SCBI-ForestGEO Tree Health and Mortality Census Protocol 2022

Supplies

- ☐ iPad - set up with FastField and maps (GitHub issue #6)
- ☐ DBH tape, calipers
- ☐ phone with clinometer app, or physical clinometer. I assume this could also be installed on the iPads.
- ☐ Binoculars, IMPORTANT to check live status of very tall trees and to distinguish between leaves of lianas or tree under inspection.
- ☐ Printed copies of visual guides, if desired (these could also be loaded on iPad)
- ☐ List of tree species codes, available here, if desired
- ☐ Personal gear/ safety equipment

Procedure

Plot Navigation & Tree Location

At the SCBI plot, a blue re-bar located in the SW corner gives the quadrat name (3 or 4 digits). Locate the rebar and orientate yourself (N-S). Coordinates (x, y) are given in reference to a 20x20m square. We have prepared maps of each quadrat with the trees to be censused and their status in the previous census (in GitHub/ Dropbox under Doc/Maps). It is important to **locate and complete census for all trees within the quadrat you are working on before moving to the next quadrat**.

To find a tree, review info (species, size, position) of tree for which you're searching. Locate the based on x-y coordinates and/or map, check tag to ensure you've got the right tree.

If you can't find a tree: (1) double check that quadrat matches data sheet/ Fastfield App (2) look on the ground for fallen trees/ lost tags (3) sometimes x and y coordinates get switched, so try switching and see if you find it (note wrong coordinates) (4) check trees that otherwise don't seem to match what you're looking for (5) if a thorough search yields nothing, record it as not found **DN** status, or "Dead not found" in FastField App. Avoid giving a tree the DN status; you need to do a thorough search for all trees on the list. *One of the challenges of this survey is getting frustrated when you can't find those little ash trees and wanting to give up. The solution is to go back another day or week with a fresh mind set and you'll usually find them. Sometimes they're just a stick on the ground, but they're there!*

Data Entry in FastField

Status **Alive (A)**= live with no FADs (see below), wounds, cankers, or rot. **Alive Unhealthy (AU)** = living but unhealthy ($\geq$ 1 FAD, possibly wounds, cankers, or rot). **Dead Standing (DS)** = dead with no living foliage above breast height (can be dead with resprouts; see below). **Dead on the ground (DC)** = dead (no living foliage) and fallen. Note: a tree that has fallen but has living foliage is AU. **Dead not found (DN)** = neither stem nor tag could not be found following a *thorough* search. Presumed dead.

Guide to measurements needed based on status:

If the status us "A": (1) Mark status (2) Record crown position (3) Record percentage of crown still intact (%) (4) Record percentage of crown living

If the status is "AU": (1) Record FADs in order of importance* (at least 1 factor)- See FAD codes below. (2) Record crown position. (3) Record percentage of crown still intact (%). (4) Record percentage of crown living (5) Record lean angle (if leaning > 15°) (6) Record liana load. (7) Record wound, canker, or rot categories (if applicable) (8) Take pictures: Take a picture of alive unhealthy tree if picture appropriately captures FAD.

For example, take picture of wounds to main bole, but not of leaf damage high in canopy. Take a picture of the tag first then make 2-3 pics of main FADS. Make nice close-ups if any insect or insect galleries are found.

If the status is "DS" & previously "A": (1) Record FADs in order of importance (at least 1 factor)- See FAD codes below. (2) Record crown position *and* "Dead crown position". (3) Measure and record DBH (mm) (4) Record Percentage of crown still intact (%). (5) Record percentage of crown living (%) (6) Record lean angle (if leaning $> 15°$) (7) Record liana load. (8) Record wound, canker, or rot categories (if applicable) (9) Take pictures: Take a picture of dead tree if picture appropriately captures FAD. Take a picture of the tag first then make 2-3 pics of main FADS. Make nice close-ups if any insect or insect galleries are found.

If the status is "DC" & previously "A": (1) Record FADs in order of importance (at least 1 factor)- See FAD codes below. (2) Record Percentage of crown still intact (%). (3) Record percentage of crown living (%) (4) Measure and record DBH (mm) (5) Record liana load. (6) Record wound, canker, or rot categories (if applicable) (7) Take pictures: Take a picture of dead tree if picture appropriately captures FAD. Take a picture of the tag first then make 2-3 pics of main FADS. Make nice close-ups if any insect or insect galleries are found.

If the status is "DS" & previously "DS": (1) Mark status (2) Record crown position* *and* "Dead crown position". (3) Record percentage of crown still intact (%) *(4) Record percentage of crown living (%)* (5) Record lean angle (if leaning $> 15\hat{}\circ$) *(6) Record liana load.* *record this information for remote sensing/crown delineation purposes

If the status is "DC" & previously "DS" or "DC": Record status and continue.

–Additional Fields–

***DWR* (Dead with resprouts)** If the tree is dead but with living resprouts at its base, record as yes. Otherwise, leave as is.

Crown Position (aka Crown Illumination Index) **5** = Canopy completely exposed to overhead and lateral light; **4** = Full overhead light; $>$ 90% exposed to vertical light; **3** = some overhead light; **2** = Lateral light; $<$ 10% exposed to vertical light; **1** = No direct light; only receives light filtered through other trees

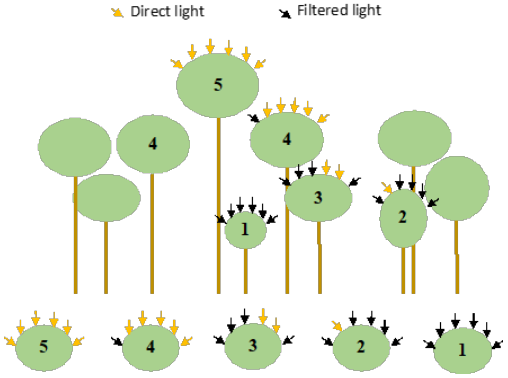

Figure 1: *Crown Position (a.k.a., "Crown illumination"; taken from Arellano et al., 2020)*

Dead Crown Position (collected on dead trees only) **Dominant (D)**: Crown extends above the general level of the canopy receiving full sunlight. **Codominant (CD)**: Crown forms main level of canopy, tree receives full sunlight from above. **Intermediate (I)**: Shorter trees with smaller crowns, receive little light from above and none from sides. **Suppressed (S)**: Crown below canopy, small crown receives no direct light. **Open grown (OG)**: Crown on open areas of the stand.

Dead DBH (diameter breast height in mm; collected on dead trees only) If a tree is dead, you will be prompted for a DBH measurement. Measure DBH, being sure to report **units in mm**. If a stem

has fallen and it's DBH can't be measured with a tape, measure it later using a big caliper (find one in Radiotracking lab - Office Annex building).

Percentage of Crown Intact This is the percent of the crown intact.

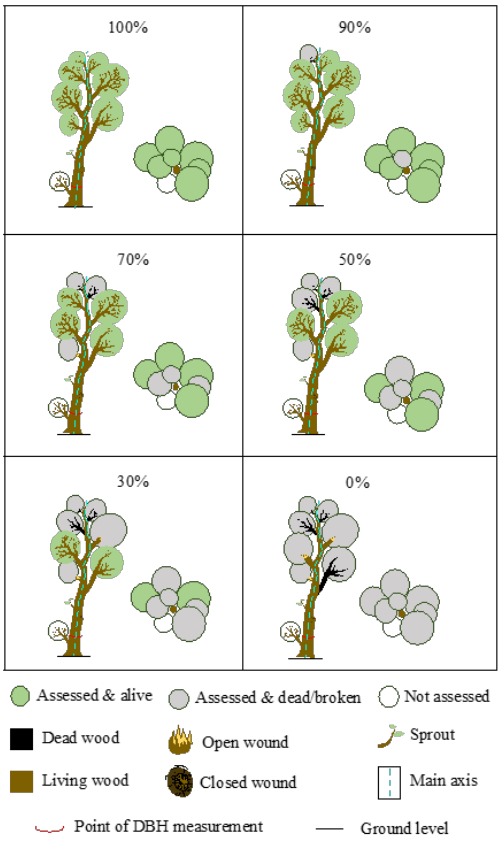

Figure 2: Crown Assessment (taken from Arellano et al., 2020). Top left is 100% crown intact and 100% crown living, top right—100% intact and 90% living, middle left—90% intact and 70% living, middle right—90% intact and 50% living, bottom left—70% intact and 30% living, bottom right—40% intact and 0% living

Percentage of Crown Living Percentage of crown living (indicated by live foliage). **This is relative to an 100% intact crown, and therefore should be $\leq$ Percentage of Crown Intact.**

Lean angle (%) If tree is still rooted and is leaning, estimate the angle of lean in degrees from vertical. This angle is measured in degrees from the base through the POM

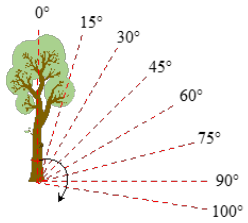

Figure 3: Lean angle (Taken from Arellano et al., 2020)

Liana load in tree crown (levels: 0 – 4) **0** = lianas absent *from tree crown* (category includes trees with lianas present only on trunk) **1** = up to 25% of the tree crown covered by lianas **2** = 26–50% liana cover **3** = 51–75% liana cover **4** = 76–100% liana cover.

***FAD* (Factors Associated with Death/Decline)**

- Record Factors associated with death (FAD) ***in order of importance*** (will be listed in order selected).
- To scrutinize the FAD's, look at our Tree Disease Guide and Visual Guides.
- For tree conditions or agents of mortality not specifically defined below, record diagnosis in the notes or comments section of the form.

FAD list :

U = Unable to determine cause of death

Mechanical Damage:

B = Broken stem (note cause, indicate level on tree); **CR = Crushed by other tree or tree parts**; **UP = Uprooted Tree** (root system exposed); **S = Slope failure** (evident landslide even if small. rare at SCBI); **L = Lightning** (tree splitting, straight scars from above); **FI = Fire** (stem charred, fire scars on bark. not expected at SCBI);

Biological agents:

AN = Animal Damage (this category excludes insects. specify animal in notes if possible); **BB = Bark beetles** (in the subfamily Scolytinae) and/or beetle galleries present. (At SCBI, elm bark beetles are in this category, but EAB are not.) *Note: BB is a sub-catagory of I, and it is not necessary to mark I if BB is selected.*); **I = Insect infection** *other than BB (bark beetles in subfamily Scolytinae* (e.g., EAB); **DF = Complete defoliation for a portion of stem** (record crown condition using Smith/Flower method below 1-5 scale); **F = Fungi visible** (includes fruiting mushroom bodies, fungal mats, and discoloration inside wounds or cankers. if canker is present, also record K. if would is present, record W. note that Armillaria root disease is its own category); **K = Canker or swelling present** (if fungi is visible, also record F. if open wound, also record W); **LF = Leaf damage** (Leaf spots, blotch, mildew, discoloration etc.); **W = Wound** (any situation where the bark has been removed and wood is exposed to the air or soil. not mutually exclusive with F or K); **R = Rotting stem**; **R1 = Root damage**; **R2 = Armillaria root disease** (subcateogry of F; including F not needed)

Wounded main axis (levels: 1 = small, 2 = large, 3 = massive) Size of wound on main trunk. **1** = small damage, smaller in area than a square of DBH × DBH in shape. **2** = large damage, greater in area than a square of DBH × DBH in shape. **3** = massive damage, affecting >50% of the basal area (i.e., a very deep and extensive wound) or >50% of the living length. These are cases of main stem breakage in which the breakage is not complete and the broken part is still connected and alive, and trunks that have been longitudinally split in two.

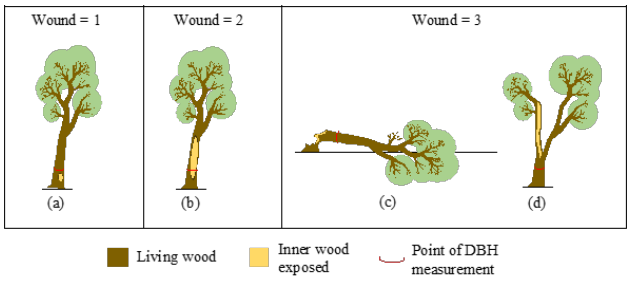

Figure 4: Schematic of wound size (taken from Arellano et al., 2020)

Swelling, deformity (levels: 1 = small, 2 = large, 3 = massive) Size of patch of swelling/deformity on trunk. Note: swelling or deformity is commonly caused by a canker. **1** = small canker/ deformity area, smaller in area than a square of DBH × DBH in shape. **2**= big canker/ deformity, greater in area than a square of DBH × DBH in shape. **3** = massive deformity or canker, greater than >50% of the basal area or >50% of the main axis length.

Rotting trunk (levels: 1 = small, 2 = large, 3 = massive) Size of patch of rot (hollow) on/ in trunk. This may be caused by a canker/ fungal infection. **1** = small rotting area, smaller in area than a square of DBH × DBH in shape. **2** = big rotting area, greater in area than a square of DBH × DBH in shape. **3** = massive rotting, affecting >50% of the basal area or >50% of the main axis length.

Notes Record any relevant info for which there's no place in the form:

- Disease/ decline symptoms, or important details about these, not recorded in fields
- Plot/previous data problems: incorrect coordinates, missing tree tags, suspected problems with previous data
- Sometimes a tree recorded dead in a previous year is "back to life". If a dead tree is alive in the current census (meaning you are 100% sure it is alive), mark the tree as **A** or **AU** and make a note in comments.

Take photos Take a picture of every unhealthy or dead tree found. Include photos of all factors associated with death (FADs). Make nice close-ups if any insect or insect galleries are found.

Emerald Ash Borer Add-ons

EAB crown thinning **1** = no sign of defoliation/ leaf loss **2** = slight reduction in leaf density (thinning), yet all top branches exposed to sunlight have leaves **3** = thinning canopy and some top branches exposed to sunlight are defoliated (<50% dieback) **4** = >50% defoliation/dieback **5** = No leaves in canopy other than epicormic sprouting

Figure 5: Guide to estimating EAB crown thinning via visual assessment per Smith/Flower 2013:

EAB Epicormic growth Evaluate using 6-class rating system (see figure).

EABF (Emerald Ash Borer Factors) **VB** = Vertical bark splitting, **SS** = Stump sprouts, **AS** = Ash snap of the branches/limbs, **W** = Bark blonding from woodpecker predation. In comment section, write percentage estimate. **DE** = D-shaped exit hole presence.

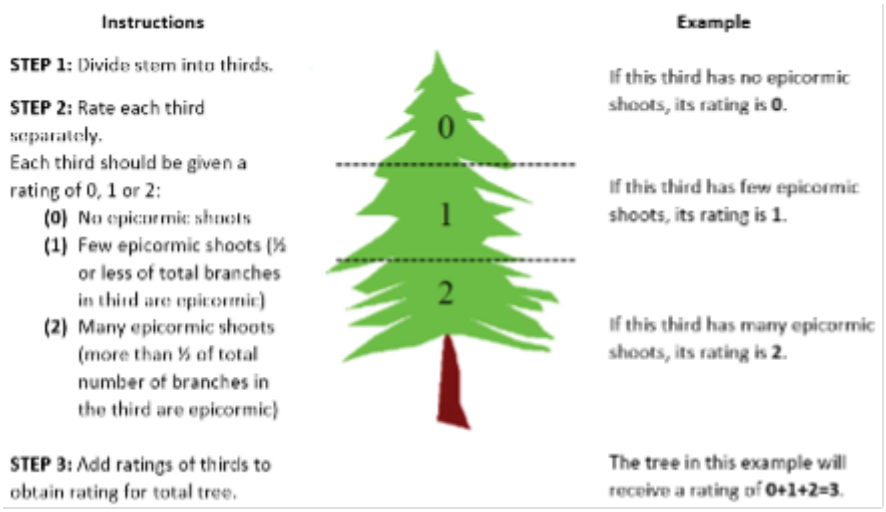

Figure 6: 6-class dwarf mistletoe rating system (Hawksworth 1977) to evaluate epicormic growth

D-shaped exit hole count Count all visible D-shaped holes around the circumference of the tree in an area 50 cm high at breast height and record this number. At SCBI almost all tags are located at 1.3 m, so use the tag as reference to visually define the 50 cm area. That is, search for DE all the way around the tree between 1.05 and 1.55m height.

Coring of Dead Trees

If time allows, cores will be taken at the end of survey and saved for future analyses.

Target species: ceca, amar, cofl, ploc, prav, rops, saal, and all Quercus.

Follow steps in document "Coring_instructions_SCBI" located in 'Protocol' folder.

We will need to take data on trees cored (instructions to be determined later).

Changes from previous years

- PD (previously dead) is no longer an option in FastField (was not in 2021 protocol)