

## DISTURBANCES AND PREDATION ON CAPERCAILLIE AT LEKS IN ALPS AND DINARIC MOUNTAINS

### UZNEMIRAVANJE I PREDACIJA TETRIJEBA NA PJEVALIŠTIMA U ALPSKOM I DINARSKOM PROSTORU

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*ABSTRACT: Capercaillie (Tetrao urogallus L.) populations in central and south-east Europe cover fragmented edge habitats and are recorded to decline since 1960ies. Capercaillie leks in Slovenia are present at the south-eastern edge of the Alpine metapopulation and at north-western edge of Dinaric. These populations were monitored at leks in two periods in 1980 (466 monitored leks) and 2000 (599). All leks were monitored by local specialists (hunters and/or foresters) and main causes of observed lek populations decline were addressed to each endangered lek. Special emphasis was given to predation at leks, as suggested by D. Jenkins (2008). The six named reasons in 1980ies affected 39 leks with logging of old-growth forests (at 71.8% of leks) and construction of forest roads (7.7%) as most pronounced. In 2000 nine reasons affected 92 leks: (i) mountain tourism (26.1%), (ii) cutting of old-growth forests (19.60%), (iii) predators attacks (18.5%), (iv) forest management in spring time (9.8%), (v) pastures of livestock with wire fences in forests (6.5%), (vi and vii) berries picking and overgrowing the last pastures in forest-landscape, (viii) constructions of forest roads and (ix) infrastructure. The most profound change in reasons between 1980 and 2000 mapping data were: predation at leks, mountain tourism development, increasing of forest management in spring time, wild pasturage of cattle and sheep in forests, overgrowing the last pastures in forest-landscape. A comparison of the increasing percentage of leks endangered by predators since 1980 has shown positive correlations with increasing of the main predator populations' densities. Population density of martens (Martes sp.) and wild boar (Sus scrofa) increased for 150% since 1980, while red fox (Vulpes vulpes) density increased only after 1990. Our results confirmed the assessment of reasons for threats to leks based on descriptions and experiences of observers as a suitable approach for capercaillie habitat risk assessment. Results for past decline and differences regarding to the negative impacts on lek habitats are important guidelines for foresters and wildlife managers concerning sustainable forest management and maintenance of capercaillie populations.*

*Key words: Capercaillie (Tetrao urogallus), causes of leks endangerment, predation, mountain tourisms, forest and wildlife management, rare species population's conservation*

#### INTRODUCTION – Uvod

Capercaillie is a rare and endangered umbrella species of temperate and boreal forests in Europe (Suter

et al. 2002; Sachot et al. 2003; Angelstam 2004). Capercaillie population densities are declining continuously over the several last decades in Central Europe (Klaus and Bergmann 1994, Čas 2006). Several different habitat disturbances were recognised as cau-

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ses of capercaillie decline in their distribution area in temperate Europe (Klaus et al. 1997; Storch 1999, 2007; Saniga 2002, 2004; Thiel et al. 2007). Especially at the population edges disturbances led to a severe population reduction or to their complete destruction (Poolo et al. 2005, Quevedo et al. 2006; Blanco-Fontao et al. 2009). Similar trends were observed in temperate and in optimal boreal habitats. In boreal forests the fragmentation of habitats due to forest logging was recognised as the main cause of population decline (Rolstad and Wegge 1987; Beškarev et al. 1995; Kurki et al. 2000; Angelstam 2004; Graf et al. 2007).

Capercaillie habitat in Slovenia occupies the south-eastern edge of its distribution range in the Alps (90% of total habitat) and north-western edge in the Dinaric Mountains (south-east Europe) (10% of total habitat), connecting both large mountain regions (Adamič 1987; Čas 2006). The capercaillie habitats in Slovenia can be found in old coniferous and mixed forests (spruce, fir, beech) where leks are distributed in chains on the slopes or in networks on forest plateaus (Čas and Adamič 1998; Purnat et al. 2005). The density of active leks depends on the site suitability (Čas and Adamič 1998; Braunisch and Suchant 2008) and on the conservation status and structures of the forest ecosystem (Čas 2001). An observed mean distance (median) among leks in the studied and representing suitable habitat complexes is about 1.250 m between two lek centres (Čas and Adamič 1998; Purnat et al. 2007).

#### STUDY AREA AND METHODS – Područje istraživanja i metode rada

The study area covered about 20.000 km<sup>2</sup>, mainly the Alpine and the Dinaric habitats in Slovenia. We included all altitudes from the low elevation population at 400 m a.s.l. to the high altitude at the forest line (about 1700 m a.s.l.). The capercaillie population and decline was studied in two 3-years periods with an aggregated data for year 1980 and 2000. In the first period we analyzed 466 leks and in the second period 599 leks. Capercaillie leks and subpopulations densities were monitored in several research projects taking part at the Slovenian Forestry Institute since 1980 (Adamič 1987, Čas 2000).

Disturbances at leks were noted as a descriptive parameters of the monitoring questionnaire, where each expert in fields stated the main reasons for lek or subpopulation decline for each endangered or extinct lek. All together 460 experts (hunters and/or foresters) studied leks for three consecutive years in both monitoring periods. Reasons for lek subpopulations decline or dead were recorded. From available questionnaires we extracted and summarised nine most frequent reasons for lek subpopulation disturbance and damage (Table 1) and use them for comparison among monitoring periods and statistics.

In general, capercaillie population size is decreasing. A severe drop of population for 37% (over 50% decrease of active leks) on about 290 leks with active subpopulations of about 1250 birds in year 2000 was noted through the intensive monitoring in years 1980 and 2000 (Čas 2001). The hunting of capercaillie in Slovenia was prohibited by Slovenian Hunter Association, since 1984, after the Bird directive (1979) and was protected with law since 1993 (Official Gazette of RS 1993/57) but the current population situation still remains unsatisfactory (Čas 2001) and urges for a deeper review of potential threats.

The aim of the study was to estimate main reasons for a decline of active leks and role of predation in capercaillie habitats shrinking and species extinct with adapted forest and wildlife management. The study is based on the population monitoring in years about 1980 and 2000. Available data on the causes for capercaillie lek decline in the area of Slovenian Alps and Dinaric Mountains was investigated, and a yearly dynamics of predators and their removal from population by hunting statistics was recorded and correlated to lek decline. We gratefully accepted the idea for a deeper review of potential causes of lek decline given by an open email question raised in July 2008 by Prof. D. Jenkins, the IUCN Grouse Specialist Group member and researcher, who suggested a special focus on the influence of animal predation at leks.

To support predation as one of frequently stated reasons for capercaillie population decline at leks, we analysed predator's population density from hunting statistics data, similarly as suggested by Adamič (1974) or Storch et al. (2005). Available information on hunting statistics for hunted (shot or otherwise removed) animals from population were obtained from the Annual statistics reports of hunting game (Slovenian Hunters Association / SHA/). Data for martens (*Martes foina* Erx. and *Martes martes* L.), wild boar (*Sus scrofa* L.), red fox (*Vulpes vulpes* L.) as potential predators were analysed for 5 years corresponding to each capercaillie leks monitoring period. The data for lynx (*Lynx lynx* L.) and raptors removal were not analysed since only sporadically named as a reason for lek disturbance.

## RESEARCH RESULTS – Rezultati istraživanja

3.1. Leks destruction – causes and dynamics – *Uništenje pjevališta i dinamika*

In years 1979–1981 39 (or 8.4%) out of 466 analysed lek habitats experienced disturbance or destruction. As the main reasons of capercaillie lek habitat destruction in this monitoring period were: cutting of old-growth forests (71.8% of disturbed or destructed leks), building of forest roads (7.7%), overgrowing of pastures in mountain forest areas (7.7%), berry picking (5.1%), human disturbances of mountain tourism (recreation, motor vehicles) (5.1%) and predators (fox, martens, wild boar, lynx, etc.) (2.6%) (Table 1).

In the monitoring period 2000 92 leks were disturbed or destructed (15.4% out of 599 monitored). Main reasons for a lek disturbance or destruction were; different forms of mountain tourism (26.1% of disturbed or destructed leks), cutting of old-growth forests (19.6%), predation at lek habitats (18.5%), forest management in spring matting time (9.8%), pasturage of cattle and

sheep in forests (namely the dangerous are wire fences) (6.5%), overgrowing of pastures in mountain forests (5.4%), berry picking (5.4%), construction of forest roads (4.3%), and infrastructure building activities (electricity cords) (1.1%) (Table 1).

The comparison of both monitoring periods (Table 1) revealed differences in lek disturbance or destruction causes which were correlated with the following improvements: a decrease in the cutting of old-growth forests at leks (-52.2%), and a minimum decline of impact of forest roads construction (-3.3%). The deterioration in habitats showed an increase in the negative impact of mountain tourism (with 21% increase among years) and increase of the negative predator impact (15.9%). Other lek disturbance or destruction causes showed lower increase among the two monitoring periods.

Table 1 The most frequent causes of capercaillie lek disturbance or destruction as revealed from 1980 and 2000 monitoring periods questionnaires

Tablica 1. Najučestaliji razlogi za poremećaj ili uništavanje staništa tetrijeba u godinama 1980 – 2000, dobivenih na osnovu upitnika

Impacts at leks' habitats	Number of disturbed or damaged leks in 1980 monitoring	Percentage within disturbed or destructed leks (%) in years 1980	Number of disturbed or destructed leks in 2000 monitoring	Percentage within disturbed or destructed leks (%) in years 2000	Difference among two monitoring periods, expressed as a % of change in regard to 1980 monitoring period
Cutting of old-growth forests	28	71.8	18	19.6	-52.2
Construction of forest roads	3	7.7	4	4.3	-3.3
Infrastructure (electricity)	0	0.0	1	1.1	+1.1
Forest management in spring time	0	0.0	9	9.8	+9.8
Mountain tourism (recreation, motor vehicles, etc.)	2	5.1	24	26.1	+21.0
Predators (fox, martens, wild boar, lynx, raptors, etc.)	1	2.6	17	18.5	+15.9
Berries picking	3	7.7	5	5.4	-2.3
Pasturage of livestock in forests, wire fences	0	0.0	6	6.5	+6.5
Overgrowing of pastures in mountain forests	2	5.1	5	5.4	+0.3
Overall number of disturbed or destructed observation leks	39		92		

3. Lek predators and predation level – *Predatori na pjevalištimu i razina predatorstva*

A comparison of the increasing percentage of leks endangered by predators and trends in density of hunted predator animals in Slovenia showed a positive correlation with capercaillie leks disturbance and destruction in 20-year time among the two monitoring periods (Table 2). Trends of population dynamics of all three main predator species were positively correlated with lek predation. Density of hunted martens increased from 1.0 to

2.5 animals/1000 ha and for wild boar from 0.8 to 2.0. The hunting dynamics of red fox showed a slight decrease for 18% in the same period. The population dynamics of red fox is suggested to be under a cyclical population changes trends causing an increase of population and changes in hunting (to 3.5 hunted animals/1000 ha) and a negative impact on the capercaillie leks vitality was expected to start only after year 1990.

Table 2 Density of shot predator animals in Slovenia (1980–2000) (animals / 1000 ha)  
 Tablica 2. Gustoća odstrijeljenih jedinki u Sloveniji (1980–2000) (broj jedinki / 1000 ha)

Predation species of wildlife	Average in 1980 (5 years) (shot animals/1000 ha)	Average in 1990 (5 years) (shot animals /1000 ha)	Average in 2000 (5 years) (shot animals /1000 ha)	Trend of population dynamics	Change of density of shot animals in age 1980–2000
Marten ( <i>Martes martes</i> , <i>M. foina</i> )	1.0	2.2	2.5	+	+150%
Red fox ( <i>Vulpes vulpes</i> )	4.3	2.6	3.5	+	18%
Wild boar ( <i>Sus scrofa</i> )	0.8	1.8	2.0	+	+150%

## DISCUSSION – Rasprava

Cumulative results indicated high negative impact on lek habitat suitability in the several main clusters of reasons (Table 1, 2).

The main reasons for the decline in capercaillie population density over the two decades since 1980 were studied at leks and the endangerment by predation of red fox, martens and wild boar were correlated with the hunting statistics data. Research has included the area of a suspended habitat corridor in the Central European distribution range in Slovenia (Čas 2006). Analyses of data from lek monitoring questionnaires confirmed the assessment of leks threats reasons on the basis of the descriptions and experiences of observers as a good indicator of the causes of risk habitats. Observations of leks showed several causes for population decline. Different land use on mountain landscapes and predator densities turned out to be the main reasons causing a gradual destruction of past subpopulations and their retrieval to habitat remains of mix conifer forests in colder and less accessible areas (Čas 2006; Čas and Adamič 2007).

An important cause of lek subpopulations died turned out to be predation. This is one of the third main reason for disturbance and destruction of lek habitats. From 1980 to 2000 the predation at observed leks in Slovenia raised from 2.6% to 18.5% (Table 1), mainly due to the habitat fragmentation (Kurki et al. 2000; Andrén 1994) and an increase of predator populations densities; Storch et al. 2005; Čas 2006). Changes of land use, nature conservation policies, hunting management, a sustainable nature use and changes in rural society structure and functioning in post industrial society in various ways promoted predator species (Angelstam et al. 2001; Čas 2001, 2006). With the adoption of the Birds Directive (1979) and Habitat Directive (1992), hunting of all raptors' species was banned in Slovenia (Official Gazette of RS 1993/57). The ban coincided with a decline in the popularity of fur clothing. These actions changed the attitude and behaviour of hunters towards predators as the important regulator of grouse population densities. Population density of many rare or generalist species of grouse predators (fox, martens, wild boar, raptors, raven) therefore (cyclically) increased (Lindström et al. 1994,

Budiansky 1995, Klaus et al. 1997, Cattadori and Hudson 2000, Storch et al. 2005) and showed a higher impact in predation at leks and a weaker breeding success (Storaas et al. 1999, Saniga 2002, Baines et al. 2004; Merta et al. 2009). The frequently observed predator noted with a prey at observed capercaillie leks were red fox, martens, lynx and sporadically goshawk (*Accipiter gentilis* L.) and eagle (*Aquila chrysaetos* L.). In one case lynx was noted as a sporadic predator in 1980 at a single lek in Dinaric area of Slovenia following its re-introduced (1973). Animal killed all three males at one lek. This establishment of predator pressure was confirmed by a pilot study of predator tracks of red fox, martens and lynx in snow at four capercaillie leks in Slovenian Alps (Dretnik et al. 1999; Čas 2000). Observed lynx tracks were caused by only one lynx pair yet, seen at the 20,000 hectares area (which confirmed their mysteriously life and waylaying strategy of plunder at promising locations).

The observation of predation at leks increases between 1980 and 2000 showed similarities with an increase of negative influence of the few main predator of wildlife populations' density increase for 150% (martens, wild boar) (Table 2). Population dynamics of red fox showed a slight reduction in density (-18%), but the data suggest the negative influence of cyclical trend of 33-year cycle with minimum in 1990 and increase the density of population about year 2000 (to 3.5 shoot animals/1000 ha) (Čas 2006). However, the habitat fragmentation and negative impact of red fox on capercaillie population size after 1990 has increased, similar to the martens and wild boar increase in Alps after 1980 (Storch et al. 2005; Čas 2006). Additionally we assumed the predators as one of the main reasons for capercaillie density decline in open forestland in this part of Europe. In summary we assumed a negative correlation between predator species densities by hunting statistics and capercaillie population density, as prey.

The predator pressure at leks has shown adapted strategy for survey of capercaillie birds. The behaviour of capercaillie birds caused by predator confirmed to influence the fear of the subpopulation activities and the change of the mating time at leks. In case of one continuously observed lek with approximately five ac-

tive cocks in the Alpine region in north Slovenia we established avoidance of beginning of display of cocks on the ground to higher visibility in light early morning in later time due to predators waiting at ground (martens, fox) before in darkness (Čas, unpubl.). Interesting and important was the surmise that behaviour and shift of capercaillie birds out of the mating leks do not take regard of the predators (Ellison and Wegge 2007). On the other hand predation as a cause of lek disturbance occurred very seldom on Norwegian leks. But both males and females were taken by predators during daytime when they were not on the lek (P. Wegge, pers. comm. 8. Aug. 2008).

The first important parameter of lek habitats suitability in management forest landscape are suitable structure with above 60 to 80% of opened mature and old forests with gaps and with sufficient share of pasture areas (3–5%) with berries and with persistence of sufficiently high percentage of conifers in mixed forests (60–95%) (Storch 1999; Čas 2006). There are habitat suitable rich field layer (above 60%) with bilberry (Eiberle 1984; Storch 1999; Bolman et al. 2005; Graf et al. 2007). In old forest habitats are important persistence of lying trunks and ant hills (Čas 2006). Comparable results were obtained for other capercaillie habitats in Eurasia (Rolstad and Wegge 1987, Beškarev et al. 1995; Klaus and Bergmann, 1994; Storch 1999; Saniga 2004). Since 1960ies Slovenia experienced intensive thinning in co-natural multipurpose forest management and intensive opening of mountain forests with forest roads to between 1980–1990ies (Robek and Klun 2007). In that time many leks were destroyed as a result of the cutting of old-growth forests. It coincided with an account for a high percentage (71.8 % in the reason responsible) of active leks decline around year 1980. Later, the effect of cutting decreased to 19.6% leks and the effect of construction of forest roads from 7.7% to 4.3% leks around in 2000. This phenomenon is confirmed by the fact that forest road construction in Slovenia rose strongest by 63.7% gradually between 1964 and 1989 up to 19.8 m/ha (ReNGP, Ur.l. RS, 111/2007). Intensified the

forest management in mountain forests considerably caused temporary destruction of habitat and its fragmentation and other human disturbances impacts on capercaillie habitat reduced (Adamič 1987, Čas 2006); and similarly is in other countries of capercaillie distribution (Rolstad and Wegge 1987; Beškarev et al. 1995; Storch 1999; Zubić 2009).

Additional negative human impacts in habitat were caused by forest management in spring matting and breeding time, pasturing of cattle and sheep or wildlife and berries picking (Table 1) which negative impact on persistence of bilberry food and breeding success were confirmed in other studies (Baines et al. 2004; Purinat et al. 2005). In recent times cables of pasture fences turned out to have negative influence on capercaillie as well (Catt et al. 1994). In addition a natural forest development to more deciduous structures and the habitat of mix coniferous forests shrinking due to the climate change and temperature increase was obvious in Slovenia (Čas and Adamič 2007; Kutnar et al. 2009) and wider in Europe (Fanta 1992; Stutzer 2000; Marrachi et al. 2005). Overgrowing of last pastures in mountain management forestland was indicated as an additional cause of leks endangerment observed in Slovenia.

The second main negative impact on the suitability of capercaillie and also black grouse (*Tetrao tetrix*) habitats in Europe were mountain tourist activities (Storch 1999, Gulič et al. 2005; Menoni et al. 2006; Thiel et al. 2007). After an opening of mountain forests with forest roads to the 1980ies, areas became favourite spots for mountain tourism including motor vehicles and snow sledges driving. This impact on lek abundance was reflected in an increase of endangered leks from 1980 to 2000 (+21.0 %) (Table 1). The human disturbances on the edge of capercaillie distribution area and habitat fragmentation in parallel to climate changes and air pollutions impacts on habitat changes to unsuitable structures influenced capercaillie population in studied forests (Čas and Adamič 1995, Storch 1999, 2007; Angelstam et al. 2004; Poolo et al. 2008; Thiel et al. 2008).

## CONCLUSIONS AND SUGGESTIONS FOR ADAPTED FOREST AND WILDLIFE MANAGEMENT – Zaključci i prijedlozi za adaptaciju šumskog i lovnog gospodarstva

The sustainable dynamic of majority percentage of mountain old-growth mix forest in areas with a moderate road density and unaggressive and controlled mountain tourism was important for conservation of capercaillie habitat suitability. Predator number control (hunting of predators) (Budiansky 1995) in the capercaillie lek areas and the nature of coherent population density of predators were crucial regulators of stable grouse densities in mountain forest landscapes of Central and South-

East Europe (Storch et al. 2005; Čas 2006). This analysis showed that the assessment of the reasons for threats to leks on the basis of the descriptions and experiences of observers as a good indicator of the causes of risk habitats. Results of the current situation and differences regarding the negative impacts on habitats were an important guideline for forest and hunting management planning, and for a sustainable multipurpose landscape use with a continuous presence of forest grouse species.

On the base of comparable research of another predator species (red fox), influencing to the roe deer (*Capreolus capreolus* L.) population density with a negative impact on population dynamics (Čas 2008) we suggested that forest grouse species (capercaillie, black grouse, hazel grouse *Bonasa bonasia* L.) to be under strongest predator pressure too. Negative influences of red fox, martens and wild boar population dynamics on capercaillie population density was confirmed by results of significant cyclically relations from hunting statistics data in Slovenian lands since 1874 (Čas 2006). Confirmation in this study (Table 1, 2) permits predator number control (predator control) in these hunting association areas as urgent wildlife management measure for sustainable capercaillie (and roe deer) stabile populations (Budiansky 1995).

In past two years the suggestion of predator control (Čas 2008) resulted in positive consequences in a pilot

experiment at two hunting districts at Koprivna and Bistra valleys (104.3 km<sup>2</sup>). This narrow study areas represented optimal site for capercaillie habitats within a larger area of Koroška (Carinthia) in northern Slovenia (Peca – 2.126 m a.s.l. and Smrekovec – 1.684 m a.s.l. mountain). Our solution of predator control through the granting of hunters with one premium offspring roe deer or chamois for each ten foxes or five martens shot in one hunting season resulted in successful control with a total of up to four times increased number of shot foxes or martens per year. The increase of shot predators was most pronounced in winter time when the population is in general most vulnerable for density changes (Sandcock 2010) as it used to be in past times with a good sale of fur from these predators. Now a higher density of forest grouses and roe deer were observed in that area.

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**SAŽETAK:** *Populacije tetrijeba (Tetrao urogallus L.) u središnjoj i jugoistočnoj Europi obuhvaća fragmentirani rub staništa. Brojnost je u opadanju još od 1960. Staništa (pjevališta) tetrijeba u Sloveniji prisutna su na jugoistočnom rubu alpske metapopulacije i na sjeverozapadnom rubu dinarske metapopulacije. Te populacije praćene su na pjevalištima u dva razdoblja, u 1980. g. (466 praćenih lokaliteta) i 2000. g. (599). Svi lokaliteti pratili su lokalni stručnjaci (lovci i / ili šumari). Promatrali su glavne uzroke pada populacija u staništima, koje su utvrdili za svaki ugroženi lokalitet. Poseban naglasak istraživanja bila je predacija staništa, kao što je predložio D. Jenkins (2008). Glavni razlozi (od šest) ugrožavanja pjevališta (39 pjevališta) u 1980. g. bili su: sječa starih šuma (na 71,8 % lokaliteta) i izgradnje šumskih cesta (7,7 %) i branja šumskih plodova (7,7 %), dok je u 2000. g. bilo devet razloga na 92 ugrožena lokaliteta: (i) planinski turizam (26,1 %), (ii) sječa starih šuma (19,6 %), (iii) predatori (18,5 %), (iv) šumski radovi tijekom proljeća (9,8 %), (v) ispaša stoke u šumama, žičane ograde (6,5 %), (VI i VII) branje šumskih plodova i zaraštanje pašnjaka, (viii) izgradnja šumskih cesta i (ix) ostale infrastrukture. Najznačajniji razlozi promjena i ugrožavanja staništa između 1980. i 2000. g. bili su: razvoj planinskog turizma, predatora na staništima, radovi u šumama u proljeće, divlje pašarenje goveda i ovaca u šumama, zaraštanje posljednjih pašnjaka u šumskim područjima. Usporedba povećanja postotaka ugroženih lokaliteta od grabežljivaca od 1980. godine pokazala su pozitivne korelacije s povećanjem gustoće populacija glavnih grabežljivaca. Gustoća naseljenosti kuna (*Martes spp.*) i divlje svinje (*Sus scrofa*) porasla je za 150 %, dok se gustoća naseljenosti lisice (*Vulpes vulpes*) povećala od 1990. g. (za 35 %). Naši rezultati potvrđuju ocjenu uzroka negativnog utjecaja na pjevališta, a temelje se na opisima i iskustvima promatrača kao prikladan pristup za procjene rizika za staništa tetrijeba. Spoznaje o uzrocima sadašnjeg pada pojavnosti tetrijeba nameću donošenje smjernica koje bi omogućile promjenu načina gospodarenja šumama i divljači u cilju podizanju kvalitete staništa za ovu vrstu.*

*ključne riječi:* tetrijeb (*Tetrao urogallus*), uzroci ugroženosti staništa, predacija, planinski turizam, gospodarenje šumama i lovištima, zaštite populacija rijetkih vrsta