California Department of Parks and Recreation
Natural Resources Division

Forest and Woodland Composition Monitoring At Wilder Ranch State Park

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by
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I. Introduction

Wilder Ranch State Park supports five different forest and woodland types. Following the Sawyer-Keeler-Wolf classification system described in "A Manual of California Vegetation" (1995), these types are: Redwood Series, Coast Live Oak Series, Douglas Fir Series, Knobcone Pine Series, and a riparian series. In the 1998 Natural Resources Inventorying and Monitoring Program at Wilder Ranch State Park report, the Santa Cruz District identified monitoring the effects of the lack of fire on the forest and woodland species composition and species abundance as one of the projects for the Natural Resources Division, Inventory, Monitoring, and Assessment (IMAP) Team. Due to the absence of fire as an ecosystem process, there is concern that the forest and woodlands are susceptible to catastrophic wildfires and potential loss of plant and animal species diversity in the understory when dead, woody materials accumulate on the forest floor, and the potential replacement of broadleaf tree species with conifer tree species that are shade- tolerant when young.

This inventory project established permanent monitoring sites and collected baseline data on the plant species composition and abundance in the Redwood, Douglas Fir, Coast Live Oak, and Santa Cruz Mountain Live Oak vegetation series.

The proposed sampling objective for the forest and woodland plant communities at Wilder Ranch State Park is to be 90% certain of detecting a change of 30% or greater from the Spring 2001 species composition and vegetative cover. We are willing to accept a 10% chance of detecting a change when no change has actually occurred (i.e. the false-change error rate is 10%).

II. Methods

Different methods were considered to use for monitoring, including CNPS releve and Fire Monitoring Handbook (National Park Service 2000). The CNPS releve protocol was not used because the data is qualitative and change could not be detected with statistical significance. The Fire Monitoring method was deemed too time intensive requiring one day to set up the plot and another day to collect the data. With input from Dr. Jim Barry, Senior State Park Resource Ecologist, and Dr. Roy Woodward, Environmental Scientist IV, both from the California Department of Parks and Recreation, IMAP decided to use a combination of point-centered quarter and point intercept-line transect to gather the baseline data. The following sections discuss the location selection and methods used to conduct and collect the forest and woodland composition data.

A.) Location Selection

Stratified random sampling of redwood, douglas fir, and coast live oak vegetation communities selected from a draft vegetation map of Wilder Ranch State Park were used to initially generate a candidate pool of plot locations. The draft Wilder Ranch State Park vegetation map was created on November 3, 2000, by Laurie Archambault and Gary Walter as a GIS ArcInfo coverage. The purpose of this draft vegetation map ("Vegclip" coverage) was to identify and label vegetation complexes to the association or series level in accordance with "A Manual of California Vegetation" (Sawyer and Keller-Wolf 1995). Using this vegetation coverage, the GIS database was queried for polygons identified as redwood, douglas fir, coast live oak, and knobcone pine series within the existing operational park boundaries. Random points within polygons of each series were generated using the ArcView "simple random" extension for each series polygons. This was saved as an ArcView shape file named "wr_veg.apr" with coverages for redwood, douglas fir, oak, and knobcone pine series. The "add XY" extension in ArcView was used to generate UTM x and y-coordinates for each of the random points. ArcView database lists the random points consecutively from north to south and east to west for each series. To randomize the order that the locations are chosen for the monitoring, random numbers were generated in Excel 2000 using the software function "RAND" for each series.

To physically locate the sampling plot locations, the UTM coordinates were entered as x-coordinate (easting) and y-coordinate (northing) as waypoints in a Trimble GeoExplorer 3 and the approximate locations (within $\pm$3 meters) found. If the random point navigated did not fit the series description, where the slope was greater than 45 degrees or unsafe to work, the location was not used and the next random number was chosen. Due to time constraints, random points in the knobcone pine series were not visited for potential site selection, hence no transects were established for the knobcone pine series.

B.) Transect Placement, Monumentation, and Location Documentation

Each site was sampled using two methods to measure the plant community, fuel load, and tree density. All data was collected along a single line transect in each plot. The direction of each transect was determined by using a random numbers generator in a calculator to generate the azimuth. If the transect direction was not initially within the plant community series sampled, a new random number was generated for a new azimuth. The transect distances were established by the transect length required by the point-center-quarter method to determine tree density and other details discussed in the methodology section. The compass bearings include +15.5 degrees east from true north (0/360 degrees).

At times, compass bearing required the transect tape to be laid through a large object, e.g. tree, rock outcrop, etc., that the tape could not be threaded through or

around without great deviation from the compass bearing. A stake monumented the endpoint of the tape at the compass bearing on one side of the obstacle and another stake was placed on the other side of the obstacle at the compass bearing. A second 100 m tape was used to continue the transect where the other tape left off as indicated by notes on the datasheet.

Each permanent transect was marked with an 18 inch aluminum angle stake (1 x ½ x 1/8); the surface roughened with sandpaper; etched with pertinent information (i.e., monitoring type, IMAP ID #822, and site number); and painted with bright orange spray paint. A stake was placed at the start (0 m) of the transect and every 50 m interval thereafter to aid in tape relocation. The stake was pounded into the ground with a hammer, leaving about 4-6" above the ground. Where possible, GPS positions of the stakes were recorded. Otherwise, physical descriptions (compass direction and distance from landmarks) were documented. Four general photographs were taken to aid in relocation of the stakes beginning with the direction of the transect tape and at 90 degrees thereafter. The photographs included a white board containing the site number, date, UTM northing and easting if available, location along the transect, and the compass direction of the picture.

See Appendix A for a table of transect lengths and data collection intervals and check list of data collection tasks by location along the transect.

C.) Point-Centered Quarter Method

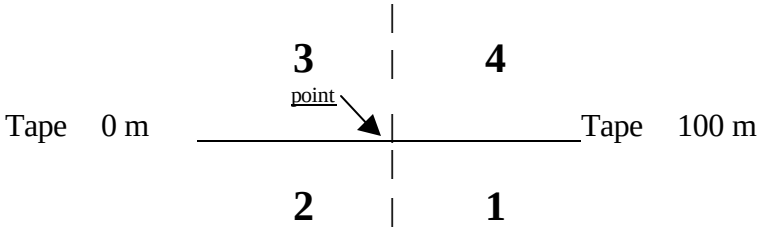
Point-centered quarter method was used to determine the density of trees, species present, and diameter (Mueller-Dombois and Ellenberg 1974). Depending upon the vegetation series, the total transect length and distance interval between readings (i.e., points on the transect) varied by transect from 10-20 m apart to reduce the chances of measuring the same trees from two consecutive points. The table below shows the distances used for each vegetation series:

Vegetation Series	Redwood	Doug Fir	Oak
Total Transect Length (m)	200	200	100
Point-Centered Quarter Reading intervals (m)	20	20	10

Both the transect lengths and distance between points were determined during the pilot sampling. A minimum of 10 points or 40 trees were measured on each transect.

At each designated point on the tape, a 360-degree circle around the tape was designated and divided into four 90-degree quarters relative to the tape. The four

quarters were relative to the transect tape and read clockwise in order. See figure below:



In each quarter, the nearest tree to the point was identified to species, measured for its distance from the point to the tree with a meter tape to the nearest centimeter, and the diameter of the tree was taken at breast height (1.5 m or 4.5 ft) from the ground with a diameter tape. The following rules were used for measuring diameter at breast height (dbh) generated from pilot sampling with Dr. W.J. Barry and Dr. R. Woodward (personal communications):

- Trees less than 5 cm dbh or a dead tree is not measured.
- If greater than 50% of the tree's trunk is in a quarter, then the tree is considered in that quarter.
- The diameter at breast height (dbh) is normally taken at 150 cm (54 inches) from the ground level.
- If the tree is on a slope, go to the side of the tree and take the dbh measurement of the tree from halfway up the slope.
- On multiple-stem trees, measure the largest single stem at dbh.
- If branching occurs at breast height, measure the narrowest area below where the tree forks.
- Distance from the point to the nearest tree is measured as a straight-line distance from the point on the transect line to the closest part of the tree at breast height.
- If a tree trunk occurs at exactly the point on the transect, count that tree in Quarter #1 and continue with the other quarters accordingly.
- If no tree occurs in a quarter within 100 m of the point along the transect, no data need be collected for that quarter and document the reason why in comments.
- Due to the prevalence of poison oak (*Toxicodendron diversilobum*) embracing the tree trunks, some of the measurements of dbh include the poison oak vines.

D.) Point-Intercept Line Transect Method and Fuel Load Component

The point-intercept line transect method was used to collect data regarding percent cover of vegetation and estimate of fuel loading. The same transect used for the point-centered quarter was used for the point-intercept line transect method. The distance between the points, the total length of transect, and the total

number of intercepts or "hits" per each transect based on vegetation series are indicated below:

Plant Community Type	Redwood	Douglas Fir	Oak
Total Transect Length (m)	200	200	100
Point-intercept Reading intervals (m)	2	2	1
Total # intercepts	100	100	100

At each point, data was collected for plant species in three height classes: $\leq$1 m (low); > 1 m and $\leq$ 15 m (mid-canopy), and > 15 m (canopy). For the low and mid-canopy plant height classes, a 1/8 inch diameter, 1 m long fiberglass rod was lowered vertically. When the tip of the rod intercepts a part of a living plant in the mid-canopy and/or low height classes, the name of the first plant species hit was recorded for each height class. If the mid-canopy height class (>1 m and $\leq$15 m) intercepts a low branch from a canopy height class tree (> 15 m), then the next plant species intercepted was recorded.

For recording purposes on the field data sheets, a 6-letter code was used to denote both the genus (first three letters of the genus) and the species (first three letters of the species). If the plant species was unknown it was recorded as UNK and given a number (e.g., UNK1). Besides a written description of the plant, a collection of the plant outside the plot was taken and pressed for later identification and verification. If the genus was known, record the 1st three letters of the genus name followed by XXX and number (e.g., BROXXX1) with plant description and collection.

If the pointer hits a dead and downed log, branches, twigs, etc. (no cones, bark, needles, or leaves) within the low height class, "fuel" and the diameter (inches) of the fuel were recorded. If the pointer intercepts a decomposed part of a log, the log was followed until reaching the parent material and the intact parent material was measured.

Should the pointer not intercept any part of a plant, the pointer was lowered to the ground. If the pointer touched "rock" or "bare ground" in the low height class, then that is what is recorded. Additional rules from the Fire Monitoring Handbook (NPS 2000) were used: If the pointer touches dead vegetation material, then "litter" and the depth of the litter to soil (in centimeters) is recorded. If a tree, stump, or large rock is on the point, record the litter or duff depth as zero, even if there is litter or duff on top of the stump or rock. If a log is in the middle of the litter or duff measuring point, move the data collection point

one foot over to the right, perpendicular to the sampling plane and note in comments this was done (Brown et al. 1982).

A densitometer is used to determine if the point intercepts plant species in the canopy height class. See Appendix B for instructions on the use of this device. If the densitometer intercepts no part of a plant, then "sky" was recorded.

Because the point intercept-line transect is not likely to detect to the rare plant species, all other plant species observed within approximately 2.5 meters of either side of the line transect but not intercepted along the transect were recorded as an incidental species.

E.) Equipment List

The following is a list of the equipment used to complete the monitoring:

- Two 100 m fiberglass transect tape
- 50 m fiberglass transect tape
- 10 m dbh tape
- 0.25 inch diameter fiberglass pointer (1 m in length)^
- GRS densitometer* (canopy cover determination)
- Data sheets (in wet areas, print on "write in the rain" underwater paper*)
- Topographic map
- Clipboard
- Pencils with erasers
- monument stakes (0 m, 50 m, 100 m, 150 m, & 200 m depending on the transect length) previously painted and etched with information
- mallet or hammer
- compass (declinated to +15.5 degrees east from true north, 360 degrees)
- digital camera
- white board and dry-erase black markers
- GPS unit

^Note: Per Fire Monitoring Handbook (NPS 2000), purchase bicycle flag and use hacksaw to cut to desired length.
*Note: These items can be purchased from Forestry Suppliers, Inc. or Ben Meadows, Co.

III. Findings

The site descriptions and the results of the summary statistics are presented in this section.

A). Site Descriptions

We established eleven transects in different areas of Wilder Ranch State Park. An area not sampled was the Gray Whale property north of Empire Grade Road. The site descriptions include UTM (zone 10) northing and easting coordinates of the 0

m monument, if available. Some of the sites were under heavily forested areas and/or in steep ravines where there was no reception of satellite signals, therefore descriptions of how to get to a site are provided in lieu of GPS coordinates. Check the original data sheets and IMAP database for additional details on locations and monuments. All compass bearings include +15.5 degrees declination. See Appendix C for a Site Map and directions.

- SITE 1
  Access: Drive to the intersection of Wild Boar and Wagon Wheel trails (currently closed to public access) and park.
  Directions to 0 m monument: Navigate using GPS unit to UTM N: 4093200 and E: 581426 along Wagon Wheel trail. From this location, take a compass bearing of 236 degrees for 36 m to find the 0 m stake.
  Transect Bearing: 148 degrees
  Transect Distance: 200 meters

- SITE 13
  Access: Take the east most trail of Eucalyptus Loop. Drive until the fire road becomes single-track trail (southwest of Old Cabin trail intersection) and park at the end of the fire road.
  Directions to 0 m monument: UTM N: 4093896, E: 580937
  Transect Bearing: 233 degrees
  Transect Distance: 200 meters
  Comments: The transect line runs into a large redwood tree at 116 meters (stake installed). On the other side of the tree trunk is a stake where the transect line continues at 117 meters. (The diameter of the trunk was 1 meter.)

- SITE 15
  Vehicle access: Take the east most trail of Eucalyptus Loop. Drive until the fire road becomes single-track trail (southwest of Old Cabin trail intersection) and park at the end of the fire road.
  Directions to 0 m monument: UTM N: 4092384, E: 581889
  Transect Bearing: 322 degrees
  Transect Distance: 100 meters
  Comments: The Eucalyptus Loop trail (single track) bisects the line transect.

- SITE 23
  Vehicle access: From Smith Grade Road, access the gate at the Gray Whale property. From the gate, drive on dirt road approximately 0.8 mile.
  Directions to 0 m monument: Navigate using GPS unit to UTM N: 4096784, E: 579741. From this location, take a compass bearing of 270 degrees for 6.1 m to find the 0 m stake (at the base of very large madrone tree).
  Transect Bearing: 305 degrees

Transect Distance: 200 meters
Comments: Way trail and fence bisect the line transect.

- SITE 25
  Vehicle access: Take Wilder Ranch Ridge Loop trail and park at either intersection of Twin Oaks and Wilder Ranch Ridge Loop trails. The site location is about midway on Twin Oaks trail.
  Directions to 0 m monument: UTM N: 4093555, E: 580876
  Transect Bearing: 141 degrees
  Transect Distance: 100 meters

- SITE 27
  Vehicle access: Take Wilder Ranch Ridge Loop trail to Zane Grey trail.
  Directions to 0 m monument: UTM N: 4092767, E: 579928
  Transect Bearing: 198 degrees
  Transect Distance: 100 meters

- SITE 35
  Vehicle access: Drive to the north most Enchanted Loop and Baldwin trails intersection and park.
  Directions to 0 m monument: Navigate using GPS unit to UTM N: 4093762, E: 579098. From this location, take a compass bearing of 311 degrees for 120 m to find the 0 m stake.
  Transect Bearing: 258 degrees
  Transect Distance: 200 meters

- SITE 36
  Vehicle access: Drive to Scaroni property gate on the north side of Highway 1. Drive 1.9 miles (take the right fork in the road, the left fork goes to Majors Creek dam) to the third gate that is the boundary of State Parks property. Turn vehicle around and park.
  Directions to **100 m** monument: At approximately 1.8 miles from the Highway 1 gate, there is a game trail that takes off from the road at 320 degrees (northwest). Follow the game trail downhill towards the creek and down a rather steep slope. The 100 m monument is estimated to be less than 100 m from the road and on the right side of the game trail when facing the creek.
  Transect Bearing: 249 degrees
  Transect Distance: 200 meters
  Comments: This was one of the original pilot sampling sites. The transect line runs into a large redwood tree at 49.2 meters. The 50.5 m stake was placed to the downhill side of the tree. On the other side of the tree is a stake where the transect line continues at 54.8 meters. At the time of data collection, the fuels were placed in size classes.

- SITE 40
  Vehicle access: Take the west most Englesmann Loop trail.
  Directions to 0 m monument: UTM N: 4092384, E: 581889
  Transect Bearing: 233 degrees
  Transect Distance: 100 meters

- SITE 46
  Vehicle access: Take the east most Eucalyptus Loop trail.
  Directions to 0 m monument: UTM N: 4094924, E: 580094
  Transect Bearing: 40 degrees
  Transect Distance: 200 meters

- SITE 48
  Vehicle access: Take the east most Englesmann Loop trail about 0.5+ miles from the intersection of Englesmann Loop and Wagon Wheel trails (not far beyond the intersection of the dirt road to the ponds).
  Directions to 0 m monument: Navigate using GPS unit to UTM N: 4092314, E: 582222. From this location, take a compass bearing of 135 degrees for 10 m to find the 0 m stake.
  Transect Bearing: 217 degrees
  Transect Distance: 200 meters
  Comments: This transect line is in Wilder Creek for a distance. The 150.5 m stake is located on the edge of the streambed at 108 degrees at 6.43 meters from the 150.5 m mark on the transect tape. The 150.5 m mark on the transect tape at is 288 degrees and 3.0 m from the opposite stream bank. The 200 m stake is in a cut redwood stump (285 degrees at 14 m from UTM N: 4092163, E: 582191).

B.) Statistical Summaries

The point intercept-line transect and point-centered quarter data were hand written on data sheets in the field and entered manually to the Inventory, Monitoring, and Assessment (IMAP) database created in Microsoft Access 2000 software. Once entered, the database entries were checked for accuracy against the original data sheets. See Appendix D for copies of the data forms used and original data sheets. See Appendix E for the point intercept-line transect data summary sheets; and Appendix F for the point-centered quarter data summary sheets.

1.) Point Intercept–Line Transect
The number of intercepts of species along a transect were tallied by querying the IMAP database. Percent cover and percent relative cover were calculated using the following formulas from Bonham (1989) in Excel 2000 software:

Percent cover = (number of point intercepts / total points) * 100.

Percent relative cover = (number of point intercepts / total point intercepts of vegetation)*100.

The substrate (i.e., bare ground, litter, fuel, rock, and water) intercept counts were determined from the original data sheets. The mean and standard deviations were calculated using a scientific calculator.

2.) Point-Centered Quarter

The IMAP database was queried to generate the statistical summaries. The standard deviation of the basal area was calculated in Excel 2000. Because of questionable accuracy of Excel software program functions, the standard deviations were spot checked for accuracy using a scientific calculator.

The following formulas were used to calculate point-centered quarter data summary statistics (Mueller-Dombois, 1974):

Diameter at breast height (DBH) was measured using a diameter tape (cm) approximately 4 feet from the ground.

Basal Area (BA) in centimeters (cm) = [(0.5 * DBH)^2]*3.14
The actual space covered by the tree trunk.

Mean Distance (D) in meters (m) = Total distance for all species (m) / Total number of quarters (40)

Absolute Density (trees/hectare) = Area (1 hectare = 10000 m^2) / (D)^2
Where D = mean distance

Percent Frequency (%) = [Number of trees of a species / Total number of quarters (40)] * 100

Number of Trees of a Species per hectare (estimate) = [Number of trees of a species / Total number of quarters (40)] * Absolute density of a species

Absolute Dominance by area = mean BA per tree (m^2) * number of trees/10000 m^2
Absolute dominance is a combination of the number of trees and basal area, the amount of actual space the tree occupies.

Dominance Rank is based on the absolute dominance value. Rank 1 is given to the species with the largest absolute dominance value. Rank 2 is awarded to the second largest absolute dominance value, etc. The smallest absolute dominance value would be given the largest rank.

3.) Fuel Loads

The diameter of the fuel and the depth of the litter and duff will be used to estimate fuel time lag class. See table below (Wayne Harrison 1999):

Time Lag Class	Period	Roundwood	Litter & Duff
1 hour	hour	0 – 0.25"	surface
10 hour	day	0.25" – 1.0"	surface – 0.75"
100 hour	week	1.0" - 3.0"	0.75" – 4"
1000 hour	season	> 3.0"	>4.0"
[10,000 hour]	?	[>9.0"]	N/A

C.) Results

1.) Simple statistical summaries by site.

- SITE 1

Three tree species dominated the tree canopy. The most dominant species encountered was *Quercus agrifolia* or *Q. agrifolia* hybrids (oak species phenotypically expressing *Q. agrifolia* and another oak species characteristics) with the highest relative percent cover for all layers and absolute dominance. *Sequoia sempervirens* followed as second in both categories. The third dominant tree species was *Umbellularia californica* based on relative percent cover. Although, *Pseudotsuga menziesii* ranked third in absolute dominance based on the basal area of three large trees.

The mid-canopy layer was comprised mostly of *Umbellularia californica* and *Lithocarpus densiflorus.* A large patch of *Rubus ursinus* was encountered on the transect line and had the highest relative cover for the low vegetation layer. Litter was the most common substrate (> 50% cover) and fuels of several round wood diameter classes were present.

All species recorded along the transect were all native plants. However, *Myosotis latifolia* and *Lactuca virosa* are non-native plant species observed on site but not intercepted along the transect.

- SITE 13

Sequoia sempervirens clearly dominated the tree canopy by relative cover and basal area. It is also a co-dominant species in the mid-canopy layer with *Q. agrifolia* hybrids. *Rubus ursinus* and *Oxalis oregana* were the most frequently encountered in the low vegetation layer. The most common substrate encountered was litter (50% cover). Four out of the eight fuel intercepts were greater than 9 inches in diameter.

All species recorded along the transect were natives. However, *Euphobia peplus,* non-native plant, was found on site.

- SITE 15
  The tree canopy and basal area were dominated by *Quercus agrifolia* and *Quercus agrifolia* hybrids, with some *Quercus parvula* interspersed. *Corylus cornuta* var. *californica* was the major mid-canopy shrub. The low vegetation layer was occupied by *Rubus ursinus* and *Toxicodendron diversilobum* with few substrate intercepts of litter.

  Three non-native species occurred at this site. *Briza maxima* was intercepted along the point intercept-line transect. Also, *Cotoneaster* species and *Galium aparine* were observed on site.

- SITE 23
  Pseudotsuga menziesii var. *menziesii* had the highest percent cover for the tree canopy layer, followed by *Sequoia sempervirens* and *Arbutus menziesii.* Although *P. menziesii* var. *menziesii* was the most numerous, *S. sempervirens* and *A. menziesii* were larger trees as exhibited by the basal area results. In the mid-canopy layer the three most common species were *P. menziesii*, *Corylus cornuta* var. *californica*, and *Quercus agrifolia*. Half of the substrate intercepts were litter. All species encountered were native plants.

- SITE 25
  Quercus agrifolia dominated this site in relative percent cover of all canopy layers and in absolute dominance. *Umbellularia californica* and *Corylus cornuta* var. *californica* were major species in the mid-layer canopy. In the low vegetation layer, *Rubus ursinus* was most frequently encountered plant, and litter was the most frequent substrate.

  Non-native species were found on this site. *Rumex acetosella* was encountered on the point intercept-line transect. *Briza minor*, *Torilis nodosa*, and *Conium maculatum* were also observed in the area of the line transect.

- SITE 27
  Quercus agrifolia dominated this site in relative percent cover of all canopy layers and in absolute dominance. *Umbellularia californica* dominated the mid-canopy layer and was second in relative percent cover and absolute dominance to *Q. agrifolia*. *Rubus ursinus* and *Urtica dioicea* occupied majority of the low vegetation layer. Litter and fuel were minor components of this site. All species encountered on site were native plants.

- SITE 35
  The dominant species was *Sequoia sempervirens* in percent relative cover and absolute dominance. In the mid-canopy layer, *Lithocarpus densiflorus* had the highest percent cover and was second to *S. sempervirens* in percent frequency. Although *L. densiflorus* was numerous (18 trees), *Pseudotsuga menziesii* var. *menziesii,* was second in absolute dominance based on the basal area of one large tree. In the low vegetation layer, *Oxalis oregana* and *Polystichum munitum* had the highest and next highest percent cover, respectively. Litter was frequently intercepted. Relative to most other sites, the fuels here were more numerous and large. Only native species were observed along the transect and around the site.

- SITE 36
  Lithocarpus densiflorus and *Sequoia sempervirens* were co-dominant species based on overall relative percent cover and relative percent composition. *S. sempervirens* had the highest absolute dominance followed by *Pseudotsuga menziesii* var. *menziesii*, based on the basal area of two very large trees. In the low vegetation layer, *Oxalis oregana* had the highest percent cover. Relative to most other sites, the fuels here were more numerous and large. Only native species were observed along the transect and around the site.

- SITE 40
  Quercus agrifolia was the dominant species based on relative percent cover (in the canopy and mid-canopy layers) and absolute dominance. *Rubus ursinus* and *Umbellularia californica* were close second and third, respectively, in relative percent cover. Litter and fuels were minimal relative to the other sites.

  Non-native plants were observed on site. *Briza maxima*, *Avena barbata*, *Carduus pycnocephalus*, and *Cotoneaster* species were documented along the point intercept-line transect. *Briza minor* was observed on site. (Note: This site was sampled after the grasses were past seed and forb vegetation dried.)

- SITE 46
  Sequoia sempervirens had the highest relative percent cover and absolute dominance at this site. *Lithocarpus densiflora* was second in relative percent cover. In the low vegetation layer, *Oxalis oregana* had the highest percent cover at 19%. However, the substrate intercepts were far more numerous. Bare ground was relatively high in percent cover. In addition, this line-transect partially followed Baldwin Creek and therefore had a high incidence of rock and water percent cover. Only native species were observed along the transect and around the site.

- SITE 48
  The species with the highest relative percent cover and greatest relative percent composition was *Lithocarpus densiflorus. Sequoia sempervirens* was second in relative percent cover to *L. densiflorus*, but was ranked first in absolute dominance due to larger diameter trees. There was very little vegetation in the low layer (< 10% cover). Much of the substrate intercepts were litter (>50% cover) and the rest comprised of bare ground, rock, water, and fuel. This transect line follows Wilder Creek for a small distance.

2.) Minimum sample size
The minimum sample size was calculated using the "Sample size equation #3: Determining the necessary sample size for detecting differences between two means when using paired or permanent sampling units" in Elzinga et al. (1998):

$$n = \frac{(s)^2(Z_{alpha} + Z_{beta})^2}{(MDC)^2}$$

s = standard deviation of the difference between paired samples
Z_{alpha} = Z-coefficient for the false-change (Type I) error rate
Z_{beta} = Z-coefficient for the missed-change (Type II) error rate
MDC = minimum detectable change size in absolute terms
(See Elzinga et al. 1998 for Z-coefficient tables and MDC)

Since there is only one year of data, we cannot calculate a standard deviation of differences between the paired samples of two years of data. However, estimates of the standard deviation of differences (s_{diff}) were calculated using a formula in Elzinga et al. (1998) and substituted in the above equation for "s". The minimum samples size or "n" was calculated using two different minimum detectable change sizes and a mid-range correlation coefficient of 0.5. (The closer the correlation coefficient is to 1, the number of the sample size "n" decreases.) The estimated sample size needed to be 90% certain of detecting a true difference of 30 % between percent relative cover from a site sampled in two different years with a false-change error rate of 0.10 = 3 point-intercept transects. When the estimated sample size is calculated using a MDC of 10% (increasing the ability to detect smaller amount of change) instead of 30%, the final estimated sample size of 25 point intercept-line transects.

D.) Discussion

1.) Comments regarding Site Selection and Methods

- Originally, four sites in each plant community (redwood, Douglas fir, coast live oak , and knobcone pine) were targeted for monitoring.

However, due to time constraints of other field inventory and monitoring projects and limited field personnel, the four permanent transects were not established in the knobcone pine (*Pinus attenuata*) community.

- The data collection occurred over a prolonged season from May through July 2001. The first sites sampled were the coast live oak (*Quercus agrifolia*) plant community in May and June 2001 because the phenology of the flowering season is typically ahead of the redwood (*S. sempervirens*) and Douglas fir (*Pseudotsuga menziesii*) plant communities (Tim Hyland, personal communication). The redwood and Douglas fir plant communities were sampled in July 2001.

- Initially the point where the line transect begins was in one plant community. However, some line transects crossed into other plant communities due to the random bearing, length of the transect, and vegetation patterns at Wilder Ranch State Park. Therefore, each transect should be statistically compared only to itself as the transect placement probably does not represent a homogenous plant community.

- Mr. Tim Hyland, Assistant State Park Resource Ecologist at Santa Cruz District, verified all plant identifications. Mr. Hyland was indispensable in teaching the field crew the plant species for this project at Wilder Ranch State Park.

- The *Quercus agrifolia* hybrids were common in the coast live oak woodlands. The trees (i.e., leaves, bark, and habit) exhibited a range of characters between *Q. agrifolia* and *Q. parvula*. In the IMAP database, these plants are classified as *Q. agrifolia* with a check in a box if it is a hybrid. At times, the genus *Quercus* was recognized but the species could not be determined. In these instances, the plant is listed as "*Quercus*, species not determined" or QUERXXXX.

- Non-native species were encountered at some of the sampling sites. The more invasive species were *Ageratina adenophora* (Site 48), *Carduus pycnocephalus* (Site 25), *Conium maculatum* (Site 25), and *Cotoneaster* species (Site 15, 40).

2.) Minimum sample size

The standard deviation of the percent relative cover of all species from all layers was relatively low (mean 164.5 percent relative cover $\pm$28.0) indicating there was not dramatic differences from each site's percent relative cover of all species and the mean of all the percent relative cover of the sites sampled. After calculating the minimum sample size based on vegetative cover of all species, the final estimate of sample size appeared to be quite low based on the pilot sampling. This may indicate that percent relative cover of all species may not be a sensitive parameter to detect the desired level of change.

IV. Data Management

- Field data was copied and is stored in two separate locations at the IMAP office.
- All GPS waypoints were stored in rover files, which were downloaded onto GPS Pathfinder software and differentially corrected. These were stored electronically and used as shapefiles in an Arcview GIS project. Please note that some waypoints were hand placed in their approximate locations on the Arcview GIS project because of a lack of satellite reception in the field.
- A CD accompanies the report containing
  1. A copy of the report.
  2. Excel databases and associated blank datasheets, in a folder titled Data
  3. Data summaries of statistical work, in a folder titled Stats
  4. CNPS revele methodology
  5. A folder containing pertinent digital photographs, titled F&W comp
  6. An Arcview project: F&W transects.apr. This project covers the forest & woodland transect locations at Wilder Ranch State Park.

V. Future Monitoring Plan

The data collected from this study are a partial inventory of the forest and woodland resources at Wilder Ranch State Park. This pilot sampling will assist in the fine-tuning of future vegetation monitoring at the park. The first step is to develop a specific and measurable management objective (see Elzinga 1998 or NPS 2000 for examples). The more specific the management objective, the easier it is to create the sampling objective and design the monitoring plan to collect the necessary data. The Environmental Condition Assessment Indicator Monitoring Project summary sheet for the Forest and Woodland Composition (part of the 1998 Natural Resources Inventorying and Monitoring Program at Wilder Ranch State Park report), indicated the monitoring of species composition and abundance, determining forest age classes and stand structures, determining number of conifer species, and measuring of fuel loads. Measuring for all these parameters is very labor intensive. If the management and the sampling objectives could be simplified, i.e., focusing on only one of the parameters, the data collection and analysis would be simplified accordingly. [If these areas of Wilder Ranch State Park are planned to be part of a future prescribed burns, IMAP would recommend using the monitoring protocols in the Draft Fire Monitoring Handbook (NPS 2000).]

Since this was the first year of data collection, there was little statistical analysis that could be performed. A minimum of two years of data is necessary to conduct a paired t-test to analyze whether a statistically significant change took place (Elzinga et al. 1998). In addition, power and minimum sample size calculations can be performed using actual data instead of estimated numbers.

Other recommendations include:

- Annually, check for the presence of the transect markers at each site and spray with additional paint as needed. Make copies of the original data sheets and digital photographs to refer to in the field.

- If additional point-centered quarter sites are established in the future, IMAP recommends using the NPS Fire Monitoring Handbook protocols (draft 2000) for tagging and rules for where to measure diameter at breast height of trees.

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Conversion Table

1 hectare = 10,000 square meters
1 inch = 2.54 centimeters
12 inches = 1 foot
3 feet = 1 meter

Appendix A

Table of Transect Length and Reading Intervals by Plant Community and Check List of Transect Set-up and Data Collection

Transect Length and Reading Intervals by Community

Plant Community Type	Redwood	Doug Fir	Oak
Total Transect Length (m)	200	200	100
Point Center Quarter Reading intervals (m)	20	20	10
Point-intercept Reading intervals (m)	2	2	1

Check List of Transect Set-up and Data Collection

The following is a checklist of the tasks/activities that were performed at particular locations along the monitoring line transect. Individuals collecting the data should perform the tasks in an order that works best for them. Make copies of the original data sheets and digital photographs to refer to in the field.

0 meter

- Write up directions and sketch map to location.
- Install stake
- Collect distance and compass (declinated 15.5 degrees east) bearing on two landmark trees to help refind or reposition a replacement stake, if necessary.
- Collect GPS data on position if possible. If not take compass bearing and distance from an identifiable landmark.
- Generate random compass direction
- Begin to lay 100-200 meters of transect tape with two people. One person has compass and makes sure the tape is on the correct bearing. The other threads the tape through the vegetation at the direction of the person with the compass.
- After tape is laid, take four photographs: in direction of the tape and 90 degrees thereafter.
- After tape is laid, collect point-centered quarter data on four trees

50.5 m, 100.5 m, 150.5 m, and 200 m

- Install stake
- Collect distance and compass bearing on two landmark trees to help refind or reposition a replacement stake, if necessary.
- Collect GPS data on position if possible.
- Take four photographs: in direction of the tape and 90 degrees thereafter

Every 1 or 2 m

- Depending on the vegetation series, collect point intercept data for canopy (> 15 m), mid-canopy (>1 m and ≤ 15 m), low (≤ 1 m), and substrate classes (bare ground, rock, water, litter, and fuel). Record the species name of the plants intercepted in the three height classes. If the substrate class is "litter", then the depth to mineral soil is measured in centimeters. If the substrate class is "fuel", then the diameter is recorded in inches.
- Record incidental species not intercepted along transect.

Every 10 or 20 m

- Depending on the vegetation series, collect point-centered quarter data recording tree species, distance (m), and dbh (cm). This is taken for 10 locations along the transect tape for a total of 40 trees.

Appendix B

Densitometer Instructions

Appendix C

Site Map and Directions

Directions to Forest & Woodland Composition Sites at Wilder Ranch State Park

Site 1
From the intersection of Wild Boar trail and Wagon Wheel trail (closed), follow Wagon Wheel trail south. After the first switchback, the trail heads northward uphill across the slope. On the downhill slope (west), look for large *Pseudotsuga menziesii* (Doug fir) with a lower branch growing upwards (see photo 456ME1_PSEMENlandmarktree) growing near the trail. Keep walking on the trail (northward) a little further. On the downhill slope next to the trail, there will be a cut stump with two Doug fir trees growing out of the stump (see photo 456ME1_PSEMENstump+2sprouts; UTM northing 4093200 and easting 581426). This should also be the crest of the trail. On the south side of the stump, leave the trail at a bearing of 236 degrees (w/ 15.5 degree declination) for 36 meters to find the 0 m stake. If you begin to walk downhill on the trail to the ravine, you have gone too far.

Site 13
Access via the east most Eucalyptus Loop trail where the fire road becomes single-track trail (S. of Old Cabin Trail intersection). 0 m stake is at UTM northing: 409389.7 and easting: 580936.9. If satellite difficulties, follow the trail west from the edge of the woodland canopy approximately 63 meters. Just as it begins to descend to a stream, you should reach UTM northing: 4093927 and easting: 580936 on the trail. The 0 m stake is 30 m from this point @ 180 degrees.

Site 15
Driving directions: Enter park from Twin Gates entrance and head south on Chinquapin trail. Turn left (east) following Eucalyptus Loop Trail (beyond Old Cabin Trail) until it changes from fire road in grasslands to single track trail (thru forested area). 0 m stake is at UTM easting 581045 and UTM northing 4093888 or 43 m @ 180 degrees from the trail sign post.

Site 23
Take Empire Grade Road north beyond UCSC west entrance and Twin Gates. Turn left (east) at Smith Grade Road. About 3/4-1 mile, turn left at locked gate (across from a turn out) to access dirt road. This road leads to the Sandhills on Gray Whale (DPR property) and is also the access road to Brian Campbell's private property. From the locked gate, drive about 0.8 mi (over single vehicle bridge at 0.3 mi) to get to the first pull out on right side in redwoods. Area near 0 m stake using UTM northing 4096784 and easting 579741 then the 0 m stake is 6.1 m @ 270 degrees at the base of a large *Arbutus menziesii* (madrone) tree.

Site 25
The sampling site is approximately halfway between Twin Oaks trail from either end of Wilder Ridge Loop trail.

Site 27
Take Wilder Ranch Loop trail to Zane Gray trail. Along Zane Gray trail go to UTM northing 4092765 and easting 580002. From this point, the 0 meter stake is at bearing of 273 degrees and 75 meters distance. 0 meter stake UTM northing 4092766.5 and easting 579928.06.

Site 35
Shortest access via vehicle is where the south end of the west most Enchanted loop trail and the north end of Baldwin loop trail both intersect (close to the "600" on the 600 ft. contour line of the Wilder Ranch trail map). Can use GPS to navigate to a point on the ridge UTM northing: 4093762 and easting: 579098. The 0 meter stake is 120 meters at 311degrees (compass) from that GPS point. One can also take the Enchanted Loop trail at the above trail intersection. The trail descends across the ridge towards the northeast then switchbacks to the southwest. You will come to a large switchback that makes a sweeping turn towards the northeast and eventually crosses the Baldwin Creek. About 27 m down the trail beyond the sweeping switchback, there is a large multi-trunk *Lithocarpus densiflorus* (LITDEN) to the downhill side of the trail (see photo 456R35_LandmarkLITDEN). From this tree, the 0 m stake is located 58 meters at 256 degrees (compass + 15.5 declination) across a small ephemeral watercourse and in a group of redwoods (see photo 456R35_0mStake). The transect is above the Baldwin "lake". The 100.5 m stake is next to a well-used game trail.

Site 36
Take Highway 1 North towards San Francisco. Turn left into the Scaroni property driveway. Open gate with District key (0 mi) and follow the unmaintained road. When the road forks, take the left fork that continues uphill in grassland. (The right fork goes to the Scaroni Dam.) At 1.4 mi there will be an old fence line and old wooden gate w/o lock (2nd gate). Drive through the gate and continue to follow the road. At 1.7 mi the road enters under a forest canopy. At 1.8 mi, on the left is a game trail (that goes downhill) passes close by to the 100 m stake. This is the easiest access. (See photos: 456R36_085d, 456R36_265d, and 456R36_gametrail320d.) At 1.9 mi is the 3rd gate that is the DPR boundary of the Scaroni property. (Beyond the gate is private property.) Park the vehicle off the road. Fastest way to initially find the transect is to walk down the road to 1.8 mi and follow game trail. Keep taking the trails that go downhill. The 100.5 m stake is on the right side on a steep section of a well-used pig trail going downhill.

Site 40
Set GPS unit to UTM northing 4092384 and easting 581889 (location of the 0 m stake). The easiest access is via the south on the west most Englesmann loop trail. You have gone too far if you reach the south most intersection of Wild Boar trail.

Site 46
Take west most Eucalyptus loop to 0 meter stake at UTM northing 4094924.22, easting 580093.8. If satellite difficulties, try UTM northing 4094900 and easting 580199 (a clearing in grassland at edge of forest). From that point the 0 meter stake is at 270 degrees and 106 meters.

Site 48

Take the east most Englemann Loop trail. The site is approximately 0.5+ mile to the southern most intersection of the Englemann Loop trail and Wagon Wheel trail (just north of the spur road to ponds). The 0 meter stake can be found from UTM northing: 4092368, easting: 582175 @ 135 degrees (GPS) and 88 meters. The 200 meter stake (in cut redwood stump) can be found from this point on east most Englemann loop trail UTM northing: 4092195.94, easting: 582031.52 @ about 112 degrees (GPS) and down approximately 4 sloped terraces in redwoods.

Appendix D

Data Forms and Copies of Original Raw Data Sheets

Appendix E

Point Intercept-Line Transect Data Summary Statistic Sheets

Appendix F

Point-Centered Quarter Data Summary Statistic Sheets