

BODY MEASUREMENTS AND HARVESTING DYNAMICS OF  
THE FAT DORMOUSE (*GLIS GLIS* L.) IN THE MOUNTAINOUS  
PART OF CROATIA

GRUBEŠIĆ, M., KRAPINEC, K., GLAVAŠ, M. and MARGALETIĆ, J.

*University of Zagreb, Faculty of Forestry  
Department of Forest Protection and Wildlife Management, Zagreb, Croatia  
E-mail: krapinec@sumfak.hr*

The paper discusses research results related to dormice hunting in three municipalities in Gorski Kotar between 1991 and 2001. The body mass, total body length, tail length and body length of dormice from two localities (Vrbovsko and Gerovo) were compared. Data on the harvest show that harvest culminates almost every fourth year, but also that there are years without any harvest. In comparison with dormice from Gerovo, those from Vrbovsko exhibit significantly higher values for all body parameters. The number of caught adult and juvenile dormice from the area of Vrbovsko shows a significantly stronger positive correlation with the days of hunting than the dormice caught in the area of Gerovo. Whereas juvenile dormice from Gerovo show a weak but positive correlation ( $r = 0.30$ ,  $p \leq 0.01$ ) and adult dormice show a negative correlation ( $r = -0.31$ ,  $p < 0.01$ ) with the days of hunting. It means that the closer the hibernation period, the lower the body mass of caught adult dormice is. In the locality of Vrbovsko, the culmination in the number of juvenile dormice occurred on 26 October and of adult dormice on 17 October. The harvest of adult specimens from the area of Gerovo culminated on 14 October and of young animals on 23 September. Since the juvenile animals caught in the second part of September had an average mass of  $96 \pm 15$  g and accounted for about 40% of the harvest, the beginning of the hunting season should be postponed from 16 September to 1 October.

Key words: fat dormouse, harvest, body mass, total body length, body length, tail length

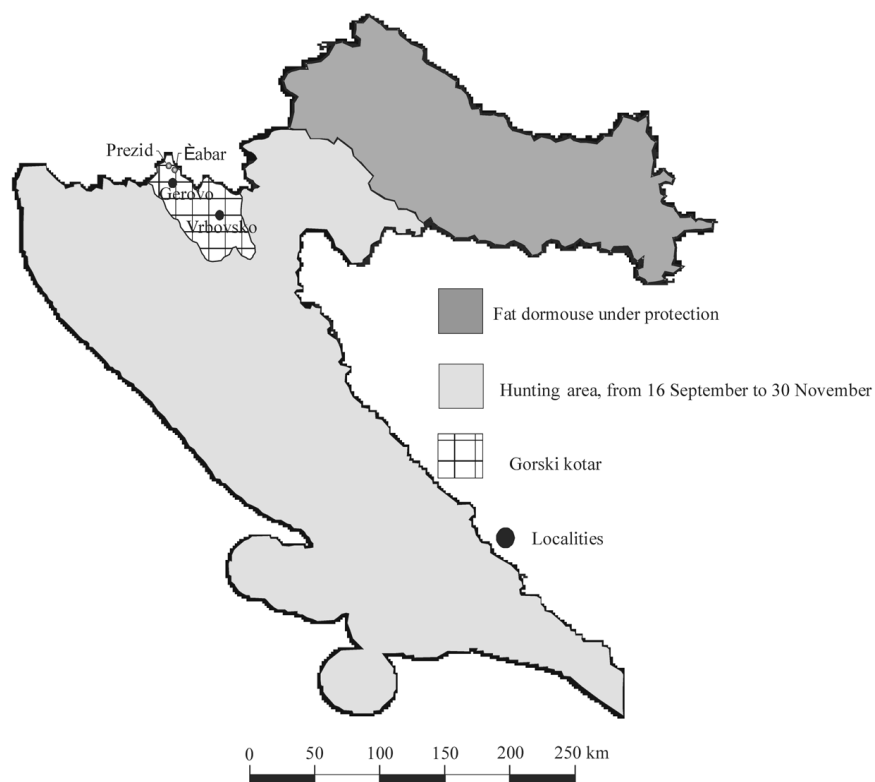
## INTRODUCTION

The fat dormouse (*Glis glis* L.) is distributed over the whole territory of the Republic of Croatia. One of the reasons for such a wide distribution lies in the fact that forests in Croatia cover about 40% of its territory. According to some authors, the principal cause of the disappearance of the fat dormouse from some regions in Europe can be attributed to unorganised logging and poor forest management (JURCZYSCZYN & WOLK 1998), although the real cause is still unknown. This is why the fat dormouse is protected almost in all European countries. Moreover, in some countries this species, has been included in the red book of threatened species. Past research shows that this species in Croatia has been less well investigated north of the river Sava, which has led to its protection north of this river while south of the river it is freely hunted (Fig. 1). The regulation on the closed season

stipulates dormouse hunting with special dormice traps supplied with natural bait from 16 September to 30 November. A permit is needed for dormouse hunting, which is issued by the hunting concession holder in a hunting ground, or the hunting ground owner.

Croatia is a country with diverse habitat conditions supporting over 70 different forest communities (VUKELIĆ & RAUŠ 1998) stretching from the Pannonian hilly and mountainous regions to the Croatian Mediterranean. The majority of dormouse species prefer woodland habitats and they are present in larger or smaller numbers in every forest community in Croatia (TVRTKOVIĆ *et al.* 1995), except for the common dormouse (*Muscardinus avellanarius* L.), which has the broadest ecological niche (BAKÓ *et al.* 1998).

Some records of the history of dormice hunting in the area of Čabar mention the fact that dormice have been hunted since the first settlers came into the area at the time of the Dukes of Krk, the Frankopans, when they cleared the forests and



**Fig. 1.** The area of protection, permitted hunting and research of the fat dormouse (*Glis glis* L.) in Croatia

colonised this exceptionally rich woodland area. At that time dormice hunting was not only a custom and an entertainment, but also a necessity. Skinned and salted dormouse meat was put into wooden containers and kept in cold rooms to ensure “food of the Gods” (*deorum cibus*) in long snowy winters.

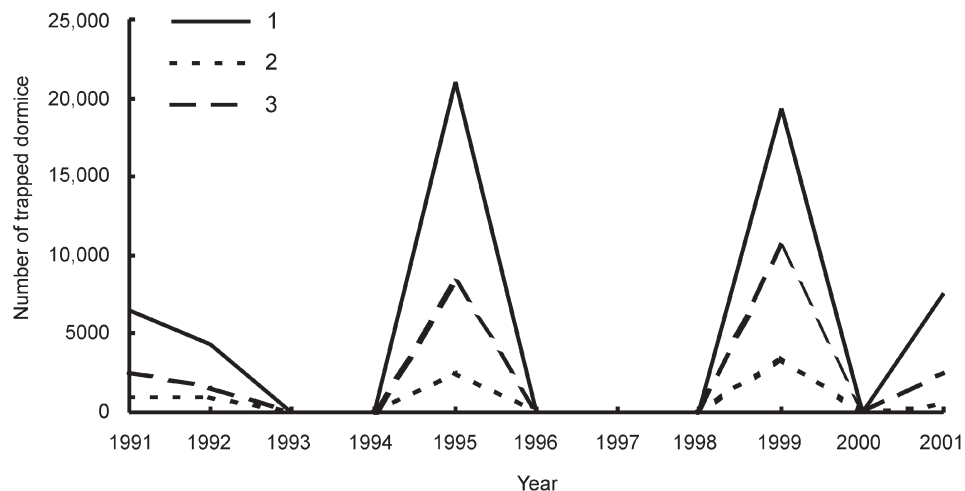
However, there is a few data about body parameters and age structure of harvested dormice in Croatia. In the present paper we analyse harvesting dynamics, data of body parameters, age structure and catchability of trapped fat dormice during autumn 1994 and 1999 from two localities in Gorski Kotar in order to obtain basic population dynamic parameters for ecological hunting management.

## MATERIAL AND METHODS

Research was conducted in the area of Gorski Kotar (Fig. 1). The average annual air temperature in the study area is 10.2°C, but in winter it might drop to –32°C. The average annual precipitation quantity amounts to 2,486 mm, with the main maximum in November (279 mm) and the secondary in April (183 mm).

The following forest communities are represented in the study area: *Seslerio-Ostryetum sorbetosum* HT., *Fagetum montanum croaticum* HT., *Helleboro-Fagetum*, *Fagetum croaticum abietetosum* HT., *Luzulo-Fagetum sylvaticae* MAUSEL, *Blechno-Abietetum typicum* HT., *Blechno-Fagetum sylvaticae* HT., *Lamio orvale-Fagetum sylvaticae* HT., *Ostryo-Fagetum sylvaticae* WRABER, *Erico-Ostryetum* HT. However, hunting was done only in a beech and beech-fir forest.

The study of the fluctuations in the fat dormouse population was based on the data on dormice harvest. The contingent of caught dormice for the period from 1991 to 2001 was calculated on the ba-



**Fig. 2.** Trends in harvesting the fat dormouse (*Glis glis* L.) in the municipalities of Gerovo (1), Tršće (2) and Prezid (3) between 1991 and 2001

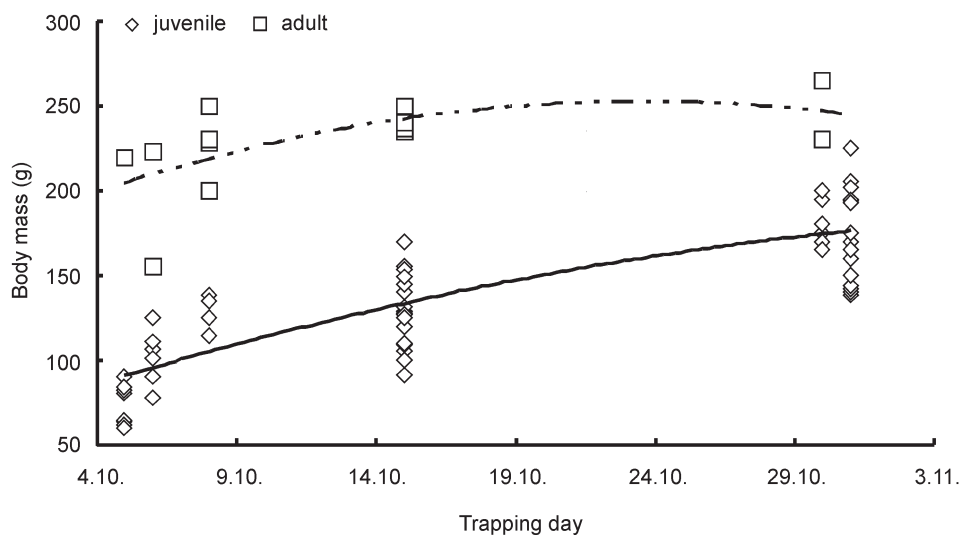
**Table 1.** T-test for the parameters of body mass, total body length, body length and tail length for adult specimens of the fat dormouse (*Glis glis* L.) in the localities Vrbovsko (n = 13) and Gerovo (n = 64). \*: p < 0.001

Parameters	Body mass (g)		Total body length (mm)		Body length (mm)		Tail length (mm)	
	Vrbovsko	Gerovo	Vrbovsko	Gerovo	Vrbovsko	Gerovo	Vrbovsko	Gerovo
Mean	228	134	360	296	189	169	171	127
SD	27.1	24.3	7.5	15.9	7.0	10.1	5.8	12.6
Min	155	114	345	236	180	150	160	76
Max	265	233	370	331	200	154	200	200
t	11.5*		22.1*		8.7*		19.3*	

sis of the issued dormice hunting permits. The permit is generally issued in the name of the dormouse hunter, is valid for the current hunting year, and contains the number of caught dormice by dates and localities. Since dormouse hunting is the most intensive in the area of the three forest offices (Prezid, Gerovo and Čabar), the data on eleven-year harvest trends have been collected for only these three places.

In order to compare morphometric parameters, dormice were caught in two localities and in different years. In the locality of Vrbovsko, they were caught for five days, from 5 to 31 October 1994, and in the locality of Gerovo for 21 days, from 23 September to 31 October 1999. In Vrbovsko area 40 dormice traps were placed every day, and in Gerovo area 80 traps were set up.

Dormice were caught with traps typically used in this part of Gorski Kotar. The traps were not selective and were in the form of wooden boxes sized 20 × 10 × 10 cm.



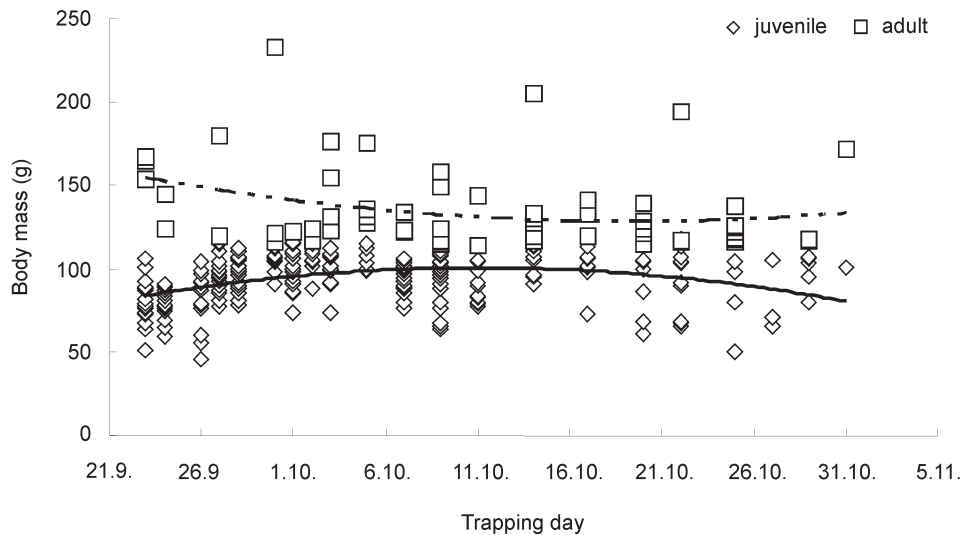
**Fig. 3.** Correlation between the body mass of caught fat dormice (*Glis glis* L.) and the days of hunting for the locality of Vrbovsko during the autumn of 1994

**Table 2.** T-test for the parameters of body mass, total body length, body length and tail length for juvenile specimens of the fat dormouse (*Glis glis* L.) in the localities Vrbovsko (n = 67) and Gerovo (n = 247). \*: p < 0.001

Parameters	Body mass (g)		Total body length (mm)		Body length (mm)		Tail length (mm)	
	Vrbovsko	Gerovo	Vrbovsko	Gerovo	Vrbovsko	Gerovo	Vrbovsko	Gerovo
Mean	138	94	319	274	168	154	151	120
SD	40.0	14.9	17.6	18.6	9.8	10.2	13.6	11.5
Min	60	46	260	203	145	124	113	77
Max	225	118	365	321	190	186	180	141
t	9.8*		18.4*		10.1*		16.9*	

As a rule, one trap was placed on one tree, and if the tree was very branchy and forked, two traps were set up 1 to 5 m from the ground. The bait included apples, pears, sweet chestnuts and walnuts. The traps were set up late in the afternoon (depending on the quantity of traps). The next morning or during the next day the catch was checked. The age of the caught dormice was determined on the basis of their fur colour. They were subsequently classified into adult and juvenile individuals. The classification method used is typical for dormice hunting – the dormice that had hibernated through at least one winter were classified into the adult group. The overall body length and the tail length were measured with a steel metal tape, and the dormice were weighted to the gram.

The obtained morphometric indicators were next used to detect differences between the dormice population from Gerovo and that from Vrbovsko. Two-sided t-test was used to examine the dif-



**Fig. 4.** Correlation between the body mass of caught fat dormice (*Glis glis* L.) and the days of hunting for the locality of Gerovo during the autumn of 1999

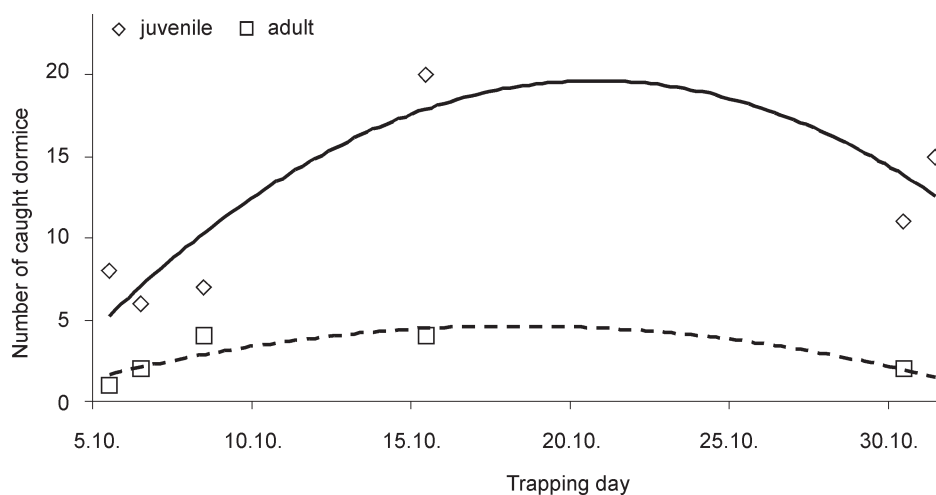
ference. In order to obtain trends in the mass during the hunting period, regression was made with a square function between the body mass and the day of hunting (BART *et al.* 1998).

## RESULTS

In the period from 1991 to 2001 a total of 92,495 specimens of the fat dormouse were caught in the municipalities of Prezid, Gerovo and Tršće (Fig. 2). The annual harvesting contingent ranged from 0 to 33,395 individuals (the year 1999). As for the quantity of the catch, the majority of the animals were caught in the area of Gerovo (58,698 animals), and the annual harvesting quantity ranged from 0 to 21,046 animals. The area of Prezid took the second place with 25,288 animals caught in the eleven-year period and the annual quantity from 0 to 10,578 individuals. The lowest number of dormice was caught in the area of Tršće (8,509 animals) with the annual quantity from 0 to 3,503 animals. Figure 2 illustrates that the hunting dynamics culminated approximately every four years.

During 1994, a total of 80 dormice were caught in the Vrbovsko area, of which 67 (84%) were juvenile and 13 (16%) were adult, while in the locality of Gerovo, 311 dormice in all were caught, of which 247 (70%) were juvenile and 64 (21%) were adult.

Both juvenile and adult dormice from the area of Vrbovsko had larger dimensions than those from the area of Gerovo (Table 1). Adult dormice from the

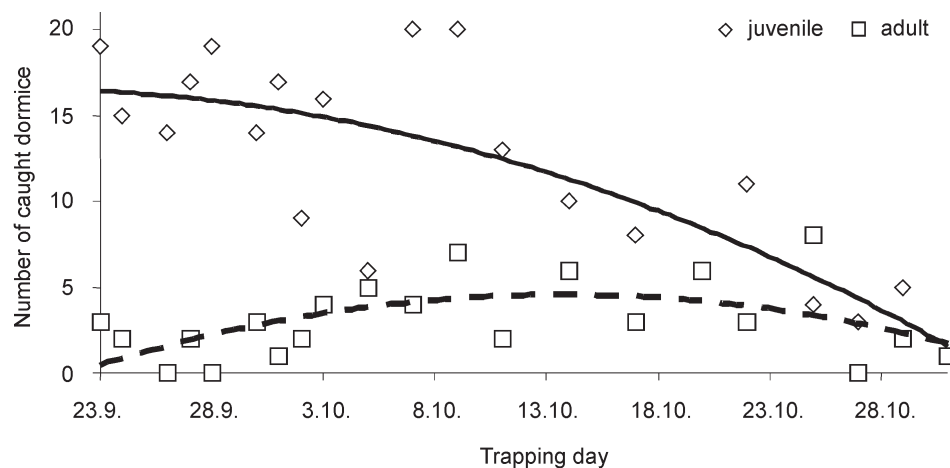


**Fig. 5.** Correlation between the number of caught fat dormice (*Glis glis* L.) and the days in the hunting season for the locality of Vrbovsko during the autumn of 1994

Vrbovsko area were almost twice as heavy as their counterparts from Gerovo. On average, the total body length of adult dormice from the Vrbovsko area was 6.4 cm longer, the body length was 2 cm longer and the tails were 4.4 cm longer in comparison with the same traits in the dormice from Gerovo. With reference to the total body length, body length and tail length, the dormice from the Gerovo area showed higher variability. Young dormice from the Vrbovsko area were on the average 44 grams heavier and 4.5 cm longer, with bodies longer by 1.4 cm and tails longer by 3.1 cm on the average (Table 2). Young dormice from the Vrbovsko area showed exceptionally high variability in terms of body mass, while other parameters did not show any major differences in the variability.

Adult and juvenile dormice from Vrbovsko (Fig. 3) showed a much stronger positive correlation with the days of hunting ( $r = 0.86$ ,  $p < 0.01$  adult and  $r = 0.55$ ,  $p < 0.01$  juvenile) than the dormice from Gerovo (Fig. 4). Young dormice from the Gerovo area showed positive correlation ( $r = 0.30$ ,  $p \leq 0.01$ ) with the hunting days, adult dormice showed negative correlation ( $r = -0.31$ ,  $p < 0.01$ ).

Figures 5 and 6 give a good insight into the trend of dormice catchability during the hunting season. If the daily yield is expressed as the dependence on the hunting season, it is clear that there are still differences between the studied localities. In the locality of Vrbovsko there is a high correlation between the time of hunting and the number of caught individuals. For juvenile and adult dormice it amounts to  $r = 0.86$  ( $p < 0.01$ ). The correlation curve in adult dormice shows a significantly higher, almost regular, symmetry. The culmination in the number of caught juvenile dormice is on 26 October and in the number of adult dormice on 17



**Fig. 6.** Correlation between the number of caught fat dormice (*Glis glis* L.) and the days in the hunting season for the locality of Gerovo during the autumn of 1999

October approximately. After that the number of caught dormice declines, but the number of juvenile dormice is higher at the end of the hunting season than at the beginning. Adult dormice from the area of Gerovo show a similar regular curve of harvest correlation with the days of the hunting season. However, young dormice show a declining harvest trend as the hunting season moves to a close. The culmination of the harvested adult individuals occurs on 14 October and of the juvenile ones on 23 September. In terms of the summary harvest quantity it can be noted that the number of caught dormice falls as the hunting season approaches the end.

## DISCUSSION

Like the majority of rodents, the fat dormouse does not appear in equal numbers every year. The mechanisms determining its population fluctuation have yet to be explained. The dormice hunters from Gorski Kotar know that the probability of dormice occurrence is strongly dependent on the mast of beech. On average ample beechnut crop occurs every four years, so that such a year is popularly called a "dormouse year". In these years the quantity of dormice is so high that they gather into large groups and move to other habitats, inflicting considerable damage on trees, on spruce (*Picea abies* (L.) KARST) in particular, but they also harm orchards and fruit storages in households. The correlation between the quantity of fat dormice and the yield of heavy forest seeds has been confirmed by a number of authors, including BIEBER (1997, 1998). She monitored the fat dormouse in Germany and found that the absence of reproduction in a current year coincided with the absence of beech (*Fagus sylvatica*) flowering in the spring of that same year. In forecasting the occurrence of dormice, hunters as a rule inspect forests in the spring and check the quantity of flower buds. If the flowering percentage is low, they know that the year will be very poor in dormice or there will be no dormice at all.

In the observed period, there were only five years with a more or less good beech mast in the area of Gerovo, when a high number of dormice were caught. These were the years 1991, 1992, 1995, 1999, and 2001. The years without beech mast were 1993, 1994, 1996–1998 and 2000. Accordingly, in the past eleven years the number of dormice-less years exceeded that of dormice years; it was also found that the thesis on the four-year period of beech mast is incorrect. The problem is that in recent time beech has not produced mast every year (HILTON & PACKHAM 1997). With regard to heavy forest seed, which is the crucial source of concentrated dormice food in this region, the food range for dormice is very narrow, with the exception of beechnut. However, in other parts of Croatia (in the zones where



dormice are protected) there are many stands of different oak species (*Quercus robur*, *Q. petraea*, *Q. cerris*, *Q. pubescens*) but also sweet chestnut (*Castanea sativa*); yet, the dormouse does not occur in such high numbers as in Gorski Kotar. It should be borne in mind that the inhabitant – forest ratio in Croatia is 1 : 0.5, and that only 5% of the forests in Croatia are forest cultures and plantations. Accordingly, if it is true that dormice (all four species) do not appear in forest-free areas (PILASTRO 1992), then Croatia should abound in these species. Obviously, the amount of forests is only one in a series of factors responsible for habitat conditions favoured by dormice. North of the river Sava in Croatia dormice are mainly found next to cottages in vineyards, which are not always in the vicinity of forests. Vineyard owners often complain that dormice cause damage in their cottages by gnawing on fruit or furniture (KRAPINEC, pers. comm.). Other factors are still being investigated. Also, the presence of dormice in Gorski Kotar despite their being hunted only confirms the thesis that hunting does not affect its occurrence.

Although forest management in Croatia is for the most part extensive, PRELAC (1996) claims that the number of natural hollows is not decisive for the number of dormice. There is a trend in Europe today of setting up artificial hollows (nest boxes) not only for birds but also for dormice. According to SCHULZE (1970), a total of 1,200 artificial hollows were set up in the districts of Roßla Vorberge and Schwiederschwende, which were inhabited by birds in 70 to 80% of the cases. Some dormice hunters set up special artificial dormice nest boxes in order to catch them alive. Such artificial nest boxes are called “tivuc” and are 16 × 16 × 40 (50) cm in size. They used to be constructed of small round logs, but today they are made of small boards and do not attract unwanted guests. This kind of hunting is much better than trapping because young dormice may be set free and only the adults are taken.

During the autumn to the beginning of hibernation, dormice eat abundant quantities in order to gain on mass and survive the hibernation period. VOGEL and FREY (1995), VOGEL (1997) did research related to dormice hibernation. In five fat dormouse specimens caught during September and October they recorded masses of 68.2 to 133.0 g (105.4 g on average). These animals were kept in captivity and by the beginning of hibernation they had gained an average of 61.2% of the original mass (60.6 g). FREIHERR (1955) studied trends in the body mass of tagged fat dormice throughout the year and found that the loss of body mass during the winter hibernation varied. The same author concludes that the loss of body mass under certain conditions may amount to as much as 50%. This indicates the possibility that the significant differences in the mass and size of dormice between the localities Vrbovsko and Gerovo could be of trophic nature. In 1996, 1997 and 1998 there was no beech mast in Gerovo area and no dormice were hunted, which means that

three “hungry years” for the dormouse occurred in a row. The years 1993 and 1994 were the years of medium beech mast in the area of Vrbovsko, which probably resulted in higher nutritive potentials and indirectly, in larger body dimensions of dormice from Vrbovsko. It should be noted that BIBER (1998) obtained different body mass trends in the fat dormouse during the year when reproduction occurred and the year when reproduction was absent. The mass of adult males increased from spring towards autumn regardless of whether it was the reproduction year or the year in which reproduction did not occur. In contrast, adult females showed an average drop in the body mass in the reproduction year, while in the year with no reproduction their body mass increased from summer towards autumn.

Whereas data from the Gerovo area more or less coincide with those by BIBER (1997), it seems that dormice from Vrbovsko are somewhat larger. The same is true if body lengths and tail lengths are compared with the specimens of the fat dormouse caught in Hungary (BAKÓ *et al.* 1998). It is questionable whether such a difference is possible with regard to the fact that the localities of Vrbovsko and Gerovo are only 38 km apart as the crow flies. However, BIBER (1997) points out that in the year with poorer trophic conditions reproduction is absent and energy is saved, so that dormice have a larger mass.

The cause of mass increase in the dormice caught in the Vrbovsko area, or mass decrease in the dormice caught in the Gerovo area is not known. This phenomenon was explained with climatic effects and air temperatures. For this reason, data were taken for air temperatures from the two stations closest to the investigated areas. Data from the meteorological station Delnice (21 km from Vrbovsko) were taken for the Vrbovsko area, and data from the meteorological station Parg (near Gerovo) were taken for the Gerovo area. In the area of Vrbovsko air temperatures were lower in the second half of September 1994 than in the same period in 1999 in the area of Gerovo. The same drop in temperatures in Vrbovsko was also recorded in mid-October. However, from the second half of November, the air temperature was lower in Gerovo. Such trends in air temperatures in September and October in the Vrbovsko area probably prolonged the active period, or the nutrition period of adult dormice, so that they retired for hibernation later.

Dormice hunters are still debating what is the critical mass under which dormice should not be hunted, or if caught should be set free. Since dormice are still predominantly trapped by killing traps, the possibility of catching dormice that are too small is difficult to avoid. In Croatia there are discussions around postponing the dormice hunting season to the beginning of October (by law it begins on 16 September) as this might prevent catching juvenile specimens with inferior body mass. Juvenile individuals caught in the second half of September had an average mass  $96 \pm 15$  g and accounted for 40% of the catch in the Gerovo area. If the crite-

tion of dormice maturity is the arithmetic mean of dormice mass caught during September and reduced by one standard deviation, then the minimal mass would amount to 81 grams. Accordingly, in 29% of the juvenile dormice caught during September the mass was below 81 grams. The share of such dormice in October was only 14%. For this reason, hunting grounds concessionaries do not allow dormice hunting before the beginning of October. However, the question is whether juvenile dormice with such low masses may gather sufficient critical mass to survive the winter, or whether dormice hunters make selection of those specimens that are for genetic or some other reasons (later litter) inferior in relation to the population average.

In conclusion, although hunting dormice is a tradition in this area, there are still many unresolved issues whose solutions would contribute to good quality management of this species in terms of its preservation, but also of the preservation of the tradition. This relatively poor region of Croatia would reap economic benefits by including limited dormouse hunting among its tourist attractions. This would satisfy not only the protective but also the social component of natural resource management.

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Revised version received November 22, 2004, accepted November 26, 2004, published December 29, 2004