North-Western Journal of Zoology
P-ISSN: 1584-9074, E-ISSN: 1843-5629

Vol. 6, No. 2, 2010, pp.190-202
Article No.: 061118

Assessing the threatened status of *Testudo hermanni boettgeri* Mojsisovics, 1889 (Reptilia: Testudines: Testudinidae) population from Romania

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Abstract. The Hermann tortoise (*Testudo hermanni boettgeri* Mojsisovics, 1889) is present in Romania at its range limit. The main range is located in the Southwestern part of the country, in a sub-optimal sub-Mediterranean climate. *Testudo hermanni boettgeri* is also found in the Southeastern part of the country, the population there being insignificant to be included in our study. The range from Southwestern part of Romania has a surface of ~4420 sq km, from which only ~672 sq km is favorable to the tortoise. From the range extension point of view, the Hermann tortoise is a subspecies with a restrictive habitat, and the population is strongly declining—a tendency that most likely will continue in the future. This decline is accentuated by the habitat loss. The main threats for the Hermann tortoise are due to housing and urban area encroachment, tourism and recreation areas, annual and perennial non-timber crops, mining and quarrying, energy production and mining, recreational activities, increase in fire frequency/intensity, droughts, temperature extremes, climate change and severe weather. The threatened status established according to IUCN criteria for the regional level under uncertainty have led to framing the species in the endangered EN B1ab(i,ii,iii,v) category.

Key words: *Testudo hermanni boettgeri*, conservation, threats, Romania, IUCN Red List

Introduction

The tortoises are among those animals whose IUCN status is being revised. (Cox & Temple 2009). Survivors of several geological periods, they seem to restrain their territory due to rapid climate change (Gibbons et al. 2000). Threats like land use changes, road infrastructure development and global climate change (Primack et al. 2008) are making *Testudo hermanni* and *Testudo greaca* vulnerable (Cogălniceanu & Venczel 1993, Iftime 2000–2001, Iftime 2005). *Testudo hermanni* Gmelin, 1789 and its subspecific taxons' nomenclature is controversial, and there are several nomenclatural combinations (Fritz & Havaš 2006, Lapparent de Broin et al. 2006). The currently accepted taxonomic framing for the subspecies from Romania is: Order: Testudines; Superfamily: Testudinoidea; Family: Testudinidae; Scientific name for the species: *Testudo hermanni*; Species authority: Gmelin, 1789; Scientific name for the subspecies *Testudo hermanni boettgeri*; Subpecies authority: Mojsisovics, 1889 (Fritz & Havaš 2006). *Testudo hermanni boettgeri* beneficiates from different legal protection status such as natural monument according to Romanian Academy, and protected species under both CITES Convention and Habitat Directive (2006/105/EC 2006, Rozylowicz 2008, UNEP-WCMC 2010).

The populations of both species are found in Romania at their range edge (Gasc et al. 1997), with *T. hermanni boettgeri* also being isolated from the other groups (Cheylan 2001). This separation from the main range appeared

relatively recent, the population not being yet genetically distinct (Fritz et al. 2006). Despite the fact that there is clear evidence, which makes *Testudo hermanni* a strong candidate for a threatened status (Cheylan 2001), at EU27 level the species was classified after IUCN as being in a safe category—Near Threatened (Cox & Temple 2009). To set up national priorities in conservation a regional assessment of the threatened status is required. (IUCN 2003, Cogălniceanu & Cogălniceanu 2010).

The goals of our study were 1) to evaluate the threatened level of the species at the national level, according to IUCN 3.1 criteria that are applicable to regional level (IUCN 2001, 2003) and 2) to identify the conservation measures that are needed in order to reduce the effects of these threats.

Methods

To assess the threatening status of Hermann's tortoise at the regional level, we used a spatially explicit approach, which allows incorporating uncertainties in the input data (IUCN 2003, Mace et al. 2008). The analysis was conducted with RAMAS Red List Professional (Akçakaya & Root 2007) by considering the following data: Species' taxonomic classification, Life history, Geographic range, Population information, Habitat preferences, Major threats and Conservation measures.

Generation length, parameter that determines the period for assessing past changes and their estimation for the future, was calculated using the age of the first reproduction and adult survival rates (SPWG 2010).

Data concerning the distribution recorded three generations ago were obtained from Fuhn and & Vancea (1961), occurrence points being located with a 2 km precision. For mapping current distribution, we have used recent studies presenting information about Hermann's tortoise occurrence in its Southwestern range (i.e. Covaciu-Marcov et al. 2005, Iftime 2005, Rozylowicz 2008, Covaciu-Marcov et al. 2009a).

For life history, biometric characteristics, life cycle, clutch parameters, predation, diet, and population structure we compiled data from literature (i.e. Cruce & Şerban 1971, Cruce 1978, Rozylowicz 2008). Bioclimatic characteristics of the tortoise range were obtained by extracting the values from the Worldclim 1.4 database (Hijmans et al. 2005) recorded in the 737 points of occurrence (Rozylowicz 2008). For habitat preference, we used 2006 Corine Land Cover Map (European Environment Agency 2006). Land use within the area of occupancy for the Hermann's tortoise was extracted using as background estimated Area of Occupancy (AOO).

The occurrence points used in this study are identified between 2000 and 2008 and those mentioned in the recent literature that allowed marking them on the map within an error of maximum 2 km (Rozylowicz 2008).

The Extent of Occurrence (EOO) for *T. hermanni boettgeri* was estimated using the convex hull and AOO by counting the number of non-overlapping occupied cells in a uniform grid, with a grid size of 2 km (a cell area is ~4 sq km) (IUCN 2001).

The density of the tortoise's population was estimated for three generations ago, present days and three generations in the future using available data (Cruce 1978, Rozylowicz 2008), compared with European syntheses data (Cheylan 2001). Estimated size was calculated by maximum density, average density and minimum density inside of AOO, considering that 25% are mature individuals (Hailey & Willemsen 2000).

The major threats and conservation measures for the tortoises were standardized according to IUCN Red List Criteria (IUCN 2001, 2003), compiling the data from literature (e.g. Iftime 2005, Matache et al. 2006, Săhlean et al. 2008) and our recent observations.

Results and discussions

1. Specie's ecology

1.1. Distribution

The Hermann tortoise is a European species, and its range overlaps the Mediterranean climate from Spain (Catalonia) to Turkey, with infiltration through the area with sub-Mediterranean influence in Romania and Bulgaria (Gasc et al. 1997).

The spatial distribution of the Hermann tortoise in SW Romania have been assessed in several papers, covering past and present situations (Fuhn & Vancea 1961, Iana & Petcu 1976, Covaciu-Marcov et al. 2005, Iftime 2005, Covaciu-Marcov et al. 2009a).

Outside the Southwestern range, the Hermann tortoise was confirmed in Dobrogea (Iftime 2002, Sos et al. 2008), being either a vagrant specimen brought by people or belonging to populations from Bulgaria. In several papers

have been recorded occurrences from Central (i.e. Haţeg Depression, Jiului Gorge) and Eastern Romania (i.e. Galaţi county), rejected by extensive field research – e.g. Covaciu-Marcov et al. (2009b) for Jiului Gorge.

The actual range from Romania, without possible vagrant population overlay the Southwest part of Romania, in habitats from Locvei Mountains, Almăjului Mountains, Cerna Corridor, Domogled and Cerna Mountains, Mehedinţi Plateau, Coşuştea's Hills, Jiana Plane and Bălăciţei's Hills (Fig. 1).

1.2. Life history

The Hermann tortoise is a terrestrial tortoise of medium size, with an accentuated sexual dimorphism (Rozylowicz & Pătroescu 2004). The average age for the sexual maturity is 8 years for males and 9 years for females or for females with Straight Carapace Length > 150 mm (Cruce & Răducan 1975a, Cruce & Răducan 1976). The generation length for *T. hermanni boettgeri* was estimated at 16.9 years.

Within the range of the species, the bioclimatic parameters (Table 1) indicate the presence of a soft sub-Mediterranean climate, with gentle winters and hot summers. The climatic data are calculated as an average for the period 1950–2000. With regard to the mean annual temperature, the range is in a suboptimal potential (Huot-Daumbremont 2002), the tortoise being constrained in critical times to protect itself by staying in burrows underground to reduce its metabolic rate.

The Hermann tortoise has an annual life cycle divided into two parts: the sleep-hibernation period (November–March/April) and the active period (March/April–November). During the sleep-hibernation period, there can be interruptions when the temperatures are extremely high. During the tropical hot summer days, when the tortoises are not moving for more than 5 consecutively days, the aestivation phenomena appears (Cruce & Răducan 1975b, Cheylan 2001).

Mating occurs several times per annum, from spring to autumn, starting in April. There is a synchronization of the whole population during the same month in spring (Cruce & Răducan 1976). The clutch is usually laid once per annum, starting in the middle of May through the end of July based on the temperature. Rarely, the tortoise lays a second clutch in August or September (Rozylowicz 2008).

The tortoise lays the clutch generally on gentle slopes, rarely flat with sunny aspect. When laying the eggs, the tortoise digs a ditch with a width of 6–7.5 cm, a length of 7–10 cm and a depth of 5–8 cm (Cruce & Răducan 1976). The tortoise lays around 5.28±3.02 eggs per tortoise, with the average weight of the laid eggs being 19.96±2.82 grams (Rozylowicz 2008).

The nests are predated upon by small carnivores, insectivores, ungulates and rodents. Point observations from the area Bahna–Bucovăţ–Ţarovăţ and Mala–Eşelniţa areas have shown that the predation rate-calculated as the number of predated nests per number of observed mature females was 98% for Bahna–Bucovăţ–Ţarovăţ and 85% for Mala–Eşelniţa (Rozylowicz 2008).

The tortoise's main predators are foxes (*Vulpes vulpes*), wild boars (*Sus scrofa*), dogs (*Canis familiaris*), martens (*Martens* ssp.), badgers (*Meles meles*), and polecats (*Mustela putorius*). In addition to these predators, feral dogs can also affect the mature individuals by inflicting large wounds. In the sleep-hibernation period, the tortoises can be easily wounded or killed by predators like the wood mouse (*Apodemus sylvaticus*), fat dormouse (*Glis glis*), garden dormouse (*Eliomys* ssp.), and rats (*Rattus* ssp.) (Cheylan 2001, Rozylowicz 2008).

The tortoise's diet is made almost exclusively from plant species, mushrooms and mosses that the habitat if offering in all the seasons with biological activity. The point observations made by (Rozylowicz 2008) in the Iron Gates Natural Park indicated for the tortoise's diet

the following plant taxa: (leaves, flowers, fruits, very rarely roots): *Arenaria* ssp., *Carex* ssp., *Cardamine* ssp., *Carpinus orientalis, Cirsium vulgare, Cornus mas, Crataegus monogyna, Crataegus pentagyna, Euonymus latifolius, Hieracium* ssp., *Lathyrus* ssp., Leguminosae family, *Medicago* ssp., *Oxalis* ssp., *Plantago* ssp., *Potentilla* ssp., Poaceae family, *Prunus spinosa, Quercus frainetto, Quercus cerris, Rosa* ssp., *Rubus* ssp., *Stellaria media, Taraxacum officinale, Trifolium* ssp., *Veronica* ssp., *Urtica* ssp. This list is incomplete; the tortoise's diet is more diverse and the studies who have been made so far were very limited.

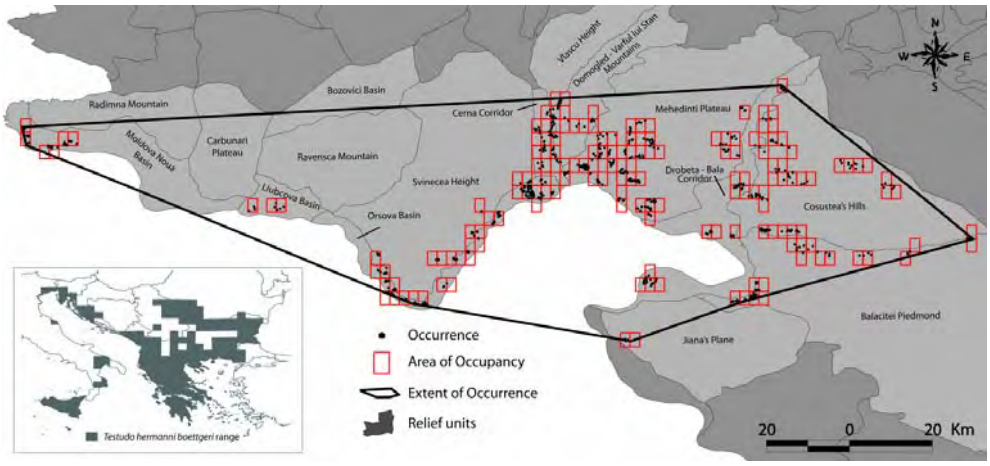

Figure 1. *Testudo hermanni boettgeri* distribution in the southwestern part of Romania

Table 1. Bioclimatic parameters within the habitat of *T h b.* (C.I. = Confidence Interval, S.D. = standard deviation).

Parameter	Mean	CI- 95%	CI+95%	Min	Max	S.D.
Annual Mean Temperature	10.28	10.14	10.42	8.07	11.36	0.68
Temperature Annual Range	30.75	30.62	30.89	28.90	32.10	0.66
Mean Diurnal Range	9.47	9.41	9.52	8.60	9.83	0.26
Max Temperature of Warmest Month	26.71	26.50	26.92	23.40	28.40	1.018
Min Temperature of Coldest Month	−4.04	−4.17	−3.91	−5.50	−2.60	0.62
Mean Temperature of Wettest Quarter	18.17	18.01	18.34	15.53	19.50	0.79
Mean Temperature of Driest Quarter	1.54	1.41	1.68	−0.43	2.90	0.66
Mean Temperature of Warmest Quarter	19.77	19.61	19.93	17.18	21.06	0.78
Mean Temperature of Coldest Quarter	0.06	−0.04	0.18	−1.63	1.20	0.56
Annual Precipitation	654.94	647.39	662.49	599.00	780.00	36.66
Precipitation of Wettest Month	90.75	89.38	92.12	80.00	114.00	6.64
Precipitation of Driest Month	40.25	39.84	40.66	37.00	46.00	1.99
Precipitation of Wettest Quarter	233.16	229.69	236.62	206.00	291.00	16.81
Precipitation of Driest Quarter	122.77	121.63	123.91	115.00	141.00	5.52
Precipitation of Warmest Quarter	214.68	211.23	218.14	187.00	273.00	16.76
Precipitation of Coldest Quarter	133.30	131.99	134.60	124.00	151.00	6.33

1.3. Habitat preference assessment

The species prefers tessellated habitats, with high fragmentation, open vegetation, relatively small areas and surrounded by brushwood and forests (Rozylowicz et al. 2003). This habitat structure allows the development of large densities of tortoise groups, especially because of the habitat's capacity for offering protection in critical development phases (Pătroescu & Rozylowicz 2007).

In the Southwestern range *T. hermanni boettgeri* AOO overlaps 20 Corine Land Cover land use categories from which we have selected only 12 as suitable habitats for Hermann's tortoise. Water bodies, water courses, inland marshes, port areas, industrial and commercial units, and sport and leisure facilities were left out from our study as it is impossible for the tortoise to naturally occur in those areas. We have also not considered bare rocks and coniferous forest as their percent from the total area for AOO is very small. All the categories that were left out represent 6.17% from the total AOO surface.

For a better understanding of the land used by the Hermann tortoise, we have combined the percent of the land use patches within the area of AOO into 4 groups: *agricultural patches* = land principally occupied by agriculture, with significant areas of natural vegetation, complex cultivation patterns, fruit trees, vineyards and non-irrigated arable land; *temperate forest* = broadleaved forest and mixed forest; *grassland and pastures* = natural grassland and pasture; *sparsely vegetated area* = transitional woodland − shrub and sparsely vegetated areas.

Based on the points of occurrence for the tortoise, we have extracted from 2006 Corine Land Cover Map the land cover behind each point (Fig. 2). Agricultural patches and temperate forest have a similar percent from the total AOO surface, 45% from the total number of the occurrence points. This is a result of the effect that tortoises spend most of their lives at the interface between forest and agricultural land, grassland or pastures (Pătroescu & Rozylowicz 2007, Rozylowicz 2008). Even if the grassland and pastures represent only 3.16% percent of the total AAO, 24.83% of the tortoises were found in this habitat. The same situation was observed for

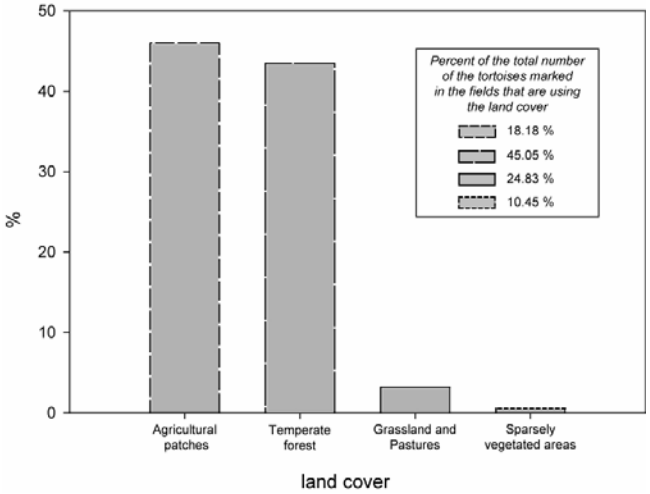

Figure 2. Landuse within the AOO and percent of the occurrence points of the tortoise, on different land use.

sparsely and vegetated areas with 0.56% from the total AOO surface and a percent of 10.45% from the tortoise using this habitat.

Temperate forests (Broad-leaved forest and mixed forest) appears to be key habitat for tortoises as nearly half of them were found there. The presence of a tortoise on one type of land cover or another is a function of the availability of the other habitat in the vicinity. Therefore, whether the tortoises are found in agricultural patches, grassland, pastures or sparsely vegetated areas, there will always be temperate forest habitat within the close vicinity.

1.4. Range assessment:

Extent of Occurrence and Area of Occupancy

The purpose of EOO is to measure the way to which risks derived from threats are distributed across the taxon's geographical range (SPWG 2010).

The populations from the Southeastern part of Romania were excluded because the numbers of individuals that have been found are too small compared to the extent of the occurrence EOO. The distance between Strehaia city (the eastern limit of the Southwestern range) and Canaraua Fetii Valley (from Dobrogea) is ~400 km in straight line. The population of tortoises from Southwestern Romania occupies a habitat of ~4420 sq km, with a maximum diameter of 148 sq km. Within the minimum convex polygon, there are higher proportions of unfavorable habitats, where the tortoises cannot survive, so this parameter is over-estimating the tortoise's habitat (SPWG 2010). From a geographic point of view, understand as EOO surface, the Hermann tortoise in Romania is Endangered-EN B1ab (i,ii,iii,v) (IUCN 2001, 2003).

AOO for *T. hermanni boettgeri* is of 672 sq km (168 cells, 2×2 km). The population is highly fragmented, the number of occurrence groups deduced through grid adjacency being 23. From a geographic range point of view, understood as AOO surface, the Hermann tortoise meets the Vulnerable criteria – VU B2c (i,ii,iii,iv) (IUCN 2001, 2003).

2. Population size and density

The number of tortoise individuals from Romania have been evaluated in Coşuştei Hills, Siseşti area (Cruce 1978), in Almăj Mountains at Eşelniţa, and in Mehedinţi Mountains at Bahna (Rozylowicz 2008). The tortoise's density is between 44.5 individuals ha^{-1} (Cruce 1978) and 12 individuals ha^{-1}, the sub-populations being optimal and sub-optimal compared to the densities indicated by Cheylan (2001): 45 individuals ha^{-1} in optimal habitats and 3 individuals ha^{-1} in suboptimal habitats. We have considered the maximum densities of 44.5 individuals ha^{-1}, average density of 12 individuals ha^{-1}, and minimum density of 3 individuals ha^{-1}. We also have estimated that for an AOO of 672 sq km, the Romanian tortoise population could have between 220,400 mature individuals (maximum), 60,120 mature individuals (average) and 15,030 individuals (minimum). When the current density of tortoises at Siseşti is compared to the densities recorded by Cruce (1978), three generations ago, the populations than were more numerous, between 330,000 mature individuals (maximum) and 22,500 mature individuals (minimum). Keeping the same rate of the reduction of population size in the following three generations, to which we add also the effect of habitat loss, the tortoises will reduce to 165,000 individuals (maximum estimated size of population) or 11,250 mature individuals (minimum size). According to this population estimate *T. hermanni boettgeri* can be listed from EN to LC, Criterion A2b and A3c. As the Criteria A (Population reduction) varies and the input data are only estimations with weak qualifiers, the evaluation exceeds the IUCN standards for uncertainty (IUCN 2001, 2003).

3. Major threats

In the Southwestern area, 24 categories of present threats, 19 categories of past threats (three generations ago), and 30 future threats (within the next three generations) to the Hermann tortoise were identified. These threats can be structured into eight categories (Gibbons et al. 2000): habitat loss and degradation, harvesting, accidental mortality, pollution, natural disaster, changes in native species dynamic, intrinsic factors and human disturbance.

Habitat loss and degradation contribute the most to the decline of the tortoise population (Necşuliu & Popescu 2003, Pătroescu & Rozylowicz 2007). The loss of habitat and its degradation is happening because of changing land use such as the extension of the agricultural landscapes, deforestation, forestation, and development (Necşuliu 2007). Development projects can compound the reasons for the tortoise's demise: degrading the habitat's proximity by raising the accessibility and subsequent tortoise removal, road kill, attracting predators of household wastes, feral dogs, etc. (Rozylowicz 2008). Now, 95% of the agricultural patches have less than one ha (Necşuliu 2007, Pătroescu & Necşuliu 2008), resulting in habitats being highly tessellated (Pătroescu & Rozylowicz 2007). The current trend is to link these patches, especially the area's Eastern and Western extremities and to use mechanized agricultural tools and fertilizers (Necşuliu & Popescu 2003, Matache et al. 2006). This change is leading to a higher rate of accidental tortoise killing and to the reduction of the grassland's floristic diversity (Pătroescu & Rozylowicz 2007).

The activities of mineral extraction, both on the ground and underground, represent a traditional activity within the area of Iron Gates Natural Park (Pătroescu et al. 2004). These activities increased after 1700, when the Austrian Empire opened mines in these areas (coal, complex mineral, limestone, slate, gravel, sand, etc.). There were and there still are activities for mineral extraction, for example, at Moldova Nouă, Bigăr, Feţele Dunării, Ciucarul Mic, Gura Văii etc. (Pătroescu et al. 2004, Necşuliu 2007). These quarries destroy the tortoise's habitat and lead to an increase in their mortality rate due to intense traffic with heavy trucks. In addition, the dust that deposits on the side walk will change the composition of the meadows leading to a decrease in food resources (Rozylowicz 2008).

Tourism developments constitute another major threat due to the conversion of the habitat and by raising the habitat's accessibility to tourists. After 1989, the Danube's shores were greatly modified, whereas before there were no houses on the shore, nowadays there are almost no free land patches. There is a tendency towards human disturbance in the future, like the construction of a neighborhood between Eşelniţa and Orşova (Pătroescu, pers. comm. 2009). The road network is a significant threat, with many cases of traffic accidents being recorded (Rozylowicz 2008). The tortoise-proof fencing is a noticeable omission as well in key habitats.

Collecting the tortoises as pets represent an increasing threat (Pătroescu & Necşuliu 2008). In the last years numerous specimens have been recovered and reintroduced after having been taken out of their habitats and abandoned (e.g. from Timişoara, Bucureşti, and Craiova). Trade of this species is illegal, though there have been tortoises found for sale (Primack et al. 2008, Rozylowicz 2008).

Global climate change will strongly influence the tortoise's population in the future. It will change the meadow composition, will result in an increase in fire frequency, drought, and will implicitly reduce the habitat's favorability. Due to the limited dispersal ability, the tortoises will not be able to establish populations in new areas (Gibbons et al. 2000).

Table 2. Major threats for the Hermann tortoise in SW Romania

Major threats	Past	Present	Future
1. Habitat Loss/Degradation (human induced)			
1.1. Agriculture			
1.1.1. Crops			
1.1.1.2. Small-holder farming			yes
1.1.4. Livestock			
1.1.4.1. Nomadic	yes	yes	yes
1.1.4.2. Small-holder			yes
1.1.4.3. Agro-industry		yes	yes
1.3. Extraction			
1.3.1. Mining	yes		yes
1.4. Infrastructure development			
1.4.1. Industry	yes		yes
1.4.2. Human settlement	yes	yes	yes
1.4.3. Tourism/recreation		yes	yes
1.4.4. Transport - land/air		yes	yes
1.4.6. Dams	yes	yes	yes
1.4.8. Power lines	yes	yes	yes
1.7. Fires	yes	yes	yes
3. Harvesting [hunting/gathering]			
3.6. Other: Collection for national and international pet trade	yes	yes	yes
4. Accidental mortality			
4.1. By-catch			
4.1.2. Terrestrial			
4.1.2.3. Poisoning	yes		
4.2. Collision			
4.2.2. Vehicle collision		yes	yes
6. Pollution (affecting habitat and/or species)			
6.1. Atmospheric pollution			
6.1.1. Global warming			yes
7. Natural disasters			
7.1. Drought			yes
7.2. Storms/flooding	yes	yes	yes
7.4. Wildfire	yes	yes	yes
8. Changes in native species dynamics			
8.2. Predators	yes	yes	yes
9. Intrinsic Factors			
9.1. Limited dispersal	yes	yes	yes
9.2. Poor recruitment/reproduction/regeneration	yes	yes	yes
9.3. High juvenile mortality	yes	yes	yes
9.4. Slow growth rate	yes	yes	yes
9.5. Low densities		yes	yes
9.6. Skewed sex ratios	yes	yes	yes
9.7. Slow growth rates	yes	yes	yes
9.9. Restricted range	yes	yes	yes
10. Human disturbance			
10.1. Recreation/tourism		yes	yes
10.4. Transport		yes	yes
10.5. Fire		yes	yes

4. Conservation measures

Conservation measures were compiled from a comprehensive revision of literature (i.e. Pătroescu et al. 2004, Iftime 2005, Primack et al. 2008, Rozylowicz 2008, Săhlean et al. 2008) as well as data from our research and conservation projects.

Policy based actions. European laws that have been adapted by the national legislation protect the Hermann tortoise and its habitats. There have been efforts to recognize the protection status of the species both at the international and national level and to establish management plans for the species protection (Pătroescu et al. 2004). As Romania is in its infancy of applying new regulations, most of the conservation measures are not effectively applied (Iojă et al. 2010).

Communications and Education actions. The attention on the species both at the national and local level was raised through different awareness campaigns and meetings with the local stakeholders. The results were promising as many of the inhabitants within the local communities are now aware of the existence and importance of the species, but proper education is needed for the local people to actively participate in the management activities (Primack et al. 2008). As the species habitats overlay a border area, there are cases when the tortoises are illegally collected and transported over the border to be sold as pets (Rozylowicz 2008). Furthermore, many tortoises are collected by tourists and abandoned outside of their range without any chance to survive during the winter. In other cases, local inhabitants kill the tortoises as they are entering the vegetable gardens for feeding (Pătroescu & Rozylowicz 2007).

Research Actions. The research actions of the species started in the 70's with a series of studies followed by extensive research after 2002 at *Testudo hermanni* Conservation Centre, Eşelniţa, Mehedinţi County (Pătroescu et al. 2004). Most of these studies were related to taxonomy, population range, biology and ecology. To assure the survival of the species in the future, other actions are needed that include uses and harvest level, cultural relevance, monitoring trends, road kill rate, and mortality rate from intrinsic factors (Primack et al. 2008).

Habitat and site-based actions. Through European legislation, four Natura 2000 sites have been established in the species range (Southern part of Iron Gates Natural Park, Stârmina Forest, Southern part of Domogled Valea Cernei National Park and Mehedinţi Plateau Geopark) as well as management actions (Pătroescu & Rozylowicz 2007, Pătroescu & Necşuliu 2008). However, for the long term conservation plans of the species, measures need to be established to minimize the fragmentation of the range. These measures should be based on landscape level studies (Hartel et al. 2008), identification of new protected areas in the Eastern part of the range (Iojă et al. 2010) and growth of the suitable habitats, especially as the area will be constantly under development stress (Pătroescu & Rozylowicz 2007). The community-based initiatives could be one of the most important measures for the future of the species (Rozylowicz 2008).

Species-based actions. Since 2002, 242 juveniles have been reintroduced in the Hermann's habitats, with individuals hatched in *Testudo hermanni* Conservation Centre (Pătroescu pers. comm. 2009). Since the number of the mature individuals has been decreasing in the last three generations and will decrease more in the next three generations to an average of 45,000 individuals, other measures of ex-situ conservation action like Captive breeding/Artificial propagation are needed. These efforts should be secondary to eliminating the causes that lead to habitat reduction and species mortality (especially road kill and illegal trade) (Gibbons et al. 2000).

Table 3. Conservation measures for Hermann tortoise in SW Romania

Conservation measures	in place	needed
1. Policy-based actions		
1.1. Management plans		
1.1.1. Development	yes	
1.1.2. Implementation		yes
1.2. Legislation		
1.2.1. Development		
1.2.1.1. International level	yes	
1.2.1.2. National level	yes	
1.2.2. Implementation		
1.2.2.1. International level	yes	
1.2.2.2. National level	yes	
2. Communication and Education		
2.1. Formal education		yes
2.2. Awareness	yes	
2.3. Capacity-building/Training	yes	yes
3. Research actions		
3.1. Taxonomy	yes	
3.2. Population numbers and range	yes	
3.3. Biology and Ecology	yes	
3.4. Habitat status	yes	
3.5. Threats	yes	
3.6. Uses and harvest levels		yes
3.7. Cultural relevance		yes
3.8. Conservation measures	yes	
3.9. Trends/Monitoring		yes
4. Habitat and site-based actions		
4.1. Maintenance/Conservation		yes
4.4. Protected areas		
4.4.1. Identification of new protected areas		yes
4.4.2. Establishment	yes	
4.4.3. Management	yes	
4.6. Community-based initiatives		yes
5. Species-based actions		
5.1. Re-introductions	yes	yes
5.3. Sustainable use		
5.3.2. Trade management	yes	yes
5.4. Recovery management		
5.5. Disease, pathogen, parasite management		yes
5.7. Ex situ conservation actions		
5.7.1. Captive breeding/Artificial propagation	yes	
5.7.2. Genome resource bank		yes

Conclusion

The threatened assessment for the Hermann tortoise in Southwest Romania was made following the IUCN criteria for regional level under uncertainty. The population of Hermann tortoise in Romania is declining compared to three generations ago, the evaluation of the

threat level allowing us to frame the subspecies at a national level as EN B1ab (i,ii,iii,v). This framing was made due to the species' restricted range (EOO=4420 sq km; AOO=672 sq km; 23 groups).

Although the current threats are well known, the conservation measures (especially policy-based actions, habitat and site-based actions, and species-based actions) are insufficient, and there is a decreasing trend in the number of mature individuals—or even a cessation of species from certain locations—because the restraint in the actual range. A strong impact is due to housing and urban areas, tourism and recreation areas, annual and perennial non-timber crops, mining and quarrying, energy production, recreational activities, increase in fire frequency/intensity, droughts, temperature extremes, climate change and severe weather. These threats are strengthened, due to ecosystem conversion and degradation, high mortality rates of species and skewed sex ratios.

Acknowledgements. We thank Rufford Small Grants Foundation for supporting this study through the Rufford Small Grants for Nature Conservation, Booster Grant 49.01.08 "Securing the future of Hermann tortoise in SW Romania". We are grateful to Professor Maria Pătroescu, head of Center for Environmental Research and Impact Studies, University of Bucharest for her useful advices and for providing the framework needed for conducting this research. We appreciate the valuable comments on the manuscript made two anonymous reviewers.

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Submitted: 26 June 2009
/ Accepted: 31 July 2010

Published Online: 04 August 2010