Part 2

Management

Chapter 4

Principles and Concepts of Management

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Abstract

In this section, an introduction to management of mountain pine beetle (*Dendroctonus ponderosae* Hopk. [Coleoptera: Scolytidae]) and its host is provided and basic principles and concepts of management are described. Preventive management is used in Western Canada to reduce tree, stand and landscape susceptibility to the mountain pine beetle. As well, direct control strategies and tactics are used to reduce mountain pine beetle populations. The two approaches are combined and form an integral part of a management plan.

Forest protection and management of forest health are vital components of land management to achieve stated objectives. Plans to manage insects, including the mountain pine beetle, are developed to support land management objectives and form an integral part of land management plans.

The principles for reducing losses of lodgepole pine (*Pinus contorta* Dougl. ex Loud. var. *latifolia* Engelm.) to the mountain pine beetle must be based on the main features of beetle population dynamics, especially the evolved insect-host interaction. Key features of this interaction are the effects of tree, stand, and site parameters on tree and stand susceptibility, the process of population change from the endemic to the epidemic state, and the role of beetle population size and spatial distribution of susceptible stands in the development and maintenance of outbreaks at the landscape level. These and other aspects of the insect host interaction are described in detail elsewhere in this volume.

Résumé

Dans la présente section, on trouve une présentation de la lutte contre le dendroctone du pin ponderosa (*Dendroctonus ponderosae* Hopk. [Coleoptera: Scolytidae]) de même que de l'hôte de ce dernier, et on décrit les principes et les concepts de base qui s'y rattachent. Dans l'Ouest canadien, on fait de la lutte préventive pour réduire la vulnérabilité des arbres, des peuplements et des paysages au ravageur. On a également recours à des stratégies de lutte directe et à des tactiques pour réduire les populations de dendroctones du pin ponderosa. Les deux approches se combinent et font partie intégrante d'un plan de lutte contre le dendroctone du pin ponderosa.

La protection et la gestion de la santé de la forêt sont des éléments essentiels de l'aménagement des terres lorsqu'on veut atteindre les objectifs qu'on s'est fixés à cet égard. Des plans de gestion des insectes, y compris du dendroctone du pin ponderosa, sont élaborés pour favoriser l'atteinte de ces objectifs, et ils font partie intégrante du plan d'aménagement des terres.

Les principes à considérer pour réduire les pertes de pins tordus latifoliés *(Pinus contorta* Dougl. ex Loud. var. *latifolia* Engelm.) causées par le dendroctone du pin ponderosa doivent tenir compte des principales caractéristiques de la dynamique des populations de dendroctones, en particulier de l'interaction insecte-hôte qui se produit. Les principaux aspects de cette interaction comprennent : les effets des paramètres qui caractérisent les arbres, les peuplements et les lieux où ils se trouvent sur la vulnérabilité des arbres et des peuplements; le processus de développement des populations de l'état endémique à celui d'épidémie et le rôle que joue la taille des populations de dendroctones ainsi que la répartition spatiale des peuplements vulnérables dans l'apparition et la continuation des infestations à l'échelle du paysage. D'autres aspects de l'interaction insecte-hôte sont également décrits dans le présent volume.

How do outbreaks begin?

At endemic levels, beetle populations persist at low numbers across the landscape and mainly breed in weakened trees, which are often widely dispersed. The transition from endemic to epidemic state occurs when local population size exceeds a minimum threshold necessary to overcome the resistance, through mass-attack of healthier, large-diameter trees that provide a high-quality habitat for large brood production. Periodically, one or both of two situations make this possible (Fig. 1). The population of mountain pine beetle may increase locally, either through immigration or because favourable weather conditions result in increased beetle survival during the winter and the flight period. Alternatively, or in addition, tree and stand resistance to attack by the beetle may be reduced during periods of drought, or if stands become too dense or too old (Fig. 1). Depending on how widespread these optimum conditions are, the population may increase quickly and spot infestations become evident in many stands. As the population gets larger, beetles can successfully attack more and more trees as large numbers of beetles eventually overcome the resin defence of even the most vigorous trees. Unless spot infestations are promptly controlled, the mountain pine beetle infestation will spread across the landscape, given abundant host material, with dispersing beetles joining resident populations to sustain an outbreak. As a result, severe losses of mature pine will occur and even some younger planted or natural pine stands can sustain heavy mortality.

Managing the beetle

Treatments aimed at reducing beetle populations are termed "direct control" and those aimed at increasing stand vigour or reducing the amount and concentration of susceptible stands are termed "indirect control" or "preventive management" (Fig. 2). The two approaches should be used in combination in a landscape-level management plan.

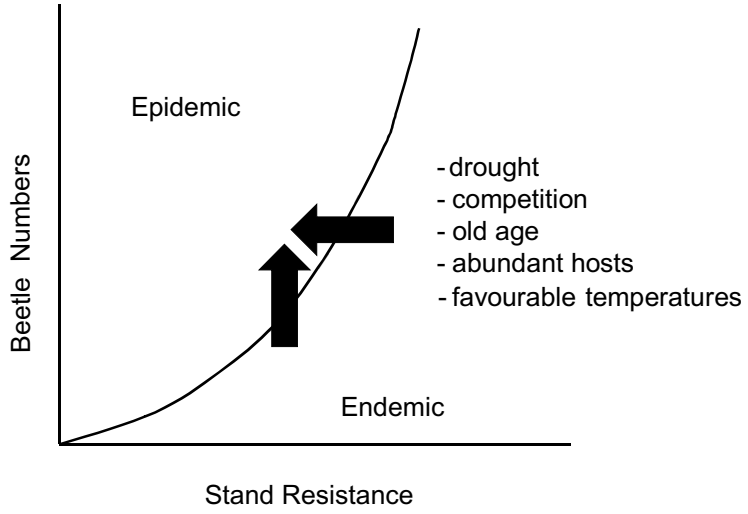

Figure 1. Factors contributing to mountain pine beetle shift from endemic to epidemic populations (after Berryman 1978). The vertical arrow represents increase in beetle population and the horizontal arrow represents a decrease in stand resistance. The curved line is the threshold between endemic and epidemic populations.

Preventive management can be considered a pro-active approach because it is primarily done before a mountain pine beetle outbreak develops. Its aim is to reduce the susceptibility of stands on the landscape using various forestry practices including prescribed fire. Direct control, on the other hand, tends to be a reactive approach aimed at reducing beetle populations by various means following observation of tree mortality. The strategic objectives of direct control mainly depend on combinations of ownership, beetle population level, access, and the resources available for implementation.

A combination of timely detection, assessment of susceptibility and risk, access development, direct control, and preventive management is required to effectively manage the mountain pine beetle. The key principles in applying direct control are the timeliness and thoroughness of detection and treatments. The key principle in applying preventive management is the continued application of well-planned forestry practices during periods when mountain pine beetle populations are at endemic levels.

The epidemiology of the mountain pine beetle has implications for management. The risk of tree mortality from the mountain pine beetle is related to the susceptibility of the trees and to the number of beetles attacking. The risk of significant economic damage from the beetle depends on the susceptibility of stands, their size and arrangement on the landscape, and the size and location of the beetle population. Thus, management of the mountain pine beetle is necessarily focused on reducing tree, stand-level, and forest-level susceptibility and on keeping the beetle population low. This requires stand-level management within a long-term strategy to reduce forest-level susceptibility to damage, yearly detection and assessment surveys, and timely and effective treatment of local infestations (Fig. 3). Decision support systems can be utilized to guide selection of treatment strategies and tactics, as described elsewhere in this volume.

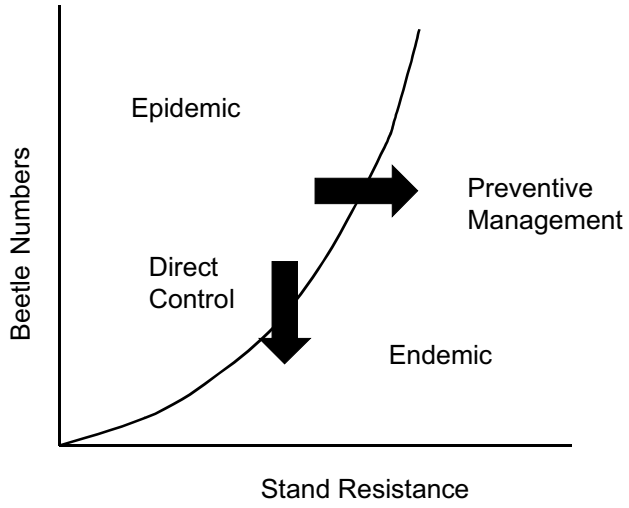

Figure 2. The role of population reduction (direct control) and preventive management in maintaining mountain pine beetle at endemic levels. The vertical arrow represents reduction in beetle population and the horizontal arrow represents an increase in stand resistance. The curved line is the threshold between endemic and epidemic populations.

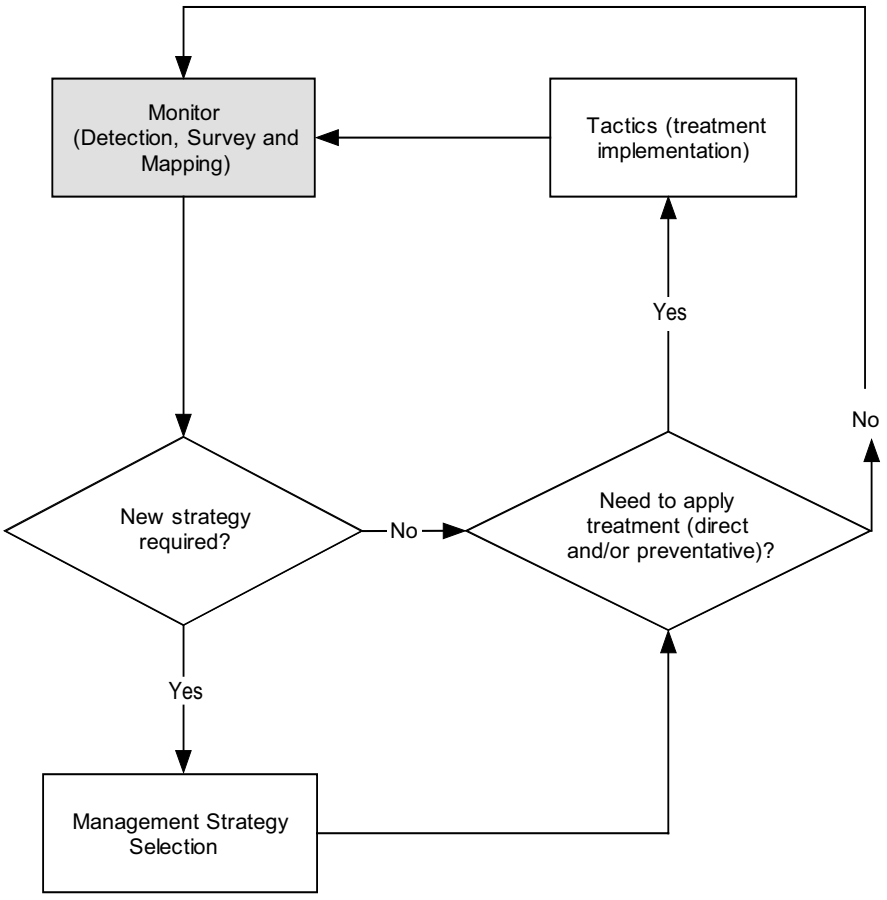

Figure 3. Flowchart of the main components of the mountain pine beetle management process.

In addition to information on the biology of the mountain pine beetle and its interaction with the host, development and implementation of a knowledge-based management system requires information on host characteristics and host distribution. Specifically, it is necessary to know the characteristics and distribution of stands on the landscape where pine is present, as well as the location and numbers of those infested with mountain pine beetle. The former is obtained through forest inventory updates and the latter is obtained through annual surveys.

Inventory information allows the manager to determine the susceptibility of the forest to mountain pine beetle. Susceptibility and risk rating systems are available to forest managers to help them set priorities for beetle control treatments and plan access development and preventive management. Other decision-support tools include stand and landscape level models in which management options can be evaluated. As management of public forests in western Canada must typically integrate objectives for several uses and values, socioeconomic considerations need to be considered.

Preventive management when the mountain pine beetle population is at an endemic level can save huge losses in the future. Similarly, timely and thorough treatment of infested trees when the beetle population is relatively low can prevent an infestation from becoming epidemic. Awareness of this fact has to be at the political level so that resources are continually available to prevent mountain pine beetle epidemics. Too often, investment in preventive management and direct control treatments are reduced during the endemic phase of the mountain pine beetle only to be followed by large, and often ineffective expenditures of resources when an epidemic arises.

The following chapters discuss mountain pine beetle management in more detail including detection and monitoring, decision support systems, preventive management and direct control, and socioeconomic concerns.

References

Berryman, A.A. 1978. A synoptic model of the lodgepole pine/mountain pine beetle interaction and its potential application in forest management. Pages 98-105 *in* Berryman, A.A.; Amman, G.D.; Stark, R.W.; Kibbee, D.L., eds. Theory and Practice of Mountain Pine Beetle Management in Lodgepole Pine Forests, Symposium Proceedings. Forest, Wildlife and Range Experiment Station, University of Idaho, Moscow, ID.