Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 3, No. 12, p. 13-19, 2013
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Effects of recreational activities on some stand parameters and biodiversity indicators in Fandoghlou forests, Northwestern Iran

Farshad Keivan Behjou[1*], Ehsan Zandi Esfahan[2]

[1]*Faculty of Agricultural Technology and Natural Resources, University of Mohaghegh Ardabili, Ardabil, Iran*

[2]*Rangeland Research Division, Research Institute of Forests and Rangelands, Tehran, Iran*

Article published on December 9, 2013

Key words: Forest biodiversity, biodiversity indicators, recreational activity, fandoghlou forest.

Abstract

In the current study, the impacts of different intensities of small-scale recreational activities, including no-impacted, slightly impacted, moderately impacted and severely impacted, were analyzed on some stand parameters and forest biodiversity indicators. The study was conducted in the Fandoghlou forest ecosystem in Northwestern Iran. Data was collected by a set of 120 circular plots with 5 m radius from both recreational and control areas. Number of trees, number of species, and canopy cover percentage were measured. In the biodiversity study, the Berger-Parker dominance index, Fisher alpha diversity index, Margalef richness index and Equitability J evenness index were used. According to the results obtained in this study, number of trees, number of species and amount of canopy cover on the recreational area was found considerably lower than that of control area. On the other hand, there were some crucial changes among different intensities of recreational activities regarding biodiversity indicators. Thus, studied forest parameters and biodiversity indicators in the recreational areas were negatively affected by recreational pressure.

***Corresponding Author:** Farshad Keivan Behjou ✉ keivanbehjou@gmail.com

Introduction

Forests provide a broad range of benefits to society, in addition to supplying timber and other marketable goods. Forests are important for environmental reasons such as biodiversity, the protection of plants and animals, and as a carbon sink (Erikson *et al.*, 2012). Biological diversity is now recognized increasingly as a vital parameter to assess global and local environmental changes and sustainability of developmental activities (Saha *et al.*, 2011). The biodiversity element of sustainable forestry has been especially challenging to forestland owners, states, countries, and many other policymaking bodies (Hagan and Whitman, 2006). Biodiversity maintenance is a key management objective and an important requisite for sustainable forestry and it is necessary to understand the dynamics and heterogeneity of natural forests to provide guidelines for management (Spies and Turner, 1999; Lindenmayer *et al.*, 2000). It is also important for recognizing the role of disturbances as integrated features of ecosystems (White, 1979). In this context, forest recreational activity treatments can be understood as disturbances that may have a large influence on the biodiversity of the forest. Recreational activities, in particular the use of fire places, can cause extensive damage to soil, ground vegetation, shrubs and trees (Amrein *et al.*, 2005; Behjou, 2011; Behjou, 2012). Effects of human activities on species diversity have attracted the attention of ecologists both from theoretical and practical points of view (Tynsong and Tiwari, 2010). Over the past decades, adverse effects associated with human recreation activities have increased progressively (Roovers *et al.*, 2006; Cakir *et al.*, 2010). In all kinds of recreational areas, soil and vegetation properties are the most ecosystem properties affected by visitors' pressure (Hegetschweiler *et al.*, 2009; Sarah and Zhevelev, 2007; Cakir *et al.*, 2010). Some researchers proved the changes in plant populations and communities due to recreational activities (Nuzzo, 1996; Farris, 1998; McMillan and Larson 2002; Rusterholz *et al.*, 2004). Also, negative impacts of recreational activities have been reported by numerous authors (Green and Peterken, 1997; McComb and Lindenmayer, 1999; Marage and Lemperiere, 2005; Rowland *et al.*, 2005).

In recent years, research about biodiversity in managed landscapes has been motivated by species decline and habitat loss (Halpern and Spies, 1995) and the use of management practices to emulate natural disturbances and dynamics has been explored in several studies (Hansen *et al.*, 1991; Niemela, 1999). The compatibility of recreational activities with biodiversity conservation in forests is a critical challenge (Behjou, 2012; Behjou and Mollabashi, 2013), not only because of societal demands but also because human-managed ecosystems are critical for maintaining biodiversity (Pimentel *et al.*, 1992). Recent studies have analyzed the influence of recreational activities on biodiversity, suggesting alternatives to maintain biodiversity in managed forests. Our study aims to assess the effects of recreational activities on some forest site parameters and forest biodiversity indicators in the Fandoghlou forest of Ardabil. Specifically, the aim of this study is to analyze the effects of recreational activity on biodiversity indicators of tree species richness and diversity. It is proved that the ecosystems with high species diversity are more stable and resilient to human disturbances than those having low species diversity (Hegetschweiler *et al.*, 2009; Tynsongand Tiwari, 2010). Effects of recreational activities on plant communities are attracting more and more attention (Liddle, 1997). However, little information is available about the impact of recreational activities on some forest parameters and biodiversity. The Fandoghlou forests in northwestern of Iran, as an Ecotone area are considered as one of the richest biodiversity centers of Iran. The main objectives of present study are: (i) comparing indicators of biodiversity between recreational and control areas, and (ii) evaluating the effects of each of the recreational activity treatments with different intensities on the biodiversity indicators, testing the

hypothesis that the control forest has the highest biodiversity values.

Materials and methods

Study area

The study was performed in the Fandoghlou forest region of Ardabil (Northwestern Iran). Conditions in the region have favored great vegetation diversity and a number of endemic species. In the region, some parts of the Forest have been strongly transformed by human recreational activities for decades and little amount of virgin forests has remained in the region. Currently, forests occupy about 20% of the territory. The dominant forest tree species in Fandoghlou are hazel (*Corylusaviena*), oak (*Quercus castanefolia*), hornbeam (*Carpinus betulus*), beech (*Fagus orientalis*) and maple (*Acer velutinum*).

Methods

Sampling method

Sampling plots were located according to a systematic sampling design in the intersections of the 50 m_ 50 m grids inside forests, with an average sampling intensity of four plots per 1 hectare of land. Plots were circular and concentric, with a fixed size, at a plot radius of 5 m (approximately 78.5 m^2). The total number of sampling plots that were analyzed was 120. Generally, 4 areas including 3 recreational activities treatments and one undamaged area were studied by sampling. Sixty of them were located in control area (undisturbed area) and sixty of them were located in recreational area (disturbed area). Recreational area was divided into three categories including slightly impacted (20 plots), moderately impacted (20 plots), and severely impacted (20 plots).

Biodiversity study

In the biodiversity study, the Berger-Parker dominance index, Fisher alpha diversity index, Margalef richness index and Equitability J evenness index were used. PAST software was used to detect biodiversity indices.

Statistical analysis

ANOVA was used to examine the impact of recreational activities on the number of individual trees, number of species and the amount of canopy cover in different areas. To test for significant effects of forest recreational activities of different intensities (slightly impacted, moderately impacted, and severely impacted), the mean values for the biodiversity indicators on the plots with the different recreational activities were contrasted with those corresponding to the control plots.

Results

Descriptive statistics for number of individuals per plot, number of tree species per plot, and canopy cover per plot are given for each area in Table 1.

Summary statistics are given for estimates of each variable and for each area (control and recreational areas with different levels of impact) (Table 1.). The results of one-way ANOVA indicated that recreational stands had significantly fewer amount of trees ($F_{3,\ 119}$= 38.74, P=0.000), number of species ($F_{3,\ 119}$= 26.88, P=0.000), and canopy cover ($F_{3,\ 119}$= 112.40, P=0.000) than that of control ones (Table 2.)

Table 2. Analysis of Variance of the Effect of recreational activities intensity on the number of trees, number of species, and canopy cover.

Variable	MS	$F_{3,\ 119}$	p_{value}
Number of trees	353.68	38.74	0.000**
Number of tree species	21.56	26.88	0.000**
Percent of canopy cover	10389.09	112.40	0.000**

*P<0.05, **P<0.01

(P=0.000). The results of Tukey test indicated that number of trees per plot (15.08) in the control area, was significantly higher than that in the recreational areas (slightly, moderately, and severely recreational impacted area (Fig. 1.).

The low number of trees in the recreational area indicated that recreational activities tended to decrease the density with increasing intensity of recreational impact. In the control area number of species per plot was significantly higher than that in the recreational areas (slightly, moderately, and severely recreational impacted area) (Fig. .2).

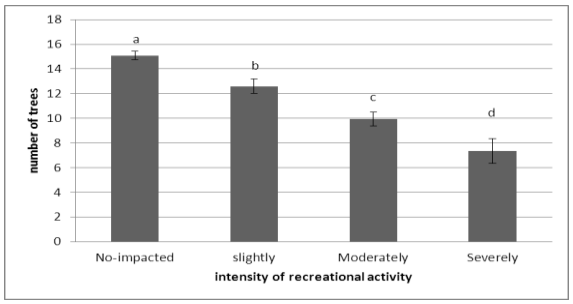

Fig. 1. The number of trees (per plot) in control area and different recreational areas.

Discussion

A significant decrease in tree canopy cover and tree density and number of tree species were recorded in recreational area compared to control area. Other researchers have reported similar results (Cakir *et al.*, 2010). The present study showed that

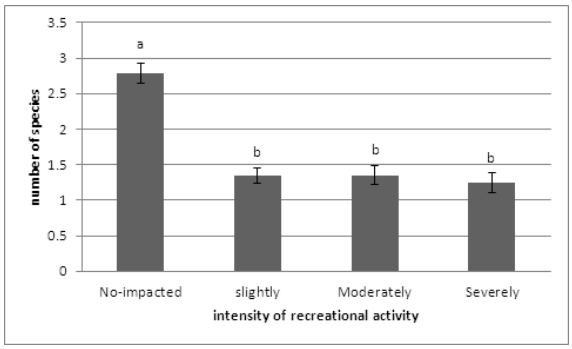

Fig. 2. The number of species (per plot) in control area and different recreational areas

The low number of species in the recreational area indicated that recreation activities tended to decrease the diversity. Also, in the control area the percentage of canopy cover per plot was significantly higher than that in the recreational areas (slightly, moderately, and severely recreational impacted area) (Fig. 3.). The low percentage of canopy cover in the recreational area indicated that recreation activities tended to decrease the canopy area.

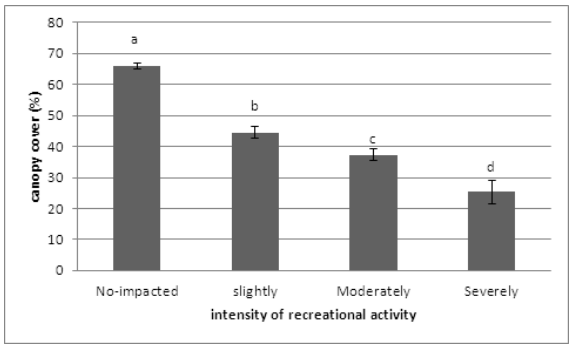

Fig.3. The amount of canopy cover (per plot) in control area and different recreational areas.

Table 1. Descriptive statistics of the variables in the plots in four treatments.

Variable	Treatment		number	minimum	maximum	mean	Standard deviation
Number of individuals	Control		60	9	23	15.08	2.61
	Disturbed*	1	20	9	19	12.60	2.50
		2	20	5	15	9.95	2.70
		3	20	0	16	7.35	4.58
Number of s	Control		60	1	5	2.78	1.12
		1	20	1	2	1.35	0.59

pecies	Disturbed*	2	20	1	3	1.35	0.49
		3	20	0	3	1.25	0.64
Percent of canopy cover	Control		60	48	77	65.90	6.59
	Disturbed*	1	20	21	61	44.50	8.66
		2	20	21	55	37.35	9.10
		3	20	0	55	25.35	16.48

* Control: No-impacted, 1: Slightly impacted, 2: Moderately impacted, 3: Severely impacted

Table 3. The diversity indices of control and disturbed areas.

Treatments	Recreational	Biodiversity indicators			
		Margalef richness	Berger-Parker Dominance	Fisher alpha diversity index	Equitability J evenness index
Control	No-recreational activity	1.30	0.91	1.71	0.72
	Slightly impacted	0.87	0.84	1.11	0.83
	Moderately impacted	0.43	0.55	0.58	0.32
Disturbed	Severely impacted	0.22	0.78	0.35	0.76

Recreational activities affected the tree diversity indicators at the Fandoghlou forests in northwestern Iran. The low number of biodiversity indicators in recreational forest areas, precluding the existence of forests in advanced or decadent stages of development and negatively impacting the abundance of these elements that are considered critical for forest biodiversity, (McComb and Lindenmayer, 1999), as has been observed by numerous authors (Green and Peterken, 1997; Marage and Lemperiere,2005; Rowland *et al.*, 2005). Hansen *et al.*, (1991) reported similar results for intensively managed forests in the Coastal Northwest United States, where they found a higher abundance of large trees and large snags in natural forests than in managed stands. This result is supported in part by other authors (Rowland *et al.*, 2005). Many studies have pointed out that vegetation was affected by recreational activities, and they noticed a negative correlation between recreational intensity and plant cover, plant height, species richness and species diversity (Kutiel *et al.*, 1999; Sarah and Zhevelev, 2007; Cakir *et al.*, 2010). Our results are in consistence with other studies on changes in plant populations and communities due to recreational activities (Nuzzo, 1996; Farris, 1998; McMillan and Larson 2002; Rusterholz *et al.*, 2004). To preserve the threatened plant communities in the Fandoghlou region, management plans need to be developed and implemented. Closure or controlled access to frequently recreational areas would stop additional species loss and changes in plant communities. This aim could be reached through closed parking lots or parts of the trail systems because the majority of recreational activities usually occur in their close neighborhoods. However, closure of the areas with heavy recreational use is not the best solution, because visitors tend to respond to such closure by moving into control habitats.

Conclusions

A monitoring program of the population size of selected indicator plants in recreational and control regions could provide a basis for future management plans. Furthermore, user-additive information on the potential impact of recreational activities on the biodiversity in different earth conditions should be provided. Undoubtedly, recreationists accept management plans when they are aware of ecological reasons behind the restrictions. Our findings indicate that knowledge on the quantity and quality of the biodiversity is important for developing restoration plans for forest sites affected by intensive recreational activities.

Acknowledgements

It is with immense gratitude that we acknowledge the financial support and help of the University of Mohaghegh Ardabili.

References

Amrein D, Rusterholz HP, Baur, B. 2005. Disturbance of suburban beech forests by recreational activities: Effects on soil characteristics, above ground vegetation and seed bank. Applied Vegetation Science **8**, 175-182.

Atlegrim O, Sjo¨berg K. 2004. Selective felling as a potential tool for maintaining biodiversity in managed forests. Biodivers Conserv **13**, 1123–1133.

Behjou FK. 2011. A practical sampling strategy for environmental evaluation of damages to residual stands caused by recreational activities in Fandoghlou forests, Ardabil. Journal of Food, Agriculture & Environment **1**, 231–242.

Behjou FK. 2012. Assessing damages to residual trees due to recreational activities in Fandoghlou forest. Iranian Journal of Forest **1**, 83 - 87. In Persian.

Behjou FK, Mollabashi OG. 2013. A practical sampling strategy for assessing woody debris in Fandoghlou forest, Iran. Journal of Environmental Science **8**, 83 - 87.

Bengtsson J, Nilsson SG, Franc A, Menozzi P. 2000. Biodiversity, disturbances, ecosystem function and management of European forests. For Ecol Manage **132**, 39–50.

Cakir M, Makineci E, Kumbasli, A. 2010. Comparative study on soil properties in a picnic and undisturbed area of Belgrad forest, Istanbul. Journal of Environmental Biology **31**, 125-128.

Farris MA. 1998. The effects of rock climbing on the vegetation of three Minnesota cliff systems. Can J Bot, **76**, 1981-1990.

Green P, Peterken GF. 1997. Variation in the amount of dead wood in the woodlands of the Lower Wye Valley.UK in relation to the intensity of management. For Ecol Manage **98**, 229–238.

Hansen AJ, Spies TA, Swanson FJ, Ohmann JL. 1991. Conserving biodiversity in managed forests. Lessons from natural forests. Bioscience **41**, 382-392.

Halpern U. 1992. Desertification: time for an assessment. Ambio **20**, 372-383.

Hegetschweiler KT, Loon NV, Ryser A, Rusterholz HP, Baur B. 2009. Effects of fireplace use on forest vegetation and amount of woody debris in suburban forests in Northwestern Switzerland. Environmental Management **43**, 299-310.

John M, Hagan A, Whitman A. 2006. Biodiversity Indicators for Sustainable Forestry: Simplifying Complexity. Journal of Forestry **3**, 203-210.

Liddle M. 1997. Recreation ecology. The ecological impact of outdoor recreation and ecotourism. Chapman and Hall. London. UK. P. 340.

Lindenmayer DB, Margules CR, Botkin DB. 2000. Indicators of biodiversity for ecologically sustainable forest management. Conservation Biology **14**, 941–950.

Eriksson L, Annika M,NordlundA, Olsson O,Westin K. 2012. Recreation in Different Forest Settings: A Scene Preference Study. Forests **3**, 923-943.

McComb WC, Lindenmayer D. 1999. Dying, dead, and down trees. In:Hunter, M.L. (Ed.), Maintaining Biodiversity in Forest Ecosystems. Cambridge University Press. Cambridge, pp. 335–361.

Marage D, Lemperiere G. 2005. The management of snags: a comparison in managed and unmanaged ancient forests of the Southern French Alps. Ann For Sci **62**, 135–142.

McMillan M, Larson DW. 2002. Effects of rock climbing on the vegetation of the Niagara escarpment in southern Ontario, Canada. Conservation Biology **16**, 389-398.

Niemela J. 1999. Ecology and urban planning. Biodiversity Conser **8**, 119-131.

Nuzzo VA. 1995. Effects of rock climbing on cliff goldenrod (Solidagosciaphila Steele) in northwest Illinois. Am Midl Nat **133**, 229-241.

Pimentel D, Stachow U, Takacs DA, Brubaker HW, Dumas AR, Meaney JJ, O'Neil JAS, Onsi DE, Corzilius DB. 1992. Conserving biological diversity in agricultural/forestry systems. Bio Science **42**, 354–362.

Roberts MR, Gilliam FS. 1995. Patterns and mechanisms of plant diversity in forested **SahaHK, Sarkar A, Haldar P.** 2008. Effects of Anthropogenic Disturbances on the Diversity and ecosystems: implications for forest management. Ecol Appl **5**, 969–977.

Rowland EL, White AS, William HL. 2005. A literature review of the effects of intensive forestry on forest structure and plant community composition at the stand and landscape levels. Miscellaneous Publication 754. Maine Agricultural and Forest Experiment Station. the University of Maine.

Rusterholz HP, Miiller SW, Baur B. 2004. Effects of rock climbing on plant communities on exposed limestone cliffs in the Swiss Jura Mountains. Applied Vegetation Science **7**, 35-40.

Roovers P, DumontB, GulinckHM. 2006. Recreationists' perceived obstruction of field and shrub layer vegetation. Urban For Urban Green **4**, 47-53.

Spies TA, Turner MG. 1999. Dynamic forest mosaics. In: Hunter, M.L.(Ed.), Maintaining Biodiversity in Forest Ecosystems. Cambridge University Press, Cambridge, pp 335–361.

Sarah P, Zhevelev HM. 2007. Effect of visitors' pressure on soil and vegetation in several different micro-environments in urban parks in Tel Aviv. Landscape Urban Plan **83**, 284-293.

Tynsong H, TiwariBK. 2010. Diversity of plant species in arecanutagro forests of south Mghalaya, north-east India. Journal of forestry research **21**, 281-286.

White PS. 1979. Pattern, process and natural disturbance in vegetation. Bot. Rev **45**, 229–299.