Monitoring California Grasslands for Native Perennial Grasses
Workshop Handbook

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I. Measurement Methods for Native Grass Abundance

- Workshop is to demonstrate and practice monitoring methods with three variables—percent absolute cover, density, and frequency of native perennial grasses.
- Workshop assumes each sampling site and the sampling points were defined and selected using appropriate stratification and randomization methods.
- Locate the starting point of the transect (sampling plot) with GPS based on stratification of monitoring unit classes and random selection using a grid overlaid on sampling unit aerial photo or map (see descriptions of sampling methods below); randomly select compass bearing for transect; run-out the 25 meter tape and secure it at both ends to keep it taught.
- Measurement rules: focus on native perennial grasses only; ignore other species (refer to grass list); walk only on the left or downhill side of the transect so the other side will remain free of traffic damage for most accurate measurement.
- Data forms—separate forms for each variable; revise these forms to fit your needs (download from the CTP website); rule: fill-out completely; use a compass for bearing.
- Ideally, take a photograph of each transect facing from the starting point to the end of the transect, and close-up looking at the ground; include in the view a white board marked with the place, date, and plot ID; include in the view a person or known-size object for scale.

Table 1. Measurement Specifics

Variables	Units	Number of Measurements	Description	Equipment
% Foliar Absolute Cover	Line point "hits"	50 points (hits or misses) at each half-meter	Top hit on any standing plant part, live or dead, but no litter; record only if top hit is a native perennial grass	25 m tape, tape stakes, pointer
Density	Number of individuals per quadrat	25 quadrats, one per meter	Numbers of any species; count only if rooted $\geq$ 50 % within quadrat and $\geq$ 5 cm apart	25 m tape, tape stakes, quadrat frame
Frequency	Presence of species per quadrat	25 quadrats, one per meter	Presence of each species; record only if rooted $\geq$ 50 % within quadrat	25 m tape, tape stakes, quadrat frame

II. The Californian Grassland (Bartolome et al. 2007)

III. The Coastal Prairie of California (Ford and Hayes 2007)

IV. Monitoring Versus Assessment

V. Steps in Establishing a Monitoring Program

- Bush Sotoyome RCD book—very useful starting place for planning a developing a monitoring plan for coastal sites (p. 39); and for a management effects summary (p. 50).
- USDA-ARS Monitoring Manual (2 vols. available on-line)—based on semi-desert grasslands of SW; in CA it is mostly applicable to native grasses.

A. Define goals and objectives.
- Use Table 2; we concentrate on "Special Management #a."

B. Assemble background information (to assess native grass status and management).

C. Select variables and methods.
- Use Table 3 to select appropriate variables.
- Include costs assessment, speed required, expertise available (training required), and feasibility

D. Determine baselines (current status) and standards for selected variables and potential results.

E. Stratify and select monitoring sites.
- Assess and mark on maps
- Assure obvious patterns are stratified; to reduce costs exclude some strata
- Use Table 4 to determine site divisions appropriate for level of monitoring intensity.

F. Determine sampling system and schedule.

G. Conduct the monitoring; record and store data and photos.

H. Summarize, evaluate, interpret, and report results.
- Eventually look for trends among results of multiple monitoring periods.

I. Prescribe adaptations of previous plans, as needed; make adaptations to plan based on results.

Table 2. Potential Management Goals Pertaining to Native Grasses (Sotoyome RCD 2006, USDA-ARS 2005, and Central Coast Rangeland Coalition 2007)

Three Principal Categories of Goals:	Two Principal Purposes of Monitoring:	
	Compliance (meet contractual requirements)	**Effectiveness (improve practices)**
Stewardship Planning	a. Planning as a pre-requisite	a. Determine optimal management practices b. Determine site potentials
Universal Ecological (Ecosystem Health)	a. Grazing management (stocking rates, autumn RDM) b. Reduce fire hazard	a. Increase or maintain plant productivity b. Increase or maintain functioning recovery mechanisms c. Increase or maintain habitat diversity
Special Management	a. Increase or maintain abundance of special-status species habitat and natural communities, including native grasses and associates b. Control problem plants and animals and diseases	a. Increase or maintain abundance of special-status species habitat and natural communities b. Limit or reduce undesirable type conversion c. Recover from degradation d. Control problem plants and animals and diseases

Table 3. Selecting Monitoring Variables (Bonham 1989)

Variables	Advantages	Disadvantages	Rapid	Rigorous
Foliar Absolute Cover	• Can produce quick info about cover and composition • Line-points more accurate than quadrat measurements	• Results vary with season and weather, which can be misleading • Requires training and practice to be accurate (improve accuracy with point frame)	no	yes

Table 3. Selecting Monitoring Variables (Bonham 1989)				
Variables	**Advantages**	**Disadvantages**	**Rapid**	**Rigorous**
Density	• Can produce species list • Tends to be more constant between years than cover or biomass • Tells most about populations (assess cohorts) • Required to confirm trends • Can force managers to notice more, such as vigor and cryptic seedlings	• Most costly • Distinction of individuals can be difficult and misleading	no	yes
Frequency	• Less costly than density • Can produce quick information about spatial distribution; highly sensitive to abundance • More accurate than line-point cover • Produces species list • Useful to assess change and to compare grassland or management types • Can generate estimates of density and cover	• Presence tells little about populations • Requires adjustment of quadrat size for each species/group (increase quadrat size if plants large or low density exclusion of other species; reduce quadrat size if higher density so that variation appears; no frequency differences or change detectable if too large)	yes	yes
Biomass/ Production/ Utilization	• Reflects season and weather • Required to measure herbivore utilization and resource use by plants • Distinguish peak standing crop, pre- and post-grazing, non-livestock use, and thatch • Alternative measure—livestock weight pre- and post-grazing	• Costly, especially if repeated measurement is required • Subject to bias if not stratified and randomized	no	yes
Photos	• Least costly • Produces visual record with easy comparison between photo periods • Used mostly for landscape-scale characteristics	• Qualitative and subject to bias—results not quantitative and species often not identifiable • Requires photography when native grasses are visible (color contrasts—summer)	yes	no

Table 4. Potential Stratification of Grasslands (USDA-ARS 2005)	
Categories of Stratification:	**Monitoring Units**
Landscape Position Units (topographic type, aspect, slope)	• Mountains/hills/valley floors/streams, ponds, or lakes • Slopes (percent categories) • North/south facing slopes • Watershed units
Soil Units	• Major soil categories • Range sites
Vegetation Units	• Open grassland, savanna, oak woodland • Special grassland vegetation characteristics
Special Sites of Degradation, Hazard, or other Special Attention	• Severe erosion sites • Severe slopes • Wildfire sites • High density native grasses or associates • Sites of concentrated attention (public views)
Type of Management	• Grazed (timing and intensity) • Ungrazed (time since last grazed) • Distance to water • Mowed for hay production • Other specialized management (e.g. high frequency burning)

VI. Additional Sampling Guidance

A. **Best determine plot size and sample numbers by pre-monitoring testing** for appropriate precision and reducing variation (advanced class).

B. **Select sampling points randomly** by overlaying a 100 cell grid onto each grassland monitoring site, then randomly select $\geq$ 5 numbers corresponding to cells using a random number generator.

C. Rules for identifying transect starting points:

- Avoid edges, woody cover, water, and other sampling points (use predetermined course to re-locate if mapped point is inappropriate).
- Avoid overlap with another transect (select another bearing until no overlap).

D. **Establish permanent plots** for re-measurement in future monitoring periods.
   - Permanent plots enable tracking of individual plants, and avoids confusion with spatial variability.
   - Use rebar stakes to mark sampling point (transect starting point), hammered low into the ground, or with bent-over top with plastic colored caps, to resist sun and livestock damage.
   - Also mark with replaceable wooden stakes for better visibility.
   - Use a metal detector to re-locate rebar stakes if re-visited infrequently or there's heavy site disturbance.

E. **Randomly choose bearing for each permanent transect**, and record on data sheet.

VII. Additional Considerations in Monitoring Design

A. Recommendations for improved accuracy and value:

- Expect variation among monitoring workers--train to improve and use same worker for same measurements and during subsequent monitoring.
- Use at least 5 plots per study/monitoring strata or management unit, and at least 5 replicates of management units within a strata.
- Use at least 25 points on a transect, which produces data increments of no more than 4%.
- Since native grasses don't exist apart from their ecosystems, other goals must be integrated into plans and monitoring systems.
- Since monitoring is so costly and requires technical sophistication, find and use cooperators, such as "barn-building" teams, regional coops, interns, or students guided by a competent teacher.
- If for no other purpose, monitoring supports managers to be directly aware of their properties.

B. Risks of reduced intensity or care in design of monitoring:

- Results are irrelevant or poorly relevant to management goals, practices, and questions.
- Results are never analyzed, and thus not available to evaluate or to make adaptations of management plans.
- Results are so variable that differences cannot be detected with significance.
- Results are skewed or inaccurate.
- Potential results or conclusions are missed or mis-interpreted, including trends and management effects.
- Results that cannot confirm or refute unquantitative observations promoted by you or advocates of management practices.
- Results that cannot be used in science, legal proceedings, or to convince skeptics/plaintiffs (or supervisors) because of lack of rigor.
- Resources were wasted conducting the monitoring.

C. Requirements to apply at other sites and conditions:

- Use scholarship to determine appropriate goals and conditions at each property.
- Determine feasibility for each property.
- Adjust stratification, variables, monitoring intensity, and prescription for management adaptation for goals and conditions.
- Test and adapt the monitoring system to achieve highest accuracy and relevance to conditions and management at each property.

D. Rapid monitoring:

- Requires a team with advanced technical skills (advanced class).
- Usually involves reduced knowledge to stratify, numbers of variables, and sampling intensity, and thus reduced rigor.
- Increased potential for bias, inaccuracy, and irrelevance to management.

E. Substitute "Professional Judgment" for rigor to reduce costs:

- Since monitoring is so costly, reduce some costs by reducing the degree of monitoring intensity to professional judgment for site selection and sampling.
- Supplement with extensive photo monitoring (see other guidance to assure it detects key trends).
- Select "key" areas—that are representative (rather than randomly selected with extensive sampling) and that will respond clearly to management changes or differences
- Since no statistics may be used, reduce to 1-2 replicates and 1-2 plots

VIII. Swanton Pacific Ranch Workshop Information

A. Workshop objectives:

1. Review scientific information about ecology, monitoring approaches, and integration into management planning for California valley grassland and coastal prairie.
2. Use and compare monitoring variables and methods applicable to common management goals for native grasses.
3. Understand the basics of developing and conducting an appropriate monitoring program for grasslands managed for native grasses.

B. Equipment: Aerial photos and maps, sampling point markers, GPS, 25-meter tape, stakes, points, nested meter-square quadrat, data forms, compass, random number table

C. Handouts:

1. Monitoring
   - Sotoyome RCD Grazing Handbook (L. Bush)
   - USDA-ARS Jornada Experimental Range Monitoring Manual Quick Start (intro pages only)

2. Swanton Pacific Ranch
    - Google aerial photo map (CTP website only)
    - Swanton Pacific Ranch aerial photo map (CTP website only)
    - Monitoring pastures aerial
    - Monitoring pasture SCS soils map
    - Lower pasture blow-up aerial with sampling grid and GPS coordinates
    - G. Hayes research data
3. Workshop
    - Agenda
    - Data forms
    - Recent peer-reviewed references on California grasslands and coastal prairie (Bartolome et al. 2007; Ford and Hayes 2007; Hayes and Holl 2003a and 2003b)

D. Native grasses likely to be found at Swanton Pacific Ranch:

- *Bromus carinatus* California brome
- *Danthonia californica* California oatgrass
- *Elymus glaucus* Blue wild rye
- *Koeleria macrantha* June grass
- *Melica imperfecta* Coast range melic
- *Nassella lepida* Foothill needlegrass
- *Nassella pulchra* Purple needlegrass

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