Available online at www.sciencedirect.com
ScienceDirect
Journal of Terramechanics 45 (2008) 45–49
Journal of Terramechanics
www.elsevier.com/locate/jterra

Revegetated herbaceous plant species on a compacted skid road

Beyza Sat Gungor [a], Ender Makineci [b,*], Murat Demir [c]

[a] Istanbul University, Faculty of Forestry, Lansdscape Architecture Department, 34473 Bahcekoy, Sariyer, Istanbul, Turkey
[b] Istanbul University, Faculty of Forestry, Soil Science and Ecology Department, 34473 Bahcekoy, Sariyer, Istanbul, Turkey
[c] Istanbul University, Faculty of Forestry, Forest Construction and Transportation Department, 34473 Bahcekoy, Sariyer, Istanbul, Turkey

Received 28 December 2007; received in revised form 6 March 2008; accepted 14 May 2008
Available online 25 June 2008

Abstract

This study intended to determine the plant species on a skid road subjected to soil compaction due to timber skidding in a pure sessile oak (*Quercus petrea* L.) forest. Our previous studies show that ground based skidding destroyed the soil and ecosystem. The timber skidding limits recovery and growth of plant cover on skid roads. However, some herbaceous plant species show healthy habitat, and they can revegetate and survive after the extreme degradation in study area.

The composition and cover-abundance scales of these plant species investigated in a 100 m × 3 m transect. Twelve plant species belongs to 10 plant family were determined. Compositae and Liliaceae were the most abundant families. *Daphne pontica* L., *Smilax aspera* L., *Trachystemon orientalis* (L.) G. Don, *Carex distachya* Desf. var. *distachya* Desf. have the highest cover-abundance scale among all of determined species on compacted skid road.

Keywords: Skidding; Timber harvesting; Compaction; Logging; Herbaceous plant

1. Introduction

Forest roads are crucial for effective forest management, regardless of its main objectives. Forest maintenance, wood harvesting, game control, recreational activities – all require the accessibility provided by suitable road network [1]. Skidding or yarding on terrain requires the construction of relatively dense network of forest roads including skid roads, haul roads and landings [2]. Skid roads are defined as secondary roads that are used by skidders and forwarders that move logs from the point of felling and bucking to log landings. Apart from the felling of occasional trees to provide a clear path, few improvements are made to skid roads [3]. Harvesting works being carried out in the forest areas causes loss, mixing and compaction of the soil to a great extent. Ground based skidding, timber harvesting and logging operations in forest ecosystems cause the reduction and redistribution of organic matter, changes in plant cover, organic layer and soil properties, and modification of microclimate [3–5]. Soil compaction typically alters soil structure and hydrology by increasing bulk density, breaking down aggregates, decreasing porosity, aeration and infiltration capacity and by increasing soil strength, water runoff, erosion, water logging and possibly inappropriate soil nutritional status [6]. Potential ecological impacts of roads have received a great deal of attention in recent years. Effects of roads on forest plant communities are less well-documented. Studies focused on exotic plant invasions in roadside plant communities along main forest and grassland roads and in adjacent communities have been completed, but changes in plant composition within interior haul roads and skid trails have received little attention. The extent of haul road and skid road networks in managed forests and linkages between understory vascular plant communities and other flora and fauna, the impacts of these features on ecosystem properties and processes could be substantial [3]. The extraction operation of

* Corresponding author. Tel.: +90 212 2261100x25302; fax: +90 212 2261113.
E-mail addresses: beyza@istanbul.edu.tr (B.S. Gungor), emak@istanbul.edu.tr (E. Makineci), mdemir@istanbul.edu.tr (M. Demir).

0022-4898/$34.00 © 2008 ISTVS. Published by Elsevier Ltd. All rights reserved.
doi:10.1016/j.jterra.2008.05.001

Table 1
Investigated soil properties in soil of skid road [8,9]

Characteristics	Units	0–5 cm	5–10 cm
Sand (%)	%	73.38	58.05
Silt (%)	%	18.05	25.74
Clay (%)	%	8.57	16.21
Soil acidity	pH	6.23	5.80
Electrical conductivity	μhos cm^{-1}	86.57	60.05
Fine soil (<2 mm) weight	g cm^{-3}	0.887	1.015
Coarse soil (>2 mm) weight	g cm^{-3}	0.13	0.215
Root mass	g cm^{-3}	0.00336	0.01904
Organic carbon	%	7.97	5.72
Moisture equivalent	%	22.58	21.57
Total porosity	%	47.84	45.52
Moisture	%	22.04	19.85
Compaction	kg cm^{-2}	2.71	3.37
Bulk density	g cm^{-3}	1.028	1.235
N	%	0.285	0.124
P	ppm	3.76	0.31
K	ppm	123.24	85.04
Na	ppm	19.87	18.88
Ca	ppm	2139.09	1227.48
Mg	ppm	361.29	316.71
Fe	ppm	0.70	0.62
Zn	ppm	62.00	31.57
Cu	ppm	0.99	1.45
Mn	ppm	55.60	49.68

trees can be performed by man-power, animals and machine power. The logs are skidded on the ground or loaded on a cart, sledge or hauled by a crane is mounted on a farm tractor, or a portable cable-way in the extraction operation. The man-power and the animals are still being used in Turkey for that purpose.

In this study, survived plant species composition and their cover-abundance scales were evaluated on the skid road subjected to compaction due to ground based timber skidding activities that have been carried out for many years (since 1956) in an sessile oak (*Quercus petrea* L.) forest.

2. Materials and methods

Belgrad Forest is located in Istanbul province in the Marmara geographical region between 41° 09′–41° 12′ N latitude and 28° 54′–29° 00′ E longitude in Turkey. The Belgrad Forest covers 5441.71 hectares. The research area is in the boundaries of zone 82 of Belgrad Forest. According to the (long-term) data given by Bahcekoy Meteorology Station, the nearest meteorology station to the research area, average annual precipitation is 1074.4 mm, annual mean temperature is 12.8 °C, mean maximum temperature is 17.8 °C and the average minimum temperature is 9 °C. The climate of Istanbul Belgrad Forest is maritime climate with medium water deficit in summers. General texture type of soil in research area is loam. Vegetation period maintains for 7.5 months (230 days) in average.

Research area is a pure sessile oak (*Q. petrea* L.) stand. Canopy cover has been estimated as 0.8. Average diameter at breast height (1.3 m above ground level) is 29.72 cm, average height is 22.94 m and stand density has been measured as 900 trees/ha. It was estimated that average 195 m^3 $year^{-1}$ timbers had been skidded in harvest activities on the skidding road [7], and last using date of the skid road was 2004. Altitude is 140 m, slope is 10–15% and it is in the SW aspect. The skid road passing through the stand in east–west direction has long been used (since 1956) in the production works, and the width of skid road was 3 m. Skidding works in the research area have been carried out by man-power, animal power and machinery.

In the research area, the negative impacts of timber skidding on herbaceous cover, forest floor and soils of skid road documented in previous studies [8,9].

In this manuscript, impacts of disturbance in interior skid road on understory herbaceous vegetation were evaluated by documenting the areal extent composition of plants along 100 m × 3 m belt transect in October 2006. During sampling 100 m tapes were stretched along transect to

Table 2
Survived plant species on compacted skid road, their general site characteristics and the cover-abundance scales

The plant family	The scientific name of the plant species	General site characteristics	The cover-abundance scale
PRIMULACEAE	*Primula vulgaris* Huds.	Often damp places in open or shady turf slopes, evergreen or deciduous woodlands, alpine meadows	r
ROSACEAE	*Rubus discolor* Weihe et Nees.	Deciduous forests and scrubs, shady banks, coastal plains	
COMPOSITAE	*Doronicum orientale* Hoffm.	In forest clearings, cleared woodland, dunes	
RANUNCULACEAE	*Ranunculus constantinopolitanus* (DC.) D'urv.	Moist places especially in marshy meadows	
OLEACEAE	*Ligustrum vulgare* L.	Deciduous woodland in mix forests (Beech-Fir), open scrubs, moist places	+
COMPOSITAE	*Bellis perennis* L.	Moist places often in forests.	
GERANIACEAE	*Geranium asphodeloides* Burm. Fil. subsp. *asphodeloides* Burm. Fil.	Forests, scrubs, meadows, banks	
LILIACEAE	*Ruscus hypoglossum* L.	Mixed forests, scrubs, ravines, rocky places	
LILIACEAE	*Smilax aspera* L.	Macchie, scrub, ravines, and rocky limestone slopes	1
CYPERACEAE	*Carex distachya* Desf. *var. distachya* Desf.	Dry stony slopes, open forests, roadsides	
THYMELAEACEAE	*Daphne pontica* L.	On igneous rocks, limestone slopes, edge of fir-beech forests	
BORAGINACEAE	*Trachystemon orientalis* (L.) G. Don	Fir forests, shady riverbanks, moist ravines	