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Mechanisms and predictors of ecological change in managed forests: A selection of papers from the second international conference on biodiversity in forest ecosystems and landscapes

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ABSTRACT

Maintaining biodiversity is a key goal of global forest policy which promotes ecosystem health and resilience in the face of changing land use and climate. Sustainable management of forest ecosystems is essential to the social and economic services that forests provide, is an important component of the environmental policies of national governments, and is a specific focus of the Conventional on Biological Diversity. Sustainable forest management supports the maintenance and enhancement of biodiversity, and relies on evidence based research to underpin associated policies and practices. Studies that take a focussed approach are particularly helpful in this regard where they identify mechanisms of ecological change in forest habitats, and predictors appropriate to determining the impact of management practices. Observational research can suggest likely mechanisms for ecological change, which can be tested and confirmed through experimental research. Predictors based on long-term research, on the mechanisms underlying ecological relationships, or on modelling approaches can be used to infer information about existing forests and to forecast future trends. This special issue presents a selection of papers which were first presented at the second international IUFRO conference on biodiversity in forest ecosystems and landscapes at University College Cork, Ireland in August 2012. The aim of this conference series is to '*share knowledge, discuss new trends, reflect on future directions in biodiversity management for sustainable forestry, and provide a stronger scientific basis for biodiversity management in forest landscapes in the light of climate change*'. The selected papers exemplify the use of observational and experimental approaches to identify mechanisms of ecological change in forests, and the use of indicators to predict current and future patterns of biodiversity. Trends in forest biodiversity were examined and discussed, drawing on what we know about forests to reconstruct ancient forested landscapes and to identify strategies for the management of forests into the future.

1. Introduction

Forests provide economic, social and environmental services, contributing significantly to human health and wellbeing (Ojea et al., 2010). Increasing pressure on forests for the provision of ecosystem services, as well as challenges presented by ongoing changes in land use and climate, require forest policies across the globe to prioritise forest ecosystem health and resilience (Yoshikawa et al., 2011; Schaich and Milad, 2013). Both of these ecosystem attributes are underpinned by biological diversity in forests (Thompson et al., 2009), which contributes to essential ecosystem functions such as nutrient cycling, water cycle, carbon cycle, soil stability and the provision of habitat for species. The importance of forest biodiversity is reflected in the policies of most national governments and at an international level biodiversity maintenance and enhancement is highlighted by the Conventional on Biological Diversity.

Globally, forests are becoming progressively modified and fragmented, leading to biodiversity loss (Foley et al., 2005). As a result, research and policy aimed at achieving sustainable management of forests place an increasing emphasis on 'naturalness', and in particular on the biodiversity supported by 'old growth' forest conditions (Winter, 2012). However, in many regions where natural forest cover is low, the role that highly modified forests (including plantations) can play in supporting biodiversity is critically important (Bremer and Farley, 2010; Quine and Humphrey, 2010). At 11%, Ireland's forest cover is lower than that of most other European

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countries (Cross, 2012) and is dominated by plantation forests (ITGA, 2012). Research has shown that plantations in Ireland can provide habitat for forest specialists of ground-dwelling spiders and beetles (Mullen et al., 2008; Oxbrough et al., 2005; Oxbrough et al., 2010) birds and plants (Coote et al., 2012; Irwin et al., in press) and early successional forest species (Oxbrough et al., 2006). Furthermore, recent studies have shown that plantation forests can provide suitable habitat for organisms that are poorly adapted to the intensive agricultural landscapes that typify much of the Irish landscape (Gittings et al., 2006; Wilson et al., 2009). This body of research highlights the importance of landscape context when assessing the biodiversity value of forests, and of considering the contributions of highly modified forests as well as near-natural forests.

The second international IUFRO conference on Biodiversity in Forest Ecosystems and Landscapes was held at University College Cork, Ireland from 27th to 30th August 2012 (http://www.uc-c.i.e./en/iufro2012/). The aim of this conference series is to bring together researchers from across the globe to '*share knowledge, discuss new trends, reflect on future directions in biodiversity management for sustainable forestry, and provide a stronger scientific basis for biodiversity management in forest landscapes in the light of climate change*'. Over 130 delegates from 33 countries attended the conference. Nine symposia were convened, spanning a diverse range of issues including the conservation of particular species groups, the use of long term data to examine forest biodiversity, the development of biodiversity indicators, and the impact of invasive alien species. The conference also included an excursion to some of Ireland's typical plantation forests, where delegates participated in talks and discussions on the maintenance and enhancement of biodiversity in these habitats. This was followed by a visit to internationally rare oak (*Quercus patraea* (Mattuschka) Liebl.) and yew woodlands (*Taxus baccata* L.) in Killarney National Park, Ireland, where presentations were made on the challenges posed to forest management by mammal grazing and *Rhododendron ponticum* L. invasion. This special issue presents a selection of papers from the conference that focus on mechanisms and predictors of ecological change in forested landscapes, across a range of spatial scales and taxonomic diversity.

2. Mechanisms of ecological change in forests

Observational research can reveal likely mechanisms for ecological change in forested landscapes, which can be tested and confirmed through experimental research. Nine manuscripts in this special issue examined mechanisms of ecological change from a range of perspectives and scales. Two manuscripts explored the impacts of forest policy and practice by using experimental manipulations. Sheehan et al. (this issue) experimentally investigated the impact of forest harvesting methods on forest birds, focussing on Cerulean warbler (*Setophaga cerulean*, Wilson), which is a species of conservation concern in North America. This study demonstrates that intensity of harvest plays an important role in determining the suitability of post-harvest habitats for Cerulean warblers and other bird species. By manipulating the number and type of trees left after harvesting, forest managers can tailor individual stands towards particular forest bird species, and ensure continued availability of habitat for all birds of early successional stages. Work et al. (this issue) examined the impact of post-harvest biomass removal on ground-dwelling spiders and beetles with the aim of setting thresholds for minimum residual deadwood to support biodiversity. The practice of biomass removal is common in Northern Europe and is being explored in North America, despite it being at odds with international criteria which promote deadwood retention in forests (Barbati et al., this issue). Their findings showed that intensive removal of woody debris further modifies the ground spider and beetle assemblages in addition to that attributed to traditional felling.

Two papers examined the influence of forest stand type on biodiversity, with a focus on different assemblage groups. Barsoum et al. (this issue) examined the potential of mixed tree species stands to support a greater range of ground-dwelling spider and beetle diversity than monocultures in the context of highly managed plantation forests. Their findings show that mixed stands support similar assemblages to those in monocultures and suggest that, for the tree species examined, the inclusion of a secondary species in forest plantations does not enhance invertebrate diversity. Ódor et al. (this issue) reported on factors which influence the diversity of epiphytic lichens and bryophytes in forests. The authors found tree species to be a key driver of compositional changes at small scales and among stands. This highlights the importance of considering species traits in forest biodiversity research, as organisms which are more closely linked with tree species are more likely to be influenced by management. The multi-scale approach of this study acknowledges the importance of studying forest ecosystems across a range of scales, which have relevance to different organisms and processes (Lindenmayer et al., 2000).

Three of the papers used observational data to identify factors that influence species of conservation interest and assess how forest management can make appropriate use of this information. Devaney et al. (this issue) examined the relationship between spatial distribution and the natural regeneration of English yew (*Taxus baccata* L.), a species of conservation importance across Europe. They recommend that conservation efforts focus on natural regeneration at forest edges for this species. Roth et al. (this issue) examined the link between legacy tree retention and nest habitat quality for Golden-Winged Warblers (*Vermivora chrysoptera* L.). Male breeding density in young, aspen-dominated stands was influenced by the number, size and species composition of trees retained after harvesting of the preceding crop of commercially mature trees. The authors also demonstrate a useful relationship between male density and pairing success of individual males, strongly suggesting that the former can be used as an indicator of breeding success, and possibly habitat quality. Graham et al. (this issue) examined the influence of the level of afforestation and associated changes in hydrochemistry on brown trout (*Salmo trutta* L.) populations. They found that changes in hydrochemistry are associated with increasing levels of plantation forest cover across the landscape. They found no evidence of forestry-related acidification, and no consistent impact of afforestation upon brown trout growth or density. However, this research corroborates other recent findings which suggest that forestry could increase temperature in lakes, which in turn may negatively impact upon brown trout.

Two papers examined processes influencing biodiversity at larger scales, particularly highlighting the importance of connectivity across a landscape. Olson et al. (this issue) used an experimental approach to investigate the width of corridors required to support fish and amphibians and found that, over the medium term (10 year post-thinning), narrow buffers can support a similar number of species to those found in wider buffers. Ernst (this issue) tested a new metric aimed at describing the relationship between connectivity and movement of organisms through a landscape, that can be tailored to suit the dispersal abilities of different species. They study concluded that, under the range of variation modelled, the effects of fragmentation were poorly mitigated by organising reserves to form corridors, and that the compromising effect of forestry activity on connectivity is likely to be more severe in forest landscapes subject to frequent natural disturbances.