

CLARIFICATIONS AND MODIFICATIONS OF PROTOCOLS
FOR ESTABLISHING AND SAMPLING HEMLOCK PERMANENT PLOTS
For Implementation at Delaware Water Gap NRA
10 June 1993

PERMANENT PLOT DATA

Stand Composition: Locating the BAF plot at tree #1 as suggested is problematic. Instead, a BAF plot will be centered at the midway point of the transect. If a tree blocks this point, the BAF center will be moved 1 meter to the right. No adjustments or compensations are made for nearby trees that block the view. Locating the BAF plot at the center of the plot will provide stand composition data which is more pertinent to the sampled hemlock trees than locating it at tree #1.

Trees and DBH: The length of the transect will parallel the topographic contour and run in the direction of the highest concentration of hemlocks. If both directions have about the same hemlock concentrations, the transect will run in the "upstream" direction of the local drainage. If a suitable transect cannot be made paralleling the topographic contour, then the transect will run in the direction of highest hemlock concentration.

The transect will comprise a rectangle 6 meters wide and of variable length to be measured from the "outer" edge of tree #1 to the "outer" edge of tree #10. Trees whose boles are only partly inside the rectangle will be considered IN if bordering the near side and OUT if bordering the far side of the rectangle. Trees bordering on the left and right sides of the rectangle will be considered IN or OUT on an alternating basis (see enclosed figure).

Radial Growth: This measurement will not be made; the data so obtained are not reliable or valuable enough to justify the injury to the trees and the effort involved.

Crown Position: This measurement will be added to the permanent plot data. Crown position describes a tree's position in relation to neighboring trees and will be rated as Open Grown, Dominant, Codominant, Intermediate, or Suppressed. Guidelines for this measurement are found in the U.S. Forest Service Crown Condition Rating Guide.

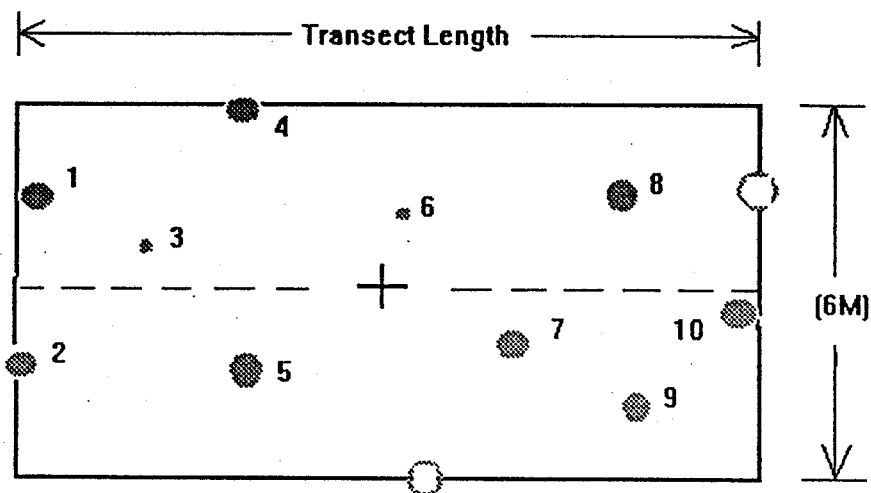
YEARLY PLOT DATA

Crown Diameter: Measurement will be made to the nearest 10 cm.

Dieback: Twigs with all brown needles will be counted as dieback. Twigs with yellow needles will not be counted as dieback.

Percent Defoliation: This measurement will not be made; changes in crown condition ratings over successive years will be tracked.

Damage: Six categories of damage will be included as yearly plot data. These categories, taken from the U.S. Forest Service Crown Rating Guide, Appendix III, are: General Discoloration of Foliage, Leaning Trunk, Open Wound, Broken, Conks & Fruiting Bodies, and Imbedded Foreign Objects.



● Trees included within the plot

○ Trees not included within the plot

⊕ BAF Center

Diagram of Plot Transect and Rectangle

REVISED PROTOCOLS FOR NEW GROWTH AND HWA DATA

6/13/96 Richard Evans

NOTE: Different protocols for counting HWA must be used at different times of year, as outlined below. Sampling from May through July is strongly recommended, for the following two reasons: (1) Data can be collected quickly, because HWA woolly masses and hemlock new growth are readily apparent. (2) HWA presence on a branch can be directly correlated with the new growth on the same branch. Sampling from August through April is less advantageous, for the following reasons: (1) HWA presence on a branch can not be directly correlated with the new growth on the same branch. [It is presumed that the spring generation of HWA (progrediens) affects new growth of the same year, but that fall-winter generation of HWA (sistens) affects new growth of the following year.] (2) From August through November, a hand lens ($\geq 5X$) must be used to search for early instar HWA. (3) From December through April, new growth is difficult to distinguish.

NEW GROWTH

Wherever possible, sample a single 12 inch branch on each of the 10 plot trees. If, for any plot tree, a branch is not within reach, sample the nearest hemlock tree outside of the plot which has a branch within reach. DO NOT CUT (or break) BRANCHES!

Terms (Terminals): Count and record the number of non-new growth terminals (do not count new growth terminals in this measurement). This is really the total number of terminals that were present on the branch before the new growth developed. See figure 1.

New (New growth): Determine whether or not each of the terminals counted above has new growth on it; count and record the number of those that have produced new growth. Include new cones as well as new shoots. Note that the number of terminals with new growth ("New") is a sub-set of the number of "Terms"; the number of "New" can not be greater than the number of "Terms." If all "Terms" have new growth, "New" will equal "Terms." See figure 1.

HWA

The same 12 inch branch examined for new growth (above) is examined for HWA. As noted above, do not cut (or break) branches!

MAY - JULY

+HWA (presence of adelgid): Count and record the number of non-new growth terminals ("Terms" as described above) that have HWA (woolly masses). Again, if all "Terms" have HWA, "+HWA" will equal "Terms." See figure 2.

-HWA (absence of adelgid): Count and record the number of non-new growth terminals ("Terms" as described above) that do not have HWA (woolly masses). Note that the sum of "+HWA" and "-HWA" must equal "Terms." See figure 2.

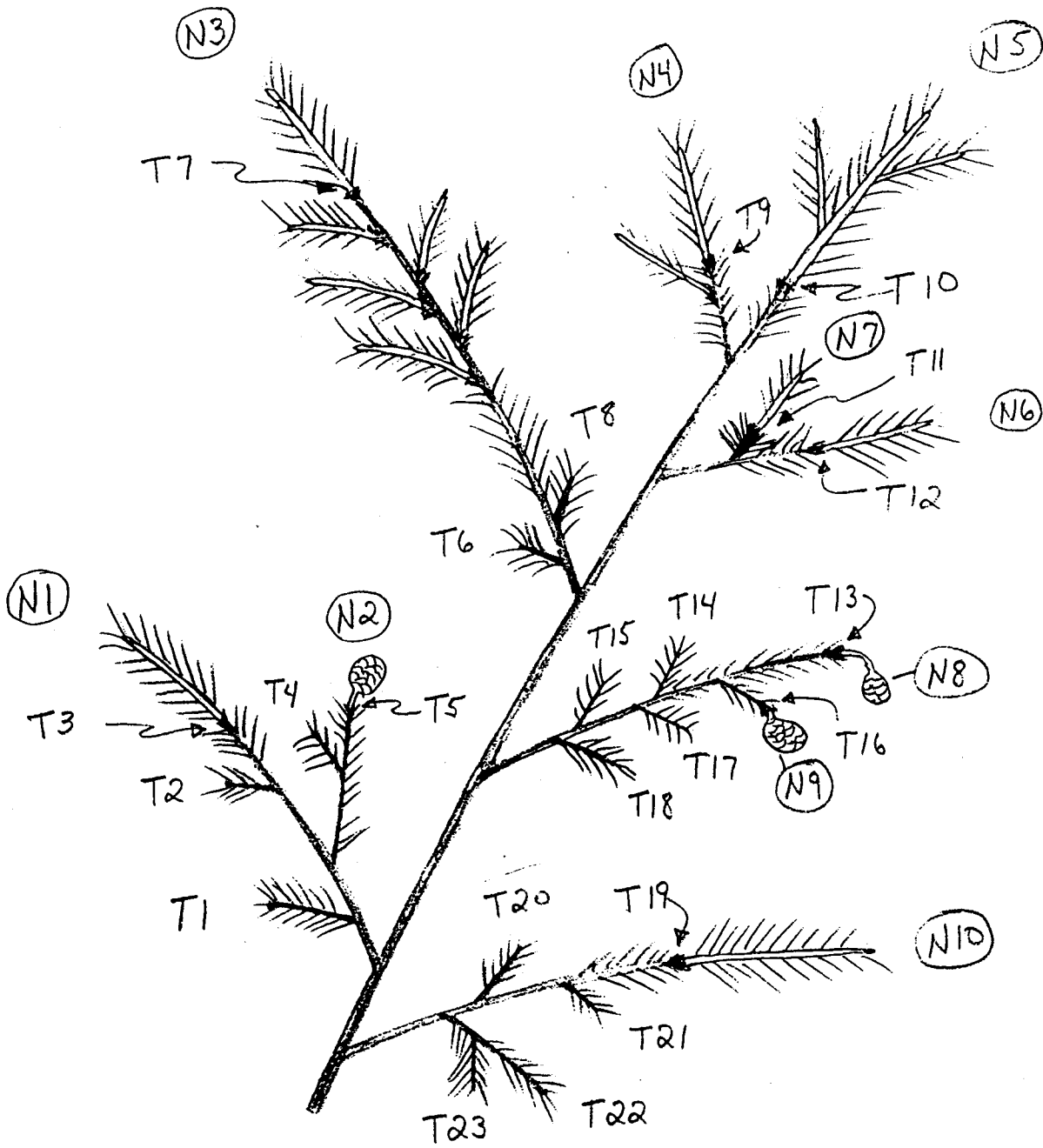


Figure 1. Terminals = 23; New Growth = 10.

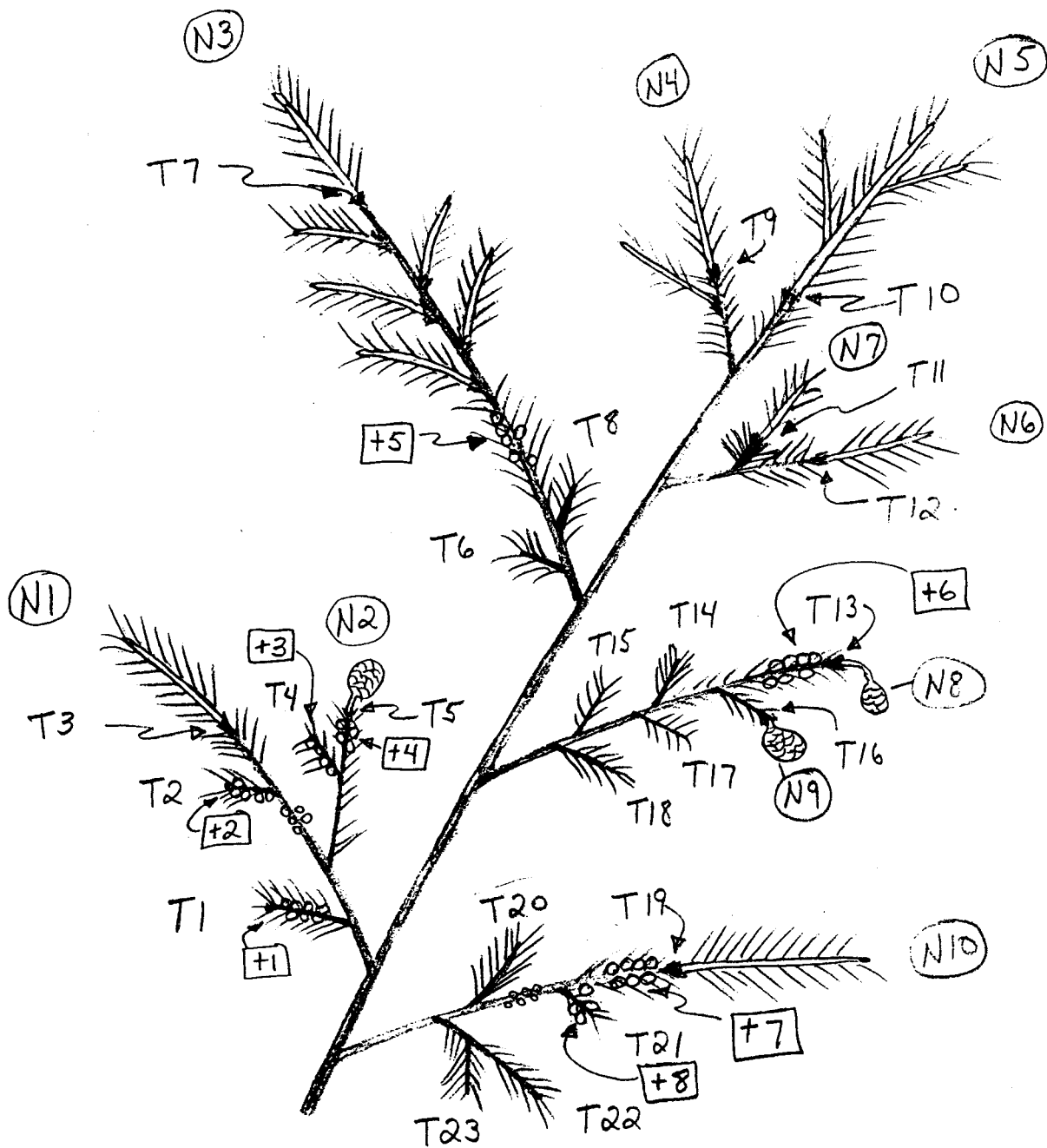


Figure 2. May - July HWA count.
 "+HWA" = 8 ; "-HWA" = 15.

Revised Sampling Protocol for Hemlock Woolly Adelgid (HWA)

Crown Ratings Variables

New Growth and HWA data

May 11 1998

Objective: To measure the effect HWA has on crown ratings and production of new growth from branch terminals through time. To measure this effect we need to follow the same trees and branch tips for several years. By following the same branch tips from trees we should be able to relate proportion of HWA presence to changes in new growth production and changes in crown ratings. Measurement of **terminals affected** will be presence of HWA on a terminal. The measurement of **new growth** will be the number of terminals that produce new growth. The reason we need to sample dominate and co-dominate trees for HWA effects is to be able to use this information in Forest Health monitoring analyses.

Plot setup for tree and branch selection:

Optimal plot: Five dominate or codominant trees which are used for crown ratings (CR) and have branch tips within reach. On three of these trees, permanently mark four terminals, one from each cardinal direction for tip sampling.

Realistic plot: We expect that on many dominant/codominant trees the lowest terminal branches will not be accessible for non-destructive sampling from the ground. We thus propose the following minimum standards: (a) choose 3 dominant/codominant trees for CR samples; (b) choose 3 trees which have branch tips in cardinal directions that can be reached and on each of these three trees, four terminals per tree will be permanently marked and sampled, one tip from each cardinal direction. This means that 6 trees/plot are sampled for CR variables each year allowing us to link crown ratings to adelgid and new growth on three of these same trees.

When establishing a plot take into consideration that two types of observations are going to be conducted: 1) Crown ratings 2) HWA effects on new growth. We need to use the same tree for both samples so HWA affects can be related to CR. If sample trees are not dominate or co-dominate they should be in close proximity to the ones that are and they should also be sampled for CR. All plot trees and tips should be marked so they can be relocated. The branch tips should be within reach and located at cardinal directions from the bole of the tree. Mark and number the branch tip twelve inches (30.5 cm) from its distal point with a twist tie or plastic cable tie. From the marked point toward the distal point you will be counting terminals and those that produce new growth each year. In subsequent years the branch tip should be longer than 12 inches. When marking branch tips, attach the marker loose enough that there is space for tip diameter growth in coming years.

Instructions for Forms #1, #2, and #3 are contained in the study plan that is dated September 1994.

Instruction for form #4

Tree Crown Data: The treed data recorded at each plot comes from the 5 trees which were selected for the permanent plot. Tree crowns are analyzed using the US Forest Service Crown Condition Rating Guide. (See the guide for more details).

D-1 (Diameter 1) is the width of the tree crown measured on the ground from the outermost branch tips and tangent to the tree bole taken along a North-South (0°) line. (Metric - cm)

D-2 (Diameter 2) is the width of the crown, measured perpendicular to D-1 and tangent to the tree bole. (Metric - cm)

Ratio (Live Crown Ratio) is the percent of total tree height that supports live foliage. (5 percent classes)

Dens (Foliage Density) is the amount of branches, foliage and reproductive structures that block light visibility through the crown, relative to a fully foliated crown. (5 percent classes)

Dbk (Dieback) is branch mortality that begins at the terminal portion of the upper branches and proceeds to the trunk. (5 percent classes)

Trans (Transparency) is the amount of skylight visible through the foliated portion of the crown or branch. The dead parts of the crown are excluded. (5 percent classes)

Defoliation other than HWA,. If there are other defoliating agents record as “yes” or “no”.

Cause If there is defoliation by an agent other than HWA then list the type.

Vigor 6 classes indicate crown health ranging from dead to healthy including;

DF (Dead, removed dropped) – tree has been sawed or girdled by humans;

DN (Dead, natural) – tree is still standing dead; phloem under bark has brown streaks;

SD (Severe decline) – more than half the crown with branch mortality, dieback, discoloration, or leaf dwarfing, but foliage still present indicating that the tree is alive;

MD (Moderate decline) – branch mortality, twig dieback, foliage discoloration or dwarfed leaves on 26-50% of crown;

LD (Light decline) – branch mortality, twig dieback, foliage discoloration, or dwarfed leaves present on 10-25% of the crown;

H (Healthy) – tree appears to be reasonably good health; less than 10% branch or twig mortality, discoloration, or dwarfed leaves present.

Damage: can fall into six categories as outlined in the Crown Condition Rating Guide:

F General discoloration of foliage

L Leaning trunk

W Open wound

B Broken stem or significant portion of branches in the crown

C Conks & fruiting bodies

I Imbedded foreign bodies

Instructions for Form #5

1) TREE NUMBER

Record the number of the tree from which the branch tip is collected, use the same tree and number as on form #4.

2) BRANCH TIP

We need twelve (12) branch tips per plot. Take no more than four (4) tips from one tree. Locate tips in cardinal directions. Permanently label each tip with its number (1,..., 12).

3) TERMINALS

Count and record the number of non-new growth terminals. This is the number of terminals that were present on the branch before new growth developed.

4) TERMINALS THAT PRODUCE NEW GROWTH

Determine whether or not each terminal counted above has new growth on it, count and record the number of terminals that actually produce new growth. The count **cannot** be larger than the number of terminals (#3).

5) +HWA

Count and record the number of terminal that have HWA present on them. This number can not be larger than the number of terminals.

NOTE: As mentioned in the revised sampling protocol of 6/13/96, and reiterated here, sampling of the Hemlock Woolly Adelgid should be done between late May and early July. It is during this time that new growth and HWA are easiest to measure.