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Investigation ground based logging damages on natural regeneration in a selection cutting stand in the Caspian forests of Iran

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Abstract

In this study ground based logging damages on natural regeneration following selection cutting were investigated in Nav Asalem forest in the Caspian forests of Iran. Systematic plot sampling method before and after finishing logging operation was used for collection of data. Results showed 5.8% of natural regenerations were wounded and 9.7% were destroyed by logging operation in the study area. The most percentage of wounded and destroyed regeneration was observed on *Acer cappadocicum* (10.1% and 13.9%), while the least percentage of wounded and destroyed regeneration were observed on *Carpinus betulus* (4.1% and 6.4%). Extent and severity of damages to regeneration were occurred in the winching area. The results indicated that percentage of logging damages on regeneration were increased with increasing of height of regeneration.

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Introduction

Caspian forests of Iran are located in the north of Iran and south coast of Caspian Sea. These forests cover are 1.8 million hectares of land area and are only commercial forests of Iran. They are suitable habitats for a variety of hardwood species such as Beech, Hornbeam, Oak, Maple and Alder. These forests are the most valuable forests in Iran. These forests are known as one of the most basic resources for wood production and have a big share in supplying wood to the related industries. Approximately 60 percent of these forests are used for commercial purposes and the rest of them are more or less degraded. Recently, shelter-wood cutting has been replaced by selection cuttings as alternatives to logging in Caspian forests of Iran. The main goal of selection cutting is provide the mixed and uneven-aged stand. Selection cutting has been denoted as the practice of harvesting the most important timber species in natural forests, allowing the remaining forest to naturally regenerate over time. In the Iran Caspian forests logging operation is generally performed by using ground based skidding system. Chainsaw and cable skidder are two main logging machines for wood harvesting in Caspian forests. During wood harvesting residual stand are damaging in these forests. Residual stand damage is a natural prospect of selective cutting, but the level of damage should be minimized to assure future product quality. The amount of ground based logging damage to residual stand in selection cutting are affected by several factors, such as level of planning in the logging operation (Pinard and Putz, 1996), harvesting intensity (Sist et al., 1998), residual basal area (sist et al., 2003), season of logging (Limbeck-Lilienau, 2003), logging machines (Han and Kellogg, 2000), road density (Iskandar et al., 2006), stand conditions and skill of equipment operators (Pinard et al., 1995). Hosseini et al. (2000) compared damages to natural regeneration by two logging system: skidding operation and cable operation in the Caspian forests of Iran. They results showed that approximately 11% of regeneration was damaged in the skidding operation: 8.7% were wounded (bark removed) and 2.3% were broken or uprooted, where approximately 5% of regeneration was damaged by the cable operation: 4% were wounded and 1% was broken or uprooted. In a study logging damages on stand and soil were investigated in Nav forest area and reported that 4.9% of regeneration were destroyed in harvested area (Tavankar, 2000). Nikooy (2007) studied logging damage on regeneration in the Caspian forest and reported that damage rate on the seedling, small sapling and large sapling stage were 20.3, 20.6 and 26.5% in felling gaps. Lotfalian et al. (2008) reported about 3.2% of natural regeneration was damaged by felling operation and about 4.8% was damaged by skidding operation in a selectively logged parcel in northern forests of Iran. Majnounian et al. (2009) reported that 23% of stand regeneration were damaged by tree felling operation and the results of this study showed that the amount of damage to seedling was less than to the small sapling and thicket. Tavankar et al. (2011) observed approximately 5.6 % of natural regeneration was wounded and about 8.1% was destroyed following selection cutting in a steep slope area of Nav-Asalem forest with harvesting intensity 7.5 trees/ha. The main objective of this study was to investigate ground based logging damage to natural regeneration and Examination of the stand regeneration damages by considering different growing stage and species of regeneration.

Material and methods

Study area

This study was conducted in parcel 35 as well as district 1 of Nav forests. The Nav forests are located between 37° 38' 34" to 37° 42' 21" N, 48° 48' 44" to 48° 52' 30" E. The total surface area of parcel 35 is 39 ha which 7 ha is under protection, with the remainder being suitable for harvesting. Elevation of the study area is ranged from 11350 m to 1500 m. In the study area, average ground slope is 30 to 55% and the general aspect of the hillside is west. The mean annual precipitation is approximately 950 mm and the mean annual temperature is 9.1° C. The original vegetation of this area is uneven-aged mixed forest dominated by *Fagus orientalis* and *Carpinus betulus*, with companion species *Alnus subcordata*,

Acer platanoides,Acer cappadocicum, Ulmus glabra and Tilia rubra. The soil type is forest brown and soil texture varies between sandy clay loams to clay loam. The results of conducted inventory in this forest showed that the trees density and stock growth above 10 cm dbh (diameter at breast height) were 292 tree/ha and 212 m^3/ha respectively. Total number and volume of marked trees in this parcel was 216 trees (6.75 trees/ha) and 688 m^3 (21.5 m^3/ha). Manual chain saw and Timberjack 450 C wheel skidder were used for cutting and extraction of marked trees.

Collection of data

Systematic plot sampling was used for data collection. The dimensions of right angle grid were 100 m by 100m, plot area was 0.1 ha and plot shape was circular. 28 sample plots were established systematically across the logged are (32 ha) with random starting point. Sampling intensity was 8.75%. Sample plots were inventoried before and after logging operation and regeneration (diameter at breast height less than 7.5 cm) conditions such as number, species, growing stage (seedling, height < 0.5 m; small sapling, 0.5 m < height < 2 m and large sapling, height > 2 m) and logging damages were noted. Regeneration was careful examined and two types of logging damages were noted: i) wounded regeneration, include bent over or severely leaned and broken crown branches, ii) destroyed regeneration, include broken bole and complete uprooted.

Results

Numbers, percentages and condition of species of regeneration before and after the logging operation in the sample plots is presented in table 1. From all examined regeneration (1384 stems) in sample plots, species were comprised 51.3% *Fagus orientalis* (513 stems), 21.4% *Carpinus betulus* (296 stems), 9.8% *Acer velutinum* (136 stems), 7.5% *Alnus subcordata* (104 stems), 5.7% *Acer cappadocicum* (79 stems) and 4.3% other species (59 stems). From all examined regeneration 81 stems (5.8%) were wounded and 134 stems (9.7%) were destroyed by ground based logging operation in the sample plots in the study area (Table 1). These results indicated that number and percentage of destroyed regeneration was more than number and percentage of wounded regeneration. The most percentage of wounded and destroyed regeneration was observed on *Acer cappadocicum* (10.1% and 13.9%), while the least percentage of wounded and destroyed regeneration were observed on *Carpinus betulus* (4.1% and 6.4%). The most numbers of wounded and destroyed regeneration was observed on *Fagus orientalis* with 37 and 76 stems (Table 1). The ratio of destroyed regeneration to damaged regeneration in the *Fagus orientalis* was 0.67 (67/113), in the *Carpinus betulus* was 0.61 (19/31), in the *Acer velutinum* was 0.61 (17/28), in the *Alnus subcordata* was 0.57 (13/23) and in the *Acer cappadocicum* was 0.58 (11/19).

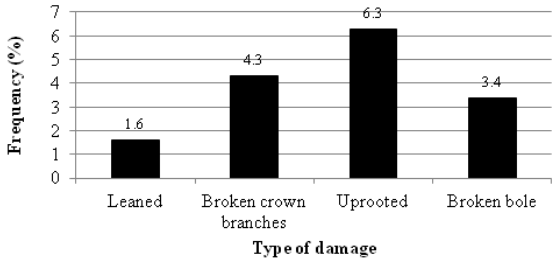

Fig. 1. Frequency of damage type on regeneration.

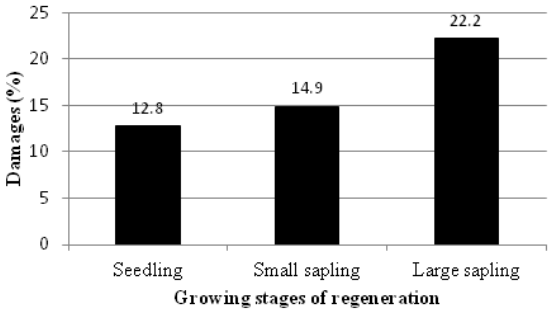

Fig. 2. Percentages of damages in growing stages of regeneration.

In this study two types of wounded regeneration (Leaned and broken crown branches) and two types of destroyed regeneration (uprooted and broken bole) were observed and were noted in the sample plots after ground based logging operation (Figure 1). From all damaged regeneration (215 stem), 22

stems (10.2%) were leaned, 59 stems (27.4%) were broken crown branches, 87 stems (40.5%) were uprooted and 47 stems (21.9%) were broken bole. These results indicated that after ground based logging operation 1.6% of regenerations were leaned, 4.3% were broken crown branches, 6.3% were uprooted and 3.4% were broken boles in the study area (Fig. 1).

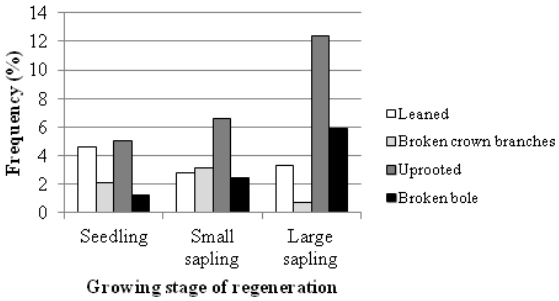

Fig. 3. Frequency of damage types in growing stage of regeneration.

Table 1. Numbers, percentages and condition of species of regeneration before and after logging.

Species of regeneration	Before logging		After logging			
	Safe		Damaged			
			Wounded		Destroyed	
	(Number)	(%)	(Number)	(%)	(Number)	(%)
Fagus orientalis	710	51.3	37	5.2	76	10.7
Carpinus betulus	296	21.4	12	4.1	19	6.4
Acer velutinum	136	9.8	11	8.1	17	12.5
Alnus subcordata	104	7.5	10	9.6	13	12.5
Acer cappadocicum	79	5.7	8	10.1	11	13.9
Other species	59	4.3	3	5.1	6	10.2
All species	1384	100	81	5.8	134	9.7

Table 2. Numbers, percentages and condition of growing stage of regeneration before and after logging.

Growing stage of regeneration	Before logging		After logging			
	Safe		Damaged			
			Wounded		Destroyed	
	(Number)	(%)	(Number)	(%)	(Number)	(%)
Seedling (Height < 0.5 m)	655	47.3	44	6.7	40	6.1
Small sapling (0.5m<Height<2m)	423	30.6	25	5.9	38	9.0
Large sapling (2m<Height<8m)	306	22.1	12	3.9	56	18.3
All stages	1384	100	81	5.8	134	9.7

From all examined regeneration 655 stems (47.3%) were in seedling stage, 423 stems (30.6%) were in small sapling stage and 306 stems (22.1%) were in large sapling stage (Table 2). The results indicated that percentage of wounded regeneration in seedling stage (6.7%) were more than small sapling stage (5.9%) and large sapling stage (3.9%), while the percentage of destroyed regeneration in large sapling stage (18.3%) were more than small sapling stage (9.0%) and seedling stage (6.1%). The ratio of destroyed regeneration to damaged regeneration in the seedling was 0.48 (40/84), in the small sapling was 0.60 (37/63) and in the large sapling was 0.82 (56/68).

The percentage of damages (wounded and destroyed) in large sapling stage were more than damages in small sapling stage and damages in small sapling stage were more than damages in seedling stage (Figure 2). These results indicated that percentage of logging damages on regeneration were increased with increasing of height of regeneration. About 22.2% of large saplings were damaged, while 12.8% of seedlings were damaged by ground based logging system in the study area (Figure 2).

The uprooted type of damage was most frequency in the all stages of regeneration (Figure 3). The frequency of uprooted and broken bole types of damage was increased with increasing height of regeneration (Figure 3). In the study area approximately 12.4% of large saplings were uprooted by ground based logging operation. The most frequency of leaned regeneration were observed in seedling stage (Figure 3).

Discussion

In this study ground based logging damage on natural regeneration were investigated in a selectively logged parcel in the Caspian forest of Iran. The results showed that about 15.5% of regeneration were damaged by logging operation that 5.8% were wounded and 9.7% were destroyed. According to results of other researchers, the amount of ground based logging damages on the regeneration were reported variety between 8 to 23% in the Caspian forest. The logging intensity, Logging machines, road density and site condition are important factors that influence on amount of ground based logging damages to residual stand in these forests. According to results of this study number of destroyed regeneration was more than number of wounded regeneration. So, stand regeneration can not to resist against logging mechanical damages and many of them were destroyed. Many of wounded regeneration cannot growth and will die. Directional felling is a important technique to reduce logging damages to residual stand. With directional felling, trees were felled to reduce damage to stand, to facilitate choker hookups in preparation for skidding and to without creating unnecessary large forest disturbance. Extent and severity of damages to regeneration were occurred in the winching area. Many of uprooted regeneration were occurred in the winching area. Winching operation is the main cause of damages to regeneration during ground based logging operation. Logging studies have shown that poor felling and skidding techniques can result in excessive damage to residual stand. The detailed planning strategy will reduce damage to level which is acceptable and predictable. The results of this study showed that highest damages were occurred on the species of *Acer cappadocicum* and *Alnus subcordata* regeneration. These results indicated that regeneration of light demanding species were more damaged than other species. One of the objectives of selective silviculture method is protection of tree species diversity. More damages on light demanding regeneration species may decrease forest diversity at future years. Good care of regeneration is important to the success of uneven aged practice. The results showed that frequency and intensity of damages on the large saplings were more than the small saplings and seedlings. Other researchers have showed same results in the Caspian forests. These results indicated that with increasing of height of regeneration, flexibility of them reducing and intensity of damages increasing. The results showed about 18.3% of large saplings were destroyed by the ground based logging system in the study area. This amount of large sapling destroyed is risky for future of forest sustainability.

Conclusion

In the Caspian forest silviculture method and logging system is selection cutting method and ground based skidding system. Damages to residual stand and regeneration is a natural prospect of selection cutting method specially, when ground based skidding system have been using for timber extraction. But the level of damage should be minimized to assure future stand quality. It must be recognized that controlling logging damage is critical when the selection cutting systems are utilized. To reduce stand damage in uneven-aged forests during selection cutting operations, felling directions should be predetermined, road networks should be well planned, loggers and operators should be experienced and adequately trained and skidding distance should be kept shorter. The skidder and chain saw operators are important factors can be influence on productivity and environmental impacts during logging operation. So training of forest

workers can be useful to reducing logging damage on residual stand and natural regeneration.

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