

CALIFORNIA NATIVE PLANT SOCIETY RELEVÉ PROTOCOL  
CNPS VEGETATION COMMITTEE  
October 20, 2000 (Revised 4/2/04)

## **Introduction**

In *A Manual of California Vegetation* (Sawyer and Keeler-Wolf 1995), CNPS published a Vegetation Sampling Protocol that was developed as a simple quantitative sampling technique applicable to many vegetation types in California. Investigators use an ocular estimation technique called a relevé to classify and map large areas in a limited amount of time.

The relevé method of sampling vegetation was developed in Europe and was largely standardized by the Swiss ecologist Josias Braun-Blanquet. He helped classify much of Europe's vegetation, founded and directed a synecology center in France, and was editor of *Vegetatio* for many years. The relevé was, and is, a method used by many European ecologists, and others around the world. These ecologists refer to themselves as phytosociologists. The use of relevé in the United States has not been extensive with the exception of the US Forest Service.

The relevé is particularly useful when observers are trying to quickly classify the range of diversity of plant cover over large units of land. In general, it is faster than the point intercept technique. One would use this method when developing a classification that could be used to map of a large area of vegetation, for example. This method may also be more useful than the line intercept method when one is trying to validate the accuracy of mapping efforts.

The relevé is generally considered a “semiquantitative” method. It relies on ocular estimates of plant cover rather than on counts of the “hits” of a particular species along a transect line or on precise measurements of cover/biomass by planimetric or weighing techniques.

### **Selecting a stand to sample:**

A stand is the basic physical unit of vegetation in a landscape. It has no set size. Some vegetation stands are very small, such as alpine meadow or tundra types, and some may be several square kilometers in size, such as desert or forest types. A stand is defined by two main unifying characteristics:

- 1) It has compositional integrity. Throughout the site the combination of species is similar. The stand is differentiated from adjacent stands by a discernable boundary that may be abrupt or indistinct, and
- 2) It has structural integrity. It has a similar history or environmental setting that affords relatively similar horizontal and vertical spacing of plant species throughout. For example, a hillside forest originally dominated by the same species that burned on the upper part of the slopes, but not the lower, would be divided into two stands. Likewise, a sparse woodland occupying a slope with very shallow rocky soils would be considered a different stand from an adjacent slope with deeper, moister soil and a denser woodland or forest of the same species.

The structural and compositional features of a stand are often combined into a term called homogeneity. For an area of vegetated ground to meet the requirements of a stand it must be homogeneous.

Stands to be sampled may be selected by assessment prior to a site visit (e.g. delineated from aerial photos or satellite images), or may be selected on site (during reconnaissance to determine extent and boundaries, location of other similar stands, etc.). Depending on the project goals, you may want to select just one or a few representative stands for sampling (e.g., for developing a classification for a vegetation mapping project), or you may want to sample all of them (e.g., to define a rare vegetation type and/or compare site quality between the few remaining stands).

### **Selecting a plot to sample within in a stand:**

Because most stands are large, it is difficult to summarize the species composition, cover, and structure of an entire stand. We are also usually trying to capture the most information with the least amount of effort. Thus, we are typically forced to select a representative portion to sample.

When sampling a vegetation stand, the main point to remember is to select a sample that, in as many ways possible, is representative of that stand. This means that you are not randomly selecting a plot; on the contrary, you are actively using your own best judgement to find a representative example of the stand.

Selecting a plot requires that you see enough of the stand you are sampling to feel comfortable in choosing a representative plot location. Take a brief walk through the stand and look for variations in species composition and in stand structure. In many cases in hilly or mountainous terrain look for a vantage point from which you can get a representative view of the whole stand. Variations in vegetation that are repeated throughout the stand should be included in your plot. Once you assess the variation within the stand, attempt to find an area that captures the stand's common species composition and structural condition to sample.

### Plot Size

All relevés of the same type of vegetation to be analyzed in a study need to be the same size. It wouldn't be fair, for example, to compare a 100 m<sup>2</sup> plot with a 1000 m<sup>2</sup> plot as the difference in number of species may be due to the size of the plot, not a difference in the stands.

A minimal area to sample is defined by species/area relationships; as the sampler identifies species present in an area of homogeneous vegetation, the number will increase quickly as more area is surveyed. Plot shape and size are somewhat dependent on the type of vegetation under study. Therefore general guidelines for plot sizes of tree-, shrub-, and herb-dominated upland, and fine-scale herbaceous communities have been established. Sufficient work has been done in temperate vegetation to be confident the following conventions will capture species richness:

- Alpine meadow and montane wet meadow: 100 sq. m
- Herbaceous communities: 100 sq. m plot or 400 sq. m plot (Consult with CNPS, and use one consistent size)
- Grasslands and Shrublands: 400 sq. m plot
- Forest and woodland communities: 1000 sq. m plot
- Open desert vegetation: 1000 sq. m plot

## Plot Shape

A relevé has no fixed shape, plot shape should reflect the character of the stand. If the stand is about the same size as a relevé, you need to sample the entire stand. If we are sampling a desert wash, streamside riparian, or other linear community our plot dimensions should not go beyond the community's natural ecological boundaries. Thus, a relatively long, narrow plot capturing the vegetation within the stand, but not outside it would be appropriate. Species present along the edges of the plot that are clearly part of the adjacent stand should be excluded.

If we are sampling broad homogeneous stands, we would most likely choose a shape such as a circle (which has the advantage of the edges being equidistant to the center point) or a square (which can be quickly laid out using perpendicular tapes). If we are trying to capture a minor bit of variety in the understory of a forest, for example a bracken fern patch within a ponderosa pine stand, we would want both bracken and non-bracken understory. Thus, a rectangular shape would be appropriate.

## **GENERAL PLOT INFORMATION**

The following items appear on each data sheet and are to be collected for all plots. Where indicated, refer to attached code sheet.

Polygon or Relevé number: Assigned either in the field or in the office prior to sampling.

Date: Date of sampling.

County: County in which located.

USGS Quad: The name of the USGS map the relevé is located on; note series (15' or 7.5').

CNPS Chapter: CNPS chapter, or other organization or agency if source is other than CNPS chapter.

Landowner: Name of landowner or agency acronym if known. Otherwise, list as private.

Contact Person: Name, address, and phone number of individual responsible for data collection.

Observers: Names of individuals assisting. Circle name of recorder.

Plot shape: indicate the sample shape as: square, rectangle, circle, or the entire stand.

Plot size: length of rectangle edges, circle radius, or size of entire stand.

NOTE: See page 2 for standard plot sizes.

Study Plot Revisit: If the relevé plot is being revisited for repeated sampling, please circle "Yes".

Photo interpreter community code: If the sample is in area for which delineation and photo interpretation has already been done, the code which the photointerpreters applied to the polygon. If the sample site has not been photointerpreted, leave blank.

Other polygons of same type (yes or no, if applicable), if yes, mark on map: Other areas within view that appear to have similar vegetation composition. Again, this is most relevant to areas that have been delineated as polygons on aerial photographs as part of a vegetation-mapping project. If one is not working from aerial photographs, draw the areas as on a topographic map.

Is plot representative of whole polygon? (yes or no, if applicable), if no explain: Detail what other vegetation types occur in the polygon, and what the dominant vegetation type is if there is more than one type.

Global Positioning System Readings: Due to the recent availability of very accurate and relatively low cost GPS units, we highly recommend obtaining and using these as a standard piece of sampling equipment. Now that the military intentional imprecision (known as “selective availability”) has been “turned off” (as of July 2000), it is typical for all commercial GPS units these units to be accurate to within 5 m of the actual location. Also note that the GPS units can be set to read in UTM or Latitude and Longitude coordinates and can be easily translated. Thus, the following fields for Latitude, Longitude, and legal description are now optional. In order for all positional data to be comparable within the CNPS vegetation dataset We request using UTM coordinates set for the NAD 83 projection (see your GPS users manual for instructions for setting coordinates and projections).

Caveat: Although GPS units are valuable tools, they may not function properly due to the occasionally poor alignment of satellites or due to the complexity of certain types of terrain, or vegetation. We thus also recommend that you carry topographic maps and are aware of how to note your position on them in the event of a non-responsive or inaccurate GPS.

UTMN and UTME: Northing and easting coordinates using the Universal Transverse Mercator (UTM) grid as delineated on the USGS topographic map, or using a Global Positioning System.

UTM zone: Universal Transverse Mercator zone. Zone 10S for California west of the 120<sup>th</sup> longitude; zone 11S for California east of 120<sup>th</sup> longitude.

Legal Description: Township/Range/Section/Quarter Section/Quarter-Quarter section/Meridian: Legal map location of the site; this is useful for determining ownership of the property. California Meridians are Humboldt, Mt. Diablo, or San Bernardino. (This is optional, see above discussion of GPS units)

Latitude and Longitude: Degrees north latitude and east longitude. This is optional (see above)

Elevation: Recorded in feet or meters. Please indicate units.

Slope: Degrees, read from clinometer or compass, or estimated; averaged over relevé

Aspect: Degrees from true north (adjust declination), read from a compass or estimated; averaged over relevé.

Macrotopography: Characterize the large-scale topographic position of the relevé. This is the general position of the sample along major topographic features of the area. *See attached code list.*

Microtopography: Characterize the local relief of the relevé. Choose the shape that mimics the lay of the ground along minor topographic features of the area actually within the sample. *See attached code list.*

## VEGETATION DESCRIPTION

Dominant layer: Indicate whether the community is dominated by the Low layer (L), Mid-layer (M), or Tall (T) layer.

Preliminary Alliance name: Name of series, stand, or habitat according to CNPS classification (per Sawyer and Keeler-Wolf 1995); if the type is not defined by the CNPS classification, note this in the space.

Adjacent alliance: Adjacent vegetation series, stands or habitats according to CNPS classification; list in order of most extensive to least extensive.

Structure: Characterize the structure of each layer.

Continuous = greater than 2/3 (67%) cover; crowns touching

Intermittent = between 1/3 and 2/3 cover (33% to 66 %); interlocking or touching crowns interrupted by openings.

Open = less than 1/3 (33%) cover; crowns not touching or infrequently touching.

Phenology: Based on the vegetative condition of the principal species, characterize the phenology of each layer as early (E), peak (P), or late (L).

## WETLAND COMMUNITY TYPES

Community type: Indicate if the sample is in a wetland or an upland; note that a site need not be officially delineated as a wetland to qualify as such in this context.

Dominant vegetation form: This is a four letter code which relates the vegetation of the plot to the higher levels of the NBS/NPS National Vegetation Classification System hierarchy. *See attached code list.*

Cowardin class: See “Artificial Keys to Cowardin Systems and Names” (attached). If the plot is located in a wetland, record the proper Cowardin system name. Systems are described in detail in Cowardin et al. 1979. Classification of wetlands and deepwater habitats of the United States. US Dept. of the Interior, Fish and Wildlife Service, Office of Biological Services, Washington, D.C.

**Marine**: habitats exposed to the waves and currents of the open ocean (subtidal and intertidal habitats).

**Estuarine:** includes deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land (i.e. estuaries and lagoons).

**Riverine:** includes all wetlands and deepwater habitats contained within a channel, excluding any wetland dominated by trees, shrubs, persistent emergent plants, emergent mosses, or lichens. Channels that contain oceanic-derived salts greater than 0.5% are also excluded.

**Lacustrine:** Includes wetlands and deepwater habitats with all of the following characteristics: 1) situated in a topographic depression or a dammed river channel; 2) lacking trees or shrubs, persistent emergents, emergent mosses or lichens with greater than 30% aerial coverage; and total area exceeds 8 ha (20 acres). Similar areas less than 8 ha are included in the lacustrine system if an active wave-formed or bedrock shoreline feature makes up all or part of the low tide boundary, or if the water in the deepest part of the basin exceeds 2 m (6.6 feet) at low tide. Oceanic derived salinity is always less than 0.5%.

**Palustrine:** Includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity derived from oceanic salts is less than 0.5%. Also included are areas lacking vegetation, but with all of the following four characteristics: 1) areas less than 8 ha (20 acres); active wave-formed or bedrock shoreline features lacking; 3) water depth in the deepest part of the basin less than 2 m (6.6 feet) at low water; and 4) salinity due to ocean-derived salts less than 0.5%.

Vertical distance from high water mark of active stream channel: If the plot is in or near a wetland community, record to the nearest meter or foot the estimated vertical distance from the middle of the plot to the average water line of the channel, basin, or other body of water.

Horizontal distance from high water mark of active stream channel: If the plot is in or near a wetland community, record to the nearest meter or foot the estimated horizontal distance from the middle of the plot to the average water line of the channel, basin, or other body of water.

Stream channel form: If the plot is located in or near a community along a stream, river, or dry wash, record the channel form of the waterway. The channel form is considered S (single channeled) if it consists of predominately a single primary channel, M (meandering) if it is a meandering channel, and B (braided) if it consists of multiple channels interwoven or braided.

Photographs: Describe the number of color photographs taken at the relevé, and the camera's view direction from compass bearings. It is helpful to take a photograph of the relevé from the intersection of the tapes (if tapes were used to define the plot), and another from inside the relevé. Additional photos of the stand may also be helpful. If using a digital camera or scanning in the image into a computer, relevé numbers and compass directions can be recorded digitally. If using a 35mm camera, please note the roll number, frame number, compass direction, and the initials of the person whose camera is being used. (e.g. Roll 5, #1, to the NW, SS)

## STAND AND ENVIRONMENTAL INFORMATION

Vegetation trend: Based on the regenerating species and relationship to surrounding vegetation, characterize the stand as either increasing (expanding), stable, decreasing, fluctuating, or unknown.

Impacts: Enter codes for potential or existing impacts on the stability of the plant community. Characterize each as either 1. Light, 2. Moderate, or 3. Heavy. *See attached code list.*

Site location and plot description: A concise, but careful description that makes locating and/or revisiting the vegetation stand and plots possible; give landmarks and directions. Used in conjunction with the GPS position recorded earlier, this should enable precise re-location of the plot. Indicate where the GPS reading was taken within the plot. In general, the location of the GPS reading should be on the Southeastern corner of the plot, if the plot is square or rectangular, or in the center if the plot is circular. It is also helpful to briefly describe the topography, aspect, and vegetation structure of the site. If you can't take the GPS reading at the Southeast corner (an obstacle in the way) then note where the GPS point was taken. If you can't get a GPS reading, then spend extra time marking the plot location as precise as possible on a topo map.

Site history: Briefly describe the history of the stand, including type and year of disturbance (e.g. fire, landslides or avalanching, drought, flood, or pest outbreak). Also note the nature and extent of land use such as grazing, timber harvest, or mining.

Unknown plant specimens: List the numbers of any unknown plant specimens, noting any information such as family or genus (if known), important characters, and whether or not there is adequate material for identification. Do not take samples of plants of which there are only a few individuals or which you think may be rare. Document these plants with photographs.

Additional comments: Feel free to note any additional observations of the site, or deviations from the standard sampling protocol. If additional data were recorded, e.g. if tree diameters were measured, please indicate so here.

## COARSE FRAGMENTS AND SOIL INFORMATION

Coarse fragments, litter: Estimate the cover class of each size at or near the ground surface averaged over the plot. Always remember to estimate what you actually see on the surface as opposed to what you think is hiding under, organic litter, big rocks, etc. However, rocks, organic litter, or fine material visible under the canopy of shrubs or trees should be included in the cover estimate.

One way to consider this is to assume that all of the components of coarse fragments plus the basal cross-section of living plant stems and trunks (at ground level) will add up to 100%. Thus, estimate the cover value of each of the items in the box on the form for coarse fragments (including the basal area of plant stems) so that they will add up to 100%. Remember that the basal area of plant stems is usually minimal (e.g., if there were 10 trees, each 1 m in diameter at ground level on a 1000 square meter plot, they would cover less than 1% {0.79%} of the plot).

These data are asked for because certain categories of coarse fragments of rock and other materials have been shown to correlate with certain vegetation types and are thus likely influencing the type of vegetation that is growing in a given area. These estimates should be made quickly with the main point to keep in mind being a rough estimate of the relative proportions of different coarse fragments on the plot.

Fines: Fine mineral fragments including sand, silt, soil, “dirt” < 2 mm in diameter

Gravel: rounded and angular fragments 0.2-7.5 cm (0.08 -3 in.) diameter

Cobble: rounded and angular fragments >7.5-25 cm (3 -10 in.) in diameter

Stone: rounded and angular coarse fragments >25 cm-60 cm (10 -24 in.) in diameter

Boulder: rounded and angular coarse fragments >60 cm (>24 in.) in diameter

Bedrock: continuous, exposed, non-transported rock

Litter: extent of undecomposed litter on surface of plot (this includes all organic matter, e.g. fallen logs, branches, and twigs down to needles and leaves).

Soil texture: Record the texture of the upper soil horizon, below the organic layer if one is present. *See attached key and code list.*

Parent Material: Geological parent material of site. *See attached code list.*

## **VEGETATION DATA**

### **Assessment of Layers**

This first step is described in the CNPS point-intercept transect protocol. Estimates the maximum height for the low and mid layers and the minimum height for the tall layer are recorded. These estimates are made after a quick assessment of the vegetation and its structure. The estimates need not be overly precise and will vary among vegetation types. A caveat: if several relevés are being sampled within the same vegetation type, it is important to be consistent when assigning layers. Some types will have more than three layers (e.g. two tree layers of different maximum height); this should be indicated in the relevé description. However, data are recorded for only three layers (low, mid, and tall). The layer a species occupies will often be determined by growth form, but exceptions do occur. For example, with trees young seedlings may occupy the low layer, saplings the mid layer, and mature individuals the tall layer for some taxa, for example.

### **Species List**

The collection of vegetation data continues with making a comprehensive species list of all vascular plants within the relevé. This list is achieved by meandering through the plot to see all microhabitats. During list development, observers document each taxon present in each layer in



which it occurs separately, recording it on a different line of the data form and noting which layer is represented. This is important for data entry because each layer of each represented taxon will be entered separately. Each individual plant is recorded in only one layer, the layer in which the tallest portion of the individual is found. One should reach a point at which new taxa are added to the list only very slowly, or sporadically. When one has reached that point, the list is probably done.

The following sections explain how to perform the actual relevé, the Estimation of Cover Values. The sections prefaced by bold-faced titles explain the technique, and the sections with regular font titles refer to the steps needed to complete the accompanying Field Form.

### **Tree dbh** (optional)

The CNPS protocol does not require observers to record the diameter at breast height (dbh) of each tree species in the plot. However, the dbh is important in certain studies and may be recorded next to the each tree species name, in the column labeled "Final species determination or Tree dbh". You should measure the tree dbh of every tree trunk that has diameter  $>$  or  $=$  10 cm at breast height in the plot, and each measurement should be in centimeters (cm) using a dbh tape measure. For trunks that may be fused below breast height and branched at breast height, each trunk at breast height gets a separate measurement.

Depending on the density of trees in each plot, you can record dbh of trees for every tree trunk in the plot, or you can sub-sample the trunks to estimate dbh for every tree species in relatively dense plots. If you opt to sub-sample, you should do it for each tree species in a representative "quarter" or quadrant of the plot, and then you will come up with an estimated dbh for the entire plot (once data is processed).

When sub-sampling, make sure to denote this as a sub-sample (can note in the Additional comments field) and record the sub-sample of dbh's for each tree species in the appropriate row on the Field Form. Once the data are post-processed and entered into a database, then you will need to record each sub-sampled dbh reading three additional times to come up with a full sample of dbh readings. For example, with a sub-sampled tree dbh of 15 cm, this value of 15 should be entered four times (not just once) when it is entered in the database.

### **Estimating Cover:**

There are many ways to estimate cover. Many people who have been in the cover estimation "business" for a long time can do so quickly and confidently without any props and devices. However, to a novice, it may seem incomprehensible and foolhardy to stand in a meadow of 50 different species of plants and systematically be able to list by cover value each one without actually "measuring" them in some way.

Of course, our minds make thousands of estimates of various types every week. We trust that estimating plant cover can be done by anyone with an open mind and an "eye for nature." It's just another technique to learn.

It is very helpful to work initially with other people who know and are learning the technique. In such a group setting, typically a set of justifications for each person's estimate is made and a

“meeting of the minds” is reached. This consensus approach and the concomitant calibration of each person’s internal scales is a very important part of the training for any cover estimate project.

An underlying point to remember is that estimates must provide some level of reliable values that are within acceptable bounds of accuracy. If we require an accuracy level that is beyond the realm of possibility, we will soon reject the method for one more quantitative and repeatable. As with any scientific measurement, the requirement for accuracy in the vegetation data is closely related to the accuracy of the information needed to provide a useful summary of it. Put into more immediate perspective - **to allow useful and repeatable analysis of vegetation data, one does not need to estimate down to the exact percent value the cover of a given plant species in a given stand.**

This point relates to two facts: there is inherent variability of species cover in any environment. For example, you would not expect to always have 23% *Pinus ponderosa*, 14% *Calocedrus decurrens*, and 11% *Pinus lambertiana* over an understory of 40% *Chamaebatia foliosa*, 3% *Clarkia unguiculata*, and 5% *Galium bolanderi* to define the Ponderosa pine-Incense cedar/mountain misery/bolander bedstraw plant community. Anyone who has looked at plant composition with a discerning eye can see that plants don’t space themselves in an environment by such precise rules. Thus, we can safely estimate the representation of species in a stand by relatively broad cover classes (such as <1%, 1-5 %, 5-25%, etc.) rather than precise percentages.

The data analysis we commonly use to classify vegetation into different associations and series (TWINSPAN and various cluster analysis programs, for example) is likewise forgiving. When analyzed by quantitative multivariate statistics information on species cover responds to coarse differences in cover and presence and absence of species, but not to subtle percentage point differences. This has been proven time and again through quantitative analysis of vegetation classification. Many of the world’s plant ecologists estimate cover rather than measure it precisely. Some of the seminal works in vegetation ecology have been based on cover estimates taken by discerning eyes.

With this as a preamble, below we offer some suggestions on estimating cover that have proven helpful. These are simply “tricks” to facilitate estimation, some work better for different situations. You may come up with other methods of estimation that may seem more intuitive, and are equally reliable in certain settings. All values on the relevé protocol that require a cover class estimate, including coarse fragment and vegetation layer information, may rely on these techniques. Just make the appropriate substitutions (using the coarse fragment example substitute, bedrock, stone, cobbles, gravel, and litter for vegetation).

#### Method 1: The invisible point-intercept transect:

This method works well in relatively low, open vegetation types such as grasslands and scrubs where you can see over the major stand components. For those who have worked with the original CNPS line intercept methodology it’s like counting hits along an imaginary line at regular intervals of the 50 m tape. Here’s how it goes:

Envision an imaginary transect line starting from your vantage point and running for 50 m (or however many meters you wish, as long as you are still ending up within the same

stand of vegetation you're sampling - never keep counting outside of your homogeneous stand). Now "walk" your eye along this tape for 50 m and visually "take a point" every 0.5 m. Don't worry about precision, just try to "walk" your eye along the line and stop every 0.5 m or at any other regular interval until you reach its end and mentally tally what species you hit. Once you come up with a number of hits for each major species in one imaginary transect, take another transect in another direction and estimate the number of hits on that one. Do this several times (usually 3-4 is enough if you are in a homogeneous stand), then average your results.

This can go quickly in simple environments and in environments where the major species are easily discernable (chaparral, bunch-grassland, coastal scrub, desert scrub). Your average number of hits need not be a total of 100 as in the original transect method, but could be 50 along a 25 m imaginary line (in which case you would multiply by two to get your estimated cover), or 25 along a 12.5 m line (multiply average by 4), etc.

#### Method 2: Subdivision of sample plot into quadrants:

Many plots, whether they are square, circular, or rectangular, may be "quartered" and have each quadrant's plant cover estimated separately. If the plot is a given even number of square meters (such as 100, 400, or 1000 m<sup>2</sup>) then you know that a quarter of that amount is also an easily measurable number. If you can estimate the average size of the plants in each of the quarters (e.g, small pinyon pines may be 5 m<sup>2</sup> (2.2m x 2.2m), creosote bush may be 2m<sup>2</sup> (or 1.41 m x 1.41 m), burrobush may be 0.5m<sup>2</sup>) then you simply count the number of plants in each size class and multiply by their estimated size for the cover in a given quadrant. Then you average the 4 quadrants together for your average cover value.

This method works well in vegetation with open-to-dense cover of low species such as grasses or low shrubs, in open woodlands, and desert scrubs.

#### Method 3; "Squash" all plants into a continuous cover in one corner of the plot :

Another way to estimate how much of the plot is covered by a particular species is to mentally group (or "march", or "squash") all members of that species into a corner of the plot and estimate the area they cover. Then calculate that area as a percentage of the total plot area. This technique works well in herb and shrub dominated plots but is not very useful in areas with trees.

#### Method 4: How to estimate tree cover:

Cover estimates of tall trees is one of the most difficult tasks for a beginning relevé sampler. However it is possible to do this with consistency and reliability using the following guidelines.

1. Have regular sized and shaped plots that you can easily subdivide.
2. Estimate average crown spread of each tree species separately by pacing the crown diameter of representative examples of trees of each species and then roughly calculating the crown area of each representative species.

3. Add together the estimated crown area of each individual of each species of tree on the plot for your total cover.

#### Method 5: The process of elimination technique:

This method is generally good for estimating cover on sparsely vegetated areas where bare ground, rocks, or cobbles cover more area than vegetation. In such a situation it would be advisable to first estimate how much of the ground is not covered by plants and then subdivide the portion that is covered by plants into rough percentages proportional to the different plant species present. For example, in a desert scrub the total plot not covered by plants may be estimated at 80%. Of the 20% covered by plants, half is desert sunflower (10% cover), a quarter is California buckwheat (5% cover), an eighth brittlebush (2.5% cover), and the rest divided up between 10 species of herbs and small shrubs (all less than 1% cover).

Any of these techniques may be used in combination with one another for a system of checks and balances, or in stands that have characteristics lending themselves for a different technique for each layer of vegetation.

In a relevé, cover estimates, using the techniques described above, are made for each taxon as it is recorded on the species list. Estimates are made for each layer in which the taxon was recorded. For example, if individuals of coast live oak occur in the tall, the mid, and the low layer, an estimate is made for Tall CLO, for mid CLO, and for low CLO.

In a traditional relevé, cover is estimated in “cover classes,” not percentages, because of the variability of plant populations over time and from one point to another, even within a small stand. This protocol uses the following 6 cover classes:

- Cover Class 1: the taxon in that layer covers < 1 % of the plot area
- Cover Class 2: the taxon in that layer covers >1 % - 5 % of the plot area
- Cover Class 3a: the taxon in that layer covers >5 - 15 % of the plot area
- Cover Class 3b: the taxon in that layer covers >15 - 25 % of the plot area
- Cover Class 4: the taxon in that layer covers >25 - 50 % of the plot area
- Cover Class 5: the taxon in that layer covers >50 - 75 % of the plot area
- Cover Class 6: the taxon in that layer covers > 75% of the plot area

#### **Percentages (optional)**

This CNPS protocol also encourages observers to estimate percentages if they feel confident in their estimation abilities. This optional step allows the data to be compared more easily to data collected using different methods, such as a line or point intercept. It also instills confidence in the cover estimate of borderline species that are close calls between two cover classes (e.g., a cover class 2 at 5% as opposed to a cover class 3 at 6%). It is particularly useful for calculating cover by the process of elimination techniques and for estimating total vegetation cover (see below) and coarse fragment cover.

## Total Vegetation Cover by Layer

In addition to cover of individual taxa described above, total cover is also estimated for each vegetation layer (e.g. tall, medium, low). This is done using the same cover classes as described above but combines all taxa of a given category. They can be calculated from the species percent cover estimates, but please make sure to disregard overlap of species within each layer. These estimates should be absolute aerial cover, or the “bird’s eye view” of the vegetation cover, in which each category cannot be over 100%.

## National Vegetation Classification height Classes for Vegetation Strata

The relevé method just described calls for estimates of plant cover for each taxon. It is strongly floristically oriented. Another way of considering the relationships between plants in vegetation is by evaluating structure, or physiognomy. The underlying thinking is that life forms within a stand of vegetation occur in response to similar ecological pressures (TNC 1998). Estimation of cover within predetermined height classes is one way to describe the structure of vegetation. Structure of a stand of vegetation also is used in modeling wildlife use of the vegetation (WHR).

For information gathered using this CNPS protocol to be comparable with the wealth of information being gathered by the National Park Service and the Biological Resources Division (BRD) of the USGS it is also necessary for CNPS to estimate vegetation cover according to pre-defined vegetation strata. The following height classes are defined by the USGS/NPS:

High Tree	>30 m
Medium High Tree	20-30 m
Medium Low Tree	10-20 m
Low Tree	5-10 m
High Shrub	2-5 m
High Herb/ Medium Shrub	1-2 m
Low Shrub	0.5-1 m
Medium Herb	25-50 cm
Low Herb	0-25 cm
Moss/Lichen	

Cover in these vegetation strata is estimated using the same cover classes as were used for cover of individual taxa. Again, estimation of percentages is optional. Please note that although these strata have names in the national classification, they don’t necessarily have to be populated by the type of species that are their namesake (e.g., tall herbaceous species may be diagnostic of the tall shrub category in the case of a giant reed stand). For this reason we have simply listed the strata by their height classes and have opted not to name them.

We have also requested that you list the diagnostic species for each layer. In this case the diagnostic species is the single species that seems to best characterize that layer it may be the only species found in a given layer, it may be as common as other species in that layer but is more restricted to that single layer, or it may be less common than other species in that layer, but so representative of that layer that it can't be ignored. The cover of the diagnostic species in that layer does not have to be re-estimated as it is estimated in the individual species tally already.

Caveats:

Please consult with the members of the vegetation committee for advice and feedback on proposed vegetation surveys prior on initiating projects.

Notes on the Order and Division of Labor for Data Collection: As with every procedure there are always more and less efficient ways to collect the information requested. Although we respect each field crews' option to choose in what order they collect the data, we suggest the following general rules:

- Work with teams of two for each plot collected.
- Both team members can determine the plot shape and size and lay out the tapes and mark the edges for the plot boundary (see below).
- The two person teams can also divide up tasks of data collection with one member collecting location, environmental (slope, aspect, geology, soil texture, etc.) and plot description information while the other begins the species list. Thus, two clipboards are useful and data sheets that are at first separated (not stapled).
- Following the making of the initial species list and collection of location and environmental data both team members convene to do the estimation of plant cover by species followed by the estimation of total vegetation cover and cover by layer.
- Following that process, the estimation of cover by the up to 10 height strata classes and the listing of the diagnostic species for each is done collaboratively.
- This is followed by the estimation of the coarse fragment information, again done collaboratively.

For egalitarian and familiarization purposes we suggest that the roles be switched regularly between the team members and that if multiple teams are being used in a larger project, that each team member switches frequently between teams, building all-important calibration, and camaraderie among the whole group.

Suggestions for Laying out Plots: If you are laying out a circular plot, work with two or more people. One person stands at the center of the plot and holds the tape case while the other walks the end of the tape out to the appointed distance (radius 5.6 for 100 m<sup>2</sup> circle, radius 11.3 m for a 400 m<sup>2</sup> circle, and radius 17.6 m for a 1000m<sup>2</sup> circle). The walker then fixes the tape end with a pin flag and walks back to the center where he/she instructs the center person to walk in the opposite direction of the already laid out tape radius, stretching the rest of the tape to an equal length (another 11.3 or 17.6 m) to the opposite edge of the plot, where he/she affixes it with another pin flag. This process is again repeated with another tape laid out perpendicular to the first so that an “+” shape is created. The margins of the circle can be further delineated by

measuring to the center of the circle with an optical tape measure (rangefinder) and marking mid points between the four ends of the crossed tapes.

When laying out square or rectangular plots work with two or more people per team. If doing a rectangle, determine the long axis of the plot first and have one person be stationed at the zero m end of the tape while the other person walks the unrolling tape case out to the appropriate length. The stationary end person can guide the walker, keeping them moving in a straight line. Once that tape is laid out and the far end staked, the team lays out another tape perpendicular to the first, either at one end, using the same type of process. This establishes the width of the rectangle (or square). Using an optical rangefinder and pin-flags, or colored flagging the team can further mark additional points along the other parallel long axis and short axis of the plot (every 5 m for shorter plots or every 10 m for longer plots is suggested) so that the entire plot boundary can be easily visualized.

### References:

Barbour M.G., J.H. Burk, and W.D. Pitts 1987. Terrestrial Plant Ecology, Second Edition. Benjamin/Cummings Publishing Co. Menlo Park, CA. 634 pages.

Sawyer and Keeler-Wolf. 1995. Manual of California Vegetation. California Native Plant Society, Sacramento, CA. 471 pages

The Nature Conservancy and Environmental Systems Research Institute. 1994. Final Draft, Standardized National Vegetation Classification System. Prepared for United States Department of the Interior, National Biological Survey, and National Park Service. Arlington, VA.

Complete document available at the following website:

<http://biology.usgs.gov/npsveg/fieldmethods.html>

### Suggested Equipment:

Equipment List: Prices as of May 2000, toll free orders from Forestry Suppliers (1-800-647-5368) (item numbers in parentheses)

Chaining pins, surveyor steel (#39167)	\$21.50
Fiberglass tapes 2 - 165'/50 m (#39972)	\$42.90
Logbook cover 8 ½ " x 12" (#53200)	\$23.95
Perforated flagging (#57960)	\$1.95
UTM Coordinate Grid (#45019)	\$16.95
Rangefinder, 10-75m (#38973)	\$51.60
Silva Compass w/ clinometer (#37036)	\$43.90
Garmin GPS 12XL (#39095, #39111)	\$244.90

### **Simplified Key to Soil Texture** (Brewer and McCann, 1982)

Place about three teaspoons of soil in the palm of your hand. Take out any particles >2mm in size, and use the following key to figure out the soil texture (e.g. loamy sand). Then figure out the texture subclass by using the Code List attached (e.g. coarse loamy sand).

- A1 Soil does not remain in a ball when squeezed..... sand
- A2 Soil remains in a ball when squeezed..... B
- B1 Add a small amount of water. Squeeze the ball between your thumb and forefinger, attempting to make a ribbon that you push up over your finger. Soil makes no ribbon.....loamy sand
- B2 Soil makes a ribbon; may be very short.....C
- C1 Ribbon extends less than 1 inch before breaking.....D
- C2 Ribbon extends 1 inch or more before breaking.....E
- D1 Add excess water to small amount of soil; soil feels very gritty or at least slightly gritty .....loam or sandy loam
- D2 Soil feels smooth.....silt loam
- E1 Soil makes a ribbon that breaks when 1–2 inches long; cracks if bent into a ring.....F
- E2 Soil makes a ribbon 2+ inches long; does not crack when bent into a ring.....G
- F1 Add excess water to small amount of soil; soil feels very gritty or at least slightly gritty.....sandy clay loam or clay loam
- F2 Soil feels smooth.....silty clay loam or silt
- G1 Add excess water to a small amount of soil; soil feels gritty or at least slightly gritty.....sandy clay or clay
- G2 Soil feels smooth.....silty clay



**CALIFORNIA NATIVE PLANT SOCIETY RELEVÉ FIELD FORM CODE LIST** (revised 7/8/02)

**MACRO TOPOGRAPHY**

- 00 Bench
- 01 Ridge top (interfluvial)
- 02 Upper 1/3 of slope
- 03 Middle 1/3 of slope
- 04 Lower 1/3 of slope (lowslope)
- 05 Toeslope (alluvial fan/bajada)
- 06 Bottom/plain
- 07 Basin/wetland
- 08 Draw
- 09 Other
- 10 Terrace (former shoreline or floodplain)
- 11 Entire slope
- 12 Wash (channel bed)
- 13 Badland (complex of draws & interfluvial)
- 14 Mesa/plateau
- 15 Dune/sandfield
- 16 Pediment
- 17 Backslope (cliff)

**MICRO TOPOGRAPHY**

- 01 Convex or rounded
- 02 Linear or even
- 03 Concave or depression
- 04 Undulating pattern
- 05 Hummock or Swale pattern
- 06 Mounded
- 07 Other

**SITE IMPACTS**

- 01 Development
- 02 ORV activity
- 03 Agriculture
- 04 Grazing
- 05 Competition from exotics
- 06 Logging
- 07 Insufficient population/stand size
- 08 Altered flood/tidal regime
- 09 Mining
- 10 Hybridization
- 11 Groundwater pumping
- 12 Dam/inundation
- 13 Other
- 14 Surface water diversion
- 15 Road/trail construction/maint.
- 16 Biocides
- 17 Pollution
- 18 Unknown
- 19 Vandalism/dumping/litter
- 20 Foot traffic/trampling
- 21 Improper burning regime
- 22 Over collecting/poaching
- 23 Erosion/runoff
- 24 Altered thermal regime
- 25 Landfill
- 26 Degrading water quality
- 27 Wood cutting
- 28 Military operations
- 29 Recreational use (non ORV)
- 30 Nest parasitism
- 31 Non-native predators
- 32 Rip-rap, bank protection
- 33 Channelization (human caused)
- 34 Feral pigs
- 35 Burros
- 36 Rills
- 37 Phytogenic mounding

**PARENT MATERIAL**

- ANDE Andesite
- ASHT Ash (of any origin)
- GRAN Granitic (generic)
- GREE Greenstone
- DIOR Diorite
- BASA Basalt
- OBSI Obsidian
- PUMI Pumice
- IGTU Igneous (type unknown)
- MONZ Monzonite
- PYFL Pyroclastic flow
- QUDI Quartz diorite
- RHYO Rhyolite
- VOLC General volcanic extrusives
- VOFL Volcanic flow
- VOMU Volcanic mud
- BLUE Blue schist
- CHER Chert
- DOLO Dolomite
- FRME Franciscan melange
- INTR General igneous intrusives
- GNBG Gneiss/biotite gneiss
- HORN Hornfels
- MARB Marble
- METU Metamorphic (type unknown)
- PHYL Phyllite
- SCHI Schist
- SESC Semi-schist
- SLAT Slate
- BREC Breccia (non-volcanic)
- CACO Calcareous conglomerate
- CASA Calcareous sandstone
- CASH Calcareous shale
- CASI Calcareous siltstone
- CONG Conglomerate
- FANG Fanglomerate
- GLTI Glacial till, mixed origin, moraine
- LALA Large landslide (unconsolidated)
- LIME Limestone
- SAND Sandstone
- SETU Sedimentary (type unknown)
- SHAL Shale
- SILT Siltstone
- DIAB Diabase
- GABB Gabbro
- PERI Peridotite
- SERP Serpentine
- ULTU Ultramafic (type unknown)
- CALU Calcareous (origin unknown)
- DUNE Sand dunes
- LOSS Loess
- MIIG Mixed igneous
- MIME Mixed metamorphic
- MIRT Mix of two or more rock types
- MISE Mixed sedimentary
- CLAL Clayey alluvium
- GRAL Gravelly alluvium
- MIAL Mixed alluvium
- SAAL Sandy alluvium (most alluvial fans and washes)
- SIAL Silty alluvium
- OTHE Other than on list

**SOIL TEXTURE**

- COSA Coarse sand
- MESN Medium sand
- FISN Fine sand
- COLS Coarse, loamy sand
- MELS Medium to very fine, loamy sand
- MCSL Moderately coarse, sandy loam
- MESA Medium to very fine, sandy loam
- MELO Medium loam
- MESL Medium silt loam
- MESI Medium silt
- MFCL Moderately fine clay loam
- MFSA Moderately fine sandy clay loam
- MESL Moderately fine silty clay loam
- FISA Fine sandy clay
- FISC Fine silty clay
- FICL Fine clay
- SAND Sand (class unknown)
- LOAM Loam (class unknown)
- CLAY Clay (class unknown)
- UNKN Unknown
- PEAT Peat
- MUCK Muck

**DOMINANT VEGETATION GROUP*****Trees:***

- TBSE Temperate broad-leaved seasonal evergreen forest
- TNLE Temperate or subpolar needle-leaved evergreen forest
- CDF Cold-deciduous forest
- MNDF Mixed needle-leaved evergreen-cold deciduous forest
- TBEW Temperate broad-leaved evergreen woodland
- TNEW Temperate or subpolar needle-leaved evergreen woodland
- EXEW Extremely xeromorphic evergreen woodland
- CDW Cold-deciduous woodland
- EXDW Extremely xeromorphic deciduous woodland
- MBED Mixed broad-leaved evergreen-cold deciduous woodland
- MNDW Mixed needle-leaved evergreen-cold deciduous woodland

***Shrubs:***

- TBES Temperate broad-leaved evergreen shrubland
- NLES Needle-leaved evergreen shrubland
- MIES Microphyllous evergreen shrubland
- EXDS Extremely xeromorphic deciduous shrubland
- CDS Cold-deciduous shrubland
- MEDS Mixed evergreen-deciduous shrubland
- XMED Extremely xeromorphic mixed evergreen-deciduous shrubland

***Dwarf Shrubland:***

- NMED Needle-leaved or microphyllous evergreen dwarf shrubland
- XEDS Extremely xeromorphic evergreen dwarf shrubland
- DDDS Drought-deciduous dwarf shrubland
- MEDD Mixed evergreen cold-deciduous dwarf shrubland

***Herbaceous:***

- TSPG Temperate or subpolar grassland
- TGST Temperate or subpolar grassland with sparse tree
- TGSS Temperate or subpolar grassland with sparse shrublayer
- TGSD Temperate or subpolar grassland with sparse dwarf shrub layer
- TFV Temperate or subpolar forb vegetation
- THRV Temperate or subpolar hydromorphic rooted vegetation
- TAGF Temperate or subpolar annual grassland or forb vegetation

***Sparse Vegetation:***

- SVSD Sparsely vegetated sand dunes
- SVCS Sparsely vegetated consolidated substrates

