Montana Fish, Wildlife & Parks

weather & wildlife

volume ii: upland game birds

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weather & wildlife

volume ii: upland game birds
an annotated bibliography

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A PUBLICATION OF THE HABITAT SECTION
WILDLIFE BUREAU

Montana Fish, Wildlife & Parks

Rough Writers *Studio*

Robert L. Eng

Terry Lonner photo

Weather & Wildlife Volume II: Upland Game Birds is dedicated to ***Dr. Robert L. Eng*** in recognition of his extensive research and publication on the life history of upland game birds.

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Table of Contents

"Much of wildlife management is in the nature of insurance against future probable contingencies"
R. T. King 1937 Ruffed Grouse Management

"The ups and downs of any animal population are just as natural as changes in the weather. It is even fair to say, dependent on changes in the weather. The weather furnishes them a poor house or a good house, depending on how much cover is grown by the rains which may or may not fall. It freezes or bakes them."
R. Dahlgren 1967 The Pheasant Decline

Definitions

Climate: the average WEATHER conditions throughout the seasons over a fairly wide or very extensive area of the earth's surface and considered over many years (usually 30 to 35 years) in terms of CLIMATIC ELEMENTS, CLIMATOLOGY, LOCAL CLIMATE, MACROCLIMATE, MESOCLIMATE, MICROCLIMATE, MICROCLIMATOLOGY.

Weather: a general term for the conditions prevailing in the ATMOSPHERE-1, especially in the layer near the ground (TOPOSPHERE), over a short period of time (in contrast to CLIMATE) or at a specific time, at any one place, and as affecting human beings. Temperature, sunshine, pressure and wind, humidity, amount of cloud, precipitation (rain, sleet, hail, snow), the presence of fog or mist are all taken into account.

Clark, Audrey N. 1998. Dictionary of Geography. Penguin Books, New York.

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Foreword

In recent years, much ado has been made about climate change, using models that are complex, incomplete and not well understood. Most people, however, readily recognize the effects of daily and seasonal weather on their lives.

So it is also in the lives of wild animals—weather effects their movements, growth and survival. Wildlife management pioneers suggested that the effects of weather should be incorporated into the new science of wildlife studies and management. We have been very slow to do so.

This document is an effort to encourage working field biologists to better understand and incorporate weather and its effects into their wildlife and habitat management recommendations and actions. My hope is this publication will establish weather in its rightful place as a major factor in professional wildlife management decisions as well as in the public's understanding of weather impacts on wildlife populations.

Stephen J. Knapp

Steve Knapp
Chief, Habitat Section

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Preface

Weather & Wildlife, Volume II: Upland Game Birds emphasizes literature describing the influence of weather-related events these birds rather than addressing the larger topic of global climate change. While the bibliography contains a few papers related to modeling, our focus is on the direct and indirect influence of weather events on the life cycle, ecology, and evolution of upland game birds.

While not comprehensive, this bibliography of over 500 entries, combined with additional references in the introductory material, provides the wildlife manager, researcher, and student with an extensive cross-section of literature on the subject. Research from around the world was sought based upon an extensive database search including, among others, JSTOR, BioOne, Biological and Agricultural Index, Wildlife and Ecology Studies World Wide, Zoological Record and Biological Abstracts.

Weather & Wildlife, Volume II: Upland Game Birds is a companion to *Weather & Wildlife, Volume I: Large Ungulates*.

Roberta Bomar copyright 2008

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Introduction

Weather & Wildlife:Volume I emphasized research papers defining the relationship between weather and large ungulates; the 562 references in Volume II illustrate the relationship between weather and upland game birds. Together Volumes I and II provide the reader with a source of 957 publications on the subject of weather and wildlife. Our hope is that wildlife managers and researchers will find the bibliography useful in making science-based decisions for the conservation of upland game birds. Since the inception of the profession, wildlife managers have struggled with how to account for varying and unpredictable impacts of weather patterns on wildlife. *W&W II* is intended to provide a resource for the professional, student and generalist in considering this important variable in upland game bird management.

Bibliography

"Strong habitat is the best and only practicable defense against extremes of weather."
Hamerstrom, Mattson & Hamerstrom - 1957
A Guide to Prairie Chicken Management

001

Adler, P. H., D. Roach, W. K. Reeves, J. P. Flanagan, M. E. Morrow, and J. E. Toepfer. 2007. Attacks on the endangered Attwater's prairie-chicken (*Tympanuchus cupido attwateri*) by black flies (Diptera: Simuliidae) infected with an avian blood parasite. Journal of Vector Ecology 32(2):309-312. Abstract: With fewer than 50 birds remaining in the wild, Attwater's prairie-chicken (*Tympanuchus cupido attwateri*) is critically endangered. Individuals of this species on the Attwater Prairie Chicken National Wildlife Refuge, Colorado Co., TX have been attacked in successive winters, 2005-2006, by the blood-feeding black fly *Cnephia ornithophilia*. Attwater's prairie-chicken is a previously unreported host for *Cnephia ornithophilia*. Molecular screening indicated that about 15% of 13 blood-fed flies sampled from captured Attwater's prairie-chickens carried parasite of the genus *Leucocytozoon* that can cause a debilitating avian malaria-like disease. If blood feeding or transmission of the disease agent becomes a threat to the birds, particularly in years of lean food supply or harsh winter, management of *Cnephia ornithophilia* should be considered. **Key words: prairie chicken, severe winter, nutrition, insects, disease**

002

Aldrich, J. W. 1963. Geographic orientation of American Tetraonidae. Journal of Wildlife Management 27(4):529-545. Notes: "In the ruffed grouse, we find a classic example of the correlation of intensity of coloration with the amount of moisture in the environment, as well as with the density and background shades of the vegetation cover, themselves correlated with moisture. Thus the darkest ruffed grouse are in the lush forests of the Olympic Peninsula rain forest and the palest in the relatively arid aspen groves of the Great Basin Mountains of Utah and the low hills rising out of the shortgrass prairies of the central states and provinces." **Key words: ruffed grouse, precipitation, humidity, morphology**

003

Aldridge, C. L. 2003. Understanding the decline—is there hope for Alberta's sage-grouse? Biodiversity Makes It Work; Newsletter of the Alberta NWAMP Partnership. Ducks Unlimited, Edmonton, Canada. Notes: Aldridge concluded that a

large mid-May snow storm and three days of continuous cold, heavy rain in 2002 resulted in the lowest-ever-recorded nest success for the population in southeastern Alberta: only 5% of 37 nest attempts were successful (13.5%), due to eggs being frozen early in incubation. **Key words: sage-grouse, snow, temperature, precipitation, reproduction**

004

_____. 2000. Reproduction and habitat use by sage-grouse (*Centrocercus urophasianus*) in a northern fringe population. M.S. Thesis, University of Regina, Regina, Canada. Notes: Pages 33-34—"Climate. Although sage-grouse are fairly robust birds, harsh climatic conditions at the northern edge of the species' range may affect populations. Short summers and particularly harsh winters likely reduce the ability of individuals to find enough food in winter months and decrease lipid reserves necessary for reproduction and possibly lower overwinter survival. There is a positive relationship between spring precipitation and sage-grouse productivity. During the 1980s, spring precipitation was considerably lower than the long-term average. This likely contributed to decreased productivity and survival. The effects of other limiting factors may be compounded during drought conditions. For example, consistent cattle stocking rates during the drought of the 1980s may have resulted in a substantial loss of vegetative cover, perhaps lowering nest success, increasing predation, and possibly lowering overwinter survival. Impacts may have been particularly severe in more moist habitats, which supply important herbaceous growth during nesting and brood rearing. The attraction of cattle to these areas was probably increased during drought conditions, which may have decreased brood survival." Page 84—"I did not observe a shift in habitat used by broods, which typically occurs due to changing dietary requirements of chicks….Spring precipitation was above average in both years of my study, resulting in increased vegetation growth. Thus, broods likely had increased food resources available to them in sagebrush habitat, allowing them to remain in sagebrush uplands. In dry years, broods should have to move from sagebrush uplands to more mesic sites. However, mesic wetland type habitats are generally limited and may not be available for broods in dry years. Thus, brood survival may be even lower during times of drought." Page 85—"In years when precipitation is average or below average, forb cover may be below that required to provide suitable brood habitat. The lack of a shift in brood habitat between early and late-brood rearing in my study suggests that differences in the availability of forbs did not exist, at least in wet years. However, the limited cover provided by forbs at brood locations despite high spring precipitation suggests that key brood habitat in moist wetlands and drainages may be limiting in southeastern Alberta, even in moist years." Page 85—"Virtually all research on brood habitat use has found that areas with forbs are selected and that a shift to more mesic sites occurs after broods reach six weeks of age. Sage-grouse broods in my study did not select use sites based on forb availability and no shift in habitat use occurred. Mesic areas with nutrient rich forbs may be limiting and forbs as a food resource may be even more limiting during drier years. Lack of suitable moist drainages for broods to forage in may also be a factor contributing to low chick survival and poor recruitment." **Key words: sage-grouse, precipitation, drought, grazing, vegetation, productivity, mortality, movement, habitat use, recruitment**

005

_____. 1998. Status of the sage-grouse (*Centrocercus urophasianus*) in Alberta. Alberta Environmental Protection, Wildlife Management Division, and Alberta Conservation Association, Wildlife Status Report No. 13, Edmonton, Canada. Notes: Page 14—Climate. Summarizes research of weather impacts on sage-grouse. The author notes that the drought of the 1980s may have limited productivity and contributed to a population decline. He also states that the impacts of other limiting factors may be compounded during drought and goes on to cite stocking rates during drought that may have resulted in substantial loss of vegetative cover possibly impacting nesting success, predation and winter survival. **Key words: sage-grouse, drought, temperature, precipitation, population dynamics, grazing, vegetation**

006

_____ and R. M. Brigham. 2003. Distribution, abundance, and status of the greater sage-grouse, *Centrocercus urophasianus*, in Canada. Canadian Field-Naturalist 117:25-34. Notes: Page 30—"Overgrazing has long been suggested as one of the main reasons for declining sage-grouse numbers. The removal of vegetation cover by cattle can have an impact on sage-grouse populations, either by reducing habitat suitability or by increasing the exposure of birds and nests to predators or extreme weather, all of which decrease survival and nest success…heavy grazing during drought conditions could intensify these effects…grazing may simply decrease the carrying capacity of sage-grouse habitat, especially in years with below average annual precipitation." Page 31—"Climate. Although sage-grouse are large robust birds, harsh climatic conditions at the northern edge of the species/ range likely affect populations. Short summers and particularly harsh winters likely reduce the ability of individuals to find enough food in winter months, especially given the low abundance of sagebrush in Canada. This would result in decreased lipid reserves that are necessary for reproduction and possibly reduce overwinter survival. There is a positive relationship between spring precipitation and sage-grouse productivity. Years with below-average spring moisture result in less vegetation growth, apparently reducing sage-grouse nest success and reducing the availability of lush vegetation that is an important dietary component, especially for chicks. During the 1980's, spring precipitation was considerably below the long-term average. This likely contributed to decreased productivity and resulted in reduced chick survival in Alberta. However, cold, wet spring precipitation events (rain or snow) can also result in increased nest failures. The effects of other limiting factors may be compounded during drought conditions. For example, consistent cattle-stocking rates in Canada during the droughts of the 1980's may have resulted in a substantial loss of vegetative cover, perhaps lowering nest success, increasing predation, and possibly lowering overwinter survival. The impacts may have been particularly severe in more moist habitats, which supply important herbaceous growth during nesting and brood rearing. The probable increased attraction of cattle to these areas during drought conditions may decrease chick survival." **Key words: sage-grouse, precipitation, drought, temperature, vegetation, reproduction, mortality, chick survival**

007

Allen, D., editor. 1956. Pheasants in North America. Stackpole Company and Wildlife Management Institute, Washington, D.C., USA. Notes: Chapter 2—Chinese Pheasants in the Northwest: Page 56—"Although a general reduction in bird populations is apparent and explainable, wide fluctuations within this pattern are difficult to account for. There are many indicators that they are correlated with weather cycles or variations in temperature and rainfall during the nesting season." Page 61—"During periods of heavy and prolonged snowfall, there is evidence that a supplement of grit may be of greater value to pheasants than other foods." Chapter 3—Pheasant in California: Page 105—"All available evidence on pheasant populations and reproduction for this area points to the fact that success hinges upon weather conditions during spring and early summer." Page 107 – "It is believed that…indirect effects of spring rainfall upon nesting by influencing farming practices is more important than direct effect upon clutch size, hatch, or chick survival (Sacramento Valley rice belt). Page 110 – San Joaquin Valley Habitat – "Detailed studies of limiting factors have not been made in this region, but low rainfall and unfavorable agricultural conditions generally are believed to be basic." Imperial Valley – "Low rainfall is the basic reason for poor nesting conditions." Chapter 4—Pheasants in the Arid Southwest: Page 161—" Moisture-temperature relationships and land use practices that severely reduce cover and food seem to explain the lack of success of the ringneck in the south and southeast portions of the region." Page 171—"…predation becomes serious during blizzards, when hundreds, even thousands, of pheasants may be driven to the insecure shelter of small wooded areas. Under such conditions, losses may be severe." "…blizzards..loss seems to result from the combination of low temperatures, heavy snow, and high wind; and death actually is caused by suffocation rather than freezing. The greatest mortality always occurs in cover-deficient areas, where birds roosting in stubble, or in other thin cover, receive the full force of the wind." Page 171—" Unusually heavy, wet snow in May or early June may destroy many nests, forcing extensive renesting and late hatching peaks. The obvious approach to meeting the contingencies of winter extremes is the creation of more and better cover." Chapter 5—Pheasants of the Plains and Prairies: Page 210 – "…increased rainfall resulted in more abundant cover in the form of sweet clover, sunflower, and other herbaceous species." Page 211 – "…population fluctuation and shifts appear to be explainable on the basis of environmental changes." "Highest loss came from freezing and choking during severe weather." "Mortality from predators and from accidents is associated with winter storms and may be considered as indirect storm losses…following a severe storm they are more susceptible to predation since they may be encumbered by balls of ice and snow, and because escape cover is filled with snow." Chapter 6—Ringnecked Pheasants in the Great Plains—Page 289—"Hunger alone, prior to any physical evidence of starvation, is a stress factor. When such stress is coupled with any one or a combination of extreme cold, high wind, rain, pursuit by predators, reduction of cover, or deep snow, it may render birds more vulnerable or even cause death." Page 320 – "There is a good possibility that spring weather conditions may have their most significant effect through the timing of such farm operations as hay mowing or sod plowing." Page 322 – "It seems that local pheasant abundance may be explained by the occurrence of weather extremes, but rangewide comparisons must of necessity rely on means….it seems that high temperature alone is not detrimental and that relative humidity or a temperature:moisture ratio may be of importance.” Page 324 – “…these ideas appear to be important relative to the pheasant and weather: 1) cold and wet spring weather that may be detrimental in one part of the Lake States range may be beneficial in another; 2) High temperatures alone do not limit distribution; 3) Some relationship between temperature and moisture governs suitability of pheasant range and perhaps yearly productivity; 4) What to pheasants are ideal climatic conditions are not necessarily those measured by weather stations.” Chapter 8—The Pheasant in the Northeastern States: Page 400—“…a 20%...decrease was [caused by] the combined result of blizzard conditions in January and February climaxed by a severe ice storm in March, with ice glaze persisting as much as a week in much of the pheasant range.” Page 405 – “…the pheasant decline in New York started when weather conditions could not be considered adverse, unless because of drouth, but the most rapid decline was associated with cold and wet springs, probably aggravated by a hard winter.” **Key words: ring-necked pheasant, temperature, precipitation, drought, snow, ice, wind, humidity, mortality, population dynamics, habitat modification, predation, productivity**

008

Andreev, A. V. 1990. The winter biology of Siberian spruce grouse (*Falcipennis falcipennis*) in the Priamurie. Zoologicheskii Zhurnal 69(3):69-80. Abstract: The biotopes preferred by the Siberian spruce grouse in winter are concentrated in a zone between spruce and larch forests, particularly close to mossy swamps. In the spruce forests grouses feed and settle for night in the snow on margins of the mossy swamps. The daylight activity of the birds starts and ends at the illumination intensity of 5 to 7 lux; the daylight time the grouses spend in the tops of *Picea jezoensis* changing one to two trees a day. The birds spend feeding about forty percent of the daylight time (in January it is approximately 4 hours). The dominant food is coniferous needles. When feeding intensively the grouse consumes every minutes from 37 to 73 needles mainly from the branch ends in the spruce top. An average digestivity of the coniferous needles is 0.28; the daily food needed in January is 89 g of dry and 150 g of wet food for the bird’s bodyweight of about 700 g. The total flight distance does not exceed 100 m per day and their duration, 10 sec/day. The duration of one flight is 2.5 sec. At the air temperature above -20 degree, the birds prefer spruce tops at night and dig in snow if it is cold. The anthropogenic landscape transformation in the grouse biotopes resulted in a drastic growth of the hazel hen population. It is assumed that in a number of regions the competitive relations with the hazel may suppress the grouse population. **Key words: Siberian spruce grouse, solar radiation, snow, temperature, movement, behavior**

009

_____. 1977. Temperature conditions in snow cavities of the hazel grouse (*Tetrastes bonasia kolymensis* But.). Soviet Journal of Ecology 8(5):454-455. Notes: The results of the measurements show that the temperature in the cavity can change from -15 to -0.3 deg and depends little on the temperature of the outside air. How the bird buried itself had much greater influence on the temperature in the cavity:

the length, the bends in the entrance tunnel, and, in particular, the presence of an opening between the ceiling of the chamber and the snow plug, closing the chamber from the tunnel. If the plug was sufficiently tight, then even during a very strong frost the temperature in the cavity could approach 0°…The maintenance of the high temperature in the cavity is provided for not only by the insulating properties of snow and the heat given off by the bird. Of important significant is the flow of heat coming from the soil surface. It also depends on the air temperature and the thickness of the snow. From November to March hazel grouse pass a large part of the day in the snow. Thus, in spite of the severe climatic conditions they winter under highly mild microclimatic conditions (it is only necessary that the thickness of the snow be more than 25 cm). Specifically these conditions permit the smallest representative of tetraonid birds to winter successfully at northern latitudes, being nourished by comparatively low-quality branch forage. **Key words: hazel grouse, temperature, snow, behavior, nutrition**

010

Applegate, R. D. and T. Z. Riley. 1998. Lesser prairie chicken management. Rangelands 20:13-15. Note: Winter cover can be particularly important in periods of drought when cover, food, and moisture from leafy vegetation are limited. “There is little free water across most of the range of lesser prairie chickens, and leafy vegetation may be the only moisture available in winter during periods of drought. An extended drought over several years can be devastating to prairie chickens. Flocks will travel great distances to find sources of food and moisture, but mortality rates increase dramatically when sources are difficult to locate.” **Key words: prairie chicken, drought, vegetation, nutrition, movement**

011

Archibald, H. L. 1976. Spring drumming patterns of ruffed grouse. Auk 93(4):808-829. Abstract: Drumming of 7 male ruffed grouse [*Bonasa umbellus*] was monitored from 7-56 days with modified automatic radio-tracking equipment during spring 1970. Grouse generally drummed at the same times of day, but certain individuals drummed at shorter intervals than others consistently throughout the day. The highest drumming frequencies within a day tended to occur at the beginning of a drumming period and an average of 38.7 min before sunrise. During the first 2 ½ wk of the drumming season, nocturnal drumming was consistently recorded for all radio-marked males except under windy or inclement weather conditions. Within about 5 days, drumming became nearly exclusively diurnal and continued so thereafter. Peak drumming periods coincided with the full moons in April and May. Estimated dates of copulation of 3 hens coincided with the drumming peak in April. The 2nd peak may have been associated with remating of hens that had lost their initial clutch. Five abiotic factors accounted for approximately 67% of the variation in the seasonal distribution of the average daily total number of drums; the most important of these factors were moon fullness (seasonal variation) and kilometers of wind/day (day-to-day variation). Two possible forms of communication between adjacent males were identified: drumming shortly after the start of a neighbor’s drum and duplication of the interval between successive drums of a neighbor. Stimulus-response functions for 2 neighboring grouse showed a tendency for the drums of 1 bird to occur either within 10 s or between 50 and 130 s after the drums of the other bird. **Key words: ruffed grouse, behavior, wind**

012

Armbruster, J. W. 1994. Early season nesting success of mourning doves (*Zenaida macroura*) in central Illinois. Transactions of the Illinois State Academy of Science 87(1-2):37-41. Summary: Early season mourning dove (*Zenaida macroura*) nests are subjected to cold weather which may reduce fledging success. In a residential setting in central Illinois, a wind storm destroyed 50% of all nests and fledging success was only 13.7% because of the storm and low hatching success of eggs that remained in the nests. Although early season nests may often have low reproductive success, if they are successful, they may result in fledglings that can breed by the end of the season. **Key words: mourning dove, wind, mortality, reproduction**

013

Aulie, A. 1976. The pectoral muscles and the development of thermoregulation in chicks of willow ptarmigan (*Lapopus lagopus*). Comparative Biochemistry and Physiology 53A:343-346. Abstract: 1. The O_2 consumption, EMG from m.pectoralis major and body temperatures during cold exposure were measured and the weights of pectoral muscles, leg muscles and liver recorded in ptarmigan chicks of different ages. 2. Up to the second day the pectoral muscle made up ~1.8% of the body weight. From the third day their mass increased faster than the rest of the body and was 11% on the twelfth day. 3. The shivering response was weak until the second day and increased about 6-fold from the third day. 4. It was a clear connection between the increase in pectoral muscle mass, maximal O_2 consumption ($m10_2$/g hr) and improved resistance to cold. Three factors seem to be of vital importance in the development of thermoregulation in ptarmigan chicks: (1) The chick responds to cold exposure with thermo-conserving behavior, remaining calm and fluffed up. (2) Activation of its skeletal muscles strongly through shivering. In most chicks both these factors seem to appear between the second and third day after hatching. From this stage, a further improvement of the thermoregulatory capacity seems to depend on (3) the mass increase of the pectoral muscles. **Key words: willow ptarmigan, temperature, thermoregulation, behavior**

014

_____ and P. Moen. 1975. Metabolic thermoregulatory responses in eggs and chicks of willow ptarmigan (*Lagopus lagopus*). Comparative Biochemical Physiology 51A:605-609. Abstract: (1). The Co_2 production in eggs and chicks of willow ptarmigan has been measured during cold exposure. (2) Fourteen-day-old embryos showed no sign of thermoregulation. In the fully developed embryo a 10°C drop in ambient temperature decreased the metabolic rate with only 26 percent, indicating that a thermoregulatory response is present. (3) Newly hatched (wet) chicks were unable to increase the metabolism when exposed to 29°C in spite of increased muscular activity. Half a day old chicks increased the metabolism with 45 percent at this temperature. No sign of shivering could be observed on the first day and the non-shivering thermogenesis is thought to be caused by the increased muscular activity in connection with the flight behavior. (4) Some of the 2- and 3-day-old chicks balled up and shivered when exposed to cold and became less hypothermic (35-0°C) than the one that did not shiver (31.2°C) when exposed to 19°C for 20 min. (5) Within 5 days after hatching all the chicks balled up and shivered when exposed to cold and they became only slightly hypothermic (35.8-38.3°C) when exposed to 19°C for 20 min. The lower critical temperature in the 5- to 7-day-old chicks was about 30°C. (6) Brooding is thought to be a more important mechanism than shivering in maintaining a high and constant body temperature in the willow ptarmigan during the first week after hatching. **Key words: willow ptarmigan, temperature, thermoregulation, reproduction, morphology**

015

Austin, D. E. and L. W. DeGraff. 1975. Winter survival of wild turkeys in the southern Adirondacks. Proceedings of the National Wild Turkey Symposium 3:55-60. Abstract: The survival and behavior of an isolated population of wild turkeys (*Meleagris gallopavo silvestris*) was investigated in the southern Adirondack Mountains, 1966-73. Five winters had mild or average weather conditions and the turkey survival averaged 75 percent. Two winters were severe and the survival was only 55 percent. Although the wild turkeys were adaptable to extreme winter weather conditions, the severe winters caused sufficient mortality to limit population growth. **Key words: wild turkey, severe weather conditions, mortality, population dynamics**

016

Back, G. N., M. R. Barrington, and J. K. McAdoo. 1987. Sage-grouse use of snow burrows in northeastern Nevada. Wilson Bulletin 99(3):488-490. Notes: The authors note that the type of roost used by sage-grouse varies with snow conditions and identify two distinct burrow types: “snow forms” and “snow burrows”, the first being shallow depressions or open bowls in the snow. They observed 83 snow burrows at a number of locations; in the majority of cases, the burrowing occurred within one week of snowfall. Minimum temperatures during the periods of snow-burrowing use were <-10°C in all but one case. The type of burrow varied with snow conditions. Drift burrows were used when drifts provided the only deep snow in which to burrow. Open-snow burrows only were observed when soft, dry snow >25 cm was available. In over 75% of the precipitation events, the daily minimum temperature was at least 10°C lower for several days following precipitation. Increased loses of hazel grouse and black grouse have occurred when snow cover was lacking and temperatures were extreme. **Key words: sage-grouse, snow, temperature, behavior**

017

Baines, D. 1996. Seasonal variation of lek attendance and lekking behaviour by male black grouse *Tetrao tetrix*. Ibis 138(2):177-180. Abstract: Eleven black grouse *Tetrao tetrix* leks in the Scottish Highlands were visited at dawn once every week for a year. Apart from July and three leks which were unoccupied in winter, males visited leks throughout the year. Total numbers of males attending leks peaked in March in one study area (six leks) and in April in the second (five leks). The number of males present and the proportion of leks occupied varied seasonally. The proportion of males at leks was at a maximum in April (80% of males) when all leks were attended, with a secondary peak in September when 60% of leks had males present. Males spent the most time displaying in April. The optimal conditions for attendance were calm, dry mornings just after dawn. Most reliable counts of numbers of males were those made between the last week of March and the end of the first week of May. **Key words: black grouse, wind, precipitation, behavior**

018

______. 1991. Factors contributing to local and regional variation in black grouse breeding success in northern Britain. Ornis Scandinavica 22(3):264-269. Notes: "Differences in gamebird chick mortality between years have been frequently explained by extrinsic factors such as cold, wet weather or shortage of insect food. Findings from this and other studies have led me to produce three hypotheses regarding factors which could reduce black grouse breeding success and which may contribute to the decline in both numbers and range of black grouse recorded in Britain: (1) A tendency for wetter, cooler weather in June; (2) an increase in the number of egg and chick predators; and (3) a decline in the abundance of preferred insect foods. Adverse weather will tend to increase the need for brooding at the expense of foraging time. Cold, hungry chicks are often noisy and may attract predators, whilst hens with reduced foraging time may have to feed more intensively and as a result be less vigilant. Ground predators that hunt by scent may even be more effective after rain. In June 1989, the weather at and after hatching was warm and dry. Chick survival was high and production was 2.7 juveniles per hen. But in the cold, wet June of 1990, more hens were broodless and only 1.7 juveniles per hen were reared, a 37% reduction. **Key words: black grouse, temperature, precipitation, population dynamics, behavior, predation, mortality, productivity, chick survival**

019

_____, P. Warren, and M. Richardson. 2007. Variations in the vital rates of black grouse *Tetrao tetrix* in the United Kingdom. Wildlife Biology 13 Supplement 1:109-116. Abstract: In the United Kingdom, black grouse *Tetrao tetrix* are in severe decline with only 6,500 displaying males in 1995-1996 and a range retraction of 28% between 1972 and 1991. Recent declines have been greatest in central and southern Scotland and parts of Wales and contrast with relative stability in northern England. We compare the demography of black grouse in three regions: North Wales, northern England and the Scottish Highlands. Patterns in annual fecundity, measured as fledglings per breeding female, were correlated between regions, suggesting that annual weather patterns common across regions may be a key determinant of breeding success. Site related effects such as habitat quality or management were also significant in northern England and North Wales. Male population growth rates at leks were positively correlated with fecundity in the previous year. Fecundity was highest in North Wales and the Scottish Highlands at 1.7 chicks per female in August compared to 1.3 in northern England. Variations in the annual fecundity of radio-tagged females were linked to differences in brood survival rather than clutch survival, which did not differ among years. We found a non-significant trend for juvenile survival to be lower in North Wales (0.18) than in either northern England (0.65) or the Scottish Highlands (0.56).

Similarly, annual adult survival also tended to be lower in North Wales (0.44) than in either northern England (0.70) or the Scottish Highlands (0.66). Predation was the main cause of death in all regions, with red fox *Vulpes vulpes* and raptors being the chief predators in North Wales and the Scottish Highlands and stoat *Mustela erminea* in northern England. The last 10 years have seen the implementation of a series of black grouse recovery projects in the UK. An understanding of the limiting demographic stage in each project area is critical before appropriate remedial management prescriptions can be implemented. **Key words: black grouse, fecundity, weather patterns**

020

Bakken, G. S. 1990. Estimating the effect of wind on avian metabolic rate with standard operative temperature. Auk 107:587-594. Abstract: I developed a simplified procedure to estimate the effect of wind on avian energy use rates from published and unpublished studies of 10 passerine and 7 nonpasserine species. Below the lower critical temperature, energy-use rates of passerines resting in the dark can be estimated as that of a bird of the same species in a metabolism chamber set to the standard operative temperature, T_{es} of the habitat, defined as $T_{es} = Tb - (1 + 0.26\sqrt{u})(T_b - T_e)$. Wind speed is u, and T_b is body temperature. Operative temperature (T_e), is ordinarily close to air temperature for birds resting at night, but T_e can include the effects of thermal and solar radiation. The 95% confidence interval for predictions of the average metabolic rate of a passerine is ±9.3% for air speed up to 4 m/s and temperatures below the thermal neutral zone. The procedure also appears valid for some, but not all, nonpasserines. **Key words: ruffed grouse, Gambel's quail, wind, temperature, metabolism, technique**

021

Ballard, W. B. and M. C. Wallace, editors. 2005. Changes in land use patterns and their effects on Rio Grande turkeys in the Rolling Plains of Texas and southwest Kansas. Final Report to the Texas Parks and Wildlife Department and the National Wild Turkey Federation, Texas Tech University, Lubbock, USA. Notes: This report contains a discussion of the effects of precipitation and cover on Rio Grande turkey nesting ecology in the Texas panhandle and southwestern Kansas. It states, in part, "No relationship was found between pre-nesting precipitation and nesting rate of first attempts, or nesting success. Nesting season precipitation had no relationship to nesting success, nor did the number of days with precipitation during nesting had no relationship to nesting success. Days since precipitation for depredated nests did not conform to any distribution pattern. However, almost 30% of nests were depredated on days with measurable precipitation. Managers can use local weather data to determine the probability of nests being successful; this may allow for estimates of recruitment into the fall populations. Managers should develop habitat management plans that maximize visual obstruction available for potential nesting habitat." **Key words: turkey, precipitation, vegetation, habitat use, predation, population dynamics, habitat manipulation**

022

Barnett, J. K. and J. A. Crawford. 1994. Pre-laying nutrition of sage-grouse hens in Oregon. Journal of Range Management 47(2):114-118. Notes: “Production of sage-grouse, measured by chicks/hen and average brood size, decreased in 1991. This corresponded to a decrease in forbs eaten and decrease in nutrient content of the composite diet. Many factors contribute to successful reproduction, including predation, weather, and nutrition. Our study revealed that forbs are an important source of protein and other nutrients, and consumption of forbs increased nutritional status of the hens. Differences in amounts of forbs consumed between 1990 and 1991 likely was related to decreased availability of forbs between the 2 years. This change in abundance of sage-grouse foods perhaps was related to the 40% reduction from normal precipitation for the year preceding the 1991 sample. **Key words: sage-grouse, precipitation, vegetation, nutrition, habitat use**

023

Battazzo, A. M. and E. Greene. 2006. Winter survival and habitat quality of greater sage-grouse in south Phillips County, Montana. Annual Conference Wildlife Society 13. Abstract: Factors influencing sage-grouse (*Centrocercus urophasianus*) populations vary across the species/ range, requiring conservation strategies to be developed from geographically-specific data. We studied two populations of sage-grouse hens in Phillips County, Montana to understand how winter conditions and habitat quality influence sage-grouse winter survival rates and habitat use. We radio-collared 148 hen sage-grouse and located individuals one to three times per week. Observations took place from December 15-March 15 during 2005 and 2006 winter seasons. We use locations to generate population-level winter home ranges using minimum convex polygon (MCP) and kernel techniques. Home ranges were stratified into low, medium, and high-use categories, and habitat quality (defined as percent sagebrush cover and protein composition) was assessed in each strata. If we observed high winter survival, we predicted fitness consequences would be apparent in the early stages of reproduction. Our analyses examined associations between climatic (temperature and wind speed), habitat (sagebrush cover and protein composition), group (density and study site), and individual (age and sex) covariates and winter survival, nest initiation, and clutch size. Results from analysis of population-level winter range habitat quality were compared with current conservation recommendations. We tested the hypothesis that levels of use (low, medium, and high) ordinally follow levels of habitat quality (poor, marginal, and good), and investigated the effects of climatic conditions on winter movements and distribution. We will summarize our results and discuss management implications with respect to sage-grouse winter habitat conservation. **Key words: sage-grouse, temperature, wind, vegetation, habitat use, reproduction, movement, distribution**

024

Baumann, D. P. Jr., W. E. Mahan, and W. E. Rhodes. 1995. Effects of Hurricane Hugo on the Francis Marion National Forest wild turkey population. Proceedings National Wild Turkey Symposium 7:55-60. Abstract: The Francis Marion National Forest (FMNF) is an important area for wild turkeys (*Meleagris gallopavo silvestri*) in

South Carolina. On 21 September 1989, Hurricane Hugo, a category IV storm, struck the South Carolina coast, and the strongest winds swept across the FMNF. Over 1 billion board feet of timber were damaged or destroyed. To determine the effects of Hurricane Hugo on the FMNF wild turkey population, we examined spring turkey harvest and reproduction pre- and post-Hugo. Prior to Hugo, the spring turkey harvest increased at a mean annual rate of 18% on the FMNF and 25% statewide. Following the storm, the harvest declined 22% per year on the FMNF, whereas the statewide spring harvest increased 4% annually. Mean number of hens with poults (P = 0.07), brood size (P = 0.008), gobblers observed (P = 0.018), total turkeys observed (P = 0.011), and recruitment ratio (P = 0.006) have declined since the storm. The negative habitat alterations from Hurricane Hugo that occurred on the FMNF were responsible for the decline in the wild turkey population. **Key words: wild turkey, wind, habitat modification, productivity, reproduction**

025

Baumgartner, F. M. 1939. Studies on the distribution and habits of the sharptail grouse in Michigan. Transactions of the North American Wildlife Conference 4:485-490. Notes: Page 486—"The birds generally roost fairly close together in snow beds beneath scattered trees or clumps of bushes and brush…During mild weather the birds seem to prefer to feed in areas where green herbaceous plants, persistent fruits, or grain are not covered over by deep snow; during stormy weather or on extremely cold days sharptails have been found to retire to the edge of white birch and aspen thickets. At such times their diet appears to consist entirely of buds and catkins. The period of daily activity has revealed some surprising variations dependent upon weather conditions. On bright, warm days, sharptails were observed to leave their snow roosts shortly after sunrise, spend a few minutes in a sketchy courtship display, and then fly to feeding grounds. By the middle of the morning, after their crops were stuffed, they either bury themselves beneath the snow or sit out in some open spot, apparently to enjoy the rays of the sun. Active feeding is resumed again in mid-afternoon and lasts until dusk. The contrast between this period of 8 to 10 hours and the very limited activity on extremely cold or stormy days is quite marked. On such days the sharptails do not leave their roosts until 8:00 to 9:00 a.m. Immediately they fly to a nearby feeding station or grain field or commence to fill their crops with birch or aspen buds. By 9:30 or 10:00 a.m. they are back into their snow forms for a 22-hour period of inactivity not emerging again until the following morning." Page 487—"During the heat of the day and at night the cocks and hens spend most of their time feeding or resting in the edges of willow thickets or beneath the aspens and tag alders along the swamp and stream borders." Page 488—"We have found that the birds are extremely difficult to flush during the heat of the day. However, in the early morning and again toward evening small flocks feed on the plants and fruits of strawberry, the leaves of clover, dandelions, and other herbs, and to a considerable extent on insects…[when] "heavy snow and stormy weather in December and January make it impossible for the grouse to obtain grain and weed seeds or sufficient quantities of green plants…they move to the white birth and aspen thickets and take up a diet of buds and catkins for the winter." **Key words: sharptailed grouse, snow, temperature, solar radiation, behavior, habitat use, census**

026

Baxter, W. L. and C. W. Wolfe. 1973. Life history and ecology of the ring-necked pheasant in Nebraska. Nebraska Game and Parks Commission, Lincoln, USA. Notes: Page 18 – "Factors that cause changes in nesting chronology – Climate: Regression analyses were performed using temperature and precipitation measurements in the following forms: monthly mean, monthly high, monthly low, and monthly deviation from normal. All of these measurements were shown to exert an influence on the mean date of hatch, but the clearest example of this influence was noted in a multiple regression of the total deviation from normal of temperature and precipitation for the months of February, March, April, May, and June. In this analysis, a significant *r* value (0.619) was obtained. Warmer temperatures were associated with an earlier mean hatching date, while above normal precipitation delayed hatching. Using a standard partial regression analysis on the above *r* value, it was calculated that 33.5 percent was attributable to temperature, while 66.5 percent was attributable to precipitation. It appeared from this analysis that in south-central Nebraska, seasonal precipitation deviation from normal had more effect on the mean date of hatch than did temperature deviation from normal. The earliest hatching peak occurred during a year classified by the Weather Bureau as "warm and dry", while the latest occurred during a "cold and wet" year. No relationship between degree-days and mean date of hatch was shown using analysis of variance for the regression (P>.05). A non-significant F value (P>.05) using analysis of variance for the regression indicated that no relationship existed between percent of possible sunshine (Lincoln Station) and mean date of hatch." **Key words: wild turkey, temperature, precipitation, reproduction**

027

Beasom, S. L. 1973. Ecological factors affecting wild turkey reproductive success in south Texas. Dissertation, Texas A&M University, College Station, USA. Unable to obtain for abstract.

028

_____ and O. H. Pattee. 1980. The effect of selected climatic variables on wild turkey productivity. Proceedings National Wild Turkey Symposium 4:127-135. Abstract: Net reproductive success of Rio Grande wild turkey (*Meleagris gallopavo intermedia*) was monitored yearly between the months of June and August from 1968 through 1977 on 2 study locations in south Texas by way of repetitive road transect counts. Rainfall and temperature data were compiled from U. S. Climatological Records and soil moisture data were calculated from these parameters. Between-year turkey production fluctuated from 0-576 poults per 100 hens on the Santa Gertrudis area near Kingsville and from 8-443 on the Encino area near Falfurrias. The maximum R^2 determination indicated that 97.3% of the variability in annual rate of turkey productivity on Santa Gertrudis was explainable by a model composed of soil moisture storage the previous August, combined total precipitation for the previous September and October, and total precipitation for the current March. Similarly, 98.3% of this variability on Encino was explainable by a model composed of combined total precipitation for the previous August and September, soil moisture storage in the previous September, and soil moisture storage in the current May. **Key words: Rio Grande turkey, precipitation, soil moisture, productivity**

029

Beck, T. D. I. 1977. Sage grouse flock characteristics and habitat selection in winter. Journal of Wildlife Management 41(1):18-26. Abstract: Sage grouse (*Centrocercus urophasianus*) were studied in North Park, Colorado, during the winters of 1973-74 and 1974-75. Distribution was plotted from sightings of 199 flocks and 17 single birds, totaling 5,080 grouse. Only 50 percent of the 1,252 km^2 of lands dominated by sagebrush (*Artemisia* spp.) sustained winter use by grouse because of snow depth, steepness of slope, and sagebrush disturbance. Nearly 80 percent of the use occurred in 7 areas comprising less than 7 percent of the total area. Sexes segregated; males formed more unisexual flocks. Flocks were the dominant social unit and contained less than 50 individuals in 88 percent of all observations. Flocks containing more than 50 percent females were larger than male flocks and used denser sagebrush stands for feeding and loafing. Roosting and feeding sites had similar vegetal and physical characteristics. Sixty-six percent of flocks were on slopes less than 5 percent, and only 13 percent were on slopes greater than 10 percent. Sixty-two percent of 2,350 grouse in 1973-74 and 61 percent of 1,984 grouse in 1974-75 were females. **Key words: sage grouse, snow, habitat use**

030

Bell, L. A., S. D. Fuhlendorf, and M. A. Patten. 2003. Brood survivorship in relation to microclimate/habitat use of lesser prairie chickens. Proceedings of the Prairie Grouse Technical Council 25:16. Abstract: Chicks have a high surface-area-to-volume ratio, so maintaining their internal body temperature can be difficult. Thus, apart from predation, relative humidity, ambient temperature, and exposure to wind are factors that influence survival of chicks. We studied the relationship between survivorship and microhabitat use for lesser prairie chicken (*Tympanuchus pallidicinctus*) broods from hatch to reproductive stages. Results will indicate the effect heat stress and other variables have on brood movements, microhabitat selection, and survivorship. **Key words: lesser prairie chicken, thermoregulation, humidity, temperature, wind, heat stress, movement, habitat use, chick survival**

031

Bendell, J. F. 1955. Disease as a control of a population of blue grouse, *Dendragapus obscurus fuliginosus* (Ridgway). Canadian Journal of Zoology 33(3):195-223. Abstract: A population of blue grouse was studied on its summer range at Quinsam Lake, Vancouver Island, to determine the factors of importance in population control. The population was stable with a density of 0.40 adult males and 0.78 yearling and adult females to the acre. A life table was constructed from band returns on the basis of a stable population. This disclosed that 80% of the chicks died in the first three months after hatching and that the death of 31% of the adults occurred each year. The survivorship curve was negatively “J”-shaped. Mortality rates appeared constant and independent of age after the first year of life. Space, weather, food, predators, and disease are considered as factors capable of population control. Six parasites were recorded as new for this host. Two, *Plagiorhynchus formosus* and *Dispharynx nasuta*, occurred commonly and almost exclusively in the chicks, where they caused extreme damage to gut tissues. Parasitism by these helminthes was an important mortality factor in chicks and a major cause of population stability. **Key words: blue grouse, weather, disease, mortality**

032

_____ and L. I. Bendell-Young. 2006. Eggs of spruce grouse dry at a faster rate than those of ruffed grouse. Canadian Journal of Zoology 84:1688-1692. Abstract: We measured the rate of water loss and pore density of eggs of spruce grouse (*Canachites canadensis canace* (L., 1766)) and ruffed grouse (*Bonasa umbellus togata* (L., 1766)) from different parts of their range in Ontario. Eggs were dried in enclosed glass jars over Drierite® and in paper trays in open air at room temperature and humidity. Eggs were weighed to the nearest 0.01 g every 2-4 days and change in mass was measured as water loss. Pores of shells were counted (pores/cm^2) in the blunt, middle, and pointed sections of the egg. Eggs of spruce grouse lost water at a fast rate in Drierite® and in open air and had a greater density of pores than eggs of ruffed grouse. Rates of water loss were constant and varied inversely with ambient humidity, with the difference between species greatest in open air. Eggs late in incubation of ruffed grouse dried at a faster rate than those early in incubation in Drierite®. The adaptation of eggs of each grouse to the moisture of the nest may help explain their distribution, density, and habitat and nest-site selections, as well as behavioral aspects of the nesting hen. Both, especially the spruce grouse, may be good indicators of climate change. **Key words: spruce grouse, ruffed grouse, humidity, temperature, index**

033

Bennitt, R. and H. V. Terrill. 1940. Possible temperature factors in north central pheasant distribution. Transactions of the North American Wildlife Conference 5:428-432. Notes: Page 429—It seems very likely that lethal temperatures may occur under natural conditions. The egg temperature in ground-nesting birds would depend most upon the temperature of the ground and the degree of exposure to the sun…it is possible that the pheasant's occasional practice of leaving the nest during the hottest part of the day may raise the temperature of the eggs if the air and ground temperatures are unusually high. **Key words: ring-necked pheasant, temperature, solar radiation, behavior, mortality**

034

Berry, J. D. and R. L. Eng. 1985. Inter-seasonal movements and fidelity to seasonal use areas by female sage-grouse. Journal of Wildlife Management 49(1):237-240. Notes: "Although snowstorms appeared to induce migration to wintering areas, movement was often completed in advance of snow accumulation that would cover food resources. One hen moved onto the wintering area, returned to the summering area, and moved back toward the wintering area before finally returning to the breeding ground. This uncharacteristic midwinter return to a summering area was associated with moderating winter weather. It is possible that extrinsic factors, primarily moisture conditions and the resulting distribution of succulent vegetation, played a major role in summer distribution, but only after the initial brood rearing phase is completed. Migration to the winter range was observed in the absence of severe winter conditions. The annual return to specific wintering areas by adult hens, regardless of apparent weather or food conditions, may introduce recruits within a population to traditional areas. When seasonal key areas for a population are separated to this extent, numerous land owners are often involved. In such cases, agencies responsible for wildlife resources are obligated to assess year-long rather that seasonal requirements and to look at large ecologically defined land units rather than economically or politically delineated parcels of land." **Key words: sage-grouse, snow, temperature, vegetation, movement, habitat use, habitat management**

035

Blake, C. S. 1970. The response of sage-grouse populations to precipitation trends and habitat quality in south central Idaho. Annual Conference Western Association of State Game and Fish Commissioners 50:452-462. Notes: The author states that a reduction in annual precipitation lead to a downward trend in sage-grouse numbers lasting for ten years. "It was obvious that a reduction of succulent food plants and early desiccation of vegetation was denying hens and broods the use of important summer ranges. Reproductive success was low and for several years over 55% of the hens observed on brood count routes were without young." **Key words: sage-grouse, precipitation, vegetation, nutrition, reproduction, drought**

036

Blanchett, P., J.-C. Bourgeois, and S. St-Onge. 2007. Winter selection of roost sites by ruffed grouse during daytime in mixed nordic-temperate forests, Quebec, Canada. Canadian Journal of Zoology 85(4):497-504. Abstract: We determined the categories of roost sites used by ruffed grouse (*Bonasa umbellus* (L., 1766)) during daytime in winter from 245 radiotelemetric locations of 26 adult females. We conducted our study in the Réserve Faunique de Portneuf, located in a mixed nordic-temperate softwood-hardwood forest in Quebec, Canada. We evaluated the effects of weather, snow, and habitat variables on the incidence of snow burrowing, tree roosting, and on-snow roosting using mixed multinomial models, ANOVA, and logistic regressions. The best logistic regression model of snow burrowing probability was identified using the Akaike path. The incidence of each category of roost sites was 41.2% tree roosts, 36.3% snow burrows, and 22.4% on-snow roosts. Coniferous canopy closure and depth of fluffy snow were the variables that influenced roosting behavior the most. Probability of snow burrowing increased with compaction depth and decreased with coniferous cover. Probability of tree roosting increased with temperature. On-snow roosts had a denser lateral obstruction than snow burrows, whereas tree roosts had a greater coniferous basal area, stem density, and canopy cover than snow burrows. Stand type also influenced the incidence of each category of roost sites, snow burrows dominating in deciduous stands and tree roosts dominating in mixed and coniferous stands. **Key words: ruffed grouse, snow, temperature, behavior, habitat use, snow condition**

037

Boggs, C., E. Norris, and J. B. Steen. 1977. Behavioral and physiological temperature regulation in young chicks of the willow grouse *Lagopus lagopus*. Comparative Biochemistry and Physiology A 58(4):371-372. Abstract: The length of brooding and foraging periods was measured for a brood of 8 grouse chicks and parents kept in a 255 m^2 open air enclosure. The chicks had shorter foraging periods and longer brooding, the poorer the weather. Foraging periods became longer and brooding shorter as the chicks grew older. At 8 days of age the heaviest chick was thermally independent at ambient temperatures above 15°C. The duration of foraging is apparently determined by the degree of hypothermia. **Key words: willow grouse, temperature, thermoregulation, foraging, behavior**

038

Bohl, W. H. 1957. Chukars in New Mexico 1931-1957. Bulletin No. 6. New Mexico Department of Game and Fish, Sante Fe, USA. Notes: <u>Page 41</u> – Feeding, Weather Tolerances: No adverse snow conditions have been experienced at three Turkish trial areas during the study. From Turkey there is information that may illustrate what effects heavy snow may have on the chukar should these conditions occur late in the trial areas: ‘Chukers stand winter snows well, so long as adequate food is available. If it is not, they will move either to the edges of the villages or down into the lower valleys, returning to higher ground in the spring. It is doubtful however, if they can survive any extended periods of snow covered habitat if the snow remains for long to a depth exceeding 8-12 inches, unless considerable areas are swept bare by wind, or on southern exposures, are uncovered by the winter sun.’ **Key words: chukar partridge, snow, wind, nutrition, movement, solar radiation**

039

Boos, M., J.-P. Boidot, and J.-P. Robin. 2005. Body condition in the Eurasian woodcock wintering in the west of France: practical study for wildlife management during cold spells. Wildlife Biology in Practice 1(1):15-23. Abstract: The Eurasian woodcock (*Scolopax rusticola*) is one of the most widespread species of the *Scolopax* genus in temperate regions. However, population levels can be greatly affected by harsh cold spells that lead woodcocks to starve by exhaustion of their body fuels. To better understand the vulnerability of woodcocks to such climatic conditions it is of a major importance to determine the amount of their body reserves (both lipids and proteins) throughout the wintering season. This was performed on 55 individuals collected by hunters in the western part of France during two consecutive winters under mild weather conditions. Body reserves, that can be mobilized, were determined as the difference between the total amount of lipids and proteins minus the values obtained on starved individuals found dead during previous cold spells. Overall, body reserves did not significantly change over both winters (p>0.40), the maximal mean value (1539 [plus or minus] 117 kJ) being however reached in January. Storing body fuels would not adversely affect wing and power loading, suggesting that the amount of body reserves would agree with the “starvation-predation trade-off”. If woodcocks sit through a cold spell, their mean survival time (or fasting endurance) would be 6.5 [plus or minus] 0.5 days; 25 to 40% of the birds would have a life expectancy of 7-9 days, and about 8 to

17% less than 5 days. On the contrary, if woodcocks immediately leave their wintering quarter, they would be able to perform a trip of 740 [plus or minus] 50 km, 20 to 40% of the woodcocks being able to fly over 750 km. Body mass explains only 47 to 57% of the fasting endurance and flight autonomy variations, and therefore we recommend a further carcass analysis to accurately estimate body condition. These results underscore the suitability of determining the state of body reserves for practical cases of population management and hunting policy during cold spells. **Key words: Eurasian woodcock, temperature, mortality, nutrition**

040

Botsford, L. W., T. C. Wainwright, J. T. Smith, S. Mastrup, and D. F. Lott. 1988. Populaiton dynamics of California quail related to meteorological conditions. Journal of Wildlife Management 52(3):469-477. Abstract: Demographic responses of California quail (*Callipepla californica*) to precipitation-related variables vary among locations with different mean rainfall. With 23 years of data from a California quail population in a semiarid region, we determined a positive response of reproductive success (juv/ad) to precipitation during the previous winter. Computed correlations with soil moisture content and actual evapotranspiration were significant but not as high as with precipitation. Correlations with mean monthly temperature, days/month <0C, and days/month >38C were not significant. Attempts to account for possible lower reproductive capability of first-year breeders did not improve statistical relationships. The number of adults each year was positively correlated with the number of juveniles in the previous year. The number of juveniles produced each year was correlated with the number of adults in that year only when the effect of precipitation was removed; the relationship was then linear. The interannual fluctuations in population numbers resulted from low adult survival and the influence of precipitation on recruitment through unknown mechanisms. **Key words: California quail, precipitation, fecundity, temperature, recruitment**

041

Boughton, R. V. 1937. Endoparasitic infestations in grouse, their pathogenicity and correlation with meteoro-topographical conditions. Technical Bulletin 121, University of Minnesota Agricultural Experiment Station, Minneapolis, USA. Notes: Page 39—"The third cause, meteorological and topographic factors, is in the writer's opinion the most important. It is well known that the ova of many parasites when outside the host require moisture before development can proceed. Lack of moisture, on the other hand, reduces or prevents development, and after a limited time the ova may fail to hatch even when placed in a suitable environment. In addition to moisture, other important factors affecting the percentage of ova that hatch are temperature, type of soil, and vegetation.…These experiments show…that the development of nematode ova depend upon a number of physical factors, the most important of which are moisture, type of soil, temperature and coverage.…The important factor with regard to the soil is its ability to retain or lose water." Page 46—"In the case of the ruffed grouse, a definite correlation between the degree of parasitism and the meteorological and topographical factors appear to occur. Infestation in the different zones outlined appears to depend upon the mean temperature, mean precipitation, soil type, and coverage, the maximum infestation taking place where the mean temperature and precipitation are highest, where the humus content of the surface soil is greatest, and where abundant coverage occurs…That the parasites have played a secondary part in the death of the birds is probable. Accompanying the increase in infestation, there has been a definite increase in weight difference between parasitized and non-parasitized birds. The parasites may have played a part in reducing the vitality of the birds to a point where secondary diseases could set in." **Key words: grouse, ruffed grouse, temperature, precipitation, topography, soil, solar radiation, vegetation, disease, mortality, population dynamics, parasites**

042

Bousquet, K. R. and J. J. Rotella. 1998. Reproductive success of sharp-tailed grouse in central Montana. Prairie Naturalist 30(2):63-70. Abstract: We estimated nest success and survival of broods and chicks for plains sharp-tailed grouse (*Tympanuchus phasianellus jamesi*) on a large grassland in central Montana. We collected productivity data from 24 different radio-marked females during 1994-95. Nest success varied between years (P = 0.02) and was high (0.93, n = 12) in 1994 when yellow sweetclover (*Melilotus officinalis*) was dense and moderate (0.56, n = 18) in 1995. Mean hatching date was 18 June, and the average successful nest produced 11.3 chicks/nest (SE = 1.0, n = 21 nests). Chick survival to 56 days of age varied by year (P = 0.05) and was higher in 1994 (0.44, SE = 0.15) than in 1995 (0.09, SE = 0.10) when extensive, cold, wet weather was suspected of causing high chick mortality. **Key words: sharp-tailed grouse, temperature, precipitation, mortality, chick survival**

043

Bradbury, J. W., S. L. Vehrencamp, and R. M. Gibson. 1989. Dispersion of displaying male sage grouse I. Patterns of temporal variation. Behavioral Ecology and Sociobiology 24(1):1-14. Abstract: The distribution of lek sizes was examined in each of three populations of sage grouse in eastern California [USA]. Peak seasonal lek sizes collected over a 35-year period were found to co-vary among the three sites indicating that some global environmental or demographic features modulated male attendance in any given year. Despite these annual variations, the ranks of the three populations with regard to mean lek size remained stable. In all three populations, there was a persistent excess of small and large leks, compared to random settlement on the same number of sites, and a consistency in the ranking by size of particular sites in successive years. The sequential phenology of lek site occupation in each population was correlated with recolonization of habitats surrounding central wintering refuges each spring. Some lek sites utilized for display in early spring were regularly abandoned prior to the onset of mating as more peripheral leks became active. On top of population, site, and seasonal variations in lek size, pronounced daily fluctuations in attendance were common. Multivariate regressions indicated than an average 36% of the daily variation in male numbers was correlated with weather variables, female attendance levels, and prior raptor harassment. Several outcomes of the analyses support the notion that dispersion of males is partly determined by male settlement on current female traffic patterns (hotspot settlement). The analyses also suggest that display is sufficiently costly that variations in male attendance are in part a result of conflicts between strutting and thermoregulatory expenditures. **Key words: sage grouse, temperature, thermoregulation, behavior, movement**

044

Braun, C. E., J. W. Connelly, and M. A. Schroeder. 2005. Seasonal habitat requirements for sage-grouse: spring, summer, fall and winter. Pages 38-42 *in* N. Shaw, M. Pelland, and S. B. Monsen, compilers. Sage-grouse habitat restoration symposium, Boise, Idaho. RMRS-P-38, Rocky Mountain Research Station, Fort Collins, USA. Abstract: Sage-grouse (*Centrocercus minimus, C. urophasianus*) are dependent upon live sagebrush (*Aremisia* spp.) for all life processes across their entire range. This paper describes habitats used by sage-grouse as documented in the scientific literature. The leaves of sagebrush are eaten by sage-grouse throughout the entire year and comprise 99 percent of their winter diets. Spring (late March through May) habitats are those with intermixed areas of taller (40 t 80 cm) sagebrush with canopy cover of 15 to 25 percent and taller (>18 cm) grass/forb cover of at least 15 percent. Sites used for display have shorter vegetation, frequently few or only short sagebrush plants, but with taller, more robust sagebrush within 100 to 200 m that is used for escape cover. Nesting cover mimics that used overall during spring but with clumps of tall (> 50 cm), dense (about 25 percent) live sagebrush and abundant forbs (> 10 to 12 percent cover). Early brood rearing areas are those within 200 m (initial 3 to 7 days posthatch) to 1 km (up to 3 to 4 weeks posthatch) of nest sites. Forbs and taller (> 18 cm) grasses are important for broods; forbs provide succulent foods, grasses provide hiding cover, and the grass/forb mixture supports insects used by chicks. Summer use areas are those with abundant succulent forbs with live, taller (> 40 cm), and robust (10 to 25 percent canopy cover) sagebrush useful for cover. These areas continue to be used into fall when sage-grouse move to higher benches/ridges where they forage on remaining succulent forbs such as buckwheat (*Eriogonum* spp.) and switch to more use of sagebrush leaves. Winter (early December to mid-March) use areas are often on windswept ridges, and south to southwest aspect slopes as well as draws with tall, robust live sagebrush. Height (25 to 35 cm) of sagebrush above the surface of the snow in areas used in winter is important, as is canopy cover (10 to 30 percent). Management of habitats used by sage-grouse should initially focus on maintaining all present use areas. Practices to enhance sagebrush habitats to benefit sage-grouse are reviewed, as is the need to annually monitor sage-grouse numbers along with systematic monitoring of the health of sagebrush ecosystems. **Key words: sage-grouse, snow, vegetation, nutrition, habitat use**

045

_____, R. W. Hoffman, and G. E. Rogers. 1976. Wintering areas and winter ecology of white-tailed ptarmigan in Colorado. Special Report Number 38, Colorado Division of Wildlife, Denver, USA. Abstract: Aspects of the ecology of white-tailed ptarmigan (*Lagopus leucurus*) in winter were periodically investigated in Colorado from 1964 to 1975. Ptarmigan were found to select areas dominated or co-dominated by willow (*Salix* spp). Areas utilized in winter most frequently were drainage basins at or above treeline and stream courses below treeline from 2,591 to 3,810 m elevation (8,500 to 12,500 ft) where food (willow) and roosting sites (soft snow) were readily available. Partial sex segregation occurred from late October through mid-April, with males wintering at higher elevations, frequently krummholz areas at treeline. Flocks of females most commonly selected large drainage basins and stream courses. Arrival and departure were weather-related and varied with year. Flock size was stable among months and years, with male flocks being smaller in number (<15 birds) than female flocks (20 to 40 birds). Within individual wintering areas, essentially all sites were utilized each winter, with use depending upon snow depth and wind action. Adult ptarmigan exhibited greater affinity for wintering areas where they were banded than did subadults. Wintering areas have been altered and reduced in size through reservoir construction, development of roads, mining activity, domestic livestock grazing, and increased recreational use and development. Maps of known wintering areas are presented. **Key words: white-tailed ptarmigan, snow, wind, habitat use, movement**

046

_____, J. W. Connelly, and M. A. Schroeder. 2001. Seasonal habitat requirements for sage-grouse: spring, summer, fall, and winter. Pages 38-42 *in* N. L. Shaw, M. Pellant, and S. B. Monsen, compilers. Sage-grouse habitat restoration symposium proceedings, Boise, Idaho. Notes: Page 40—"Sagebrush height (>20cm, but usually >30 cm, above the surface of the snow) is important as is the robust structure of live sagebrush. Sage-grouse use a variety of sites in winter including windswept ridges with open stands of sagebrush to draws with dense stands. Quality of the snow can be important because sage-grouse are known to use snow roosts and burrows. Aspect is also important with south and southwest slopes most used in hilly terrain. Leaves of live, vigorous sagebrush plants provide >99% of the foods eaten during the winter period (early December until early to mid-March). Generally, winter is a time of body mass gain, although severe winter conditions over prolonged intervals can reduce the amount of area available for foraging and cover. Overall movement during winter may be extensive and home ranges can be large. **Key words: sage-grouse, snow, wind, topography, habitat use, vegetation, nutrition**

047

_____ and R. K. Schmidt Jr. 1971. Effects of snow and wind on wintering populations of white-tailed ptarmigan in Colorado. Pages 238-250 *in* A. O. Haugen, editor. Proceedings of the snow and ice in relation to wildlife and recreation symposium, Iowa State University, Ames, USA. Abstract: Studies of wintering populations of white-tailed ptarmigan (*Lagopus leucurus*) were initiated in Colorado in the fall of 1966 and were continued through December 1970. Objectives were to describe the habitat and environmental features typical of major wintering areas, determine composition of winter flocks, and delineate behavior and movements of individual birds and flocks in relation to changes in environmental conditions. Ptarmigan were found to prefer sites where willow (*Salix* spp.) was a major component of the vegetation. Partial segregation of sexes occurred in winter with males preferring higher, more windswept areas than females. Willow density on upland sites was sparse, and availability was a result of wind action. Female ptarmigan preferred lower areas near or below tree line where tall, dense willow stands occurred. While willow was the most important component of wintering areas, wind and snow depth were most important in determining availability. Snow quality was of extreme importance to ptarmigan in winter, with most overnight roosts completely under the snow surface. Ptarmigan were observed to move up to 7 miles from fall to winter use sites and up to 1 mile from feeding areas to sites with snow suitable for roosting. **Key words: white-tailed ptarmigan, snow, wind, nutrition, habitat use, behavior, vegetation, movement, snow condition**

048

_____, T. Britt, and R. O. Wallestad. 1977. Guidelines for maintenance of sage-grouse habitats. Wildlife Society Bulletin 5(3):99-106. Notes: The authors stated the extent of seasonal movements in sage-grouse vary with the severity of winter weather, topography and vegetative cover. They note that during winter, sage-grouse may be restricted to less than 10 percent of the sagebrush-dominated lands within a given area. Suitability of sagebrush manipulation is closely linked to seasonal precipitation and forb production. **Key words: sage-grouse, precipitation, habitat manipulation, habitat use, nutrition**

049

Braunisch, V. and R. Suchant. 2007. A model for evaluating the 'habitat potential' of a landscape for capercaillie *Tetrao urogallus*: a tool for conservation planning. Wildlife Biology 13 Supplement 1:21-33. Summary: Most habitat models developed for defining priority conservation sites target areas currently exhibiting suitable habitat conditions. For species whose habitats have been altered by land use practices, these models may fail to identify sites with the potential of producing suitable habitats, if management practices were modified. Using capercaillie *Tetrao urogallus* as an example, we propose a model for evaluating the potential of ecological conditions at the landscape level to provide suitable habitat at the local scale. Initially, we evaluated the influence of selected landscape parameters on the structural characteristic of vegetation relevant to capercaillie. Then we used capercaillie presence data and an ecological niche factor analysis (ENFA) to identify landscape and land use variables relevant to capercaillie habitat selection. We also studied the effect of scale on predictive model quality. Despite high variance, correlations between landscape variables and forest structure were detected. The greatest influence on forest structure was recorded for climate and soil conditions, which were also found to be the best predictors of capercaillie habitat selection in the ENFA. The final model, retaining only two landscape variables (soil conditions and days with snow) and three land use variables (proportion of forest, distance to roads and forest-agricultural borders), explained a high degree of capercaillie habitat selection, even before considering patch size and connectivity. By restricting the analyses to areas with stable subpopulations and a set of relatively stable landscape variables capable of explaining habitat quality at a local scale, we were able to identify areas with long-term relevance to conservation of capercaillie. **Key words: capercaillie, model, snow, conservation**

050

Bridges, A. S., M. J. Peterson, N. J. Silvy, F. E. Smeins, and X. B. Wu. 2001. Differential influence of weather on regional quail abundance in Texas. Journal of Wildlife Management 65(1):10-18. Abstract: Although weather variables are known to influence quail abundance in some habitats, most studies have addressed only limited geographic areas and indices to weather conditions. The few replicated studies addressed relatively similar climate zones. We used 21 years (1978-98) of quail abundance data collected by the Texas Parks and Wildlife Department (TPWD) biologists to address the relationship between both simple precipitation and Palmer drought indices and northern bobwhite (*Colinus virginianus*) and scaled quail (*Calipepla squamata*) abundance in 6 ecological regions of Texas. Three 12-month Palmer indices were more highly correlated with changes in northern bobwhite abundance in the South Texas Plains ecological region than was raw precipitation alone. The 12-month Modified Palmer Drought Severity Index (PMDI) was correlated ($r_s \geq 0.78$, $P \leq 0.001$) with the mean number of northern bobwhites visually observed per survey route in the Rolling and South Texas Plains ecological regions, while a 12-month, raw precipitation index was correlated ($r_s = 0.64$, $P = 0.002$) with northern bobwhite abundance in only the South Texas Plains. The PMDI and raw precipitation were correlated ($r_s = 0.67$, $P \leq 0.001$and $r_s \geq 0.57$, $P \leq 0.007$, respectively) with the mean number scaled quail observed per survey route in the Edwards Plateau, South Texas Plains, and Trans-Pecos Mountains and Basins ecological regions. There was no relationship ($P \geq 0.437$) between changes in quail abundance and the PMDI or raw precipitation in the Gulf Prairies and Marshes physiographic region, where precipitation was relatively high. The monthly PMDI was a better indicator of changes in both northern bobwhite and scaled quail abundance among years than was monthly precipitation alone. Both monthly and 12-month precipitation-based weather indices were more correlated with changes in northern bobwhite and scaled quail abundance among years in relatively dry as opposed to wet ecological regions. Our approach should help wildlife biologists and managers better account for annual variability in quail productivity in semi-arid environments so that long-term population trends can be better elucidated. **Key words: bobwhite quail, scaled quail, drought, index, precipitation, population dynamics**

051

Bridgman, C. L. 2002. Habitat use, distribution and conservation status of the mikado pheasant (*Syrmaticus mikado*) in Taiwan. Dissertation, University of Tennessee, Knoxville, USA. Abstract: To evaluate the conservation status of Taiwan's Mikado pheasant, *Syrmaticus mikado* (*Phasianidae*), I test the similarity of preferred habitat to primary and secondary forest, develop models of habitat availability within Taiwan, and examine population trends within two locations inside Yushan National Park. The characteristics of locations with pheasant activity were most similar to secondary forest: high shrub stem counts and low canopy and leaf litter coverage. None of these variables were applicable to geographic information systems analysis. To the known extent of range and area of occupancy, I compared a model based on the habitats described in field guides. This model underestimated extent of range, confirmed that 39% of the pheasant's range is protected inside parks and reserves, and suggested that Taiwan potentially has 6477 km^2 of habitat available to *S. mikado*.

Within Yushan National Park, there may be as many as 10,000 *S. mikado.* The small home ranges (<0.86 km^2) and the lack of movement across the 400 m separating the study sites imply limited gene flow between populations and poor ability to colonize suitable habitat. There were 58 pheasants per km^2 in the primary forest site and 48 in the secondary forest sites. At the primary forest site, the population appeared stable. At the secondary forest site, the population declined 65% from 3.56 pheasants encountered per day in 1989-1992 to 1.24 in 1996-1999 due to poor productivity because of increase numbers of nest predators (from 1.4 predators per day to 2.2) and the cooler weather conditions during hatching. In 1989-1991, most rainfall was in the last week of June, but rainfall was evenly distributed throughout May and June of 1996-1998. Poaching, a threat to adult pheasants, increased during this time from 0.6 incidents per day to 0.23. As the pheasant lives at elevations naturally disturbed by landslides, tolerance for disturbance would be adaptive. Because of the poaching, the limited nature of the pheasant's distribution, and until the population decline is identified as indicating a general trend or part of a cyclic pattern in the pheasant's population dynamics, I recommend *S.mikado* be considered vulnerable to the risks of extinction. **Key words: Mikado pheasant, temperature, precipitation, productivity, landslide**

052

Brittas, R. 1988. Nutrition and reproduction of the willow grouse *Lagopus lagopus* in central Sweden. Ornis Scandinavica 19(1):49-57. Notes: Page 55 – "…arctic monocotyledons like cotton grass begin growth and reach peak concentrations of nutrients sooner after the snow-melt than do dicotyledons. Since the birds start laying eggs closer to the snow-melt in late springs, this may indicate that a supply of cotton grass is of greater importance to grouse in such springs, than in early ones. When the snow disappears early, dicotyledons like bilberry probably have increased their food quality to a larger extent before the egg-laying period." **Key words: willow grouse, snow, reproduction, nutrition, vegetation**

053

Brown, D. E. 1979. Factors influencing reproductive success and population densities in Montezuma quail. Journal of Wildlife Management 43(2):522-526. Notes: This study analyzes harvest statistics and correlates them with climatological information to determine the effects, if any, of weather on Montezuma quail populations in Arizona. Correlations analysis showed a positive correlation between reproductive success and summer precipitation. The highest positive correlation coefficient tested was with the percentage of young quail in the harvest and the preceding summer's June through August precipitation (r=0.55, P<0.10). Except in 1977, the maximum reproductive success measured was no more than 78% young in the bag and it appears that summer precipitation in excess of about 23 cm (9 inches) was superfluous and possibly even served to depress the percentage of young birds. There was a negative correlation coefficient between winter (October-March) precipitation and the following season's reproductive success (r=-0.73, $P\leq$0.02). There was a positive linear relationship between hunting success and the summer precipitation of the year previous to the summer preceding the hunt plus the population density (as measured by hunting success)(r=0.53; $P\leq$0.10). These data suggest that survival is normally more important in determining Montezuma quail population levels than reproductive success….the estimated annual survival rates also had a positive correlation with the previous year's summer precipitation (r=0.60; $P \leq 0.05$). Lack of either food or grass production brought on by inadequate precipitation or the removal of grasses by livestock would then reduce overwinter survival and result in lower population densities. It is easy to see how continued heavy grazing, particularly during summer droughts, results in the extirpation of Montezuma quail. Deep snows and long periods of subfreezing temperatures are also known or believed to have caused high mortality, both locally and generally. **Montezuma quail, precipitation, snow, temperature, reproduction, population dynamics, vegetation, grazing**

054

_____. 1978. Grazing, grassland cover and gamebirds. Transactions of the North American Wildlife and Natural Resources Conference 43:477-485. Conclusions—"California quail, Gambel's quail and mountain quail evolved within comparatively moderate climates having winter-spring rainfall and a dry growing season. These so called "Mediterranean" species are characterized by "boom or bust" fluctuations in reproductive success which is an evolutionary adaptation to annual variations in precipitation related conditions. These scrub-adapted birds are thus able to rapidly exploit favorable situations and adjust to less favorable ones. Just the opposite is true for the grassland gamebirds that evolved with "continental" or tropical climatic regimes. Prairie chickens, bobwhite, Montezuma quail, sharp-tailed grouse and scaled quail all display less pronounced variations in reproductive success than Mediterranean species. Reproductive success in at least 3 of these species in the Southwest is related to summer precipitation which, within the range of these species, is less variable than winter rainfall. Continental species are adapted to changes in overwinter survival and population fluctuations are, at least partially, responses to changes in perennial grass and/or food production. The reduction of either of these entities decreases the survival rate (and population level) by increasing the incidence of predation and starvation. The removal of herbaceous vegetation by livestock deprives these grassland birds (which are all more or less cryptically colored) of their principal cover—residual grasses….Even a conservative utilization of forage in the neighborhood of 20 to 40 percent could be highly detrimental to grassland birds during drought periods because it could remove that percentage of the bird's cover habitat for the next year." **Key words: prairie chickens, bobwhite quail, Montezuma quail, sharp-tailed grouse, scaled quail, California quail, Gambel's quail, precipitation, nutrition, predation, drought, vegetation**

055

_____. and R. H. Smith. 1980. Winter-spring precipitation and population levels of blue grouse in Arizona. Wildlife Society Bulletin 8(2):136-141. Abstract: Multiple regression analysis showed an interdependent positive relationship between winter-spring precipitation, density, reproductive success and subsequent survival rates of blue grouse (*Dendragapus obscurus*) in Arizona. With the exception of one year, the percentage of juvenile grouse observed in August was consistently high and close to a mean of 65%. Variations in survival are probably more important in determining grouse population levels in Arizona than changes in reproductive success. Precipitation, hunting success, and survival data suggest that most mortality occurs between spring and autumn. Annual variations in mortality are thought to be influenced by variations in the spring growth of herbaceous vegetation and density of grouse. **Key words: blue grouse, precipitation, fecundity, mortality, vegetation**

056

Bruce, J. R. 2008. Greater sage-grouse movements and habitat use during winter in central Oregon. M.S. Thesis, Oregon State University, Corvallis, USA. Notes: "Winter habitat used by sage-grouse has, in other states, been reported to be influenced by the amount of big sagebrush exposed above the snow, and these past studies had snow when they measured sagebrush as being either 0.25-0.46 m above the snow, or having a total sagebrush height of 0.41-0.56 m. These contrast strongly with our reported average canopy height range of 0.25 to 0.75 m. We suggest that his larger range may be that our study lacked enough snow to cover sagebrush, and the period we measured sagebrush height in plots used by sage-grouse extended into large winter/early spring when females tended to begin using taller sagebrush…Wyoming big sagebrush was still used during our study even with little snow as well as presence of low sagebrush within the study site...We determined that this sage-grouse population is a resident population, as opposed to a migrant one…however, it is possible that this population of sage-grouse could be described as migrant if more severe winter weather caused grouse to move longer distances in order to find appropriate food and cover…Based on a year of limited snow cover, we recommend management strategies for winter habitats that restore or enhance a mosaic of low, mountain, and Wyoming big sagebrush with sagebrush heights ranging from 0.25 m to 0.75 m tall in areas that have a large percentage of flat ground and/or areas having no greater than 10% slope and provide northeast aspects…the time period of our study had a greater range of temperatures, and was much drier than average overall. Although this study found that most sage-grouse were located in low sagebrush, various types of sagebrush habitat are necessary to provide differing sagebrush heights and cover during winter as snow depth may be a limiting factor to sage-grouse survival during winters with more precipitation…As sage-grouse seek different levels of cover or different compositions of sagebrush communities for food and shelter, they will require a landscape large enough to provide such habitats. Effective sage-grouse management efforts to create or maintain habitat diversity on extensive tracts large enough to encompass a mosaic of habitat types for different seasons is essential for the long-term conservation of sage-grouse populations. **Key words: sage-grouse, snow, temperature, vegetation, habitat use, movement**

057

Brunjes, J. H. IV. 2005. The population biology and landscape ecology of Rio Grande wild turkeys in the Rolling Plains of Texas and Kansas. Dissertation, Texas Tech University, Lubbock, USA. Notes: Page viii—"Researchers investigating survival of wild turkeys traditionally have assumed mortalities within the first 14 days may be capture-related, and have excluded those data from analyses. Few have explored ways to reduce mortality during this period. In 2000, we initiated a long-term radio telemetry study of the ecology of Rio Grande wild turkeys (*M. g. intermedia*) in the southern Great Plains. During 2000-2002, we captured and outfitted 667 turkeys with backpack-style radio transmitters. We recaptured 123 previously transmittered birds for a total of 780 14-day survival periods. Sixty-seven birds (8.5%) died ≤ 14 days post capture and were considered capture-related mortalities. Male mortality (13.4%) was greater than female (5.8%) mortality (P = 0.001). Birds captured in the afternoon had higher (P = 0.035) mortality rates (11.6%) versus morning (8.0%) or mid-day (7.1%) captures. We found no differences in mortality among study sites (P = 0.14), years (P = 0.27), age class for males (P = 0.38) or females (P + 0.99), or capture method (P = 0.64). We found no relationship between weather conditions and 14-day postcapture survival of turkeys with the exception of precipitation 48 hours post capture (P = 0.01). We recommend minimizing handling of males and avoiding afternoon captures to reduce capture-related mortalities.” **Key words: Rio Grande turkey, precipitation, capture mortality**

058

Burdukov, G. N. and V. M. Kozlov. 1979. Experiment in measuring specific loading of animals moving through snow. Ekologiya 1:107-109. Abstract: A method is presented for determining specific loading of animals moving over snow. Specific loading was studied in the pine marten, otter, wolverine, white hare, squirrel, lynx, ermine, mink and several species of grouse. A spring-controlled durometer with alternating punches was used to measure snow resistance (hardness). Paw penetration was measured and reproduced by the durometer. This method was more precise and readily performable than previous static methods. Specific loading data help determine an animal’s potential for locomotion. **Key words: grouse, snow, movement, technique**

059

Burkepile, N. A., K. P. Reese, and J. W. Connelly. 2004. Modeling greater sage-grouse chick survival in southeast Idaho. Meeting of the Western Agencies Sage and Columbian Sharp-tailed Grouse Technical Committee 24:8. Abstract: Sage-grouse populations have been declining throughout their range. As a result of this decline we initiated a 4-year study to determine what reproductive parameters were limiting greater sage-grouse productivity. During 1999-2002, we radio-marked greater sage-grouse hens and monitored nesting activity. After eggs hatched, we radio-marked one-day-old chicks and monitored survival to 10 weeks post-hatch. Nest success ranged between 41-51% and did not differ (P<0.001) between years. From 1999-2001, chick survival ranged between 20-25% and did not differ (P<0.001) between years. However, in 2002 chick survival was higher (35%, P>0.10) than the previous 3 years. In all years, the highest mortality occurred during the first 3 weeks post-hatch. Proportional hazard models indicated that increased May-June precipitation had a positive influence on chick survival. Along with weather, vegetative cover (i.e. grass height, grass and forb cover) also had a positive influence on chick survival. Our results indicate that greater sage-grouse populations are negatively influenced by drought conditions through reduced chick survival, likely mediated through reduced vegetative cover. **Key words: sage-grouse, precipitation, drought, chick survival, mortality, vegetation**

060

Burnett, L. E. 1905. The sage-grouse, *Centrocercus urophasianus*. Condor 7:102-105. Notes: Page 15—"After feeding they hide either on the feeding ground or at some distance from it where the sage is large enough to screen them from enemies and the rays of the sun…Hail storms often kill large numbers when they strike the places of hiding. When their feathers are drenched with rain, the birds are often unable to rise, and at such times have been killed with a stick." **Key words: sage-grouse, temperature, precipitation, hail, mortality, habitat use, solar radiation**

061

Buss, I. O. and C. V. Swanson. 1950. Some effects of weather on pheasant reproduction in southeastern Washington. Transactions of the North American Wildlife Conference 15:364-378. Summary: "During 1948 the months of March through July were abnormally wet and cool, whereas the same months in 1949 were relatively dry and warm. The wet spring of 1948 terminated in flood conditions during late May. Plotting 71 hatching dates for 1948 showed that most nests hatched from June 15 to 28, whereas 117 hatching dates for 1949 showed that most nests hatched between May 28 and June 4, over two weeks earlier than the hatching peak for 1948." **Key words: ring-necked pheasant, temperature, precipitation, productivity**

062

Cain, J. R., S. L. Beasom, L. O. Rowland, and L. D. Rowe. 1982. The effects of varying dietary phosphorus on breeding bobwhites. Journal of Wildlife Management 46(4):1061-1065. Summary: This study was undertaken to determine if the availability of dietary phosphorus could be a factor in the variability of bobwhite quail reproductive success. Phosphorus content of the soil, and thus the forage, is commonly deficient in southwestern quail ranges. Further, phosphorus deficiency can be aggravated during periods of inadequate moisture. Although phosphorus deficiency can be magnified during drought periods, these findings suggest that a phosphorus-deficient diet for at least 90 days prior to and including the normal egg-laying period may be a contributory factor, but is not singularly responsible for causing periodic reproductive failures in bobwhite quail. **Key words: bobwhite quail, precipitation, drought, diet, fecundity, soil**

063

Call, M. W. 1974. Habitat requirements and management recommendations for sage-grouse. Technical Note 330, U.S. Department of the Interior, Bureau of Land Management, Denver. Notes: Page 5—"The oft mentioned decimating factors of unfavorable weather, increased predation, hunting and disease may have been of significance in localized areas, but were relatively unimportant in the overall decline in sage-grouse number." Page 10—"The primary factor involved with sage-grouse is that precipitation be adequate to provide for succulent forbs and grasses amongst or near their sagebrush habitat." Page 12—" …In winter, snow takes care of their moisture requirements, either directly or as it melts and provides free water on warm days.

Precipitation distribution, amounts, and seasonal occurrence, all affect sage-grouse distribution to some extent. Where late spring and early summer precipitation is abundant and widespread, the development of succulent vegetation usually induces a wider distribution of grouse, whereas in drought years they congregate in areas where free water is available." "Deep snow may cover the spring and summer ranges forcing the birds to migrate to some distant area for winter and to return for nesting as snow depths decrease. Where grouse nest and raise their broods on sage-covered slopes on in mountain valleys at high elevations, they usually must migrate to the desert floors or other low elevations to find exposed sagebrush for food during the winter. In many areas, summer and winter areas may be as much as 20 or more miles apart." Page 17—"In late August at high elevations, or in September or October in some lower areas, the meadows dry and the incidence of frost increases, leading to drying or killing of the foliage of forbs. The incidence of sagebrush consumption increases at that time. Increased moisture content may make sagebrush more palatable than during summer." Page 17—"Sage-grouse live almost exclusively on the leaves of sagebrush during the winter. In Montana when snow depth exceeded 12 inches, sage-grouse were restricted to taller sagebrush stands, a relatively small percentage of the total range available to them in a normal (lesser snow) winter…As weather moderated in February, activities shifted to more open stands of sagebrush." Page 20—"Wintering birds respond to snow. Snow depth forces the birds to lower elevations and appears to be a factor determining the actual wintering site for a flock. "Deep snow limits the availability of food….In some areas, sage-grouse occupy windswept sagebrush ridges in winter." Page 26—"In wintering habitats, there is little place for fire. Retention of sagebrush is essential on winter ranges. Even tall, decadent sagebrush, not useful for nesting or brooding, may be important during severe winters when most other sagebrush could be covered by snow." **Key words: sage-grouse, precipitation, snow, frost, fire, wind, vegetation, habitat use, movement**

064

_____ and C. Maser. 1985. Wildlife habitats in managed rangelands—the Great Basin of southeastern Oregon, Sage-grouse. General Technical Report PNW-187, Pacific Northwest Forest and Range Experiment Station, Portland, USA. Notes: Abiotic factors-Climate. The highest densities of sage-grouse occur where precipitation averages 25-38 cm (10-16 in) per year. Marginal populations occur in areas of lesser precipitation. Page 10—Grouse consumption of sagebrush intensifies as meadows and foliage of forbs dry and the incidence of frost increases, in late August at high elevations or in September and October in lower areas. Wintering Habitat: As snow begins to accumulate on their summer-fall ranges, sage-grouse start moving to lowlands or other sites, such as windblown ridges, where their needs for forage and cover can be met throughout the winter. The extent of seasonal movements varies with the severity of winter weather, topography, and vegetative cover. Sedentary populations meet all their seasonal requirements in the same general area and, as winter approaches, simply change their use areas from meadows to sagebrush, because they live almost entirely on the leaves of sagebrush in winter. Page 11—In seeking wintering areas, grouse initially select areas with the most palatable sagebrush; if those areas become covered with snow, they shift to available sagebrush. Page 12—Habitat surveys conducted during the summer may give the impression of vast acreages of sagebrush available as winter range for grouse. Observations during winter, however, reveal that much of the habitat is not available because of snow depth or it is unsuitable for other seasons. For example, when snow depth in Montana exceeds 12 in., sage-grouse were restricted to taller sagebrush stands. Only 7 percent of the range was available when snow depth exceeded 11.8 inches. Sage-grouse in Idaho moved to taller sagebrush types when snow depth reached about 13 in. **Key words: sage-grouse, snow, precipitation, frost, wind, vegetation, diet, movement, habitat use**

065

Campbell, H. 1968. Seasonal precipitation and scaled quail in eastern New Mexico. Journal of Wildlife Management 32(3):641-644. Abstract: Spring-summer rainfall was positively and significantly correlated with subsequent hunter success on scaled quail (*Callipepla squomata*) in eastern New Mexico during 1957-66. It is reasonable to assume that hunter success is related to quail population density in a direct, but not necessarily proportional, way. On this assumption it appears that the quail population of eastern New Mexico is importantly influenced and perhaps controlled by spring-summer rainfall. No statistically significant correlation was found between fall-winter precipitation and hunter success. Hence, it appears that, unlike the situation in Arizona with respect to Gambel's quail (*Lophortyx gambelii*), fall-winter precipitation had no important influence on the scaled quail population studied. **Key words: scaled quail, Gambel's quail, precipitation, population dynamics**

066

_____, D. K. Martin, P. E. Ferkovich, and B. K. Harris 1973. Effects of hunting and some other environmental factors on scaled quail in New Mexico. Wildlife Monograph 34, The Wildlife Society, Washington, D. C., USA. Summary: Quail breeding success on the study areas was strongly related in a positive way with spring-summer precipitation, and the July-August component of the precipitation was especially important. There was no statistical relationship whatever between scaled quail breeding success and the fall-winter precipitation which Swank and Gallizioli found essential for successful production of Gambel's quail in Arizona. It is unlikely that seasonal precipitation *per se* exerts an important influence on quail populations, but rather that precipitation controls some other factor which does exert an important or controlling influence. This factor probably is nutritional, most likely the food, vitamins, minerals, etc., produced by a diversity of forbs, all of which depend for their development and fruiting on adequate rainfall during definite seasons of the year. The influence of seasonal rainfall in producing crops of insects useful to quail as food may also be of great importance. Climatographs suggest the possibility that there may have been a negative causal relationship between comparatively high summer temperatures and high quail production, but that there was no relationship between winter temperatures and quail production. **Key words: scaled quail, precipitation, temperature, productivity, nutrition**

067

Campbell-Kissock, L., L. H. Blankenship, and L. D. White. 1984. Grazing management impacts of quail during drought in the northern Rio Grande Plain,

Texas. Journal of Range Management 37(5):442-446. Abstract: Relationships between the abundance of 2 quail species and range site and grazing management during drought were evaluated in the northern Rio Grande Plain of Texas. Clay loam range sites provided better nesting cover and greater abundance of forbs for quail than sandy loam and shallow ridge range sites. Foliar cover and aboveground standing crop of grass were greater on the 3 range sites within the short duration and deferred rotation systems as compared with the yearlong system. During drought, grazing systems provided better nesting and protective cover for quail than yearlong grazing. **Key words: quail, drought, vegetation, grazing, soil**

068

Cardona, C. J., A. Ihejirika, and L. McClellan. 2002. *Haemoproteus lophortyx* infection in bobwhite quail. Avian Diseases 46(1):249-255. Abstract: This report chronicles recurring outbreaks of *Haemoproteus lophortyx* infection in captive bobwhite quail. Clinically, the signs of infection included reluctance to move, ruffled appearance, prostration, and death. These signs were associated with parasitemia, anemia, and the presence of large megaloschizonts in skeletal muscles, particularly those of the thighs and back. The average cumulative mortality for flocks experiencing outbreaks was over 20%. In a typical outbreak, mortality rose when the birds were 5-6 weeks of age, peaked in 8- to 10-week-old quail, and declined rapidly when the quail were 9-11 weeks old. Outbreaks occurred exclusively between the months of May and October, and warm weather was determined to be a risk factor for *H. lophortyx* mortality. This protozoan most likely overwinters in native California quail in the area and is transmitted to quail on the ranch by an insect vector that emerges in warm weather. Infection of the large population of naïve bobwhite quail on the ranch leads to amplification of *H. lophortyx*, resulting in epidemics in successive flocks. **Key words: bobwhite quail, temperature, disease, mortality, parasites**

069

Carpenter, J. E. 2007. West Nile virus and parasites in greater sage-grouse (*Centrocercus urophasianus*) populations. M.S. Thesis, University of Alberta, Edmonton, Canada. Notes: “Because development of *C. tarsalis* appears closely tied to temperature and moisture regimes, local differences in temperature and moisture will influence the annual risk presented by WNv. Early virus activity, detected from wild bird surveillance and mosquito monitoring, coupled with local moisture and temperature conditions are critical indicators of WNv risk.” **Key words: sage-grouse, temperature, precipitation, disease, insects**

070

Case, R. M. and R. J. Robel. 1974. Bioenergetics of the bobwhite. Journal of Wildlife Management 38(4):638-652. Abstract: Ten bobwhites (*Colinus virginianus*) of each sex were individually confined under controlled, simulated seasonal conditions (10- and 15-hour photoperiods, temperatures from 0 to 40 C) in order to quantify energy requirements (gross energy intake, existence energy, and excretory energy). Quails confined under a 15-hour photoperiod had significantly ($P < 0.005$) greater energy requirements than those under a 10-hour photoperiod. There was no difference ($P >$

0.05) between males and females at 10 hours, nor between males and nonlaying females at 15 hours, for energy requirements. The above energy variables decreased with increasing temperature, in a linear manner, except for egg-laying females (changed quadratically). Existence energy of quails increased 108 percent between 0 and 30 C for 10-hour and 124 percent for 15 hour photoperiods. Body weights changed curvilinearly with temperature, at both photoperiods, in each sex. Males were heavier than females at 10 hours; at 15 hours the females were heavier. Body weight accounted for less than 1 percent of the total variation about energy variables. Males survived higher temperatures than females at both photoperiods (mean upper lethal temperature 43.7 C vs. 42.6 C at 10 hours and 44.7 C vs. 41.0 C at 15 hours). There was no predictable pattern for efficiency of feed utilization. The highest efficiency (76 percent) was at the 10-hour photoperiod. Productive energy for egg-laying females decreased at both high and low temperatures and was maximum (13.800 kcal/bird-day) at 25 C. None of our egg measurements correlated significantly ($P > 0.05$) with body weight of quails. **Key words: bobwhite quail, temperature, bioenergetics**

071

Cattadori, I. M., D. T. Haydon, and P. J. Hudson. 2005. Parasites and climate synchronize red grouse populations. Nature 433:737-741. Abstract: There is circumstantial evidence that correlated climatic conditions can drive animal populations into synchronous fluctuations in abundance. However, it is unclear whether climate directly affects the survival and fecundity of individuals, or indirectly, by influencing food and natural enemies. Here we propose that climate affects trophic interactions and could be an important mechanism for synchronizing spatially distributed populations. We show that in specific years the size of red grouse populations in northern England either increases or decreases in synchrony. In these years, widespread and correlated climatic conditions during May and July affect populations regionally and influence the density-dependent transmission of the gastrointestinal nematode *Erichostrongylus tenuis*, a parasite that reduces grouse fecundity. This in turn forces grouse populations into synchrony. We conclude that specific climatic events may lead to outbreaks of infectious diseases or pests that may cause dramatic, synchronized changes in the abundance of their hosts. **Key words: red grouse, temperature, humidity, precipitation, disease, parasites, fecundity, mortality, population dynamics**

072

Cedarleaf, J. D., S. D. Worthen, and J. D. Brotherson. 1982. Weather conditions in early summer and their effects on September blue grouse *Dendragapus obscurus* harvest. Great Basin Naturalist 42(1):91-95. Abstract: Relationships of temperature and precipitation to the reproductive success of blue grouse (*D. obscurus*) were investigated. Maximum and minimum temperatures followed similar patterns during the years 1976-1981 and showed no patterns relative to hatching success. Precipitation data was variable. When significant amounts of precipitation fell during the last three weeks of the hatching period, chick survival and thus recruitment were adversely affected. Precipitation occurring at the end of the hatch period probably reduces the September harvest of birds. **Key words: blue grouse, temperature, precipitation, reproductive success, chick survival, recruitment**

073

Chamberlain, E., R. D. Drobney, and T. V. Dailey. 2002. Winter cover height and heat loss: is taller better? Proceedings of the National Quail Symposium 5:157. Abstract: Previous studies have demonstrated that roost site selection affects energy requirements for thermoregulation in several avian species; however, the influence of microhabitat characteristics on heat loss has not been evaluated for northern bobwhites (*Colinus virginianus*). One frequently measured microhabitat feature that is commonly thought to influence the thermal characteristics of avian ground roost sites is cover height. We simultaneously measured thermoregulatory energy expenditure of bobwhites across a range of low ambient temperatures (-24° to 14° C) in 3 cover heights (0 cm, 46 cm, 124 cm) using 3 heated taxidermic mounts. Predicted metabolic rates (PMR) were derived on the basis of power consumption of the taxidermic mounts. Predicted metabolic rate for each vegetation height was linearly related to ambient temperature, and decreased significantly ($P < 0.769$) among the 3 vegetation heights across a range of environmental conditions. These findings suggest that under the conditions occurring during our field measurements, thermoregulatory energy requirements of bobwhites was essentially independent of vegetation height at the roost, and primarily are a function of conductive rather than convective heat loss. **Key words: bobwhite quail, temperature, thermoregulation, vegetation**

074

_____, _____, and _____. 2000. Vegetation and thermal characteristics of bobwhite nocturnal roost sites in native warm-season grass. Proceedings of the National Quail Symposium 4:58. Abstract: Native warm-season grass (NWSG) has been widely promoted as wildlife habitat, but little empirical evidence is available to support its value for most wildlife species. One justification for a conversion to NWSG is the high thermal quality of cover resulting from the height and structure of the vegetation. Because vegetation cover is an important factor contributing to bobwhite winter survival, we predicted that they should select roost sites with superior thermal characteristics during winter when energy requirements for thermoregulation are greatest. In this 3-year study we used data derived from roost sites (n=166) obtained from radio-marked quail to compare the relative use of NWSG and 5 other habitat types, and the micro-habitat characteristics of winter roost and random sites on an area intensively managed for quail in Missouri. Of the 6 habitats used for roosting, most locations (51.2%) were in old-field habitats. NWSG ranked third with 17% of the locations. Our findings indicated that roost site selection may be influenced to a greater extent by the micro-habitat characteristics of a site rather than by habitat type. Two micro-habitat features that were of particular importance in habitats used most by quail were litter cover and canopy cover. These habitat features are valuable in reducing conductive and convective heat loss. **Key words: bobwhite quail, thermoregulation, vegetation, habitat use, micro-habitat**

075

Charette, J. 2000. On the diet of the American woodcock (*Scolopax minor*) during drought periods. *In*: D. A. Stroud and N. C. Davidson, editors. Wader Studies

Methods: Practical Papers Published in the Wader Study Group Bulletin Part 2: Feeding, census and survey techniques. Unable to obtain copy for abstract.

076

Choate, T. S. 1963. Habitat and population dynamics of white-tailed ptarmigan in Montana. Journal of Wildlife Management 27(4):684-699. Abstract: The ecology and structure of a population of white-tailed ptarmigan (*Lagopus leucurus leucurus*), residing during the summer near Logan Pass, Glacier National Park, were studied from early June to mid-September, 1959-62. Although ptarmigan were observed in a wide variety of habitats within the alpine zone, they showed a preference for areas having moderate rock cover, plentiful snow or water, and short, young vegetation. During the breeding season, 21 males and 14 females used the study area (7.08 acres of ptarmigan habitat). Territorial males returned to the same sites year after year and occasionally had the same mates. Yearling males rarely established and mated in their first year, but yearling females bred successfully. Females occasionally returned to the same breeding areas. Few females born on the study area returned to it, but many males did. Clutch size averaged 5.2 eggs (range 3-9). Nest parasitism was rare. Renesting occurred occasionally in phenologically early years. The percent of successful females varied from 35 to 82. Poor success was often caused by inclement weather. Hatching success was 85.5 percent. Brood size at flight age ranged from 3.25 to 3.47. Despite a large variation in natality, the size of the adult population at Logan Pass varied little. Average adult annual mortality was 29 percent, lower than that reported for other galliform species. Chick mortality was 35-44 percent by the time of dispersal. Mortality of immature birds was 63 percent by the following spring. A life table based on these average mortalities indicates a maximum life-length of 15 years, a mean longevity of 3.02 years, and an annual mortality rate of 42.1 percent. The Logan Pass population did not show the fluctuation in numbers reported for other species of ptarmigan and suggested for the tundra biome. **Key words: white-tailed ptarmigan, snow, mortality**

077

Christensen, G. C. 1970. The chukar partridge: its introduction, life history, and management. Biological Bulletin No. 4, Nevada Department of Wildlife, Reno, USA. Notes: In a section titled “Inimical Factors”, the author discussed the effects of climate Pages 43-46—“Deep, persistent snow can completely cover food in higher areas that causes the chukars to migrate to lower elevations where food is available. Chukars are able to scratch beneath brush when snow is only an inch or two deep. In 1951 chukars in the Peavine Mountain area northwest of Reno were forced onto highways near Reno and into the town, obtaining food uncovered by plows along roadways. One specimen showed near depletion of fat reserves. Other birds showed no distress. Chukar losses due to snowfall were recorded in some areas. There can be severe losses to local chukar populations as a result of heavy snows. Prolonged cold temperatures following heavy snows compound the problem. In terms of precipitation, recently hatched chicks can be killed as a result of exposure to rains.” “Factors affecting reproduction” Pages 38-39—“Precipitation is discussed as a factor in determining population dynamics directly and indirectly through nutrition. In arid or semi-arid regions it is important that the precipitation occur at the proper time of year to facilitate vegetal growth and production culminating in a seed crop. Localized thundershowers can have a considerable influence in some areas resulting in pockets of good bird production and other areas exhibiting poor production. Temperature and wind as well as soil condition (frozen or not) play important roles in determining the effectiveness of precipitation. In Nevada population trends show chukars exhibit boom and bust patterns correlated with drought conditions and lack of nutritious food. During the severe drought years of 1953 and 1954 the adult:young ratios in Washoe County were 100/63 and 100/11 respectively, showing the production had almost reached a standstill. Food conditions were so poor that adult birds were found to be subsisting on dry rootstocks and stems of grass. When a population bottoms out it seems to require a minimum of three good production years, back to back, to bring the population to a peak again. In addition to affecting chukar production indirectly through the food chain, climatic conditions can also directly affect the success of the hatch. Abnormally heavy precipitation in May and early June can cause chick morality and in some instances adverse climate may result in nest loss. **Key words: chukar partridge, precipitation, drought, temperature, soil, productivity, mortality, vegetation, nutrition, population dynamics**

078

_____.1958. The effects of drought and hunting on the chukar partridge. Transactions of the North American Wildlife Conference 23:331-341. Summary: The precipitation pattern and effectiveness has a direct bearing upon the annual food crop which is produced in chukar habitat. The condition of the range follows in turn as the determining factor in chukar production. During a three-year drought in Nevada there was a decided decrease in chukar production and decline in population. With the advent of proper range conditions the populations made a quick recovery. **Key words: chukar partridge, drought, nutrition, productivity**

079

Christiansen, T. 2005. Greater sage-grouse job completion report, June 1, 2005-May 31, 2006. Wyoming Game and Fish Department, Cheyenne. Notes: Page 7—"Results of this and prior monitoring suggest sage-grouse populations in the Wyoming (sic) were at their lowest level ever recorded in the mid-1990s. Grouse numbers then responded to increased precipitation during the late 1990's with some individual leks seeing three fold increases in the number of males counted between 1997 and 1999. The return of drought conditions in the early 2000's led to decreases in chick production and survival and therefore population declines, although the population did not decline in mid-1990's levels. Improved habitat conditions due to timely precipitation in 2004 led to high chick production and survival. This resulted in 2006's counts and surveys having the highest recorded average males per lek since 1978. **Key words: sage-grouse, precipitation, temperature, vegetation, population dynamics**

080

Church, K. E. and W. F. Porter. 1990. Population responses by gray partridge to severe winter conditions. Pages 295-303 *in* K. E. Church, R. E. Warner, and S. J. Brady, editors. Proceedings *Perdix* Symposium V: gray partridge and ring-necked pheasant workshop. Minnesota Department of Natural Resources, Mankato, USA.

Abstract: We compared 3 methods of estimating changes in the abundance of gray partridge (*Perdix perdix*), and described population responses during a severe winter in New York. Change-in-ratio analysis and biweekly census provided similar estimates of winter mortality, whereas changes in mean covey sizes underestimated loss due to migration and extinction. We estimated 58% population loss over a 2-week period in early February. During this period subadult partridge were 3 times less likely to survive than adults. Evidence from radio-tagged partridge indicated loss was primarily due to predation by great horned owl (*Bubo virginianus*) or red-tailed hawk (*Buteo jamiacensus*), not starvation. We concluded overwinter survival may limit gray partridge populations, and recommend supplemental feeding to minimize the risk of predation. **Key words: gray partridge, ring-necked pheasant, severe winter, mortality, predation**

081

Churchwell, R., J. T. Ratti, and F. Edelmann. 2004. Comparison of fall and winter food habits for sympatric chukar and gray partridge in Hells Canyon of Idaho and Oregon. Northwest Science 78(1):42-47. Abstract: Chukar and gray partridge are abundant and sympatric in Hells Canyon, Idaho and Oregon. We collected crops (birds collected during the hunting season) from both species to compare fall and winter food habits, which allowed for comparison of food selection, estimation of niche overlap, and identification of important food resources. We collected 143 chukar and 112 gray partridge crops during the 1999 and 2000 hunting seasons (late September through early January). We identified 21 items consumed by chukar and 16 items consumed by gray partridge. Both bird species consumed similar foods, with an 80% dietary overlap. Dominant food items for both species included prairiestar root nodules and vegetative parts from various grasses and forbs. Food items differed between years, which may have reflected variation in weather and plant cycles. This is the first study of gray partridge from a non-agricultural environment, and the first rigorous comparison of food habits for sympatric chukar and gray partridge population in North America. **Key words: chukar partridge, gray partridge, weather, vegetation, diet**

082

Clarke, J. A. and R. E. Johnson. 1992. The influence of spring snow depth on white-tailed ptarmigan breeding success in the Sierra Nevada. Condor 94(3):622-627. Abstract: The relationship between spring snow depth and breeding success of an introduced population of white-tailed ptarmigan (*Lagopus leucurus altipetens*) in the Sierra Nevada, California, was studied from 1982 through 1987. Yearly spring snow depth varied from 50.8 cm to 424.2 cm. Hatch dates were later in years of deep snow ($P<0.05$) but brood size showed no relation to snow depth. Nesting success, chick survival, and brood success (all of which contribute to breeding success) were negatively correlated with snow depth as was breeding success ($P<0.05$). The number of paired ptarmigan in the study area varied from 22 (in 1987) to 46 in 1985 which was the year with the least snow; however, no significant relationship existed between breeding numbers and snow depth. Successful reproduction of white-tailed ptarmigan in the Sierra Nevada appears to be strongly affected by snow, potentially due to its influence on the availability of resources such as nest sites, food, and cover. **Key words: white-tailed ptarmigan, snow, reproduction**

083

Coates. P. S. and D. J. Delehanty. 2008. Effects of environmental factors on incubation patterns of greater sage-grouse. Condor 110(4):627-638. Abstract: Birds in which only one sex incubates the eggs are often faced with a direct conflict between foraging to meet metabolic needs and incubation. Knowledge of environmental and ecological factors that shape life-history strategies of incubation is limited. We used continuous videography to make precise measurements of female greater sage-grouse (*Centrocercus urophasianus*) incubation constancy (percentage of time spent at the nest in a 24-hour period) and recess duration. We used an information-theoretic approach to evaluate incubation patterns in relation to grouse age, timing of incubation, raven abundance, microhabitat, weather, and food availability. Overall, sage-grouse females showed an incubation constancy of 96% and a distinctive bimodal distribution of brief incubation recesses that peaked at sunset and 30 min prior to sunrise. Grouse typically returned to their nests during low light conditions. Incubation constancy of yearlings was lower than that of adults, particularly in the later stages of incubation. Yearlings spent more time away from nests later in the morning and earlier in the evening compared to adults. Video images revealed that nearly all predation events by common ravens (*Corvus corax*), the most frequently recorded predator at sage-grouse nests, took place during mornings and evenings after sunrise and before sunset, respectively. These were the times of the day when sage-grouse typically returned from incubation recesses. Recess duration was negatively related to raven abundance. We found evidence that incubation constancy increased with greater visual obstruction, usually from vegetation, of nests. An understanding of how incubation patterns related to environmental factors will help managers make decisions aimed at increasing productivity through successful incubation. **Key words: sage-grouse, solar radiation, microhabitat, weather, predation, incubation**

084

Cobb, D. T. and P. D. Doerr. 1997. Eastern wild turkey reproduction in an area subjected to flooding. Journal of Wildlife Management 61(2):313-317. Abstract: We used cohort analyses and population cohort matrices to model a wild turkey (*Meleagris gallopavo silvestris*) population under perturbed (i.e., man-induced flooding on 3-year intervals) and unperturbed (i.e., non-flood) conditions. The net reproductive rate (R_O) of a cohort in which reproduction in the hatching-year (HY) age class was perturbed by flooding dropped to 0.460 from R_O = 1.383 for unperturbed cohorts. The R_O of cohorts in which only after-hatching-year (AHY) age classes were exposed to flooding was > 1.0. Cohort analyses demonstrated the importance to the population of nesting by HY hens and the significant effects on cohort reproductive potential of exposing the HY age class to flooding. Evaluation of population cohort matrices also suggested that flooding on a 3-year interval precludes sufficient reproduction to maintain this wild turkey population. **Key words: turkey, reproduction, flood**

085

Coggins, K. A. 1998. Relationship between habitat changes and productivity of sage-grouse at Hartt Mountain National Antelope Refuge, Oregon. M.S. Thesis, Oregon State University, Corvallis, USA. Notes: "After early studies (1989-1991), climatic conditions and land-use practices changed at HMNAR. Livestock grazing was eliminated from HMNAR in 1991 and during 1989-1997 there was an upward trend in crop year precipitation (total precipitation from 1 September-30 June). Because of these changes a study was initiated to test the relationships inferred from earlier studies. Two sample periods (1989-1991 and 1995-1997) were compared to determine the collective effect of increased crop year precipitation and reduced livestock grazing on key habitat components in 4 cover types and on sage-grouse productivity measures….Herbaceous vegetation increased in all cover types during 1995-1997 compared with 1989-1991 at HMNAR. Increased herbaceous vegetation during the second time period was probably related to above average crop year precipitation in conjunction with the absence of livestock grazing during 1992-1997. Results of my study indicated that mean nest initiation and renesting rates increased concordantly with spring forbs, which increased 2- to 3-fold in several key cover types between periods. Cover type use by pre-laying hens did not change between time periods; therefore, increases in nest initiation and renesting rates apparently were related more to changes in habitat components (spring forbs) in these cover types rather than changes in use of cover types by grouse. Greater availability off spring forbs at HMNAR likely provided hens more opportunity to consume protein rich foods, and ultimately, to become physiologically prepared to initiate nesting and renesting, if necessary. I also found that mean nesting success increased concomitantly with increases in tall grass cover available during spring….greater residual herbaceous cover in sage-grouse nesting habitat during spring increased the chances of nest success by providing scent, physical, and visual barriers to predators….Results of this study revealed that sage-grouse productivity increased concomitantly with increased herbaceous vegetation at HMNAR and confirmed the relationship of certain hebaceous habitat components to reproductive success of sage-grouse…data from Oregon hunter wing returns indicated sage-grouse productivity was at record high levels throughout Oregon in 1996 and 1997. During 1989-1991, 35% of hunter harvested sage-grouse were immatures, whereas during 1995-1997, 47% were immatures. These results possibly reflected widespread changes in herbaceous vegetation related to increased precipitation in conjunction with reduced livestock stocking rates…Herbaceous vegetation and, ultimately, sage-grouse productivity increased concurrently with increased crop year precipitation and removal of livestock grazing at HMNAR." **Key words: sage-grouse, precipitation, grazing, vegetation, nutrition, reproduction**

086

Connan, R. M. and D. R. Wise. 1994. Further studies on the development and survival at low temperatures of the free living stages of *Trichostrongylus tenuis*. Research in Veterinary Science 57(2):215-219. Abstract: To assess the ability of the free living stages of *Trichostrongylus tenuis*, a pathogen of red grouse, to survive the winter in significant numbers, the temperatures prevailing during the autumn, winter and spring of 1991-1992 on the North Yorkshire moors were simulated in an incubator into which replicate cultures of *T. tenuis* eggs were placed at intervals. September and early October eggs developed into larvae which survived over winter and were infective the following spring. Few November to February eggs survived to become larvae but early March eggs were reasonably successful. Continuous temperatures of -15 degree C were lethal to infective larvae within 12 days, but significant numbers of larvae survived temperatures of -10 degrees C or higher for up to three weeks and remained infective. **Key words: red grouse, temperature, precipitation, disease, parasites**

087

Connelly, J. W., K. P. Reese, R. A. Fischer, and W. L. Wakkinen. 2000. Response of a sage-grouse breeding population to fire in southeastern Idaho. Wildlife Society Bulletin 28(1):90-96. Notes: "…we…concluded that breeding population declines became more severe in years following fire. Prescribed burning negatively affected sage-grouse in southeastern Idaho and should not be used in low-precipitation sagebrush habitats occupied by breeding sage-grouse." **Key words: sage-grouse, fire, precipitation, reproduction**

088

Conover, M. R. and J. S. Borgo. 2009. Do sharp-tailed grouse select loafing sites to avoid visual or olfactory predators? Journal of Wildlife Management 73(2):242-247. Abstract: Grouse should seek loafing sites hidden from predators; however, good hiding sites from predators that use vision to locate prey differ from good hiding sites from predators that use odor to locate prey. We compared characteristics of control sites to sites used for loafing by sharp-tailed grouse (*Tympanuchus phasianellus*) to determine whether selection of loafing sites was more influenced by the need to hide from visual or olfactory predators. Sites used for loafing were similar to control sites in characteristics that would help hide a grouse from visual predators (i.e., visual obstruction, lateral visibility, visual obstruction, cover height, and surface roughness), but loafing sites differed from control sites in characteristics that would help hide a grouse from olfactory predators (i.e., greater updrafts, wind velocities, and atmospheric turbulence). **Key words: sharp-tailed grouse, wind, predation, topography, habitat use, behavior**

089

Coon, R. A., P. D. Caldwell, and G. L. Storm. 1976. Some characteristics of fall migration of female woodcock. Journal of Wildlife Management 40(1):91-95. Abstract: Nine female woodcock (*Philohela minor*) were radio-tagged in central Pennsylvania before fall migration to monitor premigratory and migratory movements. Within 15 days of departure, 5 of the birds moved 0.8 to 8.0 km from their normally used area, but the remaining 4 did not move. In 1973 five marked woodcock began migration between 30 November and 8 December. In 1974, four birds departed between 18 and 29 November. Departures coincided with high pressure centers approaching from the north and west or low pressure centers retreating to the north and east, or both. Eight of the 9 woodcock departed 2.5 or more hours after sunset and at least 7 left before midnight. Two hatching-year birds were tracked for up to 201 km SSW of the study area during 2 nights. Their air speeds (mean ± SD) were 36 ± 2 and 45 ± 3 km/h. **Key words: American woodcock, barometric pressure, movement, behavior**

090

Cope, M. G. 1992. Distribution, habitat selection and survival of transplanted Columbian sharp-tailed grouse in the Tobacco Valley, Montana. M. S. Thesis, Montana State University, Bozeman, USA. Notes: Page 35—"Use of grasslands in winter was attributed to the fact that snow cover was minimal, and food may not have been a limiting factor. Complete snow cover on the Tobacco Plains is rare, so this assumption might also be applied to the Tobacco Valley." **Key words: sharp-tailed grouse, snow, habitat use**

091

Copelin, F. F. 1963. The lesser prairie chicken in Oklahoma. Oklahoma Wildlife Conservation Department Technical Bulletin No. 6, Oklahoma City, USA. Notes: Page 37—Brood Range. Broods seemed to be more mobile in dry years when grass and shinnery cover was sparse than during wet seasons when cover was dense. During the summer of 1956, a severe drought year when population density was very low, one marked brood was observed in 13 places in July and August, and they covered a minimum enclosed area of 256 acres. The greatest distance between points of observation was 1.43 miles. On the other hand, in 1959 when rainfall was near the long term mean and vegetation was dense, three marked broods were found in no more than three places, and on a smaller range of about 160 acres. Habitat Use—In summer, during hot weather, lesser prairie chickens apparently required adequate shade. During summer they were found only in pastures, never in cultivated fields. In the shin oak type of vegetation prairie chickens gathered in the shade of oak motts, but only when it was very hot. In sand sagebrush and mixed-grass prairie types they moved into the shade of sagebrush, skunkbrush, sand plum, ragweed, and other bushy plants and forbs. The dependence of prairie chickens on good shade in summer is indicated by the following correlations between weather, soil moisture, and habitat use: 1. Insolation (solar radiation). Prairie chickens were found in motts only on clear days. Motts provided better shade than shinnery. 2. Air Temperature. More prairie chickens were found in motts on hot days than on cool days. A direct correlation existed between the numbers of birds in motts and daily maximum temperatures, except during late August soon after a 1.02 inch rain when ground moisture was high. 3. Wind velocity. There appeared to be little correlation between wind velocity and the number of prairie chickens in motts, except winds above 30 miles per hour may have reduced usage slightly. 4. Soil moisture (three inches below the ground surface). More prairie chickens were found in motts when the ground was dry than when it was moist…It is important to recognize that birds used motts only when both temperature was high and ground moisture was low. Page 42—Finding and trapping prairie chickens was less rewarding when either temperature or soil moisture was not optimum….I believe herein is the reason lesser prairie chickens occur only in regions with brushy vegetation. The need of shade in summer is critical when temperatures near or exceed 100°F. Apparently, grassy vegetation does not provide sufficient shade, particularly during extreme droughts when temperatures are highest and grass cover is sparse. Page 47—The change in winter feeding habits apparently was influenced by increased production of acorns, grass seed, and forb seed in the pastures. This year (1957) was the first wet year following a long drought. Vegetative ground cover had been sparse. With increased moisture, forbs and legumes prospered and produced an abundance of seed. Page 51—One important component of lesser prairie chicken habitat is “brushy” vegetation. Shinnery oak, sand sagebrush, plum and skunkbrush commonly provide shade in summer. Sagebrush and skunkbrush provide protection from strong winds in winter. Lesser prairie chicken range does not extend to grasslands where brush is absent. Sagebrush leaves and shin oak acorns are eaten by prairie chickens. **Key words: lesser prairie chicken, precipitation, temperature, drought, wind, vegetation, habitat use, nutrition, soil moisture, census, movement, habitat modification, solar radiation**

092

Coup, R. N. and P. J. Pekins. 1999. Field metabolic rate of wild turkeys in winter. Canadian Journal of Zoology 77(7):1075-1082. Abstract: We investigated the winter bioenergetics of eastern wild turkeys (*Meleagris gallopavo sylvestris*) by measuring standard metabolic rate (SMR) and existence metabolism (EM) of captive turkeys and field metabolic rate (FMR) of free-ranging turkeys. Mean SMR and EM were 0.511±0.040 mL $O_2 \cdot g^{-1} \cdot h^{-1}$ and 499.7±17.7 kJ·kg body mass $^{-0.734} \cdot d^{-1}$ (mean ±SE) as measured by indirect respirometry and food consumption, respectively. FMR was measured with doubly labeled water and was 10.5% higher in juvenile (0.976±0.039 L $CO_2 \cdot kg^{-0.734} \cdot h^{-1}$) than adult turkeys (0.883±0.034 L $CO_2 \cdot kg^{-0.734} \cdot h^{-1}$); their FMR:SMR ratios were 1.74 and 1.58, respectively. Juvenile turkeys weighed less and had less body fat (13.5%) than adults (18.9%). Mean FMR was lowest in 1996, when ground forage was unavailable and weather was more windy and cold than in 1995, when ground forage was available and the turkeys’ activity and range were greater. Turkeys reduced FMR in 1996 by restricting movement and range, and using proximate shelter and supplemental food. We predict that juvenile turkeys are at an energetic disadvantage when food availability is restricted because of their higher FMR, lower body and fat masses, and higher activity costs than adults. **Key words: eastern wild turkey, bioenergetics, temperature, wind, vegetation, habitat use**

093

Crawford, J. A. 1978. Factors affecting California quail populations on the E. E. Wilson Wildlife Area, Oregon. Murrelet 59(1):7-13. Summary: Flush censuses and transect counts revealed that California quail preferred early successional stages and open habitat. Long-term effects of weather and succession also were examined; succession was the only variable (r = 0.58) which was related significantly to the population decline. Rate of harvest did not affect quail populations from 1958 to 1974. Because of the rapid rate of succession, California quail were closely associated with early successional stages and open habitat. **Key words: California quail, weather, habitat use, vegetation**

094

Criddle, N. 1930. Some natural factors governing the fluctuation of grouse in Manitoba. Canadian Field-Naturalist 44(4):77-80. Abstract: The author suggests that young birds starve from lack of insects during cold and rainy weather rather than succumb directly to rain and cold. An annually repeated census of 2 areas in Manitoba from 1914 to 1929 shows a periodic fluctuation in the numbers of ruffed grouse and various other birds, peaks of abundance occurring in 1915 and 1924. A graph shows fluctuations in sharp-tailed and ruffed grouse and grasshoppers in correlation with rainfall in Aweme, Manitoba, from 1895 to 1929.Grasshopper abundance is generally preceded or accompanied by abnormally dry seasons. The peaks of grouse abundance, in turn, are preceded or accompanied by grasshopper outbreaks. Grasshoppers are apparently necessary food for young sharp-tailed grouse. The ruffed grouse, being more of a woodland species than the sharp-tailed, seems to be less affected than the latter by grasshopper prevalence. **Key words: sharp-tailed grouse, ruffed grouse, temperature, precipitation, drought, insects, nutrition, population dynamics**

095

Crissey, W. F. 1947. Influence of weather. Pages 299-306 *in* G. Bump, R. W. Darrow, F. C. Edminster, and W. F. Crissey, editors. The ruffed grouse; life history, propagation, management. New York State Conservation Department, New York, USA. Notes: Page 300—"Weather is a basic influence on grouse and other wildlife species through its effect on the environment in which they live; its effect is largely indirect and specific relationships are therefore difficult to determine; Page 301—"direct losses from weather conditions seem negligible in New York, but on one occasion a severe cloudburst and flood before the chicks were six weeks old apparently took a heavy toll"; Page 303—"although the onset of the reproductive season is primarily controlled by the progressively increasing length of daylight in the spring, minor variations in nesting dates from year to year seem related to the average minimum temperature during early April; there is apparent correlation between temperature and precipitation during the three weeks immediately following hatching and the brood mortality occurring during the latter part of the summer"; Page 304—"the degree of over-winter loss among adult grouse seems to be affected to some extent by the severity of the weather during March"; Page 306—"there appears to be some degree of agreement between the occurrence of low temperatures during March and June and periods of grouse scarcity which have been recorded in the past." **Key words: ruffed grouse, precipitation, flood, temperature, solar radiation, mortality**

096

Dahlgren, R. 1974. Pheasant mortality and production in South Dakota related to antibodies for western and eastern viral encephalitis. American Midland Naturalist 91(1):237-241. Notes: Page 240—Sizes of insect vector populations would, of course, be influenced by weather patterns. Success of pheasant reproduction has also been shown to be dependent on weather patterns. Since the extent of arbovirus diseases is dependent on weather and vector populations, WEE and EEE may be influenced by the same weather patterns which are associated with ups and downs in pheasant populations. These interrelationships are too complex to be analyzed easily. However, the relationship of disease to population fluctuations in pheasants has neither been thoroughly investigated nor discussed. While further research is necessary to determine if WEE and EEE are casually or causally related to success of pheasant reproduction, we think the correlations presented in this paper given sufficient reason for the wildlife biologist to consider diseases as a factor that may be involved in population regulation. **Key words: ring-necked pheasant, weather patterns, disease, insects, population dynamics**

097

_____.1967. The pheasant decline. South Dakota Department of Game, Fish & Parks, Pierre, USA. Notes: Page 5 – "…such things as blizzards, pesticides, herbicides, fertilizers, fall plowing, corn chopping, an increase in alfalfa, more livestock grazing, less cover for pheasants to live in, predators, cold springs, low spring humidity, too much hot weather at hatching time, and diseases—all tend to lower pheasant numbers." "Blizzards kill pheasants. A good example was the blizzard of March, 1966. About 85 percent of our pheasants in several counties in north central South Dakota were killed. When blizzards strike, they not only reduce the winter population, but the next hatching season is not enough to replace birds lost during the winter." Page 10 – "…years of late springs have been poor pheasant years…low April temperatures correlate with our "low" pheasant years, especially before 1959." Page 11 – "…the nesting or brooding instinct depends on other factors, one of which is weather. When April temperatures are below average, egg laying goes on, but serious nesting is delayed. Thus less time is left for brooding a clutch. Late springs mean fewer broods are produced before the nesting cycle is thrown out of gear in July, and results in a poor pheasant year…The stress of laying extra eggs in years of late springs resulted in poor pheasant years and high adult pheasant mortality." Page 12 – "Really poor pheasant reproduction occurred in 1950, 1959, and 1964 when temperatures rose to 94 degrees or higher in both May and June….cool May and June temperatures are an indicator of how many pheasant young will be produced. Freezing and flooding…affect pheasant nesting…dips occurred 4 to 5 weeks after severe thundershowers." Page 13 – "One of the Department's biologists voiced the opinion in 1964 that low humidity during pheasant nesting was one of the causes for a poor hatch." Page 16 – "A one-year drought in our modern day and age has a disastrous effect on the pheasant population, not only for that year, but for the next." Page 28 – "The ups and downs of any animal population is just as natural as changes in the weather. It is even fair to say, dependent on changes in the weather.' The weather furnishes them a poor house or a good house, depending on how much cover is grown by the rains which may or may not fall. It freezes or bakes them. Normally they can take such conditions admirably well—but they are vulnerable during reproduction." Page 29 – "In 1959, a drought year with a substantial pheasant decline, we tested pheasant blood and found over half of our birds had been infected with the virus [equine encephalitis]. In 1960 and 1961, good pheasant years, we found very few pheasants reacting to the blood tests." **Key words: ring-necked pheasant, temperature, precipitation, flood, reproduction, mortality, disease, drought, thundershower, snow, humidity**

098

Dale, F. H. 1942. Influence of rainfall and soil on Hungarian partridges and pheasants in southeastern Michigan. Journal of Wildlife Management 6(1):17-18. Summary: From the differences in habitat requirements of the two species, it seems likely that the increase in pheasants and the decrease in Hungarians on lake-bed soils of southeastern Michigan in the latter part of the decade 1920-39 was influenced largely by the heavier summer precipitation of that period. It also appears likely that the early success of the Hungarian partridge in this area, on soils of a texture generally regarded elsewhere as unfavorable to the species, was made possible by a succession of years with less than average rainfall. **Key words: Hungarian partridge, pheasant, precipitation, productivity, soil**

099

Dalke, P. D. 1943. Effect of winter weather on the feeding habits of pheasants in southern Michigan. Journal of Wildlife Management 7(3):343-344. Notes: Dalke states that snow appeared to not exert significant impact on pheasant feeding in southern Michigan in 1929-33. They fed along sheltered spots in marshes or along steep ditch banks where grass was available. The author states “A sleet storm which covers all vegetation with ice is not a real hazard to feeding unless the coating is an inch or more in thickness, or unless it is followed by heavy snow.” Dalke found pheasants dug out food covered with ice using their bills; in fact, in March 1933 these birds pecked through nearly an inch of ice to eat corn on the cob available in crop fields. When ice reached ¾ inch thick, it does restrict the kinds of food available. The birds then shifted their feeding to berries which remained ice-free on one side. “In one case a flock of nine pheasants discovered and fed exclusively upon frost grade throughout a severe sleet storm.” One negative impact is the “balling up” of pheasant tails by slush and ice, making flight difficult or impossible, and walking to search for food becomes very difficult. “Temperature does…seem to have a pronounced effect on mobility. The birds prefer to stand in protected fence rows of shrubs or herbaceous growth rather than walk about and expose themselves…Rainstorms do not keep pheasants under cover unless the showers are very heavy.” **Key words: pheasant, snow, precipitation, ice, temperature, movement, habitat use, nutrition**

100

_____, D. B. Pyrah, D. C. Stanton, J. E. Crawford, and E. F. Schlatterer. 1963. Ecology, productivity and management of sage-grouse in Idaho. Journal of Wildlife Management 27(4):811-841. Abstract: A study of the seasonal movements, productivity, and management of sage-grouse (*Centrocercus urophasianus*) was undertaken by the Idaho Cooperative Wildlife Research Unit from August, 1952, to May, 1960, on an area in Fremont and Clark counties in Idaho, directly west of Yellowstone National Park. Nineteen individual strutting grounds 1/10=10 acres in size were located along 12 miles of the Red Road. Summer brood range was found to be 13-27 miles north and northeast of the Red Road strutting grounds. Flocks of sage-grouse began migrating west and southwest in October and November and traveled 30-50 miles, depending upon the depth of the snow. Winter concentrations were usually found where snow was less than 6 inches deep. **Key words: sage-grouse, snow, habitat use, movement**

101

_____, _____, _____, _____, and _____. 1960. Seasonal movements and breeding behavior of sage grouse in Idaho. Transactions of the North American Wildlife Conference 25:396-407. Abstract: A study of seasonal movements and strutting ground behavior of sage grouse was undertaken in 1952 in an area comprising parts of three counties in southeastern Idaho directly west of Yellowstone National Park. The study area is mostly high sagebrush plains with scattered irrigated farming, and livestock grazing is the principal use of the sagebrush-grass lands. Sage grouse travel 50 to 100 miles from the summer range, westerly and southwesterly, to winter ranges which have only 3 to 6 inches of snow for short periods. Adult males arrive on their strutting grounds on the Red Road area north of St. Anthony during late March while snow is still on the ground. The breeding population is at a maximum on the Red Road strutting grounds from April 7 to 21 during most years. Marking of males and females show movements up to 3.3 miles. Females are more likely to move to other strutting grounds than males. The annual high-count of males on strutting grounds is a useful population trend tool, but may, in some years, fail to provide the game manager with the means of forecasting the annual crop of sage grouse in some areas. The numbers of grouse returning to the strutting grounds in 1959 indicated a high yield of subadult birds. Adverse weather conditions at the time when 75% of the eggs were hatching resulted in the lowest population of young birds in the 7 years of the study. Brood-count routes at least 20 miles in length give reliable results until about July 30; however, there is only a small decline in the average brood size after July 15. By the third week in July information is available for reliable forecasting of the annual crop of sage grouse which will be available to hunters in the September hunting season. **Key words: sage grouse, snow, mortality, population dynamics**

102

Davies, R. G. and A. T. Bergerud. 1988. Demography and behavior of ruffed grouse in British Columbia. Pages 78-121 *in* A. T. Bergerud and M. W. Gratson, editors. Adaptive strategies and population ecology of northern grouse, University of Minnesota Press, Minneapolis, USA. Notes: Page 110—Role of the extrinsic environment in population change. Survival of chicks was higher in years when the weather was warm in June, the time when the chicks were only 2-3 weeks old. Several studies of grouse have now shown that growth is improved with warm springs. Chick survival was not correlated with mean or mean-maximum temperatures in May. Page 113—In summary, results support a hypothesis that approximately 50% of the population change was caused by spring weather and chick survival, and 50% by changing, adult survival rates than may result from predation. Ruffed grouse use snow as cover to escape goshawks…the greatest decline occurred in the winter of 1972-73, which had the least snow, consistent with the explanation of the need for snow by ruffed grouse to escape goshawks. Page 115—Hypotheses for the different mortalities of gray hens in colder springs are: (1) physiological stress during incubation and early brood rearing and (2) differential mortality relative to predation. Page 116—Weather not only may affect birds directly but may also affect plant growth and hence concealment from predators. **Key words: ruffed grouse, temperature, snow, predation, nutrition, vegetation**

103

Davis, J. R. 1976. Management for Alabama wild turkeys. Federal Aid in Wildlife Restoration Project W-35, Special Report No. 5. Alabama Department of Conservation and Natural Resources, Game and Fish Division, Alabama, Montgomery, USA. Notes: Page 9 – "Severe flooding and other adverse weather factors cause nest losses…Certain conditions such as adverse weather, disease, predation and abandonment of poults by the hen are some of the explanations for this loss of poults (52%)." **Key words: turkey, flood, mortality, severe weather**

104

Davison, V. E. 1949. Bobwhites on the rise. Charles Scribner's' Sons, New York, USA. Notes: Page 5—"Although bobwhites might be very plentiful and afford good shooting for several years (in Michigan), hard winters sometimes wipe them out over large areas or reduce their numbers so drastically that it took as much as a decade for them to become reestablished. It is quite evident that in the bobwhite quail we have a species whose distribution to the north is delineated by climate. Snow may cause mortality in several ways. As it piles up in depth over weed seeds and grains, or when accompanied by low temperatures and high winds, it may bury a covey completely and imprison them in a cell where they die either from starvation or suffocation. It seems justifiable that snow and ice are the most destructive climatic agents to the bobwhite quail on the northern edge of its range. They operate either by cutting off the birds' food supply or by killing them directly when accompanied by strong winds and low temperatures. It is the exceptional year which kills the quail, and it has been estimated that such a winter in the north central region can be expected every 4 to 7 years." **Key words: bobwhite quail, snow, ice, temperature, wind, nutrition, mortality, distribution**

105

Devers, P. K. 2005. Population ecology of and the effects of hunting on ruffed grouse (*Bonasa umbellus*) in the southern and central Appalachians. Dissertation, Virginia Polytechnic Institute and University, Blacksburg, USA. Notes: "Model 16 received the more support than other models and indicated nest success was influenced by the interaction between mast production the previous fall and mean minimum temperature in April and May. Nest success has been found to be positively correlated with mean minimum temperature in other studies. During cold springs females may be required to feed more often and for longer periods to meet their energetic requirements. During these feeding bouts, eggs are exposed to cold temperatures and predators which may decrease hatchability and increase nest predation." **Key words: ruffed grouse, temperature, vegetation, nutrition, behavior, predation, model**

106

_____, D. F. Stauffer, G. W. Norman, D. E. Steffen, D. M. Whitaker, J. D. Sole, T. J. Allen, S. L. Bittner, D. A. Buehler, J. W. Edwards, D. E. Figert, S. T. Friedhoff, W.

W. Giuliano, C. A. Harper, W. K. Igo, R. L. Kirkpatrick, M. H. Seamster, H. A. Spiker Jr., D. A. Swanson, and B. C. Tefft. 2007. Ruffed grouse population ecology in the Appalachian Region. Wildlife Monograph 168:1, The Wildlife Society, Washington, D.C., USA. Abstract: We posit ruffed grouse in the Appalachian region exhibit a clinal population structure characterized by changes in life-history strategies. Changes in life history strategies are in response to gradual changes in forest structure, quality of food resources, snowfall and accumulation patterns, and predator communities. **Key words: ruffed grouse, snow, life history**

107

Doerr, P. D., L. B. Keith, D. H. Rusch, and C. A. Fischer. 1974. Characteristics of winter feeding aggregations of ruffed grouse in Alberta. Journal of Wildlife Management 38(4):601-615. Notes: Page 608 -"When sufficient soft snow is present (about 6-8 inches [15.2-20.3 cm]) grouse may burrow into the snow to roost immediately after feeding, thereby moderating the effects of severe cold and wind." **Key words: ruffed grouse, snow, temperature, wind, behavior**

108

Doherty, K. E. 2004. Fall movement patterns of adult female American woodcock (*Scolopax minor*) in the western Great Lakes region. Thesis, University of Minnesota, Minneapolis, USA. Notes: Decreasing daily low temperature was negatively correlated with movement distances, with >2/3 of movements >500 m occurring when the daily low temperature was above the median low temperature of 2.4°C. This suggests that woodcock make fewer large movements to conserve energy when decreasing temperatures increase metabolic demands. Conservation of energy has been documented during a drought in Maine, where woodcock ceased to make flights to nocturnal roosting areas in conditions of low food availability…The positive relationship of soil porosity was linked to the interaction between rain and porosity, suggesting woodcock responded to this interaction by making large movements into new foraging areas that were previously too dry to adequately provide them with their primary food source, earthworms. The combination of rain and porosity interacting together exhibited the greatest positive relationship to movement than any of the predictive variables…woodcock made large movements into previously unused areas after precipitation events. The strong influence of the interaction of soil porosity and rain also suggests that habitat use is influenced by prevailing conditions that affect habitat quality at a particular time. **Key words: American woodcock, precipitation, habitat use, movement, behavior, soil**

109

Dorney, R. S. 1959. Relation of hunting, weather, and parasitic disease to Wisconsin ruffed grouse populations. Dissertation, University of Wisconsin-Madison, Madison, USA. Notes: Page 64—"In summation, it appears that low populations of ruffed grouse respond to warm spring temperatures by having above-average production and reduced differential adult female mortality (more equal adult sex ratios): conversely, cold May weather results in low production and high differential adult female loss. Laying and incubation temperatures (May) appear to be more important than pre-laying (April) or hatching (June) temperatures. A possible explanation for the difference between high and low population-temperature relationships will be presented later in this report." "…a lightly crusted snow that ruffed grouse cannot penetrate, through sublimation in cold weather, can crystallize and again become "soft", allowing birds to burrow under it. Exposure, cloud cover and wind as well as temperature all effect the qualities of snow." Page 65—"…mild and open conditions in northern Wisconsin typically lead to crusted snow, with little or no bare ground present. General snow conditions in the north, therefore, appeared to be correlated with above-average fall and winter mortalities computed from flush counts and age ratios. One exception to the above observations must be mentioned. In Otter Creek in the winter 1957-58, with little snow present, total annual mortality measured by spring age ratios and territorial cock counts was very low. Apparently some compensatory factor or factors must have been present to counteract any unfavorable influence from warm winter weather." Page 67—"As far as this study could ascertain, summer weather (June 15-"August) exerts little influence on chick survival." Page 76—"Adult females are more heavily parasitized. Furthermore, adult female mortality is closely related to May temperatures for the low populations only. The poor correlation for high populations suggests that additional density-dependent factors must be involved in this adult female loss….This parasite (grapeworm) could be one density-dependent factor involved, since this nematode has a known devitalizing effect on penned galliformes….This increased parasitism could interact with the physiological stresses of egg laying and incubation to accelerate female losses under nesting temperatures that would not ordinarily cause mortality in low populations." Page 87—"In summation, my observations appear to indicate that an interplay of spring weather and parasitic disease are related to population fluctuations." Page 88—"A warm May was characterized by above-average production and an almost even fall adult sex ratio; a cold May, by low production and a loss in adult females; high populations were more sensitive to May temperatures than low populations." **Key words: ruffed grouse, temperature, precipitation, snow, disease, parasites, population dynamics, mortality, reproduction**

110

_____ and C. Kabat. 1960. Relation of weather, parasitic disease and hunting to Wisconsin ruffed grouse populations. Wisconsin Conservation Department Technical Bulletin No. 20. Wisconsin Conservation Department, Madison, USA. Notes: Page 31--"Factors Affecting Population Levels—Weather". …it appears that ruffed grouse respond to warm spring temperatures by having higher fall age ratios and more equal adult sex ratios; conversely, cold May weather results in low production and high differential adult female loss. Laying and incubation temperatures (May) appear to be more important than pre-laying (April) or hatching (June) temperatures. Low populations respond to favorable May temperatures better than do high populations since summer chick loss is about 12 percent in "low" years compared to 23 percent in "high" years. Winter: "General snow conditions in the north appeared to be correlated with above-average fall and winter mortalities computed from flush counts and age ratios. [One exception is described.] The possibility that density-related factors may be involved in over-winter loss cannot be excluded. It appears that above average winter temperatures may be unfavorable to grouse in northern Wisconsin. The exact mechanism of this relationship must await more detailed ecological research. Summer:

“As far as we could ascertain, summer weather (June 15-August) exerts little influence on chick survival. Losses due to cold and rainy weather immediately following hatching might logically be expected.” **Key words: ruffed grouse, temperature, snow, precipitation, productivity, mortality, sex ratio, age ratio,**

111

_____ and A. C. Todd. 1960. Spring incidence of ruffed grouse blood parasites. Journal of Parasitology 46(6):687-694. Summary: Occurrence of blood parasites in Wisconsin ruffed grouse was examined. May temperatures in 1954 during the peak of the breeding season were extremely cold, in contrast to a warm May in 1955. The percentage of red blood cells containing *Haemoproteus* gametocytes was 2.4 times higher in late May 1954 as compared to levels at the same time in 1955. Perhaps the abnormally cold temperatures directly and/or indirectly may have acted as an additional stress causing a more severe “relapse” in 1954. The specific mortality and production during the 2 years 1954 and 1955 were as follows. In 1954, the spring breeding population was at a low point in the 10-year period, 1949-1958. Weather was extremely cold in May with a 6-inch snowfall interrupting cock drumming early in the month. Production of young was poor (average summer brood size 6.8) and adult sex ratios in fall considerably distorted, 58 males:42 females, suggesting a heavy summer hen loss. In 1955 the spring was strikingly different than that of 1954, with above average temperatures. Production of young was high with summer brood sizes averaging 8.5. Adult female loss in summer was low as indicated by a fall sex ratio of 52 males:48 females. Yet, adult male survival over the 12-month period to spring 1956 was considerably poorer with a calculated mortality of 48 percent, double that of the preceding year. The increased adult female mortality in 1954 could conceivably be due to the combined effect of unfavorable weather in May for nesting, and infection with blood protozoa. Factors unimportant in years of low population density may become limiting at high densities. **Key words: ruffed grouse, temperature, snow, disease, parasites, mortality, population density, sex ratio**

112

Doucette, D. R. and S. Reebs. 1994. Influence of temperature and other factors on the daily roosting times of mourning doves. Canadian Journal of Zoology 72:1287-1290. Abstract: From November 1992 to February 1993, observations were made during 30 departures and 30 arrivals at a mourning dove (*Zenaida macroura*) roost in Moncton, New Brunswick, Canada. Our objective was to identify the effect of cold on the timing of roosting flights in this species, a recent addition to the local wintering fauna. The effect of other environmental factors was taken into account by including them, along with temperature, in a multiple regression analysis. Doves left the roost later relative to sunrise (i) on longer days, (ii) on cloudy mornings, (iii) when fewer birds were using the roosts, (iv) on colder mornings, and (v) when winds were high. They returned to the roost later relative to sunset (i) on colder evenings and (ii) in clear weather. Late arrivals on colder days represent an unusual finding. Anatomical and behavioral considerations suggest that mourning doves cannot reduce heat loss as substantially as other species; therefore, late arrivals on cold evenings may reflect the more important role of energy gain through extended foraging required to survive the long winter night. **Key words: mourning dove, temperature, clouds, wind, behavior, thermoregulation**

113

Drovetskii, S. V. 1997. Spring social organization, habitat use, diet, and body mass dynamics of hazel grouse *Bonasa bonasia* in northeastern Asia. Wildlife Biology 3(3/4):251-259. Abstract: Hazel grouse *Bonasa bonasia* encounter more severe climates in northeastern Asia than anywhere else in their range, yet the time between snow melt and laying is shorter here than elsewhere. Birds were able to lay early because they moved to follow the phenology of snow melt, changing their diet as they did so. Before snow melt, habitat distribution and diet were the same as in winter. As soon as the first snow-free patches occurred on terraces, grouse moved there and fed on thawed berries, which were available in great quantities on these terraces only. This habitat shift coincided with the shift in diet; winter foods such as twigs, buds and catkins decreased from 75 to 3%, whereas the proportion of berries increased from 6 to 70%. Females began to lay a few days after all snow had melted, returning to riparian habitats where the variety and abundance of plants were greatest. Foliage increased from 27 to 72% of the diet, and the proportion of berries declined from 70 to 19%. In winter, Asian hazel grouse primarily occur in flocks. In spring males guard their mates rather than their territories; they follow females up to a few kilometers from their riparian breeding habitats, as these move on to terraces to gain weight for egg laying. Such food related movements between habitats have not been reported for this species in Europe. **Key words: hazel grouse, snow, diet, habitat use, movement**

114

_____. 1992. Materials on the ecology of the hazel grouse *Tetrastes bonasia* in south Magadan Oblast in winter. Zoologicheskii Zhurnal 71(4):45-59. Abstract: Influence of weather parameters on biotopical distribution, feeding content, food quality and hazel grouse population structure were investigated by the author from October 1988 till March 1989 in the Yana River valley [Russia] (59°59'N, 150°18'E). Generally, hazel grouse occurred in mixed forests in river valleys (43% of encounters; *n* = 339). Usage of other biotopes was less common and depended on weather conditions. Alder (*Alnaster fruticosus*) catkins were the most important food item (68% of dry mass of crop content; *n* = 55). In very cold periods birds fed on chosenia (*Chosenia arbutifolia*) twigs (67%). Flock size depending on the habitat size was 5, 8-5, 6 birds (*n* = 58) in average. 1988/89 wintering population consisted of adult birds mainly (88,6%, *n* = 79). **Key words: hazel grouse, temperature, habitat use, behavior**

115

_____ and S. Rohwer. 2000. Habitat use, chick survival and density of Caucasian black grouse *Tetrao mlokosiewiczi*. Wildlife Biology 6(4):233-240. Abstract: We surveyed Caucasian black grouse *Tetrao mlokosiewiczi* residing on the Lagonakskiy Ridge, northwestern Caucasus, Russia, in July-July 1998, and on the Magisho Ridge in July 1999. Weather affected habitat use by brood hens: on sunny days 18 broods were encountered in meadows, six in ravines, and three in pine forests; on wet days broods moved to the ridge tops (*n* = 9) and only one was observed in pine forest. Subadult males used the same habitats as females with broods. Seven of eight adult males were encountered in ravines; only one was encountered in a meadow. Habitat use by adult males was not affected by weather and differed from habitat use by females and subadult males. Well-camouflaged females, chicks and subadult males used relatively open, food-rich habitats, whereas black adult males preferred ravines, where nutrition was poor, but where tall grass protected them from aerial predators. One nest with five hatched eggs was found. In broods an average of one chick per 10 days was lost. A goshawk *Accipiter gentilis* killed one adult female. Our density estimate of 2.3 adults/km^2 for the Lagonakskiy Ridge was similar to densities reported elsewhere (2.3±1.2; n = 7). **Key words: black grouse, temperature, precipitation, habitat use, behavior**

116

Duck, L. G. 1943. Seasonal movements of bobwhite quail in northwestern Oklahoma. Journal of Wildlife Management 7(4):365-368. Notes: Page 367 – "There appears to be a greater shift of birds from uplands to bottomlands and dunes during winters of severe weather. The winter of 1939-40 was one of the most severe experienced in northwestern Oklahoma for some years and considerable mortality of bobwhite quail occurred…The general trend of the shift…[is] from poor cover to good winter range on the approach of cold weather…observations here and elsewhere indicate that the richness of the habitat in relation with severity of winter weather determines the proportion of birds forced to move….seasonal movements are intensified during winters of severe weather, indicating that the movement is forced." **Key words: bobwhite quail, temperature, behavior, movement, habitat quality, mortality, severe weather**

117

Duke, G. E. 1966. Reliability of censuses of singing male woodcocks. Journal of Wildlife Management 30(4):697-707. Abstract: Factors affecting the courtship performance of woodcocks (*Philohela minor*) and the accuracy of annual singing ground survey for the U. S. Fish and Wildlife Service were studied in 1963 and 1964. Woodcock courtship calls were counted at 2-min. intervals, alternating each day between several areas of differing woodcock density. At the same time, cooperators made the standard singing ground survey through the study area each evening. Climatic conditions were measured for each woodcock performance. The most stable courtship activity occurred from about April 15 to May 15 and appeared to be affected only by extremes in climatic conditions. The performance seemed to be initiated by light intensities averaging 2.1 footcandles, so that starting times were earlier in relation to official sunset when the cloud cover was heavier. Male activity increased briefly with the coincident appearance of many broods. As the density of performing males increased, the level of preening activity per bird significantly decreased; courtship flight activity was less affected. As density increased, the probability of hearing individual males was reduced. The predawn performance was deemed unsuitable for surveys. Poor hearing ability of survey cooperators lowered the survey results significantly. The inclusion of flight songs was not detrimental to the daily tally, nor was the survey significantly affected by stage of the moon. Recommendations for singing ground survey changes are presented. **Key words: woodcock, census, clouds, solar radiation**

118

Dunn, P. O. and C. E. Braun. 1986. Late summer-spring movements of juvenile sage-grouse. Wilson Bulletin 98(1):83-92. Abstract: Late summer to early spring movements of radio-marked juvenile sage-grouse (*Centrocercus urophasianus*) were studied on Cold Spring Mountain, northwestern Colorado, from July to February 1981-82 and August to May 1982-83. Movements were analyzed from 118 locations (*N*=8 grouse) during July-November 1981 and 213 locations (*N*=10 grouse) during August-November 1982. Grouse steadily moved away from capture sites until November each year when they moved to winter-use sites. Movements to wintering areas in late November were related to snowfall and subsequent availability of sagebrush. Maximum one-way distance to wintering areas was 30.3 km (*N*=4 radio-marked grouse). Sage-grouse generally followed topographic features and avoided areas without sagebrush cover, although they were capable of long-distance (23 km) movements over areas without shrub cover. During spring recruitment there appeared to be roving groups of males, probably yearlings, that spent much of the breeding season displaying near females away from traditional leks. **Key words: sage-grouse, snow, movement, vegetation**

119

Duriez, O., H. Fritz, F. Binet, Y. Tremblay, and Y. Ferrand. 2004. Individual activity rates in wintering Eurasian woodcocks: starvation versus predation risk trade-off? Association for the Study of Animal Behavior, published online 30 November, Elsevier Ltd. Abstract: Wintering birds face a trade-off between starvation and predation risk. In Eurasian woodcocks, *Scolopax rusticola*, habitat use may reflect this trade-off because meadows, where most birds spend the night, are characterized by a higher risk of predation and a higher biomass of food (earthworms) than the woods, used by day. We monitored activity of 34 woodcocks fitted with tiltswitch radiotags. Young birds were more active than adults, probably because they were less efficient at foraging. In general, nocturnal activity was inversely correlated with air temperature and with daylight foraging activity, suggesting some compensatory mechanism, modulated by thermoregulatory constraints. Individual activity patterns differ, and we classified woodcocks according to three main wintering strategies: ‘always’, ‘sometimes’ or ‘never’ visiting fields at night. The decision to fly to fields at night seemed to be taken every evening, according to the amount of daylight foraging activity in woods and the air temperature. After feeding in a rich patch of food on a mild day, woodcocks did not have to risk going to meadows. Conversely, in patches of fewer food resources or at lower temperatures or both, woodcocks could not meet all their energy requirements without going to fields at night (where there was always sufficient food) and eventually, changing their diurnal sites. Therefore, the trade-off between feeding and predation risk depends on how efficiently birds find a rich patch of food in the forest and exploit it optimally during the day. **Key words: woodcock, temperature, thermoregulation, habitat use, nutrition, predation**

120

Dusek, G. L., C. D. Eustace, and J. G. Peterson. 2002. The ecology and status of sage-grouse in Montana. Intermountain Journal of Science 8(2):67-81. Abstract: We describe the ecology and status of the greater sage-grouse (*Centrocercus urophasianus*) in Montana as part of an effort to develop a species conservation plan. Sage-grouse are primarily associated with big sagebrush (*Artemisia tridentata*)-grassland although the original range has been greatly reduced or fragmented by a variety of human uses and activities. Efforts by the State's wildlife agency to delineate distribution of sage-grouse in Montana during the 1960s and 1970s suggested that sage-grouse occupied about 4.4 million ha in eastern and southwest Montana although more recent efforts to assess sage-grouse habitat suggest occupied habitat could be as much as 10.9 million ha. Findings from studies during that period suggested that yearlong distribution and movements reflect regional or local conditions. That is, sage-grouse tend to be nonmigratory in eastern Montana, where close interspersion of seasonal habitats rarely requires large movements, and migratory in the intermountain valleys of southwest Montana. Habitat requirements of sage-grouse vary seasonally, in terms of structure and composition, to accommodate successful breeding and brood rearing and over-winter survival. Yearly precipitation patterns, in addition to habitat quality, can affect nesting success and chick survival. Data from statewide wing collections suggest that productivity of sage-grouse declined from an average of 2.63 juveniles/hen during 1962-1979 to an average of 2.08 juveniles/hen during 1980-1992; drought conditions were more frequent during the latter period. An estimate of mortality of sage-grouse during the first year of life approaches 85 percent of which about two-thirds occurs prior to the opening of the upland bird hunting season in September. Sage-grouse populations in southwestern Montana have declined from the 1960s through the 1980s following a period of large-scale sagebrush manipulation and conversion of native range to cropland. Numbers of birds remain relatively abundant throughout areas of central and eastern Montana that continue to support large, unfragmented stands of big sagebrush. Several state-initiated programs offer incentives to private landowners to maintain or enhance habitat quality for sage-grouse and other wildlife species. **Key words: sage-grouse, drought, precipitation, vegetation, habitat quality, population dynamics, habitat manipulation**

121

Edminster, F. C. 1947. The ruffed grouse. Macmillan, New York, USA. Abstract: Largely the results of extensive field studies on about 3,000 acres of abandoned farmland and 2d-growth beech-birch-maple-hemlock forest near Ithaca, New York, from 1930 to 1941. Following a popularized general account of the ruffed grouse's life history are presentations of basic ecological and management data. Shelter is considered the probable principal factor limiting abundance in the northeastern states. For optimum benefits, overgrown land or slashings and uneven aged hardwoods, mixed woods and coniferous woods must be thoroughly interspersed with all points within 300 ft. of an edge. Extensive areas of continuous woodlands may be improved by properly spaced clear-cut areas. Protection from grazing, half-cutting small trees, light release cuttings of conifers, woods border establishments, creation and maintenance of 30-ft wide woods roads, slashings, preservation of selected "weed tree" species and provision of drumming and dusting places are among the forest management measures suggested for use where consistent with the primary economic values of the area. The range carrying capacity, rather than predators, disease or other apparently limiting factors, generally seems to determine grouse populations. Carrying capacities vary from 4 to 20 acres per bird. Ten to 100-acre refuges are occasionally warrantable. While abnormal weather conditions may prove disastrous to young grouse, average early-season losses are still not fully explained. All notable grouse declines in New York since 1890 occurred after 2 years of severe February-March snow and cold conditions followed by a very cold June. The details however were not uniform and the declines do not seem to follow a truly cyclic pattern. No authentic case is known of grouse being killed in snow roosts by imprisoning ice, despite hearsay to the contrary. Red and gray foxes, the great horned owl, 2 weasels and several accipitrine hawks take many grouse, but predation is not a limiting factor. Experts in predator control show definitely that such control is costly and of negative value; the "vermin" shooting hunter is a detriment to grouse conservation. A number of diseases and parasites affecting grouse are discussed, but disease is not considered to be a general primary morality agency. Grouse foods, especially the plants, are discussed in detail but deaths due to starvation were found negligible. Both chicks and adults are independent of open water. **Key words: ruffed grouse, snow, temperature, ice, mortality**

122

Edwards, W. R. 1972. Quail, land use, and weather in Illinois, 1956-70. Proceedings of the National Quail Symposium 1:174-181. Abstract: Bobwhite quail (*Colinus virginianus*) populations were at a 15-year high in 1968 and 1969 in Illinois. Analysis indicated that quail abundance over the years from 1956 through 1970 was significantly correlated with changes in land use and weather. Adverse effects associated with increased acreages of row crops and reduced acreages of oats appeared to be offset by aspects of land use, favorable to quail, that were associated with reduced acreages of harvested hay. Quail also appeared to be adversely affected by heavy snow, above-normal rainfall in late winter and spring, heavy summer rains, and drought in summer and fall. **Key words: bobwhite quail, precipitation, snow, drought, mortality**

123

_____, P. J. Mikolaj, and E. A. Leite. 1964. Implications from winter: spring weights of pheasants. Journal of Wildlife Management 28(2):270-279. Abstract: Ecological implications regarding reproductive condition were obtained from weights of pheasants (*Phasianus colochicus*) killed accidentally in Ohio from January through June, 1961. Weights of female pheasants averaged 35.0 ounces. Hens had a low mean weight of about 31 ounces in early January and a high of about 37 ounces in early May. Weights of cocks had a mean of 44.8 ounces but did not exhibit as great a proportionate weight change, although similar seasonal trends were evident. Mean weights of both sexes declined during the nesting season. On the basis of data from this and other studies, it was postulated (1) that in some years the reproductive success of pheasants is partially controlled by the severity of winter weather and its subsequent effect on the physical condition of hens in early spring, and (2) that there is an increasing probability of excessive hen mortality and lowered reproductive success as weights in early May fall below about 37 ounces. **Key words: ring-necked pheasant, severe weather, mortality, reproduction, nutrition**

124

Eiberle, K. 1987. Effects of air temperature and precipitation on the annual bag of grouse (*Tetraoninae*). Cahiers d'Ethologie Appliquee 7(2):109-128. Abstract: The present paper deals with the effects of the weather on the annual bag of capercaillie, black grouse, hazel hen and ptarmigan in the canton of Grison (Switzerland). The investigation covers the period 1919-1979, comprising 41, 44 or 59 annual bags, depending on the game species concerned. The results showed that under the given general climate the grouse bag was influenced by climatic factors to a remarkably high degree. The effects of the weather during early rearing and the long-term living conditions in winter, in particular, proved to be important key factors in shaping the pattern of abundance dynamics in this central alpine region. The bird species involved showed different sensitivity with respect to the individual climatic factors. **Key words: capercaillie, black grouse, hazel grouse, ptarmigan, precipitation, temperature, abundance**

125

Eierl, K. 1980. Effect of the weather on the kill of some game species in the canton of Graubuenden Switzerland. Zeitschrift für Jagdwissenschft 26(3):142-153. Abstract: How the kill of some game species [fox, marten, badger, rock partridge, ptarmigan, heathcock, hazel grouse, hare and marmot] in the canton of Graubuenden was affected by annual mean temperature and annual total precipitation was studied using multiple correlations. A statistically significant relationship between meteorological factors and kill was found only in the case of those game species on which meteorological elements had an immediate and great effect on population development. How effective and important the meteorological factors are depends on the general character of the climate and the location of the habitats typical of a particular kind of species. The influence of the weather as compared to that of predators was dominant in the canton of Graubuenden. The influence of predators on prey populations should not be overestimated because a considerable amount of ecological compensation must be expected. The fact that low precipitation was advantageous to many game species is typical for the characteristic climate existing in the canton of Graubuenden. The lack of habitats at optimum heat level which is due to high altitude is not compensated for by the continental character of the climate. **Key words: hazel grouse, heathcock, ptarmigan, rock partridge, temperature, precipitation**

126

Einarsen, A. S. 1945. Some factors affecting ring-necked pheasant population density. Murrelet 26(1):2-9. Summary: The excessively wet nesting season in 1942 adversely affected hatching and chick survival. The weather at hatching time in 1942 was wetter than at any previous hatching season, and may have been a vital factor in reducing hatches for that year. Another effect of weather upon chicks is the scarcity of insects due to the cool and damp climate. Few dead chicks were found during any period, however. **Key words: ring-necked pheasant, precipitation, temperature, chick survival, hatching**

127

_____. 1946. The importance of weather data in wildlife management. Murrelet 27(2):28-33. Notes: Einarsen discusses the importance of temperature and precipitation in relation to pheasant production and survival as well as to other species. He states "…in much of our game habitat the customary records are not as satisfactory as records where both weather and habitat conditions are observed…The effects of weather on wildlife are too great to be overlooked or relegated to a place of minor importance. The establishment of weather-data collecting stations in correlation with wildlife and range management programs is essentially a sound practice. The facilities of existing weather stations can be more useful if their programs are altered to include supplemental observation points and the addition of certain pertinent data in problem areas." **Key words: ring-necked pheasant, temperature, precipitation, reproduction, weather data, vegetation**

128

Eng, R. L. 1954. Upland game bird survey and investigations; Sage-grouse brood studies, 1953. Job Completion Report, Project No. W-38-R-5, Volume V, No. 1, Montana Fish and Game Department, Helena. Summary: (1) Brood studies were continued in 1953 on established routes on the same trend areas as used in 1952. Additional spot counts were made by project personnel and brood count data was collected by deputy wardens in their districts. (2) Temperature and precipitation data for the trend areas show adverse conditions consisting of excessive rains and cool temperatures which prevailed throughout the initial incubation and hatching peak in 1953. This condition is in contrast to the mild dry weather in 1952. (3) Low production was observed on the trend areas in 1953 as determined by a decrease of 16 percent in the breeding population, an increase of 65.7 percent in the percentage of adults in the populations during the brood season, and a 10.6 percent decrease in the average brood size. (4) Yearly differences in production appear to be reflected to a greater extent in the percent of successful females and/or the percent of adults in the population throughout the brood season than the average brood sizes. (5) Comparison of production data from the trend areas to that from a similar habitat experiencing no adverse weather during 1953 further illustrates the importance of favorable weather to yearly production of sage-grouse. **Key words: sage-grouse, temperature, precipitation, productivity, population dynamics**

129

_____ and P. Schladweiler. 1972. Sage grouse winter movements and habitat use in central Montana. Journal of Wildlife Management 36(1):141-146. Abstract: Movements and habitat use by sage grouse (*Centrocercus urophasianus*) were studied in central Montana during the winters of 1965-66 and 1966-67. Two and three female sage grouse were radio-equipped and tracked during the two respective winters. Winter ranges of the five instrumented females ranged from approximately 2,615 to 7,760 acres. A 4-square-mile primary study area, containing over half of the relocations of the five instrumented birds, was separated into two big sagebrush (*Artemisia tridentata*) canopy cover classes on 16-inch:1-mile aerial photographs. Fifty-five percent of the primary study area was in the more dense (over 20 percent canopy coverage) and 45 percent in the less dense (under 20 percent canopy coverage) category. Observed use of the two canopy coverage classes was significantly (*P* < 0.01) different, a decided preference for the more dense stands being indicated. The characteristics of central Montana sage grouse winter areas (large expanses of dense sagebrush with little if any slope) make them prime targets of sagebrush control programs. Removal of sagebrush from these areas would greatly reduce their capacity to support wintering sage grouse. **Key words: sage grouse, habitat use, snow, vegetation**

130

Erikstad, K. E. 1986. Relationship between weather, body condition, and incubation rhythm in willow grouse *Lagopus lagopus lagopus*. Fauna Norvegica Seris C Cinclus 9(1):7-12. Abstract: The incubation of 18 willow grouse *Lagopus lagopus lagopus* hens was studied during two breeding seasons. Incubation constancy of hens averaged 95.5±1.9% (range 90.8-97.5), number of recesses per day 3.4±1.1 (range 2.5-8) and the mean length of recesses 19.2±10.3 min. (range 10.9-30.6). Yearling hens weighed less than adults and tended to leave the nest more often and for longer periods. Hens in good physical condition took few recesses and lost about 30% of their body weight. Hens in poor physical condition took more recesses and lost little or no weight. Hens in good condition preferred to leave the nest during the night and early morning when ambient temperatures were less favorable. Two captive willow grouse hens kept in large outdoor enclosures and given additional food increased their incubation constancy and lost less weight than normal hens. Incubation behavior in willow grouse is suggested partly to have evolved to minimize the exposure of eggs to predators, but this behavior conflicts with the energy demands of the hen. **Key words: willow grouse, temperature, behavior, predation**

131

_____. 1985. Growth and survival of willow grouse chicks in relation to home range size, brood movements and habitat selection. Ornis Scandinavica 16(3):181-190. Summary: Spacing, movements and mortality of willow grouse *Lagopus l. lagopus* broods were studied using radio-telemetry during three breeding seasons on a small island in northern Norway. Chicks survived worse during two cold summers with few insects than in a warm summer with many. In cold weather, many died at 3-5 days. Broods selected forests, bogs and fens, and shore vegetation which supported the largest number of insects. Mean differences between years in spacing and brood movements were small. Within years, growth was slower and survival lower among those broods with the greatest mobility and largest home ranges. Broods occupying small home ranges restricted their movements to areas especially rich in insects, whereas longer movements were made in poorer habitats. There appeared to be a dominance hierarchy among broods which effectively prevented them from occupying the same areas. **Key words: willow grouse, temperature, movement, mortality, insects, nutrition, behavior**

132

_____ and R. Andersen. 1983. The effects of weather on survival, growth rate and feeding time in different sized willow grouse broods. Ornis Scandinavica 14(4):249-252. Abstract: During cold and wet summers 0-8 day old chicks from small (2-6 chicks) willow grouse *Lagopus lagopus lagopus* broods grew faster and survived better than chicks from large broods (8-14 chicks). Chicks from large broods spent longer time being brooded by the hen and had consequently shorter time available for feeding than chicks from small broods. These results agree with the finding that cold and wet weather prevents sufficient food intake in willow grouse chicks. **Key words: willow grouse, temperature, precipitation, nutrition, population dynamics, behavior**

133

_____ and _____. 1982. The influence of weather on food intake, insect prey selection and feeding behavior in willow grouse in northern Norway. Ornis Scandinavica 13(3):176-182. Summary: During a warm and dry summer crops of 0-27 day-old chicks contained nearly twice as much food by dry weight as during an extremely wet and cold summer. Weather did not influence the ratio of insects and plants in the diet but greatly influenced the insect prey selection. During the warm summer chicks selectively fed on larvae (80%), while in the cold summer they fed mainly on smaller insects like Cicadinae, Aphidinae, and adult Diptera. A drop in mean ambient temperature from 19.5 to 9°C and rain reduced the available feeding time for 2-5 day-old chicks by about 60%. This reduced feeding time was caused by shorter feeding periods (mean of 20.8 and 7.8 min) and longer resting periods during evening and night. Evidence is also presented that in bad weather young chicks avoid habitats with dense vegetation (which supports the best food supply) to avoid becoming wet. Extremely cold and wet weather is suggested to be critical in preventing sufficient food intake in willow grouse chicks. **Key words: willow grouse, temperature, precipitation, nutrition, behavior, habitat use**

134

Errington, P. L. and F. N. Hamerstrom Jr. 1938. Observations on the effect of a spring drought on reproduction in the Hungarian partridge. Condor 40(3):71-73. Summary: “On the whole, we doubt that the adverse conditions (drought) of 1934 resulted in any drastic change in the population of the Hungarian partridge in northwestern Iowa, though they were not without effect. The ecological picture seems to be essentially one of retardation and decreased productivity of the nesting season rather than one of ultimate failure.…one of the three breeding seasons (1934) during which notes were taken was characterized by extreme spring drought that continued until early June. The spring drought of 1934 naturally was attended by scanty growth of ground cover. Dry grass and weed clumps of the previous year afforded initial concealment for many nests, but ‘short pastures’ forced the farmers to graze their stock along roads, fence rows, and borders of marshes, with resulting detriment to the nesting habitats of the birds frequenting such places. Midsummer rainfall was followed by some recovery of vegetation and improvement of environmental conditions for the partridges. So far as we can see, the nesting losses of 1934 differed from those of 1933 and 1935 principally in the increased scale upon which they occurred, and this in turn may be attributed in large measure to the exceptionally unsatisfactory status of nesting habitats during the period of drought. On the whole, we doubt that the adverse conditions of 1934 resulted in any drastic change in the population of the Hungarian partridge in northwestern Iowa, though they were not without effect. The ecological picture seems to be essentially one of retardation and decreased productivity of the nesting season rather than one of ultimate failure. **Key words: Hungarian partridge, drought, vegetation, precipitation, productivity**

135

Erwin, M. J. 1975. Comparison of reproductive physiology, molt, and behavior of the California quail in two years of differing rainfall. M.S. Thesis, University of California, Berkeley, USA. Unable to obtain for abstract.

136

Etter, S. L., R. E. Warner, G. B. Joselyn, and J. E. Warnock. 1988. Pages 111-127 *in* D. L. Hallett, W. R. Edwards, and G. V. Burger, editors. Pheasants: symptoms of wildlife problems on agricultural lands. North-central Section of The Wildlife Society, Bloomington, USA. Abstract: Survival of wild ring-necked pheasants (*Phasianus colchicus*) in east-central Illinois was studied during 1962-1972—a period of abrupt change in agriculture and declining pheasant abundance. During the phase-out of the Federal Feed Grain Program of the 1960's, increasing farm disturbances and reduced interspersion of prime cover types rendered the fall-winter landscape less hospitable for pheasants. In general, pheasants were found to have variable year-to-year patterns of survival and reproduction, reflecting complex interactions of weather, characteristics of cover, farming practices, and pheasant movements. Dispersal was similar between age classes. However, fall-to-early winter survival of juvenile hens was typically only one-half to two-thirds that of adult hens. Differential survival between juvenile and adult hens was confined to fall and early winter. For a juvenile hen, the later the date of hatch, the lower its probability of survival from autumn into winter. Likelihood of survival was not a simple function of physiological condition as expressed by body weight, but apparently related to how pheasants responded to changing weather and farming disturbances in fall, with older, relatively experienced birds more likely to cope with these changes. Had juvenile hens survived as well as adults, numbers of pheasants in winter would have been nearly one-third higher. **Key words: ring-necked pheasant, mortality, winter, behavior, nutrition, habitat modification**

137

Eustace, C. D. 2002. Sage-grouse hatching success and chronology for south-central Montana. Intermountain Journal of Sciences 8(2):82-93. Abstract: A recent short-term fluctuation in sage-grouse (*Centrocercus urophasianus*) abundance for south-central Montana was attributed to dramatically reduced productivity. This period of low productivity was associated with a peak hatching date 2 weeks earlier than normal. Molt patterns for adult hens indicated the early hatch was due to a shift in breeding and nesting and not reduced survival during June. These molt patterns also indicated a significant attempt at renesting by hens $\geq$ 2 years of age during periods of low productivity. To test the influence of climatic conditions on hatching chronology, I selected years that were at least one standard deviation above or below the long-term average for hatches occurring before 1 June. I concluded that early hatches occurred during warm dry springs, which were also associated with drought conditions. Warm dry springs also may result in earlier dates for spring green-up and grasshopper hatches. I interpret early hatches as an adaptation by sage-grouse hens to take the best possible advantage of cover and forage conditions during the first critical weeks of life for their chicks. **Key words: sage-grouse, temperature, precipitation, drought, productivity, population dynamics**

138

Evans, C. A. and S. D. Schemnitz. 2000. Temperature and humidity relationships of scaled quail nests in southern New Mexico. Proceedings of the National Quail Symposium 4:116-118. Abstract: We observed unmarked and radio-marked (20 females/1994; 9 females and 11 males/1995) scaled quail (*Callipepla squamata*) during the nesting season in the Chihuahuan Desert of southern New Mexico. In 1994, pairing was completed by early April. Clutch size averaged 13.8 ± 1.7 (n=7). Nests were located an average 216 ± 13.8 m from permanent water. All 97 chicks disappeared from radio-marked pairs by 16 July. In 1995, all radio-marked females and 6 of the radio-marked males were paired by mid-April. Clutch size averaged 10.3 ± 1.3 in nests (n=8) that averaged 545 ± 1.7 m from permanent water. Almost half of the hatched chicks (49.6%) fledged in 1995. Nest temperature never exceeded 34°C, while ambient temperatures reached ≥43°C. Nest humidity averaged 23%, while ambient humidity averaged 12%. Notes: Page 117/118—We hypothesize that the long period of high temperature exacerbated by drought conditions was primarily responsible for reproductive failure on JER in 1994. **Key words: scaled quail, drought, temperature, productivity, mortality**

139

Evans, K. E. 1968. Characteristics and habitat requirements of the greater prairie chicken and sharp-tailed grouse—a review of the literature. Conservation Research Report No. 12. Rocky Mountain Forest and Range Experiment Station, Fort Collins, USA. Notes: Greater Prairie Chicken Page 8—"Decimating Factors: Weather – Weather conditions during nesting are important in determining the number of young birds available for the fall hunting season. A series of torrential cloudbursts followed by a long, cold rainy period during the first two weeks of June will cause heavy brood mortality. Although weather significantly influences the distribution and activities of prairie chickens, to adequately appraise its part in controlling population numbers is difficult." Sharp-tailed Grouse Pages 16-17—" Decimating Factors: Weather – Weather probably has very little effect on survival of adult sharptails. Sharptails exist in extremely cold conditions near the Arctic Circle, and in areas of the Great Basin where hot dry summers are common. Undoubtedly, some adult birds are lost during hailstorms, blizzards, and ice storms. This loss probably does not greatly reduce the population. Weather conditions during early June are important in determining brood success. Torrential cloudbursts, and long, cold rainy spells, during the early brood season probably reduce the nesting success of sharptails as with all ground nesters. **Key**

words: prairie chicken, sharp-tailed grouse, precipitation, temperature, mortality, cloud burst

140

_____ and A. N. Moen. 1975. Thermal exchange between sharp-tailed grouse (*Pedioecetes phasianellus*) and their winter environment. Condor 77(2):160-168. Summary: Winter energetics of sharp-tailed grouse includes both heat production and heat loss factors. This report deals with factors influencing nonevaporative heat loss by grouse during fall and winter on the northern Great Plains. Maintenance metabolic rate, weight change features, effective surface area, thermal transfer properties, thermoregulatory behavior, wind velocity, and ambient temperature were analyzed to facilitate the prediction of energy requirements for homeothermy. The equation representing nonevaporative heat exchange between a sharp-tailed grouse and its environment is $Q = (KhAh + Kb\ Ab)\ \Delta Tt$. Q is heat exchange (Kcal); K*h* and K*b* are thermal conductance values for the head and body, respectively; A*h* and A*b* are the effective surface area of the head and body, respectively; ΔT is the temperature (C) gradient between deep body temperature and ambient temperature; and *t* is time. Thermal conductance values change with wind velocity up to approximately 8 mph and can be predicted with the following two equations: $Kh = 6.50 – [(2.84=\sqrt{Uw})^2/10]$ and $Kb = 2.12 – [(2.84 - \sqrt{Uw})2/10]$, where U*w* is the wind velocity in mph. Behavioral thermoregulation involves the selection of habitats and postures to regulate heat balance. The series of habitats and postures available contains gradients of ambient temperatures and wind velocities that greatly influence nonevaporative heat dissipation. Grouse can vary the effective surface area of the neck and heat from 5 to 20% of the maximum surface area. Maximum surface area (m^2) was determined to be $(7.46W_{(g)}{}^{0.65}) \times 10^{-4}$. A 1000-g grouse at an ambient temperature of -20°C and an 8 mph wind velocity in exposed areas could utilize the available habitat and posture gradients to regulate nonevaporative heat loss between 142 Kcal/day (1.9XBMR) and 319 Kcal/day (4.3XBMR). Grouse can reduce heat loss by adding insulation such as nocturnal roosting in the snow or dense vegetative cover. Such responses also reduce wind velocities over a bird's surface. Overhead cover reduces net radiative heat loss by protecting a bird's surface from exposure to the night sky, which, when clear, is colder. Wind velocity gradients also exist through the vertical and horizontal planes of grouse habitats." **Key words: sharp-tailed grouse, wind, temperature, thermoregulation, behavior, vegetation, bioenergetics**

141

Evard, J. O. 1996. Winter weather and pheasant populations and harvests in northwestern Wisconsin. Research Report 171, Wisconsin Department of Natural Resources, Grantsburg, USA. Abstract: A study was conducted during 1982-91 in northwest Wisconsin to examine the effects of winter weather on spring ring-necked pheasant (*Phasianus colchicus*) populations and subsequent fall harvests and to determine pheasant harvest characteristics. The 502 $mile^2$ study area was located in St. Croix and southern Polk counties, on the northern limit of pheasant range. Winter weather records were obtained from an Amery weather station, and a winter food availability index was developed by examining a random sample of 10% of the study area. Crowing pheasant cocks were censused throughout the study area, including Waterfowl Production Areas (WPAs) and Conservation Reserve Program (CRP) lands. Hunter bag checks were conducted during the first 2 days of the hunting season, while other hunters were asked to maintain season-long hunting diaries. Little food, in the form of standing corn, was available to pheasants in most winters. There was a significant negative relationship between winter severity and spring pheasant indices. Crowing cocks declined following winters with prolonged deep snow and subzero temperatures and increased following mild winters. There was a relationship between winter weather and spring crowing-cock trends and between spring crowing-cock trends and fall pheasant harvests. Trends in hunter bag checks during the first 2 days of the hunting season predicted total season bags. Inexpensive hunter diaries provided accurate trends in pheasant harvests and hunter success. **Key words: ring-necked pheasant, snow, temperature, nutrition, index, hunting**

142

Fallis, A. M. and C. E. Hope. 1950. Observations of ruffed grouse in southern Ontario with a discussion of cycles. Canadian Field-Naturalist 64(2):82-85. Abstract: Observations on [*Bonasa umbellus*] in isolated woodlots suggested that egg laying was related to weather conditions, especially temperature. Egg laying was not prolonged by removal of eggs from a nest. Destruction of nests was not increased as a result of human trails made to them. Second clutches appeared to be the exception rather than the rule following destruction of eggs that were being incubated. The irregularity of cyclical fluctuation in grouse populations, and the need for the accumulation of more quantitative data to explain these periodic fluctuations is discussed. **Key words: ruffed grouse, temperature, nesting**

143

Farnes, P. E. 1991. A scaled index of winter severity. Proceedings of the Western Snow Conference 59:12-15. Introduction: Various methods have been used to represent winter severity and usually include temperature and some measure of snowfall or winter precipitation. Most represent winter severity as some departure from normal or as percent of average. Likewise, most use mean monthly temperatures or monthly snowfall or precipitation. In many cases, the mean monthly temperature does not fully explain the stresses that are imposed on wildlife during extremely cold periods that persist for periods less than a month. Also, it is difficult for non-technical people and even some professionals to quantify how severe or mild a given winter might be. The scaled index of winter severity (IWS) was developed to assist both wildlife managers and the general public better understand how mild or severe a given month or season might be or might have been compared to the historical variations. An index of -4 represents the most severe condition while a +4 represents the mildest condition. An index of 0 represents average or 50 percent probability of occurrence. **Key words: snow, temperature, index**

144

Fields, T. L., G. C. White, W. C. Gilbert, and R. D. Rodgers. 2006. Nest and brood survival of lesser prairie-chickens in west central Kansas. Journal of Wildlife

Management 70(4):931-938. Abstract: We evaluated the effect of habitat use and other sources of variation on survival of lesser prairie-chicken (*Tympanuchus pallidicinctus*) and greater prairie-chicken (*Tympanuchus cupido*) nests and broods. Daily nest and brood-survival probabilities were a function of a quadratic time trend, and both declined as the season progressed. Daily nest survival was negatively associated with nest age, and daily brood survival was positively associated with brood age. Lastly, broods tended by adult females had higher daily survival rates than broods reared by subadult females. The probability of a nest surviving from 10 May to 1 June was 0.72 (SE = 0.06). The probability of a brood surviving from 1 June to 30 July (hatch to 60 days posthatch) was 0.49 (SE = 0.19) and 0.05 (SE = 0.06). The probability of a brood surviving from 1 June to 30 July (hatch to 60 days posthatch) was 0.49 (SE = 0.19) and 0.05 (SE = 0.03) for broods reared by adults and subadults, respectively. Although nesting females and females with broods were using Conservation Reserve Program grasslands, there appeared to be no benefit to nest and brood survival during our study. Instead, age of the nest and brood, timing during the season, age of the brooding female, and precipitation during brooding were more important predictors of survival. Further experimentation is needed to determine the mechanisms responsible for decreased nest and brood survival throughout the season. Results from such research could be used to formulate management strategies to improve nest and brood survival. **Key words: prairie-chicken, precipitation, productivity**

145

Fischer, R. A., K. P. Reese, and J. W. Connelly. 1996. Influence of vegetal moisture content and nest fate on timing of female sage grouse migration. Condor 98(4):868-872. Summary: Sage grouse most likely obtain the majority of their water from vegetation, because free-standing water is not readily available or when available is only occasionally used. Sage grouse inhabit areas having low annual precipitation. We hypothesized that (1) cumulative annual precipitation and temperature influence timing of spring and summer vegetal dessication, (2) vegetal moisture content would be higher in plants collected at sites used by sage grouse than at random sites, and (3) annual timing of sage grouse migration is related to vegetal moisture content and nest fate. Timing of both migration and vegetal moisture content varied among years. During drier years grouse tended to initiate migration earlier in the summer. During 1991 (a wet year) ≥12% of females remained on the study area at least through late July. Our data indicated that there was a threshold of moisture content that provided a cue to birds to initiate summer migration. During all three years the largest proportional increase in female migration occurred during the largest decline in vegetal moisture, when moisture amounts in vegetation declined to approximately 60% water. Although there was a strong correlation between moisture in vegetation and onset of migration, our study design precluded us from ruling out possible endogenous factors. Successful female sage grouse also moved to summer range later than unsuccessful females, presumably because of brood care. However, during the extremely dry summer of 1992, even successful females initiated migration early in the summer. Although timing of migration varied among years, nest success was similar among years. Our study indicates timing of plant dessication can vary annually with precipitation. Our data also indicate that during wet summers, fewer grouse moved to summer range. However, 34 years of precipitation data suggest that there have been few years with precipitation that would have provided succulent vegetal growth throughout the summer sufficient to attenuate migrational behavior. **Key words: sage grouse, precipitation, vegetation, behavior, movement**

146

Flake, L. D., C. P. Lehman, A. P. Leif, M. A. Rumble, and D. J. Thompson. 2006. The wild turkey in South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota Agriculture Experiment Station, Brookings, USA. Notes: Chapter 4 – “Snow depths exceeding about 12 inches can essentially stop movements of wild turkeys on the ground. Wild turkeys can sustain several days of severe weather, provided high-energy food sources are readily available, but without a concentrated food supply, birds soon face starvation. Consequently, migrations from summer to winter ranges may occur in mountainous terrain where snow accumulations are common. In the central Black Hills, Merriam’s turkeys began dying one week after snow accumulations of about 11 inches, despite mild conditions and eventual snowmelt within about a week. For approximately four days following this storm, birds stayed in sunny areas and made no effort to obtain food. Similarly, juvenile hens in the southern Black Hills began dying within 9 days following 9 inches of snowfall followed by persistent snow cover. Merriam’s turkeys in the Black Hills were found frozen in roost trees and on the ground below a roost following nighttime conditions of approximately -30°F with 40 mph winds. Wild turkeys, however, can withstand extremely cold nighttime temperatures if they have high-energy food available. Eastern and Rio Grande turkeys in northeastern South Dakota survived temperatures of -30 to -40°F, high winds, and deep snow as long as cereal grains were available at farmsteads or in windswept crop fields.” **Key words: Merriam’s turkey, Rio Grande turkey, snow, wind, temperature, nutrition, mortality, movement**

147

Flanders, B. L. 2002. Prairie grouse production on Valentine National Wildlife Refuge: the effects of weather and grassland management. M.S. Thesis, Colorado State University, Fort Collins, USA. Abstract: Valentine National Wildlife Refuge, located in the Sandhills of Nebraska, maintains permanent populations of two prairie grouse species, greater prairie chicken (*Tympanuchus cupido pinnatus*) and plains sharp-tailed grouse (*Tympanuchus phasianellus jamesi*). A greater prairie-chicken population increase beginning in the mid-80s was partially equated to increased vegetative cover on the refuge through improved grassland management, as well as to favorable weather conditions in the region throughout that time. However, there was no indication of a similar increase in prairie grouse fall production during the same time period. Therefore, my goal was to use historical data to assess how vegetation and weather factors affected production in the fall….I assessed the effectiveness of specific fire and grazing treatments in increasing vegetation visual obstruction, a determinant in the quality and availability of escape and thermal cover…I then evaluated the validity of bird harvest age ratios as an index of production….Next I used linear multiple regression methods to evaluate the importance of various vegetation and weather factors on sharp-tailed grouse production. Model-averaged production estimates provided reasonable predictions of actual production indices, although prediction intervals were large. The most useful predictor variables according to cumulative AIC*c* weights were wall weather variables, emphasizing the significant influence of weather on sharp-tailed grouse production. As hypothesized, 'May Average Temperature', 'June Average Temperature', and 'Cumulative Precipitation through July 31' were positively correlated with sharp-tailed grouse production, while 'June Number of Days 35C(95F)' and 'June Number of Days of Precipitation >2.54 mm (0.10 in)' were negatively correlated with sharp-tailed grouse production. 'Cumulative Precipitation through July 31' was the largest predictor of sharp-tailed grouse production. Finally, I assessed area effects using the nearby Samuel "R. McKelvie National Forest, which is more completely grazed and grazed at a heavier stocking rate than Valentine National Wildlife Refuge. Averaged across years, the Valentine model over-predicted the real sharp-tailed grouse production indices on Samuel R. McKelvie National Forest by 0.77 juveniles per adult. Notes: Under Management Implications, Flanders states "It is apparent that a large amount of the variability in sharptail production from year to year is influenced by weather. However, that does not mean that managers are rendered helpless in terms of managing for sharptail populations. Manipulating habitat to increase vegetative cover may help alleviate negative weather effects that can impair sharptail production….In drought years, there may not be adequate vegetation growth to provide escape cover and shelter from extreme weather events. Therefore managing grasslands for good standing residual cover provides a sort of insurance policy that chicks will have sufficient shelter in all years. Of course, weather will always have effects on extraneous factors, such as insect abundance, that are generally beyond a manager's control. Poor shelter, low insect abundance, and high predator numbers can cause sharptail production to crash. Ensuring that chicks have adequate shelter and escape cover in all years helps buffer sharptail production in years of low insect abundance…Reductions in stocking rate and/or annually grazed acreage would result in less vegetation disturbance and increased standing residual cover for sharptails and other prairie grouse. **Key words: sharp-tailed grouse, greater prairie chicken, precipitation, temperature, vegetation, grazing, habitat modification**

148

Flanders-Wanner, B. L., G. C. White, and L. L. McDaniel. 2004. Weather and prairie grouse: dealing with effects beyond our control. Wildlife Society Bulletin 32(1):22-34. Abstract: We used multiple-linear-regression methods to simultaneously assess effects of vegetative disturbance and weather on the production of sharp-tailed grouse (*Tympanuchus phasianellus*) on Valentine National Wildlife Refuge (NWR) in Nebraska using a long-term data set of harvest-age ratios as production indices. After developing the model, we plotted the model-averaged predictions of sharp-tailed grouse production indices for Valentine NWR against actual sharp-tailed grouse production indices for our reference area, Samuel R. McKelvie National Forest (NF), Nebraska. Model-averaged estimates of production provided reasonable predictions of actual production indices on Valentine NWR, although prediction intervals were large. The most useful predictor variables according to cumulative Akaike's Information Criterion weights were weather variables, emphasizing the significant influence of weather on sharp-tailed grouse production. As hypothesized *a priori*, "May Average Temperature," "June Average Temperature," and "Cumulative Precipitation from 1 January-31 July" were positively correlated with sharp-tailed grouse production, while "June Number of Heat Stress

Days" and "June Number of Days of Precipitation > 2.54 mm" were negatively correlated with sharp-tailed grouse production. The drought index, Cumulative Precipitation from 1 January-31 July, explained the most variation in sharp-tailed grouse production indices. The model developed on Valentine NWR over predicted sharp-tailed grouse production indices on Samuel R. McKelvie NF by 0.77 juveniles per adult, when averaged across years. Further experimentation is needed to support our hypothesis that vegetative disturbance on Samuel R. McKelvie NF is negatively affecting sharp-tailed grouse production at its current levels. **Key words: sharp-tailed grouse, precipitation, temperature, productivity, brood survival, model**

149

Fleming, K. K. and W. F. Porter. 2007. Synchrony in a wild turkey population and its relationship to spring weather. Journal of Wildlife Management 71(4):1192-1196. Abstract: Synchrony is an important component of wildlife population dynamics because it describes spatial pattern in temporal population fluctuations. The strength and spatial extent of synchrony can provide information about the extrinsic and intrinsic forces that shape population structure. Wild turkey (*Meleagris gallopavo silvestris*) populations undergo annual fluctuations, possibly due to variation in weather during the reproductive season. To determine if spring weather plays a role in synchronizing wild turkey populations, we used a modified Mantel-type spatial autocorrelation procedure to measure the synchrony in fall wild turkey harvest data collected in 443 townships from 1990 to 1995 and compared this to the pattern of synchrony in spring weather variables (May rainfall and temp) over the same period. We measured correlation using Spearman correlation coefficients between the total fall harvests from 1990 to 1995 for each pair of townships, and sorted pairs into 6 50-km distance intervals. We calculated a mean correlation coefficient for each interval and estimated its *P*-value using resampling. We found moderately significant synchrony in the fall harvest (r_s = 0.12-0.34, P<0.008) among township paired <150 km apart, but no significant synchrony beyond this distance. In contrast, both May temperature (r = 0.82-0.90, P<0.001) and rainfall (r = 0.49-0.76, P<0.001) were strongly synchronized across all 6 distance intervals. Visual inspection of time series in the wild turkey fall harvest suggests that populations may be synchronized in some years when weather promotes high reproductive success (i.e., a synchronized growth peak) and asynchronous in other years. Knowledge of the spatial dynamics of wild turkey populations will aid wildlife managers in estimating population change, setting harvest quotas, and managing habitat. **Key words: Merriam's turkey, temperature, precipitation, reproduction**

150

Formozov, A. N. 1964. Snow cover as an integral factor of the environment and its importance in the ecology of mammals and birds. Boreal Institute for Northern Studies, Occasional Publication No. 1, University of Alberta, Edmonton, Canada. Notes: Formozov devotes several chapters to the description of various types of snow and its modification through the interaction of other meteorological factors. <u>Page 36</u> – "Observations show that for many animals a thick layer of snow which is covered by *nast* [ice] is sometimes more dangerous than relatively deep and fluffy snow." <u>Page 42</u> – "There are indications that black grouse, when followed by goshawk (*Accipiter* *gentilis*) plunge into the fluffy snow, digging in fast and deep, as they do in the evening when they hide for the night." Page 46 – "…ptarmigan obtained their food form under the snow and partly even from under the icy crust which usually covers the parts of the tundra which had been blown free of snow by wind. It appeared that the ptarmigan in this case used the services of reindeer which dug the snow with their feet." Citing Romanov 1934, "…I often saw how grey partridge had fed at the places where hares had grazed." Page 47 – For a long time it has been known that flocks of snow partridges (*Tetraogallus caucasicus*) congregate in winter at the places where turs (*Capra caucasica*) have grazed, an adaptation which can be explained by the same ease of securing food on the places where the snow cover has been even partly destroyed by the strong hoofed animals. The above described phenomena of temporary symbiosis actuated by the winter presence of deep or compact snow cover is a good example of how specific and finely attuned some biotic relationships are. Undoubtedly the destruction of deer or hares would aggravate the wintering conditions of ptarmigan or partridge, and during difficult winters their die-off would be more frequent and complete." Page 73 – "…northern Caucasian pheasants...are sharply diminished in numbers after hard winters, but their numbers are re-established after 2 or 3 easy years." "There is a marked decrease in the numbers of Manchurian pheasants in Primoria and Ussuri Krai after winters with increased snowiness." **Key words: snow, temperature, wind, Manchurian pheasant, snow partridge, ptarmigan**

151

Forrester, N. D., F. S. Guthery, S. D. Kopp, and W. E. Cohen. 1998. Operative temperature reduces habitat space for northern bobwhites. Journal of Wildlife Management 62(4):1506-1511. Abstract: High operative temperatures may cause wild animals to avoid habitat space-time, leading to thermal fragmentation of habitat. We evaluated thermal fragmentation of habitat space for northern bobwhites (*Colinus virginianus*) in a subtropical-subhumid portion of Texas during June 1994-August 1995. Based on data from 606 random points, 405 flushing points, and 237 landing points, bobwhites avoided habitat space-time with operative temperatures >39°C during the hottest period (Jul-Sep). The estimated proportion of habitat space-time avoided exceeded 0.50 during all seasons and reached maximums of 0.65 for flushing points (Mar-Jun) and 0.74 for landing points (Jul-Sep). Habitat management that fosters lower operative temperatures near the ground may increase the abundance of bobwhites in tropical and subtropical environments. **Key words: bobwhite, temperature, habitat modification, habitat use**

152

Francis, W. J. 1970. The influence of weather on population fluctuations in California quail. Journal of Wildlife Management 34(2):249-266. Abstract: Age ratios of quail (*Lophortyx californicus*) in San Luis Obispo County, California, were available for 14 consecutive years. Ratios were based on hunter-shot samples averaging 672 birds per year. Weather data were compiled and a multiple linear regression of quail productivity on selected weather parameters revealed a close relationship (P < 0.01). Quail productivity seemed to be a function, in order of importance, of (1) soil moisture in late April calculated from temperature and rainfall data, (2) proportion of breeding females over 1 year old, and (3) the seasonal rainfall from September to April. Three geographically isolated wild quail populations and one penned population were observed during two breeding seasons that were very different in productivity. In 1963, quail produced many young. The breeding period was characterized by intense activity and persistence of breeding effort extending, in captive birds, to production of second broods. Vegetation that year included many annual forbs growing vigorously during the breeding season. In 1964, production of quail was very low on all areas. The birds seemed to lack reproductive drive, and breeding effort terminated early. Forb vegetation that year was sparse. **Key words: California quail, temperature, precipitation, vegetation, behavior, nutrition, productivity**

153

_____. 1968. Temperature and humidity conditions in potential pheasant nesting habitat. Journal of Wildlife Management 32(1):36-46. Abstract: Measurements of temperature and humidity within different vegetative cover types in Illinois pheasant range were made, and absolute humidity parameters calculated. Preferred nesting cover of pheasants (*Phasianus colchicus*) has been found to be strip cover (such as fencerows and roadsides) and hayfields. Within these cover types summertime maximum temperatures remained lower than in other cover types. Saturation deficits were also lower in the preferred cover types than in other cover types, and were very high in cornfields and certain grasses. Success of pheasant reproduction appears to be related to placement of nests in vegetative types offering a favorable microclimate. Temperature and humidity variations among cover types exceed the mean geographical variation over a wide area. **Key words: pheasant, humidity, temperature, reproduction, habitat use**

154

_____. 1967. Prediction of California quail populations from weather data. Condor 69(4):405-410. Summary: A method is presented by which the productivity (proportion of subadults in the fall population) of California quail in San Luis Obispo county, California, can be predicted from the age-ratio of females, and two weather parameters (1) the soil moisture at the end of April computed by the Thornthwaite evapotranspiration and water-balance method, and (2) the total seasonal precipitation from September through April. Tests on independent data verify the predictive value of the method. **Key words: California quail, index, productivity, precipitation, evapotranspiration**

155

_____. 1965. The effect of weather on population fluctuations in the California quail (*Lgopus phortyx californicus*). Dissertation, University of California, Berkeley, USA. Abstract: “Discussion: …The multiple linear regression analysis of the data for the Shandon area pins down with considerable accuracy the factors that vary in correlation with reproductive success, i.e., the age ratio of the breeding females, the soil moisture in the spring, and the total seasonal rainfall. The first of these is so strongly supported by the observed breeding behavior of birds in captivity, and is also so clearly independent of the other factors that little discussion is called for...In wild quail, dark cloudy days in February and March might similarly delay breeding and enable the first year hens to reach a physiological condition that would permit more effective breeding. Such light conditions are so closely tied up with rainfall conditions that the effect would be included in other weather parameters; there does not seem to be any clear indication from the regression analysis that this is important, the correlation between reproduction and the temperature range in early spring (measuring the degree of cloudiness) not being highly significant. The soil moisture calculated for the end of April, the most important factor in the regression equation, serves to measure the accumulated effect of the amount and distribution of rainfall as modified by the temperature regime. It is more useful to think of this parameter as an index of the combined weather effect than as an accurate measure of the actual soil moisture which could be measured at a given locality. The latter varies considerably with soil type, exposure, relief, land use, and perhaps other factors; the former depends only on the rainfall and temperature regime which is similar over a wide area, in just the same way that variations in quail populations are similar. It should be noted that this parameter is relatively constant throughout the early spring, so that it is not merely at the end of April that a high or low value may have an effect on quail reproduction; the value for any decade depends strongly on that for the previous decade, as well as on the rainfall during the decade. The importance of this parameter in the multiple regression equation enables us to say with confidence that our hypothesis is supported by the data. i.e., that 'soil moisture storage during the breeding season maintains green growth that stimulates breeding.' This hypothesis was of course based on numerous reports linking reproductive success with green growth. We should then attribute production of gonadotropins to some factor in the vegetation that is available in the early breeding season of California quail. The precise nature of the link is not shown by this study. Examination of specimens and observations of the vegetation during my study show that lack of food to the point of emaciation cannot be a factor in reproductive failure in these populations. Birds which failed to breed had fat deposits, and green vegetation was available even under the poor conditions of 1964 in the Shandon area. It is evident that the deficiencies must be qualitative, and that some factors which are available under normal weather conditions are lacking in a regime characterized by a low calculated oil moisture. These factors may include proteins found only in rapidly growing young shoots of new plants, any of various vitamins, or nutritional factors found only in certain species of plants used as food by quail. The third factor in the regression equation is the total seasonal rainfall, which is negatively correlated with the reproduction index. Since it is positively correlated with the calculated soil moisture storage (r=0.874), this is to be interpreted as meaning that an excess of rainfall over that required to give the maximum soil moisture storage will tend to reduce the rate of reproduction somewhat. For example, both 1952 and 1958 had high values of calculated soil moisture in the Shandon area; 1958 had 5 inches more rainfall than did 1952, but a lower immature:adult ratio of 2.46, compared to 4.30 in 1952. Of the difference, 1.13 can be assigned to the female age ratio (1952 having almost all adults in its breeding population), leaving 0.64 attributed to the greater rainfall in 1958. This is a relatively large figure, amounting to one-fourth of the total reproductive rate for this year, and about one-half of the standard deviation of the immature:adult ratio. The distribution and amounts of rainfall were similar in both years until mid-winter, but in 1958 heavy rains continued up to the first part of April, while 1952 had appreciable rains only in January and March. The mechanisms by which

these weather factors affect quail reproduction can only be conjectured. More sunshine and longer effective day lengths occurred in 1952, but the correlation of reproduction with early spring temperature range was relatively low; it is possible that light and sunshine will have an effect on reproduction only in those years when other factors are favorable. It seems more likely that such differences are related to the plant species which are abundant under the different rainfall regimes, and to the times at which they germinate and when they are growing most vigorously…Observations in the present study, both in the field land in the Behavior Laboratory enclosure, showed striking differences in the vegetation composition, years of good quail reproduction being those with an abundance of annual forbs, including legumes, known to be important as quail foods. Species and growth stage of these plants may be more important to quail nutritionally than the production of food in quantity. Still another effect of vegetation, consistent with the heavy growth of grass in the Behavior Laboratory enclosure in 1964 when reproduction was poor, is the observation by Linsdale (1947) of the 'reduction of California quail which came with the increased density of the ground cover', referring to dense growth of grass on the Hastings Reservation. To sum up the considerations discussed above, it appears that the temperature and rainfall regime in a given year is responsible for the production, at the beginning of the quail breeding season, of highly nutritious plant foods which, under optimum conditions, supply all the elements (protein, vitamins, and other) necessary to vigorous reproductive behavior. An appropriate photoperiod will trigger the beginning of the reproductive season; if nutrients are present in an adequate amount, gonadotropic secretions of the pituitary will lead to full gonadal development, as evidenced by pairing, aggressive behavior, vocalizations, mating, etc., followed by nesting and egg-laying. Normal environmental stimuli, and perhaps gonadal feed-back to the pituitary, will then stimulate the production of prolactin and other hormones associated with incubation and with parental behavior; the latter are more readily elicited in experienced females than in those breeding for the first time. With deficiencies of essential nutrients, the pituitary will produce subnormal amounts of both gonadogropins and prolactin, and both reproductive and parental behavior will be expressed at a low level, resulting in poor hatches of eggs and poor survival of young."
Key words: California quail, solar radiation, precipitation, temperature, clouds, vegetation, nutrition, reproduction, soil moisture, index

156

Gabbert, A. E., A. P. Leif, J. R. Purvis, and L. D. Flake. 1999. Survival and habitat use by ring-necked pheasants during two disparate winters in South Dakota. Journal of Wildlife Management 63(2):711-722. Abstract: Severe winter weather in the Northern Great Plains of North American can alter availability of winter cover and cause increased mortality of ring-necked pheasants (*Phasianus colchicus*). We monitored pheasant survival and habitat use via radiotelemetry during the second most severe winter in eastern South Dakota since 1892. We captured and radiomarked 489 female ring-necked pheasants at the onset of the 1996-97 winter and monitored survivors through spring at 3 sites in eastern South Dakota. We also monitored 58 female ring-necked pheasants at the same sites during 1995-96 winter, a winter characterized by below average temperature and average snowfall (winter severity rank: 35th). Survival of radiomarked hens in 1995-96 (0.61 [SE = 0.07]) was higher (P < 0.001) than that in 1996-97 (0.03 [SE = 0.02]). Mortality due to predation was higher (P

≤ 0.042) than mortality due to weather in both winters. Mortality due to weather did not differ (*P* = 0.787) between winters. However, 31 of 41 deaths occurred during blizzard periods in 1996-97, indicating severe weather increased the vulnerability of pheasants to predation. Radiomarked hens showed the highest preference for tall grass (> 75 cm), cattail (*Typha* spp.) wetland, and corn food plot habitats in winter 1995-96, and early winter 1996-97. Shelterbelt and corn food plot ranked highest for pheasants that survived to the second half of the 1996-97 winter. We conclude that shelterbelt and food plot habitats are essential to the survival of pheasants in eastern South Dakota during extreme winter weather conditions. **Key words: ring-necked pheasant, temperature, snow, predation, habitat use, mortality, severe weather**

157

Gates, R. J. 1983. Sage-grouse, lagomorph, and pronghorn use of a sagebrush grassland burn sites on the Idaho National Engineering Laboratory. M. S. Thesis, Montana State University, Bozeman, USA. Notes: Page 24—"…burn and control sites were probably snow-free or had minimal snow cover for a longer period in the winter 1980-81 than in the other 2 winters. This may at least partially explain the relatively higher grouse pellet density which was observed in 1980-81." Page 44/47—" Grouse observations per km of transect declined 72% between the summers of 1980 and 1982. The ratio of juveniles to adult hens observed on the transect indicated low production of young during the springs of 1980-82. Precipitation during May, the normal month of peak hatching on the INEL was 2.9 and 1.8 cm above the 20 year average in 1980 and 1981. Also, daily temperatures averaged 0.7C and 1.7C below normal in May of 1980 and 1981…Despite below average precipitation during the spring of 1982 production was still estimated to be low; however, the small number of hens and broods observed in 1982 may not have accurately reflected reproductive success." Page 47—"…during the years of this study in which precipitation during the first 6 months was above average, grouse moved to summer ranges earlier than in a year when precipitation was below average. In spite of lower precipitation, succulent forbs were observed in sagebrush grassland through most of the summer in 1982; whereas during 1980 and 1981 most forbs became desiccated by the end of June. Abnormally high precipitation (1.3 cm above average) during July and August 1982 may have prolonged the season of forb growth into July and August 1982." Page 62—"Since fecal pellet densities on the burn area varied inversely with the depth and persistence of snow cover over 3 years, grouse may have concentrated on portions of the study area other than burn site as snow depth increased. The low pellet density observed in 1982, after the winter of greatest snow cover, may also have in part reflected the declining population trend." **Key words: sage-grouse, precipitation, snow, vegetation, habitat use, movement, nutrition, reproduction, habitat manipulation**

158

Gatti, R. C., R. T. Dumke, and C. M. Pils. 1989. Habitat use and movements of female ring-necked pheasants during fall and winter. Journal of Wildlife Management 53(2):462-475. Abstract: We studied diurnal habitat use and movements of 56 female ring-necked pheasants (*Phasianus colchicus*) on private and public lands in southern Wisconsin from September through April 1968-71 using radio telemetry.

Habitat use of female pheasants was a function of month, year, female age, and snow cover depth, but not female survival through April. Females preferred food patches and brush, and avoided pastures and active croplands in all 7 months. Shrub-carr wetlands were preferred by females in all months except October, and marshes were preferred in all months except January and February. Retired croplands were preferred from October to December, but avoided in January. Upland hardwoods were avoided in most months except for periods of deep snow cover. Monthly home-range sizes averaged 32 ha. Home-range size during 10-day periods peaked in late October through early November, and declined to a low in early January through early February. Juveniles had larger ranges than adults, and preyed-upon females had larger ranges than surviving females. Home-range size was positively related to corn harvesting and pheasant hunting pressure, and negatively related to snow cover depth. Females began a directional move (mean = 1,150 m) to winter cover in late September. Distance to winter cover was also a function of female age, female fate, corn harvest, and snow cover depth. Heavy hunting pressure appeared to temporarily suppress the use of food patches and strip cover, and accelerate the final move to winter cover, but did not cause females to move off public lands. Females remained in winter cover from early November through early February, using a variety of areas and habitats. The abundance of wetland cover in winter may have been responsible for a lack of winter concentration and independent moves between adults and juveniles. **Key words: ring-necked pheasant, snow, habitat use, movement**

159

Gefell, D. J. 1990. An exploration of the influence of environmental factors on variation in wild turkey populations. M. S. Thesis, State University of New York, Syracuse, USA. Abstract: The 2 primary objectives of this study were: (1) to explore the utility of harvest data for assessing absolute and relative wild turkey abundance, and (2) to assess the correlations of wild turkey density and rate of change in density with potentially limiting weather, hunter pressure, and land use factors. The first objective was addressed using wild turkey spring and fall harvest data from townships in southern New York State during 1969-1981. Two methods of assessing absolute abundance, and 4 potential indices of relative abundance were examined. Neither technique for estimating absolute abundance was found to be reliable. However, 1 method of indexing relative wild turkey abundance successfully passed tests of accuracy and logical consistency. The second objective was addressed by using the turkey density index to compare how weather, hunter pressure, and land use patterns each influenced historical township-level wild turkey population variability across southern New York. **Key words: wild turkey, weather, population dynamics, index**

160

Gerstell, R. 1939. Certain mechanics of winter quail losses revealed by laboratory experimentation. Transactions of the North American Wildlife Conference 4:462-467. Conclusions: (1) That the characteristic huddling habit of the bobwhite quail may at least in part represent an instinctive reaction which tends to reduce the heat loss from the bodies of the various individuals which make up any given covey. (2) That, at least within certain limits, the ability of a covey of quail to withstand low environmental temperatures is directly proportional to the size of that covey. (3) That the body temperature of individual quail may drop more than 25° F below normal without the bird's suffering a breakdown of its thermal regulatory system which would result in death. In closing, it seems fitting to call to the game manager's and sportsmen's attention the practical importance of the results obtained even from the few experiments so far completed. This lies in the indication that throughout the northern portion of the quail range, the bobwhite coveys should not be shot down to a point where their chances of winter survival are seriously endangered simply by too great a reduction in the average size of the bevies. **Key words: bobwhite quail, temperature, biothermal regulation, behavior, hunting**

161

Gill, R. B. 1966. A literature review on the sage-grouse. Special Report No. 6. Department of Game, Fish and Parks, Game Research Division and Cooperative Wildlife Research Unit, Denver, USA. Notes: Page 23 – "Decimating Factors, Weather. Patterson studied nesting under contrasting weather conditions and concluded that little or no nesting mortality occurred as a result of rain or snow during the incubation period. However, periods of cold rain, sleet, or snow during or immediately following the hatch caused mortality among chicks. Concluded from his studies in Idaho that above-average rainfall during the months of May and June depressed production of sage-grouse. Schlatterer continued this study and found that adverse weather reduced the average brood sizes of birds hatched during the bad weather. Pyrah reported that high nesting success and brood survival in Wyoming occurred one year after periods of above average rainfall. He concluded that while adverse weather depressed production in the year that it occurred, it increased production the following year." **Key words: sage-grouse, precipitation, snow, sleet, productivity**

162

_____.1966b. Weather and sage-grouse productivity. Outdoor Facts No. 37, Game Information Leaflet, Colorado Game, Fish and Parks Department, Denver, USA. Summary: The primary effect of weather on gallinaceous game birds is manifested in nesting success and survival of young chicks. The two most important weather factors reported in the literature were temperature and precipitation during the nesting and early brood rearing season. Investigations conducted in the Lake John area of North Park, Colorado, indicated that temperature was the most important single factor affecting sage-grouse productivity. Variations in temperature alone accounted for 68 percent of the variability in strutting male counts the following spring, and the combined effects of temperature and precipitation accounted for 87 percent of the variation. Knowledge of the relationship between temperature and production permitted the calculation of a prediction formula from which reliable predictions of strutting male counts can be made. In general it was found that when the mean average temperature for the period April-June exceeded 44.5°F, good production resulted. Also it was found that the best production resulted from spring seasons which had a mean average temperature above 45.0°F and two or more inches of total precipitation. A scale for evaluating the combined effects of temperature and precipitation was constructed from known and predicted values…One interesting sidelight in connection with these data is that when spring counts of strutting males were correlated with hunter harvest data on the previous year, no significant correlation resulted (r=0.324). From this it was apparent that present levels of hunting pressure have had little or no effect on sage-grouse populations in the Lake John area; instead, the most important factors affecting these populations were found to be the combined effects of temperature and precipitation during nesting and early brood rearing. **Key words: sage-grouse, temperature, precipitation, productivity, index, population dynamics**

163

Giuliano, W. M. and R. S. Lutz. 1993. Quail and rain: what's the relationship? Proceedings of the National Quail Symposium 3:64-68. Abstract: We used Christmas Bird Count reports in conjunction with precipitation data from 9 locations in Texas, to investigate relationships between rainfall and northern bobwhite (*Colinus virginianus*) and scaled quail (*Callipepla squamata*) abundance. Regional differences in northern bobwhite abundance could not be predicted by precipitation regimes, whereas scaled quail abundance was negatively correlated with fall and winter rainfall. Differences in rainfall patterns were not significantly correlated with year-to-year changes in northern bobwhite and scaled quail abundance. **Key words: bobwhite quail, scaled quail, precipitation, population dynamics**

164

Gjerde, I. and P. Wegge. 1987. Activity patterns of capercaillie, *Tetrao urogallus*, during winter. Holarctic Ecology 10(4):286-293. Summary: Winter activity patterns of 16 radio-marked capercaillie, *Tetrao urogallus*, were studied during 1981-83 at Varaldskogen, SE Norway. Activity was confined to the light hours of the day, closely following the photoperiod. Diel distribution showed a major peak near sunset during every month. A second peak was found in the morning. This peak was comparable to the evening peak in early and late winter, but nearly disappeared in midwinter. Ambient temperature rather than photoperiod seemed to be the important proximate factor responsible for the changes in morning activity. By postponing activity to the afternoon, capercaillie avoids energy expenditure during the coldest morning hours.Total daily activity (TDA) during the period November-April averaged about 3 hours for both sexes. TDA of cocks was U-shaped with the lowest values (2.0 hours) in December-January, whereas TDA of hens was fairly stable during November-March with mean value of 2.7 hours, increasing abruptly to 4 hours in April. TDA during December-January is believed to express the time used for feeding in pine trees. The significantly higher TDA of hens (26%) compared with cocks during this period may be explained by a higher relative heat loss of hens (body weights: hens 2.0 kg, cocks 4.3 kg). The increased level of activity during early and late winter among cocks was probably due to display and related territorial behavior, whereas increased activity of hens during April probably was caused by a shift from feeding in pines to more time-consuming selective feeding on the ground. **Key words: capercaillie, temperature, behavior**

165

Glover, F. A. 1948. Winter activities of wild turkey in West Virginia. Journal of Wildlife Management 12(4):416-427. Notes: Under “Summary” the author notes: “The daily range was reduced markedly by deep snows. At times the birds moved just between the roosting sites and the feeding areas. During the periods of deep, soft snow the turkeys traveled through the trees or flew short distances. Turkeys commonly scratched through snow 12 inches deep to obtain food.” **Key words: Eastern wild turkey, snow, movement, habitat use**

166

Gobeille, J. E. 1992. The effects of fire on Merriam’s turkey brood habitat in southeastern Montana. M. S. Thesis, Montana State University, Bozeman, USA. Notes: <u>Page 42</u>—Poult mortality was difficult to assess due to inability to observe very young poults in herbaceous cover. However, some broods appeared to suffer heavy mortality due to wet spring weather…hen #1177 lost 70% of her poults during the first 3 weeks after hatching when 3.5 cm of rain occurred in the Ekalaka Hills. The majority of this fell in 2 storms over a 4-day period. **Key words: Merriam’s turkey, precipitation, mortality**

167

Goddard, A. D. 2007. Reproductive success and habitat selection of sharp-tailed grouse (*Tympanuchus phasianellus*) in the Peace Reiver region, northeast British Columbia. M.S. Thesis, University of Northern British Columbia, Prince George, Canada. Abstract: Sharp-tailed grouse (*Tympanuchus phasianellus*) are relatively abundant across the Peace River region. Local biologists and landowners suggest, however, that populations have been steadily declining over the past several decades, and little is known regarding the current population status and habitat requirements of the species. Success during the reproductive season is often the most important factor limiting population growth of sharp-tailed grouse. To effectively manage populations and the habitats required by sharp-tailed grouse, it is important that baseline data describing patterns of reproductive success and habitat selection are collected. Using 15-g radio collars to monitor female sharp-tailed grouse during 2 consecutive breeding seasons, I quantified the success of first and re-nest attempts, the survival of offspring to 35 days of age, and I determined patterns of habitat selection during the nesting and brood-rearing periods. Nesting success in 2004 and 2005 was 41% and 50%, respectively, and was positively influenced by habitat conditions at the nest site including increased shrub and living cover. Seventy-five percent of females successfully reared a minimum of 1 chick to 35 days of age. Only 35% of chicks, however, survived the same period. Survival of offspring was positively related to pre-hatching and negatively related to post-hatching weather conditions as well as the distance travelled by a brood during the first week after hatching. Breeding sharp-tailed grouse selected habitats in a hierarchical fashion, selecting habitats at the landscape, patch, and site scales. At the landscape scale, breeding females selected areas with non-forest cover-types between 550-650 m in elevation. At the scale of the nest site, females selected sites with greater overhead cover, shrub and grass cover, taller vegetation, and sites with more residual vegetation than random. During the early part of the brood-rearing period (offspring 0-

14 days of age), females with broods selected for agricultural habitats rather than natural habitats. This trend was not observed, however during the late brood-rearing period (15-49 days of age). In general, habitat selection choices made by breeding sharp-tailed grouse corresponded with increased fitness in the form of greater reproductive success. **Key words: sharp-tailed grouse, productivity, habitat use, vegetation**

168

Goldstein, D. L. 1984. The thermal environment and its constraint on activity of desert quail in summer. Auk 101(3):542-550. Abstract: I measured the thermal environments experienced by Gambel's quail (*Callipepla gambelii*) during the summertime in the Clorado Desert by using estimates of standard operative temperature (T_{es}). Simultaneously with these measurements, I monitored the activity pattern of quail. The thermoneutral zone of freshly captured quail extends to 44°C, yet T_{eo} in sunlit areas may exceed this upper critical temperature for more than 10 hours of a hot day. Even in the shade, T_{eo} is at the upper limits of thermoneutrality for much of the day. At these temperatures the birds maintain a body temperature that is very close to their upper lethal limit. The activity pattern of Gambel's quail on hot summer days is bimodal, with morning and late afternoon foraging separated by a long quiescent period during midday. The time of onset and the duration of this inactive period varies directly with T_{eo} and foraging occurs throughout the day on cool, overcast, summer days. This suggests that the thermal environment constrains midday activity. A bimodal activity pattern during the winter is probably a response to predation pressure from avian raptors. During the summer, however, it is advantageous for growing juvenile quail to maximize foraging, and the thermal environment is the most important factor shaping the activity schedule. **Key words: Gambel's quail, thermoregulation, temperature, behavior**

169

_____. 1983. Effect of wind on avian metabolic rate with particular reference to Gambel's quail. Physiological Zoology 56:485-492. Abstract: The metabolic rate of Gambel's quail (*Callipepla gambelii*) increases linearly with increasing wind speed at both 10 and 20 C. These results are compared with data from the literature for seven other avian species. The square root of wind speed, though often used as the independent variable, does not provide the best description of metabolic rate in wind for most species and temperatures; however, presentation of all data in a common form does reveal patterns among and within species. The effect of convective heat loss on metabolic rate—that is, the slope of metabolism (in watts, W) on the squared root of wind speed (m/s)—increases as mass increases. This slope also increases within a given species as ambient temperature (T_a) decreases. These relationships are the result of relative changes in surface area, thermal conductance, and the temperature difference driving heat flux. The slope of the regression of metabolism on the square root of wind speed [b, in $W/(m/s)^{1/7}$] may be described as $b = .0092M.66\Delta T^{.32}$, where M is mass in grams and ΔT is the difference between the lower critical temperature and T_a (in °C). This equation predicts the metabolic rate of a bird at any wind speed in temperatures below thermoneutrality. **Key words: Gambel's quail, wind, temperature, thermoregulation**

170

Gore, H. G. 1973. Land-use practices and Rio Grande turkeys in Texas. Proceedings of the National Wild Turkey Symposium 2:253-262. Abstract: Populations of Rio Grande turkeys (*Meleagris gallopavo intermedia*) in Texas are now closely correlated with areas of least human activity located where mean annual rainfall is 16 to 20 inches. Turkey range and populations are further restricted by overgrazing, human occupation and disturbances, and destruction of habitat. In general, turkeys have declined in direct proportion to the increase in human occupation of the land. Most lands in Texas are privately owned with no restrictions on use. Both Rio Grande and eastern turkeys (*M. g. silvestris*) were abundant in Texas in 1870 when the population of 818,500 Texans owned 4.5 million head of livestock. Today's 12 million people and 3.5 million head of livestock (including 3.5 million goats and 4.0 million sheep) have made inroads into turkey habitat that cannot be readily corrected. Vegetative associations that once produced an abundance of food for turkeys have been subjected to brush-control programs or have been replaced by various invader species of limited value to turkeys. The economic importance of livestock points to even greater decreases in turkey habitat as human populations and demands increase. Removal of brush and timber is not the only reason that the number of turkeys has decreased, because properly managed open range is extensively utilized by turkeys for nesting and feeding. It is destruction of winter roost sites and large-scale removal of mast-producing species that presently cause remnant flocks to change their ranges-changes that more often than not result in conditions that make the survival of turkeys impossible. Transplanting of wild-trapped birds to ancestral ranges is credited with increasing the number of turkeys within their present range. Widespread precipitation and improved range conditions following periods of drought have also increased local turkey populations. The future of the Rio Grande turkey hinges on whether limited habitat can be maintained or improved under the present system of agricultural economics. Land-use practices that presently promote increases in the number of turkeys are rotated grazing systems, decreases in numbers of goats and sheep, planting of small grains in winter food plots, minimal human disturbance, and supplement feeding during critical periods of drought. **Key words: Rio Grande turkey, eastern turkey, precipitation, drought, habitat modification, grazing**

171

Graham S. A. and G. Hesterberg. 1948. The influence of climate on the ring-necked pheasant. Journal of Wildlife Management 12(1):9-14. Summary: The author applied the "bioclimatograph" to explore the failure of pheasant to thrive in southern North America while they succeeded further north. From the discussion of meteorological influences it seems entirely possible that the southern distribution of pheasants in the United States may be due to intense spring insolation of the exposed eggs during oviposition. However, it must not be inferred that temperature is the only controlling factor. If the insolation hypothesis proves to be sound, spring and early summer temperatures on exposed surfaces would mark the limits of possible distribution toward the south. But within the favorable area other limiting factors would operate to make specific localities either favorable or unfavorable. **Key words: ring-necked pheasant, temperature, insolation, precipitation, distribution**

172

Grandjean-Thomsen, A. 1994. The influence of some factors on the display activity of black grouse (*Tetrao tetrix*) in Denmark. Dansk Ornitologisk Forenings Tidsskrifft 88(2):85-90. Abstract: The present work identifies some factors influencing the display activity of the black grouse on an arena in central Jutland, studied in 1974-75. The activity varies seasonally, with a peak period from April to the end of May. Strong winds damp the activity, whereas decreasing temperature apparently has a stimulating effect. It was not possible to demonstrate any effect of cloud cover, but rain interrupted the display. The presence of hens on the display ground has a strong stimulating effect on the displaying cocks. Overflying curlews (*Numenius arquata*) have a similar effect, apparently because they are taken for black grouse hens in the twilight of the morning. **Key words: black grouse, wind, temperature, precipitation, behavior**

173

Gratson, M. W. 1988. Spatial patterns, movements, and cover selection by sharp-tailed grouse. Pages 158-192 *in* A. T. Bergerud and M. W. Gratson, editors. Adaptive strategies and population ecology of northern grouse. Wildlife Management Institute and University of Minnesota Press, Minneapolis, USA. Notes: <u>Page 182</u>—Generally, flocks were largest when snow was on the ground but was less than 18 cm, a depth beyond which birds could no longer obtain ground foods easily but at which they could snow-burrow. Thus, mean flock size decreased when there was a reduced availability and distribution of ground foods, and also when there was increased snow-burrowing opportunities. These changes were statistically significant for males from conditions of no snow to those with snow less than 18 cm and for females from conditions of snow less than 18 cm to those greater than this depth. <u>Page 189</u>—At snow depths greater than 18 cm, flocks were generally smaller than when snow was present but less than 18 cm. Food availability and distribution, certainly the latter, decreased with snow depth, if at all; however, more birds did not join flocks when snow was deep. Rather, mean flock size decreased. Flock sizes were related to snow-burrowing opportunities. At snow depths that allowed grouse to snow-burrow, birds left flocks. When depths were reduced and they had to roost exposed on the snow, birds joined others, and mean flock sizes increased. These data appear consistent with the general hypothesis that grouse join flocks when they are most conspicuous, on top of the snow. When sharp-tailed grouse snow-burrowed, the benefits of increased vigilance owing to flocking should have been fewer, and as predicted by the general antipredator models, birds left flocks. **Key words: sharp-tailed grouse, snow, behavior, habitat use, predation**

174

Gray, B. T. and H. H. Prince. 1988. Basal metabolism and energetic cost of thermoregulation in wild turkeys. Journal of Wildlife Management 52(1):133-137.

Abstract: Metabolism of eastern wild turkeys (*Meleagris gallopavo silvestris*) was measured as a function of temperature during the winters of 1983-84, 1984-85, and the summer of 1984. Basal metabolism (mL oxygen/g/hr) did not differ between sexes within seasons, but was higher for juveniles during winter and adults in summer than for adults in winter. Metabolic costs for thermoregulation below the lower critical temperature (T_k) for females was greater than for males during each season. Extended periods of deep powder snow combined with low temperatures are considered a major limiting factor for wild turkey populations. During periods of deep powder snow mobility is greatly reduced and feeding is restricted to the immediate vicinity of the roost. If no food is readily available, turkeys must fast. The more rapid rise in energy expenditure below T_k in females than males during periods of fasting would result in depletion of female's lipid reserves at a greater rate. **Key words: eastern turkey, bioenergetics, snow, temperature, nutrition, population dynamics, mortality**

175

Green, R. E. 1984. The feeding ecology and survival of partridge chicks (*Alectoris rufa* and *Perdix perdix*) on arable farmland in East Anglia. Journal of Applied Ecology 21:817-830. Summary: (1) Broods of grey and red-legged partridges were radio-tracked for 20 days after hatching and their diet determined from feces collected at nocturnal roosts. (2) Grey partridge chicks foraged in cereal fields and red-legged partridge chicks in cereal, carrot and sugar-beet fields. Chicks of both species fed on arthropods, weed seeds, leaves, flowers and cereal grain but grey partridge chicks were more insectivorous than red-legged partridges. Both species preferred to feed at the edges of fields, where arthropods and weeds are more abundant, and among cereals they preferred winter wheat fields which had the highest densities of arthropods and grass seeds. (3) Periods of brood activity and resting were monitored by continuous recording of radio signal strength. Activity was reduced during periods of low temperature and rain or dew. (4) Surveys of chick survival rates and food supplies on different farms showed that the survival of grey partridge chicks increased with increasing density of prey arthropods. Red-legged partridge chick survival was influenced by the abundance of arthropod prey and grass seeds. (5) Mean survival rates for partridge chicks estimated annual for samples of farms in East Anglia showed that survival increased with June and July temperature for both species. It is uncertain to what extent weather affects chick survival directly via its effect on chick activity rather than indirectly via effects on food supplies. **Key words: grey partridge, red-legged partridge, temperature, precipitation, dew, behavior, nutrition, insects**

176

Gregg, L. 1984. Population ecology of woodcock in Wisconsin. Technical Bulletin No. 144, Department of Natural Resources, Madison, USA. Notes: Page 19—"Although predators were responsible for the destruction of eggs in many nests, the fate of some of those nests might have already been sealed. Because the woodcock is a very early nester, inclement weather conditions, including cold temperatures and significant snowfalls, are not unusual during the nesting season. Such adverse weather has been known to result in deserted clutches when eggs are frozen or buried under snow…although weather conditions caused the loss of many nests which were then subsequently destroyed by predators, it was seldom possible to document such losses. During the 1979 nesting season, however, a late snowstorm provided an opportunity to gain information on the effect of weather on nesting success. A 6-inch snowfall within the study area on 5 May was judged to have forced hens to abandon those nests having little or no overhead cover. Of 17 nests under surveillance at the time of the storm, 9 were found inactive upon inspection 8 May. The eggs were missing from 6 nests, shells from eggs destroyed by predators remained in 2 nests, and abandoned but intact eggs were found in only 1 nest. There is little doubt that the impact of this storm was unusually severe because snow depth was sufficient to cover nearly all of the ground vegetation surrounding the nests, thus making the hen or the eggs very visible to passing predators. Nevertheless, the rapid disappearance of the eggs from those nests points up the difficulties involved in discriminating between weather and predation as causes of nest losses. Page 20—Fate of individual eggs in completed clutches was dependent upon environmental factors, such as weather and predators, and also upon intrinsic factors such as fertility. Page 38—Year-to-year variations in average brood size were smaller than those recorded for nesting success but were still large enough to indicate that chick survival varied between years. Annual variations in weather conditions were believed to be primarily responsible for observed differences in brood size, but an examination of weather records provided little evidence of a relationship. If weather conditions during some years caused a large number of hens to lose their entire brood, however, such losses would not necessarily be reflected in smaller average brood sizes during those years since it is impossible to identify the proportion of hens which had lost their brood. Page 42—Causes of Mortality, Weather. Although several records of woodcock mortality resulting from cold waves exist for the wintering grounds, such losses are more difficult to detect on the breeding grounds. Within our study areas, inclement weather caused significant losses of nests and occasionally even young chicks, but was believed to be a much more important mortality factor than indicated by any carcass counts…we recorded two instances of weather-related starvation among males in the spring. Males, because of their smaller body size and associated greater heat loss, are less well equipped than females to withstand cold weather. Body weights of adult males are at their lowest point during the spring courtship period, and energy reserves in the form of body fat would not be available to sustain them if food became unavailable. Thus, any mortality resulting from severe spring weather would involve primarily male birds and could be a factor in maintaining the preponderance of females among adult woodcock. **Key words: American woodcock, temperature, snow, productivity, mortality, predation, nutrition, population dynamics, sex ratio**

177

Gregg, M. A. 2006. Greater sage-grouse reproductive ecology: linkages among habitat resources, maternal nutrition, and chick survival. Dissertation, Oregon State University, Corvallis, USA. Notes: Page 40 – "Reduced availability and consumption of forbs during 2002 may have been related to late winter snow that covered my study area during the early collection period, which perhaps delayed forb growth. In contrast, my study area was snow free during the early collection period in 2003, forb phenology was advanced, and availability and consumption of forbs was greater than I observed in 2002. Variation in availability and consumption of forbs between years was also related to ovary weight of my hens. Follicle development was advanced for hens collected during the early period in 2003 compared with 2002 and may have been related to greater nutrition because of increased consumption of forbs during 2003.” **Key words: sage-grouse, snow, vegetation, nutrition, productivity**

178

Gross, A. O. 1930. Progress report of the Wisconsin prairie chicken investigation. Report of the Wisconsin Conservation Commission, Madison, USA. Abstract: Important factors which control the numbers of grouse in Wisconsin are periodic cycles, weather conditions, fires, encroachment of agriculture upon nesting and feeding grounds, hunting, predators, diseases, and parasites. Prior to 1887 there were no laws limiting hunting of prairie grouse in Wisconsin. The open season has gradually decreased from 3 months in 1887 to 5 days in certain counties in recent years. The bag limit has been reduced to 5 birds. Estimates place the numbers of prairie chicken at 54,000, and the sharp-tailed grouse at 55,000, or very roughly one prairie chicken and one sharp-tailed grouse to each square mile of land in Wisconsin. The prairie chickens undergo distinct migrations in the northern portion of their range. There were 6 internal and 6 external parasites of varying importance found in Wisconsin grouse. The dreaded poultry disease “blackhead” was found in 3 of the prairie chickens examined. The organic food of the birds examined was made up of 84 kinds of vegetable matter, constituting 72 percent, and 82 kinds of animal matter, making up 28 percent of the food. Gravel constituted 6 percent of the combined organic and inorganic contents. Experimental winter feeding stations established by planting plots of ground of one to two acres in buckwheat and other grains to be used by the birds during times when the natural food is covered with ice and snow proved an excellent conservation measure. Forty-six nests were used in the life history study. The average number of eggs per set was 11.5. The average measurements of 100 eggs was 44.86 by 33.59 mm; weight, 21.86 grams. The incubation period was 23 days. Destruction of nests by predators is one of the serious problems of conservation of the prairie chicken. Hybrids between prairie chickens and sharp-tailed grouse are common. Erythrim and albinism occur. Courtship and behavior of the prairie chicken is identical with that of the heath hen, confirming their subspecific relationship. **Key words: prairie chicken, sharp-tailed grouse, snow, ice, mortality**

179

Gruys, R. C. 1993. Autumn and winter movements and sexual segregation of willow ptarmigan. Arctic 48(3):228-229. Abstract: Willow ptarmigan (*Lagopus lagopus alexandrae*) in northern British Columbia leave their breeding areas during autumn and winter. The movements differ between males and females. In this study I examine the causes and extent of these differences. Ptarmigan did not leave their breeding grounds immediately after the breeding season, but remained on or near their territories until December. After chicks fledged, part of the population moved uphill from their territories. Coincident with moult into winter plumage, ptarmigan moved farther from their territories. Both movements were probably to areas with better protection against predators. After moulting, all tagged males and half of the tagged females returned to their territories, and males resumed territorial display. Ptarmigan remained on their territories until increasing snow cover depleted cover, forcing them to leave. Males left the breeding grounds later than females and returned earlier in spring. In winter females moved farther than males, supporting the reproductive strategy hypothesis, but segregation was not complete. Sexual segregation may not be related to migration alone, but could occur at any time ptarmigan are in flocks. **Key words: willow ptarmigan, snow, habitat use, movement**

180

Gullion, G. W. 1970. Factors influencing ruffed grouse populations. Transactions of the North American Wildlife and Natural Resources Conference 35:93-105. Notes: Page 94—"In northern Minnesota I believe we must consider ruffed grouse to be chionophiles, or "snow lovers" and that their overwinter welfare depends in large degree upon snow conditions…20 inches of snow with a hard crust can be as deleterious as 6 inches of soft snow with no crust, when the temperatures remain in subzero (°F) ranges for prolonged periods." Page 95—"During the 10 years of adequate study only in 1963-64 was the overwinter loss substantially greater than a mean of about 55 percent. This we attribute to increased predation associated with poor snow conditions…Poor snow conditions in 1967-68 resulted in a poor production season in 1968 and 1969 proved only moderately successful." Page 96—"We believe that when environmental temperatures drop much below 20°F they are below the thermoneutral range of this grouse and that the birds must increase their metabolic rates to maintain body temperatures…snow depth and quality is a most important factor affecting year-to-year changes in northern Minnesota's ruffed grouse populations—but it is not the entire story." Page 97—"We have found at Cloquet that the color of a ruffed grouse's tail indicates the bird's probable longevity. Over the past 13 years male grouse with red tails have lived an average of only 69 percent as long as the birds with gray tails (11.4 months vs 16.6 months—significant at 99.5% level; 275 df). Furthermore, this differential survival appears to be related to environmental stress. It is during winters of unfavorable snow conditions that the red birds show the greatest losses. In good snow years, such as 1964-65, the red birds survived as well as the gray birds." **Key words: ruffed grouse, snow, temperature, thermoregulation, color-phase, wind, fire, habitat use, habitat alteration**

181

Gunderson, P. 1990. Nesting and brood rearing ecology of sharp-tailed grouse on the Charles M. Russell National Wildlife Refuge, Montana. M.S. Thesis, Montana State University, Bozeman, USA. Abstract: Spring and summer habitat use was studied for plains sharp-tailed grouse (*Tympanuchus phasianellus jamesi*) during 1988 and 1989. The study area spanned 104 km^2 in south Valley County, Montana. Thirty-four sharptails with transmitters were followed. Males used 5 display grounds, slightly raised from surrounding topography and interspersed with big sagebrush (*Artemisia tridenata*), from the start of field seasons in April, until early June. Twenty-seven nests were located over 2 years and used to characterize nesting habitat vegetatively and topographically. Most nests (63%) were located in junipers (*Juniperus* sp.). Canopy height over nests averaged 47 cm, and screening cover height was near 18 cm. Hatching occurred in early to mid-June. Success of nesting hens was high (65%), but predators destroyed nearly 30%. Four hens nested in both years, and another renested in 1989. Fidelity to nesting areas was shown by 2 hens. *Due to weather and predation, no chicks were alive after 2 weeks in 1988.* Adults centered summer home ranges around Juniper, Shale, and Lakeshore cover types. In 1989, 5 hens with broods were followed until late August. Vegetative measurements were recorded at 105 locations sites and at areas within Juniper, Shale, and Lakeshore cover types, along with *Poa sandbergii/Sarcobatus vermmiculatus*. Cover type use by broods differed between early, middle, and late summer in 1989. Brood habitat contained significantly more grass than at random points. Brood home ranges (433 ha) were larger than for adults without broods (274 ha). Two hens were followed during both summers. Hen 1788 used the same summer area in both years. *Only 14 chicks were raised in 1989. Low overall production was caused by weather and predation*. Lack of production in 1988 was evidenced by census and trapping data collected in 1989; numbers of displaying males was reduced 33% from 1988 to 1989, and most birds (88%) captured in 1989 were adults. Page 60—Later hatching in 1989 was possibly caused by a 5-day rainstorm in late April which may have delayed female attendance on dancing grounds. Rain and snow have inhibited dancing activity in Minnesota and North Dakota. Weather conditions during the breeding period may modify the peak of hatching in any given year. Egg hatchability in 1988 (81%) was lower than 1989 (100%). This was probably due to the extremely high temperatures experienced during the 1988 hatching period. Cooler temperatures prevailed in 1989 and hatchability was comparable to other studies. Page 63—Nests in 1989 were more screened from view by vegetation than in 1988. Height-density pole readings were also significantly higher in 1989. This increase in vegetation was associated with a 7.1 cm increase in precipitation totals during April and May in 1989. In 1989, both vegetation height and effective height increased significantly throughout incubation. The decrease in vegetation height and effective height, in 1988, was most likely caused by lack of grass and forb growth nests and natural reduction of residual vegetation. Lack of new growth may have contributed to the death of an entire clutch. This nest, in residual grasses, became increasingly exposed to the sun as incubation progressed. Page 65—In 1988, high daily temperatures in June were over 32 C (90 F) and 38 C (100 F), 22 and 6 times, respectively. Ground temperatures on the shale soils were probably considerably higher. Two chicks were found dead within 10 m of nests and 10 chicks died while exiting their eggs. In 1989, temperatures during the early brood period were mild and no loss of entire broods was recorded. Weather conditions in early June are important in determining brood success. Although hot weather was a major cause of early chick mortality in this study, cold, wet weather is reported more often as having detrimental effects on young gallinaceous birds. Page 66—It appears that young in 1988 were initially affected by excessive heat prior to normal predation. **Key words: sharp-tailed grouse, productivity, temperature, precipitation, vegetation, predation, habitat use, behavior, movement**

182

_____. 1989. 1988 sharp-tailed grouse production in the Missouri River Breaks. Proceedings Annual Meeting of the Montana Chapter of The Wildlife Society 27:6-7. Notes: Gunderson found that sharp-tailed grouse production was poor. He states: “Despite high nest success, 50 percent of the nests in my study had eggs that didn’t hatch. Eight partially pipped eggs were also found in three separate successful nests. The chicks either became desiccated or overheated before they could escape the shell. The high mortality at hatching appeared unusual since I have not located published reports of similar losses. On two separate occasions, despite successfully exiting the shell, a newly-hatched chick was found dead within ten feet of the nest." Page 7 – "The peak of hatch occurred in the first week and a half of June. The average daily high for the first ten days of June was 96.4°F, including 8 days over 90° and 4 over 100°." **Key words: sharp-tailed grouse, temperature, drought, mortality**

183

Guthery, F. S. 1985. Bobwhite and turkey management during drought. Pages 31-36 *in* R. D. Brown, editor. Livestock and wildlife management during drought, Caesar Kleberg Wildlife Research Institute, Kingsville, USA. Summary: A "mini-drought" struck south Texas in 1984. Many areas received less than ten inches of rain from January through September. In fall 1984, we measured bobwhite densities on 16 sites scattered from Victoria to Zapata. The lowest density was 1 bird/100 acres on an overgrazed pasture in Zapata County. The highest was 190 birds/100 acres on a 1,600-acre pasture in Hidalgo County. The results show that good bobwhite densities can be carried through short droughts if managers are willing to plan and make some sacrifices. Late fall and late spring rains are more important to bobwhites than rains at other times. Research by the Texas Parks and Wildlife Department shows that chick production and fall rains go hand in hand. The same is true of poult production in turkeys. Drought or no, you have to address habitat structure first. **Key words: bobwhite quail, wild turkey, drought, precipitation, productivity, habitat quality**

184

_____, J. J. Lusk, D. R. Synatzske, J. Gallagher, S. J. DeMaso, R. R. George, and M. J. Peterson. 2002. Weather and age ratios of northern bobwhites in south Texas. Proceedings of the National Quail Symposium 5:99-105. Abstract: Understanding the effects of weather on quail reproduction in semiarid environments requires simultaneous consideration of temperature and precipitation data. Therefore, we used neural modeling to assess the interactive effects of summer (Jan-Aug) temperatures (monthly means of daily maxima) and seasonal precipitation (totals) on age ratios (juvenile/adult) of northern bobwhites (*Colinus virginianus*) in south Texas based on data collected during 1940-97 (*n*=35,23 years missing). Age ratios increased with June temperature. Ratios were insensitive to mean maximum daily temperature in July up to 36°C, when they began to decline rapidly. Ratios were insensitive to August temperatures. Ratios increased in an asymptotic manner with fall (Sep-Nov), spring (Mar-May), and summer precipitation, and were least sensitive to fall precipitation and most sensitive to spring precipitation. Based on our analysis, temperature and precipitation influenced bobwhite production in a complex, nonlinear manner that seemed to contain thresholds and asymptotes. Low temperatures can ameliorate the negative effects of drought, and high temperatures can suppress the positive effects of precipitation. The apparent asymptotic effect of precipitation, given temperature, illustrates that assumed linearity between precipitation and production may lead to errors of interpretation and expectation for production in a particular year. **Key words: bobwhite quail, temperature, precipitation, productivity**

185

_____, A. R. Rybak, S. D. Fuhlendorf, T. L. Hiller, S. G. Smith, W. H. Puckett Jr., and R. A. Baker. 2005. Aspects of the thermal ecology of bobwhites in north Texas. Wildlife Monographs No. 159, The Wildlife Society, Washington, D.C., USA. Abstract: We studied the thermal ecology of northern bobwhites (*Colinus virginianus*) to better understand the role of temperature in the field behavior of these birds. We obtained descriptive data on thermal aspects of the landscape; bobwhite selection for Normalized Difference Vegetation Index (NDVI; vegetation biomass) classes and cover associations relative to their thermal properties; and thermal conditions at nests, mid-day coverts, and roosts. We collected data on a 796-ha area in the Texas Rolling Plains during May 2000-July 2003 using satellite imagery, black-bulb temperature probes, mortality- and temperature-sensing radiotransmitters, and continuous-recording video cameras for nest observations. Linear models of black-bulb temperature (T_{bb}) as a function of air temperature (T_a) at a base weather station explained 42-70% of the variation in T_{bb} in 10 NDVI classes during daylight and 78% during night in summer (all NDVI classes; July 2001). During February 202, T_a explained 38-92% of the variation during day and 89% of the variation at night. The linear models provided a means of qualitatively assessing thermal space on the landscape as T_a changed and of predicting T_{bb} in NDVI classes. At T_a = 42°C, 100% of the 796-ha landscape under study had predicted T_{bb} > 39°C, the approximate threshold leading to hyperthermia in bobwhites. Based on 9,287 radiolocations of 217 bobwhites, bobwhites selected for all NDVI classes in mixed-shrub cover (sandplum, [*Prunus angustifolia*]; fragrant sumac, [*Rhus aromatica*]) on an annual and seasonal basis. If T_a was <35°C, the approximate upper critical temperature, the operative temperature (T_e) experienced by bobwhites exceeded T_a in 699 of 818 simultaneous readings (n = 24 bobwhites with thermal transmitters) and the difference between T_e and T_a increased as air temperature declined. Data from video cameras indicated thermal stress (i.e., gular flutter) in 25 of 26 incubating bobwhites. Gular flutter began at an average T_a of 30.4±0.2°C SE (n = 158) and total bouts of gular flutter averaged 87 minutes/bird/day after 16 June. Data from thermal radiotransmitters indicated 91.3±6.1% of incubating adults were in thermal stress at T_a > 35°C. Temperature of nest contents averaged about 30°C and incubating bobwhites appeared to protect nest contents more rigorously from hyperthermia than from hypothermia. Mid-day covert selection (NDVI 6, mixed-shrub cover; n = 58) during summer reduced bobwhite exposure to T_{bb} > 30°C by an average of 1,6000.7 heating-degree minutes in comparison with random points (n = 58) during 1200-1600 hours. The roosting disc appeared to confer energetic advantages at Ta < 16.2°C and the advantage increased as Ta declined. Our results were consistent with the heat hypyothesis on reproduction variability because we observed thermal stress at low Ta ($\geq$ 22.1°C) in incubating birds and we projected lethal T_{bb} (53.2°C) at high T_a (45°C) in NDVI classes used by nesting bobwhites. Our results reaffirm that temperatures on the landscape are a legitimate concern for bobwhite managers. The goal of habitat management vis-à-vis temperature is to insure well-distributed mid-day coverts for thermal refugia in summer and ground cover of sufficient height and density to prevent heat excess in the near-ground environment. **Key words: bobwhite quail,**

temperature, habitat use, habitat management, biothermal regulation, behavior, vegetation

186

_____, M. J. Peterson, and R. R. George. 2000. Viability of northern bobwhite populations. Journal of Wildlife Management 64(3):646-662. Abstract: Quail populations are declining in North America. Hence, we modeled the viability of northern bobwhite (*Colinus virginianus*) populations subject to weather catastrophes and harvest to help focus management and research efforts to reverse the decline. We examined northern-latitude (winter weather catastrophes) and southern-latitude (summer weather catastrophes) populations separately, because winter survival is lower and density-dependent production is stronger in northern- than in southern-latitude populations. Under a criterion of quasiextinction at ≤ 14 birds (1 covey), the demographic capacity required for at least a 95% probability of persistence for 100 years was about 100 birds with summer weather catastrophes, about 500 birds with winter weather catastrophes, and about 800 birds with both winter and summer weather catastrophes. Given assumptions underlying the model, populations subject to summer weather catastrophes were sustainable under a ≤ 30% harvest rate if demographic capacity in autumn was about 700 birds. Populations subject to winter weather catastrophes could persist at ≤ 40% harvest rates and a demographic capacity of about 400 birds. Northern populations were more vulnerable to extinction in the absence of harvest, whereas southern populations were more vulnerable to extinction in the presence of harvest. **Key words: bobwhite quail, model, weather catastrophes**

187

_____, N. D. Forrester, K. R. Nolte, W. E. Cohen, and W. P. Kuvlesky Jr. 2000. Potential effects of global warming on quail populations. Proceedings of the National Quail Symposium 4:198-204. Abstract: Populations of scaled quail (*Callipepla squamata*) and northern bobwhites (*Colinus virginianus*) have declined in North America coincident with global warming. We speculate on a cause-effect relation between global warming and quail declines. Quail are sensitive to operative temperatures > 38.7°C, which commonly occur under natural conditions in southern latitudes. Based on empirical results, the laying season for quail may be reduced by as much as 60 days because of high temperatures. We provide mechanistic models that show how reduction in length of the laying season suppresses per-capita annual production. Global warming could be associated with declining quail populations through suppression of reproduction; it also could exacerbate the effects of habitat loss and fragmentation. These possibilities should be explored in field and laboratory research. **Key words: scaled quail, bobwhite quail, temperature, reproduction, productivity, habitat loss/fragmentation, model**

188

Hamerstrom, F. N. Jr. 1939. A study of Wisconsin prairie chicken and sharp-tailed grouse. Wilson Bulletin 51(2):105-120. Notes: The author notes the effects of weather on breeding behavior. The dancing of the Columbian sharp-tailed grouse is correlated with light conditions. Hamerstrom, based on his study, believed the prairie chicken mating is regulated by light and temperature. He found that (a) late winter displays occurred on days warmer than usual, (b) early spring displays occurred for an hour or two after sunrise on clear bright mornings with temperatures a few degrees below freezing, but not on raw cloudy mornings which were five or six degrees warmer, (c) during the early part of the main booming season booming occurred all day on cloudy days; later, in warmer weather, cloudy days did not produce the day-long response, (d) during the height of the season booming occurred from the first faint trace of light until an hour or two after sun-up, again for about two hours before dark; there was less activity on unusually hot days than on moderate ones, (e) on those hot days and toward the end of the season generally, there was more activity in the cooler early morning than in the evening, and morning booming stopped earlier than usual, and (f) at the end of the season, although cocks continued to come to their regular stations morning and evening, booming was heard only on occasional clear frosty mornings and stopped as soon as the air grew warmer shortly after sunrise. Light rains did not deter booming cocks; heavy rains silenced them completely. **Key words: sharp-tailed grouse, prairie chicken, temperature, precipitation, clouds, behavior, frost**

189

_____, O. E. Mattson, and F. Hamerstrom. 1957. A guide to prairie chicken management. Technical Wildlife Bulletin Number 15, Wisconsin Conservation Department, Madison, USA. Notes: Page 79 – Weather. The only real defense against extremes of weather is good habitat….the prairie chicken can be saved only by guaranteeing to it a place to live. Above all else, this means habitat management. **Key words: prairie chicken, weather extremes, habitat management**

190

Hammond, M. C. 1941. Fall and winter mortality among Hungarian partridges in Bottineau and McHenry counties, North Dakota. Journal of Wildlife Management 5(4):375-382. Notes: "..there [is a] decided tendency for the partridges to include a graveled, or at least a graded, road within their winter range, especially during periods of moderately deep snow." "Even during periods of deep snows and extremely low temperatures, all partridges examined were in very good physical condition, while pheasants in the same localities were often found to be thin and sometimes, apparently, were starving." "Winter conditions are quite variable in the portion of North Dakota studied, and years of relatively mild weather as well as those of extreme cold occur. Even though the snow was 20 inches in depth at times (in areas protected from drifting), winds kept it piled in drifts, and the stubble fields had a covering that averaged not more than 5 or 6 inches. Field observations disclosed that partridges were able to dig through these snow depths and find waste grain." "Yeatter found evidence that wet weather combined with certain soil conditions resulted in mudballing of young chicks." **Key words: Hungarian partridge, snow, temperature, habitat use, nutrition, soil**

191

Hannon, S. J. and K. Martin. 2006. Ecology of juvenile grouse during the transition to adulthood. Journal of Zoology 269:422-433. Notes: Page 423—The primary causes of early juvenile mortality were cold wet weather, predation, lack of food and low quality of the chick or hen. When cold wet weather occurs shortly after hatch, juvenile mortality can be high. Chicks are not able to thermoregulate fully until they are 8-10 days old, and during inclement weather must reduce foraging time to brood. In poor weather, the lower availability of insects may reduce foraging success, resulting in poor chick growth. Chicks may also be more susceptible to predation after cold wet weather. Before achieving adult body mass, juveniles have higher energy demands because of growth and moulting, poorer insulation and higher surface/volume ratio than adults. In species where males are much larger than females, male chicks have higher mortality rates than females in years with poor weather and/or low food production. This has been attributed to the higher energy requirements and growth rates of males. For prairie grouse, drought conditions may also reduce juvenile survival. However, several studies found little or no link between chick mortality and weather. Page 429—There appear to be two main 'bottlenecks' for juvenile survival. The first is over the first 2 weeks of life when chicks are dependent on the hen for thermoregulation, habitat selection and protection from predators. For species where males are much larger than females, males suffer proportionately higher mortality than females in years with poor weather and/or food. **Key words: grouse, precipitation, temperature, habitat use, insects, nutrition, mortality, thermoregulation, drought, predation**

192

Haroldson, B. S. and R. O. Kimmel. 1990. Winter bait-trapping of gray partridge as influenced by snow cover. Pages 159-164 *in* K. E. Church, R. E. Warner, and S. J. Brady, editors. Proceedings Perdix V: Gray partridge and ring-necked pheasant workshop. Minnesota Department of Natural Resources, Mankato, USA. Abstract: Gray partridge (*Perdix perdix*) were trapped in south-central Minnesota during the winters of 1984 through 1988 using walk-in bait traps. Trapping success ranged from 0.00 birds per trap-day in 1985 and 1987 to 0.52 birds per trap-day in 1988. Success increased during periods with complete snow cover and decreased with patchy snow conditions. Snow cover should be present for several weeks before tapping begins. **Key words: gray partridge, snow, technique**

193

Haroldson, K. J. 1995. Energy requirements for winter survival of wild turkeys. Proceedings of the National Wild Turkey Symposium 7:9-14. Abstract: As wildlife managers expand the range of wild turkeys (*Meleagris gallopavo*) beyond ancestral northern limits, information on the tolerance of wild turkeys for severe winter weather becomes increasingly important. I used predictive models based on time-energy budgets to estimate winter food requirements of wild turkeys. An average 4.23 g wild turkey would require 11.3 kg of a mixed diet during a 120-day winter with a mean temperature ≥11°C. Winter food requirements would increase by 2.4 kg/bird for every 10°C drop in mean winter temperature. Because wild turkeys in northern climates often supplement natural foods with corn during winter, I estimated size of corn food plots needed to sustain wild turkeys based on average winter temperature. **Key words: wild turkey, temperature, model, nutrition**

194

_____, R. O. Kimmel, M. R. Riggs, and A. H. Brener. 2006. Association of ring-necked pheasant, gray partridge and meadowlark abundance to Conservation Reserve Program grasslands. Journal of Wildlife Management 70(5):1276-1284. Notes: Page 1282—In Minnesota, statewide partridge indices peaked during a widespread drought in 1987-1990, declined when the drought ended in 1991, and fell to a low during the extremely wet summer of 1993…We believe that spring and summer precipitation trends heavily influenced the strong year effect we observed. **Key words: gray partridge, precipitation, drought, population dynamics**

195

_____, M. L. Svihel, R. O. Kimmel, and M. R. Riggs. 1998. Effects of winter temperature on wild turkey metabolism. Journal of Wildlife Management 62(1):299-305. Abstract: We used indirect calorimetry to measure the effects of air temperature (T_a), age class, and body mass on metabolic rates of 9 adult and 7 juvenile female eastern wild turkeys (*Meleagris gallopaco silvestris*) during winter. Previous studies produced disparate results on this important aspect of winter ecology of wild turkeys. Standard metabolic rates (SMRs) of adult and juvenile hens were not different (P = 0.122) and averaged 28.69 mL O_2.min^{-1}.bird^{-1}. Wild turkey metabolism increased with decreasing T_a (P < 0.001) below the lower critical temperature (T_{lc}) of 10.9°C. Metabolic rates were not related to body mass (P = 0.571), and age-specific metabolic rates were not distinguishable (P = 0.998). We estimated that a flock of 20 hens would need to find 400 g/day of additional food to meet thermoregulatory demands for each 10°C drop in T_a below 10.9°C. **Key words: turkey, temperature, thermoregulation, nutrition**

196

Harper, H. T., B. H. Harry, and W. D. Bailey. 1958. The chukar partridge in California. California Fish and Game 44(1):5-50. Notes: Page 49—"The so-called 'wet' years in the desert and semi-desert areas appear to be more favorable to chukar reproduction than any other factor, especially when precipitation occurs during the late winter and spring months….During the hot, dry summer months chukars are seldom observed more than one mile from water. After the first cool days and the first rains in early fall, chukars disperse from their summer haunts near water and forage into range not frequented during the summer." **Key words: chukar partridge, precipitation, temperature, behavior, habitat use**

197

Hawkins, A. D. 1937. Winter feeding at Faville Grove 1935-1937. Journal of Wildlife Management 1:62-69. Notes: "The summer of 1935 was ideal for wildlife. Food of all sorts was plentiful and cover was lush. Nesting was unusually successful and game birds were abundant, but winter brought the deepest snow and most intense cold of the century. As a result the plentiful food supply was buried under several feet of snow, and the birds died. In the summer of 1936 a record drought severely curtailed both food and cover. The diminished crop of ragweed and acorns suffered a further loss of 10 per cent from insect attack. Nesting results were poor due to the drought. Winter brought no snow and little severe cold, but the fields were sealed by a blanket of ice on January 6 and remained so, without a break, for two months. Few birds died on fed areas like Faville Grove; but on some unfed areas quail and Hungarian partridges perished in large numbers." **Key words: quail, Hungarian partridge, snow, precipitation, ice, temperature, nutrition, mortality**

198

Hays, D., M. Tirhi, and D. Stinson. 1998. Washington state status report for the sage-grouse. Washington Department of Fish and Wildlife, Olympia. Notes: The authors provide a synthesis of weather impacts on sage-grouse and its impacts on populations. They state in part "Habitat that provides good shrub and grass cover for nesting and wintering allows grouse to increase despite predation"; they also note the negative impacts of overgrazing and fire on sage lands. **Key words: sage-grouse, weather, population dynamics**

199

Healy, W. H. and E. S. Nenno. 1985. Effect of weather on wild turkey poult survival. Proceedings of the National Wild Turkey Symposium 5:91-101. Abstract: Weather conditions are partly responsible for annual variations in poult production, but the specific effects of weather on the survival of eastern wild turkey poults (*Meleagris gallopavo silvestris*) are not well documented. Understanding the relationships between weather and poult survival might permit predicting fall populations from the preceding spring weather. Weather conditions and poult survival were monitored daily during 2 breeding seasons. The impact of weather on poult mortality included both age-specific and random effects. Rain and low temperatures (3.8 cm, 7-8° C) over an 18-hour period produced mortality in 12- and 15-day-old broods, but not in 4- and 6-day-old broods. One hen abandoned her nest during this storm. The disappearance of 8 of 11 poults in another brood coincided with a heavy thunderstorm that occurred about 1 hour after the birds left the nest. Predation and accidents were additional causes of poult mortality. Systematic brood counts provide the best means for predicting fall populations because spring weather accounts for only part of the annual variation in productivity. **Key words: eastern wild turkey, precipitation, thunderstorm, temperature, mortality, chick survival**

200

Heath, B., R. Straw, S. Anderson, and J. Lawson. 1996. Proceedings of the sage-grouse workshop, Pinedale, Wyoming, USA. Notes: "All large-scale sagebrush control projects, regardless of type, adversely affect sage-grouse populations. The combination of sagebrush eradication and drought is devastating to sage-grouse populations. During drought, ungulate numbers need to be reduced to diminish the impact to sagebrush rangelands." <u>Page 5</u> – "Impacts such as drought, fire, and heavy livestock grazing greatly reduce the availability of forbs and insects that are required by sage-grouse chicks. Connelly stated that drought impacted early brood rearing habitat by reducing important food forbs, furthermore, when drought conditions persist certain plant species are not produced at all. Connelly's research in Idaho indicated that fire in the *Artemisia tridentata wyomingensis* type degraded early brood rearing habitat by reducing sagebrush cover and insect abundance (especially ants). When the affects of fire are coupled with drought, it dramatically lowered chick survival. It was universally agreed that sage-grouse use sagebrush exclusively for food during the winter. Because of the variability in winter snow depths, managers need to maintain different heights and coverages of sagebrush to ensure sage-grouse use. The use of a particular area is dependent on the severity of the winter. Typically, sage-grouse will move to "critical winter habitat" once every 8-10 years and these areas are of extreme importance. These critical winter areas provide sage-grouse with food and cover when most of the surrounding areas are snow covered. Page 6 – "Mike Schroeder indicated that windswept, sagebrush ridges often provide winter habitat for sage-grouse because they provide sagebrush for food and cover even during the harshest winters. Additionally, they provide snow drifts that sage-grouse can roost in to escape extreme cold." Page 8 – "Connelly stated that since 1986, with the exception of 1989 and 1993, Idaho has been experiencing a drought. During this time some sage-grouse populations have declined 60-70%. Drought, in association with other factors, was thought to contribute to these population declines. During prolonged periods of drought, herbaceous cover is not produced or is produced at lower levels. The problem is compounded when grazing pressure is not adjusted. The reduction in herbaceous cover results in lower nesting success and lost clutches in the 2 week period after hatch. It appears that chicks are dying from starvation as a result of the lack of herbaceous forage and/or are being predated when they are forced to move long distances through sparse cover to obtain food." **Key words: sage-grouse, snow, precipitation, drought, nutrition, mortality, range modification**

201

Heffelfinger, J. R. and R. J. Olding. 2000. Montezuma quail management in Arizona. Proceedings of the National Quail Symposium 4:183-190. Abstract: The Montezuma quail (*Cyrtonyx montezumae mearnsi*) has substantially different habitat requirements than other quails found in the U.S. They inhabit evergreen oak woodlands of mountain ranges in the southwest and feed primarily on underground bulbs and tubers. Populations respond to summer precipitation because the vegetation which provides food and cover for Montezuma quail flourishes after the summer rains. Moderate to heavy grazing increases availability of Montezuma quail food plants, but resultant lack of cover precludes use of such sites. Montezuma quail avoid areas with greater than 50% forage utilization by ungulates. As with other Arizona quail species, hunting has been shown to have limited or no impact on the population level during the following years. Birds may be depleted in localized areas temporarily, but available habitat is re-occupied when pre-nesting dispersal occurs. Annual pre- and post-hunt flush counts were conducted 1988-1996 by the Arizona Game & Fish Department, United States Forest Service, volunteers, and local quail hunters. Average covey size decreased during the hunting season, but the magnitude of the decrease was similar in unhunted populations. Montezuma quail populations fluctuate in response to habitat and weather conditions. A state-wide hunter questionnaire program estimated total harvest trends for Arizona. In addition, wing collection barrels had been placed in heavily hunted areas from 1981 to 1996 to obtain hunter-effort information and sex/age characteristics of the harvest. Data from these wings indicate average percentage of juveniles in the harvest was higher for Montezuma quail (mean – 74.4%, range = 55.9-84.9%) than other Arizona quail species such as Gambel's (mean = 65.6%, range = 23-77%). Hunters harvested an average of 2.2 Montezuma quail per day. In 3,107 hunter-days during this period, only 13 (0.4%) resulted in a limit of birds. Three of these limits occurred in 1996 when the bag limit was reduced from 15 to 8 Montezuma quail. **Key words: Montezuma quail, precipitation, vegetation, cover, nutrition, hunting**

202

_____, F. S. Guthery, R. J. Olding, C. L. Cochran Jr., and C. M. McMullen. 1999. Influence of precipitation timing and summer temperatures on reproduction of Gambel's quail. Journal of Wildlife Management 63(1):154-161. Abstract: We analyzed the influence of rainfall and temperature patterns on Gambel's quail (*Callipepla gambelii*) to better understand variability in call counts and reproduction, based on data collected in Arizona during 1978-96, midwinter (Dec-Jan) precipitation invoked a stronger calling response than early-winter (Oct-Nov) or late-winter (Feb-Mar) rainfall. Reproductive failure (< 1 juv/ad) was associated with low rainfall in October-March and high mean daily temperatures during June-July. Moderate production (1-2 juv/ad) occurred under low rainfall in winter, if June-July temperatures were cool. For any rainfall pattern, higher temperatures in July were associated with lower age ratios. **Key words: Gambel's quail, temperature, precipitation, census, productivity, population dynamics, age ratio**

203

Hejl, S. J., J. Verner, and R. P. Bala. 1988. Weather and bird populations in true fir forests of the Sierra Nevada, California. Condor 90(3):561-574. Abstract: We monitored bird communities of true fir forests at 51 study sites in the western Sierra Nevada during the breeding seasons of 1983, 1984, and 1985. The summer of 1983 followed the El Niño winter of 1982-1983, with the greatest snowfall on record. The summers of 1984 and 1985 followed winters with moderate snowfalls. Bird species richness (BSR) and average total count (ATC) increased linearly from 1983 to 1985. The relative abundances of 12 common species increased from 1983 to 1985; abundances of two common species did not differ among years. Twenty-eight uncommon species increased and four decreased in numbers from 1983 to 1985. Bird response patterns differed between lower-elevation white fir (*Abies concolor*) forests and upper-elevation red fir (*A. magnifica*) forests. Bird numbers were similar in both habitats in 1983 but greater in white fir than in red fir in 1984 and 1985. Although abundances of the common species increased in both habitats in both years, those of uncommon species did not increase substantially in red fir until 1985. We suggest that bird numbers were depressed in 1983, but not atypically so for true fir forests. Numbers of permanent residents are often limited by frequent but unpredictable winters with excessive snowfall (Beedy 1982, Granholm 1982, Raphael and White 1984). Numbers of migrants, as in the case of this study, are sometimes affected similarly. White fir and lower-elevation forests may harbor "source" populations for red fir "sink" populations during periods of resource stress. **Key words: mountain quail, blue grouse, snow, El Niño, habitat use**

204

Henderson, C. W. 1971. Comparative temperature and moisture responses in Gambel and scaled quail. Condor 73:430-436. Summary: Various responses to high temperature and low moisture were studied in the laboratory in Gambel quail (*Lophortyx gambelii*) and scaled quail (*Callipepla squamata*). The minimum daily water requirements of the two species were found not to differ significantly at 28-29°C. Evaporative water loss rates were similar at 25, 30, and 35° C. At ambient temperatures of 40 and 45° C, Gambel quail lost significantly higher percentages of water through evaporation than did scaled quail. The response of body temperature to increasing ambient temperatures was, in general, the same for both species, and indicated that the thermoneutral zone was probably between 25 and 35° C. Both species were able to tolerate an ambient temperature of 40° C without ill effects, but at 45° C Gambel quail survived better than scaled quail. Gular fluttering was exhibited by Gambel quail when body temperature exceeded 43° C, but was not observed in scaled quail at any experimental temperature. Oxygen consumption values were similar at 30° C, but at 40° C the values were significantly higher for Gambel quail. Both species were able to dissipate all metabolic heat while experiencing hyperthermia at 40° C. These results indicate that Gambel quail are better adapted, physiologically, to hot, arid environments than are scaled quail. This is quite plausible since Gambel quail inhabit extreme desert areas while scaled quail are confined to more mesic areas with more moderate temperatures. Scaled quail are better adapted with regard to water economy when ambient temperatures do not exceed 40° C. **Key words: Gambel's quail, scaled quail, temperature, hydration**

205

Hennessy, T. E. and L. Van Camp. 1963. Wintering mourning doves in northern Ohio. Journal of Wildlife Management 27(3):367-373. Notes: Winter Injuries – Winter injuries to doves in the form of frozen toes and losses of plumage have been reported by several workers. On this study, 26 of 36 birds trapped in Huron County during the winter of 1961-62 had one or more frozen toes. Some of the birds, probably adults, had lost nails from the digits and had one or more enlarged, club-like toes. After a severe ice storm on February 25, 1961, which covered the ground and vegetation with an inch of ice, 8 doves from a flock of 60 had lost their tails completely. Others had lost some tail feathers. At ground roosts, after such weather, Van Camp has found dead doves frozen to their perches. Several doves, trapped after a wet snow followed by a sharp drop in temperature, had balls of frozen snow on their lower breast feathers. Some birds exhibited tears up to 2.5 cm in diameter in the skin of their breasts. It is unlikely that the weight of the snow caused the tears. Probably they were self-inflicted when doves were freeing themselves from perches to which they had become frozen. **Key words: mourning dove, temperature, ice, snow, mortality**

206

Herman, C. M. 1969. The impact of disease on wildlife populations. BioScience 19(4):321-330. Notes: "A possible relationship between the intensity of coccidian infection of California quail and food habits was observed some years ago. During the dry summer months, when intensity of coccidian oocyst output was at its lowest, the birds subsisted mainly on seeds. During the months of heaviest rainfall, the birds fed mainly on leafy plants and had many more coccidial oocysts in their feces." **Key words: California quail, precipitation, diet, vegetation, disease, mortality**

207

Herman-Brunson, K. M. 2007. Nesting and brood-rearing habitat selection of greater sage-grouse and associated survival of hens and broods at the edge of their historic distribution. M.S. Thesis, South Dakota State University, Brookings, USA. Notes: <u>Page 76</u>—"Exposure to wet and cold weather can also reduce survival of chicks. I found high mortality to chicks exposed to rain and cold weather immediately after hatch. Greater precipitation in 2005 resulting in increased herbaceous cover and delayed plant desiccation may have resulted in higher survival of chicks $\geq$5-6 weeks to 1 January in 2005." **Key words: precipitation, temperature, mortality, vegetation, nutrition**

208

Hermann, M. F. 1980. Spruce grouse habitat requirements in western Montana. Dissertation, University of Montana, Missoula, USA. Abstract Note: "Climatic differences between the 2 years somewhat limited the availability of berry-producing plants. Thus, in 1977, the birds supplemented their diets with lodge pole pine, ponderosa pine, Douglas-fir, and Engelmann spruce needles coupled with grasses, sedges, and forbs." **Key words: spruce grouse, temperature, vegetation, diet**

209

Hernández, F., J. D. Vasquez, F. C. Bryant, A. A. Radomski, and R. Howard. 2002. Effects of Hurricane Bret on northern bobwhite survival in south Texas. Proceedings of the National Quail Symposium 5:87-90. Abstract: The impacts of intense storms such as hurricanes on wildlife rarely are documented. We had the opportunity to monitor the impact of Hurricane Bret on northern bobwhite (*Colinus virginianus*) survival and reproduction in Brooks County, Texas. On 23 August 1999, Hurricane Bret struck our study area, which received >45 cm of rain and experienced wind gusts >160 km/h. We documented the survival of bobwhite adults (n=82), broods (n=15), and nests (n=4) via radiotelemetry before and after the hurricane. Only 11 (13%) adult bobwhites were killed, with 4 killed directly from exposure to the hurricane. Broods experienced higher mortality, with 7 (47%) broods killed during the hurricane. Six of the 7 dead broods were <1 week old. Sizes of the 8 surviving broods were reduced from a mean brood size of about 11 chicks prior to the hurricane to a mean size of 4 after the hurricane (P=0.01). Of the 4 nests monitored, 3 were depredated and eggs in 1 nest hatched the weekend of the storm. Hurricanes may negatively impact the survival of young (i.e., <2 weeks old) bobwhite broods. **Key words: bobwhite quail, wind, hurricane, mortality, predation**

210

Herzog, P. W. 1980. Winter habitat use by white-tailed ptarmigan in southwestern Alberta. Canadian Field-Naturalist 94(2):159-162. Abstract: Winter habitat and movement of white-tailed ptarmigan (*Lagopus leucurus*) were investigated in Alberta during January and February of 1977 and 1978. The critical feature influencing habitat use appeared to be the availability of food, mainly willow (*Salix* spp.). In 1977, most sightings of ptarmigan occurred in alpine cirques where low-growing willows remained snow-free. Alpine willows were completely snow-covered in 1978, when 99% of ptarmigan sightings occurred along stream courses and willow flats in subalpine forest, 2.5-7.5 km from cirque habitats. Food availability, determined by snow accumulation, may be an important factor influencing the migration of ptarmigan. Page 161—I suggest that the geographic differences in migration of willow and sage-grouse may be due to variations in snow accumulation between different areas. **Key words: white-tailed ptarmigan, snow, vegetation, nutrition, behavior, habitat use, movement**

211

Hewitt, D. G. and R. L. Kirkpatrick. 1997. Ruffed grouse consumption and detoxification of evergreen leaves. Journal of Wildlife Management 61(1):129-139. Abstract: Ruffed grouse (Bonasa umbellus) in the southeastern United States commonly eat evergreen leaves during winter. Despite their abundance, these leaves rarely make up >50% of the diet. We fed diets containing 20 and 40% mountain laurel (ML) (*Kalmia latifolie*) and Christmas holly fern (CHF) (*Polystichum acrostichoides*) to captive ruffed grouse to determine the bird's ability to exist on these forages and to investigate detoxification of secondary plant compounds. Grouse consuming diets with 20% of test forages performed similar to grouse eating a control diet. Diets with 40% of the test forages caused reduced intake and birds consuming the CHF diet were unable to maintain body mass. Conjugate-based detoxification systems were stimulated by both test forages, although detoxification strategies varied between forages and levels of forage in the diet. Although grouse appear unable to exist solely on evergreen leaves, these forages probably contribute to ruffed grouse winter survival by remaining available during snow accumulation and by decreasing foraging times due to high intake rates. **Key words: ruffed grouse, snow, nutrition, vegetation**

212

Hillman, C. N. and W. W. Jackson. 1973. The sharp-tailed grouse in South Dakota. Technical Bulletin Number 3, South Dakota Department of Game, Fish and Parks, Pierre, USA. Notes: In the segment titled Limiting Factors the authors address effects of weather on sharp-tailed grouse. They state these birds in South Dakota "…endure cold temperatures and high winds with little known adverse effects. During periods of deep snow, birds burrow or roost beneath the snow which provides insulation from cold temperatures and wind. Grouse resort to tree budding when deep snow covers their preferred foods. During mild winters the birds are located throughout the prairie, but during extreme weather conditions, the birds retreat to sheltered areas such as river bottoms or windbreaks. Severe blizzards, which may cause extensive pheasant losses, do not greatly affect grouse populations. In many areas a cold, wet spring is detrimental during the nesting and brood rearing periods. In South Dakota, however, wet spring weather appears favorable to the grouse hatch. Age ratios obtained from fall bag checks indicate better reproduction during relatively wet years as compared to hot, dry years. Reproduction the following year is probably increased because of the additional birds in the breeding population and more residual cover resulting from the extra rainfall. Hail storms or local hard spring rains may be detrimental to broods in localized areas." Page 58—"Weather conditions over large areas influence habitat conditions which in turn may cause fluctuations in sharptail numbers." **Key words: sharp-tailed grouse, temperature, snow, wind, precipitation, hail, behavior, mortality, vegetation, habitat use, reproduction**

213

Hjorth, I. 1966. Influence of abiotic factors upon the display of the black grouse *Lyrurus tetrix*. Var Fagelvarld 25(4):289-314. Abstract: The following is a brief outline of a preliminary statistical investigation of data from 1962-1964 concerning the correlation of display activity of the black grouse with weather and ground conditions. The field work was done on the Gyamossen bog, about 7 m to the west of Jassjo in the central part of the highlands of southern Sweden. At those periods of the year, during which the black grouse had display activity, daily barograph and thermohygrograph recordings were taken. The weather situation (clouds, precipitation, rime, mist, wind, etc.) was written down 4 times/day. Light evaluations were made with a luxmeter every 10 min during the lek observations. Some of the factors which influence the display were viz. motivation, ground conditions, weather, light, activity of other cocks and hens, territorialism. Thus, sign stimuli belonging to display behavior emanate partly from the biotic and partly from the abiotic environment. Here only the abiotic factors are treated. Activities belonging to lek behavior are released by a stimuli-chain, in which the different links offer new factors in each situation on the cocks' way from the nightquarters till arrival at the arena. In spring, when motivation is at a high level, the cocks normally ignore weather conditions (except light). Then the birds come to the arena even when there are strong winds or when rain is falling. Therefore an analysis of the significance of the weather factors must exclude the spring data. During the rest of the year abiotic factors had strong influence upon the display activity. This report contains data from September 1 to March 15 only. The black grouse begins the morning display later when snow covers the ground of its nightquarters. When the ground is bare he flies to the arena early at dawn. If, however, the hollows of the arena bog are covered with frozen slush, the cocks leave the place rather quickly, returning at sunrise. The snow itself did not have a negative influence on the display motivation, but lek was hindered when the loose snow-covering exceeded 6 cm. Display motivation was often manifested in the tree-tops on those occasions. A thick snow-covering also affected the territorialism on the arenas. Then the territory boundaries (well-known to each territorial cock in bare ground conditions) cannot be recognized and more real fighting occurred as a result. In this report Chi^2-tests were used to test the relationship between air pressure tendencies, amount of clouds, temperature tendencies and wind velocities respectively and estimates of the display intensities observed. There was apparently a relationship between increasing air pressure and display activity, while decreasing pressure did not seem to have much significance. Low morning temperatures (ranging from -20°C to about 2°C) were more favorable to lek than higher ones. In the latter case the cocks display over a wide range of their habitat. Low temperature conditions seem to favor aggregation and territorialism on the arena. Temperature tendency had a strong effect on lek activity. A lowering of temperature stimulates the cocks to lek activity while rising or unchanged conditions did not have any significant effect. The influence of falling temperature was much stronger in mild weather than in cold weather. The velocity of wind near the ground affected the grouse more in open places, where the arena is situated, than in the forest, where the birds have nightquarters. Thus, in the forest, velocities over 3 m/sec counteracted display activity, but in the arena values over 2 m/sec made the cocks give up lek activity entirely. Clear weather was more favorable to lek than was a cloudy sky. In this method of correlation the influence of other weather factors than that treated cannot be estimated. In addition, meteorological factors were not freely varied but were dependent on each other. The results presented must not be taken as examples of obligate relationships. The weather factor which seemed to favor display or lek could have varied in accordance with some other meteorological quantity, which also stimulated the cocks. It was evident, however, that all weather conditions, favorable to display, were to be found in one and the same meteorological situation, viz. the high pressure condition. When all positive factors, occurred the same morning, lek will always follow. **Key words: black grouse, wind, precipitation, ice, snow, barometric pressure, clouds, behavior**

214

Hoffman, D. M. 1973. Some effects of weather and timber management on Merriam's turkeys in Colorado. Proceedings of the National Wild Turkey Symposium 2:263-271. Abstract: The climate of the range occupied by Merriam's turkey (*Meleagris gallopavo merriami*) in Colorado is usually not severe, because flocks move from high summer range to preferred winter range at lower elevations. Measurements of snowfall and precipitation within two preferred winter areas are listed. Occasionally, as in the 6-week period from early February 1964 to mid-March 1964, frequent heavy snows and high winds resulted in unusual winter stress on turkeys, unless food conditions are exceptionally good. Methods of harvesting timber affect selection of roost sites and the establishment and maintenance of forest openings. Selective cutting that removed approximately half of the old growth in stands of uneven-age ponderosa pine (*Pinus ponderosa*) on two summer roost sites did not appear to deter turkeys from using these sites for roosting. There were 17 other roost sites (9 winter and 8 summer sites) in unlogged tracts of old-growth timber. No roost sites were found in second-growth timber after clear-cutting operations. **Key words: Merriam's turkey, snow, precipitation, wind, habitat modification**

215

_____. 1963. The lesser prairie chicken in Colorado. Journal of Wildlife Management 27(4):726-732. Notes: "A major reduction in lesser prairie chicken range and numbers apparently coincided with the dust-bowl condition of the 1930's. Drought and land-use practices undoubtedly contributed to this reduction." "Appropriate grassland management is required for the survival and increase of the lesser prairie chicken. The decline in number of lesser prairie chickens in Colorado has been attributed to pasture depletion during the severe drought of the 1930's." "Best counts were obtained on clear, calm mornings, when the cocks were most active on the grounds. On mornings with strong winds or rain, the cocks were usually far less active." **Key words: prairie chicken, drought, wind, precipitation, census, vegetation, population dynamics, behavior**

216

_____. 1962. The wild turkey in eastern Colorado: a research and management study of Merriam's wild turkey in eastern Colorado. Technical Publication No. 12. Colorado Department of Game and Fish, Denver, USA. Notes: Page 8 – "Findings also indicate that turkeys will desert an area when water becomes scarce. In the winter when snow is available, the flocks will eat snow and drink from melting snow so that open water is not needed as in the warmer seasons." "Most roosts are selected in locations sheltered from high winds." Page 15 – "Predation plays an important role in disposing of sick and weak birds and is probably more beneficial than harmful except where predator populations become excessively large or the wild turkeys become weak from lack of food caused by deep snow or other adverse conditions." Page 17 – "Two instances in which adverse weather affected wild turkey populations were recorded during this study. Purgatoire River Flood: During late July 1954 a flood from heavy rains east of Trinidad moved down the Purgatoire River. Ranchers in the Higbee area reported that a strip of land approximately a half mile wide was flooded. Mr. W. W. Zimmerman stated that he and several other local ranchers pulled four live wild turkey hens from the flood waters near a wide curve in the main channel above Higbee bridge. Several other hens could be seen, but could not be reached. Those rescued were completely exhausted, but after resting awhile, they wandered off. Later the same party pulled three dead hens from the waters of the main channel and two more from an irrigation ditch. The number of hens caught in the flood at this time of year indicates that the hens were probably attempting to hatch a second setting of eggs. Much of the nesting cover in this area is found along the main river bottom where a flood of this intensity can be dangerous. Late Spring Snows: The late heavy snow during May 1955 undoubtedly ruined many wild turkey nests on the eastern slope mountain ranges although the turkeys in much of the Lower Purgatoire River and Mesa de Maya areas were apparently unaffected. The snow, which accumulated to depths varying between 3 and 5 feet in most mountainous areas came when most hens are normally nesting. The effect of this storm was a reduction in the number of broods in the mountain areas. Many broods were much later and much smaller than usual, indicating that many hens were forced to renest in order to bring off any young. Two carcasses and seven ruined nests were reported in Huerfano and Las Animas counties following these heavy snows." **Key words: Merriam's turkey, snow, flood, mortality**

217

Hoglund, N. H. 1980. Winter ecology of the willow grouse *Lagopus lagopus lagopus*. Swedish Wildlife Research Viltrevy 11(5):249-270. Abstract: The Loevhoegen area, situated on the border between Dalarna and Haerjedalen at latitude 62°N, was studied during mid- and late winter, 1966-1968. The grouse's food consisted almost exclusively of twigs, buds and birch catkins. The birds always fed walking on the snow. When not occupied by eating, the grouse roosted, always on the ground and preferably in snow burrows. The night burrows were completely closed, dug below the surface of the snow during January and February. In March, grouse begin to roost for the night in open burrows *sbd* pits in the snow. The time spent by the grouse in the burrow could be estimated by counting the pellet-shaped feces in it. The diurnal rhythm in the activity of the grouse, the alternation between food gathering and roosting, was adapted to light and weather conditions. A strong coherence within the flocks was noted. The activity of the grouse was very concordant, during food gathering as well as during roosting. Under snow conditions, with available nutrition, the grouse population remains stationary. Otherwise, it moves down to lower situated areas with more readily accessible food, especially the hens. **Key words: willow grouse, snow, light, behavior**

218

Holloran, M. J., B. J. Heath, A. G. Lyon, S. J. Slater, J. L. Kuipers, and S. H. Anderson. 2005. Greater sage-grouse nesting habitat selection and success in Wyoming. Journal of Wildlife Management 69(2):638-649. Abstract: Nesting habitat degradation and its negative effect on nesting success might contribute to the recent population and distributional declines of greater sage-grouse (*Centrocercus urophasianus*) throughout North America. We used radiotelemetry to locate greater sage-grouse nests in 7 different areas of central and southwestern Wyoming between 1994 and 2002; we studied each area for 2 to 4 years. Using binary logistic regression, we compared microsite vegetal data collected at nests (n = 457) and random (n = 563) sites and successful (n = 211) and unsuccessful (n = 238) nests to test hypotheses concerning greater sage-grouse nesting habitat selection and vegetal conditions associated with nesting success. We used Akaike's Information Criterion (AIC_c) and model averaging to make inference about the weighted support for the importance of individual habitat variables through the comparison of sets of competing models. Selected nest sites were located in areas with increased total shrub canopy cover (relative importance [RI] = 1.00), residual grass cover (RI = 0.47) and residual grass height (RI = 0.77) compared to random sites. Successful nests had increased residual grass cover (RI = 0.43) and height (RI = 0.48) relative to unsuccessful nests. Additionally, annual nest success rates (i.e., above vs. below our study's average) were related to the preceding year's spring (Apr-May, RI = 0.44) and winter-early spring (Jan-Jun) precipitation (RI = 0.32). Correct classification rates for weighted average models that we derived through the 3 comparisons were between 60 and 70%, suggesting the variables adequately differentiated between plot types. However, high model selection uncertainty (i.e., the total number of models included in the sets of AIC_c-selected models) suggested that nest site selection and nesting success may be influenced by factors not considered in the modeling process. Management strategies that protect dense sagebrush stands and enhance residual grass cover and height within those stands should be used to maintain nesting habitat and increase nesting success of greater sage-grouse. **Key words: sage-grouse, precipitation, habitat use, model, vegetation**

219

Homan, H. J., G. M. Linz, and W. J. Bleier. 2000. Winter habitat use and survival of female ring-necked pheasants in southeastern North Dakota. American Midland Naturalist 143:463-480. Abstract: From 1992 to 1995 we used radiotelemetry to monitor winter habitat selection and survival of female ring-necked pheasants (*Phasianus colchicus*) in southeastern North Dakota. We captured 100 birds at nine sites in six study blocks centered on cattail-dominated (*Tyha* spp.) semi-permanent wetlands. Pheasants showed nonrandom habitat use at two hierarchical scales. At the second-order scale (23-km^2 blocks) semi-permanent wetlands were preferred during two winters in which habitat selection could be assessed (1992-1993 and 1994-1995). An additional second-order preference for grass-covered uplands was shown during the mild 1994-1995 winter. At the third-order scale (home-range) pheasants preferred the edges of wetlands in 1992-1993 and 1994-1995. The central portions of wetlands were preferred in 1992-1993 and used proportionately in 1994-1995. The average winter survival rate was 0.41, with rates ranging from 0.04-0.86 and differing significantly among winters. Survival was lower during early winter and midwinter periods for birds weighing less than 1090 g and for birds captured in semi-permanent wetlands under private ownership. A 1°C increase in the mean weekly maximum temperature decreased the probability of death by 0.06 and a 2.5 cm increase in new snow raised the probability of death by 0.08. **Key words: ring-necked pheasant, temperature, snow, mortality**

220

Hoodless, A. N. and J. C. Coulson. 1998. Breeding biology of the woodcock *Scolopax rusticola* in Britain. Bird Study 45:195-204. Abstract: A total of 449 nest record cards collected by the British Trust for Ornithology during 1945-89 was used to examine timing of nesting and brood production of the woodcock. Daily chick mortality rates were estimated from recaptures of 26 woodcock broods during an intensive study in 1988-92. Clutches were initiated between March and July, with a mode at the end of March. On average, egg laying commenced earlier in England (median first-egg date 8 April) than in Scotland (20 April) and there were negative relationships between first-egg dates and mean March air temperatures, both between years and regionally within years. Nest survival during egg laying and incubation was 41 ± 1% and the mean number of clutches hatched per female alive in March was 0.89 (95% CL 0.47-1.58). Chick survival until fledging was estimated as 56 ± 8%, resulting in a mean annual production of 1.80 ± 0.72 fledged young per female alive at the start of the breeding season. A small second peak in the distribution of first-egg dates in mid-May indicates that in some years females may attempt to rear second broods. **Key words: woodcock, temperature, reproduction, productivity**

221

Hörnell-Willebrand, M., V. Marcström, R. Brittas, and T. Willebrand. 2006. Temporal and spatial correlation in chick production of willow grouse *Lagopus lagopus* in Sweden and Norway. Wildlife Biology 12(4):347-355. Notes: The authors believe that variation in annual production of willow grouse is largely affected by external factors, stating “Most likely, weather plays an important role in large-scale synchronization, but other factors such as food quality and predation are also known to be important. Of course none of these factors are independent, and they may interact in different ways. Weather seems to be the only likely candidate explanation for the long-distance correlations in the harvest data, but neither Hammarström nor Haakenstad found any evidence that weather was affecting the juvenile ratio in the harvest data. Brittas showed a positive relationship with spring weather, digestibility of food, abundance of microtine rodents and the breeding success of willow grouse at site No. 1. The two years with the lowest breeding success were years with poor willow grouse nutrition and condition together with a decline in small mammal populations. Extremely bad weather during the first week after hatching has been shown to increase chick mortality. Slagsvold found a positive correlation between a high mean temperature in the middle of June and the breeding success of willow grouse. Myrberget et al showed a similar relationship, with warm weather during the early chick period having a positive effect on survival and growth rate of chicks. However, many studies have not found any correlation between chick survival and weather. It is difficult to evaluate weather data without an understanding of the potential mechanism between weather and breeding success. Climate changes have strong impacts on wildlife species at high elevations, and higher temperatures have the potential to alter the amount of alpine and subalpine habitat and to increase alpine fragmentation because of rising subalpine tree line. Long-term monitoring programs for alpine and subalpine wildlife, like the Swedish willow grouse census, will be important when even small increments in warming are shown to significantly impact habitat quality and quantity for breeding and migration in other *Lagopus* species. **Key words: willow grouse, precipitation, temperature, reproduction, mortality, nutrition**

222

Hörnfeldt, B., T. Hipkiss, and U. Eklund. 2001. Juvenile sex ratio in relation to breeding success in capercaillie *Tetrao urogallus* and black grouse *T. tetrix*. Ibis 143:627-631. Notes: Page 629—"…many studies indicate the importance of weather to breeding success in capercaillie. Frequent rain, especially around the time of hatching, and late snowmelt affect breeding success detrimentally in capercaillie, but rain around the time of hatching was found not to affect black grouse breeding success. Adverse weather conditions affect juvenile male capercaillie more severely than females, since males have higher energy requirements even under normal conditions, and this might also be the case for black grouse. Additionally, the increased food requirements of males may force them to forage during adverse weather, while females may be able to take shelter." **Key words: capercaillie, black grouse, precipitation, snow, temperature, productivity, sex ratio, behavior**

223

Host, P. 1942. Effect of light on the moults and sequences of plumage in the willow ptarmigan. Auk 59:338-403. Summary: Over several years the author kept between thirty and sixty willow ptarmigan, in an attempt to raise them in captivity on a large scale. Observations on these birds, especially during the breeding season, showed a marked synchronization of the plumage cycle with the different phases of reproduction. Smaller numbers of the birds were used at different times for experiments to test the effects of light and temperature on plumage and reproduction. Birds kept at normal, low temperatures during the winter months, November to February, were exposed to artificial light day and night. They responded to these changes in light conditions by showing different signs of reproductive activity, most marked in a female that laid a normal clutch of eggs in the last days of December and the beginning of January. While all the control birds kept their winter plumage unchanged during this period, all birds that were exposed to light developed different phases of spring plumage and summer plumage, thus indicating that light and not temperature is the main controlling factor for both the reproductive cycle and the development of spring and summer plumages in this species. One of the birds, a male, that showed fully developed spring plumage by the beginning of February, had day-length again reduced to seven hours a day. It responded to this by moulting and developing new white feathers, and within two months had completely changed from spring plumage directly into a new winter plumage. The winter plumage was developed in spite of the fact that the bird was kept at temperatures considerably higher than normal at the time of year when winter plumage develops in nature. Five ptarmigan, that had the normal day-length reduced at the beginning of August, responded to this by developing winter plumage one month earlier than the control birds which developed this plumage at the normal time. These experiments indicate that the development of fall plumage and winter plumage also are controlled by light conditions, and are caused by the reduced length of day in fall and winter. Several observations from the different experiments are mentioned, showing that even very small changes in light conditions can produce marked effects on plumage development. **Key words: willow ptarmigan, solar radiation, temperature, reproduction**

224

Hubálek, Z., J. Halouzka, and Z. Juøicova. 2003. Host-seeking activity of ixodid ticks in relation to weather variables. Journal of Vector Ecology 28(2):15-165.
Abstract: *Ixodid* ticks were monitored in a temperate deciduous broad-leaved forest in South Moravia (Czech Republic). Relative abundance of the ticks collected before noon (10:00-12:00 h) was compared to several weather variables (air and soil temperatures, relative humidity, precipitation, wind speed, and derived values) using the Pearson correlation coefficient. The tick numbers were found to be most closely related to the amplitude of the soil (-5 cm) temperature between 07 h and 14 h (TSamp, in *Ixodes ricinus*), and the soil temperature (TS) at noon (in *Haemaphysalis concinna*) or in the morning (*Dermacentor reticulates*). While a growing amplitude of TSamp caused an increased host-seeking activity of *I. rincinus* and *H. concinna*, it suppressed the activity of *D. reticulates*, a tick species mainly occurring in colder seasons of the year in Central Europe. The air temperature (TA) and relative humidity (RH) were also closely related to the tick activity, whereas rainfall and wind speed remained largely uncorrelated with the activity of the three tick species. Multiple linear regression on several variables (TSamp, TA, TS, TA-TS, RH) explained 48% of the variance in *I. ricinus*, 47% in *H. concinna*, and 38% in *D. reticulates*. Predictive two-variable regression models of relative abundance in host-seeking ticks were based on morning temperature (TA or TS) and morning RH as the most important environmental factors: they explained 32% (*I. ricinus*), 39% (*H. concinna*), and 35% (*D. reticulates*) of the variance. **Key words: temperature, soil, precipitation, humidity, wind, insect, behavior**

225

Hudson, P. J., M. Cattadori, B. Boag, and A. P. Dobson. 2006. Climate disruption and parasite-host dynamics: patterns and processes associated with warming and the frequency of extreme climatic events. Journal of Helminthology

80(2):175-182. Abstract: Levels of parasitism and the dynamics of helminth systems is subject to the impact of environmental conditions such that we may expect long term increases in temperature will increase the force of infection and the parasite's basic reproduction number, R-O. We postulate that an increase in the force of infection will only lead to an increase in mean intensity of adults when adult parasite mortality is not determined by acquired immunity. Preliminary examination of long term trends of parasites of rabbits and grouse confirm these predictions. Parasite development rate increases with temperature and while laboratory studies indicate this is linear, some recent studies indicate that this may be non-linear and would have an important impact on R-O. Warming would also reduce the selective pressure for the development of arrestment and this would increase R-O so that in systems like the grouse and *Trichostrongylus tenuis* this would increase the instability and lead to larger disease outbreaks. Extreme climatic events that act across populations appear important in synchronizing transmission and disease outbreaks, so it is speculated that climate disruption will lead to increased frequency and intensity of disease outbreaks in parasite populations not regulated y acquired immunity. **Key words: grouse, disease, parasites, temperature, climate change**

226

Huempfner, R. A. and J. R. Tester. 1988. Winter arboreal feeding behavior of ruffed grouse in east-central Minnesota. Pages 122-157 *in* A. T. Bergerud and M. W. Gratson, editors. Adaptive strategies and population ecology of northern grouse. Wildlife Management Institute and University of Minnesota Press, Minneapolis, USA. Notes: <u>Page 128</u>—The mean numbers of grouse per km observed each day during evening budding were 9.0, 1.8, and 2.2 for the three winters, respectively. About half of this 82% reduction can be explained by a decline in the ruffed grouse population based on fall flushing rates. The remainder was apparently caused by variations in snow depth, snow quality, and duration of snow cover among winters, and the actual timing of winter predation. The generally deep and more favorable snow profile in 1973-74, compared with 1972-73, resulted in a slightly higher daily observation rate in 1973-74, even though the grouse population was apparently lower. <u>Page 139</u>—When snows were crusty, total daily activity was increased as grouse walked on the snow surface primarily in search of hazel catkins. This pattern changed from April to June for both male and female grouse at Cedar Creek. Both sexes showed increased daily activity during this interval, even though they began activity later and terminated it earlier relative to sunrise and sunset, respectively. Our explanation for this change from an early morning and late evening activity pattern in winter is based on the elevated light levels in the woodlot in winter owing to snow cover and the absence of leaves. It may be that daily activity of ruffed grouse begins and ends at similar light levels year round, but that these levels occur at different times relative to sunrise and sunset based on the presence or absence of snow and leaf cover…consistently cold temperatures in data periods 8-10 appeared to cause equally consistent and early peak feeding. A warmup during data periods 11-13 appeared to cause a shift in peak budding to almost 8 minutes later. A gradual warming trend in 1972-73 from data periods 11 to 14 was also accompanied by a shift in peak budding from 32.5 minutes to 9.5 minutes before sunrise. It appeared that ruffed grouse may have shifted the period of peak morning feeding to compensate for a potentially large, negative energy balance during particularly cold portions of the winter. Seiskari (1962) noted that feeding activity of penned black grouse and capercaillie increased with cold weather and high barometric pressure. Seiskari's data suggest that earlier morning feeding appeared to follow low temperatures for each species. Unlike the morning period, peak evening budding was poorly correlated with temperature. **Key words: ruffed grouse, snow, temperature, behavior, census, habitat use**

227

Huffman, R. T. 2005. The effect of precipitation on Rio Grande wild turkey nesting ecology in the Texas panhandle and southwestern Kansas. M. S. Thesis, Texas Tech University, Lubbock, USA. Abstract: Nesting activity of Rio Grande wild turkeys (*Meleagris gallopavo intermedia*) was monitored from 2000 through 2004 at 3 sites in the Texas Panhandle and 1 site in southwestern Kansas. During this time 360 adult female and 282 juvenile female wild turkeys attempted 396 nests. A total of 129 (33%) nests successfully hatched out !Ŷ1 (sic) live poult. Nesting rate did not vary among sites (P = 0.2871) or years (P=0.2453), but did range from a low of 15% to a high of 58%. No relationship was found between pre-nesting precipitation (September-March) and nesting rate of first nest attempts (P = 0.207), or nesting success (P = 0.8495). Nesting season precipitation (April-July) had no relationship to nesting success (P = 0.1542), nor did the number of days with precipitation during nesting had no (sic) relationship to nesting success (P = 0.106). Days since precipitation for depredated nests (moisture-facilitated nest depredation hypothesis) did not conform to any distribution pattern. However, almost 30% of nests were depredated on days with measurable precipitation. Using data from 269 nests stepwise logistic regression selected 3 variables into a model predicting nesting success. Pre-nesting precipitation (PRE) and number of rainfall events during nesting (EVENTS) had a positive relationship to the success of a nest while the week of nest initiation (WEEK) had a negative relationship. More precipitation during pre-nesting, more rainfall events during nesting, and initiation of a nest early in the nesting season increased the probability of a nest being successful. Height of visual obstruction did not differ between successful nests and unsuccessful nests. Mean height of visual obstruction at successful nests and unsuccessful nests was 0.5 m. Regardless of nesting outcome nest sites had greater height of visual obstruction than paired random plots. This relationship held among all years and all sites except at the Matador Wildlife Management Area in 2001. In 2003 and 2004 females selected for greater height (0.4-0.5 m) of visual obstruction and avoided lower height (0.1-0.2 m) of visual obstruction (P < 0.001). In 2004 nests sites with trees in the nesting area were selected for while nest sites without trees were avoided across all study sites (P < 0.001). Managers can use local weather data to determine the probability of nests being successful; this may allow for estimates of recruitment into the fall populations. Managers should develop habitat management plans that maximize visual obstruction availability for potential nesting habitat. **Key words: Rio Grande turkey, precipitation, reproduction, productivity, vegetation, predation**

228

Hungerford, C. R. 1964. Vitamin A and productivity in Gambel's quail. Journal of Wildlife Management 28(1):141-147. Abstract: The influence of available natural sources of vitamin A on reproduction of Gambel's quail (*Lophortyx gambelii*) in southeastern Arizona was investigated in a 5-year study. Birds were observed and collected during critical seasons on three basic types of quail range. The amount of liver vitamin A in a sample of 177 birds was found to vary with rainfall and the resulting green plant growth. Differences in covey behavior, reproductive activity, and a size variation in reproductive organs was associated with differences in vitamin A storage. Vitamin A or a closely associated substance derived from green plant material apparently acts as a stimulator which influences the rate of breeding in this desert quail. **Key words: Gambel's quail, precipitation, fecundity, nutrition, habitat quality, vegetation**

229

Hupp, J. W. 1987. Sage-grouse resource exploitation and endogenous reserves in Colorado. Dissertation, Colorado State University, Fort Collins, USA. Abstract: Winter habitat use and foraging ecology of sage-grouse (*Centrocercus urophasianus)* were studied in the Gunnison Basin, Colorado between 1985 and 1986. Sage-grouse foraging activity (N=157 feeding sites) was not proportionally distributed (P<0.001) among topographic features. Topographic distribution of feeding activity was influenced by physiographic variation in shrub structure of mountain big sagebrush (*Artemisia tridentata vaseyana*) relative to snow depth. Most foraging (45-64% of feeding sites) occurred in drainages and on southwest slopes where sagebrush exposure above snow was maximized. Sage-grouse rarely foraged (1-4% of feeding sites) on northeast aspects with slopes >5° because exposed sagebrush was not widely available. Distribution of foraging was not influenced by topographic variation in crude protein or monoterpene concentrations of mountain big sagebrush. Within feeding sites, sage-grouse did not selectively forage on plants with high crude protein or low monoterpene concentrations. Sagebrush structural characteristics at 87 winter feeding sites were compared to 100 random locations. Sagebrush structural measures were not useful to identify winter habitat in the mesic terrains where sagebrush removal is most likely to occur. Spring lipid reserves of adult male sage-grouse were determined from carcass analysis of 96 individuals collected from 2 Colorado populations between 1983 and 1985. Spring lipid reserves were affected by winter severity. Males depleted lipid reserves during the courtship season. Males in Jackson County mobilized 125-130 g of fat during courtship while males in Gunnison County used an average of 66 g. Strutting display rates of adult males were quantified in Jackson and Gunnison counties in 1986. Slower display rates, lack of evening display, greater variance in male attendance at leks suggest reduced energetic investment in courtship among males in Gunnison County. However, behavioral differences could not be attributed to unequal size of endogenous reserves as lipid deposits (N=10 adult males/population) during early courtship were similar between populations in 1986. Lipid catabolism likely provides <10% of adult male energetic needs during courtship. Lipids may primarily be mobilized during early courtship when male displays are most vigorous due to the presence of females on leks, and when male reproductive success is determined. **Key words: sage-grouse, vegetation, snow, habitat use, nutrition**

230

_____ and C. E. Braun. 1991. Geographic variation among sage-grouse in Colorado. Wilson Bulletin 103(2):255-261. Notes: "Winter severity affects body condition of sage-grouse and may cause body mass to vary. The winter of 1983-84 was especially severe in Colorado, and lipid reserves and body mass of adult males were lower than in other years. Carpal length also varied among years and suggests that growth and wear of sage-grouse remiges may be influenced by environmental conditions." **Key words: sage-grouse, severe weather, condition**

231

_____ and _____. 1989. Topographic distribution of sage-grouse foraging in winter. Journal of Wildlife Management 53(3):823-829. Abstract: We studied sagebrush (*Artemisia* spp.) exposure above snow and topographic distribution of sage-grouse (*Centrocercus urophasianus*) foraging sites in winter (Jan-Mar) in the Gunnison Basin, Colorado. Sage-grouse feeding activity (n = 157 foraging sites) was not proportionally distributed among 5 topographic categories (P < 0.001). Most (46 and 75% of foraging sites in 1985 and 1986, respectively) feeding activity occurred in drainages and on slopes with south or west aspects. Use of slopes with north or east aspects was less than expected. Distribution of sage-grouse feeding activity was influenced by topographic variation in snow depth and mountain big sagebrush (*A. tridentata vaseyana*) exposure above snow. During a severe winter in 1984, <10% of the sagebrush vegetation in the Gunnison Basin was exposed above snow and available to sage-grouse. During milder winters in 1985 and 1986, exposure of sagebrush was 84 and 79%, respectively. We recommend that sagebrush be maintained in drainages and on slopes with south or west aspects. **Key words: sage-grouse, snow, temperature, habitat use, nutrition, vegetation**

232

_____ and _____. 1989. Endogenous reserves of adult male sage-grouse during courtship. Condor 91:266-271. Abstract: Lipid reserves of 116 adult (>1 year of age) male sage-grouse (*Centrocercus urophasianus*) were evaluated in two Colorado populations during lek attendance between 1983 and 1986. Lipid reserves following winters (November-March) with snowfalls <124 cm were larger (P<0.001) than reserves following winters with snowfalls >160 cm. Lipid reserves during early courtship were larger than reserves during late courtship (P<0.001). Males catabolized lipids during courtship but did not use breast muscle protein. Catabolism of lipids likely provides <5% of male energetic requirements during courtship. An adaptive advantage to fat deposition before breeding may exist if males primarily mobilize lipids during the peak period of female lek attendance when male reproductive success is determined, or during periods when thermoregulatory costs are high due to low ambient temperatures or wind. **Key words: sage-grouse, wind, temperature, snow, bioenergetics**

233

Ivacic, D. L. and R. F. Labisky. 1973. Metabolic responses of mourning doves to short-term food and temperature stresses in winter. Wilson Bulletin 82(2):182-

196. Summary: Winter-acclimatized mourning doves were subjected to a photoperiod and an ambient temperature range designed to simulate conditions of a severe winter storm, common in central Illinois. Metabolic rates were recorded for two daily cycles of decreasing temperatures (10°C to -18°C) in darkness and increasing temperatures (-18°C to 10°C) in light; the doves were fasted throughout the 44-hour treatment. Juvenile doves had higher metabolic rates than adults, and females had higher rates than males, but neither difference was statistically significant ($P > 0.05$). The metabolic rates of doves were greater during exposure to decreasing ambient temperatures and darkness than during exposure to increasing ambient temperatures and light, the difference being statistically significant ($P < 0.05$). The doves responded metabolically more to the directional temperature gradient than to either actual ambient temperature or light. The consumption of oxygen by doves did not follow a straight line increase with concurrent declines in ambient temperatures. Oxygen consumption was not only less at -18°C than at -10°C (in darkness), but also diminished with extended exposure at -18°C. These observations suggested that mourning doves employed a physiological mechanism (perhaps reduced body temperature) to decrease their metabolic expenditures at low ambient temperatures; the mechanism permits the conservation of energy and thus augments survival. The potential survival ability of doves exposed to simulated winter storms was related to sex and age attributes. Adult doves (particularly males), because of their age or greater weight, or both, were better equipped physiologically than juveniles (particularly females) to survive the stresses of low ambient temperatures without food. Thus, among mourning doves wintering in the northern and central U.S., the autumn-to-spring changes in sex ratios and in age ratios, which usually favor males and adults, respectively, probably reflect the differential survival abilities of the sex and age cohorts. **Key words: mourning dove, temperature, mortality**

234

Jackson, A. S. and R. DeArment. 1963. The lesser prairie chicken in the Texas Panhandle. Journal of Wildlife Management 27(4):733-737. Abstract: Trends in populations of lesser prairie chicks (*Tympanuchus pallidicinctus*) in the Texas Panhandle were investigated by censusing drumming grounds annually on two study areas during a 10-year period, 1952-62, for comparison with data from a census of the same areas in 1942. Severe drops in populations came in 1952. The decline was triggered by onset of a major drought lasting through 1956, but populations did not increase during a series of good rainfall years starting with 1957. Changing land-use practices are responsible for keeping lesser prairie chickens at low population levels in the Texas Panhandle. The more important of these are overgrazing of cattle range, particularly in dry weather, resulting in displacement of the tall grasses; accelerated programs of aerial spraying with herbicides for brush control; and combine harvesting of grain sorghum in place of storage by stacking and shocking in the field. **Key words: prairie chicken, drought, precipitation, population dynamics, vegetation, range condition**

235

Jarvis, J. M. 1973. The Parker Mountain sage-grouse study. Proceedings of the Annual Conference of the Western Association of State Game and Fish

Commissioners 53:345-352. Abstract: This was a three-year study of sage-grouse (*Centrocercus urophasianus*) on the Parker Mountain in south central Utah. The population trend was downward during the study because of poor production. The dry warm springs of 1971 and 1972 allowed for early mating and nesting but the lack of succulence indirectly increased brood mortality. The lack of production affected the harvest so the hunter effort diminished as the population diminished. Observations of individually color marked birds indicated cocks were loyal to one strutting ground in succeeding years. That hens orient more toward nesting habitat than strutting grounds for nest sites. Twenty-four percent (24%) of the population was harvested annually. **Key words: sage-grouse, temperature, precipitation, nutrition, vegetation, mortality, production**

236

Jenkins, D., A. Watson, and G. R. Miller. 1967. Population fluctuations in the red grouse *Lagopus lagopus scoticus*. Journal of Animal Ecology 36(1):97-122. Notes: The "browning" of heather by frost was found to be correlated with poor breeding with supporting the hypothesis that breeding success depended on the condition of the hens' food in early spring. The data from all study areas since 1960 confirm this hypothesis. Variations in the heather index parallel variations in hatching date and clutch size in all four years, and in 1962-64 they were also related to the clutch size, the dimensions of eggs, the weight of chicks at hatching and the chicks' survival. An "intermediate" year was related to early breeding and large clutches, but with poor chick survival, fairly small eggs, and light chicks. The authors conclude early nesting and large clutches may have been determined by food quality in early April with some other factor affecting egg size and chick survival, perhaps new plant growth. They analyzed the weather records from 1962-65 between the start of heather growth and egg laying. There were more frosts in 1965, which might have delayed heather growth. Using available data, there is a potential correlation between the first week of heather growth and breeding success. **Key words: red grouse, frost, vegetation, nutrition, reproduction**

237

Johnson, D. E. 1999. Ruffed grouse productivity and habitat selection at the base of the Beartooth Plateau in southcentral Montana. M.S. Thesis, Montana State University, Bozeman, USA. Notes: <u>Page 60</u>—"Likely causes of [chick] mortality include weather, predation, physiological disturbance, and starvation." **Key words: ruffed grouse, predation, chick mortality, nutrition, weather**

238

Johnson, R. A. 1927. The ruffed grouse in winter. Auk 44(3):319-321. Notes: The author states that the more severe the weather, the less active are the ruffed grouse. Also that the grouse is reluctant to leave roosting places on dark and stormy days. On bright and sunny winter days, however, the ruffed grouse perch in conifers to take advantage of the sunlight. In severe weather the grouse feeds in the very early morning and in the late evening just before dark. In severe weather, after some snow has accumulated, the ruffed grouse favors a berth in the snow. **Key words: ruffed grouse, temperature, snow, behavior**

239

Jonas, R. J. 1968. Adverse weather affects Merriam's turkey reproduction in Montana. Journal of Wildlife Management 32(4):987-989. Abstract: A 37-inch snowfall was recorded in the Long Pines study area in southeastern Montana on May 1, 1967, near the end of egg laying and beginning of incubation for most Merriam's turkeys (*Meleagris gallopavo merriami*). Compared with normal years (1961-62-63), most egg laying or incubation was delayed or interrupted during the first 10 days in May, 1967, and no successful hatching occurred May 1-20. The population was maintained by late nesting or renesting. There was no evidence of renesting by hens that lost broods during May 1-20, 1967. **Key words: turkey, snow, reproduction**

240

_____. 1966. Merriam's turkeys in southeastern Montana. Montana Fish and Game Department, Technical Bulletin No. 3, Helena, USA. Notes: Page 15—"Differences in productivity may have been related to precipitation. For the three months critical to nesting, hatching and rearing success (April, May and June), deviations in precipitation from the long-term mean were as follows: 1961, -2.03"; 1962 +2.01" and 1963 +6.30". The dry spring of 1961 had been preceded by two abnormally dry years. Possibly most effects of precipitation in the dry years (1959, 1960, 1961) and the wet 1962 were indirect through influence upon vegetation and hence cover. Cover was poor in 1961 and excellent in 1962. It was also superior in 1963; however, four heavy snows occurred at intervals of about one week in April (one 17 inches) and rainfall was 4.81 inches above the average for June. Weather may have had a direct adverse affect upon reproductive success that year. Further evidence of this is apparent from some late hatching dates for 1963, resulting from retarded first nests or re-nesting."; Page 16—"Following three dry years, superior cover in 1962 ma have made formerly submarginal habitats suitable for turkeys. Thus improvement rather than deterioration of the habitat may promote turkey emigration."; Page 18—"Weather appeared to control the time of movement from summer range."; Page 20—"Apparently weather was the primary factor determining the time of departure from the summer range.";Page 22—"During periods of snowy or windy weather, turkeys apparently roosted all day or restricted their movements to 100 acres or less. Temperatures down to -10°F did not appear to restrict the birds as they fed or loafed on the bare slopes. During periods of warm weather, birds often moved up into the ponderosa pine forest even into one or two feet of snow when the slopes below were comparatively bare. They moved down the slopes to roost."; Page 23—"During periods of snowy or windy weather, turkeys apparently roosted all day or restricted their movements to 100 acres or less. Temperature down to -10°F did not appear to restrict the birds as they fed or loafed on the bare slopes. During periods of warm weather, birds often moved up into the ponderosa pine forest even into one or two feet of snow when the slopes below were comparatively bare. They moved down the slopes to roost."; Page 25—"Percentages of the hatch occurring June 1 or after were 17.1 per cent, 45.0 per cent and 45.2 per cent for 1961, 1962 and 1963 respectively. Percentages of juveniles retaining the eighth juvenile wing-primary during the fall hunting season in 1961, 1962 and 1963 were 37.1 per cent, 40.7 per cent and 44.7 per cent respectively. This corroborates data in Table 17 indicating progressively later hatching dates for 1961, 1962 and 1963. This information suggests a direct relationship to weather, especially precipitation, for April, May and June for those years (Table 18). The year of 1961 was a dry "normal" year. Higher percentages of hatches occurring later in the wetter 1962 and 1963 suggests delay in nesting or re-nesting. Some of the disruption may have been due to cooler temperatures accompanying the rain and snow. At the beginning of the peak hatching period May 21, 1963, a temperature of 18°F was recorded."; Page 29—"Late fall rains in 1961 brought about a 'greening up' of the vegetation and most of the crop contents that winter consisted of green grass blades. Effects of above average rainfall the spring and summer of 1962 were evident in crop contents the following winter."; Page 31—" During the record year for precipitation (1963), grasses and shrubs were so tall, even under the usually heavy grazing, poults had difficulty flying from the ground when flushed."; Page 31—"Low precipitation during winter months generally results in a light snow cover. Relatively heavy rains and some cool temperatures in spring may delay nesting, but all evidence indicates that this is no serious threat to productivity. Moisture on the vegetation early in the morning is common in June. Apparently this is no particular problem to poults 10 to 15 days old that have been seen feeding in moisture-soaked vegetation on several occasions." **Key words: Merriam's turkey, precipitation, snow, temperature, wind, productivity, movement, vegetation, nutrition, behavior**

241

Jørgensen, E. and A. S. Blix. 1988. Energy conservation by restricted body cooling in cold-exposed willow ptarmigan chicks? Ornis Scandinavica 19(1):17-20. Summary: Metabolic heat production (M) and body temperature (T_b) in relation to ambient temperature (T_a) were measured in 72 7-9 day old willow ptarmigan chicks. M increased linearly with falling T_a in the 6 to 35°C range and can be described by the equation: $M(W \cdot kg^{-1}) = -0.66\ T_a(°C) + 37.4$ ($r = 0.792$). Upon cold exposure, M rapidly rose to a stable level, which was maintained in spite of a linear decrease in T_b. The drop in T_b was similar at all T_a below 27°C when exposure lasted for only 10 minutes, while the drop in T_b was significantly higher at 6°C compared with 21°C when exposure lasted for 30 minutes. These results indicate that M is chiefly influenced by peripheral thermal inputs, and that willow ptarmigan chicks do not utilize their full thermoregulatory capacity to maintain T_b. Apparently, they do instead use it to restrict body cooling, whereby feeding time will be less dependent on T_a. **Key words: willow ptarmigan, thermoregulation, behavior, temperature**

242

_____. and _____. 1985. Effects of climate and nutrition on growth and survival of willow ptarmigan chicks. Ornis Scandinavia 16(2):99-107. Summary: Effects of ambient temperature (T_a), and food availability and quality on growth and survival of willow ptarmigan chicks *Lagopus l. lagopus* were investigated in the laboratory. Under standard food conditions, growth increased with increasing T_a. Only a persisting sub-zero T_a affected survival. Because of changes in the chicks' behavior a 67% reduction of food availability did not affect their growth and survival. When food was available only 22% of the time, however, all chicks died within 5 days after hatching, irrespective of T_a. Even small reductions in food quality strongly affected growth and survival. Food intake was always correlated with body weight, irrespective of age, T_a, and food quality. These results indicate that young ptarmigan chicks are unable to compensate for increased energy expenditure and reduced food quality with increased food intake. Therefore the availability of high quality food seems to be crucial for their growth and survival, while low ambient temperatures *per se* seem to be of little consequence. **Key words: willow ptarmigan, temperature, behavior, nutrition, mortality**

243

Jurgenson, P. B. 1968. A study of fluctuations of populations of the hazel grouse. Pages 75-81 *in* Z. D. Spurin, chief editor. Birds of the Baltic region: ecology and migrations. Israel Program for Scientific Translations [from Russian]. Notes: Page 80 – "Our main conclusion, based on the differences and similarities of the fluctuations of populations of the Siberian and Manchurian hazel grouse in various parts of the Northern Hemisphere, is that there are different environmental factors which have a similar effect and act to a considerable extent simultaneously. Such factors which act similarly over enormous areas can only be climatic factors." **Key words: hazel grouse, climate, population dynamics**

244

Kabat, C., D. R. Thompson, and F. M. Kozlik. 1950. Pheasant weights and wing molt in relation to reproduction with survival implications. Technical Wildlife Bulletin Number 2, Pittman-Robertson Project 9-R, Wisconsin Conservation Department, Madison, USA. Notes: Page 12—Whatever the basic cause is that brings on molt and the regaining of the weight lost during the breeding season, it appears to be linked with the time the adult hen becomes broody, incubates and hatches her clutch. Hence the occurrence of adverse weather or other factors which delay reproduction will also set back the date of the post-nuptial molt and the post-breeding season weight recovery. It is possible then that the survival of adult hens which are behind in physical development, when fall and winter conditions prevail, could be handicapped accordingly. The exact way in which delayed reproduction could affect the survival of adult hens or their subsequent reproductive efforts is unknown, but probably it would be an increased susceptibility to mortality factors of all types that is involved. Page 15—Prolonged egg laying due to nest destruction or other factors inhibiting the development of broodiness constitutes an abnormal stress that may result in an increased susceptibility to mortality causes of all types. Thus hens bringing off late broods or not becoming broody may have a higher incidence of such diseases as the avian-leucosis complex…Delay of the hatching date schedule by adverse weather or some other factor may result in both the production of a relatively small crop of young birds and an increase in the mortality rate of adult hen pheasants. **Key words: ring-necked pheasant, adverse weather, productivity, mortality, predation, disease, population dynamics**

245

Kaczor, N. W. 2008. Nesting and brood-rearing success and resource selection of greater sage-grouse in northwestern South Dakota. M.S.Thesis, South Dakota State University, Brookings, USA. Notes: The second-ranked model of nest success

(AIC_c weight = 0.15) included grass height, litter, daily precipitation, and a 1-day lag effect of precipitation. Although daily precipitation had a positive influence on nest success (β = 29.45 SE = 40.35), and the 1-day lag effect negatively influenced nest success (β = -1.89 SE = 0.77), neither variable improved the top model and were only present due to being combined with grass height and litter. The third and fourth ranked models included daily precipitation, and bird age, respectively, but they were also combined with grass height and litter. Nest success varied 14.8% between years (37.7 ± 7.3% in 2006 compared to 525 ± 7.2% in 2007). However, adding a year affect to the top model did not improve model fit. **Key words: sage-grouse, nesting success, precipitation, model**

246

Kane, D. F., R. O. Kimmel, and W. E. Faber. 2007. Winter survival of wild turkey females in central Minnesota. Journal of Wildlife Management 71(6):1800-1807. Abstract: There is interest in expanding eastern wild turkey (*Meleagris gallopavo silvestris*) populations north of their current range. We hypothesized that winter survival and food availability are primary determinants in setting the northern extent of wild turkey distribution. To test our hypothesis, we translocated wild turkey females north of their present range into central Minnesota, USA, and compared survival in areas with supplemental food in the form of corn food plots versus areas with no supplemental food. During 2 winters with below-average snow, winter survival was higher for females with supplemental food. In one winter with above-average snow depths, survival was extremely low even with supplemental food. Supplemental food could augment survival during mild winters if wildlife managers arrange with farmers to, annually, retain standing corn near roosting habitat, but food plots may only partially offset effects of deep snow. Managers should critically evaluate northern habitats, long-term costs of sustained feeding, and potential outcomes of concentrating animals and introducing wild animals into new ecosystems. Winter survival may delimit the northern range of wild turkeys, though annual survival rates may also be important and need further research. **Key words: turkey, snow, nutrition, distribution**

247

Kasprzykowski, Z. 2002. Decline of the black grouse *Tetrao tetrix* population in east-central Poland. Vogelwelt 123(5):253-258. Abstract: The study was conducted in the Mazovian and South-Podlasian Lowlands, east-central Poland, covering ca. 13% of the area of Poland. The data for 1975-2000 are based on the author's own observations and material gathered by the regional card-index of the Mazovian Society for the Protection of Fauna. In addition, in 1989-2000 population abundance was surveyed on 8 plots. In the mid-1980s, 96 leks were known, mostly from the eastern part of the region. Over a period of 10 years (by 1985) leks disappeared from central and southern parts of the Mazovian Lowland. Black grouse abandoned over 60% of the known refuges. Early in the 1990s this process continued, and lekking grouse were recorded mainly from the northern part of the region. Surveys in 1997-2000 revealed only 8 leks. This means that over a period of 25 years, the number of leks decreased by 92%. A detailed analysis of changes in numbers was possible for northern portion of the grouse population. At the end of the 1980s, the number of birds varied between 1 and 6 on five plots; they were absent from the remaining three plots. A comparison of numbers for 1990 and 1998 showed a decline from 101 to 17 individuals, that is by 83%, over a period of 8 years. The number of males declined by more than 80% and that of females by about 70%. The mean annual rate of decline was 10-13%. The number of individuals per lek decreased with the total population. Early in the 1990s, groups of 8-20 (8.2 on average) lekking males were noted, whereas in 1998, only four males were present on the biggest lek, and only single birds were observed on the remaining leks (x = 1.8 male/lek). The most important factors causing this decline are assumed to be increasing predation, mainly by foxes, hunting on leks and the weather conditions in winter (thin snow cover). Co-occurrence of pheasants and changes in the natural habitat are believed to be of less importance in the study region. **Key words: black grouse, snow, population dynamics**

248

Kennamer, J. E., D. H. Arner, C. R. Hopkins, and R. C. Clanton. 1975. Productivity of the eastern wild turkey in the Mississippi delta. Proceedings of the National Wild Turkey Symposium 3:41-47. Abstract: Eastern wild turkey (*Meleagris gallopavo silvestris*) productivity was determined during the summers of 1968-72 in the Mississippi River Delta, Mississippi. Highest productivity occurred in 1969 and the lowest in 1970. Production was not correlated with rainfall but it appeared to be influenced by extreme river flood conditions. An inverse relationship was found between percentage of hens with poults and total number of adults observed per field day during August. **Key Words: Eastern wild turkey, precipitation, flood, productivity**

249

Keppie, D. M. 1977. Snow cover and the use of trees by spruce grouse in autumn. Condor 79(3):382-384. Summary: I investigated whether snow in autumn affects the tendency of spruce grouse (*C. c. franklinii*) to spend more time in trees. The significant increases of birds in trees from August to September in 1971 and 1972 occurred only after the first snowfall. Within months, birds were usually in trees more frequently on days with greater snow cover than on days with lesser snow cover. In 15 of 19 cases, proportionally more birds were in trees on days when a greater extent of snow was present and differences were significant in 13 cases. The proportion of birds in trees on snow-free days increased significantly between successive months in only two of five possible instances. Spruce grouse were seen more frequently in trees as the autumn progressed, and long before snow cover became permanent. The frequency of birds in trees did not begin to increase until after the first snowfall. Grouse were found in trees more often on days of major snow cover. The proportion of birds in trees on snow-free days generally did not increase through autumn, although snow-free days became less common as autumn progressed. This latter point suggests that after being in trees on a day with much snow cover, grouse did not tend to remain in trees on a succeeding day with less snow present. Pendergast and Boag (Condor 73:437-443, 1971) speculated whether heavy mortality, particularly of young, might occur at the start of winter if grouse were suddenly forced onto a conifer diet because of heavy snows, without previous conditioning of the gastrointestinal tract to the new diet. This probably does not occur, at least in regions with autumn snow. Data from Alberta suggest that periods of temporary snow accustom the grouse to aboreal life. My initial interpretation of my data was that snow causes birds to take to trees more frequently, enabling them to begin heavy feeding on conifer browse, thus changing the size of the gastrointestinal tract. With a delay in snowfall, the chain of events might be delayed, as well as in areas without autumn snow. If this sequence does occur, ineffective dietary changeover might cause mortality in regions that are snow-free in autumn. **Key words: spruce grouse, snow, habitat use, diet, mortality**

250

_____ and J. Towers. 1990. Using phenology to predict commencement of nesting of female spruce grouse (*Dendragapus canadensis*). American Midland Naturalist 124(1):164-170. Abstract: Dates for loss of snow cover and beginning of plant growth were evaluated with respect to median dates for commencement of egg-laying and hatch of cultures by female spruce grouse (*Dendragapus canadensis*) in three widely separated localities in Canada. Female spruce grouse begin to lay eggs at a time when environmental conditions are predictable as witnessed by low variation in calendar dates among years in phonological evens. Among the events that we monitored, the dates for first flowers of blueberry (*Vacinium angustifolium*) and trailing arbutus (*Epigaea repens*) and the dates for 50% snow cover were correlated best with median dates for commencement of egg-laying and hatch of clutches. Median nesting dates can be predicted well by these events. There is now circumstantial evidence that timing of plant development influences commencement times for egg-laying. **Key words: spruce grouse, vegetation, phenology, index, reproduction**

251

Kerwin, M. L. 1971. The status, behavior, and ecology of the sage-grouse in Saskatchewan. M.S. Thesis, University of Saskatchewan, Regina, Canada. Notes: Kerwin concluded that unusually cold and wet conditions in the spring of 1970 reduced nesting success, compared to the more normal temperatures and dry conditions of 1971. **Key words: sage-grouse, temperature, precipitation, reproduction**

252

Kessler, F. W. 1959. A study of the effects of weather on breeding behavior, nest establishment, egg laying, and hatchability of the ring-necked pheasant. Dissertation, Ohio State University, Akron, USA. Summary: Territorial behavior occurred later in 1956 when the spring was colder and wetter. The clutch size was smaller during wet breeding seasons. Incubating hens spent a greater amount of time off the nest during the early and late stages of incubation than during the intermediate period. Average egg temperatures were lower during 1956, the year with more rainfall. Winds of 15 to 18 mph during the early part of the breeding season forced pheasants into small areas of heavy cover with consequent strife among cocks. This strife resulted in some of the territorial cocks becoming submissive and remaining so throughout the season. At an ambient temperature of 70°F, winds of 10-20 mph acting for a period of 30 min. caused a differential egg temperature decrease of 2°-8° F between eggs in exposed nests and eggs in nests sheltered from the wind. Data from this study indicated that the duration of rainfall had no noticeable effect on incubation temperatures. The amount of rainfall did not noticeably influence the egg temperatures of the pheasants in this study. The number of periods of precipitation may under certain conditions influence the number of times a hen leaves the nest. **Key words: ring-necked pheasant, temperature, precipitation, wind, habitat use, behavior, reproduction**

253

Kienzler, J. M., T. W. Little, and W. A. Fuller. 1995. Effects of weather, incubation and hunting on gobbling activity in wild turkeys. Proceedings of the National Wild Turkey Symposium 7:61-67. Abstract: The setting of spring wild turkey (*Meleagris gallopavo*) hunting seasons has been influenced by tradition, gobbling, and hen vulnerability. Knowing the peaks of gobbling and the beginning of incubation is important in setting spring hunting seasons. We were interested in (1) determining the effects of hunting and weather factors on gobbling activity, (2) quantifying daily and seasonal trends in the intensity of gobbling activity, and (3) determining the relationship of chronology of incubation and gobbling activity. Early morning gobbling activity was monitored daily from mid-March through early June on two areas in south-central Iowa, 1978-81. Although no linear trend of gobbling activity and hunter density could be detected (P = 0.87), the presence of hunters depressed gobbling counts (P<0.001). Temperature and light intensity were also related to gobbling counts (P<0.01). Precipitation the previous 12 hours and wind were inversely related to the counts (P<0.01). Although gobbling activity was usually consistent between years, the chronology of nesting did not appear to strictly coincide with gobbling every year. After sunrise, within-day patterns of gobbling were similar before and during the hunting season. Before the hunting season started, high average counts were relatively higher prior to sunrise, however. Hunting depressed gobbling counts at all times of the day. Hunting was estimated to be responsible for part of the late-April dip in gobbling activity usually attributed to nesting. **Key words: wild turkey, temperature, solar radiation, wind, behavior, hunting**

254

King, R. T. Ruffed grouse management. 1937. Journal of Forestry 35(6):523-532. Notes: Winter cover for ruffed grouse must provide protection from extreme weather conditions and roosting places safe from predators. In the northern part of their range, snow ordinarily meets both of these requirements. Where snow occurs to a depth of twelve inches or more and is not crusted the birds deliberately dive into it; they not only roost under the snow at night, but we have found that they spend a great part of each day under its protection when temperatures are near or below zero. On our grouse ranges there is always a sufficient depth of snow to provide excellent protection, and it is usually not crusted to the extent that the birds cannot utilize it. There are, however years in which a sufficient depth of snow has not fallen by the time the deciduous trees have lost their leaves; under these conditions, the birds are exposed to the effects of low temperatures and bad storms during the winter which put a crust on the snow that no bird can break through. This condition also forces them to roost in trees. At such times when snow protection is not available the next best protection is provided by clumps or fringes of balsam, spruce, or cedar. Pines do not furnish good winter cover except as young dense stands. At about 15 years of age they outgrow their usefulness in this respect. If snow could be depended upon each winter all winter long, there would be no need to worry about coniferous cover. Unfortunately it can not be depended upon for the reasons just mentioned. It is, therefore, essential that coniferous cover be provided, even though this cover is necessary only once in every several years. Much of wildlife management is in the nature of insurance against future probable contingencies. A two-day ice storm one in five years can do away with all the increase built up during that period unless the management measures have taken account of and provided for the ice storm. **Key words: ruffed grouse, snow, temperature, ice, vegetation, habitat use**

255

Kirby, A. D., A. A. Smith, T. G. Benton, and P. J. Hudson. 2004. Rising burden of immature sheep ticks (*Ixodes ricinus*) on red grouse (*Lagopus lagopus scoticus*) chicks in the Scottish uplands. Medical and Veterinary Entomology 18:67-70.
Abstract: The sheep tick *Ixodes ricinus* (L.) (Acari:Ixodidae) is an ectoparasite of major economic and pathogenic importance in Scotland. Its distribution in the Scottish uplands is assumed to be governed by the abundance and distribution of its definitive hosts (deer and sheep) and climatic variables such as temperature and rainfall. As the numbers of its major host in Scotland, red deer, have increased dramatically and climatic conditions have become more favourable, the level of parasitism could have been expected to rise. We use data gathered from tick counts on over 4000 red grouse chicks *Lagopus lagopus scoticus* Latham (Galliformes:Tetraonidae) in various experiments over the past 19 years to ascertain whether the intensity and prevalence of parasitism has been increasing. From 1985 to 2003 the average tick burden of a parasitized red grouse chick has grown from 2.60±1.12 ticks per chick to 12.71±1.44. Over this period the percentage of chicks of a given brood parasitized has also increased from 4±2% to 92±3%. The possible implications of this increase in parasitism for red grouse production are discussed. **Key words: red grouse, temperature, precipitation, disease, insects**

256

Klaus, S. 2007. A 33-year study of hazel grouse *Bonasa bonasia* in the Bohemian Forest, Sumava, Czech Republic: effects of weather on density in autumn. Wildlife Biology 13 Supplement 1:105-108. Abstract: The only long-term census of hazel grouse *Bonasa bonasia* in Central Europe was conducted during 1972-2004 on a 100-km^2 area of the Bohemian Forest, Sumava, Czech Republic. To obtain a density index in October, I recorded indirect signs of hazel grouse, such as dust bathing sites, feathers, droppings or tracks, and reactions to a whistle that imitates the male territorial song along fixed routes covering 80 km in total. During the 33 years of counting, I found no statistically significant trend in the fluctuating numbers. I also looked for the influence of weather on hazel grouse abundance. Analysis by stepwise multiple regression suggested that six weather variables were correlated with the annual rate of change of hazel grouse density in autumn, explaining 44% of the variation in density: mean temperature and total precipitation in April (highly significant positive correlations) and mean temperature and total precipitation in May and September (significant negative correlations). The results for April and May seem to indicate a positive effect of rainfall and temperature in April on reproductive success in the prelaying period, but a negative effect of rainfall in May on chick survival. **Key words: hazel grouse, temperature, precipitation, density, reproduction**

257

Klongan, E. D. 1971. Effects of some Iowa winters on pheasants. Pages 268-278 *in*: A. O. Haugen, editor. Snow and ice in relation to wildlife and recreation symposium. Iowa Cooperative Wildlife Research Unit, Iowa State University, Ames, USA. Abstract: Severe winter conditions are an important factor influencing pheasant population levels in Iowa. Significant snowfall in combination with low temperatures and strong winds exerts the greatest stress on the birds. Mortality usually occurs in a short time from exposure and freezing complications, with starvation exerting little or no importance. Effects of some of the most severe winters in Iowa history on pheasants are described. Rapid changes in farming technology in northern Iowa are resulting in limitations from lack of safe nesting cover to assume an equal, or even greater, role than winter cover in determining pheasant numbers. Relationships between location of food sources and winter cover are also becoming increasingly important. Winter feeding programs would have done little or nothing to prevent the types of winter pheasant losses described, though increasingly intensive farming may have an effect here, too. **Key words: ring-necked pheasant, snow, temperature, wind, mortality, nutrition, habitat modification**

258

Knapton, R. W. 1980. Winter mortality in a gray partridge population in Manitoba. Canadian Field-Naturalist 94(2):190-191. Notes: “The storm, the worst on record in the area since March 1966, continued unabated from noon on 10 January 1975 until noon on 12 January, and covered all of southern Manitoba and southeastern Saskatchewan. Temperatures varied between -16 and -25°C, wind speeds from 55 to 65 km/h, with gusts to 100 km/h, and 16.5 cm of snow fell at Lyleton. The result was a 38% loss in total numbers of partridges, covey 2 being particularly hard hit as its numbers declined from 7 to 2 birds. No further losses were noted for the duration of the winter. The reduction in numbers was almost certainly a result of the storm, and not of other factors such as emigration...thus, one storm was responsible for 70% of the total over-winter loss of partridges on the study area.” **Key words: gray partridge, snow, wind, temperature, mortality**

259

Kobriger, J. 1989. Effects of weather conditions on sharp-tailed grouse brood surveys. Prairie Grouse Technical Council Conference 18:14. Abstract: Sharp-tailed grouse brood routes have been conducted in North Dakota since 1977. Weather conditions during brood surveys were recorded. A numerical rating for weather was devised using temperature, wind, cloud cover, and dew. Routes were graded from 1 to 12, 1 being very poor while 12 was excellent. A significant correlation was found between both sharptails/100 miles (R^2 = .95, P = <.05) and sharptail broods/100 miles

(R^2 = .98, P = <.01) and weather conditions. **Key words: sharptail grouse, temperature, wind, clouds, dew, humidity, census**

260

Korhonen, K. 1989. Heat loss of willow grouse (*Lagopus lagopus l.*) in a snowy environment. Journal of Thermal Biology 14:27-31. Abstract: 1. The amount of heat lost by willow grouse (*Lagopus l. lagopus L.*) in a snowy environment was measured using a heat flow sensor. 2. During digging of the burrow, the heat flux density from chest and feet increased to 1100-1500 Wm^{-2} in only a few minutes. The heat loss from the back was less (250-1000 Wm^{-2}). 3. As the burrow became warm, the heat flux density decreased from the chest, back and legs to ca 115-130 Wm^{-2}. 4. Digging in the snow created a state of cold stress in the grouse, which was also expressed in accelerated heartbeat and strong shivering at short intervals. 5. A snowy environment increases heat loss from grouse walking on the surface or digging into the snow, although snow also has the opposite, insulating, effect of efficiently protecting birds in warmed, snow burrows from the cold. **Key words: willow grouse, snow, temperature, thermoregulation, behavior**

261

_____. 1987. The effect of short-term fasting on certain blood parameters and on glycogen storage in pectoral muscles of willow grouse *Lagopus lagopus lagopus* L. Comparative Biochemistry and Physiology A 88(4):677-682. Abstract: (1) The blood plasma glucose, cholesterol, total protein, urea, and uric acid contents of willow grouse raised in a bird yard in northern Finland were measured after fasts of 12, 24, and 48 hours in mild and severe cold weather. (2) There were significant differences between the sexes in the urea and total protein contents of normal blood (12 hr fast). (3) In all the blood parameters studied, changes occurred after 24 and 48 hour fasts, which were greater or took place more rapidly in severe cold than in milder weather. **Key words: willow grouse, temperature, blood parameters, nutrition**

262

Kothmann, H. G. and G. W. Litton. 1975. Utilization of man-made roosts by turkey in west Texas. Proceedings of the National Wild Turkey Symposium 3:159-163. Abstract: The Rio Grande turkey (*Meleagris gallopavo intermedia*) has extended its range into 1.4 million hectares (ha) of semi-arid scrub mesquite prairie in west Texas. A well established and increasing population exists where the southern edge of the High Plains meets the Edwards Plateau and Trans-Pecos. Population fluctuations are proportional to range conditions and rainfall patterns. Natural roost sites are absent, but man-made structures such as utility line and poles, oil storage tanks, and windmill towers provide adequate substitutes. **Key words: Rio Grande turkey, precipitation, habitat condition**

263

Kozicky, E. L., G. O. Hendrickson, P. G. Homeyer, and R. Nomsen. 1955. Weather and fall pheasant populations in Iowa. Journal of Wildlife Management 19(1):136-

142. Summary: (1) An attempt was made to determine the relationship of the fall roadside census from 1936 through 1952 within Iowa's primary pheasant range and winter and spring mean temperatures and mean total precipitation. (2) The rate of pheasant production was apparently related to changes in habitat and population level. (3) Two months of continuous subnormal temperatures from December through February apparently influenced the subsequent fall pheasant population. (4) Cold temperatures in May and/or June were not conducive to an increase in fall pheasant populations. (5) A warm March and/or April did not have any discernible benefits to pheasant production over a normal and/or cold corresponding bimonthly period. In fact, a warm March and April accompanied by a cold May, 1946, was followed by a decrease in the fall pheasant population. (6) Above normal mean total precipitation in conjunction with low temperatures were only evident in years of decreasing fall pheasant populations; with high temperatures, precipitation had no apparent adverse effect on fall pheasant populations. (7) Normal spring weather prevailed during years in which the fall pheasant population remained the same or increased, depending to an undetermined extent on the level of the pheasant population. (8) The present analysis merely represents the weather-pheasant relationships for the past 17 years. Some permutations of temperature and precipitation have been examined only once, and many not at all. **Key words: ring-necked pheasant, precipitation, temperature, population dynamics**

264

Krementz, D. G. and J. J. Jackson. 1999. Woodcock in the southeast. Natural history and management for landowners. University of Georgia College of Agricultural and Environmental Sciences, Bulletin No. 1183, Cooperative Extension Service, Athens, USA. Notes: "Weather and Worms: Weather affects worms. If surface soil is too cold or too hot, worms go deep. A soil temperature of 50° to 68°F is about right for most of the woodcock's favorite worms. During the southern summer, the surface temperature is too hot for the woodcock's favorite worms. We wonder if that is one reason why they migrate north to find better feeding. When surface soil dries out, worms also go deep. Woodcock cannot get worms from hard, dry soil. Nor can woodcock feed in soil that is too wet. Surface soil moisture of abut 20 percent to 50 percent is best for woodcock and worms. Occasionally, widespread, extremely cold winter temperatures in the South have caused soil to freeze and woodcock to move. In most years, however, it is flooding on the winter grounds that causes relocations of wintering woodcock. Their movements are generally local; at most, a few miles. During these times, woodcock suffer much predation because the better covers are often inundated with water and woodcock are forced into poor-quality cover. As floods recede, the woodcock fly back to their old haunts. The worms survive the flooding." **Key words: American woodcock, temperature, precipitation, flooding, movement, behavior, nutrition, predation**

265

Labisky, R. F., C. A. Harper, and F. Greeley. 1964. Influence of land use, calcium, and weather on the distribution and abundance of pheasants in Illinois. Biological

Notes No. 51, Illinois Natural History Survey, Urbana. Notes: Page 12—Pheasants and Weather:

266

Laperriere, A. J. 1972. Seasonal precipitation influence on mourning dove breeding populations in Iowa. Journal of Wildlife Management 36(3):979-981. Abstract: An inverse relationship was found between June-July rainfall in Iowa and percentage of change in the Iowa mourning dove (*Zenaidura macroura*) call-count index the following year. Indications are that unfavorable seasonal rainfall during the past decade may be involved in the recent decline in breeding populations of mourning doves in Iowa. **Key words: mourning dove, precipitation, fecundity**

267

Larsen, J. A. 1957. Influence of weather upon the ruffed grouse population of the Cloquet Experimental Forest, Minnesota. M. S. Thesis, University of Wisconsin-Madison, Madison, USA. Unable to obtain for abstract.

268

_____ and J. F. Lahey. 1958. Influence of weather upon a ruffed grouse population. Journal of Wildlife Management 22(1):63-70. Summary: A statistical technique developed by Fisher (1924) has been employed to demonstrate that about 50 per cent of the variability of the ruffed grouse population of the Cloquet Experimental Forest in Minnesota during the years 1927-55 is associated with corresponding annual changes in the distributional pattern of maximum temperature. The curve depicting the effect of a degree above average of maximum temperature throughout the year shows that warm days in spring and summer tend to be associated with a high grouse population the following April, and that warm days during winter tend to be associated with a low grouse population the following April. **Key words: ruffed grouse, population dynamics, temperature**

269

Larson, M. A. 2005. Identifying plots for surveys of prairie chickens in Minnesota. Pages 39-43 *in* Wingate, P. J., R. O. Kimmel, J. S. Lawrence, and M. S. Lenarz, editors. Summaries of Wildlife Research Findings 2005. Minnesota Department of Natural Resources, Fish and Wildlife Division, St. Paul, USA. Notes: To explore potential improvements in surveys of greater prairie chickens (*Tympanuchus cupido pinnatus*) in Minnesota, I developed this study to determine landscape-scale characteristics associated with plots of land occupied by prairie chicken leks, and to evaluate potential within-year sources of variation in the probability of detecting a prairie chicken lek, if one is present. The study area consisted of nearly the entire range of prairie chickens in northwest Minnesota…Wind speed and cloud cover were negatively correlated with the probability of detecting a lek. **Key words: greater prairie chicken, wind, clouds, census**

270

Latham, R. M. 1947. Differential ability of male and female game birds to withstand starvation and climatic extremes. Journal of Wildlife Management 11(2):139-149. Summary: A series of experiments with six different species of game birds, which included 1,332 individuals, pointed toward a significant difference between the sexes in their ability to withstand fasting and climatic extremes. Among polygamous species, the females proved the stronger; and among monogamous species, the reverse was the case. **Key words: Hungarian partridge, bobwhite quail, ring-neck pheasant, wild turkey, nutrition, temperature, wind, mortality**

271

_____. 1976. Complete book of the wild turkey. Stackpole Company, Harrisburg, Pennsylvania USA. Notes: Page 78-79—"When deep snows cover the food on the ground, turkeys will regularly go to springs and spring runs to scratch for whatever food may be available under water. During this wading and feeding, ice may form on the wet feathers of breast, belly and tail. This heavy coating of ice will often cause feathers to pull or break off, leaving the bird without adequate protection against cold. These "bare breasted" birds probably suffer considerably and perhaps die if exposed to long periods of intense cold and high wind. Ice storms in themselves have been blamed for such losses. When freezing rains cover all branches and twigs so that a twig the size of a lead pencil becomes as large around as a hoe handle, the turkey roosting in the open may become so weighted with ice, particularly on its tail feathers, that it is unable to fly or even walk without great difficulty. At the very least, this has a tendency to weaken the bird and make it less resistant to stress. Also, on the ground or on the roost it becomes easy prey to its natural enemies." **Key words: turkey, snow, ice, temperature, precipitation, wind, nutrition, predation, mortality**

272

Lauckhart, J. B. 1957. Animal cycles and food. Journal of Wildlife Management 21(2):230-234. Abstract: Some rodent fluctuations apparently can be accounted for by population buildup, food depletion, starvation, and recovery of food base. Malnutrition from use of poor foods is commoner than starvation. Malnutrition may lead to disease, low reproduction, and less survival of young, all of which appear in cyclic declines. There is evidence that buds and twigs of northern trees, food supply of various herbivores such as grouse, are very low in nutrients, so that a slight change could cause malnutrition. A cyclic change that does affect northern trees is the seed cycle. It seems that trees in the north must store food for an average of about 3.5 years before they can produce seed crop. In this period their twigs and buds apparently become more nutritious, but become suddenly less so after seed formation. This might explain cycles of bud and twig eaters, and why these animals do not peak the same years as seed eaters. Interacting seed cycles could cause longer animal cycles. Weather can prevent a seed crop in any one year and thus lengthen a cycle. **Key words: grouse, vegetation, weather, nutrition, disease, fecundity**

273

Lehman, C. P. 2005. Ecology of Merriam's turkeys in the southern Black Hills, South Dakota. Dissertation, South Dakota State University, Brookings, USA. Notes: "Successful nests were on steeper slopes, had greater visual obstruction, and greater total ground level vegetation and shrub cover than unsuccessful nests. Precipitation during the incubation period was also an important variable predicting nest success. Survival of poults ≤14 days posthatch decreased during cold periods and during or immediately following periods of rainfall. Monitoring rainfall and temperature data during May and June may provide an index of annual nest success and poult recruitment. **Key words: Merriam's turkey, precipitation, temperature, index, reproduction**

274

_____, M. A. Rumble, L. D. Flake, and D. J. Thompson. 2008. Merriam's turkey nest survival and factors affecting nest predation by mammals. Journal of Wildlife Management 72(8):1765-1744. Abstract: Nest success is an important parameter affecting population fluctuations of wild turkeys (*Meleagris gallopavo*). Factors influencing mammalian predation on turkey nests are complicated and not well understood. Therefore, we assessed nest hazard risk by testing competing hypotheses of Merriam's turkey (*M. g. merriami*) nest survival in a ponderosa pine (*Pinus ponderosa*) ecosystem during 2001-2003. We collected nesting information on 83 female Merriam's turkeys; annual nest success averaged 50% for adult females (range = 49-59%) and 83% for yearling females (range = 75-100%). Proportional hazard modeling indicated that precipitation increased the hazard of nest mortality. However, estimated hazard of nest predation was lowered when incubating females had greater shrub cover and visual obstruction around nests. Coyotes (*Canis latrans*) were the primary predator on turkey nests. We hypothesize that precipitation is the best predictor of nest survival for first nests because coyotes use olfaction effectively to find nesting females during wet periods. Temporally, as the nesting season progressed, precipitation declined and vegetation cover increased and coyotes may have more difficulty detecting nests under these conditions later in the nesting period. The interaction of concealment cover with precipitation indicated that nest hazard risk from daily precipitation was reduced with greater shrub cover. Management activities that promote greater shrub cover may partially offset the negative effects of greater precipitation events. **Key words: Merriam's turkey, precipitation, predation, vegetation, habitat management**

275

_____, L. D. Flake, M. A. Rumble, and D. J. Thompson. 2008. Merriam's turkey poult survival in the Black Hills, South Dakota. Intermountain Journal of Sciences 14(4):78-88. Abstract: We investigated poult survival from hatching to 4 wks of age for Merriam's wild turkey (*Meleagris gallopavo merriami*) poults in the southern Black Hills, South Dakota, We estimated survival from 841 poults reared by 57 radio-marked wild turkeys (*n*=52 adult females, *n*=5 yearling females). Survival of poults to 4 wks posthatch averaged 33 percent with 54 percent of the mortality occurring in the first 7 days after hatching. Merriam's turkey poult survival in the southern Black Hills was low compared to Merriam's populations found elsewhere in the entire current range. Survival of poults increased with age, fewer precipitation events, and fewer extreme cold and wet events. The interaction of age of poults with cold and wet events through 15 days posthatch indicated that younger poults were more susceptible to cold and wet weather events than older-aged poults. We observed several poults ≤3 days of age that apparently died from hypothermia. A fine-scale based weather index that uses individual weather stations for specific areas occupied by turkeys may be a valuable tool for managers to estimate production in Merriam's turkeys if survey or radio telemetry data are not available. **Key words:** Merriam's turkey, precipitation, chick survival, index

276

Lehman, V. W. 1953. Bobwhite population fluctuations and Vitamin A. Transactions of the North American Wildlife Conference 18:199-246. Summary and Conclusions: "In this paper the results of analysis of 270 quail livers for Vitamin A are considered against a background of field data on population fluctuations, breeding, food habits, parasites, cover, and intra-specific tolerance on southwestern rangeland. The study period (1949-1951) included both "normal" times and the unusually cold winter of 1950-1951 which followed a "dry" summer and fall. Winter mortality was heavy, and Vitamin A reserves in the time of crisis were lower (average 132 I.U.'s per gram of liver and 236 I.U.'s per liver) than at any other time. Averages of Vitamin A reserves per gram of liver and per liver seemingly identified periods of greatest abundance (as September, 1949) and scarcity (March, 1951). The Vitamin A reserves of individual birds, however, showed a wide range of variation at all seasons. Under adverse conditions, the ability to manufacture and store Vitamin A may be influenced by sex and age. As crisis approached in 1950, old males, old females, and young-of-the-year appeared able to maintain Vitamin A reserves, and life itself, in the order named. Fluctuations in average Vitamin A reserves, one collection period to the next, were sometimes coincidental with changes in diet. Rises in average Vitamin A levels were recorded with increased consumption of weed seeds or mast. Reductions in Vitamin A levels were sometimes concurrent with high consumption of grass seed, prickly pear fruit, and insects (principally termites). Marked Vitamin A improvement on diets importantly "greens" occurred only after the material was largely buds, flowers, and dough-stage seeds as contrasted to emergent sprouts and leaves There was not a significant correlation between body weight and Vitamin A reserves. At the time of winter die-off, low Vitamin A reserves (40 I.U.'s or less per liver) occurred in 21 per cent of the study specimens weighing over 150 grams and in 25 percent of the quail weighing less than 150 grams. Symptoms of distress, i.e., ruffled plumage, rhinitis, decreased alertness, weak flight, heavy parasite infestations, etc., were not confined to the birds of light weight. It did not appear that high Vitamin A reserves were necessary for awakening the breeding urge. General breeding effort, however, was definitely associated with lush range and its frequent accompaniment of above-average feed. Quail, especially females, quickly attained high Vitamin A reserves after generous rainfall, and most successful breeding occurred after heavy May rains in both 1949 and 1950. With verdant range of short duration in 1951, survival of young was only 1.3 per adult as compared to 2.6 per adult in 1950, and 3.9 per adult in 1949." **Key words:**

bobwhite quail, precipitation, vegetation, nutrition, population dynamics, mortality

277

_____. 1949. Bobwhite quail reproduction in southwestern Texas. Journal of Wildlife Management 10(2):111-123. Summary: Bobwhite renesting was influenced importantly by rainfall. Hatchability was high (about 94%) in spring, but decreased (71%) as the weather warmed. Successful renestings produced only about half as many chicks as spring layings. Important factors regulating quail reproduction in southwestern Texas are rainfall, through its effect on nesting activity, and coyote predation, because of its severity except in mid-summer. Quail are limited by overgrazing on many ranches. **Key words: bobwhite quail, precipitation, productivity, renesting, behavior, grazing**

278

Lehtinen, S. A. 1983. Movements and habitat use of ruffed grouse in the Bridger Mountains, Montana. M. S. Thesis, Montana State University, Bozeman, USA. Notes: <u>Page 85</u>—Ruffed grouse preferred coniferous forests for tree roosting. No changes in habitat selection were observed between day and night by tree-roosting grouse. The preference for dense coniferous cover as tree roosting sites could be expected, since it offered better protection from inclement winter weather and predators than the other habitats. <u>Page 86</u>—Topographic Preference – In winter the aspects most often associated with birds were south and west, while southeast, north, and southwest were all avoided. Hungerford found ruffed grouse on the upper parts of south-facing slopes during winter in Idaho. In Stauffer’s study, higher elevations were preferred during winter. Grouse were always associated more with south and east aspects, although in summer and fall they could be found across all aspects. Slopes used were generally less than 20°, which he considered as gentle terrain. Both of the above authors believed that the higher hillsides were warmer than areas below. This seems to be a likely explanation for the preference of hillsides. The solar radiation on those aspects that face the sun for the longest part of the day would cause snow to melt during sunny days, even in mid-winter, uncovering more shrubs for feeding grouse. The density of fruit-bearing plants might also be higher on south-facing slopes than on those facing north. **Key words: ruffed grouse, snow, solar radiation, temperature, behavior, habitat use, diet, vegetation**

279

Lennerstedt, I. 1966. Egg temperature and incubation rhythm of a capercaillie (*Tetrao urogallus L.*) in Swedish Lapland. Oikos 17:169-174. Abstract: A thermistor was mounted in one of the eggs in a capercaillie’s nest, and the remaining space of the egg was filled with paraffin. Automatic registration of the electrical resistance every sixth minute throughout the last twelve days of the incubation period made calculation of the egg temperature possible. During incubation the temperature showed only minor variations, usually within the limits 34-35°C. The minimum egg temperature during absence was on average 27.7°C, the lowest recorded value being 21°C. During three days the weather conditions were severe with snow-fall and the average of the minimum egg temperatures was 2.4°C lower than that for the other days. As long as the female behaves in a normal way. i.e. the length of the absent periods are within the normal limits, even severe weather conditions do not seem to affect the embryonic development. The diurnal rhythm of incubation and absence was calculated from the temperature values. There was no concentration of periods of absence to any particular part of the day except five hours in the afternoon, 18.00-23.00, when there always occurred a period of uninterrupted incubation. These five hours obviously represent a period of rest in the diurnal rhythm of certain activities such as feeding. **Key words: capercaillie, temperature, reproduction, behavior**

280

Leopold, A. 1937. The effect of the winter of 1935-36 on Wisconsin quail. American Midland Naturalist 18(3):408-416. Summary: (1) The winter of 1935-36 greatly constricted the range and population density of Wisconsin quail. Mortality on measured samples ranged from 30 to 83 per cent. (2) The lethal effect is ascribed to 40 days of continuous cold and snow. The previous winter of 1934-35, as measured by a "hardness test," was only 15 percent as severe; 1917-18, 72 per cent. (3) Fat well-fed quail died in numbers, a phenomenon hitherto unrecorded. Some of these had ice under the wings. Many were imprisoned in snow. (4) Attempts to develop a size-index from body measurements, and an emaciation-index from weight:length ratios, were unsuccessful. **Key words: quail, snow, temperature, ice, mortality, nutrition**

281

Leopold, A. S. 1977. The California quail. University of California Press, Berkeley, USA. Notes: In Chapter 9, "Rainfall as a factor affecting reproductive success", Leopold provides a synthesis of research on the direct and indirect impacts of precipitation upon the reproduction and population dynamics of California quail. The timing of rain and temperature fluctuations as well as the type of vegetation promoted in the environment exert influences on fecundity, survival, and recruitment. **Key words: California quail, precipitation, temperature, vegetation, nutrition, reproduction, population dynamics**

282

Leopold, B. D., L. A. Brennan, W. Rosene, and G. A Hurst. 1993. Long-term trends of northern bobwhite populations in the southeastern U.S.: the role of abiotic factors. Proceedings of the National Quail Symposium 3:185. Abstract: We assessed the potential influence of precipitation variation and drought-severity on long-term trends of northern bobwhite population indexes using data derived from the Christmas Bird Count (1961-89) in the southeastern U.S., and harvest data (number of bobwhite bagged per unit effort) from Groton Plantation (1957-89) and Oakland Hunting Club (1927-87) in South Carolina. We calculated long-term yearly drought-severity indices to simultaneously scale precipitation, average temperature, water holding capacities of soil, and evapo-transpiration, and used these data as independent variables in regression analyses of long-term bobwhite population indices. Drought-severity indices were correlated ($P < 0.5$) with long-term bobwhite population trends and explained approximately 50% of the year-to-year variation in population changes. Variation in population indices not explained by drought-severity indexes is apparently the result of biotic factors associated with changes in land use. **Key words: bobwhite quail, precipitation, drought, temperature, evapotranspiration, soil, index**

283

Leptich, D. J. 1992. Winter habitat use by hen pheasants in southern Idaho. Journal of Wildlife Management 56(2):376-380. Notes: Wildlife managers should promote a change in management direction to one that encourages tall, erect, perennial herbaceous and, where it does not interfere with farming or maintenance, woody vegetation on these sites. Furthermore, because this cover type may be flattened or filled with snow and become unusable during severe winter weather, it is important that habitat managers provide a good interspersion of other preferred cover types throughout the agricultural ecosystem. Remnant tracts of sagebrush provide pheasants with important winter loafing and escape cover. Habitat managers should work to ensure a good distribution of sagebrush tracts up to 1 km wide across the agricultural ecosystem and provide firebreaks or green stripping to protect them from fire. **Key words: ring-necked pheasant, vegetation, habitat management, snow**

284

Lewis, J. C. 1963. Observations on the winter range of wild turkeys in Michigan. Journal of Wildlife Management 27(1):98-102. Abstract: The daily home range of 21 flocks of 12 wild turkeys (*Meleagris gallapavo*) was studied in Allegan County, Michigan, during the winter of 1957-58. The area of the daily home range seemed to vary inversely with snow depth and directly with temperature; however, positive relationships were somewhat obscured by other influencing factors. Twenty-nine measurements of the area contained within the limits of the daily movements of turkey flocks varied from 2 to 160 acres and averaged 49 acres. The home range used throughout the winter averaged 683 acres for 8 flocks of gobblers only, 435 acres for 7 flocks of hens only, and 492 acres for 6 flocks of mixed sexes. Flocks remained individually identifiable throughout the winter either by flock composition or the discreteness of flock ranges. The range of 86 percent of 132 turkeys bordered streams or lakes, and 74 percent of 19 winter roosts were found there. It was hypothesized that an efficient and economical census of turkeys in winter could be based on a search along streams and borders of lakes for turkeys and for their signs in snow. **Key words: turkey, snow, temperature, census**

285

_____, J. W. Ault, III, V. J. Heller, and J. A. Morrison. 1976. Delayed molt of primary feathers of mourning doves during winter. Journal of Wildlife Management 40(1):184-187. Notes: “Presumably, severe winter weather and the associated food shortages were factors slowing the molt of immature mourning doves in Oklahoma. The winter of 1972-73 was the more severe of the study period and the one having the higher percentage of the population showing indications of a prolonged molt. Also during January 1973, a heavy mortality of doves coincided with 6 days of low temperatures and snow and ice covering food supplies. Severe weather and food shortages may magnify the delay in molting patterns, but they may not be the only factors responsible for the delay in Oklahoma. Biologists should be cautious about estimating hatching dates of doves by using birds harvested or trapped in late fall and winter.” **Key words: mourning dove, snow, temperature, nutrition, behavior, technique**

286

Lewis R. A. and M. A. Degner. 1982. Mortality of nestling blue grouse owing to inclement weather. Canadian Field-Naturalist 96(2):218-219. Notes: “Young blue grouse usually leave the nest within a day of hatching, and our finding indicates that inclement weather can cause mortality during this period. Ours was the only instance [on Vancouver or Hardwicke Island] in which nestlings died as a result of adverse weather. Therefore, in most cases, cool, wet weather does not affect survival of nestling blue grouse in coastal British Columbia.” “Although the direct cause of death was almost certainly cool, wet weather, poor cover at the nest site may have contributed indirectly to the mortality.” **Key words: blue grouse, precipitation, wind, temperature, mortality, reproduction, severe weather**

287

Ligon, J. S. 1946. History and management of Merriam’s wild turkey. New Mexico Game and Fish Commission. University of New Mexico Press, Albuquerque, USA. Notes: Page 43 – “Cold rains are seriously detrimental to young turkeys, because of the direct effects of wet and chill; furthermore, if the storms are too extended or continuous, the loss of feeding time results in weakening of the young, which renders them less resistant.” “…dense spruce and other conifers are a most important element of turkey-nesting habitat in high country in that they furnish shelter for hens and young during frequent rain or sleet squalls after the rainy season begins. Spruce gives the best protection (from rain, sleet, and snow), as the branches, in addition to being heavily foliaged from top to bottom, extend out in more or less flat fans, providing a maximum of protection. However, continued cold and blowing rains may be seriously destructive to young turkeys, regardless of all natural protective cover.” **Key words: Merriam’s turkey, precipitation, temperature, sleet, snow, wind, nutrition, habitat use**

288

Lindström, J. 1996. Weather and grouse population dynamics. Wildlife Biology 2(2):93-99. Abstract: One paradigm in the biology of game animals is that short-term fluctuations in population densities can be explained with variations in weather. A number of empirical models have been produced supporting this view. However, validation of such models has often been lacking or insufficient. Two methods for checking the validity of such models are presented. The first method is to derive a model for one population and test it against another data set. The second method is to evaluate the forecasting power of the model. For these purposes, the relation between 36 weather variables and population parameters of capercaillie *Tetrao urogallus*, black grouse *T. tetrix*, and hazel grouse *Bonasa bonasia* was studied using population data (1964-1984) from three adjacent provinces in Finland. Total population size, number of juveniles and population growth rate were used as dependent variables. Prior to the analyses, the population data were In-transformed and detrended. Stepwise regression analysis was used with province-specific weather data as explanatory variables. These models were then used to make forecasts one year ahead for each species and province, and the prediction was tested against observed data. Transferred models from the other provinces were also used. The requirement for a good empirical model is that it should be possible to use the model on similar problems in nearby areas. Stepwise regression analyses yielded reasonable fits in most cases (hivin R-2 ranging between 0.2-2.0). However, a model from a given province invariably produced a poor fit when applied to another province. Forecasting the population dynamics was only occasionally successful, and was not directly related to the fit of the models. The results suggest that it may often be hazardous to use weather data for predicting population fluctuations of game species, especially for management purposes. This conclusion was further strengthened by demonstrating that using 36 province-specific white noise variables, it was possible to build models with fit and forecasting properties essentially equal to those of the weather-based models. **Key words: capercaillie, black grouse, hazel grouse, model, index**

289

_____, E. Ranta, and H. Lindén. 1996. Large-scale synchrony in the dynamics of capercaillie, black grouse and hazel grouse populations in Finland. Oikos 76:221-227. Abstract: We analyzed 1964-1983 data on population numbers of capercaillie, black grouse and hazel grouse in 11 provinces in Finland. The three species are known to display cyclic dynamics with a periodicity of approximately six years. Synchrony in species-specific population fluctuations was scored by calculating cross correlations with zero lag among all the provinces. Provincial data were also used to assess the relation between climatic factors and synchrony in the population fluctuations. To enable the statistical analysis, the number of the 12 climatic variables was reduced to three non-correlating principal components. A bootstrap method was used both for parameter estimation and for assessing statistical significance level when comparing the tetraonid synchrony with the climate data. For all three species we found large-scale synchrony in population fluctuations. The level of synchrony decreased, however, with geographic distance among the provinces. When a partial correlation analysis is done correcting for the weather-derived principal components, correlations with synchrony and distance remained with two of the three principal components. When corrected for distance, there is correlation between synchrony and climate for capercaillie and black grouse. We conclude that spatial phenomena, such as climatic homogeneity within closely located areas and dispersal of individuals are responsible for maintaining large-scale synchrony. **Key words: capercaillie, black grouse, hazel grouse, temperature, snow, precipitation, population dynamics**

290

Long, C. R. 2007. Pre-breeding food habits and condition of ruffed grouse and effects on reproduction in the central and southern Appalachians. M.S.Thesis, West Virginia University, Morgantown, USA. Notes: Grouse were collected throughout the northern states and it is likely that the lack of snow and warming temperatures enabled grouse in some areas to forage on herbaceous vegetation more easily. **Key words: ruffed grouse, temperature, snow, behavior, nutrition, reproduction**

291

Loneux, M. 2003. Are climate changes the cause of the decline of the black grouse? Levende Natuur 104(3):104-107. Abstract: Population data and meteorological records performed for several decades have allowed us to model the climates influence on black grouse (*Tetrao tetrix*) population dynamics. Results obtained in several European protected areas where the species breeds still nowadays have shown the important role of some climatic parameters during the life cycle of the bird to explain the observed fluctuations. The common factors involved in the modeling for the different geographical sites studied in West-Europe suggest that global climate warming can explain the declining trend of the species. On one hand the winters are more and more rainy and less snowy due to the warming of the minimal temperature, while black grouse is adapted to rough snowy conditions. On the other hand, rainfalls are more and more abundant during key times of this species brooding period. However the new climatic trend cannot fully explain the general decline of black grouse observed even in protected areas in Western Europe. The species is suffering from the global climate change in addition to attacks on its habitat and tranquility. At short term and local level decisions and actions of managers to improve and maintain the quality and carrying capacity of the typical habitats used by the species during its whole life cycle will play major role for the short term survival of this emblematic bird in the west positions of its distribution. On longer term, the future of the small isolated populations of the species will depend on its ability to face the changing environment. **Key words: black grouse, temperature, precipitation, population dynamics, climate change**

292

_____, J. Lindsey, and J. C. Ruwet. 1997. Influence of the climate on the dynamics of the black grouse (*Tetrao tetrix*) population in the Belgian "Hautes-Fagnes" from 1967 to 1996. Cahiers d'Ethologie 17(2-4):345-386. Abstract: This study involves demographic data on the varying population size of black grouse living in the Hautes-Fagnes obtained during yearly spring censuses on their arenas. These are related to data on local meteorological conditions having a known influence on the survival of these birds during the various periods of the life cycle of the species. The data were modeled by Poisson multiple regression using the GLIM4 software. The dynamics studied cover a period of thirty years of censuses (1967-1996). The predictions from the best statistical model follow the observed values exceptionally well. The variables best explaining the changes in population size of the black grouse in the Hautes-Fagnes are, in addition to the mother population: the climate during the previous two winters as measured by the mean of the minimum temperatures from 1 November to 31 March (negative effect); the climate close to the period of hatching, measured by the mean minimum temperature during the three weeks starting on 16 June (positive effect) and the total precipitation during the three weeks starting on 1 June (negative effect); the climate during incubation, measured by the total precipitation during four weeks starting on the 19 and 25 May (negative and positive effects, respectively); and the climate during September, measured by the total precipitation during this month (negative effect). All of these data involve the year preceding that being studied. Black grouse benefit from cold winters, standing badly the mild winters. This relationship is explained by the low level of their winter metabolism, adapted to a winter life based on long rests in igloos and short periods looking for food of low energy value. Winter acts as an elimination trial for the young grouse who do not yet have the adult weight. Later, this is also a crucial period of the life cycle of adults. Our results unquestionably confirm this for the population in Hautes-Fagnes. Black grouse benefit from a warm dry summer climate during the periods covering the first weeks of life of the chicks. For the total precipitation over the four weeks covering the incubation period, a subsequent study will look at shorter periods to attempt to determine at what date the effect is reversed. A rainy September is bad for the grouse. When the predictions are far from the observed values, other variables than the climatic ones used in the model must dominate. The model predicts well the direction of the variation observed, but diverges more or less from the exact value in five of the 30 years, in one direction or the other (1980, 1983, 1986, 1990, 1996). It is reassuring that this climatic model does not agree perfectly with the observations because that would mean that all other factors are negligible, contradicting many publications on the subject. If it seems reasonable to ignore the effects of illness in favor of factors involving “quality of habitat” or “disturbances”, the factor, “predation”, thought to be negligible in a variable population, may have had more impact the last four years because of the higher density of foxes (an opportunistic predator) and the low density of grouse (the lowest point since 1967). For the poorly predicted years, we should look for events or phenomena that could have produced effects, positive or negative: fires, specific management activities or lack of management, direct or indirect disturbances by walkers or their dogs, skiers, photographers. This type of information requires archives regularly fed by the facts noticed by foresters, wardens, naturalists as well as local inhabitants who are often in the field. **Key words: black grouse, temperature, snow, precipitation, climate change, population dynamics, model**

293

Longcore, J. R., D. G. McAuley, G. F. Sepik, and G. W. Pendleton. 2000. Survival of female American woodcock breeding in Maine. Proceedings of the American Woodcock Symposium 9:65-76. Notes: Excluding birds that died from entanglement, only 2 of 7 (28%) females (1 each in 1988 and 1989) died within 16 days of being radio-marked, which is within the period of most severe weather in spring. Page 71—Females, because of larger body size and associated heat dynamics are better able to withstand sub-zero temperatures and sparse foods in spring than are males. No females starved during this study, but two males did. In Maine in 1989, when the minimum, mean daily temperature in April was the lowest (-2.5°C) among years. Page 72--…”In 1986 when the mean, minimum daily temperature in April was the highest among years, survival was the lowest, but based on a sample of 11 birds. Although deep frost caused by lack of snow and sub-zero temperatures in early winter and spring snowstorms can limit food availability and cause females to delay nesting, survival of females in 1989 was not adversely affected. This high survival rate may have been related to reduced nesting effort. Furthermore, the energetic advantages of larger body size and not engaging in energetically costly display flights, as do males, probably contributes to higher survival rates for females than for males, especially in years with inclement spring weather." **Key words: American woodcock, temperature, snow, frost, mortality, nutrition, behavior**

294

_____, _____, _____, and _____. 1997. Survival of breeding male American woodcock in Maine. Canadian Journal of Zoology 74:2046-2054. Abstract: We radio-marked 150 male American woodcock (*Scolopax minor)* during 1987-1989 and estimated period survival for 1 April – 15 June. Survival varied from 0.690 (1989) to 0.924 (1988), with a 3-year mean (95% confidence interval) of 0.789 (0.693-0.885). Woodcock were killed by raptors (n=14, 53.8%), mammals (n=1, 3.8%), or unknown predators (n=5, 19.2%); six deaths (23.1%) were from miscellaneous causes, including three (11.5%) from entanglement in the transmitter harness. A composite survival estimate based on telemetry studies for the breeding, postbreeding, and wintering periods was 0.471 (0.789 x 0.923 x 0.647). The calculated survival rates were 0.881 for the spring migration period and 0.853 for the combined hunting and fall migration period. In a proportional hazards model, body mass at capture was not related to survival. Forest type (hardwood versus conifers) affected survival (P<0.016), which was lower for woodcock using mostly conifer sites. Survival was related positively to mean snow depth in December (P<0.038), negatively to snow depth in April (P<0.046), and positively to minimum temperature in December (P<0.054) and April (P<0.066) in some analyses. **Key words: American woodcock, snow, temperature, habitat use, mortality**

295

Lowery, D. K. 1999. Relationships among wild turkey hens, predators, and environmental conditions on Tallahala Wildlife Management Area, Mississippi (*Meleagris gallopavo*). M. S. Thesis, Mississippi State University, Starkville, USA. Abstract: Wild turkey (*Meleagris gallopavo*) hen nest success, survival, and recess movements (time away from nest) were studied on Tallahala Wildlife Management Area in central Mississippi, 1991-1995. Additionally, microhabitat and weather variables were collected at nest sites and were compared between successful and unsuccessful nests. Nesting rate and nesting success averaged 42% and 19%, respectively. Major cause of nest failure was predation (87%, n = 27). Hen survival rates differed significantly among years and averaged 50.5%. Predation was the major cause of hen mortality accounting for 50% of all known mortalities. Hen recess movements (time away from nest) did not differ in duration or frequency between successful and unsuccessful hens. However, successful hens had more days without any recess movement than unsuccessful hens (P = 0.017). Successful hens had significantly less cumulative rainfall (P = 0.002) and fewer rainfall events (P =0.002) during incubation. Annual nesting success was significantly correlated (r = 0.90, P = 0.03) with the number of rainfall events from March-June of each year. Known dates of predation of hens (n = 19) had significantly fewer days since rain (P = 0.004) and more rain the day of predation (P = 0.003) than random dates during the same period. It rained on or just prior to the date of predation. Micro-habitat variables for nest sites were similar to what has been reported. Percentage grass at ground level and percentage canopy closure were significantly different between successful and unsuccessful hens. Percentage grass averaged

56.13% for successful and 24.58% for unsuccessful nests (*P* = 0.003). Canopy closure averaged 62.45% for successful and 73.45% for unsuccessful (*P* = 0.043). Other variables were similar for both groups. Management implications were also made. **Key words: wild turkey, precipitation, microhabitat, reproduction, vegetation**

296

Lu, X. and G. M. Zheng. 2001. Habitat selection and use by a hybrid of white and Tibetan eared pheasants in eastern Tibet during the post-incubation period. Canadian Journal of Zoology 79:319-324. Abstract: We investigated habitat selection and use by a recently discovered hybrid of the white eared pheasant (*Crossoptilon crossoptilon*) and Tibetan eared pheasant (*Crossoptilon harmani*) in the forests of eastern Tibet (93°39'E, 32°24'N) during the post-incubation period in 1995. The frequency of encountering molted feathers was used as an indicator of the relative abundance of eared pheasants in order to analyze patterns of habitat selection and use. Forests on south-facing slopes, dominated by the holly leaf-like oak (*Quercus aquifolioides*) and Tibetan juniper (*Sabina tibetica*), were the habitats preferred by eared pheasants. North-facing slopes with coniferous forest, which is the most preferred habitat of eared pheasant species in other areas, were completely avoided, probably because moisture-heat conditions that are beyond the birds' physiological tolerance. We conclude that climatic conditions are the main determinant of macrohabitat selection by eared pheasant species. In preferred habitats, oak and juniper woodland accounted for a larger proportion of home ranges of family flocks. Daily movements of a flock might cover a large altitudinal range, from the base of the mountain to the area above tree line, with an apparent preference for sites that can be used for foraging and dusting. **Key words: Tibetan eared pheasant, white-eared pheasant, temperature, humidity, habitat use, behavior**

297

Ludwig, G. X., R. V. Alatalo, P. Helle, H. Lindén, J. Lindström, and H. Siitari. 2006. Short- and long-term population dynamical consequences of asymmetric climate change in black grouse. Proceedings Royal Society B 273:2009-2016. Abstract: Temporal asymmetry in patterns of regional climate change may jeopardize the match between the proximate and ultimate cues of the timing of breeding. The consequences on short- and long-term population dynamics and trends as well as the underlying mechanisms are, however, often unknown. Using long-term data from Finland, we demonstrate that black grouse (*Tetrao tetrix*) have responded to spring warming by advancing both egg-laying and hatching. However, early summer (the time of hatching) has not advanced, and chicks have to face colder post-hatching conditions. Demonstrating that these conditions are critical to post-hatching survival, we show that chicks are increasingly suffering higher mortality because they hatch too early. Consequently, breeding success and population size has severely declined over the past four decades. Finally, we modeled the impact of this particular climate change scenario on population dynamics and show that the mismatch can further explain the observed collapse of cyclic fluctuations. Because the evolutionary response of grouse is lagging behind the novel selective pressures, seasonally asymmetric climate change is likely to constitute an important determinant of future short- and long-term changes in the dynamics of black grouse populations. **Key words: black grouse, population dynamics, temperature, mortality, breeding success**

298

Lusk, J. J., F. S. Guthery, R. R. George, M. J. Peterson, and S. J. DeMaso. 2002. Relative abundance of bobwhites in relation to weather and land use. Journal of Wildlife Management 66(4):1040-1051. Abstract: Weather and land use are important factors influencing the population dynamics of northern bobwhites (*Colinus virginianus*) in Texas and elsewhere. Using an artificial neural network, we studied the effects of these factors on an index of bobwhite abundance (hereafter, index) in 6 ecoregions in Texas. We used roadside-count data collected by the Texas Parks and Wildlife Department (TPWD) during 1978-1997. Weather variables were June, July, and August mean maximum temperatures, and winter (Dec-Feb), spring (Mar-May), summer (Jun-Aug), and fall (Sep-Nov) rainfall. We also included the proportion of county area in cultivation, the number of livestock per hectare of noncultivated land, and the previous year's bobwhite count in the analyses. The data were partitioned into training and validation data sets prior to analyses. The neural model explained 65% of the variation in the training data (n = 72) and 61% of the variation in the validation data (n = 17). The most important variables contributing to network predictions were July temperature, fall rainfall, cattle density, and the previous year's bobwhite count. State-level simulation results indicated that the bobwhite index decreased with increasing June temperature and livestock density. The bobwhite index increased with July and August temperature, fall rainfall, and the previous year's bobwhite count. Bobwhite abundance increased with the proportion of county area in cultivation up to approximately 20% cultivation and then declined. Winter, spring, and summer rainfall had little effect on the bobwhite index. Although many relationships appeared approximately linear or were decelerating, proportion of county area in cultivation and livestock density on noncultivated land showed strongly curvilinear responses. Therefore, cultivation up to approximately 20% of county area was beneficial, but the benefits disappeared as cultivation increased beyond this level. Further, at low livestock densities, between 0.15 and 0.40 head/ha, small increases in head/ha resulted in a decrease in the bobwhite index of 156.4%/head/ha. The results also indicated that a potential bias might exist in the survey protocol resulting in artificially inflated counts under some weather conditions. **Key words: bobwhite quail, temperature, precipitation, census, abundance, index**

299

_____, _____, and S. J. DeMaso. 2001. Northern bobwhite (*Colinus virginianus*) abundance in relation to yearly weather and long-term climate patterns. Ecological Modeling 146(1-3):3-15. Abstract: We used multilayered, backpropagation neural network to investigate the relative effects of yearly weather and long-term climate patterns on the abundance of northern bobwhites (*Colinus virginianus*; hereafter, bobwhite) in Oklahoma, USA. Bobwhite populations have been declining for several decades across the United States, and predicted global climate change might accelerate the rate of decline. We were interested in whether bobwhite abundance was more responsive to yearly precipitation and temperature, or to annual deviations from long-term mean climate patterns. We used roadside count data collected over a 6-year period (1991-1997) by the Oklahoma Department of Wildlife Conservation as a measure of bobwhite abundance. We standardized quail counts among counties by calculating the standard normal deviate for each county. Weather data were obtained from weather stations closest to the roadside-count route. We had 280 training cases and 68 test-validation cases. Two data sets were constructed; one using yearly weather data (actual rainfall and temperature) and the second using annual deviations from long-term mean values. We conducted simulation analyses to determine the nature of the relationship between each dependent variable and the standardized bobwhite counts. A neural network with eight neurons was most efficient for the yearly weather data, counting for 25% of the variation in the training data. The adjusted sum-of-squares for this model was 2.42. A four-neuron network was selected for the deviation-from-normal data set, accounting for 23% of the variation in the training data. The adjusted sum-of-squares for the deviation model was 1.44, indicating it performed better than the model for yearly weather patterns. Deviation from long-term mean July and August temperatures combined contributed 31.5% to the climate network's predictions, and deviations from mean winter, spring, and summer precipitation combined contributed 42.8% to the network's predictions. As July temperature increased over the long-term mean, the number of bobwhites counted increased over the route mean, but the relationship decelerated at high July temperatures. Predicted increases in bobwhites counted were highest when August temperatures were below the mean and decreased rapidly for all temperatures greater than the mean. Predicted bobwhite counts increased asymptotically as winter rain increased over the long-term mean, but were greatest at mean spring-rainfall amounts and at below average amounts of summer rainfall. We conclude that the absolute changes in yearly weather pattern predicted by some global change models will not have as great an impact on bobwhite abundance as will the magnitude of the deviations of these values from the climate bobwhites are adapted to in this portion of their range. **Key words: bobwhite quail, temperature, precipitation, population dynamics, model, climate change**

300

McAdoo, J. K. and G. N. Back. n.d. Sage-grouse habitat requirements. Fact Sheet FS-01.-44. University of Nevada, Cooperative Extension, Reno, USA. Notes: Winter Habitats – Winter habitat for sage-grouse varies according to weather conditions. But regardless of weather, the presence of sagebrush for food and cover is the common denominator. Sage-grouse feed almost exclusively on sagebrush leaves at this time of year. At least 10 to 12 inches of sagebrush must be exposed above the snow to allow feeding by sage-grouse. Although big sagebrush dominates sage-grouse diets in most portions of this bird's range, other sagebrush species are also eaten. In northern Nevada, low sagebrush is used until it is covered with snow, at which time the birds move to big sagebrush areas. Sagebrush is also important in winter for cover. Sage-grouse will roost in open, low sagebrush sites on clear, calm nights above 10°F. However, on windy nights or during snowstorms the birds seek out taller shrubs in areas with 20% or more canopy cover. On cold nights when powdery snow is available, sage-grouse will burrow in the snow to conserve energy. These birds will fly more than 5 miles between winter-feeding and snow roosting sites during very cold weather (below 10°F)…sage-grouse use other habitats, like wet meadow areas, and increase their dependence on these habitats in mid to late summer during drought years. **Key words: sage-grouse, snow, temperature, wind, habitat use, vegetation, drought**

301

McAtee, W. L., editor. 1945. The ring-necked pheasant and its management in North America. American Wildlife Institute, Washington, D.C., USA. Summary: This book presents the status of pheasants in various regions of the U.S. as follows: Northeast: In Vermont, towns having the least annual snowfall have the most pheasants. Occasional 3- to 4-inch snows and sleet storms that may coat the cover for days, or subzero spells down to -30°F, alone do not ordinarily restrict pheasant increase. As a rule, if good food and cover are available, the birds can be counted upon to hold their own against the elements in the northeast without unreasonable losses. Excessive snowfall, followed by heavy crusting may seal in some of the birds. Prolonged sleet storms, and protracted subzero weather will eventually take a toll. These conditions have a cumulative effect, gradually sapping the vitality of the birds, and making them more susceptible to disease and predation. Ice storms, aside from depriving the birds of food, may cause ice to form under their wings or freeze their tail feathers to the ground. Extreme winter conditions conceivably can result in catastrophe for the pheasant populations. Spring freshets, or other floods, cause nest losses in some locations. Some swales are avoided or only partly utilized (for roosting) because air drainage from slopes above makes them frost pockets, several degrees colder than surrounding areas. Prevailing winter winds may drift in much of the swale with deep snow for more or less extensive periods. Other part-time roosts are flooded in winter thaws. Ohio: Deep snows and sleet sometimes make grain, weed seeds and other foods relatively unavailable to pheasants. Such conditions, prolonged, may result in starvation. Rain sometimes floods and destroys pheasant nests in low places. However, a rainy period may delay the average date of hay mowing for a week or more at the height of the pheasant nesting season and, in so doing, permit thousands of eggs to hatch that would otherwise be destroyed. In winter pheasants commonly frequent drainage ditches where they find shelter from the wind. In the thick growths of cattails and sedges found in the bottoms of many of the ditches, there are often hollows and channels through the snow. These are utilized by pheasants in severe winter weather. Michigan: There is a lag in the time of day when the birds leave their roosting sites in search of food and a hastening of their return to the roosts, both of which are associated with lower temperature and diminished light intensity. High wind velocity leads them to search persistently for windbreaks, such as the protected sides of trees, heavy brush cover, lower spots protected by sedges, and weedy places. It is generally believed that pheasants seek marshlands largely for cover, but the temperature factor may also be an important secondary influence for this choice, for it has been demonstrated that the winter temperature may be 19° higher among the marsh sedges than in the grass and mixed herbaceous cover in more elevated locations. Cover is valuable not merely in providing shelter from enemies or from adverse climatic conditions, but in giving a sense of security that may conserve nervous and muscular energy which would otherwise be expended in unnecessary skulking from dangers that do not exist. Concerted crowing and fighting of cocks appear to be affected by temperature, being conspicuous during warm periods and almost lacking during cold spells. The pheasant's movements off of the roost are retarded by decreased temperature, especially during periods of strong winds. When temperatures remain below 10° to 15°F, pheasants usually do not leave marsh cover to feed in nearby cornfields, but take materials available within the margins of the marsh, which may provide only a starvation diet. On very cold days, pheasants linger near or within the roosting sites, and frequently do not leave the roost at all. Northern prairie states: Prairie winds, while covering much ground with drifts, leave large spaces exposed, so this bird is unlikely to go hungry. It can endure fairly protracted fasting in cold weather and quickly recover lost weight when food is again available. There is evidence that sheer severity of the winter climate alone may delimit pheasant populations on the northern edge of their prairie range. In northern Iowa a severe winter caused a large die-off. A large part of the loss…was attributed to freezing and choking. Birds, caught in drift storms and blizzards away from dense escape cover, almost invariably turn their tails to the wind and crouched on the snow. The body feathers of such unfortunate pheasants were ruffed and the driven snow was packed under the feathers. Body heat melted the snow and the severe cold caused the water to freeze and thus encase the birds in ice. Many froze to death. Survival was highest in the flocks that roosted in dense cover of willows and groves adjacent to an available food supply that required little ranging to obtain. Nebraska: Weather affects carrying capacity of sandhill habitat. Dry years cut down on the winter food supply. Extremely wet years also are detrimental as the marshes are filled with water, freeze over as soon as winter arrives, and exclude pheasants from normally important feeding grounds. Winter kill of the birds is always very severe during periods of heavy snowfall on areas that have a limited food supply. Heavy snows hardened by winds and subzero temperatures prevents the birds from getting to the ground for food, and winter kill occurs within 15 days after such weather begins. Pheasants also become inactive at subzero temperatures, do less foraging, and may soon succumb to freezing. Intermountain Irrigated Region: There is no question that near the surface of the (irrigated) ground and among cultivated plants the temperature and particularly the humidity have been markedly affected. Winter snow conditions appear to be especially important, with light to moderate snowfall favoring high populations. Snow conditions are apparently a more serious factor than differences in elevation and winter temperature. It was evident that the pheasants became more dependent upon food other than waste grain as the snow cover increased (they ate seeds and fruits of native plants). Pacific Northwest: After a snowfall of 3 feet, that remained for about 10 days, numerous kills were made on pheasants by hawks and other predators both in cover and in the open. Rains apparently have little effect upon adult ring-necked pheasants. It is undesirable to take inventories during the first fall rains, as the pheasants then remain in seclusion for a week or 10 days. After that period of adjustment, they ignore the rain and carry on normally. Weather…definitely affects survival of newly-hatched and immature birds. Birds hatched during periods of extremely wet or cold weather do not survive. Wet, chilly weather during the hatching period is directly reflected in a lessened number reaching maturity. **Key words: ring-necked pheasant, precipitation, snow, ice, wind, temperature, nutrition, predation, mortality, behavior, habitat use**

302

McAuley, D. G., J. R. Longcore, D. A. Clugston, W. H. Teman, and G. F. Sepik. 2006. Survival of American woodcock broods and chicks in Maine. *In* 10th

American Woodcock Symposium:25, Michican Department of Natural Resources and the United States Fish and Wildlife Service. Abstract: During 1986-1989, 89 female American woodcock (*Scolopax minor*) were radio-marked during the period 1 April-30 June at Moosehorn National Wildlife Refuge in Maine. Forty-six broods made up of 190 chicks were followed for a 21-day period to determine survival. Brood survival, the probability of fledging >1 chick, during the 21-day period ranged from 0.339 to 1.000. Survival of chicks varied from 0.142 to 0.944. Survival rates differed among years. Preliminary estimates indicate that survival of chicks and broods from after second year (ASY) females differed from second year (SY) females. Differences between original nests and re-nests and effects of weather were investigated. **Key words: American woodcock, weather, reproduction, mortality**

303

McCabe, K. F. and L. D. Flake. 1985. Brood rearing habitat use by wild turkey hens in south-central South Dakota. Proceedings of the National Wild Turkey Symposium 5:121-131. Notes: Page 127—"Adverse weather may have been a factor in the low recruitment. During both years of the study, late snowfalls may have caused poor initial nesting success because of abandonment. Also, prolonged rains and cool weather occurred in June of both years, when any initial hatch of poults was most vulnerable to adverse conditions…".Page 128—"South-facing slopes also provide the benefit of early morning sunlight, useful in burning off dew quickly, which reduces the hazard of poults being dampened and chilled. South-facing woodlands likely were selected over south-facing grasslands because the 48% average canopy cover could provide protection from aerial predators, shelter against rain and wind while giving ready access to open drying areas wherever trees are sparse, and shade from heat (which also may concentrate insects)." **Key words: Merriam's turkey, snow, temperature, precipitation, productivity, solar radiation, dew, habitat use, vegetation**

304

McCabe, R. A. and A. S. Hawkins. 1946. The Hungarian partridge in Wisconsin. American Midland Naturalist 36(1):1-75. Notes: Page 9—"The true effect of climate is often obscured by averages. Adverse climatic conditions become lethal in three ways, suddenness, severity, and duration, all of which may be absorbed in averages. Climatic conditions that in themselves would have no effect on wildlife may be combined to produce a climatic complex that is detrimental. For example, rain or temperatures just below freezing are of no importance separately, but a temperature drop to below freezing during a rain may cause serious food shortage by coating both food and grit with ice."; "Weather Mortality—The partridge is a hardy bird and it takes a combination of adverse weather conditions such as snow, wind, and prolonged low temperatures to bring about mortality. Two such combinations occurred during the winters of 1935-36 and 1936-37…the first winter brought very deep snow and continued sub-zero temperatures, and many partridges died. In January of the second winter, rain followed by freezing temperatures covered southeastern Wisconsin with a sheet of ice which remained for almost two months. Food and grit were difficult to obtain, and again many partridges perished. It was also during this winter that loss through egress took place.

Roosting habits vary somewhat with weather conditions. On mild winter nights the partridge covey may roost as a loose group, but on cold nights roost in a ring as compact as that of the bobwhite. On one occasion…a covey of partridges roosted in grouse fashion by plunging into a snowdrift. Feeding habits, like roosting, conform to weather changes. When snow covers a field, they often tunnel, in one case to a depth of twelve inches, to reach the feed." **Key words: Hungarian partridge, snow, wind, ice, precipitation, temperature, mortality, behavior, nutrition**

305

McClure, H. E. 1942. Mourning dove production in southwestern Iowa. Auk 59(1):64-75. Notes: Page 66 – "No new nests were built after September 17, 1938, and after September 24, 1939. Although a storm of August 30 served only to truncate the September peak, a three-day cold rain and wind from September 13 through September 17 brought a halt to nest building in 1938. Hot winds from September 4 to 15, 1939, stopped nest building except for three unsuccessful attempts made after September 15. Continued warm and calm weather after these disruptive spells failed in both years to stimulate the birds to more nesting, although some were seen courting. Captive birds showed a cessation of activity at this time, too. Wind and heavy storms are the greatest decimating factors of nests, eggs and young. During 1938 there were but few severe storms, while in 1939 the season was a series of blasts. On June 7 a hailstorm occurred during which hailstones weighting as much as one-half pound fell. Nests were not only knocked out by wind and rain, but parents and young were killed on the nests by direct blows." **Key words: mourning dove, precipitation, temperature, wind, hail, behavior, mortality**

306

McCrow, V. P. 1982. Gray partridge habitat use and nesting biology in north-central Iowa. Dissertation, Iowa State University, Ames, USA. Abstract: Gray partridge (*Perdix perdix*) movements, habitat use, and nesting were studied from 1975 to 1977 in north-central Iowa, a region of intensive row-crop agriculture. Use of 4 habitat classes by 9 birds monitored by radio telemetry was compared with habitat availability over 4 seasonal periods. Strip cover was used at higher than expected frequencies in all periods. Partridge utilized the periphery of fields at a relatively high frequency while use of the central portion was less than expected. Three partridge broods utilized soybeans at a high frequency and corn at a relatively low frequency through the 1st 4 weeks of life, but use of corn increased from 5 to 8 weeks of age. Hay and strip cover were used at a relatively high frequency through 2 weeks of age as were the edges of fields. Average overall activity range for 6 mated birds that were monitored over 4 or more months was 1.93 km('2) (range = 0.84 to 3.66 km('2)). Paired partridge occupied relatively restricted ranges from the pre-nesting through the nesting period, but activity ranges increased in the late summer. An unmated male followed a different pattern of range size distribution with extensive wandering in the spring and a large activity range followed by a general reduction in range size through the summer. Birds occupying habitat with relatively high interspersion of cover types tended to have smaller overall activity ranges. Over all years, 23 partridge nests and 29 ring-necked pheasant (*Phasianus colchicus*) nests were found. Rates of nest success were 0.26 for partridge and 0.41 for pheasants. Mean clutch size for 9 completed partridge nests was 14.9 eggs. In contrast to pheasants, partridge made little use of drainage ditchbank, railroad righty-of-way, or grass waterway cover for nesting; 83% of the partridge nests were found in roadside and fenceline cover. Only 2 pheasant nests and no partridge nests were found in hayfields. Spring-to-fall gain was more closely associated with an index to pair success than the mean brood size. Low pair success was affected by weather, re-nesting effort, and the scarcity of stable and protected nesting cover. Protection of roadside nesting cover from disturbance should benefit partridge populations in northern Iowa. **Key words: gray partridge, ring-necked pheasant, weather, productivity, vegetation, habitat use**

307

McGowan, J. D. 1969. Starvation of Alaskan ruffed and sharp-tailed grouse caused by icing. Auk 86(1):142-143. Summary: In 1968 thick accumulations of ice cut off food supplies and roosting sites of sharp-tailed and ruffed grouse. A die-off resulted. Exposed vegetation near Minto, Alaska was coated with about ½ inch of ice which persisted for 5 weeks. Dead grouse were first noticed about 4 weeks after the heavy glaze occurred. Less severe icing occurring near Fairbanks did not appear to affect local ruffed grouse. Return to very low temperatures following glazing could make the effect of icing more severe in interior Alaska than in temperate areas, especially if glazing caused heavy crusting of snow, and thus prevented snow roosting. **Key words: ruffed grouse, sharp-tailed grouse, ice, temperature, nutrition, mortality**

308

Mackenzie, J. M. D. 1952. Fluctuations in the numbers of British tetraonids. Journal of Animal Ecology 21(1):128-153. Abstract: Data on red grouse, *Lagopus scoticus*, are given for some 80 moors and the oldest records go back to 1834. Peaks are shown, and some records of disease outbreaks back to 1797 are noted. Data on other tetraonids, *Tetrao urogallus*, *Lyrurus textrix, Lagopus mutus*, from other estates in central Scotland from 1866 to 1949 are given. *L. scoticus* fluctuates throughout its range, the period being irregular, between 3 and 10 years but mostly 5 or 6. There is a general synchrony which is not however exact. Peak years may differ even on adjoining moors. It is suggested that this synchrony is brought about because, while crashes on each moor are due to the interaction between the birds and their immediate environment, there is occasionally a very good or very bad year which brings big areas into line. The critical density may differ in the same area in different periods and varies widely from place to place. Where density is high, strongylosis (infestation by the nematode, *Trichostrongylus pergracilis*) is often but not always associated with crashes. Cycles with much the same rhythm and dates occur in areas where it is unknown, when bad nesting seasons are thought to be the limiting factor. Some of the worst crashes occur when they are associated with strongylosis. A possible explanation is that once the critical density is exceeded or resources are reduced below requirements (perhaps only temporarily) the particular agency which reduces numbers may vary. The other three tetraonids show rises and falls more or less synchronously with grouse. Duplicate peaks sometimes occur at intervals of 2 years only. Species other than grouse sometimes have interpolated peaks in long intervals. The only common factor likely to cause these events is food, which is affected by weather. Peak periods of 2 or 3 years are suggested, during which most peaks occur. Blackgame bags from south Scotland from 1850 and 1949 are given and agree in general with data from central Scotland. An increase in warmth and wetness in the northern climate may be the ultimate cause of the long-term variations. **Key words: black grouse, red grouse, temperature, precipitation, nutrition, disease, mortality, population dynamics**

309

McLean, R. G. 2006. West Nile Virus in North American birds. Ornithological Monographs 60:44-64, American Ornithologists' Union, USA. Notes: Page 50 – "In contrast to epidemic conditions in the western United States, WNV activity in areas east of the Rocky Mountains was reported to be significantly less in 2004 than in 2003, likely because of unfavorable weather for WNV transmission. Climatic data for 2004 showed a significantly cooler and wetter summer, particularly compared with 2003, in the eastern region of the United States, whereas weather in the western region—including Arizona and California -- where there was increased WNV activity—did not change from the previous five years. A combination of a wet and cool summer along with other factors can greatly reduce mosquito production and activity, lengthen the extrinsic incubation period of the virus in the vector, and affect reproduction and populations of insect-eating birds, all of which could reduce WNV transmission and lower the number of infected birds, equines, and humans in the temperate areas of the eastern United States. However, reduced WNV transmission in southeastern states such as Florida in 2004 was attributable to summer drought." Page 53 – "Mortality of greater sage-grouse (*Centrocercus urophasianus*, a declining and threatened species in western North America) caused by WNV was documented in free-ranging populations in Montana, Wyoming, and Alberta in 2003. Of 22 radiomarked females from four study sites that could be tested, 18 (82%) died from WNV infection. In addition, serum collected from 112 greater sage-grouse from those areas after the outbreaks were all antibody-negative, which suggests a low survival rate following WNV infection. Experimental studies confirmed the high susceptibility and mortality in greater sage-grouse from WNV infection: 100% mortality in second-year birds, with a 3.7-day mean survival time." Page 59—"Climate and seasonal weather affect the winter survival, spring initiation, summer intensity and diversity, and the intensity and distribution of local or regional mosquito-borne virus activity. Climate appears to have less effect on winter survival and early-spring initiation of WNV than of other mosquito-borne viruses." **Key words: sage-grouse, precipitation, temperature, drought, insects, disease, mortality**

310

MacMillan, I. I. 1964. Annual population changes in California quail. Journal of Wildlife Management 28(4):702-711. Abstract: A population of California quail (*Lophortyx californicus*) in San Luis Obispo County, California, was kept under study and management from 1946 to 1962. Observations and age ratios obtained during fall hunting have indicated wide fluctuation of reproductive success, age ratios varying from 6-81 percent young. In general, years of high rainfall correlated with high reproduction; dry winters were followed by reduced breeding. The key factor in reproductive rate was the drive to keep nesting and renesting throughout the summer, resulting presumably from a physiological preconditioning whose nature and origin is unknown. Reproductive drive was shown to be independent of environmental conditions during the actual nesting season, appearing to be related more to early breeding season weather conditions that control annual plant growth and production of quail food. **Key words: California quail, precipitation, fecundity, nutrition**

311

MacMullan, R. A. and L. L. Eberhardt. 1953. Tolerance of incubating pheasant eggs to exposure. Journal of Wildlife Management 17(3):322-330. Summary: Incubating pheasant eggs were subjected to low temperatures and simulated rain for various lengths of time. From the tolerance data thus obtained, an equation has been set up to approximate the relationship between temperature, stage of incubation, and length of exposure as affecting survival. Conclusions: 1) As exposure temperature is lowered, length of time pheasant embryos can safely tolerate exposure decreases. 2) Embryos are progressively more vulnerable to exposure as incubation progresses. 3) Alternate cooling and incubating do not cause higher mortality than a similar elapsed time of continuous cooling. 4) Exposure to simulated rainfall or flooding reduces the survival threshold below that of simple cooling to approximately the same temperatures. 5) Death from chilling evidently occurs during the exposure. “After-effects” are of minor importance. 6) Newly-hatched chicks exposed to lowered temperatures are much more vulnerable than eggs in any stage of incubation. The tolerance shown by pheasant eggs in these experiments was considerably greater than popularly supposed. For much of the incubation period, tolerance is great enough that widespread mortality from unseasonal cold spells would not likely occur in the wild. There are two possibilities for widespread mortality of chicks or eggs in the wild, however, that warrant further consideration and study: 1) Changes of habits of hens during cold, wet weather could affect survival of eggs in the wild. At ‘normal’ spring temperatures, hens apparently do not remain off the nest long enough to allow lethal chilling. A change in habits of hens during cold weather at late stages of incubation, when eggs are more vulnerable, however, could allow lethal exposure. 2) Chicks appeared markedly less tolerant to cold than eggs in any stage of incubation. While the experiment with chicks was limited, it suggested that chicks are highly dependent upon the brooding hen for warmth. Conceivably, severe cold, especially in conjunction with precipitation, could cause widespread mortality, if it occurred at a time when a large proportion of the chick population was vulnerable. **Key words: ring-necked pheasant, temperature, precipitation, flood, behavior, mortality, behavior**

312

McNeil, J., H. Yin, and R. McNeil. 2007. Analysis of the climate in the greater sage-grouse range of southwestern Saskatchewan and southeastern Alberta. Report prepared for Prairie Farm Rehabilitation Administration, Agriculture and Agri-Food Canada; Grasslands National Park, Parks Canada; Saskatchewan Watershed Authority; and the Interdepartment Recovery Fund. LandWise Inc., Lethbridge, Alberta, Canada. Notes: This report discussed the potential effects of cold wet weather and hot dry weather on sage-grouse. Page 36 “Correlations between extreme weather and sage-grouse decline” states: “Sage-grouse numbers based on lek counts declined dramatically after the spring of 1988, corresponding to the exceptionally hot and dry conditions or drought in 1987 and 1988. The greater frequency of extreme weather events in May and June in the 1990s and beyond may have contributed to the continued but more gradual decline in sage-grouse populations since 1989. For example, the recent population decrease may be in part related to the greater frequency of cold and wet spring conditions in the study area between 1999 and 2004." Page 40: "The exceptionally hot and dry conditions in 1988 were followed by a dramatic decline in sage-grouse counts in the following spring. This severe decline may be directly related to the extremely hot and dry weather in 1989. Insecticide use to control high grasshopper populations associated with drought conditions in the mid to late 1980s may also have contributed to the decline. Some insecticides used in Saskatchewan at that time are highly toxic to birds, and the decrease in insect populations may also have had a detrimental effect, particularly on sage-grouse chicks. The exceptionally hot and dry conditions that culminated in 1988 were followed by several years with exceptionally cold and wet springs, including 1991, and in particular, 1999, 2002, 2003 and 2004. The recent cold and we conditions may have contributed to the more gradual decline in sage-grouse numbers since 1998." **Key words: sage-grouse, drought, precipitation, temperature, pesticide, mortality, population dynamics, index**

313

Manzer, D. L. and S. J. Hannon. 2007. Survival of sharp-tailed grouse *Tympanuchus phasianellus* chicks and hens in a fragmented prairie landscape. Wildlife Biology 14:1:16-25. Notes: The authors state death from exposure appeared to be associated with periods of heavy precipitation. They speculate that heavy losses in a single year presumably could occur if a prolonged period of wet and cold weather persisted (2-3 days) through the early stages of chick growth before chicks are able to thermoregulate. **Key words: sharp-tailed grouse, precipitation, temperature, mortality**

314

Marcstrom, V. and N. H. Hoglund. 1980. Factors affecting reproduction of willow grouse *Lagopus lagopus* in two highland areas of Sweden. Swedish Wildlife Research Viltrevy 11(7):285-314. Abstract: Reproductive success in willow grouse is investigated in relation to weather conditions during the chick period, time of breeding, population fluctuations in small mammals and other factors. Unfavorable weather, especially sleet and snow, had a drastic effect on survival of young chicks. Less than 30% young willow grouse in the autumn population could always be referred to poor posthatching weather. Successful reproduction was more usual in early than in late springs. An apparent correlation often existed between small mammal numbers and reproductive success in willow grouse, although some obvious exceptions occurred. The timing of small mammal declines was most likely of importance for the number of predators present in spring to feed upon eggs and young of grouse. The situation could be complicated by the fact that all small mammal species did not always decline in the same time, and to the same extent. The average age composition in autumn was 54% young willow grouse both at Lovhogen and Ammarnas. Available studies on population dynamic in tetraonids seem to show that many factors are necessary to explain all the complex population changes. **Key words: willow grouse, snow, ice, sleet, chick survival, reproductive success, predation**

315

Marjakangas, A. 1990. A suggested antipredator function for snow-roosting behavior in the black grouse *Tetrao tetrix*. Ornis Scandinavica 21(1):77-78. Summary: Several studies suggest that grouse conserve heat in cold winter weather by snow-roosting. However, black grouse frequently snow-roost even in mild weather when it may not be necessary for energetic reasons, and in moist snow when there is the risk of being imprisoned after freezing of the snow. Thus, snow roosting may also have other important functions for black grouse, such as avoidance of predators. **Key words: black grouse, snow, predation, behavior**

316

_____. 1986. On the winter ecology of the black grouse *Tetrao tetrix* in central Finland. Acta Universitats Ouluensis Series A Scientiae Rerum Naturalium Biologica, 29:1-87. Abstract: The snow roosting behavior of the black grouse and the effects of artificial feeding were studied at three feeding sites in Oulu (75°N) and Ylivieska (64°N), W Finland, in the winters of 1976/1977-1981/1982. The black grouse roosted regularly in snow burrows when there was at least 27 cm of readily penetrable snow, but were able to penetrate relatively hard crusts within the snow. Under adverse burrowing conditions they tended to prefer the micro- and macrohabitats with the deepest snow available. The thickness of the roofs of their closed cavities averaged not more than about 10 cm irrespective of the snow conditions. This together with some other structural features of their burrows may be related to the avoidance of ground predators. In relative terms, the closed cavities were high, and those excavated by the females 8.7% wider than those of the males, enabling more effective ptiloerection. The black grouse roosted exclusively in closed burrows at -3°C and below, and also in milder weather, in which case cavity temperatures were well above zero, as shown experimentally. The flushing distance from closed burrows showed diurnal variation, being longer for flocks than for solitary grouse. The birds in large flocks roosted closer to each other than those in small ones. When able to roost in closed burrows, they restricted their activity In approximately 1 h 25 min in the morning. The black grouse fed on oats daily, the mean distance of the roosting sites from the feeding site being only 591 m. The sex ratio of the feeding flocks was skewed in favor of males. The birds spent 62.8% of their diurnal activity at the feeding site. Adult males occupying territories devoted 43.2% of their individual activity to display throughout the winter, but only 29.9% to feeding on oats, although this was compensated for by a high pecking rate and prolonged activity. A dominance rank order prevailed among the non-territorial birds, the juvenile females being the most subordinate, but there were no appreciable differences between the individual time budgets of the males and females. No ranking was evident in trees, and the females fed at an equal rate to the males. The rate of dry matter intake was superior when feeding on oats and lowest with pine. The average composition of the diet was 86.1% oats, 4.6% birch and 9.3% pine. Particularly in late winter, the black grouse browsed heavily on bare pine twigs and needles. The mineral content of the oats, especially Ca and Mn, was lower than that of their natural winter food, and consequently the soft tissues of the birds which had fed on oats contained significantly less of some of the minerals than did those of the control birds and their caeca were significantly shorter. Possibilities for improving feeding practices are discussed. **Key words: black grouse, snow, behavior**

317

_____, H. Rintamäki, and R. Hissa. 1984. Thermal responses in capercaillie and the black grouse roosting in snow. Physiological Zoology 57(1):99-104. Abstract: Thermal responses were studied in the capercaillie and the black grouse roosting in closed snow burrows in northern Finland. For capercaillie, the air temperature within the burrow declined with the distance from the bird but was as high as 11C adjacent to the bird when snow temperatures varied between -7.5 and 11.5C. The body temperature of the burrowed capercaillie was significantly lower than that of those roosting on the snow surface, indicating lessened alertness. In a comparison of the responses of the two species, the body temperature of burrowed black grouse was significantly higher than that of similarly situated capercaillie. The burrowed black grouse shivered occasionally but weakly during the nest. Measurements of pectoral muscle electromyographic activity (EMG) were not taken for capercaillie. The results support the hypothesis that in winter, under suitable snow conditions, these birds are able to shelter in, or close to, a thermoneutral microenvironment. **Key words: capercaillie, black grouse, snow, thermoregulation**

318

Marks, J. S. and V. S. Marks. 1988. Winter habitat use by Columbian sharp-tailed grouse in western Idaho. Journal of Wildlife Management 52(4):743-746. Abstract: We studied habitat use by Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*) during 3 winters in western Idaho. Grouse were closely associated with mountain shrub and riparian cover types, the only cover types that provided food and escape cover regardless of snow depth. Fruits of Douglas hawthorn (*Crataegus douglassi*) and buds of Saskatoon serviceberry (*Amelanchier alnifolia*) and common chokecherry (*Prunus virginiana*) were the main winter foods. Hawthorn buds apparently were not eaten by grouse. Because hawthorn fruits were not available throughout the winter, plants producing palatable buds or catkins should be present to provide food during late winter and in years when fruit production is poor. **Key words: Columbian sharp-tailed grouse, snow, vegetation, nutrition**

319

Marra, R. P., S. Griffing, C. Caffrey, A. M. Kilpatrick, R. McLean, C. Brand, E. Saito, A. P. Dupuis, L. Kramer, and R. Novak. West Nile Virus and wildlife. BioScience 54(5):393-402. Notes: Page 399—“Wet springs and hot, dry summers may also facilitate WNV epidemics. Such was the case in the New York City area in 1999 and in Colorado in 2003, when the production of mosquitoes in higher than normal numbers was followed by maximized rates of viral replication within mosquitoes (because of warm temperatures), leading to shortened transmission and amplification cycles. Torrential rains at summer’s end can also lead to heightened amplification by causing an increase in ovipositioning sites.” **Key words: temperature, disease, West Nile Virus**

320

Marshall, A. J. 1949. Weather factors and spermatogenesis in birds. Proceedings of the Zoological Society of London Series A 119:711-716. Unable to obtain for abstract.

321

Marshall, W.H. 1965. Ruffed grouse behavior. BioScience 15(2):92-94. Summary: The authors believe that the paramount factors affecting ruffed grouse behavior during cold periods involve both a quest for habitats to minimize energy loss and for foods of high calorigenic value. During 1963 the lack of snow precluded roosting at night in snow burrows, one means by which grouse avoid heat loss. Instead, this bird was forced to remain exposed to the winter night sky which, at Cloquet, Minnesota, is often a clear and an intensely cold radiation sink. By utilizing the spruce-fir stands for roosting at night, this bird selected a habitat wherein energy leakage by radiation was limited. By feeding rapidly on the buds of clones of staminate aspen trees for short periods of time the birds choose a very rich source of food while minimizing energy loss. **Key words: ruffed grouse, temperature, snow, behavior, habitat use**

322

_____ and M. S. Jensen. 1937. Winter and spring studies of the sharp-tailed grouse in Utah. Journal of Wildlife Management 1(3/4):87-99. Notes: The shifts to and from the maple-chokecherry type parallel changes in snow depth and in elevation. Roosting—Cover requirements…apparently varied largely with snow depths and crust conditions. When there was no snow the birds were found using both the sage types and the weed-grass type. As snow covered up the latter, they shifted to the sage types and even when the sage was covered, they would use this type, if there was no crust, by diving or burrowing into the snow often until they were in the branches of the sage brush. Heavy snow crusts in January and February caused the birds to roost in bushes that were above the snow; since maple and chokecherry were the only ones present on the area, they were the ones used. Feeding—Availability of food apparently influenced the food habits greatly. Only once has evidence been obtained that the sharptail digs or scratches for food; thus, as snow depths increase or decrease, certain foods in turn lose or maintain availability. The heights of the important foods above the ground are charted with snow depths for the winter period…attention is called to the correlation of changes in foods eaten with snow depths. **Key words: sharp-tailed grouse, snow, snow condition, habitat use, feeding, behavior, vegetation**

323

Martin, K. and K. L. Wiebe. 2004. Coping mechanisms of alpine and arctic breeding birds: extreme weather and limitations to reproductive resilience. Integrated Comparative Biology 44:177-185. Synopsis: As ground nesting homeotherms, alpine and arctic birds must meet similar physiological requirements for breeding as other birds, but must do so in more extreme conditions. Annual spring snowfall and timing of snow melt can vary by up to 1 month and daily temperatures near the ground surface vary from below freezing to over 45°C in alpine and arctic habitats. Species breeding in these environments have various behavioral, physiological, and morphological adaptations to cope with energetically demanding conditions. We review the ways birds cope with harsh and variable weather, and present data from long term field studies of ptarmigan to examine effects of spring weather on reproduction. In variable but normal spring conditions, timing of breeding was not influenced by snow melt, snow depth or daily temperatures in the alpine, as breeding did not commence until conditions were generally favorable. Arctic ptarmigan tended to vary breeding onset in response to spring conditions. Generally, birds breeding in alpine and arctic habitats suffer a seasonal reproductive disadvantage compared to birds at lower latitudes or elevations because the breeding window is short and in late years, nest failure may be high with little opportunity for renesting. Coping mechanisms may only be effective below a threshold of climactic extremes. Despite strong resilience in fecundity parameters. When snowmelt is extremely delayed breeding success is greatly reduced. Alpine and arctic birds will be further challenged as they attempt to cope with anticipated increases in the frequency and severity of weather events (climate varia bility), as well as general climate warming. **Key words: ptarmigan, snow, temperature, reproduction**

324

Martinson, R. K. 1963. The relationship of weather to productivity in upland game birds. Pittman-Robertson Project W-67-R-4, Phase B, Upland Game Investigations, Job No. 17, North Dakota State Game and Fish Department, Bismark, USA. Abstract: The relationship of annual weather patterns to productivity among sharp-tailed grouse, ruffed grouse and European partridges in North Dakota was investigated by comparing age ratios from those species with weather data. The various weather parameters used in the analyses included: (1) temperature, (2) precipitation, (3) Setzer Indices and (4) Hammond Method indices. Age ratios among sharp-tailed grouse from the western part of the state showed positive correlation with April plus May precipitation; those from the eastern part of the state with March plus April precipitation. In general, high age ratios among sharp-tails were found in years that had relatively high spring precipitation. Age ratios from ruffed grouse exhibited positive correlation with April plus May plus June temperatures; i.e., the higher rates of productivity among ruffed grouse occurred in years when spring and early summer temperatures were warmer than average. European partridge age ratios showed negative correlation with indices of coolness calculated for periods during June and July. That is, the higher age ratios among partridges were observed in years that had relatively warm periods in June and July. The decline which occurred in sharptail, partridge and pheasant populations in 1959 and the ten-year ruffed grouse “cycle” were discussed with reference to the affects of weather. Notes: At the present time it appears that weather, among all density-independent factors, has perhaps the most profound impact on upland game bird populations occupying static habitat. If this is so, the game manager with a knowledge of climatological phenomena and their influence on populations may be able to foretell or explain changes in the abundance of game birds.

Key words: sharp-tailed grouse, ruffed grouse, European partridge, precipitation, temperature, age ratio, productivity, index

325

_____ and C. R. Grondahl. 1966. Weather and pheasant populations in southwestern North Dakota. Journal of Wildlife Management 30(1):74-81. Abstract: High productivity and survival of ring-necked pheasants (*Phasianus colchicus*) were correlated with high rainfall and cool temperatures in May and June during an 8-year period in southwestern North Dakota. These findings differed markedly from those of several earlier studies in the less arid Midwestern United States where cool, wet weather in the spring generally affected pheasant populations adversely. General trends in the pheasant population could be explained on the basis of precipitation in May and June. The population was relatively high during the mid-1950s when wet and dry May and June periods occurred in alternate years but declined markedly after 2 consecutive years of spring and summer drought. The population remained at a static low during 1960 through 1963 when wet and dry spring and summer periods again occurred alternately. **Key words: ring-necked pheasant, temperature, precipitation, drought, population dynamics**

326

Merchant, S. S. 1982. Habitat use, reproductive success and survival of female lesser prairie chickens in two years of contrasting weather. M.S. Thesis, New Mexico State University, Las Cruces, USA. Abstract: Spring and summer habitat use, home ranges, reproductive success, and survival of female lesser prairie chickens (*Tympanuchus pallidicinctus*) in Roosevelt and Lea counties, New Mexico, are contrasted between 1979 and 1980. In 1979, weather was near optimal for prairie chicken reproduction and survival, whereas in 1980, drought conditions existed. Effects of these conditions are discussed….The increased size of home ranges in 1980 was attributed to effects of the drought…All indices to reproductive success were lower for 1980 than for 1979. These included the percent of females nesting, percent of females renesting, percent of successful nests, number of brood observations, and mean brood size. The lower reproductive success in 1980 was attributed to direct and indirect influences of the drought. Spring and summer survival of females was lower in 1980, probably due to increased vulnerability to predators, which was associated with the stressful drought conditions. **Key words: lesser prairie chicken, drought, precipitation, vegetation, habitat use, predation, reproduction**

327

Meriggi, A., D. Montagna, D. Zacchetti, C. Matteucci, and S. Toso. 1990. Population dynamics of the gray partridge in relation to agriculture and weather in northern Italy. Pages 241-253 *in* K. E. Church, R. E. Warner, and S. J. Brady, editors. Proceedings Perdix V: gray partridge and ring-necked pheasant workshop. Minnesota Department of Natural Resources, Mankato, USA. Abstract: Car censuses were carried out on a 175-km^2 area of north Italy from spring 1984 to fall 1988. Seasonal and annual changes in gray partridge density, recruitment and mortality were estimated. The average density was 4.2 pairs/km^2 (SE = 0.39) in spring and 3.4

broods/km^2 (SE = 0.29) in summer. Average brood size was 12.8 (SE = 2.73) at hatching and 8.2 (SE = 0.33) when full grown. Chick mortality rate from hatching to 30 days old averaged 42.4%. Brood size was constant after 30 days post-hatching. Spring density was closely correlated with the percentage of winter cereals (wheat and barley) and the length of hedgerows. The high rate of recruitment is followed in winter by a high rate of mortality (64.3%), as the population was reduced to the levels of the previous spring. We hypothesize cereals determine the carrying capacity of the study area for gray partridge, as a food source and alternative nesting cover. **Key words: gray partridge, mortality, winter weather**

328

Meunier, J. 2005. Fall migration chronology and habitat use of the American woodcock in the western Great Lakes region. M.S. Thesis, University of Wisconsin-Madison, Madison, USA. Conclusions: “Result of my investigation indicated that there are many factors that likely contribute to the onset of woodcock migration including factors often described by observations of woodcock in the process of migration, namely synoptic weather variables of low pressure systems like barometric pressure changes and northwest wind directions. My research indicates that these weather variables may be of secondary importance to photoperiod, which served as the initial cue and in all years demonstrated the greatest influence on woodcock migration. Photoperiod likely serves to synchronize the *Zugstimmung*, the initiation of migration of woodcock such that woodcock at northern latitudes initiate migration prior to woodcock at lower latitudes despite proximate weather in different locales…Once migration begins, local weather influenced the rate of migration.” **Key words: American woodcock, barometric pressure, wind, photoperiod, movement, behavior**

329

_____, R. S. Lutz, K. E. Doherty, D. E. Andersen, E. Oppelt, and J. G. Bruggink. 2006. Fall diurnal habitat use by adult female American woodcock in the western Great Lakes Region. 10th American Woodcock Symposium:11. Michigan Department of Natural Resources and United States Fish and Wildlife Service. Abstract: We assessed how habitat structure and food availability influenced use of cover types at the habitat patch and home-range scales by adult female (after hatch year) American woodcock in Michigan, Minnesota, and Wisconsin from 2002 through 2004. We also investigated use of alder (*Alnus* spp.) as a staging cover prior to fall migration. We selected this cover to investigate seasonally changing use of cover types based on past observations. Seasonal changes in cover type use could have important ramifications for woodcock management intended to provide or improve woodcock habitat. We measured edge proximity, stem density and earthworm abundance at woodcock locations and paired these locations to random locations at the micro-habitat scale (2002 data); 20 m from use locations within the same stand. We also compared edge proximity with paired use and random locations at the home range scale (2003 and 2004 data): >35<200 m from use locations across cover types and investigated habitat selection at this scale. Adult female woodcock (n=139) used a variety of cover types and the percent of total use changed among years and states. *We found the greatest frequency of alder use across all states in 2003, a drought year.* We found no difference between alder use during the entire fall period and early fall (*P*=0.9) or late fall (*P*=0.7) indicating that alder was not used as staging cover prior to migration. We found that structural habitat features were more important than food resources to habitat selection at both the micro-habitat and home-range spatial scales. Cover types most heavily used by woodcock often had the lowest earthworm abundances. We did find evidence that woodcock selected for edge proximity at both home-range and micro-habitat scales, especially in mature cover types. Woodcock also selected habitats with higher shrub densities and fewer mature stems in young cover types than we found at random. **Key words: American woodcock, drought, habitat use**

330

Middleton, A. D. 1936. The population of partridges (Perdix perdix) in Great Britain during 1935. Journal of Animal Ecology 5:252-261. Notes: "…general observation indicates that the heavy rainfalls and lack of sunshine during June and July have been the cause of a great deal of mortality among young partridges over most of England." **Key words: partridge, precipitation, solar radiation, mortality**

331

Miller, D. A., G. A. Hurst, and B. D. Leopold. 1997. Factors affecting gobbling activity of wild turkeys in central Mississippi. Proceedings of the Annual Conference Southeast Association of Fish and Wildlife Agencies 51:352-361. Abstract: Call counts for a number of gamebirds (e.g., northern bobwhite [*Colinus virginianus*] and wild turkey [*Meleagris gallopavo*]) have been used to index population levels and trends and to document species presence or absence. Call counts for wild turkeys have been used for these purposes, but gobbling activity has not been related quantitatively to population size, reproduction, weather, male age structure, or hunting variables. Consequently, we examined these factors as they affected gobbling activity on Tallahala Wildlife Management Area, Bienville National Forest, in central Mississippi, from 1984 to 1995. Using multiple linear regression, we determined that within-year gobbling activity was related to hunter effort, days into call count period, wind velocity, year, and dewpoint. Among years, gobbling activity was related to hunter effort and hunter success. An index to proportion of 2-year-old gobblers in the population was correlated to an increased number of gobblers heard, but not number of calls heard. Gobbling activity was influenced by a complex interaction of population and environmental conditions that cannot easily be modeled. In central Mississippi, gobble call counts were not related to gobbler population size, and their applicability in other areas warrants examination. **Key words: turkey, wind, dewpoint, behavior, census**

332

Miller, M. R., C. L. Stemler, J. L. Yee, and D. S. Blankenship. 2001. Differences in mourning dove productivity among three time periods at Gray Lodge Wildlife Area, California. California Fish and Game 87(3):93-101. Abstract: We used published and unpublished data to compare mourning dove, *Zenaida macroura*, recruitment among the 1949-50 (early), 1979-80 (middle), and 1992-95 (late) periods in riparian habitat at Gray Lodge Wildlife Area, California, to document any differences that corresponded to the long-term decline of doves in California (as estimated by the

U. S. Fish and Wildlife Service's annual Call-count Survey). Estimates of true nest success, fledglings produced per nesting attempt, and fledglings produced per active dove pair, were highest in the early period, lowest in the middle period, and low to moderate in the late period (nest success: 44-56% early, 25-29% middle, 24-25% late; fledglings/nest attempt: 1.20-1.44 early, 0.78-0.91 middle, 0.81-1.03 late; fledglings/pair: 5.93-6.58 early, 2.403.40 middle, 5.00-5.60 late). In the early period, high production coincided with the warmest and driest spring weather and an active predator control program, conditions thought to boost dove production. However, based on banding estimates of survival, fledgling production/pair during each period should have been more than adequate to increase breeding populations (2.5 requires)(with the exception of 1980). Therefore, continued population decline in California must result from landscape-scale habitat alteration, poor survival, or both, and not recruitment; or high recruitment at Gray Lodge was not representative of California nesting doves (or riparian habitats) in general; or the three periods during which data were collected at Gray Lodge were too infrequent relative to the 47-year time period to detect long-term change in recruitment. Initiation of a wing-collection survey to monitor harvest age ratios and an operational banding program to estimate survival would ultimately provide more predictable data sets for analyses of long-term trends in annual population status than would additional analyses of historical nesting data. **Key words: mourning dove, temperature, precipitation, productivity**

333

Mitchell, G. J. 1977. The effects of spring and summer weather on Hungarian partridge productivity in southern Alberta. Pages 201-209 *in* G. D. Kobriger, editor, Proceedings Perdix I Hungarian Partridge Workshop, Dickinson, North Dakota, USA. Notes: …correlation analysis shows that, with but two exceptions, all of the correlations involving temperatures and the hours of bright sunshine are positive, while those involving rainfall, the number of days with rain, and the number of days with frosts are negative. These relationships and the brood size and weather data for 1961 and 1953, indicate that reproductive success of the Hungarian partridge in Alberta is enhanced by warm and dry spring-summer weather, and impaired by rainy and cool weather during the nesting and rearing season…It appears that weather factors have both a pre-hatching and post-hatching influence on the productivity of the Hungarian partridge in Alberta. This productivity—expressed in terms of mean brood size—is highest in years with above average temperatures and hours of bright sunshine; few days with frost; and below-average amounts of rainfall in the May to July period. Conversely, productivity is lowest in those years characterized by cool and moist summer weather. During the pre-hatching period, the relatively high correlations found between brood size data and the values for temperatures and rainfall in May indicates that the minimum daily temperatures and the amounts of rainfall are important factors influencing Hungarian partridge productivity. **Key words: Hungarian partridge, precipitation, solar radiation, fog, frost, temperature, reproduction, productivity**

334

Montagna, D. and A. Meriggi. 1991. Population dynamics of grey partridge (*Perdix perdix*) in northern Italy. Bollettino di Zoologia 58(2):151-155. Abstract: Population dynamics of grey partridge was studied from 1982 to 1986 in northern Italy in order to evaluate fluctuations in density and the relationships between population parameters and climatic factors. The general trend was a clear decrease both in spring and summer density after 1984, weighting 34.6% and 22.2%, respectively, mainly due to severe winters. The reproductive success and the recruitment were negatively correlated with spring density. Brood size significantly decreased through the rearing season and chick mortality occurred mainly within the first 30 days after hatching in 1985, while in 1984 it was distributed over the whole growing period. It was also significantly related to the hatching period, earlier broods showing higher mortality. Chick mortality was strongly related to weather conditions in spring, which negatively affected the abundance and distribution of insects. Adult losses from spring to summer were found to be negatively related to reproductive success and positively to spring density. Both density-dependent and climatic factors appeared responsible for a control of population levels. Severe winters and cold springs represented limiting factors; however, the population showed ability to recover by increasing reproductive success and recruitment. **Key words: grey partridge, temperature, mortality, population dynamics, insects, severe winter**

335

Moritz, W. E. 1988. Wildlife use of fire-disturbed areas in sagebrush steppe on the Idaho National Engineering Laboratory. M. S. Thesis, Montana State University, Bozeman, USA. Notes: Page 55—“Although this area does not appear to be critical winter range, removal of any sagebrush probably reduced its suitability as winter habitat. Because sage-grouse distribution on winter range has been reported to vary with snow depth, higher winter use of this fire scar may have been a result of mild winters occurring both years.” Page 59—“The precise use of prescribed burning to increase sage-grouse populations required detailed knowledge of sage-grouse movements related to seasonal weather patterns plus a detailed vegetation inventory of the entire area utilized…the best management practices is a maintenance of sagebrush habitats known to be utilized by sage-grouse.” Page 85—“Seasonal use and distribution of most mobile species on the INEL appears to be related to seasonal precipitation patterns. Snow depth and summer rains appear to follow storm tracks which may be related to the locations of nearby mountain ranges. While weather monitoring stations currently exist on the area, a map of precipitation patterns and storm tracks would be of great benefit to investigations of animal movements, especially in situations where both migratory and non-migratory populations appear to coexist.” **Key words: sage-grouse, precipitation, snow, vegetation, habitat manipulation, movement, habitat use, weather mapping**

336

Morrow, M. E., R. S. Adamcik, J. D. Friday, and L. B. McKinney. 1996. Factors affecting Attwater’s prairie-chicken decline on the Attwater Prairie Chicken National Wildlife Refuge. Wildlife Society Bulletin 24(4):593-601. Abstract: We examined the association between changes in the number of Attwater’s prairie-chicken (*Tympanuchus cupido attwateri*) on the Attwater Prairie Chicken National Wildlife Refuge from 1972 to 1993 and changes in refuge management practices (burning and grazing). We also examined the relationship of prairie-chicken population increases and decreases on the refuge to rainfall and off-refuge prairie-chicken populations. Burning within the prairie-chicken's core habitat on the refuge and variability in grassland structure were directly correlated ($P < 0.05$) with increases and declines in prairie-chicken populations. Refuge population increases and declines were inversely correlated ($P < 0.1$) with average April rainfall/event, May absolute departure from long-term average rainfall, May number of rainfall events, annual absolute departure of rainfall from the long-term average, and the annual number of rainfall events. Refuge population increases and declines were directly correlated ($P < 0.1$) with off-refuge populations, although the off-refuge population decline began 4 years earlier than on-refuge. **Key words: prairie-chicken, precipitation, land use**

337

_____ and N. J. Silvy. 1982. Nestling mortality of mourning doves in cental Texas. Proceeding of the Annual Conference Southeast Association of Fish and Wildlife Agencies 36:537-542. Abstract: Mourning dove (*Zenaida macroura*) nests were located on the Texas A&M University Campus from February-October 1981. Mortality differed between the various stages of the nesting cycle, and in different months within each stage. The number of days in which wind speed exceeded 27.6 km/h (15 kts) each month explained 34% of the variability (P=0.10) associated with total nesting mortality. Mean monthly temperature was positively correlated (P<0.10) with mortality occurring during the 1^{st} nestling week and negatively correlated during the 2^{nd} week after hatching. Loss of nestlings was correlated (P<0.05) with an index to blue jay (*Cyanocitta cristata*) production and total monthly rainfall (P=0.10). **Key words: mourning dove, wind, temperature, precipitation, mortality**

338

Moss, A. 1985. Rain, breeding success and distribution of capercaillie *Tetrao urogallus* and black grouse *Tetrao tetrix* in Scotland. Ibis 128:65-72. Abstract: The number of chicks reared by capercaillie was inversely related to the number of days with rain during and just after their hatching. However, rain had no detectable effect on the breeding success of black grouse on the same study area. The breeding distribution of capercaillie in Scotland is more limited than that of black grouse, which extends into rainier areas. It is speculated that sexual selection for large size in capercaillie has indirectly caused their chicks to be more vulnerable to rain and, consequently, has limited their distribution to less rainy areas. **Key words: capercaillie, black grouse, precipitation, productivity, population dynamics**

339

Moss, R. and A. Watson. 2001. Population cycles in birds of the grouse family (*Tetraonidae*). Advances in Ecological Research 32:53-111. Abstract: Population cycles of boreal herbivores such as voles, hares and birds of the grouse family (*Tetraonidae*) were an early problem in ecology. Here we systematize present understanding of population cycles in tetraonids. Cycles have not been recorded in all grouse species, and non-cyclic populations occur in all grouse species known to show cycles. Much knowledge about cycles comes from time series of measures of population abundance. The fluctuations in such series have properties such as period, amplitude, symmetry, and degree of synchrony with other time series of the same and other species. Each property shows temporal and spatial variation, and is used to delineate hypotheses about causes of cycles. Cyclic time series show delayed density dependence, as expected from models. From species known to show cycles, we give three examples of non-cyclic populations that showed direct density dependence. Each was in fragmented or degraded habitat. Much anecdotal evidence suggests that grouse cycles occur mostly in large tracts of fairly homogeneous habitat, and that fragmentation of such habitat is associated with disappearance of cycles. This has been attributed to increased dispersal out of fragmented habitat patches into population sinks, and to increased predation from generalist predators. We distinguish between processes that drive cycles and those that determine cycle period. Commonly reported periods are 3-4, 6-7 and 10 years. Different populations of the same species show different periods, and sympatric species with different mean vital rates fluctuate together with the same period. Hence cycle period is not a necessary consequence of a particular set of mean vital rates. Period is characteristic more of location than of species. There is no simple large-scale relationship between cycle period and latitude or longitude. One example, of a 10-year rock ptarmigan cycle going together with a 10-year weather cycle, suggests that local weather might affect period. Documented extremes in the amplitude of cycles in population density vary from about two-fold to about six-fold. Most documented tetraonid population cycles are fairly symmetrical, with decline and increase phases in any one fluctuation taking similar number of years. Fluctuations of spatially separate parts of cyclic populations have shown partial synchrony that diminishes with distance between the parts. Explanations of this include the effects of weather and dispersal. Dispersal might be of the cyclic species, or its resources, or one of its natural enemies or competitors. A consequence of dispersal in some cyclic model populations is travelling waves of population density, so far confirmed for species of grouse, hare and vole. The main documented demographic cause of changes in tetraonid breeding numbers is variation in the recruitment of young birds into the breeding population. In seven studies of two species, including cycles with periods of 3-4, 7-8 and 10 years, this happened in two stages. First, during cyclic declines the birds' breeding success' was lower, that is fewer young were reared to independence per adult. Second, a smaller proportion of these independent young survived the winter to be recruited into the breeding population. However, mean breeding success differed among populations within species, such that cyclic increases in some populations occurred with lower breeding success than cyclic declines in other populations. **Key words: grouse, weather, population dynamics**

340

_____ and J. Oswald. 1985. Population dynamics of capercaillie in a north-east Scottish glen. Ornis Scandinavica 16(3):229-238. Abstract: During a 9-year study of capercaillie almost twice as many female as male chicks were reared, but there were no more hens than cocks in the adult population. Both the proportion of male chicks in late summer each year, and mean brood size, were related to the chicks' condition in July. Condition was related to the number of days with rain in early June, during and just after hatching. The breeding density of hens each year varied between 4.0 and 8.0 km^2 but was related neither to their density in the previous year nor to the production of female chicks in the intervening summer. The best predictive model was simply that breeding densities would return to their mean each year. It was inferred that breeding densities were determined by density-dependent losses and gains involving emigration and immigration. Autumn densities of young and old birds were not related to breeding densities and breeding success, but were inversely related to the proportion of broods which disappeared, and probably emigrated, during the summer. **Key words: capercaillie, precipitation, population dynamics**

341

_____, _____, and D. Baines. 2001. Climate change and breeding success: decline of the capercaillie in Scotland. Journal of Animal Ecology 70(1):47-61. Summary: (1) The hypothesis that climate change caused lower breeding success was investigated in this study. (2) Temperature usually rose during April. There was no trend in mean April temperature during the study (1975-99) but there was a progressive cooling in mid-April relative to the rest of the month, such that the normal April warming was increasingly delayed. (3) Hens reared more chicks when the temperature rose more in early April. It is suggested that this stimulated timely plant growth, so improving the laying hens' plane of nutrition and the viability of their chicks. (4) Hens also reared more chicks when late May was warmer and early June was warmer and had fewer rain days. Young chicks may have foraged more successfully in warm dry conditions. However, neither temperature nor rain days in late May or early June showed any trend during the study. (5) Increasingly protracted spring warming seems to have been a major cause of the decline of the capercaillie in Scotland. **Key words: capercaillie, temperature, precipitation, population dynamics, vegetation**

342

_____, A. Watson, R. A. Parr, I. B. Trenholm, and M. Marquiss. 1993. Growth rate, condition and survival of red grouse *Lagopus lagopus scoticus* chicks. Ornis Scandinavica 24(4):303-310. Summary: An index of condition was developed for wild red grouse chicks aged 10-30 days. This was derived from the difference between the observed weight and that expected from the chick's age, or stage of feather development. To measure it, the chicks needed to be caught only once. Variations in condition among different broods of wild chicks were greater than variations among broods of captive chicks in the same years, probably because the wild chicks' environment was harsher and more variable. Within years, the condition of wild chicks was not related to their brood size. Among years, mean condition was correlated both with breeding success and with the biomass of green heather food available in spring. This was because the chicks' condition and survival were poor for two years following an episode of severe weather damage to the heather. **Key words: red grouse, index, nutrition, fecundity**

343

_____, _____, _____, and _____. 1993. Caecal threadworms *Trichostrongylus tenuis* in red grouse *Lagopus lagopus scoticus*: effects of weather and host density upon estimated worm burdens. Parasitology 107(2):199-209. Abstract: *Trichostrongylus tenuis* eggs were counted in feces from individually marked wild red grouse for 8 years. Egg counts varied seasonally and annually. In some years, a sudden increase in mid-April was consistent with delayed maturation of larvae which had overwintered in the birds in a hypobiotic state. A more gradual increase in summer was probably due to uninterrupted maturation of larvae ingested then. Despite 30-fold year-to-year variation in mean egg counts, relative differences in egg counts among known individuals within years tended to persist across years. Rainfall in previous summers explained much of the year-to-year variation in egg counts, probably because parasite recruitment was greatest during wet summers. Grouse density was only weakly related to worm egg counts. The data were not consistent with the hypothesis that the cyclic-type population fluctuation in red grouse numbers observed at the time of this study was caused by the parasites. **Key words: red grouse, disease, precipitation, population dynamics, parasites**

344

Mossop, D. H. 1988. Winter survival and spring breeding strategies of willow ptarmigan. Pages 330-378 *in* A. T. Bergerud and M. W. Gratson, editors. Adaptive strategies and population ecology of northern grouse. Wildlife Management Institute and University of Minnesota Press, Minneapolis, USA. Notes: Page 337—Wind, as manifested by windchill and blowing snow, is probably the chief factor of winter severity. The windchill at Chilkat Pass was low enough that humans often found it difficult to function. However, in the microclimates that ptarmigan occupied, the birds virtually never exposed themselves to these extremes in wind. Even in the worst weather, ptarmigan were found with full crops and did not forgo feeding. I found no evidence that the formation of a surface crust prevented snow-roosting. Snow sufficiently loose to excavate was always available in the wind shadows of shrubs. Page 340—Food actually became more available on the Chilkat Pass as winter passed and the snow level rose. Birds gained access to higher and higher levels of the shrub crown, where abundance and possibly nutritional content of buds and twigs were better. I recorded an increase in browse availability in food tallies immediately after blizzards. Page 347—The physical link between vegetative cover and snow roosts is also maintained; snow roosts of willow ptarmigan are normally dug close to or in shrub cover. Birds roosting near shrubs gain advantage because predator search paths are partly blocked. Page 352—When birds left the Highland area in February, adequate food remained available. Birds actually moved to an area with more heavily browsed shrub resources. Further, they shared this food with more birds from many adjacent ranges. They did not make this move until late winter, after the worst weather had passed. Accumulation of the snowpack was the only weather parameter that I could causally relate to movement. As the accumulated snow reached about 1 m, leaving only 1 m of overhead shrub cover, birds began to leave upland sites and move to tall patches of riparian willow cover at lower elevations…cover to escape predators (both detection and once pursued, i.e. in the broad sense) is a sufficient explanation for this late-winter migration. When the snowpack had reached about 1 m on unprotected ground, drifting snow had inundated shrubs on the pass well into their crowns. This left ample food, in the form of shrub tips above the snow, but cover was lacking. Larger riparian shrubs at lower elevations were sought by the ptarmigan—this was the winter migration. **Key words: willow ptarmigan, snow, wind, habitat use, vegetation, predation, microclimate, movement, behavior**

345

Moynahan, B. J. 2004. Landscape-scale factors affecting population dynamics of greater sage-grouse (*Centrocercus urophasianus*) in north-central Montana, 2001-2004. Thesis, University of Montana, Missoula, USA. Abstract: Populations of greater sage-grouse (*Centrocercus urophasianus*) have declined by 69-99%. Information on population dynamics of these birds at a landscape scale is essential to informed management. I radio-collared 243 female sage-grouse, monitored 287 nests and 115 broods, and measured 426 vegetation plots at 4 sites during 2001-2003 in a 3,200 km^2 landscape in north-central Montana, USA. My objective was to examine the relationship between nest success, brood survival, and hen survival rates, habitat conditions, environmental variables, and hen characteristics. I used program MARK to model (1) daily survival rates of nests and broods and (2) seasonal and annual survival of hens. Nest survival varied with year, grass canopy cover, daily precipitation with a 1-day lag effect, and nesting attempt. The best-approximating model of brood survival included effects of brood age and year, indicating substantial annual variation. Hen survival analyses indicated that survival varies by season within years and by year within seasons, that nesting hens have higher breeding-season survival than non-nesting hens, and that individuals at one site had lower hunting-season survival than hens at other sites. I observed considerable variation in hen survival. Low annual survival in 2003 is a result of the compounded effects of a West Nile virus outbreak in August of that year and a severe winter of 2003-2004. My findings underscore the importance of large-scale approaches to conservation of sage-grouse habitats and to maintenance and recovery of sage-grouse populations. Management for hen survival must address hunting pressure and identification and conservation of important wintering areas. Maintaining quality habitat and a high proportion of adult hens will maximize potential for population growth when environmental conditions are favorable. **Key words: sage-grouse, precipitation, temperature, snow, disease, mortality, model, habitat**

346

______, M. S. Lindberg, J. J. Rotella, and J. W. Ward. 2007. Factors affecting nest survival of greater-sage grouse in north central Montana. Journal of Wildlife Management 71():1773-1787. Abstract: We studied greater sage-grouse (*Centrocercus urophasianus*) in north central Montana, USA, to examine the relationship between nest success and habitat conditions, environmental variables, and female sage-grouse characteristics. During 2001-2003, we radiomarked 243 female greater sage-grouse, monitored 287 nests, and measured 426 vegetation plots at 4 sites in a 3,200-km^2 landscape. Nest survival varied with year, grass canopy cover, daily precipitation with a 1-day lag effect, and nesting attempt. In all years, daily survival rate increased on the day of a rain event and decreased the next day. There was temporal variation in nest success both within and among years: success of early (first 28 d of nesting season) nests ranged from 0.238 (SE = 0.080) in 2001 to 0.316 (SE = 0.055) in 2003, whereas survival of late (last 28 d of nesting season) nests ranged from 0.276 (SE = 0.090) in 2001 to 0.418 (SE = 0.055) in 2003. Renests experienced higher survival than first nests. Grass cover was the only important model term that could be managed, but direction and magnitude of the grass effect varied. Site, shrub and forb canopy cover, and Robel pole reading were less useful predictors of nest success; however, temporal and spatial variation in these habitat covariates was low during our study. We note a marked difference between both values and interpretations of apparent nest success, which have been used almost exclusively in the past, and maximum-likelihood estimates used in our study. Annual apparent nest success (0.56) was, on average, 53% higher than maximum-likelihood estimates that incorporate individual, environmental, and habitat covariates. The difference between estimates was variable (range = +8% to +91%). Management of habitats for nesting sage-grouse should focus on increasing grass cover to increase survival of first nests and contribute to favorable conditions for renesting, which should be less likely if survival of first nests increases. **Key words: sage grouse, precipitation, nesting success**

347

_____, M. S. Linberg, and J. W. Thomas. 2006. Factors contributing to process variance in annual survival of female greater sage-grouse in Montana. Ecological Applications 16(4):1529-1538. Abstract: Populations of greater sage-grouse (*Centrocercus urophasianus*) have declined by 69-99% from historic levels, and information on population dynamics of these birds at a landscape scale is essential to informed management. We examined the relationships between hen survival and a suite of landscape-scale habitat and environmental conditions. We radio-marked 237 female sage-grouse and measured 426 vegetation plots during 2001-2004 at four sites in a 3200-km^2 landscape in north-central Montana, USA. We used program MARK to model monthly survival rates for 11 seasonal intervals. There was strong support for the best-approximating model (AIC*c* weight = 0.810), which indicated that (1) hen survival varied by season within years' and by year within seasons, (2) nesting hens had higher nesting-season survival than non-nesting hens, and (3) individuals at one site had lower hunting-season survival than at other sites. We observed considerable variation in hen survival. Process variation was 0.255, with an expected range of annual survival of 0.12 to 1.0. The ratio of process to total variation was 0.999, indicating that observed variation was real and not attributable to sampling variation. We observed a nearly fourfold difference in maximum and minimum annual survival, ranging from 0.962± 0.024 (mean ± SE) for nesting hens in 2001-2002 to 0.247 ± 0.050) for non-nesters in 2003-2004. Low annual survival in 2003 resulted from the compounded effects of a West Nile virus outbreak in August and a severe winter in 2003-2004. Increased hen mortality associated with severe winter weather contrasts with prior beliefs that sage-grouse populations are typically unaffected by winter weather conditions and underscores the importance of protecting winter sagebrush (*Artemisia* spp.) habitats. **Key words: sage-grouse, severe weather, vegetation, mortality**

348

_____ and J. Walker. 2004. Literature review of Montana upland game bird biology and habitat relationships as related to Montana Fish, Wildlife & Parks upland game bird habitat enhancement program. Personal Services Contract: FWP-050046. Montana Department of Fish, Wildlife & Parks, Helena. Summary: The authors provide an overview of the grouse species, pheasants, turkey and partridges. Includes a literature cited. **Key words: upland birds, weather**

349

Mussehl, T. W. and F. W. Howell, editors. Game Management in Montana. Montana Fish and Game Department, Helena, USA. Notes: In Chapter 15, Sharp-tailed grouse, R. L. Brown notes that "…snow, rain, wind and temperature extremes greatly influence the welfare of grouse, depending of course on condition of the habitat sheltering grouse from the elements. Strong prairie winds and snow are an ever changing stress in the winter. By roosting behind rough topography or in deep snow, sharp-tails find protection from the weather as well as predators. In Chapter 18, Pheasants, the authors write "Winter is a critical time for pheasants. Artificial feeding, however, is not justified, since the birds seldom need additional food. When they do, feeding concentrates them and exposes them to diseases, predators and highway traffic. If feeding must be stopped during a critical period, the pheasants are less likely to survive than if they had not been fed at all. Heavy losses occur during severe blizzards. Birds caught without suitable cover face the storm. Their nostrils and mouths fill with ice and they suffocate. Sometimes whole flocks in small cover patches are buried under deep drifts. After a severe winter, hens in poor condition may die because of the additional stress imposed by nesting. Recovery of the population after these losses is usually rapid if food and cover are adequate. Chapter 19, Hungarian Partridge, the authors note: "Factors responsible for…losses include adverse weather.." among other factors. "Optimum conditions for a flourishing population of Hungarian partridge are a cool, moderately dry climate and mixture of cultivated and non-cultivated land." Chapter 21, Chukar Partridge – "While the chukar successfully inhabits areas of sparse rainfall, they are heavily dependent on free water within close proximity. Periods of drought or low-water levels will cause birds to cluster around available water sources. Perhaps the most critical limiting factor is snow conditions during the winter months. Populations may be seriously affected by heavy or prolonged snow covering feeding and roosting areas. In many localities where chukars initially survived and bred, severe winters gradually eliminated them. **Key words: sharp-tailed grouse, pheasant, Hungarian partridge, chukar partridge, snow, temperature, drought, mortality, habitat use, behavior, topography**

350

Myhre, K., M. Cabanac, and G. Myhre. 1975. Thermoregulatory behavior and body temperature in chicks of willow grouse (*Lagopus lagopus lagopus*). Poultry Science 54:1174-1179. Abstract: Cloacal temperatures (T_{cl}) of outdoor living captive willow grouse chicks (*Lagopus lagopus lagopus*) were found to increase from 39.4 ± 0.5°C the first day to 40.3 ± 0.5°C the twelfth day after hatching. Average T_{cl} of adults was 40.7 ± 0.3°C. When left alone for 30 min. in a controlled test environment providing temperatures ranging from 21°C to 46°C, the one-day-old chicks preferred significantly higher ambient temperatures than eight-day-old birds. T_{cl} was significantly lower in the chicks tested the day after hatching than in the older chicks. It is concluded that the chicks' thermoregulatory behavior is essential for maintaining homeothermia, and that the birds' thermoregulatory set-point is low the day after hatching and climbs to adult level during the first week. **Key words: willow grouse, temperature, thermoregulation, behavior**

351

Myrberget, S. 1988. Demography of an island population of willow ptarmigan in northern Norway. Pages 379-419 *in* A. T. Bergerud and M. W. Gratson, editors. Adaptive strategies and population ecology of northern grouse. Wildlife Management Institute, Washington D.C. and University of Minnesota, Minneapolis, USA. Notes: Page 401—Failure of eggs to hatch. There was a strong tendency, however, for hatching failure to be large in years with much snow remaining in May and delayed egg-laying…Chick Mortality—For 7 years Myrgerget *et al* found that the annual survival of chicks was significantly correlated with the mean temperature before hatching…no significant relationship was found between the chick survival rate and the mean ambient temperature during the 10 days following the average hatching date…Page 408—In spring there is a gradual shift in the diet of ptarmigan on Tranøy from woody plants to evergreen heath species and finally to herbs. Availability of the plants forming the ground layer to tetraonids, and their chemical composition, are affected by the date of snowmelt and by the weather in the spring, factors that vary in a random manner…Page 411—Environment of chicks. Cold and rainy weather reduce the available time in which small ptarmigan chicks are able to feed, because they are dependent on the hen for warmth. Cold weather may also reduce the availability of insects that chicks eat. But no relationship existed between the chick mortality rate and the air temperature just after hatching. This agrees with results obtained for other *Lagopus* populations. In some areas, however, extremely unfavorable weather conditions, such as snow or sleet showers, have resulted in the death of many ptarmigan chicks. ..On Tranøy, a relationship was found between the weather before hatching and the mortality rate of chicks, in agreement with Slagsvold's hypothesis. However, a close relationship between the amount of insects during the early stages of the life of the chicks and mortality rate was not apparent…Page 412—At Tromsø, annual variations in the survival of willow ptarmigan chicks kept in captivity were apparently caused by variations in plant phenology, but in such a way that more chicks died when the spring was early and warm, because of an early onset of the lignification of bilberry leaves. In some years there may also have been a shortage of certain vitamins in the food available to chicks…the relationship between the spring weather, the chicks' food, and survival rate…would seem more complex than suggested by Slagsvold…Page 414—My conclusion is that the poor productivity of ptarmigan in vole crash years occurs because the predator situation, the quality of the food supply, and the weather in the chick period are likely to be unfavorable in such years. **Key words: willow ptarmigan, snow, temperature, reproduction, nutrition, vegetation, productivity**

352

_____, R. Blom, and K. E. Erikstad. 1977a. Effect of a bad production year for willow grouse on the size of the breeding population the following year. Fauna 30(2):88-97. Abstract: Data are given on the number of breeding *Lagopus lagopus* in 1975 and 1976 in the Tranoy study area, northern Norway. The total autumn population in 1975 and the breeding population in 1976 (17 pairs/km^2) were less than in any year since 1960. The winter mortality rate for adult grouse hens in 1975-1976 was about average for the area, 42.5%. The winter loss of immature birds was estimated at 83%, which is slightly higher than the average (75%), but in fact, the value for this particular winter is somewhat imprecise. The possible higher rate of mortality of immatures in the winter of 1975-1976 may have been due to the particularly poor physical condition of the young grouse in the autumn of 1975 as a result of an extremely unfavorable environment for chicks that summer. **Key words: willow grouse, reproduction, severe winter, mortality, nutrition, chick survival**

353

_____, K. E. Erikstad, and T. K. Spidsø. 1977b. Variations from year to year in growth rates of willow grouse chicks. Astarte 10(1):9-14. Abstract: Data are given for increase of total weights and wing lengths of chicks of willow grouse, *Lagopus lagopus*, for 7 years in a study area in northern Norway. There was a significant difference in growth rates for different years and a positive correlation between variations in annual growth rates and survival rates of the chicks. High temperatures before hatching had a positive influence on the growth and survival of the chicks. The weather during the early chick period may modify growth rates for small chicks. **Key words: willow grouse, temperature, chick survival**

354

_____, C. Norris, and E. Norris. 1975. Grit in Norwegian *Lagopus* spp. Norwegian Journal of Zoology 23:205-212. Abstract: There was found to be a decrease from summer to winter in the quantity and weight of grit, and an increase in the size of the individual stones, from *Lagopus lagopus* and *L. mutus* in Norway. These changes are related to changes in the snow cover. In chicks, the size, roundness, weight, and the amount of grit were all found to increase with age. The grit consisted of hard minerals, poor in calcium. **Key words: willow grouse, snow, grit**

355

Naugle, D. E., C. L. Aldridge, B. L. Walker, K. E. Doherty, M. R. Matchett, J. McIntosh, T. E. Cornish, and M. S. Boyce. 2005. West Nile Virus and sage-grouse: what more have we learned? Wildlife Society Bulletin 33(2):616-623. Abstract: Evidence suggests that risk of infection was low in 2004 because unseasonably cool summer temperatures delayed or reduced mosquito production. Moreover, mortalities occurred 2-3 weeks later in 2004 than in 2003, and the shift to later timing was consistent between years at sites where WNv reduced survival both years. **Key words: sage-grouse, disease, temperature, West Nile Virus**

356

Neave, D. J. and B. S. Wright. 1969. The effects of weather and DDT spraying on a ruffed grouse population. Journal of Wildlife Management 33(4):1015-1020. Abstract: A study of population dynamics illustrated the effects of temperature and pesticide spraying on a ruffed grouse (*Bonasa umbellus*) population in central New Brunswick. May and June temperatures were related to the date of nest initiation, to a partially developed egg loss, to fall age ratios and to annual kill fluctuations. A synergistic effect of chemical spraying with DDT (in oil at the rate of 0.5 lb/0.7gal/acre or 0.25/0.5gal/acre) and temperature is suggested in the partially developed egg loss. Spraying was also correlated with immature survival as significant differences were found in June brood sizes in sprayed and unsprayed areas and in fall age ratios, suggesting complete and partial brood losses. **Key words: ruffed grouse, temperature, population dynamics, habitat manipulation**

357

Nelson, O. C. 1955. A field study of the sage-grouse in south-eastern Oregon with special reference to reproduction and survival. M. Sc. Thesis, Oregon State College, Corvallis, USA. Notes: Page 53—"Comparable weather data was recorded for the study year 1954. Total precipitation for April was .62 inch, part of which was in the form of snow amounting to 2.0 inches in depth. Total precipitation for May was 1.25 inches, part of which was 3.0 inches of snow. The month of April was mild with no critical storms. The temperature for this month never dropped below 15°F and had a 29.3° average minimum. The highest temperature recorded for the month was 71°, the average maximum being 56.3°. Thus, weather conditions during April favored a successful nesting period for sage-grouse….In making a comparison of April and May of 1954 with the same months for the years 1941 to 1953, it appears that the weather conditions for the study year were much more conducive to successful nesting on the basis of more mild conditions with less extremes in temperature." Page 82—"Weather conditions, as they affect brood survival, are frequently given as causes for losses. On May 29, shortly after the peak of hatching, .70 inch of rain and one inch of snow, sleet, and hail fell on the study area. This was accompanied by strong winds and cold temperatures. On June 5, similar conditions occurred. No observations were made or data collected that indicated any harmful effect of such weather conditions on brood survival. Brood counts following such critical periods showed no noticeable decrease in brood sizes. The species inhabits areas exhibiting extremes in temperatures and weather conditions; however, the brooding instincts of the the sage-grouse appear strongly developed. Thus, it seems likely that losses are at a minimum in this respect." Page 90—"Causes for…movement into and out of the meadow areas appeared to be the result of a combination of factors. On June 10, 1.18 inches of rain fell. This was the last appreciable amount of precipitation for the remainder of the summer. It is believed that the sage-grouse began to move into the more preferable meadow areas because of the shortages of water and green foods from most of the area as conditions became drier. The meadows had much to offer the birds in the area at this time such as water, greens, and a plentiful supply of insects for the young in particular. However, in the absence of any rainfall, these benefits gradually disappeared." **Key words: sage-grouse, precipitation, snow, temperature, sleet, hail, wind, mortality, nutrition, movement, habitat use, productivity**

358

Nestler, R. B. 1946. Vitamin A, vital factor in the survival of bobwhites. Transactions of the North American Wildlife Conference 11:176-195. Notes: "Of 45 wild quail shot or trapped this winter in Pennsylvania, Maryland, Virginia and Alabama, at least 31 per cent, or nearly one third, had not enough vitamin A stored in their livers to help them survive more than 4 weeks of a deficiency of this factor in their diet. Imagine the effect of a thick blanket of snow lasting for a long period. Most of all, sources of vitamin A would be made unavailable. While carnivores can obtain their vitamin A from the tissues of other animals, quail, in winter at least, depend largely on carotene in plants. Unless they have stored away a plentiful supply in their livers their case would become desperate." "Less carotene is manufactured in plants during a hot, dry period than during a cool, wet season. Combine a droughty summer and fall with a severe winter of prolonged snow, as was the case in Ohio in 1944-45, and the result is an ideal condition for vitamin A deficiency. Birds will die either directly or indirectly from avitaminosis. Weakness, impaired eyesight, lack of alertness, and loss of speed causes them to succumb quickly to predation and severe weather. Thus, submarginal, or even marginal, intakes of vitamin A, while sufficient to keep birds from dying from avitaminosis, yet many underline their constitutions to such an extent that death results anyway from other causes. Also death of a part of a covey from vitamin A deficiency may so reduce the size of the group; that the survivors may perish from lack of protection from cold during huddles. **Key words: bobwhite quail, nutrition, snow, drought, vegetation, predation, temperature, disease**

359

_____, J. B. DeWitt, and J. V. Derby Jr. 1949. Vitamin A storage in wild quail and its possible significance. Journal of Wildlife Management 13(3):265-21. Summary: Research on penned bobwhite quail concluded that during winter especially, Vitamin A apparently stands on par with carbohydrates as a factor that could decide the fate of wild quail and might be a very important factor in population fluctuations in quail. In winter quail depend largely on carotene in plants. Unless they have stored away a plentiful supply in their livers, their chances for survival under adverse weather conditions are much reduced. Less carotene is manufactured in plants during a hot dry period than during a cool wet season. Drought-affected plants are lower in carotene than plants grown under normal weather conditions. Combine a droughty summer and fall with a severe winter of prolonged snow, as was the case in Ohio during 1944-45 and Iowa during 1936-37 (an estimated quail loss of 88%), and the result seemingly is an ideal condition for vitamin A deficiency. Birds may die either directly or indirectly from avitaminosis. Weakness, impaired eyesight, lack of alertness, and loss of speed cause them to succumb to predation and severe weather. **Key words: bobwhite quail, nutrition, disease, mortality, predation, drought, temperature, vegetation**

360

Nguyen, L. P, J. Hamr, and G. H. Parker. 2003. Survival and reproduction of wild turkey hens in central Ontario. Wilson Bulletin 115(2):131-139. Abstract: Recent success of Eastern wild turkey (*Meleagris gallopavo silvestris*) reintroductions across southern Ontario has prompted wildlife managers to investigate the potential of extending the northern limit of this subspecies' range. We monitored the survival and reproduction of introduced wild turkeys on the Precambrian Shield in central Ontario during 1999-2001. Mean annual survival of 39 radio-tagged hens was 0.288±0.057 SE. Summer and winter survival rates differed between the first and second years of the study. Spring and fall survival rates did not differ significantly between years.

Reproductive parameters that characterized the population included a nesting rate of 0.588, mean clutch size of 10.0 eggs/nest success of 0.500, hatching rate of 0.81, hen natality rate of 1.18 female hatched/female, poult survival of 0.54, and fall recruitment of 0.63 juvenile females/breeding hen. Success of the pilot wild turkey introduction in central Ontario was compromised by high predation, low numbers of introduced birds, and a prolonged period of deep snow during 2000-2001. **Key words: turkey, snow, mortality**

361

Norman, G. W., T. M. Fearer, and P. K. Devers. 2004. Factors affecting wild turkey recruitment in western Virginia. Proceeding of the Annual Conference Southeast Association Fish and Wildlife Agencies 58:248-262. Abstract: Annual recruitment of eastern wild turkeys (*Meleagris gallopavo silvestris*) should be closely monitored to regulate fall turkey seasons and reduce risk of over-harvest. However, previous studies have not encompassed the spatial or temporal scales needed to produce models that can consistently predict recruitment over a large region. Our objective was to assess the ability of using long-term data sets of sex-age ratios, oak (*Quercus* spp.) mast, and weather variables to forecast annual wild turkey recruitment in western Virginia. We conducted a thorough literature search on factors believed to be limiting reproduction and developed a series of 14 *a priori* models and 1 *a posteriori* model to predict recruitment. We used fall harvest ratios of juveniles per adult female, averaged over 26 western Virginia counties, during 1973-2002 as an index to annual recruitment and investigated the relationship of recruitment to age structure of the population, oak mast production in the previous fall, and spring weather. We considered impacts of different weather severity measures and investigated effects of deviation from mean, 90%, and 75% quartile values on recruitment. Our best model (ω_9=0.812) predicting recruitment incorporated May and June rainfall and March temperatures at the 75% quartile scale. This model accounted for a significant amount of variation in recruitment residuals (R^2=0.50, R^2_{ajd}=0.44). Monitoring these selected weather parameters offers managers the ability to predict significant changes in recruitment annually. **Key words: eastern wild turkey, precipitation, temperature, recruitment, production, model**

362

Northrup, R. D. 1991. Sharp-tailed grouse habitat use during fall and winter on the Charles M. Russell National Wildlife Refuge, Montana. M.S. Thesis, Montana State University, Bozeman, USA. Notes: Pages 33-34—"In this study, birds were active on display grounds through January 1990 of winter 2; however, display did not occur during January or February 1989. Snow accumulations and/or cold air temperatures apparently prevented such activity until early March that year." Page 34-"Grouse habitat selection was also affected at least in part by weather conditions. Heavy snow and/or cold temperatures presumably forced grouse to use the juniper type almost exclusively for cover and food during winter 1. Of the cover types used by sharptails in this study, juniper undoubtedly provided the best security cover and shelter from harsh winter weather." Page 38—"A number of sharptails roosts during winter 1 consisted of snow burrows and shallow snow depressions. Fresh drifts created from wind and large junipers or broken topography typically provided sufficient snow depths for burrowing…as fresh drifts became available, grouse immediately switched to burrows. However, because snow developed a crust within days of a snowfall, depression snow roosts were the most common." Page 40—"Sharptail management objectives should include maintaining and/or enhancing shrub cover which provides protection and food especially during periods of harsh winter weather." **Key words: sharp-tailed grouse, snow, temperature, wind, topography, behavior, habitat use, vegetation, habitat manipulation**

363

Norton, M. A. 2005. Reproductive success and brood habitat use of greater prairie chickens and sharp-tailed grouse on the Fort Pierre National Grassland of central South Dakota. M.S. Thesis, South Dakota State University, Brookings, USA. Notes: Chick survival was higher in 2005 than the previous two years, probably attributable to increased precipitation and warmer temperature patterns. PC broods utilized habitats with a mean vegetation height of 32 cm (*n*=8), and with ground cover of 18% grass and 10% forbs in 2004. During 2005, PC broods used habitats with a mean vegetation height of 38 cm (*n*=10) and 18% grass and 5% forb ground cover. ST broods used habitats with a mean vegetation height of 43 cm during both 2004 (*n*=8) and 2005 (*n*=9). High nesting success and survival rates found during this study are likely attributed to the vast grassland ecosystem and the implemented rotational grazing regime, both of which had multiple positive influences. Predators had to spend more time searching to find a nest or bird to prey on in larger unfragmented grasslands. The large expanse of grassland is maintained by a grazing regime that provided an ample food source of invertebrates and a mosaic of habitats needed for brood rearing hens. **Key words: greater prairie chicken, sharp-tailed grouse, temperature, precipitation, vegetation, nutrition, predation, habitat manipulation**

364

Novoa, C., A. Besnard, J. F. Brenot, and L. N. Ellison. 2008. Effect of weather on the reproductive rate of rock ptarmigan *Lagopus muta* in the eastern Pyrenees. Ibis 150(2):270-278. Abstract: Understanding the effects of climate on avian life history traits is essential if we wish to predict the demographic consequences of expected climatic changes. We investigated the influence of weather conditions on the reproductive success of rock ptarmigan *Lagopus muta* in the eastern French Pyenees, one of the southernmost areas inhabited by the species. Reproductive success was estimated in early August between 1997 and 2006 by counting adults and well-grown chicks with pointing dogs. The number of young per adult varied from 0.08 to 0.72. Using Poisson regression and Akaike's information criterion, we selected the best model explaining the effect of weather (date of snowmelt and, for both laying/incubation and post-hatching periods, mean minimum and maximum temperatures, monthly rainfall and number of days with rain) on the proportion of young in August. Reproductive success was positively associated with early appearance of snow-free ground, and date of snowmelt alone was the model that best explained annual variation in reproductive success. Other models, which included a negative effect of rainfall, particularly after hatching, also had some support. Hence, both pre-laying and post-hatching weather conditions influenced reproductive success of rock ptarmigan in the eastern French

Pyrenees. On a continental scale, reproductive success of alpine populations of rock ptarmigan is consistently lower than that of northern populations. This difference in productivity may be partly correlated with climatic conditions observed along an arctic-alpine gradient, the amount and variation of rainfall being greater in southern alpine areas than elsewhere in the species' range. **Key words: rock ptarmigan, rain, snow, fecundity, productivity**

365

Oakleaf, R. J. 1971. The relationship of sage-grouse to upland meadows in Nevada. M. S. Thesis, University of Nevada, Reno, USA. Unable to obtain for abstract.

366

Oberlag, D. F., P. J. Pekins, and W. W. Mautz. 1990. Influence of seasonal temperatures on wild turkey metabolism. Journal of Wildlife Management 54(4):663-667. Abstract: We measured standard metabolic rate (SMR) and the effects of temperature on metabolism of adult eastern wild turkeys (*Meleagris gallopavo silvestris*) during each season of the year. Female SMR was similar throughout the year, and male SMR was lower during spring. Female SMR exceeded male SMR each season and was significantly ($P < 0.05$) higher during summer and autumn. Both sexes had similar lower critical temperatures (T_k), but females lost heat faster below T_k. Low winter T_k (about -15C) indicated that thermoregulatory costs are probably minimal for turkeys at normal winter temperatures in south-central New Hampshire. **Key words: Merriam's turkey, temperature, metabolism, thermoregulation**

367

Osmolovksya, V. I. 1966. Reasons for changes in the number of tetraonid birds. Byul. Mosk. Obshchest Ispyt prir Otd Biol 71(5):61-70. Abstract: There are different causes that affect the changes in the number of tetraonids (*Tetraonidae*) in different geographic zones. On the basis of 733 questionnaires, it has been established that cold springs are of decisive importance in northern taiga environments. Further south the first role belongs to the anthropogenic factors of mass deforestation, immoderate hunting, agriculture and forestry methods unfavorable for game birds and forest fires in sparsely populated areas of Siberia. Populations of different species of tetraonids react to certain changes in the environmental conditions in a varying way. The number of capercaillie (*Tetrao urogallus* L.) decreases mainly owing to deforestation, while the black grouse (*Lyrurus tetrix* L.), which inhabits more open biotopes, is affected by a much greater number of factors (changes in weather, activity of the beasts of prey, grazing of cattle, poisoning by chemicals, etc.). The number of hazel hen (*Tetrastes bonasia* L.) is under the influence of cold springs and deforestation. Tetraonids, as an object of hunting, can be preserved only under a reasonable combination of the interests of forestry, agriculture and hunting. **Key words: capercaillie, black grouse, hazel grouse, temperature, population dynamics**

368

Overton, C. T., R. A. Schmitz, and M. L. Casazza. 2005. Post-precipitation bias in band-tailed pigeon surveys conducted at mineral sites. Wildlife Society Bulletin 33(3):1047-1054. Abstract: Many animal surveys to estimate populations or index trends include protocol prohibiting counts during rain but fail to address effects of rainfall preceding the count. Prior research on Pacific Coast band-tailed pigeons (*Patagioenas fasciata monilis*) documented declines in use of mineral sites during rainfall. We hypothesized that prior precipitation was associated with a short-term increase in use of mineral sites following rain. We conducted weekly counts of band-tailed pigeons at 19 Pacific Northwest mineral sites in 2001 and 20 sites in 2002. Results from regression analysis indicated higher counts ≤ 2 days after rain (11.31±5.00% [mean±SE]) compared to ≥ 3 days. Individual index counts conducted ≤ 2 days after rain were biased high, resulting in reduced ability to accurately estimate population trends. Models of band-tailed pigeon visitation rates throughout the summer showed increased mineral-site counts during both June and August migration periods, relative to the July breeding period. Our research supported previous studies recommending that mineral-site counts used to index the band-tailed pigeon population be conducted during July. We further recommend conducting counts ≥ 3 days after rain to avoid weather-related bias in index estimation. The design of other population sampling strategies that rely on annual counts should consider the influence of aberrant weather not only coincident with but also preceding surveys if weather patterns are thought to influence behavior or detection probability of target species. **Key words: band-tailed pigeon, census, precipitation**

369

Palmer, W. E., S. R. Priest, R. S. Seiss, P. S. Phalen, and G. A. Hurst. 1993. Reproductive effort and success in a declining wild turkey population. Proceedings of the Annual Conference Southeast Association of Fish and Wildlife Agencies 47:138-147. Abstract: We monitored reproductive effort and success of a wild turkey (*Meleagris gallopavo*) population on a public wildlife management area in Mississippi for 9 years using telemetry and other indices. Adult hens (N=143) had a nesting rate of 72.7% (range 54-100) and was greater (P=0.0001) than the nesting rate (26.7%) of juvenile hens (N=15). Annual nest success of 104 nests of adult hens averaged 30.8% (range 0-62) and poult survival to >50 days was 22.7% for 27 broods (N=203 poults). Clutch size averaged 9.1 (SE=0.54) and 6.7 (SE=1.1), and hatchability was 93% and 100%, for first and second clutches, respectively. During this period, turkey population estimates and indices (gobbler harvest, hen ancillary observations) declined 250%-350%. Low reproduction was due primarily to high predation of nests and poults and appeared to have caused the population decline. However, environmental factors (i.e., food, rainfall) appeared to significantly impact reproduction in some years. Reproduction was greatest in 1992 following a distemper outbreak among some nest/poult predator populations in 1991. **Key words: wild turkey, precipitation, reproduction**

370

Panek, M. 1992. The effect of environmental factors on survival of grey partridge (*Perdix perdix*) chicks in Poland during 1987-89. Journal of Applied Ecology 29:745-750. Summary: 1.The survival of grey partridge chicks was estimated from the brood sizes in several areas of Poland, and related to weather conditions, abundance of insect food, occurrence of weeds, and the use of herbicides. 2. Geometric mean brood size in different areas and years ranged from 7.5 to 11.2, with a mean of 9.3, and the estimated chick survival rate ranged from 42 to 71%, with a mean of 56%. 3. Chick survival rates increased with mean temperatures and decreased with increasing numbers of rainy days in June. 4. Chick survival rates increased with numbers of plant bugs, but they had no significant effect after removal of the effect of weather. Numbers of plant bugs increased with temperature. 5. Density and species diversity of dicotyledonous weeds in cereals were relatively high, and difference in weeds between areas were not in accordance with differences in the abundance of insects selected by partridges. The application of herbicides in Poland so far has not had a marked indirect negative effect on the survival of partridge chicks. Presumably the occurrence of permanent cover in crop fields has a positive effect on chick survival. **Key words: grey partridge, temperature, insects, nutrition, precipitation, vegetation, habitat modification, chick survival**

371

_____. 1990. Factors influencing winter mortality of gray partridge in western Poland. Pages 304-314 *in* K. E. Church, R. E. Warner, and S. J. Brady, editors. Proceedings Perdix V: gray partridge and ring-necked pheasant workshop, Minnesota Department of Natural Resources. Abstract: I surveyed gray partridge (*Perdix perdix*) coveys near Czempin, Poland twice a month during December through February, 1985-1988 (n = 225 surveys). Mortality rate per half a month was calculated from a decrease in covey sizes. Mortality was lower when there were 2 to 7 cm of soft snow than in the absence of snow ($P < 0.01$). However, it was higher during periods of hard snow cover than soft snow ($P < 0.001$) and in the absence of snow ($P < 0.001$). The rate of mortality increased when the depth of hard snow increased from 0 to 10 cm. No correlation was found between mortality rate and air temperature, but in the presence of hard snow MR increased with declining air temperature in the preceding half-month period. Mortality was higher on large than on small crop fields ($P < 0.05$). A negative correlation was found between mortality rate and the distance of coveys from the forest. The rate of mortality was higher when densities of coveys exceeded the mean value than when it was below the mean ($P < 0.01$). Total winter mortality averaged 35%, and ranged from 32 to 42%. **Key words: gray pargridge, snow, temperature, mortality**

372

Parmalee, P. W. 1955. Some factors affecting nesting success of the bobwhite quail in east-central Texas. American Midland Naturalist 53(1):45-55. Abstract: Locally bobwhite (*Colinus virginianus*) abundance is controlled by conditions within the immediate habitat, primarily adequate food and cover, although a large number of additional factors are continually affecting quail numbers to a somewhat lesser degree.

Geographically, bobwhites appear to be limited by extremes in temperature and precipitation and by such factors that accompany each of these conditions. Climate, in addition to its geographic influence, is of such significance as to produce periodic or seasonal fluctuations in quail numbers in regions where bobwhites have successfully established themselves and are filling a particular ecological niche. The influence of climate on bobwhite populations in the post oak region during 1950 and 1951 has become evident from data based on temperature and precipitation records, nesting success, and sex and age ratios. **Key words: bobwhite quail, temperature, precipitation, distribution, productivity, sex ratio, age ratio**

373

Paterni, M. J. 1979. Winter habitat selection by female spruce grouse (*Canachites canadensis franklinii*) in a mixed coniferous forest. M. S. Thesis, University of Montana, Missoula, USA. Abstract: Captured spruce grouse were fitted with solar powered radio transmitters and/or coded leg bands. The movements, areas used, social groupings, and food habits of radioed and banded birds were monitored during the fall and winter seasons. Meteorological conditions were monitored to evaluate the effects of extreme temperatures, winds, and snow conditions on habitat selection of grouse. Sites used by grouse were analyzed to determine the horizontal and vertical structure of vegetation. Areas utilized by observed grouse were compared to unused available areas on the basis of vegetation species composition, basal area, relative density, canopy cover, and the vertical distribution of foliage. The topographic diversity of spruce grouse habitat in the intermountain west influences not only vegetation community structure and distribution, but also thermal and radiant energy regimes. Over the winter period spruce grouse activity is concentrated within areas subject to tolerable microclimatic conditions. Ridges, upper slope positions, and southerly aspects are selected over drainage bottoms and northerly aspects. In coincidence with the physiographic features selected, certain forest vegetation communities with distinct structures (horizontal and vertical), and furthermore, specific sites exhibiting distinct structures were selected for daytime activities and night roosting. Needles of ponderosa pine (*Pinus ponderosa*) were major food consumed by spruce grouse during the winter period." On pages 34-35, Paterni states "…short movements within activity areas were apparently influenced by changing weather. Wind conditions appeared to be the major factor stimulating movement. Radio-marked spruce grouse exposed to winds sufficiently intense to ruffle the bird's feathers often flew to sites protected from the wind. Given equivalent intensities, gusty winds did not stimulate movement to the same extent as constantly flowing winds. The longest movement witnessed under gusty wind conditions (n=3) was approximately 250 m (813 ft). In most cases spruce grouse were able to find suitable protection from the wind by shifting their position within the roost tree or clump of trees being used. Precipitation and fluctuating temperatures did not apparently influence spruce grouse movement during the feeding-loafing period beyond limited position adjustment within a given tree. During periods of precipitation spruce grouse often roosted beneath clumps of needles in the roost tree, and exhibited no difficulty in finding adequate cover at feeding-loading sites. On clear, cold days wintering spruce grouse appeared to take advantage of direct solar radiation by roosting at positions on or in the canopy of the roost tree which was directly exposed to the sun's rays. On warm, clear days, the grouse often perched in the shade of clumps of needles, the bole of the tree, or other tree canopies." **Key words: spruce grouse, temperature, solar radiation, wind, behavior, habitat use, movement**

374

Patten, M. A., D. H. Wolfe, E. Shochat, and S. K. Sherrod. 2005. Effects of microhabitat and microclimate selection on adult survivorship of the lesser prairie-chicken. Journal of Wildlife Management 69(3):1270-1278. Abstract: Populations of the lesser prairie-chicken (*Tympanuchus pallidicinctus*), an endemic grouse of the south-central United States, have declined precipitously. This species occurs in short- and mixed-grass prairies with sandy soils. Apart from perennial grasses of short stature, prairie-chicken habitat is characterized by dryland shrubs of the sand shinnery community, particularly the shinnery oak (*Quercus havardii*) and sand sagebrush (*Artemisia filifolia*). We measured microhabitat and microclimate characteristics at bird-centered and random points at the southwestern (New Mexico) and northeastern (Oklahoma) edges of the species' range. We estimated survival by locating radio-tagged prairie-chickens (n = 544) from April 1999 to June 2003. We found that lesser prairie-chickens used sites within the sand shinnery community that had a higher cover and greater density of shrubs (ANOVA: P<0.0001). Microclimate differed substantially between occupied and random sites (MANOVA: P<0.001), and prairie-chicken survival was higher in microhabitat that was cooler, more humid, and less exposed to the wind. Survivorship was higher for adults that chose microhabitat with a higher cover of shrubs and grasses and a higher density of vegetation. Survivorship was higher for prairie-chickens that used sites with >20% cover of shrubs than for those choosing 10-20% cover; in turn, survivorship was higher for prairie-chickens choosing 10-20% cover than for those choosing <10% cover (Cox regression: P<0.05). Whereas vegetation may recover following moderate habitat disturbance, land managers applying herbicides or otherwise removing shrubs should understand the potentially negative effects of reduced shrub cover on adult survivorship of lesser prairie-chickens. **Key words: lesser prairie-chicken, temperature, humidity, wind, shelter, habitat use, habitat modification, mortality, microhabitat, microclimate, predation**

375

Patterson, R. L. 1952. The Sage-grouse in Wyoming. Wyoming Game and Fish Commission. Sage Books, Inc., Denver, USA. Summary: Page 54—"The nature of the environment has placed heavy demands upon the physiological system of the sage-grouse. Long winters, dry summers, high elevations, heavy snowfall and ground blizzards all have provided critical hazards in the search for food, shelter and water." Page 55—"Snow conditions naturally altered the ground feeding patterns. In winter, birds may be forced to feed on the exposed tips of sagebrush branches or compelled to pick the leaves from small prostrate bushes on windswept ridges. In Utah sage grouse were documented digging holes in the snow to reach the tips of sagebrush leaves. Observations in Wyoming have revealed the importance of antelope in making snow-covered sagebrush available to sage chickens as a result of digging for their own food supply." Page 67—"Evidence indicated hens retired to the foothills region and more abundant water supplies during unusually dry seasons. On the basis of their behavior, it was felt that a series of drought years would likely telescope sage-grouse populations into areas less likely to exhibit the effects of continued drought as expressed in the vegetation and available surface water. It would, in effect, not only result in a restriction of sage-grouse distribution, but would cause a noticeable decrease in numbers on sub-marginal ranges." Page 72—"Another outbreak of coccidiosis occurring among sage-grouse in Wyoming in 1939. This loss, which began in June and continued until September, again involved young birds. It was his (Scott) opinion that the drought years concentrated the grouse on available water, thereby creating a situation favorable to the transmission of the coccidium." Page 115 – Weather and its effect upon nesting and brood survival – "Hatching success in 1949 and 1950 was 92.1 per cent and 91.4 per cent, respectively. No nests under observation were deserted or failed to hatch as a result of low temperatures or snow conditions which prevailed during the 1950 nesting season, even though weather of this nature generally is supposed to be extremely unfavorable to successful sage-grouse nesting seasons." Page 118 - "Juvenile mortality was high (during this period) due to several consecutive days of cold rain, sleet, and snow, accompanied by low temperatures." Page 138 – "Hail storms occur frequently in parts of Wyoming and may at times kill young birds over local areas. Weather apparently exerts no serious effects upon sage-grouse once they have passed the vulnerable early stages of their growth." Page 152 – "On days with strong winds, rain, snow storms, and low barometric pressure, the activity of birds was greatly reduced and many failed to appear on the strutting grounds at all…maximum strutting activity, accompanied by the largest number of cocks on the grounds, occurred on mornings with clear, fair weather, irrespective of low temperatures and the amount of snow on the ground." Page 179 – "Local residents have reported to me that sage-grouse on occasion dig into deep-crusted snow and roost in these open holes." Page 184 – "Honess reported the number of sage chickens wintering in the (Jackson Hole) area was related to snow depths which, of course, regulated the amount of exposed sagebrush." Page 189 – "Movements of sage-grouse onto their winter ranges was correlated with snow conditions and the availability of sagebrush. In the absence of open water, snow furnished the moisture requirements for sage-grouse in the winter." Page 208 – "Sage-grouse have also been observed to regularly visit partially frozen streams in Eden Valley during the late fall months in order to drink through holes in the ice." **Key words: sage-grouse, wind, rain, snow, barometric pressure, drought, behavior, mortality, parasites, disease, nutrition, reproduction**

376

Pedersen, A. Ø., Ø. Overrein, S. Unander, and E. Fuglei. 2005. Svalbard rock ptarmigan (*Lagopus mutus hyperboreus*): a status report. Report No. 125, Norwegian Polar Institute, Norway. Notes: Page 14—"Climate: The large fluctuations in numbers seen in most ptarmigan populations seem to be caused by a combination of biotic factors and climatic variation. The systematic component of the fluctuation (i.e. cycles) most likely originates from biotic interactions (self regulation through e.g. social behavior, predator-prey or host-parasite interactions). Also regular fluctuation in sun-spot activity has been invoked as cause of cycles in some northern vertebrate species. In willow ptarmigan and rock ptarmigan climate events like bad weather during the breeding season compromising breeding success is thought to be a vital factor in synchronizing the population dynamics at different locations, often called the "Moran effect"…"Poor climate conditions as heavy snow fall during egg laying caused delayed hatching in Svalbard rock ptarmigan, but how important such conditions are in shaping population dynamics is at the present unknown." **Key words: rock ptarmigan, snow, sun spots, reproduction**

377

Pedersen. H. Chr. and J. B. Steen. 1979. Behavioral thermoregulation in willow ptarmigan chicks *Lagopus lagopus*. Ornis Scandinavica 10(1):17-21. Summary: The effect of behavior on the T_b of ptarmigan chicks was studied in captive and wild birds of different ages and at different ambient temperatures (T_a). Newly hatched chicks show inter-brood coordinated periods of brooding and browsing. During browsing T_b decreases; during brooding it returns to normal. At T_a from 7 to 10°C, the lowest recorded value was 34.3°C. Post browsing T_b showed little variation with T_a but increased with age. No hypothermia was found in 3-week-old chicks. The duration of each browsing period increased both with increasing T_a and with age. If prevented from brooding, the chicks start to utter distress calls when their T_b drops below 34°C and they become lethargic at T_b below 32°C. The sensory input which triggers the chicks' return to brooding (the hen) appears to be the decreased T_b rather than signals from the hen. T_a near freezing appear to be a limiting factor for ptarmigan chicks during their first week of life, especially if the food supply is scarce. **Key words: willow ptarmigan, temperature, behavior, nutrition**

378

Pekins, P. J. 1988. Winter ecological energetics of blue grouse. Dissertation, Utah State University, Logan, USA. Abstract: This study investigated relationships between blue grouse (*Dendragapus obscurus*) winter habitat and blue grouse adaptive strategies and overwinter survival. Blue grouse metabolism, physical characteristics of use-trees and roost sites, microclimatic parameters at roost sites, daily winter energy costs, and specific energy-saving behaviors were studied. Blue grouse have a relatively low standard metabolic rate (SMR: 0.835 ml $O_2 \cdot g^{-1} \cdot hr^{-1}$) and lower critical temperature in comparison to other northern tetraonids. Metabolic rate did not significantly increase from -5 to -20 C. Ambient temperature (T_a) and the square root of wind speed were significantly correlated with metabolic rate…Wind speeds were reduced by 63 and 85% at diurnal and nocturnal roosts, respectively. Douglas-firs provided exposure to solar radiation, protection from wind, and a food source during the day. Subalpine firs increased protection from the wind and provided near maximum canopy coverage at night. Nocturnal subalpine roost sites provided a 10% net energy savings in comparison to diurnal Douglas-fir roost sites. The average field metabolic rate (FMR) of blue grouse measured with doubly-labeled water was about 1.4 times SMR, and was not influenced by weather. The proportion of FMR due to basal metabolism was twice that commonly assumed for other species, indicating the importance of microhabitat selection and relative inactivity by blue grouse in minimizing energy costs. Other energy saving behaviors included sunning, snow roosting, and walking uphill instead of flying. Habitat selection by blue grouse, particularly microhabitat selection of roost sites, reflects active choices designed to minimize energy costs imposed by winter weather. This selection indicates the importance of Douglas-fir and subalpine fir for overwinter survival. **Key**

words: blue grouse, temperature, wind, habitat use, biothermal regulation, behavior, vegetation

379

_____, J. A. Gessaman, and F. G. Lindzey. 1997. Microclimatic characteristics of blue grouse Dendragapus obscurus roost-sites: influence on energy expenditure. Wildlife Biology 3(3/4):243-250. Abstract: Energetic models which incorporate environmental measures have demonstrated that significant thermoregulatory savings are accrued from nocturnal winter roost-sites, usually from reduced wind speed and radiated heat loss. Because blue grouse *Dendragapus obscurus* occupy high elevation, snow-bound coniferous stands in the Rocky Mountains during winter, selection of a favorable microhabitat is likely their primary thermoregulatory behavior. Therefore, we measured the microclimatic conditions at diurnal and nocturnal roost-sites of blue grouse to determine whether their choice of roost-sites reflects thermoregulatory behavior. Temperature, wind speed and solar radiation were measured at 17 diurnal Douglas-fir *Pseudotsuga menziesii* and 17 nocturnal subalpine fir *Abies lasiocarpa* roost-sites and compared to those of an open control site in Logan, Utah, 1985-1986. Temperature varied <2°C between the roost-sites and the control site. Wind speed was significantly lower in 15 of 17 diurnal (mean = 0.71 m/sec) and all nocturnal roost-sites (mean = 0.24 m/sec) than in the control site (mean = 1.75 m/sec). Wind speed was reduced >75% at all but one nocturnal roost-site. Solar radiation at the diurnal roost-sites (mean = 51 W/m^{-2}) was significantly lower than at the control site (201 W/m^{-2}); however, five roost-sites had maximum values >90% of the control maximum. Douglas-fir roost-sites had significantly greater solar radiation, diurnal, and nocturnal wind speed than subalpine fir roost-sites. Reduction of convective heat loss was the major thermoregulatory contribution of both diurnal and nocturnal roost-sites. Diurnal roost-sites also afforded measurable radiant energy and, presumably, grouse could track the sun in roost trees to maximize such heat input. Daily energy costs predicted from metabolic equations incorporating temperature and wind speed were below the metabolizable energy intake of captive blue grouse. Application of the average microclimatic conditions from both roost trees to an energetic model revealed that a blue grouse would realize a 50% greater reduction in convective heat loss, and a 10% greater net energy savings, by roosting overnight in a subalpine fir rather than a Douglas-fir. This difference may explain why blue grouse show affinity to subalpine firs for nocturnal roosting, and points to the energetic importance of specific coniferous habitats to wintering blue grouse. **Key words: blue grouse, solar radiation, wind, habitat use, thermoregulation, microclimate**

380

_____, _____, and _____. 1994. Field metabolic rate of blue grouse during winter. Canadian Journal of Zoology 72:227-231. Abstract: We measured the field metabolic rate (FMR) of seven free-ranging and two captive blue grouse (*Dendragapus obscurus*) with doubly labeled water. Average carbon dioxide production (1.016±0.088 L $CO^{2}\cdot kg^{-0734}\cdot h$-1) of free-ranging grouse was 8% higher but not significantly different (*P*<0.05) from captive grouse (0.944±0.058 L $CO^{2}\cdot kg^{-.734}\cdot h$-1). Ambient temperature was not correlated with FMR (*P* = 0.268). The mean fat content of free-ranging blue grouse was

39 g (3.4%), which was equal to the energy equivalent of about 3 x daily standard metabolic rate (SMR). The FMR of free-ranging grouse averaged 657±62 kJ/d or 1.6 x SMR. The FMRs of free-ranging blue grouse averaged about 25% below FMRs predicted from allometric equations; most were 35-40% below those predicted. We suggest that there is little energetic constraint on blue grouse during winter because they are able to maintain a positive energy balance by minimizing energy costs through effective thermoregulation, microhabitat selection, and reduced activity. **Key words: blue grouse, temperature, metabolism, thermoregulation, habitat use, behavior**

381

_____, _____, and _____. 1992. Winter energy requirements of blue grouse. Canadian Journal of Zoology 70:22-24. Abstract: We measured the effects of temperature (T_a) on the metabolic rate of 6 blue grouse (*Dendragopus obscurus*) with indirect respiration calorimetry. The standard metabolic rate was $0.812\ L\ O_2 \cdot (kg^{0.734})^{-1}$ and was 24% higher than that predicted allometrically. The lower critical temperature (T_{lc}) of fasted grouse was -5°C; metabolism occurred linearly below -5°C. The heat increment associated with a Douglas-fir (*Pseudotsuga menziesii*) diet lowered the T_{lc} by 5°C. From -5 to -20°C, the metabolism of fasted and fed grouse increased by 30 and 12%, respectively. A positive winter energy balance was predicted for blue grouse from estimates of the field metabolic rate and the consumption and assimilation rates of a Douglas-fir diet. **Key words: blue grouse, thermoregulation, nutrition**

382

Pelgren, E. C. and J. A. Crawford. 1997. Blue grouse *Dendragopus obscurus* recruitment and weather relationships in northeastern Oregon, USA. Wildlife Biology 3(3/4). Not able to obtain for abstract.

383

Pendlebury, C. J., M. G. MacLeod, and D. M. Bryant. 2004. Variation in temperature increases cost of living in birds. Journal of Experimental Biology 207:2065-2070. Abstract: The effect of temperature variability on laying birds was studied experimentally, using Japanese quail. Two aspects of temperature variability were investigated: the effects of regular daily variation in temperature, and of a sudden change in temperature. Both of these may become more common as a consequence of climate change. These manipulations were carried out at two levels of food supply. Energy expenditure increased with higher daily temperature variation, and also after a sudden change in temperature, taking several days to settle to a constant level. Manipulating daily temperature variation also resulted in smaller eggs being laid under more variable temperatures, when food quality was also low. The results demonstrate that day-to-day variation in temperature, as well as mean temperature, affects energy expenditure, which can have consequences for egg production. **Key words: Japanese quail, temperature, climate change, biothermal regulation, productivity**

384

Pépin, D. and M. Fouquet. 1992. Factors affecting the incidence of dawn calling in red-legged and grey partridges. Behavioural Processes 26:167-176. Abstract: Seasonal variations in the frequency and the timing of calling in red-legged (*Alectoris rufa*) and grey (*Perdix perdix*) partridges, and their relationships with biological and environmental factors, were investigated during 89 morning surveys. In winter, when birds were living in social groups, the vocal activity of both species decreased. Most calling began before sunrise. Yet many variations in the timing of first calls were observed when sunrise was prior to 0530 h, i.e. when the daylength was above 13 hours. On the contrary, when daylength was shorter, calling activity always began approximately 45 minutes before sunrise. Red-legged partridge calls were more particularly stimulated when sunrise was between 0530 h and 0700 h, with no wind, when moonrise was between 000 h and 0900 h, and when cloud cover was low. **Key words: grey partridge, red-legged partridge, behavior, solar radiation, wind, clouds**

385

Pepper, G. W. 1972. The ecology of sharp-tailed grouse during spring and summer in the aspen parklands of Saskatchewan. Wildlife Report No. 1, Saskatchewan Department of Natural Resources, Regina, Canada. Notes: <u>Page 31</u> – "Very hot weather resulted in heavier-than-normal woody cover selection and on cool, heavily overcast days broods were often found all day in very heavy herbaceous vegetation. After heavy rains or on cool sunny days broods were more likely to be found in lighter than usual cover." **Key words: sharp-tailed grouse, temperature, clouds, precipitation, solar radiation, behavior, habitat use**

386

Perez, R. M., J. F. Gallagher, and M. C. Frisbie. 2002. Fine scale influence of weather on northern bobwhite abundance, breeding success, and harvest in south Texas. Proceedings of the National Quail Symposium 5:106-110. Abstract: Weather plays a substantial role in annual changes in populations of northern bobwhite (*Colinus virginianus*) within and among ecological regions. Few studies have tested this relationship within the confines of specific sites. We examined the fine scale influence of annual (12-month), seasonal (6-month), and monthly Modified Palmer Drought Severity Indices (PMDI) and raw precipitation on abundance, breeding success, and harvest of northern bobwhites on 2 sites in south Texas. We used 18 years (1984-01) of roadside census, juvenile:adult ratios, and harvest records from the Chaparral Wildlife Management Area (CMWA) in La Salle County and 15 years (1984-99) of juvenile:adult ratios and harvest records from a private property in Brooks County (BCP) to examine relationships and trends with weather variables. Bobwhite abundance was correlated ($r \geq 0.53$, $P \leq 0.023$) with 12- and 6-month sums of precipitation and PMDI. Breeding success was correlated ($r \geq 0.53$, $P \leq 0.023$) with 12-month precipitation for both sites and was correlated ($r = 0.53$, $P = 0.040$) with 6-month precipitation for BCP only. Harvest variables for CWMA were correlated ($r \geq 0.54$, $P \leq 0.022$) with 12- and 6-month PMDI, while BCP harvest/ha was correlated ($r = 0.54$, $P = 0.027$) with the 12-month precipitation sum. Monthly correlates with precipitation increased from spring to summer until July when they became negatively related to rainfall on both sites. Monthly PMDI correlates became increasingly important from spring through summer including July. Our findings account for at least part of the annual variation in northern bobwhite abundance in south Texas and provide information useful in understanding of the influence of weather at fine spatial scales. **Key words: bobwhite quail, precipitation, drought, index, population dynamics, reproduction**

387

Perkins, A. L., W. R. Clark, T. Z. Riley, and P. A Vohs. 1997. Effects of landscape and weather on winter survival of ring-necked pheasant hens. Journal of Wildlife Management 61(3):634-644. Abstract: We studied populations of ring-necked pheasant hens (*Phasianus colchicus*) on a diverse landscape in Palo Alto County, Iowa and on an intensively farmed area in Kossuth County, Iowa to examine the hypothesis that differences in habitat composition influence winter survival. We captured hen pheasants by nightlighting or bait trapping on each site and relocated them with telemetry from December through March, 1989-94. We determined home range area, habitat use, and movements during the day. We estimated survival using Kaplan-Meier statistics and related survival to habitat and weather covariates using parametric models. In both landscapes, home ranges were located in areas with more grass habitat than the surrounding landscape ($P < 0.05$). Home range area averaged 76 ha and daily movements averaged 251 m at Palo Alto, whereas these variables were 96 ha and 270 m at Kossuth. Survival from 27 November to 1 April ranged from 0.23 in 1993 on Kossuth to 0.96 in 1990 on Palo Alto but the average difference in survival between sites among years was not different from zero ($P = 0.77$). Parametric hazards models indicated that measures of weather and temperature were predictive of mortality, but that small scale habitat use and daily movements were not. Winters with extensive snow cover and cold temperatures periodically reduce survival even where the distribution of small blocks of cover such as idle grass, woody cover, and wetlands is considered adequate by managers. **Key words: ring-necked pheasant, snow, temperature, mortality, habitat use**

388

Perry, R. F. 1946. An appraisal of pheasant abundance in New York State during 1945 and some of the factors responsible for the recent decline. Transactions of the North American Wildlife Conference 11:141-155. “Discussion of limiting factors—The most important factors controlling the quality of the environment are shelter, food, and weather. The whole structure rests on the soil which basically determines the vegetative cover (food and shelter) and on the climate. Surveys and field observations have indicated that whatever forces that caused the sudden decline in pheasant abundance since 1941 have been operative principally during the spring and summer period. This fact has been particularly obvious in areas where appreciable breeding populations failed to produce expected numbers of young. Observations during this period for the past several years have shown that unusually cold, wet weather has often been associated with such failures….known seasons of poor pheasant hunting coincide to a marked degree with years which were abnormally cold and wet during the breeding and rearing season…it appears quite possible that adverse weather during the spring and summer may have been to a large extent responsible for the recent “crash” in pheasant abundance.” **Key words: ring-necked pheasant, mortality, precipitation, temperature, productivity**

389

Petersen, L. R., R. T. Dunke, and J. M. Gates. 1988. Pheasant survival and the role of predation. Pages 180-196 *in* D. L. Hallett, W. R. Edwards, and G. V. Burger, editors. Pheasants: symptoms of wildlife problems on agricultural lands. North-central Section of The Wildlife Society, Bloomington, IN, USA. Abstract: Fluctuations in pheasant abundance are caused primarily by variable rates of mortality, with reproductive performance playing a subsidiary role. This paper examines seasonal and annual (fall-to-fall) survival with emphasis on predation. Mean annual survival of hens of 30-35% appears normal. Wisconsin pheasant studies suggest a long-term decline in survival and abundance, and an increase in productivity. Low survival has resulted from habitat loss, and operates through increased predation. Important predators of adult pheasants are the red fox, red-tailed hawk, and great horned owl. Predator numbers vary spatially and temporally. High numbers of red foxes have persisted since the 1940’s in nearly all Midwestern states. In addition, the red fox expanded westward into the prairie states in the 1950’s to early 1960’s. Red-tailed hawk and great horned owl numbers were relatively stable in the 1950’s and 1960’s, but generally increased 1965-85 in the plains and prairie states, the Great Lakes states, and those parts of New England that support pheasants. Predation rates are related to snow depth in winter. Unfavorable weather combined with poor habitat occasionally results in excessive predation in spring. Predator-prey ratios are likely higher in Wisconsin than in the more intensively cultivated and highly simplified agricultural habitats of the plains and prairie states. Predation is, at best, imperfectly density dependent. It appears that severe winters lead to loss of body condition and increased mortality due to predation. Attainment of weights favorable for reproduction depends on the time of winter break-up, and on favorable pre-nesting temperatures. Reproduction success relates in part to the physiological condition of hens at the start of reproduction as well as weather and spring cover conditions as they influence predation. **Key words: ring-necked pheasant, snow, habitat condition, predation, nutrition, reproduction**

390

Peterson, M. J. and N. J. Silvy. 1994. Spring precipitation and fluctuations in Attwater’s prairie-chicken numbers: hypotheses revisited. Journal of Wildlife Management 58(2):222-229. Abstract: Two related hypotheses argue that greater than normal precipitation during May alone or spring (Mar-Jun) leads to decreased Attwater’s prairie-chicken (*Tympanuchus cupido attwateri*) breeding success, whereas less than normal precipitation during these periods leads to increased breeding success. These hypotheses have been accepted by wildlife managers and, seemingly because of observer expectancy bias, have been used to explain annual variation in Attwater’s prairie-chicken numbers. We demonstrate that neither hypothesis is supported by available data. Similarly, alternative hypotheses that May or spring flooding, the date in May when maximum precipitation occurs, or precipitation variability among spring months drives spring breeding numbers also were not supported. We found, however, that breeding success in spring can drive proportional changes in breeding numbers the following spring. **Key words: prairie-chicken, precipitation, temperature, population dynamics**

391

Piao, Z.-J. 1997. Reproductive success of hazel grouse at Changbai Mountain. Acta Zoologica Sinica 43(3):279-284. Abstract: The reproductive success of hazel grouse (*Bonasa bonasia*) was studied at Changbai Mountain from 1986 to 1995. Radio-tracking data showed that the rate of reproductive success was 20.9% (n = 4), and the survival rate of chicks at the time of brood dissolution was 37.5% (n = 3). Field observations on broods during May to August showed that the brood chick numbers decreased with their daily age, with the regression equation of $y = 9.916-0.185x+0.001x2$ ($P<0.0001$). Analysis for the effects of weather during April to August on the reproductive success of hazel grouse indicated that the IRS (index of reproductive success) was correlated with the weather during early chick period. The reproductive success was significantly ($P<0.005$, $P<0.025$) negatively correlated with the precipitation and the days of precipitation in June during the young chick period, suggesting that precipitation had an adverse effect on chick survival. We found that parasitism by the tick *Ixodes persudactus* was one of the main factors causing death of the chicks. **Key words: hazel grouse, precipitation, disease, mortality, parasites**

392

Porkert, J. 1991. Hoarfrost deposits as a factor contributing to the extinction of tetraonids in the eastern Sudetes. Ornis Scandinavica 22(3):292-293. Notes: “Hoarfrost, snow and ice deposits on vegetation affect tetraonids directly in the following ways: (a) food consumption is hindered, (b) metabolic rates are disturbed, and (c) toxic substances found in frost and snow are consumed. The birds are also affected indirectly because (d) the structure of the habitat and the quality of plant foods deteriorate as an effect of increasing acidity and high contents of toxic substances in the hoarfrost. The thawing to body temperature of the winter food, together with hoarfrost, snow and ice, in a bird’s crop requires considerable energy. Energy losses may not be compensated for by eating more food or by using richer energy sources. In the presence of heavy hoarfrost, larger amounts of frost are consumed during each activity period because hoarfrost, ice and snow are consumed simultaneously with the food. In periods with wind and crusty snow, birds have difficulty in digging depressions in the snow, and thereby lose considerable energy. **Key words: grouse, ice, snow, hoarfrost, pollution, nutrition, wind, thermoregulation**

393

Porter, W. F. and D. J. Gefell. 1995. Influences of weather and land use on wild turkey populations in New York. Proceedings of the National Wild Turkey Symposium 7:75-80. Abstract: We assessed the influence of weather and land use of the population dynamics of wild turkeys (*Meleagris gallopavo*) during a 12-year period in southern New York. Wild turkey abundance and rate of population change were indexed using hunter effort and harvest records from fall hunting across 256 townships. Winter and spring weather conditions were assessed using data collected at National

Oceanic and Atmospheric Administration (NOAA) weather stations. Land use was assessed using data from New York's Land Use and Natural Resources (LUNR) survey conducted in 1970. Population abundance was generally below the long-term mean, with periodic eruptions. On an annual basis, weather and land use were poor predictors of population dynamics. However, on medium time intervals (3-4 years), weather and land use accounted for 19 to 95% of the variation in population abundance and rate of change. We hypothesize that weather factors are poor predictors in annual intervals because positive and negative influences of different factors are seldom in synchrony. When favorable conditions are coincident among several weather factors, rapid population growth occurs. The magnitude of population growth appears related to land use. **Key words: wild turkey, weather, population dynamics**

394

Porter, W. F., G. C. Nelson, and K. Mattson. 1983. Effects of winter conditions on reproduction in a northern wild turkey population. Journal of Wildlife Management 47(2):281-290. Abstract: Nine aspects of the reproductive performance of female wild turkeys (*Meleagris gallopavo*) were measured in Minnesota during 1975, 1977, and 1978. Sixty-eight of 75 (90%) radio-tagged females attempted to nest, renesting was common, and eggs in nests of 67% of the females ultimately hatched. Clutch size averaged 11.7 eggs, hatching success was 82% and 37% of the young produced survived to late summer. Winter severity, measured in terms of impacts of site-specific conditions on late-winter body weights of females and mortality rates, varied within 14 different winter flocks. Females weighing less than 4.3 kg were less likely to survive to breed, less likely to nest, and had a natality rate of 2.6 females/female in the breeding population. Heavier females had higher survival and nesting rates and natality was 4.3. Strong correlations were observed between survivorship within winter flocks and reproductive performance of females that survived to breed. Severe winter conditions appeared to reduce egg hatching success among yearling females and recruitment of young among adults. Population modeling demonstrated that winter mortality and impaired reproduction performance can result in a significant decline in the population. At least 2 breeding seasons are necessary for population recovery. Impacts on hunting harvest quotas are discussed. **Key words: turkey, temperature, snow, population dynamics, nutrition**

395

Potapov, R. L. and A. V. Andreev. 1982. Time and energy budgets in wintering Tetraonidae. Congressus Internationalis Ornithologici XVIII:409-412. Summary: Daily energy budgets in 6 species of the family Tetraonidae, wintering in North Palearctic at Ta-20° - 44° were determined in two or three ways, including simultaneously measured time budget. The low level of winter's DEB is the result of: (1) low level of activity – the birds spend only 1-4 hours daily for obtaining the food; (2) the birds spend much time (20-23 hours daily) in snow burrows – the thermal refuges with constant Ta of -4° - -5°; (3) the low lower critical To. Using the thermal refuges, tetraonid birds may regulate average daily Ta near -7° instead of -10° - -60° in open air. **Key words: grouse, snow, temperature, biothermal regulation, behavior**

396

Potts, G. R., S. C. Tapper, and P. J. Hudson. 1984. Population fluctuations in red grouse *Lagopus lagopus* analysis of bag records and a simulation model. Journal of Animal Ecology 53(1):21-36. Abstract: A time-series analysis of numbers of red grouse (*L. lagopus*) shot per annum was carried out for 52 moors in northern England [UK] where data were available for at least 20 consecutive years during the period 1870-1977. Correlograms were constructed and auto-correlation coefficients were tested for statistical significance. In the most representative sub-sample of moors, 83% of the series had significant negative coefficients at T + 2 or T + 3 years or both. A mathematical model was fitted to the fluctuations to describe their quasi-cyclic nature and the average cycle-length was 4.84 ± 0.086 yr field observations and data from trials with captive grouse were combined to construct a simulation model of a red grouse population; its main features were: an inverse logistic curve relating mean numbers of the parasitic nematode *Trichostrongylus tenuis* in adult red grouse to their breeding success; *T. tenuis* accumulation by young red grouse to steady state levels (the numbers of worms accumulated per bird varied according to a combined effect of the density of grouse prior to the breeding season and the worm burden of these grouse); a logistic curve relating to the proportion of grouse shot with the density of grouse available; and an annual survival rate of the non-shot population inversely proportional to the density of old grouse. The simulation model successfully captured mean levels and other population parameters, but it fit well to observed fluctuation patterns only when stochastic elements were introduced to represent known effects of weather. The model showed that red grouse cycles could be caused by effect of *T. tenuis* working together with stochastic elements and a time delay arising form the uptake of worms. **Key words: red grouse, disease, weather, population dynamics, parasites, model**

397

Prellwitz, D. M. 2002. Greater sage-grouse at Bowdoin National Wildlife Refuge, Montana. Intermountain Journal of Science 8(2):115-116. Notes: Page 115 – "Refuge employees, while conducting annual waterfowl nesting studies, nest drag from 160-510 ha of upland grass habitat, and occasionally flush lone sage-grouse in front of the drag. One sage-grouse nest was found on 6 June 1988. The nest of seven eggs was found in dense grass cover beneath one of only a few plains silver sagebrush plants in the area. The nest hatched at least four eggs by 27 June during one of the hottest months on record when daytime highs were >32°C on 22 days with 9 of those days >38°C. Although this age grouse nest survived despite the above-normal daytime temperatures, several nests of other species dehydrated and were lost. Total precipitation in 1988 was 24.4 cm, far below the long-term average of 31.9 cm. **Key words: sage-grouse, temperature, precipitation, habitat use, vegetation, productivity**

398

Priest, S. R. 1995. Relationships between wild turkey hens, environmental factors, and predation during the wild turkey reproductive period on Tallahala Wildlife Management Area (Mississippi, *Meleagris gallopavo*, *Procyon lotor*). M. S.Thesis, Mississippi State University, Starkville, USA. Abstract: Racoon (*Procyon lotor*) home range size, habitat use, survival rates, and effects of meteorological events on wild turkey (*Meleagris gallopavo*) hen nest losses from predation were studied on Tallahala Wildlife Management Area (TWMA) in central Mississippi, 1991-1992. Data from 33 transmittered raccoons and 103 turkey hens were used in analyses. Raccoon seasonal home range sizes were significantly larger during the wild turkey nesting period and generally were smallest during the post-nesting period. Composite home range sizes were consistent with results of other recent studies of raccoons conducted in the Southeast. Bottomland hardwood forests were preferred by raccoons during all periods. However, during the turkey nesting period raccoon habitat use changed to include more mature pine (*Pinus* spp.) stands and pine regeneration areas and less hardwood. Disease seemed to be a major mortality factor of raccoons during 1991. Illegal trapping was the major cause of death during 1992. Survival rates were 0.53 and 0.69 for 1991 and 1992, respectively. Although total amount of rainfall during the wild turkey nesting period was not correlated with nesting success, pattern of rainfall was important. Predation on turkey nests often occurred after rains preceded by at least 2 days of dry weather. Management implications and recommendations for future research are discussed. **Key words: wild turkey, precipitation, predation, mortality**

399

Pullianen, E. and P. S. Tunkkari. 1991. Responses by the capercaillie (*Tetrao urogallus*) and the willow grouse (*Laogpus lagopus*) to the green matter available in early spring. Holarctic Ecology 14(2):156-160. Abstract: Food matter eaten in the first snowless spots early in the spring by capercaillie *Tetrao urogallus* and willow grouse *Lagopus lagopus* was studied in Finnish Forest Lapland. When the snow disappears, both species change to feeding mainly on the plants available in the snowless spots, although male capercaillie does not exploit this nutritious diet to the same extent as female capercaillie and willow grouse. Selection in favor of nitrogen and phosphorus-rich food items, i.e. *Betula pubescents*, male catkins (*Eriophorum vaginatum*), flower buds, and *Equisetum* spp., stems and tips, seems to be characteristic especially of the female capercaillie, whose winter diet is poor in these elements. Female capercaillie also feeds on more plant species or different parts of plants at one time than willow grouse, while no differences were recorded between male and female willow grouse in the composition of their spring food. The crowberry *Empetrum hermaphroditum*, almost regularly produces a bountiful berry crop in northern Finalnd, and since it overwinters well, it represents an easy source on energy and water available almost every spring. The quality and/or the quantity of the green food matter available early in the spring may fluctuate considerably and be of importance for short-term fluctuations in the populations of these tetranoid species. **Key words: capercaillie, willow grouse, snow, temperature, vegetation, phenology, nutrition**

400

______. 1978. Behavior of a willow grouse *Lagopus lagopus lagopus* at the nest. Ornis Fennica 55(4):141-148. Abstract: The behavior of a nesting willow grouse pair was studied mainly with the aid of a field television system with remote control in eastern Finnish Lapland (67°N44'N, 29°37'E) in continuous daylight. During the laying period the hen covered the eggs with plant matter. Incubation started before the laying of the penultimate egg. Only the hen incubated. The hen could be off the nest at any time of the day and the nest was left unattended 5.7% of the time. Snowfalls occurred during the incubation period. In continuous daylight the willow grouse is active for 24 h. In cold weather the frequency of settling movements remained high, while preening, shifting, resettling and nest-building activities decreased. Exceptionally high frequencies of preening, feeding (catching) and nest-building were recorded during the hatching of the chicks, which points to displacement activity. The period from the beginning of intensive incubation to departure of the brood was about 22 days. **Key words: willow grouse, temperature, behavior**

401

Queal, L. M., J. A. Norman, K. Sexson, and G. J. Horak. 1971. Population dynamics of prairie chicken in grassland and cropland areas. Pittman-Robertson Project W-23-R, Job No. D-3, Kansas Forestry, Fish and Game Commission,Topeka, USA. Notes: Page 64—Effects of Rainfall on Brood Survival. There appears to be a correlation between variations in the annual precipitation patterns and variation in prairie chicken population density. The precipitation pattern during the latter part of May and into June, when young are susceptible to inclement weather, seem particularly important. Page 67—Effects of Weather on Hunting Success. Temperatures below 30°F occurred only twice during 1964 prior to the hunting season when hunting success was at the lowest….During both days of the opening weekend in the low year of 1964 and in the high of 1966, fog was prevalent until 8:30 A.M. or 9:00 A.M. In 1966, when the temperatures dipped to the lower teens prior to the season, certain populations of insects and living vegetation were frozen, lowering the availability of food in the pastures; prairie chickens then began using feed fields where food was more plentiful. **Key words: prairie chicken, precipitation, temperature, fog, mortality, hunting, habitat use, movement**

402

Quinn, N. W. S. and D. M. Keppie. 1981. Factors influencing growth of juvenile spruce grouse. Journal of Canadian Zoology 59(9):1635-1855. Abstract: The influences of date of hatch, and age and prelaying body weight of brood female on the growth rate of juvenile spruce grouse (*Canachites canadensis*) were studied in central New Brunswick in 1977 and 1978. Because of differential timing of hatch of broods of adult and yearling females, it was not clear whether a difference in juvenile growth rates during 5-14 days of age in 1977 was related to date of hatch, age of brood female, or both. Differences in juvenile growth rates within and between years apparently were not influenced by body weight of brood females prior to egg laying. Results suggest that posthatch factors are more important in determining growth rate than a prehatch or "maternal" influence. Notes: Page 1793—The marked difference in growth of juveniles during the 2 years of this study probably was due to much warmer, drier weather throughout the summer of 1978 than 1977, which allowed chicks to divert more metabolizable food energy to growth. Faster early growth of late-hatched than early-hatched juveniles also has been reported for blue grouse (Redfield 1978). Redfield speculated that the relation between hatch date and growth was due to changing abundance of insects used as food. Faster early growth of late-hatched juveniles could be due to any factor such as food supply or temperature which influences the partitioning of food energy. **Key words: spruce grouse, temperature, precipitation, morphology, insects, nutrition**

403

Rabe, D. L. 1981. Habitat and energetic relationships of American woodcock in Michigan. Dissertation, Michigan State University, East Lansing, USA. Abstract: Studies were undertaken to examine (1) the role of interspersion and food availability on habitat utilization by breeding woodcock (*Philohela minor*), (2) the proximal cues of habitat used to locate feeding sites and the foraging strategies used to capture earthworms (*Lumbricidae*), and (3) the impact of weather on food availability and bioenergetics of breeding woodcock. During the springs of 1978 and 1979, 23 aspen (*Populous tremuloides*) community habitat complexes were censused for singing males and intensively searched with a pointing dog to locate nests, broods, and solitary birds. At the same time, data were collected on habitat structure and earthworm abundance. Thirty-two solitary birds and 31 broods were located during 78 h of searching in the two years. Singing male woodcock used 17 and 20 of the habitat complexes in 1978 and 1979, respectively. Three of the complexes were never used by woodcock during the study. Between-year comparisons of each habitat complex revealed that use by singing males and solitary birds was much more consistent than brood use. Numbers of broods using a complex were correlated ($P < 0.10$) with numbers of singing males in 1979. Earthworm abundance was correlated ($P < 0.10$) with brood use in both years; correlations to males were weaker. Structural measures of the habitat complexes (i.e., size, shape, and interspersion) were not consistently correlated with any woodcock use between the years. In a series of laboratory experiments, the foraging behavior of live-trapped adult woodcock was examined in order to test specific hypotheses about the proximal cues of habitat used to select feeding sites and foraging strategies used to capture earthworms. Foraging trials were conducted in a circular arena where the birds were allowed to probe among eight soil trays containing various soil types, soil moistures, and earthworm size classes and densities. Color, which tends to be correlated with soil types and moisture regimes preferred by earthworms, was found to be the primary proximal cue used by woodcock for selecting feeding sites in these experiments. Birds concentrated searching effort in areas of relatively high prey density, but exhibited no size selectivity. Following the capture of one earthworm, birds tended to concentrate additional searching in the immediate area. This non-random search pattern seems to account for the greater efficiency of capture when prey are aggregated. **Key words: American woodcock, moisture, soil, nutrition, bioenergetics**

404

_____, H. H. Prince, and E. D. Goodman. 1983. The effect of weather on bioenergetics of breeding American woodcock. Journal of Wildlife Management 47(3):762-771. Abstract: Simulation modeling was used to investigate the impact of weather on the bioenergetics of breeding and postbreeding American woodcock (*Scolopax minor*). Using air temperature and precipitation as inputs, the model calculates the daily energy requirements of an adult female woodcock and chicks along with the availability of their primary food, earthworms (Lumbricidae). Energetics were modeled from previous studies on woodcock and related species. Earthworm availability was modeled from field data collected in northern Michigan. Results suggest that the greatest potential for weather-related stress on woodcock occurs during the brood-rearing period, with nesting being the 2nd most critical time. When simulated earthworm availability during the brood period was compared with reproductive success data, it indicated that the impact of spring weather on earthworm availability is a significant factor affecting chick survival. **Key words: American woodcock, temperature, precipitation, bioenergetics, nutrition, reproduction, model**

405

Raitt, R. J. and R. E. Genelly. 1964. Dynamics of a population of California quail. Journal of Wildlife Management 28(1):127-141. Abstract: Dynamics of a population of California quail (*Lophortyx californicus*) were studied for 8 years, 1950-57, by capture-recapture methods. Fall population size varied between 25 and 140. Productivity varied between 56.5 immatures:100 adults and 222 immatures:100 adults as indicated by fall age ratios. Reproductive success appears to have been promoted by early onset of the breeding season and a minimum of fog and rain during the hatching season. The composite overall mortality rate was 71 percent, and life tables indicate only slight variation with age. The success of the breeding effort was probably the major factor in determining fall population size. Seasonal changes in the type and degree of mobility—correlated with changes in social behavior—are described. Population reductions were carried out in two winters, and in both years the population had returned to normal size by autumn. Immigration of birds from surrounding areas, rather than compensatory changes in mortality and productivity, appears to have been responsible for the recovery. **Key words: California quail, precipitation, fog, reproduction, productivity**

406

Rand, A. L. 1947. Clutch size in the spruce grouse and theoretical considerations of some factors affecting clutch size. Canadian Field-Naturalist 61:127-130. Abstract: The available data indicate that clutch size in *Canachites canadensis* is 4-7, which is fewer than indicated in standard texts. There is no geographic variation in clutch size in Canada. Clutch size may be affected by food abundance, cyclic abundance, spring weather changes, age of bird, interrupted nesting and by whether the bird is a determinate or indeterminate layer. With the red grouse of Europe the number of eggs laid is said to be 4 to 9 in cold wet springs; 6 to 12 in very favorable seasons, and 7 to 8 in average years. **Key words: spruce grouse, red grouse, weather, reproduction**

407

Ratti, J. T. and J. H. Giudice. 2001. Assessment of chukar and gray partridge populations and habitat in Hells Canyon. Technical Report Appendix E.3.2-7, Hells Canyon Complex FERC No. 1971. Report to Environmental Affairs, Idaho Power Company, Boise, USA. Summary: This report contains a detailed literature review on the chukar and gray partridge. Subsections 4.5.4 Wintering provides a discussion of the impact of weather on these two species. **Key words: chukar partridge, gray partridge, precipitation, snow, wind, habitat use, vegetation**

408

Remington, T. E. and C. E. Braun. 1985. Sage-grouse food selection in winter, North Park Colorado. Journal of Wildlife Management 49(4):1055-1061. Notes: "Sage-grouse use seasonal habitats that differ in plant composition and structure, and that may be widely separated. Winter habitat is probably the most limited seasonal habitat and thus may be the most critical. This study has shown that winter use areas have a specific species/subspecies composition and unique chemical characteristics in addition to topographic and structural features. Identification and protection of these areas is essential if sage-grouse populations are to be maintained. Locating stands of palatable sagebrush (e.g., Mountain big sagebrush) is not enough, because snow cover can make large expanses of sagebrush unavailable to sage-grouse in winter. Within wintering areas, particular protection should be given to stands of palatable species/subspecies of sagebrush. Identification of big sagebrush to subspecies is essential because use differs greatly. Use and importance of Mountain big sagebrush may increase in winters of heavy snowfall because of its generally taller growth form. Use and preference of species/subspecies of sagebrush should be investigated locally, particularly where composition differs from that encountered in this study. **Key words; sage-grouse, snow, diet, nutrition, habitat management, vegetation**

409

Rice, S. M., F. S. Guthery, G. S. Spears, S. J. DeMaso, and B. H. Koerth. 1993. A precipitation-habitat model for northern bobwhites on semiarid rangeland. Journal of Wildlife Management 57(1):92-102. Abstract: Models that predict wildlife responses to natural and human perturbations are useful in research, extension, and management. Thus, we developed *a priori* and tested a precipitation-habitat model for predicting autumn density of northern bobwhites (*Colinus virginianus*) on semiarid rangeland. Variables in the model included the proportion of an area usable based on dispersion of woody cover, Thornwaite's index of precipitation effectiveness, proportion of sand-sized particles in the soil, proportional coverage of woody cover and forbs, and proportional exposure of bare ground. Observed densities were a linear function of modeled densities based on pooled data from the Rio Grande Plains (n = 16) and Gulf Coast Prairies, Texas (n = 6) (r^2 = 0.34, 20 df, α = 0.0021). The model differed from species-habitat models by using an environmental correlate of bobwhite abundance (precipitation effectiveness), which allowed incorporation of quail population history into model output. The model provides an analytical framework for identifying habitat deficiencies on semiarid rangeland and for predicting bobwhite population response to remedial management. **Key words: bobwhite quail, precipitation, model, population dynamics, index**

410

Rich, T. 1985. Sage-grouse population fluctuations: evidence for a 10-year cycle. Technical Bulletin 85-1, Bureau of Land Management, Idaho State Office, Boise, USA. Abstract: Thirty-two years of counts of sage-grouse (*Centrocercus urophasianus*) males on leks in southern Idaho revealed major population peaks about every 10 years. Lek counts from northern Utah and western Nevada and harvest data from Idaho and Utah all show strong synchrony in this cycle. Individual lek counts within each region tended to fluctuate together despite being located in different habitats or at different elevations. Eight of nine monthly weather variables having significant correlations with lek counts in Idaho were precipitation, rather than temperature, variables. However, weather variables were not useful in predicting mean lek counts through linear-regression analysis. In Idaho 79% of the variation in mean lek count could be explained by knowing the mean lek count of the previous spring and the juvenile/adult ratio in the preceding autumn's harvest. About 65% of the variance in the juvenile/adult ratio could, in turn, be explained by knowing the amount of precipitation in July and August. There is no evidence that sage-grouse populations decline as a result of being alternate prey in a predator-prey system involving coyotes (*Canis latrans*) and cycling black-tailed jackrabbit (*Lepus californicus*) populations. **Key words: sage-grouse, precipitation, temperature, population dynamics**

411

Riley, T. Z., W. R. Clark, E. Ewing, and P. A. Vohs. 1998. Survival of ring-necked pheasant chicks during brood rearing. Journal of Wildlife Management 62(1):36-44. Abstract: Survival of chicks is an important and poorly understood component of ring-necked pheasant (*Phasianus colchicus*) population dynamics. We implanted transmitters in day-old chicks (n = 332) with brooding hens (n = 117) during 1990-94 in northern Iowa and calculated survival to 28 days of age. We contrasted survival among years and between an area in Palo Alto County with >25% grassland habitat and an area in Kossuth County with <10% grassland. Average survival (S_{28}) of pheasant chicks in Palo Alto County was 0.46± 0.11 and did not differ (P = 0.355) from Kossuth County (S_{28} = 0.37±0.13, P = 0.039). Weasel (*Mustela erminea*), red fox (*Vulpes Vulpes*), and mink (*Mustela vison*) together accounted for >85% of the mortality. Twenty-three chicks died of exposure on days when at least a trace of rainfall fell, and 11 of 23 (48%) died on days when rainfall was >0.6 cm (mean = 0.86 cm, range = 0.68-3.38 cm). Age of the hen did not influence chick survival. Chick mortality rate was increased by 2.3% for each day chicks hatched after the median date of hatch (15 Jun) and was decreased by 10% for each gram of mass above the average chick mass at hatch (18.5±0.13 g). Habitat management to improve chick survival of pheasants on agricultural landscapes should emphasize perennial grass and legume cover dispersed among crop fields. Grassland cover should remain undisturbed, particularly early in the nesting season (15 April-1 Jun), to improve the chances of successful first-nest attempts. **Key words: ring-necked pheasant, precipitation, mortality, temperature, habitat use, chick survival**

412

Ritcey, R. 1995. Status of the sharp-tailed grouse (*columbianus* subspecies) in British Columbia. Wildlife Working Report No. WR-70, Ministry of Environment, Lands and Parks, Wildlife Branch, Victoria, British Columbia, Canada. Notes: Page 8—Weather, disease and starvation. There is no evidence that severe weather is a significant direct mortality factor affecting "Columbian" sharp-tailed grouse. However, its indirect effects may be more profound. Years of low precipitation may reduce production of vegetation needed for security or nesting cover, leading to increased predation of adults and chicks. **Key words: sharp-tailed grouse, precipitation, vegetation, predation, mortality**

413

Ritcey, R. W. and R. Y. Edwards. 1963. Grouse abundance and June temperatures in Wells Gray Park, British Columbia. Journal of Wildlife Management 27(4):604-606. Abstract: A study of weather records and the annual grouse kill in Wells Gray Park, British Columbia, showed a relationship between June weather and the fall kill. A positive correlation coefficient of 0.913 was found to exist between the fall grouse kill and the mean maximum June temperature. The grouse involved were chiefly ruffed grouse (*Bonasa umbellus*). It seems apparent that high temperatures in late spring and early summer are an important factor in the reproductive success of grouse. **Key words: ruffed grouse, temperature, reproduction**

414

Rivera-Milán, F. F. 1997. Seasonal and annual changes in the population density of Zenaida doves in the xerophytic forest of Guanica, Puerto Rico. Journal of Field Ornithology 68(2):259-272. Abstract: The Zenaida dove (*Zenaida aurita*) is common and widely distributed in the three major life zones (dry, moist, wet) of Puerto Rico. The xerophytic forest of Guanica may be a key habitat for the reproduction of Zenaida doves in the dry zone. Point-counts (six 3-min stations) were conducted from 1986-1996 and nest-counts (46 0.1-ha strip-transects) from 1987-1992 to study the changes in the density (D) of Zenaida doves and their active nests in the xerophytic forest. From 1987-1992, the mean D of Zenaida doves was 4.83/ha and the mean D of active nests was 1.66/ha. The mean D of active nests was higher in areas dominated by semi-deciduous vegetation than in areas dominated by deciduous and thorn-scrub vegetation. Point-counts and strip-transects suggested a population decline from 1987-1992, with 1989 having the lowest D of Zenaida doves and active nests. The rainfall of the first 6 mo of the year explained 72-80% of the variation in 6 from point-counts and strip-transects from 1987-1992. Point-counts suggested a significant population decline from 1986-1996, with 1989 and 1995 having the lowest counts of Zenaida doves. The rainfall of the first 6 mo of the year explained a significant proportion (51%) of the variation of point-counts from 1986-1996. To detect 10-25% differences (a=0.05, power=0.80) in the annual mean D of Zenaida doves and their active nests, sampling 32 3-min stations and 79 0.1-ha strip-transects monthly from April-June is recommended. These sample sizes are large enough to detect positive or negative trends of 10% through linear regression analysis. The conservation and management of the xerophytic forest may be of critical importance for maintaining current population levels of Zenaida doves in the dry zone of Puerto Rico. **Key words: Zenaida dove, precipitation, population dynamics**

415

_____ and F. C. Schaffner. 2002. Demography of Zenaida doves on Cayo del Agua, Culebra, Puerto Rico, Condor 104:587-597. Abstract: The demography of Zenaida doves (*Zenaida aurita*) was studied on Cayo del Agua, Culebra, Puerto Rico.

We collected capture-recapture and reproductive success data and monitored annual changes in the density of ground nests in 1987-1993 and 2000. Models with time-specific apparent survival and constant capture rates and constant apparent survival and time-specific capture rates were equally parsimonious, with the former having 1.5 times more support from the data. Rainfall of the first six months of the year was positively related to nest density, and crab density was negatively related to nesting success and the number of doves fledged per nest. Crabs are the main predators of the dove nests on Cayo del Agua. Models, parameterized with field data, were used to simulate full and reduced stochastic variation in environmental and demographic conditions, and predict annual changes in population size. High recruitment (birds or births + immigrants) offset high losses (deaths + emigrants) in all instances. Our field data suggest that Zenaida doves suffered an ecological crunch between 1989 and 1990, when weather (a hurricane followed by a drought), food availability, and nest predation interacted, lowering the number of locally fledged doves that survived the hatching year (1989-1990) and reproductive success (1990). Under severe conditions, population size and recovery mainly depend on immigration. Apparent survival returned to pre-hurricane levels between 1990 and 1991, and reproductive success was about average in 1991. **Key words: dove, wind, precipitation, drought, nutrition, predation, mortality, productivity, model**

416

Robel, R. J. 1969. Movements and flock stratification within a population of blackcocks in Scotland. Journal of Animal Ecology 38(3):755-763. Notes: (Page *759*)—Blackcocks roosted far more frequently in the forest than on the moor. Roosting in trees was most commonly observed during rainy nights in the winter months, while roosting amongst the heather on the forest floor was most frequent when deep snow covered the moor. Only when the weather was dry and mild did blackcocks normally roost on the open moor. **Key words: blackcock, precipitation, temperature, snow, habitat use, behavior**

417

Roberts, S. D. 1997. Relationships between weather and the annual dynamics of wild turkey populations in New York (*Meleagris gallopavo*, reproductive). Dissertation, State University of New York, Syracuse, USA. Abstract: Reproductive success can be highly variable within wild turkey (*Meleagris gallopavo silvestris*) populations, and success in some regions appears to be primarily associated with annual fluctuations in nest or poult survival. Identification of factors causing variation in these parameters could result in new indices to productivity. Radio-telemetry data obtained from wild turkeys in southcentral New York during 1990-93 were analyzed using logistic regression to: (1) examine relationships between 14 weather variables and daily nest survival, and (2) investigate the influence of heating-degree-days and deviation from normal precipitation on survival of poults to 25-days posthatch. In addition, linear regression analyses were used to examine relationships between May precipitation and fall wild turkey harvest in southwestern New York during 1972-95. Daily nest survival was negatively associated with cumulative departure from normal seasonal rainfall (P = 0.003) and daily precipitation (P = 0.07), and positively associated with heating-degree-days (*P* = 0.01). Predicted and observed rates of daily nest survival were not highly correlated (*r* = 0.31), but rates based on 10- or 20-day means were more highly correlated (*r* = 0.76 and *r* = 0.93, respectively). The proportion of poults surviving the 25 days posthatch was negatively associated with mean daily heating-degree-days during the first week post hatch (*P* = 0.0001) and negatively associated with mean deviation from normal daily precipitation during the second week posthatch (*P* = 0.08). Survival rates within broods were not highly associated with weather-based predictions of brood survival (*r* = 0.46, *n* = 26), but observed and predicted estimates of annual poult survival were similar. Annual changes in reported harvest were negatively associated (*P*<0.0001) with the $\log_e$ of annual changes in May precipitation. Weather-based indices can be a viable alternative to brood surveys: a simple linear regression model correctly predicted observed annual trends (increase vs. decrease) in fall harvest for 19 of 24 years. Predictability was similar for a more complex model that accounted for autocorrelation of error terms. Data indicate that nest success may be driving annual trends in New York's wild turkey population. **Key words: eastern wild turkey, temperature, precipitation, reproduction, index, model**

418

_____, J. M. Coffey, and W. F. Porter. 1995. Survival and reproduction of female wild turkeys in New York. Journal of Wildlife Management 59(3):437-447. Abstract: Annual fluctuations of northern wild turkey (*Meleagris gallopavo silvestris*) populations often are attributed to high winter mortality. However, studies conducted in agricultural environments have demonstrated that seasonal survival can be highest during winter, suggesting other factors are more important to annual population change. We examined survival and reproduction of female eastern wild turkeys in south-central New York during 1990-93 and conducted a sensitivity analysis to determine the relative importance of demographic parameters to annual population change. Seasonal survival rates (*n* = 238) were 0.800 for spring, 0.855 for summer, 0.834 for fall, and 0.873 for winter. Fall survival rates varied by years (*P* < 0.01) and were higher during years of above average hen success. Annual survival rates averaged 0.498, and crude annual mortality rates (*M*) averaged 0.321 for predation and 0.117 for poaching, hunting, and wounding combined. Subadult females had lower nesting rates (*P* = 0.002, *n* = 201), lower renesting rates (*P* = 0.001, *n* = 115), and lower hen success rates (*P* = 0.02, *n* = 196) than adult females. Nest success averaged 37.9% (n = 323) and was highest (P = 0.005) during years with average to below average May rainfall. We observed annual variation in nest success (*P* = 0.001), hen success (*P* = 0.003), and hatching rates (*P* = 0.04). Poult survival averaged 40% (*n* = 605) and did not vary among years (*P* = 0.74). Nest success was the primary factor contributing to annual population change. We suggest that annual fluctuations of northern populations in mixed agricultural and forested environments rarely result from variability of annual survival and may result from variability of annual nest success and poult survival. Northern populations subjected to infrequent severe winters in mixed agricultural and forested environments likely would benefit more from enhancement of nesting and brood-rearing habitat. **Key words: eastern turkey, precipitation, population dynamics, reproduction, vegetation**

419

_____ and W. F. Porter. 1998a. Relation between weather and survival of wild turkey nests. Journal of Wildlife Management 62(4):1492-1498. Abstract: Recruitment can be highly variable within eastern wild turkey (*Meleagris gallopavo silvestris*) populations and appears primarily associated with annual fluctuations in nest survival. Identification of the causes of variation in nest survival could lead to the development of new indices to productivity. We used logistic regression to examine relations between 14 weather variables and daily survival of wild turkey nests (n = 3,332 nest-days from 206 nests) in south central New York from 1 May to 9 June 1990-93. Daily nest survival was associated negatively with cumulative departure from normal seasonal rainfall ($P = 0.003$) and daily precipitation ($P = 0.07$) and was associated positively with heating degree-days ($P = 0.01$). Although estimates of daily nest survival predicted by the logistic regression model were not correlated highly with observed estimates ($r = 0.31$), a strong positive correlation was observed between predicted and observed probabilities of 20-day nest survival ($r = 0.93$). **Key words: turkey, precipitation, temperature, nest survival**

420

_____ and _____. 1998b. Influence of temperature and precipitation on survival of wild turkey poults. Journal of Wildlife Management 62(4):1499-1505. Abstract: New methods for determining annual trends in wild turkey (*Meleagris gallopavo*) populations are desirable, especially when heavily hunted populations are managed with limited resources. Cost-effective indices to population trends could result from an increased understanding of relations between environmental factors and reproductive success. We examined the influence of heating degree-days (HDD) and deviation from normal precipitation on the 25-day survival of eastern wild turkey poults (*M.g. silvestris*) in southcentral New York during 1991-93. The proportion of poults surviving to 25 days posthatch was associated negatively with mean HDD/day during the first week posthatch ($P < 0.001$) and associated negatively with mean deviation from normal daily precipitation during the second week posthatch ($P = 0.08$). Observed survival rates of poults within broods were not highly associated ($r = 0.46$, $n = 26$) with weather-based predictions of survival within broods, but observed and predicted estimates of annual poult survival were similar. This similarity suggested weather might be a good predictor of annual rates of poult survival. **Key words: turkey, index, temperature, precipitation, productivity, chick survival**

421

Robinson, J. D. 2007. Ecology of two geographically distinct greater sage-grouse populations inhabiting Utah's west desert. M.S. Thesis, Utah State University, Logan, USA. Abstract: "…nesting success was higher in 2005 than 2006. Brood success was similar for the two years. The ratios of chicks per successful brood were higher in 2005 than 2006, for both sites, Ants (Formicidae) were the most abundant arthropod available to sage-grouse within the Sheeprock Watershed. I attribute these differences to precipitation. The spring of 2005 had twice the 30-year average spring precipitation, coming after a 5-year drought. However, there were no differences in vegetation at brood and random sites between years for either population. Chick recruitment in both populations was lower than reported in the literature. Sage-grouse survival rates for the Sheeprock and Deep Creek Watershed populations are lower and higher, respectively, than most published reports. Sage-grouse conservation strategies in both areas should emphasize enhancing existing brood-rearing habitat and protecting critical seasonal winter habitat." **Key words: sage-grouse, precipitation, reproduction**

422

Roersma, S. J. 2001. Nesting and brood rearing ecology of plains sharp-tailed grouse (*Tympanuchus phasianellus jamesi*) in a mixed-grass/fescue ecoregion of southern Alberta. M.S. Thesis, University of Manitoba, Winnipeg, Canada. Notes: (*Page 93*): "Weather conditions can be a major factor in brood mortality. Several researchers have identified extended periods of wet cold weather as a cause of brood loss. Hens in this study experienced a significant loss of broods due to similar conditions in mid June of 1998. During this time 3 broods were lost to exposure, which constituted 37.5 percent of the total broods. In addition to 1 predation and 2 unconfirmed loss, brood survival in 1998 was 0.25. These results parallel those documented by Brousquet and Rotella who in one year reported a 0.30 brood survival rate due to inclement weather. Hence, the presence of dense cover to escape inclement weather conditions is essential to ensure sufficient year-to-year recruitment of juvenile individuals into the population." (*Page 94*): "…I feel that the habitats available to brood rearing hens on the Milk River Ridge mitigated any further brood losses due to the effects of weather." **Key words: sharp-tailed grouse, temperature, precipitation, reproduction, vegetation, population dynamics**

423

Rogers, G. E. 1968. The blue grouse in Colorado. Technical Publication No. 21, Colorado Game, Fish and Parks Department, Denver. Notes: Pages 44-45: Weather and vegetative relationships. Personnel making upland game-bird brood counts are usually instructed to run census trends only when weather conditions are clear, calm, and dry. However, while establishing sage-grouse trends it was noted that counts were often high following a storm since birds moved to open areas to escape wet vegetation. In 1961, while less than 10% of trend-route travel was under wet or rainy conditions, one of the seven broods was observed while rain was falling, five of seven were observed while vegetation was wet from rain, four of seven when cloud cover exceeded 50%; and five of seven while the sun was not shining. Page 46: With equal coverage in 1963 under wet and dry conditions, one of three broods was observed in damp vegetation, light showers having occurred early in the morning; two of three were observed under clear, dry conditions; and none were observed during wet and cloudy conditions. The average wind velocity was recorded at the start and end of the census route and at each observation. In only one instance during 3 years was a brood observed when wind velocity exceeded 14 miles-per-hour. Page 59: The peak of hatch probably occurs during the latter part of June. Optimum time of day for brood observations varied, partly due to moisture conditions; early morning, late evening, and from 2:00 to 5:00 PM were most productive. No broods were observed where shrubs were absent. **Key words: blue grouse, precipitation, clouds, wind, population survey, vegetation, movement**

424

______. 1964. Sage-grouse investigations in Colorado. Technical Publication Number 16, Game Research Division, Colorado Game, Fish and Parks Department, Denver. Notes: Page 21—Seasonal Distribution. “In some instances, sage-grouse begin strutting on their winter range and gradually move to strutting areas at higher elevations as snow and mud disappear, thus the birds may use 2 or 3 grounds during a single season. The use of alternate strutting grounds was observed in the Gunnison area.” Page 27—“Sagebrush growth from 7 to 15 inches high were preferred for feeding, nesting, and roosting, with the taller plants being used for nesting, shade, and escape cover.” Page 48—Factors Affecting Reproductive Success: Several authors found weather to be a factor in nest destruction or desertion; two researchers found weather had little, if any, effect on nesting sage-grouse. **Key words: sage-grouse, snow, soil, solar radiation, vegetation, behavior, habitat use**

425

Rolley, R. E., K. F. Kubisiak, R. N. Paisley, and R. G. Wright. 1998. Wild turkey population dynamics in southwestern Wisconsin. Journal of Wildlife Management 62(3):917-924. Abstract: We studied the population dynamics of eastern wild turkeys (*Meleagris gallopavo silvestris*) in southwestern Wisconsin during 1987-94 to better understand the effects of variation in reproduction and fall harvest on growth of a northern population. We combined yearly estimates of reproduction, survival, and population size in a stochastic population model to estimate the finite rate of increase of the population. Our model indicated recruitment during 1989-92 was inadequate to offset observed mortality: the finite rate of increase was 0.831 ± 0.097 (mean ± SE). The simulated trend was corroborated by declines in spring harvest success and observations of turkeys by deer hunters. We illustrate that population growth is affected by variation in both reproduction and fall harvest rates. The population decline was apparently caused by reduced recruitment in combination with reduced hen survival associated with initiation of fall hunting. The decline in recruitment was associated with cold and wet spring weather ($r^2 = 0.92$, $P < 0.001$). Analysis of 103 years of weather data suggested the low level of recruitment observed during 1989-92 may be representative of the long-term recruitment potential of this population. More conservative harvest strategies may be appropriate for northern populations. **Key words: eastern turkey, precipitation, temperature, population dynamics, recruitment, model, hunting**

426

Roseberry, J. L. 1964. Some responses of bobwhites to snow cover in southern Illinois. Journal of Wildlife Management 28(2):244-249. Abstract: An uncommonly long period of snow coverage early in 1960 (23 consecutive days with 3-16 inches of snow) afforded an opportunity to observe responses of bobwhites (*Colinus virginianus*) to adverse weather conditions. Daily contact was maintained with four coveys on the 1,600-acre Carbondale Research Area in southern Illinois. Roosting and loafing sites were shifted from open to woody cover, especially clumps of Japanese honeysuckle (*Lonicera japonica*). As waste grain in harvested fields was covered by snow, feeding was generally confined to small patches of unharvested corn and soybeans adjacent to woody cover. Coveys were more sedentary during the snow coverage. Daily movements varied from 70 to 600 yards, averaging 265 yards. Three late winter ranges averaging 23.7 acres were reduced during the snow to include only woody cover and unharvested cropland; one covey utilized only 3.3 acres for a period of 7 days. An estimated 29 birds perished out of a pre-snow population of 162; losses appeared to correlate with quality of winter range, especially the availability of agricultural grains. **Key words: bobwhite quail, snow, habitat use, movement, mortality, habitat quality**

427

______. 1962. Avian mortality in southern Illinois resulting from severe weather conditions. Ecology 43(4):739-740. Summary: A prolonged period of snow coverage in early 1960 increased avian mortality in parts of southern Illinois. Meadowlarks and bobwhites constituted 45% of 112 avian deaths observed. Starlings and other blackbirds comprised 20% of the recorded mortality. The severe weather may have had an adverse effect on bobwhite fecundity during the subsequent breeding season. A large amount of available corn and soybeans possibly prevented mortality from being much greater. **Key words: bobwhite quail, snow, fecundity, mortality**

428

_____ and W. D. Klimstra. 1972. Some aspects of the dynamics of a hunted bobwhite population. Proceedings of the National Quail Symposium 1:268-282. Abstract: Multiple regression analysis showed that annual rates of productivity were significantly influenced by the combined effect of breeding density, length of snow cover during the previous 2 winters, and amounts of prenesting rainfall. It was not clear whether 2 severe winters caused the apparent cyclic regularity or merely accentuated the lows. **Key words: bobwhite quail, snow, precipitation, productivity, severe weather**

429

Rosene, W. 1969. The bobwhite quail: its life and management. Rutgers University Press, New Brunswick, USA. Summary: <u>Chapter 9 Natural Mortality</u>, contains a lengthy discussion under the subheading Weather as a Factor. The author notes the differences in the impacts of weather events in terms of severity and/or combinations of events, e.g. rain and low temperature leading to icing, etc. He also relates these occurrences to impacts depending on the lifecycle stage of the bobwhite quail in several areas of the United States. **Key words: bobwhite quail, temperature, precipitation, ice, snow, wind, clouds, behavior, mortality, habitat use, reproduction**

430

Rowland, M. M. and M. J. Wisdom. 2002. Research problem analysis for greater sage-grouse in Oregon. Final report. Oregon Department of Fish and Wildlife; U. S. Department of the Interior, Bureau of Land Management, Oregon/Washington State Office; and U. S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, USA. Summary: On page 15, the authors review the influence of weather and climate upon sage-grouse stating: "Weather patterns frequently have been linked to sage-grouse abundance and nest success, primarily through the influence of moisture and temperature on abundance and phenology of herbaceous plants used as forage and cover. Studies in a Wyoming big sagebrush community in central Oregon showed wide fluctuations in both forb and total herbaceous production, as well as plant species numbers, in response to variation in annual precipitation. Willis et al (1993) found no relationship between long-term trends in sage-grouse productivity and precipitation. Weather, however, may influence timing of seasonal movements in sage-grouse as well as diets. Call and Maser (1985) reported that sage-grouse densities in Oregon were greatest in areas of 25-40 cm of annual precipitation. Further analyses of relationships between long-term trends in sage-grouse productivity and weather should be conducted to better understand these interactions." A citations list is provided. **Key words: sage-grouse, precipitation, temperature, vegetation, productivity**

431

Rozycki, A. L. M. Keller, and T. Buczek. 2007. Numbers and habitat preferences of the hazel grouse *Bonasa bonasia* in the Lasy Parczewskie Forest. Notatki Ornitologiczne 48(3):151-162. Abstract: The study was carried out in 2002-2004 in the Lasy Parczewskie Forest (eastern Poland) covering c. 7500 ha by the annual territory mapping method performed in two stages: in the autumn-winter season the whole area was walked over by several people in extended order and then in early spring the prior localized sites of the hazel grouse were verified. In total, 243 observations of birds were made and evidence of their occurrence—feces, feathers or track—recorded. The species abundance was estimated at 104-116 territories, yielding a density of 1.4-1.6 territories/km^2 which made this population one of the most numerous in the belt of central Poland. A clear increase in the hazel grouse numbers was noted relative to the early 1990s. The paper discusses hypotheses that associate the increasing trend with a few factors which are not mutually exclusive: (1) advantageous habitat changes connected with formerly open peat-bogs getting overgrown with birches due to drainage of the terrain (land reclamation in the 1960s and 1970s); (2) introduction by foresters of the spruce into the understory; (3) a series of warm winters in a dozen or so years preceding the study period; (4) favorable meteorological conditions in the season of young rearing, and (5) a decline in the goshawk (*Accipiter gentilis*) abundance. The basic food items during winter are birch and hazel buds. The sheltering function is played by spruce undergrowth or, alternatively, pine stickstands, especially ones with a hazel understory. Tree stands of younger age category (20-40 years) and old-growth pine forest with dense hazel underbrush (coverage level of 0.5-0.7) are decidedly more preferred. Typical sites where the hazel grouse occurs are ecotone zones between young birchstands and old-growth pine forest with spruce in the understory. The more mosaic in character the vegetation cover(diverse species composition and age structure) and surface features the more attractive the site to hazel grouse. **Key words: hazel grouse, temperature, reproduction**

432

Rumble, M. A., F. Wakeling, and L. D. Flake. 2003. Factors affecting survival and recruitment of female Merriam's turkeys. Intermountain Journal of Science 9:26-37. Notes: Based on personal observations, we conclude that predation and weather are important contributors to early mortality of Merriam's turkey poults. **Key words: Merriam's turkey, mortality, predation, weather**

433

_____ and S. H. Anderson. 1996. Microhabitats of Merriam's turkeys in the Black Hills, South Dakota. Ecological Applications 6(1):326-334. Abstract: Merriam's turkeys (*Meleagris gallopavo merriami*) are associated with ponderosa pine (*Pinus ponderosa*) forests in the western United States, but are not native to the ponderosa pine forest of the Black Hills, South Dakota. The Black Hills population was established by transplanting birds from New Mexico and Colorado between 1948 and 1951. Despite being outside its original range, this population provides a unique opportunity to assess mechanisms of habitat selection because the age of the population is known and literature indicates that it is more productive than other populations. We studied microhabitats of Merriam's turkeys in the Black Hills between 1986 and 1991. We found few differences in microhabitats among diurnal time periods or between sexes. Turkeys preferred southern exposures during winter. Production of pine seed, a major food item of turkeys, differed among years. There was a strong relationship between abundance of pine seeds and microhabitats selected by turkeys. Basal area of microhabitats between October and March was positively correlated with annual ponderosa pine seed production. Abundance of ponderosa pine seeds at turkey microhabitats during this period was at least four times the estimated average annual production. Management prescriptions for ponderosa pine of basal area ≤ 18 m^2/ha will reduce winter habitat for turkeys. Summer habitats are more compatible with timber management goals for ponderosa pine in the Black Hills. **Key words: turkey, habitat use, habitat management, temperature, microhabitat**

434

______ and R. A. Hodorff. 1993. Nesting ecology of Merriam's turkeys in the Black Hills, South Dakota. Journal of Wildlife Management 57(4):789-801. Abstract: Merriam's wild turkeys (*Meleagris gallopavo merriami*) were introduced to the Black Hills approximately 40 years ago, and recently population estimates show a large and stable population. Until now, few studies have evaluated nesting ecology of Merriam's turkeys, and none occurred in predominantly pure ponderosa pine (*Pinus ponderosa*) forests. Thus, we studied nesting and nest habitat factors that influence population productivity using a hierarchical approach in the Black Hills, South Dakota. In contrast to other studies, yearling Merriam's turkey hens showed a high propensity to nest. Nest survival for adult hens did not differ (P = 0.18) from yearlings, but adult hen success was higher (P = 0.03). April-June precipitation was positively related (R^2 = 0.93, P <

0.01) to the number of nest attempts. Primary nest predators were mammals and American crows (*Corvus brachyrhynchos*; hereafter referred to as crows). Among macrohabitats (third-order habitats), there were no (*P* = 0.45) patterns of nest site selection. Among microhabitats (fourth-order habitats), hens selected small sites (< 5 m across) with obstructed view of the nest and vegetation averaging 2.3 dm tall. Few microhabitat differences occurred between successful and unsuccessful nests, and those that did were related to higher (*P* = 0.02) survival of third nest attempts. Our data indicate that availability of nest habitat was not limiting turkey populations in this area. **Key words: turkey, precipitation, productivity**

435

Ruth, J. M. 1972. Influence of weather on movement and habitat use of hen pheasants during brood rearing. M.S. Thesis, South Dakota State University, Brookings, USA. Notes: The objective of this study was to determine the effect of selected weather conditions on the movement and habitat use of hen pheasants during the brood-rearing period. Habitat-use indices were compiled to determine habitat preferences. An index for each weather class was prepared for each of the 3 years of study. These indices were then combined and a weighted mean index value calculated for each weather class. Alfalfa was the preferred cover type under all conditions. Under low barometric pressure conditions, alfalfa, corn and residual cover were the preferred habitat types with indices over 1.0. Pasture and ditches had indices of 0.7 while all other cover types were 0.5 or less. Under high pressure conditions the same four types remained preferred, but residual cover was preferred over corn. Analysis of wind velocity showed three major shifts in preference. During precipitation, preference for residual cover and treerow and farmstead increased markedly, while preference for alfalfa dropped rather sharply during periods of precipitation. No significant relationships were found between distance of bird movement and any of the weather factors tested. Normal daily fluctuations of weather elements did not affect pheasant activities to a large degree. Under conditions of precipitation, high wind velocity, and low barometric pressure the preference index for alfalfa was much lower. With these same conditions an increase in use of corn and residual cover was noted. This seems to be a logical shift in usage because these two cover types offered more protection from the elements. **Key words: ring-necked pheasant, precipitation, wind, barometric pressure, habitat use, movement, index**

436

Ryser, F. A. and P. R. Morrison. 1954. Cold resistance in the young ring-necked pheasant. Auk 71:253-266. Summary: The development of cold resistance was studied in young ring-necked pheasants. Although living in a hot thermal environment the body temperature of the chick is lower than that of the adult, and the regulated level of body temperature gradually rises during the first few weeks of life in a brooder to the adult level. During this period (2 to 15 days), exposure to moderate cold (20°) results in substantial losses in body temperature (2 to 4°). When two- to three-day-old chicks are repeatedly chilled by 30-mnute exposures at 20°, the development of cold resistance is impaired, and they experience a high rate of mortality. Chicks of seven days and older are not adversely affected by repeated exposures at 20°, which instead improve their resistance to cold. **Key words: ring-necked pheasant, temperature, thermoregulation, mortality**

437

Saab, V. A. and J. S. Marks 1992. Summer habitat use by Columbian sharp-tailed grouse in western Idaho. Western North American Naturalist 52(2):166-173. Abstract: We studied habitat use by Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*) in western Idaho during 1983-85. Vegetative and topographic measurements were recorded at 716 locations of 15 radio-tagged grouse and at 180 random sites within the major vegetation/cover types in the study area. The mean size of summer home ranges was 1.87 ± 1.14 km^2. Of eight cover types identified in the study area, individual grouse used the big sagebrush (*Artemisia tridentate*) cover type more than or in proportion to availability, the low sagebrush (*A. arbuscula*) in proportion to availability, and avoided the shrubby eriogonum (*Eriogonum* spp) type. Characteristics of the big sagebrush cover type that sharp-tailed grouse preferred include moderate vegetative cover, high plant species diversity, and high structural diversity. Grouse used areas of dense cover (i.e., mountain shrub and riparian cover types) primarily for escape cover. Compared with random sites, grouse selected areas with (1) greater horizontal and vertical cover, (2) greater canopy coverage of forbs typically decreased by livestock grazing, (3) greater density and canopy coverage of arrowleaf balsamroot (*Balsamorhiza sagittata*), and (4) greater canopy coverage of Bluebunch wheatgrass (*Agropyron spicatum*) in the big sagebrush cover type in 1984 and the low sagebrush cover type in 1985. The importance of the native perennials arrowleaf balsamroot and Bluebunch wheatgrass became apparent during a drought year when many exotic annuals dried up and provided no cover. Overall grouse selected vegetative communities that were least modified by livestock grazing. **Key words: sharp-tailed grouse, vegetation, habitat use, grazing, drought, temperature**

438

Sandercock, B. K., K. Martin, and S. J. Hannon. 2005. Life history strategies in extreme environments: comparative demography of arctic and alpine ptarmigan. Ecology 86(8):2176-2186. Abstract: Arctic and alpine habitats are extreme environments characterized by short breeding seasons, cold temperatures, limited food availability, and potentially high predation rates. Stringent ecological conditions are likely to have important consequences for the evolution of life history traits, but direct empirical tests are few. We compare the demography of three populations of ptarmigan on an environmental gradient spanning alpine, subalpine, and arctic habitats. Female willow ptarmigan (*Lagopus lagos*) and white-tailed ptarmigan (*L. leucurus*) breeding at subalpine and alpine sites had smaller clutches and lower probabilities of nesting success, fledging success, and renesting than willow ptarmigan nesting at a low-elevation arctic site. Annual fecundity, measured as female fledglings per breeding female, did not overlap among the three populations and was ranked: alpine (0.40 ± 0.08, mean ± SE, 95% CI = 0.26-0.58) < subalpine (1.33 ± 0.10, 1.13-1.54) < arctic (2.04 ± 0.18, 1.68-2.39). There was a nonsignificant trend for apparent survival rates (Φ) of breeding females to vary in the opposite direction: alpine (0.46 ± 0.04) >

subalpine (0.43 ± 0.03) > arctic (0.37 ± 0.06). Population growth rates predicted significant declines for the alpine population ($\lambda = 0.65 \pm 0.07$, 95% CI = 0.52-0.79), but not the subalpine ($\lambda = 1.00 \pm 0.07$, 0.86-1.14) or arctic populations ($\lambda = 1.13 \pm 0.20$, 0.78-1.54). The adjusted estimates of survival necessary to sustain a stationary population indicated that actual variation in female survival was more pronounced than the observed rates: alpine (0.71) > subalpine (0.43) > arctic (0.33). Together, the fecundity and survival values provide evidence that even congeneric populations can exhibit a continuum between high reproductive and survivor life history strategies. Variation in ptarmigan life history traits was consistent with population differences in predation rates on eggs and breeding females, and it was not related to duration of the breeding season, climatic conditions, or food availability. Ptarmigan demography also covaried with body size, but not in the predicted pattern. Overall, the life history strategies of ptarmigan are consistent with our current understanding of the impacts of environmental factors upon life history variation in passerine songbirds. **Key words: willow ptarmigan, white-tailed ptarmigan, fecundity, reproduction, temperature**

439

Saniga, M. 2002. Nest loss and chick mortality in capercaillie (*Tetrao urogallus*) and hazel grouse (*Bonasa bonasia*) in west Carpathians. Folia Zoologia 51(3):205-214. Notes: In the years with very cold weather during May (heavy snowfall), nests were destroyed by snow cover and abandoned (20%). Nine clutches (6%) were found abandoned, their hens probably having been predated by goshawk, golden eagle, or Ural owl, or by some of the mammalian predators: lynx, red fox, marten. Predation pressure on capercaillie and hazel grouse nests decreased significantly during the incubation period. A decrease in nest losses during the incubation period was expected as, at the time of egg-laying, there only birds of prey and owls are breeding. Capercaillie and hazel grouse nest quite early in the spring prior to the onset of breeding of other resident and migratory birds. Thus the predation pressure on the two forest-dwelling grouse species is much higher in the first half of May than later when the forest habitat is inhabited by 53-59 breeding bird species. A second factor is that nests placed on the ground at the beginning of May may be exposed to predators until the vegetation has adequately developed. Like the study of Angelstam on black grouse, I recorded a pronounced increase in capercaillie hen mortality during the nesting period than hazel grouse hens. This was not surprising, as the larger capercaillie females mate about 10-15 days earlier than the hazel grouse hens. Presumably, they are therefore even more dependent on access to the limited snow-free patches and emerging new vegetation, thus putting themselves at a high risk of predation. When rodent density crashed during winter, the predation pressure on capercaillie and hazel grouse nests increased significantly during the incubation period of the following year. Nest losses in hazel grouse were much higher in years when the weather conditions during May and June were unsuitable – heavy rains or snowfalls. Monthly mortality of hazel grouse chicks was 10-12% in the Ural region and was correlated with the weather conditions during late spring and early summer. **Key words: capercaillie, hazel grouse, snow, precipitation, predation, mortality**

440

Savage, D. E. 1969. Relation of sage-grouse to upland meadows in Nevada. Nevada Fish and Game Commission. Transactions California-Nevada Section The Wildlife Society:8-17. Abstract: Meadow utilization by sage-grouse was studied for two summers at three locations in Nevada. The principal methods used included observation and collection of birds and vegetational description of the meadow and surrounding sagebrush vegetation types. Movements to the meadow areas were apparently stimulated by the desiccation of vegetation in the sagebrush types. Meadows were used almost exclusively by hens and young birds with only a few cocks being observed in the drier of two summers studied. A pattern of use was evident while the birds were on the meadows. Variations in use, however, occurred with varying climatological conditions. Segregation of cocks, hens with chicks and hens without chicks was evident, but the degree of segregation was also dependent upon climatological conditions. Hens and chicks, however, would congregate only at those portions of meadows having some meadow vegetation. Bare portions of the meadows or water sources lacking the desired vegetation would be ignored by this group. Food habits of the various ages and sexes of birds showed a high preference for certain species of succulent forbs by young birds and hens. The meadow, as a sole source of the desired food species, became a necessity to these groups. Consumption of forbs decreased with age in the young birds and by fall with the older birds. Movement away from the meadows was associated with the decreasing temperatures and precipitation of fall. **Key words: sage-grouse, precipitation, temperature, vegetation, habitat use, movement**

441

Sayre, M. W. and N. J. Silvy. 1993. Nesting and Production. Pages 81-104 *in* T. W. Baskett, M. W. Sayre, R. E. Tomlinson, and R. E. Mirarchi, editors. Ecology and management of the mourning dove. Wildlife Management Institute, Stackpole Books, Harrisburg, USA. Notes: Page 101 – "Weather. Weather is thought to be an important source of nest loss. It is not uncommon to find broken dove eggs on the ground under nests after thunderstorms or periods of high winds. In Texas, Morrow and Silvy (1982) found significant correlations between monthly estimates of nest mortality and the number of days in which wind speed exceeded 15 knots per hour (27.6 km/hr). Mean monthly temperature also was positively correlated with nest success, indicating that below-normal temperatures may adversely affect nesting success. Yahner (1983) found that 7 percent of nest loss in a Minnesota shelterbelt could be attributable to weather conditions". **Key words: mourning dove, thunderstorms, wind, temperature, solar radiation, mortality**

442

Schemnitz, S. D. 1961. Ecology of the scaled quail in the Oklahoma Panhandle. Wildlife Monographs 8:3-47. Notes: Page 40—"During the winter period, the birds remained closely associated with the protective shelter provided by shrubs and man-made cover." The author also notes the scaled quail used shrubs for shelter from the sun. **Key words: scaled quail, temperature, habitat use, vegetation**

443

_____. 1964. Comparative ecology of bobwhite and scaled quail in the Oklahoma Panhandle. American Midland Naturalist 71(2):429-433. Abstract: Bobwhite quail were encountered primarily in the riparian habitat in Cimarros County while the scaled quail occupied parts of the short grass, sandsage grassland, and piñon-juniper vegetation types. During a severe drought period, 1954-56, scaled quail populations remained at a high level while bobwhite quail numbers diminished. The early winter diet of bobwhite and scaled quail was similar. Scaled quail mingled in larger coveys during the winter period than did bobwhites. **Key words: bobwhite, scaled quail, drought, population dynamics, behavior**

444

Schmidt, P. A., J. A. Hanf, and E. B. Groshens. 1994. Relationship between precipitation and number of males on leks in central Oregon: a model to predict number of sage-grouse. Proceedings of the Western States Sage and Columbian Sharp-tailed Grouse Workshop 29. Unable to obtain copy for abstract.

445

Schneegas, E. R. 1967. Sage-grouse and sagebrush control. Transactions of the North American Wildlife and Natural Resource Conference 32:270-274. Notes: Page 274—"The decline of sage-grouse populations after 1930 was probably caused by unfavorable changes in vegetative types resulting from drought and overuse by livestock." **Key words: sage-grouse, drought, vegetation, habitat use, grazing**

446

Schroeder, M. A. 1997. Unusually high reproductive effort by sage-grouse in a fragmented habitat in north-central Washington. Condor 99:933-941. Summary: The annual variation in date of nest initiation observed in this study of almost 2 weeks was similar to that recorded in other studies. The variation in nest initiation appeared to be related to annual variation in weather; cold, snowy winters and/or cold, wet springs appeared to result in later dates of nest initiation. **Key words: sage-grouse, temperature, snow, precipitation, reproduction**

447

Schröder, W., J. Schröder, and W. Scherzinger. 1982. Über die rolle der Witterung in der populationsdynamik des Auerhuhns (*Tetrao urogallus*). Journal of Ornithology 123(3):287-296. Summary: This study examines the hypothesis that random yearly variation in weather conditions can cause long term cycles in capercaillie populations. Observations in captivity as well as in the field indicate that air temperature and precipitation during the first few weeks after birth have an effect on the survival of chicks. The station Hohenpeißenberg of the German Weather Service has measurements of such values for the past 200 and 100 years respectively. The effect of these weather factors over many years was studied in a population simulation. The results support the hypothesis that phases of favorable and unfavorable population development can occur, caused merely by random year to year variation in the weather after hatching of capercaillie chicks. The simulated population trends correspond to historical records of increase and decrease, expansion and decline of the species. **Key words: capercaillie, temperature, precipitation, mortality, model, population dynamics**

448

Schwertner, T. W., M. J. Peterson, and N. J. Silvy. 2005. Effect of precipitation on Rio Grande wild turkey poult production in Texas. Proceedings of the National Wild Turkey Symposium 9:10-15. Abstract: Precipitation can strongly influence the population dynamics of gallinaceous birds in semiarid regions. Little is known, however, about the interaction of precipitation and Rio Grande wild turkey (*Meleagris gallopavo intermedia*; RGWT) production in Texas, particularly across broad spatial and temporal scales. We compared RGWT production data with precipitation and drought data across 5 ecological regions of Texas for 1976-2000. Poult production was positively correlated with both the June Modified Palmer Drought Severity Index (PMDI) and September-June raw precipitation in all ecological regions. We found weaker correlations with June raw precipitation in all ecological regions except the Post Oak Savannah, and with cumulative September-June PMDI in the Edwards Plateau, Cross Timbers and Prairies, and South Texas Plains. Our results indicate that poult production is more influenced by cumulative weather effect over several months than by individual rainfall events, suggesting that direct precipitation-induced mortality does not substantially affect RGWT production in Texas. Further, precipitation data provides managers with an inexpensive, effective indicator of RGWT production in Texas. **Key words: Rio Grande turkey, precipitation, drought, production, Palmer Drought Severity Index, index**

449

Scott, T. D. 1937. Snow-killing of the bobwhite. Wilson Bulletin 49(1):21-27. Summary: Reasonably healthy bobwhites may perish through imprisonment by drifting snow. Exposure to cold, high winds and snow may kill reasonably healthy bobwhites. Cover subject to heavy drifting is not ideal. **Key words: bobwhite quail, snow, temperature, wind, mortality**

450

Sedvarsky, W. D. 1988. Reproductive ecology of female greater prairie-chickens in Minnesota. Pages 193-239 *in* A. T. Bergerud and M. W. Gratson, editors. Adaptive strategies and population ecology of northern grouse. Wildlife Management Institute, Washington D.C. and University of Minnesota Press, Minneapolis, USA. Summary: Page 239—The poor drainage of the study area and the early summer peaks in precipitation were believed to contribute to poor brood survival. Exposure to precipitation and cool temperatures were affected by hatching dates, characteristics of brood habitats, and extent of movements as influenced by disturbance and proximity of nest sites to brood cover. Climatic factors may affect chick survival directly or indirectly by affecting insect populations. **Key words: greater prairie-chicken, temperature, precipitation, population dynamics, mortality, insects, habitat use**

451

Seiler, T. P., R. D. Drobney, and T. V. Dailey. 2002. Use of weather variables for predicting fall covey calling rates of northern bobwhites. Proceedings of the National Quail Symposium 5:91-98. Abstract: A newly developed technique for estimating fall northern bobwhite (*Colinus virginianus***)** density is currently being employed in parts of the United States. One aspect of this technique involved predicting morning covey calling rates (i.e., the proportion of coveys that call on a given morning). We monitored 60 radiomarked coveys, a total of 229 covey observations, to determine whether or not each covey called. Calling rates were evaluated in relation to date, year, area, temperature, relative humidity, barometric pressure, barometric status, cloud coverage, and wind speed. We used logistic regression to test 9 *a priori* models as predictive models of bobwhite covey calling behavior. Models were compared using Akaike information criteria (AICc) values to determine the relative importance of 6 different variables (wind speed, date, temperature, cloud coverage, barometric pressure, and relative humidity). An exploratory analysis was then conducted to find the best predictive model using the best subsets model selection procedure. Standard errors of the coefficients in the best models were calculated using a traditional bootstrapping technique. We found an overall calling rate of 78%. Wind speed and date were the most influential of the 6 variables used in *a priori* model tests. Nine of the 19 exploratory models fit the data reasonably well. The best model included area and wind speed as independent variables, and was a better model than the best *a priori* model. There was a difference in calling rates between areas, and as a consequence, we recommend caution in application of our models to new areas. **Key words: bobwhite quail, wind speed, temperature, clouds, barometric pressure, humidity, behavior, census, model**

452

Selås, V. 2006. Patterns in grouse and woodcock *Scolopax rusticola* hunting yields from central Norway 1901-24 do not support the alternative prey hypothesis for grouse cycles. Ibis 148:678-686. Abstract: According to the alternative prey hypothesis, autumn populations of ground-nesting game birds fluctuate in synchrony with vole numbers because generalist predators that mainly eat voles switch to alternative prey, such as eggs and chicks, when vole numbers decline. In hunting statistics from Nord-Trøndelag, central Norway, 1901-24, annual fluctuations in the number of willow grouse *Lagopus lagopus* and western capercaillie *Tetrao urogallus*, but not of woodcock *Scolopax rusticola*, were positively related to vole numbers in the current year. Both woodcock and grouse indices were related to hunting indices of Goshawk *Accipiter gentilis* and to *weather variables assumed to influence the birds' survival or reproduction*, suggesting that the indices actually reflected local population levels. Synchronous vole and grouse fluctuations are consistent with the alternative prey hypothesis (although predator densities were low in the early 1900s), but the asynchronous woodcock fluctuations refute the hypothesis. Rather, because the woodcock does not feed on plants utilized by voles and grouse, I suggest that food quality is the ultimate factor for the synchrony in vole and grouse numbers in Norway. **Key words: willow grouse, capercaillie, woodcock, reproduction, nutrition**

453

_____. 2001. Autumn population size of capercaillie *Tetrao urogallus* in relation to bilberry *Vaccinium myrtillus* production and weather: an analysis of Norwegian game reports. Wildlife Biology 7(1):17-25. Summary: From a study area in Aust-Agder, southern Norway, game reports from 1920-1978, supplemented with autumn counts carried out during 1968-1984, were used to determine whether the autumn population size of capercaillie *Tetrao urogallus* showed no increase, a slight increase or a strong increase compared to the population size the previous year. Based on the mast depression hypothesis, it was predicted that adverse weather conditions should have less influence on the reproduction and thus also on the autumn population size in post-mast years of bilberry *Vaccinium myrtillus* than in other years, because of a higher food quality and therefore also a higher body condition of the birds. In a logistic regression model, only the bilberry index and the June-September temperature of the previous year contributed significantly to explain the status of the capercaillie population. A negative effect of high summer temperatures in the previous year was highly significant when analyzing post-mast years separately, possibly because bilberry plants were less depressed after a high seed crop if summer temperatures and thus primary production were high. Only when years with high bilberry production were analyzed separately, did I find effects of weather conditions which could be assumed to have direct impacts on breeding success, such as snow conditions in spring and precipitation in early summer. **Key words: capercaillie, productivity, nutrition, temperature, snow, precipitation**

454

_____. 2000. Population dynamics of capercaillie *Tetrao urogallus* in relation to bilberry *Vaccinium myrtillus* production in southern Norway. Wildlife Biology 6(1):1-11. Abstract: Forester T. Grasaas' data on numbers of capercaillie *Tetrao urogallus* cocks and hens observed at leks and clutch sizes in Vegårshei, southern Norway, during 1953-1962 (high population level) and 1969-1978 (low population level) were analyzed with regard to bilberry *Vaccinium myrtillus* production, autumn population indices and snow conditions in spring. From the mast depression hypothesis, it was predicted that the number of capercaillies counted at leks and the mean clutch size should be high after high seed crops (masts) of bilberry, usually produced at intervals of 3-5 years. In stepwise regression models, both the bilberry index of the preceding year and the autumn population index one (hens) or two (cocks) years earlier contributed to explain the mean number of capercaillies counted at leks during 1970-1978. Capercaillie clutch sizes were highest in years with early thaw, but the effect was significant only for the period 1969-1978. For this period, there also was a positive effect of the bilberry index and a negative effect of the autumn population index of the previous year. It is concluded that the synchronous population fluctuation of grouse and voles in Norway and Sweden cannot be explained by the alternative prey hypothesis alone, and that food quality should also be considered as a possible contributing factor when analyzing population fluctuations of grouse and other herbivorous species. **Key words: capercaillie, snow, population dynamics, vegetation, diet**

455

Seiskari, P. 1962. On the winter ecology of the capercaillie, *Tetrao urogallus* and the black grouse, *Lyrurus tetrix*, in Finland. Riistatieteellisia Julkaisuja 22:3-119.
Abstract: The present investigation deals with the winter habitat requirements of two sympatric species and the factors influencing them in Finland. Attention has mainly been devoted to the feeding ecology and feeding activities in winter. The capercaillie and the black grouse have very specialized habitat requirements in winter. The ultimate cause of these is adaptation to a single food plant. The food plants seem to act as an important proximate factor in habitat selection, too. Openness of the environment in the shelter habitat is required by the black grouse and north Finish capercaillie, since they roost in the snow. The southern capercaillie seem to seek shelter among the branches of the spruce, however, as this tree species is important in the shelter habitat in winter. The male capercaillie selects as feeding plants pines of a certain structure and chooses its habitat on this basis. The feeding habitat requirements of the female are based on structural features of the environment. The black grouse selects its habitat according to the amount of its favorite food, catkins, and the edge effect also influences habitat selection. The capercaillie and the black grouse have clearly become adapted to different niches, as have the different sexes of the capercaillie, owning to great morphological sex differences. This is reflected in many differences in activities and habitats. The shift to winter food is more clearly correlated with temperature than with snow cover. As a rule, most of the ground is still under snow at the time the birds begin to feed on the ground in the spring. Of the external factors influencing the winter feeding the shortness of the light period puts a limit to feeding. The capercaillie takes more food in late than in mid-winter, probably owing to the lengthening of the light period. There is no comparable phenomenon in the black grouse, probably because a filled crop suffices to satisfy the food requirements of one day, whereas the contents of a filled crop seem to be insufficient for the capercaillie. Feeding activity does not become bimodal until the end of Feb., which seems to mean that the birds have time to fill their crops twice a day. Short days reduce the amount of food consumed by less than half that consumed during long days, since the capercaillie feeds throughout the day during short days, and there probably is a continuous food stream from the crop to the gizzard. The feeding activity of both species shows a rise in March. The feeding activity is correlated with changes in the weather. A change in weather stimulates the birds' general activity, even in the night. Feeding activity is slight on such days but as a rule is intensified thereafter, whereas general activity is reduced. Feeding activity is stimulated by cold weather and high pressure, whereas warm weather and low pressure reduce it. The winter food supplies of the capercaillie and the black grouse are of a different nature, since the replacement of the food supply of the former is influenced by consumption, whereas the replacement of catkins, which are the favorite food of the black grouse, is independent of consumption. Perhaps this explains why the reserves of the capercaillie are markedly larger than those of the black grouse. The adequacy of the food supply is no proximate ecological factor for the capercaillie, although the quality of the food maybe reflected in fluctuations of density. Fluctuations in the amount of catkins can cause density fluctuations in the black grouse. But the same factors (climatic factors) which favor the food plants may be important as proximate factors influencing the habitat requirements of both species. In the winter community to which the capercaillie and the black grouse belong different animal species have adopted niches in different stages of the natural

forest succession. Many species have become adapted to the pioneer stages, whereas only a single species, the capercaillie, feeding on the vegetative parts of plants, has become adapted to one of the 2 types of climax (pine and spruce climax). In explanation it is suggested that the climax stage is a more hazardous food resource because of its slow recovery after catastrophes. The effects of man on the winter ecosystem is great, especially as he alters the natural succession. It is the species adapted to the several stages on which silvicultural practices are concentrated that are most strongly affected. Forestry seems to leave the pioneer stages almost unaltered, whereas the middle-aged stages deviate greatly from the natural stages. The alteration in the structure of the forests which has taken place during recent decades has had a visible effect on the populations of capercaillie and the black grouse. **Key words: capercaillie, black grouse, solar radiation, habitat use, habitat modification**

456

Semenov-Tyan-Shanskii, O. I. 1959. Ecology of grouse. Tr Oaplandsk Gos Zapovednika 5:1-319. Abstract: The numbers of young in grouse populations (particularly wood grouse) vary from year to year, depending on the weather during the breeding season. Air temperature and precipitation during the hatching period have the highest significance. “Peak” years and depression years usually coincide with the widespread area from Scotland to the Urals. Embryonic deaths from unfavorable meteorological conditions during incubation under natural conditions was investigated (in Lapland and Pechoro-Ilych Forest Preserves) by means of special autographs. It was apparent, that during unfavorable weather the setting hens abandon the nests. More rarely, the eggs freeze at the beginning of incubation. The abandoned nests and addled eggs are preserved in the forest for a long time and play some role in the winter nutrition of marten and foxes, so that in the winter after a failure of tundra partridge nesting, the significance of this food increases. **Key words: wood grouse, air temperature, precipitation, nest success, mortality**

457

Sepik, G. F., W. H. Goudy, and D. R. Dessecker. 2000. Factors influencing recruitment and condition of American woodcock in Minnesota. American Woodcock Symposium 9:96-100. Abstract: Hunting regulations for American woodcock (*Scolopax minor*) are based on information on the status of the population from data collected during the previous hunting season and the following spring. No surveys, however, measured the status of the population through spring and summer prior to the hunting season. A model was developed to predict recruitment to the fall population based on weather during the spring and summer. Also determined was whether the condition of birds in fall reflected weather conditions prior to the hunting season. The model was based on Minnesota weather and the recruitment index (immatures-adult female). The model predictor was April mean minimum temperature. The model was tested using Maine and Wisconsin data and the predicted and estimated values for the recruitment index were correlated. The weights of birds shot in early October differed among years and were correlated with September mean maximum and mean minimum temperatures. The frequency of feather retention of adult females was correlated with the recruitment index. Weather during April had the greatest influence on the recruitment index. **Key words: American woodcock, temperature, index, model, recruitment, nutrition**

458

_____, R. B. Owen, and T. J. Dwyer. 1983. The effect of drought on a local woodcock population. Transactions of the Northeast Section of The Wildlife Society 40:1-8. Unable to obtain for abstract.

459

Shaw, J. L. 1988. Epidemiology of the caecal threadworm *Trichostrongylus tenuis* in red grouse (*Lagopus lagopus Scoticus* Lath.). Dissertation, University of Aberdeen, UK. Abstract: The prevalence of *Trichostrongylus tenuis* in red grouse was high and the distribution of parasites in their hosts highly aggregated. The prevalence and intensity of threadworms were greater in old birds than in young ones. There was no relationship between the body condition of individual grouse and their burden in adult worms. On the moor, *T. tenuis* eggs did not develop to third-stage infective larvae during the winter. In the summer, when development did occur, yields of third-stage larvae were dependent on temperature. Third-stage larvae moved laterally through the heather but were relatively short-lived and very few survived over winter. The proportion of larvae, ingested by captive grouse, which developed to adult worms varied with season and between individuals. Red grouse acquired little or no effective immunity to reinfection after challenge with infective larvae. Consequently, caecal threadworms produced a chronic infection in grouse: mature worms survived for over two years with very little mortality. Parasite fecundity decreased as the worms aged but not with intensity of infection. The transmission of *T. tenuis* is presumably influenced mainly by the density of infective larvae, which in turn was affected by weather, particularly temperature. A major regulatory constraint on this parasite is host mortality. Mortality, however, is unlikely to be linearly related to parasite intensity because developing larvae were more pathogenic than adult worms. Furthermore, there seemed to be no important intensity-dependent processes acting to regulate *T. tenuis* in red grouse populations. **Key words: red grouse, temperature, disease**

460

Sheldon, W. G. 1967. The book of the American woodcock. University of Massachusetts Press, Amherst, USA. Notes: The author found that stormy weather, including high winds with or without heavy rains, downpours with no wind, and temperatures below freezing curtailed breeding activity of these birds, particularly relevant to census and marking efforts. Windy nights with an air movement of more than five miles per hour yielded poor bird catches. Still, hot, humid evenings following afternoon thunder showers created conditions which were most consistently productive of birds and often stimulated insect activities. Woodcock were also active on quiet evenings, with a light drizzle or fog. Clear nights with full moon caused erratic behavior and few birds were captured. Many woodcock die in years marked by periods of prolonged freezing in the wintering grounds. There are fewer records of woodcock deaths under unfavorable weather conditions during migration. Extreme cold and heavy snow in spring undoubtedly cause woodcock mortality since the birds then are in relatively poor condition and under the stress of breeding. Such losses have not been detected more often because, unlike the concentrations on the wintering ground, the birds are scattered over far-flung migration lanes. It is unlikely that heavy fall freezes cause appreciable mortality, since the birds can move south. Sustained cold, rainy weather during the height of the hatch probably causes some losses of downy chicks. Some recently hatched chicks have been killed by a heavy rainstorm. It is doubtful if drought causes woodcock deaths in their breeding grounds, since they will readily feed on all types of invertebrates other than earthworms in summer. **Key words: American woodcock, precipitation, snow, temperature, fog, humidity, mortality, census, technique, drought**

461

Shelford, V. E. and R. E. Yeatter. 1955. Some suggested relations of prairie chicken abundance to physical factors, especially rainfall and solar radiation. Journal of Wildlife Management 19(2):233-242. Notes: The authors summarize the construction and use of thermohydrograms to examine the impacts of solar radiation and precipitation on the fecundity of prairie chickens and other game birds. They note “The effect of temperature is in part controlled by the moisture present. Two factors which operate in this way have been called paired factors.” Also “The possible effect of weather on cover, food, and dissemination of parasites should not be neglected.” Shelford suggests a relationship between the prairie-chicken population in northwestern Indiana and sunshine paired with rainfall, noting “In the case of prairie chickens in Illinois, the usual effects of sunshine and rain hold good only so long as there is plenty of cover.” **Key words: prairie chicken, precipitation, temperature, clouds, solar radiation, fecundity, technique**

462

Sherfy, M. H. 1992. The influence of season, temperature and wind speed on sage-grouse metabolism. Thesis, University of New Hampshire, Durham, USA. Abstract: We used indirect respiration calorimetry to measure the metabolism of six adult sage-grouse (*Centrocercus urophasianus*) during winter, spring, and summer. During winter the metabolic rate of fed birds was higher (P<0.05) than that of fasted birds. The standard metabolic rate (SMR) of females (0.692 mL $O_2 . g^{-1} . h^{-1}$) was higher than of males (0.583 mL $O_2 . g^{-1} . h^{-1}$) in winter; in both sexes SMR was higher in winter than in summer. Females’ SMR was lower (P = 0.0001) in spring than in winter. Lower critical temperatures of both males and females were substantially lower in winter (-0.6°C, -4.8°C) than in summer (19.9°C, 14.8°C). Although seasonally elevated, the SMR of sage-grouse in winter is low in comparison with that of other galliforms with northern distributions. Thermoregulation during a winter night at -10°C would result in minimal (<5%) expenditure of endogenous reserves by either sex. Thermoregulation and SMR in winter are more energetically costly to female sage-grouse than to males, and may necessitate increased behavioral thermoregulation by females. Seasonal change in SMR differs between the sexes, and is probably influenced by the energetic demands of the breeding season. **Key words: sage-grouse, temperature, thermoregulation, behavior, wind speed**

463

_____ and P. J. Pekins. 1995. Influence of wind speed on sage-grouse metabolism. Canadian Journal of Zoology 73:749-754. Abstract: We measured the effect of wind speed on the metabolic rate of six adult sage-grouse (*Centrocercus urophasianus*) with indirect respiration calorimetry at ambient temperatures above, near, and below the lower critical temperature. There was a significant effect ($P < 0.05$) of temperature on metabolic rate at all wind speeds, and a significant effect ($P < 0.05$) of wind speed on metabolic rate for temperatures less than or equal to 0°C. Wind speed had a more pronounced effect on metabolism at temperatures below the lower critical temperature for sage-grouse. Metabolic rates measured at wind speeds of ≥ 1.5 m/s were significantly higher than those measured at wind speeds <1.5 m/s. Multiple regression analysis of wind speed (u; m/s) and temperature (Ta; °C) on metabolism (MR; mL $O_2 \cdot g^{-1} \cdot h^{-1}$) yielded the equation MR = 0.0837 (u) – 0.0248 (Ta) + 0.5444. The predicted cost of thermoregulation at conditions of -5°C and u = 1.5 m/s was about 1.5 times standard metabolic rate; half the increase was due to wind. Measurements of wind speed in sagebrush (*Artemisia* spp.) stands indicate that such habitat effectively reduces wind speeds to less than 1.5 m/s. Microhabitat value should be recognized in the management of sagebrush stands. **Key words: sage-grouse, wind, metabolism, habitat use, vegetation, wind speed**

464

_____ and _____. 1994. The influence of season, temperature, and absorptive state on sage-grouse metabolism. Canadian Journal of Zoology 72:898-903. Abstract: We used indirect respiration calorimetry to measure the metabolism of six adult sage-grouse (*Centrocercus urophasianus*) during winter, spring, and summer. During winter the metabolic rate of fed birds was higher ($P<0.05$) than that of fasted birds. The standard metabolic rate (SMR) of females (0.692 mL $O_2 \cdot g^{-1} h^{-1}$) was higher than of males (0.583 mL $O_2 \cdot g^{-1} \cdot h^{-1}$) in winter; in both sexes SMR was higher in winter than in summer. Females' SMR was lower ($P = 0.00001$) in spring than in winter. Lower critical temperatures of both males and females were substantially lower in winter (-0.6°C, -4.8°C) than in summer (14.9°C, 14.8°C). Although seasonally elevated, the SMR of sage-grouse in winter is low in comparison with that of other galliforms with northern distributions. Thermoregulation during a winter night at -10°C would result in minimal (<5%) expenditure of endogenous reserves by either sex. Thermoregulation and SMR in winter are more energetically costly to female sage-grouse than to males, and may necessitate increased behavioral thermoregulation by females. Seasonal change in SMR differs between the sexes, and is probably influenced by the energetic demands of the breeding season. **Key words: sage-grouse, temperature, metabolism, thermoregulation, behavior**

465

Shields, P. W. and D. A. Duncan. 1966. Fall and winter food of California quail in dry years. California Fish and Game 52(4):275-282. Abstract: Fall-winter diet of California quail, *Lophortyx californica*, was studied on the San Joaquin Experimental Range near O'Neals, California during November, December, and January of 1960-

1963. Results were compared with a 1937 study in the same area. Crops were collected from 375 California quail during the regular hunting seasons. They were grouped by month, and 171 chosen at random and analyzed. Diet components were reported by month and by year, and separated into seeds and leafage. Important differences between current results and results of the 1937 study are shown and discussed. Varying weather conditions and resultant botanical composition caused wide variations in quail diet. The year 1937 and preceding years were wet; the period 1960-63 was rather dry. In 1937, seed of filaree and turkey mullein formed more than 50 percent of quail diet in November and December, but made up only 6% in the 3-year period 1960-1963. Filaree was abundant in both periods, but early rains in 1960-1963 caused general plant germination that reduced availability of this seed. Turkey mullein was very scarce in 1960 and 1961 and seed was not available. Far more green leafage was taken in November and December of 1960-1962 than in 1937. This was a result of earlier rains, general plant germination, and availability of green material in 1960-1962. Other important differences are discussed. **Key words: California quail, precipitation, vegetation, diet**

466

Sieux, J.-S. and W. Delvingt. 1997. The hazel grouse (*Bonasa bonasia*) in western Ardennes: habitat, conservation measures and integration in a forestry management. Aves 34(4):185-194. Abstract: The population of the hazel grouse has been declining for several decades in the Ardennes region and in the surrounding areas, largely as a result of the disappearance of copses (simple or standards). Intensive forestry and hunting management have eliminated the thick diverse understory necessary for the species. Recent field surveys in western Ardennes have shown that the species requires a high diversity and density of understory shrubs for feeding purposes as well as protection against predators and bad weather. Measures have to be taken if the species is to survive in this country, especially the maintenance of low thickets in areas where traditional forestry does not pay. **Key words: hazel grouse, shelter, severe weather, vegetation**

467

Siitari, H., J. Viitala, and M. Hovi. 2002. Behavioral evidence for ultraviolet vision in a tetraonid species: foraging experiment with black grouse *Tetrao tetrix*. Journal of Avian Biology 33(2):199-202. Abstract: In addition of wavelengths visible to humans (400-700 nm), many birds are able to detect near ultraviolet light (320-400 nm). Most studies of ultraviolet (UV) vision in birds have concentrated on the importance of UV vision in intraspecific signaling, especially in passerine birds. However, birds may also use UV vision for other purposes, e.g. foraging. We performed a laboratory experiment to test whether a tetraonid species, black grouse *Tetrao tetrix*, could detect the difference between UV-reflecting and non-UV-reflecting food items (two color morphs of bilberry (*Vaccinium myrtillus*). Black grouse preferred UV-reflecting berries when UV light was used for illumination, but showed no preference in the absence of UV light. This observation establishes a potential UV sensitivity in this species; such a sensitivity should be considered in behavior experiments with this species. **Key words: black grouse, UV light, behavior, feeding**

468

Siivonen, L. 1948. Decline in numerous mammal and bird populations in north-western Europe during the 1940’s. Riistatieteellisia Julkaisuja 2:1-26. Abstract: An exceptionally long decline, which started at the turn of the 1930’s into the 1940’s and is still continuing in many areas in respect to numerous species of mammals and birds, has been found to have occurred in Finland, Sweden, Norway, Germany, and England. The reason for the decline has not been the same for all spp. One group is comprised of those spp of a southern character that during the last decades have spread to the north. Such spp are the tawny owl, partridge, pheasant, field hare, polecat, blue titmouse, blackbird, hedgehog and roe deer. The other group is composed of spp of a northern character, such as the woodpeckers, capercaillie, blackgame, willow grouse, red grouse and varying hare. The spp belonging to the southern group have not been able to withstand the increasing thickness of the snow layer and severe cold weather during the winters of 1939-40, 1941-42, and 1942-43; and 1946. Spp belonging to the 2d group suffered a decline caused by a deviation in the short-term fluctuations in numbers. Normally those yrs ending in the numbers 0 or 1, in 3 or 4, as well as in 6 and 7 are peak yrs for those spp in n-w Europe. Those yrs ending in 2, 5, or 8 are normally yrs of minima. In the 1930’s the fluctuations in numbers of the spp were generally normal. In 1939, however, normally a peak yr, the stock declined to 1/7 of the preceding minimum (1934) and in certain cases even to 1/30 of the preceding maximum (1937). As a result of this deviation the theoretical peak in 1940 (41) did not appear. This kind of deviation is not unique, as it can well be compared to the so-called great deviations which continue over 2-3 consecutive cycles. A similar deviation occurred in the 1880’s. The decline during the 1940’s might have been considerably alleviated by measures that aimed at the protection of the increasing stock of 1939. **Key words: pheasant, partridge, willow grouse, capercaillie, snow, temperature, population dynamics**

469

Sime, C. A. 1991. Sage-grouse use of burned, non-burned, and seeded vegetation communities on the Idaho National Engineering Laboratory, Idaho. M. S. Thesis, Montana State University, Bozeman, USA. Notes: Page 42—“Movements in 1988 and 1989 varied with precipitation. In extreme drought years like 1988, sage-grouse were forced to leave Tractor Flats, retreating to alternate spring/summer range because palatable forbs had desiccated by July. However, in more normal years such as 1989, sage-grouse could meet life history requirements on Tractor Flats.” Page 45—“During years of below normal moisture and limited forb growth such as 1988, plant phenology is either accelerated or truncated. Thus more forbs may be removed by early livestock grazing before the peak of grouse hatch.” Page 53—“…this tool [fire] would be most effective in areas where adequate annual precipitation enables rapid revegetation and in areas with a limited potential for invasion of the disturbed sites by weedy undesirable species.” **Key words: sage-grouse, precipitation, vegetation, movement, habitat use, habitat manipulation**

470

Sisson, L. 1976. The sharp-tailed grouse in Nebraska. A research study. Nebraska Game and Parks Commission, Lincoln, USA. Notes: Under the section II Population Studies, the author writes – Page 20—"Regression analysis was used to evaluate the joint relationship between sharptail numbers (standard score) and values of several weather variables during spring counts on the Bessey area…significant terms in equation were the first- and second-order terms of time of spring, temperature, and relative humidity (P<0.05). The first order term of wind was significant (P<0.05), as were the products (interactions) of time of spring and temperature, and temperature and wind (P<0.05). Both terms of relative humidity were significant with no significant interactions with other variables…numbers of birds…decreased at higher temperatures in combination with low wind velocities. A possible explanation for these phenomena was that, while unusually warm mornings were normally windy, a calm, warm morning was often associated with changes in weather, particularly an approaching storm. Experience indicated that attendance and courtship activity usually decreases under such conditions…precipitation had an obvious effect on attendance and courtship activity. During mornings with light rain, display activity decreased and fewer birds were present." Weather variables subjected to analysis included temperature, relative humidity, wind and cloud cover. **Key words: sharp-tail grouse, temperature, humidity, wind, clouds, behavior**

471

Slagsvold, T. 1975. Production of young by willow grouse *Lagopus lagopus* in relation to temperature. Norwegian Journal of Zoology 23:269-275. Abstract: The number of young willow grouse (*Lagopus lagopus*) per two adults bagged during the autumn shoots 1963-72 in Norway were compared with the temperatures prevailing during various periods throughout the year. A significant correlation was found with June temperatures, the period 7-16 June yielding the highest correlation coefficient. Earlier data on the fluctuations in grouse populations (1873-1963) also lend support to the hypothesis of a positive influence of high temperatures in June. Higher temperatures lead to lower energy demand for body maintenance for the incubating hen and, at the same time, accelerate the phonological development of those plants and insects which are important as food for both hen and chicks. **Key words: willow grouse, temperature, population dynamics, nutrition, bioenergetics**

472

_____ and T. Grasaas. 1979. Autumn population size of the capercaillie *Tetrao urogallus* in relation to weather. Ornis Scandinavica 10(1):37-41. Summary: Annual fluctuations in the autumn population size of the capercaillie *Tetrao urogallus* at Vegårshei in South Norway, 1920-70, were analyzed statistically in relation to various meteorological factors to discover short-term effects. The most important weather variables which coincided with a high population size were: an early snowmelt in spring, only a few days of rain at the time of egg-hatching at the beginning of June and only a few days of rain in July. These factors may have operated through their influence on the production of young. The results are discussed in relation to data on the species from other countries. **Key words: capercaillie, snow, temperature, precipitation, productivity**

473

Smith, J. T. 2003. Greater sage-grouse on the edge of their range: leks and surrounding landscapes in the Dakotas. M.S. Thesis, South Dakota State University, Brookings, USA. Notes: Page 48—"Counts [lek] should be made from sunrise to 8:00 A.M. on days with low to moderate wind (<10 km per hr) and no precipitation." **Key words: sage-grouse, wind, precipitation, census**

474

Smyth, K. E. and D. A. Boag. 1984. Production in spruce grouse *Dendragapus canadensis franklinii* and its relationship to environmental factors and population parameters. Canadian Journal of Zoology 62(11):2250-2257. Abstract: The extent to which a relationship between selected environmental and population parameters, and annual production in a population of spruce grouse (*D. canadensis franklinii*) was investigated through correlation analysis of data spanning 16 yr. Production of young grouse varied between 0.0 and 1.4 young, aged 4 or more weeks, per resident female over the period of this study. There was no evidence that differences in annual productivity were related to variation (maximum of 17 days) in the onset of reproduction, a function of spring temperatures. Nevertheless, weather conditions during incubation and the immediate posthatch period did exhibit a significant correlation with productivity; cold, wet conditions during incubation were associated with years of poor productivity. The same conditions during the immediate posthatch period were associated with years of good survival of young (at least to 19 years of age). Clutch and brood sizes of yearlings were smaller than those of adults; hence, production could be influenced by the proportion of the population in each age category. An inverse relationship between the density of resident females in spring and their annual production, believed to be important in this population, was reexamined with data form an additional 6 yr. The relationship, although still inverse, was no longer significant. **Key words: spruce grouse, temperature, precipitation, productivity**

475

Snyder, W. D. 1985. Management procedures for ring-necked pheasants in Colorado. Special Report Number 59, Project W-37-R, Colorado Division of Wildlife, Denver, USA. Notes: Page 3—The section of particular interest in relation to weather is titled Predicting Population Trends Based on Environmental Factors. Over a 45-year interval, a general relationship was evident between harvest and precipitation. Productivity was influenced by influence of rain and temperature on agricultural crops (wheat). "Thus, precipitation received in a given year influences wheat growth that year while the amount stored as subsoil moisture in summer fallow impacts wheat growth the next year. Better wheat growth usually results in taller stubble which is carried as potential nesting cover into the 3rd spring. Therefore, precipitation in any one year can influence pheasant production over a 3-year period." Snyder then explains how information on precipitation and temperature can be used to predict productivity and population trends well in advance of hunting seasons. He further notes that "…one year of below average precipitation may not have major impacts on pheasants, but a series of drought years or a combination of drought and severe winter loss can be devastating. Precipitation also influences the quality of cover in roadsides, waste areas, and other habitats much in the same way that it impacts wheat. Thus, weather is the primary agent affecting pheasants and their habitat in Colorado and can be used as a general predictor of population trends.” **Key words: ring-necked pheasant, temperature, precipitation, soil moisture, vegetation, productivity, index**

476

_____. 1978. The bobwhite in eastern Colorado. Technical Publication No. 32. Project W-37-R. Colorado Division of Wildlife, Denver, USA. Notes: The author discussed weather influences on bobwhites in the section titled Environmental Influences (page 50). Impacts include winter snow stress and winter mortality, and the interaction of combinations of conditions. He also discussed the interaction of hunting and snow stress and impact of precipitation on reproduction. Snyder specifically notes that lack of brush cover in quantities that won’t be buried by snow interacts to exclude bobwhite from much of eastern Colorado. **Key words: bobwhite, snow, precipitation, temperature, mortality, stress, vegetation**

477

Spidsø, T. K., O. Hjeljord, and J. G. Dokk. 1997. Seasonal mortality of black grouse *Tetra tetrix* during a year with little snow. Wildlife Biology 3(3/4):205-209. Abstract: The seasonal mortality of black grouse *Tetrao tetrix* was studied in southeastern Norway (60°26’N, 10°45’E), in a study area dominated by up to 80% Norway spruce *Picea abies*. Modern forestry with clear-cuttings has been practiced, and 50% of the forest was younger than 30 years. Fourteen males and seven females were captured on a lek in spring 1991 and equipped with radio transmitters. During the following 12 months, 72% of the birds were killed, mostly by predators. No birds died from capture through July. In autumn, predation was higher, with four black grouse being killed. Mortality was highest during winter, with 58% of the birds dying. The goshawk *Accipiter gentilis* was the most important predator during winter. High predation by goshawks in winter 1991-92 may have been the result of black grouse being more vulnerable to predation because limited snowfall precluded snow roosting, or of an invasion by goshawks. Therefore, snow roosting may be an important antipredator behavior in black grouse. The effect of increased adult mortality is discussed in relation to chick production. **Key words: black grouse, snow, predation, mortality, habitat modification**

478

Stanford, J. A. 1972. Bobwhite quail population dynamics: relationships of weather, nesting, production patterns, fall population characteristics, and harvest in Missouri quail. Proceedings of the National Quail Symposium 1:115-139. Abstract: For 25 years Missouri has investigated bobwhite quail (*Colinus virginianus*) behavior, production, and population response to 4 major types of weather. Ten population parameters are examined annually to compare effects of Normal, Wet-Deluge, Snow-Cold and Drought weather years on quail populations. Different types of weather are related to varying annual quail abundance by affecting productivity and survival and influencing relative levels of annual harvest and hunter interest. Normal and Wet-Deluge years yield favorable fall quail populations and satisfactory hunting. Years having winters of severe snow and cold have high breeder losses, low production, and reduced hunting success. In years having high temperature and drought in spring and summer, quail reproduction is inhibited, resulting in high losses of eggs and young, greatly reduced fall bird crops, and below-par hunting for many hunters. Recovery from weather-caused population lows usually occurs within 2 or 3 years after favorable weather conditions return. Reliable techniques for sampling have been developed to yield indices of annual production and hunting success. Production curves show the value of data on the distribution of peaks in hatching for understanding annual production and fall population levels of quail in Missouri. Such data form the basis for setting annual hunting regulations of bobwhite harvest. **Key words: bobwhite quail, precipitation, snow, temperature, drought, production, abundance**

479

_____. 1971. Bobwhite quail population responses—losses and recovery—to excessive snowfall and low temperatures. Pages 203-237 *in* A. O. Haugen, editor. Proceedings of the snow and ice in relation to wildlife and recreation symposium, Iowa State University, Ames, USA. Abstract: Within the snow portion of the bobwhite quail (*Colinus virginianus*) range, the winter period is the most critical time in the bird's life. Severe snowfall causes exceptionally high and dramatic quail losses. In Missouri, such losses occur on the average of once per 11 years. The "big snow" of 1960, its effects on quail and the post snow recovery period, is illustrative of severe winter-quail relationships. Heavy snow buries food and cover causing abnormal bird movement with resulting high mortality from starvation and predation. Quail body weights decline as much as 64%. Mortality, varying with vegetative types, agriculture, and habitat quality, may reach 80-90%. Subsequent first hunting season success is very poor. Public relations problems must be met with skill and firmness. Winter feeding, while fulfilling human desires, accomplishes little. Both fed and unfed quail populations recovered equally fast or within three nesting seasons. An animal's abundance within its geographical range is dependent upon habitat quality and annual climatic occurrences. Man can, to a varying degree, determine the course of habitat quality. On the effects of climatic factors, he exerts no control except, by the management of habitat quality he may alleviate damaging effects of severe winter weather. Within the snow portion of the bobwhite quail range, winter and its related snowfall, is the most critical period in the life of the bird. While weather of other seasons may impose drastic limitations on quail production and survival, it is the winter-snow time when direct losses to potential breeders occur. And it is the overly severe winter when such losses become exceptionally high and dramatic. Within its optimum climatic range, quail thrive well in the niche provided by moderate degrees of agriculture, woodland disturbance and the resulting open ground. The annual bird surplus resulting from favorable habitat-climatic conditions usually provides unexcelled game bird hunting. Bobwhite quail abundance or scarcities result from one or several conditions which are categorized as either long-term or short-term occurrences. Category number one pertains to the habitat and is concerned with land use and vegetation control. These vegetative-land use conditions which hinge on plant composition and time are classed long-term habitat factors.

Annual climatic conditions which affect overwintering potential breeders, production season success and young bird survival are short-term occurrences. Results are measured in annual bird crops which may vary considerably from year to year. Man has no control over these factors, but his management of habitat factors can reduce bird losses and hasten bird recoveries from climatic caused quail lows. This paper applies to short-term production factors, which as climatic emergencies, affect annual quail abundance. While the adverse effects of either (a) drought-high temperatures or (b) snow-cold share notoriety as decimators of quail, the specific subject selected here pertains to the effects of snow-cold on quail populations with special emphasis from Missouri investigations. **Key words: bobwhite quail, temperature, snow, mortality, predation, nutrition, habitat quality, habitat modification, vegetation**

480

Steen, J. B., O. Andersen, A. Sæbo, H. Chr. Pedersen, and K. E. Erikstad. 1988. Viability of newly hatched chicks of willow ptarmigan *Lagopus l. lagopus*. Ornis Scandinavica 19(2):93-96. Notes: The authors document that the mortality of newly hatched willow ptarmigan chicks was due to reduced chick viability caused by inadequate maternal nutrition and unfavorable weather conditions during incubation. Chemical composition of available plants prior to egg-laying indicated the quality of maternal food; air temperature and humidity were the weather conditions of concern during the reproductive period. Heavy rainfall during the days following mean hatching date evidently took a far higher toll on chicks. Egg water loss was related to increase in conductance and ambient vapor pressure. The authors state their results "demonstrate that the poor reproductive results in 1982 was associated with eggs of poor quality. They were smaller and had more porous shells than in the other years." **Key words: willow ptarmigan, mortality, egg quality, vegetation, nutrition, precipitation, humidity**

481

Steen, J. B., H. Steen, N. Chr. Stenseth, S. Myrberget, and V. Marestrom. 1988. Microtine density and weather as predictors of chick production in willow ptarmigan *Lagopus l. lagopus*. Oikos 51(3):367-373. Abstract: We have evaluated to what extent biotic (predation) and abiotic (weather) factors influence annual chick production in willow ptarmigan (*Lagopus lagopus lagopus*). An index of predation was derived from data on microtine density; weather conditions from daily records of temperature and precipitation. Stepwise regression analysis between observed chick production on two Scandinavian study sites (Tranøy and Lövhögen) for periods of 23 and 19 years, and independent variables characterizing predation and weather conditions suggested which variables were the most important in determining chick production. The resulting model explains between 56% and 25% of the annual variation in chick production; the calculated values deviating on average between 1.14 and 0.95 checks/2 adults from the observed ones. Predation was found to be the dominant factor, accounting for 41% and 25% of the annual variation in chick production in the two areas. We suggest that year-to-year variation in reproductive success is, in general, influenced to a greater degree by biotic than by abiotic factors, possibly because the predators “co-adapt” to the ptarmigan. **Key words: willow ptarmigan, temperature, precipitation, predation, model, productivity**

482

Stewart, P. A. 1967. Hooting of Sitka blue grouse in relation to weather, season and time of day. Journal of Wildlife Management 31(1):28-34. Abstract: The hooting behavior of a population of Sitka blue grouse (*Dendragapus obscurus sitkensis*) was studied on Mitkof Island in southeastern Alaska, chiefly by counting hoots at different times and under different weather conditions. Hooting was first heard on April 7 and last on June 12, but a longer hooting season could be assumed for larger populations. Hooting was maximum on April 26 when 627 hoot-series were heard in 1 hour. Hooting began to decline 1 week after its peak. The level was high from April 24-May 6, and lower but still relatively high during May 7-15. Hooting then declined markedly; during some counting periods there was no hooting. Eight seconds was the shortest interval observed between hooting of individual birds. Early in the season, hooting was inhibited by inclement weather; after peak activity was reached, weather seemed to have no effect. Hooting started in the morning 58-95 min before sunrise and continued until 19-65 min after sunset, with a lull between 5:00 and 7:00 A.M. **Key words: blue grouse, behavior, precipitation, snow, clouds, fog, technique, index**

483

Stiver, S. J. 1984. Himalayan snowcocks: Nevada’s newest upland bird. Cal-Neva Wildlife Transactions:55-57. Notes: Page 56 – “In the winter, snowcocks in their native range are reported to descent to lower elevations, especially if snowfall is heavy….snowcocks are reported to prefer big game concentration areas during the winter.” **Key words: Himalayan snowcock, snow, habitat use**

484

Stoddard, H. L. 1931. The bobwhite quail: its habits, preservation and increase. Charles Scribner’s Sons, New York. Notes: Page 60 – “Other habits-Quail behavior in relation to weather. When storms are threatening they may feed off and on all day, keeping their crops full. On hot, clear days they are apt to be lazy, and if food is plentiful most of their feeding will be carried on in the cool of the morning and very late in the evening, and once located, they usually ‘lie’ well to the dog. In windy weather they frequently fly badly, and scent is mixed up by the air currents, while, as previously mentioned, on wet days they are inclined to run and only flush when compelled to, a fact taken advantage of in by-gone days when netting was in vogue.” Page 123 – “The character of the food of the bobwhite varies with its availability, and availability is governed by the weather, by fruiting habits of plants from which food is obtained, by season, by environment, and by other factors. During years of either severe drought or excessive rainfall the seed crop of many plants is affected. Furthermore, when swampy areas dry up, this makes available many foods that are little used at other times. Plants such as the pine seed abundantly once in several years. Berries and insects are more abundant during the warmer months, and seeds during the late fall and winter. Food plants are not equally abundant over the whole range. It is readily seen that these several constantly changing factors greatly vary the availability of food.” Page 200 –

"Loss due to the elements. There is a general belief among rural people that many quail chicks are 'drowned out' during heavy rains. As torrential rainstorms, or cloudbursts, do occur at times and with such severity that newly hatched chicks could scarcely escape, it is probable that considerable loss sometimes is occasioned in restricted areas. Experience in the field and in the artificial propagation of these birds, however, would indicate that actual drowning of quail chicks is exceptional and largely confined to such as are caught in ditches and low spots. Quail chicks frequently get into ditches and become lost from the brood, and all such would drown in ordinary rainstorms. Where one or both parents are with the broods on well-drained ground, the chicks are protected perfectly during the heaviest rains. The experience of the Investigation would indicate that one important reason why very wet years are poor seasons for quail reproduction is that considerable destruction and desertion of nests are occasioned by torrential rainstorms. If rains are cold and of very long duration, a comparatively rare thing in the South, quail chicks also become wet and chilled; chilled chicks seldom recover in captivity, and the same may be expected afield. Chicks that are flushed on cold or wet nights in the field, by cats, dogs, or other roving enemies, undoubtedly perish before they can be assembled, for a baby quail in the natal down quickly gets wet to the skin, and is chilled when running about in dew-laden grass…Severe hailstorms undoubtedly cause a loss in the breeding season, especially in the rare instances where the hailstones are very large, but we have no detailed data on their effect on bobwhites…Very wet summers...are unfavorable to developing chicks in many ways, all of which contribute to the dwindling of the broods. While the main damage is undoubtedly caused by the destruction and desertion of nests, the young chicks have their vitality lowered by wet and chilling; constant wetting may cause their death either directly or indirectly by making them more susceptible to disease. The general belief that wet summers are unfavorable to quail multiplication undoubtedly is only too well founded. Drought, if extreme, may be equally detrimental. Not only do eggs spoil, but the food supply in the shape of small fruits, insects, and succulent vegetation is much reduced." Page 223 – "(2) The elements. Some loss to growing birds may be expected annually from meteorologic conditions, which may reach serious proportions during seasons either of abnormal rainfall or of intense drought. A season of normal rainfall or one somewhat dried than average, but not dry enough seriously to affect the food supply, is the most favorable to bobwhite increase, and fluctuations due to the elements must be expected and allowed for in the shooting." **Key words: bobwhite quail, precipitation, drought, temperature, hail, nutrition, mortality, productivity**

485

Stokkan, K.-A. 1992. Energetics and adaptations to cold in ptarmigan in winter. Ornis Scandinavica 23(3):366-370. Summary: Ptarmigan *Lagopus* spp inhabit arctic, subarctic and temperate alpine regions where winter is typically cold and snowy. Low ambient temperatures, however, have little effect on their energy budget. Ptarmigan have a highly insulative white winter plumage which contributes to a very low heat loss. They normally evade exposure to severe cold by roosting in the snow, where ambient temperature usually exceeds their lower critical temperature. Ptarmigan have a diurnal activity pattern and each day collect and store enough food in their crop-sack to last the long winter night. Their digestive system shows seasonal changes in length which apparently adapt the birds to a low quality winter diet. With the exception of high-arctic species, ptarmigan do not store substantial amounts of fat in the winter. The Svalbard ptarmigan living at 77-80°N prepare for winter by depositing large stores of fat (up to 35% of body mass; BM) in autumn. Concurrently there is a marked reduction in their daily energy expenditure which permits such fattening to occur despite the fact that food intake is simultaneously reduced. **Key words: ptarmigan, snow, temperature, behavior, thermoregulation**

486

Straw, J. A. Jr., D. G. Krementz, M. W. Olinde, and G. F. Sepik. 1994. American woodcock. Pages 97-114 *in* T. C. Tacha and C. E. Braun, editors. Migratory shore and upland game bird management in North America. International Association of Fish and Wildlife Agencies, Washington, D.C., USA. Notes: Migration chronology is affected by wintering latitude and weather, especially strong cold fronts. Temperature and moisture influence food availability and, thus, selection of wintering areas by woodcock. During wet winters, woodcock winter more extensively in Texas than during normal or dry winters. Most mortality during winter is attributed to predation, although prolonged cold temperatures may result in localized mortality due to starvation. **Key words: woodcock, temperature, precipitation, behavior, nutrition, mortality**

487

Stribling, H. L. and P. D. Doerr. 1985. Nocturnal use of fields by American woodcock. Journal of Wildlife Management 49(2):485-491. Abstract: Nocturnal behavior of the American woodcock (*Scolopax minor*) was studied during the winters of 1978-82 in agricultural crop fields in North Carolina. Woodcock preference for cutover soybean fields could be attributed to at least two factors: earthworm (Oligochaeta) quality and thermal advantages offered by soybean field microtopography. Over 75% of the woodcock sampled in soybean fields fed during the night, and earthworms made up 99% of the food ingested (wet weight). Availability of earthworms (wet weight) among cutover soybeans, disked corn, and winter wheat fields was similar ($P > 0.05$). The percent protein of earthworms found in soybean fields was greater ($P < 0.05$) than in other field types (corn and wheat). The parallel ridge/furrow microtopography of soybean fields offered thermal advantages to woodcock. The plant debris that accumulated between the furrows prevented the soil from freezing and allowed woodcock access to earthworms on cold nights. **Key words: American woodcock, thermal cover, nutrition, habitat use, microtopography**

488

Summers, R. W., R. E. Green, R. Proctor, D. Dugan, D. Lambie, R. Moncrieff, R. Moss, and D. Baines. 2004. An experimental study of the effects of predation on the breeding productivity of capercaillie and black grouse. Journal of Applied Ecology 41:513-525. Summary: (1) The capercaillie *Tetrao urogallus* and black grouse *Tetrao tetrix* are declining in the UK, and low breeding success has been identified as the key factor in the decline of the former. To investigate possible causes, breeding productivity was studied in relation to predation, weather, vegetation changes and deer numbers over an 11-year period (1989-99) within native pinewood at Abernethy Forest, Scotland. The abundance of predators (crows *Corvus corone* and red foxes *Vulpes*

vulpes) were experimentally manipulated in 1992-96 by culling. Productivity (chicks reared per female) was compared between forests with and without experimental predator management. (2) During predator control, the number of breeding crows was reduced from 10 pairs to one. The attempted reduction in red fox abundance was unsuccessful; only small numbers of adults were killed, and neither scat nor den counts declined significantly. (3) Predation on artificial nests containing six hen eggs and a hen egg filled with wax was measured as an index of predator activity from 1991 to 1999. Predation was lowest during the last three years of predator control, 1994-96. Predators could sometimes be distinguished by signs on depredated eggs. Predation on artificial nests by crows was highest during 1991-93. However, after predator removal stopped in 1997 few crows returned, and increased predation on artificial nests did not involve increased sign of crow predation. Pine marten *Martes martes* numbers increased during the study period and became significant predators of artificial nests. (4)The total number of capercaillie eggs and nests depredated by crows was estimated from the number of depredated capercaillie eggs found and the proportion of crow-predated hen eggs in artificial nests. The values ranged from 18 to 158 eggs over 3 years, equivalent to 3-23 capercaillie nests year^{-1}. (5) Capercaillie productivity was low (<1 chick per female) during 1989-93 and 1997-99 but higher during 1994-96. Compared with nine other forests in Scotland, changes in capercaillie productivity at Abernethy were different. Productivity at Abernethy was negatively related to June rainfall, and to the minimum daily predation rate on artificial nests by crows. There was also a significant interaction in that capercaillie were most productive when low rainfall coincided with low predation by crows on artificial nests. (6) The productivities of black grouse and capercaillie were positively correlated, but greater in the former. As in capercaillie, black grouse productivity was negatively related both to June rainfall and the minimum daily predation rate on artificial nests by crows, and there was an interaction. (7) Synthesis and applications. The long-term increase in crows and red foxes and the predicted increase in rainfall in Scotland may have negative effects on capercaillie and black grouse. In the short term, control of crows is likely to improve productivity. In the long term, increased woodland size and some reversal of fragmentation might decrease the access to woodland of predators associated with the interface between farmland and woodland. **Key words: capercaillie, black grouse, predation, precipitation**

489

Swank, W. G. and S. Gallizioli. 1954. The influence of hunting and of rainfall upon Gambel's quail populations. Transactions of the North American Wildlife Conference 19:283-297. Notes: Page 287—"In the desert country, the range of the bird in question, production of green vegetation in the spring is primarily dependent upon the quantity of rainfall received during the preceding winter months. A ratio of more than two young to one adult occurred only during those years when the accumulated rainfall from December through April amounted to more than the average of 5.58 inches." Page 294—"Information on fluctuations of the Gambel's quail population in Arizona over the past 13 years indicates that the amount of rainfall during winter months, December through April, is the factor limiting abundance." **Key words: Gambel's quail, precipitation, productivity**

490

Swanson, D. L. and D. P. Weinacht. 1997. Seasonal effects of metabolism and thermoregulation in northern bobwhite. Condor 99(2):478-489. Abstract: Seasonal differences in metabolism and cold hardiness are common among small passerine birds. However, seasonal adjustments of metabolism and insulation are less well studied in nonpasserines and in larger birds. We measured basal metabolic rate (BMR), metabolic response to temperature, and maximal capacity for thermogenesis (peak cold-induced oxygen consumption, VO_{2sum}) in late spring/summer and winter in outdoor captive northern bobwhite (*Colinus virginianus*) near the northern boundary of their natural range, to determine whether seasonal adjustments in metabolism are a component of acclimatization in this species. Mass, BMR and regression equations describing diurnal and nocturnal metabolic response to temperature were not significantly different between seasons. After metabolic tests below thermoneutrality, cloacal temperature (T_b) was not dependent on ambient temperature (T_a) at either season, and nocturnal T_b did not differ significantly between seasons. However, after metabolic tests below thermoneutrality, diurnal T_b was significantly greater in summer (38.9± 1.1°C) than in winter (37.7 ± 1.1°C). Although body mass of winter birds was significantly greater than their body mass in late spring, maximal thermogenic capacity did not differ significantly on a seasonal basis, and winter bobwhite were only marginally more cold tolerant than late spring birds under severe cold stress. For individual birds tested in both winter and late spring, individual ranging of VO_{2sum} was not consistent between seasons (i.e., birds with a high VO_{2sum} in winter did not necessarily have a high VO_{2sum} in late spring). These data suggest little seasonal adjustment of metabolism or insulation in the northern bobwhite, a relatively large nonpasserine species native mainly to regions with relatively mild winter climates. **Key words: bobwhite quail, thermoregulation, temperature**

491

Swearingin, R. M. 2007. Winter roosting ecology of Rio Grande wild turkeys in the Rolling Plains of Texas. M.S. Thesis, Texas Tech University, Lubbock, USA. Notes: We examined possible relationships between roost/flock counts and climatic variables. We predicted that daily low temperature and length of photoperiod would explain a significant amount of the variation in foraging and roosting flock sizes throughout the year. Wild turkey attendance at traditional winter roost sites was not correlated with daily precipitation (r=0.139, n = 101, P=0.164), daily snowfall (r=0.139, n=101, P=0.164), length of photoperiod (r= -0.091, n=101, P=0.368), or daily maximum temperature (r=0.177, n=101, P=0.077). We did find a significant correlation between roost size and minimum temperature (r= -0.245, n=11, P=0.014). We found no relationship between wild turkey flock sizes and daily precipitation (r=0.008, n=3047, P=0.640) or daily snowfall (r=0.028, n=3047, P=0.128). However, we did find weak negative correlations between wild turkey flock size and maximum daily temperature (r= -0.290, n=3047, P=0.000), minimum daily temperature (r= -0.323, n = 3047, P=0.000), and length of photoperiod (r= -0.367, n=3047, P=0.000). We suggest that daily precipitation and daily snowfall may have had little effect on wild turkey flocking behavior. Most (70%) rainfall on the study sites occurred between April and August, there were few rain and snowfall events during our period of interest. We found that minimum temperature influences flock size and that minimum temperature, maximum temperature, and length of photoperiod influence roost size. Although these correlations were significant, these variables explained little of the variation in flock and roost size. Even though we observed low correlation coefficients, we believe that these variables may have a greater influence on winter turkey concentrations in combination. There may also be an effect of time lag influencing winter concentrations. Since cold temperatures impact wild turkey concentrations, roosts should be counted during the coldest portion of the specified peak period for the greatest likelihood of the highest densities of wild turkeys using major roosts. **Key words: turkey, snow, precipitation, temperature, behavior, census**

492

Swenson, J. E. 1991. Evaluation of a density index for territorial male hazel grouse *Bonasa bonasia* in spring and autumn. Ornis Fennica 68(2):57-65. Abstract: A density index for territorial male hazel grouse *Bonasa bonasia* in spring and autumn is presented and evaluated. One whistles with a hunter's whistle every 30 seconds for 6 minutes from census points located at 150-m intervals within the area to be censused, and responding hazel grouse are counted. Counts were conducted throughout days with little or no wind. The number of counted males was significantly and linearly correlated with the number of known territorial males on an intensive study area. There, 82% of the territorial males responded and were counted. Response rate appeared to be independent of density, based on counts in areas with a 20-fold variation in densities. When censuses were repeated, both results were similar. Within the conditions of these counts, no effects of weather or date were found. However, hazel grouse responded less at midday. Using this method, one can count hazel grouse at a rate of about 5 minutes per ha along transects and 5-9 minutes per ha on blocks of habitat, depending on plot size. I recommend that censuses be conducted during 4-5 weeks prior to laying in spring and during 4-5 weeks after brood dissolution in autumn. **Key words: hazel grouse, index, technique, wind, temperature, census**

493

_____.1986. Differential survival by sex in juvenile sage grouse and gray partridge. Ornis Scandinavica 17(1):1417. Summary: Studies of capercaillie *Tetrao urogallus* and black grouse *T. tetrix* in northern Europe have found that juvenile males of these sexually size dimorphic species suffer higher morality than juvenile females during adverse conditions. This difference may be due to the more rapid growth rates among males. Differences in the juvenile survival of the dimorphic sage-grouse *Centrocercus urophasianus* and the monomorphic gray partridge *Perdix perdix* were studied in western North America. Juvenile male sage grouse survive less well than juvenile females during years unfavorable for juvenile survival and in poorer habitats. Juvenile male gray partridge showed little or no such trend. These results are consistent with those obtained in the European studies. Pressures on sexual selection may have led to a growth rate in juvenile males of highly dimorphic grouse species which is near the upper limit of that which can be sustained by their ecological niche. **Key words: sage-grouse, gray partridge, mortality, genetics, habitat quality**

494

_____. 1985. Seasonal habitat use by sharp-tailed grouse, *Tympanuchus phasianellus,* on mixed-grass prairie in Montana. Canadian Field-Naturalist 99:40-46. Abstract: Upland grass and upland crops were first and second, respectively, in observed use by sharp-tailed grouse (*Tympanuchus phasianellus*) during all seasons. Hardwood draws were used for foraging for fruits and berries in autumn and for buds in winter. Winter use of habitats varied with snow depth; during periods of deep snow, the grouse used hardwood draws more and upland grass and crops less. Upland grass was selected for placement of arenas. A mosaic of upland grass with Skunkbush sumac (*Rhus trilobata*) and riparian hardwood draws seemed to comprise optimum habitat; but small upland winter wheat fields interspersed throughout the area and within 500 m of hardwood draws provided an apparently preferred food source. **Key words: sharp-tailed grouse, snow, habitat use, behavior**

495

_____ and B. Olsson. 1990. Hazel grouse night roost site preferences when snow-roosting is not possible in winter. Ornis Scandinavica 22(3):284-286. Abstract: Hazel grouse *Bonasa bonasia* typically roost in snow burrows at night in winter, but this is often not possible in maritime climates. The alternative, roosting in trees, was studied in south-central Sweden during three winters. Data from 64 roost sites showed that hazel grouse preferred to roost in Norway spruce *Picea abies*, the tree species on the area providing the greatest amount of vertical cover. Roost trees were consistently shorter than the surrounding canopy trees and birds roosted low in the trees. Roosting sites had a significantly higher density than expected of both spruces and total trees. Thus, hazel grouse roost sites had more vertical and horizontal cover than expected. This type of site probably provided thermal benefits to roosting grouse. **Key words: hazel grouse, behavior, thermoregulation, temperature, wind, snow, habitat use**

496

_____, L. Saari, and Z. Bonczar. 1994. Effects of weather on hazel grouse reproduction: an allometric perspective. Journal of Avian Biology 25(1):8-14. Summary: We analyzed the effects of weather during prelaying, incubation, and early chick periods on the reproductive success of hazel grouse *Bonasa bonasia* in southwestern Finland (14 years) and southern Poland (6 years). Reproductive success was most clearly correlated with weather during the prelaying period in both areas, with days of precipitation correlating negatively and temperature positively. We suggest that the availability of nutritionally rich food and the ability of the females to obtain it during the prelaying period, when the females are rapidly gaining mass and forming eggs, determine in large part the reproductive success of hazel grouse. A literature review suggested that this is generally true for small grouse species. The larger species, which have greater endogenous reserves and invest relatively less in their clutches, are less affected by prelaying weather conditions. Chicks of larger species have higher growth rates and energy requirements, however, which is probably the reason why the reproductive success of the larger species is more affected by weather during the early chick period. **Key words: hazel grouse, precipitation, temperature, productivity**

497

Szaro, R. C. and R. P. Balda. 1986. Relationships among weather, habitat structure, and ponderosa pine forest birds. Journal of Wildlife Management 50(2):253-260. Abstract: Avian community structure during the breeding season in a ponderosa pine (*Pinus ponderosa*) forest of northern Arizona was influenced by weather and a series of timber harvest treatments. Fewer birds and bird species were present after a winter with the heaviest snowfall on record and low temperatures than after milder winters. Bird density was greater ($P<0.05$) on the light and medium cut plots than on the untreated plot. A cluster analysis of bird densities over plots and the 3-year study period indicated treatment effects were more important in determining bird community composition than weather effects. **Key words: mourning dove, temperature, precipitation, snow, habitat use**

498

Tacha, T. C. and C. E. Braun, editors. 1994. Migratory shore and upland game bird management in North America. International Association of Fish and Wildlife Agencies and Fish and Wildlife Service, Lawrence, Kansas, USA. Abstract: White-tipped doves (*Leptotila verreauxi*) are large tropical columbids native to southern Texas, Mexico, Central America, and portions of South America. They have been a legally hunted game species in the United States since 1984. Their range in the U.S. is a 14-county area of southern Texas. White-tipped doves are sedentary and do not migrate. In southern Texas they nest in native brush and citrus orchards. The annual breeding population has been stable in Texas for the past 10 years, except for declines during years following major freezes that adversely affect citrus and native brush nesting habitat. A limited harvest of 2 white-tipped doves per day is allowed during the special white-winged (*Zenaida asiatica*) and mourning dove (*Z. macroura*) dove hunting seasons. Improvements in harvest surveys are needed. Other management and research needs include more detailed breeding population surveys in the northern part of their range, and additional life history data. Chapter 7—American Woodcock: Notes – Page 100 – "Weather factors such as temperature and moisture influence food availability and, thus selection of wintering areas by woodcock. The abundance and distribution of woodcock in Louisiana…varies with winter severity. Furthermore, during wet winters, woodcock winter more extensively in Texas than during normal or dry winters. Most mortality during winter is attributed to predation, although prolonged cold temperatures may result in localized mortality due to starvation." **Key words: white-tipped dove, American woodcock, temperature, ice, moisture, nutrition, distribution, mortality, population dynamics**

499

Tautin, J., P. H. Geissler, R. E. Munro, and R. S. Pospahala. 1983. Monitoring the population status of American woodcock. Transactions of the North American Wildlife and Natural Resources Conference 48:376-388. Notes: Page 381-- "(Calling) counts should not be made during heavy rain, snow, high wind, or temperatures below 40°F (4°C). Normally, weather has little effect on courtship performances, but the conditions listed above result in curtailed activity." Page 386 -- "Does the Singing-Ground Survey provide information useful or management purposes? We believe it does and that our proposed new analytical methods will enhance its capabilities. Although the studies of the 1970s did not conclusively answer the question, certain empirical information suggests that the answer is affirmative. The blizzard that struck the northeast in early April 1982 was predicted to impact adversely on woodcock that had already returned to their breeding grounds. Subsequent results from the singing ground survey showed a decrease of 20.3 percent from 1981, suggesting that the survey is sensitive to between year population changes." **Key words: American woodcock, census, precipitation, snow, wind, temperature, behavior, index**

500

Tavecchia, G., R. Pradel, F. Grossmann, C. Bastat, Y. Ferrand, and J.-D. Lebreton. 2002. Temporal variation in annual survival probability of the European woodcock *Scolopax rusticola* wintering in France. Wildlife Biology 8(1):39-48. Abstract: The Eurasian woodcock *Scolopax rusticola* is an important quarry species hunted all over its range. Some authors have reported local declines in both wintering and breeding woodcock numbers. In order to investigate whether these possible declines are the result of a negative trend in survival, we analyzed 3,312 recoveries of 15,839 woodcocks ringed in France during 14 consecutive winters (1984/85-1997-98). We distinguished between winter (October-February) and summer (March-September) recoveries in order to estimate survival and recovery rate separately for each period because selective pressures during these two periods are likely to be different. Survival varied according to year during both winter and summer. Winter survival probability covaried positively with mean winter nocturnal temperature and ranges from 0.74 (SE = 0.057) during the winter of 1985/86 to 0.83 (SE = 0.042) during the winter of 1994/95. Mortality of first-year birds was 22% higher than that of adults in any year. Results from a second analysis in which we compared survival of birds ringed during 1991-1997 in the three main woodcock wintering areas along the French Atlantic coast suggested a threshold effect of weather conditions. Mean winter survival covaried with temperature and rainfall mainly in the northernmost regions where weather conditions are more severe. We did not find any particular trend in survival probability that could explain the possible declines in woodcock numbers. However, the generally low adult annual survival, and the negative influence of stochastic events such as severe winter conditions might drive populations to a level from which it would be difficult to recover. Results of a two-age-class demographic model are discussed together with implications for management. **Key words: Eurasian woodcock, temperature, precipitation, population dynamics, model**

501

Taylor, J. S., K. E. Church, and D. H. Rusch. 2000. Habitat and weather effects on northern bobwhite brood movements. Proceedings of the National Quail Symposium 4:153-157. Abstract: We observed radio-marked northern bobwhite (*Colinus virginianus*) broods (adults with chicks ≤ 1 days old; n = 12) in Kansas during 1991-94 to test effects of weather (temperature and precipitation) and macrohabitat (composition, relative diversity, and mean distance to grassland) variables on brood home range size and daily movements at large (28.5 km^2), intermediate (3.14 km^2), and small (about 0.14 km^2) spatial scales surrounding habitats available for broods. Principal component analyses followed by stepwise multiple linear regression indicated neither weather nor habitat influenced ($P \geq 0.1$) home range size at the large and intermediate scales. However, the principal component representing mean distance to grassland and percent cropland within the home range (i.e., at a small scale) was positively related to home range size. Neither temperature nor habitat influenced daily distance of movements. We concluded that brood mobility was independent of landscape-scale features, but that habitat management at smaller spatial scales could influence movements. To create optimal habitat for bobwhite, managers should consider relationships among habitat attributes and the movement of individuals, including the spatial scales at which these relationships are most important. **Key words: bobwhite quail, temperature, precipitation, behavior, movement, habitat manipulation**

502

Theberge, J. B. and G. C. West. 1973. Significance of brooding to the energy demands of Alaskan rock ptarmigan chicks. Arctic:138-148. Abstract: Rock ptarmigan (*Lagopus mutus*) chicks are brooded periodically during the first few days of life; longer in cold and rainy weather. Computed minimum foraging time in adverse weather conditions is 96 minutes/24 hours. Crop analysis and calorimetry of the 6 major food items show that a full crop may contain up to 0.47 kcals. Energy requirements were calculated for both an 18-gram chick and a 30-gram chick. The 18-gram chick required between 34 and 50 crop loads per 24 hours. With 96 minutes foraging time, and the observed pecking rates, this was considered possible. The 30-gram chick required twice as much foraging time but since it was approaching homeothermy, it was tentatively concluded that neither was that chick being handicapped by brooding. Vagaries in early survival of rock ptarmigan chicks, therefore, are not due to difference in post-hatch weather. **Key words: rock ptarmigan, temperature, precipitation, nutrition, thermoregulation**

503

Thomas, V. G. 1987. Similar winter energy strategies of grouse, hares and rabbits in northern biomes. Oikos 50(2):206-212. Abstract: Neutral fat and protein reserves were measured in three species of grouse, cottontail rabbits, snowshoe hares and European hares collected during the mid to late winter period in their natural habitats. Neutral fat levels were measured in arctic hares from the Canadian high arctic during late summer. Sharp-tailed grouse, spruce grouse and ruffed grouse contained, respectively, 2.2, 2.3 and 1.0 g of fat per 100 g fat-free body weight, regardless of sex, year or location. Cottontail rabbits, arctic hares, snowshoe hares and European hares had, respectively, 4.1, 2.5, 2.3-4.1 and 6.9 g of fat per 100 g fat-free body weight. The low values for fat and protein reserves are similar to those reported for other grouse and leporid species in different parts of North America and Scandinavia. Collectively they indicate that species in both taxa have little metabolic resistance to winter fasting and must feed regularly to maintain energy balance. Grouse, hares and rabbits in winter habitats share similar energetic tactics of acquiring small energy reserves, feeding regularly for short periods and emphasize energy conservation rather than energy acquisition. A theoretical model relates the size of energy reserves in these species to the probability and duration of fasts due to severe winter weather, the changing quality of diets, and the probability of predation while amassing reserves prior to winter and using them during winter. **Key words: sharp-tailed grouse, spruce grouse, ruffed grouse, bioenergetics, severe weather**

504

Thompson, D. J. 2003. Roosting habitat and poult survival of Merriam's turkeys in the southern Black Hills of South Dakota. M.S.Thesis, South Dakota State University, Brookings, USA. Abstract: Poult survival rates were insignificantly higher during 2002 (P>0.10). The increased invertebrate abundance during 2002, coupled with cold wet weather during poult development in 2001, accounted for the slight variation between poult survival between years in the southern Black Hills. **Key words: Merriam's turkey, temperature, precipitation, mortality, nutrition, chick survival**

505

Thompson, D. R. 1950. Foot-freezing and arrestment of post-juvenal wing molt in the mourning dove. Wilson Bulletin 62(4):212-213. Notes: The author notes that mourning doves were captured that had badly frozen feet in the winter of 1949-50. The frozen distal phalanges dropped off; had these birds needed to forage for their own food during their convalescence they would probably have died of starvation. Arrestment of the post-juvenal molt was apparent in all three of the birds held captive following foot freezing. The arrest of molt varied between the birds. These birds were described as "short, ragged, and faded dull brown, lacking entirely the sheen of the pearly gray new feathers." If birds of late-hatched broods do not molt the outer primaries before the arrival of cold weather the molt may be arrested or suspended. **Key words: mourning dove, temperature, frost, molt**

506

Thompson, K. M., M. J. Holloran, S. J. Slater, J. L. Kuipers, and S. H. Anderson. 2006. Early brood-rearing habitat use and productivity of greater sage-grouse in Wyoming. Western North American Naturalist 66(3):332-342. Notes: Page 339 – "We found virtually no relationship between weather and productivity. It is possible that short-term, extreme weather conditions (e.g. heavy rainfall, severe cold spells) influenced productivity; but these occurrences were not detectable using annual weather data. However, the trends we did observe were consistent; all weather variables were positively associated with our two measures of productivity. Warm and dry conditions appeared to be more favorable for productivity than cold and wet conditions." **Key words: sage-grouse, precipitation, temperature, productivity**

507

Thompson, F. R. III and E. K. Fritzell. 1988. Ruffed grouse metabolic rate and temperature cycles. Journal of Wildlife Management 52(3):450-453. Abstract: We measured the effects of temperature and wind on ruffed grouse (*Bonasa umbellus*) metabolic rates in an open-circuit respiration system with a closed-circuit wind tunnel.

Metabolic heat production was linearly related to operative temperature (T_e) below a lower critical temperature of 1.5 ± 0.99 (SE) C. Standard metabolic rate was 3.2 ± 0.11 W (66.1 kcal/day) for a grouse of mean weight (607 g). Metabolic rate was related linearly to wind speed$^{0.5}$. The regression predicting net metabolic heat production (metabolic heat production – evaporative cooling [M – E]) was 3.1589 – 0.1176T_e + 0.4141 (wind speed)$^{0.5}$(r^2 = 0.98, *P*<0.001), where Te = 0 to -20C and wind speed ≤ 3 m/second. Mean high daytime cloacal temperature (40.6 ± 0.24 C) was > mean low nocturnal cloacal temperature (38.3 ± 0.54 C) (*P* = 0.006). **Key words: ruffed grouse, temperature, wind, metabolic rate**

508

_____ and ______. 1988b. Ruffed grouse winter roost site preference and influence on energy demands. Journal of Wildlife Management 52(3):454-460. Abstract: We located winter roosts of ruffed grouse (*Bonasa umbellus*) in Missouri with radiotelemetry and determined roost type preference. Thermostatic energy demands in 4 roost types were measured with a heated taxidermic mount calibrated with metabolic rates of captive grouse. Ruffed grouse preferred to roost in the canopies of eastern red cedar (*Juniperus virginiana*) and avoided roosting in deciduous cover. Roost sites had higher woody stem densities (mean = 5,494 stems/ha) than random plots (mean = 4,236 stems/ha). We predicted ruffed grouse metabolic rates (±0.75%), at ambient temperatures (T_a) of -20 to 0 C, from power (P_m) used by the heated taxidermic mount. Standard operative temperature (T_{es}) was elevated 7.3, 2.6, 2.9, and -0.3 C in snow roosts, cedar tree roosts, cedar ground roosts, and deciduous roosts, respectively, above that at an open site for T_a of -20 to 0 C. When wind speed was 3 m/second in the open, T_{es} was elevated a mean of 12.9, 7.0, 6.7, and 2.5 C, in snow, cedar tree, cedar ground, and deciduous roosts, respectively. These increases in T_{es} resulted in a 33, 19, 18, and 6% reduction in metabolic rate in snow roosts, cedar tree roosts, cedar ground roosts, and deciduous roosts, respectively, from that in the open at -20 to 0 C and 3 m/second wind speed. About 40% of the elevation in T_{es} resulted from reduced convection inside roost sites and 60% from a more favorable radiation balance in roosts. Low coniferous vegetation provided thermal benefits that may be important because snow roosts are rarely available. **Key words: ruffed grouse, thermoregulation, behavior, wind, snow, temperature, habitat use, solar radiation, vegetation**

509

Thompson, W. L. 1993. Ecology of Merriam's turkeys in relation to burned and logged areas in southeastern Montana. Dissertation, Montana State University, Bozeman, USA. Abstract: Merriam's turkeys (*Meleagris gallopavo merriami*) were captured, equipped with radio transmitters, and monitored via telemetry to study their ecology in relation to burned (1988 wildfire) and logged areas in southeastern Montana, 1989-1991. Neither burned nor logged areas appeared to restrict seasonal movements of monitored turkeys during spring and fall. However, males and subadult hens in the burned study division moved farther than those in the unburned during spring/fall. Hens tended to nest more in burned areas with each subsequent year following the fire. Nest success was highest during the spring with largest amounts of precipitation. High levels of precipitation during spring likely promoted understory plant growth and increased nesting cover especially where fire opened the canopy to more sunlight and increased nutrient release to soils. Only 12 of 49 nests occurred in logged areas. Clearcut logging may be more detrimental to nesting habitat in xeric (for example, southeastern Montana) than mesic regions because of slower vegetational growth and lower habitat structural diversity. Nests generally occurred in cover ≥6.5 dm high and on ≥20% slopes. Summer home range sizes were not correlated with percent burned or logged areas that they contained. Roost trees within burned areas were larger in diameter than those in unburned areas. More “large” trees in severely burned areas may have become attractive to roosting turkeys through loss of dense canopy and simplified branch structure. Turkeys usually roosted in the taller (mean = 18m) and larger diameter (mean = 41cm dbh) trees available. On average, roosts occurred on 25% slopes with easterly or northeasterly aspects. Severely burned trees used for roosting may be lost over time because of their breakage and falling. No roosts occurred in forest stands subjected to any type of timber harvesting scheme. Survival rates of monitored turkeys were similar between burned and unburned areas. Overall, habitat quality for turkeys likely was lowered during the first year or 2 following the fire, but should generally increase (except roosting habitat) in subsequent years. The effects of logging on turkey habitat in southeastern Montana remain unclear; however, logged areas were rarely used by monitored turkeys during this study. **Key words: Merriam’s turkey, precipitation, fire, habitat use, vegetation**

510

Toepfer, J. E. 1988. The ecology of the greater prairie chicken as related to reintroductions. Dissertation, Montana State University, Bozeman, USA. Notes: Page 34—“In the fall, cocks displayed only during the morning on clear, calm mornings. During stormy or very cold days in winter the birds fed only in the morning…wild prairie chickens typically feed twice a day except during cold winter weather when they fed only once.: Page 49/50—“Adult cocks returned to the booming grounds in mid-September to re-establish their territories about the time of the first hard frost…[a] cock was observed displaying on a regular basis even on snow…” Page 71—“The decline [in weight] in winter was due to lower ambient temperatures and snow cover and reduced availability of food and increased energy demands. Reductions in food and cover caused daily movements and ranges to expand which thus increased energy demands caused by lower temperatures.” Page 73—“Immatures and adult hens appeared to be more sensitive to the rigors of winter than adult cocks.” Page 73/76—“Reasons for increased weight loss observed in the winter of 1976 are unknown. Weather differences between the years may have a greater effect on hens and immature cocks since they are generally smaller and more mobile than adult cocks.” Page 78—“The quantity and distribution of winter food and cover arte critical to survival as they directly influence daily movements and hence weight loss. Weight gains, during fall and on early winter peak, imply that food and cover in the fall are also very important.” Page 79—“The rapid increase in mean weights observed in prairie chickens during the early spring correspond to warming temperatures and the loss of snow cover, which increased distribution, quantity and quality of food and cover.” Page 80—“After snow melted radioed prairie chickens…were also attracted to the green plants which started to grow early in cultivated fields because of warmer soil conditions created by the disturbed soil." Page 82—"A relationship seemed to exist between the occurrence of green-up and onset of breeding since both were usually associated with warm springs." Page 175—"Winter was the period when wild prairie chickens were most vulnerable and suffered highest mortality." Page 201—"Seasonal variation in flushing distances was believed to be related to security provided by vegetative cover. Mean flushing distances were greatest in winter when cover was limited by snow and shortest during the summer when vegetation provided the greatest security." Page 218—"Snow cover restricted the availability of food causing both cocks and hens to form larger flocks." Page 225—"The number of movements made per day by radio-tagged prairie chickens varied with and within the seasons and was influenced most by the distribution of food and cover, breeding activities, sex, age, and weather conditions." Page 232—"The large home ranges in winter were related to snow cover, which reduced the availability of food and cover causing individuals to increase their home ranges to meet their daily needs. Page 233—"Home range sizes increased in fall as temperatures declined and birds began feeding in the agricultural fields in the mornings and evenings." Page 235—"Seasonal home ranges of both cocks and hens and immatures and adults were most comparable during summer and winter in the absence of breeding behavior. During these periods habitat conditions appeared to have the greatest influence on the size of a bird's home range." Page 237—"The fluctuations in weekly [home] ranges during winter were due to snow cover which changed food and cover conditions." Page 250—"Resident radio-tagged prairie chickens made movements that covered relatively large areas during periods when they were adjusting to new or changing conditions. These extended irregular movements in residents occurred…in winter when new snow covered a food source and birds made irregular movements to locate a new one…"Page 269—"Mean DD movements remained high and fluctuated throughout the winter as birds adjusted their movement patterns whenever fresh snow altered food and cover conditions. The magnitude and patterns of daily movements during winter were comparable between the sexes and ages and reflected the strong influence that habitat distribution had on movements." Page 274—"…twice daily feeding pattern stopped in winter during periods of sub-zero weather. During periods of cold weather radio-tagged birds and their flock members remained in roosts longer in the A.M., fed in agricultural fields later or during midday, flew to roosts earlier than normal (as early as 1400 hrs), and remained there until the following day." Page 275—"Visual observations were obtained of radio-tagged birds and flock members in snow burrows several hours before they normally would have gone to roost. Reduced activity during cold weather is believed to be an energy conservation mechanism. Several days of very cold weather are necessary for prairie chickens to initiate this behavior…radio-tagged prairie chickens have been known to remain in snow burrows after a heavy snow storm for 36 hours." Page 283—"The first permanent snow cover greater than 6 cm caused the cocks to abandon their booming grounds and center their activities around a food source…in fall, adult hens moved away from the booming grounds with the first heavy frosts as they began to feed in agricultural areas." Page 334—"Transplanting birds during winter because they are easy to catch will only compound the high natural mortality that resident prairie chickens experience at this time." Page 342—"The variation in plant species identified in seasonal cover reflected their structural form and their ability to provide cover at different times of the year, particularly the ability to withstand the weight of snow." Page 247—"Winter was the most difficult season for prairie chickens because snow reduced the amount and availability of food and cover. Each new snowfall changed conditions and altered the distribution of food and cover which caused prairie chickens to increase their movements and energy demands. Habitat types which provided cover and food above the snow were utilized most by birds…The snowfence effect of…willows caused an accumulation of snow on the lee side that was used for snow burrowing. This accumulation of snow also kept some of the leeward vegetation from being covered by snow." Page 350—"Some habitat types used at other times of the year were not used during winter because of snow cover. Upland grass was used during periods without snow, but used very little during winter." Page 351—"The only true shrub habitat used by the prairie chickens was *Spirea* in central Wisconsin which made up only 0.8% of day use and 8.3% of night use. However, shrub habitat may play an important role in providing cover when snow becomes crusted or unusually deep reducing the amount of wetland vegetation and grass-forb." Page 357—"In this study birds…made no movements to shrubs or trees for shade during hot weather. Instead of woody cover the radio-tagged prairie chickens…used taller clumps of grass and grass-forbs for shade." Page 360—"Frost and changing temperatures during fall caused the quality of upland grass to deteriorate as night cover. Changing weather conditions also caused cover to open up and allow access to some cover that was too dense to use in summer." Page 367—"Habitat use trends at night were influenced by snow and cold temperatures." Page 369—"Vegetation that projected above the snow was critical in providing prairie chickens with screening cover and protection from the snow and wind during winter….Classes I and II cover were used by prairie chickens when loafing in snow depressions or when the snow was deep enough to permit snow burrowing." Page 373—"During winter, snow altered the [vegetation] structure and permitted access to much of the taller vegetation…even during summer when temperatures were warm, radio-tagged prairie chickens shifted from shorter more open cover to faller….vegetation which made up 79.5% of the night roosting cover." Page 376—"Use of vegetation by height classes also varied within the seasons and was related to the development of vegetation and weather conditions. Page 381—"Much of the grass and sedge cover in the Class IV+ vegetation category was reduced to Class III or II category by weathering in fall and snow cover in winter." Page 467—"In Missouri, where the winters are milder and snow of lesser amount and duration, the bulk of the prairie chickens' diet consisted of native plants. Cultivated grains were used most when snow covered native vegetation. Deep persistent snow cover and the inability to subsist entirely on browse may have been the barrier that originally isolated the prairie chicken from the sharptail." **Key words: prairie chicken, snow, temperature, wind, frost, solar radiation, vegetation, habitat use, distribution, movement, soil, habitat quality, mortality, behavior, transplanting, plant phenology, plant structure**

511

Trautman, M. B., W. E. Bills, and E. L. Wickliff. 1939. Winter losses from starvation and exposure of waterfowl and upland game birds in Ohio and other northern states. Wilson Bulletin 51(2):86-104. Conclusions: Winter mortality of waterfowl and some species of upland game birds, caused by starvation, exposure to low temperatures, or a combination of both, occurs in widely scattered localities in the northern United States. Such mortality generally takes place during or immediately following severe sleet or snow storms when low temperatures freeze the surface water shutting off the usual food supply. During the average stress period apparently only those birds die which are weakened by disease, parasitism, lead poisoning, mechanical injury such as are made by gunshot wounds, or ice formation over eyes, in bill and nostrils. In extreme stress periods, and especially when the accumulated, adverse effects of winter are most pronounced, mortality of normal birds may occur from starvation and exposure. **Key words: ruffed grouse, ring-necked pheasant, bobwhite quail, snow, temperature, ice, mortality, nutrition**

512

Tsuji, L. J. S. 1992. Snowfall causes lek movement in the sharp-tailed grouse. Wilson Bulletin 104(1):188-189. Summary: Observations made on two leks suggest that stability of territories on leks can be affected by unusual environmental circumstances. In one case, flooding caused the lek to move 30.5 m from its location noted the previous day; in the other, a snowstorm covered existing landmarks on the muskeg with the lek forming and reforming in three different locations in the same morning. Although the location of the lek changed in these two cases, the actual infrastructure of the lek appeared unchanged. In other words, individuals in the lek maintained their positions relative to one another. **Key words: sharp-tailed grouse, snow, flood, habitat use, behavior**

513

Uhlig, H. G. and R. W. Bailey. 1952. Factors influencing the distribution and abundance of the wild turkey in West Virginia. Journal of Wildlife Management 176(1):24-32. Notes: Under “Summary” the authors state—“The turkey kill and mast conditions correlate with minimum temperatures occurring during May. The greater the extent of below normal temperatures for that month, the poorer the crop of mast and the lower the reported turkey kill of the same year.” **Key words: Eastern wild turkey, temperature, vegetation, hunting**

514

Vander Haegen, W. M. 1992. Bioenergetics of American woodcock during the breeding season on Moosehorn National Wildlife Refuge, Maine. Dissertation, University of Maine, Orono, USA. Abstract: Bioenergetics of female American woodcock (*Scolopax minor*) was studied from 1987-1989 at Moosehorn National Wildlife Refuge, Maine. A model of daily energy expenditure was developed from laboratory-derived data on metabolic rates; from data on activity and microclimates collected in the field; and from body component analysis of collected birds. Energy demands incurred by female woodcock on the breeding grounds were highest during the pre-nesting (60.3 kcal/day) and laying (89.1 kcal/day) periods. Availability of food (earthworms – *Lumbricidae*) is normally sufficient during these periods, but shortages such as the one caused by persistent soil frost in spring of 1989 can delay nesting and affect productivity. Female woodcock feed throughout the diel period prior to incubation, obtaining nutrients for reproductive tissues and to store fat for use during incubation. Incubating females spend only 8% of the day active and used endogenous reserves to supplement energy derived by feeding, losing about 75% of their body fat over incubation. In March and April 1989, energy intake was too low to initiate egg production as nesting did not occur until the frost melted and earthworm availability returned to normal, 3-4 weeks later than the typical nesting date in Maine. Woodcock chicks are not homeothermic until 15-20 days old, and there is an inverse relationship between air temperature and brooding requirements. At air temperatures typical of the brood period, a drop in mean air temperature of (illegible) can result in a 40% decrease in time spent active, with a concomitant loss of foraging time. Rainfall also increases the brooding requirements of chicks, reducing by 30% the time spent activity by chicks (illegible) 10 days old. Reduced foraging time lowers both energy intake by the female and her ability to feed the chicks. Lack of snow cover, and freezing temperatures, influence the depth of soil frost and can reduce both food availability in spring and woodcock productivity. In addition, weather during the brood period and condition of the female at the end of incubation play important roles in determining the number of offspring produced. Thus, habitat management should strive to provide high earthworm biomass in a variety of suitable feeding sites to ameliorate the effects of weather. **Key words: American woodcock, temperature, frost, precipitation, snow, soil, nutrition, productivity**

515

______, W. B. Krohn, R. B. Owen Jr., J. R. Longcore, and G. F. Sepik. 1993. Effects of weather on earthworm abundance and foods of the American woodcock in spring. Proceedings of the American Woodcock Symposium 8, U. S. Fish and Wildlife Service Biological Report 16:26-31. Abstract: Earthworms composed greater than 90% (dry weight and volume) of food consumed by 48 American woodcocks (*Scolopax minor*) collected during the springs of 1987-89 on the Moosehorn National Wildlife Refuge, Maine. The availability of earthworms seemed related to amount of snow in winter and persistence of frost in the soil in spring. When earthworms were less available, the intake of food by woodcocks declined and the relative importance of litter-inhabiting prey (Coleoptera and Araneae) increased. Reduced intake of food lowered the body mass of female woodcocks in 1989 and evidently caused a 3-4 week delay in nesting. Results suggest that conditions in winter and spring affect availability of food and subsequently influence body mass, time of nesting, and reproductive success of woodcock. **Key words: American woodcock, snow, frost, temperature, nutrition, reproduction**

516

______, M. W. Sayre, and W. E. Dodge. 1989. Winter use of agricultural habitats by wild turkeys in Massachusetts. Journal of Wildlife Management 53(1):30-33. Abstract: We examined winter habitat use by eastern wild turkeys (*Meleagris gallopavo sylvestris*) in western Massachusetts during 1984 and 1985. Use-availability analyses revealed that flocks used cropland, pasture, and softwood habitats more, and hardwoods, mixed woods, and abandoned fields less than expected ($P < 0.05$). Flocks spent 54% of the diurnal period in cropland and pastures and spent more time feeding on manure spread on fields than on any other single food source. During period of deep snow, turkeys restricted their movements to < 20 ha, used softwood stands and adjacent cropland and pastures, and fed largely on manure. Decline of dairy farming in

Massachusetts may adversely affect local turkey populations. **Key words: turkey, snow, habitat use, behavior**

517

Van Kooten, G. C., A. J. Eagle, and M. E. Eiswerth. 2007. Determinants of threatened sage-grouse in northeastern Nevada. Human Dimensions of Wildlife 12:53-70. Abstract: We examined potential human determinants of observed declines in greater sage-grouse (*Centrocercus urophasianus*) populations in Elko County, Nevada. Although monitoring of sage-grouse has occurred for decades, monitoring levels have not been consistent. This article contributes to the literature by normalizing grouse counts by the annual effort to count them, performing regression analyses to explain the resulting normalized data, and correcting for sample selectivity bias that arises from years when counts were not taken. Our findings provide some evidence that cattle grazing contributes to a reduction in sage-grouse populations, but this result should be interpreted with caution because our data do not include indications about the timing and precise nature of grazing practices. Annual variations in weather appear to be a major determinant after statistically controlling for human interactions with the landscape, suggesting that climate change is a key potential long-run threat to this species. **Key words: sage-grouse, climate change, population dynamics**

518

Vehrencamp, S. L., J. W. Bradbury, and R. M. Gibson. 1989. The energetic cost of display in male sage-grouse. Animal Behavior 38:885-896. Abstract: The energetic expenditure of displaying male sage-grouse, *Centrocercus urophasianus*, was measured for 18 individuals in the field using the doubly labeled water technique. Daily energy expenditure increased significantly with increased display rate, increased time spent on the lek, and decreased ambient temperature. Daily energy expenditure for the most vigorously displaying males was two times higher than for a non-displaying male and four times higher than basal metabolic rate. Estimates of the instantaneous rate of energy expenditure during display ranged from 13 x 9 to 17 x 4 times basal metabolic rate. The effort devoted to display differed markedly among males and was correlated with certain other male characteristics. Males that attended leks were in better condition (higher body weight relative to size) than non-attenders, but among lek attenders condition was negatively correlated with increased display effort. **Key words: sage-grouse, temperature, behavior**

519

Voronin, R. N. 1991. Variability in the lay size of *Lagopus lagopus* in the Bolshezemelskaya Tundra, Russian SFSR, USSR. Ekologiya 1:68-72. Abstract: Dynamics of the lay size of the willow grouse (*L. lagopus*) were studied from 1970 to 1984 in the Bolshezemelskaya Tundra. In different years the average lay varied from 6.09±0.39 to 10.85±0.15 eggs. A series of biotic and abiotic factors serves as the basis for these variations (i.e., physiological status of individuals, the structure of the population, and weather conditions). **Key words: willow grouse, productivity, weather**

520

Vysotsky, V. G. and I. V. Iljinsky. 2004. Method of forecasting changes in the abundance of woodcock (*Scolopax rusticola*) based on weather conditions on the wintering grounds. Proceedings of the Zoological Institute, Russian Academy of Sciences 300:165-174. Notes: Page 165—"It is known that woodcock winter survival in France covaried positively with mean winter nocturnal temperature. We…tested the hypothesis that annual survival rates depend on winter precipitation and temperature within woodcock main winter range." Page 172—"Average monthly air temperature for November-February in United Kingdom, France, and Italy is an important index for bird annual survival process. It is known that temperature affects directly activity (and hence availability) of many species of earthworms, which are the basis of woodcock diet. Temporal variability in earthworm availability may be an important determinant of woodcock winter survival. Moreover, annual variation in woodcock abundance during breeding in north-western Russia may well be explained by winter severity in the main part of the wintering area." **Key words: woodcock, temperature, precipitation, index, model, mortality, nutrition**

521

Walker, B. L., D. E. Naugle, K. E. Doherty, and T. E. Cornish. 2007. West Nile Virus and greater sage-grouse: estimating infection rate in a wild bird population. Avian Diseases 51:691-696. Summary: Understanding impacts of disease on wild bird populations requires knowing not only mortality rate following infection, but also the proportion of the population that is infected. Greater sage-grouse (*Centrocercus urophasianus*) in western North America are known to have a high mortality rate following infection with West Nile virus (WNv), but actual infection rates in wild populations remain unknown. We used rates of WNv-related mortality and seroprevalence from radiomarked females to estimate infection rates in a wild greater sage-grouse population in the Powder River basin (PRB) of Montana and Wyoming from 2003 to 2005. Minimum WNv-related mortality rates ranged from 2.4% to 13.3% among years and maximum possible rates ranged from 8.2% to 28.9%. All live-captured birds in 2003 and 2004 tested seronegative. In spring 2005 and spring 2006, 10.3% and 1.8%, respectively, of newly captured females tested seropositive for neutralizing antibodies to WNv. These are the first documented cases of sage-grouse surviving infection with WNv. Low to moderate WNv-related mortality in summer followed by low seroprevalence the following spring in all years indicates that annual infection rates were between 4% and 29%. This suggests that most sage-grouse in the PRSB have not yet been exposed and remain susceptible. Impacts of WNv in the PRB in the near future will likely depend more on annual variation in temperature and changes in vector distribution than on the spread of resistance. Until the epizootiology of WNv in sagebrush-steppe ecosystems is better understood, we suggest that management to reduce impacts of WNv focus on eliminating man-made water sources that support breeding mosquitoes known to vector the virus. Our findings also underscore problems with using seroprevalence as a surrogate for infection rate and for identifying competent hosts in highly susceptible species. **Key words: sage-grouse, temperature, insects, disease**

522

Wallestad, R. 1975. Life history and habitat requirements of sage-grouse in central Montana. Montana Department of Fish and Game, Helena, USA. Notes: Under the heading Limiting Factors, the author gives a brief treatment of weather. Wallestad notes “The success or failure of sage-grouse in a particular year has generally been attributed to weather conditions during hatching. Cold, rainy weather were the conditions usually blamed for poor productivity.” He cites research by Wallestad and Watts that showed no correlation between productivity and rainfall during the hatching period, and an inverse correlation between productivity and rainfall during the egg-laying period. Heavy rain (greater than 1 inch) during the egg-laying period caused a late hatch resulting in poor productivity (less than 400 juveniles:100 females). Total spring precipitation, as it potentially affected spring greenup of vegetation, further explained variations in productivity. Even if rainfall was optimum during the egg-laying period, production would be poor if total spring precipitation during the growing season was inadequate for necessary plant growth (les than 3 inches from mid-April thorough mid-June). They found no correlation between temperature and productivity. **Key words: sage-grouse, precipitation, temperature, productivity, vegetation**

523

______ and R. C. Watts. 1972. Factors effecting annual sage-grouse productivity in central Montana. Small Game Research W-120-R-3, Montana Department of Fish and Game, Helena, USA. Abstract: Analysis of 10 years (1962-1971) of sage-grouse population and selected climatic variables have identified several factors apparently affecting sage-grouse productivity in central Montana. Years with a late hatch have significantly poorer productivity than years with a normal hatch. Total rainfall or storm intensity during the egg laying period is inversely correlated to productivity. However, a lack of moisture necessary for spring green-up of vegetation can cause poor productivity. There is also a correlation between productivity and percent of successful yearling females in the population. None of the other climatic or population variables analyzed affected productivity. **Key words: sage-grouse, precipitation, productivity**

524

Wambolt, C. L., A. J. Hapr, B. L. Welch, N. Shaw, J. W. Connelly, K. P. Reese, C. E. Braun, D. A. Klebenow, E. D. McArthur, J. G. Thompson, L. A. Torell, and J. A. Tanaka. 2002. Conservation of greater sage-grouse on public lands in the western U.S.: implications of recovery and management policies. PACWPL Policy Paper SG-02-02. Policy Analysis Center for Western Public Lands, Caldwell, USA. Notes: Page 5—“In years of high precipitation, succulent forbs may persist in sagebrush uplands and change bird movements…In very dry years, sage-grouse may use summer habitat until November. Grouse may also move to higher elevations containing moist sites.” Page 6—“…fires in sagebrush habitats may decrease insects used by grouse as food….In some areas, meadows are important summer habitat for sage-grouse because they provide an abundance of succulent forbs. These areas are especially important during drier summers….Desiccation and frost kill forbs in summer foraging areas….Unlike other seasonal habitats that have two or more components important to sage-grouse, the only critical habitat component important during winter is sagebrush. Sage-grouse are totally dependent upon sagebrush habitats for food and cover throughout the winter period.” Page 7—“…low sagebrush and black sagebrush also provide important winter habitats when snow depth allows grouse access to these relatively low-growing shrubs. Sagebrush canopy cover in sage-grouse winter habitats ranges from 12 to 43%, and sagebrush height above snow ranges from 8 to 22 inches (20 to 56 cm) throughout the species’ range….On a landscape scale, sage-grouse winter habitats should allow grouse access to sagebrush under all snow conditions…There is little, if any, evidence that severe winter weather affects sage-grouse populations unless sagebrush cover has been eliminated or significantly reduced. However, without adequate sagebrush leaves available for winter forage, body mass may decrease and spring breeding displays may be reduced.” Page 25—“ Drought: When drought is severe on most allotments, grazing regimes are already, or should be, altered to comply with the agency standards and guidelines. Public grazing lessees often feel that grouse advocates are singling them out unfairly. They feel that many factors affect the grouse and, until other factors are addressed as well, grazing should not be further restricted beyond what is required to meet standards and guidelines. Grouse advocates and most environmentalists counter by pointing out that if grouse habitats were ‘optimal’ then the grouse population should be able to withstand drought periods without such serious declines.” **Key words: sage-grouse, precipitation, fire, frost, snow, vegetation, nutrition, habitat use, reproduction, drought, grazing**

525

Wang, G., N. T. Hobbs, H. Galbraith, and K. M. Giesen. 2002. Signatures of large-scale and local climates on the demography of white-tailed ptarmigan in Rocky Mountain National Park, Colorado, USA. International Journal of Biometeorology 46:197-201. Abstract: Global climate change may impact wildlife populations by affecting local weather patterns, which, in turn, can impact a variety of ecological processes. However, it is not clear that local variations in ecological processes can be explained by large-scale patterns of climate. The North Atlantic Oscillation (NAO) is a large-scale climate phenomenon that has been shown to influence the population dynamics of some animals. Although effects of the NAO on vertebrate population dynamics have been studied, it remains uncertain whether it broadly predicts the impact of weather on species. We examined the ability of local weather data and NAO to explain the annual variation in population dynamics of white-tailed ptarmigan (*Lagopus leucurus*) in Rocky Mountain National Park, USA. We performed canonical correlation analysis of the demographic subspace of ptarmigan and local-climate subspace defined by the empirical orthogonal function (EOF) using data from 1975 to 1999. We found that two subspaces were significantly correlated on the first canonical variable. The Pearson correlation coefficient of the first EOF values of the demographic and local-climate subspaces was significant. The population density and the first EOF of local-climate subspace influenced the ptarmigan population with 1-year lags in the Gompertz model. However, the NAO index was neither related to the first two EOF of local-climate subspace nor to the first EOF of the demographic subspace of ptarmigan. Moreover, the NAO index was not a significant term in the Gompertz model for the ptarmigan population. Therefore, local climate had stronger signature on the demography of ptarmigan than did a large-scale index, i.e., the NAO index. We conclude that local responses of wildlife populations to changing climate may not be adequately explained by model that project large-scale climatic patterns. **Key words: white-tailed ptarmigan, NAO, index, model, population dynamics**

526

Ward, J. M., D. J. McCafferty, G. D. Ruxton, and D. C. Houston. 2007. Thermal consequences of turning white in winter: a comparative study of red grouse *Lagopus lagopus scoticus* and Scandinavian willow grouse *L-l. lagopus*. Wildlife Biology 13(2):120-129. Abstract: The red grouse *Lagopus lagopus scoticus* differs from the willow grouse *L. L. lagopus* of mainland Europe in not developing a white winter plumage. Previous studies have suggested that plumage coloration in birds can have important consequences for heat transfer through the feather layer. We examined the thermal consequences of plumage coloration in both subspecies of grouse. There were no differences in feather density, plumage depth or thermal resistance of the plumage between dark rufous Scottish and white Scandinavian grouse. In still air, heat gained from simulated solar radiation was greater through dark than through white plumage. However, in wind there was no difference in heat load between dark and white plumages. Our study suggests that there may be a tradeoff between thermal and camouflage benefits of plumage color for grouse in the wild. **Key words: red grouse, willow grouse, thermoregulation, solar radiation, wind, morphology**

527

Warner, R. E. and L. M. David. 1982. Woody habitat and severe winter mortality of ring-necked pheasants in central Illinois. Journal of Range Management 46(4):923-932. Abstract: Ring-necked pheasant (*Phasianus colchicus*) populations declined 44-82%, primarily from exposure to precipitation and severe wind chill, in the severe winters of 1976-77 and 1977-78 on 5 study areas in east central Illinois. Pheasant abundance, estimated by cock-call counts, and woody vegetation were measured on 45 1,036-ha subunits during 1976-78. Multiple regression analyses indicated no relationship between pheasant abundance on the 45 subunits before or after severe winter weather, and the abundance, growth forms, or arrangement on the landscape of woody vegetation. Declines in cock calls, 1976-78, were a mathematical function of pheasant densities prior to severe winter weather (r = 0.94, P < 0.001). **Key words: ring-necked pheasant, temperature, wind, precipitation, mortality**

528

Watson, A., R. Moss, and P. Rothery. 2000. Weather and synchrony in 10-year population cycles of rock ptarmigan and red grouse in Scotland. Ecology 81(8):2126-2136. Abstract: Rock ptarmigan (*Lagopus mutus*) on two adjacent submassifs, the red grouse (*Lagopus lagopus scoticus*) on lower ground between them, showed largely synchronous ~10-year cycles during a ~50-year study on the infertile Cairngorms massif of Scotland. Adult birds of both these *Lagopus* species were counted along transect walks. Both species showed the very low mid-1940s trough previously recorded for *tetraonids* in much of northwest Europe. Each of five subsequent peaks in all three populations fell within a year of one another, and 1-2 year after cyclic high June temperatures at a nearby village. Troughs were less synchronous. A model with lagged June temperatures and fourth-order delayed density dependence, with no input from observed bird numbers after the first 4 years, gave a good postdiction of rock ptarmigan numbers on the bigger submassif for 49 years, suggesting a weather cycle entraining on rock ptarmigan cycle. However, June temperatures had little explanatory value for rock ptarmigan numbers on the smaller submassif. Indirect evidence suggested that synchrony between the two rock ptarmigan trajectories may have been due partly to emigration from the bigger to the smaller submassif. The population trajectory of red grouse resembled that of rock ptarmigan on the smaller submassif more closely than the two rock ptarmigan trajectories resembled one other. Hence synchrony depended more on local circumstances than on species. **Key words: rock ptarmigan, red grouse, temperature, population dynamics, behavior**

529

_____, _____, and S. Rae. 1998. Population dynamics of Scottish rock ptarmigan cycles. Ecology 79(4):1174-1192. Abstract: Scottish rock ptarmigan (*Lagopus mutus*) showed unstable population dynamics, with density-dependent features differing between areas on rich and poor soils. The study was conducted on arctic-alpine land on four submassif, three of nutrient-poor granite and one of richer schist. Ptarmigan numbers cycled with a period usually of ~10 yr, but sometimes 6 yr. Delayed density dependence was detected in populations on granite submassif, but not on schist, despite significant cyclicity there. Spring densities and the number of young reared per brood were higher on schist than on granite. Population change from one spring to the next was related to intervening breeding success on both granite and schist, but to summer loss only on granite. The same factors that determined variations in clutch size among years also largely affected breeding success. Population change, breeding success, summer loss, and clutch size showed delayed density dependence on granite, but not on schist, where numbers fluctuated more erratically. On granite, but not schist, early plant growth was followed by larger clutches, breeding success was related to June air temperature, and June temperature tended to peak 1-2 yr before ptarmigan peaks. Cyclic June temperature may have entrained the timing of ptarmigan cycles on granite. Results on both schist and granite were inconsistent with expectations from predator-prey hypotheses for cycles. In years of rising numbers, hens laid more eggs and reared more chicks per extra egg laid than in years of decline, and the proportion of surviving young recruited into the spring population was probably greater. Our hypothesis is that Scottish rock ptarmigan show unstable dynamics, driven by intrinsic positive feedback between recruitment in one year and the next, regulated by negative feedback between recruitment and density, and modified by the physical factors of weather and soil fertility that affect female nutrition and breeding success. **Key words: rock ptarmigan, temperature, population dynamics, soil**

530

Watts, C. R. 1973. Factors affecting annual sage-grouse productivity in central Montana. Western States sage-grouse Workshop Proceedings 8:49. Abstract: Analysis of 10-years (1962-71) of wing data has identified several factors apparently affecting sage-grouse (*Centrocercus urophasianus*) productivity in central Montana.

Years with a late hatch have significantly poorer productivity than years with a normal hatch. Total rainfall or storm intensity during the egg laying period is inversely correlated to productivity. However, a lack of moisture necessary for spring green up of vegetation can cause poor productivity. Productivity and percent of successful yearling females in the population is directly correlated. None of the other climatic or population variables analyzed affected productivity. **Key words: sage-grouse, precipitation, productivity**

531

Wayne, A. T. 1899. Destruction of birds by the great cold wave of February 13 and 14, 1899. Auk 26:197-198. Notes: "The woodcock arrived in countless thousands. Prior to their arrival I had seen but two birds the entire winter. They were everywhere and were completely bewildered. Tens of thousands were killed by would be sportsmen, and thousands were frozen to death. The great majority were so emaciated that they were practically feathers and of course were unable to withstand the cold." [The cold wave which struck the coast of South Carolina was the severest recorded for 200 years including deep snow up to 5 in. and drifts 2 ft. deep with cold temperatures.] **Key words: woodcock, snow, temperature, mortality**

532

Wegge, P. and L. Kastdalen. 2007. Pattern and causes of natural mortality of capercaillie, *Tetrao urogallus*, chicks in a fragmented boreal forest. Annales Zoologici Fennici 44:141-151. Abstract: Over a 3-year period, we equipped 115 newly hatched capercaillie chicks in 29 broods with small radio transmitters in southeast Norway. Besides monitoring the fate of the chicks, we measured the abundance of microtine rodents and insect food and, together with weather records, we examined the observed mortality in relation to these factors. On average, 57% of the chicks died within the first month of life. Mortality was highest during the first 3 weeks, coinciding with the period when chicks feed almost exclusively on insects, depend heavily on their mother for maintaining body warmth, and cannot fly well. Predation was by far the most important proximate cause of mortality, accounting for 90% of all observed losses. Only 7% of the losses could be ascribed to direct effects of cold and wet weather, all recorded during the first 8 days of life. However, because predation losses were also quite high during and immediately after heavy rainfalls, adverse weather probably predisposed the chicks to mammalian predation. Most chicks were killed by mustelids, mainly pine martens; low numbers of red fox due to sarcoptic mange probably explains the low proportion taken by this predator. Among known predation losses (n = 40), goshawks accounted for a minimum of 25%. Chick mortality during the first month varied markedly (29%-83%) among the three years. It was highest in the year when June weather was exceptionally wet and cold; the same year when the density of microtine rodents and food abundance in terms of insect larvae were highest. Net production in late August was poorly related to chick loss during the first month posthatch. **Key words: capercaillie, temperature, precipitation, predation, chick survival**

533

Weigand, J. P. 1980. Ecology of the Hungarian partridge in north-central Montana. Wildlife Monographs 74:3-106. Notes: Under the subheading “Effects of Weather”, Weigand states: “Findings of the current study generally agreed that weather conditions, particularly amounts of precipitation, in late spring-early summer influenced partridge production. A dry spring results in early nesting and yields above average production unless heavy and/or prolonged rainfall is received during the first 3 weeks after peak hatching periods. The latter conditions will effectively reduce anticipated population gains. Above average precipitation in April probably will delay or interfere with early nesting, but low precipitation received after hatching will permit greater chick survival and reasonably good, overall production. Heavy rainfall during nesting and hatching probably precludes any reasonable degree of successful production for that year.” **Key words: Hungarian partridge, precipitation, temperature, productivity**

534

_____. 1977. The biology and ecology of Hungarian (European gray) partridge (*Perdix perdix L.*) in northcentral Montana. Dissertation, Montana State University, Bozeman, USA. Notes: On page 176 under “Effects of Weather” Weigand discusses the impacts of precipitation and temperature on nesting and brooding. He found that in 1969 some incubated nests were adversely affected in June and renesting occurred. Spring of 1970 was the wettest period in 5 years. Above normal precipitation in April/May and below normal temperatures apparently delayed nesting. Mean brood sizes were 1% below the 5-year mean in July and 11% in August. In 1971 a dry early brooding period favored chick survival and the result was above normal chick production. “Findings of the Montana study generally agreed that weather conditions, particularly amounts of precipitation, in late spring-early summer influenced partridge production. A dry spring results in early nesting which yields above-average production unless heavy and/or prolonged rainfall is received during the first three weeks after peak hatching periods. The latter conditions will effectively reduce anticipated population gains. Above-average precipitation in April will probably delay or interfere with early nesting but low precipitation received during post-hatching will permit greater chick survival and reasonably good overall production. Heavy rainfall during nesting and hatching probably precludes any reasonable degree of successful production for that year.” Page 245 – “Shelterbelts and tree groups were in greatest association during Dec-Feb (>95%) and least in October (60%). Low use of shrubs in winter was attributed to these types filling in with snow, thereby severely limiting their value as protective cover. Page 265—“Partridge proximity to woody cover I winter appeared to be influenced by weather and ground conditions. Partridge were less mobile early in milder than average (1969-70) and average (1970-71) winters than in a severe winter (1971-72)…recurrence of severe winter conditions caused the birds to resume close association.” **Key words: Hungarian partridge, temperature, snow, precipitation, habitat use, reproduction, population dynamics**

535

______ and R. G. Janson. 1976. Montana’s ring-necked pheasant. Montana Department of Fish and Game, Helena, USA. Summary: Under Decimating Factors, the authors present a discussion of weather and its impact on productivity. Among the weather factors that exert such impacts are snow depth, precipitation, hail, temperature, and man-made weather alterations. **Key words: ring-necked pheasant, temperature, snow, hail, precipitation, mortality, productivity, habitat use**

536

Whitaker, D. M. 2003. Ruffed grouse (*Bonasa umbellus*) habitat ecology in the central and southern Appalachians. Dissertation, Virginia Polytechnic Institute and State University, Blacksburg, USA. Notes: Page 32—"Weather-related variables influenced roost site selection by grouse. Although snow depths were never sufficient to allow snow burrowing, ground roosting increased when any snow cover was present. Precipitation during the night also influenced the incidence of ground roosting, with the smallest proportion of ground roosts observed during nights having rainfall, and the greatest proportion observed during nights having snowfall. Grouse shifted from predominantly using above ground roosts at temperatures above freezing to using ground level roosts when temperatures fell below 0°C. However this relationship may have resulted from the association of snow cover with cold weather, and no difference was detected when observations were restricted to nights having no snow cover. Air temperature did not influence the proportion of grouse roosting in evergreen vegetation." Page 34—"Ground roosting was frequent on nights when temperatures fell below freezing and least common on nights having rainfall, when leaves were wet. Because snow cover was always shallow, ground roosts in snow typically extended down into the leaf litter. Snow cover is associated with low temperatures, and it may be that the combination of these factors contributes to a general superiority of ground roosts during cold weather. Finally, grouse in the region are red-phased, so are inconspicuous to predators when buried flush with the similarly colored leaf litter. Given the behavioral parallel to snow burrowing, the development of such leaf-roosting behavior seems reasonable." **Key words: ruffed grouse, snow, temperature, precipitation, behavior, habitat use**

537

_____. and D. F. Stauffer. 2003. Night roost selection during winter by ruffed grouse in the central Appalachians. Southeastern Naturalist 2(3):377-392. Abstract: In northern regions, ruffed grouse (*Bonasa umbellus*) conserve considerable energy during winter by burrowing under snow cover to roost. When conditions are unsuitable for snow burrowing grouse almost invariably roost in conifers. We studied selection of winter night roosts by ruffed grouse in western Virginia, a region where snow accumulations are rare and transient. Grouse almost always used ground roosts when snow was present even though snow was never deep enough for snow burrowing. When snow was absent grouse did not show any clear preference in roost microsite type, and were found roosting in and under deciduous and evergreen trees and shrubs, in brush piles, and in leaf litter. We hypothesize that this ambivalence to conifers was due in part to persistent accumulations of fallen oak leaves, which likely afford grouse good thermal cover and concealment. Grouse were frequently found at low elevations during daytime, but rarely roosted in bottoms. This suggests daily elevational movements, possibly to avoid cold air settling in low-lying areas during night. **Key words: ruffed grouse, snow, temperature, behavior, thermoregulation**

538

Whiting, R. M. Jr., D. A. Haukos, and L. M. Smith. 2005. Factors affecting January reproduction of American woodcock in Texas. Southeastern Naturalist 4(4):639-646. Abstract: *Scolopax minor* (American Woodcock) populations have been declining for the past several decades. Weather conditions have been hypothesized to affect reproductive efforts in February and March in the southern United States, but similar influences on January breeding activities are unknown. We used a 17-year harvest data set from eastern Texas to examine the influence of several temperature and precipitation measures, female body mass, and forest habitat type on the occurrence of reproduction by woodcock in January. Only adult females exhibited characteristics of breeding activity. There was annual variation (0-29%) in the occurrence of breeding adult females, but local temperature and precipitation measures were not correlated with January reproduction. More breeding woodcock were harvested in open sapling stands than other habitats. Environmental factors other than monthly temperature and precipitation may influence January reproductive efforts of woodcock in eastern Texas. We suggest investigation of timing of fall migration and condition of the birds upon arrival on wintering grounds as potential factors influencing reproductive efforts in January. **Key words: American woodcock, temperature, precipitation, reproduction**

539

Wiebe, K. L. and K. Martin. 1995. Ecological and physiological effects on egg laying intervals in ptarmigan. Condor 97:708-717. Abstract: Birds lay eggs at different rates and at different times of the day. Some species also show skipped days during the laying sequence, "laying gaps," but patterns of egg laying have not been well studied. We compared timing of laying during the day, laying gaps, and laying rates (number of eggs/day) for white-tailed ptarmigan (*Lagopus leucurus*) and willow ptarmigan (*L. lagopus*). Both species tended to lay eggs near midday, but willow ptarmigan had fewer laying gaps and faster laying rates than white-tailed ptarmigan. The variation in laying rates among individuals was greater for white-tailed ptarmigan which had a bimodal distribution if inter-egg intervals, long (mean = 44 hr) and short (mean = 26 hr). Laying gaps were not associated with spring body condition but severe spring storms seemed to cause some laying delays. The patterns and frequency of gaps observed within and between species may be the result of nutrient constraints on egg formation in conjunction with physiological mechanisms which control a time-window for egg laying. **Key words: white-tailed ptarmigan, willow ptarmigan, severe weather, reproduction**

540

Wiley, E. N. II and M. K. Causey. 1987. Survival of American woodcock chicks in Alabama. Journal of Wildlife Management 51(3):583-586. Abstract: Survivability of American woodcock (*Scolopax minor*) chicks hatched in Alabama was investigated from March through April 1984-85. Ten broods (36 chicks) were radio tracked intermittently between hatching and brood breakup (at 32 days). Eleven chicks died during this period, 10 after fledging (15 days). The most common cause of mortality was predation (4 avian, 2 mammalian, and 2 unknown). One death was accidental and 2 died of unknown causes. Weather conditions apparently did not result in any chick losses. The pre-fledging survival probability (0.95) possibly indicates a high survival rate for Alabama-hatched chicks prior to fledging. The most vulnerable interval of the brood-rearing period occurred after fledging (16-32 days) when the survival probability decreased to 0.67 but may have been influenced by study methods. **Key words: American woodcock, mortality, weather conditions, chick survival**

541

Williams, G. R. 1954. Population fluctuations in some northern hemisphere game birds (Tetraonidae). Journal of Animal Ecology 23(1):1-34. Notes: Page 26 – "…it does seem that weather systems must play an important part. But, so far, all attempts to find a climatic factor correlated with the population changes have failed. Chitty has suggested how random variations in weather might tend to correlate cycles: in widespread favorable years, peak populations which had already approached their maximum densities might be unable to reach much higher levels; whereas sparser populations would be increasing rapidly towards the maximum possible for each particular environment—thus all populations would tend to approach their respective peaks together. On the other hand, if a widespread spell of severe weather were to result in mortality rates which increased with population density, then all populations would be reduced to similarly low levels. The effects of these two extreme conditions should be the promotion of some degree of synchrony. **Key words: weather extremes, population dynamics**

542

Williams, H. W. and A. W. Stokes. 1965. Factors affecting the incidence of rally calling in the chukar partridge. Condor 67:31-43. Summary: The purpose of this study was to measure the effects of physical and biotic factors on rates of rally calling in chukar partridge. Calling was most frequent around sunrise and sunset with little calling in between. Of the physical factors, light intensity and precipitation had the greatest effect on calling. The four factors of light intensity, temperature, wind, and rain accounted for 45% of the variation in morning calling and 54% of the variation in evening calling. Low light intensities associated with cloudiness during the day did not always result in increased calling rates. Wind velocities ranged from 0 to 45 mph; however, there were only 47 sampling periods with velocities in excess of 10 mph. At these times the chukars normally remained close to cover and did not call. The decrease in calling with increasing winds could be due to either the depressing effect of wind on the birds or the inability of a person to hear chukar calls above the noise of the wind. Rainfall normally caused the chukars to move to cover and stop calling. When unusually motivated, chukars may continue to call despite wind and rain. **Key words: chukar partridge, wind, precipitation, temperature, census, clouds**

543

Wilson, W. B., M. J. Chamberlain, and F. G. Kimmel. 2005. Survival and nest success of female wild turkeys in a Louisiana bottomland hardwood forest. Proceedings of the Annual Conference Southeast Association Fish and Wildlife Agencies 59:126-134. Abstract: Survival of female wild turkeys (*Meleagris gallopavo*) influences turkey productivity. Although patterns of survival and productivity have been extensively researched in most forested landscapes, little information is available for female turkeys in bottomland hardwood systems, although importance of these systems is widely recognized. Therefore, we captured and radiomarked 39 female wild turkeys in a bottomland hardwood forest in south-central Louisiana during 2001-2004. Mean annual survival was 0.67. Survival was greatest during preincubation (1.00) potentially because of increased habitat sampling and movement during this period. Fall-winter survival was high (0.93), likely attributable to stable foraging resources and a lack of illegal and legal harvest during this period. Lowest survival occurred during incubation (0.75) and brood-rearing (0.83), primarily as a result of increased risks of predation associated with nesting and brood rearing. Nest initiation rates (33%) were among the lowest reported, likely attributable to high nest loss from predation and flooding prior to completion of laying. Nest success of females reaching onset of incubation was 38%. Our findings suggest that the wild turkey population on our study site balances exceptionally low productivity with relatively high adult female survival. To ensure sustainable populations of wild turkeys, managers should monitor relationships between survival and productivity. Specific to our study site, improvements in nesting habitat may be needed to increase nest success and recruitment. **Key words: turkey, flooding, reproduction, recruitment**

544

Windingstad, R. M., S. M. Kerr, R. M. Duncan, and C. J. Brand. 1988. Characterization of an avian cholera epizootic in wild birds in western Nebraska. Avian Diseases 32(1):124-131. Summary: Avian cholera killed an estimated 2,500 birds in western Nebraska and eastern Wyoming from 28 November 1985 to late January 1986. Wild mallards (*Anas platyrhynchos*) suffered the most losses. Other wild waterfowl, wild turkeys (*Meleagris gallopavo*), a few domestic fowl, and a bald eagle (*Haliaeetusleucocephalus*) also died. *Pasteurella multocda* serotype 1 was the predominant isolate from these carcasses. Cold, wet weather persisted throughout the outbreak, but daily losses in the flock of 50,000 mallards using the area were low. *Pasteurella multocida* was isolated from nasal swabs of 35 of 37 cattle from a feedlot in which many of these mallards were feeding. Eighty percent of the cattle isolates had antigenic characteristics of serotype 3 or serotype 3 with cross-reactivity. Isolates from wild mallards, wild turkeys, and the bald eagle were virulent to game-farm mallards when inoculated subcutaneously, but *P. multocida* isolates from cattle were not. **Key words: turkey, disease, temperature, precipitation, mortality, Avian cholera**

545

Wiseman, D. S. and J. C. Lewis. 1981. Bobwhite use of habitat in tallgrass rangeland. Wildlife Society Bulletin 9(4):248-255. Notes: Page 250—"Coveys often rested in tall shrub habitat for several hours during midday." Page 251—"Coveys also showed preference (24% of use) for short shrubs that made up only 9% of the home ranges. Coveys used short shrubs for resting and for protection from weather and predators…during snow, rain, and prolonged cold some coveys spent most of the day in short shrubs and in December and January often roosted there." **Key words: bobwhite quail, snow, precipitation, temperature, habitat use, vegetation, behavior**

546

Wisinski, C. L. 2007. Survival and summer habitat selection of male greater sage-grouse (*Centrocercus urophasianus*) in southwestern Montana. M.S. Thesis, Montana State University, Bozeman, USA. Abstract: During the 20th century, greater sage-grouse (*Centrocercus urophasianus*) populations in North America have declined by 69-99%. In southwest Montana little is known about the factors leading to declines in sage-grouse populations; as a result, there are strong concerns regarding sage-grouse population trends and habitat quality. I used radio-marked male sage-grouse to obtain known-fate survival data and provide locations for habitat analyses. From 2001-2005, 45 male sage-grouse were instrumented and monitored. The estimated annual survival rate was 0.34 (95% CI: 0.21 to0 0.47). In 2004 and 2005, I measured vegetation characteristics at 78 habitat plots (43 used, 35 available). I used logistic regression to model habitat selection; grass height was an important predictor of use, but the negative relationship between the probability of a site being used and grass height was opposite of what I had predicted. Further research is needed to determine whether this behavior is adaptive. An important predictor of use in my exploratory analysis was solar radiation index (SRI). The negative effect of SRI on habitat selection may have been a result of sampling only during summer daylight hours, and SRI may have acted as a proxy for microsite temperature. Further research is needed over a wide variety of conditions to determine how habitat components relate to or interact with each other, habitat selection by sage-grouse, and survival of sage-grouse. **Key words: greater sage-grouse, solar radiation, index, habitat use, vegetation**

547

Withers, P. C. and T. M. Crowe. 1980. Brain temperature fluctuations in helmeted guineafowl under semi-natural conditions. Condor 82:99-100. Notes: Page 100--…the scatter in T_{br} for the guineafowl indicates that environmental variables, such as air temperature, radiation, convection and rain, probably influence T_{br} greatly. The highest T_{br}'s (41.8±SE 0.1°C, *n*=9) were consistently recorded between 09:00 and 13:00 when the aviary was in direct sunlight. The lowest T_{br}'s were 38.6±0.4°C (*n*=16) during the night and particularly after rain. The T_{br}'s during the day, in diffuse but not direct sunlight, were intermediate at 39.9±0.2°C (*n*=32). Brain temperature was significantly higher (ANOVA test, P<0.001) during the day with direct solar radiation than at other times, but T_{br} was not significantly correlated with either shade or sunlight air temperature. Although T_{br} was significantly lower with diffuse radiation (P<0.001) and during the night (P<0.001), T_{br} was not correlated with shade air temperature. Free-ranging guineafowl are clearly able to maintain higher T_{br}, through physiological or behavioral means, than birds in the laboratory…These data for the T_{br} regulation of Helmeted Guineafowl under semi-natural conditions, although preliminary, clearly indicate that: (1) guineafowl under semi-natural conditions have a markedly labile T_{br};

(2) T_{br} is generally greater for free-ranging guineafowl than for birds in the laboratory, reflecting the importance of incident solar radiation and diffuse radiation, and normal behavior patterns; (3) T_{br} of guineafowl under semi-natural conditions can be elevated in diffuse, and particularly in direct, solar radiation; we believe that the radiation effect is to directly warm the head and neck rather than influence blood flow patterns to the head; (4) postural adjustment scan result in rapid changes in T_{br} because of altered heat exchange with the environment. **Key words: helmeted guineafowl, solar radiation, rain, temperature, behavior, biothermal regulation**

548

Woodward, J. K. 2006. Greater sage-grouse (*Centrocercus urophasianus*) habitat in central Montana. M.S. Thesis, Montana State University, Bozeman, USA. Notes: Page 52 – "I also observed larger flocks on my study site when weather was cold. Flocks ranged from 1 to >150 birds during the two winters. I noticed flocks flushed when the observer was at a farther distance in the winter than was the case during nesting and brood rearing season. This suggests grouse would use cover for hiding from predators in nesting and brood rearing, but in the winter sage-grouse relied on one another to acknowledge predators and quickly leave the area." **Key words: sage-grouse, temperature, behavior**

549

Wright, R. G., R. N. Paisley, and J. F. Kubisiak. 1996. Survival of wild turkey hens in southwestern Wisconsin. Journal of Wildlife Management 60(2):313-320. Abstract: Successful restoration of wild turkeys (*Meleagris gallopavo*) to Wisconsin has stimulated increased interest in hunting and a need for specific management information. We determined survival and causes of mortality for 224 radiomarked hens during 1988-94 in Vernon County, Wisconsin under a relatively liberal fall harvest regime. Annual survival ranged from 43.1 to 66.0 and averaged 52.7% (SE = 4.8). Seasonal survival averaged 72.2 (SE = 2.9), 81.3 (SE = 3.3) and 89.3% (SE = 2.5) during recruitment (16 Mar to 14 Jul), post-recruitment (15 Jul to 21 Nov), and winter (22 Nov to 15 Mar), and was lower (P = 0.001) during recruitment than during winter. Predation accounted for 71.2% of all deaths and was highest during recruitment. Localized starvation occurred during a winter with 49 consecutive days of deep snow and cold temperatures. Cumulative fall hunter densities were about 3.5/km^2 of woodland and the fall harvest rate of radioed hens averaged 7.3%. Turkey densities declined during the study and more conservative fall harvests may be necessary. **Key words: turkey, snow, temperature, nutrition, mortality**

550

Wunz, G. A. and A. H. Hayden. 1975. Winter mortality and supplemental feeding of turkeys in Pennsylvania. Proceedings of the National Wild Turkey Symposium 3:61-69. Abstract: During a 12-year study in north-central Pennsylvania, wild turkeys (*Meleagris gallopavo silvestris*) starved in four winters when extended periods of deep powder snow prevented their foraging for food. More than half the turkeys at higher elevations died, even when supplemental food was provided. Turkey populations usually recovered in one breeding season and appeared more dependent upon the previous summer's reproductive success than upon the mildness of the preceding winter or the number of breeders available. **Key words: Eastern wild turkey, snow, nutrition, population dynamics**

551

Yahner, R. H. 1981. Avian winter abundance patterns in farmstead shelterbelts: weather and temporal effects. Journal of Field Ornithology 52(1):50-56. Notes: "Use of shelter belts by this species [pheasants] at the Rosemount Station was not correlated with weather or temporal factors in winter 1979, yet snow depth was important in winter 1980. I suggest that mean snow depth in 1979 (0.46 m) plus additional depth resulting from drifting in certain sectors of all shelterbelts, virtually eliminated access to low-lying sources of food and cover in shelterbelts during the 1979 winter. In contrast, decreased amounts of snow in shelterbelts during winter 1980 (0.10 m) conceivably permitted ring-necked pheasants to more easily obtain food and/or cover near ground level and in leaf litter with reduced time-energy costs because a smaller portion of shrubs and herbaceous plants were buried in snow compared to the previous winter…in years of reduced snow accumulation use of shelterbelts by ring-necked pheasants may be largely a function of snow depth; when snow depths are excessive, use of shelterbelts perhaps is contingent on other factors, such as annual fluctuations in population densities or proximity to alternate food sources. **Key words: ring-necked pheasant, snow, wind, habitat use, feeding, shelter**

552

Yeatter, R. E. 1950. Effects of different preincubation temperatures on the hatchability of pheasant eggs. Science 112(2914):529-530. Notes: "It seems probable that vulnerability of pheasant embryos to air temperature during the laying period has an important influence in limiting the southern distribution of pheasants. Pheasants reported breeding locally in the southern Pacific Coast and Rocky Mountain regions may be predominantly of southern Asiatic origin, and possibly thus more tolerant of higher temperatures." **Key words: ring-necked pheasant, temperature, reproduction, species range**

553

Yom-Tov, Y., Y. Benjamini, and S. Kark. 2002. Global warming, Bergmann's rule and body mass: are they related? The chukar partridge (*Alectoris chukar*) case. Journal of Zoology (London) 257(4):449-495. Abstract: Using museum specimens collected in Israel during the second half of the 20th century, no support was found for the hypothesis that body mass and tarsus length of chukar partridges *Alectoris chukar* has changed as a result of global warming. Body mass showed fluctuations during the year, reaching a maximum in late winter and spring and a minimum in summer. Bergmann's rule predicts that in warm-blooded animals, races from warm regions will be smaller than races from colder regions, and a wider explanation states that body size is positively related to latitude. Because of its topography and varied climate, Israel provides a unique opportunity to separate partly the effect of latitude from that of ambient temperature, thus testing if Bergmann's rule is related to latitude or to climatic variables. We found that body mass (and marginally also tarsus length) declined significantly with decreasing latitude in accordance with the wider explanation of Bergmann's rule, but ambient temperature explained a much smaller fraction of the variation in body mass than latitude. These results weaken the traditional explanation to Bergmann's rule that a heat conservation mechanism causes the latitudinal size variation. **Key words: chukar partridge, temperature, morphology, global warming**

554

York, D. L. and S. D. Schemnitz. 2003. Home range, habitat use, and diet of Gould's turkeys, Peloncillo Mountains, New Mexico. Southwestern Naturalist 48(2):231-240. Abstract: Our study documents home range, habitat use, and diet of Gould's turkey (*Meleagris gallopavo mexicana*) in the Peloncillo Mountains of New Mexico and Arizona. Fieldwork began in 1989 and consisted of 2 field seasons from May to August, with periodic winter and spring forays. The study was conducted during a drought period with only 58% of average rainfall. Combined annual home range (mean = 4,385 ha, *SE* = 1,845) of radio-equipped Gould's hens was similar to home ranges of other wild turkey subspecies that inhabit arid regions of the western United States. Preferred Gould's turkey habitat consisted of pinyon-juniper woodland with an abundance of pinyon ricegrass (*Piptochaetium fimbriatum*). In addition, 3 riparian habitat types were used disproportionately to their availability. A food habits analysis showed that the diet of turkey in our study consisted primarily of juniper (*Juniperus deppeana*) and manzanits (*Arctostaphylos pungens*) fruit, though mustard forbs (*Cruciferae* spp.) and pinyon ricegrass also were utilized. Periodic drought combined with livestock grazing in the Peloncillo Mountains most likely is a major factor determining forage availability and subsequent habitat use by this turkey population. A combination of natural and anthropogenic factors might result in fluctuations in the Gould's turkey population. **Key words: Gould's turkey, drought, precipitation, habitat use, vegetation, diet, population dynamics**

555

Young, J. A. 1981. Chukar partridge. Rangelands 3(4):166-168. Notes: <u>Page 168</u>—"Winter kill is to be periodically expected throughout the northern range of chukars in North America. Although chukars are very tolerant of cold weather, long periods of deep snows on feeding slopes can result in starvation." **Key words: chukar partridge, temperature, snow, motality**

556

Zablan, M. A., C. E. Braun, and G. C. White. 2003. Estimation of greater sage grouse survival in North Park, Colorado. Journal of Wildlife Management 67(1):144-154. Abstract: We estimated survival rates of greater sage grouse (*Centrocercus urophasianus*) in North Park, Colorado, USA, from band-recovery data of 6,021 birds banded during spring, 1973-1990, with recoveries through 1993. Average annual adult female survival (S = 0.59, SE + 0.011) was greater than average adult male survival (S = 0.37, SE = 0.007), and average subadult (<1 yr old at time of banding) female survival (S = 0.77, SES = 0.030) was greater than average subadult male survival (S = 0.63, SE = 0.034). Four weather covariates (spring and winter precipitation and temperature) did not contribute to predicting annual survival. **Key words: sage grouse, precipitation, temperature, survival prediction**

557

Zbinden, N. and M. Salvioni. 2004. Bedeutung der Temperatur in der fruehen Aufzuchtzeit fuer den Fortpflanzungserfolg des Birkhuhns *Tetrao tetrix* auf verschiedenen Hoehenstufen im Tessin, Suedschweiz (The importance of temperature during the early chick-rearing period for the reproductive success of black grouse *Tetrao tetrix* at different altitude levels in the Ticino, southern Swiss Alps. Der Ornithologische Beobachter 101(4):307-318. Abstract: In their first days of life grouse chicks are very susceptible to outside temperature because thermoregulation has not fully developed. From 1981 to 202 the relationship between reproductive success of black grouse and temperature was studied in the southern Swiss alps. Data showed that at different altitude levels temperature conditions in different time periods were particularly important: In northern Ticino (at the highest altitude) reproductive success depended on the mean daily temperature of five-day period 41 (20—24 July), in the central Ticino that of five-day period 39 (10—14 July) and in southern Ticino (at the lowest altitude) temperature of five-day period 37 (30 June to 4 July). At the altitude levels of the home ranges of Black grouse hens temperature in these three five-day periods reached a mean of 11.4 t0 11.8 degrees C. In northern Ticino five-day period 41 lies in the warmest season. In central and southern Ticino temperatures continue to grow after the five-day period most relevant for reproductive success. A comparison of the temperature conditions in the southern Swiss alps with those in Finland indicated different time constraints for alpine and northern birds: in Finland, before the start of egg-laying only one month with temperatures above 0 degrees C and thus increased assimilation of food plants is available to the hens, whereas in northern Ticino this period reaches more than two months. When spring arrives late Finnish hens are not able to build up sufficient reserves and lay eggs from which weak chicks hatch. On the other hand, temperature conditions in Finland after hatching are favorable for chick rearing. In the southern Swiss alps the opposite is the case. Hens have enough time to build up reserves before egg laying. In cold summers, however, temperature after hatching is often not high enough to enable a high number of chicks to survive the first critical days. **Key words: black grouse, temperature, mortality**

558

Zimmerman, G. S., R. R. Horton, D. R. Dessecker, and R. J. Gutiérrez. 2008. New insight to old hypotheses: ruffed grouse population cycles. Wilson Journal of Ornithology 120(2):239-247. Abstract: We examined factors hypothesized to influence ruffed grouse (*Bonasa umbellus*) population cycles by evaluating 13 *a priori* models that represented correlations between spring counts of male ruffed grouse drumming displays and these factors. We used AIC_c to rank the relative ability of these models to fit the data and used variance components analysis to assess the amount of temporal process variation in ruffed grouse spring counts explained by the best model. A hypothesis representing an interaction between winter precipitation and winter temperature was the top-ranked model. This model indicated that increased precipitation during cold winters (soft snow cover for roosting) was correlated with higher grouse population indices, but that increased precipitation during warm winters (snow crust effect) was correlated with lower spring counts. The highest ranked model (AIC_c weight = 0.45), explained only 17% of the temporal process variation. The number of migrating northern goshawks (*Accipiter gentillis*), which has been correlated with grouse cycles in previous studies, does not adequately explain, by itself, the variation in annual population indices of ruffed grouse. Other factors not considered in our analysis, such as endogenous mechanisms, parasites, or interactions among factors may also be important, which suggest that mechanisms mediating the ruffed grouse cycle still require investigation. **Key words: ruffed grouse, precipitation, snow, temperature, model, population dynamics**

559

_____ and R. J. Gutiérrez. 2006. The influence of ecological factors on detecting drumming ruffed grouse. Journal of Wildlife Management 71(6):1765-1772. Abstract: We surveyed drumming ruffed grouse (*Bonasa umbelus*) to estimate the probability of detecting an individual and we used Bayesian model selection to assess the influence of factors that may affect detection probabilities of drumming grouse. We found the average probability of detecting a drumming ruffed grouse during a daily survey was 0.33. The probability of detecting a grouse was most strongly influenced by the temperature change during a survey and its interaction with temperature at the start of the survey. Although the best model also included a main effect of temperature at the start of surveys, this variable did not strongly correlate with detection probabilities. Model assessment using data collected at other sites indicated that this best model performed adequately (i.e., positive correlation between observed and predicted values) but did not explain much of the variation in detection rates. Our results are useful for understanding the historical drumming index used to assess ruffed grouse populations and for designing auditory surveys for this important game bird. **Key words: ruffed grouse, census, technique, model, temperature, index, behavior**

560

Zwickel, F. C. 1977. Local variations in the time of breeding of female blue grouse. Condor 79(2):185-191. Abstract: Timing of breeding of female blue grouse (*Dendragapus obscurus*) was studied in 2 populations living about -3 km apart. Timing of breeding varied among years, between populations, and between adults and yearlings. Variations in time of breeding among years showed some correlation with annual differences in April weather. Breeding was about 1 wk later on the area that was higher in elevation, cooler, wetter, had more snowpack and held its snowpack longer in spring. Most yearling females copulated only after most adult females were beginning to nest. The period of copulation was up to 10 wk long in adult females but only up to 7 wk long in yearlings. Most females were on breeding range only about 2-3 wk prior to copulation. While there was a 3-4 wk difference in timing of loss of snow between areas, there was only a 1 wk difference in timing of breeding. Differences in timing of breeding between age classes may relate to differences in physiological maturity, amount of time on the breeding range prior to copulation, harassment of yearlings by adults or interactions among new recruits (yearlings) themselves. Proximate control of the reproductive cycle of females appears most subject to local ecological conditions. The breeding period of males has likely been selected to cover the entire receptive period of females, including annual, geographical and age-class variations. **Key words: blue grouse, temperature, snow, precipitation, breeding**

561

_____ 1967. Some observations of weather and brood behavior in blue grouse. Journal of Wildlife Management 31(3):563-568. Abstract: Two broods of wild blue grouse (*Dendragapus obscurus fuliginosus*) were observed for a total of nearly 27 hours in 1962, each on two consecutive days, the first day in each case being cold and wet and the second warmer and drier. These broods, plus another for which some data are presented, experienced what is generally considered to be inclement weather for young gallinaceous birds. There was no apparent correlation between periods of brooding and occurrence of rain. Rain and cold, as described here, did not seem to injure chicks directly but did increase the amount of time spent in brooding, and thus shortened the time available for feeding. This too had no apparent effect on the young. It is suggested that young blue grouse are able to cope with the kinds of conditions noted here. **Key words: blue grouse, precipitation, temperature, behavior, nutrition**

562

_____ and J. F. Bendell. 1967. Early mortality and the regulation of numbers in blue grouse. Canadian Journal of Zoology 45(5):817-851. Notes: In trying to explain the variations in the annual pattern of mortality, it is impossible to overlook the fact that the peak of hatch in 1962, the year of poor survival, was later than in other years. The peak of hatch is, of course, determined prior to, or during, the laying season. No correlations with this delay and general weather conditions in the spring were found. This does not mean, however, that weather is not involved, for there may be interactions between reproduction and weather which were not detected. **Key words: blue grouse, weather, reproduction**

Avian Taxa

American woodcock	*Scolopax minor*
Attwater's prairie chicken	*Tympanuchus cupido attwateri*
Band-tailed pigeon	*Columba fasciata*
Black grouse	*Tetrao tetrix*
Blue grouse	*Dendragopus obscurus*
Bobwhite quail	*Colinus virginianus*
California quail	*Callipepla californica*
Capercaillie	*Tetrao urogallus*
Caucasian black grouse	*Tetrao mlokosiewiczi*
Chukar partridge	*Alectoris chukar*
Common snipe	*Capella gallinago delicata*
Columbian sharp-tailed grouse	*Tympannuchus phasianellus columbianus*
Desert quail	*Callipepla gambelii*
Eastern wild turkey	*Meleagris gallopavo silvestris*
Eurasian woodcock	*Scolopax rusticola*
European woodcock	*Scolopax rusticola*
Gambel's quail	*Callipepla gambelii*
Gould's turkey	*Meleagris gallopavo mexicana*
Gray partridge	*Perdix perdix*
Greater prairie chicken	*Tympanuchus cupido*
Greater sage-grouse	*Centrocurcus urophasianus*
Hazel grouse	*Bonasa bonasia*
Helmeted guineafowl	*Numida meleagris*
Himalayan snowcock	*Tetraogallus himalayensis*
Hungarian partridge	*Perdix perdix*
Lesser prairie chicken	*Tympanuchus pallidicinctus*
Merriam's turkey	*Meleagris gallopavo merriami*
Mikado pheasant	*Syrmaticus mikado*
Montezuma quail	*Cyrtonyx montezumae*
Mourning dove	*Zenaida macroura*
Prairie chicken (Lesser)	*Tympanuchus pallidicinctus*
Red grouse	*Lapopus lagopus scoticus*
Red-legged partridge	*Alectoris rufa*
Ring-necked pheasant	*Phasianus colchicus*
Rio Grande turkey	*Meleagris gallopavo intermedia*
Rock ptarmigan	*Lagopus muta*
Ruffed grouse	*Bonasa umbellus*
Sage-grouse	*Centrocercus urophasianus*
Scaled quail	*Calipepla squamata*
Sharp-tailed grouse	*Tympanuchus phasianellus*
Sitka blue grouse	*Dendragapus obscurus sitkensis*
Snow partridge	*Tetraogallus caucasicus*
Spruce grouse	*Dendragapus canadensis*
Tibetan eared pheasant	*Crossoptilon harmani*
White-eared pheasant	*Crossoptilon crossoptilon*
White-tailed ptarmigan	*Lagopus leucurus*
Wild turkey	*Meleagris gallopavo silvestris*
Willow ptarmigan	*Lagopus lagopus*
Zenaida dove	*Zenaida macroura*

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Author Index

C

D

H

L

M

N

S

U

V

W

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TOPIC INDEX

A

B

E

F

G

H

N

P

S

T