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Shelterwood Cutting System for Forest Management

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Abstract

The shelterwood system is one of the traditional methods used to encourage the regeneration of the species with heavy seed such as beech, oak and pine. Shelterwood forest management removes the overstory trees in a series of cuts in regeneration unit. This silvicultural system involves preparatory cut with felling intensity of 20-25%, regeneration cut with felling intensity of 20-25% for shade tolerant species and 30% for light demanding species, primary, secondary light cuts and final cuts. Other units are under improvement cuttings and tending operations when regeneration unit is under shelterwood cutting. It confirms that instead of shelterwood system other silvicultural practices such as single tree selection system and group selection system should be applied for the mountainous beech stands of the Hyrcanian forests of Iran.

Keywords: Shelterwood cutting, Silvicultural method, Tending operations, Regeneration, Hyrcanian forests.

INTRODUCTION

The shelterwood system can be used to establish regeneration and to improve the growing conditions of seedlings and, thereby, increase their probability of survival after final harvest [8, 18]. One of the tenets of shelterwood harvesting is that maintaining some degree of forest canopy cover maintains a forest influence which lessens the impact of harvesting on ecosystem functioning [13]. Although shelterwood harvesting is deemed adequate to preserve aesthetic as well as some wildlife values, little is known about its impact on stand structure and forest regeneration [4]. The shelterwood system is one of the traditional methods used to encourage the regeneration of the species with heavy seed such as beech, oak and pine [15, 21].

Under a shelterwood silvicultural system, some mature trees are removed in a series of separate cuts. The purpose is to regenerate a new, even-aged stand under the shelter of remaining trees. The new growth may result from planting, natural regeneration from seed, or established advance regeneration from the pre-harvest stand [12]. The shelterwood method is particularly useful as an alternative to clearcutting. It is a gentler method; the land is never without trees and their presence lessens the harshness of the environment. The habitat provided is midway between the open sunlit clearcut and that of the dense shady uncut forest [16].

Taheri- Abkenar [28] notes that at the end of a 30-year period, after removal felling, 75 percent of the forest area had not sufficient regeneration, likely due to the seed cutting made in inadequate seed production year. Amani and Hassani [2] state that in stands managed with shelterwood objectives, technical defects in marking and harvesting have been the reasons for regeneration deficiency and herbal vegetation invasion. Agestam et al. [1] studied the natural regeneration of beech (Fagus sylvatica) under various shelterwood densities and soil preparations in a 130-year-old beech stand in southern Sweden. Results showed that the seedling emergence was higher in the shelterwood than in the clear cut. The mortality was the highest during the first year. The seedling number was the highest on bare mineral soil and the lowest on undisturbed ground, for all cutting regimes. The increase in seedling height and dry mass was greater in the clear cut and in the sparse shelterwood than in the dense shelterwood. Damages due to frost were more frequent in the clear cut than in the shelterwood.

Tabari et al. [27] reported that most Fagus orientalis Lipsky. Seedlings were not discolored or slightly discolored under gaps of 50, 200 and 600 m^2 and were slightly too moderately discolored in the open. There was a general tendency for higher discoloration in larger openings. It is concluded that small non-regenerated canopy gaps (200 m^2) of beech forests in northern Iran can be restored by planting beech wildings as well as nursery seedlings in small openings, whereas nursery seedlings are preferred in larger gaps (600 m^2). Brose [5] reported that root development of oak species is least in the uncut treatment and change little after the first year. Northern red oak showed an increase in root size in the preparatory cut by the fourth year. All oak species had larger roots in the first removal cut and final cut treatments by the fourth year with black and northern red oak having their most root development in the final cut and chestnut and white oak having their most root growth in the first removal cut.

In this research, we are going to describe the shelterwood cutting system as a traditional silvicultural method which was used previously in different parts of northern forest ecosystems of Iran (Hyrcanian zone). For studying the effects of shelterwood cutting system on understory herbaceous species, tree vegetative parameters and forest regeneration, we test the following hypotheses:

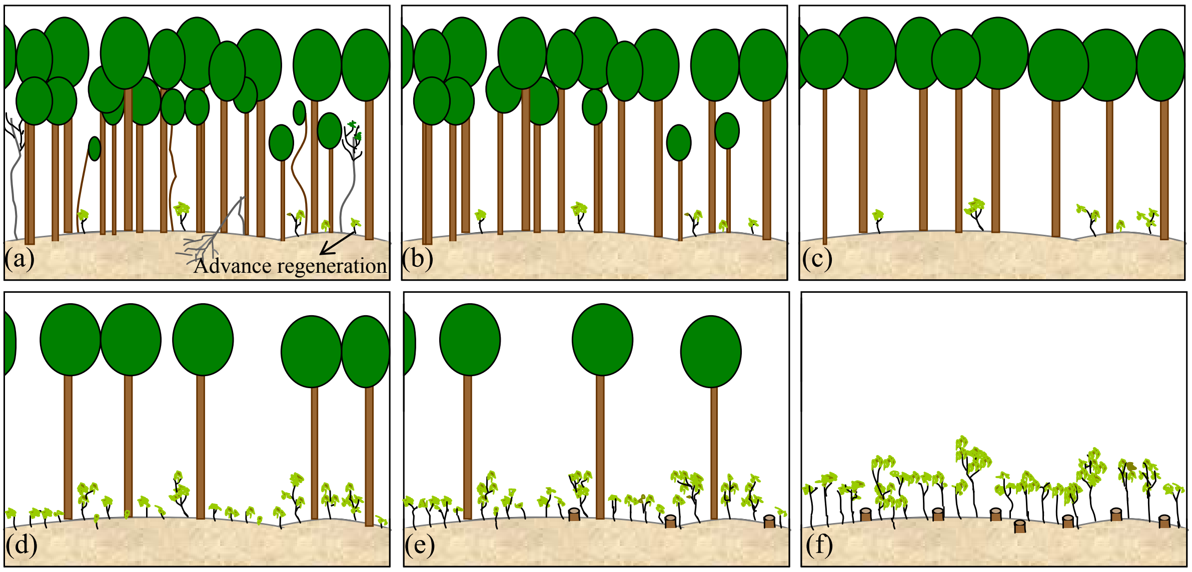

Figure 1. Schematic of the series of cuts in shelter wood cutting system in a regeneration unit

H1: Forest management with shelterwood cut system affected the frequency and diversity of the understory herbaceous species

H2: Vegetative parameters of trees are affected by shelterwood cutting system

H3: Seedling establishment with relatively high vitality was greater in gaps of treated stands than under closed canopy.

MATERIAL AND METHOD

Shelterwood management removes the overstory in a series of cuts in regeneration unit. Following figure shows mature stand (Figure 1a), preparatory cut with felling intensity of 20-25% (Figure 1b), regeneration cut with felling intensity of 20-25% for shade tolerant species and 30% for light demanding species (Figure 1c), primary (Figure 1d) secondary light cuts (Figure 1e) and final cuts (Figure 1f).

Figure 2 shows the schematic diagram of trees distribution in different units with even aged stands after shelterwood cutting at the end of a 100 years period. Units II, III, IV and V are under improvement cuttings and tending operations when Unit 1 is under shelter wood cutting (Figure 3).

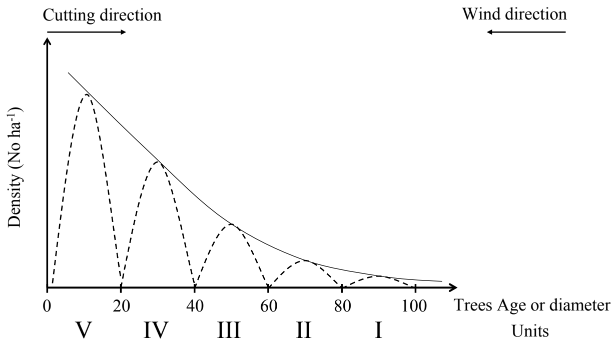

Figure 2. Schematic diagram of trees distribution in different units at the end of 100 years period.

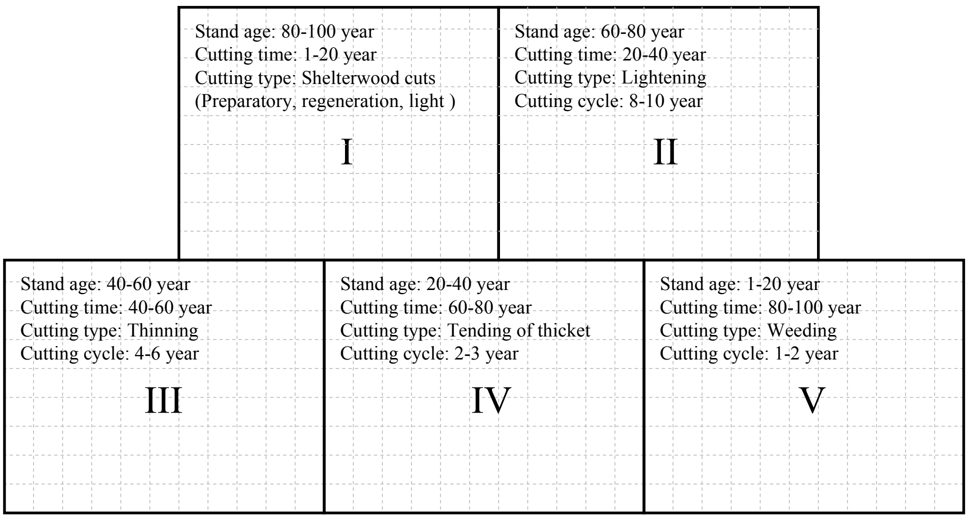

Figure 3. Unit 1 is under shelter wood cutting and units II, III, IV and V are under improvement cuttings and tending operations

RESULTS AND DISCUSSION

In this section of paper we present analysis the results of research hypotheses. The following subsections provide analysis of results of hypotheses testing. Forest management with shelterwood cut system affected the frequency and diversity of the understory herbaceous species [6]. So that the frequency of some species increases significantly after the shelterwood cut in treated stand. This increase in the plant density is due to the canopy opening after harvesting [1]. So, the shelterwood system seems to be an option for maintaining plant species diversity after logging. Similar findings have been reported for Fagus orientalis Lipsky in Sangdeh forests of Iran [20]. Decrease of frequency for some shade tolerance herbaceous species was recorded in treated stand. This species might disappear due to the exposure to greater sun light. Poorbabaei and Poor-rostam [19] proved that the tree richness, tree diversities, evenness and diversities of understory species in area with one seed cutting is highest. Shelterwood cutting has been reported to make beech regeneration more difficult in many Japanese beech forests, but this method might not significantly affect plant species diversity [17].

Effect of Shelterwood Cutting on Vegetative Parameters of Tree

It has been proven that commercial species DBH in control stands (Without shelterwood cutting) is more than treated stands (With shelterwood cutting). In addition, the bole height of trees in control stands is higher than treated stands. This may be due to intense competition and closed canopy in control stands. In treated stands the bole branchiness can be increased because of human interference and solar radiation entering into the stands [22]. Composition and structure of a three-storied Fagus orientalis-dominated forest was investigated in the Caspian forests, north of Iran. The measurements were carried out before the first shelterwood cutting (in 1974) and after the last shelterwood cutting (2004). The results after 30 years (in 2004) revealed that frequency, basal area and standing volume was significantly enhanced for beech and reduced for hornbeam but did not statistically differ for alder, maple and other species. Sapling and thicket groups were observed in parts of the investigated site and where the mature trees were not felled. The research area was converted into an irregular uneven-aged 2-4-storied forest, owing to recruits, advance regeneration, mature trees and small and large pole groups maintained through the forest [26]. In the first cuts of the shelterwood system the most of the original basal area is harvested. Cutting removed virtually all competition and allowed seedlings almost unlimited growing space with increased available water, nutrients, and sunlight [9]. So, in treated stands, trees density in small diameter classes is greater than that in control stands. Moreover, trees volume in small diameter classes in treated stands is more than those of in control stands.

Effect of Shelterwood Cutting on Forest Regeneration

Seedling establishment with relatively high vitality was greater in gaps of treated stands than under closed canopy of control stands. Another explanation can be the light accessibility for seedlings in gaps of treated stands [15, 7, 23]. In clearcuts of lowland stand, the size of red spruce (Picea rubens Sarg.) seedlings established in skid trails seemed to be negatively affected by the considerable quantity of woody debris strewn over them [18]. Unsuitable harvesting methods during last 30 years and lack of forest protection are the two main technical reasons for failure of the shelterwood system in Hyrcanian forests [11, 25]. In addition, infrequent mast years occurring at intervals of five to eight years, closed canopies that rarely produce a fertile seed-crop and a high proportion of infested and predated nuts are natural reasons that add to the regeneration failure in shelterwood systems of Hyrcanian forests [25]. This incomplete regeneration is common also in European forests, which are successfully managed by shelterwood system and artificial planting is prescribed to supplement natural regeneration [14, 24].

Holgén and Hånell [10] recommended that the number of shelter conifer trees should be at least 200 per hectare to provide adequate protection for the new tree generation. Shelterwood methods (by natural establishment or planting) used in highly productive spruce forests yield acceptable or desirable levels of regeneration in Sweden [10]. Beguin et al. [3] demonstrated that the use of silvicultural treatments (shelterwood cutting and strip clear cutting) alone is unlikely to restore balsam fir regeneration on Anticosti Island, as long as the deer population remains higher than 20 deer km^{-2}.

CONCLUSIONS

Shelterwood system is a common knowledge in silviculture. This research presented a detailed description of the forest type, its management history and the problems of shelterwood cutting management in Iran and other countries of world. In conclusion, it confirms that instead of shelterwood system other silvicultural practices such as single tree selection system and group selection system should be applied for the mountainous beech stands of the Hyrcanian forests of Iran. Also, despite a large number of studies on nutrient availability and microbial properties of forest soil affected by shelterwood system, there are still not enough indications of the effect of this system on the natural regeneration and stand structure. Hence, still further studies are required to provide a better understanding of the forest regeneration and stand structure as a key control factor on shelterwood cutting successfulness in deciduous Hyrcanian forests ecosystem.

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