Forest Ecology and Management 429 (2018) 394–405

Contents lists available at ScienceDirect

Forest Ecology and Management

journal homepage: www.elsevier.com/locate/foreco

Deadwood management in Central European forests: Key considerations for practical implementation

Lucie Vítková*, Radek Bače, Petr Kjučukov, Miroslav Svoboda

Department of Forest Ecology, Faculty of Forestry and Wood Sciences, Czech University of Life Sciences, Kamýcká 129, Praha 6 – Suchdol 16521, Czech Republic

ARTICLE INFO

Keywords:
Long-term retention
Saproxylic diversity
Microhabitats
Forest management

ABSTRACT

A substantial amount of literature on the importance of deadwood in Central European forests has been available providing partial recommendations to enhance deadwood-dependent biodiversity. However, a comprehensive review of science- and forestry experts-based recommendations effectively enhancing deadwood bearing in mind operational implications has not been presented in international literature. Therefore, this paper compiles the key aspects regarding the implementation of deadwood management in managed forests where the aim is to favour biodiversity without compromising or negatively affecting operational and commercial aspects of forest management. Simple deadwood management guidelines rooted in science and forestry expertise aiding decision-making in the efforts to effectively enhance biodiversity without compromising other management objectives are thus provided. Specifically, long-term retention of individual trees or tree groups and the retention of already existing deadwood (e.g. snags, coarse woody debris, uprooted, snapped, and sun-exposed trees) as well as artificial creation of deadwood (e.g. tree girdling) are presented here as we identified them as the key approaches to successful deadwood management. The major advantages and disadvantages of individual deadwood management approaches in terms of biological and operational/commercial aspects are also emphasised in order to assist forest managers in their decision-making. Furthermore, the key factors that should be considered when applying ecologically and economically efficient deadwood management are discussed; i.e. retention of trees with microhabitats, size of retained trees, position and arrangement, and decay stage. The main points regarding these factors are also addressed in the light of supporting realistic implementation of individual deadwood management approaches.

1. Introduction

Biodiversity is considered a fundamental driver of high intrinsic value that steers forest ecosystem functionality and facilitates for key ecosystem processes and services (Mori et al., 2017). An increasing amount of evidence supporting the significance of deadwood for biodiversity has been available. Although the significance of deadwood as a support for biodiversity has been widely recognised (e.g. Vandekerkhove et al., 2005; Bütler et al., 2007; Lassauce et al., 2011; Lachat et al., 2013; Bouget et al., 2014a, 2014b, etc.), deadwood was also reported to be important for carbon storage (Kueppers et al., 2004; Woodall and Liknes, 2008; Olajuyigbe et al., 2011), nutrient cycling (Laiho and Prescott, 2004; Yuan et al., 2017), soil forming processes and hydrology (Harmon et al., 1986), etc. Deadwood volumes in forests greatly vary depending on forest type (Christensen et al., 2005), tree species (Debeljak, 2006), stand age (Ekbom et al., 2006), geographical location (Stokland et al., 2012) as well as other factors. However, forest management and natural disturbance history also alter the volume of deadwood as well as its type and distribution throughout the forest.

Deadwood is generally present in rather low volumes in conventionally managed forests in comparison to natural forests (Siitonen et al., 2000; Pedlar et al., 2002; Debeljak, 2006; Larrieu et al., 2012; Dieler et al., 2017; Nagel et al., 2017). This is mainly due to the harvesting of trees once they reach the target diameter for felling, which allows to retain only a small amount of deadwood typically in a form of short stumps, small twigs and branches resulting in the absence of snags or large logs (Kruys et al., 1999). However, larger segments of deadwood are particularly important as they remain longer in the forest ecosystem continuously providing habitat as opposed to deadwood of small dimensions offering habitat only temporarily (Lachat et al., 2013). It is also essential to manage for diversity in the retained deadwood; i.e. a range of sizes, decay stages, tree species, locations, etc.

* Corresponding author at: Department of Forest Ecology (Room 409), Faculty of Forestry and Wood Sciences, Czech University of Life Sciences, Kamýcká 129, Praha 6 – Suchdol, 165 21, Czech Republic.
E-mail address: lvitkova@fld.czu.cz (L. Vítková).

https://doi.org/10.1016/j.foreco.2018.07.034
Received 19 April 2018; Received in revised form 17 July 2018; Accepted 18 July 2018

in order to provide suitable environment for a variety of deadwood-dependent species. Deadwood in natural forests results from tree mortality caused by senescence processes or by competition. Alternatively, deadwood may be created by natural disturbances whose quantity and type is rather variable (Rahman et al., 2008) similarly as the deadwood types and quantities it creates (e.g. splintered stems, snapped or broken stems and branches, uprooted trees, etc.). The structure and function of the deadwood changes over time following the natural disturbances (McComb and Lindenmayer, 1999) also depending if any silvicultural interventions are consequently applied. Salvage logging, for instance, tends to remove most of the deadwood substantially reducing the overall deadwood quantities (Priewasser et al., 2013, Michalová et al., 2017).

To a limited extend, the concept of deadwood management has been a part of forest management of some state forest enterprises as well as for some private forest properties in e.g. Germany, Switzerland, France, Italy, Austria, Sweden and Denmark. Life and Life+ projects reports also provided relevant information on some of the practical cases of deadwood management (i.e. Cavalli and Mason, 2003; Mason et al., 2003) with NATURA 2000 reports also delivering information on deadwood management in some of the above-mentioned European countries (European Commission, 2015). Nonetheless, outcomes of forest management practices focusing on the enhancement of deadwood quantity and quality have not been available in published international literature with only some exceptions (e.g. Doerfler et al. (2017) focusing on the success of a deadwood enrichment strategy in production forests in Germany). Although deadwood volumes are assessed on a 5-years basis across European Union (e.g. Forests Europe, 2015), detailed information on deadwood quantities of different types and stages of decay in production forests is unavailable in many countries since the management practices aiming at deadwood enhancement have been applied only for the last 20 years. This period is too short to allow us to record sufficient data on the development of deadwood over time. Besides, detailed deadwood monitoring that would normally yield valuable data on deadwood quantities and qualities has not been part of national forest inventories in some countries. However, although strategies to increase the deadwood qualities in managed forests have been implemented in the light of biodiversity enhancement and certified sustainable forest management (e.g. PEFC, 2010; FSC, 2013) and they have been monitored as a part of National Forest Inventories in some countries (e.g. Germany, Switzerland, the Netherlands), their success have been largely under-reported across Europe (Doerfler et al., 2017). Nonetheless, deadwood has been stated as one of the indicators of sustainable forest management.

Maintenance of sufficient deadwood quantities comprising of a variety of deadwood types does not only locally increase saproxylic species diversity. It also reduces the risk of the saproxylic species becoming extinct thanks to the presence of suitable habitat and thus their viable population. Maintaining sufficient population also reduces the risk of undesirable loss of genes, which occurs during prolonged reduction in population due to ecological and stochastic reasons (Økland et al., 1996). A variety of deadwood types shall be also encouraged, with the same applying to the diversity of deadwood's spatial distribution and stages of decay supporting a range of habitats since different species require different conditions (Bouget et al., 2013). The importance of the presence of old trees and continuous deadwood supply in the conservation of red-listed species was also highlighted especially since the occurrence of relict saproxylic species correlates with the continuity in forest cover containing such features (Buse, 2012). The retention of trees bearing microhabitats and deadwood should be thoughtfully planned in order to ensure long-lasting habitat continuity (Bütler et al., 2013).

A substantial amount of literature on various aspects of deadwood providing and summarising valuable information on deadwood diversity and volume but also the importance of deadwood for ecology of saproxylic species has been available among other topics (Heilmann-Clausen and Christensen, 2003; Heilmann-Clausen et al., 2005; Müller and Bütler, 2010; Lassace et al., 2011; Bouget et al., 2012, 2013; Dittrich et al., 2014; Müller et al., 2015a; Gossner et al., 2016; Doerfler et al., 2017). Individual recommendations supporting specific deadwood management approaches have also been offered; i.e. the necessity to have certain deadwood quantity and/or quality (dimension, position, tree species, etc.) (e.g. Kappes et al., 2009; Müller and Bütler, 2010; Doerfler et al., 2017). However, international literature concisely compiling and presenting a combination of science- and expertise-based recommendations guiding the enhancement of deadwood volumes and diversity in managed temperate forests of Central Europe has not been available; especially when considering commercial feasibility of individual approaches but still bearing in mind the biodiversity enhancement. Although deadwood-related literature often concludes with recommending the increase in deadwood volumes and/or deadwood diversity (e.g. Bunnell and Houde, 2010; Müller and Bütler, 2010), a range of specific, simple and feasible operational approaches that can be implemented to achieve these deadwood management recommendations is rarely mentioned. Especially, if the balance between the deadwood management benefits biodiversity with operational and commercial aspects also taken into an account.

Therefore, the major aim of this paper is to concisely present the key deadwood management approaches – based on scientific findings and expertise - that can be considered in public and private temperate forests of Central Europe. This is conducted in the efforts to effectively enhance deadwood volume and its diversity without compromising other management objectives or increasing operational costs. The major factors necessary to be considered when applying an effective deadwood management are also included in order to support its realistic implementation in practice. We further emphasise the major benefits and drawbacks of individual deadwood management approaches in order to provide a representative picture of its application bearing in mind operational feasibility and commercial viability of these approaches.

2. Approaches to forest management enhancing deadwood

Based on the vast amount of literature published on deadwood as an important biodiversity indicator as well as on existing expertise, several approaches that can be used to increase deadwood quantities and types in managed forest were identified; i.e. the retention of single trees or groups of live trees or the retention of snags and already existing deadwood. Although these methods reflect research concerning the functional effectiveness of measures to promote biodiversity (e.g. Fedrowitz et al., 2014; Hämäläinen et al., 2014), other methods such as retention of lying logs following harvesting, retention of uprooted trees or artificial creation of deadwood by generating high tree stumps or killing of targeted trees (e.g. girdling) can also be considered. Combination of individual deadwood management approaches is also considered a suitable concept for deadwood management in order to achieve greater volume and diversity of deadwood (Ranius et al., 2005).

Opting for deadwood enhancement approaches can increase the diversity (decay stage and dimensions) of deadwood, which is more important for biodiversity than the actual deadwood quantity (Rimle et al., 2017). It is important to work with natural processes that create deadwood but also to improve linkages between existing deadwood features by artificially generating additional deadwood as well as protecting already existing deadwood (Humphrey and Bailey, 2012). Deadwood management is challenging and presents numerous trade-offs between biodiversity enhancement and operational or commercial aspects. Therefore, some of the major advantages and disadvantages of selected deadwood management approaches forest managers are likely to encounter when adopting deadwood management are demonstrated in Tables 1 and 2. Although some efforts towards tree retention already takes place in many commercial forests, it is important to bear in mind