Angora Fire Restoration Monitoring Protocol

 

For the

California Tahoe Conservancy

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INTRODUCTION

The Angora Fire burned 3,100 acres in and near South Lake Tahoe, California in Summer 2007. The fire ignited on Sunday, June 24 at approximately 2:00pm. It began as an untended campfire near Seneca Pond and spread quickly due to a combination of low fuel moisture, low relative humidity, high temperatures, and high winds, consuming the majority of its final area within the first 12-18 hours. The fire spread northeast along Angora Ridge and consumed more than 250 homes before it was contained on July 2.

Figure 1: The Angora Fire flares up on the afternoon of June 26

The California Tahoe Conservancy is an independent State agency established to develop and implement programs through acquisitions and site improvements to improve water quality in Lake Tahoe, preserve the scenic beauty and recreational opportunities of the region, provide public access, preserve wildlife habitat areas, and manage and restore lands to protect the natural environment. The Conservancy owns 229 urban parcels within the fire perimeter. 177 of these were affected by the fire, totaling 90 out of 104 acres owned. The majority of these parcels had been treated to reduce fuels in the past.

Following containment of the fire, the Conservancy deployed resource assessment teams for a rapid, initial analysis of post-fire conditions. These teams determined that 12% of CTC parcels were a very high priority for treatment, 18% were high priority, 33% were moderate priority and 37% were low priority.

Figure 2. One of 250 homes burned by the Angora fire.

In the weeks following the fire, the Conservancy formed a detailed restoration plan using information provided by the resource assessment teams (CTC 2007). This plan prioritized the removal of dead, dying and hazard trees in installation of erosion control measures. The fire also prompted rapid fuel reduction treatment of unburned acres within the fire perimeter. An emergency contract was put into place with Sierra Pacific Industries for salvage operations on the Conservancy’s two larger ownerships and designated urban lots within the burn area, totaling 53 acres. The remaining 47 acres were treated using hand crews both in-house and on contract.

The Conservancy completed tree removal on 86 of the 90 acres by the end of the 2007 field season. The remaining 4 acres will be completed by June 2008.

SCOPE OF MONITORING PROTOCOL

The overall goal of this monitoring plan is to evaluate the effectiveness of the post fire restoration treatments carried out by the California Tahoe Conservancy. This protocol includes specifications for study design and methods for data collection to monitor the effectiveness of forest and vegetation restoration on CTC owned parcels within the Angora burn area including reseeding and revegetation, fuels treatment, salvage harvesting and replanting, and installation of erosion control measures.

This plan was used as a guide for collecting post burn monitoring data in summer and fall 2007. Field methods included here focus on tree and herbaceous vegetation reestablishment, fuel reduction, soil impacts and erosion control measures. Additional methods included here are appropriate for monitoring wildlife, invasive weeds or other values.

Forest community restoration is necessarily a long-term effort that will occur over decades. This plan monitors the initial and intermediate stages of community establishment and development on CTC parcels, within the first 10 years.

Implementation of this plan presupposes a working knowledge of basic plant ecology, forest and vegetation sampling, plant identification, and erosion control methods. Knowledge of wildlife and weed species is also important for those field methods. References provided at the end of this protocol provide details on the field methods presented.

RESTORATION OBJECTIVES

Figure 3. Moderately burned Jeffrey pine forest.

This plan applies to the following treatment types:

- Fuels treatment: Hand thinning of burned and unburned parcels in the Angora burned area.
- Salvage harvesting: Removal of burned trees and vegetation within the burned area
- Revegetation: Planting and natural recruitment of new trees and other vegetation within the burned area
- Erosion control: Installation of straw wattles, coir logs, silt fences, cross-contour-felled logs, and mulch, and immediate seeding of native plant species, to stabilize soils exposed by the burn.

The primary objectives for these projects are to restore the desired vegetation community in the Angora burn area as quickly as possible with as few negative impacts as possible. The desired vegetation community consists of the conifer species common to these sites, Jeffery Pine (*Pinus jeffreyii)* Incense Cedar *(Calocedrus decurrens)* Sugar Pine *(Pinus lambertiana)* Lodgepole Pine *(Pinus contorta)* and White Fir *(Abies concolor)* and a variety of understory shrubs and herbs, arranged in such a way as to maintain structural complexity and simultaneously reduce the risk of catastrophic fire.

Goals of restoration treatments are to:

- Reduce fuel loading in burned and unburned areas within the burn perimeter.
- Accelerate recovery of the forest community through the reestablishment of desirable tree and other vegetation species.
- Improve soil stability by increasing vegetative cover and root mass.
- Avoid soil erosion and weed invasion in newly exposed soils.

EFFECTIVENESS MONITORING QUESTIONS

The goal of this monitoring program is to assess the effectiveness of alternative types of vegetation treatment (e.g., planting versus no planting as a means of achieving increased cover) and the effects of different environmental conditions on treatments (e.g., effects of vegetation type or elevation on plantation survival). The following is a list of questions that will be addressed:

Figure 4. CTC restoration crew reseeding a lightly burned parcel, August 2007

- Did hand fuels treatment accelerate forest stand development?
- Did hand fuels treatment reduce ground fuels accumulation and associated fire risk?
- Did post fire salvage logging accelerate forest stand development?
- Did post fire salvage logging reduce ground fuels accumulation and associated fire risk?
- Did post fire salvage logging impact soil quality?
- Did planted vegetation survive at an acceptable rate?
- Did reseeding and mulching promote increased ground cover and desired species in the burned area?
- Did erosion control practices minimize soil erosion from burned areas?
- Did weed control methods applied post burn reduce abundance of these weeds?

STUDY DESIGN

The general study design used here is a before-after-control-impact approach (BACI) (Smith 1998; Stewart-Oaten et al. 1986, Crawford and Johnson 2003). Sampling of the project (impact) area is conducted before and after treatment. Similar sampling is also conducted in a similar nearby location that is not planned for treatment (control).

Forest inventory plots have been established on CTC parcels using a stratified approach based on vegetation types and severity of burn (see Table 1). Vegetation types in the burned area include Lodgepole Pine (in the urban parcels) and Jeffrey Pine (in the urban parcels and the larger Expressway and Mule Deer parcels). The severity of the burn ranged from severe, moderate, and light to not burned. A minimum of two plots was established in each of these two vegetation types to capture all four of these burn severities, with the exception of two conditions, unburned Jeffrey Pine and severely-burned Lodgepole Pine, which were rare on Conservancy property.

Table 1. Number of plots by burn severity and vegetation type on CTC property.

Vegetation Type	Unburned	Lightly Burned	Moderately Burned	Severely Burned
Jeffery pine	1	2	10	7
Lodgepole pine	2	2	2	1

Hand thinning, reseeding and mulching, salvage harvesting, and replanting are being implemented on these plots on CTC lands. In addition, 12 control plots were established on nearby USFS lands (see Table 2). These lands include another vegetation type, mixed conifer. USFS plots include severely burned mixed conifer stands, a moderately-burned Red Fir stand, as well as severe and moderately burned Jeffrey Pine stands.

Table 2. Number of plots by burn severity and vegetation type on USFS property.

Vegetation Type	Moderately Burned	Severely Burned
Jeffery pine	2	2
Mixed conifer	0	6
Red fir	1	0

Figure 5. Salvage harvesting on the CTC Mule Deer parcel, August 2007.

Other treatments will occur on USFS plots. Until treated, USFS vegetation plots will serve as no treatment control plots to compare with CTC plots.

The majority of field methods within the monitoring plan will be performed within the inventory plots, with others being utilized elsewhere as conditions deem appropriate.

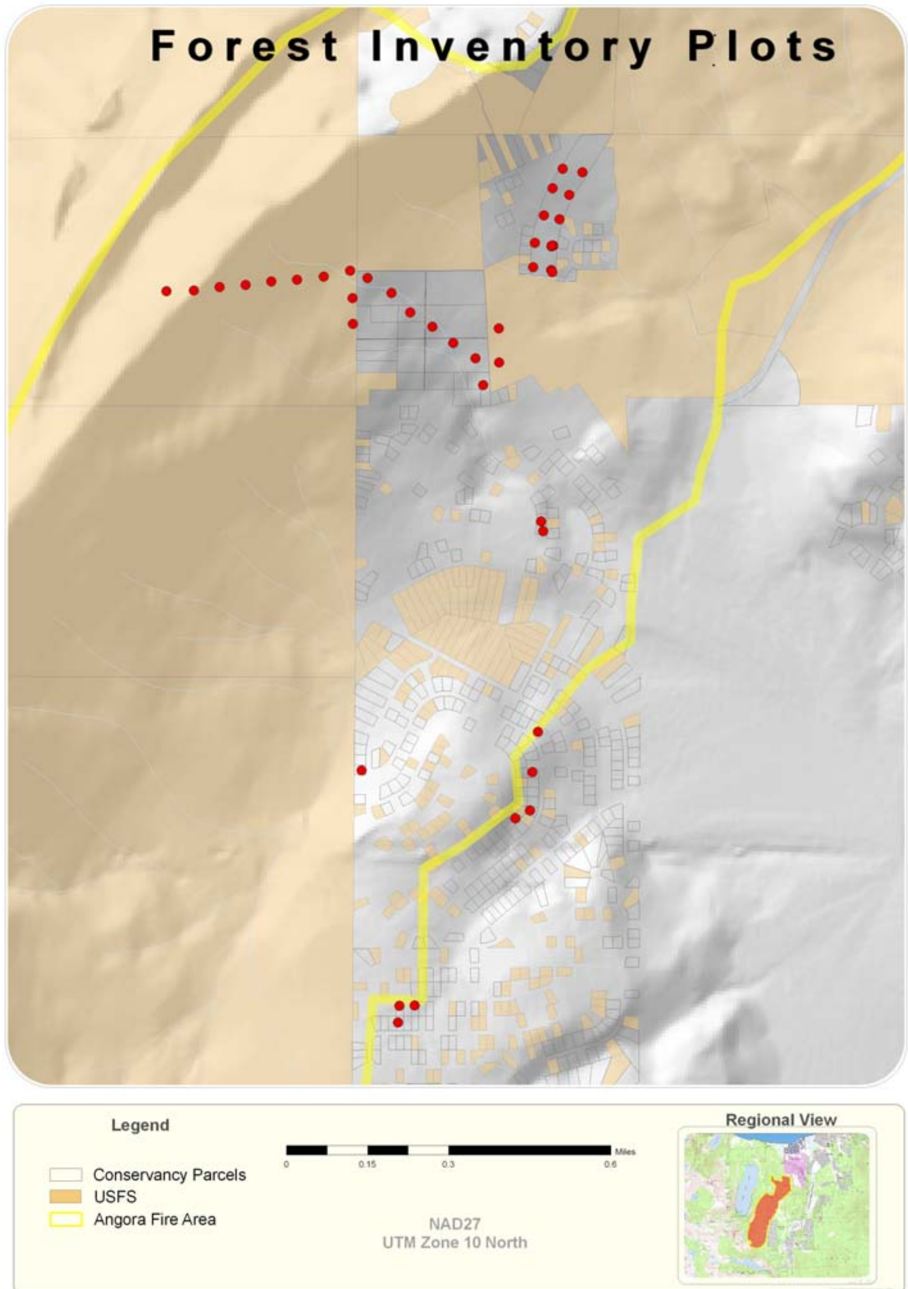

Figure 6. Location of Inventory Plots

RESTORATION MONITORING FIELD METHODS

The table below lists the parameters to be measured for each monitoring question, the field method to measure it and when, and the criteria for success against which the data will be measured.

DATA COLLECTION

Pre-project data were collected by a combination of CTC crews and UC Cooperative Extension personnel in the month of August. Collaboration with the USFS led to data collection on USFS lands during the last week of August 2007. Silt fences and erosion pin installations were accomplished in November 2007.

Table 3. Parameters and Field Methods to be Used for Each Monitoring Question

Monitoring Question	Parameters	Timing	Effectiveness Criteria	Field Methods
Did planted seedlings survive at an acceptable rate?	Number and vigor of surviving seedlings.	Immediately post planting, spring and fall for three years	-Seedling survival equals or exceeds 80 percent after 3 years.	Planted tree survival assessment (field method #4).
Did reseeding and mulching promote increased ground cover and desired species in the burned area?	Percent cover of native vegetation.	Late summer for three years	- Greater % cover of native species where seeded compared to not seeded. - 50% cover of native species in 2008	Line intercept transects across treatment areas comparing planting before mulch, after mulch and unplanted areas (field method #5).
Did hand fuels treatments accelerate forest stand development?	Number and size of trees	Pre- treatment, immediately post treatment, every two years.	More rapid modeled and observed recovery of forest conditions and reduced shrub cover compared with control.	Inventory plots (field method #1), use of Forest Vegetation Simulator (FVS) for predicted results.
Did hand fuels treatment reduce ground fuels accumulation and associated fire risk on forested parcels?	Tons per acre by size class, decay class.	Pre- treatment, immediately post treatment, every two years thereafter.	Modeled flame lengths of less than 4 ft., rate of spread less than 400ft. per hour (using FVS Fire and Fuels Extension).	Brown's fuel transects (field method #2), two per 1/100th acre plot
Did post fire salvage logging accelerate forest stand development?	Number and size of trees	Pre- treatment, immediately post treatment, every two years	More rapid modeled and observed recovery of forest conditions and reduced shrub cover compared with control.	Inventory plots (field method #1), use of Forest Vegetation Simulator (FVS)for predicted results.
Did post fire salvage logging reduce ground fuels accumulation and associated fire risk on forested parcels?	Tons per acre by size class, decay class.	Pre- treatment, immediately post treatment, every two years thereafter	Modeled flame lengths of less than 4 ft., rate of spread less than 400ft. per hour (using FVS Fire and Fuels Extension).	Brown's fuel transects (field method #2), two per 1/100th acre plot
Did post fire salvage logging impact soil quality?	Soil strength Moisture content	Pre- treatment, immediately post treatment, spring and fall for 5 years.	No significant increase in soil strength where heavy equipment was used compared with the control	Soil strength measurements, 20 per 1/100th acre plot (field method #3), Soil moisture measurements, 1 per plot.
Did erosion control practices minimize soil erosion from burned areas?	Soil volume leaving site	Immediately post treatment, post storm, and 5 post winter seasons.	50% decrease in captured sediment volume over predicted, unmitigated sediment flux following fire.	Silt fences (field method #6), erosion pins (field method #7), channel longitudinal profile (field method #8).
How were invasive species populations affected by the fire?	Incidence and cover of invasive species	Pre-treatment, post treatment and for three seasons	Identification and treatment of invasive species in the fire area	Weed surveys and treatments (field method #9)

Figure 7: Plot inventory data collection on CTC Mule Deer parcel, August 2007.

DATA STORAGE AND ANALYSIS

All plot and fuels data was entered into an Excel spreadsheet by CTC to check for completeness. Data was then distributed to the USFS and UCCE, and stored at CTC for further analysis. This will include comparison of pre and post treatment conditions for effectiveness judgments as well as use of the USDA Forest Service-developed Forest Vegetation Simulator (FVS) for modeling future conditions. As data is collected each subsequent field season, it will be stored in CTC files and analyzed in the same manner.

DATA QUALITY

This protocol and field methods are intended for use by agency staff or practitioners who are trained in vegetation and riparian sampling methods. There are data quality objectives inherent to the field methods presented here. Generally, a goal of between-observer variability of plus or minus 10 percent in measurements is desirable. Bias will be minimized through the use of standards and training. Quality control will be achieved through a combination of: 1) initial training, 2) repeat surveys by independent surveyors, and 3) follow-up training.

WORK PLAN

Pre-treatment data collection was completed in fall of 2007 prior to the application of various treatments to the properties. Where treatment was completed, tree and stand attributes that may have been affected by the treatment (tree status, canopy cover, presence of a regeneration cohort, and soil compaction) were re-measured. Due to time constraints and the likelihood that no significant change in fuels will occur over the winter period, fuel transects were not re-measured in the fall. In the Spring and Summer of 2008, the remainder of first-round post-treatment data will be collected, following completion of restoration treatments. Also in 2008, the first round of planted tree survival assessments will be performed for those trees planted in fall 2007, vegetation line-intercept transects will be installed to measure the success of seeding and mulching projects, and fuel transects will be re-measured to detect initial changes in post-treatment fuel loading.

Scheduled data collection and analysis and estimated work hours over the first ten years of the Plan are outlined below. A detailed list of costs of the first three years is provided in the Angora Fire Monitoring Plan Costs Summary, Appendix A.

Monitoring Activity	Estimated Person Hours
Data Collection and storage, spring/summer 2007 • Pre-treatment inventory plot measurement • Post-treatment plot measurement where treatment completed • Pre-treatment and some post-treatment soil compaction measurements • Set up of silt fences and erosion pins • Cover and channel longitudinal profile measurement • Invasive weed survey and treatment	**500**
Data handling, fall/winter 2007/2008 • Data entry and initial analysis • Possible measurement of soil movement at silt fences and erosion pins	**150**
Data collection and storage, spring/summer 2008 • Post-treatment measurement of plots treated in 2008 • Post-treatment fuel transects • Continuation of post-treatment soil compaction monitoring • Planted tree survival assessment for those planted in 2007 • Ground cover transects to assess seeding/mulching done in 2007 • Measurement of soil movement/accumulation at silt fences and erosion pins • Cover and channel longitudinal profile measurement • Invasive weed survey and treatment	**390**
Data handling, fall/winter 2008/2009 • Data entry and analysis • Possible measurement of soil movement at silt fences and erosion pins • Initial reporting of monitoring results	**150**
Data collection and storage, spring/summer 2009 • Re-measurement of soil compaction • Planted tree survival assessment to assess all planted seedlings • Ground cover transects to re-assess seeding/mulching done in 2007 • Measurement of soil movement/accumulation at silt fences and erosion pins.	**350**
Data analysis, Fall 2009 • Final analysis and write-up for final report of monitoring findings for the funded period. Report to be delivered Winter 2009/2010	

DATA REPORTING

An update of the data and findings of this monitoring plan will be produced each winter, beginning in January 2009. The report will detail data collected to date, any results from analyses performed, including that based on observed and modeled data, and future directions for data collection and analysis. This Monitoring Plan has been created with the process of Adaptive Management in mind, meaning that procedures may be amended throughout the execution of the Plan in light of new information gleaned from the data and procedures themselves. Any amendments to the Plan will be included in the appropriate annual report.

FIELD METHODS

Field Method#1: Forest Inventory Plots

The field method used to collect forest inventory data is based on the University of California, Berkeley's Blodgett Forest Research Station Forest Inventory Guide and the Common Stand Exam (CSE) method developed by the USFS (http://www.fs.fed.us/emc/nris/products/fsveg/index.shtml) CSE includes three different levels of data collection intensity, 1) quick plots, 2) extensive, and 3) intensive. Data collected for this project used the intensive level.

LOCATION: Plot locations were chosen based vegetation type and fire severity, so that each combination of vegetation type (Jeffery Pine or Lodgepole Pine) and severity (severe, moderate, light, or unburned) was represented by a number of plots. Those plots on larger CTC parcels were established 4-chains apart along a transect, offsetting the plot location directly west or east to 40' inside the project boundary when necessary. Plots on smaller parcels were located to enable an entire plot within the parcel, and were started in a random location. All plots are circular and 1/10-acre in diameter.

In order to ensure relocation of plot center, three witness trees were established. An aluminum nail with its head spray painted RED was driven into the base of the tree, facing plot center. The distance (in 1/10ft) and azimuth (in deg.) from the plot center to the head of the nail was measured and recorded. Witness trees were chosen based on maximum triangulation, tree size, and nearness to plot center. Other permanent markers were monumented when appropriate trees could not be found.

Instructions for Completing Plot Inventory Data Form

<u>PLOT DATA</u>

A. Plot #: Provide a project name and sequential plot # (i.e. BM01 for Boulder Mountain project area, first plot). A Plot ID tag containing the plot # is temporarily located on tree #1, until a permanent plot center can be established, at which point a tag will be fastened to a secure pole at plot center.

B. UTM: Collect this data by recording a GPS point at plot center.

C. SLOPE: Measure uphill and downhill with a clinometer to the nearest 1%, and record the average, ex: 9, 22.
D. ELEV: elevation to the nearest 10' from a map ex: 4350, 4500 or from a GPS file.
E. ASPECT: Record this to the nearest degree using a compass bearing.
F. POSITION: Slope position code (topo maps may be helpful)

- **B**ottomland; low gradient area near bottom of slope
- **L**ower 1/3 of slope
- **M**iddle 1/3 of slope
- **U**pper 1/3 of slope
- **R**idge top; within 200' of a major ridge top

G. CANOPY: Measure canopy density using a sight tube. Take 5 shots, at 3 pace intervals from plot center, in forming a 5x5 point grid for a total of 25 shots. Multiply the number of hits by 4 to get % canopy cover. Ex: 16 hits = 16 x 4 = 64%
H. DATE: Month/Day/Year
I. CREW: First and last initial of crew members
G. TIME: Time taken to complete plot
H. COMMENT**:** comments on plot location, plot center stake/identifier location, key features, plot relocation, etc.

<u>TREE AND SNAG DATA</u>
A. TREE OR SNAG #: Number trees and snags of measurable size sequentially starting with north and continuing in a clockwise direction. If a tree forks below breast height, count it as 2 trees.
Trees >4.5dbh within 1/10 acre plot: nail aluminum tag @ base of tree, facing plot center.
Snags: dead trees >4.5" DBH and >4.5' tall. If the living tree had a number, use the same number.
B. STATUS:

- L= live (Some green foliage or buds remain)
- D= dead (snag)
- S= stump
- X= dead on ground
- Y= live on ground

C. SPECIES: Two- letter code consisting of common name initials. Ex. Jeffrey Pine=JP
D. DBH: Measured at breast height (4.5ft) on uphill side of tree to nearest 0.1"
E. HEIGHT: Tree or snag height to nearest foot on uphill side.
F. HTLCB (Height to live crown base): Height to base of current live foliage
G. P-HTLCB (Previous height to live crown base): Estimate the height to base of live foliage pre-fire.
H. CLASS (Crown Class):

- **P**reDominant: Tree much older than the main stand; residual from a previous stand.
- **D**ominant: Receives direct light from top and sides for most of the day; crown above the main canopy.
- **C**odominant: Receives direct light from above and sometimes the sides; crown in the upper canopy.
- **I**ntermediate: Light from above only; most of the crown is in the main canopy.
- **S**uppressed: Only indirect light; crown is below the main canopy level; slow growing.

Understory: Below the main canopy; may or may not receive direct light, trees much younger than the above crown class; not a suppressed tree.

I. DAMAGE: Damage Codes as follows:

10- Insect Damage
19- General Diseases
21- Root/Butt Diseases
22- Stem Decays/Cankers
25- Foliage Diseases
30- Fire
71- Harvest
99- Physical Damage

(the comment field may be used to describe specific defects)

J. SCORCH: Measure the greatest height of scorch on tree trunk in feet.

K. REMOVE: Indicate whether or not the tree is marked for removal (yes/no).

M. COMMENTS: Any useful comment about a tree (i.e. joined with another, a witness, growth or site tree, etc.)

STUMP AND SAPLING TALLIES

A. Stumps: Record diameter (measure largest and smallest diameter across top; average) and species for each stump in the entire 1/10th acre plot.

B. Saplings: Within the entire 1/10th acre plot, tally all saplings greater than 4.5' tall and less than 4.5" DBH by height class (4.5-10', 10-20', >20') and DBH class (0-2", 2-4.5") using the table provided.

GROUND VEGETATION AND REGENERATION DATA

Record the following for each vegetation class (Live shrubs, Burned shrubs, Forbs, Graminoids):

A. % COVER: for each category to the nearest 5%. An area 5' x 5' = 0%; 20' x 20' = 10%. Ex: 0, 10

B. HT.: average height of the species to the nearest 0.5'. Ex: 0.2' = 0, 2.3' = 2.5

(For each category in which no vegetation is present, leave the field blank, as zeros indicate any presence of less than 2.5%)

C. REGENERATION TALLY: Tally seedlings (<4.5' tall and >2 years old) on the 1/100 acre subplot (11.8' radius) by species and height class (<1', 1-3', 3-4.5').

GROWTH SAMPLE AND SITE TREES

A. GROWTH SAMPLE TREES: Age, radial or height growth increment, and height are measured. If only one tree species is expected to be present in the stand, two growth sample trees will be measured on each plot. Measure the first live standing tree encountered when moving clockwise from north, and the tree closest to exactly opposite that tree, across the plot.

If more than one tree species is expected to be present in the stand, two growth trees for each species will be measured on each plot, in the same manner as described above. Do not select the radial growth trees until you have tallied ALL trees on a plot, both the large and small trees. This will insure that you do not skip the trees greater than 3 inches DBH that may be found on the small tree plot and which may be one of the first trees from Due North required to be a growth tree.

If age cannot be determined due to rot, select the next tree as growth tree. If the tree has a missing or dead top, select the next tree as a growth tree.

a. Trees >3"DBH: Measure radial growth for the last 10 years in 1/10in
b. Trees <3"DBH: Measure height growth for the last 5 years (count whorls) to nearest 1/10in.

Note: During pre-treatment data collection, due to the difficulty of coring burned trees and the lack of sufficient equipment, in some places only one large growth tree was measured per plot. No small growth trees were measured (no height growth increment values taken) because there were no smaller trees with sufficient branches to count 5-years growth.

B. SITE TREES: One site tree for each species on each plot will be chosen (or for every 2 plots if close together and similar in site characteristics. Height and age are measured.

a. select trees that are free from damage and suppression
b. preferably middle-aged

PHOTOS

A. Photos**:** Take photos from plot center, facing due north, south, east and west. Back up 10 ft from plot center before taking photo. Take photo completely zoomed out. Within frame, include a board with photo name, consisting of plot name and direction in which the photo is taken (i.e. BM01 N) and the date, or make sure you have another way of identifying the photo when downloading it.

Inventory plots were established and measured post-fire and prior to any restoration treatment in the 2007 field season. Those treated in the 2007 field season have been re-visited, and those not yet treated will be re-visited in 2008. Subsequently, plots will be measured every to years to detect changes in forest structure and composition, and to determine the success of treatments in accelerating the re-development of a forested condition. Success will be defined by the more rapid re-development of a forested condition in both observed and modeled (Forest Vegetation Simulator) conditions on treated parcels compared with a control (no treatment).

INVENTORY PLOT DATA FORM (page 1)

PLOT#		SLOPE		ASPECT		CANOPY		CREW				*SAPLING TALLY*				*SAPLING T
UTM		ELEV		POSITION		DATE		TIME			Spp:				Spp:	
												DBH				DBH
PLOT COMMENT:											HEIGHT	0-2"	2-4.5"		HEIGHT	0-2"
											4.5-10'				4.5-10'	
WITNESS TREES											10-20'				10-20'	
DISTANCE											>20'				>20'	
AZIMUTH																
DESCRIPTION																
TREE, SNAG AND STUMP INVENTORY DATA															*STUMP TALLY*	
TREE, SNAG															DIAMETER/SPP	
OR STUMP#	STATUS	SPECIES	DBH	HEIGHT	HTLCB	P-HTLCB	CLASS	DAMAGE	SCORCH	REMOVE	COMMENTS					
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
FUEL TRANSECT																
	(0-6ft)	(0-6ft)	(0-10ft)	(depth)--->							(with decay class)					
AZIMUTH	O to .24"	.25 - .99	1" - 3"	1ftDUFF	1ftLITR	3ftDUFF	3ftLITR	1ftFUEL	2ftFUEL	3ftFUEL	>3"FUEL	>3"FUEL	>3"FUEL	>3"FUEL		
SHRUB & FORB DATA																
TYPE		LS	DS	GM	FB			LS=LIVE SHRUB			GM=GRAMANOID					
%COVER								DS=DEAD SHRUB			FB=FORB					
HT.																
REGENERATION TALLY			(for saplings <4.5' tall within 100th acre (11.7ft) of plot center)													
SPP.	<1'	1-3'	3-4.5'													
SITE AND GROWTH TREES								1 GROWTH TREE PER PLOT								
TREE#	SPP	S OR G	AGE	HEIGHT	R-GRW				1 SITE TREE EVERY 2-3 PLOTS							

Page 2

TREE, SNAG																
OR STUMP#	**STATUS**	**SPECIES**	**DBH**	**HEIGHT**	**HTLCB**	**P-HTLCB**	**CLASS**	**DAMAGE**	**SCORCH**	**REMOVE**	**COMMENTS**					
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Field Method #2: Fuels Transects

Figure 8. Examining the number of downed woody pieces on a fuel transect. August 2007.

The field method used to characterize fuel loading on CTC inventory plots is described in the Handbook for Inventorying Downed Woody Material, by James K. Brown, a USDA Forest Service publication. The Log Decomposition Classes were taken from FSH 2509.18 - Soil Management Handbook, R5 Supplement # 2509.18-95-1. The following is a summary of the procedure.

LOCATION: Within an inventory plot, randomly pick one of the two lines running along the slope contour from plot center. Record the azimuth of this line and one of the two lines (also randomly chosen) 60° from it. These are your 2 fuel transects.

Instructions for Completing Fuels Transect Data Form

AZIMUTH: Ex: 252 and 312, 349 and 49

0 to 3" Fuel: Run a tape from plot center to 37.2' along each of the azimuths above. Use a go-no-go gauge with 0.25" & 1" openings, and a 3" edge to record the number of downed woody pieces (twigs, branches, logs) intersecting the transect from the ground to a maximum height of 6'. Pieces must be severed from the original source of growth and their central axes must be above the duff layer. Do not count needles, grass, bark or cones.

0 to .25": number of particles up to than .25" diameter from plot center to 6'.
.25 to 1": number of particles between .25" and 1" diameter from plot center to 6'.
1" to 3: number of particles between 1" and 3" diameter from plot center to 10'.

Duff and **Litter**: Use a trowel to expose 2 vertical planes, at 36.2' and 34.2' (1 and 3 ft from the end of the transect), of duff and litter, down to the mineral soil. If a tree or stump occurs at 34.2' or 36.2', offset 1' to the right. Measure the depths of the duff (visibly decomposing organic material) and litter (freshly fallen needles, leaves, bark, cones, and twigs) layers with a ruler to the nearest 0.1".

36.2', **35.2'**, and **34.2' FUEL**: At 36.2', 35.2', and 34.2' (1, 2 and 3 feet from the end of the transect) measure, to the nearest 0.1", from the bottom of the litter layer to the highest dead particle (not to exceed 72") intersecting a 1' wide vertical plane perpendicular to the transect. Fuel particles must be severed from the original source of growth.

>3"FUEL: Enter decomposition code and size, to the nearest 1", of each piece of wood greater than 3" diameter from plot center to 37.2' that crosses the transect. Do not count stumps. Record decomposition class first. ex: A6 (very solid 6" diameter), C4 (decayed but holding form 4" diameter) .

A = Fresh, hard logs or branches with bark and many branches intact.
B = Hard logs with few branches, but most bark intact.
C = Intact, soft logs; no branches or bark.
D = Intact to fractured cubical wood and bark.
E = Fractured cubical wood.

Fuel measurements were taken following the Angora fire, previous to any restoration treatment. Re-measurement has or will take place post-treatment, and subsequently every two years. The Fire and Fuels Extension of the USDA Forest Service growth model, Forest Vegetation Simulator, will be used to simulate fire behavior. Treatments will be deemed effective in reducing fuels accumulation and associated fire risk if modeled (FVS Fire and Fuels Extension) flame lengths do not exceed 4 feet and rate of spread does not exceed 400 feet per hour under 90^{th} percentile fire weather conditions.

Fuel Transect Data Form
(use Plot Inventory Data Form above)

Field Method #3: Soil Compaction Measurements

Soil compaction data was collected using a Rimik CP-20 recording soil penetrometer, which measures soil strength. Measurements were taken at five points within each 1/10th acre inventory plot, including plot center, plot north (37.2 feet due north from plot center), plot east, plot south, and plot west. Three readings were taken at each point.

Readings that overloaded the penetrometer were discarded. The sequence of point readings, including those discarded was kept in a notebook in order to identify the exact location of each reading during the data download process.

Figure 9. Using the recording soil penetrometer to measure soil strength.

After all data was recorded, it was downloaded onto a laptop computer for further data processing.

Soil moisture measurements were also taken in order to provide a context for soil strength measurements, as soil strength is greatly influenced by soil moisture. This was done by collecting a 2" soil sample between 2 and 4 inches depth using a slide hammer. This sample was weighed, dried, and weighed once again to determine the soil moisture content.

These measurements were also taken on inventory plots where hand crews were used for tree removal, to serve as a control.

Soil strength and moisture measurements will be re-taken during the spring and fall (wet and dry seasons) for 5 years following the use of heavy equipment. Salvage logging treatments will be considered successful in avoiding significant impacts to soil if there is no significant increase in soil strength on salvage harvested plots compared with hand treated plots after five years.

Field Method #4: Planted Tree Survival Assessments

Survey techniques for evaluating the survival of planted trees are well established (Stein 1992). The method recommended here is appropriate for evaluating treatment areas with a relatively uniform distribution of single stem seedlings. This method is not appropriate for projects where seedlings are planted in single lines, randomly or in clumps. For those projects, it would be necessary to flag or otherwise identify planted seedlings in order to track survival.

Figure 10. Volunteer planting Jeffrey pine on Forest Stewardship Day, September 30th, 2007

For evaluating survival of shrub and/or herbaceous plantings, other methods are required. Line intercept methods are recommended to evaluate survival of vegetative clumps or shrubs within delineated treatment areas. For plantings involving grasses or other small, individual plants, point intercept methods may be more appropriate.

LOCATION: If the treatment area is less than 30 acres, two percent of the area should be sampled. In any event, a minimum of 5 sample plots should be surveyed. If the treatment area is less than 0.25 acre, all seedlings should be counted.

- Determine locations of sample plots within the project area. The plots need to be equally distributed. First, divide the number of acres in the project area by the number of plots that will be surveyed. This will give the portion of an acre that each plot represents. Multiply this number times the square feet in one acre: 43,560. Then calculate the square root of the result to provide a value in lineal feet. This will be the distance between lines and between plots on the line.
- After the distance between plots and lines has been determined, these lines and plot locations are drawn onto the appropriately scaled map. All lines must be parallel to each other and the first line should be inset from the treatment boundary by one half the calculated distance between plots and lines (147.5/2 = 73.8 feet). After drawing the grid on the map, determine the distance and bearing to the first plot from a recognizable reference point. After locating the plot center, measure out a distance of 11.4 feet due north. Search the plot in a clockwise direction for seedlings until arriving back at the due north starting point of your search. For every seedling within 11.4 feet of plot center record *species* and *vigor class* (live, dead, or dying). Record any observations regarding obvious causes of

death (browsing, desiccation, competition, etc.) or other relevant observations in the comments section for the plot, not for each seedling.

These data may be used to calculate: average number of trees per acre by species across all plots, percent of live versus dead seedlings observed and percent of plots with at least one live seedling. A confidence interval of survival rate at each site can be computed (if the treated area is less than 0.25 acres then the survival rate is known).

Instructions for Completing the Planted Tree Survival Assessment Data Form

PLOT DATA

1) **Plot Name—**Enter in the name of the plot.
2) **Date—**Enter the date: *mm/dd/yy*
3) **Implementation—**Enter the month and year that implementation of the project feature being evaluated is scheduled for or was completed*: mm/yy*.
4) **Crew—**Enter the names of the survey crew in the following format: *last name, first initial*.
5) **Start Point—**Describe the location at which the survey began, using permanent reference points.
6) **Survey Direction**—Circle the direction of travel taken by surveyors during data collection, if applicable.
7) **Species—**Enter the species of the seedlings found on the plot.
8) **Vigor—**Enter all possible vigor classes for seedlings of each species, live, poor health and dead.
9) **Tally**—For each species and vigor class, enter the number of seedlings found on that plot as a dot tally.
10) **Comments**—Enter any pertinent comments on the seedlings found in that plot.

Each property on which seedlings are planted will be a project area, so that all planted areas are surveyed. This field method will be applied to project areas planted to conifer seedlings in the Angora fire area twice annually, during the spring and fall, for three years beginning in 2008. Efficacy of planting treatments will be declared if seedling survival exceeds 80% at three years.

PLANTED TREE SURVIVAL ASSESSMENT DATA COLLECTION FORM

Contract #:__________ Date *(mm/dd/yy)* **:__________ Implementation** *(mm/yy)* **:_______________**
Stream:_____________________________ Drainage:____________________________________
Crew: ________________________________ Polygon #/Location:___________________________
Start Time:__________ Start Point:____
Streambank: (*Left* or *Right*) **Direction:** *(Upstream* or *Downstream)* **Page______ of** ________

Plot #	Species	Vigor	Tally	Comments

Vigor Class = Live, Dead, Poor health

Species Codes

Field Method #5: Line Intercept Transects

Line intercept transects are intended for monitoring changes in vegetation due to seeding a treatment area, most likely an urban parcel. If individual plants have been planted, use the seedling survival field method instead. It is assumed that generally, this method will be used to assess effectiveness of reseeding. Consequently, the parameter of greatest interest will be vegetation cover as a proportion of total transect length. This will be equivalent to percent vegetation cover within the treatment parcel. In a study assessing effectiveness of practices across many sites or regions, each transect would be a sample and an estimate of the mean difference in condition before and after treatment on treated and control sites. A paired single-sided *t*-test will be used for statistical comparison.

LOCATION: The recommended procedure is to place multiple transects perpendicular to the slope. The summed transect length represents the sample. The number of transects to be used to obtain an adequate sample will depend on the length and variability of treated and control areas. Generally, evaluation of effectiveness in reducing or increasing cover within the treatment unit should only be done on a parcel scale. The use of paired observations tends to reduce the variance thereby reducing the required sample needed to detect differences (Dixon and Massey 1969).

- Establish the first transect in a random location. The location of each transect should be recorded in relation to a defined reference point.
- Describe and/or monument the starting point for the transect. Multiple monuments may be needed to ensure relocating the point in the future. Tie this point into other monitoring activities if possible. It is essential that the starting point be identifiable in the future
- From the monumented starting point, establish the line intercept transect.

Instructions for Completing the Line Intercept Data Form

- Walk along the transect and record (in feet and/or inches, to the nearest 0.5 foot) by each shrub or plant species (or genus if species is not identifiable) within three height class categories (less than 3 feet, 3 to 15 feet, and over 15 feet). Record interception by herbaceous cover (if >10 percent; barren otherwise), litter, or rock, where vegetation is not present. Estimate the average plant height only for the portion of the plant intercepted by the tape. If the tape crosses the entire plant then average the height for the entire plant (A). If the tape only crosses a portion of the plant, estimate the average height for only the part that is intercepted (B).
- As required, relocate the tape to the opposite bank and repeat the data collection process.

This field method will be employed late in the summer for three years, beginning in 2008. Efficacy of seeding and mulching treatments will be declared in the presence of at least 50% cover of native species.

Field Method # 6: Monitoring Silt Fences

Figure 11. Installation of monitoring silt fences on CTC Mule Deer parcel

Sediment Capture

Geotextile sediment traps have been installed in order to capture all sediment eroded from a defined contributing area. The fences are designed to capture sediment while allowing water to pass through. They are roughly three feet tall and supported by rebar and a wire fence backing. A second layer of geotextile fabric is attached about halfway down the main fence layer, and the excess fabric is spread out along the ground surface and the last 6 inches or so is buried at a right angle to the ground surface. This second layer spread out along the ground surface allows for accurate collection of deposited sediment, as all sediment above this layer can be easily collected and measured.

As one of the greatest sources of error associated with this method of sediment capture is overtopping of the fence by large sediment loads (MacDonald, et al 2006) a second fence is constructed behind the first to capture any access sediment. TheTraps are set up within a stream zone, where sediment eroding from a hillslope will be funneled, and the contributing area (swale) can be most simply defined.

Contributing Area Delineation

It is important to delineate the area contributing sediment to the traps in order to accurately quantify the amount of sediment delivery per area. This is accomplished by using a GPS unit to map the boundary of the area that topography dictates as contributing sediment to the traps. GIS is then used to quantify the contributing area.

Ground Cover

Ground cover is quantified within the contributing area so that a relationship may be determined between erosion and the character of the ground surface. Cover is assessed using at least five lateral transects, evenly spaced across the contributing area. Sample points are systematically placed along the transects so that a total of at least 100 points are assessed. At each point, ground cover is characterized as bare soil, live vegetation, downed wood, litter, tree, or rock.

Precipitation

Precipitation must also be measured as it can be a major contributing factor to erosion. In the area in which this monitoring plan is being implemented, precipitation will be less of a contributing factor because the majority of precipitation falls as snow. Therefore, precipitation will be measured when it falls as rain, but the occurrences expected to lead to most erosion events will be rain-on-snow events and spring melting of the snowpack. Precipitation data measured at a nearby station will be contributed by the County of El Dorado’s Transportation Department.

Collection and Analysis

Data will be collected following any rain events, any rain-on-snow events, and throughout the period of snowpack melt. Following an event that leads to sediment deposition at the traps, all sediment will be removed and weighed. The dry weight of the soil will be determined by measuring the soil moisture content. The sediment removed from the trap is placed into a pile and thoroughly mixed. A sample of the soil is taken with a trowel, measuring 1-2kg. The moisture content of this sample is determined by weighing the sample, drying it at 105 degrees Celsius for 24 hours, and weighing the dry sample. The percent moisture of the sample is then applied to the whole of the sediment captured, yielding an accurate dry weight.

A particle size analysis will also be performed to determine what portion of the deposited sediment is made up of fine sediment, the size class of greatest concern to Lake Tahoe’s tributaries. This analysis will be done at a qualified lab.

The total sediment load and the fine sediment load will be compared to the expected annual sediment load for the site in the absence of fire, and the expected sediment load following a catastrophic fire in the absence of erosion control measures. The criteria for declaring the erosion control measures taken in the contributing area to be effective will be a 50% reduction in the unmitigated increase in sediment yield expected following a fire. Measurements will be taken following any significant rain or snowmelt events for 5 years following treatment.

Field Method #7: Erosion Pins

Erosion pins are an effective and efficient way to make estimates of erosion rates and sediment movement across a broad area, and can be used to measure the relative effectiveness of different erosion control techniques in minimizing these events (Weaver and Harris, 2005). In order to compare the relative effectiveness of the application of one type of ground cover (straw, compost, bare ground) to another, a sample of each area is taken (ex: 100ft x 100ft). The sample area should be sufficient to capture all of the conditions within the treatment area, while a buffer may be allowed for on either side of the study area to minimize the influence of other conditions outside of the treatment area. Within each sample area, 30 plated steel erosion pins are installed, each 1 foot long and 3/16” in diameter. Pins are typically less than .25 inch diameter and between 6 and 18 inches long, installed on a grid developed as follows. The slope is divided into five sections, each representing 20% of the slope. A row of pins is installed at the mid line of each of these sections (in the 100ft x 100ft study area example, at 10, 30, 50, 70, and 90 feet). Each row contains 6 pins, also equally-spaced along each of the 5 lines.

Figure 12. Measuring sediment deposition around erosion pins

If a rock or other obstruction prevents installation of a pin at the pre-determined location, the pin is offset and the location noted. Each pin is driven into the ground perpendicular to the slope and the aboveground portion is measured on the downhill side (each pin may be marked at a set distance from the top to aid in easy installation).

Upon installation, the slope position, slope azimuth, slope, and percent slope at each pin location are recorded, along with a characterization of the location, such as the presence of any obstructions, lack of cover, etc.

Pins should be re-measured on the same side as previously done following any significant rain or snowmelt events throughout the first wet season and at the end of the first wet season. Measurements will be repeated following each wet season for 5 years.

In the Angora fire area, a site was selected on which half of a hillslope was covered in straw, and the other half in compost. This field method is being employed in order to compare the relative efficacy of straw versus compost in reducing erosion rates. Compost is being considered as an increasingly-employed means of erosion control, and its efficacy will be tested against that of straw, a more commonly-used ground cover.

Field Method #8: Channel Longitudinal Profiles

This method involves the use of a simple auto-level survey to document changes in the channel bed (profile) on the CTC's Mule Deer parcel. Surveyed longitudinal profiles are a technique for monitoring channel incision, head cut migration, or aggradation of channel beds. In this case, the longitudinal profile is being used monitor to the response of the channel to upland activities including wildfire and post wildfire rehabilitation treatments. The basic question that will be addressed with longitudinal profile surveys is: Did the fire and rehabilitation project cause upstream or downstream incision? If so, how large was the effect and how long did it persist?

Figure 13. Measuring the longitudinal profile of the channel draining the Mule Deer Parcel, October, 2007.

Profiles used for monitoring require a certain level of accuracy, precision and repeatability. All the requisite elements of a proper survey apply, including the establishment of horizontal and vertical control. Monumented endpoints (upstream and downstream) should be established outside the expected area of change so that subsequent surveys will have common, unchanged points against which topographic changes can be compared. One or more additional reference points should also be surveyed to tie all survey points together to a common relative elevation benchmark.

The profiles will be surveyed down the thalweg. All major slope breaks, such as head-cuts, nick-points, and other significant features should be included. Local base level controls should be identified during the survey and on plots of longitudinal profiles. These include local bedrock outcrops and other resistant materials that are likely to affect channel incision.

Assuming use of an auto-level, a tape measure will be strung down the channel thalweg to locate long profile stations, usually starting at the upstream end (Harrelson et al. 1994). First, pound a stake into the streambed or gully thalweg at the starting point. Attach a tape measure (≥100 feet) to the thalweg stake and unwind the tape along the thalweg. Pound additional stakes into the streambed at intervals sufficient to allow the tape to remain suspended over the wetted channel width as the tape is strung from stake to stake. This procedure will be repeated for as many tape lengths as necessary to complete the longitudinal channel survey.

An auto level is used to read relative elevations from the rod. Elevations are read at locations determined by channel bed topography, but not less frequently than every two feet along the tape measure. All elevations are relative to the fixed benchmark.

After setting up the stakes and tape measure down the channel thalweg, elevation is recorded using standard differential leveling techniques (Harrelson et al. 1994). The person holding the stadia rod (Rod Operator, RO) will call out to the person recording the data the distance along the tape measure (long station) for each place the rod is positioned along with any other survey notes (tributary junctions, structure locations, habitat unit breaks, etc.). The elevation and location of significant grade breaks should also be measured as they are encountered. The elevations and positions of head cuts are particularly important for calculations of erosion rates.

Instructions for Completing the Longitudinal Profile Data Form

General Information- section 1

1) **Date-** Enter the date: *mm/dd/yy*
2) **Drainage Name -** Enter the name of the main drainage basin that the stream is a tributary to.
3) **Crew-** Enter the names of the survey crew in the following format: *last name*, *first initial*, *task (rod or level).*
4) **Profile Length**- Enter the total length of the completed transect.
5) **Page ___ of ____**- Number the page. For example, if this is page 2 out of 3 total pages, enter: Page 2 of 3.
6) **Start Time -** At the beginning of each transect, enter the time in military time notation: *hh:mm* (24 hour clock).
7) **Start Point-** Describe the location at which the survey began, using permanent reference points.
8) **Survey Direction**- Circle the direction of travel taken by surveyors during data collection, if applicable.
9) **Datum/Coordinate System –** Specify the vertical datum of the survey or coordinate system (Arbitrary US feet or meters, NAD83, California State Plane, etc.).

Longitudinal Data – section 2

10) **Station #**- Enter the distance from the left cross-section endpoint where the elevation measurement is recorded. All cross-sections start at 0 on the left bank side and end at the right bank end point. Enter the “TP#” for turning points.
11) **Offset –** Enter the number of feet/meters to the right or left of the tape or centerline.
12) **BS- Back Sight** is a rod reading taken on point of known or assigned elevation, this reading is entered as a positive value. Enter stadia readings for back sightings to benchmarks or turning points.
13) **HI – Height of Instrument** is the elevation of the line of sight projected by the instrument. This is calculated by adding the rod reading from the back sight to the known (or assumed) elevation at that point, typically a benchmark (EL + BS = HI).
14) **FS – Foresight** is a rod reading taken on any point to determine its elevation. The algebraic sign for the foresight is negative (-) since the FS is subtracted from the HI to find the ground elevation of the point in question.

15) **Elevation –** is the actual elevation of the point in question. Enter the known benchmark elevation or enter the calculated survey point elevation
(El. = HI – FS).

16) **Comments –** Enter all relevant descriptions for benchmarks and locations, survey points, start or end of survey, and rod heights for total station surveys.

Longitudinal Profile Data Form

(Opposite page)

LONGITUDINAL PROFILE FIELD DATA COLLECTION FORM

Contract #:__________ **Date** *(mm/dd/yy)* **:**__________ **Implementation** *(mm/yy)* **:**_____________
Stream:______________________________ **Drainage:**___________________________________
Crew: _________________________________ **Profile length:**_________ **Page**___ **of** ____
Start Time:__________ **Start Point:**____
Direction: *(Upstream* or *Downstream)* **Datum/Coordinate System**:________________________

Benchmark Location: _________________________ **Diagram:**
____
____
____
____
____

Station#	Offset	(+) BS	HI	(-) FS	Elevation	Comments

Field Method #9: Invasive Weed Surveys

During the summer of 2008, pedestrian surveys were performed to identify populations of invasive weeds on all CTC lands affected by the Angora fire. Inventory and treatment is being completed by invasive weed program staff at the Tahoe Resource Conservation District.

All identified populations will be mapped and eradicated at the time of detection or shortly after. A second round of pedestrian surveys and control will be completed during the summer of 2009. Eradication of new populations by hand treatment or chemical application, depending on the species is done at the time of discovery.

Locations of discovered populations will be mapped according to the protocol established by the Lake Tahoe Basin Weed Coordinating Group.

- All infestations of less than 0.01 acres (436 square feet, or about 20.9 feet x 20.9 feet) should be mapped as single points. Assign an estimated acreage to the infestation. Whenever possible, provide the approximate length and width in feet.
- All infestations greater than 0.01 acres should be mapped as polygons or lines.
- If multiple species coexist at the same site, map each as a separate infestation.
- Whenever possible, map parcels separately.
- Revisit and remap infestations from previous years to document changes.
- Provide all data to Conservancy and the El Dorado County Agriculture Department no later than October of each year

Record the following data when mapping:

1. Date
2. Plant common name
3. Plant code (First 2 letters of genus and first 2 letters of species; see Table 4)
4. Latitude and longitude (use your existing datum; provide the projection when reporting the data)
5. Line width (if applicable) based on greatest width infested
6. Age of infestation – new or historic (mapped during previous years)
7. Size of infestation, in units of feet, for point infestations
8. Density (assign a specific percent cover using the attached graphic as a guide; base density on canopy cover)
9. Number of plants (if infestation is small enough to count the plants)

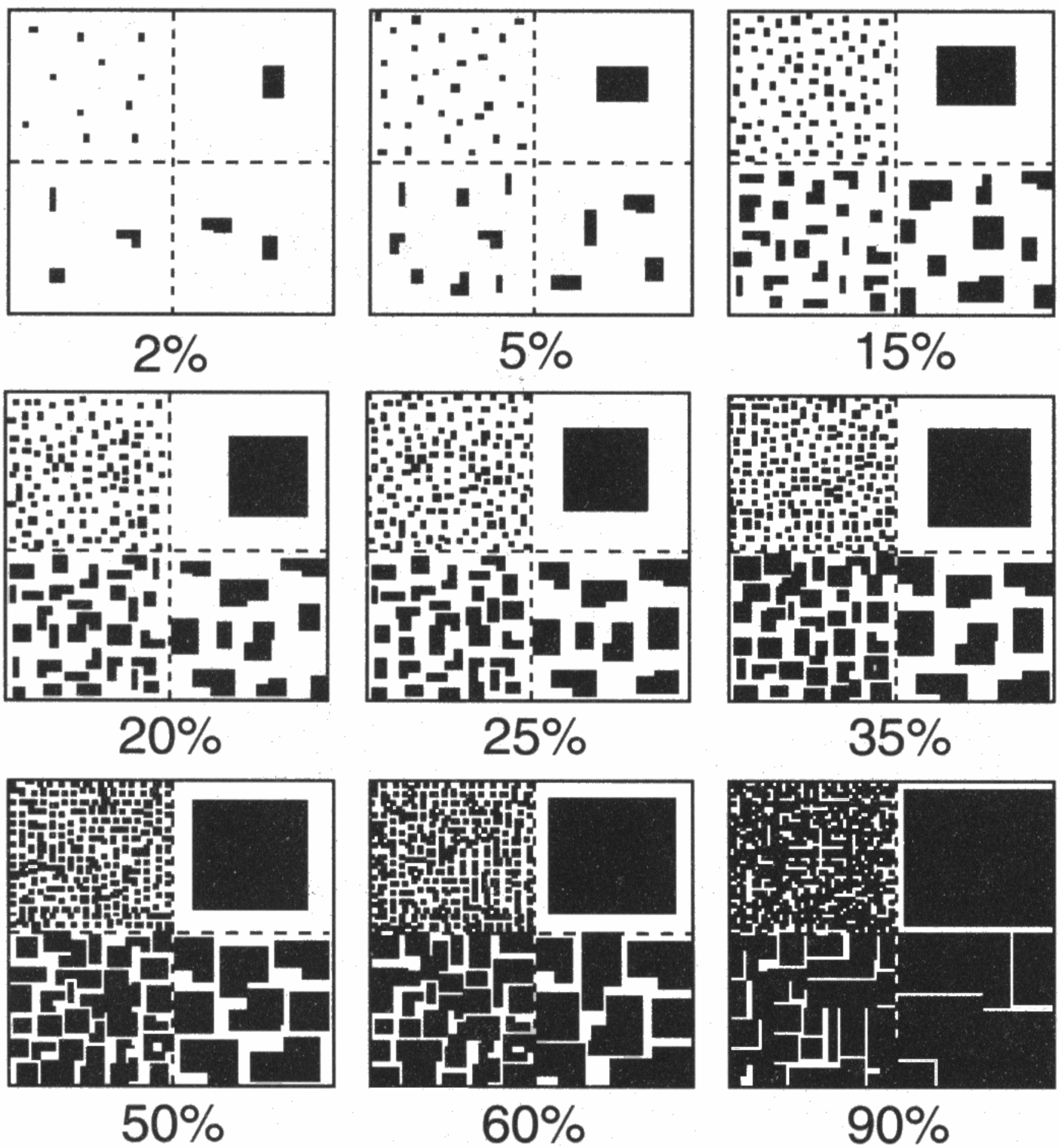
The following data is also very useful, but not required:

10. Growth stage
11. Distance to water (>/< 25 feet)
12. Disturbance type
13. Street address or other description of site location

Table 4. Invasive Weed Plant Codes for Mapping

Common name	Scientific name	Code
Thistles		
Bull thistle	*Cirsium vulgare*	CIVU
Canada thistle	*Cirsium arvense*	CIAR
Musk thistle	*Carduus nutans*	CANU
Scotch thistle	*Onopordum acantium*	ONAC
Knapweeds		
Diffuse knapweed	*Centaurea diffusa*	CEDI
Purple starthistle	*Centaurea calcitrapa*	CECA
Russian knapweed	*Acroptilon repens*	ACRE
Spotted knapweed	*Centaurea maculosa*	CEMA
Squarrose knapweed	*Centaurea virgata Lam. ssp. squarrosa*	CEVI
Yellow starthistle	*Centaurea solstitialis*	CESO
Mustards		
Perennial pepperweed (tall whitetop)	*Lepidium latifolium*	LELA
Hoary cress	*Cardaria draba*	CADR
Miscellaneous		
Sulfur cinquefoil	*Potentilla recta*	PORE
Klamathweed	*Hypericum perforatum*	HYPE
Teasel	*Dipsacus fullonum*	DIFU
Ornamentals		
Dalmatian toadflax	*Linaria genistifolia spp. Dalmatica*	LIGE
Yellow toadflax	*Linaria vulgaris*	LIVU
Oxeye daisy	*Chrysanthemum leucanthemum*	CHLE
Scotch broom	*Cytisus scoparius*	CYSC
Aquatics		
Eurasian watermilfoil	*Myriophyllum spicatum*	MYSP
Curlyleaf pondweed	*Potamogeton crispus*	POCR

Estimating plant density:



HISTORY OF PROTOCOL DEVELOPMENT AND REVISION

This protocol was initially developed in July, 2007, directly following the adoption of the California Tahoe Conservancy's Angora Fire Resource Assessment and Restoration Plan. Those field methods deemed most appropriate for answering the effectiveness questions were chosen. No major modifications were made to the field methods following initial field testing in 2007. Further field testing will occur in the subsequent ten years, and future revisions may be made.

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