WS1/3 LONG-TERM SUCCESSIONAL STUDIES: SAMPLING PROTOCOLS FOR UNDERSTORY VEGETATION AND TREES

BRIEF HISTORY

There has been long history of geomorphic, hydrological, and ecological study in the experimental watersheds of HJA, which include WS1 and WS3 and the neighboring old-growth basin, WS2. These include comparative studies of sediment yield, stream chemistry, and water flow following whole-basin logging of WS1 and patch-cut logging of WS3, and long-term studies of post-harvest forest development. The latter, initiated in 1962, are among the longest-running and most intensive studies of secondary succession in forests of North America. They are based on two types of permanent plots (understory and overstory), spatially linked to facilitate analyses of overstory-understory interactions. Understory quadrats were established in 1962, prior to harvest, and have been sampled periodically since the watersheds were cut and broadcast burned. They have been used to study how species' life histories, pre-disturbance composition, disturbance intensity, and overstory development contribute to the long-term dynamics of the understory (Dyrness 1973, Halpern 1988, Halpern 1989; Halpern & Franklin 1990, Halpern & Spies 1995, Dovciak & Halpern 2010, Halpern & Lutz 2013). Overstory tree plots were established nearly two decades later (1979-1980) to characterize the early stages of forest development, including the recruitment (ingrowth), growth, and mortality of conifers and hardwoods (Acker et al. 2002, Lutz & Halpern 2006). Understory quadrats were last sampled in 2012 and tree plots in 2013. Summer 2017 will be the first time since the tree plots were established that both sets of plots are sampled coincidentally.

GENERAL NOTES

Before setting out each day, consult the following reference material:

Plot Check-off Lists (separate lists for understory and tree plots)**.** Not all plots on each transect are present or sampled for understory vegetation or trees

WS1/3 Miscellaneous Plot Notes. This document contains notes accumulated over the years on locations and conditions of quadrats, corner posts, rebar, and other useful information specific to each plot (e.g., locations of poison oak).

WS1/3 Trees Needing New Tags in 2017. This details which tags need to be carried to specific plots to

retag trees that have temporary tags.

Plot spacing. Plots are spaced 30 m apart along each transect but distances are slope corrected, thus distances between plots will increase with slope. Plot numbering (low to high) varies in direction among transects: consult the **Watershed 1 and 3 transect and plot location maps** for the directions in which plots are numbered on each transect.

Tree plots are circular with a radius of 8.92 m, and are not slope corrected (Fig. 1). Blue flagging marks the plot boundary. The center of the tree plot is marked with a steel reinforcing bar (rebar); red/blue flagging is often hung above/on the rebar to make it more obvious. At the base of the rebar is an aluminum tag with the transect and plot number (e.g., "1 / 4" = Transect 1, Plot 4). The tag may be buried by litter. If it is missing, make a note on the vegetation sampling sheet to replace it next time.

Permanent vegetation quadrat. The rebar serves as one corner of a central, permanent, 2 x 2 m vegetation quadrat established in 1962 prior to clearcutting (Quadrat 0; Fig. 1). Often, a second corner of Quadrat 0—oriented along the line of the main Transect— is a tall (>2 m) metal "sighting" pole. Over time these poles have fallen and been replaced. Usually, but not always, the remaining corners of the quadrat are red (spray-painted) PVC posts; however, other markers are possible: (1) white or orange PVC, (2) a nail on a log or stump spray-painted orange and/or flagged in red, or (3) an orange spray-painted dot on a rock surface. **Quadrats are slope corrected**, thus on steep slopes their shapes may be deceiving. Because Quadrat 0 is sampled for understory vegetation it is important to avoid stepping in it when you sample the larger tree plot.

Quadrat maintenance and corner post reestablishment. If possible, reorient any leaning corner posts vertically, using a hammer to tap the base into the ground. If a post is down or missing it will need to be reestablished by triangulation using two long PVC posts (2 m for an edge; 2.83 m for the diagonal). This requires two people. Place one end of each long post on an existing corner post. The opposite ends are held horizontally above the approximate location of the missing post and moved together until they touch. From the point that they touch, drop a small solid object (stone, pencil) and watch where it hits the ground; insert the new post at that point. If a log prevents insertion of a post, a tall nail should be used (flagged in red). If any posts need to be reset or reestablished, make a note on the comment line of the understory data sheet, **Watershed 1 and 3: Long-term Succession Plots—Understory Vegetation**.

Satellite quadrats (no longer sampled). Each plot has four additional "satellite" quadrats at ~5 m distance from the rebar (Fig. 1, see exception below**). These were established in 1979/1980 to increase the intensity of understory sampling. These are no longer maintained or sampled.

> ****For WS3, Unit 1, Transect 2, Plot 2,** Quadrat 0 occupies **a satellite position** and conversely, a satellite plot lies at the center of the tree plot. Quadrat 0 has the rebar and should continue to be measured for understory vegetation. In this tree plot, use the appropriate corner of the **central-most quadrat** as plot center.

Order of sampling. In 2017 we will sample understory vegetation first, then trees, to avoid potential damage to the understory during tree sampling.

UNDERSTORY VEGETATION PROTOCOL

The following descriptions apply to the understory data sheet, **Watershed 1 and 3: Long-term Succession Plots—Understory Vegetation.**

Header information should always be recorded on each sheet: **Month** (mo) and **Day** (day), **Personnel** (last names), **Watershed**, **Unit** (1 for WS1; 1, 2, or 3 for WS3), **Transect**, and **Plot.** Be sure to record the same information on any **Understory Continuation Pages.** At the top of each page be sure to fill in the correct page number and total number of pages for a plot, once sampling is done (**Pg. __ of __)**.

Adding reference tags for plot-center rebars: To facilitate future relocation of missing or fallen plot-center rebars, we will add reference tags to the bases of two trees and survey their distances and bearings to the rebar. Select two vigorous trees near plot-center to serve as reference trees. If possible, select trees whose azimuths to the rebar differ by 90-135 deg (i.e., somewhat perpendicular). Nail a pre-numbered (#1 or #2) tag into the base of each reference tree with the tag facing the rebar. Use a meter tape and compass to measure the distance (nearest cm) and azimuth from each tree to the rebar. Record tag #s, distances, and azimuths in the spaces provided at the top of the understory data form.

Marking the edges of Quadrat 0. Place a long PVC post along each edge of the quadrat, and one to split the quadrat in half (typically oriented up and down the slope). Two people will estimate the cover of each species in separate halves of the quadrat, then a total will be recorded.

1. Canopy Cover (>2 m tall)

In this study "canopy species" can be conifers, hardwoods, and tall shrubs with foliage >2 m from the ground surface. Canopy cover is recorded in two ways in the upper portion of the data form.

Canopy cover >2 m tall (%) using a truck-mirror densiometer

The densiometer is a convex mirror with a 10 x 10 grid (100 squares) divided into 4 quadrants of 25 cells each. The mirror sits on a swivel on a 1+ m PVC pole, which is pushed into the soil to hold the mirror stable at ~1 m height.

Place the pole at the rebar marking the center of the tree plot. **There is one exception:** for WS1, Transect 5, Plot 8 place the pole at the PVC in the NE corner.

The mirror should be leveled with a "bubble" and positioned so the center lines dividing the quadrants are oriented along cardinal directions, giving NW, NE, SE, and SW quadrants. Compass declination should be set at 15 deg E. The eye should be held 20 cm above the mirror, in the quadrant diagonal to the one being read. Be sure to close the other eye while making canopy estimates.

Each of the 25 grid cells within a quadrant is scored on a scale of 0 to 4: 0 = open (<12.5% closed), 1 = ~25% closed, 2 = ~50% closed, 3 = ~75% closed, and 4 = ~100% closed. Estimate cover in each grid cell and accumulate (sum) values as you move from one cell to the next. If the canopy is mostly closed, it is easier to tally the inverse (i.e., open sky) then subtract the sum from 100. One you are done with a quadrant, reposition yourself to read the next quadrant. Be sure to record each estimate under the appropriate quadrant on the data form.

Canopy cover by growth form >2 m tall (%)

This is a visual estimate of projected cover >2 m off the ground into the 2 x 2 m quadrat for each major growth form (see list below) and for all growth forms together (canopy cover irrespective of growth form). The maximum is 100% for each growth form and for the total. **Total cover should be equal to or greater than the maximum of the growth-form values, but it should not exceed 100%**. Record 0% if there is no canopy cover.

Potential canopy species by growth form in WS1/3

Conifers

Libocedrus decurrens	LIDE2	Incense cedar (aka *Calocedrus decurrens*)
Pinus lambertiana	PILA	Sugar pine
Pseudotsuga menziesii	PSME	Douglas-fir
Taxus brevifolia	TABR	Pacific yew
Thuja plicata	THPL	Western redcedar
Tsuga heterophylla	TSHE	Western hemlock

Hardwoods

Acer macrophyllum	ACMA	Bigleaf maple
Alnus rubra	ALRU	Red alder
Arbutus menziesii	ARME	Madrone
Castanopsis chrysophylla	CACH	Golden chinquapin (aka *Chrysophylla chrysolepis*)
Cornus nuttallii	CONU	Pacific Dogwood
Populus trichocarpa	POTR2	Black cottonwood (aka *Populus balsamifera* var. *trichocarpa*)
Prunus emarginata	PREM	Bitter cherry
Rhamnus purshiana	RHPU	Cascara (aka *Frangula purshiana*)

Tall Shrubs (see species for full names)

ACCI, ACGL, ALSI, AMAL, ARCO3, CEIN, CESA, CEVE, COCOC, GAFR, HODI, OECE, PHLE2, RHDI, RHMA, RIBES, RILA, RILO, ROGY, RULE, RUPA, SACE, SALIX, SASC, SASI2, VAME, VAPA

2. Ground Conditions and Growth-form Totals

The second section of the data form is used to record cover of ground-surface conditions and the total cover of major growth forms in the 2 x 2 m quadrat. These are defined below.

Ground conditions

BARE	Bare ground (mineral soil)
STONE	Rock >7 cm in width (or smaller pieces if they form a contiguous surface)
LOG	Pieces of wood (branch, bole, root wad, or bark >10 cm in the smallest dimension. Smaller pieces of wood/bark forming a contiguous surface >10 cm wide can also qualify as LOG.
STUMP	Only if upright (otherwise LOG)
BUTT	Live tree base (if $\geq$ 1% cover)
SNAG	Dead tree base (if $\geq$ 1% cover)
LITTER	Leaves, needles, or woody debris <10 cm wide. Often easiest to estimate as the difference between 100% and the categories above (but see exception below).

Notes: (1) If you cannot see BARE under a plant, consider it LITTER. (2) Sum of BARE, STONE, LOG, STUMP, and LITTER is typically 100%. However, if a LOG is elevated over BARE or LITTER, or if it is on the ground but broad enough to overhang BARE or LITTER, the total can exceed 100%. If this occurs make a note adjacent to the LOG cover line (e.g., "LOG elevated").

Growth forms

MOSS	Moss or liverwort. Use the vertical projection for cover on the sides of logs or stumps (this estimate will be much smaller than the actual vertical area covered).
TREE	Total cover of trees, **irrespective of height** (see species list)
TALL SHRUB	Total cover of tall shrubs, **irrespective of height** (see species list)
HERB	Total cover of herbs (grasses, sedges, herbs, and low shrubs; see species list). **Note**: for this study, low growing woody species *Berberis nervosa* (BENE) (aka *Mahonia nervosa*) and *Gaultheria shallon* (GASH) are considered herbs (present in the herb layer).

3. Species Cover and Biomass-related Measurements

For each quadrat, all species found at the last sampling date (2013) are listed. Depending on how many species were present, there may be one or two pre-printed pages per quadrat. Some of these species may no longer be present, but you may also find new species (not currently listed). New species can be penciled in to the form if there is room, or they can be added to the continuation page. The following data are recorded for each species present.

Species name. Write the species name in full (common species can be abbreviated, e.g., salal can be recorded as "Gaul shall"). Use of full names will allow us to correct erroneous codes. If the species cannot be identified, provide a description of the plant in this space (e.g., "grass w/ long awns")

Species code. Codes are "PNW codes" (Garrison et al. 1974). See the complete list of names and codes in the species list. If a plant can only be identified to genus, record the first 5 letters of the genus. If a plant cannot be identified in the field, record it as "UNKN#" (where # is a unique number for the quadrat). Collect a specimen from outside the quadrat (inside the larger tree plot is ok) and include a label in/on the bag with collector's name, date, and WS/transect/plot number. Describe or sketch the plant on the data form (use the back if necessary), or take several photos.

LC (line count). LC = 1 designates the first record of a species in a quadrat. If more than one line is needed to record biomass measures (see below), increment the LC value (e.g., 2, 3, etc.). **Cover is recorded only on the line for which LC = 1.**

Cover (%). Cover is estimated as a vertical projection, as a percentage of the plot. Include plants that overhang the quadrat but are not rooted in. The minimum cover value recorded for a species is 0.1%; cover <0.1% is recorded as 0.1%. Maximum cover of a species is 100%.

Cover estimates require two observers. Divide the quadrat in half (two, 1 x 2 m quadrats); this usually works best if each individual stands side-slope of the quadrat with a PVC pipe oriented up/down slope through the vertical center. Cover estimates for each half of the quadrat can be combined in two ways:

1. For species that occupy large portions or at least half of the quadrat, estimate cover (%) in each half then average the two values.

2. For species that occur in only one of the two sections or occupy a small portion of both, estimate the physical dimensions then convert these to cover. Here are some useful dimension-to-cover conversions:

Physical dimensions	Cover (%)
Fist with knuckles folded under (10 x 10 cm)	0.2-0.3%
Sheet of 8.5 x 11" paper or standard clipboard	1.5 %
50 x 50 cm (1/16 of the 2 x 2 m quadrat)	6.2 %
1 x 1 m (1/4 of the 2 x 2 m quadrat)	25.0 %

Cover should be recorded **only once** for a species and only on the **LC = 1** line.

Biomass-related measurements. For a subset of species, one or more measurements are made to estimate biomass non-destructively for stems rooted in the quadrat. Data are recorded in the columns that follow after Cover: **DBA, DBH, Height, No. stems,** and **Length**. The data form is designed with pre-printed underscore lines that indicate the parameter(s) that should (or could) be measured for each species. These parameters are also listed in **Table 1. WS1/3 Biomass-Related Parameters to Measure (2017)** (pg. 12). However, these data are recorded only for stems rooted in the quadrat. If there are none rooted in, place a check-mark in the "**Rooted out**?" column. This way we know that the biomass measurement was not overlooked. For large-diameter stems (e.g., trees), presence in the quadrat is based on the center of the stem. Details on biomass-related measurements follow:

DBA (cm). DBA is measured for stems of **tall shrubs** of any size (except RUPA), **trees of any size without tags** (<1.4 m tall at the last measurement), **trees with tags wired/zip-tied on a branch**, and a small subset of **non-woody species** (see list below). Measure diameter at the base (above the major butt swell for trees) using a caliper or small diameter strip. Measure to the nearest 0.1 cm. If a caliper is used on an oval-shaped stem, take two measurements perpendicular to each other and record the average.

Each stem should be measured separately and its diameter recorded on a separate line. However, if there is more than one stem of the same diameter, you can record the number of stems of that diameter in the **No. stems** column (this reduces the number of data records). **The first DBA entry should be on the first line (LC= 1) for the species** (where cover is recorded) unless a **DBH** (trees only) has already been listed. If DBH has been recorded already, use a new line. For small trees with wired-on tags, **Tag #** is also recorded (last column).

Non-woody species requiring a DBA measurement:

ARCA3, LOCI, LOCR, and **PTAQ**: Simple DBA measurement at the base, if rooted in.

XETE: Gather the leaves in a tight bundle and wrap the diameter strip around the clump at its base.

DBH (cm). For trees with nailed tags. Measure to the nearest 0.1 cm just above the nail. Each stem should be measured separately and its diameter recorded on a separate line. **The first DBH entry should be on the first line (LC=1) for the species** (where cover is recorded) unless a **DBA** has already been entered on that line. If a DBA is already present, use a new line to record DBH. Additional DBH values should be entered on separate lines (incrementing LC). Each tree measured for DBH should also have a **Tag #** recorded (last column). If a tag is missing, see tree protocol.

Height (cm). Height is taken with a calibrated meter stick for **all species except trees**. Heights are used to characterize the vertical distribution of species in the understory. For species with erect stems/shoots, height is modal height, i.e., the most common height of stems/shoots rooted in the quadrat. For species with only basal rosettes (e.g., non-flowering HIAL) or leaves or with a decumbent/creeping form (e.g., RUUR), height is height of the foliar surface off the ground. **Rare exceptions**: for **CEVE, ARCA3** and **LOCR** (three species that haven't been recorded recently) and **XETE** (still present) height is needed for each individual stem or clump (**XETE**) to estimate biomass. For **XETE**, after leaves are gathered and compressed to measure DBA (see above), extend them fully to measure height to the leaf tip.

For **tall shrubs** estimate height as stem length (because stems often lean). Precision of the estimate varies with height: to the nearest 5 cm for plants 0-1 m tall; to the nearest 10 cm for plants 1-2 m tall; and to the nearest 20-50 cm for plants >2 m tall.

Number of stems (or fronds). Recorded for **all ferns including PTAQ but not POMU**, and for the herb, **PEFR2**. For all ferns except PTAQ (i.e., ADPE, ATFI, BLSP, POGL4), this is the number of fronds of **a particular length**. For PTAQ this is the number of fronds with **a particular DBA**. For **PEFR2** this is the number of leaves of **a particular length**.

Length: Frond length is recorded for **all ferns (except POMU or PTAQ);** leaf length is recorded for **PEFR2.**

Tag #: For any tree with a tag (see above).

TREE PLOT PROTOCOL

Use the data form **TP73 Watershed 1 and 3 Tagged Tree Remeasurement.** Complete all information in the header. Using the following procedures, systematically **re-measure** all tagged stems (conifers and hardwoods; see **Table 1**, last page) and **tag and measure** all ingrowth (non-tagged stems ≥ 1.37 m tall). This threshold value is a height if the stem is vertical or a length (base to tip) if it is leaning. Height (and dbh) are measured "side-slope" (on the contour). Hardwood stems arising as stump sprouts from a common base should be tagged individually if they are ≥ 1.37 m tall.

In the process you may need to determine if a tree is in or out of the plot. In the past blue flagging has been used to delineate the plot boundary. Plot radius is 8.92 m, parallel to the ground surface (not corrected for slope). On the perimeter of the plot if a tree is rooted out (>8.92 m from center), flagging is placed on a branch of the tree on the side nearest the rebar (designating that the bole is out). If a tree is rooted in, flagging is placed on a branch of the tree on the side away from the rebar (bole is in). "In" vs. "out" is based on the center of the bole where it meets the ground surface.

Stems are ordered sequentially on the data sheet by quarter number (**Q** column) (see Fig. 1), then tag number. **Important:** be sure to read all comments associated with each record; they may include instructions to resolve past discrepancies. Notably, some trees were given temporary tags in 2012 and will have the comment "needs new tag" (abbreviated "NNT"). These new tags will be provided in 2017, as replacements for temporary tags.

Trees may have tags nailed at breast height or wired or zip-tied on side branch (small stems that cannot hold nails), or they may not have a tag. Different measurements and tasks are performed for these situations. Details follows:

1. Live trees tagged at breast height (MP = H)

- DBH (measured directly above the nail) in the **Dbh** column, to the nearest 0.1 cm.
- Status = 1 (present and alive) in the **ST** column. Other possible codes are 2 = ingrowth, 6 = dead, or 9 = missing.
- Overall vigor in the **OV** column: 1 = good, 2 = fair (some loss of foliage, branches, or crown), or 3 = poor (few needles or live branches, almost dead),
- If necessary, a near tag number (tag number of the largest adjacent tree) in the **Near Tag** column (only if the previous near tag tree is dead, missing, of poor vigor, or if it is too distant to be "near").
- If the tag is being overgrown or if there is little room on the nail for future growth, use wire cutters to clip the head off the nail or to clip the tag off. Place the tag on a new nail at the same height, facing plot center. **Important**: do not pry a tag off by placing the head of a hammer against the bole of the tree; this can cause damage to the cambium/bark. If the previous (2012) comment is "NNT", replace the current temporary tag with the new tag provided in advance for this tree.
- If the tag has been overgrown and can't be removed, place a temporary tag on the tree at the same height, facing plot center, and note in the comments that the tree needs a new tag (i.e., "NNT").

2a. Live trees w/ a tag wired onto a branch (MP = B), but too small to nail at breast height

- Basal diameter (measured above any basal swell) in the **Dba** column, to the nearest 0.1 cm,
- Status = 1 in the **ST** column, as described above,
- Overall vigor in the **OV** column, as described above,
- Near tag number, if necessary, as described above.
- If the wire is old/flimsy, replace it with a zip-tie placed loosely on a side branch. If the wire may soon slip off the branch, move it to a secure position on a sturdier branch (one arching upwards).

2b. Live trees w/ a tag wired onto a branch (MP = B), but now large enough (5 cm dbh) to nail

- Remove wire/zip-tie, nail tag at breast height (1.37 m, side slope) facing plot center, then record:
- **BOTH** the basal diameter (**Dba**) and DBH (**Dbh**), as described above,
- Status = 1 in the **ST** column, as described above,
- Overall vigor in **OV** column, as described above,
- Near tag number, if necessary, as described above.

3. Tagged trees that have died since the last remeasurement

- DBA in the **Dba** column for a tree whose last measurement was DBA (tag with wire/zip-tie), or Dbh in the **Dbh** column for a tree whose last measurement was DBH (tag nailed),
- Status = 6 (present and dead) in the **ST** column,
- Leave overall vigor (**OV**) blank
- In the **Comments** column, describe the physical characteristics of the tree (e.g., broken crown, down on the ground, crushed) and **always** record the probable cause of death using the following syntax and examples: "**mort. = suppression**", "**mort. = mech. damage**" (mechanical damage), "**mort. = slope failure**", "**mort. = root rot**", or "**mort. = unknown**". Here is how we have defined the causes of mortality (extracted/modified from Lutz & Halpern 2006):

Suppression: smaller stems in subordinate canopy positions that exhibited slow growth (i.e., minimal increment in diameter since the previous measurement and minimal leader or branch growth), but no sign of physical damage or pathogen activity.

Mechanical damage resulting from wind or snow loading. This includes stems that were uprooted or snapped and stems that were snapped or crushed beneath other uprooted or broken stems.

Slope failure: uprooted stems associated with local slope failure.

Crushed by old-growth tree: stems that were crushed by an old-growth tree that fell into plot from adjacent old forest (rare; limited to a small number of plots).

Pathogens (root rot and dogwood anthracnose): two primary types of fungal pathogens were observed: root rots and dogwood anthracnose (*Discula destructiva*). Symptoms of root rot in conifers included gradual loss or chlorosis of needles in non-suppressed trees, absence of physical damage to boles or bark, and mortality often clumped in disease centers. (Although field crews were unable to identify fungal species, we revisited several infection centers in 2004 and verified presence of *Armillaria ostoyae*, a native pathogen.) Symptoms of the introduced pathogen, dogwood anthracnose, included distinctive brown spotting or senescence of leaves, with eventual dieback of twigs and entire stems.

Animal damage: stems exhibiting obvious signs of browsing damage or stripped bark/cambium.

Unknown: If insufficient evidence existed to assign a cause, mortality was recorded as "unknown".

4. Tagged trees that cannot be found

Before leaving a plot, check carefully that all trees in the plot list have been accounted for, and that all data have been recorded properly. Search for trees that have not be found. If a tag number cannot be located, there may be several explanations:

- **The tree was missing last time and remains missing (status = 9).** If a previously missing tree cannot be found a second time, leave all data columns blank and add the following comment "Still missing in 2017" (during data compilation/correction, these will be converted to dead trees, with the assumption that they died prior to the previous measurement in 2012).
- **You missed it.** Look again in the appropriate quarter and use the near tag number as a clue to where the tree might be. Sometimes, a tree is listed in the wrong quarter or the near tag is wrong. Occasionally a tree has been nailed with two tags and you have already taken data for the first. If

you find a tree with two tags and already have data recorded for the first tag, make a note in the comments column for the record of the second tag # ("**same as tree # ___, tag removed**") and leave the remaining data columns blank. Then, remove the second tag from the tree.

- **The tree is alive or has died and dropped its tag, the tree is alive but has fallen over, or the tree has been crushed by another stem or by an old-growth tree falling from adjacent forest**. In the area of the quarter where adjacent tag numbers exist, look again for a dead or fallen tree or for a tag on the ground under an untagged tree. Check if an old nail hole exists on candidate trees. If you are confident that you have found the tree (i.e., same species, quarter, ~dbh, appropriate near tag, etc.), and it is alive without a tag, retag it with a temporary tag inscribed with the original number, and take the measurement. Then add a comment about the tree condition, temporary tag, and need for a new tag (NNT). If you conclude that a missing tree is dead because you have found a candidate dead tree (upright or down), don't retag it but follow the directions for dead trees above (**3. Tagged trees that have died since the last remeasurement**); add a comment that the tag was missing and was not replaced.
- **The tree is alive, has dropped its tag, and you have "retagged" it as ingrowth (see below for Ingrowth Trees).** Return to the area of the quarter where there are Ingrowth tag numbers close in sequence. Among the recently tagged ingrowth, consider which individuals share the missing tree's characteristics (species, diameter, conditions). If you feel confident that you have found the tree (e.g., same species, reasonable diameter, next to trees with tags close in sequence) clip off the nail head, remove the ingrowth tag, and nail a temporary tag inscribed with the original tag number at the same height. Record the appropriate measurements on the **Remeasurement Form**, comment that the tag was missing but this individual was assumed to be the correct tree and that the tree needs a new tag (NNT). Finally, cross-out the entry from the **Watershed 1 and 3 Ingrowth Tree Measurement Form.**

If, after a reasonable search, a missing tree cannot be found, enter "9" in the **ST column**, leave the remaining columns blank, and add the comment, "NFAS" (not found after search). **Important:** Any changes that need to be made to the **Quarter (Q) number** (e.g., a tree was assigned to the wrong quarter), or **Species** (e.g., a tree was misidentified) should be done as follows: put a strikeout line through the incorrect quarter or species code, pencil the correct quarter or species code next to the error, circle the change to make it obvious, and add a comment in the **Comment** column about the correction.

5. Ingrowth: trees w/out tags but ≥ 1.37 m tall

Trees without tags that have reached the minimum height (or length) for measurement (1.37 m) are considered "ingrowth." Data should be recorded on the form **Watershed 1 and 3 Ingrowth Tree Measurement**. However, first check that the tree does not have a tag wired/zip-tied in an inconspicuous location, or that a tag has not fallen off and is lying on the ground. If a tag cannot be found and you are certain that the individual is an ingrowth stem, proceed as follows. **Important:** Before you tag an ingrowth tree, be sure that the same tag number does not already exist in the list of tagged trees.

1. For a small-diameter tree whose tag must be wired/zip-tied onto a side branch

- Wire/zip-tie the new non-duplicated tag onto a sturdy limb facing the plot center
- Record quarter number (**Q**) (Fig. 1); tag number (**Tag**); **Species** code; measurement point (**MP**) = B, DBA (**Diam**.), overall vigor (**OV**; as described above), and **Near tag** number (as described above). Comments on tree conditions are also helpful.

2. For a larger diameter tree whose tag can be nailed at DBH

- Nail the new non-duplicated tag at DBH facing plot center (as described above)
- Record quarter number (**Q**) (Fig. 1); tag number (**Tag**); **Species** code; measurement point (**MP**) = H,

DBH (**Diam.**) directly above the nail, overall vigor (**OV**; as described above), and **Near tag** number (as described above). Comments on tree conditions are also helpful.

Important: if there are no ingrowth trees in a plot, complete the plot header on the **Watershed 1 and 3 Ingrowth Tree Measurement Form** and write in large letters across the data portion of the page: "No ingrowth." Every plot should have an **Ingrowth Form** with header completed whether or not there are any ingrowth; this serves as a check for missing forms.

WS1: Access Points to Transects

Transects 1 and 2 (S- and N-facing slopes): From HJA HQ, take FR15, turn left at FR 1506 then an immediate right on FR 155, a short spur road. Drive to end of road, turn around and park so that you don't block others' access. Follow trail on S side of creek to access N-facing slope of Transects 1 and 2. Follow trail on N-side of creek to access south-facing slope, although it is not known where N-side trail intersects Transect 1 or Transect 2.

South side of WS1: North-facing slopes of Transects 3, 4, 5 and 6

General access: From HJA HQ, take FR 15 south ~3 miles to FR 1501 and turn left (E). Stay on the 1501 to either FR 202 or FR 2633, depending on transect as described below. *Note: FR 202 is not labeled on the HJA map but is on the USFS McKenzie Ranger District map (2010 version).*

Transect 3 – South side (**N-facing slope**): Take FR 1501 to FR 202, turn left on 202 and follow it to its end (or to the 240 spur road, which may not be drivable). Park and turn vehicle around. Walk FR 240 to its end, then continue down the ridge, W-NW for ~0.3 miles to Transect 3. Look for tree painted with "3" on left side of ridge. First plot is on ridge – watch for tree tags. Transect flagged in red.

Transect 4 – South side (**N-facing slope**): Access plots 4-1 through 4-17 from the south. Driving directions are the same as Transect 3, but park at L-curve in FR 202 (not at end of road) and look for a blue flag on small TSHE. Transect starts a little east on ridge, flagged blue and pink. Look for orange-painted "4" on tree.

Transect 5 – South side (**N-facing slope**): Driving directions same as Transect 4. Hike up, up, ridge to the east. No painted tree, but lots of red and blue flagging around plot 5-27. Plot is just downslope of ridge. Dense TSHE.

Transect 6 – Upper plots on south side (**N-facing slope**): Follow FR 1501 to FR2633, turn left (NW) on 2633 for ~0.5 miles to the intersection with FR 722 and park. Hike up 722 (not drivable) to its end, or hike the nose of the ridge along (but not through!) Transect 6 plots, then head NW (uphill) to Transect 6, Plot 26.

North side of WS1: S-facing slopes of Transects 3, 4, 5 and 6

General access: From HJA HQ, take FR 15 south ~3 miles to FR 1501 and turn left (E). Follow FR 1501 to FR 2633, turn right and follow it to parking spot just a short distance east of FR 722.

Transect 3 – North side (**S-facing slope**): – From parking spot off the 2633 road, follow old spur road (305 on HJA map, 784 on USFS map) to its end and continue down the ridge to the NW. When you reach WS2 Transect 5, follow blue flagged trail. Keep following until you reach WS2, Transect 4. WS1, Transect 3 is just past this. Orange "3" on stump, red flagged. *NOTE: the upper end of Transect 3 can also be accessed via the ridgeline uphill from the north end of Transect 2 (watch for poison oak on this route).*

Transect 4 – North side (**S-facing slope**): Access plots 4/27 through 4/18 from the north. Plot 18 is just above an unpassable cliff. From parking spot off the 2633 road, follow old spur road (305 on HJA map, 784 on USFS map) to its end and look for flagging and markers for Transect 4, Plot 27 (may see markers for WS2, Transect 3).

Transect 5 – North side (**S-facing slope**): From parking spot off the 2633, hike the old spur road (305 on HJA map, 784 on USFS map) to Plot 5/1. Look for flagging and faded orange paint on stump. Middle part of Transect 5 can be accessed by hiking cross-country W-NW from parking spot off 2633 (i.e., hike past Transect 6).

Transect 6 – The middle of Transect 6 is just ~100 m W-NW of parking spot off FR 2633. To access the north end of Transect 6, hike the old spur road (305 on HJA map, 784 on USFS map) where it crosses WS1, Transect 6 at Plot 11 (look for flagging)

WS3 Access to Harvest Units and Transects

General access: From HJA HQ, take FR 15 -> FR 1506 -> FR 1507, then either FR 305, FR 455 or FR 465.

Unit 1: FR 305 (off the 1507) leads to the bottom of Unit 1 but is washed out. Drive as far as reasonably possible on 305, turn vehicle around, and park alongside road. Walk the remaining distance along road (< ¼ mile). Transects 2, 3, and 4 re-flagged at both ends and at stream bottom.

Unit 2: Take FR 1507 to FR 465 to access upper ends of all four transects. Watch for flagging at ends of all transects as you drive or walk by (note: not clear how far you can drive on FR 465). Park anywhere it is safe and easy to turn around.

Unit 3: Take FR 1507 to FR 455 and drive as far as possible on 455, turn around and park. Both ends of Transect 1 flagged red. Big tree down at the start of Transect 1; it extends into Plots 1 and 2 and can be used to access both plots. Flagged from road to end of Transect #2 (wash-out plot). Also flagged from end of Transect #1 to end of Transect #2 (red).

Table 1. WS1/3 Biomass-Related Parameters to Measure (2017)

Herbs

1. DBA and individual stem heights: ARCA3, LOCI, LOCR, XETE

Ferns

1. Length, number of fronds, and modal height of fronds: ADPE, ATFI, BLSP, CYFR, POGL4

2. DBA, number of fronds, and modal height of fronds: PTAQ

3. Modal height of fronds only: POMU

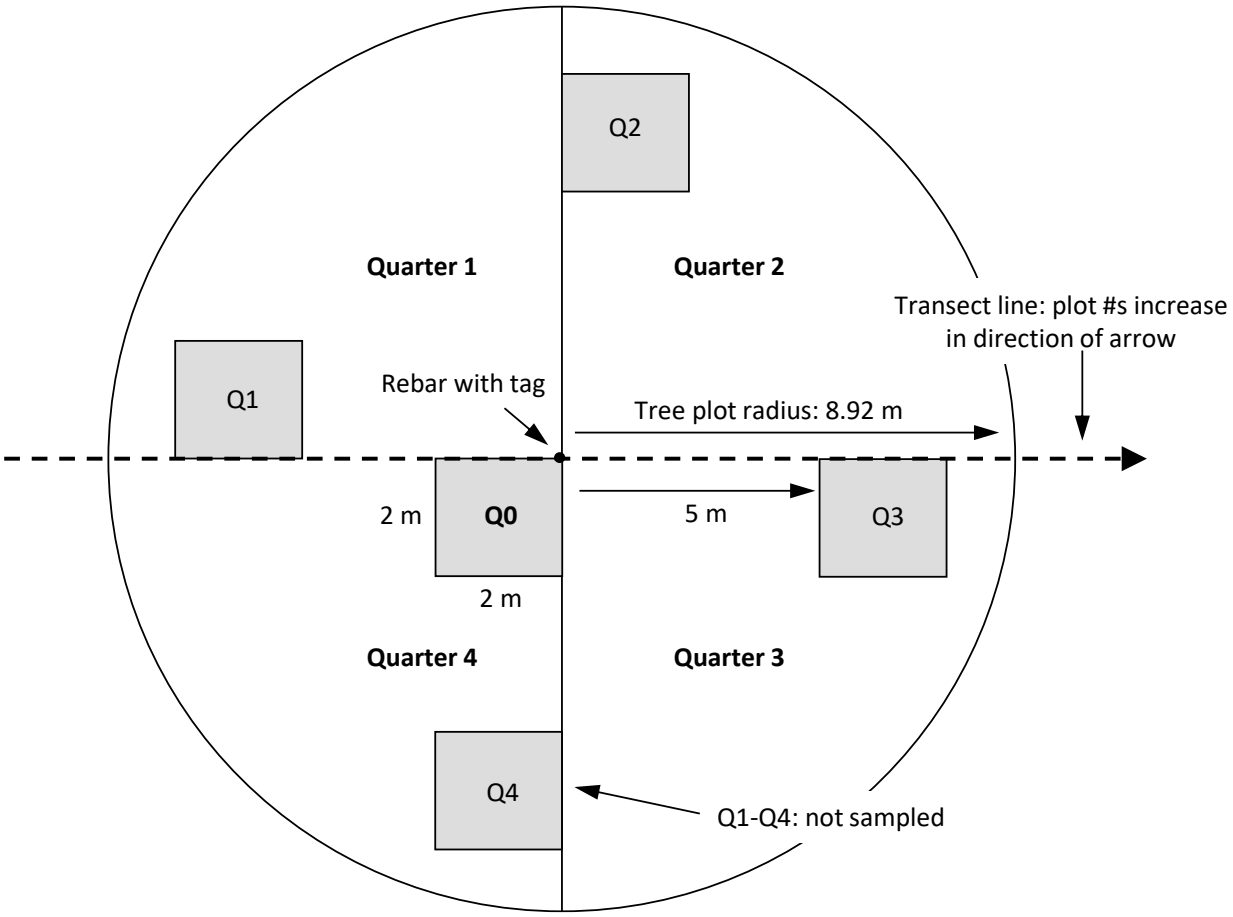
Tall shrubs

1. No DBA; modal height of stems only: RUPA

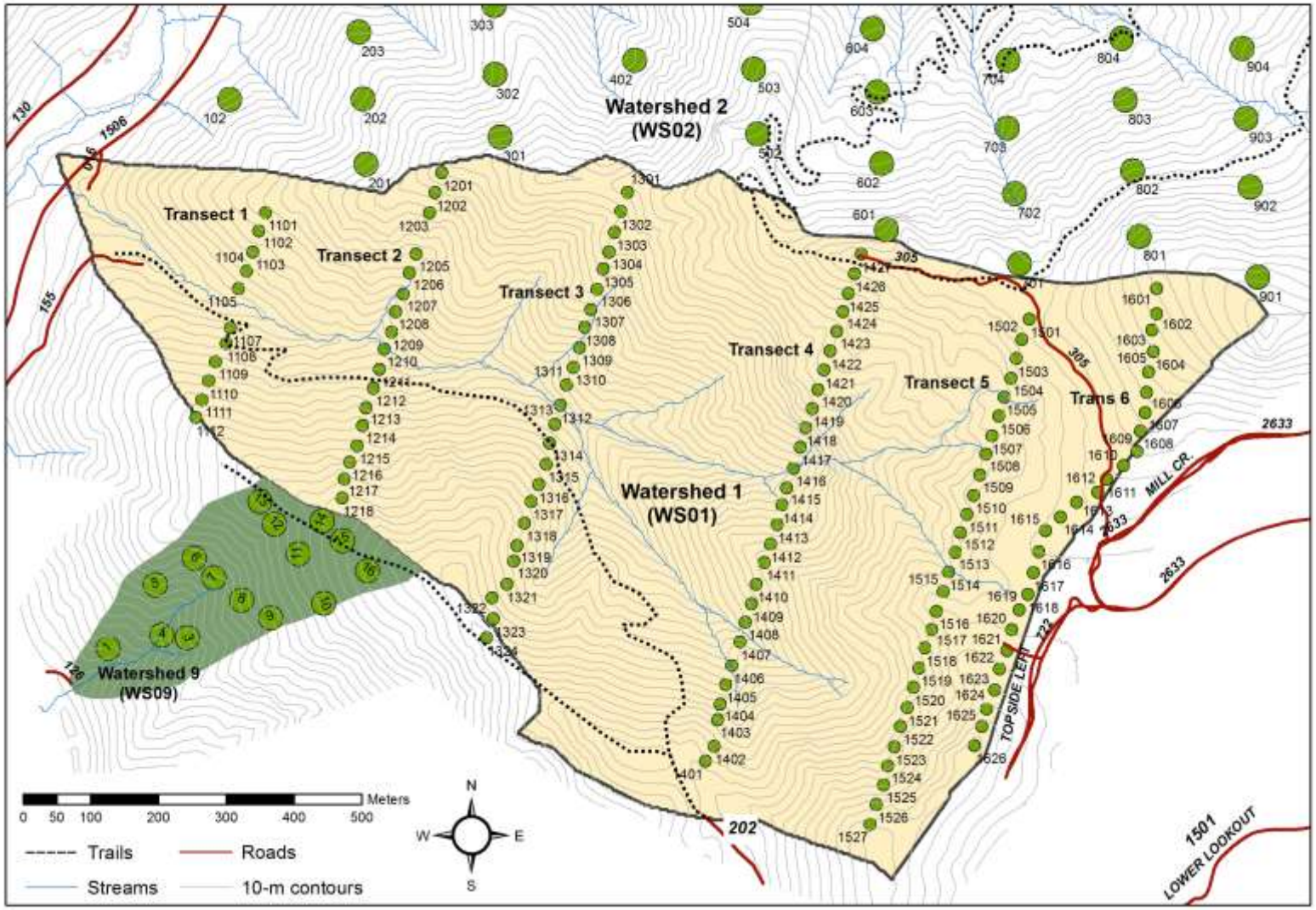
2. DBA and modal height of stems: ACCI, ACGL, ALSI, AMAL, ARCO3, CESA, COCOC, GAFR, HODI, OECE, RHDI RHMA, RIBES, RILA, RISA, ROGY, SACE, SALIX, SASC, SASI2, VAME

3. DBA and individual stem heights: CEVE

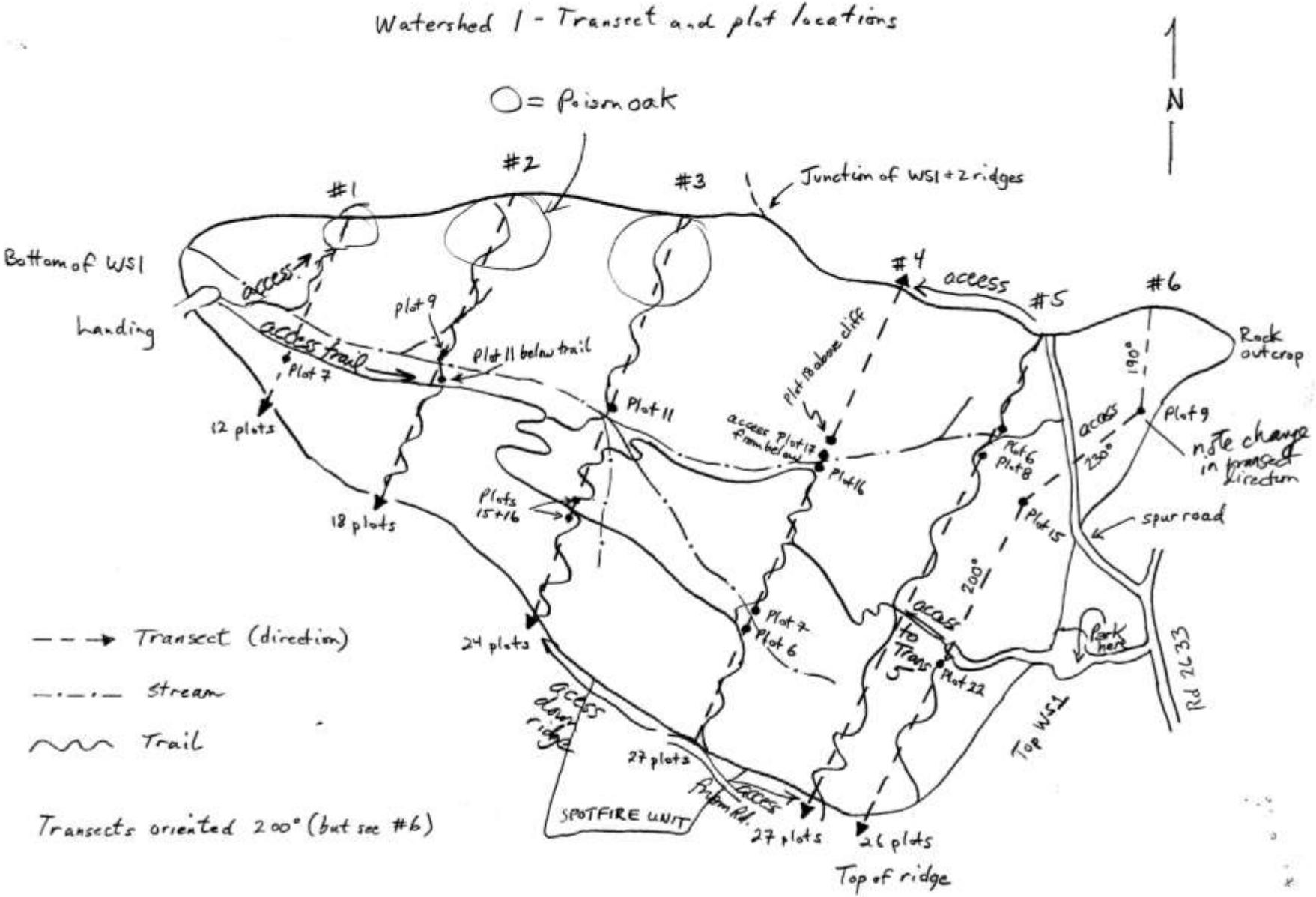
Fig. 1. WS1/3 Tree Plot and Understory Quadrats

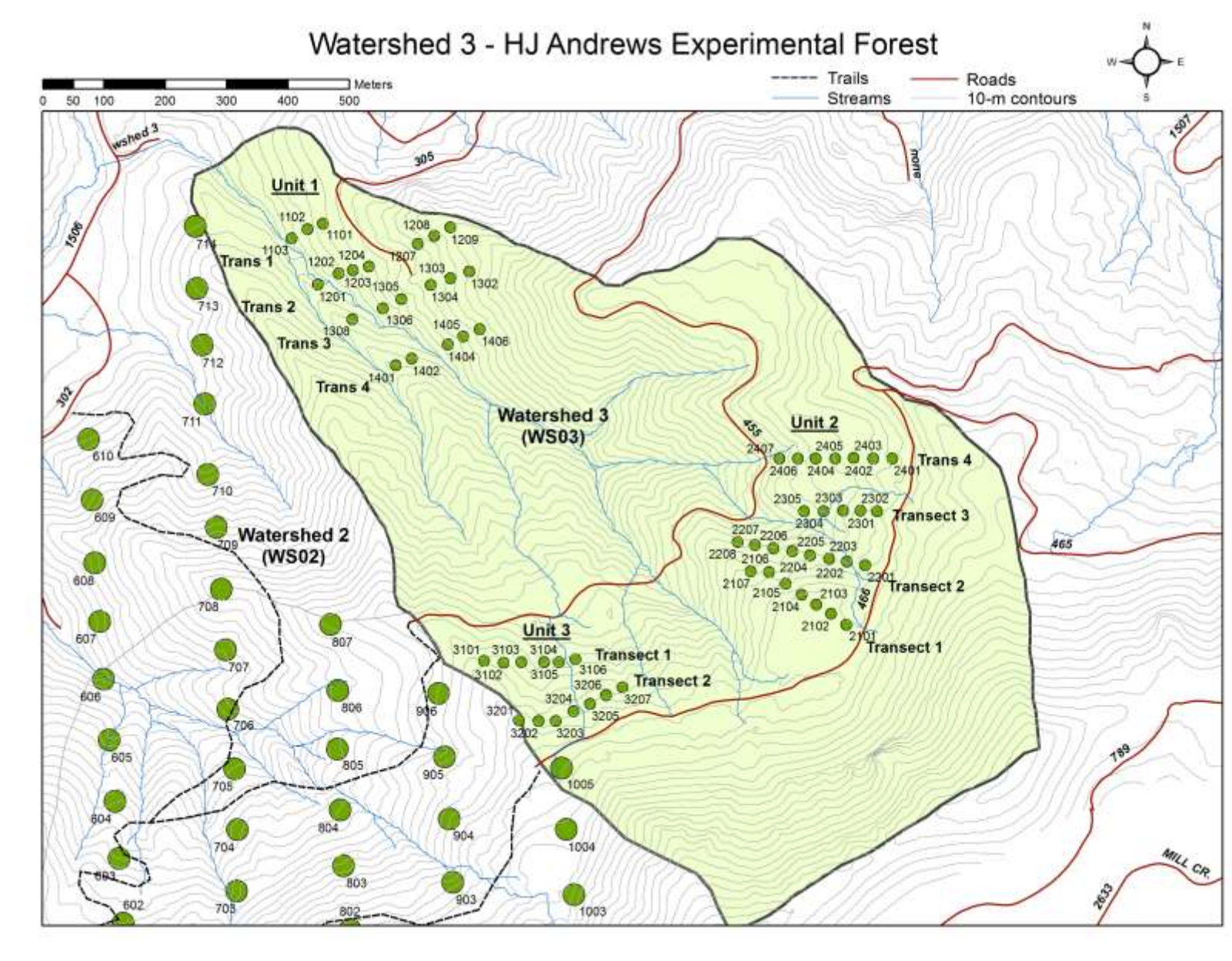


Watershed 1 - HJ Andrews Experimental Forest



WS1 Annotated Transect and Plot Map




Watershed 3 - HJ Andrews Experimental Forest
Meters
0 50 100 200 300 400 500
Trails
Streams
Roads
10-m contours
N
W
E
S
Unit 1
Trans 1
Trans 2
Trans 3
Trans 4
Watershed 3
(WS03)
Unit 2
Trans 4
Transect 3
Transect 2
Transect 1
Unit 3
Transect 1
Transect 2
Watershed 2
(WS02)
305
1506
1507
455
465
466
789
2633
MILL CR.

WS3 Annotated Transect and Plot Map