TECHNOLOGY TRANSFER NOTES
Forestry Research Applications Pacific Forestry Centre No.3 September, 1997

A Review of Tree Wounding

R. J. Nevill

Strategic Importance

Tree wounding can cause stem deformity and decay and significantly effect final crop volume and value. Partial harvesting systems and intensive forest management require multiple stand entries, thereby increasing the probability of injury to residual stems. All wounds, regardless of cause, are susceptible to decay. Wounding can be categorized in two ways: direct injury occurring during harvest and indirect injury resulting from stand management. Designing stand management and harvest entries to reduce injuries will avoid loss of fiber and value.

Wounded trees frequently have more than one injury and the cumulative effect of decay on lumber grade and value may be greater than volume losses alone.

Wounding affects crop quality and value.

Tree Response to Injury

Wounds are common events in the life of trees. A wound occurs every time a branch is lost or the xylem is exposed through a break in the bark. These wounds may lead to discoloration and decay. Trees compartmentalize wounds by forming barriers that limit the decay column to the tree's diameter at the time of injury. The decay does not usually expand into new sapwood formed after the wound occurs unless an additional injury takes place.

Closure of wounds occurs as the result of callus formation by the vascular cambium. After wound closure, the advance of discoloration and decay ceases unless further damage to the cambium occurs. Over time, trees may sustain multiple wounds with resultant overlapping regions of discoloration and decay.

There are two types of visible decay indicators: 1) conks or punk knots, and 2) indicators of infection courts such as wounds, scars, frost cracks, crooks, forks, dead mistletoe brooms, dead or broken tops, and large dead vertical branches. However, not all trees with decay have visible symptoms.

Factors Affecting Decay Development

The incidence and extent of decay in trees is highly variable and depends on many factors including species, location of wound on the stem, size and season of injury, age of wounds, stand dynamics and decay organism(s). In addition to providing possible entrances for decay organisms, wounds may also represent future grading defects. This is important where timber quality is a primary goal of partial cutting.

Natural Resources Canada
Canadian Forest Service
Ressources naturelles Canada
Service canadien des forêts
Canada

Tree Species

Generally, thin-barked species such as true firs and hemlocks are more prone to injury and decay than thick-barked species with resinous wood such as Douglas-fir. For example, in a comparison of interior tree species, Subalpine fir had three times the decay volume of Engelmann spruce, interior Douglas-fir and lodgepole pine. Lodgepole pine is a thin-barked species that appears to be an exception and shows little decay even 15 years after wounding has taken place.

Location of Injury

Many studies have reported that root wounds or wounds near or in contact with the soil are more readily infected by decay fungi than those occurring above breast height (1.3 m). Injuries higher in the stem may also become infected, but the frequency of decay generally declines as the height of the wound increases. This relationship appears to be true for both large and small wounds.

Size and Shape of Injury

Wound size is one of the most important characteristics related to decay. Wounds larger than 900 square centimeters (1 ft^2) have twice the likelihood of becoming decayed than smaller wounds, regardless of species. For some species, such as larch, most wounds greater than 400 cm^2 become decayed. The shape of wounds are also important determinants of decay severity. Wide scars result in greater decay loss (at least double) than long, narrow scars. Deep wounds or wounds with splintered wood also have more decay than smooth wounds.

Age of Injury

Together with size and location, wound age is most closely correlated with decay volume. Wounds less than 10 years old are unimportant for most tree species as decay organisms have not had sufficient time to develop. After 10 years, the percentage of wounds with decay increases regardless of tree species or wound size.

Season of Injury

Logging injuries occurring in the spring are often larger than those occurring at other times of the year. Many reports refer to spring through early summer as "the sap season"; the time when the sap is actively flowing and the bark is known to be loose and easily damaged. Thinning activities, especially in stands of thin-barked species such as western hemlock, should be avoided during “sap season”.

Direct and Indirect Injury

Injury to residual crop trees may be either direct, indirect or both. Direct injury occurs during harvest and includes broken tops, branches and stem injury. Indirect injury occurs after harvesting has been completed and includes sunscald, windthrow, mistletoe, or an increase in root disease-caused mortality.

Direct Injury

Generally, damage to the residual stand increases with increasing size and type of equipment used, number of stand entries and the amount of equipment movement within the stand. However, the extent of residual stand damage is often largely dependent on the skills and decisions of harvesting personnel.

Felling

Comparisons of damage to the residual stand resulting from manual and mechanical felling suggest that manual felling with a chainsaw may cause less damage. However, damage also varies with the silvicultural system and the method of extraction. Often any reduction in damage resulting from chainsaw felling is offset by a poorly planned or carried out skidding operation.

Skidding

Studies comparing damage caused by ground skidding to cable yarding systems show that both systems may result in damage to the residual trees.

Silvicultural systems

Harvesting systems may influence both damage during harvest and indirect damage occurring after harvest. Silvicultural systems that require repeated movement within the stand pose the greatest risk of injury to the residual stand. Single tree selection systems pose the highest risk to residual trees. Other systems such as shelterwood and green tree retention systems may also result in injury to residual trees. However, if residual trees are removed within 10 years of initial harvest, decay will not be excessive. Group selection systems present the lowest risk of injury and stem decay to residual trees as there is more space for felling and skidding operations.

Thinning

Damage to residual trees is often influenced by cutting intensity. This may also influence the type of injury. A light thinning, (e.g. removing less than 30% of the basal area of the stand), results in the highest number of injuries and subsequent decay. By contrast, a heavy thinning, (e.g. removing more than 45% of the basal area of the stand), results in fewer injuries.

Indirect Injury

Indirect injuries may not be as obvious as direct injuries but are important to long-term health of stands.

Sunscald

Sunscald typically results when the trunk of thin-barked species, such as western hemlock, is suddenly exposed to full sunlight. Sunscald lesions on western hemlock occur on the southwest face of the stem and are almost always associated with decay. Other species at risk include lodgepole pine and young Douglas-fir. Sunscald is often greater in heavily cut stands than in lightly cut stands.

Windthrow

Windthrow, or the possibility of windthrow, must be considered in any partial-cut management scheme. In addition to the immediate loss of basal area, falling trees strike and injure those that remain and open the stand to further windfall and sunscald.

Dwarf mistletoe

Partial-harvest systems, such as shelterwood, are particularly inappropriate in stands infected with mistletoe due to the manner in which the disease spreads. Dwarf mistletoe is a parasitic plant whose fruits are forcibly ejected for distances up to 10 m. Seeds are covered with a gelatinous material which facilitates movement from needles to branches where infection takes place. Young trees may be killed quickly, while older trees with well developed crowns may not show appreciable effects for years.

Root Disease

Partial cutting should not be prescribed for stands with root disease. The stumps in partially-cut or thinned stands can serve as a food base for root disease fungi such as *Armillaria ostoyae* and may cause mortality to the residual stand. Root wounds and basal scars can also serve as entry courts for other root disease fungi such as *Heterobasidion annosum* or *Innonotus tomentosus*.

Guidelines for Reducing Wounding

The most effective way to reduce decay and resulting volume losses in residual trees is to minimize wounding during stand management activities. This requires not only good planning and logging practices, but the cooperation of the contractor and well-trained personnel.

Harvest planning and layout should occur simultaneously. The logging plan must include factors such as volume removal and logging system requirements. Skid trails or cable yarding corridors should be laid out before felling and should be compatible with the terrain. Much of the damage to the residual stand is dependent on the efforts of logging personnel. Thinning crews must have a working knowledge of felling and skidding techniques that minimize stand damage. Additional training is often necessary.

Action Prior To Harvest

The following recommendations to reduce stand damage during harvest are summarized from several reports.

1. **Restrict the operating season**: Harvest should not be conducted during spring and early summer when sap is flowing and bark is not tight; trees wound easily and injuries are often larger.

2. **Consider local environmental conditions**: When considering stand management options in locations with high wind risk, removal of more than 25% of stand volume may result in excessive losses due to windfall.

3. **Gain the cooperation of operators**: Operators must be convinced that most damage to residual trees is unnecessary and avoidable. Both training and supervision may be necessary to provide desired results.

4. **Match size and type of equipment**: Operators can minimize wounding by matching the size and type of equipment to topography, tree size, soil type and site conditions.

5. **Plan skid trails prior to logging**: Use straight-line skid trails wherever possible (i.e. when it will not increase the potential for mass wasting) and avoid sharp turns. This not only reduces skidding distance, but eliminates damage occurring at turns.

6. **Designate "rub" or "bump" trees**: These trees are to be harvested last. Cull logs may also be placed along the edges of skid trails to protect residual trees. Another option is to protect rub trees with rubber tires, plastic culvert sections or some other material.

7. **Match log length with final spacing**: Close spacing of residual trees requires that logs be cut into short lengths to avoids excessive damage to residual trees. Wider spacing allows longer logs to be skidded with minimal damage to residual trees. Skidding whole trees, or tree-length logs, increases damage to residual trees.

8. **Limit rotation length**: Keep rotations to less than 150 years. Even in unmanaged stands incidence of decay begins to increase after this age due to injuries by natural causes.

Action During Harvest

1. **Use directional felling**: Trees should be felled at a 45° angle toward or away from skid trails to reduce skidder maneuvering.

2. **Log skid trails first**: Trees on skid trails should be felled and skidded first. Cut stumps low to the ground to avoid shunting equipment or logs into residual trees.

3. **Limb logs prior to skidding**: Where practical, limbs should be cut flush with the bole as stubs may redirect skidded trees into residual trees. Stubs may also snag on residual trees causing deep injuries.

Contact

Dr. Ralph J. Nevill, P.Ag.
Effects of Forest Practices Network
Canadian Forest Service
Pacific Forestry Centre
506 West Burnside Rd.
Victoria, B.C. V8Z 1M5
250-363-0600, email: rnevill@pfc.forestry.ca

Acknowledgements:

The McGregor
Model Forest Association,
Prince George, B.C.,
for providing funding
for this project;

Dean Mills,
Canadian Forest Service,
Pacific Forestry Centre, Editor;

Anne Dickinson,
Canadian Forest Service,
Pacific Forestry Centre,
Technology Transfer;

Dr. Eric Allen and Dr. Jim Wood,
Canadian Forest Service,
Pacific Forestry Centre and

John McLaughlin,
B.C. Ministry of Forests,
Forest Practices Branch,
for technical reviews.

Additional reading

Aho, P.E., G. Fiddler, and G.E. Filip. 1983a. How to reduce injury to residual trees during stand management activities. USDA For. Serv. Gen. Tech. Rep., PNW-156 17 pp

Aho, P.E., G. Fiddler, and M. Srago. 1983b. Logging damage in thinned, young-growth true fir stands in California and recommendations for prevention. USDA For. Serv. Res. Pap. PNW-304, 8 pp.

Aho, P.E., G. Fiddler, and G.E. Filip. 1989. Decay losses associated with wounds in commercially thinned true fir stands in Northern California. USDA For. Serv. Res. Pap. PNW-403, 8 pp.

Allen, E., D. Morrison, and G. Wallis. 1996. Common Tree Diseases of British Columbia. Canadian Forest Service.

British Columbia Ministry of Forests. 1997. Tree Wounding and Decay Guidebook. Forest Practices Code.

Etheridge, D.E. 1973. Wound parasites causing tree decay in British Columbia. Can. For. Serv. Pac. For. Res. Cen., Victoria, B.C., For. Pest Leaf. No. 62 14 pp.

Wallis, G.W., G. Reynolds, and H.M. Craig. 1971. Decay associated with logging scars of immature western hemlock in coastal British Columbia. For. Res. Lab., Can. For. Serv., Victoria, B.C. Info. Rep. BC-X-54. 8 pp.

Wallis, G.W. and D. J. Morrison. 1975. Root rot and stem decay following commercial thinning and guidelines for reducing losses. For. Chron. 51:203-207.

Wright, E. and L.A. Issac. 1956. Decay following logging injury to western hemlock, Sitka spruce, and true firs. USDA Tech. Bull. No. 1148, 34 pp.

For Additional CFS Information

visit our web site at:
http://www.pfc.cfs.gc.ca

Printed on recycled paper

ISSN 1209-6571 Cat. No. Fo29-47/3-1997E
ISBN 0-662-25799-5

Cette publication est aussi disponible en français.

Canada