

WATERSHED 10 (WS10) UPLANDS SUCCESSION PLOTS - SAMPLING METHODS

OVERVIEW and METHODS

Research Objective: To study the effects of clearcut logging *without* burning on plant succession, biomass, and nutrient pools.

Location and Access: Watershed 10 (WS10) is accessed from above by Road 134 (off the 130 Rd) and from below by Road 143 (off the 15 Rd). See Figure 1 (watershed map) and Table 1 (UTM coordinates of plots).

Logistics of Sampling:

- Sampling in WS10 should begin in mid- to late-June or early July.
- Optimal crew size is 2 people per plot.
- A two-person crew can measure one or two plots in a day.
- Equipment list shown in Table 2.

Site History: Old-growth and mature Douglas-fir forest were clearcut logged in 1975. Large slash was removed from the site rather than burned. Douglas-fir seedlings were planted in 1976 and 1977, but due to poor survival 4.9 ha were replanted in 1978. Despite planting, most tree stems originated naturally, either as sprouts from cut stumps (hardwoods) or as natural regeneration (conifers and hardwoods). Study plots were established and sampled prior to harvest (1973) and resampled annually from 1976-1981, then in 1983, 1985, 1989, 1993, 1998, 2004 and 2010. WS10 was intensively studied in the 1970's and 80's. The entire watershed was surveyed into a 25 x 25-m grid, with each grid corner staked and labeled; you may come across some of these grid markers, and if still labeled they can help pinpoint your location (see old map, Figure 2).

Study Design (see Figure 3): There are 35 plots in WS10 numbered 1-34 and 36 (plot #35 was dropped). Plots are 15 x 10 m, slope corrected, with the long axis parallel to the topographic contour. Each plot is comprised of two, 15 meter-long strips of 1 x 1-m quadrats along the upper (U) and lower (L) edges of the plot, for a total of 30 quadrats (microplots). The 15 x 8-m area between the two microplot strips is called the Macroplot (M).

Plot Relocation: The trail from the 143 Road is best for accessing plots 4, 11, 13, 14, 16, 19, 20, 25, 26, 27, 28 and 34. The other 23 plots are best accessed from Road 134 (see map). Before leaving vehicle, consult "Plot Access and Condition Notes" for plot-specific information. Locate the plot using a map, compass and GPS (see Table 1). Some plots are situated close together, so it is possible to confuse plot corners. Use tree tag numbers to plot identity. Find all four corner posts, marked with 2" diameter steel pipes, and *avoid walking in the 1-m wide belt that defines the microplots*. Hammer in any posts that are loose. If a post is missing or down, reestablish it from other posts using a clinometer, slope correction table (Table 3), and two 30-m tapes. Make note of any plot or corner reestablishment activities. If a post is not labeled, write the plot number and corner designation on a write-on tag (e.g., "WS10 Plot 3 LL" (LL = lower left)), and attach it tightly to the post with a zip tie. Flag each post with red and blue flagging.

Stretch one 30-m tape at a uniform height above ground between the posts on the uphill side of the plot and another 30-m tape between posts on the downhill side. Walk above the plot in establishing the upper line and below the plot in establishing the lower line to prevent trampling the vegetation in the microplots. For the upper line, the 0-meter mark on the tape should be at the *upper left* corner (facing uphill); for the lower line the 0-meter mark should be at the *lower right* corner.

The upper tape should run as close to the ground as possible and the lower tape should run at a height equal to the ground surface that marks the uphill edge of the lower (L) microplots. This will help in placing the

micrplot frame and minimize visual distortion when evaluating species cover. If the distance between corner posts is >15.20 m or <14.80 m, the last microplot should be situated according to the tape distance (not the corner post). If the discrepancy is <0.20 m, the tape should be loosened or tightened to produce a distance as close as possible to 15.00 m. For each plot, record the distance between posts to the nearest 0.01 m for the upper and lower lines in the space provided at the top of the **Cover Form**.

Microplot Establishment: There are 30 microplots in each plot. See Figure 2 for microplot positioning, coding and placement of the PVC frame. Two corners of the microplots are determined by dropping pin flags from the stretched meter tape. A third corner is determined by dropping a pin from the ends of poles held horizontally (i.e., same height as the tape) at 1.00 and 1.41 m from these corners. The fourth corner is determined by dropping a pin from the ends of horizontal poles held at 1.00 m from the third pin and 1.00 m from the pin beneath the meter tape. This last position can also be checked by triangulation.

WORK FLOW (described in detail in subsequent sections)

1. Enter plots from the side (to minimize disturbance to upper and lower microplots). Relocate corner posts and resurvey/reinstall any posts that are down or missing. Label each corner post with tag and zip tie if no tag is found.
2. Establish upper transect and 1 x 1 m microplots along **upper line, starting at upper left corner (0 m)**.
3. Do the daily "group plot" to corroborate correct species ID, identify new species, and compare measuring techniques and estimates.
4. Assess microplots on **Upper line (U)**
 - a. Even-numbered microplots (U0, U2, U4, U6, U8, U10, U12, U14)
 - i. Ground cover: estimate % cover of each type
 - ii. Growth forms: estimate % cover of each growth form
 - iii. Plant species: estimate % cover by species
 - iv. Biomass measurements for some herb and shrub species
 - v. Tree measurements (seedlings, saplings, hardwood sprouts, larger trees). Tree seedlings and saplings > 10 cm tall get tagged. Tree seedlings ≤ 10 cm tall get tallied on biomass form.
 - b. Odd-numbered microplots (U1, U3, U5, U7, U9, U11, U13)
 - i. Tree measurements (seedlings, saplings, sprouts, larger trees). Trees > 10 cm tall get tagged.
5. Establish 1 x 1 m microplots along **lower line, starting at lower right corner (0 m)**
6. Assess microplots on **Lower line (L)**
 - a. Even-numbered microplots (L0, L2, L4, L6, L8, L10, L12, L14)
 - i. Ground cover: estimate % cover of each type
 - ii. Growth forms: estimate % cover of each growth form
 - iii. Plant species: estimate % cover by species
 - iv. Biomass measurements for some herb and shrub species
 - v. Tree measurements (seedlings, saplings, hardwood sprouts, larger trees). Tree seedlings and saplings > 10 cm tall get tagged. Tree seedlings ≤ 10 cm tall get tallied on biomass form.
 - b. Odd-numbered microplots (L1, L3, L5, L7, L9, L11, L13)
 - i. Tree measurements (seedlings, saplings, sprouts and larger trees). Trees > 10 cm tall get tagged.
7. Document presence of additional plant species in the entire 15 x 10 m plot, including odd-numbered microplots (which were skipped in species cover and biomass measurements).
8. Measure trees in **Macroplot (M)**
 - a. Measure (and tag as necessary) trees and ingrowth ≥ 1.37 m tall in the 15 x 8 m macroplot area (i.e., between the microplot strips, since the trees are already done in those).

GROUND COVER AND SPECIES COVER (COVER FORM [TP4101])

At the beginning of each day, have team members independently evaluate a microplot, then compare and discuss what each person recorded. This is a good way to “calibrate” cover estimates and reinforce species identification among crew members.

As a guide to estimating percent cover within a 1 x 1-m microplot, consult the table equating area to cover (Table 4) and the resolution of cover estimates (Table 5). A trace of cover should be recorded as 0.1%.

Cover data are collected from a set of 16, 1 x 1 m microplots (8 along the upper line, **U**, and 8 along the lower line, **L**) (Figure 2). Cover data are collected **only from the even-numbered** microplots (0, 2, 4, 6, 8, 10, 12, 14) on each line (i.e., every other microplot). The microplot number corresponds to the starting distance on the tape line. The observer should stand down-slope from the microplot being read; never walk through a microplot. Begin data collection at the upper left microplot (U-0). Work left to right across the upper line before moving down to the lower right corner (L-0). Then work right to left across the lower line.

In each even-numbered microplot, estimate the percent cover of ground surface types:

- BARE = mineral soil
- LOG = wood >10 cm in the narrow dimension (any length) or chunks of wood/bark that create a 10-cm wide surface
- LITTER = foliage, needles, or wood ≤10 cm in the narrow dimension.
- STONE = rocks >7 cm wide (smaller stones that form a "pavement" also are considered stone)
- STUMP = stump of a tree that was cut
- TREEB = the base of a live or dead tree (only if >1% cover); species designation is not important

Generally, BARE + LOG + STONE + STUMP + TREEB + LITTER = 100% unless a LOG is elevated above a microplot in which case the total can exceed 100%. If plants cover the ground surface, the ground surface category for that area is assumed to be LITTER. Usually, the ground surface category with the greatest cover is estimated by difference. These categories are already listed on the first of the two Cover forms; the second form contains only blank spaces for plant species.

In each even-numbered microplot, estimate the total projected cover (in %) of each growth form (ignoring species). Growth forms are MOSS, LICHEN, HERB, TALL SHRUB, and TREE (max. = 100% for each group). Low-growing shrubs are included in the “herb” growth form for this assessment. These categories are pre-listed on the Cover forms. To determine which species are considered herbs, tall shrubs, and trees consult the **WS10 Species List** (separate document). Cover of MOSS/LICHEN should be estimated to a height of 1 m on logs or stumps. Because cover is estimated as a vertical projection, MOSS cover on the sides of logs or stumps is often low even when the surface area covered by MOSS is high.

Next, in each even-numbered microplot, estimate the projected % cover of each plant species (graminoid, herb, shrub, and tree) over the 1 x 1 m microplot area, regardless of whether the plant is rooted in or out of the microplot and regardless of its height (i.e., include canopy trees). Graminoids include grasses, sedges and rushes. A full list of species codes is provided in the **WS10 Species List**. Codes for species found in each plot during the previous sample (2010) are provided in the **WS10 Species Lists by Plot** (separate handout). If you encounter a species that is not present in the **WS10 Species List**, consult the USDA Plants Database: <http://plants.usda.gov/java/>

As you record each species (old or new), *write out its full name as well as its code*. This will allow us to correct erroneous acronyms. If a plant can only be identified to genus, record the first 5 letters of the genus; if only to family, record the first 6 letters of the family name. If a plant cannot be identified in the field, record it as

"UNKN#" (where # is a unique no. for the plot). Collect a specimen from outside the microplot and include a label in/on the bag with collector's name, date, and plot/microplot number. Note whether it is a monocot or a dicot and describe the morphology (e.g., "monocot seedlings, single leaf" or "grass with long awns"), and/or draw a picture on the data form.

After sampling all 16 even-numbered microplots, carefully search the entire 15 x 10 m plot, including the odd-numbered microplots, for any species not found in the even-numbered microplots. Add these to the **Cover Form Continuation Page**. For any species found during this search record "M" in the left-most (M) column to indicate that these were species found outside the even-numbered microplots. Record the full species name and code, but no cover value.

BIOMASS OF HERBS, SHRUBS AND SMALL TREE SEEDLINGS (BIOMASS FORM [TP4102])

For some species (particularly herbs) it is possible to estimate above-ground biomass from cover. For other species, additional measurements (e.g., basal diameter, stem length) are needed. See the full list in Table 6, **Biomass Parameters to Measure**. While sampling the cover plots, these species-specific biomass measurements (BV1 and BV2) should be recorded on the **Biomass Form**. Measurements are only needed for plants *rooted in* the 1 x 1 m microplot and *only those listed* on the **Biomass Parameters** sheet.

DBA (basal diameter)

Basal diameters are measured at the base of the stem above the root collar, but as close to the ground surface as possible (but see note below about beargrass (XETE) below). Measurements are to the nearest 0.1 cm. Herbaceous species that are not listed on this form do not require measurements other than cover. However, if a new graminoid species is found, modal (most common) height is required. If a new tall shrub species is found, basal diameter above the root collar is required for each stem rooted in the plot. If there are more than 6 measurements or pairs of measurements per species per microplot, record the microplot number, species code and biomass measures on the next line, making sure to increment the sequence number by one (sequence number = 1 for the first record of a species in a microplot).

The **Biomass Form** should also be used to record a *count of tree seedlings < 10 cm tall* by species and DBA. Seedling counts are done in **all microplots** (both even- and odd-numbered).

Height (stem length)

For all shrubs and a subset of herbs, stem length is needed to estimate biomass. Record either the modal height (ht) (the most common height in the microplot), or the individual height (i-ht) of a stem, as noted on the form **Biomass Parameters to Measure**. Measure *stem length* (rather height off the ground) because plants often grow at an angle to the slope. Units are in centimeters. Precision is to the nearest 1 cm for plants 0-1 m tall; to the nearest 10 cm for plants 1-2 m tall; and to the nearest 50 cm for plants >2 m tall.

Note about XETE biomass measurements: Gather the leaves into a tight bundle at their base and wrap a diameter strip or tape around the clump to measure "basal diameter" (dba) to the nearest 0.1 cm. Also record modal height of outstretched leaves to the nearest centimeter.

Note: Data on trees are recorded in all 30 microplots (both even- and odd-numbered microplots). Therefore, remember to collect tree data in odd-numbered microplots as you move between cover (even-numbered) microplots. See details below on sampling trees.

TREE MEASUREMENTS (TAGGED TREE AND INGROWTH FORMS [TP4103])

- Trees are sampled within the entire 15 x 10 m plot.
- Trees of all sizes (including seedlings ≥ 10 cm tall) are measured in *all 30 microplots* (i.e., across the entire 1-m wide strip at the top and bottom of each plot). (Note that tree seedlings < 10 cm tall are tallied on the Biomass data sheet (as explained above).
- In the remaining 15 x 8 m area (Macroplot) between the microplot strips, only measure stems ≥ 1.37 m tall (breast height).
- Breast height (1.37 m) on the tree is determined on the *side slope* (not up- or downslope of the tree).
- Trees must be rooted within the plot or microplot boundary to be considered for measurement.
- The **Tagged Trees Form** contains a list of all previously tagged stems, including those recorded dead or missing at the previous measurement (2010). There are separate data sheets for trees in the Macroplot (15 x 8 m area) and microplots.

TREES ≥ 1.37 m TALL IN THE ENTIRE 15 X 10 m PLOT, INCLUDING ALL 30 MICROPLOTS

The sampling procedure will vary depending on whether a tree ≥ 1.37 m tall has a tag or not, as explained below in Sections A, B and C.

A. CONIFERS OR HARDWOODS ≥ 1.37 m TALL WITH TAGS

Hardwood species include the following: *Acer macrophyllum* (ACMA3), *Alnus rubra* (ALRU2), *Chrysolepis chrysophylla* (CHCH7), *Cornus nuttallii* (CONU4), *Prunus emarginata* (PREM), *Populus balsamifera v. trichocarpa* (POBAT), and *Frangula purshiana* (FRPU7) (see **WS10 Species List**).

Tags that are nailed on: If the tag is nailed at breast height (1.37 m), the measurement point (**MP**) should be **H** (indicating breast height). Remeasure diameter of these trees just above the nail (using a dbh tape or dbh strip) and record the diameter in the **DBH** column. There should be 1-1½ inches of “growing space” between the bark and nail head. If there’s not enough growing space, use a pliers to snip the existing nail and reattach the tag with a new nail *at the same height*. Or, if the tree is large enough, use a block of wood or a branch to protect the tree from the hammer as you back the nail out of the tree – the bark of these small trees is too thin to withstand the damage.

- If a tag is being overgrown but the number can still be read, inscribe the tag # on a temporary (“write-on”) tag using a pencil and nail the temporary tag *at the same height* as the previous tag, then record “NNT” (“needs new tag”) in the comments.
- If the tag # cannot be read, determine the number using previous data on **Species, DBH, Near Tag #** and the old comment, then attach a temporary tag with the tag number and “NNT” in comments.
- **Temporary tags:** If a tree already has a temporary tag, there should be a permanent replacement tag for it (each plot should have a set of replacement tags). Again, nail the permanent tag *at the same height* as the previous tag.

Tags that are wired: If a tag is wired on a side branch, **MP = B** (basal diameter). Remeasure the tree at the base but above any butt swell, using a dbh tape, dbh strip, or caliper, and record the diameter in the **DBA** column. If, **MP** is listed as **H**, this is incorrect - measure the basal diameter and note the MP error in the comments (e.g., “MP=B”). If a wire is brittle, replace it with a new wire or a cable/zip tie. **However**, if the tag is wired but the tree is now *large enough* to handle a nail (≥ 5 cm dbh), attach the tag at 1.37 m above the ground on the side slope and then take **both** a basal diameter (**DBA**) and a breast-height diameter (**DBH**).

Trees without tags: If there is not a tag on a tree ≥ 1.37 m, see **Section B** below.

Other data to record: For all stems in the Macroplot (**M**), record the following additional information:

- The tag # of a large, adjacent tree in the **Near Tag#** column if there is not one given or the number listed is not appropriate (e.g., the near tree has died or is not really very close) .
- Overall vigor (**OV**): **1** = good; **2** = fair (browning needles, loss of branches or foliage, poor growth-form induced by injury), and **3** = very bad (likely dying).
- Status: **1**=alive, **3**=fused with another tree and measured as one, **6**=dead, or **9**=missing.
- Additional comments: Note any scarring or tree injury, presence of pests or pathogens, problems with MP designations or tag positioning, tag replaced, or if tree not found after search (“NFAS”).

Dead trees: If a tagged tree ≥ 1.37 m tall has died since the last measurement, record Status = **6** and DBA or DBH (as dictated by tag location), then fill out the **WS10 Tree Mortality Form** (instructions on form).

B. CONIFERS ≥ 1.37 m TALL *WITHOUT TAGS*

These trees may represent one of several situations:

1. **Trees in the Macroplot that were < 1.37 m tall at the previous census, but now taller than 1.37 m.**
2. **Trees that have lost their tag.**
3. **Trees that were overlooked (missed) during a previous measurement but clearly rooted in the plot.**

Data are recorded as follows for each of these three cases:

1. Conifers now tall enough to tag (ingrowth). For ingrowth, use the ingrowth tags specific to the plot. These should be in a number series not currently in use in the plot. For trees too small to accept a nail, attach a tag with a wire or zip tie to a *sturdy side branch* (not the main stem which could constrict or girdle the tree). For trees large enough to hold a nail (≥ 5 cm dbh), nail the tree tag at 1.37 m (“breast height”) on the side slope. If there is a branch or a swelling that interferes with measurement at 1.37 m, nail the tag just above or below that height. Tags should be nailed so they face the same direction as other tags in the plot. Be sure that the same tag # has not been used previously in the 15 x 10 m plot! The following data are recorded on the

Ingrowth Form:

- Plot size: “M” for Macroplot, or microplot code
- Tag #
- Near tag # (tag # of a large, nearby tree for future reference)
- Species code
- MP = measurement point (B for trees with wired/cabled tags; H for trees with nailed tags)
- Diameter (cm): DBA when MP = B, DBH for MP = H
- OV = overall vigor (as above)
- Comments

2. Live or Dead Conifers that have lost old tags. Occasionally an untagged stem is found in the Macroplot with an unusually large diameter or with a height suggesting that it should have been tagged during the previous census (for PSME, height at last census can be approximated by counting back terminal bud scale scars to 2010). Before adding a stem to the **Ingrowth Form**, compare the individual with any stems on the **Tagged Trees Form** that cannot be found. If the missing tree had a **MP = H**, search for an old nail hole at bh; if **MP = B**, look for old wire on a branch (perhaps embedded). Often trees can be matched with those on the **Tagged Trees Form** using **Species, Previous DBH, Near Tag #, and the previous comment**. If a reasonable match can be made, attach a temporary (“write-on”) tag with the tag # written on it (use a pencil) and record “NNT” (“needs new tag”) in the comment field. Also add the comment “tag missing, assumed to be “#...”. *If a match is made and the tree is dead, record status and DBA or DBH (according to previous measurement) and then fill out a WS10 Tree Mortality Sheet for the tree. It is not necessary to attach a temporary tag to a dead tree.*

3. Live Conifers that were overlooked (missed): If a reasonable match cannot be made with previously tagged trees, and the tree is definitely rooted in the plot, it is possible that it was missed last time. If you are convinced that the tree was missed, it should be tagged (with a wire, zip tie or nail depending on size). Data are then entered on an **Ingrowth Form** with a comment: “should have been tagged in 2010”. The following data are recorded on the **Ingrowth Form**.

- Microplot number, or “M” for trees in the 15 x 8 m macroplot area.
- Tag #
- Near Tag# = tag # of a large, adjacent tree
- Species code
- MP = measurement point (B for trees with wired/cabled tags; H for trees with nailed tags)
- Diameter (cm) = basal diameter for MP = B, DBH for MP = H
- OV = overall vigor (as above)
- Comments

C. HARDWOODS \geq 1.37 m TALL *WITHOUT TAGS*

These trees may represent one of several situations:

1. **Live stems in the Macroplot that were <1.37 m tall at the previous census and are now tall enough to tag as Ingrowth** (as described in **situation B1** above).
2. **Stems that have lost old tags** – treat as in **situation B2**, above
3. **Stems that were overlooked (missed)** – treat as in **situation B3**, above.

Data are entered on the **Ingrowth Form**. The following data are recorded:

- Plot size: “M” for Macroplot, or microplot code
- Tag #
- Near tag # (tag # of a large, nearby tree for future reference)
- Species code
- MP = measurement point (B for trees with wired/cabled tags; H for trees with nailed tags)
- Diameter (cm): DBA when MP = B, DBH for MP = H
- OV = overall vigor (as above)
- Comments

TREES < 1.37 m IN THE 30, 1 X 1-m MICROPLOTS

Conifer and hardwood tree species of all sizes are accounted for in **all 30 microplots**. How they are accounted for depends on their size:

- Small tree seedlings <10 cm tall (including germinants) should be *tallied by species and DBA* on the **Biomass Form**. Do not tag them.
- Trees \geq 10 cm tall should be tagged and measured. If they are not already tagged, they are either new ingrowth or trees that were tagged previously and have lost their tags (see below).
- Note: It is not necessary to record **Near Tag#** for trees rooted in microplots.

Tags that are nailed on: If a tag is nailed at breast height, measurement point, MP, should be H (dbh). Remeasure the tree just above the nail (using a dbh tape or dbh strip) and record the diameter in the **DBH** column. If there is not much room left for growth on the nail, use a wire cutter to snip off the head of the nail and use a new nail to attach the tag at the same height. If the tag is being overgrown, retag the tree with a temporary (write-on) tag with the tag # and record “NNT” (“needs new tag”) in the comment field.

Tags that are wired: If a tag is wired on a side branch, **MP = B** (dba, basal diameter). Remeasure the tree at

the base (above any butt swell, using a dbh tape, dbh strip, or caliper) and record the diameter in the **DBA** column. If, **MP** is listed as **H**, this is incorrect. Change H to B, circle it, and measure the basal diameter and note the error in the comments. If the wire is brittle, replace it with a new wire or a zip tie. Avoid cabling small trees around the main stem unless they are very small with low vigor and little potential to outgrow the wire or cable tie before the next measurement (6 years in the future). Sometimes it is necessary to cable around the main stem because small individuals do not always have side branches that can support a cable/wire.

If the tag is wired but the tree is now is large enough (≥ 5 cm dbh) to be nailed at dbh, nail the tag at dbh, then measure **both** the basal diameter (**DBA**) and breast-height diameter (**DBH**) and record them in the appropriate columns.

Tagged seedlings and saplings < 1.37 m tall that have died: If a tagged tree seedling or sapling listed for the microplot on the Tagged Trees Form has died, record tree status = 6 (dead) and note *in the Comment field* an appropriate Mortality Cause code (see Mortality Sheet for codes). Examples: "MC = 1" (for suppression) or "MC=60" (for unknown cause). *Do not fill out the mortality sheet for dead trees < 1.37 m tall.*

Seedlings and saplings ≥ 10 cm tall and < 1.37 m tall without tags: Untagged tree seedlings and saplings ≥ 10 cm tall and < 1.37 m tall without tags in the microplots are either (a) new ingrowth or (b) trees that were tagged previously and have since lost their tags. If you can't find a tag, root around in the litter at the base of the stem to see if a tag is buried. If not tag is found, it *may* be possible to match the tagless seedling or sapling with one on the Tagged Trees Form using the previous Species, Previous DBH, Near Tag #, and Comment. If you're confident a match can be made, write the tag number on a temporary tag and attach it to the tree. If a match cannot be made, treat it as ingrowth and note the position within the microplot: UL = upper left, UR = upper right, LL = lower left, LR = lower, C = center of plot, L = left edge of plot, R = right edge, T = top edge, B = bottom edge.

For ingrowth that do not have strong side branches, the tag must be placed around the main stem. Be sure to leave some growing space in the wire or cable tie for the seedling to grow. For larger ingrowth with suitably strong side branches, attach the tag on an uphill branch close to the stem so it's more likely to stay on the tree.

Figure 1. Map of Watershed 10 with plot locations.

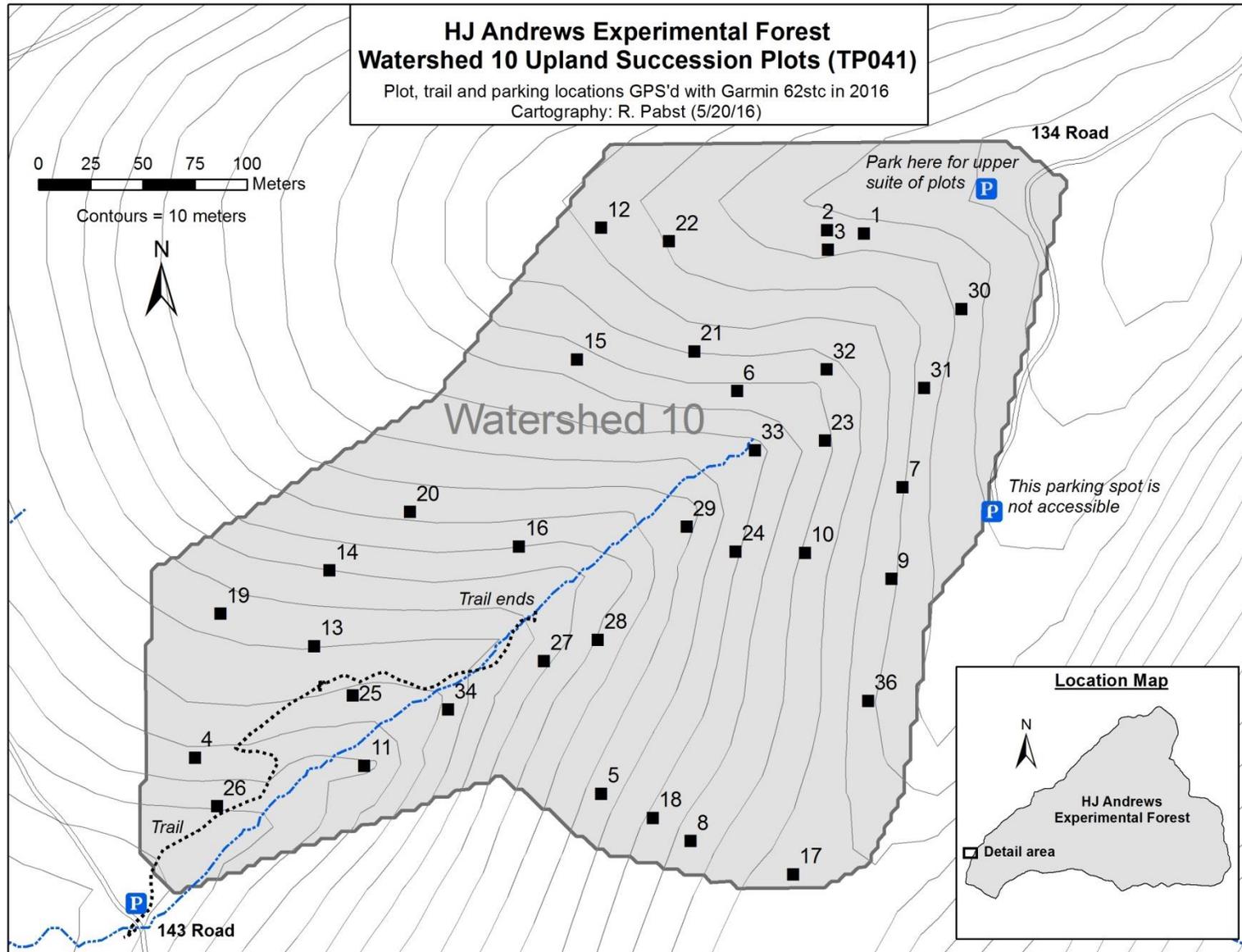


Figure 2. Old map of Watershed 10, showing 25 x 25-m grid and the location of various study installations, including the upland vegetation succession plots (TP41) indicated by squares with numbers inside. (Note that Plot 35 has been abandoned.)

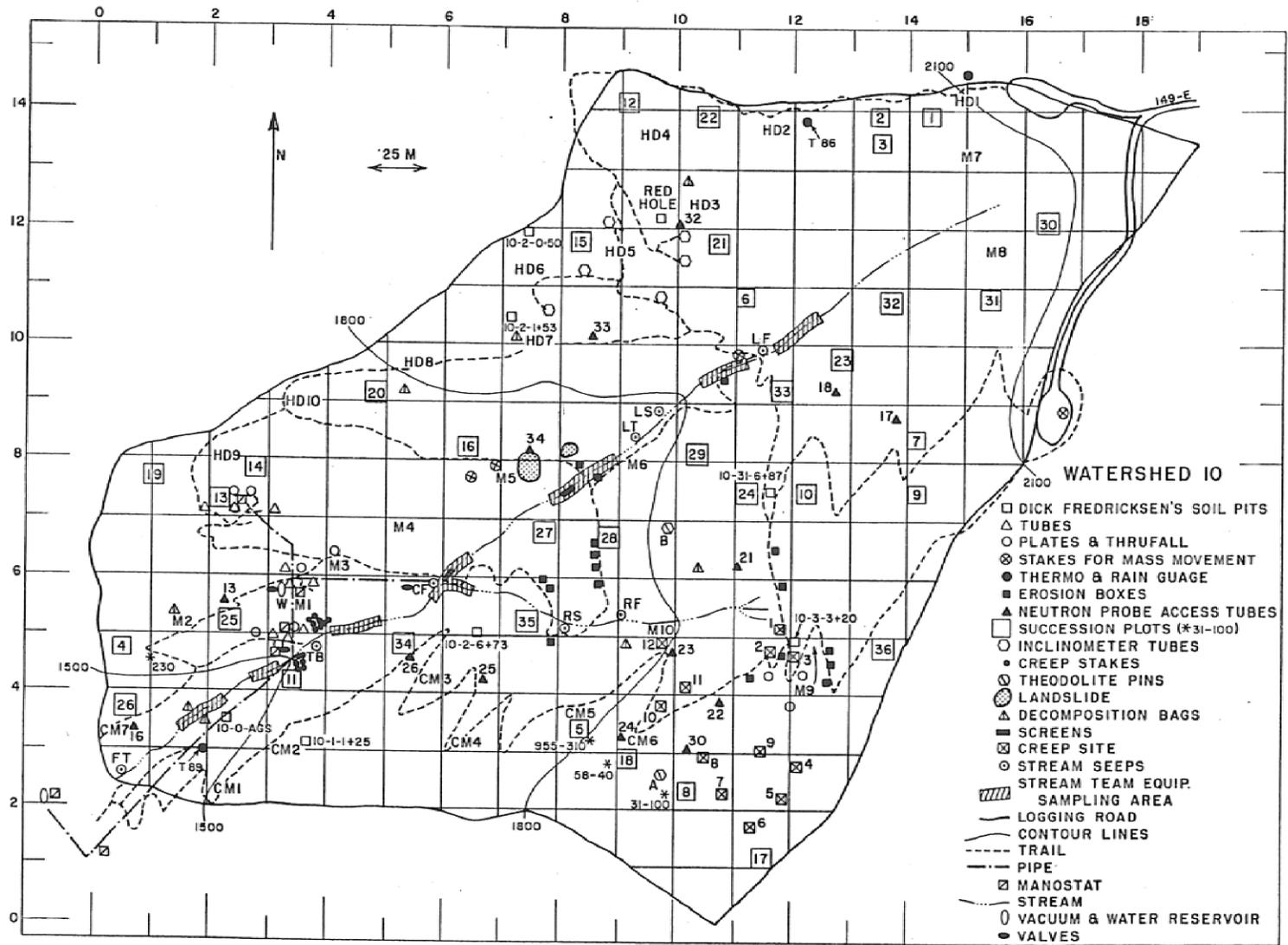


Figure 3. WS10 microplot arrangement and numbering within each plot.

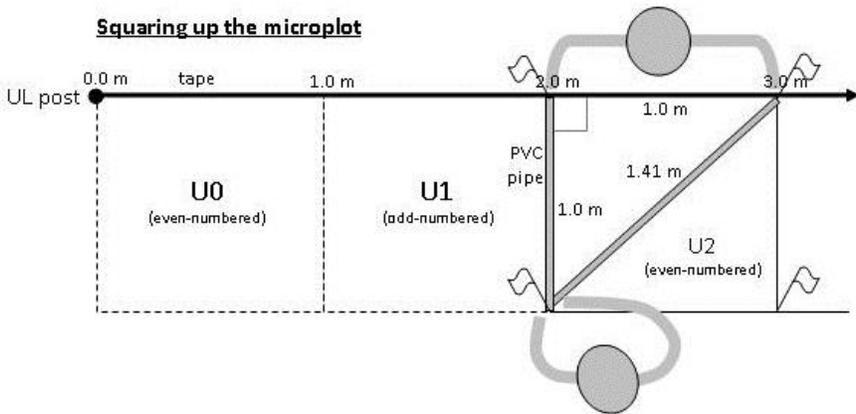
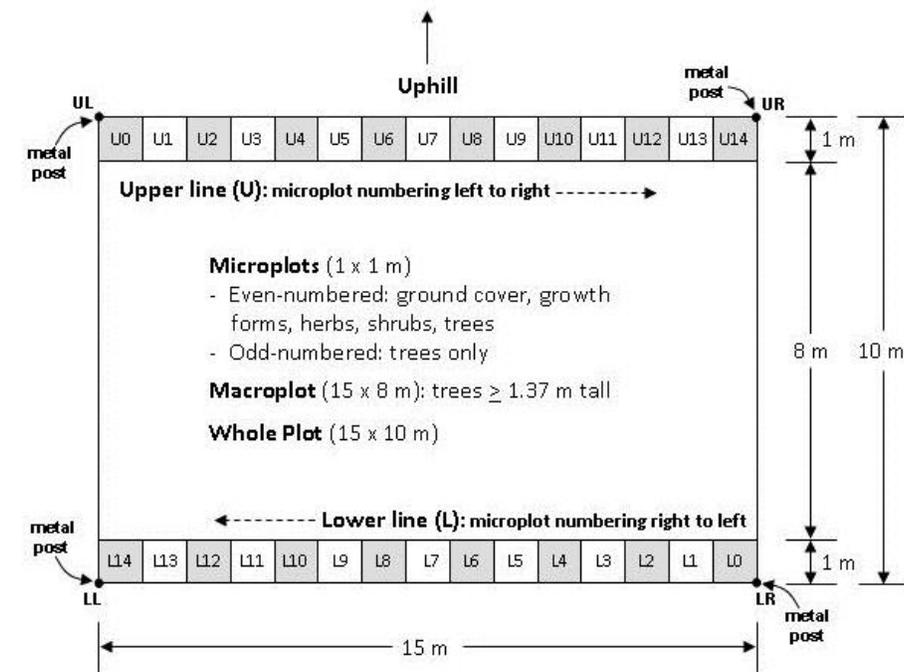


Table 1. UTM coordinates (NAD83) of WS10 Upland Succession Plots.

WS10 plot	Easting_NAD83	Northing_NAD83
1	559339	4896543
2	559321	4896545
3	559322	4896535
4	559018	4896292
5	559213	4896275
6	559278	4896468
7	559358	4896422
8	559256	4896252
9	559352	4896378
10	559311	4896390
11	559100	4896288
12	559213	4896546
13	559075	4896345
14	559083	4896382
15	559202	4896483
16	559174	4896393
17	559305	4896236
18	559238	4896263
19	559031	4896361
20	559121	4896410
21	559258	4896487
22	559246	4896539
23	559320	4896444
24	559278	4896391
25	559094	4896322
26	559029	4896269
27	559186	4896338
28	559212	4896348
29	559254	4896403
30	559386	4896507
31	559368	4896469
32	559321	4896478
33	559287	4896439
34	559140	4896315
36	559341	4896319

WS10 parking	Easting_NAD83	Northing_NAD83
Road 134	559398	4896564
Road 134 end <i>(not accessible by vehicle)</i>	559400	4896410
Road 143	558990	4896222

Table 2. Recommended equipment list for WS10 measurements.

- Daypack
- Field vest
- Compasses with correct declination (**15 degrees East in 2016**)
- 30-m fiberglass tapes (two per team)
- 1.0 and 1.5-m PVC pipes, marked at 10 cm intervals and at 1.41 m (for locating microplot boundaries)
- Calipers (metric) (one for each crew person)
- Diameter tape (one for each person)
- D-tape strips (for small trees)
- Clinometer (one for each person)
- PVC posts, rebar or stakes (to replace missing corner posts)
- Aluminum nails (lots!) in nail bag
- Hammers (one for each person)
- Pliers/wire cutters (one for each person)
- Blue flagging for trails/routes to plots
- Red and blue flagging for corner posts
- Pin flags (5 for each team)
- Tree tags
 - *Plot-specific* ingrowth tags
 - Temporary (“write-on”) tags with wires
 - Replacement tags
 - Wires and zip ties for attaching tags to small stems
- Clipboards (two per team)
- Pencils (0.9 mm)
- Data forms on Rite-in-Rain paper
 - *Plot-specific* tree remeasurement forms
 - Tree mortality forms
 - Ingrowth forms
 - % Cover forms
 - % Cover form continuation pages
 - Biomass forms
- WS10 field protocol
- Plot-specific species lists
- Reading glasses
- Hand lens
- Plant ID books
 - Hitchcock and Cronquist
 - Pojar and MacKinnon
- Garmin GPS and sheet with plot coordinates
- Radio
- 1st Aid Kit
- Whistle
- Day pack, lunch, water, sunglasses, sunscreen

Table 3. Slope correction for ground distance equivalent to 10 m and 15 m, with slope in degrees.

Formula: Ground distance = Horizontal distance/cos(slope), where slope is in degrees.

Slope (degrees)	10 m	15 m	Slope (degrees)	10 m	15 m
1	10.00	15.00	36	12.36	18.54
2	10.01	15.01	37	12.52	18.78
3	10.01	15.02	38	12.69	19.04
4	10.02	15.04	39	12.87	19.30
5	10.04	15.06	40	13.05	19.58
6	10.06	15.08	41	13.25	19.88
7	10.08	15.11	42	13.46	20.18
8	10.10	15.15	43	13.67	20.51
9	10.12	15.19	44	13.90	20.85
10	10.15	15.23	45	14.14	21.21
11	10.19	15.28	46	14.40	21.59
12	10.22	15.34	47	14.66	21.99
13	10.26	15.39	48	14.94	22.42
14	10.31	15.46	49	15.24	22.86
15	10.35	15.53	50	15.56	23.34
16	10.40	15.60	51	15.89	23.84
17	10.46	15.69	52	16.24	24.36
18	10.51	15.77	53	16.62	24.92
19	10.58	15.86	54	17.01	25.52
20	10.64	15.96	55	17.43	26.15
21	10.71	16.07	56	17.88	26.82
22	10.79	16.18	57	18.36	27.54
23	10.86	16.30	58	18.87	28.31
24	10.95	16.42	59	19.42	29.12
25	11.03	16.55	60	20.00	30.00
26	11.13	16.69	61	20.63	30.94
27	11.22	16.83	62	21.30	31.95
28	11.33	16.99	63	22.03	33.04
29	11.43	17.15	64	22.81	34.22
30	11.55	17.32	65	23.66	35.49
31	11.67	17.50	66	24.59	36.88
32	11.79	17.69	67	25.59	38.39
33	11.92	17.89	68	26.69	40.04
34	12.06	18.09	69	27.90	41.86
35	12.21	18.31	70	29.24	43.86

Table 4. Percent cover dimensions in a 1 x 1 meter microplot.

% Cover	Dimensions
0.1	= 1 x 10 cm (~ 1 finger)
0.5	= 5 x 10 cm (~ ½ palm of hand)
1	= 10 x 10 cm (palm of hand to first knuckle)
2	= 10 x 20 cm (entire large hand)
5	= 20 x 25 cm or 10 x 50 cm
7	= 1 clipboard
10	= 33 x 33 cm or 10 x 100 cm or 20 x 50 cm
15	= 2 clipboards or 40 x 40 cm
25	= 50 x 50 cm or 25 x 100 cm
50	= 70 x 70 cm or 50 x 100 cm
75	= 75 x 100 cm

Table 5. Resolution of percent cover estimates.

If cover estimate is between:	Resolution of estimate should be:
0-2%	0.1%
2-5%	0.5%
5-10%	1%
10-25%	2-5%
25-100%	5-10%

Table 6. Biomass parameters to measure (see protocol for units and resolution).

Code	Species name	BV1	BV2	Code	Species name	BV1	BV2
Grasses, Sedges and Rushes				Tall Shrubs			
AGPA8	<i>Agrostis pallens</i>	ht		ACCI	<i>Acer circinatum</i>	dba	
AGST2	<i>Agrostis stolonifera</i>	ht		AMAL2	<i>Amelanchier alnifolia</i>	dba	
AGTE	<i>Agrostis tenuis</i>	ht		ARCO3	<i>Arctostaphylos columbiana</i>	dba	
AGROS	<i>Agrostis</i> sp.	ht		CESA	<i>Ceanothus sanguineus</i>	dba	ht
ELGL	<i>Elymus glaucus</i>	ht		CEVE	<i>Ceanothus velutinus</i>	dba	i-ht
FEOC	<i>Festuca occidentalis</i>	ht		COCOC	<i>Corylus cornuta californica</i>	dba	
FERU2	<i>Festuca rubra</i>	ht		HODI	<i>Holodiscus discolor</i>	dba	
FESTU	<i>Festuca</i> sp.	ht		OECE	<i>Oemlaria cerasiformis</i>	dba	
HIOC	<i>Hierochloe occidentalis</i>	ht		PHLE4	<i>Philadelphus lewisii</i>	dba	
LOPE	<i>Lolium perenne</i>	ht		RHMA3	<i>Rhododendron macrophyllum</i>	dba	
LUCA2	<i>Luzula campestris</i>	ht		RIBES	<i>Ribes sanguineum</i> , <i>R. lobbii</i>	dba	ht
LUPA4	<i>Luzula parviflora</i>	ht		ROGY	<i>Rosa gymnocarpa</i>	dba	ht
LUZUL	<i>Luzula</i> sp.	ht		RUAR9	<i>Rubus armeniacus</i>	dba	
MEHA2	<i>Melica harfordii</i>	ht		RULE	<i>Rubus leucodermis</i>	dba	ht
SCAR7	<i>Schedonorus arundinaceus</i>	ht		SALIX	<i>Salix</i> sp.	dba	
TRCA21	<i>Trisetum canescens</i>	ht		SASI2	<i>Salix sitchensis</i>	dba	
	<i>Any other grass species</i>	ht		TODI	<i>Toxicodendron diversiloba</i>	dba	
Ferns				VAME	<i>Vaccinium membranaceum</i>	dba	
ADPE	<i>Adiantum pedatum</i>	len	num	VAPA	<i>Vaccinium parvifolium</i>	dba	
ATFI	<i>Athyrium filix-femina</i>	len	num	Trees \geq 10 cm tall			
BLSP	<i>Blechnum spicant</i>	len	num	ACGL	<i>Acer glabrum</i>	dba	
POGL8	<i>Polypodium glycyrrhiza</i>	len	num	ACMA3	<i>Acer macrophyllum</i>	dba/dbh	
PTAQ	<i>Pteridium aquilinum</i>	dba	num	ALRU2	<i>Alnus rubra</i>	dba/dbh	
Herbs and Low Shrubs				CADE27	<i>Calocedrus decurrens</i>	dba/dbh	
AGOSE	<i>Agoseris</i> sp.	ht		CHCH7	<i>Chrysolepis chrysophylla</i>	dba/dbh	
ANMA	<i>Anaphalis margaritacea</i>	ht		CONU4	<i>Cornus nuttallii</i>	dba/dbh	
ARCA3	<i>Aralia californica</i>	dba		FRPU7	<i>Frangula purshiana</i>	dba/dbh	
CHAN9	<i>Chamerion angustifolium</i>	ht		PILA	<i>Pinus lambertiana</i>	dba/dbh	
COCA2	<i>Conyza canadensis</i>	dba	ht	POBAT	<i>Populus balsamifera</i> v. <i>tricho.</i>	dba/dbh	
EPBR3	<i>Epilobium brachycarpum</i>	dba	ht	PREM	<i>Prunus emarginata</i>	dba/dbh	
EPCIW	<i>Epilobium ciliatum</i>	ht		PSME	<i>Pseudotsuga menziesii</i>	dba/dbh	
EPMI	<i>Epilobium minutum</i>	dba	ht	TABR2	<i>Taxus brevifolia</i>	dba/dbh	
GASH	<i>Gaultheria shallon</i>	ht		THPL	<i>Thuja plicata</i>	dba/dbh	
HIAL2	<i>Hieracium albiflorum</i>	ht		TSHE	<i>Tsuga heterophylla</i>	dba/dbh	
HYPE	<i>Hypericum perforatum</i>	ht		Trees < 10 cm tall			
LASE	<i>Lactuca serriola</i>	ht		· Record by species and DBA on biomass data form			
LOC13	<i>Lonicera ciliosa</i>	dba		· BV1 = DBA			
MAGR3	<i>Madia gracilis</i>	ht		· BV2 = number (for each species and DBA)			
MANE2	<i>Mahonia nervosa</i>	ht					
MYMU	<i>Mycelis muralis</i>	ht		Parameter abbreviations			
PEFR5	<i>Petasites frigidus</i>	ht	num	dba = basal diameter i-ht = individual height of each stem			
SESY	<i>Senecio sylvaticus</i>	dba	ht	dbh = diameter at 1.37 m num = number of stems			
SYMO	<i>Symphoricarpos mollis</i>	dba		ht = modal height in microplot len = stem length (some ferns)			
XETE	<i>Xerophyllum tenax</i>	clump dba	ht				