How "Bugs" Affect Wood Quality – Form, Function and Figure.

Ken Farr
Canadian Forest Service, Natural Resources Canada
580 Booth Street, Ottawa Ontario, K1A 0E4

1. Summary

The term "wood quality" may be understood to have a commercial meaning, referring to marketable attributes, and a biological meaning, referring to the structure and morphology of wood produced as a result of natural and artificial stimuli which act upon the wood-forming process of woody plants. This presentation considers both concepts of wood quality, but focuses on the "upstream" consideration of trees as wood-producing entities, a process that can be affected and physiologically altered by attacks by "bugs" (here used in the broad sense, referring to any insect or insect-like invertebrate).

2. The Continuum Concept of Wood Quality.

Growth layer analysis of tree stems and branches has produced a continuum model of wood quality whereby the quality of tracheid development is considered to be determined by distance from the foliar organs of the live crown, by age (as indicated by distance from the pith) and by time of formation in the annual growth layer (Larson, 1969). Variability of tracheid development, the result of presence and concentration of growth regulators, is exhibited as extent of radial enlargement and of cell wall thickness. These qualities naturally vary between early- and late-formed wood, but may also indicate a reaction to induced stress leading to physiological disruption of the process of wood formation. The effects of insect and pathogens on wood quality can be viewed both as physiological and structural disruption.

3. Effect on Form.

The effect of insects on tree form is demonstrated by pests, such as the white pine weevil (*Pissodes strobe* Peck.), that preferentially feed on shoots. The white pine weevil occurs naturally across Canada and the northern United States, feeding mainly on spruce species in the west, and pine and spruce species in the east of its range (Wallace and Sullivan 1985). The death of the host's terminal leader causes one or more lateral branches to turn upwards resulting in crooks and forks in the main stem. Repeated leader death can cause severe deformation of the main stem, rendering the tree non-merchantable. Studying Norway spruce (*Picea abies* (L.) Karst.), Daoust and Mottet (2006) reported a 23.7% decrease in lumber monetary value in stems deformed by weevil attack.

4. Effect on Figure.

Direct impacts on the figure (appearance) of wood caused by insects and associated pathogens can be seen in the feeding activity of ambrosia beetles, a group of beetles totalling over 1000 species worldwide (Shore, 1992). Many commercial conifer species are susceptible to ambrosia beetle attack but most damage occurs to Douglas-fir

(*Pseudotsuga menziesii* (Mirb.) Franco) , western hemlock (*Tsuga heterophylla* (Raf.) Sarg.), true firs (*Abies* spp.) and spruces (*Picea* spp). Pinholes from larvae feeding tunnels or galleries, and the dark staining of the wood caused by a fungus associated with the beetles occur in the sapwood – the most valuable, clear portion of the log. The annual economic impact of three ambrosia beetles on the British Columbia coast was estimated by McLean (1985) to be $63 million (Can.), but this has since been updated to range from $95 to $189 million (Lindgren and Fraser 1994).

5. Effect on Function.

The effect attack by insect pests on overall tree function can be readily observed in eastern North America in areas infested by the emerald ash borer (*Agrilus planipennis* Fairmaire), an invasive alien wood-feeding species. Larvae of emerald ash borer feed on the cambial layers of ash trees (*Fraxinus* spp.) disrupting water flow and translocation of photosynthates within the stem, leading to rapid, widespread tree mortality. As affected tissue is easily removed in standard milling operations, log and lumber quality is unaffected by emerald ash borer, so long as the trees are harvested before they are about one-half dead (Cassens and Makra, 2014). Losses in timber sales result from ash mortality and rapid wood decay. Detailed spatial data on ash volumes are not available for much of Canada, making it challenging to estimate potential harvest losses in the natural forest setting (McKenney et al, 2012).

6. Conclusions

Tree morphology and physiology together enable and mitigate insect-induced changes to wood quality. Damage that affects wood quality can occur at any stage of the wood-producing process and are determined by the insect pest and the physiology and structure of the host tree. As resistance of tree species to insect damage has developed through complex host-pest interactions, the risk to forests and to wood quality posed by invasive insect pests is significant, though difficult to quantify.

7. Literature

Cassens, D.L., and Makra, E. 2014. Urban Wood and Traditional Wood: A Comparison of Properties and Uses. Purdue University, Purdue Extension, Forestry and Natural Resources, FNR-490-W.

Daoust, G. and Mottet, M.J. 2006. Impact of the white pine weevil (*Pissodes strobi* Peck) on Norway spruce plantations (*Picea abies* (L.) Karst.) Part 1: Productivity and lumber quality. For. Chron. 82: 745-756.

Larson, P. 1969. Wood formation and the concept of wood quality. Bulletin no. 74. New Haven, CT: Yale University, School of Forestry. 54 p.

Lindgren, B.S. and Fraser, R.G. 1994. Control of ambrosia beetle damage by mass trapping at a dryland log sorting area in British Columbia. Forestry Chronicle 70: 159-163.

McKenney, D.W. et al., 2012. Estimates of the potential cost of emerald ash borer (*Agrilus planipennis* Fairmaire) in Canadian municipalities. Arboriculture & Urban Forestry 38(3):81-91.

McLean, J.A 1985. Ambrosia beetles: A multimillion dollar degrade problem of sawlogs in coastal British Columbia. Forestry Chronicle 61: 295-298.

Shore, T.L. 1992. Forest Pest Leaflet: Ambrosia Beetles. Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, No. Fo29-6/72-1992E.

Wallace DR, Sullivan CR. 1985. The white pine weevil, *Pissodes strobi* (Coleoptera: Curculionidae): A review emphasizing behaviour and development in relation to physical factors. Proceedings of the Entomological Society of Ontario 116 (supplement):39-62.