

## Damage to Natural Regeneration in the Hyrcanian Forests of Iran: A Comparison of Two Typical Timber Extraction Operations

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### ABSTRACT

This study investigated the impact of two different timber extraction systems on the natural regeneration in two compartments in the Hyrcanian Forests in northern Iran. These forests consist of mixed uneven-aged stands which are managed under the single tree selection system, with timber extraction taking place by cable system or by skidder. The operations were carried out by standard crews in 2 compartments with very similar terrain and stand conditions. The amount of damage to all stages of the regeneration was significantly higher in the skidding operation than in the cable operation. Based on this preliminary result and on observations of the authors, recommendations for future research and for improved harvest practices were drawn up.

**Keywords:** *Hyrcanian Forests, Forest harvesting, Cable extraction, Skidding, Regeneration, Damage levels.*

### INTRODUCTION

The Hyrcanian Forests are located in northern Iran, between the Caspian Sea and the Alborz Mountains (Figure 1). These forests are often situated on very steep terrain at average altitudes greater than 1000 metres above sea level, with snow cover during the winter. These forests are managed under the single tree selection and shelterwood systems, with harvested timber traditionally being used by the local population.

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However, in the last 30 years industrial harvesting operations have been introduced, using skidders for timber extraction. Most of this machinery is imported from abroad and questions have arisen about the suitability of skidders, both wheeled and tracked, for extraction operations under these conditions. Because of the adverse impacts of skidding operations, cable systems have recently been introduced. A study in Iran has shown that 17.5% of regeneration was damaged (i.e. wounded or broken) by skidding operations in a shelterwood system in the Hyrcanian Forests [3], while another study put the equivalent damage level at 14.5% [1]. Whitman et al. [4] reported damage levels of 50% to remaining trees (i.e. stem and root damage) and 15% to seedlings (i.e. broken or wounded) in a single tree selection harvesting operation in northern Belize, while Bertault and Sist [2] reported damage levels as high as 40% of all remaining trees after logging operations in natural forests in East Kalimantan.

In Iran, no comparative studies of skidding and cable extraction operations and their associated damage levels have been carried out previous to this research. The objective of this project was to get initial information on the quantity and quality of damage to the natural regeneration caused by the two extraction systems in two typical harvesting operations.

### METHODS

#### The Study Area

Two study sites were located near the town of Sari in the centre of the northern forests of Iran. The soil type in both sites is a forest brown earth with a high pH (i.e. more than 7). The under-lying geology is limestone. The soil depth was more than 5 m and the soil had a high clay content. The canopy cover was 80% and a recent inventory had established the standing merchantable timber volumes at 381 m<sup>3</sup> per hectare and 386 m<sup>3</sup> per hectare on the two sites respectively. The vegetation consists mainly of beech (*Fagus orientalis*) and hornbeam (*Carpinus betulus*), with smaller amounts of alder (*Alnus* sp), maple (*Acer* sp), oak (*Quercus castanifolia*) and khormandy (*Diospyrus lotus*). Both sites are managed using the single tree selection system. Tree felling on both sites was carried out motor-manually.

#### Cable System

Cable extraction was studied in compartment 7 of the Choob and Kagaz Mazandaran Company. This compartment was allocated to cable extraction, firstly because the high clay content of the soil would have made skidding difficult, and secondly, access from this compartment to

the forest road network had to take place through compartment 11 which did not contain any skidding tracks.



Figure 1. Study site locations: + Hyrcanian Mountains; 1- Choob and Kagaz Mazandaran Company; 2- Neka Choob Company.

A USW 80 D tower yarder with a standing skyline configuration and a Koller SKA 2.5 carriage with remote control and a load rating of 2500 kg were used. The slope in the compartment ranges from 25 to 40%.

The skyline cable was 25 mm in diameter and had a length of 1146 meters, with 765 m in compartment 7 and 381 m running through compartment 11 (to access the road network) (Figure 2). The skyline was supported by two intermediate support trees. The first support tree was a hornbeam of 80 cm dbh, located 305 m from the landing, the second one a beech of 75 cm dbh located 697 m from the landing. Two other support trees were located at the landing and at the yarder. The yarder was located at the top of the hill and the timber was extracted downhill to roadside, as is the normal practice in cable operations in this region. The choker setter had a radio remote control unit to operate the carriage. The effective yarding corridor was 1050 m long with a width of 60 m to each side of the skyline.

### Skidding System

Skidder extraction was used in compartment 12 of the Neka Choob Company. The skidder used was a wheeled Timberjack 450 C model with a weight of 9.8 t and a 129 kW engine. The width of the machine was 3.8 m and the length 6.4 m. The winch cable was 50 m long and its diameter was 20 mm. The landing was located at the top of the hill at roadside, and the timber was extracted uphill to the landing, as is the normal practice in skidding operations in the region. Six extraction tracks were used in this compartment. The slope in compartment 12 ranges from 15 to 30%.

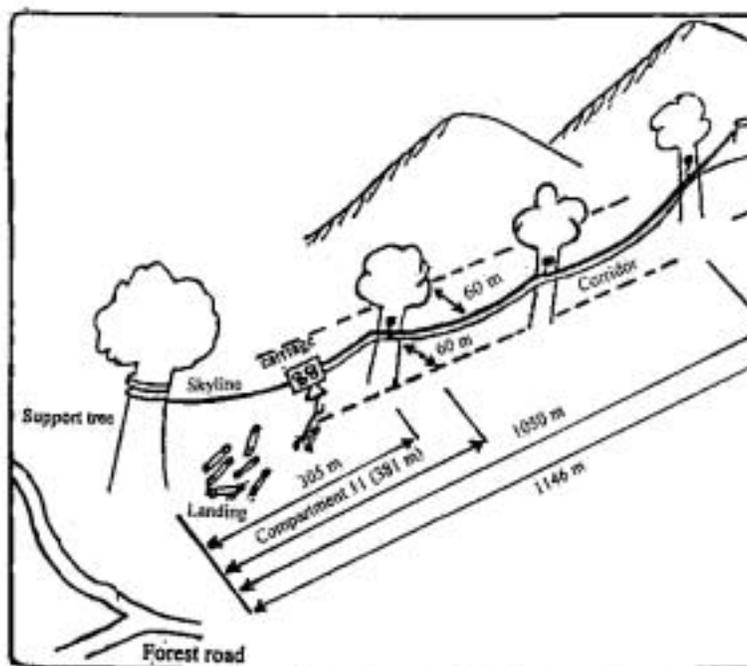


Figure 2. Site condition and skyline configuration in study compartment 7. The skyline runs for 381 m through compartment 11 to reach the forest road network.

## Damage Measurement

In compartment 7 (i.e. the cable system) 60 circular sample plots of 10 m<sup>2</sup> each were systematically laid out. The plots were located on a 25 m by 50 m grid inside the skyline corridor of 1050 m by 120 m (Figure 3).

In compartment 12 (i.e. the skidder system) 43 corresponding sample plots were located on a 100 m by 100 m grid within the area where harvesting had taken place (Figure 4). Skidding tracks were spaced on average 150 m apart in this area. Different grid sizes were used in the two compartments to account for the difference in harvested areas.

The regeneration was classified into three classes:

- \* Seedling: trees less than 0.5 m in height;
- \* Pre-thicket: trees from 0.5 to 2 m in height;
- \* Thicket: trees from 2 to 6 m in height.

For each plot the following data were recorded:

- \* the species present;
- \* the number of undamaged trees in seedling, pre-thicket and thicket classes;
- \* the number of wounded trees (i.e. trees with any level of bark, cambium or wood damage) in seedling, pre-thicket and thicket classes;
- \* number of broken / uprooted trees in seedling, pre-thicket and thicket classes.

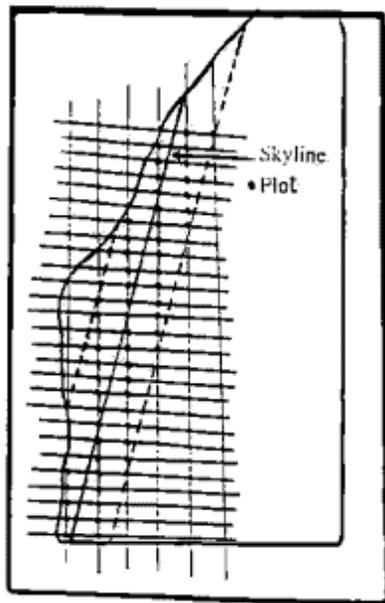


Figure 3. Plot location on 25 by 50 m grid in sub-compartment 12.

It is important to mention that this study was concerned with extraction damage only. Consequently, the above data were recorded before and after the extraction operations and the differences were analysed. Damage caused during felling was not analysed in this study.

## RESULTS

Table 1 shows summary information for the skidding and cable extraction operations. Approximately 11% of regeneration was damaged in the skidding operation: 8.7% were wounded (bark removed) and 2.3% were broken / uprooted. Similarly approximately 5% of regeneration was damaged by the cable operation: 4% were wounded and 1% were broken / uprooted. The damage levels caused by the skidding operation were about twice as high in the seedling and pre-thicket stages and more than 10 times as high in the thicket stage as compared to the damage levels caused in the cable operation (Figure 5). When total damage levels are compared, the skidding operation results in levels more than twice those caused in the cable operation.

The percent data for the two operations were adjusted using the arcsine transformation and the resulting values were analysed by unpaired t-test using plots as replicates. The analyses indicated that the level of damage in the skidding operation was significantly higher than that caused in the cable extraction operation for all 3 development stages

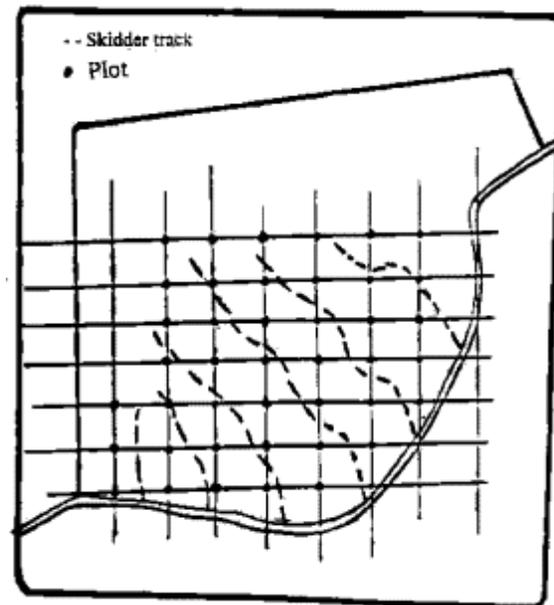


Figure 4. Plot location on 100 by 100 m grid in sub-compartment 7.

of the regeneration (Table 1). In addition, when all the development stages were combined, significant higher damage levels were associated with the skidding operation than with the cable operation.

Table 1. Numbers of plants and percentages of damage in the 3 stages of regeneration and for the total in the cable and skidder operations and the results of statistical comparisons of the stage and total differences.

| Development stage | Status    | Skidding | Cable | Significance of difference |
|-------------------|-----------|----------|-------|----------------------------|
| Seedling          | Damaged   | 111      | 101   | **                         |
|                   | wounded   | 88       | 80    |                            |
|                   | broken    | 23       | 21    |                            |
|                   | Undamaged | 1321     | 2245  |                            |
|                   | % damaged | 7.7      | 4.3   |                            |
| Pre-thicket       | Damaged   | 53       | 29    | **                         |
|                   | wounded   | 39       | 22    |                            |
|                   | broken    | 14       | 7     |                            |
|                   | Undamaged | 106      | 140   |                            |
|                   | % damaged | 33.3     | 17.9  |                            |
| Thicket           | Damaged   | 23       | 1     | **                         |
|                   | wounded   | 19       | 1     |                            |
|                   | broken    | 4        | -     |                            |
|                   | Undamaged | 55       | 39    |                            |
|                   | % damaged | 29.5     | 2.5   |                            |
| Total             | % damaged | 11.2     | 5.1   | **                         |
|                   | % wounded | 8.7      | 4     | **                         |
|                   | % broken  | 2.5      | 1.1   | **                         |

\*\* : Significant at the 0.01 level.

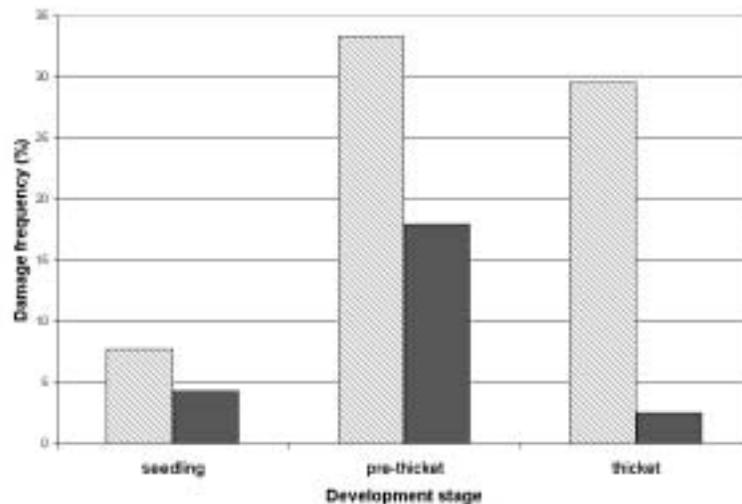


Figure 5. Comparison of the percent damage caused to the 3 development stages of the vegetation by the skidding and cable extraction operations.

## DISCUSSION

The results very clearly show the large amount of damage to the regeneration caused by the skidding operation in compartment 12. However, as only one skidding operation and one cable operation were included in this study, the results should be treated with caution. The observed differences are the result of the combination of a large number of factors, including extraction system, crew, site and stand variables. In order to get more specific information on the actual extraction systems, this study will have to be repeated on a number of sites with a number of crews. On the other hand, the results conform with observations of similar extraction operations in the Hyrcanian Forests by the Iranian authors.

As an example of an operational factor that might have influenced the results, the work practices of the skidding crew can be mentioned. The Timberjack 405 is a very powerful machine and can pull very large loads. For this reason, the choker setters did not pay attention to the hooking. Sometimes they attached the winch cable in the middle of the logs instead of at the end. This resulted in damage to the regeneration during the winching process. In addition, logs that got struck behind obstacles during the winching operations were unhooked, often rolling down the slope, causing a considerable amount of damage to the regeneration before being hooked up again and extracted along a different route.

Only two types of damage were distinguished in this study. Especially the grouping of all bark, cambium and wood damage in one class prevents the direct linkage between analysed damage levels and their economic importance in terms of reduced quality and/or quantity of future timber volumes. The use of a more detailed damage classification in future studies will allow for this linkage to be established.

## CONCLUSION

Because of steep slopes, high elevations and sensitive sites, harvesting and extraction operations in the Hyrcanian Forests in Iran need to be carefully planned and executed. This study compared the damage caused to natural regeneration during the extraction phase of two harvesting operations under the single tree selection system, one using a cable system and the other a skidder. Significantly less damage was caused by the cable operation.

Because only one operation was included for each system, this conclusion is only valid for the two specific operations studied. In order to produce more general

system results, this preliminary study will have to be expanded. However, based on the result of this study and on observations by the authors, it is recommended that, in order to reduce the impact of harvesting operations, training of the timber extraction crews in environmentally sensitive harvesting methods should be implemented as soon as possible.

Finally, the growing use of skidders in timber extraction operations in the Hyrcanian Forests should be carefully planned, using detailed terrain and stand classification information as important parameters.

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