



Environmental Analysis Program

Pomona College
Biogeochemistry Laboratory

SOP-F603

Vegetation Transect Surveys

Standard Operating Procedure

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1. Purpose

This SOP describes field procedures for conducting vegetation transect surveys using three common methods: line-point intercept (LPI), line intercept (LI), and quadrat (cover class) sampling. These methods quantify plant species composition, percent cover, and community structure across field sites and form the basis for vegetation monitoring, ecological assessment, and restoration evaluation (Bonham, 2013; Kent, 2012; **mueller-dombois1974?**).

2. Scope

- **Applies to:** Terrestrial vegetation surveys at all EA Program field sites, including the Bernard Field Station, Pomona College Farm, the Pit, restoration sites, and photovoltaic panel study areas
- **Does not apply to:** Aquatic or submerged vegetation surveys; tree-only forest inventory (DBH-based methods; see [SOP-F604](#)); remote sensing vegetation analysis
- **Location:** All EA Program field sites

3. Definitions

- **Percent cover:** The proportion of the ground surface covered by the vertical projection of the aerial parts of a plant species, expressed as a percentage. Cover is the standard metric for characterizing non-woody vegetation communities because it integrates plant size and density into a single measure (Bonham, 2013).
- **Line-point intercept (LPI):** A method that estimates cover by recording what a vertically lowered pin contacts at fixed intervals along a transect. Originally described by Levy & Madden (1933), LPI produces objective, repeatable cover estimates with minimal observer bias (Herrick et al., 2005).
- **Line intercept (LI):** A method that measures the length of transect tape intercepted by the canopy of each species. Best suited for shrubs and other plants with clearly defined canopy boundaries.
- **Quadrat:** A fixed-area frame (typically 1 m x 1 m) within which percent cover is visually estimated for each species. Visual estimation introduces more observer subjectivity than point-based methods but permits rapid assessment and better detection of rare species (Daubenmire, 1959; God'inez-'Alvarez et al., 2009).
- **Daubenmire cover class:** A categorical scale for estimating cover within quadrats: 1 (0–5%), 2 (5–25%), 3 (25–50%), 4 (50–75%), 5 (75–95%), 6 (95–100%). The midpoint of each class is used in calculations (Daubenmire, 1959).

- **Top hit / lower hit:** In LPI, the “top hit” is the first species the pin contacts as it descends through the canopy; subsequent contacts with other species or canopy layers are “lower hits.” Recording both allows multi-layer canopy analysis.
- **Species richness:** The total number of species recorded in a defined area. Richness is strongly influenced by plot size and sampling effort (**wilson2012?**).
- **Voucher specimen:** A pressed, dried, and identified plant specimen archived for verification of field identifications. See Section 9.
- **Basal cover:** The proportion of ground surface occupied by the base (stem or root crown) of a plant, as distinct from foliar cover. Basal cover is more stable than foliar cover across seasons and is sometimes used for perennial grass monitoring (Herrick et al., 2005).

4. Responsibilities

Role	Responsibility
Lab PI	Approve survey design, ensure training compliance
Field Lead	Coordinate logistics, assign transect locations
Trained Personnel	Conduct surveys, record data, collect voucher specimens
New Students	Complete training before independent surveying

5. Safety and Hazards

Hazards

- **Biological:** Poison oak, stinging nettle, ticks, snakes, bees (all common at local field sites)
- **Physical:** Uneven terrain, heat exposure, sharp stakes and rebar
- **Allergenic:** Pollen exposure during peak growing season

5.1. Required PPE

- ☐ Closed-toed shoes or field boots
- ☐ Long pants (required in areas with poison oak or ticks)
- ☐ Sun protection (hat, sunscreen)
- ☐ Nitrile gloves (when handling unknown plants)
- ☐ Tick repellent (DEET or permethrin-treated clothing)

5.2. Required Training

- [SOP-F001 Field Safety](#)

6. Summary of Methods

Three survey methods are covered in this SOP. Select the method that best fits your vegetation type and research objectives (Elzinga et al., 1998; Herrick et al., 2005).

Method	Best For	Accuracy	Speed	Observer Bias
Line-point intercept	Grasslands, herbaceous communities	High	Moderate	Low
Line intercept	Shrublands, plants with dense canopies >1 m	High	Slow	Low
Quadrat (cover class)	Mixed communities, rapid assessment, rare species detection	Moderate	Fast	Moderate

Choosing a Method

For most EA Program projects in southern California grasslands and shrublands, **line-point intercept** is the default method because it minimizes observer bias in cover estimation (God'inez-Alvarez et al., 2009; Herrick et al., 2005). Use **quadrats** when rare species detection is important or when rapid assessment is needed, recognizing that visual cover estimation varies significantly among observers even after training (Bonham, 2013). Use **line intercept** for shrub-dominated communities where canopy boundaries are distinct. When a study spans multiple years, method consistency across years is more important than selecting the “best” method in any given year (symstad2008?).

7. Required Materials

7.1. Field Equipment

Item	Notes
50 m measuring tape	Fiberglass preferred (doesn't stretch)
Chaining pins or rebar stakes	For anchoring transect endpoints
Pin flags	For marking transect start/end and quadrat locations
Sampling pin or rod	Thin metal rod (~3 mm diameter) for point intercept
1 m x 1 m quadrat frame	PVC or metal; for cover class method
Compass	For establishing transect bearings
GPS unit or smartphone	For recording transect coordinates
Field data sheets	Printed from Appendix A
Clipboard and pencils	Mechanical pencils work well in the field

Item	Notes
Plant identification guides	Regional flora; Jepson Manual for California (Baldwin et al., 2012)
Camera	For photo documentation at each transect
Collection bags and plant press	For voucher specimens of unknown species
Flagging tape	For temporary marking

8. Estimated Time

Task	Time
Site preparation and transect setup	15–30 minutes per transect
Line-point intercept survey	30–60 minutes per 50 m transect
Line intercept survey	45–90 minutes per 50 m transect
Quadrat survey	10–15 minutes per quadrat
Data entry and QC	30 minutes per transect (post-field)

9. Procedure

9.1. Survey Timing

Conduct vegetation surveys during the peak growing season for the target community. In southern California:

- **Grasslands and annual forbs:** March through May
- **Coastal sage scrub:** April through June
- **Riparian:** June through August

Consistency in timing across years is essential for detecting temporal changes ([symstad2008?](#)). Surveys conducted outside the peak window will underestimate cover for deciduous and annual species.

9.2. Transect Layout

1. Determine transect locations using the project sampling design (random, stratified random, or systematic placement within habitat zones). The choice of sampling design affects the inferences that can be drawn from the data; random or stratified random designs support unbiased estimation of population-level cover, while systematic designs maximize spatial coverage but can coincide with periodic landscape features (Kent, 2012).
2. Navigate to the starting point and record GPS coordinates
3. Establish the transect bearing using a compass (typically perpendicular to environmental gradients, e.g., slope, moisture, or distance from structures)
4. Anchor the 0 m end of the measuring tape with a chaining pin

5. Walk out the tape to the desired length (typically 50 m), keeping it taut and as straight as possible
6. Anchor the far end with a second chaining pin
7. Photograph the transect from both ends

i Permanent Transects

For long-term monitoring, mark transect endpoints with permanent markers (capped rebar driven flush with the ground, GPS coordinates recorded to sub-meter accuracy). Take a compass bearing and distance to at least two nearby permanent features for relocation.

9.3. Method A: Line-Point Intercept

This method estimates percent cover by recording what a vertical sampling pin contacts at regular intervals along the transect. The method was originally developed by Levy & Madden (1933) for pasture analysis and has since become the standard for rangeland and grassland monitoring (Herrick et al., 2005).

1. Begin at the 0 m end of the transect; always work from the same side of the tape
2. At each sampling point (every 0.5 m or 1 m, depending on project design), lower the sampling pin vertically through the vegetation canopy directly over the tape
3. Record each plant species the pin contacts as it descends from the canopy to the ground (**top hit** is the first species contacted; record all species for multi-layer canopies)
4. If the pin does not contact any vegetation, record the ground surface type: bare soil, litter, rock, moss/lichen, or other
5. Record the height (cm) of the tallest species contacted at each point
6. Advance to the next sampling point and repeat

! Pin Angle Matters

The pin must be lowered vertically (plumb). Tilting the pin even slightly increases the probability of contacting vegetation and inflates cover estimates. Some protocols use a pin guide or frame to enforce verticality.

Calculations:

$$\text{Percent cover for species } i = \frac{\text{Number of hits for species } i}{\text{Total number of sampling points}} \times 100$$

Total cover may exceed 100% when canopy layers overlap. The number of sampling points required depends on the diversity and patchiness of the vegetation; 100 points per 50 m transect (0.5 m interval) is standard for diverse grasslands, while 50 points (1 m interval) may suffice in low-diversity or homogeneous stands (Elzinga et al., 1998).

9.4. Method B: Line Intercept

This method measures the length of transect tape intercepted by each plant species. Best suited for shrubs and plants with distinct canopy boundaries (Bonham, 2013).

1. Begin at the 0 m end of the transect
2. Walk slowly along the tape, noting where each plant canopy begins and ends (intercepts the tape)
3. Record the species, the start point (cm), and the end point (cm) on the data sheet
4. If a gap occurs within a single plant's canopy that is longer than the canopy width on either side, treat it as two separate intercepts
5. Record gaps between plants as the appropriate ground cover type

Calculations:

$$\text{Percent cover for species } i = \frac{\sum \text{intercept lengths for species } i}{\text{Total transect length}} \times 100$$

9.5. Method C: Quadrat (Cover Class)

This method uses visual estimates of cover within fixed-area plots placed at intervals along the transect (Daubenmire, 1959).

1. Place quadrats at predetermined intervals along the transect (e.g., every 5 m or 10 m), or at random distances
2. Ensure enough distance between quadrats for them to be independent sampling units (typically at least 5 m apart)
3. For each quadrat, identify every plant species present
4. Estimate percent cover for each species using the modified Daubenmire cover classes:

Class	Cover Range	Midpoint
1	0–5%	2.5%
2	5–25%	15%
3	25–50%	37.5%
4	50–75%	62.5%
5	75–95%	85%
6	95–100%	97.5%

5. Also record percent cover of bare ground, litter, and rock
6. Note the maximum vegetation height (cm) in each quadrat
7. Photograph each quadrat from directly above

Visual estimation of cover is inherently subjective and sensitive to observer experience, viewing angle, and vegetation height; training with known-cover reference images or calibration frames improves consistency but does not eliminate inter-observer variability (Bonham, 2013; God'inez-Alvarez et al., 2009).

10. Voucher Specimens

When a plant cannot be identified in the field:

1. Collect a representative sample including leaves, stems, and flowers or fruit if available
2. Place in a labeled collection bag (site, transect, date, collector)
3. Press specimens the same day
4. Identify in the lab using the Jepson Manual (Baldwin et al., 2012) or other regional flora
5. Update the data sheet with the confirmed identification

11. Quality Control

- Two observers should independently estimate cover for at least 10% of quadrats to assess observer agreement. Inter-observer variability in cover estimation is the largest source of error in quadrat-based surveys; training reduces but does not eliminate this bias (Bonham, 2013; Elzinga et al., 1998).
- For LPI surveys, duplicate readings at 10% of points should agree on species identity for at least 90% of hits. Disagreements on ground cover type (e.g., litter vs. bare soil) are most common and should be resolved by applying consistent definitions.
- Photograph each transect and quadrat for archival verification
- Review data sheets in the field before leaving the site (check for missing entries, illegible writing, and species code consistency)
- Enter data within 48 hours of collection
- Maintain a species list with standardized codes used across all surveys

12. Data Management

12.1. Field Data Sheets

Use the data sheets in Appendix A. Record in pencil (ink smears when wet). Use Rite in the Rain paper if available.

12.2. Data Entry

Enter data into the project spreadsheet or database within 48 hours. Each row should represent one observation (one point, one intercept, or one quadrat-species combination). Required fields:

- Date, site, transect ID, observer
- Method (LPI, LI, or Quadrat)
- Point/interval/quadrat number
- Species (use standardized 6-letter codes: first 3 letters of genus + first 3 of species, e.g., BRODIA for *Bromus diandrus*)
- Cover value or hit/no-hit
- Height (cm)
- Ground cover type (if applicable)

13. Waste and Site Impact

- Remove all flagging tape, pin flags, and temporary markers after the survey
- Do not trample vegetation outside the immediate transect corridor
- Leave permanent markers flush with the ground to avoid hazards to people and wildlife
- Pack out all trash and supplies

14. References

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- Levy, E. B., & Madden, E. A. (1933). The point method of pasture analysis. *New Zealand Journal of Agriculture*, 46, 267–279.

15. Training Record

Before conducting vegetation surveys independently, personnel must:

1. Read this SOP and [SOP-F001 Field Safety](#) in full
2. Demonstrate familiarity with at least 20 common species at the study site
3. Participate in a supervised survey using each method to be employed
4. Demonstrate acceptable inter-observer agreement on cover estimates (within one cover class for quadrats, or within 5% for line-point intercept)
5. Be signed off by the field lead or PI

16. Appendix A: Field Data Sheets

16.1. Line-Point Intercept Data Sheet

Site: _____ Transect ID: _____ Date: _____

Observer: _____ **Bearing:** _____ **Length:** _____ m

Sampling interval: every _____ m **Start GPS:** _____

Point (m)	Top Hit Species	Lower Hit(s)	Ground Cover	Height (cm)
0.0				
0.5				
1.0				
1.5				
2.0				

(Continue on additional sheets as needed)

16.2. Quadrat Cover Class Data Sheet

Site: _____ **Transect ID:** _____ **Date:** _____

Observer: _____ **Quadrat size:** _____ m x _____ m

Cover classes: 1 = 0–5%, 2 = 5–25%, 3 = 25–50%, 4 = 50–75%, 5 = 75–95%, 6 = 95–100%

Quadrat #	Position (m)	Species	Cover Class	Max Height (cm)

Ground cover for each quadrat:

Quadrat #	Bare Soil (%)	Litter (%)	Rock (%)	Other (%)