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IMPACT OF FIRES ON SPATIAL DISTRIBUTION PATTERNS OF THE HERMANN'S TORTOISE (*TESTUDO HERMANNI*) IN A HEAVILY AFFECTED AREA IN BULGARIA

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Abstract

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Fires are among the main threats for tortoises all over the world. Recently many territories over the country were burned. In April and August 2011 fires broke out in Pastrina Natura 2000 zone. The survey was carried for three years from 2011 to 2013. Habitats where specimens were encountered were reclassified to four classes of suitability – unsuitable, least suitable, suitable and optimal. The abundance (individuals per hectare) of tortoises was calculated for every each habitat. The territory affected by fires covered 69% of total study area. In both affected and control polygons the habitats distribution was displayed in a similar pattern. More specimens were found in affected polygon (60 individuals) versus non-affected (25 ind.). The species was found in only seven out of 19 habitat types. The fire affected 0.08% least suitable, 0.14% suitable but 62.19% optimal habitats in the total area. The overall abundance values are extremely low (up to 0.1ind./ha) and in all habitats this species is critically endangered. Species is very sensitive towards large-scale fires. Deciduous and especially oak forests are relatively resistant to fire and serve as refuges.

*Key words***:** Burned area, NATURA 2000, tortoises, habitats

Introduction

Wildfires are recognized as natural disturbances that have shaped landscape structure and ecosystem composition in many regions of the world. As ectotherms, reptiles are expected to benefit from the thermal quality of open areas created by fires. However, not all the reptile species respond positively to this pattern (Santos and Poquet, 2010). Fires impact animal communities by causing director indirect mortality, reshaping the habitat structure (Wilson, 1994; Whelan, 1995; Brooks and Esque, 2002) and they have ecological consequences, in terms of changing the thermal microclimate (Hurlbert 1969; Rice and Parenti, 1978), exposureto predators, food availability (Evans, 1984; Kaufman et al.. 1990), and reproduction timing (Lillywhite and North, 1974; Withgott, 1996; Cavitt, 2000). Fire and fire management are recognized as important factors in biodiversity conservation (Sanz-Aguilar et al., 2011).Recently vast territory all over Bulgaria was burned by induced fires caused by shepherds, farmers and local people. Although the fire-raising is forbidden by law this restriction is not respected. The effects of fire on *Testudo hermanni* have been studied by Cheylan (1984) in France, Stubbs et al. (1981, 1985), Félix et al. (1989) in Spain, Hailey (2000) in Greece, Popgeorgiev (2008) and Popgeorgiev and Kornilev (2009) in Bulgaria. All these studies point out the negative effect of fires.

The goals of the present study were to evaluate the effect of fires on tortoise habitats and to determine their habitats choice in burned territories.

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Material and Methods

The survey was carried out on the whole area (3551.58 ha) of Natura 2000 zone Pastrina BG0001037 (NATURA 2000 Bulgaria 2007) an insulated hill in North-West Bulgaria for three years (2011, 2012 and 2013). In April and August 2011 fires broke out most of the study territory. Tortoises were searched during their active season (April–September). Artifacts such as shell remains and eggs were also stated. For each individual caught during the survey the geographic coordinates were taken. Individual habitat characteristics were obtained from a layer derived from joining the datasets of the open and agricultural habitats taken from the physical blocks and the forest lands data from the national forestry database, and then reclassified to 49 categories. Layer components were then categorized to four classes of habitats suitability – unsuitable, least suitable, suitable and optimal. The abundance (individuals per hectare) of tortoises was calculated for every each habitat. The study territory was divided in two polygons – affected and non-affected (control) by fires. Datasets were processed with the software NextGIS.

Results

The territory affected by fires covered 69% of total study area. More specimens were found in affected polygon (60 individuals) versus control area (25 ind.) (Figure 1).

Out of total 19 habitat types present in the study territory the species was found in only seven (six in burned area and five in the control). In both polygons the habitats distribution was displayed in a similar pattern (Table 1), as unsuitable, least suitable, suitable and optimal habitats are with almost equal area coverage. The fire affected 0.08% least suitable, 0.14% suitable but 62.19% optimal habitats in the total area, respectively 0.07/0.08% of the least suitable in control vs. burned territory, 0.65/0.14% of the suitable and 27.83/62.19% of the optimal (Table 1).

Highest abundance was encountered in oak (0.02 ind./ha for affected areas, not found in non-affected), hornbeam (0.03/0.02 ind./ha for both affected/non-affected areas) and other deciduous forests (0.10/0.05 ind./ha), pastures (0.01/0.02ind./ha), transitional woodland-shrub (0.02 ind./ha for affected areas, not found in non-affected) and moors and heath land (0.02/0.01 ind./ha).

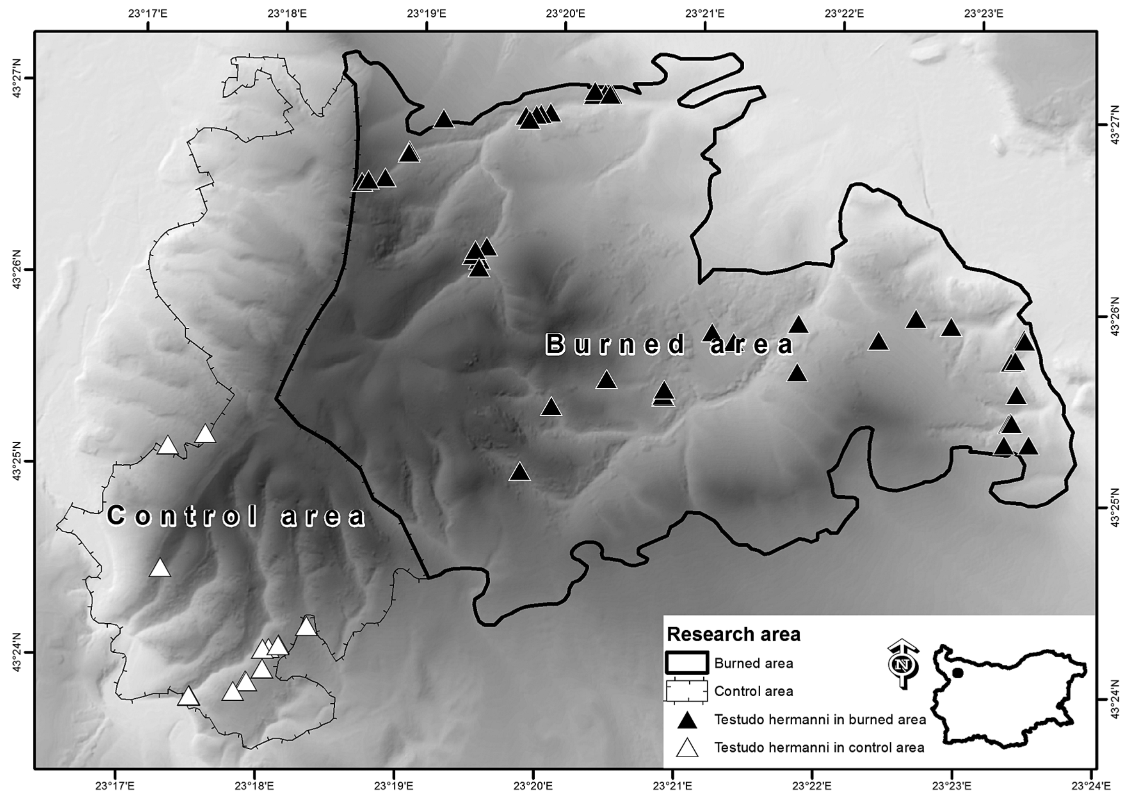

Fig. 1. Spatial distribution of sampled tortoises in Pastrina Natura 2000 zone

Table 1

Percent coverage of habitats, their degree of suitability and corresponding number of specimens

Habitat type	Control		Burned area		S
	%	N	%	N	
Pastures	7.19	6	26.96	10	3
Moors and heathland	6.41	2	13.83	8	3
oak forest	1.59		10.49	8	3
hornbeam forest	5.76	5	6.77	7	3
Sparsely vegetated areas	1.14	2	2.48		0
Permanently irrigated land	0.03		2.46		0
Transitional woodland-shrub	1.10		2.20	12	3
Broad-leaved forest	5.65	9	1.76	6	3
Annual crops associated with permanent crops	0.30		1.41		0
Burnt areas	0.00		0.20	9	0
Natural grasslands	0.12		0.18		3
Sclerophyllous vegetation	0.65		0.14		2
Discontinuous urban fabric	0.20		0.06		0
Vineyards	0.00	1	0.05		1
field and forest roads	0.01		0.03		1
Road and rail networks and associated land	0.01		0.02		0
Bare rocks	0.42		0.01		0
Non-irrigated arable land	0.04		0.01		0
black pine forests	0,06		0,00		0

Legend: % – percent coverage; N – number of specimens; S – degree of suitability

Discussion

The overall abundance values are extremely low. Population data from regions with relatively undisturbed populations in Bulgaria have given in average 5.3 ind./ha (Popgeorgiev, 2008) that is two orders higher than data presented. The fact that the values obtained are far lower than in other burned areas, where given abundance is in average 0.7 ind./ha (Popgeorgiev, 2008) is quite worrying. Low abundance values and low coverage with native oak forests and high percentage of secondary forests (hornbeam and other deciduous forest) from burned and control area revealed that the whole territory was regularly burned in the past. These findings emphasize the critical situation in which this species is. Fires have a strong negative effect on a populations of *T. hermanni* causing 64.3% mortality in sparsely vegetated areas in Southern Bulgaria (Popgeorgiev, 2008), 64% in a maquis shrubland in Northern Greece (Hailey, 2000), 85% in a pine forest in Southern France (Cheylan, 1984) and 30.4% in maquis in North Eastern Spain (Felix et al. 1989). Beside the direct extermination fires also destroy habitats whose loss was considered as a major threat for tortoises (Beshkov, 1984; Cheylan, 1984; Lambert, 1984; Swingland and Klemens, 1989). Almost all records were beside forest patches and it seemsthat tortoises use them as refuges during the fire. Oak forests particularly were defined to have higher resistance to fires (Abrams, 1992).

Only few studies promoted the beneficial role of fire for some reptiles but with many consequences and considering species well adapted to such threat (Pianka, 1996; Rugiero and Luiselli, 2006; Fenner et al., 2007).Tortoise populations are relatively resistant to a sudden and temporary catastrophe, and have a potential for recovery if left undisturbed (Stubbs, 1985). Recovering of a tortoise populations is a long term process for instance for eight years period no postfire recovery was encountered in a study in Northern Greece (Hailey, 2000). Reptiles are frequently cited as ideal indicators for environmental and restoration monitoring due to their importance to ecological functioning, dominance of vertebrate biomass, and sensitivity to environmental change (Smith, 2010). *T. hermanni* could be also used as indicator species, demonstrated in present study. Measuring species-level demographic, behavioral and population responses to different fire regimes is essential for designing adequate management policies (Sanz-Aguilar et al., 2011). Such an official management document is urgently required for Pastrina protected area.

Conclusion

This extremely low presence of the species makes it very vulnerable and sensitive towards different threats especially those with high impact such as large-scale fires. Natural habitats and especially deciduous forests are of primal importance for natural conservation of tortoises. Large forest patches are relatively resistant to fire and serve as refuges for them.

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