Abstract
In unsalvaged mountain pine beetle-killed stands, the release and growth of shade-tolerant advanced regeneration may provide an important reforestation pathway. Stands developing from advanced regeneration may restock quickly and provide short- to mid-term harvest opportunities, but the variability in release and growth responses among these stands will create numerous management challenges. The project conducted under this grant reviewed and synthesized relevant scientific literature to suggest some important differences between reforestation from advanced regeneration following mountain pine beetle (MPB) attack and conventional reforestation (i.e., planting or natural reforestation following “normal” disturbance events) in regards to stand dynamics and growth. Particular attention was given to primary traits of advanced regeneration that may determine their successional and growth trends following MPB attack, including their species composition, their abundance and spatial distribution, their age-height relationships, and their overall health. The review concludes that effective management of advanced regeneration following MPB attack will require a better understanding of the stand-level conditions and processes that control its growth. As well, management tools such as stocking standards that are suited to managing even-aged forests may need to be reexamined to address the unique conditions of unsalvaged MPB stands.

Introduction
This project conducted a literature review and synthesis that examined controlling factors and management implications of utilizing advanced regeneration as a stand regeneration process in unsalvaged mountain pine beetle (MPB) -killed stands. Operational and economic barriers will limit the salvaging and management of many attacked stands (BC Ministry of Forests 2004; Eng 2004; Hawkes et al. 2004; Pedersen 2004; Stockdale et al. 2004; Coates and Hall 2005;
Mitchell 2005), however, the regeneration and development of these stands will be important given the looming timber supply shortage. The release and development of advanced regeneration may restock some unsalvaged stands and provide a harvest opportunity in the short-to mid-term (Veblen et al. 1991; Archibald and Arnup 1993; Oliver and Larson 1996; Puttonen and Vyse 1998; Greene et al. 1999; Coates 2006). But, reliance on advanced regeneration following MPB attack may have important and unknown implications on portions of the timber-harvesting landbase. Stands developing from advanced regeneration may be quite different than managed forests or forests originating from other types of disturbances (Burton 2006), and these distinctives should be incorporated into management objectives and timber-supply predictions.

Methods
This project reviewed and synthesized relevant literature to examine how stands developing from advanced regeneration after MPB attack may be unique in terms of their species composition, the abundance and spatial distribution of regeneration, the developmental traits of regeneration, and the health and long-term viability of regeneration. Particular attention was given to the implications of these advanced-regeneration distinctives on stand development, yields, and forest-management practices. Given the lack of specific information on stand development following MPB epidemics of the current scale, observations from similar stand-releasing disturbances (e.g., windthrow, partial cutting, other bark-beetle outbreaks) that mimic stand-level MPB impacts may provide insight into post-attack stand dynamics and advanced regeneration development. Such analogous studies were incorporated into this discussion.

Results
Existing literature suggests that development and yields of stands originating from advanced regeneration following MPB attack will be highly variable. Uncertainty regarding the release and growth of released advanced regeneration in unsalvaged MPB attacked stands will complicate the capacity of forest practitioners to set management objectives and predict future yields and harvests (Messier et al. 1999), at least relative to even-aged silviculture or reforestation after fire. Some of the primary factors controlling advanced-regeneration responses to release following MPB attack include their species compositions, abundances and spatial distributions, developmental traits of the trees (i.e., height and age relationships), and general health and long-term viability. The literature suggests that all of these factors will be highly variable and as a result, complex, uneven-sized structures and distributions may characterize stands developing from advanced regeneration following MPB attack. Accurate growth and yield predictions in such stands will likely be difficult, especially compared to even-aged managed forests where regeneration cohorts display relatively uniform growth over the rotation.

Conclusions and Management Implications
British Columbia’s impending mid-term timber supply shortage in the wake of the MPB infestation will increase pressure to maximize production on the timber-harvesting landbase. Forest managers must carefully consider how to manage unsalvaged MPB killed stands, which may contribute significantly to future timber supplies and other non-timber values. The
production potential of advanced regeneration following MPB attack should be highly variable. The value of advanced regeneration toward timber-supply will depend upon interactions between key traits, including species composition, abundance and spacing, developmental characteristics, general health and vigour, and degree of release following MPB attack. Unsalvaged MPB-killed stands and their characteristics will force managers to consider unique and specific options that best reflect the condition of a stand and balance social, ecological, and economic values.

**Literature Cited**


