Journal of Applied Sciences

ISSN 1812-5654

science alert

ANSInet
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Journal of Applied Sciences 8 (9): 1750-1755, 2008
ISSN 1812-5654

Investigation of Forest Regeneration in Relation to Industrial and Traditional Skidding Methods in North of Iran

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Abstract: The objectives of this study were to estimate the quantitative damages on regeneration, comparison of industrial and traditional skidding operations and determine how to reduce utilization damages on regeneration and selection of the best method in North of Iran. In this research, the damages to the regeneration were investigated and compared by using of industrial skidding and traditional methods in Kheirood-Kenar forest (North of Iran). Also, according to this research, rates of damage to the increment groups (cores) of seedling, juvenile and sapling was surveyed. Results from this research showed that the rates of damages were 6.48, 5.34 and 9.57% in industrial skidding and 3.78, 5.34 and 2.13% in traditional skidding, respectively. As perceived, the largest rates of industrial skidding were on sapling group and also rate of the damage to the whole regeneration was 6.45% in industrial skidding and 3.48% in traditional skidding. In these two states most of the damages were in the shape of destroyed and the percentages of wounded samples were the same.

Key words: Skidding, industrial, traditional, damage, regeneration

INTRODUCTION

Iran is located in northern hemisphere that has different climates (Zobeiry, 2000, 2002). Most area of Iran are arid and semi-arid. Almost, 7% of Iran area is covered with forest and 1.9 million ha areas of these forests are situated in the Southern of Caspian that have merchant value. This forest is known as hyrcanian forests and valuable from genetic viewpoint due to the biotic fossil of European forests (Namiranian, 2007).

Human being has been meeting his demands for natural resources course of time and also been in connection with nature. However, because of the small number of people, this connection had less damaging consequences. As the population and demands increased, this connection has been damaging. Sometimes this act was in the shape of a non-standard forest harvesting which caused the degradation of the forest. This degradation maybe in the following shapes: soil destruction, damage to the stand and damage to the regeneration (Lotfalian, 1996, 2005; Majnounian, 2000).

Disturbing of forests is visible due to illegal utilization in recent years. Animals were used for transportation of forest products in last years (Also, it is usage in some of forest management plans, nowadays). Pay attention to low capacity of transportation by animals, therefore, forest products (e.g., timber) were converted to small sizes (e.g., bolts). This operation causes damages to products and economic conditions (Sarikhani, 2001). Thus, traditional methods were replaced with industrial and mechanized methods, as mechanization of utilization followed the entrance of many machines in forest (Lotfalian, 2005). TAF skidder is one of these machines that are used in some of forest management plans. This skidder is used for skidding on skid trial. The activities of this machine caused damages to saplings, compact forest soils and limit forest regeneration (Sarikhani, 2001).

The effects of skidding different methods on forest regeneration are well studied and results for models have been reported by Tashakkori (2000), Van Gradingen *et al.* (2000), Guariguata and Barreto (2000), Guarigata and Dupug (2001), Johns *et al.* (2001), Pinard *et al.* (2001), Whitman *et al.* (2001), Fox (2002), Oliveria (2002), Ghaffarian (2003), Frederickson and Pariona (2003), Mostacedo (2003), Frederickson and Mostacedo (2004), Kennard *et al.* (2005) and Seng *et al.* (2005).

Pay attention to Skidding with industrial and traditional methods have different damages on forest regeneration and appropriate thus, the objectives of this study were to estimate the quantitative damages on regeneration, to compare industrial and traditional skidding operations and to determine how to reduce utilization damages on regeneration and selection of the best method in North of Iran.

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MATERIALS AND METHODS

Study area: The study site is the Kheirood-Kenar forest (51° 32′ N, 36° 27′ W) of the Caspian in Northern Iran. The Kheirood-Kenar forest is used for education and research by Tehran University and is close to Noushahr City in Mazandaran province (Fig. 1). This research was performed in the summer of 2006. This forest is divided to eight districts and this research was conducted in one of the districts called Nam-Khaneh. The highest mean monthly temperatures of 29°C occur in February and the mean annual rainfall is 1354.5 mm at the Noushahr meteorological station, which is 10 km far from study area. The study site is a mountain forest with an altitudinal range from about 650 to 1400 m. Although some parts in study site are underlined by sandstone, limestone forms the parent material across most of the site. According to the soil survey taxonomy, the majority of soils in the study site are classified in *Inceptisoil* and *Alfisoil* orders (Anonymous, 2000). This investigation has been in the two parcels: No. 114, No. 115 in 73 ha^{-1} area.

Data collections: Cutting volume in mechanized skidding (log skidding) was 576 m^3 and in traditional skidding cut wood (bolt, rectangular, fuel) was 674 m^3 in this research. Furthermore, wheeled skidder has been used in this research (Taf E 655) it is often used for gathering and skidding timbers from cutting area. This machine has a cable winch by winch can do the skidding until the distance of 60 m. For this investigation that required the areas of the two parcels. Systematic random sampling method was used. Sample plots in circular shapes were used (Surface = 1 ARE (100 m^2), Radius = 5.64 m in horizontal line) performed sampling grid was 100×100 m in dimensions.

Number of sample plots was 72, considering the surface of the area and the dimensions of the grid calculated. Firstly, we defined the Inventory Grid on a paper and due to the plan scale put on the plan. Therefore, the locations of sample plots were defined on plan then implemented on field. The intervals of sample plots were measured in meter unit. Then, they were corrected by using slope correction table and horizontal

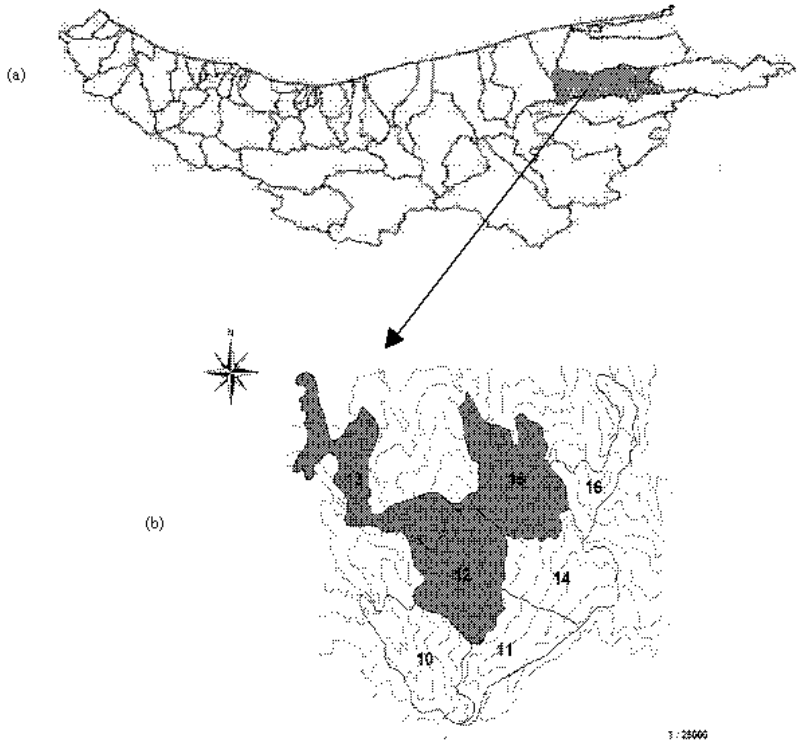

Fig. 1: Position of the study area (b) in the north of Iran-Mazandaran province (a)

intervals calculated so the center of plot located in its real place. In every sample plots slope average was measured. So mentioned radius was corrected and implemented on ground. All seedlings, juveniles and saplings were counted with their condition: intact or damaged with mentioning the reason.

Having finished industrial skidding, reference was made to the areas and the centers of the plots were found due to their specifications, inventories were made in the plots in which machines had been used for skidding. After traditional skidding which had been done by animal (mule) in the studied area and sampling was done in all the plots aging.

Plots which had been influenced by mules were counted and damaged seedling defined. Ratio estimation method was used for every industrial and traditional method, separately. Data were analyzed using the SPSS package and nested design test.

RESULTS

Data before skidding: Number of 19950 seedlings, juvenile and saplings were counted in inventories before skidding in all plots (67 plots in cutting area) (Table 1). According to abundance of the species, counted seedlings were divided into 4 groups. The three species: beech (*Fagus orientalis*), maple (*Acer insigne*) and hornbeam (*Carpinus betulus*) that had been more than other species in number were divided into three groups and the types: *Acer cappodocicum*, *Diospyros lottus*, *Quercus castaneifolia*, *Parrotia persica*, *Tillia begonifolia*, *Ulmus glabra* and *Cerasus avium*, etc. that were divided into other group (Table 1).

Data after skidding: After industrial skidding, in two investigated parcels (No. 114 and 115), 16 plots of all 67 plots were influenced. Having counted damaged seedlings, found out that 6.45% of the whole regeneration was damaged and due to increment groups, 6.48% of seedlings, 5.34% of juveniles, 9.57% of saplings were damaged. After traditional skidding, 14 of 67 plots were influenced by it. Having counted damaged seedling, we found that 3.84% of the whole regeneration damaged and due to increment groups, 3.78% of seedlings 5.34% of juvenile and 2.13% of saplings were damaged (Table 2).

Final result: Results from this research showed that damages on regeneration in industrial method doubled that of traditional method (Table 3).

Also, ratio estimation were calculated for every methods as stated below, where, Xi: every of samples; Yi: damaged samples; X: number of samples in every plots; Y: number of damaged samples in every plots; n: number of samples.

Ratio estimation for industrial skidding method: Calculations below showed that produced damages on regeneration with the use of industrial method were between of 3.7 and 9.1% in confidence level of 95%.

Table 1: Different species regeneration before of skidding

Species regeneration	*Fagus orientalis*	*Acer insigne*	*Carpinus betulus*	Other	Total No.
No. of seedlings	6497	6486	4701	1046	18733
No. of juveniles	521	43	267	198	1029
No. of saplings	20	35	11	122	188
Sum	7038	6564	4982	1366	19950

Table 2: Comparison of vulnerability between the increment groups of seedling and skidding methods

Skidding methods	Increment groups	Seedling	Juvenile	Sapling	Total
After industrial skidding	No. before skidding	18733.00	1029.00	188.00	19950.00
	No. of damaged ones	1214.00	55.00	18.00	1287.00
	Percentage	6.48	5.34	9.57	6.45
After traditional skidding	No. before skidding	18733.00	1029.00	188.00	19950.00
	No. of damaged ones	708.00	55.00	4.00	767.00
	Percentage	3.78	5.34	2.13	3.84

Table 3: Comparison damages of industrial and traditional skidding methods on total regeneration

Number/Percent	Healthy	Wounded	Destroyed	Total damaged	Total No.
No. after industrial skidding	18663.00	274.00	1013.00	1287.00	19950
Percent	93.55	1.37	5.08	6.65	-
No. after traditional skidding	19183.00	259.00	508.00	767.00	19950
Percent	96.16	1.30	2.54	3.84	-

Table 4: Analysis of variance for data collection

Variable source	DF	SS	MS	F-value
Skidding steps	2	31447	15723.5	10.06**
Species × skidding steps	9	14059	1562.0	0.20^{ns}
Increment stages × species × skidding steps	24	183714	1457.0	3.01**
Quality × increment stages × species × skidding steps	36	89084	2474.0	-

**Significant at the 0.01 F-probability level; ns = Non significant

$$Pi = \frac{\Sigma yi}{\Sigma xi} = \frac{1287}{19950} = 0.064$$

$$Sy^2 = \frac{\Sigma y^2 - \frac{(\Sigma y)^2}{n}}{n-1} = \frac{130427 - \frac{1656369}{67}}{66} = 1601.59$$

$$Sx^2 = \frac{4\times 2 - \frac{(\Sigma x)^2}{n}}{n-1} = \frac{6856018 - \frac{398002500}{67}}{66} = 13783.97$$

$$Sy_x = \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{n}}{n-1} = \frac{53871 - \frac{25675650}{67}}{66} = 2357$$

$$Spi = \sqrt{\frac{1}{x^2}\left[\frac{sy^2 - p^2 sx^2 - 2psyn}{n}\right]}$$

$$Spi = \sqrt{\frac{1}{88625.3}\left[\frac{1601.59 - (0.064)^2 \times 13873.97 - 2(0.064)2357}{67}\right]} = 0.014$$

$$Sp\% = \frac{0.014 \times 100}{0.064} = 21.87$$

$$E = \pm t \times sp = 1.96 \times 0.014 = 0.027$$

$$0.064 - 0.027 < p < 0.064 + 0.027$$

$$0.037 < p < 0.091$$

$$3.7\% < p < 9.1\%$$

Ratio estimation for industrial skidding method: Calculations below showed that produced damages on regeneration with the use of traditional method were between of 1.84 and 5.76% in confidence level of 95%.

$$Pi = \frac{\Sigma yi}{\Sigma xi} = \frac{767}{19950} = 0.038$$

$$Sy^2 = \frac{\Sigma y^2 - \frac{(\Sigma y)^2}{n}}{n-1} = \frac{60539 - \frac{588259}{67}}{66} = 784.22$$

$$Sx^2 = \frac{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}{n-1} = \frac{6856018 - \frac{398002500}{67}}{66} = 13783.97$$

$$Sy_x = \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{n}}{n-1} = \frac{176925 - \frac{25675650}{67}}{66} = 3125.66$$

$$Spi = \sqrt{\frac{1}{x^2}\left[\frac{sy^2 - p^2 sx^2 - 2psyn}{n}\right]}$$

$$Spi = \sqrt{\frac{1}{88625.3}\left[\frac{784.22 - (0.038)^2 13873.9 - 2(0.038)3125.66}{67}\right]} = 0.010$$

$$Sp\% = \frac{0.01 \times 100}{0.038} = 26.31$$

$$E = \pm t \times sp = 1.96 \times 0.01 = 0.0196$$

$$0.038 - 0.0196 < p < 0.038 + 0.0196$$

$$0.0184 < p < 0.0576$$

$$1.84\% < p < 5.76\%$$

Statistical analysis was performed by SPSS software (one-tailed test) using Nested Design method (Table 4).

$$CF = \frac{(Y0000)^2}{LMSq} = \frac{(2117)^2}{3\times 4\times 3\times 2} = -- = 66245.68$$

$$SS_T = \Sigma Y^2_{ijkL} - CF = 380551 - 62245.68 = 318305.32$$

$$SS_L = \frac{\Sigma Y^2_{i000}}{SMq} - CF = \frac{2248627}{4\times 3\times 2} - 62245.68 = 31447.11$$

$$SS_{S/L} = \frac{\Sigma Y^2_{ij00}}{Mq} - \frac{\Sigma Y^2_{ij00}}{SMq} = \frac{646513}{3\times 2} - 9362.79 = 14059.37$$

$$SS_{M/S/L} = \frac{\Sigma Y^2_{ijk0}}{q} - \frac{\Sigma Y^2_{ij00}}{Mq} = 291466.5 - 107752.1 = 183714.4$$

$$SS_{q/M/S/L} = \Sigma Y^2_{ijKL} - \frac{\Sigma Y^2_{ijk0}}{q} = 380551 - 291466.5 = 89084.5$$

The F-value, revealed that there were significant differences in the 1% level of probability for skidding steps as well as the increment groups but there were no significant differences among species.

DISCUSSION

Many factors influenced the differences observed. These may include the state of topography and physiographic, cutting area, skidding equipments, human factors, soil and geology, altitude, management, road network, driver's skill, etc. According to the results of Ahmadi (2000) the rates of the damage of the two methods to seedling and yearling were 20.7%, juvenile group 33.5%, sapling 39%. He concluded that 27.1% of the whole damages in forest were related to horse and mule.

In Hosseini (2001) research, shelter wood system was used for silviculture method. Because of that regeneration under seed bearers will be damaged more while cutting wood and also crawler tractors were used that it causes more damage to regeneration. But in the recent research, single selection system was used for silviculture they used wheeled skidder as well. Random sampling method was used for sampling both of them.

According to the results, rates of the damage of traditional skidding was 3.2% and according to the results of Tashakkori (2000), damage to regeneration was in the shape of the hedging of seedling and with the rate of 5.14% of all seedlings and juveniles in the shape of the

bending of crowns and trunks for saplings with the rate of 4.2% of all of them and wounding the annihilation of seedlings and with the rate of 4.2% of all samples. Totally the damage was 20.94% of all seedlings, juveniles and saplings.

In recent research the rate of the damages of traditional skidding were 3.84%. It's different from Tashakkori (2000). Tashakkori's system for silviculture was shelter wood system which causes much damage to the regeneration under usual trees and the most damage to juveniles and saplings because of their low flexibility. In recent research single selection system was used and may be felling and exit of them was more accurate.

According to the results, the rate of damage to the increment group of seedling and yearling in industrial skidding is 6.48%, to the increment group of juvenile is 5.34% and to the increment group of sapling is 9.57%. According to the results of Hosseini (2001) research, the rate of damage to the increment group of seedling and yearling is 14.4%, to the increment group of juvenile is 21.6% and to the increment group of sapling is 31.4%. However, in both of investigations the rate of damage increased by the increase of the age of seedling. In increment group of seedling and yearling the rate of damage was the smallest and in the increment group of sapling was the largest.

Hosseini (2001) used shelter wood system which causes damage to the regeneration located under seed bearers while felling and pulling them, in his investigation for silviculture. He suggested that felling of seed bearers should take place while located regeneration is in increment stage of seedling and yearling and has more flexibility. Therefore, the rate of damage reduces and the length of time for cutting in shelter wood system should decrease. Selecting the cutting time should be done by inspecting the area and not just contenting with cutting time tables in forest management plan. In recent investigation, single selection was used and also since inspected forest is an investigative-educational forest, the felling and the pulling of wood is done more precisely so the damages reduce.

In both of researches wheeled skidder has been used but in the former, of timber jack 450c type and in the later, of Taf E655 type. Machines type has effect on the rate of the damage. Results show that the rate of the damage due to traditional skidding is 3.84%. According to the results of Ghaffarian (2003) 58% of the regeneration in research area is damaged or annihilated. This amount is generalized to 3.2% of parcel according to the number of traditional skid trails in parcel and its surface. Results approximately resemble because the two researches (Ghaffarian's and the recent one) happened in one place. In this study the rate of damage is 3.48%. Skidding method, specifications of the area such as altitude, the topography of silviculture system, workers skill while (felling, cutting and wood transportation) were the same in these researches.

As results imply the rate of the damage to the regeneration in industrial skidding is 6.45% and according to the results of Lotfalian (2005) the rates for three increment groups of seedling, juvenile and sapling are 3.2, 10.5 and 17.7%, respectively and the rate of the damages is 4.8% totally. The former has a 95% probability between 2.4-7.2% and the latter has 95% probability between 3.7-9.1%. The rates of the damage to the increment groups of seedling, juvenile and sapling are 6.48, 5.34 and 9.57%, respectively. Single selection system was used in both of the researches and wheeled skidder as well.

According to the results, the rate of the damage to the regeneration in industrial skidding for increment groups of seedling, juvenile and sapling are 6.48, 5.34 and 9.57% and due to the results of Naghdi (2004), the rates of damage in industrial skidding in all study areas to the increment groups of seedling, juvenile and sapling are 2.4, 3.9 and 4.7%, respectively. Finally, recent research was performed in research educational forest of Tehran University. Therefore, logging activities such as felling, cutting and wood transportation have been done so precisely that reduced the damage to the minimum rate and also single selection system appeared to be the best system for Northern forest in Iran as it caused minimum rate of damage.

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