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Assessment of the trees diversity at the edge of stream and forest road in Shast Kalateh district

Aidin Parsakhoo* and Benyamin Matinnia

Department of Forestry, Faculty of Forest Sciences, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran.

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This study was conducted in an uneven aged deciduous natural forest of Hyrcanian zone to evaluate the status of trees diversity at the edge of streams and forest road. Transects were established parallel to road and perpendicular to stream and then all regenerations and trees were counted in circular plots on each transect. Past software was used to apply Shannon biodiversity index, Margalef richness index and Camargo evenness index. Results show that biodiversity index decreased with increasing distance from road edge and stream. Shannon heterogeneity index at the edge of stream (2.06) was more than that of road edge (2.03). Indeed trees species diversity tended to increase at the edge of forest roads and streams of study area.

Key words: Trees diversity, forest road, stream, past software, Shast Kalateh.

INTRODUCTION

Forest roads affects plant composition and diversity by creating gaps and altering environmental conditions such as light, soil moisture and bulk density (Ferris et al., 2000; Watkins et al., 2003; Hansen and Clevenger, 2005). Zhou et al. (2010) showed that plant diversity and soil moisture tended to increase in wide roads.

Moreover, streams are also efficient corridors for plant species in forest (Calçada et al., 2013). Scalley et al. (2009) in a study in Puerto Rico found that there is greater variation in species composition closer to streams, and less variation in species composition farther from streams. Feng et al. (2011) reported that the were significantly lower than those of the control, but the species composition had no significant difference.

Li et al. (2010) showed that in Huzhong forest of China, the effect distance reached up to 20-34 m. The plant species diversity of shrub stratum and herb stratum within the effect zone was greater than that in adjacent habitat, and the Shannon-Weiner index increased by 21 and 60%, respectively. The construction and maintenance of roads could increase the plant species diversities of communities (Li et al., 2014). Species richness is defined as the observed number of species in a mixed stand. In coverage and density of shrubs at the edge of highway contrast, species diversity considers the number and frequency of the species present (Pretzsch, 2009).

*Corresponding author. E-mail: parsakhoo@gau.ac.ir or Aidinparsakhoo@yahoo.com. Tel: +98 171 4427050. Fax: +98 171 4427176.

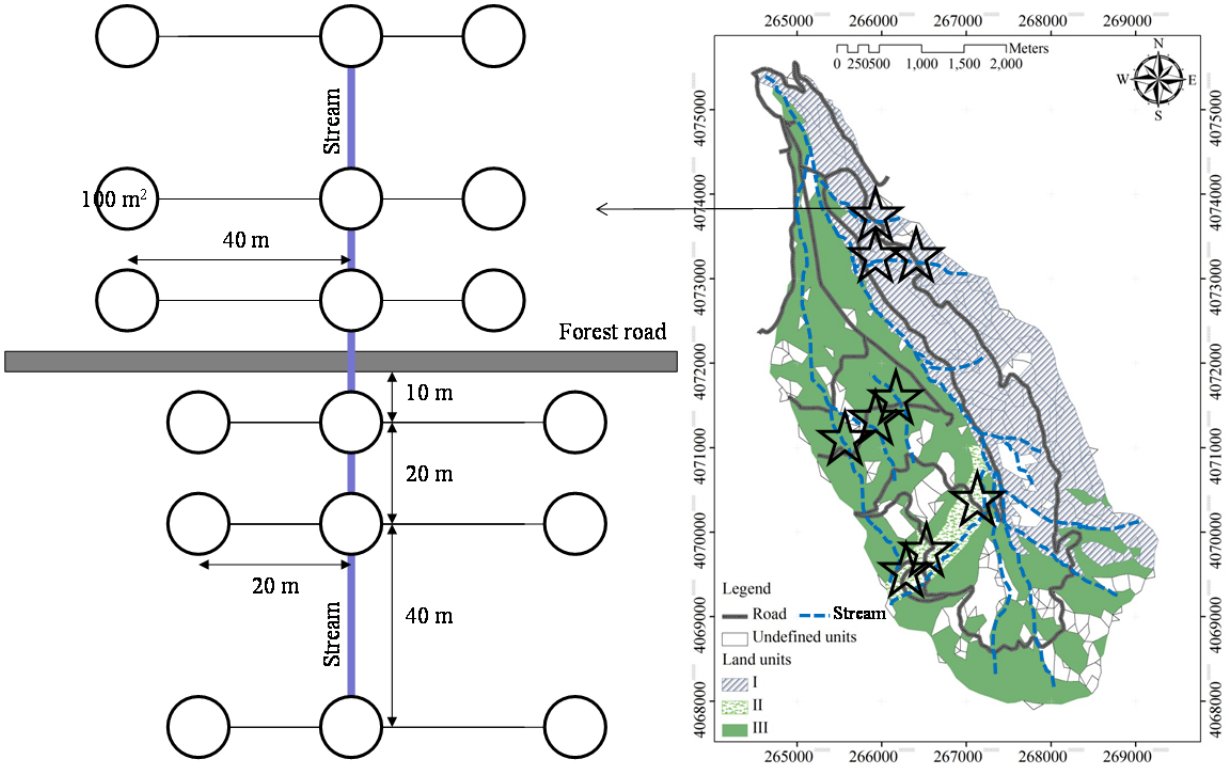

Figure 1. Sampling design in land units of study area.

Species evenness is defined as the number of individual in each of the species (Yue-hui et al., 2010).

Forest roads and streams has important effects on plant species composition and diversity across different scales, and the estimation of its effect distance is a key factor to integrate the road, stream and ecological processes in forest region (Li et al., 2010). The main objectives of this research were: (i) to evaluate the status of trees regeneration biodiversity at the edge of streams and forest road and (ii) to assess the effects of land units on tree regeneration in mentioned areas.

MATERIALS AND METHODS

Study site

District one in Shast Kalateh forests with an area of 1713 hectares is located in Golestan province and in watershed number of 85 (36˚43´27˝ to 36˚48´6˝ N and 54˚21´26˝ to 54˚24´57˝ E). The bedrock of this forest is lime and sand stone with altitude ranging from 100 to 1000 m above sea level. The forest is mixed deciduous which has been established on brown forest soil with mostly sandstone as bedrock Clay-loam-silty texture and worn stones are spread around the region. The mean forest stock growth in the study area was 247 m^3 ha^{-1}. The climate of the region is Mediterranean warm and moist. The mean annual precipitation is 562 mm with the lowest in July and August (Figure 1).

Sampling design and field survey

In this study the hydrograph map of Shast kalateh forest was extracted from topographic map. Then, a natural stream was randomly selected in each land units. Map of land units was previously prepared by the researchers in Department of Forestry in Faculty of Forest Sciences (Table 1). It attempted the stream dimension, longitudinal slope of streams, roughness of the stream's bed and hillside gradient to be same. In the next stage, at each side three transect were established parallel to road and perpendicular to stream. Three circular plots with an area of 100 m^2 and distances of 20 and 40 m were taken on each transect. All regenerations and trees were counted in plots according to the scientific name of species.

Biodiversity and statistical analysis

Vegetation diversity (Equation 1), richness (Equation 2) and evenness (Equation 3) were calculated in Past software.

$$H' = -\sum_{i=1}^{s}\left[P_I Ln(P_I)\right] \quad (1)$$

$$M = \frac{s-1}{LnD} \quad (2)$$

Table 1. Features of land units in study area.

Land units	Geology	Slope direction	Hillside slope (%)	Stock growth (m^3 ha^{-1})
I	Conglomerate sand stone	West	10-25	>300
II	Conglomerate sand stone, current age stream deposits	East	25-50	>300
III	current age stream deposits	North	0-10	100-200

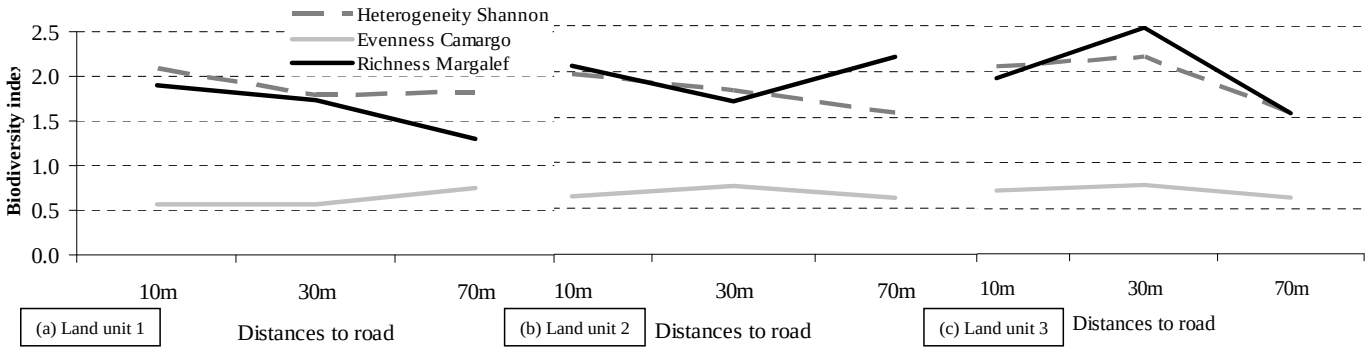

Figure 2. Variations of biodiversity indices at different distances from road.

$$E' = 1 - \left(\sum_{i=1}^{S} \sum_{j=i+1}^{S} \left[\left| \frac{P_i - P_j}{S} \right| \right] \right) \quad (3)$$

H' is Shannon biodiversity index, P_I is each of specimen's frequency percentage ratios to total species in each of community, M is Margalef richness index, s is number of species, D is number of individuals, E' is Camargo evenness index, P_i is proportion of species i in total sample, P_j is proportion of species j in total sample, and S is number of species in total sample. Data were statistically analyzed using the GLM procedure in SAS software. Student Newman Kolus test (SNK) at probability level of 0.05 was used to compare means of biodiversity indices.

RESULTS AND DISCUSSION

Plant diversity at the edge of forest road

Results of this research showed that the Shannon biodiversity index decreased with increasing distance from road in all land units (Figure 2). This case was in agreement with the findings of Zhou et al. (2010). They proved that plant diversity and soil moisture tended to increase at the road edge.

The frequency of *Parrotia persica* C.A.M. was more than that of other species in all land units (Figure 3). The mean of Shannon biodiversity index at distance of 10 m from road was 2.03 and at distances of 30 and 70 m were 1.91 and 1.64, respectively (Table 2). Road provide an corridor which can be affected by climatic, soil and human disturbances, so the seed of exotic plant species is distributed by wind and tourism. Therefore plant diversity is increased.

Plant diversity at the edge of forest stream

Shannon biodiversity index at the edge of stream was more than that of other distances from stream in different land units except for land unit 3 (Figure 4). Scalley et al. (2009) recorded the greater variation in species composition closer to streams. The reason of inverse trend of heterogeneity index in land unit 3 was unknown and need more researches especially on soil. The Margalef richness index in land unit 1 decreased with increasing distance from stream.

In land unit 2 the trend of richness index was stationary and in land unit 3 it increased by increasing distances from stream. The reason of this issue is the appearance of some species such as *Crataegus* spp. and *Fagus orientalis* L. at the distances of 40 m. *Laurocerasus officinalis Roemex* cannot be observed in land unit 1 because of the unit features (Figure 5). The mean of Shannon biodiversity index at distance of 0 m from stream was 2.06 and at distances of 20 and 40 m were 1.75 and 1.86, respectively (Table 3). It seems that depositing different materials and nutrient due sedimentation along stream lead to establishing different vegetation

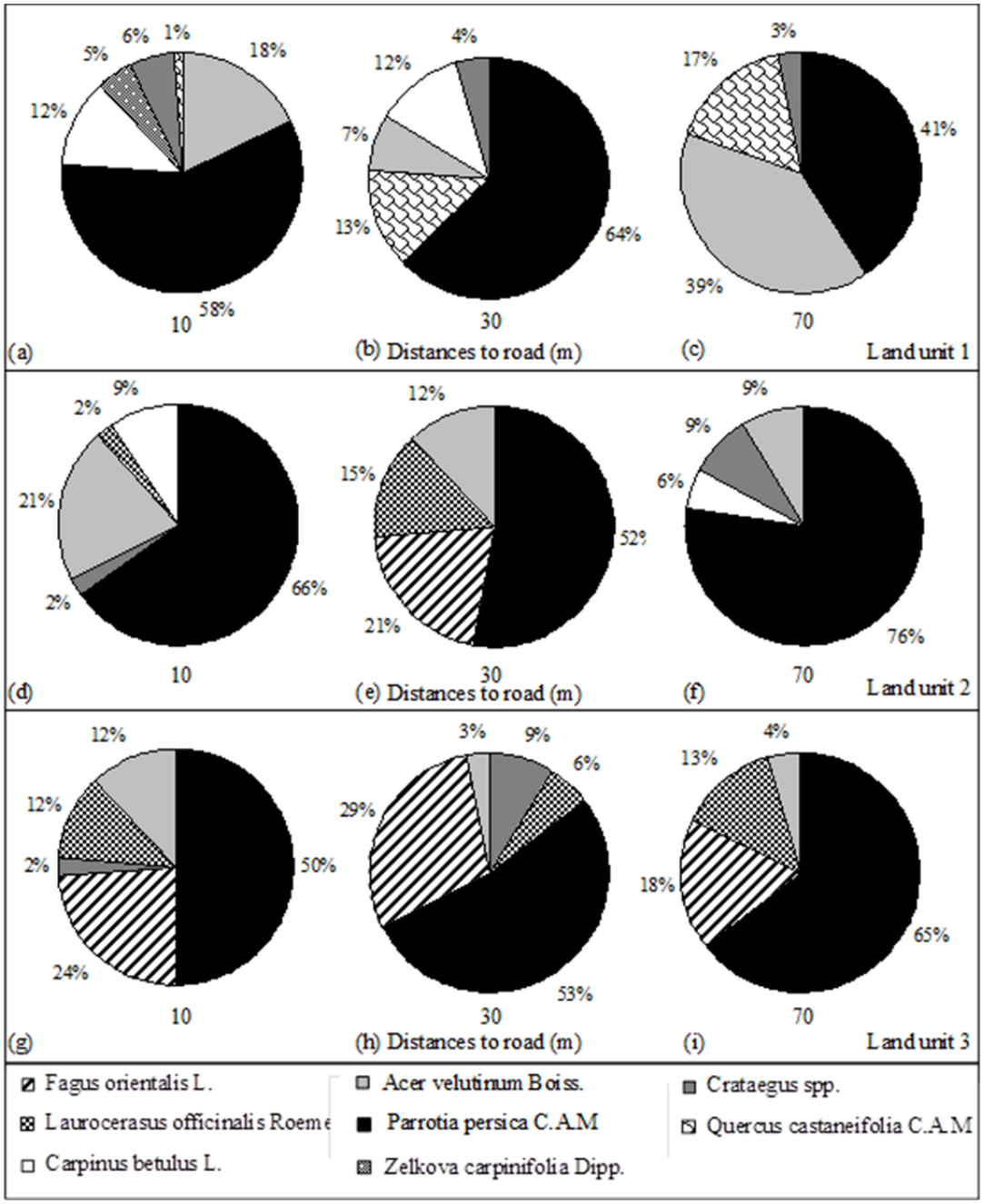

Figure 3. Frequency percentage of tree species at different distances from road.

Table 2. Mean of biodiversity indices at different distances from road.

Index Distance	Heterogeneity Shannon	Evenness Camargo	Richness Margalef
10	2.03[a]	0.63[a]	1.96[a]
30	1.91[a]	0.69[a]	1.97[a]
70	1.64[b]	0.67[a]	1.67[b]

Columns with different superscripts show significant difference at $p < 0.05$ in SNK text.

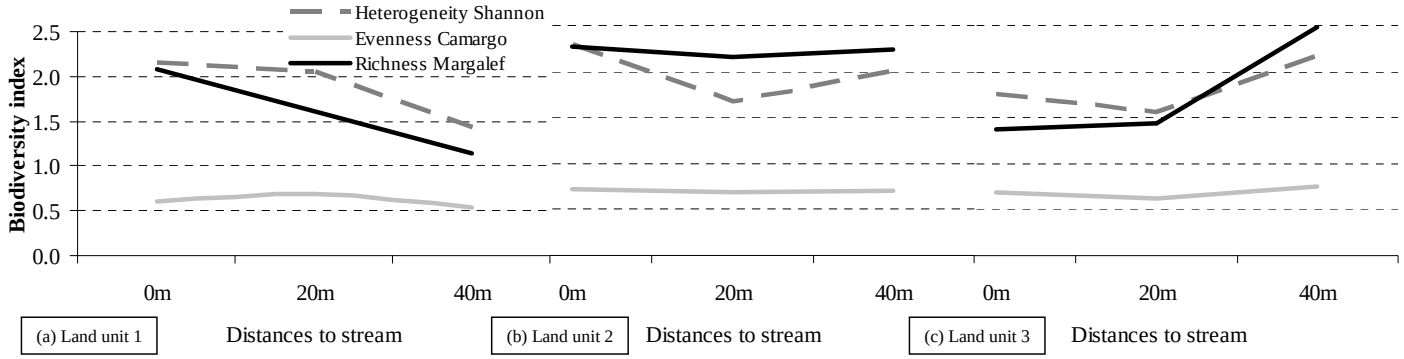

Figure 4. Variations of biodiversity indices at different distances from stream.

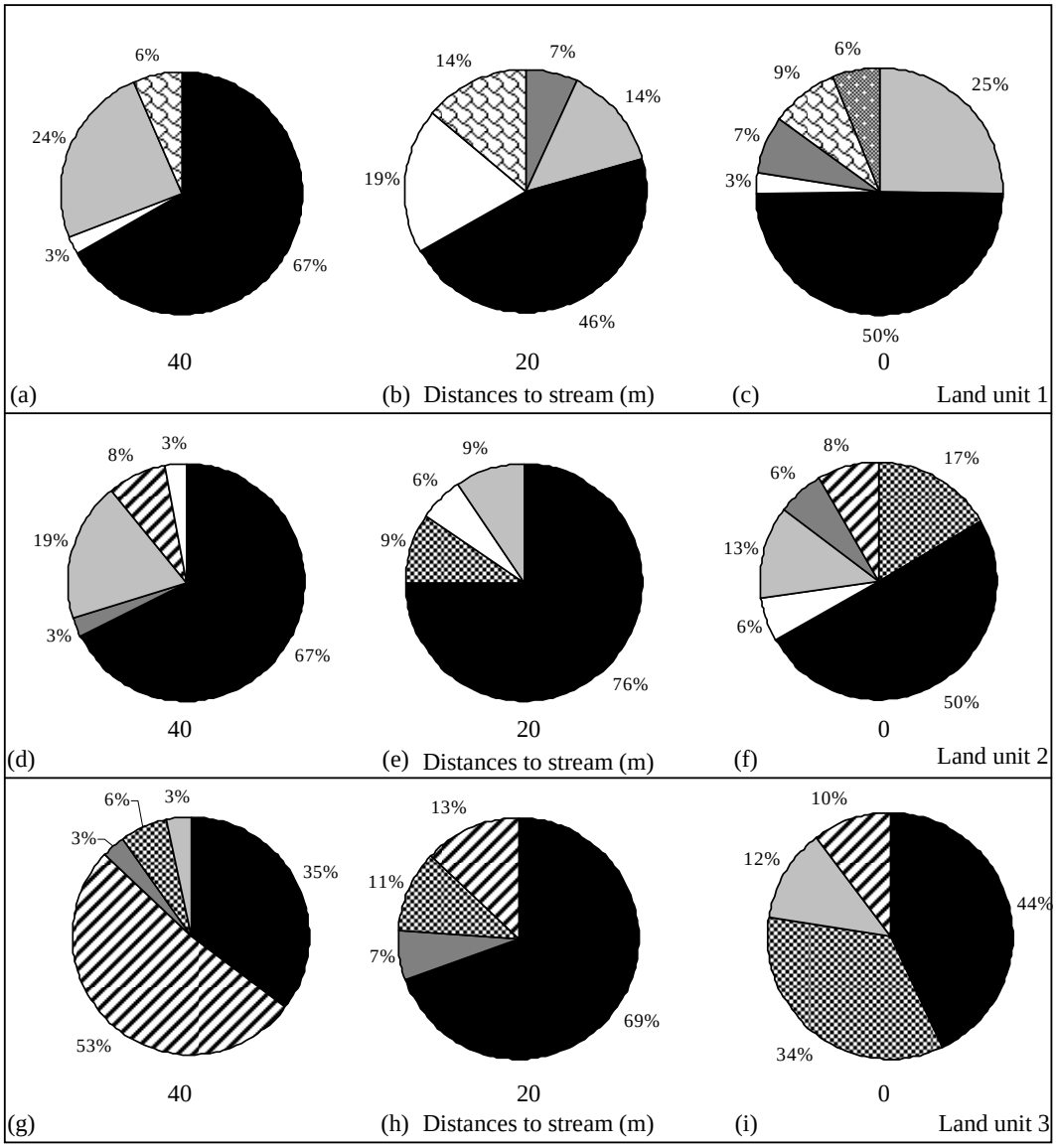

Figure 5. Frequency percentage of tree species at different distances from stream.

Table 3. Mean of biodiversity indices at different distances from stream.

Index distance	Heterogeneity Shannon	Evenness Camargo	Richness Margalef
0	2.06[a]	0.67[a]	1.91[a]
20	1.75[c]	0.67[a]	1.74[b]
40	1.86[b]	0.66[a]	1.95[a]

Columns with different superscripts show significant difference at $p < 0.05$ in SNK text.

species on these soil.

Several authors have observed that soil moisture, organic matter content, bulk density, pH and light regime change significantly within the narrow width of the road and stream corridor, affecting plant community composition and the pattern of roadside plant communities (Lausi and Nimis, 1985; Ullman et al., 1995; Olander et al., 1998; Cilliers and Bredenkamp, 2000; Delgado et al., 2007; Karim and Mallik, 2008).

Conclusions

It was concluded that biodiversity index decreases with increasing distance from road edge and stream. Shannon heterogeneity index at the edge of stream was more than that of road edge. Indeed trees species diversity tended to increase at the edge of forest roads and streams in our study area. The frequency of *P. persica* C.A.M. was more than that of other species in all land units. These results provide important information for forest managers for managing plant species composition and maintaining the integrity of biological communities.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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