# Conservation status and threats to grouse worldwide: an overview

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# Conservation status and threats to grouse worldwide: an overview

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A major task of the Grouse Specialist Group is to compile an IUCN/SSC Action Plan to assess threats and propose conservation actions for all grouse species worldwide. This paper provides an overview to the conservation status of and major threats to grouse based on information collected during the preparation of the Grouse Action Plan. Three species, Caucasian black grouse *Tetrao mlokosiewiczi*, Chinese grouse *Bonasa sewerzowi* and Siberian grouse *Falcipennis falcipennis*, are listed as globally near-threatened or data deficient, one newly-recognised species, Gunnison sage grouse *Centrocercus minimus*, is listed as globally endangered and two subspecies, Attwater's prairie chicken *Tympanuchus cupido attwateri* and Cantabrian capercaillie *Tetrao urogallus cantabricus*, qualify to be listed as globally threatened according to IUCN criteria. At a national level, 14 of the 18 species are red-listed in at least one country. Populations at the southern edge of a species' range and in densely populated regions are most often red-listed. Based on questionnaire results from 38 countries, habitat degradation, loss and fragmentation due to human land use activities are the major threats to grouse viability. Exploitation, predation and human disturbance were regionally felt to be critical. Major threats and their causes are reviewed based on questionnaire results and the literature. Integrating habitat preservation and human land use practices is concluded to be the major challenge to grouse conservationists worldwide.

*Key words: conservation, grouse, IUCN/SSC Grouse Action Plan, status, Tetraonidae, threats, WPA/Birdlife/SSC Grouse Specialist Group*

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Since 1987, a series of more than 30 Action Plans has been published by the Species Survival Commission (SSC) of the World Conservation Union (IUCN) (Gimenez-Dixon & Stuart 1993). The aim of the IUCN/SSC Action Plans is to assess the nature and scale of threats and to propose conservation actions for the species of concern (McGowan, Dekker, Dowell & Garson 1998). Action Plans are backed by up-to-date scientific information compiled by the IUCN/SSC Specialist Groups and are written primarily for decision makers, agency officials, resource managers, funding organisations, but also for scientists and students. Their major purpose is to provide a basis for identifying conservation priorities from a global perspective.

The WPA/Birdlife/SSC Grouse Specialist Group (GSG) is a voluntary network of grouse (*Tetraonidae*) professionals, having as joint parent organisations the SSC, BirdLife International and the World Pheasant Association (WPA). The GSG was formally founded in 1993. The preparation of the first IUCN/SSC Grouse Action Plan (Storch 2000) is one of the GSG's major

tasks. In this paper, I provide a brief summarising overview of the current status, population trends and threats for grouse worldwide based on data and information that was collected during the preparation of the Action Plan and updated for this paper. The objective of this paper, and of the Grouse Action Plan, is to sketch the global picture rather than to elaborate on local details. Accounts on the individual species, discussions of the various threats and recommendations for conservation are given in the Action Plan (Storch 2000).

## Methods

A questionnaire regarding the status and population trend of and threats to each of the 18 grouse species was sent to researchers, state agencies and NGOs in most of the 52 countries in which grouse are known to occur. In total, 125 country-by-species questionnaires were returned covering 38 countries and all 18 grouse species. Although the information reported may range in quality from sound monitoring data to personal guesswork, the questionnaire results may still be considered one of the best available sources to provide the coarse global overview attempted in this paper. The global conservation status of grouse was assessed according to the 2000 IUCN Red List of Threatened Species (Hilton-Taylor 2000) and IUCN threat categories (IUCN 1994). Additional information and opinions were collected from recent literature and from colleagues worldwide involved in research and conservation of grouse.

## Results and discussion

### Conservation status and population trends

Related to their extended distribution ranges and often remote habitats, the conservation status of grouse is less critical than that of other galliform taxa. Only one of the 18 species (see Table 1) is considered to be globally threatened; several taxa are, however, listed as near-threatened or data deficient (Hilton-Taylor 2000) or qualify to be listed as endangered according to IUCN criteria (IUCN 1994). Many populations of grouse are red-listed at the national and regional level.

#### *Species*

The Caucasian black grouse *Tetrao mlokosiewiczi* is endemic to the Caucasus region in Armenia, Azerbaijan, Georgia, Iran, Turkey and Russia (Kutubidze 1961, Vitovic 1986, Potapov & Flint 1989, Baskaya 1997). Its range is highly fragmented and probably contracting. Estimates of the total population size vary within 10,000-100,000 birds, but the rate of decline is unknown. Habitat degradation due to cattle grazing and shepherding, predation by feral and shepherd-dogs, and illegal hunting are believed to be major threats to the species (Klaus, Bergmann, Marti, Müller, Vitovic & Wiesner 1990, S. Baskaya, A. Gavashelishvili, S. Klaus & A. Solokha, pers. comm.). Its status is insufficiently clarified; therefore, it is currently listed as data deficient (Hilton-Taylor 2000).

The Chinese Grouse *Bonasa sewerzowi* is endemic to central China (Sun 1995, Bergmann, Klaus, Müller, Scherzinger, Swenson & Wiesner 1996, Sun 1996, Lu 1997). Its range is contracting and highly fragmented. The population is declining and is currently estimated at >10,000 birds (Y-H. Sun, pers. comm.). Major threats are habitat loss and deterioration related to increasing land use and forest exploitation, particularly large-scale clear-cutting (Bergmann et al. 1996, Klaus, Scherzinger & Sun 1996, Li 1996, Y-H. Sun, pers. comm.).

The Siberian grouse *Falcipennis falcipennis* occurs in a limited area in far-eastern Russia (Potapov & Flint 1989, Hafner & Andreev 1998). The range is fragmented and probably contracting. The population has been estimated at one million birds. The species probably has been declining since the 1970s. The major cause of decline is forest exploitation, particularly large-scale clear-cutting (Klaus, Lieser, Suchant & Andreev 1995, Hafner & Andreev 1998, F. Hafner & S. Klaus, pers. comm.).

The Gunnison sage grouse *Centrocercus minimus* in southwestern Colorado and southeastern Utah has recently been recognised as a new species separate from the common sage grouse *C. urophasianus* (Braun & Young 1995, Young, Braun, Oyler-McCance, Quinn & Hupp 2000, American Ornithologists' Union 2000). The Gunnison sage grouse is listed as endangered (IUCN 1994) in the 2000 IUCN Red List of Threatened Species (Hilton-Taylor 2000) because of low population sizes (<5,000 birds spread over eight disjunct populations), restricted range (occupied area <500km$^2$), ongoing population decline, and habitat degradation, loss, and fragmentation related to livestock grazing, agriculture, housing development and road construction (see Connelly & Braun 1997, Oyler-McCance 1999, Oyler-McCance, Kahn, Burnham, Braun & Quinn 1999).

#### *Subspecies*

Subspecies are generally not considered in the IUCN

2000 Red List of Threatened Species (Hilton-Taylor 2000), although the IUCN red-list categories and criteria can be applied to any taxonomic unit at or below species level (IUCN 1994). According to these criteria, two subspecies of grouse are globally threatened: Attwater's prairie chicken *Tympanuchus cupido attwateri* and the Cantabrian capercaillie *Tetrao urogallus cantabricus*.

Attwater's prairie chicken is critically endangered (IUCN 1994). The total population remaining in the wild in 1999 was 46 birds in two isolated populations in Texas that were largely supported by releases of captive-reared birds (N. Silvy, pers. comm.). Major causes of decline were agriculture, urban development and other human land use activities (Silvy, Griffin, Lockwood, Morrow & Peterson 1999, N. Silvy, pers. comm.).

The Cantabrian capercaillie (Castroviejo 1967) qualifies to be listed as endangered (IUCN 1994). It inhabits a severely fragmented 6,000 km$^2$ range in the Cantabrian mountains of northern Spain. The population is estimated at <1,000 birds; numbers have been declining by an estimated 25-50% over the past 10-15 years (J. Obeso, pers. comm.). The major causes of decline are seen in habitat loss, fragmentation, and degradation related to forestry and tourism, illegal hunting and disturbance by human outdoor activities (J. Castroviejo, pers. comm.).

***Populations***

At regional, national and local scales, many populations of grouse are declining and threatened with extinction. This is particularly true of grouse inhabiting regions densely populated by humans, e.g. western and central Europe, eastern and central North America, and parts of eastern Asia. Fourteen of the 18 species of grouse (78%) are included in the national red-data books of at least one country (Table 1). Only two of the 18 species, the blue grouse *Dendragapus obscurus* and the ruffed grouse *Bonasa umbellus*, are neither red-listed at global, national, nor state (US) or provincial (Canada) level.

Based on the questionnaire and published information, assumed population trends of grouse by country and species were distinguished as increasing, stable, declining or unknown. Among a total of 165 'national populations' (by country and species), only two

Table 1. Conservation status of the 18 species of grouse at the global level according to the 2000 IUCN Red List of Threatened Species (Hilton-Taylor 2000) and the 1996 IUCN Red list of Threatened Animals (IUCN 1996), and at the national level according to national red data books. Listing at state (USA) or province (Canada) level is noted in brackets. * No information for a few countries; therefore the list may not be complete.

| Species | | Conservation status | | |
|---|---|---|---|---|
| | | IUCN 2000 | IUCN 1996 | National Red Data Books* |
| Siberian grouse | *Falcipennis falcipennis* | Near-threatened | Near-threatened | China, Russia |
| Spruce grouse | *Falcipennis canadensis* | Lower risk | Lower risk | Not listed (several eastern US states) |
| Blue grouse | *Dendragapus obscurus* | Lower risk | Lover risk | Not listed |
| Willow ptarmigan | *Lagopus lagopus* | Lower risk | Lower risk | Belarus, China, Estonia, Finland, Lithuania, UK |
| Rock ptarmigan | *Lagopus mutus* | Lower risk | Lower risk | China, Germany, Italy, Japan, Portugal, Slovenia, Spain |
| White-tailed ptarmigan | *Lagopus leucurus* | Lower risk | Lower risk | Not listed (British Columbia, Canada) |
| Black grouse | *Tetrao tetrix* | Lower risk | Lower risk | Austria, Belgium, China, Denmark, Estonia, Germany, Italy, Kygystan, Lithuania, The Netherlands, Poland, Slovakia, Slovenia, UK |
| Caucasian black grouse | *Tetrao mlokosiewiczi* | Data-deficient | Near-threatened | Entire range: Armenia, Azerbaijan, Georgia, Iran, Russia, Turkey |
| Capercaillie | *Tetrao urogallus* | Lower risk | Lower risk | Austria, Bulgaria, France, Germany, Greece, Hungary, Italy, Liechtenstein, Lithuania, Poland, Portugal, Slovakia, Slovenia, Spain, Switzerland, UK, Ukraine |
| Black-billed capercaillie | *Tetrao parvirostris* | Lower risk | Lower risk | China |
| Hazel grouse | *Bonasa bonasia* | Lower risk | Lower risk | Austria, Belgium, Bulgaria, China, Germany, Greece, Hungary, Italy, Liechtenstein, Poland, Slovakia, Slovenia, Spain, Switzerland |
| Chinese grouse | *Bonasa sewerzowi* | Near-threatened | Near-threatened | China |
| Ruffed grouse | *Bonasa umbellus* | Lower risk | Lower risk | Not listed |
| Sage grouse | *Centrocercus urophasianus* | Lower risk | Lower risk | Canada (some US states) |
| Gunnison sage grouse | *Centrocercus minimus* | Endangered | (Not listed) | USA (under consideration) |
| Sharp-tailed grouse | *Tympanuchus phasianellus* | Lower risk | Lower risk | USA (some US states and Canadian provinces) |
| Greater prairie chicken | *Tympanuchus cupido* | Lower risk | Lower risk | Canada, USA (*T.c. attwateri*) |
| Lesser prairie chicken | Tympanuchus pallidicinctus | Lower risk | Lower risk | USA (some US states) |

were reported to increase: black grouse *Tetrao tetrix* in Romania and Slovenia; 58 national populations were considered to be stable. A decline was reported for 53 populations, and for 52 the trend was unknown. The tundra grouse, i.e. white-tailed *Lagopus leucurus*, rock *L. mutus*, and willow ptarmigan *L. lagopus* (Potapov & Flint 1989, Braun, Martin & Robb 1993, Holder & Montgomerie 1993, Hannon, Martin & Eason 1998), still occupy most of their original ranges; they are best protected by their often remote habitats. All national populations were believed to be stable, or trends were unknown (Fig. 1). For the forest edge, i.e. black and Caucasian black grouse (Klaus et al. 1990), and the forest grouse, i.e. capercaillie *Tetrao urogallus*, black-billed capercaillie *Tetrao parvirostris* (Klaus, Andreev, Bergmann, Müller, Porkert & Wiesner 1989), Chinese and hazel grouse *Bonasa bonasia* (Bergmann et al. 1996), ruffed grouse (Atwater & Schnell 1989, Rusch, DeStefano, Reynolds & Lauten 2000), blue grouse (Zwickel 1992), Siberian grouse (Hafner & Andreev 1998), and spruce grouse *Falcipennis canadensis* (Boag & Schroeder 1992), the largest proportion of declining national populations was reported. This is related to the ongoing changes in forest habitats worldwide (see below). Among the prairie grouse (see Fig. 1), negative trends were reported for sage grouse and Gunnison sage grouse; the sharp-tailed grouse *Tympanuchus phasianellus* and the prairie chickens were believed to be currently stable. However, the prairie grouse have lost major parts of their original ranges in the past (e.g. Braun, Martin, Remington & Young 1994, Schroeder & Robb 1993, Connelly, Gratson & Reese 1998, Giesen 1998).

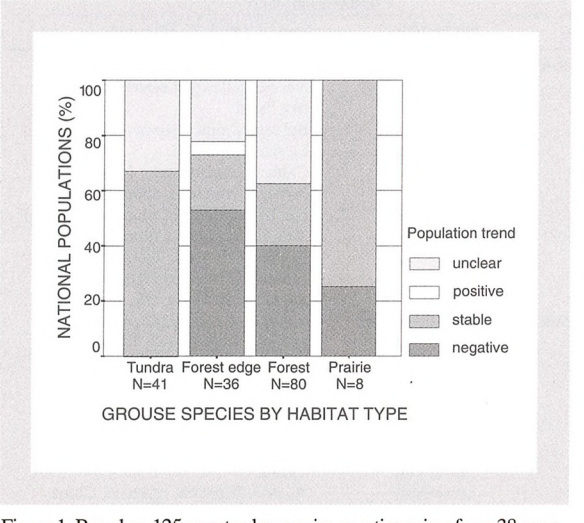


Figure 1. Based on 125 country-by-species questionnaires from 38 countries and published information, the assumed current population trends of grouse were classified as positive, stable, negative or unclear by country and species. The results from a total of 165 national populations are summarised by habitat type. The species are grouped in the following ways: tundra grouse = white-tailed, rock, and willow ptarmigan; forest edge species = black and Caucasian black grouse; forest species: black-billed capercaillie, capercaillie, blue, Chinese, hazel, ruffed, Siberian and spruce grouse; prairie grouse = sage, Gunnison sage and sharp-tailed grouse, greater and lesser prairie chicken.

## Threats

Numerous factors are thought to influence the population dynamics of grouse and to threaten their survival. Here, the most important threats are described based on the results of 115 questionnaires (per species and country) which reported on threats to grouse at a national level; all 18 species were represented (Fig. 2). Worldwide, the most frequently named threat categories were habitat degradation (73% of the questionnaires; reported from at least one country for 16 species) and habitat loss and fragmentation (72%; for 17 species). Small population size was named by 51% of the correspondents (16 species). Predation (27%; 8 species), direct exploitation (29%; 10 species) and human disturbance (26%; 5 species) were less commonly named but may be critical regionally. Significant differences between continents existed in the frequency with which predation ($\chi^2 = 7.7$, df = 2, $P = 0.02$) and human disturbance ($\chi^2 = 6.0$, df = 2, $P < 0.05$) were named as threats.

### *Habitat degradation, loss and fragmentation*

Habitat change is considered as the major threat to grouse populations worldwide. Degradation is here understood as a decline in species-specific habitat quality that leads to reduced survival and/or repro-

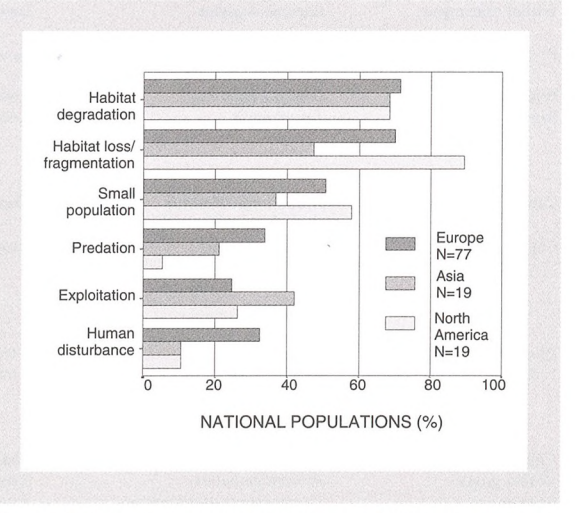


Figure 2. Relative importance of various types of threats to grouse populations by continent, based on questionnaire results per country and species. A total of 115 questionnaires which reported on threats to grouse at a national level were included in the analysis and all 18 grouse species were represented.

ductive success in a population, e.g. related to changes in food availability, cover or climate. Habitat loss means that an area completely loses its suitability for a particular species. Fragmentation is a likely consequence of habitat loss, e.g. clear-cuts result in habitat loss, but also fragment the remaining forest.

Grouse can tolerate a certain degree of human impact on the habitat. However, where industrialised farmland, timber production forests and urban areas dominate the landscape, grouse populations are likely to decline and disappear. Habitat change has also been identified as the main cause of the extinction of the heath hen *Tympanuchus cupido cupido* in Massachusetts (Schroeder & Robb 1993), the black grouse in parts of central Europe (Loneux & Ruwet 1997), and the decline and extinction of prairie chicken populations in the USA (Schroeder & Robb 1993, Westemeier, Brawn, Simpson, Esker, Jansen, Walk, Kershner, Bouzat & Paige 1998).

Agriculture: The conversion of natural habitats into farmland and settlements is the process that likely has led to the largest range contractions of grouse (see del Hoyo, Elliott & Sargatal 1994). In temperate Eurasia, forests were cleared on a large scale in the middle ages and before; somewhat later, moors and heathlands were drained and fertilised (e.g. Küster 1995). In North America, the conversion of forests and grasslands to cropland started with the European settlers in the middle of the 19th century (see Braun et al. 1994). For grouse, the results were considerable habitat loss and fragmentation. Both prairie grouse (e.g. Schroeder & Robb 1993, Braun et al. 1994, Connelly et al. 1998, Giesen 1998) and forest grouse (e.g. Rolstad & Wegge 1987, 1989, Rolstad 1991, Kurki & Lindén 1995) are likely to become extinct during the transition from a natural landscape with islands of farmland to a farming-dominated landscape with scattered islands of habitat suitable for grouse. In general, grouse cannot survive in farmland because most crops are not suitable, or only during short periods, for nesting, feeding or cover, and because of increasing risk of predation (see e.g. Mckee, Ryan & Mechlin 1998).

Grazing: Intensive grazing can affect the structure, height and species composition of the vegetation and thus destroy or degrade cover, nesting and feeding habitats of grouse (e.g. Baines, Sage & Baines 1994, Baines 1996). Trampling and erosion are additional problems. Excessive livestock-grazing is known to negatively impact prairie grouse populations on North American rangelands (e.g. Schroeder & Robb 1993, Braun et al. 1994, Connelly et al. 1998, Giesen 1998), black grouse and Caucasian black grouse populations on Eurasian heaths and treeline habitats (e.g. Klaus et al. 1990), as well as some capercaillie (Klaus et al. 1989) and hazel grouse populations (Bergmann et al. 1996) in central European forests. Deterioration of grouse habitats may also result from high densities of deer or other wild ungulates which may reduce the ground vegetation to a few centimetres in height (e.g. Baines et al. 1994, Baines 1996). Some moderate grazing can be compatible with grouse. Livestock herding may even improve grouse habitats, e.g. in the Alps, where pasturing has significantly increased the area suitable for black grouse (Glänzer 1980, Magnani 1988). Also capercaillie may profit from a moderate degree of grazing if cattle and deer contribute to maintain open forest structures (Klaus et al. 1989).

Forestry: Forestry may lead to significant changes in the structure and the temporal and spatial dynamics of forests. Because each forest grouse species has a different habitat preference, silvicultural operations may affect them in different ways (Klaus 1991, Swenson & Angelstam 1993). At the forest stand scale, grouse seem to be flexible with regard to species-composition and stand age, but are sensitive to structural changes such as the loss of the ground vegetation or understorey (e.g. Baines 1995, Storch 1995, Swenson 1995). At the landscape scale, forest grouse are susceptible to habitat fragmentation, and tend to decline rapidly as the patches of suitable habitat become too small and scattered (see e.g. Rolstad & Wegge 1987, 1989, Rolstad 1991, Wegge, Rolstad & Gjerde 1992, Zwickel 1992, Åberg 1996, Storch 1997).

Urban, infrastructure and tourism development: The extent of grouse habitats lost to settlements, roads, power-lines or ski-stations is more limited. However, infrastructure development increases the accessibility of an area and opens habitats and grouse populations to exploitation (e.g. Potapov & Flint 1989, Forman & Alexander 1998). Areas frequented by humans, e.g. for sport and leisure activities, may virtually be lost as grouse habitats, even if the habitat structure remains unchanged (e.g. Ménoni & Magnani 1998, Zeitler & Glänzer 1998). Locally, collisions with features such as power-lines (Bevanger 1995), deer fences (Baines & Summers 1997), and ski-lift cables (Miquet 1986, A. Zeitler, pers. comm.) may cause significant mortality among grouse.

Pesticides and pollution: Herbicide or insecticide-treatment of rangeland or forests may result in the loss of nesting, brood and resting cover, and may reduce the abundance of invertebrate chick food. Increased mortality due to pesticides may occur, either directly through poisoning or indirectly due to increased susceptibility to predation. Pollutants transported through wind and

rain may result in soil eutrophication and lead to vegetation changes that are disadvantageous to grouse (e.g. Porkert 1991, Bergmann & Klaus 1994a,b, Klaus & Bergmann 1994, Schroeder & Robb 1993, Connelly et al. 1998, Hannon et al. 1998, Giesen 1998).

***Small population size***

In parts of the range, e.g. in western and central Europe, loss, fragmentation and deterioration of habitats have resulted in small isolated grouse populations. Small populations generally show a high risk of extinction due to chance environmental or demographic events (Shaffer 1987, Klaus 1994). Chances of recovery are low, even if the habitat is suitable. There are several well documented examples of small grouse populations that became extinct, or are close to extinction despite major conservation efforts, e.g. black grouse in Denmark (Holst-Jørgensen 1995), Belgium, Germany (Loneux & Ruwet 1997) and the Netherlands (Niewold 1990), capercaillie in Germany (Klaus & Bergmann 1994) and prairie chickens in the USA (Schroeder & Robb 1993, Westemeier et al. 1998). It is likely that conservation efforts were made too late. An isolated grouse population should probably number at least several hundred birds (Storch 1995, Grimm & Storch 2000) in order to have good long-term survival chances (Shaffer 1987). Therefore, it is important to maintain connectivity within spatially structured populations (see Martin 1998).

There is evidence that reduced genetic variability might be an additional problem for the survival of small grouse populations: in an isolated population of prairie chickens, hatching success decreased as the population declined. This loss in fertility might have resulted from reduced genetic heterogeneity, and the fertility increased again after birds from elsewhere had been translocated into the population (Westemeier et al. 1998).

***Predation***

Parallel to land-use changes, the predation pressure on grouse regionally has increased during the past three decades (Reynolds 1990, Wegge, Gjerde, Kastdalen, Rolstad & Storaas 1990, Hudson 1992, Bergman & Klaus 1994a,b Klaus & Bergmann 1994, Fujimaki 1995). In the boreal forest, clear-cutting has resulted in higher numbers of generalist predators and increased mortality of grouse (Andrén & Angelstam 1988, Andrén 1992, Wegge et al.1990, Kurki, Helle, Lindén & Nikula 1997). In temperate Europe, fertilisation of farmland, availability of anthropogenic food sources, relaxed persecution (e.g. Hudson 1992) and vaccination of foxes *Vulpes vulpes* against rabies (e.g. Vos 1995) have contributed to increasing predator densities and negative effects on the survival rates of prey species such as grouse are likely to follow (e.g. Klaus et al. 1990, Reynolds 1990). In addition, domestic dogs and cats are a potential problem for grouse near settled or in recreational areas (A. Zeitler & F. Zwickel, pers. comm.). Predation by shepherd-dogs has locally become a threat to the Caucasian black grouse (Klaus et al. 1990, A. Gavashelishvili, pers. comm.).

Predators can have major influence on the population density of grouse, as has been shown in experimental and in empirical studies (Parker 1984, Marcström, Kenward & Engren 1988, Reynolds 1990, Hudson 1992, Kurki et al. 1997). However, there also is evidence that suitable habitat conditions may allow grouse to survive well despite high predator numbers (Baines 1996). Predation is unlikely to become a critical threat for a grouse population in a relatively undisturbed or natural landscape (e.g. Klaus et al. 1990). Many examples of populations that are considered to be threatened by predation come from severely fragmented and degraded habitats in landscapes intensively used by humans (e.g. Bergmann & Klaus 1994a,b, Klaus & Bergmann 1994, Loneux & Ruwet 1997, Weiss 1998). Accordingly, predation was named as a threat most frequently in questionnaires from European countries (see Fig. 2).

***Exploitation***

Because of the pronounced and often unpredictable fluctuations of many populations, grouse are susceptible to over-harvesting (Baines & Lindén 1991, Ellison 1991). Over-exploitation often appears to be related to insufficient enforcement of hunting regulations. Birds may be shot in excess of the legal hunting bags or outside the season. In the questionnaire, poaching has been reported most frequently from regions with poor rural economics (parts of Asia and eastern Europe), or from regions that combine relatively poor law enforcement with a high trophy or sport value of grouse (parts of southern Europe). The lekking species are particularly susceptible to over-exploitation. Birds at leks are easy targets and leks may be extirpated with little effort. Also, the spring hunt of displaying capercaillie and black grouse males at the leks, which is traditional throughout central Europe, involves a high risk of disturbing the social system at the lek, and may result in reduced reproductive success (see Baines & Lindén 1991).

***Human disturbance***

In many countries with wealthy societies, high human

population densities and urban life-styles, the growing popularity of outdoor activities increases the potential for conflicts between the interests of recreationists and the needs of wildlife. Regionally, e.g. in Japan (Y. Fujimaki, pers. comm.) and in western and central Europe (e.g. Ménoni & Magnani 1998, Zeitler & Glänzer 1998), recreationists have become one of the main concerns in grouse conservation, particularly with regard to leks, in winter habitats and during chick-rearing and moulting (Meile 1982, Baydack 1998, Ménoni & Magnani 1998, Zeitler & Glänzer 1998). Effects can be direct and indirect. The escape of a flushed grouse is energy-consuming, may expose the bird to predators and reduces the time available for foraging. Frequent presence of humans may expel grouse from otherwise suitable habitats. Individual response and population-level effects of human disturbance of birds may vary with a large number of inter-related variables, such as the number, sex and age of the birds, the proximity, type, intensity and cumulative number of human activities, and the temporal and spatial availability and distribution of food and cover (Hockin, Ounsted, Gorman, Hill, Keller & Barker 1992, Stalmaster & Kaiser 1998, Storch 1998).

### Implications for conservation

Healthy grouse populations require large or interconnected areas of natural or semi-natural habitat. Thus, grouse compete with increasing human populations and economic development. Human land use has been identified as the major threat to grouse worldwide, and has resulted in the largest range contractions of grouse in the past. The habitats of grouse have been altered by humans to varying degrees: the habitats of the tundra grouse are still largely unaffected, the forest habitats are going through a phase of major changes, and the prairie grouse have already lost most of their original ranges to human land use (Fig. 3). Thus, preservation and restoration of prairie grouse habitats, and integration of forestry practices with grouse habitat needs appear to be the most urgent tasks for grouse conservationists worldwide. As representatives of a wide spectrum of natural tundra, forest and grassland habitats of the northern hemisphere, grouse are frequently viewed as indicators of ecosystem health. Their indicator function and their attractiveness to people make grouse suitable flagship species to promote the conservation of their habitats and biodiversity in general.

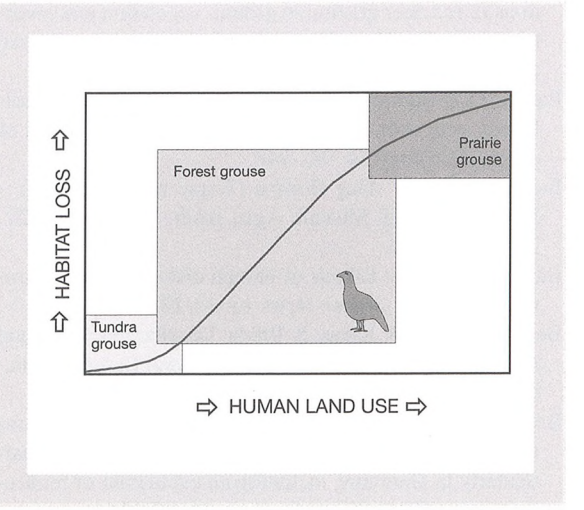


Figure 3. Conceptual model of the relationship between the intensity of human land use and the process of grouse habitat loss. The habitats of the tundra grouse have been least, those of prairie grouse most extensively affected by humans.

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