STANDARDIZED PROCEDURES FOR ESTABLISHING PERMANENT PINE PLOTS AND EVALUATING POLLUTION INJURY ON PINES

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Standardized Procedure for Establishing and Evaluating Permanent Biological Monitoring Plots of Pine Species on National Park Lands

OBJECTIVE

The objective of this procedure is to employ standard methods for determining the severity of gaseous pollutant injury to pines on National Park Service lands. These methods are designed to produce information that will provide a current assessment of the status of pollution injury, as well as a baseline for future comparison.

METHODS

Survey for Plots

Procedures described for these evaluations are patterned after ozone surveys performed by R-5 Forest Pest Management, U.S. Forest Service (Pronos et al., 1978), Division of Forest Disease Research, PSW Forest and Range Experiment Station, U.S.F.S (Miller, 1973), Resources Management Division, Sequoia and Kings Canyon National Parks (Wallner and Fong, 1982) and Usher and Williams (1982). The study is initiated by determining potential plots, systematically locating points on 1:125,000 topographic maps where roads or trails intersect countour lines within the elevational limits of the species to be evaluated. Alternately, potential plots can be randomly chosen from a grid of the area to be surveyed. Potential plots can then be transferred to 15' quadrangle U.S.G.S. topographic maps and compared with quadrangle maps of major vegetation zones. Plots that are located within vegetation zones not encompassing the desired pine species are eliminated and a second comparison with 4" = 1 mile vegetation type maps, if available, can further eliminate those sites with a low probability of containing the desired species. Of the potential plots initially identified, a lesser number will remain after the second screening.

Plot Establishment

Visit plots on the ground and consider plots valid if fifteen (15) pines of the desired species are found within two areas, each 20 meters by 120 meters, on each side of, and parallel to, a road, trail, or random point selected from a grid of the study area (Figure 1). Larger plot sizes are acceptable when utilizing a species at the limits of its elevational or latitudinal range. The near edge of each plot will be separated from the edge of the road or trail by a minimum of 10 meters. Plots established near major roads should be located at least 80 meters from the road. Trees on the plot should have a minimum diameter at breast height (dbh) of 10 cm (exceptions to dbh size are made for species of naturally small size and trees growing on harsh sites or in dense stands) and have, at a minimum, a pruneable live crown within 10 meters of the ground (this crown must be able to withstand repeated prunings over the years without affecting the vigor of the tree).

Symptom Evaluation

Pollutant symptoms (commonly ozone, sulfur dioxide or fluoride) are evaluated and rated by examining a minimum of five (5) branches from the lower, pruneable ($\leq$ 10 meters) crown of each tree. The scoring system is based on the total leaf area (upper surface) per annual whorl with pollution injury, the number and percentage of needle retention of whorls and the representative length of needles in the whorls (Table I and Data Sheets). Individual scores for each parameter are obtained for each whorl, each tree and each plot.

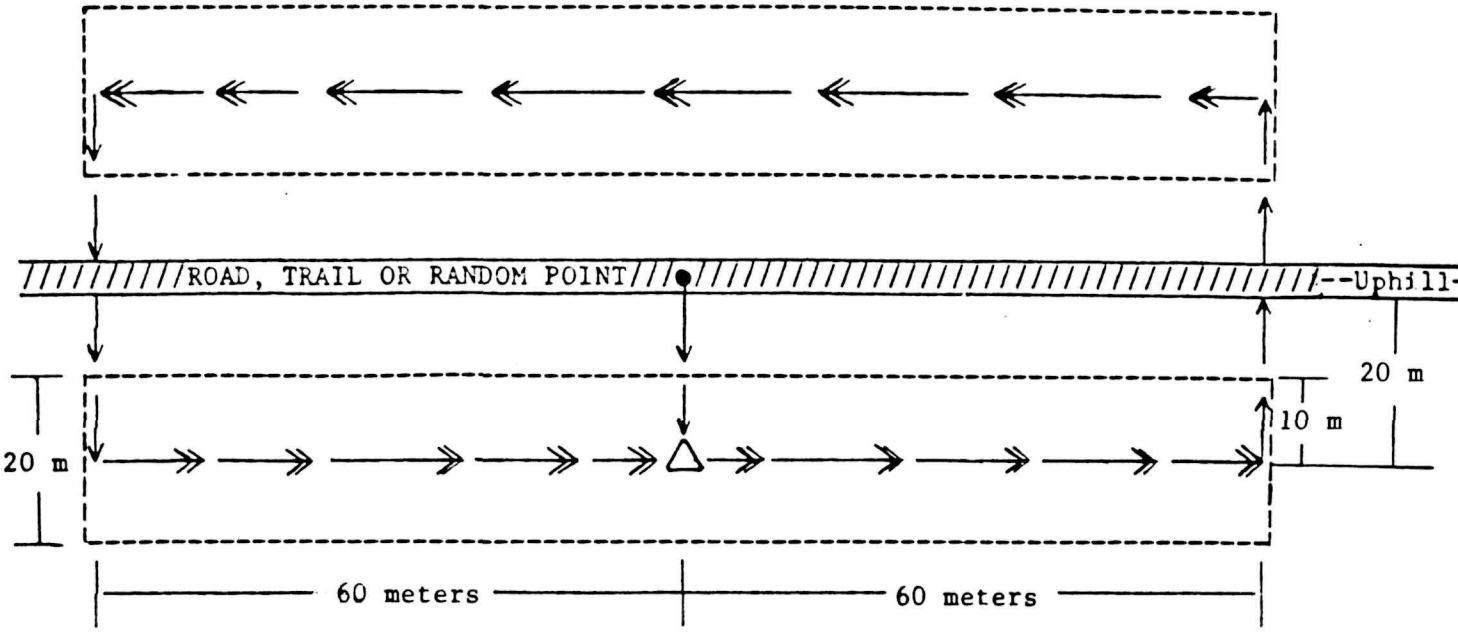
Other injury symptoms to needles or trees are also evaluated. Injury to needles is characterized by type (biotic or abiotic) and degree (percentage of leaf area per whorl with symptom). Record the percentage of each symptom (biotic or abiotic) seperately on the data sheet. Additionally for each 15-tree site, site characteristics such as slope, aspect, elevation, soil (type and depth), soil moisture (mesic to xeric) and associated species are recorded. Topographic locations, general area and site descriptions will also be recorded. Include as much detail as possible when describing each site to aid in relocation of sites at future dates.

Record symptoms and other growth parameters for each tree on the enclosed data sheet. Each sheet (double-sided) contains enough space for data from two trees. The summary sheet contains space to record data for the fifteenth tree, as well as a data block to record the average scores for all fifteen trees in the plot. For each plot seven data sheets and one summary page are required.

Plot Evaluation and Marking

Established plots are to be revisited at three year intervals, when possible, to ascertain ozone injury trends. More frequent (yearly) evaluations may be required after initial establishment to determine baseline trends. To facilitate future recognition of the plots, a tree adjacent to both the plot and the road or trail is identified by species, measured for dbh, described in detail (growth characteristics) and is marked with orange paint at its base, orange and white flagging, and an oval aluminum tag stating the plot number, the date it was established and the investigators' names or initials. In addition, individual trees in the plot are marked with sequentially numbered aluminum tags and are recorded on a map of the plot on the back of the summary data sheet. When plots are in dense vegetation or on unmaintained trails, plot trees should also be identified with orange paint at their bases and with orange and white striped flagging. The numbered tags are placed at dbh height (about 1.4 m) measured on the uphill side of the tree (for plots with a slope) or on the west side of the tree (for plots with no slope) and represent the point of measurement of tree diameters. Marking of plots and trees must be approved by park superintendents and resources managers. Alternate methods of marking plots and trees will be improvised if disagreement with park policy arises.

Figure 1. Diagram and method of establishment of pollution injury survey plots.



The starting point (●) is the intersection of predetermined contour intervals (e.g. 500 feet, 1000 foot, etc.) with a road or trail while facing the uphill portion of the road or trail. Alternately, the starting point can be randomly chosen from a grid of the study area. From the starting point the instructions are as follows:

1) Utilizing a compass, take a bearing of the road or trail while facing uphill. If working from a grid point, procede by taking a compass bearing perpendicular to the slope. Turn 90° to the right and measure 20 meters.

2) This is the beginning (△) of one transect line (⟶⟶). Now turn 90° left and measure 60 meters.

3) Turn 90° left and measure 40 meters (20 meters to road or trail, 20 meters beyond the opposite side of the road or trail).

4) Turn 90° left and measure 120 meters. This is the other transect line (⟵⟵).

5) Turn 90° left and measure 40 meters (20 meters to road or trail, 20 meters beyond the opposite side of the road or trail).

6) Turn 90° left and measure 60 meters to connnect with the beginning of the first transect line.

The sample areas are the 10 meter strips on each side of each 120 meter transect lines (dashed rectangles - 20 m by 120 m - Figure 1). There are two sample areas, one on each side of the road or trail. The first 15 pines (>10 cm dbh with pruneable lower crown) encountered within 10 m of each transect line (double arrows, Figure 1) constitute the sample trees for each plot.

Make sure the tree has a lower crown that can be pruned for this evaluation and for additional evaluations in the future. If the trees are on a slope, go to the upslope side of the tree and measure DBH, pulling the tape tight. At the point where you have measured DBH, attach an aluminum tree tag with a galvanized nail to the tree. It is at this point that future dbh determinations will be made to evaluate tree growth over time.

To evaluate the trees in the sample plot, clip five (5) randomly chosen branches (from different points around the tree) from the lower crown of each selected tree. If the lower crown can be evaluated without pruning, evaluate the branch without clipping it off. Starting with the newest foliage on the branch (current year's foliage = whorl 1), flatten the whorl in your hand and evaluate the condition of the foliage. Record the percentage of pollution-caused chlorosis and/or necrosis, and the percentage of the other injury categories (biotic or abiotic). Estimate the percentage of fascicles of needles retained in the whorl. Measure the length of needles in the center of the whorl. Each successively older whorl is evaluated in the same way (Figure 2). If more than ten (10) whorls are present on a branch, evaluate the whorls and record on the data sheet by putting a slash after 10 on whorl 10 and record the information in the appropriate columns in the same manner (e.g. whorl = 10/11/12, needle length = 16/18/19, etc.).

TABLE 1. EXPLANATION OF DATA SHEET

1.	Tree Number:	From 1-15.
2.	Tree Tag No.:	Sequential number on aluminum tag. Tag should be located at height where DBH is measured.
3.	DBH (cm):	Diameter at Breast Height. Measured at uphill (plots with a slope) or west (plots with no slope) side of tree.
4.	Branch No.:	One of five branches randomly sampled from lower, pruneable crown (<10 meters). Considered as a replication of whorls in analyses of variance.
5.	Whorl No.:	Annual whorl of needles. Current year whorl = 1; older whorls successively numbered.
6.	Pollutant Injury per Whorl:	Estimate of percentage of the total needle area [upper surface (-)] of whorl that is injured with pollution-caused chlorotic (chlorotic mottle, chlorotic banding, chlorosis) or necrotic (tip burn) symptoms. Estimate the percentage of each symptom separately. Tip necrosis (tip burn) of needles (particularly white pine) may be uniform if pollutant gases are the causal agent.
7.	Needle Length:	Representative length of needles (cm) in each whorl. Measure in the center of the whorl.
8.	Percent Whorl Retained:	Percentage of needle fascicles in each annual whorl retained on each branch. Abscissed fascicles usually leave abscission scars.
9.	Percent Other Injury:	Evaluate common non-pollutant injury symptoms by estimating the percentage of each symptom category (biotic or abiotic) of the total surface area of each whorl. Common non-pollutant injuries are winter/weather fleck, mechanical injury, and insect injury (chewing insects, piercing insects, scale, etc.). Combine and score injury as biotic (insect, fungal, etc.) or abiotic (weather fleck, wind, etc.).

% Chlorosis	40	30	10	00	00
% Necrosis	25	20	10	00	00
Branch #1					
Needle Length	19	19	18	17	11
% Retention	60	80	100	100	100

% Chlorosis	60	30	05	00
% Necrosis	20	20	10	00
Branch #2				
Needle Length	17	17	16	10
% Retention	10	60	95	100

% Chlorosis	70	60	10
% Necrosis	20	20	10
Branch #3			
Needle Length	13	10	06
% Retention	40	80	100

% Chlorosis	10	10	00	00	00
% Necrosis	10	05	00	00	00
Branch #4					
Needle Length	22	21	20	18	12
% Retention	85	90	100	100	100

% Chlorosis	60	40
% Necrosis	40	20
Branch #5		
Needle Length	10	06
% Retention	30	90

Figure 2. Sample of rating pollution injury on five branches of a pine tree (not to scale). Extreme variation in branch vigor does not reflect pollutant injury normally observed in the field on any one tree.

Plot Locator Tree (Species, DBH, Characteristics):

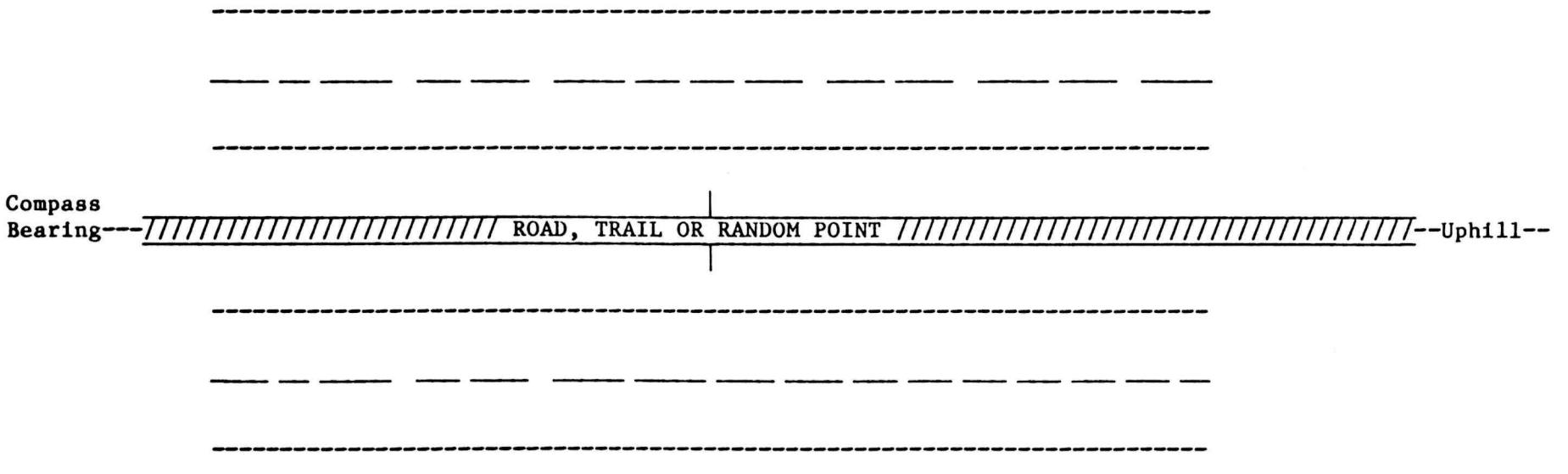
Site Characteristics:

Place Where Altimeter was Set:

Compass Bearing at Starting Point:

Investigators:

Comments:



NATIONAL PARK SERVICE - AIR QUALITY DIVISION - PERMANENT PINE PLOTS

COLLECTED BY:

DATE:

LAST EVALUATION:

SPECIES:

ASSOCIATED SPECIES:

SITE CONDITION:

SLOPE:

ASPECT:

ELEV. (FT.):

SOIL:

MOISTURE:

PLOT IDENTIFICATION:

NPS UNIT:

TOPO MAP:

MOUNTAIN:

AREA:

NUMBER:

TREE NO.	BRANCH NO.	WHORL NO.	% POLLUTION INJURY ON EACH WHORL		NEEDLE LENGTH (cm)	% WHORL RET.	% OTHER INJURY	
			CHLOROSIS	TIP BURN			BIOTIC	ABIOTIC
	1	1						
		2						
		3						
		4						
		5						
		6						
		7						
		8						
		9						
		10						
TREE TAG #	2	1						
		2						
		3						
		4						
		5						
		6						
		7						
		8						
		9						
		10						
DBH (cm)	3	1						
		2						
		3						
		4						
		5						
		6						
		7						
		8						
		9						
		10						
	4	1						
		2						
		3						
		4						
		5						
		6						
		7						
		8						
		9						
		10						
	5	1						
		2						
		3						
		4						
		5						
		6						
		7						
		8						
		9						
		10						