Habitat use, chick survival and density of Caucasian black grouse Tetrao mlokosiewiczi

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Habitat use, chick survival and density of Caucasian black grouse *Tetrao mlokosiewiczi*

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We surveyed Caucasian black grouse *Tetrao mlokosiewiczi* residing on the Lagonakskiy Ridge, northwestern Caucasus, Russia, in June-July 1998, and on the Magisho Ridge in July 1999. Weather affected habitat use by brood hens: on sunny days 18 broods were encountered in meadows, six in ravines, and three in pine forests; on wet days broods moved to the ridge tops (N = 9) and only one was observed in pine forest. Subadult males used the same habitats as females with broods. Seven of eight adult males were encountered in ravines; only one was encountered in a meadow. Habitat use by adult males was not affected by weather and differed from habitat use by females and subadult males. Well-camouflaged females, chicks and subadult males used relatively open, food-rich habitats, whereas black adult males preferred ravines, where nutrition was poor, but where tall grass protected them from aerial predators. One nest with five hatched eggs was found. In broods an average of one chick per 10 days was lost. A goshawk *Accipiter gentilis* killed one adult female. Our density estimate of 2.3 adults/km^2 for the Lagonakskiy Ridge was similar to densities reported elsewhere (2.3 $\pm$ 1.2; N = 7).

Key words: chick survival, conservation, density, habitat, Tetrao mlokosieviczi

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The Caucasian black grouse *Tetrao mlokosiewiczi* is one of the least studied grouse species. It lives on the steep and inaccessible slopes of the Greater and Lesser Caucasus Mountains of Russia, Georgia, Armenia, Azerbaijan, Turkey and Iran (Johnsgard 1983, Potapov 1985), and has long been listed as an endangered species in all of these countries. Its inaccessible range and limitations placed on working with endangered species have discouraged studies of this species, and the paucity of knowledge of its biology impedes the design of comparative studies. Thus, publication of even limited biological data may facilitate future work on this unique mountain endemic species of southeastern Europe. Other than ptarmigan *Lagopus* spp., the Caucasian black grouse is the only grouse species that spends its summer above the treeline in alpine meadows throughout its range. Furthermore, unlike every other plumage dimorphic species of grouse, yearling male Caucasian black grouse feature a female-like first basic plumage that is worn throughout their first potential breeding season (Johnsgard 1983, Potapov 1985).

Our paper presents data on chick survival and population density of Caucasian black grouse, contrasts habitat use by adult males and by subadult males and females with broods, and briefly discusses the effect of predation, grazing and poaching on population density. Hopefully our data will both foster detailed field studies that will improve management of this species and facilitate its inclusion in comparative studies of the evolution and ecology of grouse.

Material and methods

The 1998 field season

The primary author (SVD), worked on the Lagonakskiy Mountain ridge in Russia (44°07'N 39°54'E) during 20-26 June and 9-23 July 1998. The 12 km long

ridge lies 26 km eastnortheast of Mt. Shessi (1,839 m a.s.l.), which has previously been listed as the northwesternmost point of the species' range (Averin 1938).

Our study is based on an intensive survey of a 10 km² area lying in the middle third of the Lagonakskiy Mountain ridge between Mt. Zhitnaya (1,995 m a.s.l.) and Mt. Matuk (1,957 m a.s.l.). To the northwest of Mt. Zhitnaya a deep canyon limits the local movements of grouse, thereby forming a natural boundary to our study area. Just to the southeast of Mt. Matuk, the ridge remains high, but is narrow enough to restrict the movement of grouse in and out of the study area. On the ridge itself, all of the area above the timberline was suitable summer habitat for grouse. The Lagonakskiy ridge is a traditional grazing area which has been used for grazing for more than 50 years. The grazing begins in mid-June and continues through mid-September. In the 1970s and 1980s, more than 1,000 cows and 300 horses were grazing on the ridge. With the poor Russian economy of the 1990s, grazing on this ridge has declined markedly. In 1998, only 283 cows and 35 horses were grazing on the Lagonakskiy ridge.

The vegetation varies dramatically on the Lagonakskiy ridge. Slopes facing northeast are less steep (approximately 18°) with a timberline at 1,600-1,650 m a.s.l. The mixed forests of the northeast-facing slopes (called 'mixed forest' below) are dominated by medium-aged deciduous trees, such as birch *Betula* spp., mountain ash *Sorbus* sp., willow *Salix* spp., maple *Acer* spp., chestnut, *Castanea* sp., beech *Fagus* sp., hornbeam *Carpinus* sp. and ash *Fraxinus* sp., and very old and sparsely distributed firs *Abies* spp. Above the timberline, the northeast-facing slopes are covered by meadows with grass about 1 m high. In the lowermost reaches of these meadows, about 100 m above the timberline, wild roses *Rosa* spp., stunted mountain ashes *Sorbus aucuparia*, and willow shrubs 1-2.5 m high are abundant.

Southwest-facing slopes consist largely of 200-400 m cliffs situated between steep (approximately 26°) grassy inclines. The timberline is higher on the southwest-facing slopes than on the northeast-facing slopes, lying at 1,850 m a.s.l. Forests on the southwest-facing slopes are dominated by 50-60 year-old Scots pine *Pinus sylvestris* and are referred to as 'pine forest' below. Relatively large openings covered by 0.8 m tall grass and wild roses are common in the pine forests. Birches and willows are sparsely distributed and restricted to ravines. The southwest-facing slopes are much dryer than the northeast-facing slopes, so areas covered by tall grass are patchily distributed, and do not form a wide continuous belt, as they do on northeast-facing slopes.

On both northeast- and southwest-facing slopes, the 'ridge tops' are covered by dry, rocky grasslands, with short (<0.25 m) grass. Both slopes feature wet grasslands with plants 1-2.5 m high along small ravines draining deep depressions which remain snow-filled in summer or which collect melt-water ('ravines').

In calculating the area of the study site, we excluded areas below the cliffs and steep slopes on the south face of the ridge, but we did include some pine forests where grouse nest. On the north face of the ridge we used the timberline as the boundary of the study area because Caucasian black grouse do not use the dense, wet forests below the timberline during the breeding season.

Every day 4-5 people (see Acknowledgements) extensively surveyed an area of 10 km² for 4-8 hours, and the observers reported all grouse encounters to SVD right after each survey. Since the area was small, observers crossed it several times in different directions every day, so each day the entire area was covered by a network of random transects. These surveys covered all five habitats and the time spent in each habitat was proportional to its share of the total area. Each observer recorded the exact place and habitat where grouse were encountered, and SVD revisited all encounter sites reported by the observers to check the habitat type. This was possible because most of the study area was visible from our camp, which was situated nearly on the top of the main ridge, making it easy for observers to point out the exact location of their encounters. Observers also recorded the age (adult, subadult) and sex (male, female) of adults, which are easily distinguishable in the field. Adult males are large and black. Subadult males are brown, but noticeably larger than females, and their darker plumage lacks the distinctive light barring of females.

When flushed, females and their broods flew 20-150 m down slope, depending on the age of the chicks and the proximity of trees; when there were no trees nearby, broods flew considerable distances before alighting in the meadow. To ensure that all chicks were counted observers extensively searched the area where broods were flushed, and then sat quietly for at least 30 minutes to listen for additional chicks. Males that were flushed flew along the slope for 100-300 m after an initial descend of 30-50 m. When similar groups were encountered more than once within 300 m from each other on the same day, we used only the first encounter for analysis of habitat use because changes in habitat could have been affected by earlier encounters. For the analyses of habitat use, this gave us eight encounters for adult males, four for subadult males, and 37 for females with broods.

We estimated population density as the number of adults (including subadult males) per km^2. The density estimates made by plotting all encounters, as well as feathers, droppings and dust basking sites, on a detailed map of the area (scale 1:2,000) were used to identify home ranges. Feathers were identified to sex for adults and to age class (chicks or adults), and droppings were attributed to adults or chicks. We also checked our estimate of density using information provided by locals on the number of males found on the two leks situated within the study area.

The 1999 field season

During 2-10 July 1999, SVD worked at the northern part of the Magisho Mountain ridge in Russia (43°49'N 40°43'E). The 20 km long ridge, situated 85 km southeast of the Lagonakskiy Mountain ridge, runs in a north-northwest-southsoutheasterly direction and includes Mt. Markopydzh (2,442 m a.s.l.) and Mt. Magisho (3,159 m a.s.l.). As we spent little time at this locality and had few assistants here, we could not use data from 1999 for density estimates; however, we did use encounters with three broods in our analysis of habitat use and chick survival. The pine forest and alpine-meadow habitats where these birds were encountered were similar to those described above for the Lagonakskiy ridge. The Magisho mountain ridge is much higher than the Lagonakskiy ridge, and this difference in altitude apparently delays breeding.

Results

Habitat use

Caucasian black grouse were encountered in the four habitats of the highest elevation only; the habitats were pine forest, meadows, ridge tops and ravines. Meadows constituted about 40% of the area we surveyed, ridge tops and ravines about 25% each, and pine forest about 10%. We surveyed additional areas of pine forest that extended further down the south-facing slopes, as well as mixed forests on the north-facing slopes. Neither grouse nor other evidence of their presence were found in these areas, so we excluded them from our density calculations.

For subadult males and females with broods, habitat use was affected by weather (Fig. 1). During sunny days females with broods were encountered more often in meadows (N = 18), than in ravines (N = 6) or pine forest (N = 3). The four broods encountered in pine forests (three on sunny days, one on a rainy day) were less than three weeks old and incapable of sustained

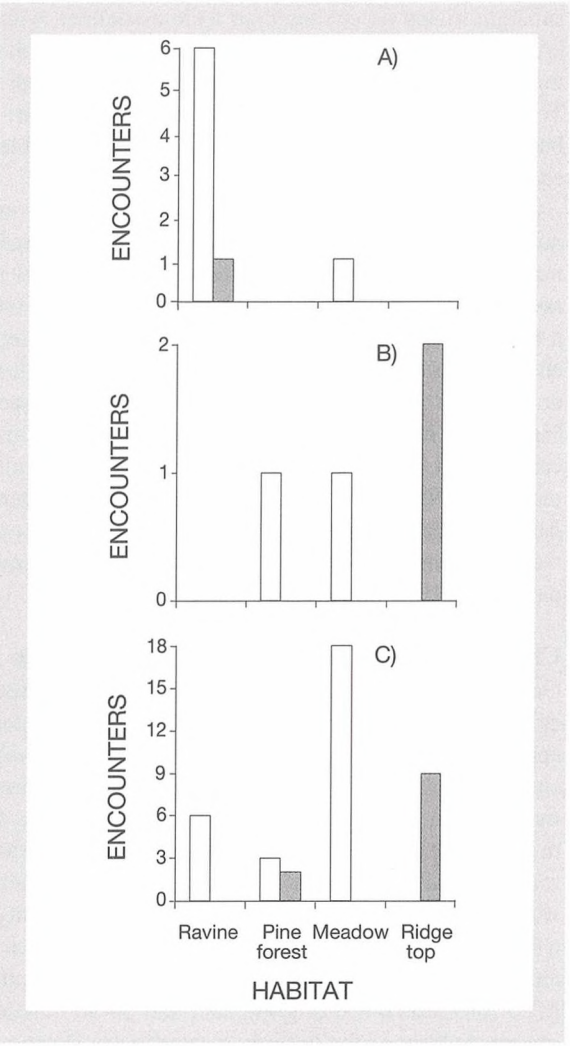

Figure 1. Habitat use by adult males (A), subadult males (B), and females with broods (C). Open bars indicate encounters in sunny weather; filled bars encounters in rainy/foggy weather.

flight. This suggests that hens do not take their broods to the more productive, but open meadows until they are capable of flying considerable distances to escape predators. Broods more than three weeks old were encountered in the tall grass of meadows and ravines only on sunny days. On days with heavy fog or rain, older broods were encountered only in the higher, open habitat of ridge tops (N = 9). This association of habitat use and weather for older broods was highly significant (χ^2 = 33.00, df = 2, P < 0.0001).

Subadult males were encountered in pine forest (N = 1) and meadow (N = 1) on sunny days, and on ridge tops (N = 2) on foggy days. Interestingly, three of the four subadult males were encountered in close proximity (within 5-20 m) to broods. The fact that three of the four

subadult males we encountered were associated with broods may suggest that the young males were exploiting the vigilant behaviour of females tending broods. This could explain the similarity in the habitat distribution of females and subadult males, which resemble each other in colouration.

Adult males were encountered almost exclusively in ravines (N = 6 in sun; N = 1 in fog/rain). Only one adult male was encountered in a meadow, just 30 m from a ravine. The fact that the only adult male encountered on a wet day was in the same habitat as most of the males encountered on sunny days suggests that adult males do not move between habitats with weather changes (see Fig. 1). The habitat use by adult males differed significantly from habitat use by broods and by subadult males (see Fig. 1; $\chi^2 = 18.40$, df = 3, P = 0.0004), when data for wet and sunny days were combined. The same was true when the analysis was restricted to sunny days ($\chi^2 = 10.78$, df = 2, P = 0.0046).

Clutch size, brood size dynamics and predation

On 12 July 1998, SVD found a nest with five hatched eggs in an open pine forest on a southeast-facing slope, approximately 30 m below the timberline. The nest was situated at the base of one of two 12 m high Scots pine trees (24 cm in diameter at breast height) that were 1 m apart. The two pine trees were growing alone, in the middle of an opening with a diameter of 10 m which was covered by thick grass 30 cm high and with only a few plants reaching 1 m. The nest had an outer diameter of 205 mm, an inner diameter of 162 mm, a depth of 57 mm, was made of grass, and had 20-30 female grouse feathers at the bottom. According to Potapov (1985) the average number of eggs per clutch is seven, but varies within 4-12.

On 23 June 1998, SVD flushed a brood of three chicks in a grassy opening in pine forest. The chicks flew only 15-20 m before landing and one was caught (mass = 113 g). On 8 July 1999, SVD found a female with a brood of three chicks, and caught all three chicks (masses = 94, 89 and 80 g, respectively). At hatching the average body mass of chicks is 22.3 g (range: 20.5-23.6 g; Tkachenko 1966). The difference in body mass between hatchlings and the chicks we caught, suggests that each of the broods caught was 2-3 weeks old. We approximated the age of the chicks by comparing their weight and the developmental stage of their feather to those of black grouse *Tetrao tetrix* chicks (Rodionov 1963). Thus, the brood we could age from the Lagonakskiy Ridge hatched at the beginning of June, and the brood from the Magisho ridge hatched in the middle of June. With just one exception, the chicks encountered in any one week seemed to be of similar age, suggesting that different broods hatched at about the same time. The exception involved two broods encountered foraging together at the top of a ridge on 17 July 1998. The chicks in one of these broods were twice the size of the chicks in the other. The smaller chicks probably hatched at the end of June, which is much later than the other broods we encountered on the Lagonakskiy ridge. Perhaps the female lost her first clutch and renested.

Both of the hatching dates we estimated are about three weeks earlier than the earliest hatching dates reported by Tkachenko (1966) from northern Caucasus, but were similar to those reported from more southern parts of the species' range. In Azerbaijan, chicks hatch during the first week of June (Khanmamedov 1965), and in northern Georgia chicks were about the size of common quail *Coturnix coturnix* (approximately 100 g) on 17 June 1967 and 25 June 1968, suggesting that they hatched in early June (Sikharulidze 1974).

We estimated chick mortality by regressing date on brood size. We reversed the axes to prevent differences in hatching dates in the population from causing the rate of chick loss within individual broods to be underestimated (Pimm 1976). All broods from both seasons were included in this analysis, but only the first encounter was counted for broods that were encountered at the same place during the same week. For the three broods from the Magisho ridge, we subtracted two weeks from the date on which they were observed, to correct for the late hatching of broods at this high-elevation site (the three broods are marked with open circles in Figure 2). We also included the hatched nest in this analysis by counting it as a brood of five chicks that hatched on 2 June.

The regression indicated that broods lost one chick every 10 days (see Fig. 2; slope = -10.083; $R^2 = 0.81$, df = 15, P < 0.0001) during their first two months of life. Removing the four extrapolated points from this analysis (the hatched nest and the three broods from 1999) had little effect on the slope (-8.82), and the regression remained significant (P = 0.004; $R^2 = 0.62$). If clutch size declines seasonally, this method will overestimate the rate of chick loss by confounding seasonal decline in clutch size with chick mortality. If all females nest, hens without broods should represent total brood losses. In our case all females encountered during the chick rearing period had chicks, so total brood loss was not a problem.

We found no remains of chicks killed by predators, but SVD did find the fresh remains of a female which was more than one year old (feathers, complete left leg,

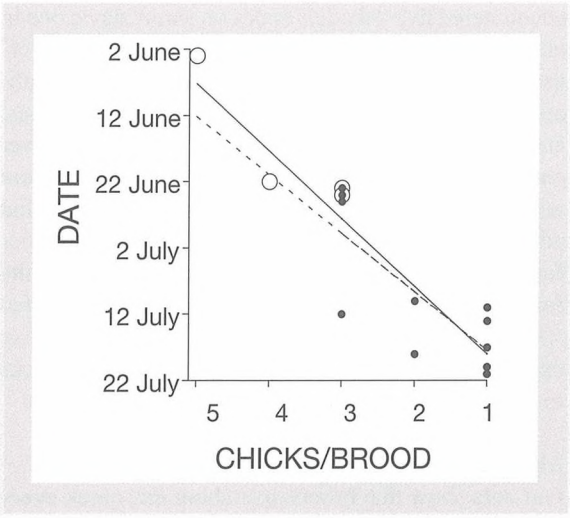

Figure 2. Survival of chicks per brood according to date. The solid line represents the regression with the four extrapolated points (○). The dashed line represents the regression without the extrapolated points.

almost complete right wing, intestines and a partially destroyed gizzard), apparently killed by an avian raptor in a 150 x 35 m opening separating two large patches of pine forest. The age of this female was determined by her relatively unworn and rounded ninth and tenth primaries (Johnsgard 1983). That none of the feathers was partially destroyed or broken, and that all were within 1 m of the fleshy remains, suggests an avian predator. Northern goshawks *Accipiter gentilis* were observed several times in the area where the female was found, including the day before and the day after her remains were found.

Population density and long-term population trends

From the composite maps, we identified 11 areas where females with broods were frequently encountered, eight areas where adult males were frequently present, and four areas where subadult males were frequently present. Feathers and droppings were frequently found in each of these areas. The areas of intense use were less than 150 m in diameter and probably represented preferred parts of home ranges. The areas were separated from their nearest neighbours in the same habitat by distances of 500-1,000 m or by landscape features that grouse normally will not cross. The number of these areas gave an estimate of 2.3 adults/km^2, and a sex ratio of 1.1 males/female.

The assumption that the areas were occupied by different individuals seems to be reasonable. When adults were encountered in the same area more than once, they were of the same sex and age as adults encountered there previously. When multiple encounters involved broods, the number of chicks never increased and the size of the chicks never decreased, suggesting that the same brood was being encountered. Only in the evening of 22 July 1998, were two females observed flying across the top of the main ridge moving from the northeastern to the southwestern slope. The next morning SVD flushed two females on the southwest-facing slope which flew an unusually long distance of about 500 m, crossing the canyon, something no bird had done earlier in the season. These observations may represent the beginning of post-breeding dispersal, initiated by non-breeding females or by females that lost their broods. We did not include these two females in calculations of population density because they may have been just passing through the study area.

Local residents reported that only two leks existed in the study area in May 1998; one had six males and the other seven. This is one more male than was observed in our surveys, suggesting that we had found practically all the mature males (adults and subadults) in the area. The additional male observed by local residents in May could have died before our censuses were made, or could have joined the lek from adjoining suitable habitat.

If all mature males attend leks, the densities can be estimated from a knowledge of the sex ratio. Vitovich (cited in Potapov 1985) reports a sex ratio in Caucasian black grouse of 1.3 males/ female. Thus, the 13 males on the two leks in the study area suggest a density of

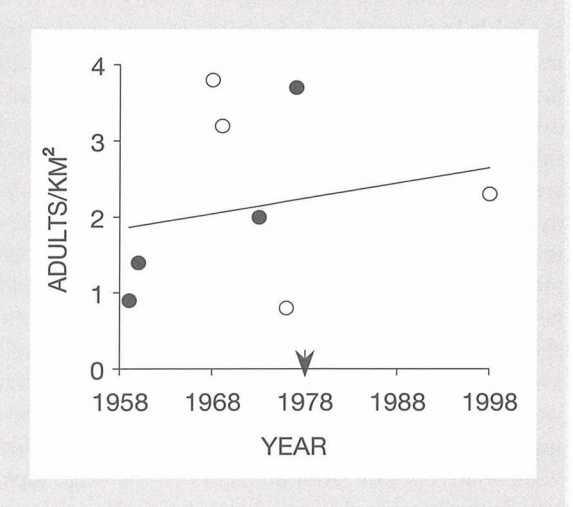

Figure 3. Long term trend in the population density of the Caucasian Black Grouse suring 1958-1998. Data come from the Teberdinskiy Nature Reserve (●) or from unprotected areas (○). The arrow indicates the year of the Red Data Book listing (1978).

2.3 individuals/ km². Averin (1938) found a sex ratio of 1:1, which would suggest a density of 2.6 individuals/km² in the study area. Our direct estimate of density of 2.3 adults/km² is similar to this indirect estimate.

Density estimates (or the data needed to make such estimates) for Caucasian black grouse have been reported by Tkachenko (1966) for 1959 and 1960, by Sikharulidze (1974) for 1968 and 1969, by Potapov (1985) for 1973, by Scott (1976) for 1976, and by Vitovich (1977) for 1977. Although census methods varied, these density estimates, combined with ours, span a 40-year period; during this period the density of Caucasian black grouse has remained about 2.3 (±1.2) adults/km² (Fig. 3; $\beta = 0.02$; $R^2 = 0.043$, df = 7, P = 0.62).

Discussion

Habitat use

Our data clearly showed that the habitats used by adult males and by females with broods were very different; furthermore, we found that subadult males and females used similar habitats in summer. These patterns have not been reported previously, presumably because earlier studies did not subdivide the habitats found above the timberline.

Adult males were found only in the tall, dense vegetation of ravines. In contrast, females commonly used meadows in sunny weather and moved to the short grass of the ridges during rainy or foggy weather. To avoid predators, adult males are presumably restricted to the tall vegetation of the ravines because of their conspicuous black plumage. However, the quality of the food available in the ravines is probably low because most insects, new leaves and flowers cannot be reached from the ground. Females which were found mainly in meadows in good weather and moved to the short grass of ridges when the weather was rainy or foggy presumably were able to use the more productive meadows in sunny weather because of their colouration which makes them melt into the background. In rainy weather the meadows become so wet that thermoregulation could be a problem, and females moved their broods to the short grass on the ridge tops. We never encountered avian predators outside the forests in bad weather, but we did find them on the ridges on sunny days. Thus, during wet weather females and their broods, probably were relatively safe from predators on the ridge tops, which surely were drier, and may have offered more food for the chicks.

Interestingly, subadult males with their brown plumage were found in the same habitats as the females. We encountered two subadult males on sunny days; one in close proximity to a brood in an open area in a pine forest, the other with a brood in a meadow. The two subadult males encountered on wet days were on ridges, and one of them was with a brood. No subadult was ever encountered in the tall vegetation of the ravines where adult males lived. This further supports the view that adult males confine themselves to this relatively poor foraging habitat to escape predation. That three of the four subadult males we encountered were associated with females with broods, suggests that subadults may exploit the vigilance of hens and the presence of chicks to reduce their own risk of predation.

Mortality

Our data show that broods lost about one chick every 10 days during the first two months after hatching. We found no dead chicks, but other studies have indicated that snow and wet weather are the main causes of chick mortality (Averin 1938, Tkachenko 1966, Vitovich 1977, 1986).

Predation seemed low in our study areas and the northern goshawk apparently was the main predator in both our study areas. We found one adult female grouse apparently killed by a goshawk in an opening in pine forest; furthermore, on two occasions we observed goshawks flying over meadows, far from the nearest forest. In some areas red foxes *Vulpes vulpes* have been reported to prey extensively on Caucasian black grouse (Sikharulidze 1974); however, the red fox was not present in our study areas.

Population dynamics

In 1978 the Caucasian black grouse was listed as rare and declining in the Red Data Books of the USSR and former Soviet republics where it occurred (Vinokurov, Grazhdankin, Kischinskiy, Ponomaryova, Sapetin & Fomin 1978). Grazing is considered a major limiting factor, followed by poaching. The Red Data Book for the Krasnodarskiy region of the northern Caucasus also claims that collecting specimens for museums has been partially responsible for the species' decline (Til'ba 1994). This seems highly unlikely because not one of the 25 specimens in the two major museums of Moscow (Moscow State University Zoological Museum and State Darwin Museum) was collected after 1959; the most recent specimen in these collections from the northern Caucasus was collected in 1897. There is not a single Caucasian black grouse in the regional museum of Krasnodarskiy Krai.

Cows and sheep, as well as shepherd dogs, have been blamed for destruction of habitats and nests (Khan-

mamedov 1965, Molamusov 1966, Sikharulidze 1974, Til'ba 1994), but none of these claims was supported by data. The data presently available are simply insufficient to satisfactorily assess the effects of grazing on population densities (see Fig. 3). Four estimates of density from an ungrazed nature reserve in the heart of the species range (mean = 2.0 ± 1.3; Tkachenko 1966, Vitovich 1977, 1986, Potapov 1985) are similar to four estimates of density from grazed areas (mean = 2.5 ± 1.3; Sikharulidze 1974, Scott 1976, this study). Field studies of the species uniformly report wet or snowy weather during incubation and brood-rearing to be the primary factor limiting breeding success for Caucasian black grouse (Averin 1938, Tkachenko 1966, Vitovich 1977, 1986).

Cows were traditionally brought to Lagonakskiy Ridge when chicks were 10-14 days old; thus nest destruction by cows or shepherd dogs was unlikely. Furthermore, cows tend to graze close to the timberline on the northeast-facing slope and along ravines, below the principle brood rearing areas. Short of total destruction of the ravine habitats, it is hard to imagine that adult males would be affected by the presence of cows. The cowherds on the Lagonakskiy Ridge had two dogs that were kept chained in their camp to guard it from theft and bears. The situation may be different for sheep because they prefer the higher meadows and ridges with shorter grass which are intensively used by broods, and dogs are often used for sheep herding.

Poachers in the area seldom hunt Caucasian black grouse; they carry large caliber rifles (≥7.62 mm) rather than shot guns and hunt chamois *Rupicapra rupicapra*, red deer *Cervus elaphus*, wild boar *Sus scrofa* and brown bear *Ursus arctos*. A few hundred grams of grouse is worth neither the risk associated with poaching, the cost of ammunition, nor the energy spent to get to the mountain habitat of this species.

Conclusions

Obviously, there is a great need for more detailed studies of the general biology and conservation status of the Caucasian black grouse. However, the limited data currently available fail to provide evidence that the species is declining and that grazing or poaching currently threaten the species in Russia. In the Greater Caucasus Mountains of Russia almost all of the habitat occupied by the grouse is contained within four nature reserves that are protected from agricultural development and hunting, and that restrict trespassing.

Continuing to list the Caucasian black grouse as an endangered species in Russia seems unreasonable. The 1978-listing of the species as endangered seems primarily to have reduced the number of scientific studies of this species, presumably because the permits required to study endangered species are difficult to obtain. Earlier publications (Averin 1938, Tkachenko 1966, Sikharulidze 1974) revealed no need for the species to be listed. Removing the species from the red lists would have two important benefits. First, studies of its biology would be easier to conduct; second, and more importantly, the credibility of Red Data Book listings is seriously jeopardized when the people living in an area see a species listed that they know is neither rare nor declining. Such incongruities diminish public support for the conservation of species listed as endangered for valid reasons.

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