Vegetation Protocols for UC Natural Reserve System (NRS)
Postfire Sampling Campaign

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Introduction

This protocol for rapid vegetation surveys after wildfire in multiple Coast Range vegetation types including grassland, oak woodland, and shrubland / chaparral. The document provides a menu of observations that can be made immediately after fire to measure severity of fire effects on the soil surface as well as on vegetation, plus a characterization of fuel loads. It also includes a set of observations that can be taken later, in a separate survey, after seeds germinate and surviving woody plants begin to resprout (though some of these protocols for vegetation regrowth are still under development).

The protocol was designed to anchor a suite of other observations of fire effects on birds, mammals, insects, and soil properties, but can also be used on its own. The protocol is based on a circular, 10m radius plot, which is generally large enough to average over very small-scale, plant-level heterogeneity in fire effects and regrowth, while being "surveyable" quickly from a single vantage point. For measurements that would take too long at this extent, such as seedling counts, the protocol recommends using smaller transects through the larger plot.

The protocol aims to collect information about woody plant demography in a way that can be done quickly: for one shrub and one tree in each quadrant, detailed fire effects data are collected, and survival and resprouting is assessed; optionally these plants can be tagged for future re-survey. With the protocol are two associated data sheets, one for plot-level characteristics and individual shrub measurements, and the other for data on individual trees. Our intention is that a trained field crew of 3-4 people could complete one plot in about half an hour (not including time navigating between plots).

Major goals of the survey:

1) Assess fire severity in terms of effects on plants at fine scale
2) Measure damage to trees and tree mortality
3) Measure the effects of fire on fuel loads in grassland, shrubland, and woodland/forest vegetation types, in terms of dead fuels as well as regrowing plants.
4) Monitor responses of main plant functional types, as well as dominant woody species, to fire during regrowth. Assess regeneration success of major species of trees and shrubs.

5) Enable linking plots and individual tagged trees to drone imagery and/or remote sensing for calibrating estimates of fire severity, regrowth rates, and fuel loads.
6) Establish a network of permanent plots at protected reserves sites that can be revisited to produce a long-term record of fire effects and vegetation responses to fire across the region.
7) Use plot network to link vegetation information to data to be collected contemporaneously on insects, mammals, birds, herps, and other taxa, as well as to soil and watershed effects of fire.

I. CHOOSING AND ESTABLISHING PLOTS

Plot size and shape:

- 10.0 m radius circle

Plot location:

- Pre-identify and mark plot locations. To maximize crew sampling time, proposed plot locations will all be identified and marked in the field before the crew arrives by the Reserve Director or other Reserve Staff / affiliates. If not, then crew will consult with Reserve staff to identify suitable areas in each habitat type on digital map, then choose precise plot locations in the field.
- Whether the Reserve staff or crew chooses plot locations, follow this procedure:
    a) Identify suitable areas on map in each habitat type (grassland, shrubland, woodland/forest). All plots should be easily accessible from roads or trails. Aim to pair environmentally similar plots in nearby burned and unburned areas. To the extent possible, keep aspect constant within vegetation type for each reserve (for example, at Quail Ridge all chamise plots are on southerly aspects, and all oak woodland plots are on northerly aspects).
    b) Navigate to a location on a road/trail within a suitable plot area. Randomize the exact location of the plot by
        i) Flip a coin or otherwise generate a random 1/0 number, where the two outcomes represent the two directions along the road/trail.
        ii) Generate a random number between 1 and 40. Walk that number of long (~1m) paces in the direction indicated by (i).
        iii) If suitable plot locations lie on both sides of the trail/road, then flip another coin to determine which side to use for the plot.
        iv) Walk 20 m from the road/trail in the indicated direction and place plot center there. (Note: if the suitable area boundary is away from the road, walk 20 paces from that boundary into the suitable area. Example: road runs through shrubland but a large patch suitable for a grassland plot starts 10m off road -- set up the plot 20m from the grass/shrub boundary).

- **Inspection/Rejection.** Inspect plot upon arrival near plot center. If plot does not meet criteria, reject it and move. Rejection criteria:
    - Wrong vegetation type or wrong burned/unburned status
    - >20% rock or water
    - Otherwise obviously atypical for the area, including extremely shallow soil or in a streambed)
- If you reject the plot, flip a coin and move plot 20m in a random direction parallel to trail/road. Repeat inspection, and move the again if necessary until a suitable site is found. (Note: If the shape of the patch requires moving in a direction not parallel to the road, select an azimuth randomly and move 20m in that direction.)

II. PLOT-LEVEL MEASUREMENTS (MAIN DATA SHEET)

Marking the plot

- Mark plot center with monument (e.g. rebar sheathed with PVC pipe).
- GPS the location of plot center or corner with high-accuracy sub-meter GPS.
- Lay out transect tapes in a "+" following cardinal directions (NSWE) from chaining pins at center of plot to 10m mark.
- Take 4 photographs of the plot, one from each end of a transect tape facing toward plot center. To keep track of which photos go with which plot, first take a picture of the whiteboard with plot name on it (or the data sheet), then take the 4 pictures.
- Always take the 4 photos in this order: S, W, N, E (start at S and go clockwise).
- Record aspect of the plot (if this is too slow, may skip because we can get this from a DEM later if we have an accurate GPS point), and note whether plot itself is on a convex, concave, or flat spot in the terrain.

Ground cover estimates (all plots, based on ground-level cover, including stems or boles of plants):

- Estimate percent cover of major categories of ground cover (see sample sheet)
- For each category, examine all 4 quadrants of the plot quickly, keeping in mind that 3 m2 is 1% of the plot, and produce an overall cover estimate to the *nearest 1% up to 5%, then to the nearest 5% up to 100%.* These cover numbers should sum to 100% (but can deviate slightly if this results from rounding each category).

Live (green) vegetation cover estimates (all plots, based on widest diameter of plant)

Estimate percent cover and modal height of major vegetation types (see sample sheet)

- Forbs, grasses, shrubs, trees

- Trees in two categories or layers: overhead canopy cover, and understory cover (understory includes regeneration such as resprouting from base)
- As in ground cover, examine all 4 quadrants quickly to get an overall estimate. Note vegetation cover values can sum to less than 100%, and can also exceed 100% where there are overlapping layers (herbaceous, shrub canopy, tree canopy).

Surface severity characterization

- Considering the plot as a whole, assess severity of fire effects on the soil surface. Score as follows:
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Index	Substrate (S)
Unburned (0)	not burned
Scorched (1)	litter partially blackened; duff nearly unchanged; wood/leaf structures unchanged
Lightly burned (2)	litter charred to partially consumed; upper duff layer may be charred but the duff layer is not altered over the entire depth; surface appears black; woody debris is partially burned; logs are scorched or blackened but not charred; rotten wood is scorched to partially burned
Moderately burned (3)	litter mostly to entirely consumed, leaving coarse, light colored ash; duff deeply charred, but underlying mineral soil is not visibly altered; woody debris is mostly consumed; logs are deeply charred, burned-out stump holes are common
Heavily burned (4)	litter and duff completely consumed, leaving fine white ash; mineral soil visibly altered, often reddish; sound logs are deeply charred, and rotten logs are completely consumed; This code generally applies to less than 10% of natural or slash burned areas.

Shrub Fuels Measurements

- For shrubs, make some additional measurements of fuel characteristics:
    - Measure percent cover and average height of *each shrub species with >10% cover*. If species not known, can group by genus (e.g. Ceanothus, Salix).
    - NOTE: for this measurement, we're really interested in fuels. Large twigs (>¼ inch) will not likely contribute to fire intensity in the next fire. So dead/burned shrubs are included in this measurement only to the extent that they have live or dead leaves, and/or live or dead twigs <¼ inch in

diameter. Estimate the cover of each shrub species by imagining a single rough polygon that encompasses the parts of the shrub canopy containing fine twigs. (If a shrub still retains its fine twigs throughout, you would include the whole shrub canopy).

- Estimate canopy density of each shrub species/genus (if canopies are present). *Use categorical scoring: low, medium, high density,* where high density represents a shrub canopy that's pretty packed with leaves and fine twigs and difficult to see through)
- Estimate percent of shrub canopy of each species that is dead (to nearest 5%).

Shrub Regrowth Measurements (burned plots only!)

- Note the dominant shrub species in the plot.
- Considering all shrub species in the plot, estimate the percentage of the shrub canopy that is green (or live).
- Considering all shrub species in the plot, estimate the percentage that are resprouting.

Fuels assessment (all plots, unless no surface fuels left after fire)

- Do 2 fuels transects starting from the outside ends of the N-S transect tape. If fuels are very heterogeneous, do 2 more fuels transects starting from the ends of the E-W transect tape.
- Fine surface fuels (1, 10, 100-hr):
    - For 1 and 10 hr fuels, count pieces of fuel intercepted by one edge of transect tape from the edge of the plot (10 m) to the 7.0m mark.
    - For 100 hr, count pieces of fuel intercepted from 10.0 m to 2.0 m.
- Coarse woody debris: count and measure diameter of pieces from 10.0 to 2.0 m. Measure diameter with ruler or tape measure where each piece intersects the transect tape; record whether it is sound or rotten.
- With a small ruler, measure duff and litter depth to nearest mm at 7.0 m and 2 mm marks along the fuels transects (7.0 and 2.0 m from plot center) .
- Measure total fuelbed depth at the same duff and litter points.

Shrub tagging and monitoring (only for burned plots!)

- Locate the shrub that is nearest to plot center in each quadrant of the plot, and tag it and record the tag number and species (if known).
- Shrubs are classified as follows for this study: if the plant species is one that has typically shrub growth form, consider it a shrub; if the species typically tree growth form, consider it a tree. If species ID or typical growth

form is ambiguous, use “gestalt” overall impression to determine whether the plant is a shrub vs a tree sapling.
- Measure smallest remaining twig diameter on burned branches of one randomly selected burned shrub in each quadrant, and record species of each of these shrubs if possible.
- If any of the shrub canopy remains green, note the percentage.
- If the shrub is resprouting, note that and estimate the number of resprouts and measure their height in cm.

II. TREE-LEVEL MEASUREMENTS (TREE DATA SHEET)

Tree Identification and Tagging (all plots with trees)

- If there are no trees in the plot or immediate surroundings (i.e. it is a shrubland or grassland without trees), skip this part of the survey.
- Identify the canopy dominant tree that is nearest to plot center in each quadrant. Canopy dominant means there are no surrounding trees that cast shade on the top of its canopy. The minimum size for canopy dominant trees will vary by plot, depending on the local canopy height, but in all cases, these trees should be >5 cm dbh, typically much larger.
- If there there is no canopy dominant tree in one or more quadrants, search for trees up to 18 m away from plot center in that direction. If there are still no canopy trees in a quadrant, skip the tree measurements for that quadrant.

For each of canopy dominant tree identified:

- Identify to species if possible
- Tag tree and record the tag number
- Record location of the tree in radial coordinates: a) distance from plot center (using laser rangefinder), and b) direction from plot center (azimuth, measured using a sighting compass).
- Measure dbh (diameter at 1.3m) using dbh tape. If the tree has multiple stems, record dbh of the largest stem, as well as the number of stems that are at least 50% the diameter of the largest stem (Example: if a tree has stems with dbh of 30 cm, 25 cm, 20 cm, and 5 cm, plus a few very small stems, record 3 stems).
- Measure tree height with laser rangefinder. To do this, move away from the base of the tree a distance about equal to the height of the tree to a location where you have a fairly unobstructed view of the tree.

Tree Damage and Regeneration Assessment (*burned plots only, immediate postfire assessment only*)

For each individual tree in plot:

- Measure bole char height using ruler or rangefinder. If uneven, record to highest height.
- Measure leaf torch height using rangefinder (for large patches of leaves that were on the tree before the fire but have been completely burned off, measure height to highest ones that are relatively continuous).
- Measure leaf scorch height using rangefinder (for leaves still on the tree, but fire-browned, measure height to highest ones that are relatively continuous, excluding isolated patches of scorched leaves)
- Estimate percent canopy remaining. Visualize the extent of the prefire canopy and estimate the percent of that that is currently still green (nearest 5%). Do this assessment from 2 different viewing angles and record the average.
- Note whether there is epicormic leaf budding (new leaves appearing on branches/stem aboveground), and if there is budding, estimate the percentage of the tree it affects.
- Note whether there is resprouting from base. If the tree is resprouting, record approximate number and average height (cm) of basal sprouts.

APPENDIX A -- Measurements to consider adding for spring

Woody Plant Seedling Census (start either in summer 2021, or spring/summer 2022)

- In a transect 2 m wide (1 m on each side of tape) and 22.6 m long, along the entire N-S axis of the plot, count shrub and tree seedlings
    - Up to 20, count individuals. For 20-100, estimate to nearest 10, 100-1000 estimate to nearest 100, >1000 just say >1000

Species Richness in Plot (start in spring 2021)

If we have the expertise we will get at this with the cover estimates; however, it would also be relatively easy for someone to walk the plot and make a species list - a talley.

- *If recording plant diversity is a high priority, should we establish a subplot for that purpose? and/or simply make a list of species present in the plot?*

APPENDIX B -- EQUIPMENT LIST

- 4 x 25-m transect tapes
- 2 chaining pins
- one compass for each crew member (adjusted for declination)
- smartphone with a good camera -- this can be used for navigating to plots using Avenza, and for taking pictures of plots
- portable power source for charging smartphone in field
- hi-vis plastic flagging
- 2 fuels gauges for fuels transects
- 2 dbh tapes
- one small pocket ruler for each crew member
- small retractable measuring tapes for each crew member
- gear vests for each crew member
- one hardhat for each crew member (if working in areas with damaged/dead trees)
- laser rangefinder (if working in areas with lots of trees, would be better to have 2).
- extra batteries for rangefinders
- GPS -- ideally a high accuracy one, ideally 2 of them
- 2 protective clipboard/data sheet holders and multiple pencils
- data sheets printed ideally on write-in-the-rain paper
- numbered tree tags, small nails and hammer
- rebar (or similar) for permanently marking plots, with caps or pvc pipe sleeves for safety