Forest Ecology and Management 371 (2016) 84–89

Contents lists available at ScienceDirect

Forest Ecology and Management

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

No support for long-term effects of commercial tree stump harvest on understory vegetation ☆

Jörgen Rudolphi [a,b,*], Joachim Strengbom [b]

[a] Department of Wildlife, Fish, and Environmental Studies, Swedish University of Agricultural Sciences, Skogmarksgränd, SE-901 83 Umeå, Sweden
[b] Department of Ecology, Swedish University of Agricultural Sciences, P.O. Box 7044, SE-750 07 Uppsala, Sweden

ARTICLE INFO

Article history:
Received 15 October 2015
Received in revised form 26 January 2016
Accepted 28 January 2016
Available online 5 February 2016

Keywords:
Biodiversity
Bio-energy production
Bryophytes
Disturbance
Ground vegetation
Whole-tree harvest

ABSTRACT

Intensification of forestry may further increase the threat that forestry already imposes on biodiversity. The recent re-introduction of stump harvest in Swedish forestry clearly represents such intensification. Stump harvest not only decreases the available habitat for organisms living on dead wood, but also causes soil disturbance that can potentially alter understory diversity. In this study we capitalized on the large-scale stump harvest (c. 10,000 ha) that took place during the period from 1977 to 1989 in south-central Sweden. In 2013, we performed vegetation surveys in forest stands where stumps were harvested and in conventionally harvested reference stands. Twenty-four to 36 years after stump harvest we found no differences in species richness and composition of vascular plants and mosses between the two categories of stands. We conclude that our study lends no support for any long-term effects of stump harvest on understory vegetation. The lack of differences between stump harvested and conventional clear-cut stands may be due to that the additional disturbance effects generated by stump harvest were overridden by the strong disturbance effects already imposed by the standard forest management, i.e. clear-cutting with subsequent soil scarification.

© 2016 Elsevier B.V. All rights reserved.

1. Introduction

Disturbance and the successional development that follows have long been recognized as important for structuring ecological communities (Connell and Slatyer, 1977; Sousa, 1984). In the vast boreal biome, both biological diversity and function are largely dictated by disturbance (Esseen et al., 1997; Nilsson and Wardle, 2005). In natural forests, the major disturbance events are fire, pest outbreaks, diseases, and severe weather. In managed forests natural disturbances are often suppressed and replaced by anthropogenic disturbances, such as clear-cutting, soil scarification, and thinning (Esseen et al., 1997). As opposed to natural disturbances, which are often heterogeneous both temporarily and spatially, anthropogenic disturbances tend to generate more homogenous forests in general (Östlund et al., 1997). For forest-living organisms, a landscape shaped by natural disturbances will therefore appear very different from one shaped by man (Esseen et al., 1997; Franklin et al., 1997; Östlund et al., 1997).

In forests, clear-cutting is the most dramatic anthropogenic disturbance, and often regarded as one of the most prominent threats to forest biodiversity (Franklin et al., 1997). On top of this, modern forest management often includes additional treatments, such as slash harvest, soil scarification, and planting that may generate additional impacts on forest communities (Åström et al., 2005; Bergstedt et al., 2008). Adding new disturbances to already stressed systems may have large consequences (Folt et al., 1999; Sih et al., 2004), and if the effects of the disturbances interact, the net effect may be much greater than predicted from the individual effects (Strengbom and Nordin, 2012). Despite their potentially large-scale impact, long-term effects of multiple disturbances in managed forests have received surprisingly little attention.

With the aim of replacing fossil fuels with renewable energy sources forest residues, such as branches and tops left at final fellings, are today routinely extracted in forestry operations in Sweden (Skogsstyrelsen, 2014). The extraction of stumps for bioenergy purposes has also recently gained interest. In Sweden, stump harvest has a long history, but its consequences for forest biodiversity have until recently been poorly studied (Persson, 2012). In addition to reducing habitat availability for dead wood dwelling organisms, the vegetation around the stump may be affected by stump removal. Clear-cutting with subsequent soil scarification has a

☆ This article is part of a special issue entitled "Stump harvesting – impact on climate and environment".

* Corresponding author at: Department of Wildlife, Fish, and Environmental Studies, Swedish University of Agricultural Sciences, Skogmarksgränd, SE-901 83 Umeå, Sweden.

E-mail addresses: jorgen.rudolphi@slu.se (J. Rudolphi), joachim.strengbom@slu.se (J. Strengbom).

http://dx.doi.org/10.1016/j.foreco.2016.01.039
0378-1127/© 2016 Elsevier B.V. All rights reserved.

strong influence on diversity of the understory vegetation (Bergstedt et al., 2008; Bråkenhielm and Liu, 1998; Jalonen and Vanha-Majamaa, 2001). Stump harvest causes additional disturbance to the system, with up to 70% of the forest floor disturbed as compared to approximately 50% after conventional scarification (Kataja-aho et al., 2011). The disturbance associated with stump harvest can also alter composition and richness of the understory vegetation, and short-term studies reveal both higher species diversity and density in stump harvested sites (Andersson, 2012; Kataja-aho et al., 2011).

Despite that studies of short-term effects of stump harvest have shown increased risk of local population declines in beetles, lichens and fungi (Walmsley and Godbold, 2010), the long-term environmental consequences of this new management regime are poorly understood. Stump harvest has only recently become more common in Sweden and Finland, which partly explains the lack of knowledge. In addition, the few published studies give an ambiguous view of the effect that stump harvest have on understory vegetation, which seriously limits the possibilities to assess the environmental consequences.

By capitalizing on the large-scale stump harvest that took place during the period from 1977 to 1989 in an area covering almost 10,000 ha in south-central Sweden, we investigated potential differences in understory vegetation between stump harvested stands and stands that were harvested using conventional methods. Since plants may react differently to stump harvest based on their life-history traits, we not only investigated species richness and composition, but also examined the response of species functional groups. Both species richness and composition of herbaceous species have been shown to change after mechanical site preparation, such as soil scarification (Newmaster et al., 2007). This group is therefore also likely to be affected by stump harvest. Woody shrubs, including ericaceous dwarf-shrubs are a dominant and functionally important component of the understory vegetation in boreal forests (Nilsson and Wardle, 2005), that may be negatively influenced by stump harvest. The species that are rhizomatous in this group may be especially sensitive. In general, rhizomatous species are more sensitive to soil disturbances than non-rhizomatous species (Bergstedt et al., 2008; Bråkenhielm and Liu, 1998; Jalonen and Vanha-Majamaa, 2001), hence rhizomatous species are expected to be disproportionally negatively influenced by stump harvest. Graminoids, irrespectively of being rhizomatous or not, are often fast colonizers of bare ground, and can thus be expected to increase both in species number and abundance as a result of soil disturbance from stump harvest. Although these types of responses have been reported as short-term responses to stump harvest, the long-term effects are still largely unknown (Kataja-aho et al., 2011).

Bryophytes (including both mosses and liverworts) constitute a very species rich and functionally important plant group in boreal forests (Longton, 1992). They are known to respond strongly to forestry operations such as clear-cutting (Rudolphi et al., 2014) and soil scarification (Newmaster et al., 2007), making this group likely to be sensitive also to stump harvest. The importance of stumps for bryophytes living on dead wood has been addressed in previous studies (e.g. Caruso and Rudolphi, 2009; Rudolphi et al., 2011), but information on effects of stump harvest on ground-dwelling bryophytes are still lacking.

Based on this previous knowledge we formulated a main hypothesis:

(1) Stump harvest reinforces effects introduced by the common forest practice associated with final felling, resulting in profound, and long-lasting effects on species richness and composition of boreal forest understory vegetation.

We further hypothesized that different functional groups of plants would respond differently to stump harvest. Based on this we formulated five more specific hypotheses:

(2) Stump harvested stands will have lower species richness and abundance of herbaceous species than conventionally harvested stands.
(3) Stump harvested stands will have lower species richness and abundance of woody shrubs than conventionally harvested stands.
(4) Stump harvested stands will have higher species richness and abundance of graminoids than conventionally harvested stands.
(5) Irrespectively of being herbaceous, woody, or graminoid, rhizomatous species are especially sensitive to soil disturbance. Therefore we hypothesize that richness and abundance of rhizomatous species will be lower in stump harvested stands than in conventionally harvested stands, whereas non-rhizomatous species will remain largely unaffected.
(6) Stump harvested stands will have lower species richness and abundance of bryophytes than conventionally harvested stands.

2. Material and methods

2.1. Study area

The study was performed in the province of Uppland, south-central Sweden (59°43′N, 17°30′E), within the hemiboreal vegetation zone (Ahti et al., 1968). The region has an average annual precipitation of 600 mm, with February as the coldest month (−4 °C) and July as the warmest (+17 °C) (Raab and Vedin, 2004). The area is mainly composed of managed mixed coniferous forests of contrasting successional stages, which cover the entire rotation period (about 100 years). Old-growth stands (>130 years) are rare because the area has a long history of logging. At final felling practically all trees are cut, despite age and species, with the exception of aspen (*Populus tremula* L.) that normally occur in low frequencies. The dominant tree species are Norway spruce (*Picea abies* (L.) H. Karst.), Scots pine (*Pinus sylvestris* L.) and birches (*Betula pendula* Roth. and *B. pubescens* Ehrh.).

In the study area stumps were harvested between the years 1977 and 1989 for pulp production. In a previous study Jansson and Albrektsson (2007) identified pairs of stands where 20 conventionally harvested stands were matched to 20 stump harvested stands. The stands in each pair were closely located geographically, cut approximately the same year, site prepared using similar methods and extent, and judged similar with respect to stand characteristics. The aim of their work was to identify stands with and without stump harvest to isolate effects of stump harvest from other effects of clear-cutting. Later, thorough field work proved several pairs dissimilar and the paired design was discarded (Magnusson et al., 2010). Magnusson et al. (2010) presented alterations to the original list of stands and from this list we selected 11 stump harvested stands and 11 reference stands to investigate long term effects of stump harvest on understory vegetation (Fig. 1).

2.2. Vegetation analysis

We measured abundance of species in the understory vegetation using a modification of the point intercept method (Jonasson, 1988), as described by Strengbom and Nordin (2012). We placed two 50-m transects on the forest floor. The transects were placed so that they never crossed or were in the same

Download English Version:

https://daneshyari.com/en/article/85918

Download Persian Version:

https://daneshyari.com/article/85918

Daneshyari.com