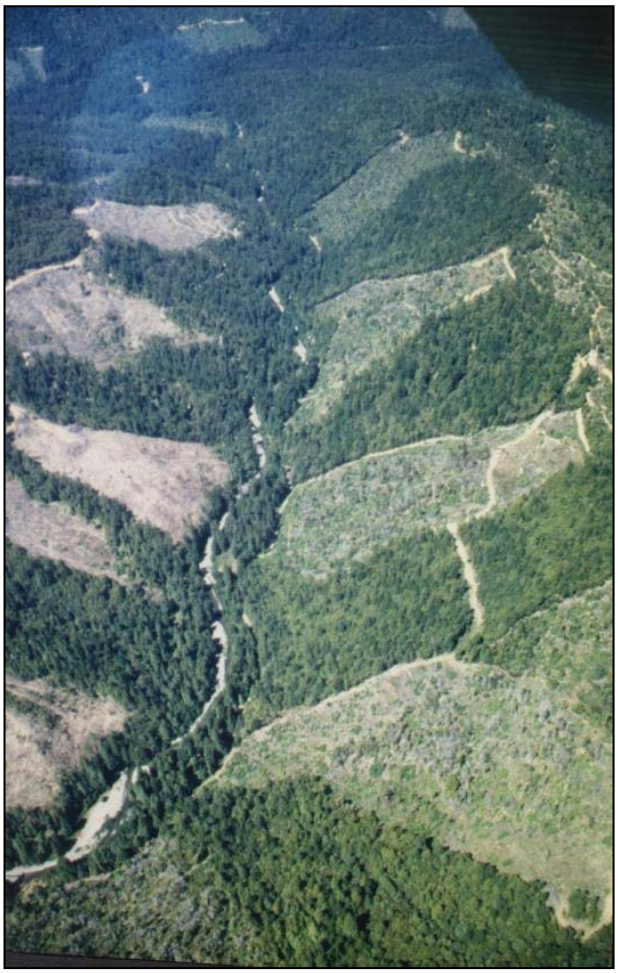
CALIFORNIA FORESTRY

This scenario is intended to represent forestlands in northern California. The area of interest (AOI) includes Trinity, Shasta, Modoc, and Humboldt counties since they are predominantly forested (Figure 1) and comprise the largest amount of pesticide application to forest lands in California. Approximately 33% of California's land surface is forested, with roughly 32 million acres and 25 forest types throughout the state. There are 18 national forests in California totalling over 20 million acres. The majority of national forest lands occur in the northern and western part of the state. The predominant forest types in northern California as well as throughout the state include Sierran mixed Conifer, Montane hardwood, and Douglas Fir (USDA, 2006a). Based on typical forest composition and common pest species, this scenario is intended to represent coniferous evergreen forests.



Forestlands in California are susceptible to a wide range of forest pests such as the Mountain pine beetle and the fir engraver. In forest lands, pesticides are used for a number of management operations that include:

1. Thinning or control of specific trees to promote growth of desirable species.
2. Thinning or control of vegetation to reduce fire fuel.
3. Site preparation for planting of trees.
4. Control of vegetation on highways, utility, and railroad rights-of-way in forests.
5. Control of vegetation in forest nurseries and riparian areas.
6. Suppression of insects and diseases.
7. Management of aquatic plants and fish.

On Forest service lands, Forest Service units applied a total of 163,015 lbs. of pesticides to 255,434 acres of National Forest System (NFS) land throughout the United States. Based on 2005 California Pesticide Use Data (CalPIP, 2006), approximately 91 thousand pounds of pesticides were applied to California forests (public and private). Nearly 60% of the total pounds applied in California were applied in the counties of Shasta, Humboldt, Siskiyou, Trinity, and Lassen Counties, located in northern California. MLRAs 4, 5 and 22 dominate northern California forest lands.

Metfile W24283 is the closest meteorological data set available to represent Northern California. The station was chosen for it's proximity to Shasta county where most pesticide application occurs (CalPIP, 2006). Its data were collected at the station in Arcata/Eureka, California, located approximately 100 miles from the center of Shasta County. The station is located approximately 62 meters above mean sea level and receives an average annual rainfall of approximately 38 inches (NOAA, 2006). On average, December and January are the wettest months, receiving approximately 30 percent of the annual precipitation (NOAA, 2006).

The Marpa series was selected for the scenario because it is a common soil in the AOI (Table 5), is among the highest in erodibility, and slope, and is listed as supporting timber production in California (USDA, 1998). It is a Loamy-skeletal, mixed, active, mesic Ultic Haploxeralfs soil found on slopes of 5 to 75%, which includes 60%, the maximum slope on which timber is harvested (D. Bakke, Pesticide-Use Specialist and Invasive Plants Coordinator State and Private Forestry, personal communication).

Marpa is a Hydrologic Group C soil. Approximately 52% of soils in the AOI are in hydrologic groups A and B. Approximately 22% are in hydrologic group C. The USLE K factor for Marpa soils is 0.37, which is among the highest soil erodibilties in the AOI. Three soils in the AOI have a USLEK greater than Marpa (Table 5), however they were not used for modeling for several reasons. Inville (0.17-0.43) is a hydrologic goup B soil, which is less preferable than C or D soils due to lower curve numbers. Deven and Jellico, are less common than Marpa soils, and do not include the maximum slope range on which timberlands are located. Moreover, these soils do not generally support timber production as a use based on the official soil series descriptions (USDA, 1997; USDA, 2003). Approximately 50% of soils in the AOI have a pH lower than Marpa soils. However, soil pH is not currently a PRZM input parameter and is not expected to often affect chemical fate in the acidic range. Marpa soils have a litter layer one inch thick, an A horizon from 0 to 6 inches (0-15 cm) deep, a B horizon from 6 to 26 inches (15-66 cm) deep, and a layer of fractured shale from 26 to 32 inches (66-81 cm) deep (USDA, 1998). Scenario parameters are based on Marpa gravely loam, Shasta County, CA (USDA, 2006c)

Table 1. PRZM 3.12 Climate and Time Parameters for Northern California – Forestry.

Parameter	Value	Source/Comments
Starting Date	Jan. 1, 1961	Meteorological File from Arcata/Eureka, CA (W24283)
Ending Date	Dec. 31, 1990	Meteorological File from Arcata/Eureka, CA (W24283)
Pan Evaporation Factor (PFAC)	0.76	PRZM Manual Figure 5.1. Value represents the mid-point of the range of values for northern CA range (from 0.73 to 0.79).
Snowmelt Factor (SFAC)	0.12	PRZM Manual Table 5-1. Maximum value of the minimum range of values
Minimum Depth of Evaporation (ANETD)	17.5 cm	PRZM Manual Figure 5.2 (EPA, 1998). Set to the mid-point of the range of values.

Table 2. PRZM 3.12 Erosion and Landscape Parameters for Northern California – Forestry.

Parameter	Value	Source/Comments
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	PRZM Manual (EPA, 1998)
USLE K Factor (USLEK)	0.37 tons EI^{-1*}	USDA NRCS Soil Data Mart (http://soildatamart.nrcs.usda.gov/) Value listed for the soil series Marpa.
USLE LS Factor (USLELS)	28.83	LS equation (Haan and Barfield, 1978) LS value for 40% slope and 400' slope length
USLE P Factor (USLEP)	1.0	Practice factor does not exist for forestlands. Default for orchards with no contour practices.
Field Area (AFIELD)	172 ha	Area of Shipman Reservoir watershed (EPA, 1999)
NRCS Hyetograph (IREG)	2	PRZM Manual Figure 5.12 (EPA, 1998)
Slope (SLP)	40%	Marpa soils. Max slope range on which pesticides are applied. (D. Bakke, Pesticide-Use Specialist and Invasive Plants Coordinator State and Private Forestry)
Hydraulic Length (HL)	600 m	Shipman Reservoir (EPA, 1999)
Irrigation Flag (IRFLAG)	0	Forestlands not irrigated.
* EI = 100 ft-tons * in/ acre*hr		

Table 2. PRZM 3.12 Erosion and Landscape Parameters for Northern California – Forestry.		
Parameter	**Value**	**Source/Comments**

Table 3. PRZM 3.12 Crop Parameters for Northern California – Forestry.

Parameter	Value	Source/Comments
Initial Crop (INICRP)	1	Set to one for all crops (EPA, 2004).
Initial Surface Condition (ISCOND)	3	3 = Residue. Brush and debris are left behind.
Number of Different Crops (NDC)	1	Set to number of crops in simulation.
Number of Cropping Periods (NCPDS)	30	Set to weather data in meteorological file: Arcata/Eureka, CA (W24283)
Maximum rainfall interception storage of crop (CINTCP)	0.25	Recommended value for orchards (EPA, 2004). In line with empirical data from Dunne and Leopold (1978) for coniferous forests.
Maximum Active Root Depth (AMXDR)	66 cm	Tree species such as Douglas fir have deep roots depending on soil depth (Harlow, et al., 1991). Value is constrained by the scenario soil depth.
Maximum Canopy Coverage (COVMAX)	100	100% canopy coverage for coniferous, evergreen woodlands.
Soil Surface Condition After Harvest (ICNAH)	3	3 = Residue. Brush and debris are left behind.
Date of Crop Emergence (EMD, EMM, IYREM)	01/01	Coniferous forests dominate Northern California. Values are set to keep E/T and canopy coverage terms working correctly for this evergreen scenario.
Date of Crop Maturity (MAD, MAM, IYRMAT)	02/01	Coniferous forests dominate Northern California. Values are set to keep E/T and canopy coverage terms working correctly for this evergreen scenario.
Date of Crop Harvest (HAD, HAM, IYRHAR)	31/12	Coniferous forests dominate Northern California. Values are set to keep E/T and canopy coverage terms working correctly for this evergreen scenario.
Maximum Dry Weight (WFMAX)	0.0	Not used in scenario
Maximum Canopy Height (HTMAX)	5,486 (180 ft)	Firs in California/Pacific Northwest can be as high as 180 feet. (Harlow, et al., 1991)
SCS Curve Number (CN)	77, 77, 77	TR-55 (Table 2-2c). Curve number for woodlands, poor condition, hydrologic group C. No fallow condition. (USDA, 1986).
Manning's N Value (MNGN)	0.040	RUSLE Project; A20OFOFNfor Eureka orchard with full cover (USDA, 2000). These data were used to approximate values in forest values, as no data for forest covers were included in the project.
USLE C Factor (USLEC)	0.006 - 0.049	RUSLE Project; A20OFOFNfor Eureka orchard with full cover (USDA, 2000). These data were used to approximate values in forest values, as no data for forest covers were included in the project.

Table 4. PRZM 3.12 Marpa Soil Parameters for Northern California - Forestry

Parameter	Value	Source/Comments

Total Soil Depth (CORED)	66 cm	Marpa gravely loam, Shasta County, CA. NRCS Soil Data Mart Database (http://soildatamart.nrcs.usda.gov/).
Number of Horizons (NHORIZ)	3	Marpa gravely loam, Shasta County, CA. NRCS Soil Data Mart Database (http://soildatamart.nrcs.usda.gov/). The A horizon spans scenario horizons 1 and 2 in order to conform to PRZM input requirements. A layer of fractured shale extends from 66 to 81 cm deep (USDA, 1998) and is not included in this scenario.
Horizon Thickness (THKNS)	10 cm (HORIZN = 1) 23 cm (HORIZN = 2) 33 cm (HORIZN = 3)	NRCS Soil Data Mart Database (http://soildatamart.nrcs.usda.gov/).
Bulk Density (BD)	1.40 g/cm^3 (HORIZN = 1) 1.40 g/cm^3 (HORIZN = 2) 1.43 g/cm^3 (HORIZN = 3)	NRCS SDM; values are mean 1/3-bar moist bulk densities of a soil sampled as a Marpa soil.
Initial Water Content (THETO)	0.215 cm^3/cm^3 (HORIZN =1) 0.215 cm^3/cm^3 (HORIZN =2) 0.159 cm^3/cm^3 (HORIZN =3)	NRCS SDM; values are mean 1/3-bar water contents of a soil sampled as a Marpa soil.
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 1.0 cm (HORIZN = 2) 3.0 cm (HORIZN = 3)	NRCS SDM
Field Capacity (THEFC)	0.215 cm^3/cm^3 (HORIZN =1) 0.215 cm^3/cm^3 (HORIZN =2) 0.159 cm^3/cm^3 (HORIZN =3)	NRCS SDM; values are mean 1/3-bar water contents of a soil sampled as a Marpa soil.
Wilting Point (THEWP)	0.103 cm^3/cm^3 (HORIZN =1) 0.103 cm^3/cm^3 (HORIZN =2) 0.093 cm^3/cm^3 (HORIZN =3)	NRCS SDM; values are mean 15-bar water contents for Marpa soil.
Organic Carbon Content (OC)	1.16% (HORIZN = 1) 1.16% (HORIZN = 2) 0.49% (HORIZN = 3)	NRCS SDM; values = mean %OM / 1.724.

Sensitive Parameter Uncertainties

Slope

The typical slope that timber is harvested on is 40%. The maximum slope of timber lands where pesticides are applied is generally 60%. However, 60% is too high and outside the range of what PRZM can handle therefore the more typical slope was selected.

USLE C Factor and Manning's N Value

The RUSLE Project did not include data for forest cover. Therefore, USLE C Factor and Manning's N values were selected from data on northern California orchards with full cover, due to the similarities between conditions. Of the available locations, Eureka has the most similar weather conditions to this scenario and full cover.

USLE LS Factor

The scenario USLELS value was calculated with the Haan and Barfield equation (1978) using a 60% slope and an assumed 400-foot slope length, as per PRZM scenario development guidance (EPA, 2004). LS values for slopes longer than 300 feet or steeper than 18% are extrapolations beyond the research data range, however, which increases uncertainty in them. A 60% slope combined with a 400-foot slope length is so far past the research data range that the uncertainty in the calculated value is very great.

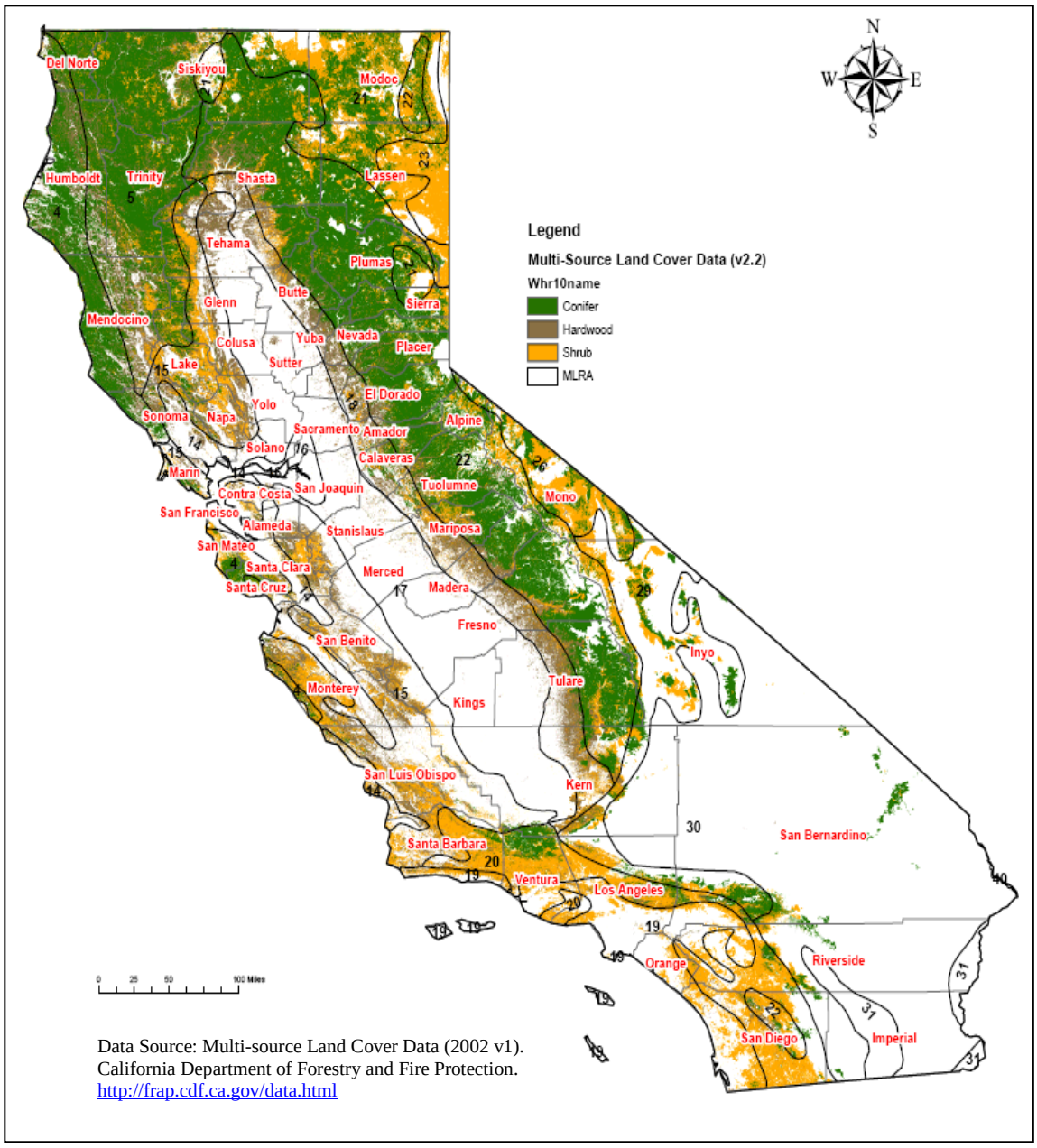


Figure 1. California forestlands by major forest type, including MLRAs.

Table 5. Soils of northern California (Shasta, Humboldt, Siskiyou, Trinity, Lassen counties).

Soil	Total Acreage	% Area	Drainage	Erodibility	Slopes (%)	pH	OM (%)	% Sand	% Silt	% Clay
CLALLAM FAMILY	360,237	3.20%	B	0.37	10-100	5.8-6.8	2-3	42.1	37.9	20
ROCK OUTCROP	310,966	2.76%	D	0.02	0-100	-	0	-	-	-
COHASSET	242,059	2.15%	B	0.24-0.37	2-75	5.8-6.1	4-6	42.1	37.9	20
TROJAN	177,595	1.58%	B	0.24-0.37	0-50	6.1-6.3	2-2.5	41.4-65.9	19.1-37.1	15-21.5
JELLYCAMP	164,694	1.46%	D	0.24-0.37	2-15	7.2	1.5	39.2-67.9	19.6-37.7	12.5-23.5
HOLLAND FAMILY	162,062	1.44%	B	0.28-0.37	0-100	5.5-6.8	2-3	42.1-65.9	19.1-37.9	15-20
SKALAN FAMILY	154,137	1.37%	B/C	0.32-0.37	0-70	5.8-6.2	2-3	42.1-65.9	19.1-37.9	15-20
SHELD	153,928	1.37%	B	0.24	0-70	5.8-6	2.5-5	68.8	23.7	7.5-8
YORKVILLE	149,382	1.33%	D	0.32	15-50	6.7	1.5	39.2	37.3	23.5
MCCARTHY	145,862	1.30%	B	0.24	2-75	6.1-6.1	6	45-66.9	15.2-45	10-18
HOPLAND	138,687	1.23%	B	0.37	15-75	6.5	3	42.1	37.9	20
INVILLE	135,030	1.20%	B	0.17-0.43	0-50	6.1-6.6	1.5-2.5	67.8-67.9	19.6-22.2	10-15
WACA	132,908	1.18%	B	0.2	2-50	6.1	9	65.7	22.8	11.5
MAYMEN	130,579	1.16%	D	0.24-0.32	9-75	5.6-6.1	0.75-1.5	43-67.2	15.3-39.5	17.5
DEADWOOD FAMILY	124,362	1.10%	B/D	0.37	30-100	5.8-6	2-3	26.5-42.1	37.9-53.5	20
WAPI FAMILY	118,835	1.06%	D	0.24	10-85	6.5	2	80.2	16.8	3
LASSEN	115,594	1.03%	D	0.37	2-50	7.2	1.5	22.1	27.9-27.9	50
MARPA	114,878	1.02%	C	0.37	5-75	6.1-6.5	1.25-2	42.1-59.6	17.9-37.9	20-22.5
DUZEL	110,325	0.98%	C	0.37	5-50	6.5	1.5	44.8	41.2	14
HURLBUT	104,649	0.93%	C	0.32-0.37	2-75	5.8	2	39.8-68.1	14.4-37.7	17.5-22.5
HUGO FAMILY	100,935	0.90%	B/C	0.32-0.37	15-70	5.5-5.8	2	21.3-42.1	37.9-54.7	20-24
WINDY	90,798	0.81%	B	0.2	8-75	5.5-6.5	9	65.7-66.9	15.2-23.1	10-18
AIKEN FAMILY	90,686	0.81%	B/C	0.37	2-70	6-6.3	2-6	42.1	37.9	20
KLICKER	89,750	0.80%	B	0.37	0-70	6.6	2.5	-	-	16
YORKTREE	85,243	0.76%	C	0.37	15-75	6.5	3	39.2	37.3	23.5
HOLLAND	77,712	0.69%	B	0.28-0.37	0-70	5.8-7	2.5-3.5	43-65.9	19.1-38.5	15-20
BURROIN	77,547	0.69%	C	0.24	2-50	5.4-5.6	5-80	15-41.1	36.9-75	10-22

Table 5. Soils of northern California (Shasta, Humboldt, Siskiyou, Trinity, Lassen counties).

Soil	Total Acreage	% Area	Drainage	Erodibility	Slopes (%)	pH	OM (%)	% Sand	% Silt	% Clay
TOOMES	77,028	0.68%	D	0.37	2-50	6.1	1.5	43	38.5	18.5
YALLIANI	76,572	0.68%	B	0.28	0-70	6.5	2.5	-	-	12
SANHEDRIN	76,501	0.68%	B	0.37	2-75	6.1	1.5	41.4	37.1	21.5
DEADWOOD	76,123	0.68%	D	0.24	30-75	6.1	2	65.9	19.1	15
JAYEL FAMILY	75,300	0.67%	C	0.37	5-60	6	3	33.3	31.7	35
NEUNS	74,236	0.66%	C	0.24-0.37	15-80	5.6-5.8	0.75-8	42.1-65.7	22.8-43.2	11.5-20
MARIPOSA	74,044	0.66%	C	0.37	5-75	5.8-6.7	2	44.3	40.7	15
KYBURZ	73,769	0.66%	B	0.24	2-50	6.1	3	44.8-66.8	19.2-41.2	14
CHAIX FAMILY	72,630	0.64%	A/B	0.24-0.37	2-100	5.8-6.8	3-4	66.9-67.9	19.1-23.1	10-13
MEISS	72,625	0.64%	D	0.24	2-75	6.5	2.5	-	-	-
TOEM FAMILY	71,106	0.63%	C	0.24	2-55	6.3	4	79	18	3
HAYPRESS FAMILY	68,186	0.61%	B	0.2	2-85	7	2	80.2	16.8	3
CASABONNE	68,158	0.61%	B	0.37	9-75	6.1	4	41.6	37.4	21
SATTLEY FAMILY	68,099	0.60%	B	0.37	0-80	6.3	2	42.1	37.9	20
KARCAL	65,530	0.58%	C/D	0.28-0.37	0-15	7-7.6	0.75	5.3-22.1	27.9-44.7	50
KINDIG	63,870	0.57%	B	0.24-0.37	15-80	6.5	3	45.8-66.9	23.1-43.7	10-10.5
DEVEN	62,822	0.56%	D	0.37-0.43	0-50	6.7-7	2	35.4-39.2	33.6-37.3	23.5-31
CHAIX	61,703	0.55%	B	0.24-0.28	5-70	6.1-6.2	4	66.9-67.8	22.2-23.1	10
HUNSINGER	61,635	0.55%	B	0.24	2-50	6.7	3.5	67.9	19.6	12.5
WACA FAMILY	60,767	0.54%	B	0.28	0-85	6.8	3	65.6	29.4	5
INVILLE FAMILY	60,610	0.54%	B	0.37	10-50	7	2	42.1	37.9	20
SCARFACE	58,603	0.52%	B	0.24	2-30	6.7	4	-	-	-
JELLICO	57,826	0.51%	C	0.55	5-50	6.7	2	29.1	53.4	17.5
AIKEN	57,552	0.51%	B	0.24-0.37	2-50	6.1-6.1	6	39.2	37.3-37.3	23.5

Contacts:

David Bakke
Pesticide-Use Specialist and Invasive Plants Coordinator
State and Private Forestry
USDA Forest Service
1323 Club Drive, Vallejo, CA 94592
Phone: (707) 562-8916
Fax: (707) 562-9054
Email: dbakke@fs.fed.us

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