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Biodiversity in forest ecosystems and landscapes: A conference to discuss future directions in biodiversity management for sustainable forestry

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ABSTRACT

Maintaining biodiversity has become a global concern and requires the implementation of sustainable management practices at a range of spatial scales. Forested ecosystems are no exception, and we report on an IUFRO conference to address biodiversity and sustainable forest management. The conference was structured into four key themes: (1) Natural disturbance and biodiversity in forests and landscapes, (2) Biodiversity, climate change and ecosystem function, (3) Biodiversity in managed forests, and (4) Monitoring of forest biodiversity at different spatial scales. The conference provided a stimulating environment to discuss conceptual and applied forest management issues, highlighting advances in our understanding of responses to natural and managed disturbances, and the role that large-scale drivers such as climate change will play. Field trips to landscapes affected by an extensive bark beetle outbreak, and to large-scale silviculture experiments provided an ideal backdrop for this conference to reconcile concepts with operational challenges.

1. Introduction

The world is faced with an unprecedented reduction of biodiversity that is occurring in virtually every ecosystem in the world. The loss of species is over two orders of magnitude higher than previously observed in the geologic record (Dirzo and Raven, 2003) and represents organisms from diverse phyla and terrestrial, aquatic and marine ecosystems. Concerns about the loss of species globally are well established (e.g. Chapin et al., 2000; Matthews et al., 2000) but only recently have local jurisdictions begun to develop a comprehensive approach to documenting conditions and threats relating to biodiversity (e.g. Austin et al., 2008). Forest ecosystems, which can be defined by the presence of tree canopies that cover more than 10% of a site (Matthews et al., 2000), have not escaped the loss of biodiversity (e.g. FAO, 2007). Excluding the Antarctic and Greenland, such forests occupy about 25% of the world's land surface and support the majority of the terrestrial biodiversity, but they have already been reduced by 20–50% since the adoption of modern agricultural practices (Matthews et al., 2000). Although the conversion of forest lands to agriculture appears to be diminishing in temperate regions, the loss of native forest lands to agriculture is continuing or even increasing in tropical regions where biodiversity is very high (FAO, 2006). In addition to biodiversity conservation, forest ecosystems supply a wide range of commodities sought by an expanding human population, including structural materials, fuels, and medicines, along with a wide range of critical ecosystem services including nutrient cycling, climate regulation, maintaining water balances and carbon sequestration.

From early studies on the role of predators in affecting community structure (e.g. Paine, 1966, 1974) and more recent work on the role of species diversity in affecting productivity (e.g. Tilman et al., 1997; Loreau et al., 2001), energy or material fluxes (Chapin et al., 2000) and ecosystem functioning (Duffy, 2009), it is clear that species diversity can play a critical role in affecting ecological processes. Although specifics of the relationship between biodiversity and ecological processes remain controversial, an increasing body of evidence suggests that biodiversity plays a greater role in the global ecosystem and is not simply a passive result of biotic and abiotic interactions (Loreau et al., 2001; Naeem, 2002). Changing biodiversity can affect a wide range of ecosystem services such as the likelihood of disease transmission (Ostfeld and Logiudice, 2003), forest insect pest damage (Jactel and Brockerhoff, 2007), and productivity in terrestrial (Loreau et al., 2001) and marine ecosystems (Worm et al., 2006). Continuing human population growth and climate change represent key driving

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stresses on global ecosystems that will need to be addressed in the 21st century if current social expectations are to be realized.

Boreal, temperate and tropical forests offer a wide array of habitats for plants, animals, fungi and micro-organisms, with the greatest diversity of species found in tropical ecosystems. The loss of biodiversity stems largely from direct and indirect human activities, including deforestation, fragmentation and the degradation of forest habitats through road construction or the introduction of exotic species (Matthews et al., 2000; Dirzo and Raven, 2003; Forman et al., 2003; Brockerhoff et al., 2008). In managed forests and elsewhere, these issues will need to be addressed if forests are to function as reservoirs of biodiversity and continue to provide the many ecological services often taken for granted (Chapin et al., 2000; Matthews et al., 2000). The Forest Biodiversity Research Group (8.02) of the International Union of Forest Research Organisations (IUFRO) aims to further our understanding of the role of forests in biodiversity conservation, the impacts of silviculture and harvesting practices on forest habitat, and to promote awareness of the ecological value of forests. As a part of this vision, the IUFRO Forest Biodiversity Research Group collaborated with the British Columbia Ministry of Forests and Range and Thompson Rivers University in Kamloops, British Columbia, Canada, to host a conference at Thompson Rivers University in August 2008 on "Biodiversity in Forest Ecosystems and Landscapes". The purpose of the conference was to enable participants to share knowledge, to discuss new trends, to reflect on future directions in biodiversity management for sustainable forestry, and to promote a stronger scientific basis for biodiversity management in forest landscapes. The conference was attended by more than 100 researchers, managers and stakeholders from 16 countries. Thirty-five oral presentations and 26 posters represented the formal exchange of information at the conference, of which 20 manuscripts were prepared to form the basis of this special issue. The conference focussed on four main themes: (1) Natural disturbance and biodiversity in forests and landscapes, (2) Biodiversity, climate change and ecosystem function, (3) Biodiversity in managed forests, and (4) Monitoring of forest biodiversity at different spatial scales. These themes reflect the perspective that: (a) Both management and natural disturbances play a key role in determining the condition and associated commodities or ecosystem services provided by forest ecosystems, (b) A better understanding of forest ecosystems is necessary to promote social awareness for biodiversity conservation, and (c) Evaluating the effects of forest management treatments at multiple spatial scales is critical if the management of forests is to be sustainable. The conference included a field visit to the Opax Mt. and Sicamous Ck. silvicultural systems sites that are monitoring the ecological response to a range of harvesting and silvicultural treatments, and viewed examples of a severe outbreak of the mountain pine beetle (*Dendroctonus ponderosae*; see Aukema et al., 2008) and associated salvage harvesting in ponderosa pine (*Pinus ponderosa* Laws) and lodgepole pine (*P. contorta* Dougl.) forests near Kamloops, BC (Fig. 1).

2. Natural disturbance and biodiversity in forests and landscapes

Five papers focus on natural disturbance and biodiversity with an emphasis on ecosystem recovery following the most extensive bark beetle outbreak on record in western Canada (Aukema et al., 2008), reaching over 14.5 million hectares in British Columbia. Klenner and Arsenault (2009) provide the first comprehensive report of ponderosa pine mortality during a severe bark beetle outbreak in British Columbia at both the stand and landscape levels, and discuss implications from a wildlife management perspective. With tree mortality reaching 95% of stems greater than 30 cm dbh, the consequences for wildlife will be significant, particularly for species dependent on mature tree canopies. Ganteaume et al. (2009) characterized fuel loads and the effects of wildfire return interval on vegetation structure on limestone origin sites in southern France. Lewis (2009) brings attention to the effects of mountain pine beetle outbreaks and salvage logging on live tree and deadwood habitat. Stand and landscape simulations suggest that widespread salvage logging will leave a paucity of large live trees, snags and downed wood in cutover areas on the landscape. Vyse et al. (2009) examined regeneration beneath

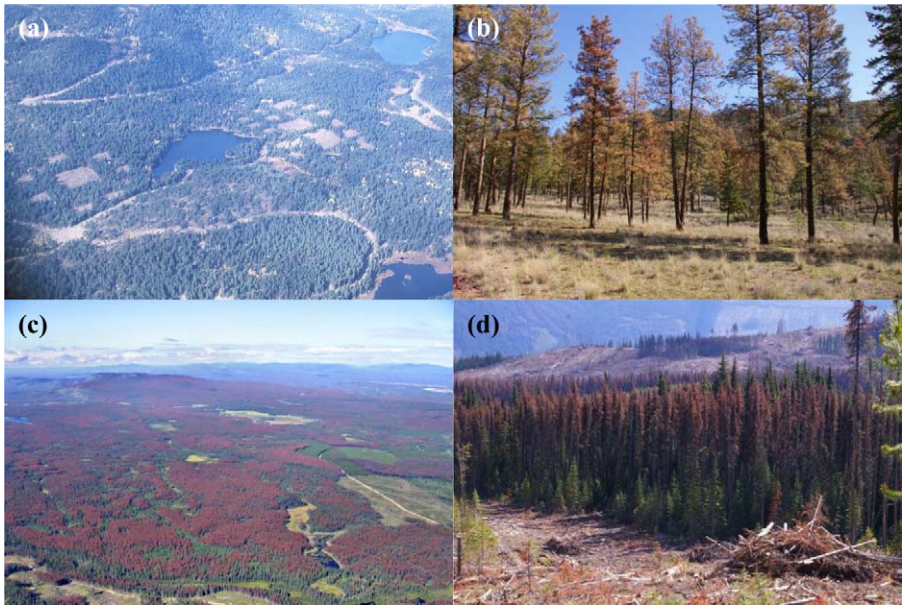

Fig. 1. (a) Overview of the Opax Mt. silvicultural systems trial near Kamloops, BC where the ecological effects of partial cut and patch cut harvesting options and post-harvest silvicultural treatments are being monitored, (b) severe mortality of mature ponderosa pine in relation to a recent bark beetle (Dendroctonus sp.) outbreak, (c) extensive and severe "red attack" caused by bark beetles in a lodgepole pine forest in central British Columbia, (d) an example of forest conditions following salvage harvest in a stand of lodgepole pine, illustrating widespread and severe mortality of mature trees and unaffected advanced regeneration in the understory that occurs in some stands.