Assessment of 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 found in Romania at its European limit. The area here is located in the Southwestern part of the country, in a sub-Mediterranean climate, sub-optimal. *Testudo hermanni boettgeri* is also found in the southeastern part of the country, the population there being insignificant to be included in the analysis for area extend. The area from southwestern part of Romania, calculated as Extent of Occurrence, has a surface of 4394.8 sq km, from which only 668 sq km are favorable for the tortoise (calculated as Area of Occurrence). From the range extension point of view, the Hermann tortoise is a subspecies with a restrictive habitat. The tortoise is found in small patches of agricultural land, grassland, pastures or sparsely vegetated areas, always with temperate forest habitat in their close vicinity. The population is strongly declining - a tendency that most likely will continue in the future. This decline is accentuated also by the loss of the habitat. The main threats for the Hermann's tortoise are mainly due to housing and urban area encroachment, tourism and recreation areas, annual and perennial non-timber crops, mining and quarrying, energy production & mining, recreational activities, increase in fire frequency/intensity, droughts, temperature extremes, climate change & severe weather. The threatened status realized according to IUCN criteria for the regional level under uncertainty a have led to framing the species in the endangered EN B1ab(i,ii,iii,v) category.

Introduction

The currently accepted taxonomic framing for the subspecies from Romania is as following: 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 2007). The holotype for *Testudo hermanni boettgeri* (lectotype *Testudo graeca* var.

boettgeri Mojsisovics, 1889), type locality Orşova, Cerna Valley, Romania, is kept by Senckenberg Museum, Frankfurt No. SMF 7836 (Bour 1987).

Testudo hermanni (Gmelin, 1789) and its subspecific taxon's nomenclature currently is controversial (Fritz & Bininda-Emonds 2007). for *Testudo hermanni boettgeri* (Mojsisovics, 1889) being spread the several nomenclatural combinations: *Testudo graeca* var. *boettgeri* Mojsisovics, 1889; *Testudo graeca* var. *hercegovinensis* Werner, 1899; *Testudo enriquesi* Parenzan, 1932; *Testudo hermanni boettgeri* Bour, 1987; *Testudo hermanni boettgeri* Engelmann et al., 1993; *Testudo hercegovinensis* Perälä, 2002; *Testudo boettgeri* Vetter, 2002; *Testudo hermanni boettgeri* Kuyl et al, 2002; *Testudo boettgeri boettgeri* Artner, 2003; *Testudo boettgeri hercegovinensis* Artner, 2003; *Testudo hermanni hercegovinensis* Vinke & Vinke, 2004; *Eurotestudo boettgeri* Lapparent de Broin et al., 2006; *Eurotestudo hercegovinensis* Lapparent de Broin et al., 2006 (Fritz & Havaš 2006, Friz et al. 2006, Rozylowicz 2008).

The delineation of the two subspecies was first made by Wermuth (1952), who classified the western populations of *Testudo hermanni* in the *Testudo hermanni robertmertensi* (Wermuth, 1952), and the eastern one in the *Testudo hermanni hermanni* (Gmelin, 1789). Bour (1987) rediscovered the holotype specimen for *Testudo hermanni* which came from the Collobrières, Département Var, France. This led to the naming of *Testudo hermanni hermanni* (Gmelin, 1789) for the subspecies from the western part of the continent and resurrection of the name *Testudo hermanni boettgeri* (Mojsisovics, 1889) for the eastern subspecies. Based on morphological arguments, Lapparent de Broin et al. (2006) proposed to recharacterize *Testudo hermanni* at genus level, *Eurotestudo* e.g., with two extant species: *Eurotestudo hermanni* and *Eurotestudo boettgeri*.

At a specific level, the taxon was first included by IUCN on its Red List in the "Vulnerable" category (Groombridge 1994). In 1996, *Testudo hermanni*'s classification was re-evaluated

into the category “Low Risk/Near Threatened” (Tortoise & Freshwater Turtle Specialist Group 1996), which is still accepted today for EU27 region (Cox & Temple 2009). At a subspecies level, IUCN have evaluated only the taxon from the western part of the continent as being considered Endangered, criteria B1+2abcde (European Reptile & Amphibian Specialist Group (1996)).

Testudo hermanni boettgeri have been evaluated at the national level by Cogalniceanu & Venczel (1993) as being included in the threatened status. Iftime (2000-2001) included in the first phase the subspecies in the category Endangered criteria A 2,4 + acde, then (Iftime 2005) assigned only as a threatened general status. *Testudo hermanni* is a natural monument according with Romanian Academy from 1938. The species is protected also by the CITES Convention, Appendix II – as a species that is not necessarily now threatened with extinction, but that may become so unless trade is closely controlled (UNEP—WCMC 2009). At the European level, the species is included in the Habitat Directive, Annex II and IV (92/43/EEC, 2006/105/EC).

The goal of the study was 1) to evaluate the threatened level of the species at the national level, conformingly to IUCN 3.1 criteria that are applicable at regional level (IUCN 2001, IUCN 2003) and 2) to identify the conservation measures that are need in order to reduce the effects of these threats. The regional evaluation was made with RAMAS® Red List Professional which allows explicitly incorporating uncertainties in the input data (Akçakaya & Root 2007, Mace et al. 2008).

1. Specie’s ecology

1.1. Distribution

The Hermann tortoise is a Palearctic species and its habitat overlaps the European Mediterranean climate from Spain (Catalonia) to Turkey, with penetration through the area with sub-Mediterranean influence in Romania and Bulgaria (Pătroescu & Rozylowicz 2007). The spatial distribution of the Hermann tortoise in Romania is discussed in several papers like Fuhn & Vancea (1961). Iana & Petcu (1976) published a distribution map for the Iron Gates area, and based on their own observations, extendedthe area presented by Fuhn & Vancea (1961) towards the West (to Lescovita) and towards the North within the interior of Iron Gates Natural Park. Rozylowicz et al. (2003) and Rozylowicz & Pătroescu (2004) again reorganized these observations to include new locations, while Iftime (2005) published a general paper that included also the location of other possible vagrant individuals, like the ones from the Haţeg Depression and South of Dobrogea. The individuals from Dobrogea are confirmed as belonging to *Testudo hermanni boettgeri* by Sos et al. (2008), being either vagrant specimen brought by peopleor belonging to populations from Bulgaria.

The actual range from Romania without vagrant population overlay the Southwest part of Romania, being directly linked to the specific habitats from Locvei Mountains, Almajului Mountains, Cerna Corridor, Domogled and Cerna Mountains, Mehedinti Plateau, Cosustea's Hills, and Balacitei's Hill (Figure 1).

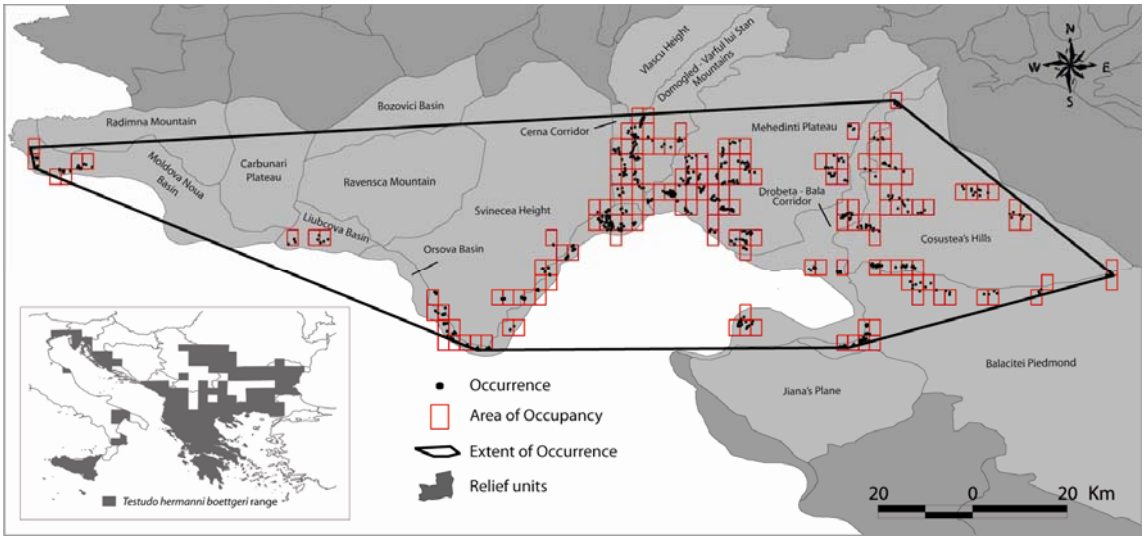

Figure 1. *Testudo hermanni boettgeri* distribution in the southwestern part of Romania

1.2. Life history

The Hermann tortoise is a land tortoise of medium size, with an accentuated sexual dimorphism. The females (n=136) are reaching maturity SCL (Straight Carapace Length) at 207.13 cm (SD=24.85) and average weights of 1684.86 grams (SD=9.82). The males (n=89) have length of the SCL of 170.94 cm (SD=20.33) and average weights of 1010.82 grams (SD=16.67) (Rozylowicz & Pătroescu 2004).

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

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

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 1975*a*, Cheylan 2001, Rozylowicz 2008).

The population structure based on the sex and age fluctuates, varying spatially and temporally due to the anthropic and natural effects, especially due to the temperature-dependent sex determination (Cruce & Răducan 1976, Cruce 1978, Cheylan 2001).The average age for the sexual maturity is 8 years for males (n = 73) and 9 years for females (n = 80), or for females starting from SCL = 150 mm (Cruce & Răducan 1975*b*, 1976).

The generation length for *Testudo hermanni boettgeri*, calculated as ($\alpha + 1/(1- Sa)$), where α is the age of first reproduction and (Sa) is adult survival rate (SPWG 2008), is 16.9 years.

Mating occurs several times per year, from Spring to Autumn, starting in April, but there is a synchronization of the whole population during the same month in spring. The clutch is usually laid once per year, starting in the middle of May through the end of July based on the temperature. Rarely does the tortoise lay a second clutch in August or September (Rozylowicz 2008).

The clutch is laid by the tortoise 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 eggs per tortoise (n=102, SD=3.02), with the average weight of the laid eggs being 19.96 grams (n = 505; SD = 2.82) (Rozylowicz 2008).

The Hermann tortoise is vulnerable to predators-especially in the egg, juvenile and subadult phases. Predation on the nest is the main cause for the small rate of the population growth. The nests are predated upon by small carnivores, insectivores, ungulates and rodents. Point observations from the area Bahna – Bucovăț - Țarovăț and Mala – Eşelnița areas have shown that the predation rate-calculated as number of predated nests per number of observed mature females-was 98% for Bahna – Bucovăț – Țarovăț and 85% for Mala-Eşelnița (Rozylowicz, 2008).

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

The tortoises diet is made almost exclusively from plant speciessuch as mushrooms and mosses that the habitat if offering in all the seasons with biological activity. The punctual observations made by Rozylowicz (2008) in the southeastern part of the Iron Gates Natural Park established the tortoise diet to include the following vegetal 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, 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 that have been made so far were very limited.

1.3. Habitat preference

The species prefers tessellated habitats, with high fragmentation, open vegetation, relatively small areas and surrounded by brushwood and forests. 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: egg, juvenile, reproduction, sleep - hibernation or aestivation (Rozylowicz et al. 2003, Pătroescu & Rozylowicz 2007). The habitat types for the Iron Gates Natural Park section were mapped using a standard key of habitat descriptions (Doniță et al. 2005, Gafta & Mountford 2008) while at the same time with morphological assessments of tortoises completed with data from synthesised works (Matacă 2005). The description key contained the physical characteristics of the habitats (location, geomorphologic, geologic and climatic parameters). According to Rozylowicz (2008), 35 habitats were identified as suitable for the occurrence of Hermann's tortoise.

Using the Corine Land Cover Map (CLC, European Environment Agency, Copenhagen, Denmark: 2006) as background and the Area of Occurrence (AOO) layer (SPWG 2008), we extracted the land use within the area of occupancy for the Hermann's tortoise. There were 20 land use categories from which we have selected only 12 as suitable as habitat 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 not possible 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 and easier understanding of the land use 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, mixed forest; *grassland and pastures* = natural grassland, pasture; *sparsely vegetated area* = transitional woodland - shrub, sparsely vegetated areas.

Based on the points of occurrence for the tortoise, we have extracted from Corine Land Cover Map (CLC, European Environment Agency, Copenhagen, Denmark: 2006) the land cover behind each point (Figure 2). Even if the agricultural patches and temperate forest have a similar percent from the total AOO surface, 45% from the total number of the occurrence points were found in temperate forest. This is is a result of the effect that tortoises spendmost of their lives at the interface between forest and agricultural land, grassland or pastures. Even if the grassland and pastures represents only 3.16% percent of the total AAO, 24.83% of the tortoises were found in this habitat. The same situation was observed for sparsely and vegetated areas with 0.56 % from the total AOO surface and a percent of 10.45% from the tortoise using this habitat.

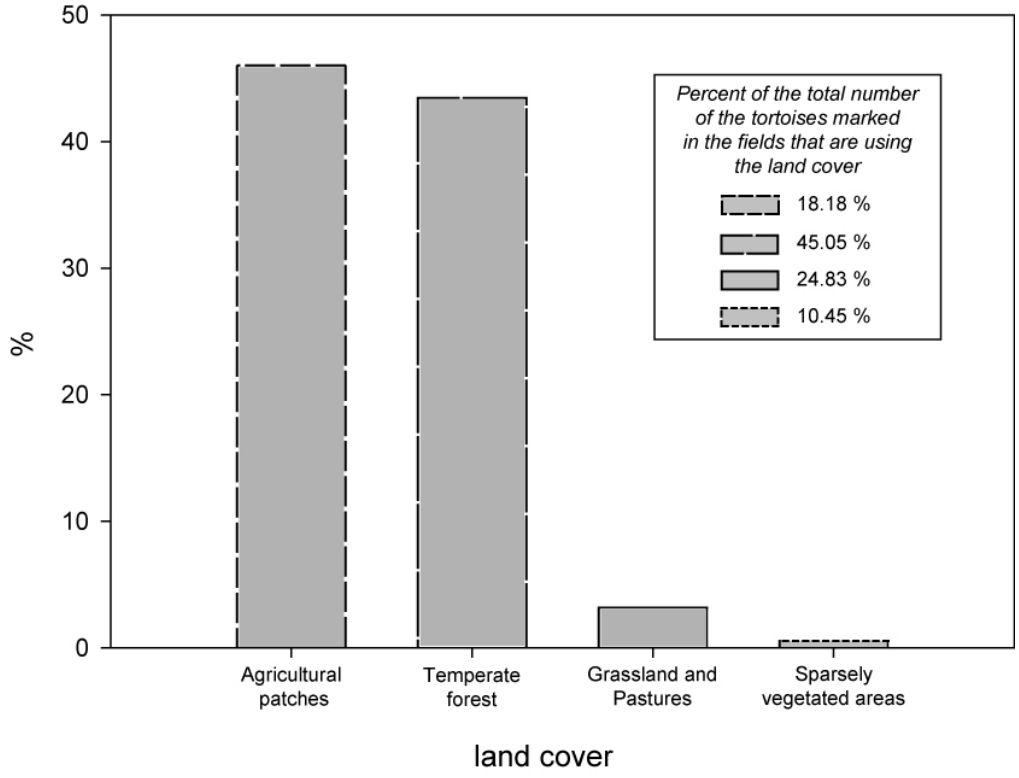

Figure 2. Landuse within the AOO and percent of the occurrence points of the tortoise, on different land use

Temperate forest are a key habitat for tortoises as almost half of them were found there. (broad-leaved forest and mixed forest) 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. So whether the tortoises are found in agricultural patches, grassland, pastures or sparsely vegetated areas, there will always be temperate forest habitat within close vicinity.

2. Range assessment

2.1. Extent of Occurrence

The Extent of Occurrence (EOO) for *Testudo hermanni boettgeri* was estimated using the minimum convex polygon method (convex hull) using the occurrence points, excluding the possible vagrant individuals or groups. The purpose of EOO is to measure the way to which risks derived from threats are distributed across the taxon's geographical range (SPWG 2008).

The occurrence points used in this study are the points identified between 2000 and 2008 and also those mentioned in the recent literature that allowed marking them on the map within an error of maximum 2 km (Rozylowicz 2008). Convex hull was estimated with the Spatial Analyst module from RAMAS® Red List Professional (Akçakaya & Root 2007). The populations from the southeastern part of Romania were excluded because the number 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 ~4394.8 sq km, with a maximum diameter of 145.06 sq km. Within the minimum convex polygon, there are a higher proportion of unfavorable habitats, where the tortoise can not survive, so this parameter is over-estimating the tortoise's habitat (SPWG 2008). From a geographic point of view, understand as EOO surface, the Hermann's tortoise in Romania is Endangered - EN B1ab(i,ii,iii,v).

2.2. Area of Occupancy

Area of occupancy (AOO) is defined as "the area within its extent of occurrence which is occupied by a taxon, excluding cases of vagrancy" (IUCN 2001). The measure reflects the situation when a taxon will not occur throughout the range of its extent of occurrence, which includes unsuitable or unoccupied habitats (SPWG 2008). We have estimated AOO with Spatial Analyst Module (Akçakaya & Root 2007) 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) that covers the entire southwest range of a taxon. At this scale, the assumption was that areas without points are confirmed absences. AOO for *Testudo hermanni boettgeri* is of 668 sq km (167 cells, 2x2 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 meet the Vulnerable criteria – VU B2c(i,ii,iii,iv).

3. Population size and density

The number of tortoise individuals from Romania have been evaluated only in Coşuştei Hills (Cruce 1978), in Almăj Mountains at Eşelnița, and in Mehedinți Mountains at Bahna (Rozylowicz 2008). The tortoises density is between 44.5 individuals per ha (Cruce 1978) and 12 individuals per ha (Rozylowicz 2008), the sub-populations being optimal and sub-optimal compared to the densities indicated by Cheylan (2001): 45 individuals per ha in optimal habitats and 3 individuals per ha in suboptimal habitats. The size of the populations was estimated inside of AOO, considering that 25% are mature individuals (Hailey & Willemsen 2000). We have considered the maximum densities of 44.5 individuals per ha, average density of 12 individuals per ha, and minimum density of 3 individuals per ha.We also have estimated that for an AOO of 668 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 oftortoises at Siseşti are compared to the densities recorded by Cruce (1978), three generations ago, the populations 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 of *Testudo hermanni boettgeri* in Romania, *Testudo hermanni boettgeri* can be listed from EN to LC, Criterion A2b and A3c (IUCN 2001). As the Criteria A (Population reduction) varies and the input data are only estimations with weak qualifiers, the evaluation exceed the IUCN standards for uncertainty (IUCN 2003).

4. Major threats

The major threats for the tortoises can be standardized according to IUCN Red List Criteria (IUCN 2001, IUCN 2003), listed in Table 2. Compiling the data from literature, mainly the ones synthesized by Iftime (2005), Matache et al. (2006), Săhlean et al. (2008), Rozylowicz (2008), 24 categories of present threats have been identified, 19 categories of past threats (three generations ago), and 30 future threats (within the next three generations). These can be structured in 8 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 contributes the most to the decline of the tortoise population. The lost of habitat and its degradation is happening as a result of changing land use such as extension of the agricultural landscapes, deforestation, forestation, and development. 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. Now, 95% of the agricultural patches have less than 1 ha (Necşuliu 2005), resulting in habitats being highly tessellated. The current trend is to link these patches, especially the area's Eastern and Western extremities and to use mechanized agricultural tools . 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 minerals extraction, both on the ground and underground, represent a traditional activity within the area of Iron Gates Natural Park. These activities started more actively in 1728, when the Austrian Empire has opened mines in these areas. There were and there still are activities for mineral extraction (coal, complex mineral, limestone, slate, gravel, sand etc.) at Iuți, Svinița, Eibenthal, Tişovița, Plavişevița, Mraconia, Tufări, Moldova Nouă, Bigăr, Cozla, Mala, Starişte, Fețele Dunării, Ciucarul Mic, Gura Văii, Podeni etc. (Necşuliu

2005). Though most of them have closed, the current economic environment is such that parties are lobbying to reopen or to enlarge them, and the consequences of these actions would be devastating for the groups of tortoises within the area of these activities (example: Gura Văii, Mala; Fețele Dunării, Ciucarul Mic) (Pătroescu et al. 2004). These quarries destroy tortoise 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 in the decreasing of the food resources (Rozylowicz 2008).

The tourism development constitutes another major threat due to the conversion of the habitat and also by raising the habitat's accessibility by tourists. After 1989, the Danube's shores were strongly modified in such a way that if compared with years before 1989 when there were no houses on the shore, there are almost no free land patches. There is a tendency of human disturbance in the future, like the construction of a neighborhood between Eşelnița and Orşova (Pătroescu, pers. comm. 2009). The road network, which developed especially after 1970, is in the process of modernization which will inevitably lead to higher traffic and speeds on these roads, with the national and European roads acting as barrier for tortoises. The road network is even now a significant threat, with many cases of traffic accidents being documented (Rozylowicz 2008). The tortoise-proof fencing is a noticeable omission even in key habitats.

Collecting the tortoises as pets represents increasing threat with the number of tourists that are visiting the tortoise range. Center for Hermann Tortoise Captive Breeding, Eşelnita, Mehedinti County (CCCTH) have recovered numerous specimensin the recent past and reintroduced those that have been taken out of their habitats and abandoned (example: from Timisoara, Bucuresti, Craiova). Trade of this species is illegal, though there have been tortoises found for sale (example: National Environmental Guard from Timis County captured 8 tortoises that were found for sale in a newspaper; the Hungarian Frontier Police captured 24

tortoises that were about to be crossed over the border, with the captured tortoises being hand over to the Romanian Herpetological Society.

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 implicitly will reduce the habitat's favorability. Due to 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's tortoise habitat.

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. Bycatch			
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

5. Conservation measures

The main conservation measures in place or needed for the Hermann's tortoise are synthesed in Table 3, according to IUCN Red List Criteria (IUCN 2001, IUCN 2003). The conservation measures where compiled from Pătroescu et al. (2004), Iftime (2005), Matache et al. (2006), Pătroescu et al. (2007), Sahlean et al. (2008), Rozylowicz (2008) as well as data from research projects. In the past 10 years, a couple of key projects were implemented for the protection and management of this species. The main projects have been financed by European Union (LIFE III project "Iron Gates Natural Park – habitat conservation and management", 2001-2004), The National University Research Council (Habitats from Iron Gates Natural Park - structure and distribution, 2001-2002) and Rufford Small Grants for Nature Conservation (Securing the future of Hermann tortoise in SW Romania, 2008-2009).

Policy based actions - In Romania, the Hermann's tortoise and its habitats are protected by European laws that have been adapted by the national legislation. As shown in the Table 3, there have been efforts to recognize the protection status of the species both at international and national level and to establish management plans for the species protection (Patroescu et al. 2004, Patroescu & Necsuliu 2008). As Romania is in its infancy of applying new regulations, most of the conservation measures are not effectively applied (Pătroescu pers. comm. 2009).

Communications and Education - The attention on the species both at national and local level was raised through different awareness campaigns in schools within the tortoise range, TV and radio public shows and meetings with the local stakeholders. The results were promising as many of the inhabitants within the local communities are aware now of the existence and importance of the species, but formal education is needed for the local people to actively participate in the management activities. As the species habitats overlays a border area, there are cases when the tortoises are collected and transported over the border in order to be sell as pets. Also many tortoises are collected by tourists and abandoned outside of their range without any chance to survive during the winter. To avoid abandonment, a special web page has been created on the website of the project (www.portiledefier.ro/carapax). In other cases, the tortoises are killed by local inhabitants as they are entering the vegetable gardens for feeding. Raising the level of cultural relevance within this area could substantially minimize the negative consequences to the species.

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 CCCTH. Most of these research being conducted was related to taxonomy, population range, biology and ecology. The research actions from the last years have augmented the existing knowledge base, expanding it in the following areas: population number, habitat status, threats, and conservation measures. To assure the species' survival 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.

Habitat and site - based actions - Through national and international legislation 4 NATURA 2000 sites have been established in the species range (Iron Gates Natural Park – southern part, Padurea Starmina, Domogled Valea Cernei National Park – southern part and Mehedinti Plateau Geopark) as well as management actions (Pătroescu & Rozylowicz 2007, Pătroescu et

al. 2007). But for the long term conservation plans of the species, measures need to be established to minimize the fragmentation of the range like maintenance/conservation, identification of new protected areas in the eastern part of the range and expansion of the suitable habitats, especially as the area will be constantly under the development stress. The community - based initiatives could be one of the most important measures for the future of the species.

Species – based actions - Since 2002, 242 juveniles have been reintroduced in the Hermann's habitats, with individuals hatched in CCCTH Eşelnița, Mehedinți County (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, but these efforts should be secondary to eliminating the causes that lead to habitat reduction and species mortality (especially road kill and illegal trade).

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 (IUCN 2001, 2003) under uncertainty (Akçakaya & Root 2007, Mace et al. 2008). 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 sub-species at a national level as EN B1ab(i,ii,iii,v). This framing was made due to the species' restricted range (EOO = 4394.8 sq km; AOO = 668 sq km; 23 groups).

Though 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 actual range. A strong impact is especially due to housing & urban areas, tourism & recreation areas, annual & perennial non-timber crops, mining & quarrying, energy production & mining, recreational activities, increase in fire frequency/intensity, droughts, temperature extremes, climate change & severe weather. These threats are higher especially due to ecosystem conversion and degradation, high mortality

rates of species and skewed sex ratios. We propose urgent measures for accelerating the evaluation procedures of the taxon at European level for framing it in a threatened category.

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