ASSESSING EXTENT AND SEVERITY OF MECHANICAL INJURIES IN TREES

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Assessing new mechanical injuries present in a tree using visual, non-invasive observations is difficult and prone to wild variability, inaccuracy, and assessor subjectivity. Assessment of relative damage levels is valuable when precision allows for comparisons across one site and over many sites. Judging recent mechanical injuries from visual criteria, although imperfect, can help gauge the relative amount of damaged tissue visible and estimate the total amount of damaged tissue present.

This assessment tool determines new injury extent, severity, and position in the tree. This tool depends upon a tree-literate, knowledgeable assessor evaluating the injury area and the entire cross-sectional area where the injury occurs. This concept is derived from static strength (bending and twisting) equations used in engineering where the weakest point of the cross section is the location of any failure. In a living, reacting tree, with a highly variable injury history, and under dynamic loading this concept is at best incomplete. This assessment method does help develop discipline, consistency, and observational skills in training assessors. This method can also help quantify, on a relative basis, the extent and severity of recent tree injuries.

The measures needed for using this assessment method are listed below. Please be sure to remain consistent in the use of units of measure. For example, use inches, in^2, and in^3 -- do not mix units of measure.

Determine and record the following items in the field --

1. Diameter of stem or branch at site of recent injury:
   A. If the stem / branch area that includes the injury area has little or no taper along its longitudinal axis then measure the mid-injury diameter of the stem / branch. (midDIAMETER)
   B. If the stem / branch area that includes the injury area has significant taper along its longitudinal axis, from injury top to bottom, then measure the diameter of the stem / branch at the top and bottom of injury. (topDIAMETER & bottomDIAMETER)
2. Dimensions of the new injury:
   A. Total linear height or length (along longitudinal axis) of injury on stem / branch. (injuryHEIGHT)
   B. Total linear width (perpendicular to longitudinal axis) of injury -- not circumference of injury area. (injuryWIDTH)
   C. Depth of injury at deepest point (as best as can be determined or estimated). (injuryDEPTH)
3. Estimate number of annual rings and tissue types breached in the injury.
4. Location of the injury section in the tree. (Figure 1)
5. Species of tree -- attempt to gauge effectiveness and efficiency of tree reactions to injury.

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To determine the DAMAGE ASSESSMENT VALUE for a tree:

STEP 1A: Determine stem / branch whole segment volume (no taper) =

injuryHEIGHT * 0.785 * (midDIAMETER)

STEP 1B: Determine stem / branch whole segment volume (significant taper) =

injuryHEIGHT * 0.262 * (topDIAMETER) +
0.785 * (bottomDIAMETER) +
SQUARE ROOT (0.616 * (topDIAMETER) * (bottomDIAMETER)2).

STEP 2: Determine injury segment volume (ellipsoidal shape factor) =

0.5 * injuryHEIGHT * injuryWIDTH * injuryDEPTH.

STEP 3: Determine DAMAGE EXTENT SCORE =

VOLUME of injury segment (STEP 2) / VOLUME of whole segment (STEP 1)

STEP 4: Determine DAMAGE SEVERITY SCORE. Estimate the number of annual rings and tissue types breached in an injury.

Select one description that most fully matches the depth of the injury.

1. Bark to xylem (score = 0)
2. Expanded growing points, one, or two year old xylem (score = 1)
3. Three to seven year old xylem -- 100% sapwood (score = 2)
4. Seven year old xylem to end of sapwood -- 100% sapwood (score = 5)
5. Heartwood (score = 11)
6. Existing damage-modified heartwood and discoloration / decay columns (score = 23)

STEP 5: Determine injury location in the tree.

1. Root collar / stem base area -- two feet out and four feet up (score = 7)
2. Root plate area -- zone of rapid tapering (ZRT) of pedestal roots or roots that support the tree under compression -- see TOOL # 7 (score = 6)
3. Stem base of the live crown (score = 5)
4. Stem / trunk (score = 4)
5. Injury into reaction wood on basal l/4 of the length of primary scaffold branches -- upper side tension wood in angiosperms / lower side compression wood in non-angiosperms (score = 3)
6. Ground contact / rain splash / direct irrigation wetting area (score = 2)
7. South and southwest exposure with full sun (score = 1)

Location numbers l-5 are unique positions and are non-additive (Figure 1). Locations 6 and 7 are additive with other location scores. These scores comprise the DAMAGE LOCATION SCORE.

STEP 6: DAMAGE ASSESSMENT VALUE =

DAMAGE EXTENT SCORE +
DAMAGE SEVERITY SCORE +
DAMAGE LOCATION SCORE

The resulting value, DAMAGE ASSESSMENT VALUE, represents a relative injury number that can be used for quantifying, evaluating, and comparing injuries (and causal agents / processes) across one site or many sites. For example, the DAMAGE ASSESSMENT VALUE can be used in judging construction injuries.

The final DAMAGE ASSESSMENT VALUE, and its meaning within current management objectives, should be carefully considered in regards to species. Some species react well to injury and others do not. The final DAMAGE ASSESSMENT VALUE should always be tempered with species understandings, given the injury(ies) present. Including a general species number in the damage scoring system as an additive (multiple) value, however, inserts unneeded imprecision and ignores individual tree genetics and environmental interactions that generate acclimatization, adaptability, tolerance and resistance processes. Species and individual tree differences do play a critical role in setting management objectives for an area and acceptance thresholds / tree removal decisions using the DAMAGE ASSESSMENT VALUE.

For trees with multiple injuries, begin scoring with the largest injury and the injury closest to the stem / branch base. Once a given management threshold has been surpassed, tree removal should be considered. For long-term tree quality, suggested threshold values for increasing managerial notice should occur at 15,22.5, and greater than 30. Removal should be considered at a DAMAGE ASSESSMENT VALUE of 3 1 and above. Changing management objectives and risk consequences should demand modification of threshold values on a periodic basis.

Note that the DAMAGE ASSESSMENT VALUE is not predictive by itself, for judging structural failures, risk levels, or biological health. The DAMAGE ASSESSMENT VALUE is a relative value that is part of a total quality management of trees (TTQM) program. Remember that the DAMAGE ASSESSMENT VALUE is also a static, one-time “snap-shot” of the tree, and its visually apparent history, and can not represent dynamic processes and their rates of change. This assessment system will underestimate the extent and severity of older injuries where compounding structural faults and pathological processes have expanded the tissues involved.

Assessing recent injuries to trees in a consistent and disciplined manner can be valuable to site and tree management. This assessment system can help estimate the extent and severity of injuries across different locations within a tree in order to assist with quantifying and formalizing information.

FIGURE 1: Diagram of DAMAGE LOCATION SCORES (STEP 5) for problem areas #1-5 in trees.

#l. Root collar / stem base area -- two feet out and four feet up (score = 7)

#2. Root plate area -- zone of rapid tapering (ZRT) of pedestal roots or roots that support the tree under compression -- see TOOL # 7 (score = 6)

#3. Stem base of the live crown (score = 5)

#4. Stem /trunk (score = 4)

#5. Injury into reaction wood on the basal l/4 of the primary scaffold branches length -- upper-side tension wood in angiosperms / lower-side compression wood in non-angiosperms (score = 3)

(Note: The scores from these problem areas (#l-5) are non-additive. In addition, there are two more location damage scores that are additive(#6-7) and listed in the text.)