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The commercial export of the land tortoises (*Testudo* spp.) from the territory of the former Yugoslavia: a historical review and the impact of overharvesting on wild populations

Katarina LJUBISAVLJEVIĆ[1,*], Georg DŽUKIĆ[1] and Miloš L. KALEZIĆ[1,2]

1. Department of Evolutionary Biology, Institute for Biological Research "Siniša Stanković", University of Belgrade, Bulevar Despota Stefana 142, 11060 Belgrade, Serbia
2. Institute of Zoology, Faculty of Biology, University of Belgrade, Serbia
*Corresponding author: K. Ljubisavljević, E-mail: katarina.ljubisavljevic@ibiss.bg.ac.rs, ljubisavljevic@EUnet.rs

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Abstract. Previous data have shown that the Former Yugoslavia had a significant role in exports of land tortoises (*Testudo* spp.) during the past century. In this paper we present historical exploitation and compare dynamics of the trade in land tortoises in the former Yugoslavia according to Federal Statistical Office and Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) database. Also we examine impact of long-term harvesting on the health of populations by calculating the condition index (CI) in the sample populations of the most common tortoise in the former Yugoslavia (*Testudo hermanni*). According to the Federal Statistical Office's records of international trade, a total of 2615 metric tonnes of tortoises (*T. hermanni* and *T. graeca*) were exported from the Former Yugoslavia within a 41-year period during the 20th century. These exports represented a total of 2.142 million specimens. The quantities of tortoises exported peaked at a value of 236 tons in 1972. Since 1929, tortoises have been exported to 19 countries. The largest importers were Germany, Italy, Belgium-Luxembourg and Great Britain. These countries accounted for 77% of the total exports. We found many discrepancies between official Federal records and CITES records for the period from 1975 onwards. Differences were found in the quantities exported, the identities of the importing countries and their relative shares of the total export of tortoises. The current optimal CI values in examined tortoises suggest a response to overharvesting through density-dependent processes. The paper discusses a current situation in tortoise farming and trade and further perspectives on conservation of tortoise populations in the region of the former Yugoslavia.

Keywords: Balkan Peninsula, *Testudo hermanni*, *Testudo graeca*, trade statistics, condition index.

Introduction

The land tortoises (Testudinidae) face constant threats to their survival resulting from global climate change and intensive loss of their habitats through habitat alteration, destruction and fragmentation (Lambert 1984, Stubbs et al. 1985, Willemsen & Hailey 1989, Gibbons et al. 2000, Hailey 2000a, Hailey & Willemsen 2003, Rozylowicz & Dobre 2010). In addition, the uncontrolled harvesting for human consumption, pet-trade, or medical purposes has also been invoked as a major factor directly contributing to the decline of the land tortoises (e.g., Schlaepfer et al. 2005, Shepherd & Nijman 2008). These threats mainly arise from life-history and demographic characteristics of tortoises whose slow population growth and limited dispersal reduce the chance of recolonisation, even if habitat restoration is successful (Hailey & Willemsen 2003). Also, low and stochastic hatching success and delayed sexual maturity make them less able to withstand a given rate of harvest (e.g., Congdon et al. 1993, Jennings et al. 1998). It was calculated that an additive annual mortality rate of only 2-3% exceeds the maximum value that will allow most tortoise species to maintain positive population growth rates (Gibbs & Shriver 2002 and references therein).

Many reptile species have been collected for centuries and are still largely exploited in many parts of the world (Thorbjarnarson 1999, Schlaepfer et al. 2005, Engler & Parry-Jones 2007, Pernetta 2009). The collection for the pet trade appeared as important threat for the land tortoises especially in Mediterranean area and the Balkans (Lambert 1979, Auliya 2003, Pérez et al. 2004, Türkozan et al. 2008, Cox & Temple 2009), where the former Yugoslavia had a significant role in tortoise exports during the past century (Honegger 1974, 1981, Blab 1980, Lambert 1984, Corbett 1989, Vetter 2006). This fact is documented not only by the large numbers cited in official databases (Türkozan et al. 2008), but also by the much greater representation of the specimens from the

Balkans in centres for captive tortoises in Italy and Netherlands (Willemsen et al. 2002) compared with western European ones. However, historical presentation, analysis and comparison of the export data recorded by Yugoslav and foreign sources have not been conducted until now.

The region of the former Yugoslavia (the current states of Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, Serbia and Former Yugoslav Republic of Macedonia) covers the western and central parts of the Balkan Peninsula. It is inhabited by two species of land tortoises, the Hermann's tortoise (*Testudo hermanni* Gmelin 1789) and the spur-thighed tortoise (*T. graeca* Linnaeus 1758). Although taxonomy of land tortoises is still in a state of flux, prevailing view proposes that the generic name *Testudo* and the classic two-subspecies model for *T. hermanni* should be kept (Fritz et al. 2006, Fritz & Bininda Edmonds 2007, Fritz & Havaš 2007). The Hermann's tortoise has a patchy distribution in the northern Mediterranean area. Isolated populations occur in continental Spain, France, Italy and on the Balearic Islands, Corsica, Sardinia and Sicily. A more nearly continuous distribution occurs over most of the Balkan Peninsula (Bour 1997). The spur-thighed tortoise has a discontinuous circum-Mediterranean distribution. The northwestern limits of its range occur in the southeastern parts of the Balkan Peninsula (Fritz et al. 2009). In the region of the former Yugoslavia, the Hermann's tortoise occurs along the Adriatic coast and is generally widely distributed in Serbia and FYR Macedonia (Cheylan 2001). The spur-thighed tortoise has a restricted range in the southernmost parts of Serbia (Tomović et al. 2004) and in FYR Macedonia (Lambert 1997), where it occurs in sympatry with the Hermann's tortoise, which is usually more abundant and the more frequent species. *T. hermanni* is listed as near threatened, while *T. graeca* is considered vulnerable in the IUCN European Red List of Reptiles (Cox & Temple 2009). Both species are included in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (UNEP-WCMC 2010), in Appendix II of the Bern Convention (Council of Europe 1979) and in Appendices II and IV of the European Habitats Directive (Council of the European Communities 1992). Among the Republics of the former Yugoslavia, *Testudo* species are protected by laws in Serbia, Croatia and Montenegro, but they are not yet afforded protection in FYR Macedonia and Bosnia and Herzegovina. Despite the general view that the Hermann's tortoise is more threatened in the western part of its range, whereas the populations in the Balkans are more stable (van Dijk et al. 2004), some studies have revealed that the populations of the Balkans also show a marked decline (Meek 1989, Hailey & Willemsen 2003, Rozylowicz & Dobre 2010). The general decline in the populations of *T. graeca* has also been recorded (Lambert 1979, Pérez et al. 2004, Cox & Temple 2009). Previous studies on aspects of the ecology of *T. hermanni* in the region of the former Yugoslavia have considered few populations from the Adriatic coast (Meek & Inskeep 1981, Meek 1985, 1989), while those in inland areas are little studied. Concerning the central Balkans the ecology of Hermann's tortoise has been studied in Romanian populations (i.e. Cruce & Şerban 1971, Cruce & Răducan 1975, 1976, Cruce 1978).

Up to now, the studies of the impact of collecting on the wild populations with supporting quantitative data have been conducted on some chelonian species (Seminoff et al. 2003, Gamble & Simons 2004, Brown et al. 2011), while the similar studies on European land tortoises are scarce (Pérez et al. 2004). Since life-history data are difficult to collect in long-lived species like tortoises, some short-term studies could provide valuable information on possible impacts of harvest on such populations. For example, evaluations of the body condition of tortoises could be used to obtain some kinds of indirect estimates of the impact of overharvesting on chelonian populations (e.g., Seminoff et al. 2003) and of the possible threatened status of these populations. Condition indices were broadly used in conservation studies where were related to environmental (habitat loss, pollution, overharvesting, climate change) or life-history characteristics of threatened species (Stevenson & Woods 2006). A body mass condition index (CI) that compares mass with size appeared to be the most useful and simplest tool for assessing condition in tortoises (Hailey 2000b, Willemsen & Hailey 2002, Willemsen et al. 2002).

The goals of this paper are two-fold. First, to present and compare the dynamics of the trade in land tortoises in the former Yugoslavia according to Federal Statistical Office (1879-2006) and CITES database (1975-2009), and second to examine possible impact of long-term harvesting on the health of populations of the most common tortoise in the former Yugoslavia (*T. hermanni*). This was done by calculating the CI in the sample populations from the Central Balkans (Serbia and Montenegro).

Materials and methods

Data on the tortoise trade

The database from the Federal Statistical Office was used to obtain records for tortoise exports from the former Yugoslavia from 1879 onwards (Anonymous 1879-1917, 1918-1928, 1929-1941, 1945-1962, 1963-1991, 1992-2002, 2003-2006). Also, the CITES database was used to obtain records for tortoise exports from the former Yugoslavia from 1975 onwards. Data were downloaded from the CITES trade database as a compiled Comparative Tabulation Table from UNEP/WCMC (http://www.cites.org/eng/ resources/trade.shtml). For each year of data, we recorded from both databases the country of import and the export quantity. The database from the Federal Statistical Office gives quantity of all exported tortoises in units of weight, while the CITES database gives the quantity of exported tortoises expressed as the number of specimens for each species (unidentified cases were recorded generally as genus *Testudo*), and the purpose of export. To enable the comparison of these two different systems with which tortoise exports were recorded, the external trade statistics of the former Yugoslavia were converted from units of weight to numbers of tortoises exported. These values are rough estimates only, because they were based on the average mass of *T. hermanni* from Serbia and Montenegro as measured for the purposes of this study (M = 1,221 g) and because both *T. graeca* and *T. hermanni* were exported in large quantities from the territory of the former Yugoslavia.

The current condition of Hermann's tortoise

In order to evaluate the current condition of the Hermann's tortoise populations, we examined CI. This parameter was analysed for five sample areas from Serbia and Montenegro (Fig. 1): 1. Limljani in Montenegro (42° 12′ N, 19° 06′ E, 156m a.s.l., 8 males, 21 females); 2. Starčevo Island in Lake Skadar in Montenegro (42° 11′ N, 19° 13′ E, 15m a.s.l., 7 males, 9 females); 3. Eastern Serbia (16 males, 18 females, localities: Stara Brza, 44° 28′ N, 22° 27′ E, 67m a.s.l.; Petrovo Selo, 44° 37′ N, 22° 27′ E, 435m a.s.l. and Vratna monastery, 44° 23′ N, 22° 21′ E, 165m a.s.l.); 4. Central Serbia (11 males, 9 females, localities: Kolare, 45° 54′ N, 21° 14′ E, 160m a.s.l. and Ivković monastery 45° 52′ N, 21° 13′ E, 218m a.s.l.); 5. Southern Serbia (10 males, 9 females, locality: Starac Mt., 42° 20′ N, 21° 52′ E, 810m a.s.l.). Population samples of *T. hermanni* from several localities in the eastern and central parts of Serbia were grouped to obtain sufficient data for analysis.

Tortoises were located by walking through the habitat during daylight hours (9 -18 h). They were measured and weighed in the field as described by Stubbs et al. (1984), photographed, and then released immediately afterwards at the point of capture. We recorded the body mass (M), the midline straight carapace length from the front of the nuchal scute to the rear of the carapace (MSCL), and the straight carapace length, measured as the maximum horizontal length of the body in a normal resting position flat on the ground (SCL). Mechanical callipers (0.1 mm precision) were used to measure MSCL. SCL was measured to the nearest mm using specially constructed at-bed callipers, a "tortometer" (Stubbs et al. 1984). M was measured with an electronic balance (1 g accuracy).

Tortoises from Serbia were inspected during the third week of June 2003 (Eastern Serbia) and during the first and third weeks of July 2004 (Central and Southern Serbia, respectively). Both samples from Montenegro were inspected in the first week of June 2003.

Sex was determined by plastral concavity and by the presence of larger tails in males in specimens larger than 10 cm carapace length. All animals smaller than 10 cm carapace length were considered to be juveniles (Stubbs et

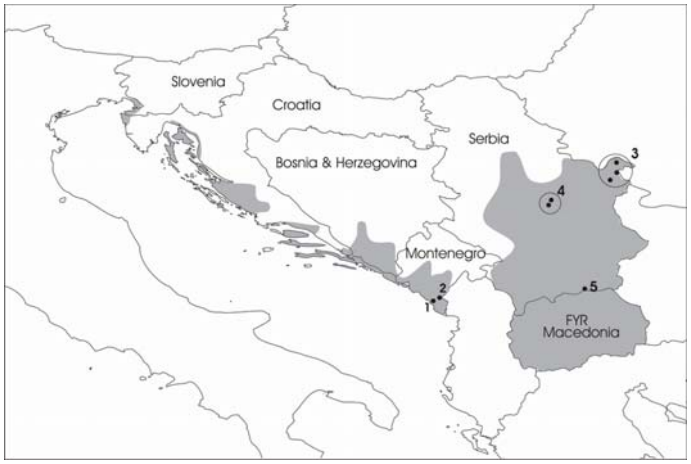

Figure 1. Map showing the distribution range of *T. hermanni* in the former Yugoslavia according to literature data and our unpublished records (shaded area). Numbers refer to sampling areas for the examination of CI. 1. Limljani; 2. Starčevo island; 3. Eastern Serbia; 4. Central Serbia; 5. Southern Serbia.

al. 1984) and were excluded from analysis because of possible ontogenetic variation in morphology (Guyot & Devaux 1997). Since the size at maturity in *T. hermanni* varies substantially among different localities (Willemsen & Hailey 1999), individuals were classified as male or female rather than as subadult, adult male or adult female (see Willemsen & Hailey 2002).

Calculations of CI in the sample areas analysed were performed according to the standard procedures given in similar studies on land tortoises (e.g. Hailey 2000b, Willemsen & Hailey 2002, Willemsen et al. 2002). CI is expressed as log (M/M′), where M is observed mass, M′ is mass predicted from SCL, and M/M′ is relative mass. CI is equal to the residual from the regression of log M on log SCL. CI has a normal distribution. This property enables the further evaluation of interactions through the analysis of variance (ANOVA). In our analyses, CI was calculated using SCL, with the exception of the samples from Montenegro. For these samples, data on SCL were unavailable, and the MSCL was used instead. A CI value equal to zero means that M/M′=1 or 100%, whereas a negative CI value indicates that M is lower than M′. A value of M/M′ less than (approximately) 80% indicates poor condition (Hailey 2000b, Willemsen et al. 2002). Variation in CI between species and sexes was analysed using ANOVA. Comparison of a sample mean with an expected value (e.g., CI=0, corresponding to a mean M equal to M′) was performed by using single-sample *t*-tests. The seasonal variation of CI in *T. hermanni* is of relatively small amplitude compared to the overall variation in CI (Willemsen & Hailey 2002). The difference between the highest and lowest monthly means of CI is approximately 0.05, with ranges of 0.005 (females) and 0.02 (males) between June and July. Therefore, we trust that inspection of tortoises in different locations in June and July in our study would not have influenced the results of the analyses of CI.

All statistical analyses were performed using the computer package Statistica® (STATISTICA for Windows. StatSoft, Inc., Tulsa, OK), considering a significance level of alpha = 0.05.

Results

Tortoise trade

According to the international trade records of the Federal Statistical Office, a total of 2,615 tonnes of tortoises were exported from the former Yugoslavia within a 41-year period during the 20th century. This total is the equivalent of about 2 million specimens. Exports before WWII were relatively modest and were most often expressed in hundreds of kilograms. Exports then increased significantly from the mid-1950s onwards and reached a value of more than 80 tonnes per year in the 1960s. Tortoise exports had peaked by the beginning of the 1970s. The greatest yearly value recorded for tortoise exports was 236 t (approximately 193 thousand specimens) in 1972 (Fig. 2). During the 1980s, exports fell consistently from year to year and finally ended in 1987, according to official records. The tortoises were exported to 20 countries: Federal Republic of Germany, German Democratic Republic, Hungary, Italy, Czechoslovakia, Belgium, Luxembourg, Greece, France, Austria, Denmark, Switzerland, Great Britain, Netherlands,

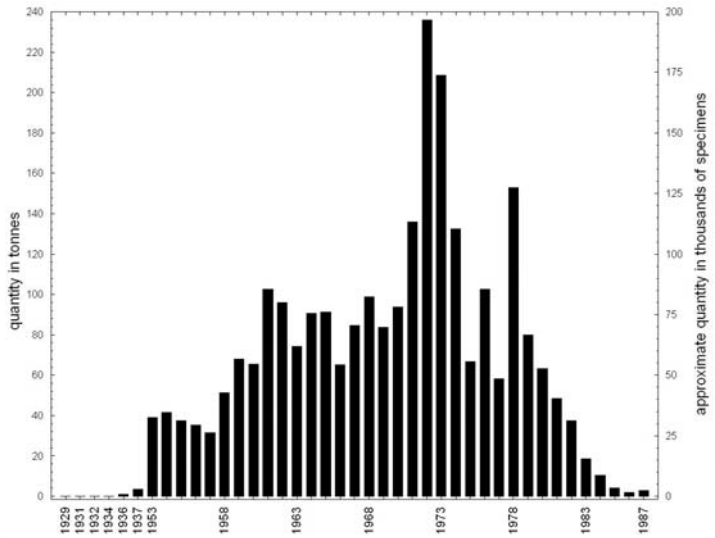

Figure 2. Annual tortoise exports from the former Yugoslavia in tonnes and in thousands of specimens (based on an average tortoise mass of 1,221 g), according to the Federal Statistical Office's international trade records.

Sweden, Norway, Finland, United States of America, Guiana, and Spain. The biggest importers were Federal Republic of Germany, Italy, Belgium, Luxembourg and Great Britain. These countries accounted for 77% of the total exports (Fig. 3).

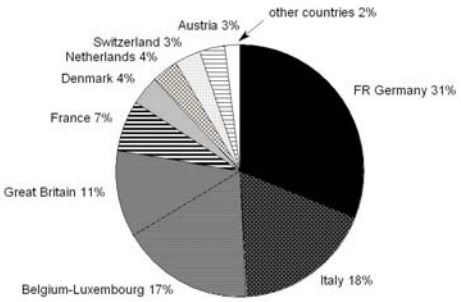

Figure 3. The quantity of tortoises exported from the former Yugoslavia during the 20th century, according to the Federal Statistical Office's international trade records, presented as the percentages of the total exports accounted for by the importing countries.

According to CITES data, during the 22 years of recorded tortoise exports from 1975 through 2009, a total of 306 thousand specimens were exported from the former Yugoslavia and subsequent countries. The highest number of exports, 107.8 thousand specimens, was recorded in 1978 (Fig. 4). The tortoises were exported to 10 countries: Federal Republic of Germany, German Democratic Republic, Austria, Denmark, Switzerland, Great Britain, United States of America, Hungary, Czech Republic and Slovenia. The largest importers, the Federal Republic of Germany and Great Britain, accounted for 69% of the total exports (Fig. 5). *T. hermanni* was the most frequent species represented (52% of the total). Of this species, the largest share of exports went to Great Britain (60%). *T. graeca* represented 34% of all tortoises exported. The highest percentage of exports of this species went to Federal Republic of Germany (72%). Unidentified specimens (*Testudo* sp.) represented 14% of the total exports. Most of these specimens (91%) were exported to Germany. *T. marginata* represented less than 0.05% of the total exports (Fig. 4).

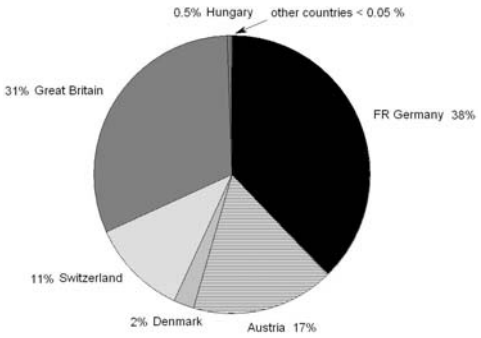

Figure 5. The quantity of tortoises exported from the former Yugoslavia from 1975, according to the CITES database, presented as the percentages of the total exports accounted for by the importing countries.

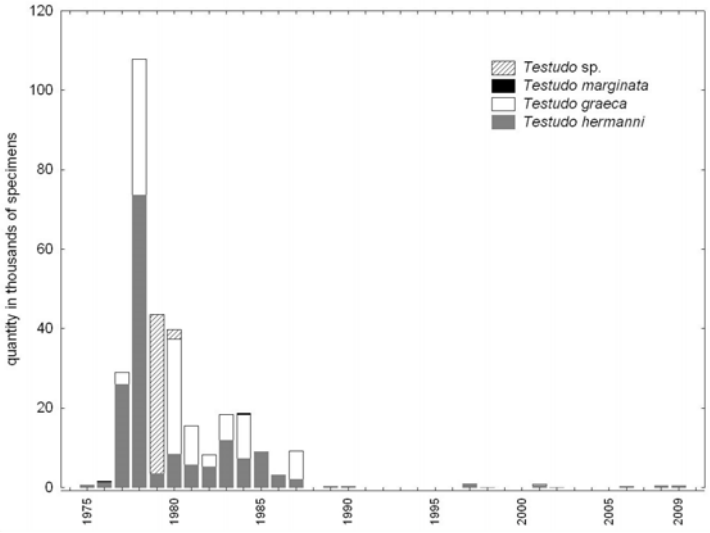

Figure 4. Annual exports of tortoise species from the former Yugoslavia in numbers of specimens, according to the CITES database.

Body condition

Parameters of condition in males and females of the five analysed sample areas of *T. hermanni* from the Central Balkans are presented in Table 1. The ANOVA procedure, with CI as the dependent variable and with population, sex and population × sex interaction as factors, revealed statistically insignificant variation in CI between populations and sexes, despite the fact that CI was calculated using the MSCL measure in Montenegrin samples: ANOVA, $F = 0.05$, df = 4, df error = 108, $p = 0.96$ (factor locality); $F = 0.09$, df = 1, df error = 108, $p = 0.76$ (factor sex) and $F = 0.19$, df = 4, df error = 108, $p = 0.94$ (sex × locality interaction). These results allowed us to present the frequency distribution of CI based on a pooled sample from both states (Fig. 6). The mean CI in the pooled sample did not differ significantly from 0 (t = 0.41, $p = 0.68$), and the mean relative mass was 100.79% (N = 118).

Discussion

Historical review of the tortoise trade in the Former Yugoslavia

The data analysed and presented here cover the period from 1929 on, for which systematic records are available. However, exploitation of the abundance of tortoises found throughout the territories of the former Yugoslavia has been recorded in earlier literature dating from the XVIII century (Marsigli 1726, Taube 1777/78). The Slavs in the region of the former Yugoslavia used tortoises in traditional medicine (Pelagić 1905), but they never used tortoises as a food source (e.g., Tomić 1907). However, records exist of translocation of tortoises along the Adriatic coast and to the northwestern parts of the Balkans by Catholic monks and gentry who occasionally used the animals for food (Tome 1996, Krofel et al. 2009). Nevertheless, the tortoises would have never been overexploited in this area if they had not become profitable export commodities. Subsequent recommendations encouraged local populations to expand their trade in tortoises (Biasoletto 1841), and other records document large numbers of traders from Europe who were buying tortoises and their shells in this area (Boué, 1840; Gaston 1960, Milunović 2005). In the Kingdom of Serbia, statistical records of tortoises as an article of export appeared as early as the end of the XIX century (year 1894), but the actual quantities exported could not be assessed because tortoise exports were recorded under joint tariff headings (e.g., "fish, crabs, snails, tortoises and shells; salted or dried fish; leeches"), and because records for some years are lacking. In part, this problem continued after WWII in the former Yugoslavia. For example, in the period from 1947 through 1952, goods under the tariff item "snails, tortoises and other crustaceans" were occasionally exported in quantities exceeding 100 tonnes per year to ten countries. It is quite certain that tortoises were exported during that period (Gaston 1960), especially to countries such as Germany, Belgium, Denmark and Switzerland. These countries were recorded as importers after tortoise exports were placed under separate tariff codes. The export of 15.5 tons of tortoise shells to Germany in 1963, according to official records of the Federal Statistical Office, is also noteworthy. The consolidation of the export trade after WWII resulted in an overharvesting of thousands of specimens per year.

Within the period for which comparative data are available (from 1975 onwards), comparison of tortoise exports as recorded by the Federal Statistical Office and from the CITES database shows similar fluctuating trends. During this period, large quantities of tortoises were exported exclusively for commercial purposes, whereas only a few specimens were exported for scientific and other purposes (according to CITES). However, the export volume decreased sharply in the 1980s, after the European Union had imposed restrictions. Smaller quantities of tortoises exported in the last two decades after disintegration of the former Yugoslavia are found in the CITES database but not in Federal statistical records (Serbia and Montenegro). These exports mainly represent illegal transactions.

Discrepancies in national and international trade data

The quantities exported, the importing countries and the relative representation of these countries in the total export trade are recorded very differently in the above two databases. Although Federal statistical records do not identify the tortoise species exported, they are far more precise regarding the exported quantities and the importing countries. For example, large importers such as Italy or Belgium-Luxembourg do not exist in the CITES database. For this reason, the percentages of participation for some of the importing countries are recorded differently in these two sources. For example, according to the CITES database,

Table 1. Parameters of condition in *Testudo hermanni* from the Central Balkans (Serbia and Montenegro) measured by the condition index (CI = log M/M´) and relative body mass (M/M´). CI was calculated on the basis of SCL for Serbian samples and MSCL for Montenegrin samples. N- sample size, SD- standard deviation.

Locality	sex	N	CI					
			mean	±	SD	range		
Limljani	males	8	0.00698	±	0.06391	-0.06657	-	0.13322
	females	21	0.00227	±	0.03597	-0.05420	-	0.11340
Starčevo island	males	7	-0.00007	±	0.03852	-0.03629	-	0.06264
	females	9	0.00332	±	0.03492	-0.05830	-	0.05891
Eastern Serbia	males	16	-0.00559	±	0.04003	-0.09793	-	0.06431
	females	18	0.00771	±	0.06206	-0.08135	-	0.21817
Central Serbia	males	11	-0.00001	±	0.02440	-0.04540	-	0.03859
	females	9	-0.00054	±	0.02164	-0.01962	-	0.04230
Southern Serbia	males	10	-0.00033	±	0.03107	-0.07465	-	0.04868
	females	9	0.00050	±	0.01894	-0.03138	-	0.02233
all groups		118	0.00151	±	0.03985	-0.09793	-	0.21817

Locality	sex	N	Relative Body Mass					
			mean	±	SD	range		
Limljani	males	8	1.02624	±	0.15990	0.85789	-	1.35901
	females	21	1.00863	±	0.08779	0.88266	-	1.29837
Starčevo island	males	7	1.00330	±	0.09172	0.91983	-	1.15514
	females	9	1.01055	±	0.08046	0.87438	-	1.14528
Eastern Serbia	males	16	0.99111	±	0.08989	0.79812	-	1.15960
	females	18	1.02884	±	0.17268	0.82918	-	1.65263
Central Serbia	males	11	1.00141	±	0.05617	0.90074	-	1.09294
	females	9	0.99987	±	0.05110	0.95582	-	1.10229
Southern Serbia	males	10	1.00150	±	0.06922	0.84208	-	1.11862
	females	9	1.00199	±	0.04317	0.93028	-	1.05277
all groups		118	1.00791	±	0.10090	0.79812	-	1.65263

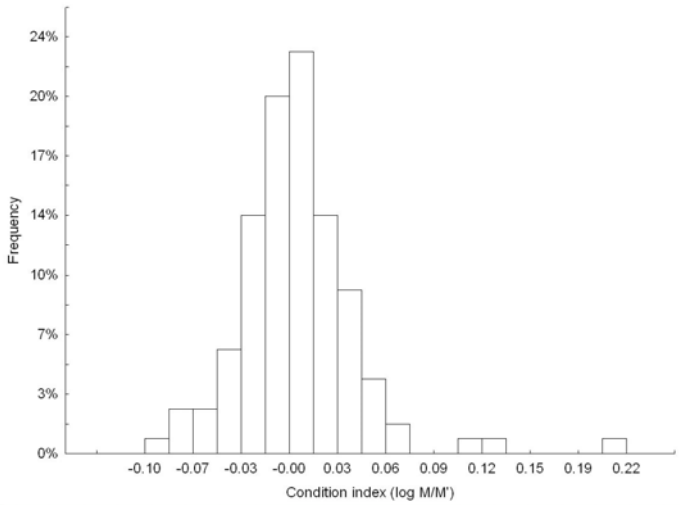

Figure 6. Frequency distributions of the condition index in *T. hermanni* from Serbia and Montenegro.

Great Britain accounted for 31% of the total imports since the year 1975. However, the percentage for Great Britain according to the international trade statistics of the former Yugoslavia is 9% for that period. Also, according to CITES, Yugoslavia was recorded as an exporter of *T. marginata*. However, no evidence is available to support the occurrence of *T. marginata* on the territory of the former

Yugoslavia. Similar discrepancies in exported and imported quantities could be identified by comparing official Federal records for particular years with the information in Blatt & Müller (1974), Honegger (1981) and Vetter (2006).

Many mismatches in reporting between the official Yugoslav database and/or the CITES database and databases of importing countries, as well as the unknown quantities resulting from illegal trade, make it likely that the amounts reported are underestimates of the total trade in tortoises that occurred on the territory of the former Yugoslavia.

The impact of harvest on the tortoise populations

According to the CI values found in this study, the tortoises examined from Serbia and Montenegro appeared to be in good health. This result might indicate that overharvesting in the past reduced population densities and thereby produced a greater per-animal abundance of food. Specimens under market size would benefit from this increase in food abundance, and their enhanced access to food would result in improved body condition later in life. Effects of this sort are known from some harvested populations of chelonians and other animals (Behrens Yamada & Peters 1988, Bjorndal et al. 2000, Seminoff et al. 2003, Gamble & Simons 2004, Fordham et al. 2007). However, the current populations are probably below the level at which further decline would stimulate compensatory density-dependent responses. We observed the decreasing number of adult specimens and absence of tortoises from areas suitable for them according to habitat characteristics, as already recorded for Romanian populations (Rozylowicz & Dobre 2010). It was shown that density-dependent processes induced by habitat fragmentation could change demography and life history parameters in tortoise populations in less than twenty years (Aponte et al. 2003).

No significant geographic variation in the condition of the tortoises was found, which may indicate similar harvesting pressure in coastal (Montenegro) and inland populations (Serbia). Although we cannot determine export quantities per republic or particular area from databases that cover the former Yugoslavia as a whole, we found several references that confirmed the collection and export of specimens from the Adriatic coast of the former Yugoslavia (Gaston 1960, Bennett 1978), or that documented declines in these tortoise populations during the XX century (Krpan 1962, Meek 1985, Vetter 2006). Of course, such information does not necessarily indicate that these regions made a greater contribution to tortoise exports than did more inland areas such as Serbia and FYR Macedonia. However, according to the analyses of Hailey & Willemsen (2003), and judging from the evidently smaller body size of tortoises from the Adriatic populations (Meek & Inskeep 1981, Meek 1985, 1989, authors unpublished data), coastal populations could be more threatened than those located inland.

Furthermore, it should be noted that although our analysis of body condition does not address the spur-thighed tortoise, the significant volume of specimens of this species exported by the former Yugoslavia (according to CITES) probably influenced the peripheral populations of this species occurring in FYR Macedonia and southern Serbia. Peripheral populations can have a high adaptive significance for the species as a whole (Scudder 1989, Lesica & Allendorf 1995). These populations could be particularly important because they can enable the species to survive in changing environments.

We propose that the usage of CI in evaluating the effects of tortoise harvesting should be accompanied by analysis of demographic parameters. This is needed due to density independence of the CI in some circumstances (Willemsen et al. 2002), and the complex influence of factors that regulate CI in animals (reviewed in Stevenson & Woods 2006). Therefore, at the moment, it is difficult to differentiate between local effects and long-term changes in factors affecting the condition of the populations examined.

Current tortoise trade, farming and conservation implications

Despite the fact that the tortoise trade decreased greatly following the implementation of CITES in the 1980s and the adoption of wildlife trade regulations throughout the EU, *T. hermanni* continued to be one of the most popular reptiles imported by the EU and the acceding states during the past decade (Theile et al. 2004).

T. hermanni are considered to be of allochthonous origin in Slovenia, an EU member (Tome 1996, Dovč et al. 2005, Krofel et al. 2009). Slovenia is a leader in the export of captive-bred specimens (Bolješič 2002, Dovč et al. 2005, Türkozan et al. 2008). However, the countries of Serbia, Croatia, Montenegro and FYR Macedonia are the major participants in the illegal tortoise trade (Theile et al. 2004, Kecse-Nagy et al. 2006). This fact is not

surprising, in view of the weakness of the control measures currently in place for the common borders of the former Yugoslav republics, and in view of the fact that historically, the territories of these countries have represented fruitful areas for the harvest of tortoises. Although commercial tortoise farming has been suggested as a way to reduce the collection of specimens from the wild (Hailey 2000c), Türkozan et al. (2008) showed that the trade in wild *Testudo* specimens did not decrease as the trade in captive-bred specimens expanded. According to our records and literature (e.g., Dovč et al. 2005), registered or illegal tortoise farms currently exist in Serbia, FYR Macedonia, Slovenia and Croatia. Inappropriate husbandry of tortoises (Philippen 2007), limits on importation of small specimens and the resulting trade in larger adult animals from wild sources (Türkozan et al. 2008), and the possibility that legal specimens that have been registered can be replaced by illegally obtained specimens (Theile et al. 2004), have led us to share deep scepticism with Vinke & Vinke (2010) concerning the usefulness of commercial tortoise farms. On the other hand, current ethical and economic/political considerations exclude the possibility of the sustainable harvest of wild tortoises in the Balkan states. According to Hailey's analysis (2000c), such a sustainable harvest could be possible only if the harvest is tightly regulated and the population is protected from other sources of mortality.

For the sake of conservation and protection of the land tortoises in the region of the former Yugoslavia it is necessary to establish adequate regulations in all former republics and to ensure the effective application of both national and international laws. It is also needed to enhance public awareness of issues related to conservation of tortoises, and to further research demographic parameters of their populations. In attempts to recover declining populations by reintroduction programmes, the standard protocols should be carefully planned and modified on a case-by-case basis (Longepierre et al., 2003; Bertolero et al., 2007). Instead of that preventing of further habitat loss and saving the species in *in-situ* environment is suggested (Hailey and Willemsen, 2003; Longepierre et al., 2003).

Conclusions

Our study reveals that the official, massive export of *Testudo* species from the territory of the former Yugoslavia during the XX century was much larger than previously reported (e.g., Lambert 1979, Honegger 1981, Türkozan et al. 2008). This was probably one of the main reasons for a significant decline in population densities as revealed through the values of CI. Although the harvesting pressure is now much smaller due to implementation of national and international nature protection laws, there are still significant threats to tortoise populations produced by other harmful human actions such as habitat destruction. Whether their population growth parameters are sufficient to cope with the threats that these tortoise populations currently face is yet to be investigated. We consider that our study could serve as a basis for further scientific studies and as a useful guide in matters relating to protection and conservation.

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