150m	150m
			2	0274847E 3923549N	80m 262ft	150m	150m	150m	150m

Table 6.4. Locations for polygons sampled in the summer of 2000.

Approximate Location	Polygon Designation	Transect Type	Point #	UTM Coordinates	Elevation	North	South	West	East
California Hot Springs	SN Iso 48 Mono 709	Belt	1	0345696E 3970295N	975m 3210ft			250m	250m
			2	0346499E 3969500N	910m 2990ft	250m	250m	250m	250m
			3	0344997E 3970496N	890ft 2920ft	250m	250m	250m	250m
			4	0348000E 3970001N	1200m 3950ft	250m	250m	250m	250m
Sequoia National Park	SN Iso 240 Mono 942	Belt	1	0330503E 4076503N	1245m 4080ft	250m	157m	250m	233m
			2	0331554E 4077442N	1290m 4250ft	200m	250m	250m	250m
Kings Canyon	SN Iso 139 Mono 154	Belt	1	0344994E 4074507N	1340m 4360ft	250m	250m		
California Hot Springs	SN Iso 435 Mono 1088	Belt	1	0345696E 3970295N	975m 3210ft	250m	250m		
			2	0346504E 3970504N	880m 2890ft	250m	250m	250m	250m
Lake Isabella	SN Iso 1076 Mono 27	Belt	1	0368519E 3945976N	845m 2770ft	250m	250m	250m	250m
			2	0367498E 3943496N	810m 2660ft	250m	250m	250m	250m
			3	0368506E 3940489N	880m 2890ft	250m	100m	250m	250m
Approx. 10 miles South of Alta Sierra	SN Iso 630 Mono 1333	Belt	1	0348463E 3941994N	1048m 3460ft	250m	250m	250m	250m
			2	0349503E 3942003N	1080m 3560ft	250m	250m	250m	225m
Approx. 10 miles South of Alta Sierra	SN Iso 315 Mono 630	Belt	1	0351008E 3941998N	1290m 4240ft	250m	250m		
			2	0349500E 3940037N	1380m 4530ft	250m	250m		
Approx. 10 miles South of Alta Sierra	SN Iso 225 Mono1194	Belt	1	0347992E 3937999N	1295m 4260ft			250m	250m
			2	0345005E 3943000N	875m 2890ft	250m	250m		
Approx. 10 miles South of Alta Sierra	SN Iso 1333 Mono 1095	Belt	1	0348998E 3942489N	1060m 3480ft			250m	250m
			2	0347996E 3943010N	995m 3270ft	250m	250m		

summers of 1999 and 2000 represented a variety of plant communities in several locales. The general descriptions of vegetation within these polygons ranged from seasonal wetlands on the valley floor (GV Iso 15 Mono 48) to forested lands high in the Sierra Nevada Mountain range (SN Iso 1232 Mono 129). Several polygons encompassed at least partial riparian habitats.

6.4.2 Species Composition and Abundance within GAP Polygons

Tables 6.5 and 6.6 summarize the overall data results for the 18 polygons, listing the most abundant species observed for each polygon, the percent composition predicted from the GAP database, the percent composition determined by the field surveys, and the upper limits of a two SE interval of the percent composition. Total polygon sample cover ranged from as little as 7% sample cover, as found in polygons SN Iso 1154 Mono 543 and GV Iso 45 Mono 84, up to 82% sample cover as found in polygon SN Iso 139 Mono 154.

In general, most of the sample cover was attributable to a few species. Many of the most abundant species found within the polygon were listed as co-dominants by the GAP database. The percentages of these co-dominant species varied greatly due to whether or not the species was present and due to the abundance of the particular species. Total co-dominant species sample cover ranged from as little as 0% as found in polygons GV Iso 15 Mono 48 and SN Iso 1333 Mono 1095 up to 66% sample cover as found in polygon SN Iso 139 Mono 154.

The observed sample cover of some co-dominants in GAP polygons often substantially exceeded the minimum predicted values (Tables 6-5 and 6-6). For example, in polygon SN Iso 139 Mono 154, *Quercus chrysolepis* provided 51% of the polygon sample cover when ≥ 7% and ≥ 3% were predicted by GAP for the secondary and tertiary assemblages, respectively. In polygon SN Iso 58 Mono 373 *Quercus kelloggii* provided 31% of the polygon sample cover when ≥ 13% was predicted by GAP. In contrast, several polygons possessed co-dominant species listed by GAP that were found to be well under the predicted GAP percentages. Polygon SN Iso 1154 Mono 543 was found to have 1% mean sample cover of *Yucca whipplei* when GAP predicted the species to have ≥ 11% and ≥ 7%

Table 6.5. Measured species cover composition observed in GAP polygons sampled in 1999.

Polygon	Genus Species	GAP Predicted Cover (%)	Mean Sampled Cover (%)	(s + 2SE)
SN Iso 58 Mono 373	*Quercus kelloggii*	≥13	31	41
	Quercus wislizeni	≥13	14	19
	Quercus garryana	-	6	17
	Calocedrus decurrens	≥7	5	9
	Cercocarpus betuloides	-	5	8
	Abies concolor	-	2	5
	Pinus ponderosa	-	1	2
	Quercus berberidifolia	-	1	1
	Ribes spp.	≥7	0.1	0.3
	Ceanothus integerrimus	≥13	0.1	0.2
	Arctostaphylos spp.	-	0.05	0.1
	Pinus sabiniana	-	0.04	0.1
	Total of sample cover		65	
	GAP co-dominants		50	
SN Iso 471 Mono 686	*Quercus kelloggii*	≥13 & ≥7	14	29
	Pinus ponderosa	≥13 & ≥7	6	13
	Arctostaphylos sp.	-	5	11
	Quercus chrysolepis	-	4	10
	Abies magnifica	-	3	6
	Calocedrus decurrens	-	2	7
	Abies concolor	≥13	1	3
	Cercocarpus betuloides	-	1	2
	Quercus wislizenii	≥7	1	1
	Salix sp.	-	0.4	1.3
	Pinus lambertiana	-	0.4	0.8
	Helianthemum scoparium	-	0.2	0.6
	Adenostoma fasciculatum	-	0.2	0.6
	Ribes sp.	-	0.2	0.4
	Urtica holosericea	-	0.1	0.2
	Vaccinium parvifolium	-	0.02	0.1
	Total of sample cover		38	
	GAP co-dominants		22	
SN Iso 737 Mono 1044	*Quercus wislizeni*	-	7	13
	Quercus douglasii	≥7	3	3
	Rhamus crocea	-	2	6
	Ceanothus cuneatus	-	2	5
	Quercus garryana	-	2	4
	Platanus racemosa	-	2	3
	Pinus sabiniana	≥7	2	3
	Quercus dumosa	-	1	4
	Aesculus californica	-	1	1
	Salix sp.	-	0.2	0.5
	Ribes quercetorum	-	0.1	0.3
	Yucca whipplei	-	0.1	0.2
	Adenostoma fasciculatum	≥3	0.1	0.3
	Toxicodendron diversilobum	-	0.1	0.2
	Avena sp. and Bromus sp.	≥11	N.D.	-
	Total of sample cover		23	
	GAP co-dominants		5	
SN Iso 1232 Mono 129	*Abies concolor*	-	13	31
	Quercus douglasii	-	9	28
	Quercus kelloggii	-	8	17
	Calocedrus decurrens	-	8	15
	Ceanothus integerrimus	-	4	13
	Aesculus californica	-	4	11
	Quercus chrysolepis	-	3	10
	Pinus ponderosa	≥17	3	8
	Pinus lambertiana	-	2	4
	Cornus nuttallii	-	1	4
	Sequoiadendron gigantea	-	1	3
	Umbellularia californica	-	1	2
	Betula sp.	-	0.4	1.3
	Arctostaphylos sp.	-	0.3	0.7
	Pinus monophylla	-	0.2	0.5
	Ceanothus cuneatus	-	0.2	0.5
	Lotus crassifolius	-	0.1	0.3
	Cercis occidentalis	-	0.1	0.3
	Quercus dumosa	-	0.1	0.2
	Sambucus caerulea	-	0.03	0.1
	Rhus diversiloba	-	0.02	0.1
	Adenostoma facsiculatum	≥3	0.0	-
	Total of sample cover		58	
	GAP co-dominants		3	

Table 6.5. Measured species cover composition observed in GAP polygons sampled in 1999 (continued).

Polygon	Genus Species	GAP Predicted Cover (%)	Mean Sampled Cover (%)	(s + 2SE)
SN Iso 1154 Mono 543	*Chrysothamnus nauseosus*	≥7	2	2
	Juniperus californica	≥3	1	2
	Yucca whipplei	≥11 & ≥7	1	1
	Unknown #1	-	0.4	1
	Artemisia tridentata	-	0.4	0.8
	Aster sp.	-	0.3	0.9
	Ceanothus sp.	-	0.3	0.9
	Adenostoma fasciculatum	≥3	0.3	0.5
	Helianthemum scoparium	-	0.3	0.3
	Salix sp.	-	0.2	0.7
	Baccharis emoryi	-	0.2	0.6
	Quercus wislizenii	-	0.2	0.6
	Pinus sabiniana	-	0.2	0.5
	Eriogonum fasciculatum	≥11 & ≥7 & ≥3	0.2	0.3
	Total of sample cover		7	
	GAP co-dominants		5	
GV Iso 15 Mono 48	*Cyperus difformis*	-	17	30
	Typha sp.	-	15	38
	Scirpus acutus	-	6	17
	Xanthium strumarium	-	4	8
	Brassica nigra	-	3	7
	Distichlis spicata	-	3	6
	Scirpus californicus	-	1	3
	Baccharis salicifolia	-	1	2
	Suaeda ramosissima	-	1	2
	Atriplex coronata	-	1	2
	Allenrolfea occidentalis	-	1	2
	Salix sp.	≥7	0.2	0.6
	Avena sp. and Bromus sp.	≥11	N.D.	-
	Populus fremontii	≥7	0.0	-
	Quercus lobata	≥7	0.0	-
	Total of sample cover		53	
	GAP co-dominants		0	
GV Iso 45 Mono 84	*Unknown #1*	-	3	7
	Populus fremontii	≥5	2	3
	Platanus racemosa	-	1	2
	Salix sp.	-	1	2
	Unknown #2	-	0.1	0.2
	Quercus palustris	-	0.05	0.1
	Amaranthus albus	-	0.04	0.1
	Unknown #3	-	0.02	0.1
	Distichlis spicata	≥15 & ≥5	N.D.	-
	Total of sample cover		7	
	GAP co-dominants		2	
GV Iso 64 Mono 27	*Allenrolfea occidentalis*	≥17 & ≥3	21	43
	Salix sp.	-	9	27
	Populus fremontii	≥3	2	5
	Scirpus californiacus	-	0.3	0.8
	Eucalyptus sp.	≥3	N.D.	-
	Total of sample cover		32	
	GAP co-dominants		23	
GV Iso 594 Mono 594	*Atriplex polycarpa*	≥19	5	9
	Adenostoma fasciculatum	-	2	6
	Brassica nigra	-	0.4	1
	Helianthus annus	-	0.3	1
	Microseris douglasii	-	0.2	1
	Avena sp. and Bromus sp	≥19	N.D.	-
	Total of sample cover		8	
	GAP co-dominants		5	

N.D. = no data. Species was observed but below survey height (about 0.6 m).

Table 6.6. Measured species cover composition observed in GAP polygons sampled in 2000.

Polygon	Genus Species	GAP Predicted Cover (%)	Mean Sampled Cover (%)	(s + 2SE)
SN Iso 48 Mono 709	*Quercus douglasii*	≥13 & ≥7	18	29
	Aesculus californica	≥7	13	17
	Quercus wislizenii	≥7	10	17
	Quercus kelloggii	≥13	9	26
	Quercus garryana	-	6	18
	Quercus chrysolepis	-	3	10
	Cercocarpus betuloides	-	3	6
	Pinus sabiniana	-	2	4
	Rhus diversiloba	-	1	3
	Ceanothus cuneatus	-	1	2
	Ribes sp.	-	1	2
	Rosa californica	-	0.1	0.4
	Ceanothus integerrimus	-	0.05	0.1
	Fremontodendron californicum	-	0.04	0.1
	Quercus dumosa	-	0.03	0.1
	Total of sample cover		67	
	GAP co-dominants		50	
SN Iso 240 Mono 942	*Cercocarpus betuloides*	-	22	26
	Ceanothus integerrimus	-	20	56
	Ceanothus cuneatus	≥19	10	29
	Quercus dumosa	-	6	16
	Aesculus californica	-	3	9
	Cercocarpus cuneatus	-	3	7
	Quercus chrysolepis	≥19	2	6
	Arctostaphylos sp.	-	2	5
	Umbellularia californica	-	2	4
	Baccharis salicifolia	-	0.3	1
	Adenostoma fasciculatum	-	0.2	0.5
	Arctostaphylos mewukka	≥19	0.0	-
	Total of sample cover		71	
	GAP co-dominants		12	
SN Iso 139 Mono 154	*Quercus chrysolepis*	≥7 & ≥3	51	-
	Calocedrus decurrens	≥11	11	-
	Umbellularia californica	-	9	-
	Cercocarpus betuloides	≥7	4	-
	Ceanothus cuneatus	-	2	-
	Quercus dumosa	-	2	-
	Arctostaphylos sp.	-	1	-
	Salix sp.	-	1	-
	Cornus glabrata	-	0.4	-
	Pinus ponderosa	≥11	0.3	-
	Yucca whipplei	-	0.3	-
	Rhamus californica	-	0.1	-
	Abies concolor	≥11	0.0	-
	Aesculus californica	≥7	0.0	-
	Pinus contorta	≥3	0.0	-
	Total of sample cover		82	
	GAP co-dominants		66	
SN Iso 435 Mono 1088	*Quercus wislizenii*	≥11 & ≥7 & ≥3	13	32
	Aesculus californica	≥11 & ≥7	10	20
	Quercus douglasii	≥11 & ≥3	8	23
	Ceanothus cuneatus	-	3	8
	Quercus dumosa	-	2	4
	Umbellularia californica	-	2	4
	Fremontodendron californicum	-	1	2
	Cercocarpus betuloides	-	1	1
	Pinus sabiniana	≥7	0.4	1
	Ribes sp.	-	0.4	1
	Quercus berberidifolia	-	0.1	0.4
	Avena sp.	≥3	N.D	-
	Total of sample cover		41	
	GAP co-dominants		31	

Table 6.6. Measured species cover composition observed in GAP polygons sampled in 2000 (continued).

Polygon	Genus Species	GAP Predicted Cover (%)	Mean Sampled Cover (%)	(s + 2SE)
SN Iso 1076 Mono 27	*Ceanothus cuneatus*	-	6	18
	Pinus sabiniana	≥11 & ≥9	4	8
	Quercus douglasii	-	2	6
	Quercus wislizenii	-	1	4
	Quercus dumosa	-	1	2
	Ephedra californica	-	1	2
	Mimulus aurantiacus	-	1	2
	Yucca whipplei	-	1	2
	Adenostoma fasciculatum	-	1	1
	Juniperus californica	-	1	1
	Eriogonum fasciculatum	-	0.1	0.4
	Chrysothamus nauseosus	-	0.1	0.2
	Sambucus caerulea	-	0.1	0.2
	Malacothammus fremontii	-	0.02	0.1
	Phacelia minor	-	0.02	0.1
	Artemisia tridentata	≥11 & ≥9	0.0	-
	Avena sp.	≥11	N.D.	-
	Total of sample cover		19	
	GAP co-dominants		4	
SN Iso 630 Mono 1133	*Aesculus californica*	-	26	28
	Quercus wislizenii	-	18	45
	Quercus berberidifolia	-	8	13
	Ceanothus cuneatus	-	7	8
	Quercus douglasii	≥15	4	6
	Quercus chrysolepis	-	3	5
	Quercus lobata	-	2	5
	Artemisia tridentata	-	2	3
	Pinus sabiana	-	1	3
	Cercocarpus betuloides	-	1	1
	Prunus subcordata	-	0.4	1
	Ribes sp.	-	0.3	1
	Adenostoma fasciculatum	≥5	0.2	0.5
	Rosa sp.	-	0.1	0.2
	Rhamnus crocea	-	0.02	0.1
	Total of sample cover		73	
	GAP co-dominants		4	
SN Iso 315 Mono 630	*Quercus kelloggii*	≥11	19	43
	Quercus douglasii	≥9	10	25
	Quercus garryana	-	8	23
	Quercus dumosa	-	8	23
	Aesculus californica	-	7	20
	Quercus wislizenii	-	3	10
	Ceanothus cuneatus	-	3	6
	Pinus sabiniana	-	2	5
	Cercocarpus betuloides	≥11	1	2
	Pinus ponderosa	-	1	3
	Fremontodendron californicum	-	0.4	1
	Ribes	-	0.3	1
	Avena sp.	≥11	N.D.	-
	Total of sample cover		63	
	GAP co-dominants		30	
SN Iso 225 Mono 1194	*Ceanothus cuneatus*	-	11	11
	Quercus lobata	-	8	23
	Quercus douglasii	-	8	11
	Aesculus californica	-	7	20
	Quercus wislizenii	-	7	12
	Quercus kelloggii	≥17 & ≥3	6	19
	Quercus garryana	-	6	18
	Quercus dumosa	-	4	6
	Ribes sp.	-	2	6
	Pinus sabiniana	-	2	6
	Cercocarpus betuloides	-	1	1
	Rhamuus crocea	-	0.2	1
	Rosa californica	-	0.05	0.1
	Urtica holosericea	-	0.02	0.1
	Avena sp. and Bromus sp.	≥3	N.D.	-
	Total of sample cover		62	
	GAP co-dominants		6	

Table 6.6. Measured species cover composition observed in GAP polygons sampled in 2000 (continued).

Polygon	Genus Species	GAP Predicted Cover (%)	Mean Sampled Cover (%)	(s + 2SE)
SN Iso 1333	*Quercus douglasii*	-	25	40
Mono 1095	*Quercus wislizenii*	-	15	40
	Aesculus californica	-	9	21
	Ceanothus cuneatus	-	9	9
	Quercus dumosa	-	3	9
	Pinus sabiniana	-	1	2
	Cercocarpus betuloides	-	1	2
	Rhamnus crocea	-	0.04	0.1
	Adenostoma fasciculatum	≥13	0.0	-
	Unidentified chaparral shrubs	≥5	N.D.	-
	Bare exposed rocks	≥3	N.D.	-
	Total of sample cover		63	
	GAP co-dominants		0	

N.D. = no data. Species was observed but below survey height (about 0.6 m).

sample cover. Also, in polygon SN Iso 139 Mono 154, *Pinus ponderosa* was predicted by GAP to be found with sample cover ≥ 11% when the field study found it to be have only 0.3% sample cover.

6.4.3 Correctness of GAP Listed Species within Species Assemblages

Tables 6.9 and 6.10 compare GAP species listings with data from field surveys. Species found within the polygons in the field were compared to the GAP listings and assessed for correct placement based on assemblage data. In the columns in these tables we present the species listed as GAP co-dominants; the species listed by GAP for a particular assemblage but which fell in another assemblage; the species listed as co-dominants which were not observed or were below all co-dominant percentages in our field surveys for a particular polygon; and species found in the field survey that could have been listed as a co-dominant within each of the polygons studied. Species were considered listed incorrectly when listed by GAP as a co-dominant in a particular assemblage (primary, secondary, and tertiary) but found within a different assemblage in the field. Potential co-dominant species were defined as species that had a sample cover percentage great enough to at least fall within the tertiary assemblage of a particular polygon, but the species was not listed by GAP as present in the polygon. When GAP listed no species for the secondary or tertiary assemblage an arbitrary value of ≥ 7% and ≥ 3% up to the next greater listed assemblage percentage were assigned, respectively, to identify potential species belonging to a particular assemblage.

There were several instances where species listed by GAP in either the primary, secondary, or tertiary assemblage were not observed in the polygon in the field for any assemblage. For example, in polygon SN Iso 58 Mono 373 *Pinus ponderosa* was listed as a primary species when it was not found to have been present at minimum percentage levels corresponding to primary, secondary, or tertiary status. In polygon SN Iso 471 Mono 686, *Abies concolor*, in the primary assemblage and *Quercus wislizenii*, in the secondary assemblage, were not found in the field. A unique example can be seen in polygon SN Iso 1154 Mono 543 in which none of the five species listed by GAP were found to be present in sample cover percentages large enough to fall within any species assemblage.

There were several instances also where numerous species in the polygons were observed in high enough abundance to warrant possible designation as co-dominants although they were not listed as co-dominants by the GAP database (Tables 6.9 and 6.10). In polygon GV Iso 15 Mono 48 *Cyperus difformis* and *Typha* sp. were found to have 17% and 15% sample cover, respectively, and fell within the primary assemblage of that polygon, but were not listed as a co-dominants by the GAP database. Polygon SN 225 Mono 1194 contained seven species, *Ceanothus cuneatus*, *Quercus lobata*, *Aesculus californica*, *Quercus wislizenii*, *Quercus kelloggii*, *Quercus garryana*, and *Quercus dumosa*, that were not listed by GAP but were found in large enough percentages, 11%, 8%, 7%, 7%, 6%, 6%, and 4%, respectively, to be considered a potential co-dominant species in the secondary assemblage of the polygon.

All of the species listed as potential co-dominant species for respective GAP polygons (Column 6 of Tables 6.9 and 6.10) fell within particular assemblages within the polygons using the GAP assemblage designation percentages. The SE interval about the mean sample cover gives additional weight for designating such species as co-dominants. An example can be seen in polygon SN Iso 1232 Mono 129 where seven species were found in percentages that warranted co-dominant species designation. One species, *Abies concolor*, was found at a high enough percentage to be considered within the primary assemblage and six species, *Quercus douglasii, Quercus kelloggii, Calocedrus decurrens, Ceanothus integerrimus, Aesculus californica, and Quercus chrysolepis*, were found with sufficient frequency to be considered co-dominants in the secondary assemblage. However, none of these seven species were listed by GAP as being present in any assemblage within the polygon.

6.4.4 Crown Closure

Tables 6.7 and 6.8 summarize the predicted and measured crown closure for the GAP polygons studied. To establish meaningful comparisons, measured crown closure was calculated using GAP definitions for percentages of primary, secondary and tertiary assemblages, but with field data for percentages of plant species found. Measured crown closure values varied greatly between assemblages (primary, secondary, and tertiary) within particular GAP polygons. When considering the upper and lower limits of plus or minus two

Table 6.7. Predicted and measured crown closure for GAP polygons sampled in 1999.

Polygon	Primary, Secondary, Tertiary	Predicted Crown Closure (%)	Measured Crown Closure (%) (c) [1]	(c - 2SE, c + 2SE)
SN Iso 58	P	40 – 59	38	(31, 46)
Mono 373	S	40 – 59	0	-
	T	0	13	(10, 16)
SN Iso 471	P	10 – 24	14	(-1, 28)
Mono 686	S	25 – 39	0	-
	T	0	18	(-1, 36)
SN Iso 737	P	25 – 39	0	-
Mono 1044	S	10 – 24	7	(2, 13)
	T	40 – 59	3	(2, 3)
SN Iso 1232	P	0	0	-
Mono 543	S	0	32	(13, 51)
	T	0	0	-
SN Iso 1154	P	0	0	-
Mono 543	S	0	0	-
	T	0	0	-
GV Iso 15	P	0	31	(5, 58)
Mono 48	S	0	16	(4, 28)
	T	0	0	-
GV Iso 45	P	0	0	-
Mono 84	S	0	0	-
	T	0	3	(-1, 7)
GV Iso 64	P	60 – 100	21	(0, 43)
Mono 27	S	60 – 100	9	(-9, 27)
	T	0	0	-
GV Iso 594	P	0	0	-
Mono 594	S	0	5	(1, 9)
	T	0	0	-

1. Measured crown closure was calculated using GAP definitions for percentages of primary, secondary, and tertiary assemblages, but with field data for percentages of plant species found.

Table 6.8. Predicted and measured crown closure for GAP polygons sampled in 2000.

Polygon	Primary, Secondary, Tertiary	Predicted Crown Closure (%)	Measured Crown Closure (%) (c) [1]	(c – 2SE, c + 2SE)
SN Iso 48	P	10 – 24	30	(19, 41)
Mono 709	S	10 – 24	18	(6, 29)
	T	0	12	(-9, 32)
SN Iso 240	P	40 – 59	35	(-11, 81)
Mono 942	S	0	0	-
	T	0	29	(3, 56)
SN Iso 139	P	40 – 59	61	-
Mono 154	S	10 – 24	8	-
	T	40 - 59	3	-
SN Iso 435	P	25 – 39	13	(-6, 32)
Mono 1088	S	10 – 24	18	(14, 21)
	T	10 - 24	3	(0, 7)
SN Iso 1076	P	0	0	-
Mono 27	S	0	0	-
	T	0	10	(-6, 26)
SN Iso 630	P	25 – 39	43	(19, 67)
Mono 1133	S	60 – 100	14	(9, 19)
	T	0	7	(6, 7)
SN Iso 315	P	10 – 24	16	(-3, 36)
Mono 630	S	40 – 59	10	(-2, 22)
	T	0	24	(-12, 60)
SN Iso 225	P	40 – 59	0	-
Mono 1194	S	25 – 39	55	(28, 82)
	T	0	0	-
SN Iso 1333	P	0	38	(30, 46)
Mono 1095	S	0	16	(8, 25)
	T	0	2	(-1, 5)

1. Measured crown closure was calculated using GAP definitions for percentages of primary, secondary, and tertiary assemblages, but with field data for percentages of plant species found.

Table 6.9. Species listed correctly and incorrectly within GAP polygons surveyed in 1999.

Polygon	Primary, Secondary, Tertiary	GAP Prediction	GAP Species Listed Incorrectly [1]	GAP Species Not Observed or Below Co-Dominant Percentages	Potential Co-Dominants (Percentage Found) [2]
SN Iso 58 Mono 373	P	*Pinus ponderosa* *Quercus wislizenii* *Quercus kelloggii*		*Pinus ponderosa*	*Quercus kelloggii* (31) *Quercus wislizenii* (14)
	S	*Quercus wislizenii* *Quercus garryana* *Cercocarpus betuloides*	*Quercus wislizenii* *Quercus garryana* *Cercocarpus betuloides*		None
	T	None			*Quercus garryana* (6) *Calocedrus decurrens* (5) *Cercocarpus betuloides* (5)
SN Iso 471 Mono 686	P	*Quercus kelloggii* *Pinus ponderosa* *Abies concolor*	*Pinus ponderosa*	*Abies concolor*	*Quercus kelloggii* (14)
	S	*Quercus kelloggii* *Quercus wislizenii* *Pinus ponderosa*	*Quercus kelloggii* *Pinus ponderosa*	*Quercus wislizenii*	None
	T	None			*Pinus ponderosa* (6) *Arctostaphylos sp.* (5) *Quercus chrysolepis* (4) *Abies magnifica* (3)
SN Iso 737 Mono 1044	P	*Avena sp. & Bromus sp.*		*Avena sp. & Bromus sp.* *	None
	S	*Quercus douglasii* *Pinus sabiniana*	*Quercus douglasii*	*Pinus sabiniana*	*Quercus wislizenii* (7)
	T	*Adenostoma fasciculatum*		*Adenostoma fasciculatum*	*Quercus douglasii* (3)
SN Iso 1232 Mono 129	P	*Pinus ponderosa*		*Pinus ponderosa*	*Abies concolor* (13)
	S	*Adenostoma fasciculatum*		*Adenostoma fasciculatum*	*Quercus douglasii* (9) *Quercus kelloggii* (8) *Calocedrus decurrens* (8) *Ceanothus integerrimus* (4) *Aesculus californica* (4) *Quercus chrysolepis* (3) *Pinus ponderosa (3)*
	T	None			None
SN Iso 1154 Mono 543	P	*Eriogonum fasciculatum* *Yucca whipplei*		*Eriogonum fasciculatum* * *Yucca whipplei*	None
	S	*Juniperus californica* *Eriogonum fasciculatum* *Yucca whipplei*		*Juniperus californica* *Eriogonum fasciculatum* * *Yucca whipplei*	None
	T	*Artemisia tridentata* *Eriogonum fasciculatum* *Chrysothamus nauseasus*		*Artemisia tridentata* *Eriogonum fasciculatum* * *Chrysothamus nauseosus*	None
GV Iso 15 Mono 48	P	*Avena sp. & Bromus sp.*		*Avena sp. & Bromus sp.* *	*Cyperus difformis* (17) *Typha sp.* (15)
	S	*Populus fremontii* *Salix sp.* *Quercus lobata*		*Populus fremontii* *Salix sp.* *Quercus lobata*	*Scirpus acutus* (6) *Xanthium strumarium* (4) *Brassica nigra* (3) *Distichlis spicata (3)*
	T	None			None
GV Iso 45 Mono 84	P	*Distichlis spicata*		*Distichlis spicata*	None
	S	*Populus fremontii* *Distichlis spicata*		*Populus fremontii* *Distichlis spicata*	None
	T	None			*Unknown #1* (3)
GV Iso 64 Mono 27	P	*Allenrolfea occidentalis*			*Allenrolfea occidentalis* (21)
	S	*Eucalyptus sp.* *Populus fremontii* *Allenrolfea occidentalis*	*Allenrolfea occidentalis*	*Populus fremontii* *Eucalyptus sp.*	*Salix sp.* (9)
	T	None			None
GV Iso 594 Mono 594	P	*Atriplex polycarpa* *Avena sp. & Bromus sp.*	*Atriplex polycarpa*	*Avena sp. & Bromus sp.* *	None
	S	None			*Atriplex polycarpa* (5)
	T	None			None

* Species noted but below minimum height (0.6m), and therefore not measured.

1. GAP Species Listed Incorrectly = Species listed by GAP as a co-dominant in a particular assemblage (primary, secondary, and tertiary) but found within a different assemblage.
2. When GAP listed no species for the secondary assemblage an arbitrary value of $\geq$7 % up to the primary percentage was assigned to identify potential secondary species. When GAP listed no species for the tertiary assemblage an arbitrary value of $\geq$3 % up to the secondary percentage was assigned to identify potential tertiary species.

Table 6.10. Species listed correctly and incorrectly within GAP polygons surveyed in 2000.

Polygon	Primary, Secondary, Tertiary	GAP Prediction	GAP Species Listed Incorrectly [1]	GAP Species Not Observed or Below Co-Dominant Percentages	Potential Co-Dominants (Percentage Found) [2]
SN Iso 48 Mono 709	P	*Quercus douglasii* *Quercus kelloggii*	*Quercus kelloggii*		*Quercus douglasii* (18) *Aesculus californica* (13)
	S	*Quercus wislizenii* *Aesculus californica* *Quercus douglasii*	*Aesculus californica* *Quercus douglasii*		*Quercus wislizenii* (10) *Quercus kelloggii* (9)
	T	None			*Quercus garryana* (6) *Quercus chrysolepis* (3) *Cercocarpus betuloides* (3)
SN Iso 240 Mono 942	P	*Cercocarpus betuloides* *Quercus chrysolepis* *Arctostaphylos mewukka*		*Quercus chrysolepis* *Arctostaphylos mewukka*	*Cercocarpus betuloides* (22) *Ceanothus integerrimus* (20)
	S	None			*Ceanothus cuneatus* (10)
	T	None			*Quercus dumosa* (6) *Aesculus californica* (3) *Cerocarpus cuneatus* (3)
SN Iso 139 Mono 154	P	*Pinus ponderosa* *Calocedrus decurrens* *Abies concolor*	*Calocedrus decurrens*	*Pinus ponderosa* *Abies concolor*	*Quercus chrysolepis* (51) *Calocedrus decurrens* (11)
	S	*Quercus chrysolepis* *Aesculus californica* *Cercocarpus betuloides*	*Quercus chrysolepis* *Cercocarpus betuloides*	*Aesculus californica*	*Umbellularia californica* (9)
	T	*Quercus chrysolepis* *Pinus contorta*	*Quercus chrysolepis*	*Pinus contorta*	*Cercocarpus betuloides* (4)
SN Iso 435 Mono 1088	P	*Quercus wislizenii* *Quercus douglasii* *Aesculus californica*	*Quercus douglasii* *Aesculus californica*		*Quercus wislizenii* (13)
	S	*Quercus wislizenii* *Quercus douglasii* *Pinus sabiniana*	*Quercus wislizenii*	*Pinus sabiniana*	*Aesculus californica* (10) *Quercus douglasii* (8)
	T	*Avena sp. & Bromus sp.* *Quercus wislizenii* *Aesculus californica*	*Quercus wislizenii* *Aesculus californica*	*Avena sp. & Bromus sp.**	
SN Iso 1076 Mono 27	P	*Pinus sabiniana* *Avena sp. & Bromus sp.* *Artemisia tridentata*	*Pinus sabiniana*	*Avena sp. & Bromus sp.** *Artemisia tridentata*	None
	S	*Artemisia tridentata* *Pinus sabiniana*	*Pinus sabiniana*	*Artemisia tridentata*	None
	T	None			*Ceanothus cuneatus* (6) *Pinus sabiniana* (4)
SN Iso 630 Mono 1133	P	*Quercus douglasii*	*Quercus douglasii*		*Aesculus californica* (26) *Quercus wislizenii* (18)
	S	*Adenostoma fasciculatum*		*Adenostoma fasciculatum*	*Quercus berberidifolia* (8) *Ceanothus cuneatus* (7)
	T	None			*Quercus douglasii* (4) *Quercus chrysolepis* (3)
SN Iso 315 Mono 630	P	*Quercus kelloggii* *Pinus ponderosa* *Avena sp. & Bromus sp.*		*Pinus ponderosa* *Avena sp. & Bromus sp.**	*Quercus kelloggii* (19)
	S	*Quercus douglasii*			*Quercus douglasii* (10)
	T	None			*Quercus garryana* (8) *Quercus dumosa* (8) *Aesculus californica* (7) *Quercus wislizenii* (3) *Ceanothus cuneatus* (3)
SN Iso 225 Mono 1194	P	*Quercus douglasii*	*Quercus douglasii*		None
	S	*Quercus douglasii* *Avena sp. & Bromus sp.*		*Avena sp. & Bromus sp.**	*Ceanothus cuneatus* (11) *Quercus lobata* (8) *Quercus douglasii* (8) *Aesculus californica* (7) *Quercus wislizenii* (7) *Quercus kelloggii* (6) *Quercus garryana* (6) *Quercus dumosa* (4)
	T	None			None

Table 6.10. Species listed correctly and incorrectly within GAP polygons surveyed in 2000 (continued).

Polygon	Primary, Secondary, Tertiary	GAP Prediction	GAP Species Listed Incorrectly [1]	GAP Species Not Observed or Below Co-Dominant Percentages	Potential Co-Dominants (Percentage Found) [2]
SN Iso 1333 Mono 1095	P	*Adenostoma fasciculatum*		*Adenostoma fasciculatum*	*Quercus douglasii* (25) *Quercus wislizenii* (15)
	S	Unidentified chaparral shrubs			*Ceanothus cuneatus* (9) *Aesculus californica* (9)
	T	Bare exposed rocks			*Quercus dumosa* (3)

* Species noted but below minimum height (0.6m), and therefore not measured.

1. GAP Species Listed Incorrectly = Species listed by GAP as a co-dominant in a particular assemblage (primary, secondary, and tertiary) but found within a different assemblage.
2. When GAP listed no species for the secondary assemblage an arbitrary value of $\geq$7 % up to the primary percentage was assigned to identify potential secondary species. When GAP listed no species for the tertiary assemblage an arbitrary value of $\geq$3 % up to the secondary percentage was assigned to identify potential tertiary species.

standard errors from the measured crown closure most of the polygons' crown closures fell within the GAP-predicted crown closure values for at least one of the predicted assemblages. For example, the upper limit of crown closure percentage for polygon SN Iso 58 Mono 373 was calculated to be 46% for the primary assemblage, which clearly falls within the GAP predicted range of 40-59%. However, measured crown closure did not always fall within GAP ranges. Some polygons were predicted by GAP to contain no crown closure for certain species assemblages, while the field surveys found otherwise. Such polygons include SN Iso 58 Mono 373, SN Iso 471 Mono 686, GV Iso 45 Mono 84, SN Iso 48 Mono 709, SN Iso 240 Mono 942, SN Iso 1076 Mono 27, SN 630 Mono 1133, SN Iso 315 Mono 630, and SN Iso 1333 Mono 1095, in which GAP predicted no crown closure for the tertiary assemblage while the field surveys found the tertiary assemblage to be 13%, 18%, 3%, 12%, 29%, 10%, 7%, 24%, and 2%, respectively.

6.4.5 Limitations of the Present Study

GAP assessment in the Central Valley and the Sierra Nevada posed special problems in terms of sampling representative areas within privately owned parts of a polygon. In the Utah GAP validation project, 42% of the state was under the control of the US Bureau of Land Management, with private interests owning only 21% (Edwards et al. 1995). In the study of Chung and Winer (1999), the San Diego County Association of Government 1990 ownership database indicated private interests owned 41% of San Diego county land (San Diego Association of Governments 1997). Private land owners typically purchase land in accessible areas within the vicinity of roads. For the purposes of conducting a GAP assessment project, suitable public lands within the vicinity of roads was limited. The lack of suitable sites to randomly place sample elements in several of the polygons resulted in extended hikes from established roads to reach a United States National Forest or county park area. Even with such effort, our ability to conduct surveys in representative areas of a polygon's major vegetation types as listed in the GAP database was limited for these polygons.

Given the effort needed to gather the field data, it was necessary to limit the area sampled. Moreover, the sample area required for estimating the true sample cover of individual species in a polygon is not known. One source (Bormann 1953) suggested surveying 7% of a forested area using parallel belt transects provided a 65% chance the sample mean of the basal area of the trees would be within 10% of the true mean for more common species (Bormann 1953). The effort needed to obtain an accurate measure of relative cover may be similar. In the present study, each sample element for belt transects occupied 0.6 ha, so for a polygon of 500 ha, two sample elements encompassing 1.2 ha were surveyed, or about 0.24% of the polygon area. For line transects, two sample elements in a 500 ha polygon would occupy about 1200 m^2, or about 0.024% of the polygon.

On the other hand, the effective size of the samples may be larger. The vegetation cover composition within the transects may approximate the cover composition of a square which immediately bounds the ends of the perpendicular transects. In that case the percentage of the polygon area sampled would have increased to 10% and 3.6% of a 500 ha polygon for belt and line transects, respectively.

6.4.6 Relative Uncertainties Associated with GAP

As discussed earlier, GAP is a GIS mapping project active throughout much of the United States. The project is designed to identify biological resources at risk through assembly of spatially allocated ecological data. California has been divided into ten regions, each having an associated GAP database in an ARCINFO vector format, with adjacent pixels of similar spectral characteristics grouped into polygons. Polygons were assigned landcover identities using a photointerpretation approach. The minimum resolution of GAP for upland vegetation is 100 ha, equal to 1 square kilometer. Plant identification for California GAP relied heavily on prior field studies, especially those of the 1930's, which developed the vegetation type maps for California (Wieslander, 1935).

The primary purpose for GAP is to identify the distribution and management status of plant communities, rather than individual plant species. The quantitative nature of GAP represents a leap in landcover classification and the values for plant cover and species percentages give an indication of the composition of plant communities. However, the GAP database is fundamentally about plant assemblages rather than species, and these assemblages may vary in precise composition depending on geographic and environmental factors. In addition, a component of leaf mass, which the GAP database does not provide must be overlaid on the species distribution data for BVOC emission calculation. Thus, the applicability of GAP for BVOC modeling requires ongoing discussion, since the requirements for BVOC emissions modeling are specific for plant species identities and leaf mass, and the correct spatial allocation of both.

6.5 Implications of GAP Assessment Results for BVOC Emission Inventories

The GAP database provides potentially valuable information for developing BVOC emissions inventories. Compared to previous databases estimating percent cover of vegetation in natural areas, the GAP database is species-specific and has a higher spatial resolution. The four classes of information predicted by the GAP database useful for the development of a BVOC emissions inventory are crown closure of an assemblage, assemblage cover, species composition within an assemblage, and the abundance of species within an assemblage. Results of this study indicate GAP should be used with caution by ARB modelers for assigning species identities to plant cover in the natural areas of California airsheds.

7.0 SUMMARY AND CONCLUSIONS

Accurate estimates of the magnitude of BVOC emissions relative to anthropogenic VOC emissions in California's airsheds are critical for formulating effective strategies to reduce concentrations of fine particles, ozone, and other secondary air pollutants which affect human health and reduce yields of agricultural crops. To obtain such estimates requires several distinct databases and the present study was divided into four major sub-projects: measurement of BVOC emissions from several hundred plant species found in California; investigation of methods for estimating leaf mass of urban trees; leaf mass measurements for native blue oaks; and evaluating the accuracy of the GAP GIS vegetation database. The study was conducted primarily in the southern San Joaquin Valley and southern Sierra Nevada mountain range. In the following sections we present the principal findings and conclusions for each of the four major sub-projects undertaken in this research.

7.1 BVOC Emission Measurements and Plant Taxonomic Relationships

7.1.1 Overall Conclusions

To validate the portable analyzer unit approach to measuring BVOC emissions, we compared PAU-measured emissions under light conditions for more than 60 plant species with published values for isoprene emissions and found them to be well correlated. For approximately 200 plant species not previously measured, observed light and dark emissions were generally found to be in agreement with specific taxonomic assignments made by Benjamin et al (1996) where such comparisons could be made. Thus, our results provide further support for the use of taxonomy in assigning estimated BVOC emissions to unmeasured plant species as proposed in our earlier research (Benjamin et al. 1996, Karlik and Winer 2001b). It is important to emphasize the PAU instrument is semiquantitative, with differing response factors to various BVOC compounds, and is most useful as a screening tool. Furthermore, the sampling methodology employed in the study was designed to measure a value for BVOC emissions from plant species after a fixed sampling period. The experimental system was not designed to ensure that the concentration of

BVOC compounds within the sampling bags reached a steady state. Therefore, no numerical calculations for emission rates can be made.

A second point to be noted is that plants sampled during this study were in full leaf, apparently healthy, and not senescing. We found a decline to near zero of emissions as measured by the PAU at the ends of the sampling seasons for certain species, usually those deciduous species native to northern geographic locations, and these data were omitted from the analyses and appendices.

Below we note significant specific findings and conclusions from this subproject.

7.1.2 Comparison of PAU Results to Specific Emission Rate Assignments of Benjamin et al. (1996).

PAU results were compared to specific emission rate assignments made on the basis of taxonomic relationships by Benjamin et al. (1996). Light emissions for species within the Aceraceae, Anacardiaceae, Bignoniaceae, Caprifoliaceae, Compositae, Cupressaceae, Cycadaceae, Ericaceae, Juglandaceae, Magnoliaceae, Oleaceae, Rhamnaceae, Rosaceae, Sapindaceae, and Taxodiaceae families were categorized from our PAU results as low, in good agreement for all 25 species in these families with the assignment of a zero isoprene emission rate made by Benjamin et al. (1996), based on either family or genus affiliation.

For the Leguminosae family, the approach taken in Benjamin et al. (1996) was to assign a family-wide isoprene emission rate of 4 $\mu g\ g^{-1}\ h^{-1}$ for unmeasured legume species (if a genus-based rate was not available). As noted in a previous study (Winer et al. 1998, Karlik and Winer 2001), the isoprene emission rates for species within the Leguminosae family were difficult to characterize based on family association alone, and subfamily affiliations for legume species were thought to provide possible guidance for characterizing isoprene emission rates, with emitting species more likely found in the Papilionoideae subfamily. In the present study, both species we measured within that subfamily had PAU light emissions characterized as high, while both species within the Mimosoideae subfamily had light emissions characterized as low. However, the two species in the Caesalpinoideae subfamily had high PAU light emissions, in contrast to reported results for other species within this subfamily (Klinger et al. 1998), suggesting a subfamily affiliation may not provide certainty for taxonomic isoprene emission rate assignments within the Leguminosae. The results of a PAU study in Africa (Klinger et al. 1998) showed that subfamily placement of legumes aided in characterizing isoprene emissions, but anomalies within subfamilies were also found by those investigators, as in the present study.

The isoprene emissions of species within the *Quercus* genus are perhaps the most troublesome to characterize because a range of two orders of magnitude exists in measured isoprene emission rates for species within that genus (Benjamin et al. 1996, Winer et al. 1998, Karlik and Winer, 2001). A taxonomic assignment of 25 $\mu g\ g^{-1}\ h^{-1}$ was made by Benjamin et al. (1996) for unmeasured oak species, which works well for many North American species and those native to California. However, the study of Csiky and Seufert (2000) employed a subgenus classification of oak species. In the present study, the species *Q. englemannii*, *Q. durata*, and *Q. chrysolepis*, for which specific isoprene emission rate assignments of 25 $\mu g\ g^{-1}\ h^{-1}$ were made by Benjamin et al.(1996) had PAU light measurements categorized as medium. The PAU light emission measurement of *Q. suber* was low, in contrast to its value in Benjamin et al. (1996) but consistent with the subgenus categorization of Csiky and Seufert (1999) and GC measurements of isoprene emission rates for *Q. suber* (Winer et al. 1998, Csiky and Seufert 1999, Karlik and Winer 2001b). However, apart from those few exceptions, for almost all other species PAU results for illuminated foliage corresponded well with taxonomic assignments of isoprene emission rates, and these results provide a broader base upon which to make such assignments for unmeasured species in the future.

For emissions from darkened foliage, the detection limit of the PAU system employed in the present study precluded detection of BVOC emission rates below about 10 $\mu g\ g^{-1}\ h^{-1}$, which would include most of those reported for monoterpenes (Benjamin et al. 1996). Accordingly, the PAU results from this study were most likely to identify only high monoterpene emitters, rather than separating negligible, low, or medium emitters from one another.

The PAU results for dark emissions for species within the Aceraceae, Caprifoliaceae, Cupressaceae, Cycadaceae, Ericaceae, Oleaceae, Platanaceae, Rhamnaceae, Rosaceae, and Salicaceae families were low, consistent with assigned monoterpene emission rates

(Benjamin et al., 1996) of less than 3 μg g^{-1} h^{-1}. Similarly, PAU results were low for darkened foliage for *Rhus* species, *Acacia melanoxylon*, *Albizia julibrissin*, *Quercus suber*, *Quercus chrysolepis*, *Caloacedrus decurrens*, and *Pinus ponderosa*, all of which had taxonomically assigned monoterpene emission rates less than 4 μg g^{-1} h^{-1} (Benjamin et al. 1996).

Emissions from darkened foliage were medium for *Pistacia chinensis* and the *Eucalyptus* species studied, as well as for *Pinus monophylla*. These observations were in general correspondence with earlier monoterpene assignments based on taxonomy (Benjamin et al. 1996), and these species likely contribute temperature-dependent BVOC emissions to California airsheds.

Species for which the PAU dark results and taxonomic assignments for monoterpene emission rates were less consistent, but still plausible given the uncertainties involved, included *Chilopsis linearis*, *Cercis occidentalis*, *Ceratonia siliqua*, *Quercus engelmanii*, and *Juglans californica*.

For several species, the PAU dark results appear to contrast with assigned monoterpene emission rates from Benjamin et al (1996), including *Baccharis pilularis* and *Euryops pectinatus*, suggesting species with low temperature dependent emissions can be found within the Compositae.

Both *Erythrina caffra* and *Olnea tesota* are within the Papilionoideae subfamily of the Leguminosae, and their high PAU results may indicate these species have high temperature dependent emissions. The high PAU result for the California native *Umbellularia californica* and the urban ornamental *Koelreuteria paniculata* also suggest these species had high emissions from darkened foliage, in possible contrast to their taxonomically assigned monoterpene emission rates. However, for most species, our PAU results for darkened foliage corresponded relatively well with taxonomic assignments of monoterpene emission rates, and provide data for an additional 200 species upon which to make assignments for unmeasured species. Our results also indicate the likelihood of previously unrecognized species with high monoterpene emission rates.

7.1.3 Summary and Future Direction for Emission Rate Measurements

With the conclusion of this study, many species significant in California's agriculture, urban landscapes, and native vegetation have been measured at least with a portable analyzer for BVOC emissions, including most of the frequently occurring woody plant families. The relative consistency of the findings of this study compared with earlier taxonomic predictions gives increased confidence for applying the taxonomic method to estimate BVOC emissions for the many species within California landscapes that remain unmeasured.

7.2 Leaf Mass and Leaf Area from Harvest of Urban Trees

Accurate leaf mass determination is a critical factor in estimating the magnitude of BVOC emissions from green plants. Vegetation within urban areas is often discontinuous and extremely varied in both size and species composition, requiring estimation methods flexible enough to accommodate this heterogeneity. In particular, biogenic emission inventories for urban areas require leaf mass estimation for plantings of large variability, including a wide range of ages and species of widely varying forms. A volumetric approach using previously established leaf mass constants has utility because of its relatively simple non-destructive data requirements in field surveys, its potential applicability to the wide range of species found in urban landscapes, and its flexibility in modeling both tree and shrub morphology. However, a volumetric approach may not precisely account for clumping of tree foliage and the change in leaf mass density as tree crowns expand and mature, especially for larger species. Despite these limitations, a volumetric approach may have particular utility in California because of the enormous number of both native and introduced tree species and the moderate size of many trees as compared to the mature urban forests found in the eastern United States.

A purpose of the present study was to examine the precision and accuracy of the volumetric approach by (a) using geometric solids to compare estimated leaf masses to measured whole-tree leaf masses, and (b) comparing leaf mass constants derived from selective sampling within tree crowns to values derived from whole tree harvest. Accordingly, total leaf masses obtained through tree harvest and leaf removal of 13 urban trees were compared to leaf masses calculated by using leaf mass constants found in the literature and by using geometric solids to model the shapes of tree crowns. Results from this study suggest leaf mass estimates developed for individual trees through a volumetric approach may be well within approximately 50% of actual values, and for total leaf mass even closer. For the 13 trees in this study, sums of leaf mass estimates were within 10% of the sums of the measured leaf masses when the paraboloid solid was used.

The paraboloid was judged to be the best solid overall for modeling tree crowns, and this result is in agreement with an earlier comment (McPherson, 1996), but differs from the result of a previous study (Winer et al. 1998, Karlik and Winer 1999) in which the vertical ellipsoid solid gave a sum of calculated leaf masses closest to the measured total. However, deciduous trees in the present study were on-average significantly larger than those in the previous study (Winer et al. 1998, Karlik and Winer 1999). Since the ratio of leaf mass-to-volume is expected to decrease as crown dimensions increase, it is not surprising the paraboloid solid gave results in closer agreement to the measured than did the vertical ellipsoid in the present study. On balance, it appears assignment of either a paraboloid solid or a vertical ellipsoid solid may be appropriate, or perhaps taking a mean of leaf mass estimates from both solids, rather than attempting to assign a preferred solid to individual specimens.

Using the experimentally measured total leaf mass and dimensions of each tree, whole-tree leaf mass constants were also calculated. Literature values for experimentally-determined leaf mass constants appeared to be reasonably accurate for the species tested, and were within a factor of two compared to those we derived from whole tree harvest, with the exception of the literature value for the camphor (75 g m^{-3}) which seems too low. A still larger dataset, including additional tree species, is clearly desirable to more accurately quantify leaf masses of urban trees and to better understand structural class values, especially for broadleaf evergreens.

Leaf masses were also calculated from published allometric equations (Nowak 1996). The equation based on crown dimensions gave estimates closer to the measured values than did the equation based on trunk diameter. The leaf mass estimates from the crown dimension equation were on average equal to the measured values for individual trees, and the sum of estimated leaf masses for all trees was 0.86 of the measured sum.

Leaf masses per unit area of crown projection for these urban trees were greater than the values of leaf mass per ground surface area reported for eastern deciduous forests. The mean leaf mass density for deciduous trees measured in this study was 1500 g m^{-2}, in contrast to the 480 g m^{-2} for deciduous trees measured in a previous study (Winer et al. 1998, Karlik and Winer 1999). For the broadleaf evergreen species in the study, the mean value was 820 g m^{-2}, less than half of the mean value of 1900 g m^{-2} for trees of the same structural class measured in a previous study (Winer et al. 1998, Karlik and Winer 1999). These results indicate overall values for LMD for structural classes of urban trees may be difficult to assign without more statistically robust samples. The sample sizes in both our earlier study (Winer et al. 1998, Karlik and Winer 1999) and the present study were quite modest, with only four broadleaf evergreen trees in the former study and six in the present study. Also, we believe LMD values scale with tree size up to some point, and broadleaf evergreen tree sizes were on-average larger, and deciduous tree sizes smaller, in the previous study than in the present study. Thus, we believe the relatively small sample sizes coupled with differences in tree sizes and shapes can explain the significant differences observed in mean LMD values.

Leaf areas were calculated with two allometric equations and compared to leaf areas calculated from an experimentally determined conversion factor for leaf mass-to- leaf area. This latter approach gave values for leaf area within about 5% of those measured with a leaf area meter (Winer et al. 1998). On average, the equation based on crown dimensions underestimated leaf areas whereas the equation based on trunk diameter overestimated leaf areas, and the former gave an estimate within 50% of the sum of leaf areas for the trees in this study.

The digital photographic method as employed in this study gave leaf area results consistently much lower than leaf areas determined from leaf mass. The digital photographic method would be expected to underestimate leaf area because of varying leaf angle distribution, and also because of obstruction of leaves in the background by leaves in the foreground. Thus, an adjustment factor for calculating leaf area from digital photography seems necessary, since the surface area of leaves "seen" by the camera will be affected by leaf angle, and only vertically oriented leaves will be "seen" as having 100% of their actual leaf area. At this time, the digital photographic method as employed in this study is not recommended for estimating leaf masses of urban trees.

7.3 Leaf Mass Density and Leaf Area Index for Native Blue Oak Trees

The leaf mass density calculated for our blue oak site, based on total leafmass divided by area needed to encompass the tree crowns, was 310 g m^{-2}, and this value was assigned as the site's LMD value. This value may be compared to literature values for oak woodlands of various locales, including 375 g m^{-2} for Atlanta, GA (Geron et al. 1995); 375 g m^{-2} for the contiguous United States (Lamb et al. 1987, 1993); 338-600 g m^{-2} for Castelporziano, Italy (Seufert et al. 1997), and a global value of 100-500 g m^{-2} (Box 1981). However, the oak grove we harvested and measured was surrounded by open grassland, and therefore the measured LMD value of 310 g m^{-2} represents a maximum for that landcover. If the oak LMD was calculated on the basis of the area of the grove plus the surrounding open grassland, the value would have been approximately 150 g m^{-2} or less, which is less than 50% of the value of 375 g m^{-2} for oak woodlands for Atlanta or the contiguous U.S., and suggests California's oak savannas contain less leaf mass than their eastern counterparts by a factor of two or more.

The mean value for leaf area index for the 14 individual native blue oaks was 3.1 m^2 m^{-2}. LAI calculated on the basis of total leaf area divided by the sum of areas of crown projection was also 3.1 m^2 m^{-2}. LAI calculated on the basis of total leaf area divided by grid area was 1.3 m^2 m^{-2} and this latter value was thought to be the LAI which would be seen by an overhead observer. As in the case of LMD, this LAI value was appropriate for this particular grove only; consideration of the surrounding area devoid of trees would result in an overall LAI value of less than 1.3 m^2 m^{-2}.

Allometric relationships for leaf mass estimation were also obtained by plotting leafmass against crown and trunk dimensions. The relationship between leaf mass and circumference at breast height had a coefficient of determination (r^2) of 0.96.

Circumference at breast height is perhaps the easiest tree dimension to measure, so this high value for r^2 is encouraging, and suggests oak circumference may be used with the allometric equation derived from our data to estimate leaf masses for blue oaks having trunk circumferences within the range of trees harvested in this study. Mean crown radius and crown projection were also well-correlated with leaf mass, and therefore measurements of crown dimensions for this species could also be used to estimate leaf mass. In contrast, measurements of tree or crown height were not well-correlated with leafmass, and therefore leaf mass estimates for blue oaks should not be based on crown height.

The volumetric method also worked well for estimating leaf mass of individual oak trees. Total measured leaf mass for trees in this study estimated by the paraboloid solid was within 2% of the measured, and for the sphere solid the result was within 15% of the measured. Thus, the leafmass constant of 280 g m^{-3} coupled with the paraboloid solid seemed to best represent the crown shapes of the native blue oak trees of this study.

7.4 Assessment of the GAP GIS Landcover Database for BVOC Emission Inventory Development

In general, most of the sample cover within the eighteen GAP polygons we surveyed in the southern San Joaquin Valley and southern Sierra Nevada Mountains was attributable to a few species in each polygon. Many of the most abundant species found within the polygons were listed as co-dominants in at least one of the assemblage classes (primary, secondary, or tertiary) by the GAP database. However, the percentages of these co-dominants varied greatly, including whether a listed species was found at all. The sample cover observed in the field for some co-dominants in the polygons we studied exceeded the values expected from the GAP database listings. In other polygons the co-dominant species listed by GAP were observed in the field in abundances much less than the GAP-predicted percentages. Finally, in certain polygons, species not listed by GAP were found in field surveys in high enough abundances to warrant inclusion as co-dominants. Thus, specific results for listed vs observed species varied over a wide range among the eighteen polygons we studied in the southern San Joaquin Valley and southern Sierra Nevada mountain range.

Finally, it is important to note that the primary purpose of the GAP Analysis Program is to identify the distribution and management status of plant assemblages, rather than to quantify individual plant species. Nevertheless, the quantitative and species-specific nature of the GAP database represents an advance in landcover classification. While those features of the GAP database may prove useful for BVOC emission inventory development, our data suggest utilization of GAP data for this purpose must be undertaken with caution by ARB modeling staff.

8.0 RECOMMENDATIONS FOR FUTURE RESEARCH

Further research should be undertaken to provide data vital for spatial allocation and quantification of BVOC emissions, in support of ARB's statewide modeling mission to determine the relative importance of VOC vs. NO_x emission controls in various airsheds. The research proposed below provides a means to address current data deficiencies and to strengthen methodology for California in a direction previously recommended (Winer et al. 1995, 1998). It has the advantage of interlinking new data to the extensive database already gathered during our earlier 1996-1997 and 1998-2000 studies, and addressing research needs proposed during the December, 2000, ARB research workshop on BVOC needs.

Obtaining additional quantitative data should permit a more refined appraisal of taxonomic predictive methods for estimating leafmass constants both for plant species found in urban landscapes and those found in natural plant communities. Field validation of other GIS databases (beyond GAP) should be designed to provide an accuracy assessment of spatial allocation of plant communities and provide quantitative data for assessment of leafmass estimation methods for natural plant communities based on previously published data. Scaling issues related to BVOC emissions should also be directly addressed through a whole-plant enclosure system with sampling at leaf-, branch-, plant- and landscape-scales.

Research questions remain in other areas as well. These include investigation of the quantities of oxygenates or other BVOC emitted by vegetation (which may be significant for some plant species); measuring NOx and other gaseous nitrogenous compound emissions from vegetation and soil in both natural and agricultural situations; developing ground-based methods for rapid and accurate LAI measurements for urban vegetation and plants in natural communities; building databases for plant specific emissions of aerosols or their precursors; developing species-specific deposition information; and developing net-effects models for vegetation in California airsheds. These research goals are described in further detail below.

8.1 Potential Future Research

8.1.1 Overall Objectives

The overall objectives of the proposed research are to provide information critical to resolve key remaining questions related to BVOC emission inventories. Because these inventories depend upon scaling up of leaf-level or branch-level emission factors via species-specific leafmass estimates within a geographic region, the proposed research addresses components within several levels of inventory development. These include an expanded survey of total plant BVOC emission rates, testing and measurement of leafmass estimation methods, and further validation and quantification of vegetation databases.

8.1.2 Specific Research Needs

(1) Semi-qualitative data generated in the present study using a PAU system for approximately 200 new species has identified several dozen plant species important in California's landscape for which GC or GC-MC measurements would be valuable. Such data would also provide further ability to test the taxonomic predictive method.

(2) The present research reveals a need to develop taxonomic and structural class frameworks, based on reported values for leafmass constants and leafmass densities derived from whole-tree sampling, including developing quantitative data regarding the precision and accuracy of leafmass estimation methods for urban trees and shrubs. A volumetric approach may have particular utility in California because of its potential applicability to the wide range of species found in urban landscapes, its flexibility in modeling both tree and shrub morphology, and the moderate size of many trees as compared to the mature urban forests found in the eastern United States. For example, the volumetric approach has been shown to work well in the present and previous studies for estimating leafmass of urban trees and oaks in natural communities. However, little is known about LMD values for urban trees, especially for broadleaf evergreen species. Only 10 such species in total have been harvested for quantification of LMD, in our recent study (Winer and Karlik 2001). Another possible approach would be analysis of the extensive data set developed by Peper and co-workers (UC Davis) for street trees of Modesto, and examining LMD and volumetric relationships for trees harvested by that group.

(3) There is a need to further develop quantitative data for leafmass of urban trees and selected oak species in a natural environment through a volumetric approach and exploration of allometric methods and indirect methods (e.g. light interception) for estimation of foliar mass of trees and comparison of calculated leafmass to whole-tree leaf removal. A volumetric approach using previously established leafmass constants has utility because of its relatively simple non-destructive data requirements in field surveys. Allometric methods may be used to bridge between volumetric estimation methods and remote sensing data.

(4) A corollary of the preceding objective would be to better understand and allocate foliage found in urban areas. At least three extensive field studies have been conducted within the SoCAB to identify urban plant species, quantify leafmass, and provide estimates of BVOC emissions. Limited field studies have been conducted for Ventura and Santa Barbara counties and the Fresno area. Although the present remote-sensing approaches for LAI and the existence of plant cover databases offer promise for describing plant masses and locations in the natural areas, similar methodologies are not available at this time for urban vegetation. Thus, field studies or testing of remote sensing methods for describing California's urban vegetation are required.

(5) Further research is required to understand the utility and uncertainty of the CALVEG or other GIS databases in the natural plant communities adjacent to the San Joaquin Valley through quantification and validation. Further assessment of GAP in key airsheds would give both a qualitative description and quantitative measure of accuracy. Additionally, field data may provide an indication of the degree of change in California's natural plant communities, and hence the reliability of other plant maps and databases derived from earlier surveys. Quantification of GAP through measurement of leafmass per volume ratios and leafmass per unit of areal coverage of selected species should provide data vital to translation of landcover information into quantity of foliage per species.

(6) There is an urgent need to quantify and understand, through parallel measurements of the same plant specimens, the relationship between BVOC emissions values obtained through leaf-level, branch-level, and whole plant sampling. One approach would be a large-enclosure study, modeled after the whole-tree enclosure work of Pier and

McDuffie (1997) for oaks, but with sampling at the various scales added. Ideally the location for this research would be chosen to allow flux measurements at a landscape scale, and could also be used to evaluate canopy models for shading. This work would be in cooperation with NCAR researchers, and intercomparison of data would allow understanding of BVOC emission scaling issues which to date have been never been directly addressed.

(7) Emission inventories to date have focused upon isoprene and monoterpenes, but compounds such as methyl butenol and other oxygenated hydrocarbons may represent significant or even dominant emissions by some plants. Research is needed to determine whether significant fractions of BVOC emissions by key California species have gone unmeasured. It is possible some of our present PAU results reveal the presence of compounds other than isoprene or monoterpenes, and this should be investigated further.

(8) The emission of gaseous nitrogen compounds from plants and soil should be quantified in California's airsheds, especially the Central Valley. Significant uncertainties remain in the understanding of soil NOx contributions from both undisturbed and agricultural soils. The Mediterranean climate of California and the fertility practices within agriculture, specifically the application of nitrogen fertilizers via irrigation water, suggests data developed for temperate regions and agronomic crops, where anhydrous ammonia is applied pre-plant, may not be transferable to California conditions.

(9) Refinement of ground-based methods for measuring LAI is needed. Data from instruments which measure LAI indirectly, e.g. from light interception, are affected by variations in clumping of leafmass, leaf angle, and other factors. Thus, it is at present difficult to measure LAI accurately, and with confidence, without time-consuming site-specific cross-checks provided by other measurement methods. Additional validation of the Nikolov LAI database (Nikolov, 1998) may offer at least a starting point for comparison of ground-based measurements with reference values for California.

(10) Both emission and deposition of aerosols or their precursors from plants in California airsheds should be measured. This is an enormous task, and research is likely more advanced in the area of emissions and less so for deposition. For example, do plant species vary in their ability to "capture" aerosols? In addition to gaseous emissions, what

fraction of PM_{10} or $PM_{2.5}$ is attributable to physical processes and removal of plant tissue such as cuticular wax or cortex. Although pollen grains and plant spores are larger than PM_{10}, their presence may be a factor in air quality in California. Seasonal and species-specific data exist for pollen loading for few regions, although some, such as Tucson, AZ have data developed from several years of focused research.

(11) The net air quality effects of California's flora should be examined through compilation of data pertaining to both emission of BVOC and deposition of pollutant compounds, including aerosols.

9.0 LITERATURE CITED

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GLOSSARY OF TERMS, ABBREVIATIONS AND SYMBOLS

APRC	Air Pollution Research Center (U.C. Riverside)
ARB	Air Resources Board
ARCINFO	Vector-format GIS used to provide DRI Landsat TM-based vegetation classification files for the SARMAP/BIOME model
AVHRR	Advanced Very High Resolution Radiometer
BEIGIS	Biogenic Emission Inventory Geographical Information System
BEIS	Biogenic Emission Inventory System (U.S. EPA)
BVOC	biogenic hydrocarbon
BVOC	biogenic volatile organic compounds
CALVEG	California Vegetation database developed by the California Division of Forestry
CARB	California Air Resources Board
CDF	California Department of Forestry
CIR	color infrared
CO2	carbon dioxide
DBH	diameter at breast height
EPA	Environmental Protection Agency
GAP	Gap Analysis Project
GC-FID	gas chromatography-flame ionization detection
GC-MS	gas chromatography-mass spectroscopy
GIS	geographical information system
IR	infrared
LA	Los Angeles
LAI	leaf area index
LDL	lower detection limit
NCAR	National Center for Atmospheric Research
NDVI	normalized difference vegetation index
NMOC	non-methane organic compound
NO_x	oxides of nitrogen ($NO + NO_2$)

NO	nitrogen monoxide
NO_2	nitrogen dioxide
N_2O	nitrous oxide
OVOC	other volatile organic compounds
PAR	photosynthetically active radiation
PAU	portable analysis unit
ppbC	parts per billion carbon
ppmC	parts per million carbon
PID	photoionization detector
PVC	polyvinyl chloride
RH	relative humidity
ROG	reactive organic gases
ROM	Regional Oxidant Model
RSI	relative sensitivity index
SCAQMD	South Coast Air Quality Management District
SCAQMP	South Coast Air Quality Management Plan
SJV	San Joaquin Valley
SJVAB	San Joaquin Valley Air Basin
SJVAQS	San Joaquin Valley Air Quality Study
SLA	specific leaf area
SoCAB	South Coast Air Basin
SO_x	oxides of sulfur ($SO_2 + SO_3$)
TM	Thematic Mapper (NASA Landsat satellite instrument)
TPD	metric tons per day
UAM	Urban Airshed Model
UCCE	University of California Cooperative Extension
UCR	University of California, Riverside
USFS	United States Forest Service

GLOSSARY OF TERMS, ABBREVIATIONS, AND SYMBOLS (Cont'd)

USGS	United States Geological Survey
UTZ	urban terrain zone
UV	ultraviolet
VOC	volatile organic compound

11.0 APPENDICES

APPENDIX A. Sampling conditions and net PAU values for plants measured with the Model 580B instrument in 1999.

APPENDIX B. Sampling conditions and net PAU values for plants measured with the ppbRAE instrument in 2000.

Appendix A. Sampling conditions and net PAU values for plants measured with the Model 580B instrument in 1999.

Scientific Name	Common Name	Loc. [1]	Date Sampled	PAR (umol m^{-2} s^{-1})	Temp. (°C)	Start Time Sampled	Mean Emissions [2] Light (nPAU g^{-1}) [4]	Mean Emissions Dark	Mean Emissions Crush	Std. Dev. [3] Light	Std. Dev. Dark	Std. Dev. Crush
<u>Aceraceae</u>												
Acer macrophyllum	Big Leaf Maple	MC	09/08/99	1850	31.5	13:40	2	0	0	3	0	0
Acer rubrum	Red Maple	MC	09/08/99	1440	30.6	14:50	0	0	0	0	0	0
<u>Agavaceae</u>												
Hesperaloe funifera	Yucca	BFD	08/12/99	1610	32.8	15:00	39	10	43	20	5	22
<u>Anacardiaceae</u>												
Pistacia chinensis	Chinese Pistache	BFD	07/29/99	1580	32.5	15:35	41	86	8300	52	100	3400
Pistacia chinensis	Chinese Pistache	BFD	08/02/99	1570	33.6	16:00	41	11	6700	57	7	10000
Pistacia chinensis	Chinese Pistache	BFD	08/03/99	982	24.5	9:00	27	55	2800	20	23	880
Pistacea vera	Pistacio	BFD	08/11/99	1870	28.5	14:30	0	0	2300	0	0	600
Pistacea vera	Pistacio	BFD	08/19/99	1950	30.6	13:40	41	33	1600	21	16	960
Pistacea vera	Pistacio	BFD	08/19/99	1860	30.9	14:20	18	30	1700	12	12	1000
Pistacea vera	Pistacio	BFD	08/19/99	1800	30.7	15:48	11	15	2100	7	4	790
Rhus ovata	Sugar Bush	BFD	08/10/99	1650	32.0	15:32	31	1	1300	10	3	1100
Rhus typhina	Staghorn Sumac	MC	09/14/99	999	22.5	9:15	7	8	7	2	5	2
Schinus molle	California Pepper Tree	BFD	08/03/99	1940	33.6	14:05	39	51	4100	18	9	870
Schinus molle	California Pepper Tree	BFD	08/03/99	1980	33.9	14:45	25	55	7800	22	37	4100
Schinus molle	California Pepper Tree	BFD	08/03/99	1900	33.5	15:50	35	28	7600	23	11	4700
<u>Aquifoliaceae</u>												
Ilex sp	Holly	MC	10/24/99	1450	20.4	13:00	0	0	0	0	0	0
Ilex sp	Holly	MC	10/24/99	1130	21.5	13:25	0	0	0	0	0	0
<u>Asteraceae</u>												
Achillea clavennae	Yarrow	BFD	09/06/99	960	29.1	9:18	100	92	5300	36	11	1500
Achillea clavennae	Yarrow	BFD	09/06/99	1240	30.5	10:00	25	47	2100	9	13	1400
Artemesia californica	California Sage	MC	09/12/99	1790	27.6	14:00	190	9	6300	320	8	2300
Artemesia frigida	Fringed Sage Bush	MC	09/12/99	1760	27.6	13:20	400	420	26000	280	450	19000
Artemesia hybrid	Powis Castle	MC	09/14/99	1470	26.5	10:20	15	9	2000	15	3	580
Baccharis pilularis	Coyote Brush	BFD	08/10/99	1290	24.8	10:05	0	4	220	0	4	130
Chrysothamnus nauseosus	Rabbitbrush	MC	09/07/99	1530	29.9	10:45	100	25	20000	40	15	6800
Chrysothamnus nauseosus	Rabbitbrush	MC	09/07/99	1740	32.0	11:30	180	53	19000	85	26	1300
Ericameria laricifolia	Turpentine Bush	BFD	09/06/99	1520	37.2	14:45	80	140	4200	36	49	740

Appendix A. Continued.

Scientific Name	Common Name	Loc. [1]	Date Sampled	PAR (umol m^{-2} s^{-1})	Temp. (°C)	Start Time Sampled	Mean Emissions [2] Light (nPAU g^{-1}) [4]	Mean Emissions Dark	Mean Emissions Crush	Std. Dev. [3] Light	Std. Dev. Dark	Std. Dev. Crush
Asteraceae (continued)												
Santolina chamaecyparissus	Lavendar Cotton	MC	10/17/99	1320	18.6	10:50	830	180	3900	1500	58	4500
Berberidaceae												
Berberis mentorensis	Mentor Barberry	MC	10/19/99	842	17.8	9:24	360	5	350	140	4	250
Berberis mentorensis	Mentor Barberry	MC	10/19/99	1110	22.7	10:15	530	9	370	200	8	20
Mahonia aquifolium	Oregon Grape	BFD	09/06/99	1200	37.1	15:55	130	22	180	73	16	100
Mahonia nevinii	Nevins Mahonia	MC	10/13/99	1450	25.3	13:05	280	7	360	130	6	140
Mahonia nevinii	Nevins Mahonia	MC	10/13/99	1500	26.3	13:40	350	16	680	320	8	220
Betulaceae												
Betula pendula	European White Birch	BFD	09/02/99	1690	25.3	11:25	25	5	20	12	6	9
Betula pendula	European White Birch	PP	09/02/99	1480	28.2	15:20	38	39	8	19	18	12
Bignoniaceae												
Campsis radicans 'Rivers'	Royal Trumpet Vine	MC	10/31/99	1070	26.1	14:10	22	5	0	16	7	0
Chilopsis linearis	Desert Willow	MC	08/24/99	1800	32.0	11:45	85	94	110	22	93	6
Chilopsis linearis	Desert Willow	MC	08/24/99	1230	32.0	1:00	61	100	95	4	28	16
Chitalpa tashkentensis	Chitalpa	MC	09/07/99	1760	34.0	14:05	15	32	4	16	11	0
Chitalpa tashkentensis	Chitalpa	MC	09/07/99	1750	32.7	14:45	10	49	2	14	43	3
Paulownia tomentosa	Empress Tree	MC	10/06/99	1510	23.2	13:45	1	0	4	2	0	0
Paulownia tomentosa	Empress Tree	MC	10/06/99	1490	21.6	14:20	0	0	1	1	0	1
Caparidaceae												
Isomeris arborea	Bladderpod	MC	09/13/99	1760	25.8	13:35	7	0	120	9	0	5
Caprifoliaceae												
Lonicera nitida	Honeysuckle	MC	09/17/99	1390	21.2	11:00	77	19	68	64	12	39
Lonicera nitida	Honeysuckle	MC	10/14/95	1150	21.0	14:50	12	72	15	11	40	1
Symphoricarpos albus	Snowberry	MC	09/13/99	1660	25.8	11:10	10	0	13	14	0	18
Symphoricarpos albus	Snowberry	MC	09/13/99	1720	24.7	11:45	19	3	13	15	8	5
Casuarinaceae												
Casuarina cunninghamiana	River She-Oak	BFD	09/03/99	1770	29.0	13:45	350	84	340	130	23	150
Casuarina cunninghamiana	River She-Oak	BFD	09/03/99	1620	31.3	14:30	220	31	480	120	15	53
Casuarina cunninghamiana	River She-Oak	BFD	08/10/99	1850	29.3	13:50	530	70	1200	150	14	1100
Celastraceae												
Euonymus alata	Winged Euonymus	MC	10/10/99	1490	29.1	13:55	0	0	0	0	0	0
Euonymus alata	Winged Euonymus	MC	10/10/99	1370	28.7	14:50	0	0	0	0	0	0

Appendix A. Continued.

Scientific Name	Common Name	Loc. [1]	Date Sampled	PAR (umol m^{-2} s^{-1})	Temp. (°C)	Start Time Sampled	Mean Emissions [2] Light (nPAU g^{-1}) [4]	Mean Emissions Dark	Mean Emissions Crush	Std. Dev. [3] Light	Std. Dev. Dark	Std. Dev. Crush
<u>Cistaceae</u>												
Cistus purpureus	Orchid Rockrose	BFD	09/02/99	1260	30.2	15:40	31	5	200	5	7	10
<u>Cornaceae</u>												
Corokia virgata	Corokia Yellow Wonder	MC	10/17/99	1410	23.6	13:10	140	0	150	140	0	210
Corokia virgata	Corokia Yellow Wonder	MC	10/17/99	1350	25.0	13:50	150	8	110	120	8	60
<u>Cupressaceae</u>												
Cupressocyparis leylandii	Leyland Cypress	BFD	08/04/99	1930	34.2	13:35	2	0	150	1	0	160
Cupressocyparis leylandii	Leyland Cypress	BFD	08/04/99	1970	34.2	14:00	3	1	120	1	0	50
Cupressocyparis leylandii	Leyland Cypress	BFD	08/04/99	1850	34.2	14:40	0	1	100	0	1	65
Cupressus nevadens	Piute Cypress	MC	10/14/99	1350	22.2	11:50	700	20	4100	160	14	200
Juniperus californica	California Juniper	MC	10/14/99	1400	23.0	11:10	9	5	1200	8	1	330
Juniperus californica	California Juniper	MC	09/17/99	1150	19.3	10:20	18	8	2900	20	3	780
<u>Elaeagnaceae</u>												
Elaegnus angustifolia	Russian Olive	MC	09/08/99	1360	29.2	15:15	4	0	6	6	0	8
<u>Ericaceae</u>												
Arbutus menzeisii	California Madrone	MC	09/20/99	1340	27.7	10:15	4	10	7	3	7	1
Arctostaphylos hookeri	Monterey Manzanita 'Sunset'	MC	09/26/99	1510	25.2	14:16	0	8	0	0	2	0
Arctostaphylos manzanita	Common Manzanita	MC	09/08/99	1130	27.0	10:25	10	0	9	2	2	0
Arctostaphylos manzanita	Common Manzanita	MC	09/13/99	1320	31.6	15:35	0	1	0	0	1	0
<u>Euphorbiaceae</u>												
Euphorbia martinii	E. amygdaloides x E. characias	MC	10/21/99	1260	24.5	11:05	5	4	5	3	6	0
Euphorbia martinii	E. amygdaloides x E. characias	MC	10/21/99	1120	25.1	11:30	2	0	0	3	0	0
Sapium sebiferum	Chinese Tallow	CSUB	07/27/99	1820	34.2	15:00	12	62	12	2	36	2
Sapium sebiferum	Chinese Tallow	CSUB	07/28/99	1850	26.5	10:10	10	34	110	14	27	27
Sapium sebiferum	Chinese Tallow	CSUB	07/28/99	1930	27.1	11:20	10	23	80	2	13	38
<u>Fabaceae</u>												
Caesalpinia gilliesii	Desert Bird of Paradise	BFD	09/06/99	1530	33.0	11:00	81	150	40	80	47	29
Caesalpinia gilliesii	Desert Bird of Paradise	BFD	09/06/99	1660	34.6	11:45	8	55	0	11	43	0
Cassia artemisiodes	Feathery Cassia	BFD	08/12/99	1210	32.1	16:30	120	55	3100	270	48	570
Cassia nemophila	Desert Cassia	BFD	08/12/99	1690	27.7	11:30	24	0	60	35	0	100
Ceratonia siliqua	Carob	MC	09/07/99	1880	33.1	12:40	440	61	570	160	15	22
Ceratonia siliqua	Carob	MC	09/07/99	1850	33.2	13:20	300	53	260	55	31	34

Appendix A. Continued.

Scientific Name	Common Name	Loc.[1]	Date Sampled	PAR (umol m^{-2} s^{-1})	Temp. (°C)	Start Time Sampled	Mean Emissions[2] (nPAU g^{-1})[4] Light	Dark	Crush	Std. Dev.[3] Light	Dark	Crush
Fabaceae (continued)												
Cercidium floridium	Blue Palo Verde	BFD	07/01/99	1930	38.0	11:40	0	0	0	0	0	0
Cercis canadensis mexicana	Forest Panzy Red Bud	MC	10/24/99	1220	22.7	10:55	7	6	4	1	4	4
Cercis canadensis mexicana	Forest Panzy Red Bud	MC	10/24/99	1330	22.7	11:35	7	0	3	5	0	0
Cercis occidentalis	Western Redbud	BFD	08/10/99	1450	26.7	10:35	250	38	250	83	10	83
Cytisus scoparius	Scotch Broom	MC	09/13/99	1530	27.0	14:15	300	36	250	110	29	140
Genista tinctoria	Dyer's Green Weed	MC	10/18/99	1530	22.7	13:35	970	93	830	410	70	130
Genista tinctoria	Dyer's Green Weed	MC	10/18/99	1440	22.7	14:20	360	15	310	120	5	130
Prospis alba 'Colorado'	Colorado Mesquite	BFD	08/10/99	1450	26.7	10:35	3	0	4	0	0	6
Prosopis glandulosa	Texas Mesquite	BFD	07/01/99	1750	37.0	10:40	0	0	0	0	0	0
Robinia pseudocacia	Black Locust	MC	09/13/99	1920	32.7	14:05	280	33	270	45	18	50
Robinia pseudocacia	Black Locust	MC	09/13/99	1520	23.5	10:40	150	14	150	74	32	110
Sophora secundiflora	Texas Mountain Laurel	BFD	07/01/99	1970	40.0	14:10	15	8	23	8	10	7
Sophora secundiflora	Texas Mountain Laurel	BFD	07/29/99	1990	30.1	13:00	120	71	200	37	28	74
Sophora secundiflora	Texas Mountain Laurel	BFD	07/29/99	1970	31.6	13:30	250	33	300	180	16	160
Fagaceae												
Castanea sativa	Chestnut	MC	10/07/99	940	22.7	9:25	4	2	5	1	3	0
Castanea sativa	Chestnut	MC	10/07/99	1290	22.3	10:20	2	8	4	2	4	1
Fagus sylvatica	Purple River Beech	MC	09/19/99	1660	25.8	11:15	0	0	0	0	0	0
Fagus sylvatica	Purple River Beech	MC	09/19/99	1710	25.6	11:50	0	4	0	0	5	0
Quercus acutissima	Saw Tooth Oak	MC	10/07/99	1080	23.1	9:45	4	6	13	4	3	1
Quercus agrifolia	Coastal Live Oak	MC	09/19/99	1250	23.5	10:00	1200	19	880	330	19	320
Quercus agrifolia	Coastal Live Oak	MC	09/19/99	1490	25.4	10:40	480	16	450	350	7	290
Quercus agrifolia	Coastal Live Oak	LAA	09/30/95	1020	32.5	15:05	220	9	200	82	7	27
Quercus agrifolia	Coastal Live Oak	LAA	09/30/95	1050	32.3	15:30	90	26	100	15	12	13
Quercus boissieri	Golan Heights Oak	LAA	09/29/99	919	37.3	10:40	200	160	890	110	65	860
Quercus boissieri	Golan Heights Oak	LAA	09/29/99	901	36.9	16:25	110	210	800	34	42	740
Quercus coccinea	Scarlet Oak	BC	08/09/99	1600	26.5	15:40	340	40	340	240	8	240
Quercus douglasii	Blue Oak	HF	07/30/99	1840	24.0	11:40	350	24	300	130	10	100
Quercus douglasii	Blue Oak	HF	07/30/99	1870	24.2	12:05	560	28	570	240	15	270
Quercus douglasii	Blue Oak	HF	07/30/99	1920	24.8	12:20	430	17	570	330	19	590

Appendix A. Continued.

Scientific Name	Common Name	Loc. [1]	Date Sampled	PAR (umol m^{-2} s^{-1})	Temp. (°C)	Start Time Sampled	Mean Emissions [2] Light	Dark	Crush	Std. Dev. [3] Light	Dark	Crush
							(nPAU g^{-1}) [4]					
Fagaceae (continued)												
Quercus englemannii	Engelman Oak	LAA	09/29/99	1500	37.2	10:00	330	30	440	160	5	160
Quercus englemannii	Engelman Oak	LAA	09/29/99	1370	38.6	14:20	50	18	16	33	8	3
Quercus englemannii	Engelman Oak	LAA	09/29/99	1260	38.3	15:00	150	220	250	74	56	71
Quercus emoryi	Emory Oak	LAA	09/30/99	1380	32.3	13:58	280	2	220	100	5	130
Quercus ilex	Holly Oak	LAA	09/30/99	1160	25.2	14:30	46	14	5	25	5	0
Quercus ilex	Holly Oak	LAA	09/30/99	1470	28.1	11:35	18	5	10	5	3	0
Fagaceae												
Quercus lobata	Valley Oak	OF	06/30/99	1960	35.5	11:45	250	12	70	67	11	11
Quercus lobata	Valley Oak	OF	07/14/99	1860	37.5	13:00	260	28	220	150	32	62
Quercus lobata	Valley Oak	BFD	08/06/99	1860	26.0	14:20	160	14	170	150	12	150
Quercus lobata	Valley Oak	BFD	08/06/99	1970	26.0	14:30	230	14	260	83	5	77
Quercus lobata	Valley Oak	BFD	08/06/99	1840	25.9	14:30	280	10	280	240	1	240
Quercus macrocarpa	Bur Oak	MC	09/02/99	1160	21.0	13:00	500	15	300	220	6	170
Quercus palustris	Pin Oak	BC	08/09/99	1600	27.5	14:10	8000	47	7700	16000	11	16000
Quercus robur	English Oak	MC	09/19/99	1790	27.4	13:14	4400	94	4400	440	31	277
Quercus robur	English Oak	MC	09/19/99	1750	27.7	13:44	670	48	1800	820	30	1300
Quercus rubra	Red Oak	LAA	09/30/99	1290	26.2	14:40	170	24	210	94	9	140
Quercus rubra	Red Oak	LAA	09/30/99	1660	37.5	11:45	130	78	120	27	34	37
Quercus suber	Cork Oak	MC	09/20/99	1660	30.0	11:30	42	0	16	29	0	8
Quercus suber	Cork Oak	MC	09/20/99	1840	30.5	12:58	81	6	140	18	9	71
Quercus virginiana	Southern Live Oak	CSUB	07/28/99	1800	30.8	14:45	380	21	2400	200	12	540
Quercus virginiana	Southern Live Oak	BFD	08/06/99	1860	26.0	14:30	450	12	450	300	5	300
Quercus virginiana	Southern Live Oak	BFD	08/06/99	1970	26.0	14:30	570	18	570	200	6	200
Quercus virginiana	Southern Live Oak	BFD	08/06/99	1840	25.9	14:50	190	22	190	100	9	100
Quercus wislizensii	Interior Live Oak	LAA	09/15/95	1530	24.5	11:10	2100	68	1400	2400	18	630
Quercus wislizensii	Interior Live Oak	LAA	09/30/99	1230	33.0	14:40	110	5	130	67	3	38
Garryaceae												
Garrya florescens	Silk Tassel	MC	08/24/99	1610	33.8	14:36	7	4	3	2	2	0
Garrya florescens	Silk Tassel	MC	08/24/99	1790	34.3	14:00	7	18	4	3	6	3
Gingkoaceae												
Gingko biloba	Gingko	BC	08/18/99	1880	30.0	13:38	23	4	32	14	5	18
Gingko biloba	Gingko	BFD	08/23/99	1640	39.7	15:00	12	57	27	14	33	4

Appendix A. Continued.

Scientific Name	Common Name	Loc. [1]	Date Sampled	PAR (umol m^{-2} s^{-1})	Temp. (°C)	Start Time Sampled	Mean Emissions [2] Light	Mean Emissions [2] Dark	Mean Emissions [2] Crush	Std. Dev. [3] Light	Std. Dev. [3] Dark	Std. Dev. [3] Crush
							(nPAU g^{-1}) [4]					
Hamamelidaceae												
Liquidambar styraciflua	Liquidambar	HP	07/19/99	1720	34.1	15:10	400	330	14000	120	190	7600
Liquidambar styraciflua	Liquidambar	HP	07/19/99	1440	33.7	16:30	360	110	19000	250	57	5100
Liquidambar styraciflua	Liquidambar	CSUB	07/27/99	1950	32.4	14:05	910	420	24000	410	160	6200
Juglandaceae												
Juglans regia	English Walnut	BFD	08/19/99	1320	26.8	9:50	12	46	300	3	32	200
Juglans regia	English Walnut	BFD	08/19/99	1680	27.5	10:50	26	120	900	9	45	820
Juglans regia	English Walnut	BFD	08/19/99	1690	27.6	11:10	29	72	860	5	25	750
Lamiaceae												
Hyptis emoryi	Desert Lavendar	BFD	06/30/99	1700	40.8	15:35	180	160	35000	89	90	12000
Marrubium rotundiflora	Silveredge Horehound	MC	09/14/99	1090	23.5	9:25	20	5	1400	4	5	70
Phlomis fruticosa	Jerusalem Sage	MC	09/15/99	1490	30.8	14:15	24	21	4000	10	8	1100
Rosmarius officinalis	Rosemary	MC	10/31/99	1210	25.2	12:35	66	28	4300	29	23	1100
Rosmarius officinalis	Rosemary	MC	10/31/99	1150	20.5	14:00	63	65	5200	34	82	1200
Salvia apiana	California White Sage	MC	10/14/99	1300	20.4	10:40	38	7	7800	49	10	220
Salvia chamedryoides	Sage	BFD	08/12/99	1700	31.5	14:15	57	86	840	65	81	400
Salvia darcyi	Soresbia	MC	09/12/99	1550	29.3	14:45	53	130	24000	15	63	6000
Salvia darcyi	Soresbia	MC	09/12/99	1460	30.0	15:15	62	230	9400	19	130	3200
Salvia officinalis	Garden Sage	MC	10/11/99	1270	26.2	10:45	100	6500	4100	97	3900	530
Salvia officinalis	Garden Sage	MC	10/11/99	1280	26.2	11:00	520	120	6800	460	74	990
Loganiaceae												
Buddleia alternifolia	Fountain Butterfly Bush	MC	09/20/99	1550	29.5	10:50	36	13	0	18	18	0
Buddleia alternifolia	Fountain Butterfly Bush	MC	09/20/99	1880	29.5	13:45	9	140	16	14	86	23
Buddleia davidii	Butterfly Bush	MC	09/23/99	1170	20.5	9:50	12	17	210	12	11	6
Buddleia marrubbifolia	Wooly Butterfly Bush	BFD	09/06/99	1650	37.5	14:05	33	18	480	25	5	95
Buddleia marrubbifolia	Wooly Butterfly Bush	BFD	09/06/99	1350	37.5	14:20	14	75	610	13	53	220
Magnoliaceae												
Magnolia grandiflora	Magnolia	GP	08/20/99	1800	32.6	13:45	36	11	920	9	11	280
Magnolia grandiflora	Magnolia	GP	08/20/99	1740	33.2	14:30	56	11	590	47	4	530
Magnolia stellata	Royal Star	MC	10/10/99	1490	28.2	11:40	0	0	0	0	0	0
Magnolia stellata	Royal Star	MC	10/10/99	1600	29.4	13:25	0	0	0	0	0	0

Appendix A. Continued.

Scientific Name	Common Name	Loc. [1]	Date Sampled	PAR (umol m^{-2} s^{-1})	Temp. (°C)	Start Time Sampled	Mean Emissions [2] Light	Mean Emissions Dark	Mean Emissions Crush	Std. Dev. [3] Light	Std. Dev. Dark	Std. Dev. Crush
							(nPAU g^{-1}) [4]					
Malvaceae												
Malacothamnus niveus	Chaparral Mallow	MC	09/14/99	1310	23.7	9:55	0	90	1400	0	31	780
Moraceae												
Morus nigra	Black Mulberry	MC	10/06/99	772	10.2	8:40	4	0	4	3	0	1
Morus nigra	Black Mulberry	MC	10/06/99	935	63.1	9:30	3	2	5	3	5	3
Myoporaceae												
Eremophila glabra	Common Emu Bush	LAA	09/29/99	1480	32.5	10:45	6	3	36	1	3	2
Eremophila glabra	Common Emu Bush	LAA	09/29/99	1270	31.1	10:15	5	3	6	5	8	2
Myrtaceae												
Callistemon citrinus	Bottlebrush	BFD	08/03/99	1430	27.2	10:20	35	370	220	34	240	81
Callistemon citrinus	Bottlebrush	BFD	08/03/99	1670	28.2	10:55	280	27	1900	92	7	1100
Callistemon citrinus	Bottlebrush	BFD	08/03/99	1800	28.6	11:20	48	510	2	26	520	1
Eucalyptus camaldulensis 'C2'	Eucalyptus 'C2'	CSUB	07/23/99	1920	30.7	12:00	190	28	1000	70	18	640
Eucalyptus camaldulensis 'C2'	Eucalyptus 'C2'	CSUB	07/23/99	1890	35.6	14:20	250	50	420	69	16	100
Eucalyptus camaldulensis 'C2'	Eucalyptus 'C2'	CSUB	07/23/99	1730	35.8	15:00	150	61	240	70	24	70
Eucalyptus grandis 'GCT'	Eucalyptus 'GCT'	CSUB	07/22/99	1860	34.6	14:45	410	27	1300	190	9	690
Eucalyptus grandis 'GCT'	Eucalyptus 'GCT'	CSUB	07/22/99	1520	33.9	15:55	310	77	5400	130	20	3600
Eucalyptus grandis 'GCT'	Eucalyptus 'GCT'	CSUB	07/22/99	1680	29.0	10:42	1000	39	7700	420	14	1600
Myrtaceae												
Eucalyptus grandis 'G3'	Eucalyptus 'G3'	CSUB	07/23/99	1820	30.0	11:22	360	81	10000	110	91	6400
Eucalyptus grandis 'G3'	Eucalyptus 'G3'	CSUB	07/23/99	1970	34.0	13:20	310	84	6000	240	20	2100
Eucalyptus grandis 'G3'	Eucalyptus 'G3'	CSUB	07/23/99	1680	34.7	15:40	590	56	1900	120	26	930
Eucalyptus polyanthemos	Silver Dollar Gum	CSUB	07/26/99	1740	30.9	11:00	640	49	12000	160	39	5200
Eucalyptus polyanthemos	Silver Dollar Gum	CSUB	07/26/99	1920	32.4	13:35	370	17	5800	120	9	1600
Eucalyptus polyanthemos	Silver Dollar Gum	CSUB	07/26/99	1850	32.7	14:30	530	180	13000	350	100	11000
Eucalyptus sideroxylon	Red Iron Bark	CSUB	07/28/99	1950	31.2	13:40	190	18	2500	59	5	480
Eucalyptus sideroxylon	Red Iron Bark	CSUB	07/28/99	1610	32.0	15:40	250	35	4300	83	5	1300
Eucalyptus sideroxylon	Red Iron Bark	CSUB	07/28/99	1490	32.3	16:05	250	69	4000	160	16	1300
Nyctaginaceae												
Bougainvillea brasiliensis	Bougainvillea	BFD	09/02/99	1700	33.0	13:50	140	260	120	45	83	76
Oleaceae												
Forestiera neomexicana	Desert Olive	MC	10/07/99	1540	27.2	13:20	0	0	17	0	0	3
Fraxnis velutina 'Modesto'	Modesto Ash	MC	09/15/99	1650	30.2	13:00	5	8	0	3	7	0
Olea europaea	Olive	BFD	08/06/99	763	25.0	10:45	0	0	0	0	0	0

Appendix A. Continued.

Scientific Name	Common Name	Loc. [1]	Date Sampled	PAR (umol m^{-2} s^{-1})	Temp. (°C)	Start Time Sampled	Mean Emissions [2] (nPAU g^{-1}) [4] Light	Dark	Crush	Std. Dev. [3] Light	Dark	Crush
Oleaceae (continued)												
Syringa vulgaris	Lilac 'Clarks Giant'	MC	09/26/99	986	18.0	9:15	12	42	7	12	19	2
Onagraceae												
Zauschneria californica	California Fuscia	BFD	08/10/99	1890	29.5	11:30	0	0	0	0	0	0
Papaveraceae												
Dendromecon rigida	Bush poppy	MC	09/14/99	867	16.3	8:45	120	13	150	37	3	33
Romenya coulteri	Matilija Poppy	MC	10/10/99	1230	26.0	10:30	3	0	0	8	0	0
Pinaceae												
Picea breweriana	Dwarf Alberta Spruce	MC	10/14/99	1350	21.7	13:05	360	17	6400	190	9	290
Picea breweriana	Dwarf Alberta Spruce	MC	10/14/99	1320	21.2	14:20	470	31	5400	160	7	620
Pinus halepensis	Aleppo Pine	CM	08/23/99	1840	36.6	13:30	50	38	1700	24	22	40
Pinus halepensis	Aleppo Pine	CM	08/23/99	1820	37.3	14:10	35	27	1700	9	13	120
Pinus pinea	Italian Stone Pine	BC	08/18/99	1590	31.3	15:05	11	7	85	6	4	29
Pinus pinea	Italian Stone Pine	BC	08/18/99	1440	34.2	15:48	6	8	210	2	11	260
Pinus sabiniana	Digger Pine	HF	07/30/99	1280	23.6	9:45	41	17	1200	20	8	280
Pinus sabiniana	Digger Pine	HF	07/30/99	1610	23.3	10:25	34	53	1600	24	67	640
Pinus sabiniana	Digger Pine	HF	07/30/99	1740	23.5	11:05	47	22	1400	25	12	290
Pinus sylvestris	Scots Pine	MC	09/23/99	1600	24.0	11:35	13	4	6000	6	10	2300
Platanaceae												
Platanus occidentalis	American Sycamore	MC	10/10/99	982	21.3	9:20	0	0	0	0	0	0
Platanus occidentalis	American Sycamore	MC	10/10/99	1150	25.0	10:00	0	0	0	0	0	0
Platanus racemosa	California Sycamore	HP	07/15/99	1950	34.0	13:30	140	40	89	44	19	42
Platanus racemosa	California Sycamore	HP	07/15/99	1670	35.5	15:00	93	35	82	43	40	34
Platanus racemosa	California Sycamore	CSUB	07/27/99	1680	34.8	16:00	550	170	550	240	68	190
Polypodiaceae												
Woodwardia fimbriata	Giant Chain Fern	MC	10/28/99	681	9.8	9:30	560	23	340	450	5	160
Woodwardia fimbriata	Giant Chain Fern	MC	10/28/99	965	11.5	10:15	2600	38	640	4400	16	340
Rhamnaceae												
Rhamnus californica	Coffee Berry	MC	09/26/99	1720	24.3	13:00	920	13	920	250	7	460
Rhamnus californica	Coffee Berry	MC	09/26/99	1970	30.3	11:50	520	10	680	240	6	39
Rhamnus cathartica	Common Buckthorn	MC	09/08/99	1770	29.1	11:15	14	22	13	2	26	0
Rhamnus cathartica	Common Buckthorn	MC	09/08/99	1670	24.6	13:35	9	0	3	3	0	5

Appendix A. Continued.

Scientific Name	Common Name	Loc. [1]	Date Sampled	PAR (umol m^{-2} s^{-1})	Temp. (°C)	Start Time Sampled	Mean Emissions [2] Light	Mean Emissions [2] Dark	Mean Emissions [2] Crush	Std. Dev. [3] Light	Std. Dev. [3] Dark	Std. Dev. [3] Crush
							(nPAU g^{-1}) [4]					
Rosaceae												
Cercocarpus ledifolius	Desert Mahogony	MC	09/07/99	1190	24.6	9:45	26	24	19	9	7	15
Cercocarpus ledifolius	Desert Mahogony	MC	09/07/99	1400	28.1	10:20	17	14	11	3	18	1
Cerocarpus montanus	Mountain mahogony	MC	09/15/99	1300	23.5	10:00	27	8	14000	8	14	3800
Cerocarpus montanus	Mountain mahogony	MC	09/15/99	1430	35.7	10:40	74	40	13000	54	20	5300
Chaenomeles 'Toyo Nishiki'	Japanese Quince	MC	09/26/99	1550	22.6	11:05	0	0	0	0	0	0
Heteromeles arbutifolia	Toyon	BFD	08/11/99	1490	30.5	15:45	83	26	79	57	26	61
Kerria pleniflora	Kerria Japonica	MC	10/18/99	895	16.5	9:34	0	0	0	0	0	0
Kerria pleniflora	Kerria Japonica	MC	10/18/99	980	17.3	9:46	9	0	0	9	0	0
Malus domestica	Apple	MC	10/28/99	1330	20.1	13:45	1	5	0	3	5	0
Malus domestica	Apple	MC	10/28/99	1300	21.3	14:10	0	0	0	0	0	0
Potentilla fruiticosa	Bush Cinquefoil	MC	09/12/99	1590	30.6	10:45	1	39	8	2	38	4
Potentilla fruiticosa	Bush Cinquefoil	MC	09/12/99	1720	30.2	11:15	14	0	14	4	0	5
Prunus laurocerasus	English Laurel	MC	09/26/99	1210	20.5	9:50	5	1	3	2	2	0
Prunus laurocerasus	English Laurel	MC	09/26/99	1400	21.6	10:25	0	7	3	0	2	4
Prunus virginiana	Red Choke Cherry	MC	10/07/99	1520	27.5	14:00	0	0	0	0	0	0
Purshia tridentata	Antelope Brittle Bush	MC	09/12/99	1260	25.5	9:45	11	92	92	3	38	51
Purshia tridentata	Antelope Brittle Bush	MC	09/12/99	1360	28.4	10:10	35	34	200	24	21	160
Pyracantha 'Mojave'	Pyracantha	MC	09/23/99	1410	24.6	10:30	7	0	0	7	0	0
Pyracantha 'Mojave'	Pyracantha	MC	09/23/99	1580	26.8	11:05	1	0	0	2	0	0
Sorbus aucuparia	European Mountain Ash	MC	10/07/99	1440	25.6	10:55	0	0	0	0	0	0
Sorbus aucuparia	European Mountain Ash	MC	10/07/99	1520	25.7	11:25	0	0	0	0	0	0
Vauquelina californica	Arizona Rosewood	BFD	08/06/99	1910	31.0	11:45	1	0	0	2	0	0
Rubiaceae												
Galium odoratum	Sweet woodruff	MC	09/26/99	1540	23.5	11:40	14	11	450	6	6	160
Rutaceae												
Correa pulchella	Australian Fuscia	BFD	08/12/99	1280	32.5	16:05	150	77	150	130	6	110
Ruta graveolens	Herb of Grace	MC	10/24/99	1340	21.1	14:15	0	8	120	0	11	2

Appendix A. Continued.

Scientific Name	Common Name	Loc. [1]	Date Sampled	PAR (umol m^{-2} s^{-1})	Temp. (°C)	Start Time Sampled	Mean Emissions [2] Light (nPAU g^{-1}) [4]	Mean Emissions Dark	Mean Emissions Crush	Std. Dev. [3] Light	Std. Dev. Dark	Std. Dev. Crush
<u>Salicaceae</u>												
Populus alba	White poplar	MC	07/20/99	2040	28.7	12:58	490	14	430	240	4	200
Populus alba	White poplar	MC	07/20/99	1990	27.2	13:45	540	22	470	150	9	200
Populus alba	White poplar	MC	07/20/99	1900	27.2	14:15	560	23	400	400	7	170
Populus fremontii	W. Cottonwood	MC	07/20/99	1360	21.8	12:00	480	15	420	130	8	150
Populus fremontii	W. Cottonwood	MC	07/20/99	1750	25.1	10:40	460	11	360	300	4	270
Populus fremontii	W. Cottonwood	MC	07/20/99	1880	27.5	11:20	500	8	350	280	4	180
Populus nigra italica	Lombardy poplar	MC	07/16/99	1910	30.7	12:10	620	33	360	150	36	92
Populus nigra italica	Lombardy poplar	MC	07/16/99	1930	29.5	14:00	150	18	95	40	7	31
Populus nigra italica	Lombardy poplar	MC	07/16/99	1750	29.8	14:55	380	17	310	130	4	130
Populus sp.	Swedish poplar	MC	07/20/99	1760	26.2	15:10	390	50	360	230	7	230
Populus sp.	Swedish poplar	MC	07/20/99	1570	26.3	15:55	290	52	220	130	19	160
Populus sp.	Swedish poplar	MC	07/20/99	1320	27.3	16:20	220	41	180	49	16	63
Salix babylonica	Weeping Willow	CSUB	07/28/99	2080	29.3	13:00	260	77	190	110	39	160
Salix babylonica	Weeping Willow	BFD	09/19/95	1280	29.3	15:25	1200	57	2700	2200	8	410
Salix sp.	Willow	BFD	07/29/99	1600	26.7	10:24	240	47	380	75	12	280
Salix sp.	Willow	BFD	07/29/99	1710	27.0	10:55	210	27	230	68	11	75
Salix sp.	Willow	BFD	07/29/99	1890	29.3	11:30	260	25	240	48	8	36
Salix laevigata	Red willow	MC	10/06/95	1590	20.1	11:35	380	3	440	170	4	200
Salix laevigata	Red willow	MC	10/06/95	1600	64.2	11:00	210	0	240	53	0	30
<u>Sapindaceae</u>												
Koelreuteria paniculata	Goldenrain Tree	BFD	07/01/99	1380	34.2	9:40	0	0	0	0	0	0
Koelreuteria paniculata	Goldenrain Tree	CSUB	07/21/99	1570	30.8	15:45	21	0	21	7	0	7
Koelreuteria paniculata	Goldenrain Tree	BFD	08/05/99	1990	33.2	14:20	2	0	2	5	0	5
<u>Saxifragaceae</u>												
Heuchera hybrid	Santa Ana Cardinal	MC	10/24/99	1050	20.0	14:45	5	10	3	5	5	5
<u>Scrophulariaceae</u>												
Leucophyllum frutescens 'White cloud'	Texas Ranger 'White Cloud'	BFD	08/04/99	1550	34.8	15:30	5	2	7	1	1	1
Leucophyllum frutescens 'White cloud'	Texas Ranger 'White Cloud'	BFD	08/04/99	1500	34.3	15:56	0	0	0	0	0	0
Leucophyllum frutescens 'White cloud'	Texas Ranger 'White Cloud'	BFD	08/04/99	1930	33.7	13:45	4	3	6	3	2	3
<u>Ulmaceae</u>												
Ulmus parvifolia	Chinese Elm	BC	09/02/99	1330	21.4	10:35	2	2	5	1	4	5
<u>Zygophyllaceae</u>												
Larrea tridentata	Creosote Bush	MC	10/27/99	1530	20.9	12:57	3	2	20	2	5	0
Larrea tridentata	Creosote Bush	MC	10/27/99	1340	20.2	12:24	0	4	8	1	6	0

1.
BC = Bakersfield College
BFD = Bakersfield, CA
CSUB = Cal. State University Bakersfield
HF = Hart Flat, Kern County
LAA = Los Angeles Arboretum
MC = Mourning Cloak Ranch and Botanical Garden, Tehachapi

2.
LIGHT = PAU unit value in the light – ambient (mean of 5 values)
DARK = PAU unit value from darkened foliage – ambient (mean of 5 values)
CRUSHED = PAU unit value when illuminated leaves were manually crushed (mean of 2 - 5 values)

3.
LIGHT = Std dev. of light value mean
DARK = Std dev. of dark value mean
CRUSHED = Std dev. of crushed value mean

4.
PAU value normalized to grams dry leaf mass. PAU was Model 580B instrument in 1999 sampling.

Appendix B. Sampling conditions and net PAU values for plants measured with the ppbRAE instrument in 2000.

Scientific Name	Common Name	Loc. [1]	Date Sampled	PAR (umol m^{-2} s^{-1})	Temp. (°C)	Start Time Sampled	Mean Emissions [2] (nPAU g^{-1}) [4] Light	Dark	Crush	Std. Dev. [3] Light	Dark	Crush
<u>Aceraceae</u>												
Acer ginnala	Amur Maple	MC	08/22/00	1500	29.1	10:37	15	14	32	5	5	14
Acer negundo	Boxelder	MC	08/21/00	890	18.8	8:40	5	0	16	1	8	3
Acer negundo	Boxelder	MC	08/22/00	1130	23.7	9:20	25	25	21	7	21	3
<u>Amaryllidaceae</u>												
Agapanthus africanus	Lily-of-the-Nile	BFD	10/04/00	1380	22.7	11:25	14	3	13	5	2	5
Agapanthus africanus	Lily-of-the-Nile	BFD	10/04/00	1460	23.6	11:55	14	7	12	7	6	6
<u>Anacardiaceae</u>												
Cotinus coggygria 'Purpureus'	Purple Smoke Tree	LEC	09/20/00	1290	30.5	10:10	28	32	16000	7	22	3700
Cotinus coggygria 'Purpureus'	Purple Smoke Tree	LEC	09/20/00	1450	32.0	10:50	22	26	12000	9	20	6800
Rhus glabra	Smooth Sumac	HF	09/14/00	1610	25.5	11:15	150	31	170	98	15	19
Rhus glabra	Smooth Sumac	HF	09/14/00	1750	26.7	11:45	23	10	190	14	10	74
Rhus lancea	African Sumac	BFD	09/01/00	1910	23.7	12:30	640	820	9800	670	1600	12000
Rhus lancea	African Sumac	BFD	09/01/00	2030	27.0	13:00	170	35	9300	69	19	6400
Rhus ovata	Sugar Bush	BFD	06/21/00	1370	30.0	9:50	100	82	1900	86	34	740
Schinus molle	California Pepper	BFD	06/15/00	1990	39.5	13:50	340	430	2600	390	210	450
<u>Apocynaceae</u>												
Trachelospermum jasminoides	Star Jasmine	BFD	09/29/00	760	21.2	9:00	3	8	11	1	6	0
Trachelospermum jasminoides	Star Jasmine	BFD	09/29/00	920	21.3	9:30	4	8	25	2	5	4
<u>Arecaceae</u>												
Syagrus romanzoffinaum	Queen Palm	BFD	09/29/00	1210	20.6	11:10	140	33	31	100	28	10
Syagrus romanzoffinaum	Queen Palm	BFD	09/29/00	1460	22.2	11:40	320	30	52	120	18	27
<u>Asteraceae</u>												
Artemisia tridentata	Big Sagebrush	MC	08/23/00	730	19.0	8:30	1200	1700	640000	600	580	590000
Bacchuris salcifolia	Mulefat	BFD	07/06/00	1560	24.2	10:45	540	2000	1100	180	1200	320
Bacchuris salcifolia	Mulefat	BFD	07/06/00	1890	26.6	11:20	660	1100	860	330	490	61
Euryops pectinatus	Euryops Daisy	BFD	09/29/00	1030	20.6	10:20	13	22	28	6	12	8
Euryops pectinatus	Euryops Daisy	BFD	09/29/00	1270	21.2	10:45	11	27	25	2	8	4
<u>Berberidaceae</u>												
Berberis thunbergii	Japanese Barberry	MC	07/11/00	1460	20.3	9:15	650	76	740	290	24	240
Berberis thunbergii	Japanese Barberry	MC	07/11/00	1400	22.5	10:00	880	190	2400	250	90	2800

Appendix B. Continued.

Scientific Name	Common Name	Loc. [1]	Date Sampled	PAR (umol m^{-2} s^{-1})	Temp. (°C)	Start Time Sampled	Mean Emissions [2] Light	Mean Emissions [2] Dark	Mean Emissions [2] Crush	Std. Dev. [3] Light	Std. Dev. [3] Dark	Std. Dev. [3] Crush
							(nPAU g^{-1}) [4]					
<u>Betulaceae</u>												
Alnus rhombifolia	White Alder	MC	09/05/00	1790	17.6	13:20	12	8	41	5	2	18
Betula papyrifera	Paper Bark Birch	MC	06/22/00	1950	30.8	14:00	41	130	41	9	36	13
Betula papyrifera	Paper Bark Birch	MC	06/27/00	1880	29.9	11:24	470	310	600	120	75	260
Betula papyrifera	Paper Bark Birch	MC	07/20/00	1870	28.2	11:35	120	130	160	13	43	43
Carpinus betulus	European Hornbeam	LEC	09/28/00	1490	24.2	12:30	4	21	54	2	11	25
Carpinus betulus	European Hornbeam	LEC	09/28/00	1490	22.9	12:50	2	14	27	1	3	7
Corylus cornuta	Walking Stick	MC	09/13/00	970	29.1	10:45	20	13	57	4	5	5
Corylus maxima	Filbert	MC	09/11/00	1440	25.1	10:10	45	63	27	24	44	11
Corylus maxima	Filbert	MC	09/11/00	1440	25.1	10:30	78	54	69	55	29	18
<u>Bignoniaceae</u>												
Chilopsis linearis 'Burgundy'	Desert Willow	IMN	10/02/00	1580	29.4	13:20	63	370	98	15	210	11
Macfadyena unguis-cati	Cat's Claw Vine	BFD	09/18/00	950	26.0	9:00	36	15	24	22	9	3
Macfadyena unguis-cati	Cat's Claw Vine	BFD	09/25/00	1700	33.6	13:50	40	100	14	29	82	1
Podranea ricasoliana	Pink Trumpet Vine	BFD	09/15/00	760	22.0	8:50	4	19	97	2	8	20
Podranea ricasoliana	Pink Trumpet Vine	BFD	09/15/00	950	23.0	9:28	9	33	27	2	12	10
<u>Buxaceae</u>												
Simmondsia chinensis	Jojoba	UCR	07/25/00	1000	33.6	16:45	580	47	790	150	13	220
Simmondsia chinensis	Jojoba	UCR	07/25/00	700	33.5	17:30	380	24	310	150	7	160
<u>Calycanthaceae</u>												
Calycanthus occidentalis	Spice Bush	IMN	10/02/00	1540	31.3	12:10	1200	120	1600	370	40	690
Calycanthus occidentalis	Spice Bush	IMN	10/02/00	1600	31.0	12:45	2400	100	2900	560	40	1600
<u>Casuarinaceae</u>												
Casuarina cunninghamiana	River She-oak	BFD	06/19/00	1310	23.4	9:20	91	16	120	75	4	100
Casuarina cunninghamiana	River She-oak	BFD	06/19/00	1460	26.1	10:00	350	27	390	120	8	130
<u>Caprifoliaceae</u>												
Lonicera tartarica	Tartarian Honeysuckle	MC	07/20/00	1890	30.3	14:00	120	60	200	35	11	1
Lonicera tartarica	Tartarian Honeysuckle	MC	07/20/00	1750	29.8	2:45	200	130	170	54	140	59
Sambucus mexicana	Mexican Elderberry	MC	09/11/00	700	12.2	8:30	5	2	49	2	1	2
Sambucus mexicana	Mexican Elderberry	MC	09/11/00	980	16.5	9:00	15	4	180	7	1	69
<u>Celastraceae</u>												
Euonymus alata	Winged Euonymus	MC	09/25/00	1080	21.7	9:30	6	6	91	2	1	25
Euonymus alata	Winged Euonymus	MC	09/25/00	1280	22.5	11:00	7	7	29	2	2	3

Appendix B. Continued.

Scientific Name	Common Name	Loc. [1]	Date Sampled	PAR (umol m^{-2} s^{-1})	Temp. (°C)	Start Time Sampled	Mean Emissions [2] Light	Mean Emissions Dark	Mean Emissions Crush	Std. Dev. [3] Light	Std. Dev. Dark	Std. Dev. Crush
							(nPAU g^{-1}) [4]					
Celastraceae (continued)												
Euonymus japonica	Evergreen Euonymus	MC	08/22/00	1930	30.7	13:20	36	20	44	20	14	27
Cercidiphyllaceae												
Cercidiphyllum japonicum	Japanese Katsura Tree	MC	07/17/00	1430	21.8	10:00	51	45	64	10	27	22
Cercidiphyllum japonicum	Japanese Katsura Tree	MC	06/22/00	1360	28.1	10:00	17	67	16	6	40	4
Chenopodiaceae												
Salsola tragus	Russian Thistle	BFD	09/15/00	1340	25.2	10:20	27	59	34	5	39	3
Salsola tragus	Russian Thistle	BFD	09/15/00	1500	25.1	11:00	59	130	63	26	94	38
Cornaceae												
Cornus stolonifera	Red Twig Dogwood	MC	07/05/00	1910	21.6	13:55	130	73	180	23	25	55
Cornus stolonifera	Red Twig Dogwood	MC	07/11/00	1690	22.3	10:45	85	48	98	17	21	17
Cupressaceae												
Cupressus nevadensis	Piute Cypress	MC	07/20/00	1370	24.2	9:25	680	170	10000	390	93	1300
Cupressus nevadensis	Piute Cypress	MC	07/20/00	1310	25.3	10:00	410	130	4600	160	26	900
Thuja occidentalis	Western Arborvitae	MC	08/23/00	1800	27.8	12:20	22	8	3300	17	1	2400
Cycadaceae												
Cycas revoluta	Sago Palm	BFD	10/09/00	1480	29.5	14:00	8	5	9	4	1	3
Cycas revoluta	Sago Palm	BFD	10/09/00	1400	30.8	14:40	13	6	9	2	2	5
Ebenaceae												
Diospyrus virginiana	American Persimmon	MC	06/22/00	1650	30.5	10:42	100	16	57	29	4	24
Diospyrus virginiana	American Persimmon	MC	06/22/00	1650	29.8	11:18	86	16	70	30	3	22
Elaeagnaceae												
Elaegnus angustifolia	Russian Olive	MC	07/17/00	1330	19.1	9:15	42	13	85	9	4	12
Ericaceae												
Arbutus menziesii	California Madrone	MC	07/11/00	1430	28.5	14:50	48	15	96	16	5	25
Arbutus unedo	Strawberry Tree	MC	08/22/00	1910	30.1	13:00	29	13	76	8	8	22
Arctostaphylos morroensis	Morro Manzanita	MC	09/12/00	866	28.5	11:00	26	3	65	30	2	1
Fabaceae												
Acacia melanoxylon	Blackwood Acacia	BFD	06/19/00	665	22.2	7:55	52	9	37	27	4	3
Acacia melanoxylon	Blackwood Acacia	BFD	06/19/00	1020	23.3	8:40	22	16	29	17	5	6
Albizia julibrissin	Mimosa	BFD	10/04/00	1540	25.1	13:30	4	4	4	1	3	3
Albizia julibrissin	Mimosa	BFD	10/04/00	1600	25.9	14:00	4	6	5	1	3	2
Calliandra eriophylla	Pink Fairy Duster	BFD	09/08/00	735	21.2	8:30	200	72	250	82	50	160

Appendix B. Continued.

Scientific Name	Common Name	Loc. [1]	Date Sampled	PAR (umol m^{-2} s^{-1})	Temp. (°C)	Start Time Sampled	Mean Emissions [2] Light	Mean Emissions Dark	Mean Emissions Crush	Std. Dev. [3] Light	Std. Dev. Dark	Std. Dev. Crush
							(nPAU g^{-1}) [4]					
Fabaceae (continued)												
Ceratonia siliqua	Carob	CSUB	09/25/00	1040	31.7	16:15	4	4	3	2	4	1
Cercis canadensis	Eastern Redbud	MC	06/22/00	1320	27.3	9:15	140	46	220	90	26	120
Cercis canadensis	Eastern Redbud	MC	06/22/00	1980	30.6	13:20	480	100	370	150	39	57
Cercis canadensis 'Flame'	Flame Redbud	LEC	09/28/00	1370	22.0	11:30	2	2	23	1	2	5
Cercis canadensis 'Flame'	Flame Redbud	LEC	09/28/00	1390	21.8	12:00	3	1	14	1	1	1
Cercis occidentalis	Western Redbud	BFD	06/21/00	1780	33.1	10:40	670	54	650	160	25	260
Dalbergia sissoo	Dalbergia	BFD	09/08/00	887	23.4	9:00	340	9	57	260	4	17
Erythrina caffra	Coral Tree	UCR	07/26/00	1680	32.9	13:15	1000	150	740	540	120	230
Genista racemosa	Broom	BFD	09/29/00	1550	22.6	12:10	530	110	96	280	55	35
Genista racemosa	Broom	BFD	09/29/00	1680	23.7	12:40	830	130	120	370	180	39
Gleditsia triacanthos inermis 'Shademaster'	Shademaster Honey Locust	LEC	09/21/00	1440	28.6	14:45	2	1	38	1	2	31
Gleditsia triacanthos inermis 'Shademaster'	Shademaster Honey Locust	LEC	09/21/00	1270	29.0	15:15	1	10	5	4	9	2
Lysiloma thornberii	Desert Fern	BFD	09/01/00	1700	22.2	11:00	88	10	33	39	3	2
Lysiloma thornberii	Desert Fern	BFD	09/01/00	1840	22.2	11:40	140	6	15	41	1	4
Olneya tesota	Desert Ironwood	UCR	07/26/00	1640	37.1	14:10	2100	170	1400	1600	83	330
Fagaceae												
Quercus berberidifolia	California Scrub Oak	RS	10/16/00	1520	28.9	12:15	210	60	120	120	34	13
Quercus berberidifolia	California Scrub Oak	RS	10/16/00	1620	31.0	12:45	240	74	80	35	22	32
Quercus brewerii	Brewers Oak	IMN	10/02/00	1420	28.7	11:10	330	17	140	160	9	18
Quercus brewerii	Brewers Oak	IMN	10/02/00	1520	29.9	11:40	1600	37	550	840	10	640
Quercus chrysolepsis	Canyon Live Oak	MC	09/13/00	1340	28.0	10:20	400	34	240	150	24	32
Quercus chrysolepsis	Canyon Live Oak	RS	10/05/00	1540	22.6	12:24	79	2	38	57	1	5
Quercus chrysolepsis	Canyon Live Oak	RS	10/05/00	1480	22.6	12:55	88	2	24	29	1	2
Quercus douglasii	Blue Oak	FR	07/18/00	1200	22.1	9:30	400	22	580	90	6	120
Quercus douglasii	Blue Oak	FR	07/18/00	1480	23.8	10:00	530	43	580	220	16	400
Quercus douglasii	Blue Oak	FR	07/18/00	1590	24.1	10:40	480	44	410	200	8	350
Quercus durata 'durata'	Leather Oak	RS	10/05/00	1380	25.9	14:30	160	6	29	49	1	8
Quercus durata 'durata'	Leather Oak	RS	10/05/00	1310	26.7	15:00	120	7	30	23	3	1
Quercus garryana 'garryana'	Oregon White Oak	RS	10/05/00	1190	20.2	11:00	76	2	137	58	1	6
Quercus john-tuckeri	Tucker Oak	RS	10/16/00	1380	30.6	14:10	160	30	68	60	9	22

Appendix B. Continued.

Scientific Name	Common Name	Loc. [1]	Date Sampled	PAR (umol m^{-2} s^{-1})	Temp. (°C)	Start Time Sampled	Mean Emissions [2] Light	Dark	Crush	Std. Dev. [3] Light	Dark	Crush
							(nPAU g^{-1}) [4]					
<u>Fagaceae (continued)</u>												
Quercus lobata	Valley Oak	BFD	06/14/00	1690	39.7	10:15	1700	36	2300	170	31	1500
Quercus pacifica	Channel Islands Scrub Oak	RS	10/16/00	1540	29.3	13:15	140	11	21	18	2	6
Quercus pacifica	Channel Islands Scrub Oak	RS	10/16/00	1490	31.1	13:45	240	18	44	130	7	20
Quercus palmeri	Palmer's Oak	RS	10/16/00	1260	30.8	14:45	300	52	900	160	35	590
Quercus peninsularis	Peninsular Oak	RS	10/05/00	1610	24.1	13:30	370	35	120	340	9	43
Quercus peninsularis	Peninsular Oak	RS	10/05/00	1460	25.0	14:00	300	25	160	120	16	86
Quercus tomentella	Island Oak	RS	10/05/00	1400	20.7	11:45	190	8	26	61	3	3
Quercus vacciniifolia	Huckleberry Oak	RS	10/16/00	1500	26.1	11:50	130	6	21	28	1	5
<u>Garryaceae</u>												
Garrya elliptica	Silktassel	MC	06/28/00	1840	29.4	11:00	49	85	35	13	24	12
Garrya elliptica	Silktassel	MC	06/28/00	1840	29.4	11:40	18	33	12	8	6	8
<u>Grossulariaceae</u>												
Ribes odorata	Clove Currant	MC	06/27/00	1900	31.2	13:32	320	44	210	210	13	190
Ribes odorata	Clove Currant	MC	06/27/00	1900	31.2	14:05	280	62	530	170	15	33
<u>Hamamelidaceae</u>												
Liquidambar styraciflua	Liquidambar	MC	07/05/00	1720	22.2	11:20	1300	510	44000	380	580	1400
<u>Hippocastanaceae</u>												
Aesculus californicum	California Buckeye	MC	06/27/00	1440	27.5	9:32	180	63	89	120	27	32
Aesculus californicum	California Buckeye	MC	06/27/00	1660	29.8	10:15	230	110	190	65	58	27
<u>Juglandaceae</u>												
Juglans californica	S. California Black Walnut	IMN	10/03/00	1190	24.0	10:30	67	81	750	55	90	390
Juglans californica	S. California Black Walnut	IMN	10/03/00	1230	24.9	11:00	180	220	840	220	340	650
Juglans regia	Carpathian Walnut	LEC	09/27/00	1420	25.7	11:30	30	120	4000	20	170	3400
Juglans regia	Carpathian Walnut	LEC	09/27/00	1340	23.7	11:00	25	140	2500	16	120	790
<u>Lamiaceae</u>												
Lavandula angustifolia	English Lavender	UCR	07/26/00	1050	24.9	9:20	3400	1800	120000	610	1700	34000
Salvia 'Bee's Bliss'	Bee's Bliss Sage	IMN	10/02/00	1520	32.2	13:50	1400	4300	21000	740	2000	6800
Salvia 'Bee's Bliss'	Bee's Bliss Sage	IMN	10/02/00	1500	31.5	14:25	3000	5000	32000	2500	2200	6300
Salvia clevelandii	Cleveland Sage	IMN	10/02/00	1430	29.1	15:10	1500	1000	24000	2100	590	5600
Salvia clevelandii	Cleveland Sage	IMN	10/02/00	1400	28.2	15:45	610	620	29000	160	230	9500
Salvia dolomitica	Sage Hybrid	UCR	07/26/00	1850	26.7	13:45	1200	85	20000	67	44	3800

Appendix B. Continued.

Scientific Name	Common Name	Loc. [1]	Date Sampled	PAR (umol m^{-2} s^{-1})	Temp. (°C)	Start Time Sampled	Mean Emissions [2] (nPAU g^{-1}) [4] Light	Dark	Crush	Std. Dev. [3] Light	Dark	Crush
Lamiaceae (continued)												
Salvia gregii	Sage	SR	10/12/00	1830	25.1	13:00	850	860	8400	240	510	6000
Salvia gregii	Sage	SR	10/12/00	1740	23.1	13:30	790	850	5400	630	340	4900
Lauraceae												
Umbellularia californica	California Bay	IMN	10/03/00	1520	26.0	12:35	510	230	70000	370	310	1700
Magnoliaceae												
Magnolia soulangeana	Saucer Magnolia	BFD	10/09/00	1130	25.5	11:00	55	16	870	22	8	220
Magnolia soulangeana	Saucer Magnolia	BFD	10/09/00	1290	26.8	11:35	64	13	780	15	9	400
Magnolia stellata	Royal Star	MC	08/23/00	1770	28.2	11:30	21	20	490	7	7	110
Magnolia stellata	Royal Star	MC	08/31/00	1800	20.1	12:08	22	9	1400	13	11	1100
Malvaceae												
Anisodontea x hypomadarum	South African Mallow	BFD	09/08/00	1430	26.9	10:40	200	97	880	64	33	83
Althaea 'W.M.R. Smith'	W.M.R. Smith Althaea	LEC	09/21/00	1630	25.6	12:30	8	8	8	4	3	2
Althaea 'W.M.R. Smith'	W.M.R. Smith Althaea	LEC	09/21/00	1740	27.0	12:55	10	9	9	5	2	1
Meliaceae												
Melia azedarach	Texas Umbrella Tree	BFD	10/09/00	907	20.0	9:30	3	5	190	1	4	87
Melia azedarach	Texas Umbrella Tree	SR	10/12/00	1430	20.8	15:15	0	0	0	0	0	0
Moraceae												
Ficus carica 'Mission'	Black Mission Fig	LEC	09/21/00	1640	27.7	13:30	290	23	92	86	18	22
Ficus carica "Mission"	Black Mission Fig	LEC	09/21/00	1580	28.3	14:05	420	47	55	150	32	5
Maclura pomifera	Osage Orange	MC	09/12/00	1080	26.7	10:00	19	22	36	3	9	1
Maclura pomifera	Osage Orange	MC	09/12/00	1090	30.3	11:20	21	25	48	14	8	22
Myrtaceae												
Eucalyptus accedens	Eucalyptus	UCR	07/26/00	1620	31.5	11:00	670	55	1800	110	29	180
Eucalyptus ebbanoensis	Eucalyptus	UCR	07/26/00	1780	34.5	11:50	1100	67	4100	340	17	1700
Eucalyptus megacornuta	Eucalyptus	UCR	07/26/00	1630	32.1	11:30	440	53	650	270	20	140
Eucalyptus spathulata	Eucalyptus	UCR	07/26/00	1890	34.8	12:20	240	100	1200	52	41	740
Nyssaceae												
Nyssa sylvatica	Tupelo Tree	MC	09/11/00	1590	27.8	11:00	750	84	98	300	42	23
Nyssa sylvatica	Tupelo Tree	MC	09/11/00	1760	28.1	11:30	1200	88	220	130	41	10
Oleaceae												
Chionanthus retusus	Chinese Fringe Tree	LEC	09/21/00	1090	22.4	10:15	3	1	25	2	2	10
Chionanthus retusus	Chinese Fringe Tree	LEC	09/21/00	1280	23.3	14:45	4	2	51	2	1	2

Appendix B. Continued.

Scientific Name	Common Name	Loc.[1]	Date Sampled	PAR (umol m^{-2} s^{-1})	Temp. (°C)	Start Time Sampled	Mean Emissions[2] Light	Mean Emissions[2] Dark	Mean Emissions[2] Crush	Std. Dev.[3] Light	Std. Dev.[3] Dark	Std. Dev.[3] Crush
							(nPAU g^{-1})[4]					
Oleaceae (continued)												
Fraxinus americana 'Junginger'	Junginger Autumn Purple Ash	LEC	09/26/00	1090	23.5	10:10	2	1	8	0	0	1
Fraxinus americana 'Junginger'	Junginger Autumn Purple Ash	LEC	09/26/00	1340	25.0	10:40	3	2	11	1	1	1
Fraxinus depetela	Fresno Ash	IMN	10/03/00	1560	27.7	13:05	15	82	33	5	44	1
Fraxinus oxycarpa	Raywood Ash	MC	09/12/00	862	23.3	9:00	10	14	140	5	3	82
Fraxinus oxycarpa	Raywood Ash	MC	09/12/00	859	24.1	9:30	21	18	180	13	8	140
Fraxinus pennsylvanica 'Patmore'	Patmore Ash	LEC	09/20/00	1510	35.7	14:45	60	5	10	33	2	0
Fraxinus pennsylvanica 'Patmore'	Patmore Ash	LEC	09/20/00	1390	35.1	15:06	61	4	7	37	4	2
Papaveraceae												
Romneya coulteri	Matilija Poppy	MC	09/06/00	936	14.2	9:00	170	8	1400	140	4	280
Romneya coulteri	Matilija Poppy	MC	09/06/00	936	14.2	9:00	120	11	840	68	7	120
Pinaceae												
Cedrus lebani	Cedar of Lebanon	MC	07/17/00	1920	29.1	14:10	26	23	260	4	18	150
Cedrus lebani	Cedar of Lebanon	MC	07/17/00	1850	28.2	14:45	23	14	830	5	6	130
Caloacedrus decurrens	Incense Cedar	MC	07/11/00	2010	25.3	12:10	60	43	1200	26	6	280
Caloacedrus decurrens	Incense Cedar	MC	07/11/00	1990	27.6	13:30	180	20	980	68	3	81
Larix kaempferi	Japanese Larch	MC	09/05/00	1810	17.4	13:00	25	23	9000	15	17	970
Picea purgens-glauca	Colorado Blue Spruce	MC	06/28/00	977	23.6	8:00	250	39	1300	48	24	380
Picea purgens-glauca	Colorado Blue Spruce	MC	06/28/00	1160	25.1	8:30	240	110	13000	170	65	7400
Pinus attenuata	Knobcone Pine	MC	09/06/00	1930	24.0	13:00	480	160	54000	220	85	28000
Pinus monophyla	Singleleaf Pinon Pine	CP	07/06/00	1950	28.3	13:30	52	440	1200	18	380	690
Pinus monophyla	Singleleaf Pinon Pine	CP	07/06/00	1980	28.3	14:10	88	150	3400	51	86	1300
Pinus ponderosa	Ponderosa Pine	PF	07/18/00	1910	25.0	12:25	67	24	260	20	12	190
Pinus ponderosa	Ponderosa Pine	PF	07/18/00	1920	26.5	13:00	63	43	4000	28	20	3600
Pinus strobus 'nana'	Dwarf Eastern White Pine	MC	09/14/00	888	23.0	9:00	70	53	6500	58	21	3200
Platanaceae												
Platanus x acerifolia 'Yarwood'	Yarwood Sycamore	LEC	09/20/00	1650	35.3	13:40	990	35	220	310	12	37
Platanus x acerifolia 'Yarwood'	Yarwood Sycamore	LEC	09/20/00	1660	35.2	14:09	650	19	91	310	4	12
Poaceae												
Cortaderia selloana	Pampas Grass	BFD	10/04/00	1490	23.9	12:25	8	10	100	3	5	55
Cortaderia selloana	Pampas Grass	BFD	10/04/00	1500	24.3	12:55	8	8	150	6	3	59

Appendix B. Continued.

Scientific Name	Common Name	Loc. [1]	Date Sampled	PAR (umol m^{-2} s^{-1})	Temp. (°C)	Start Time Sampled	Mean Emissions [2] Light (nPAU g^{-1}) [4]	Mean Emissions Dark	Mean Emissions Crush	Std. Dev. [3] Light	Std. Dev. Dark	Std. Dev. Crush
Proteaceae												
Grevillea noellii	Noel's Grevillea	BFD	08/21/00	1910	33.1	13:30	160	2	24	63	2	11
Punicaceae												
Punica granatum	Pomegranate	LEC	09/21/00	1450	24.7	11:20	3	9	62	1	8	18
Punica granatum	Pomegranate	LEC	09/21/00	1470	24.4	11:50	2	4	27	1	1	11
Rhamnaceae												
Ceanothus cuneatus	Buck Brush	MC	09/06/00	1630	23.8	11:20	23	63	30	12	20	1
Ceanothus 'Dark Star'	California Lilac	IMN	10/03/00	1540	26.8	12:00	140	63	100	80	16	15
Ceanothus thyrsiflorus 'Skylark'	California Lilac	IMN	10/03/00	1430	30.7	15:30	18	16	29	5	6	4
Ziziphus jujuba	Chinese Jujube 'Li'	LEC	09/27/00	1640	28.6	12:25	1	2	67	0	1	71
Ziziphus jujuba	Chinese Jujube 'Li'	LEC	09/27/00	1630	28.8	12:55	2	0	6	1	1	2
Rosaceae												
Amelanchier alnifolia	Serviceberry	MC	08/23/00	842	22.3	9:00	100	38	150	110	20	75
Crataegus laevigata	English Hawthorne	MC	09/11/00	1120	29.6	9:30	9	6	36	3	2	14
Crataegus laevigata 'Washington'	Washington Hawthorne	LEC	09/26/00	1530	27.1	11:45	4	7	8	2	2	4
Crataegus laevigata 'Washington'	Washington Hawthorne	LEC	09/26/00	1470	26.7	12:00	3	4	10	2	3	1
Cydonia oblonga 'Cookes Jumbo'	Cookes Jumbo Quince	LEC	09/26/00	1540	28.0	12:15	15	45	21	6	29	9
Cydonia oblonga 'Cookes Jumbo'	Cookes Jumbo Quince	LEC	09/26/00	1640	28.8	12:40	12	36	16	24	19	16
Heteromeles arbutifolia	Toyon	BFD	06/19/00	1760	34.2	15:20	1100	16	53	2000	3	11
Heteromeles arbutifolia	Toyon	BFD	06/20/00	1880	37.0	14:45	56	16	51	36	3	15
Malus domestica 'Yellow Delicious'	Yellow Delicious Spur Apple	LEC	09/28/00	1140	20.6	10:40	0	2	64	1	8	32
Malus domestica 'Yellow Delicious'	Yellow Delicious Spur Apple	LEC	09/28/00	1200	23.1	11:05	0	0	61	1	2	20
Malus 'Prairifire'	Prairifire Crab Apple	LEC	09/26/00	1550	31.4	12:45	8	18	48	5	2	7
Malus 'Prairifire'	Prairifire Crab Apple	LEC	09/26/00	1640	31.1	1:15	7	12	38	2	5	14
Prunus cerasifera	Purple Plum	BFD	06/14/00	1640	41.7	11:05	23	29	13	24	18	10
Prunus cistena	Cistena Sand Cherry	LEC	09/27/00	1480	31.3	2:30	26	6	85	8	3	65
Prunus cistena	Cistena Sand Cherry	LEC	09/27/00	1570	30.2	2:00	15	5	140	8	2	27
Prunus domestica	Apricot Tree	BFD	06/15/00	1840	38.2	11:22	31	10	27	28	4	9
Prunus domestica	Apricot Tree	BFD	06/15/00	2030	40.8	13:15	58	19	98	22	17	48
Prunus ilicifolia	Hollyleaf Cherry	MC	08/22/00	1890	31.7	12:38	45	18	62	54	9	9

Appendix B. Continued.

Scientific Name	Common Name	Loc. [1]	Date Sampled	PAR (umol m^{-2} s^{-1})	Temp. (°C)	Start Time Sampled	Mean Emissions [2] Light	Dark	Crush	Std. Dev. [3] Light	Dark	Crush
							(nPAU g^{-1}) [4]					
Rosaceae (continued)												
Spiraea x bumalda 'Anthony Waterer'	Anthony Waterer Spirea	LEC	09/28/00	870	17.6	9:30	12	21	130	7	7	46
Spiraea x bumalda 'Anthony Waterer'	Anthony Waterer Spirea	LEC	09/28/00	1030	18.1	10:00	15	77	89	7	49	51
Spiraea vanhouttei	Bridlewreath Spirea	LEC	09/27/00	1120	21.6	10:00	25	12	240	23	6	3
Spiraea vanhouttei	Bridlewreath Spirea	LEC	09/27/00	1290	22.5	10:30	17	67	560	12	48	360
Rubiaceae												
Cephalanthus occidentalis	Buttonwillow	IMN	10/03/00	1530	27.5	13:40	17	180	17	4	190	1
Cephalanthus occidentalis	Buttonwillow	IMN	10/03/00	1490	29.1	14:00	11	69	16	3	27	4
Salicaceae												
Populus balsamifera	Balsam Poplar	MC	07/05/00	1440	18.6	9:45	470	26	300	120	7	180
Populus balsamifera	Balsam Poplar	MC	07/05/00	1640	19.8	10:15	530	35	710	190	14	490
Populus nigra	Lombardy Poplar	MC	06/27/00	1930	31.0	12:04	1100	130	700	430	39	130
Populus nigra	Lombardy Poplar	MC	06/27/00	1930	31.0	12:36	670	97	500	410	15	30
Populus tremuloides	Quaking Aspen	MC	07/17/00	1890	26.8	13:30	420	50	280	200	11	270
Populus tremuloides	Quaking Aspen	MC	07/17/00	1640	28.0	15:15	750	160	1200	360	79	780
Salix x blanda 'Fan-Giant'	Fan Giant Blue Weeping Willow	LEC	09/20/00	1610	33.8	11:25	720	130	140	200	19	32
Salix x blanda 'Fan-Giant'	Fan Giant Blue Weeping Willow	LEC	09/20/00	1710	34.5	11:45	1500	190	150	720	73	1
Salix caprea	French Pink Pussy Willow	LEC	09/20/00	1260	35.8	15:36	470	40	71	180	16	9
Salix caprea	French Pink Pussy Willow	LEC	09/20/00	1060	35.6	16:01	440	48	72	160	19	14
Salix matsudana	Corkscrew Willow	LEC	09/26/00	1410	30.5	2:10	210	17	150	140	5	22
Salix matsudana	Corkscrew Willow	LEC	09/26/00	1350	31.7	2:30	500	24	120	110	9	1
Salix purpurea	Oshier Willow	MC	09/06/00	1740	25.8	14:00	1200	43	510	370	17	54
Salix purpurea	Oshier Willow	MC	09/06/00	1750	25.6	14:20	1300	71	340	310	19	80
Sapindaceae												
Koelreuteria paniculata	Goldenrain Tree	BFD	06/14/00	1990	38.2	13:13	860	1700	1000	760	1700	830
Koelreuteria paniculata	Goldenrain Tree	BFD	06/14/00	1850	34.0	11:05	760	1000	---	600	400	---
Koelreuteria paniculata	Goldenrain Tree	BFD	08/21/00	1900	31.6	12:45	63	27	110	25	11	57
Saxifragaceae												
Escallonia rubra	Pink Escallonia	BFD	10/04/00	1230	24.2	10:20	44	21	410	14	11	120
Escallonia rubra	Pink Escallonia	BFD	10/04/00	1320	24.8	10:50	58	35	360	23	14	81
Simaroubaceae												
Ailanthus altissima	Tree Of Heaven	BFD	10/09/00	974	27.2	10:00	14	10	130	3	6	160

Appendix B. Continued.

Scientific Name	Common Name	Loc. [1]	Date Sampled	PAR (umol m^{-2} s^{-1})	Temp. (°C)	Start Time Sampled	Mean Emissions [2] Light (nPAU g^{-1}) [4]	Mean Emissions Dark	Mean Emissions Crush	Std. Dev. [3] Light	Std. Dev. Dark	Std. Dev. Crush
<u>Solanaceae</u>												
Datura meteloides	Jimson Weed	MC	09/05/00	783	11.6	8:30	5	2	28	1	1	12
Lycium brevipes	Frutilla	UCR	07/26/00	1580	36.6	14:45	450	220	810	440	75	18
Nicotiana glauca	Tree Tobacco	BFD	10/09/00	1580	30.8	13:00	23	11	45	11	8	8
Nicotiana glauca	Tree Tobacco	BFD	10/09/00	1510	31.6	13:30	21	22	79	12	12	73
<u>Sterculiaceae</u>												
Fremontodendron californicum	Flannel Bush	MC	06/28/00	1440	29.5	9:48	390	68	360	110	18	120
Fremontodendron californicum	Flannel Bush	MC	06/28/00	1710	30.9	10:30	330	88	310	56	41	90
<u>Tamaricaceae</u>												
Tamarix parviflora	Tamarisk	MC	08/23/00	1240	27.5	9:42	58	67	75	12	46	16
Tamarix parviflora	Tamarisk	MC	08/23/00	1470	27.3	10:20	38	25	21	11	8	2
<u>Taxodiaceae</u>												
Sequoiadendrom gigantea	Giant Sequoia	MC	07/17/00	960	17.7	8:30	13	22	7056	4	23	1400
<u>Thymelaeaceae</u>												
Daphna caucasica	Caucasian Daphne	MC	08/31/00	1740	18.3	13:14	480	3	83	180	3	11
<u>Ulmaceae</u>												
Celtis occidentalis	Hackberry	MC	09/06/00	1340	22.4	10:00	21	4	170	12	4	70
Celtis occidentalis	Hackberry	MC	09/06/00	1340	22.4	10:20	12	7	68	7	4	23
<u>Verbenaceae</u>												
Callicorpa japonica	Japanese Beautyberry	MC	07/17/00	1610	23.0	10:30	220	110	580	130	25	360
Callicorpa japonica	Japanese Beautyberry	MC	07/20/00	1710	25.7	10:45	550	300	1100	110	81	300
Lantana montevidensis	Trailing Lantana	SR	10/12/00	1700	22.3	13:55	720	790	1700	200	460	320
Lantana montevidensis	Trailing Lantana	SR	10/12/00	1510	20.6	14:25	780	560	740	260	370	84
Vitex agnus-castus	Chaste Tree	BFD	08/25/00	859	25.1	8:45	1000	1600	15000	420	490	1600
Vitex agnus-castus	Chaste Tree	BFD	08/25/00	1100	27.1	9:30	230	220	3500	77	140	2900
<u>Vitaceae</u>												
Vitis vinifera 'Thompson Seedless'	Thompson Seedless Grape	BFD	06/15/00	1510	34.5	10:00	120	99	67	52	37	45
Vitis vinifera 'Thompson Seedless'	Thompson Seedless Grape	BFD	06/15/00	1510	34.5	10:00	36	19	38	25	23	18

1.
BFD = Bakersfield, CA
CP = Chimney Peak
CSUB = CSU Bakersfield Campus, Bakersfield
HF = Hart Flat, Kern County
IMN = Intermountain Nursery, Fresno
LEC = L.E. Cooke Wholesale Nursery, Visalia
MC = Mourning Cloak Ranch and Botanical Garden, Tehachapi
RS = Rancho Santa Ana Botanical Garden, Claremont
SR = UC Research Station, Shafter
UCR = UC Riverside Botanical Garden, Riverside

2.
LIGHT = PAU unit value in the light – ambient (mean of 5 values)
DARK = PAU unit value from darkened foliage – ambient (mean of 5 values)
CRUSHED = PAU unit value when illuminated leaves were manually crushed (mean of 2 values)

3.
LIGHT = Std dev. of the light value mean
DARK = Std dev. of the dark value mean
CRUSHED = Std dev. of crushed value mean

4.
PAU value normalized to grams dry leaf mass. PAU was ppb RAE instrument in 2000 sampling.