



Sustainable forest management of complex forest landscapes:

Interactions among fire, mountain

There is a three-way competitive interaction among fire, insects, and harvesting, and the problem for the forest manager is to minimize the losses to fire and insects and maximize the harvest in a sustainable manner.

by Dr. Hugh Barclay, Canadian Forest Service and Tina Schivatcheva, Ecosystem Productivity Extension Specialist

For more than 25 years, **Dr. Hugh Barclay**, senior forest scientist at the Pacific Forestry Centre (PFC) in Victoria, has been exploring the challenges of managing the complex forest landscapes of British Columbia in a sustainable way. His current work on the interactions among fire, mountain pine beetle (MPB), and forest management has made a significant contribution to understanding the ecological impacts of such disturbance agents. Recently, Tina Schivatcheva discussed with Dr. Barclay the implications of his work for sustainable forest management practices.

Tina Schivatcheva: *Dr. Barclay, to successfully manage forest ecosystems, it is necessary to understand the interactions between the various disturbance agents and ecosystem productivity within the context of British Columbia's forest environment. So, how do fire and insects affect forest ecosystem productivity at the landscape level?*

Dr. Hugh Barclay: The forest landscape is a complex mosaic of various tree ages and species. Landscape-level ecosystem productivity is inextricably linked to the spatial nature of the forest landscape and the structural features of the forest ecosystems; for example, fire can burn all ages and species of trees, although insects are usually more specific

and attack only some species and age classes. If fire is extensive and removes all age classes, then regeneration can be quick as new seedlings usually have little or no competition. If insects attack older age classes preferentially, then regeneration takes longer, although often not all the trees in a stand will be attacked. There is a three-way competitive interaction among fire, insects, and harvesting, and the problem for the forest manager is to minimize the losses to fire and insects, and maximize the harvest in a sustainable manner. Fire, insects, and harvesting all decrease the mean age of the forest, and productivity may often be highest in mature forests. Thus, all three factors may reduce overall productivity at the landscape scale.

TS: *Recently, a research team at the Pacific Forestry Centre, led by you and including experts in both fire and MPB, examined the joint interaction of fire, insects, productivity, and harvesting by modelling the impact of fires and MPB on a lodgepole pine forest landscape. As a result, the team developed the Forest Dynamics Simulator model. Would you briefly describe the Forest Dynamics Simulator and its implications for sustainable forest management and decision making aimed at preventing or minimizing the impact of beetle outbreaks?*

HB: The *Forest Dynamics Simulator* model is a research tool specifically designed to simulate large tracts of pine forests, i.e., landscapes of millions of hectares. In this model, wildfires occur randomly and form fires of random sizes. Over the long term, this determines the age structure of the forest. The age structure was fed into a model of susceptibility to MPB to generate a mosaic of susceptibility classes for the forest. These susceptibility mosaics were used to determine whether or not an incipient beetle population could spread across (traverse) the landscape, and this was determined by rules involving the ability of MPB to disperse over various distances across inhospitable terrain. This methodology was then applied to the entire province of BC using inventory maps from the year 2000, and susceptibility and traversability maps were produced for BC. The areas of high susceptibility and traversability coincided closely with the areas where MPB is presently in epidemic status [See references on next page].

TS: *Dr. Barclay, is the Forest Dynamics Simulator model available to the general public, and if so, where can it be accessed?*



Canadian Forest Service Photo

Dr. Hugh Barclay and Laura Benson present a mountain pine beetle display at the Pacific Forestry Centre.



pine beetle, and forest management

HB: I am happy to provide the Forest Dynamics Simulator model to anyone who is interested. [Dr. Barclay can be contacted using the email address below.]

TS: *Is there an interaction between forest fires and MPB outbreaks?*

HB: There are probably several sources of interaction. For example, a heavy attack by the beetle leaves large patches of dead trees, which dry out and may be more easily ignited. Also, fires help determine the age structure of the forest and this, in turn, helps determine the susceptibility of the forest to MPB attack.

TS: *Dr. Barclay, in your view, what kind of forest landscape structure facilitates or inhibits MPB spread?*

HB: Large-scale monocultures of mature susceptible pine facilitate the development of epidemics that can easily spread across large areas of forest. Mosaics of different ages and species will inhibit the movement of, and reduce attacks by, MPB, thus reducing the tendency of MPB populations to achieve epidemic status and move easily.

TS: *What does the model predict about the interactions of fire, MPB, harvesting, and ecosystem productivity?*

HB: Both average susceptibility and traversability of the forest generally increase with the length of the fire cycle, with fire control, and also with age at harvesting—although there are other interactions to consider and the effects are not quite that simple. *The optimal combination appears to be early harvesting and moderately intensive fire control;* this both reduces susceptibility and traversability and also maximizes harvest. The competition among fire, beetles, and harvesting implies that what one gets may not be available to the others, although beetle-killed trees can still burn or be harvested. There is also a strong effect of fire size on traversability; for fires limited to less than 100 hectares, the resulting forest is always traversable, whereas for fires that may be up to 1 million hectares, the forest is seldom traversable. Planting in large blocks of different ages or species would mimic the effects of large fires and reduce traversability. Thus, landscape-level productivity would be maintained or enhanced by landscapes with low traversability, and this will be the case in forests that are mosaics of ages and species.

TS: *The MPB epidemic presents the forestry com-*

munity with a complex problem. From a practitioner's perspective, what should forest managers be aware of in developing forest management strategies to prevent future outbreaks and to maximize the landscape-level productivity of the forests?

HB: The MPB epidemic poses significant challenges to forest managers in BC. The BC Ministry of Forests and Range has projected that MPB could destroy about 80% of the pine in British Columbia by the time the present epidemic subsides. Forest managers now have an opportunity to create a more beetle-resistant landscape by ensuring that the attacked forest is regenerated to create a mosaic of various ages and, to the extent that it may be possible, a mosaic of species such that non-host species are planted in patches that separate patches of susceptible species. Shorter rotations would also help to reduce the risk of another MPB epidemic. This opportunity will probably only occur once and the window of time available for this would appear to be restricted. Thus, although there may be risks and trade-offs to consider, forest managers should consider acting as soon as possible to regenerate a forest that is maximally resistant to the beetle. The beetle will still be present in BC, but we can reduce the size of outbreaks using the silvicultural measures I have described. 🌲

Reference

Barclay, H.J., C. Li, L. Benson, S. Taylor, and T. Shore. 2005. Effects of fire return rates on traversability of lodgepole pine forests for mountain pine beetle (Coleoptera: Scolytidae) and the use of patch metrics to estimate traversability. *The Canadian Entomologist* 137: 566-583.

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Forests killed by MPB may be more susceptible to fires.