

RAPD molecular markers to study populations of black grouse *Tetrao tetrix* in the Alps

Authors: Bagliacca, Marco, Valentini, Alessio, Cappuccio, I., Schroeder, Michael A., Bland, James D., et al.

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ABSTRACTS

RAPD molecular markers to study populations of black grouse *Tetrao tetrix* in the Alps

Marco Bagliacca, Alessio Valentini & I. Cappuccio

Bagliacca, M., Valentini, A. & Cappuccio, I. 1997: RAPD molecular markers to study populations of black grouse *Tetrao tetrix* in the Alps. - Wildl. Biol. 3: 269.

The black grouse *Tetrao tetrix* is declining in most of the Alps where it historically occurred. A better knowledge of the genetics of the wild populations and of captive-reared birds is necessary for future reintroduction into areas where they historically occurred or where they are endangered. DNA-markers are the choice of method to study genetics of wild populations, but it is difficult to get blood samples from wild birds to extract DNA. A technique based on feathers as the DNA source was developed. DNA extracted from blood and feathers from seven birds was tested by PCR, 80 10-base primers. Only seven primers showed a repeatable amplification profile between DNA sources and polymorphic variation within the population. The selected primers were

used to amplify the DNA extracted from wild black grouse feathers in different areas (Trentino, Cuneo, Maritime Alps). The Trentino population presented a reduced genetic variability with an average band sharing (ABS) of 0.76 ± 0.145 in the captive-reared birds vs 0.70 ± 0.17 in all birds. The birds from Cuneo and the Maritime Alps had an ABS of 0.48 ± 0.07 and 0.35 ± 0.10 , respectively, and were quite different from the average genotype.

Key words: black grouse, genetic variability, RAPD molecular markers, *Tetrao tetrix*, the Alps

Marco Bagliacca, Dipartimento di Produzione Animale, Università di Pisa, Via delle Piagge, Pisa, Italy
Alessio Valentini & I. Cappuccio, Istituto di Zootecnia, Università della Tuscia, Via de Lellis Viterbo, Italy.

Do sage grouse *Centrocercus urophasianus* exhibit metapopulations in northcentral Washington, USA?

Michael A. Schroeder

Schroeder, M.A. 1997: Do sage grouse *Centrocercus urophasianus* exhibit metapopulations in northcentral Washington, USA? - Wildl. Biol. 3: 269.

Metapopulations can be considered populations of subpopulations, each with characteristic patterns of gene flow, extinction, and recolonization. Increased understanding of metapopulations is essential if wildlife managers are to maintain populations in altered environments. Management of sage grouse *Centrocercus urophasianus* has often been conducted with the tacit objective of managing subpopulations; this objective typically includes the delineation of high priority habitats within a defined proximity of known lek locations. This procedure has been defended by research and conjecture: 1) most females nest close to leks; 2) most females visit only one lek; and 3) each lek appears to represent a distinct population of females. Between 1992 and 1995 the possible existence of metapopulations was examined by observing 110 radio-marked sage grouse in northcentral Washington, USA. The 2,000 km² study area consisted of a variety of altered

habitats, configured in a highly fragmented landscape. The results indicate that the sage grouse in this area comprise a single population, not several subpopulations: 1) distances between nest locations and lek locations are large; 2) visits by females to more than one lek are common; 3) movements by birds within the population indicate that genetic transfer throughout the region is unhindered by distance, geography, and habitat. The lack of distinct subpopulations in northcentral Washington indicates that this sage grouse population should be managed as a single unit. Nevertheless, it is possible that the lack of evidence for subpopulations may reflect the scale of these observations; sage grouse may exist in a metapopulation at a larger scale, perhaps consisting of northcentral and southcentral Washington subpopulations.

Key words: *Centrocercus urophasianus*, management, metapopulation, sage grouse, Washington

Michael A. Schroeder, Washington Department of Fish and Wildlife, Bridgeport, Washington 98813, USA

Biogeography and conservation of blue grouse *Dendragapus obscurus* in California

James D. Bland

Bland, J.D. 1997: Biogeography and conservation of blue grouse *Dendragapus obscurus* in California - Wildl. Biol. 3: 270.

Blue grouse *Dendragapus obscurus* habitat associations were conducted in California at two geographic scales: 3rd-order associations between hooting groups and forest composition in the Sierra Nevada Mountains, and 1st-order associations between blue grouse and major vegetation types throughout the state. Findings are discussed with respect to distribution, habitat requirements, and conservation status of insular blue grouse populations in California. A total of 104 km of potential habitat was surveyed at the perimeters of Lassen Volcanic, Yosemite, and Sequoia National Parks, and the number, density, and habitat associations of grouse were studied intensively on six selected hooting sites. A revised state range map was created by plotting 550 observation records on a 1:1,000,000 map and adjusting range limits to more closely correspond with observation records, major forest types, and elevation contours. Exploratory surveys indicated abundances of territorial male blue grouse from 0.2 to 1.5/km (0.3 - 0.4/100 ha). Spot-mapping indicated densities ranging within 7-37 ha/grouse,

distances between nearest neighbours ranging from 50 to 615 metres, and a maximum group size of five individuals. Hooting sites were generally on the upper portions of west-facing slopes, usually near an open glade, and often within a few hundred metres of a ridge or plateau. Canopies were patchy and dominated by *Abies* and *Pinus*. Understory vegetation typically consisted of low (<1m) woody shrubs (*Arctostaphylos*, *Castanopsis*, *Ceanothus*, *Ribes*) interspersed with sparse grasses, herbs, and bare ground. Plotted observation records corresponded well with the distribution of CALVEG forest types. Potential insular populations were delineated in the southern North Coast Range, The Modoc Plateau, and in the White, Piute, Tehachapi, and northern Transverse ranges. Isolated *Abies* forests were identified at the core of most insular habitat.

Key words: blue grouse, California, conservation status, *Dendragapus obscurus*, distribution, habitat requirements, hooting groups

James D. Bland, 604 E. 11th Street, Davis, California 95616, USA

Effects of landscape characteristics on the abundance of hazel grouse *Bonasa bonasia* in Finland

Paavo Kumpu, Pekka Helle & Ari Nikula

Kumpu, P., Helle, P. & Nikula, A. 1997: Effects of landscape characteristics on the abundance of hazel grouse *Bonasa bonasia* in Finland. - Wildl. Biol. 3: 270.

The importance of landscape characteristics on hazel grouse *Bonasa bonasia* density was studied in two areas in Finland combining data from grouse counts and forest inventories. Hazel grouse data for 1985-95 originated from the Finnish wildlife monitoring program in which grouse were counted in August along permanent 12-km routes (wildlife triangles). Data for landscape characteristics were from satellite-based National Forest Inventory which provides information on land-use and stand structure for every 25 × 25 m element. Areas within 2.5 km from the centre points of triangles were classified into three classes according to their importance for hazel grouse: 1) unsuitable area (e.g. water areas and fields), 2) poor habitat (e.g. young stages of forest succession), and 3) prime habitat (i.e. medium-aged and old stands). The mean hazel grouse density in August was 8.8 and 5.6 birds/km² in the southern and northern study area, respectively, roughly corresponding to the area of prime habitat in the study areas. The pro-

portion of unsuitable habitat in the landscape had no significant effect on grouse density. Although unsuitable, the open areas decrease the area available for hazel grouse, this loss is compensated by the fact that stands along lake shores and fields are highly productive and among the ones most preferred by hazel grouse. The proportion of poor habitat in the landscape was significantly negatively correlated with hazel grouse density, whereas the proportion of prime habitat was positively correlated with hazel grouse density. Correlations were generally stronger for the northern study area than for the southern area.

Key words: *Bonasa bonasia*, density, Finland, hazel grouse, landscape characteristics, land use, stand structure

Paavo Kumpu & Pekka Helle, Meltaus Game Research Station, Finnish Game and Fisheries Research Institute, FIN-97340 Meltaus, Finland

Ari Nikula, Finnish Forest Research Institute, Rovaniemi Research Station, FIN-96301 Rovaniemi, Finland

Importance of herbaceous vegetation to female sage grouse *Centrocercus urophasianus* during the reproductive period: a synthesis of research from Oregon, USA

John A. Crawford

Crawford, J.A. 1997: Importance of herbaceous vegetation to female sage grouse *Centrocercus urophasianus* during the reproductive period: a synthesis of research from Oregon, USA. - Wildl. Biol. 3: 271.

Sage grouse *Centrocercus urophasianus* were once common to abundant in Oregon, USA. During the past century, however, both distribution and numbers have declined, which prompted research that began in 1987. Previous work revealed the importance of sagebrush *Artemisia* spp. for many of the life-history needs of sage grouse. Little research emphasis has been placed, however, on the potential importance of herbaceous components of sage grouse habitat. Results of work in Oregon indicated that forbs are an important component of the diet of pre-laying hens and may be related to reproduc-

tive success. Several studies revealed that the amount of residual tall grass cover and medium height sagebrush were related closely to nest success. Further, forb availability influenced habitat use by hens with broods, and the amount of forbs and insects in chick diets may be related to recruitment of young. These studies indicated that forbs and residual grass cover are of substantially greater importance to sage grouse reproductive success than previously realized.

Key words: *Artemisia* spp, *Centrocercus urophasianus*, diets, herbaceous components, reproductive success, sagebrush, sage grouse

John A. Crawford, Department of Fisheries and Wildlife, Oregon State University, Corvallis, Oregon 97331, USA

Can raptor predation limit or regulate grouse populations? II. Impact of predation on red grouse *Lagopus lagopus scoticus*

Simon J. Thirgood & Stephen M. Redpath

Thirgood, S.J. & Redpath, S.M. 1997: Can raptor predation limit or regulate grouse populations? II. Impact of predation on red grouse *Lagopus lagopus scoticus*. - Wildl. Biol. 3: 271.

Whether vertebrate predators can limit or regulate their prey has long been a controversial question in ecology. This study presents the findings of a 5-year study of predation by hen harriers *Circus cyaneus* and peregrine falcons *Falco peregrinus* on a red grouse *Lagopus lagopus scoticus* population in southern Scotland. Monitoring grouse numbers and productivity through counts with dogs, searching for grouse carcasses, and intensive radiotelemetry, combined with concurrent studies of raptor diet and breeding densities suggests that raptor predation may influence grouse populations in three ways. First, raptor predation during winter (October-March) may reduce adult grouse numbers by up to 50%. The extent to which this predation is compensated by other factors is currently unknown. Second, raptor pre-

dation in spring (April-May) may further reduce adult grouse numbers by an additional 30%. These losses are unlikely to be compensatory and, therefore, result in lost productivity. Finally, predation by hen harriers in summer (June-July) can result in up to 25% loss of grouse chicks produced by the remaining hens. The combined impact of spring and summer raptor predation can result in up to 47% reduction in productivity.

Key words: *Circus cyaneus*, compensatory mortality, *Falco peregrinus*, hen harrier, *Lagopus lagopus scoticus*, peregrine falcon, predation, productivity, red grouse, Scotland

Simon J. Thirgood, The Game Conservancy Trust, Crubenmore Lodge, Newtonmore, Inverness-shire, Scotland, PH20 1BE, United Kingdom

Stephen M. Redpath, Institute of Terrestrial Ecology, Monks Wood, Abbots Ripton, Huntingdon, Cambridgeshire, PE17 2LS, United Kingdom

The dietary composition of black grouse *Tetrao tetrix* in the Italian Alps

Paolo F. de Franceschi, Angela Sepulcri, Stefano Filacorda & Edi Piasentier

Franceschi, P.F. De, Sepulcri, A., Filacorda, S. & Piasentier, E. 1997: The dietary composition of black grouse *Tetrao tetrix* in the Italian Alps. - Wildl. Biol. 3: 272.

The contents of the crops and/or gizzards from 54 black grouse *Tetrao tetrix* shot in the Italian Alps during October-November 1993 were examined. The frequency of foods in the diet was calculated by considering both crops and gizzards (16 birds) and by considering crops and gizzards separately (11 birds with crops and 27 birds with gizzards); the percentage dry matter (DM) weight of foods was calculated for the contents of 27 crops. The most frequently found ingredients were shoots of *Vaccinium myrtillus* (VM 67%), buds and leaves of *Rhododendron ferrugineum* (RF 50%), shoots of *Larix decidua* (LD 43%), fruits of *Sorbus* spp. (S 44%), and stems, leaves, fruits, and seeds of herbaceous species (A 56%; *Geum* spp., *Galium* spp., *Anemone* spp.). The same foods were also the most abundant when considering dry matter percentage (VM 15%DM, RF 17%DM, LD 12%DM, A 19%DM). The frequency

and DM weight proportions of VM shoots were correlated with those of RF buds and leaves and shoots of *Calluna vulgaris*, whereas those of *Rhododendron hirsutum* buds and leaves were correlated with those of shoots of *Salix* spp. and needles of *Pinus mugo*. Buds of *Fagus sylvatica* were negatively correlated with the presence of *Vaccinium* shoots and positively correlated with *Sorbus* fruits.

Key words: black grouse, correlations, crop content, dietary composition, gizzard content, Italian Alps, *Tetrao tetrix*

Paolo F. de Franceschi, Museo Civico di Storia Naturale di Verona, Via Lungadige, Porta Vittoria 9, 33127 Verona, Italy

Angela Sepulcri, Stefano Filacorda & Edi Piasentier, Dipartimento di Scienze della Produzione Animale, Università degli Studi di Udine, Via S. Mauro 2, 33010 Pagnacco, Udine, Italy

The role of the metapopulation concept in conservation of European woodland grouse

Ilse Storch

Storch, I. 1997: The role of the metapopulation concept in conservation of European woodland grouse. - Wildl. Biol. 3: 272.

The possible role of metapopulation theory in conservation of central European woodland grouse is discussed. Grouse habitats in central Europe are fragmented at hierarchical levels of scale. At the continental scale, grouse are restricted to isolated, mostly montane, distribution ranges; nearest neighbour distances average 37, 54, and 100 km for hazel grouse *Bonasa bonasia*, black grouse *Tetrao tetrix*, and capercaillie *T. urogallus*, respectively. Based on a review of published reports, median juvenile dispersal distances and adult movements range within 1-3 km; maximum reported dispersal distances were 7 km in hazel grouse, 34 km in black grouse, and 75 km in capercaillie. These distances indicate that exchange between most distribution ranges is unlikely. At the regional scale, i.e. within distribution ranges, grouse habitats are interspersed with farmland and other unsuitable habitat types. Nearest neighbour distances between patches of grouse habitats in an area of the Alps averaged 2.0 km for capercaillie and possibly hazel grouse, and 4.6 km for black grouse and, thus, were within the range of juvenile dispersal distances.

Therefore, metapopulation dynamics are likely within but not among central European grouse ranges. The metapopulation hypothesis has important implications for conservation of central European woodland grouse. Many populations are <100 birds, which is most probably too small for long-term viability. Thus, dispersal between local populations may be of major importance. Attempts to stabilize a population below minimum viable population size will fail unless dispersal from neighbouring populations occurs. Therefore, conservationists concerned with remnant grouse populations also have to consider potential donor populations. Conservation policy might be wrong in concentrating efforts exclusively on populations close to extinction. As a conceptual framework, the greatest value of the metapopulation theory is in communicating the importance of spatial aspects for population persistence in fragmented habitats.

Key words: central Europe, conservation, metapopulation theory, woodland grouse

Ilse Storch, Munich Wildlife Society, Linderhof 2, 82488 Ettal, Germany

Response of ruffed grouse *Bonasa umbellus* to forest management in the southern Appalachian Mountains, USA

Ralph W. Dimmick, Jeffrey D. Sole, Phillip E. Hale & William G. Minser

Dimmick, R.W., Sole, J.D., Hale, P.E. & Minser, W.G. 1997: Response of ruffed grouse *Bonasa umbellus* to forest management in the southern Appalachian Mountains, USA. - Wildl. Biol. 3: 273.

Ruffed grouse *Bonasa umbellus* densities were determined in four study sites in Tennessee during 1983-1993, two in eastern Kentucky during 1989-1995, and one in northern Georgia during 1976-1982. Intensive counts of drumming males were conducted 2-4 times per week from late March to mid-May. The peak drumming period occurred during mid-April. Mean numbers of drumming males over the study period combining all areas within each state were: Georgia: 1.8/100 ha (0.08 - 2.8); Tennessee: 1.3/100 ha (0 - 3.1); Kentucky: 2.8/100 ha (1.2 - 4.0). The influence of forest harvest on population density was measured on two study areas in Tennessee. Pre-harvest densities of drumming males were measured on one area for four years prior to forest harvest and for seven years post-harvest, and for 11 years in an adjacent study site with no harvest. Mean population density in the

control area varied over the 11-year study period from 0 to 1.1 males/100 ha, but did not change markedly from 1983 (0.9) to 1993 (1.1). The experimental area initially had a low population (\bar{x} = 0.2 males/100 ha), but density increased steadily following the clearcutting of several small patches in 1986. In 1993, a density of 3.1 males/100 ha was estimated in this experimental area, a 15-fold increase from the pre-harvest grouse density.

Key words: *Bonasa umbellus*, drumming males, forest harvest, population densities, ruffed grouse, southern Appalachian Mountains

Ralph W. Dimmick & William G. Minser, Department of Forestry, Wildlife and Fisheries, University of Tennessee, Knoxville, Tennessee 37901, USA

Jeffrey D. Sole, Kentucky Department of Fish and Wildlife Resources, Rt 1, Game Farm Road, Frankfort, Kentucky 40601, USA

Phillip E. Hale, School of Forest Resources, University of Georgia, Athens, Georgia 30602, USA

Temporal and spatial changes of sage grouse *Centrocercus urophasianus* habitat in the sagebrush ecosystem

Richard F. Miller & Lee L. Eddleman

Miller, R.F. & Eddleman, L.L. 1997: Temporal and spatial changes of sage grouse *Centrocercus urophasianus* habitat in the sagebrush ecosystem. - Wildl. Biol. 3: 273.

Plant species composition, community structure and matrix of plant communities across the landscape determine the quality of hiding and nesting cover, and the season of availability, abundance, and quality of food for sage grouse *Centrocercus urophasianus* throughout the year. Plant species composition and structure at the community and landscape levels vary in time and space and are functions of climate, geology, topography, soils, and disturbance. These factors vary greatly across the vast sagebrush *Artemisia* region which accounts for the majority of sage grouse habitat. The sagebrush biome also encompasses numerous other vegetation zones, of which some are important and some are not, to the sage grouse life cycle. The variability of this landscape enables sage grouse to move from valley floors to high elevation communities or from semi-arid uplands to wet meadows, following the phenology of succulent forbs during the pre-nesting and brood rearing stages. The variable landscape also provides opportunities for food and cover during winter. Structure, composition, and matrix of plant communities characterizing today's

landscapes are unique from any other time period in the past due to a change in disturbance regimes, introduction of exotic species, and land conversion to cropland, urbanization, and mining. These factors, interacting with soils, topography, and a continual change in climate, have shaped the plant communities of the 20th century. Spatial and temporal changes in vegetation across the sagebrush biome are discussed. Focus is placed on: 1) environmental factors which determine spatial change of potential natural flora across and within the different sagebrush types; 2) environmental factors which determine long-term and short-term temporal change in vegetation; and 3) management considerations which influence community structure and food availability for sage grouse.

Key words: *Centrocercus urophasianus*, habitat, management, sagebrush biome, sage grouse, spatial change, temporal change

Richard F. Miller, Great Basin Experimental Range, Oregon State University, Burns, Oregon 97720, USA
Lee L. Eddleman, Department of Rangeland Resources, Oregon State University, Corvallis, Oregon 97331, USA

Defining habitat quality for ruffed grouse *Bonasa umbellus* in the southern Appalachians using HSI models

Melora A. Doan, Ralph W. Dimmick, David A. Buehler & John C. Rennie

Doan, M.A., Dimmick, R.W., Buehler, D.A. & Rennie, J.C. 1997: Defining habitat quality for ruffed grouse *Bonasa umbellus* in the southern Appalachians using HSI models. - Wildl. Biol. 3: 274.

Two Habitat Suitability Index models were created for ruffed grouse *Bonasa umbellus* in the Cumberland Plateau physiographic region of Tennessee, USA. One model evaluated winter habitat and the other evaluated brood habitat. The model for winter habitat used four variables to evaluate habitat suitability, including proximity to evergreen shrub thickets, habitat diversity within home range size, age class of the overstory, and overstory forest group. The brood habitat model used four variables to evaluate habitat for young broods including proximity to daylighted roads, habitat diversity within home range, overstory age class, and overstory forest group. The models were applied to the currently inventoried portion (approximately 30%) of the Catoosa Wildlife Management Area. These models were used to define habitat quality based on the assumption that there are two major limiting factors for grouse in Tennessee,

winter habitat and brood habitat, and to determine the location of the best of these habitats in relation to each other on the Catoosa Wildlife Management Area. Little of the currently inventoried area had high suitability under either model. On a scale of 0-1.0 where 1.0 is optimal habitat, the winter habitat model classified only 1.06% of the currently inventoried area greater than 0.75. The brood habitat model classified only 0.30% of the inventoried area as greater than 0.75. Areas with HSI values above 0.75 for both models were often within home range size, but the scarcity of high quality habitat on Catoosa indicates that grouse densities will remain low without increased forest management for their needs.

Key words: *Bonasa umbellus*, habitat quality, HSI models, ruffed grouse, southern Appalachian Mountains

Melora A. Doan, Ralph W. Dimmick, David A. Buehler & John C. Rennie, Department of Forestry, Wildlife and Fisheries, University of Tennessee, Knoxville, Tennessee 37901, USA

Blue grouse *Dendragapus obscurus* recruitment and weather relationships in northeastern Oregon, USA

Eric C. Pelren & John A. Crawford

Pelren, E.C. & Crawford, J.A. 1997: Blue grouse *Dendragapus obscurus* recruitment and weather relationships in northeastern Oregon, USA. - Wildl. Biol. 3: 274.

Recruitment and juvenile survivorship may be primary factors affecting blue grouse *Dendragapus obscurus* populations. Studies of blue grouse relationships with weather revealed contrasting effects of winter and spring precipitation on populations, and the subsequent need for a better understanding of weather effects on the species. The relationships between winter, spring, and summer weather, and percent immature blue grouse in fall harvest were ascertained to understand potential effects of weather on blue grouse brood recruitment and survivorship. These data were based on 15 years of hunter-harvested grouse wing data obtained from the Oregon Department of Fish and Wildlife in Wallowa County. Fall immature:adult ratios were positively related to monthly mean minimum temperature ($P = 0.04$) and negatively related to precipitation ($P = 0.05$) during the breeding period (March-April) ($r^2 = 0.49$). The relationship with monthly mean minimum temperature also was present during May ($P = 0.03$, $r^2 = 0.30$), but no

relationship existed with precipitation during this time period; weather conditions during April alone were not related to fall immature:adult ratios. Relationships were not detected between population age-ratios and weather during winter (December-February), peak hatch (four weeks centered on peak hatch date), post-hatch (June), summer (July-August), or during any other months. Weather likely affected hen condition and subsequent ability to care for juvenile grouse. It also may have affected food or cover available to juvenile grouse, as well as ability to thermoregulate. Weather likely affects grouse differently in different climatological regions. Increased understanding of weather effects on specific populations may enhance management efforts for grouse.

Key words: age ratios, blue grouse, brood recruitment, *Dendragapus obscurus*, Oregon, survivorship, weather effects

Eric C. Pelren & John A. Crawford, Department of Fisheries and Wildlife, Oregon State University, Corvallis, Oregon 97331, USA

Female social behaviour on sage grouse *Centrocercus urophasianus* leks in the Gunnison Basin, Colorado, USA

Laura A. Higgins, Jennifer A. Hill, Jessica R. Young & Richard D. Howard

Higgins, L.A., Hill, J.A., Young, J.R. & Howard, R.D. 1997: Female social behaviour on sage grouse *Centrocercus urophasianus* leks in the Gunnison Basin, Colorado, USA. - Wildl. Biol. 3: 275.

Female social behaviour on leks has become an important component of sexual selection hypotheses which attempt to address the lekking phenomena. However, most data on female social behaviours on grouse leks have been *ad libitum* observations or anecdotal reports. This is in direct contrast to studies on male mating behaviours and studies such as foraging, migration, and habitat use which generally investigate both sexes. Quantified data are presented on three aspects of female behaviour: 1) female sage grouse *Centrocercus urophasianus* give context specific vocalizations on the lek; 2) females are temporally synchronized in daily and seasonal lek attendance; 3) females form tight spatial aggregations during lek visits. These data suggest that

female interactions are as socially complex as male interactions on leks. Understanding the role of sexual selection in the evolution of lek mating systems requires comparable study of both sexes during their mating season. Furthermore, management and conservation of grouse species can only be enhanced by a more complete understanding of lek social dynamics in both sexes.

Key words: *Centrocercus urophasianus*, female social behaviour, lek mating, sage grouse, sexual selection

Laura A. Higgins, Department of Zoology, University of Texas, Austin, Texas 78712, USA

Jennifer A. Hill & Richard D. Howard, Department of Biology, Purdue University, West Lafayette, Indiana 47907, USA

Jessica R. Young, Department of Biology, Western State College, Gunnison, Colorado 81231, USA

Attwater's prairie-chicken *Tympanuchus cupido attwateri*: status, limiting factors and future

Michael E. Morrow, Clifton P. Griffin, Markus J. Peterson & Nova J. Silvy

Morrow, M.E., Griffin, C.P., Peterson, M.J. & Silvy, N.J. 1997: Attwater's prairie-chicken *Tympanuchus cupido attwateri*: status, limiting factors and future. - Wildl. Biol. 3: 275.

The number of endangered Attwater's prairie-chicken (APC) *Tympanuchus cupido attwateri* has decreased dramatically since the last published status report 16 years ago. The 1980-population estimate of 1,584 individuals decreased to an estimated 42 individuals in the wild as of spring 1996. Of the 10 counties inhabited by APC in 1980, only three supported APC in spring 1996. As predicted in 1980, habitat loss has gradually reduced numbers, however, the dramatic decrease in numbers during the last four years cannot be attributed solely to habitat loss. Reduced environmental quality, disease, inbreeding, and environmental stochasticity may have contributed to this rapid decline. Environmental stochasticity is an important factor affecting low populations of *r*-selected species. Previous studies have documented the relationship between prairie grouse nesting success and subsequent population changes. Computer simulations were used to estimate the minimum popula-

tion size of APC that would be able to withstand the impacts of environmental stochasticity on nesting success with minimal (5%) risk of extinction. Extinction risks for populations of 100, 200, and 225 individuals were estimated at 13, 8, and 3%, respectively. Carrying capacity was particularly important to the resilience of a population with respect to environmental stochasticity. Captive breeding is currently underway to supplement existing populations. Without supplementation, the wild population is predicted to be extinct by the year 2000. Consideration of the risks of extinction associated with environmental stochasticity should have an integral part in recovery planning for this endangered species.

Key words: Attwater's prairie-chicken, carrying capacity, extinction, environmental stochasticity, limiting factors, status, *Tympanuchus cupido attwateri*

Michael E. Morrow, Attwater Prairie-Chicken National Wildlife Refuge, Eagle Lake, Texas 77434, USA

Clifton P. Griffin, Markus J. Peterson & Nova J. Silvy, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, Texas 77843, USA

The role of genetics and behaviour in sage grouse *Centrocercus urophasianus* management and conservation

Jessica R. Young & Dennis J. Minchella

Young, J.R. & Minchella, D.J. 1997: The role of genetics and behaviour in sage grouse *Centrocercus urophasianus* management and conservation. - Wildl. Biol. 3: 276.

Typically, in species with lek mating systems such as sage grouse *Centrocercus urophasianus*, only a small percentage of males mate and contribute genetically to subsequent generations. These extreme skews in male mating success can severely reduce the amount of genetic variation in a population due to reductions in effective population size. The extent of within and between population genetic differentiation was measured in four sage grouse populations using DNA-fingerprinting. Sage grouse had higher band-sharing and F_{st} values than those estimated for other outbred non-lekking avian species. Sage grouse exhibited moderately high levels of differentiation among populations as well as between leks within a population. The geographical distribution

of sage grouse and other North American lekking grouse has been reduced sharply during this century. It is suggested that lek mating species may be particularly vulnerable to environmental changes because their skewed male mating distribution reduces population genetic diversity and potential to adapt to changing conditions. In addition, it is suggested that male and female behaviours associated with lek mating systems may result in increased management and conservation concerns.

Key words: behaviour, *Centrocercus urophasianus*, DNA-fingerprinting, genetics, lek mating systems, North America, sage grouse

Jessica R. Young, Department of Biology, Western State College, Gunnison, Colorado 81231, USA

Dennis J. Minchella, Department of Biology, Purdue University, West Lafayette, Indiana 47907, USA

Isolation and decline of marginal capercaillie *Tetrao urogallus* subpopulations in the northern Black Forest

Helmut Weiss

Weiss, H. 1997: Isolation and decline of marginal capercaillie *Tetrao urogallus* subpopulations in the northern Black Forest. - Wildl. Biol. 3: 276.

A high density capercaillie *Tetrao urogallus* population occurred in the mountains of the northern Black Forest in the 19th century. During that period, the non-industrial exploited forests, also impacted by grazing and littering, had been optimal habitats, similar to the original virgin Taiga forests in the northern hemisphere of Europe and Asia. As these woodlands were restored to productive, economically-oriented forests, their quality as capercaillie habitat decreased. Thus, the formerly dense grouse population was diminished, leaving only marginal and isolated subpopulations, which are endangered and

threatened with total extinction. Three of these 'isles' were examined, concerning the changing numbers in the capercaillie populations and the change in space and structure of the habitat. This was done by evaluating yearly counts of displaying cocks and forest inventory data and maps of the last four decades. The results may provide important insight for silvicultural decisions as management that may positively impact capercaillie populations.

Key words: capercaillie, forest management, northern Black Forest, *Tetrao urogallus*

Helmut Weiss, Schönklingsstrasse 22, 75339 Hoefen, Germany

Habitat fragmentation and viability of capercaillie *Tetrao urogallus* populations in the French Pyrenees

Emmanuel Ménoni, Philippe Landry & C. Berducou

Ménoni, E., Landry, P. & Berducou, C. 1997: Habitat fragmentation and viability of capercaillie *Tetrao urogallus* populations in the French Pyrenees. - Wildl. Biol. 3: 277.

In the French Pyrenees, 3,000-5,000 adult capercaillie *Tetrao urogallus* occupy 2,200 km² of habitat fragmented into 93 forested areas. These areas are further subdivided into habitat islands varying in size from 5 to 12,000 ha, separated by distances of 5-100 km. The total number of leks in these islands is 600-700. Winter habitat is often limited, representing only 11% of the geographic range in some areas. Nevertheless, capercaillie show great plasticity in regard to winter foods. The birds often winter in pure stands of *Abies alba* in the French Pyrenees which is in contrast to those in the boreal forests, where capercaillie are dependent on *Pinus sylvestris*. Brood habitats are even more limited in the French Pyrenees and, in some areas, represent only 6%

of the geographic range. To compensate for the lack of brood habitats within forests, hens often rear their young in prairies or brushlands. Although the metapopulation of the Pyrenees apparently contains only 18 viable populations, the geographic range remains stable due to both dispersal of young from productive populations and habitat plasticity.

Key words: brood habitat, capercaillie, French Pyrenees, habitat fragmentation, population viability, *Tetrao urogallus*

Emmanuel Ménoni, Office National de la Chasse, F-31800 Saint Gaudens, Cedex, France

Philippe Landry, Office National de la Chasse, Saint-Benoist, F-78610 Auffargis, France

C. Berducou, Office National des Forêts, F-6400 Pau, France

Mitochondrial DNA analysis using feathers of rock ptarmigan *Lagopus mutus japonicus* and hazel grouse *Bonasa bonasia* in Japan

Yoshiyuki Baba, Hiroko Koike, Toshinao Okayama & Yuzou Fujimaki

Baba, Y., Koike, H., Okayama, T. & Fujimaki, Y. 1997: Mitochondrial DNA analysis using feathers of rock ptarmigan *Lagopus mutus japonicus* and hazel grouse *Bonasa bonasia* in Japan. - Wildl. Biol. 3: 277.

The rock ptarmigan *Lagopus mutus japonicus* is listed as an endangered species in the Japanese Environment Agency's Red Data Book (1991). Their populations, now about 3,000, are declining, because their habitat is restricted to the creeping pine forest of the Japanese Alps. Feather samples of rock ptarmigan were collected from four main local populations (Hakuba, Tateyama, Oomachi, Norikura) in the Japanese Alps during the moulting season between May and June. Wing samples of hazel grouse *Bonasa bonasia* were obtained during the hunting season from wild birds in Hokkaido. Seven specific primers were designed to amplify whole sequences of the control region of mitochondrial DNA (mtDNA) using the PCR method. Whole sequence data on the mtDNA control region for rock ptarmigan, hazel grouse, Japanese quail *Coturnix japonica*, and chicken had a length of 1,251 bp in the consensus sequence,

showing they have more polymorphic sites between 150 and 450 bp, and between 1,000 and 1,250 bp from the beginning of the control region. No polymorphic sites were found on 757 bps in the control region for 15 samples of rock ptarmigan from the four local populations in the Japanese Alps. Hazel grouse had 21 polymorphic sites on 441 bps in the control region for 36 samples, suggesting that rock ptarmigan in the Japanese Alps had little genetic variability.

Key words: *Bonasa bonasia*, control region sequence, hazel grouse, Japan, *Lagopus mutus japonicus*, mitochondrial DNA, rock ptarmigan

Yoshiyuki Baba, Hiroko Koike & Toshinao Okayama, Graduate School of Social and Cultural Studies, Kyushu University, Ropponmatu 4-2-1, Chuo-ku, Fukuoka 810, Japan

Yuzou Fujimaki, Wildlife Ecology, Obihiro University, Inadamati West 2 Line 11, Obihiro City, Hokkaido 080, Japan

Seasonal diet of black grouse *Tetrao tetrix* in the moorlands of northern England

Anne E. Westerberg

Westerberg, A.E. 1997: Seasonal diet of black grouse *Tetrao tetrix* in the moorlands of northern England. - Wildl. Biol. 3: 278.

The seasonal diet of adult black grouse *Tetrao tetrix* was studied from 1988 to 1991 within a 17 km² area of the Pennine uplands of northern England. Diet was assessed through faecal analysis of samples collected from radio-marked and flushed birds, from lek sites where males displayed throughout the year, and from broods of six radio-marked females. The diet of adults consisted of leaves, flowers, fruits, and seeds from a large number of plant species. In autumn and winter, leaves and stems of *Calluna vulgaris* formed the major part of the diet of both sexes. In winter, cocks consumed a greater proportion of heather than hens. Leafy material from herbs and grasses formed the remainder of the autumn and winter diet. In early spring, shoots of *Eriophorum vaginatum* provided a valuable early protein source for both cocks and hens. In spring and summer, leaves, flowers, fruits, and seeds of grassland and moorland ericaceous shrubs,

herbs, grasses, sedges, and rushes were taken as they became seasonally available within the birds' range. Tree food rarely occurred in the diet, but was eaten by some individuals in autumn, winter, and spring where it was available. Tentative comparisons with the diet of cocks from other north English moorlands showed similarities in plants eaten, but their proportions often varied widely. The invertebrate diet of young chicks in these moorland habitats was particularly rich in sawfly larvae, Lepidopteran larvae, beetles, dipteran flies, and parasitoid wasps, although less abundant in the diet than sawfly larvae, were also important dietary constituents. Ants, which are common in black grouse chick diets in forested habitats, were rarely found in chick faecal material.

Key words: black grouse, moorland, northern England, seasonal diet, *Tetrao tetrix*

Anne E. Westerberg, 32 Manor Road, Medomsley, Consett, Co. Durham, DH8 6QW, United Kingdom

An evaluation of nest placement theory using artificial and Columbian sharp-tailed grouse *Tympanuchus phasianellus columbianus* nests

Anthony D. Apa, Kerry P. Reese & John W. Connelly, Jr.

Apa, A.D., Reese, K.P. & Connelly, J.W., Jr. 1997: An evaluation of nest placement theory using artificial and Columbian sharp-tailed grouse *Tympanuchus phasianellus columbianus* nests. - Wildl. Biol. 3: 278.

Avian predation is a major factor affecting clutch success for ground nesting birds, especially during egg laying when the nest is unattended. Nest predation could influence nest placement by hens of lek-attending species by causing an over-dispersion of cryptic prey and/or it may also have an indirect or direct influence on lek evolution and development. This study tested two lek evolution hypotheses; the male-avoidance and sentinel/decoy models. In total, 551 artificial nests were constructed around seven active Columbian sharp-tailed grouse *Tympanuchus phasianellus columbianus* leks over two years. Nests were checked following 1, 3, 6 and 9 days of exposure during two egg-placement periods. Forty-eight Columbian sharp-tailed grouse nests were also evaluated. Distance from lek contributed significantly to the artificial nest logistic regression model for each day checked. Finite daily survival of artificial

nests increased with increasing distance from the lek as nest density decreased. Vegetation structure was homogeneous across all distances for artificial and grouse nests. Similar survival patterns were not apparent with sharp-tailed grouse nests. The data obtained in this study lend credence to the male-avoidance model and suggests that female sharp-tailed grouse in Idaho may reduce predation on their nests by nesting farther from leks where they encounter lower nest densities. The sentinel/decoy model predictions and hypotheses may not be applicable to Columbian sharp-tailed grouse in southeastern Idaho. Distance from and density of nests from active leks are interrelated aspects of nest survival.

Key words: Columbian sharp-tailed grouse, Idaho, lek evolution, nest placement, *Tympanuchus phasianellus*

Anthony D. Apa & Kerry P. Reese, Department of Fish and Wildlife Resources, University of Idaho, Moscow, Idaho 83843 USA

John W. Connelly, Jr., Idaho Department of Fish and Game, 1345 Barton Road, Pocatello, Idaho 83204, USA

Modelling harvest of willow ptarmigan *Lagopus lagopus* in Sweden

Tomas Willebrand

Willebrand, T. 1997: Modelling harvest of willow ptarmigan *Lagopus lagopus* in Sweden. - Wildl. Biol. 3: 279.

More than 60,000 km² of the state-owned Swedish mountain range was opened to the public for small game hunting in 1993, and different management strategies were discussed to avoid risk of overharvesting willow ptarmigan *Lagopus lagopus*. In 1994, the average end of season harvest rate was estimated at less than 10% of the autumn population. However, local variation in harvest rates was high. For example, harvest estimates on a study area with good road access were closer to 30%. The results of several Scandinavian willow ptarmigan studies show average production of 2.8 young per pair. Although the annual variation can be between 0.5 and 6 young per pair, there is no evidence of density dependency. There are only a few estimates of annual survival; mark-recapture methods suggest annual survival of the whole population is about 40%. A population model was

developed in which only survival was density dependent. This model was used to investigate the outcome of harvesting a willow ptarmigan population at different rates where natural survival showed either a high, medium, or low response to reduced densities. The model predictions are being compared with earlier published results and preliminary findings of a recent project on willow ptarmigan population dynamics using radio-marked individuals. Comparisons suggest that density-dependent survival and compensatory mortality were weak at the management scale (10-100 km²), and that a better understanding of the mechanisms of movement and dispersal on a landscape level is necessary.

Key words: density dependence, harvest, *Lagopus lagopus*, population modelling, Sweden, willow ptarmigan

Tomas Willebrand, Department of Animal Ecology, Swedish University of Agricultural Sciences, 901 83 Umeå, Sweden

Dispersal and movements in a Swedish willow grouse *Lagopus lagopus* population

A. Adam Smith

Smith, A.A. 1997: Dispersal and movements in a Swedish willow grouse *Lagopus lagopus* population. - Wildl. Biol. 3: 279.

Between 1992 and 1995, radio-telemetry was used to study landscape scale patterns of movement in an upland Swedish population of willow grouse *Lagopus lagopus*. The net first-year dispersal distances of juvenile females (mean = 11.4 km) differed (Z-test, $P > 0.008$) from those of juvenile males (mean = 2.6 km). Juvenile females dispersed over a few days in either or both of the periods October-January and April-May. Juvenile male dispersal was broadly continuous throughout the year. Two-thirds of marked juvenile females dispersed >6 km from their brood site. Differences within sexes were not associated with apparent breeding success, body condition index, or grouse density on the natal area. No age or sex class showed density-dependent immigration being induced by lowering grouse densities on a central hunting area. Adult females were migratory between wintering areas used as a juvenile and their first breeding site; 56% migrated over 3 km. Timing of migration for adults was

similar to that of juvenile females. Adult males and short-distance migrant females had similar annual range sizes (4 km²). Yearling females that failed to fledge young tended to disperse to a new breeding range the following year. Adult and juvenile female movements during spring were similar in all respects. Return in spring to breeding sites appeared dependent on snow cover at higher altitudes. Excursions lasting 1-5 days from winter to breeding areas were observed during spring for some females. Variable dispersal distances have important implications depending on scale effects. At scales of 5 km, movements of juveniles and adult females have a role in redistributing birds within landscape units. At landscape scales, only dispersing juvenile females and a few adult females are important in inter-population contacts.

Key words: *Lagopus lagopus*, landscape, migration, movements, natal dispersal, Sweden, willow grouse

A. Adam Smith, Edward Grey Institute, University of Oxford, Department of Zoology, South Parks Road, Oxford, OX1 3PS, United Kingdom

Habitat management for sharp-tailed grouse *Tympanuchus phasianellus* on private lands in Manitoba, Canada

Richard K. Baydack

Baydack, R.K. 1997: Habitat management for sharp-tailed grouse *Tympanuchus phasianellus* on private lands in Manitoba, Canada. - Wildl. Biol. 3: 280.

Private lands in Manitoba's agricultural zone generally contain the remaining habitat for sharp-tailed grouse *Tympanuchus phasianellus*. Much of this area has been changed through agricultural activities, resulting in fragments of suitable habitat interspersed with cropland and other intensive farming operations. Habitat alteration has resulted in reduction in suitable sites for nesting and brood rearing for sharp-tailed grouse. A Private Lands Management Program (PLMP) has been developed in Manitoba through the efforts of the Sharptails Plus Foundation. Sharptails Plus is a private, non-government organization, with the objective of maintaining or increasing populations of sharp-tailed grouse in Manitoba. The PLMP is designed to assist landowners by suggesting modifications to farming practices which improve farm profitability while also enhancing habitat for wildlife. The program identifies candidate landowners, sets project objectives for habitat improvement through a technical advisory committee, and evaluates

effects of habitat treatments from the biological and agricultural perspective. The technical advisory committee includes biologists, agrologists, and land managers working together in an interdisciplinary framework. All steps of the program must be approved by the landowner. Three Sharptails Plus demonstration projects have been initiated to depict the variety of techniques that landowners can use to enhance their farming operations and improve habitat. Data from the past three years for the demonstration sites indicate that sharptail attendance at leks has been stable or has increased, evidence of nesting in managed habitat is greater than in unmanaged, and vegetation composition in managed areas has changed from an open grassland or a forested grassland to a grass-shrub mix. Evaluation will continue through 1997.

Key words: Canada, habitat management, Manitoba, sharp-tailed grouse, *Tympanuchus phasianellus*

Richard K. Baydack, Natural Resources Institute, University of Manitoba, Winnipeg, Manitoba, R3T 2N2, Canada

The dynamics of blood parasite infections in black grouse *Tetrao tetrix* in Finland

Osmo Rätti & Rauno V. Alatalo

Rätti, O. & Alatalo, R.V. 1997: The dynamics of blood parasite infections in black grouse *Tetrao tetrix* in Finland. - Wildl. Biol. 3: 280.

Finnish black grouse *Tetrao tetrix* populations fluctuate regularly with a cycle length of about six years. Parasites can theoretically affect growth rate of a host population. Therefore, parasites may be regulating black grouse population density and causing the cyclic pattern. A black grouse population in central Finland was studied during 1988-1994, the length of a population cycle. Blood samples were taken from 284 black grouse 391 times to examine for haematozoan parasites. All samples were examined at the International Reference Centre for Avian Haematozoa by G.F. Bennett. The most common blood parasites were *Leucocytozoon lovati* and microfilaria. Additionally, some individuals were infected by *Haemoproteus mansonii* and *Trypanosoma avium*. The prevalence of *L. lovati* varied annually between 23 and 70%. The prevalence of microfilaria varied from 11 to 48%. The probability of an individual to have a

Leucocytozoon infection decreased with increasing age and was highest in yearlings (50%). The incidence of microfilaria was lowest among yearlings (12%) but increased with age. The prevalence of microfilaria in older black grouse correlated negatively with population density, being lowest during peak grouse density. *Leucocytozoon* prevalence was not correlated with population density but reached a peak during the increasing phase of the population cycle. There was no evidence that blood parasites affected survival of black grouse or population dynamics of the species.

Key words: black grouse, haematozoan parasites, population dynamics, survival, *Tetrao tetrix*

Osmo Rätti, Arctic Centre, University of Lapland, P.O. Box 122, FIN-96101, Rovaniemi, Finland
Rauno V. Alatalo, Department of Biological and Environmental Science, University of Jyväskylä, P.O. Box 35, FIN-40351, Jyväskylä, Finland

Predation and change in weight of chicken eggs in forests with different densities of spruce *Dendragapus canadensis* and ruffed grouse *Bonasa umbellus*

James F. Bendell

Bendell, J.F. 1997: Predation and change in weight of chicken eggs in forests with different densities of spruce *Dendragapus canadensis* and ruffed grouse *Bonasa umbellus*. - Wildl. Biol. 3: 281.

Predation on nests and weight change in eggs (as an indication of their moisture requirement) during the nest period were measured. Both factors may explain habitat selection and breeding density of hens. From 1994 through 1996, three chicken eggs were placed in each of 13 old nest sites of grouse, and in 20 possible nest sites 100 m apart along a line in each of four forests with different densities of grouse. Forests and estimates of breeding density (km²) of spruce grouse *Dendragapus canadensis* and ruffed grouse *Bonasa umbellus*, respectively, were: young jack pine *Pinus banksiana* 0.2; medium-aged pine 35.0; old pine 9.0; and old mixed-forest *Populus tremuloides* and *Abies balsamea* 0.18. Total egg loss in line nests (N = 59-61) ranged from 10 to 25%. Old nests (N = 38) had a total loss of 42%. Nest loss (N = 68) was apparently caused by red squirrel *Tamiasciurus hudsonicus* 50%, black bear *Ursus americanus* 37%, and corvids and red fox *Vulpes vulpes* 10%. There was no apparent correlation between density of either grouse and predation in each year and forest. Nest loss was greatest (42%) where spruce grouse were most

abundant and low and similar (20,23%) where ruffed grouse were low and most abundant. However, mean change in weight of eggs varied significantly between forests and years. Change in mean weight for each forest ranged from a loss of 0.4 g to a gain of 1.3 g. Egg weight changes in old nests were similar to egg weight changes in line nests in the same forest suggesting line nests were representative to actual nests. Based on weight change of eggs, forests were wet, wet/dry, moist, and dry. Most spruce grouse lived in wet forest (medium-aged pine) and most ruffed grouse in dry forest (old mixed-forest). Few of either species inhabited wet/dry forest (old pine) and moist forest (young pine). I infer that eggs of spruce grouse are in wetter sites than those of ruffed grouse. The habitat selection and density of both may be partly explained by the moisture requirement of their eggs.

Key words: *Bonasa umbellus*, boreal forests, Canada, *Dendragapus canadensis*, egg moisture requirements, egg weight, nest predation, Ontario, ruffed grouse, spruce grouse

James F. Bendell, University of Toronto, RR 2, Clayton, Ontario, K0A 1P0, Canada

Intake of buds and catkins by captive hazel grouse *Bonasa bonasia* in winter

Yuzo Fujimaki, Yukako Miyazawa & Kumiko Sasaoka

Fujimaki, Y., Miyazawa, Y. & Sasaoka, K. 1997: Intake of buds and catkins by captive hazel grouse *Bonasa bonasia* in winter. - Wildl. Biol. 3: 281.

The intake of buds and catkins of birch *Betula platyphylla* by captive hazel grouse *Bonasa bonasia* was measured from December 1987 to March 1988, in March 1991, from November 1991 to March 1992, and from November 1992 to March 1993. Buds included 15.3% crude protein, 32.9% crude fat, 14.1% crude fibre, and 4.1% sugar. The corresponding values for catkins were 14.1, 20.7, 22.6, and 5.8%, respectively. The amount of buds and catkins eaten by pairs of hazel grouse ranged from 8.3 ± 2.7 g/day in January to 11.8 ± 3.2 g/day (dry weight) in November. In single-bird trials, the amounts eaten ranged from 6.2 ± 1.7 g/day in November to 7.0 ± 1.5 g/day in January for males and

from 5.7 ± 1.2 g/day in March to 6.6 ± 1.9 g/day in November for females. Mean gross energy values did not show significant seasonal and sexual variations, being 232.94 ± 102.92 kJ/day for pairs and 161.87 ± 41.23 kJ/day for single birds. The gross energy obtained by eating buds and catkins was lower than that obtained from artificial diets, around 340 kJ/day. This is probably because captive birds required less food than wild birds and were accustomed to an artificial diet.

Key words: *Betula platyphylla*, *Bonasa bonasia*, dietary composition, energy uptake, hazel grouse, Japan

Yuzo Fujimaki, Yukako Miyazawa & Kumiko Sasaoka, Laboratory of Wildlife Ecology, Obihiro University of Agriculture and Veterinary Medicine, Inada, Obihiro, 080 Japan

Importance of grouse research in ecology and conservation biology

Mark S. Boyce

Boyce, M.S. 1997: Importance of grouse research in ecology and conservation biology. - *Wildl. Biol.* 3: 282.

Ecology and conservation biology textbooks were surveyed for references to grouse research as evidence of the significance of grouse studies in our broader understanding of ecology and conservation biology. Grouse have proven to be exceptional subjects for parasite research because they tend to harbour a diversity of parasites and diseases which may have substantial consequences to ecology and evolution in some populations. Because several grouse species have lek mating systems, they have been subjects of basic research that has shaped our fundamental understanding of sexual selection. Likewise, studies of territoriality in red grouse *Lagopus lagopus scoticus* and willow ptarmigan *L. lagopus* have helped us to better understand the role of this behaviour in population regulation. Studies on several grouse species have demonstrated that predation can be a significant factor in population limitation and regulation, while evidence for ultimate population consequences of food limitation and nutritional ecology have not been convincing. Ecosystem management

using burning and grazing has been practised on the moors of the British Isles for well over 100 years to enhance habitat for red grouse and red deer *Cervus elaphus*. Similarly, aspen *Populus* spp. management using clearcutting and burning is commonly practised to enhance ruffed grouse *Bonasa umbellus*, white-tailed deer *Odocoileus virginianus* and moose *Alces alces* in North America. The heath hen *Tympanuchus cupido cupido* in New England is a textbook example of an extinction vortex. The Attwater's prairie-chicken *T. c. attwateri* is undergoing the same process. Future studies on conservation genetics may enhance our ability to ensure persistence of fragmented populations of several grouse species. Much research on grouse remains descriptive; studies on captive birds and experimental field studies will help to develop reliable knowledge.

Key words: conservation biology, ecology, grouse-research

Mark S. Boyce, College of Natural Resources, University of Wisconsin, Stevens Point, Wisconsin 54481, USA

Use of a habitat-based model to predict sage grouse *Centrocercus urophasianus* occupancy of patches in southwestern Colorado

Sara J. Oyler, Clait E. Braun & Kenneth P. Burnham

Oyler, S.J., Braun, C.E. & Burnham, K.P. 1997: Use of a habitat-based model to predict sage grouse *Centrocercus urophasianus* occupancy of patches in southwestern Colorado. - *Wildl. Biol.* 3: 282.

Sage grouse *Centrocercus urophasianus* habitat is continually becoming degraded and fragmented, and much of it has been lost as sagebrush *Artemisia* spp. steppe is converted into other land uses. The goal of this study was to develop a habitat-based model which could be used to predict sage grouse occupancy based on habitat and landscape level characteristics. Habitat and landscape level data were collected from 25 sagebrush patches in southwestern Colorado. Occupancy of each patch was determined by sighting sage grouse directly or observing sage grouse droppings. Several parsimonious models were developed to predict sage grouse occupancy without overfitting the data. The Akaike's Information Criterion (AIC) corrected for small sample sizes was used to select the best model from our list of candidate models. The best model to make inferences

from the data includes patch area, distance to the nearest paved road, and the percentage of all brush that was live sagebrush. This model is useful for the conservation of Gunnison sage grouse *C. minimus* as it can be used to rank existing sagebrush patches, identify habitat or landscape characteristics which might be manipulated to increase the probability of sage grouse occupancy, and evaluate potential reintroduction sites.

Key words: *Artemisia*, *Centrocercus minimus*, *Centrocercus urophasianus*, Colorado, habitat model, sagebrush, sage grouse

Sara J. Oyler, Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, Colorado 80523, USA

Clait E. Braun, Colorado Division of Wildlife, 317 West Prospect Road, Fort Collins, Colorado 80526, USA

Kenneth P. Burnham, Colorado Cooperative Fish and Wildlife Research Unit, Colorado State University, Fort Collins, Colorado 80523, USA

Gunnison sage grouse *Centrocercus minimus* use of fragmented habitats in southwestern Colorado

Michelle L. Commons, Richard K. Baydack & Clait E. Braun

Commons, M.L., Baydack, R.K. & Braun, C.E. 1997: Gunnison sage grouse *Centrocercus minimus* use of fragmented habitats in southwestern Colorado. - Wildl. Biol. 3: 283.

Gunnison's sage grouse *Centrocercus minimus* historically occurred throughout sagebrush *Artemisia* rangelands in southwestern Colorado, southeastern Utah, and northern New Mexico. Because of the reduction of sagebrush habitat for the enhancement of livestock grazing, agricultural use, and other human activities, only a few remnant populations remain in highly fragmented habitat in southwestern Colorado and extreme southeastern Utah. In 1994 and 1995, two geographically isolated populations of sage grouse were studied in southwestern Colorado to identify seasonal movements and habitat use. Radio transmitters were fitted to 55 male and 8 female sage grouse in Dove Creek, Dolores County, and at Dry Creek Basin/Miramonte Reservoir, San Miguel County, Colorado. The Dolores County population was separated by the town of Dove Creek and movements occurred between the two sites. Sage grouse in Dolores County were in agricultural fields (alfalfa, bean, and wheat) from May through September, and sagebrush and Gambel Oak *Quercus gambelii* from October

through February. Sage grouse in Dry Creek Basin were in areas with low sage *A. arbuscula*, snakeweed *Gutierrezia sarothrae*, black greasewood *Sarcobatus vermiculatus*, and winterfat *Eurotia lanata* while sage grouse near Miramonte Reservoir were in sagebrush *A. tridentata*, *A. nova*, wet meadows, and Gambel Oak throughout the year. Hamilton Mesa between Dry Creek Basin and Miramonte Reservoir was also used by sage grouse. Dominant vegetation of this site included forbs, grass, gambel oak, and serviceberry *Amelanchier* spp. Extensive movements occurred from Dry Creek Basin to Hamilton Mesa and to Miramonte Reservoir. Management considerations must include all three sites in San Miguel County and both sites in Dolores County if sage grouse are to persist in southwestern Colorado.

Key words: *Centrocercus minimus*, Colorado, Gunnison sage grouse, habitat use, radio telemetry

Michelle L. Commons & Clait E. Braun, Colorado Division of Wildlife, 317 West Prospect Road, Fort Collins, Colorado, 80526, USA

Richard K. Baydack, Natural Resources Institute, University of Manitoba, Winnipeg, Manitoba, R3T 2N2, Canada

Reintroduction of greater prairie-chickens *Tympanuchus cupido* in northeastern Colorado

Richard W. Hoffman & Grant M. Beauprez

Hoffman, R.W. & Beauprez, G.M. 1997: Reintroduction of greater prairie-chickens *Tympanuchus cupido* in northeastern Colorado. - Wildl. Biol. 3: 283.

Greater prairie-chickens *Tympanuchus cupido* were declared endangered in Colorado in 1973. Since then, recovery efforts have focussed on habitat restoration and establishment of other self-sustaining populations in northeastern Colorado. A total of 301 greater prairie-chickens was captured on leks during spring using cannon nets or walk-in traps and released at three sites in northeastern Colorado, including Tamarack State Wildlife Area (N = 76), Pinneo (N = 84), and Wells Ranch (N = 141). Transplant stock was obtained from Yuma County, Colorado (N = 201) and Cowley County, Kansas (N = 100). Leks were established, and reproduction and recruitment were documented on all areas. Surveys conducted in 1994 revealed 19 active leks (\bar{x} =

5.4 males/lek) at Tamarack, 8 active leks (\bar{x} = 5.0 males/lek) at Pinneo, and 4 active leks (\bar{x} = 7.7 males/lek) at Wells Ranch. Greater prairie-chickens have been downlisted to threatened status in Colorado and will be delisted to species of special concern if population trends remain stable or increase.

Key words: greater prairie-chicken, lek survey, movements, reproductive success, translocation, *Tympanuchus cupido*

Richard W. Hoffman, Colorado Division of Wildlife, 317 West Prospect Road, Fort Collins, Colorado, 80526, USA

Grant M. Beauprez, Department of Biological Sciences, University of Northern Colorado, Greeley, Colorado, 80639, USA

Heritable resistance to malaria and the evolution of lek behaviour in sage grouse *Centrocercus urophasianus*

Patricia A.W. Deibert & Mark S. Boyce

Deibert, P.A.W. & Boyce, M.S. 1997: Heritable resistance to malaria and the evolution of lek behaviour in sage grouse *Centrocercus urophasianus*. - Wildl. Biol. 3: 284.

Coevolution of parasites and host has been hypothesized to explain patterns of sexual selection, including the evolution of lek behaviour. Evidence supporting the role of malaria in the evolution of sage grouse *Centrocercus urophasianus* lek behaviour is reviewed. Prevalence of malaria in sage grouse populations on the Laramie Plain in southcentral Wyoming shows substantial temporal and spatial variation. Females less frequently copulated with males possessing malaria infections, apparently due to less frequent attendance at leks by infected males. Males with malaria that secured copulations bred later in

the breeding season and mated with females of lower fitness than malaria-free males. Change in prevalence of malaria is significantly inversely correlated with the intensity of sexual selection against males with malaria, demonstrating heritability in resistance to malaria.

Key words: *Centrocercus urophasianus*, lek behaviour, malaria, mating success, sage grouse, sexual selection, Wyoming

Patricia A.W. Deibert, Wyoming Game and Fish Department, 5400 Bishop Boulevard, Cheyenne, Wyoming 82006, USA

Mark S. Boyce, College of Natural Resources, University of Wisconsin, Stevens Point, Wisconsin 54481, USA

Fragmentation of spruce grouse *Dendragapus canadensis* habitat: a synthesis of the present and direction for the future

Daniel M. Keppie

Keppie, D.M. 1997: Fragmentation of spruce grouse *Dendragapus canadensis* habitat: a synthesis of the present and direction for the future. - Wildl. Biol. 3: 284.

Fragmentation is a concept that generally carries negative connotations. Yet for spruce grouse *Dendragapus canadensis*, and indeed for many other species with broad geographic ranges, the concept has quite different biological meanings across their range. Across its northern and western range, spruce grouse inhabit forests that have large patches generated by multi-scale processes such as fire and insect defoliation. In its eastern range, forests are naturally smaller and more patchy, and along the southern border of this range anthropogenic changes to the forest have been most notable and numbers of spruce grouse have declined. Some contemporary perceptions about tactical operations in timber management, for example, that clearcutting and plantations are detrimental for spruce grouse, are, without context, incorrect. Much of the substantive population research to date in the north is of little use for management questions about forest fragmentation and pattern, and grouse population demography because explicit questions about these issues did not generate and guide the initial research. It is hypothesized that spruce grouse across their range are sensitive to their physical environment at different scales of resolution, hence, modification of the

forest at any particular scale will have different quantitative effects on grouse in different places. Population dynamics in the north probably are fundamentally different from those in the south, at least in part because of a difference in dispersion, as birds in the north are distributed more continuously over space. The direction of forest management in the north will not make much use of further single species research except where the species is endangered. Although transfer of information from northern studies to southern application is problematical, research in the north can be designed to apply to southern spruce grouse management. Investigations in the north will require that study areas are used in which forest structure and grouse density are as comparable as possible to conditions in the south. In the north, can local populations that demographically resemble those in the south be created and maintained? Research questions posed must enable us to identify controllable factors that limit grouse abundance.

Key words: *Dendragapus canadensis*, forest fragmentation, North America, spruce grouse

Daniel M. Keppie, Department of Biology and Faculty of Forestry and Environmental Management, University of New Brunswick, PO Box 44555, Fredericton, New Brunswick, E3B 6C2, Canada

Ecological implications of social constraints on resource management: the ruffed grouse *Bonasa umbellus* example

Daniel R. Dessecker

Dessecker, D.R. 1997: Ecological implications of social constraints on resource management: the ruffed grouse *Bonasa umbellus* example. - Wildl. Biol. 3: 285.

Long-term habitat loss is contributing to the decline of ruffed grouse *Bonasa umbellus* and other wildlife species dependent upon early-successional habitats in the eastern United States. Analysis of forest inventory data demonstrates that deciduous forests of the east are maturing. From Maine to Tennessee, the area covered by forest stands classified as hardwood seedling/sapling has, over the past two decades, declined by 41%. Today, only 5% of the hardwood forests of New England are ≤ 20 years of age. Few definitive data exist to quantify long-term trends in ruffed grouse populations throughout the east. Varying survey methodologies between states and within states between years exacerbate efforts to document trends. Coarse analysis of existing data suggests that ruffed grouse are declining in this region. The aspen *Populus* spp. forests of the Great Lakes region are of critical importance to ruffed grouse. Aspen forest communities are capable of producing 4-10 times the ruffed grouse per unit area as other vegetation associations. Currently, aspen forest types comprise 23% of

the total timberland in Michigan, Minnesota, and Wisconsin and are largely non-existent in the eastern United States outside of this region. Clear-cut regeneration harvests, the optimum harvest prescription for regeneration of aspen forests and for establishment of quality habitat for ruffed grouse, are poorly accepted by the general public. This lack of acceptance has led to efforts to enact legislation at the state and federal levels to prevent use of clear-cut regeneration harvests and other even-age silvicultural prescriptions. Public resource management agencies are increasingly harvesting aspen using techniques other than clear-cut prescriptions to mitigate visual impacts of management activities. Given current social and political climates and demographic trends, a continuation of the decline of early-successional communities throughout the eastern United States is likely.

Key words: *Bonasa umbellus*, eastern United States, forest succession, ruffed grouse

Daniel R. Dessecker, Ruffed Grouse Society, P.O. Box 2, Rice Lake, Wisconsin, 54868, USA

Captive rearing and release of Columbian sharp-tailed grouse *Tympanuchus phasianellus columbianus*

Christopher R. Merker

Merker, C.R. 1997: Captive rearing and release of Columbian sharp-tailed grouse *Tympanuchus phasianellus columbianus*. - Wildl. Biol. 3: 285.

Of the six recognized subspecies of sharp-tailed grouse *Tympanuchus phasianellus*, the Columbian *T.p. columbianus* has experienced the greatest decline. The goal of this study was to create an additional source of grouse for reintroduction and to measure fates of released grouse. Hatching success of eggs under artificial incubation (28.6%) was poorer ($P < 0.0001$) than parent (93.9%) and chicken-incubated (86.7%). Fledging rates of young also differed ($P = 0.0018$) between hand-rearing (31.15%), grouse (28.3%), and chicken (0.0%) rearing methods. In the two seasons monitored (autumn/winter, spring), grouse preferred unharvested small grain food patches over eight other habitats. There were differences in survival between the groups ($P =$

0.084). Fall-released parent-reared grouse survived much better than fall-released hand-reared birds ($P = 0.046$). Spring-released hand-reared birds survived longer than fall-released hand-reared grouse ($P = 0.079$). There was no difference in survival between spring-released hand-reared and autumn-released parent-reared grouse ($P = 0.754$). Captive-reared grouse can be of value in restoration programs if enough birds can be raised to meet objectives, and predator avoidance skills are maximized.

Key words: captive rearing, Columbian sharp-tailed grouse, translocation, *Tympanuchus phasianellus columbianus*, Washington

Christopher R. Merker, Natural Resource Department, Spokane Tribe of Indians, P.O. Box 100, Wellpinit, Washington, 99040, USA

Effects of range condition on habitat use by greater prairie-chickens *Tympanuchus cupido*

Thomas A. Eddy

Eddy, T.A. 1997: Effects of range condition on habitat use by greater prairie-chickens *Tympanuchus cupido*. - Wildl. Biol. 3: 286.

Habitat use by greater prairie-chickens *Tympanuchus cupido* was studied in the Flint Hills of Kansas. Five specific habitat-use categories were identified and described based on 126 observations of prairie-chickens and 3,014 indirect instances of use from 1991 to 1995 in a 5-county area. Leks were on claypan range sites in poor condition dominated by short grasses and annual forbs. These sites had a vegetation height-density index of 0.7 dm, canopy cover of 80%, and use was limited to spring and fall. Nesting areas were on loamy upland sites in fair range condition where tallgrass species dominated. The vegetation height-density index was 1.3 dm, canopy cover was 98%, and use was limited to spring. Brooding areas were on loamy upland range sites in good range condition and characterized by tall and mid

grasses with annual and perennial forbs. The vegetation height-density index was 1.8 dm and canopy cover was 109%. Brooding areas were used by birds during spring and early summer. Roosting and loafing areas were on loamy range sites in fair range condition in mid and tall-grass habitat. The height-density index was 1.2 dm and the canopy cover was 101%. Use by birds was year round. Feeding areas were on loamy upland range sites in good range condition and in 2-20 ha agricultural fields. The height-density index at feeding areas was 1.5 dm and canopy cover was 113%. Use of agricultural crops was seasonal.

Key words: greater prairie-chicken, habitat use, range condition, Kansas, *Tympanuchus cupido*

Thomas A. Eddy, Division of Biological Sciences, Campus Box 4050, Emporia State University, Emporia, Kansas 66801, USA

Status and management of sharp-tailed grouse *Tympanuchus phasianellus* in North America

Kenneth M. Giesen & Gerald D. Kobriger

Giesen, K.M. & Kobriger, G.D. 1997: Status and management of sharp-tailed grouse *Tympanuchus phasianellus* in North America. - Wildl. Biol. 3: 286.

Population status and management practices affecting sharp-tailed grouse *Tympanuchus phasianellus* were ascertained from a survey of biologists from 28 states and provinces within the historic range in North America. Populations have been extirpated from five states/provinces and have declined in 10 others. Habitat loss or fragmentation and livestock grazing practices were identified as major causes of declines. Eight states or provinces having cyclic or stable populations were primarily from northern latitudes where anthropogenic influences may be less severe. Recent population increases in five states/provinces resulted primarily from conversion of agricultural cropland to grasslands under the Cropland Reserve Program initiated in 1985 which primarily affected southern populations of *T. p. jamesi* and *T. p. columbianus*. The most common management activities practised included breeding surveys (18 states/provinces), harvest surveys (12 states/provinces), habitat management or restoration (11 states/provinces),

and transplants (11 states/provinces). Brood surveys and food plantings were not common management practices (5 and 4 responses, respectively). Only 13 states/provinces reported having conducted research on sharp-tailed grouse in the last 10 years, with most investigating seasonal movements and habitat use. Six states/provinces reported no research or management activities specifically directed at sharp-tailed grouse. Seasons varied from 17 days to 7 months with daily bag limits of 1-10 grouse in states/provinces with hunting seasons. Estimated annual harvest (>260,000) of *T. p. jamesi* from five states/provinces exceeded that of all other sharp-tailed grouse subspecies combined.

Key words: habitat, harvest, management, populations, sharp-tailed grouse, *Tympanuchus phasianellus*

Kenneth M. Giesen, Colorado Division of Wildlife, 317 West Prospect Road, Fort Collins, Colorado, 80526, USA

Gerald D. Kobriger, North Dakota Game & Fish Department, 225 30th Avenue SW, Dickinson, North Dakota, 58601, USA

Capturing techniques for the Chinese grouse *Bonasa sewerzowi*

Yun Fang & Yue-Hua Sun

Fang, Y. & Sun, Y.-H. 1997: Capturing techniques for the Chinese grouse *Bonasa sewerzowi*. - Wildl. Biol. 3: 287.

The Chinese grouse *Bonasa sewerzowi* was studied at the Lianhuashan Natural Reserve using radio-telemetry in 1995. Three techniques were used to capture Chinese grouse in different seasons: nets, modified walk-in traps, and snare-noose poles. Prior to this work, Chinese grouse had not been successfully captured. Chinese grouse were not as shy as hazel grouse *B. bonasia*, and some could be approached to within 3-5 m. The first grouse was captured on 25 March using a snare-noose pole. This method was useful to recapture birds to change radio transmitters. Nets were useful when trying to capture birds associated with radio-marked birds, or when the birds were dusting or feeding at a fixed place. Two 80-day old chicks of a radio-marked hen were successfully captured by first locating the hen and then moving the brood into the nets. The walk-in trap was the most effective way to capture Chinese grouse, especial-

ly in spring and autumn, when the ground was less snow covered. During the display period, two pairs were captured together in one cage in two separate attempts. A device to cover the cage and to make it dark when a bird entered the trap was also designed. In 1995, 26 birds were captured and radio-marked (4 by snare-noose pole, 7 by nets, 15 by walk-in traps). Three radio transmitters were changed after the birds were captured with snare-noose poles and nets.

Key words: *Bonasa sewerzowi*, capture techniques, Chinese grouse, nets, radio transmitters, snare-noose poles, walk-in traps

Yun Fang, Lianhuashan Natural Reserve, Kangle County, Gansu Province 731516, People's Republic of China

Yue-Hua Sun, Institute of Zoology, Chinese Academy of Sciences, Beijing 100080, People's Republic of China

Landscape connectivity and its effect on the ecological processes of spruce grouse *Dendragapus canadensis* populations

Scott Harrison, Ben Chatterson & David Paul

Harrison, S., Chatterson, B. & Paul, D. 1997: Landscape connectivity and its effect on the ecological processes of spruce grouse *Dendragapus canadensis* populations. - Wildl. Biol. 3: 287.

We investigate how the level of habitat connectivity affects natal dispersal, adult movement, and predation rates of spruce grouse *Dendragapus canadensis*. We also investigate how hierarchies of scale affect these ecological processes and aspects of metapopulation theory. The study area encompasses 650,000 ha east of Prince George, British Columbia, Canada in the sub-boreal spruce biogeoclimatic zone. The Bowron and Willow River valleys which form the study area have been logged extensively in the past 30 years. Logging in some parts of the study area is a dispersed-cut with 100-300 ha clear-cuts creating a checker-board pattern with 100-ha patches of unlogged forest. This landscape represents the 'medium' connectivity treatment. In the other part of the study area, the landscape is an aggregate 50,000-ha clear-cut with 150-ha patches of forest remaining. This landscape represents the 'low' connectivity treatment. Currently, spruce grouse are being radio-marked, and population parameters are being

measured in 12 study sites, each 170 ha. Experimental density increases will allow examination of population processes among study sites with different levels of habitat connectivity. Densities will be increased by introducing eggs or young chicks to radio-marked females. Four treatment combinations (medium connectivity/no density change; medium connectivity/increase density; low connectivity/no density change; low connectivity/increase density) are replicated three times for the 12 study sites as a factorial experiment in a completely randomized design.

Key words: British Columbia, Canada, connectivity, *Dendragapus canadensis*, hierarchy theory, landscape, metapopulation theory, spruce grouse

Scott Harrison, University of British Columbia, Centre for Applied Conservation Biology, c/o Research Section, Ministry of Forests, 1011 - 4th Ave., Prince George, British Columbia, V2L 3H9, Canada
Ben Chatterson & David Paul, Research Section, Ministry of Forests, 1011 - 4th Ave., Prince George, British Columbia, V2L 3H9, Canada

Insects as a possible limiting factor for Attwater's prairie-chicken *Tympanuchus cupido attwateri*

Clifton P. Griffin, Michael E. Morrow & Nova J. Silvy

Griffin, C.P., Morrow, M.E. & Silvy, N.J. 1997: Insects as a possible limiting factor for Attwater's prairie-chicken *Tympanuchus cupido attwateri*. - Wildl. Biol. 3: 288.

Declines in Attwater's prairie-chicken *Tympanuchus cupido attwateri* numbers have been linked to loss of habitat, but recently, numbers also have decreased dramatically in areas where habitat loss has not occurred. In this study, Attwater's prairie-chicken declines are linked to insect abundance by demonstrating that insect biomass availability is less than necessary to maintain chick growth. Data were collected on insect consumption by Attwater's prairie-chicken chicks at the Small Upland Research Facility at Texas A&M University during 1995 and 1996. Chicks housed in a controlled environment consumed an average of 16.2 g of grasshoppers daily. This value was applied to wild birds to examine required insect availability for chick growth over a four-week period. Insect availability data were obtained through studies within Attwater's prairie chicken habitat. Insect abundance in Attwater's habitats may have been impacted by invasion by cattle egrets *Ardea ibis* and fire ants. Increased numbers of insectivorous species and individuals have contributed to the loss of insects, which are the primary food source for juvenile prairie grouse.

Declines up to 75% have been reported for overall arthropod numbers in fire ant infested areas, and cattle egrets are known to ingest as much as 149.8 g of insects/adult and chicks daily. Pesticide use from surrounding agricultural areas also may add to declines in insects as Attwater's habitat becomes more fragmented with increases in row crops. These chemicals, through drifting of spray into Attwater's habitat and their direct effects on insect recruitment from adjoining crop lands, may reduce insect abundance in Attwater's prairie-chicken habitat. The combined effects of cattle egrets, fire ants, and insecticides on insect abundance represent a possible reason for the recent declines in Attwater's prairie-chicken numbers.

Key words: Attwater's prairie-chicken, insects, population decline, Texas, *Tympanuchus cupido attwateri*

Clifton P. Griffin & Nova J. Silvy, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, Texas 77843, USA

Michael E. Morrow, Attwater Prairie-chicken National Wildlife Refuge, P.O. Box 519, Eagle Lake, Texas 77434, USA

Can raptor predation limit or regulate grouse populations? I. Functional and numerical response of raptors

Stephen M. Redpath & Simon J. Thirgood

Redpath, S.M. & Thirgood, S.J. 1997: Can raptor predation limit or regulate grouse populations? I. Functional and numerical response of raptors. - Wildl. Biol. 3: 288.

Hen harriers *Circus cyaneus* and peregrine falcons *Falco peregrinus* on heather *Caluna vulgaris* moorland managed for red grouse *Lagopus lagopus scoticus* in Britain are killed illegally by gamekeepers because they believe these raptors have a significant impact on grouse populations and shooting bags. A 5-year study of raptor-grouse dynamics was conducted to examine how diet of hen harriers and peregrine falcons varied in relation to the availability of grouse and other prey (the functional response). Further, we considered how numbers of breeding and hunting raptors varied within and between areas in relation to grouse and other prey availability (the numerical response). Hen harriers showed a func-

tional response to grouse abundance, and both species hunted in relation to grouse abundance in winter but not in summer. Neither hen harriers nor peregrine falcons appeared to respond numerically in terms of breeding numbers.

Key words: Britain, *Circus cyaneus*, *Falco peregrinus*, hen harrier, *Lagopus lagopus scoticus*, peregrine falcon, predation, red grouse

Stephen M. Redpath, Institute of Terrestrial Ecology, Monks Wood, Abbots Ripton, Huntingdon, Cambridgeshire, PE17 2LS, United Kingdom

Simon J. Thirgood, The Game Conservancy Trust, Crubenmore Lodge, Newtonmore, Inverness-shire, Scotland, PH20 1BE, United Kingdom

Habitat selection of hazel grouse *Bonasa bonasia* and natural dynamics in different central European woodland associations

Andreas Kämpfer-Lauenstein

Kämpfer-Lauenstein, A. 1997: Habitat selection of hazel grouse *Bonasa bonasia* and natural dynamics in different central European woodland associations. - Wildl. Biol. 3: 289.

In western Europe, where hazel grouse *Bonasa bonasia* occupy coppiced deciduous woods, populations are endangered or already extinct, probably because the coppicing system is being abandoned. In central Europe, such as in the Bavarian forest, where they occupy native forests, populations are still stable. From 1992 to 1995, 30 hazel grouse were radio-marked in the 'Bayerischer Wald' National Park to examine preferred habitat structures of this species in primary habitat and natural dynamics in different woodland associations. The 'Aufichtenwald' (alluvial spruce forest) was dominated by *Picea* and *Betula*. Other species (e.g. *Fagus*, *Abies* and *Acer*) were absent due to too wet and cold weather conditions. Dense vegetation structures, bogs and large windthrows were typical, where hazel grouse had a relatively high density (2.8 males /100 ha). In winter they preferred middle-aged dense stands, in which they mostly used birch catkins. In summer, open structures such as old stands, bogs and windthrows, with a well developed *Vaccinium* spp. layer, were most important. The 'Bergmischwald' (montane mixed forest) was a mixed deciduous/conifer woodland, dominated by *Fagus*,

Abies, *Picea* and *Acer* mixed with *Sorbus* and other deciduous tree species. Hazel grouse had a lower density (1.5 males /100 ha) in this habitat. In winter, they preferred middle-aged mixed stands of 30-60 years with high proportions (up to 10%) of *Betula*, *Sorbus*, and *Populus*, or young succession stages 20-30 years old, dominated by *Betula*, *Salix*, and *Populus*. In summer, open areas such as trails, rocky boulder fields, windthrows, gaps caused by beetle infestations, and old growth forests were mostly used. Of this area, 70-80% was dominated by low structured, middle-aged stages unsuitable for hazel grouse. The 'Bergfichtenwald' (montane spruce forest) was situated above 1,200 m a.s.l., where it was too cold for firs and beeches. Its structure was similar to that of the alluvial spruce forest but the only deciduous tree present was *Sorbus* representing less than 2%. The density of hazel grouse was low (0.7 males /100 ha) and habitats remain unchanged over long periods.

Key words: *Bonasa bonasia*, coppice management, Germany, habitat selection, hazel grouse, population densities

Andreas Kämpfer-Lauenstein, Institut für Wildbiologie und Jagdkunde der Universität Göttingen, Büsgenweg 3, 37077 Göttingen, Germany

Costs of detoxification of xenobiotics in conifer needles to blue grouse *Dendragapus obscurus*

Thomas E. Remington & Richard W. Hoffman

Remington, T.E. & Hoffman, R.W. 1997: Costs of detoxification of xenobiotics in conifer needles to blue grouse *Dendragapus obscurus*. - Wildl. Biol. 3: 289.

Nutrient and energy costs of detoxifying defensive compounds in conifer needle diets were estimated for wild blue grouse *Dendragapus obscurus* captured and maintained in captivity. Ammonium ion comprised the bulk of excreted nitrogen. Excretion of ammonium ion was greatest ($P < 0.05$) on unpalatable diets, increased ($P < 0.05$) with addition of monoterpenes to the diet, and was correlated to glucuronic acid excretion. Nitrogen costs of detoxification were estimated at 9-25% of ingested nitrogen for needles of four conifer species. Glucuronic acid was the principal detoxification conjugate excreted, followed by ornithuric and hippuric acids. Glucuronic

acid excretion was highest on the least palatable diets and increased with addition of monoterpenes to the diet. The minimal energy cost of detoxification was estimated at 1-10% of energy metabolized from needles of four conifer species. Intake of defended needles was 15% less than for Douglas fir *Pseudotsuga menziesii* needles. Defensive compounds can deter feeding if absorption rates exceed detoxification rates.

Key words: blue grouse, *Dendragapus obscurus*, Douglas fir, monoterpenes, nitrogen, *Pseudotsuga menziesii*

Thomas E. Remington & Richard W. Hoffman, Colorado Division of Wildlife, 317 West Prospect Road, Fort Collins, Colorado 80526, USA

Reticuloendotheliosis in captive greater *Tympanuchus cupido pinnatus* and Attwater's prairie-chickens *T. c. attwateri*

Mark L. Drew, W.L. Wigle, David L. Graham, Clifton P. Griffin, Nova J. Silvy, Aly Fadly & Richard Witter

Drew, M.L., Wigle, W.L., Graham, D.L., Griffin, C.P., Silvy, N.J., Fadly, A. & Witter, R. 1997: Reticuloendotheliosis in captive greater *Tympanuchus cupido pinnatus* and Attwater's prairie-chickens *T. c. attwateri*. - Wildl. Biol. 3: 290.

A captive propagation program was started for prairie-chickens in 1991 using wild-caught greater prairie-chickens *Tympanuchus cupido pinnatus*. Eggs from nests of wild Attwater's prairie-chickens *T. c. attwateri* were collected in 1993 to create a breeding flock of this subspecies. Two wild-caught adult female greater prairie-chickens were observed in September 1993 to have multiple subcutaneous nodules on the face. These nodules increased in size and number, and the two birds were euthanized in August 1994. Neoplastic masses were found in multiple organs of both birds at necropsy. Histopathologic examination revealed pleomorphic lymphoreticular cells suggestive of reticuloendotheliosis. Reticuloendotheliosis virus was demonstrated in tumor tissue by polymerase chain reaction and virus isolation. Subsequently, seven additional birds (5 greater and 2 Attwater's) have been euthanized or found dead with evidence of lymphoreticular neoplasia in a variety of organs. The captive flock was screened periodically for evidence of viremia and antibody to reticuloendotheliosis virus. Prior to initiation of control efforts, over 75% of greater and Attwater's prairie-chickens in captivity were viremic, but only two developed antibodies. Viremic greater prairie-chickens had higher morbidity and mortality rates

than viremic Attwater's, which tended to remain outwardly healthy. Subsequent testing and selective culling of viremic birds has been used to gain control of the disease in the captive flock. To date, no free-ranging Attwater's prairie-chickens have been found to be infected with reticuloendotheliosis. The presence of this disease in captive Attwater's will have important ramifications in release programs for this subspecies. Testing of free-ranging greater and Attwater's prairie-chickens for reticuloendothelial virus is recommended prior to translocation.

Key words: Attwater's prairie-chicken, captivity, greater prairie-chicken, lymphoreticular neoplasia, reticuloendotheliosis, *Tympanuchus cupido attwateri*, *Tympanuchus cupido pinnatus*

Mark L. Drew, Department of Large Animal Medicine and Surgery, Texas A&M University, College Station, Texas 77843, USA

W.L. Wigle, Texas Veterinary Diagnostic Laboratory, Texas Department of Agriculture, College Station, Texas 77843, USA

David L. Graham, Department of Veterinary Pathobiology, College Station, Texas 77843, USA

Clifton P. Griffin & Nova J. Silvy, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, Texas 77843, USA

Aly Fadly & Richard Witter, Avian Disease and Oncology Laboratory, United States Department of Agriculture, East Lansing, Michigan 48910, USA.

Winter flocking behaviour of Chinese grouse *Bonasa sewerzowi*

Yue-Hua Sun

Sun, Y.-H. 1997: Winter flocking behaviour of Chinese grouse *Bonasa sewerzowi*. - Wildl. Biol. 3: 290.

Flocking behaviour of Chinese grouse *Bonasa sewerzowi* was studied in winter 1994-95 at Lianhuashan Natural Reserve in Gansu Province. Data were obtained from 18 radio-marked birds and observations. Flocks of 4-5 birds were first observed in mid-October when broods were dispersing. Flock size increased in early December to 13-14 birds and varied in different habitats. Spruce *Picea* spp. and fir *Abies* spp. trees served as cover as 80.8% of observations of feeding Chinese grouse were within 15 m of spruce or fir. From December to March, Chinese grouse favoured the fruits of sea buckthorn *Hippophae rhamnoides*, which was distributed in clusters on south slopes where no conifer-

ous trees occurred for cover. Flocks larger than five birds were observed when Chinese grouse were feeding on sea buckthorn. The main reasons for flocking were food concentration and mutual vigilance against avian predators. Flock structure and stability were stable during winter, but some birds changed flocks. In winter, most birds abandoned their territories although some did not. Some adult males occupied territories in winter; however, young males and females were more often observed in flocks.

Key words: *Bonasa sewerzowi*, China, Chinese grouse, foraging, winter flocking behaviour

Yue-Hua Sun, Institute of Zoology, Chinese Academy of Sciences, Beijing 100080, People's Republic of China

Probing the evolutionary history of sage grouse *Centrocercus urophasianus* populations using mitochondrial DNA sequence

Thomas W. Quinn, Nate W. Kahn, Jessica R. Young, Nickolas G. Benedict, Stacey Wood, Duane Mata & Clait E. Braun

Quinn, T.W., Kahn, N.W., Young, J.R., Benedict, N.G., Wood, S., Mata, D. & Braun, C.E. 1997: Probing the evolutionary history of sage grouse *Centrocercus urophasianus* populations using mitochondrial DNA sequence. - Wildl. Biol. 3: 291.

Sage grouse *Centrocercus urophasianus* are a classic example of a lek-mating species, and are becoming yet another example of a species encountering dramatic human-induced changes to its environment. A study of the patterns of genetic variation across the range of both subspecies and including the unique small-bodied birds in the Gunnison Basin, Colorado was done by sequencing 141 bp or more within region I of the mitochondrial control region. Within Colorado, the same haplotype was present in 31/32 (97%) of the small-bodied birds surveyed in the Gunnison Basin whereas a wider variety of haplotypes was found at each of the five surveyed locales within the range of the large-bodied birds (132 individuals). The predominant haplotype within the Gunnison Basin is at a frequency of 97%, but elsewhere that haplotype is at a frequency of less than 20%. This, and the observation that other haplotypes which pre-

dominate in large-bodied birds are not present in the Gunnison Basin, provides evidence there has been virtually no recent gene flow into the Gunnison population from large-bodied sage grouse found elsewhere in Colorado. Preliminary sampling from across the western USA revealed similarities across the range among large-bodied birds in that three haplotypes are shared throughout, but there was also a subset of haplotypes that was more localized in distribution and, hence, potentially more informative for defining population subdivision.

Key words: *Centrocercus urophasianus*, Colorado, Gunnison Basin, control region sequence, mitochondrial DNA, sage grouse, western USA

Thomas W. Quinn, Nate W. Kahn, Nickolas G. Benedict, Stacey Wood & Duane Mata, Department of Biological Sciences, University of Denver, 2101 E. Wesley Avenue, Denver, Colorado, 80208, USA

Jessica R. Young, Department of Sciences, Western State College, Gunnison, Colorado, 81231, USA

Clait E. Braun, Colorado Division of Wildlife, 317 West Prospect Road, Fort Collins, 80526, USA

Forest characteristics of capercaillie *Tetrao urogallus* display grounds and their surroundings in Estonia

Ene Viht

Viht, E. 1997: Forest characteristics of capercaillie *Tetrao urogallus* display grounds and their surroundings in Estonia. - Wildl. Biol. 3: 291.

The number of males on capercaillie *Tetrao urogallus* leks is largely dependent upon the quality of habitat around the lek. Territories within 1 km radius of the centre of 36 leks were studied in the southern and central part of Estonia in 1991 and 1992. The borders of each display ground were ascertained and the areas were vegetatively mapped. The areas studied were dominated by pine *Pinus* (73.3%), mixed spruce *Picea* and pine (14.5%), and deciduous forests (12.2%). The forest composition of Estonia was 38.1% pine, 24.0% spruce, and 35.4% deciduous forests. Leks occurred primarily (97.3%) in pine forests. In the study areas, the average percentage of forests older than 60 years was 50.0, but at leks it was 96.3. In spring, males used mainly two types

of forests: forests on mineral soils (*Myrtillus* site type and *Rhodococcum* site type) covering 46.7% and swamp forests (mesotrophic bog site type, drained swamp site type, and raised bog site type) covering 27.5%. The latter dominated (65.9%) on the display grounds. The most common forests have stocking densities of 0.7-0.8 (74%). Such forests also dominated in areas with display grounds. For forests with lower stocking densities (0.5-0.6) which had display grounds, the specific areas used had higher tree densities. The height of the forests differed in the study areas from 0 to 30 m, but tree height of 10 - 20 m was preferred in areas used for display.

Key words: capercaillie, Estonia, forest characteristics, habitats in spring, *Tetrao urogallus*

Ene Viht, Metsakatsejaam, Jõgevamaa, EE2350, Estonia

Patterns of density dependence within and between populations of red grouse *Lagopus lagopus scoticus* in Britain

Peter A. Robertson & Peter J. Hudson

Robertson, P.A. & Hudson, P.J. 1997: Patterns of density dependence within and between populations of red grouse *Lagopus lagopus scoticus* in Britain. - *Wildl. Biol.* 3: 292.

Red grouse *Lagopus lagopus scoticus* populations were monitored by pre- and post-breeding counts at over 40 sites in Northern England and Scotland. Counts were conducted for at least five consecutive years per site. These data were used to examine within and between site patterns of density dependence in adult loss during winter and summer, and loss of potential production. There was evidence of density-dependent adult loss on a within-site basis in both winter and summer; losses were highest in years when population density was high. There was no evidence of between-site density depen-

dence during either period; high and low density populations demonstrated similar average rates of winter and summer loss. There was no clear pattern of breeding loss on a within-site basis but evidence of between-site density dependence; sites with higher breeding densities of grouse had lower rates of breeding loss.

Key words: density dependence, *Lagopus lagopus scoticus*, Northern England, red grouse, Scotland

Peter A. Robertson, The Game Conservancy Trust, Crubenmore Lodge, Newtonmore, Inverness-shire, Scotland, PH20 1BE, United Kingdom

Peter J. Hudson, Unit of Wildlife Epidemiology, Department of Biological and Molecular Sciences, University of Stirling, Scotland, FK9 4AL, United Kingdom

Population dynamics of ruffed grouse *Bonasa umbellus* in the fragmented forests of central Wisconsin, USA

Robert J. Small, Donald H. Rusch, John R. Cary & James C. Holzwart

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Survival, reproduction, and dispersal of ruffed grouse *Bonasa umbellus* in the fragmented forests of central Wisconsin were examined during 1982-1988. Estimates of survival and reproduction indicated the population should have been declining at about 45% per year, yet population densities gradually increased from 5.8 to 7.8 drumming males per 100 ha during the 7-year study. Hunting mortality was highly site-specific, with mortality rates on public lands significantly higher ($P < 0.005$) than on private lands for both adults (0.73 vs 0.13) and juveniles (0.56 vs 0.09). These results indicate that the regional landscape was comprised of a mosaic of population 'sources' and 'sinks', with population stability maintained through dispersal. Radio-tracking during natal dispersal found that juvenile females moved more than twice the net distance (4.82 vs 2.14 km) at twice the rate (0.53 vs 0.26 km/day) of juvenile males, and distinct sexual differences in habitat selection occurred during autumn. Neither adults nor juveniles were more vulnerable to mortality during transient dispersal than during colonization dispersal. To investigate these regional population dynamics in more detail, a large-

scale individually-based metapopulation model was developed which incorporated an active dispersal paradigm based on the observed dispersal dynamics. Then the extinction and recolonization process over 100 years was simulated within each of the 113 individual forest patches in the study landscape. Although preliminary results indicated some agreement with patch-dynamic theory, less intuitive temporal and spatial dynamics of metapopulations may also exist, further emphasizing the critical role of dispersal in metapopulation dynamics, and its complex implications for conservation and management.

Key words: *Bonasa umbellus*, fragmented forests, metapopulation, population dynamics, ruffed grouse, Wisconsin

Robert J. Small, Colorado Division of Wildlife, 317 West Prospect Road, Fort Collins, Colorado, 80526, USA
Donald H. Rusch, National Biological Service, Wisconsin Cooperative Wildlife Research Unit, University of Wisconsin, Madison, Wisconsin, 53706, USA

John R. Cary, Department of Wildlife Ecology, 226 Russell Laboratories, University of Wisconsin, Madison, Wisconsin, 53706, USA

James C. Holzwart, Wisconsin Department of Natural Resources, P.O. Box 343, Berlin, Wisconsin, 54923, USA

Capercaillie *Tetrao urogallus* leks in fragmented forests: a 17-year study of the Varaldskogen population, southeastern Norway

Jorund Rolstad, Per Wegge & Ivar Gjerde

Rolstad, J., Wegge, P. & Gjerde, I. 1997: Capercaillie *Tetrao urogallus* leks in fragmented forests: a 17-year study of the Varaldskogen population, southeastern Norway. - Wildl. Biol. 3: 293.

The population dynamics of capercaillie *Tetrao urogallus* was studied at Varaldskogen in southeastern Norway from 1979 to 1996. The long-term objective was to understand the mechanisms that drive population dynamics in time and space at different spatial scales (single lek: 100 - 1,000 ha, multi-lek: 5,000 - 15,000 ha, and regional: 50,000 - 100,000 ha). The dynamics of displaying males at the single and multi-lek scale within a central area of 5,000 ha are reported. Questions asked were: how are number and spacing of displaying males affected by large-scale logging, and what are the consequences for female choice and matings? Three leks were subject to large-scale logging and three leks served as controls. These leks were censused each year and the surrounding areas were searched for single displaying males and new leks. Yearly production of chicks was estimated from August censuses with trained dogs. The number of displaying males ($N = 84$, 2 years) fluctuated between 13 (1985) and 34 (1982) and those of females ($N = 84$, 1 year) between 40 and 70. Yearly changes in numbers of displaying males were highly correlated with August counts of chicks two years before ($R^2 = 0.60$; $P < 0.001$). The population peaked in 1982, 1989, and 1996 at 7-year intervals. Within the area of the three logged leks the proportion of old (>70 years) unmanaged forest decreased from 50 to 15%, whereas

the area of the three control leks experienced a decrease from 50 to 40%. The average yearly densities of males did not differ between the logged (5.8/1,000 ha) and the control leks (6.8/1,000 ha) during the first 7-year period (1982-88: $t = 1.7$; $df = 6$; $P = 0.14$), but differed during the second 7-year period (1989-95) with 5.4 and 7.9 males/1,000 ha, respectively ($t = 2.9$; $df = 6$; $P = 0.03$). The three logged leks split into several smaller leks and single displaying males, whereas displaying males at the control leks remained highly clumped. During 1987-1996 the number of mating sites in the logged areas almost doubled (5.4 sites) compared to the control area (3 sites). The results are ambiguous regarding the effects of logging on the number of displaying males. However, logging clearly caused the clumped lek system to split into a dispersed pattern of smaller leks and single displaying males. This probably constrained female choice of mates, giving rise to a more even distribution of matings among the males.

Key words: capercaillie, fragmented forests, leks, Norway, *Tetrao urogallus*

Jorund Rolstad, Norwegian Forest Research Institute, Hoyskoleveien 12, N-1432 Ås, Norway
Per Wegge, Department of Biology & Nature Conservation, Agricultural University of Norway, P.O. Box 5014, N-1432 Ås, Norway
Ivar Gjerde, Norwegian Forest Research Institute, Fanaflaten 4, N-5047, Fana, Norway

Protection of the capercaillie *Tetrao urogallus* in Estonia

Ene Viht

Viht, E. 1997: Protection of the capercaillie *Tetrao urogallus* in Estonia. - Wildl. Biol. 3: 293.

The size of the capercaillie *Tetrao urogallus* population in Estonia is 4,500-5,000 individuals in spring. In December 1994 the capercaillie was placed under nature protection and it became possible to establish reserve areas to protect their habitats. Display grounds and male territories of ca 1 km radius are constant from year to year. Such areas should be regarded as a constant habitat and should be included in reserve areas. Nature reserves for capercaillie consist of two different areas: an area of absolute protection and an area with management limitations. Areas of absolute protection are display grounds and the surrounding area up to 300 m which has suitable forest for displaying. These areas are

categorised as reserved forests and their primary function is the preservation of habitat for the display of capercaillie. Areas with management limitations are about 1.0-3.0 km² around the area of absolute protection (size of area depends upon number of displaying males) and should include the surrounding suitable forests for capercaillie. These areas are used economically but management should follow the protection guidelines. These forests are classified as protected forests.

Key words: capercaillie, Estonia, habitat conservation, *Tetrao urogallus*

Ene Viht, Metsakatsejaam, Jõgevamaa, EE2350, Estonia

Effects of captive rearing on capercaillie *Tetrao urogallus* physiology and anatomy

Tiina Mäkinen, Ahti Pyörnilä, Ahti Putaala & Raimo Hissa

Mäkinen, T., Pyörnilä, A., Putaala, A. & Hissa, R. 1997: Effects of captive rearing on capercaillie *Tetrao urogallus* physiology and anatomy. - Wildl. Biol. 3: 294.

Captive breeding of game birds for reintroduction or population enhancement has been exercised as a form of conservation biology and wildlife management. Relatively little attention has been given to the quality of the captive-reared birds which might be an important factor in post-release survival. In this study the physiological and anatomical characteristics of 12 (4 females, 8 males) captive-reared capercaillie *Tetrao urogallus* were compared with those of eight wild birds (4 females, 4 males). In September 1995, samples were collected consisting of blood biochemical parameters (haemoglobin, glucose, total proteins, free fatty acids, uric acid, triglycerides, cholesterol, and thyroid hormones) and tissue analyses (tissue composition, glycogen content, cytochrome c-oxidase activity, muscle fibre type). In addition, anatomical measurements (body, internal organ and muscle weights, and intestinal lengths) were made. Wild and captive capercaillie differed in size of the gastrointestinal tract and in properties of the flight muscle. Wild capercaillie had a longer small intestine (range 20-39 cm, $P < 0.001$) and caecum (range 16-21 cm, $P = 0.001$), and a heavier gizzard ($P = 0.017$) than captive birds probably because of lower digestibility and nutritional value of the natural diet compared to commercial poultry food. Wild capercaillie had a heavier heart ($P = 0.003$), liver ($P = 0.005$) and leg muscles ($P =$

0.005) than captive birds. The pectoral muscle of wild birds had a higher ($P = 0.002$) activity of cytochrome c-oxidase (a respiratory chain enzyme), probably associated with better flying ability as compared with captive birds. Histological examination revealed two different fibre types in the pectoralis muscle. In wild birds, fast twitch oxidative glycolytic (FOG) predominated (80-88%) with the remainder being fast twitch glycolytic (FG) cells. The higher staining density for succinate dehydrogenase (SDH) and the larger amount of FOG fibres (39%) apparently provides wild capercaillie with improved potential for sustained flight compared to captive birds. Blood biochemical parameters showed significantly higher values of glucose ($P = 0.020$), cholesterol ($P < 0.001$) and uric acid ($P = 0.0015$) in captive birds which probably reflects the high nutritional value of commercial poultry diet. Thus, there were marked anatomical and physiological differences between captive and wild capercaillie that might affect release success. Therefore, bird quality and preconditioning should be considered in release programs using captive-reared birds.

Key words: anatomy, capercaillie, captive rearing, physiology, *Tetrao urogallus*, translocations

Tiina Mäkinen, Ahti Pyörnilä, Ahti Putaala & Raimo Hissa, University of Oulu, Department of Biology, FIN-90571 Oulu, Finland

Distribution and status of grouse in China

Wei Gao, Zhongxin Gao, Changhu Lu & Xiangtao Li

Gao, W., Gao, Z., Lu, C. & Li, X. 1997: Distribution and status of grouse in China. - Wildl. Biol. 3: 294.

Eight species of grouse, *Tetraoninae*, occur in China, all of which are protected. These species are capercaillie *Tetrao urogallus*, black-billed capercaillie *T. parvirostris*, black grouse *T. tetrix*, willow ptarmigan *Lagopus lagopus*, rock ptarmigan *L. mutus*, sharp-winged grouse *Falcipennis falcipennis*, hazel grouse *Bonasa bonasia*, and Chinese grouse *B. sewerzowi*. Their present distribution is limited to small areas in the northeast and northwest. China's grouse fauna is rich in variety and occupies a variety of environments. However, two species are disappearing in the wild. Most are listed as endangered or vulnerable species in the IUCN Red Data Book. Since about 1960, grouse research by Chinese biologists has progressed mainly in understanding distribution, captive rearing, and be-

haviour. There is still a lack of knowledge concerning China's grouse, and their conservation and management are facing great problems. Due to overhunting, grouse distribution has shrunk since the end of the 1980s, even leading to extermination in some areas.

Key words: Bonasa, China, endangered, Falcipennis, grouse, Lagopus, Tetrao

Wei Gao, School of Life Sciences, Northeast Normal University, Changchun 130024, Jilin Province, P. R. China

Zhongxin Gao & Changhu Lu, College of Wildlife Resources, Northeast Forestry University, 26 Hexing Road, Harbin 150040, P. R. China

Xiangtao Li, Beijing Natural History Museum, 126 Tian Qiao Street, Beijing 100050, P. R. China

Landscape-dependent breeding success of forest grouse in Fennoscandia

Sami Kurki, Ari Nikula, Pekka Helle, & Harto Lindén

Kurki, S., Nikula, A., Helle, P. & Lindén, H. 1997: Landscape-dependent breeding success of forest grouse in Fennoscandia. - *Wildl. Biol.* 3: 295.

In Fennoscandia, two hypotheses predict how predation on nests and broods of forest grouse may be connected to human-induced changes in landscape composition. First, predation rates are higher in forest areas fragmented and intermixed with agricultural land due to higher generalist predator densities supported by the agricultural matrix. Second, within forest land, fragmentation of mature forest due to clear-cuttings has been suggested to increase mammalian predator densities by increasing suitable grass-dominated habitats for *Microtus*. Using Finnish wildlife triangle census data (1989-94), the locations of 2,267 black grouse *Tetrao tetrix* and 1,060 capercaillie *T. urogallus* females after the breeding seasons (mid-August) were combined with land-use and forest resource data using GIS in two study areas (both 450 km²) in southern and northern Finland. Land-use and forest resource data (pixel size 25 m) were based on classification of Landsat TM 5 images with field plot network of Finnish forest inventories and digital masks of non-forest lands. After reclassifying landscape data to: 1) water area, 2) agricultural land, 3) clear-cuttings and plantations, 4) young forest, and 5) closed canopy forest, circular landscapes around locations of grouse females with six different radii (500, 1,000, 1,500, 3,000, 5,000, and 10,000 m) were formed, and the proportions of different habitat types were computed with FRAGSTATS. The probability of an observed grouse hen being with a brood was positively associated with the proportion of closed canopy forest in the landscape in both study areas. In the south, the effect was strongest with the radius of 3,000 m, and in the

north with the largest radius (10,000 m), whereas in both areas the effect was weakest, although significant, with the shortest landscape radius (500 m). Among other habitat types, depending on study area and landscape radii, the increasing proportion of young forest, clear-cuttings, plantations, and agricultural land affected negatively the proportion of hens with a brood. Landscape composition was not correlated with brood size of grouse. Breeding success of forest grouse was landscape dependent in Fennoscandia, and breeding success was negatively affected by the fragmentation of closed canopy forests. A negative correlation between red fox *Vulpes vulpes* densities and proportions of closed-canopy forest in the landscape was also found. Brood size was not affected by landscape composition, thus, predation causes total losses of either nests or broods. Lowered breeding success of grouse as a result of forest fragmentation is most likely one of the reasons for declines in grouse populations during past decades in Fennoscandia.

Key words: *Fennoscandia, forest grouse, fragmentation, nest success, predation, survival*

Sami Kurki, Laboratory of Ecological Zoology, Department of Biology, FIN- 20014 University of Turku, Finland

Ari Nikula, Finnish Forest Research Institute, Rovaniemi Research Station, P.O. Box 16, FIN-0-96301 Rovaniemi, Finland

Pekka Helle, Finnish Game and Fisheries Research Institute, Meltaus Game Research Station, FIN-97340 Meltaus, Finland

Harto Lindén, Finnish Game and Fisheries Research Institute, P.O. Box 6, FIN-00721 Helsinki, Finland

Demographic rescue and maintenance of population stability in grouse - beyond metapopulations

Kathy Martin, Peter B. Stacey & Clait E. Braun

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Population managers usually focus on recruitment and survival of individuals within populations, with relatively little emphasis on demographic contributions from other populations. However, periodic 'rescue' of populations that are declining with recruitment from productive populations may be an important feature of population biology for many species. Four populations of

white-tailed ptarmigan *Lagopus leucurus* were studied breeding in highly fragmented alpine habitats, with corresponding small population sizes, in the Rocky Mountains of North America from 1987 to 1996. The populations showed dramatic variation in young production and local survival (return) of adults over years and sites. Variation in reproductive success and survival were unlinked over sites and appear to be driven mainly by internal ecological processes such as depredation of eggs and young. Computer simulation models of individual populations predicted that all populations should

become extinct within 2-10 years, assuming no linkage between them. Treating the four populations as different fragments of a single large closed population resulted in predicted persistence times of about nine years. Yet all populations have persisted for at least 30 years and likely substantially longer. In one site, the population of breeding pairs remained stable despite zero production the previous year and no return of females. Local populations of ptarmigan were able to avoid extinction due to external recruitment. However, almost all of the recruitment (particularly females) was from outside the population and possibly from outside nearby populations. Sites may vary temporally in predation risk as ptarmigan have generalist predators which live for several years and whose hunting skills are likely to improve with age. Excellent dispersal abilities allowed recruitment from populations during a productive episode to 'rescue' populations at risk of collapse if they were dependent solely on internal recruitment. Experiments on mate and territory replacement showed no apparent reproductive costs to females switching mates or territories, suggest-

ing that dispersal to unfamiliar sites may not be costly. Ptarmigan have adapted to breeding in highly fragmented and stochastic alpine habitats by existing in a rescue effect metapopulation system functioning at a landscape scale. This pattern is well developed for ptarmigan that have low populations sizes in naturally fragmented habitats, but the pattern of demographic rescue may well apply to several other grouse species and, in fact, may apply generally to other taxonomic groups.

Key words: alpine habitat, demographic rescue, external recruitment, Lagopus leucurus, simulation model, white-tailed ptarmigan

Kathy Martin, Canadian Wildlife Service, RR 1, Delta, British Columbia, V4K 3N2, Canada

Peter B. Stacey, Program in Ecology, Evolution and Conservation Biology, University of Nevada, Reno, Nevada 89512, USA

Clait E. Braun, Colorado Division of Wildlife, Fort Collins, Colorado 80452, USA