Ruffed Grouse (*Bonasa umbellus*): A Technical Conservation Assessment

Prepared for the USDA Forest Service,
Rocky Mountain Region,
Species Conservation Project

December 6, 2006

David A. Wiggins, Ph.D.
Strix Ecological Research
1515 Classen Drive
Oklahoma City, OK 73106

Peer Review Administered by
Society for Conservation Biology

Wiggins, D.A. (2006, December 6). Ruffed Grouse (*Bonasa umbellus*): a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/ruffedgrouse.pdf [date of access].

ACKNOWLEDGMENTS

I thank Arvind Panjabi for directing me to the density information from the Black Hills National Forest. Clait Braun, Steve Sheffield, and Gary Patton read the entire manuscript and provided many useful tips for enhancing the structure and quality of this assessment.

AUTHOR'S BIOGRAPHY

David Wiggins developed an early interest in ornithology. During his high school years, he worked as a museum assistant under George Sutton and Gary Schnell at the University of Oklahoma. He later earned degrees from the University of Oklahoma (B.S. in Zoology), Brock University (M.Sc.- Parental care in Common Terns, under the supervision of Ralph Morris), and Simon Fraser University (Ph.D. – Selection on life history traits in Tree Swallows, under the supervision of Nico Verbeek). This was followed by a U. S. National Science Foundation Post-doctoral fellowship at Uppsala University in Sweden, where he studied life history evolution in Collared Flycatchers, and later a Fulbright Fellowship working on the reproductive ecology of tits (Paridae) in Namibia and Zimbabwe. He is currently a Research Associate at the Sam Noble Oklahoma Museum of Natural History, and splits time between ecological research in Sweden and North America.

COVER PHOTO CREDIT

Ruffed grouse (*Bonasa umbellus*). © Terry Sohl (used with permission).

SUMMARY OF KEY COMPONENTS FOR CONSERVATION OF RUFFED GROUSE

Ruffed grouse (*Bonasa umbellus*) occur at low densities in mid-elevation forest habitats in northern and northwestern areas of the USDA Forest Service Rocky Mountain Region (Region 2). Although there are no quantitative indications of a long-term population decline, the population status of ruffed grouse is difficult to assess because these grouse are cryptically-colored and are prone to relatively large annual fluctuations in numbers. Consequently, fixed-area census projects such as the Breeding Bird Survey do not adequately sample for ruffed grouse. Historical references suggest that ruffed grouse were formerly much more common in the Black Hills than they are today.

Development of a conservation/management plan for ruffed grouse in Region 2 will be hampered by the difficulty in accurately assessing their local status and by a lack of information on reproductive success. Ruffed grouse are considered a Management Indicator Species on two Region 2 forests, as well as a Priority species within nearby state Partners in Flight bird conservation plans. However, no research programs on the conservation status of ruffed grouse are currently underway in the Rocky Mountain Region.

At the landscape scale, optimal habitat for ruffed grouse is comprised of a mixture of early and late seral-stage aspen forest and riparian woodlands with year-round water flow (e.g., streams, creeks). The primary factor thought to limit ruffed grouse population expansion is a lack of young, dense aspen stands that are the preferred habitat of nesting and brood-rearing females. Potential threats to species viability include: 1) fire suppression, which reduces the occurrence and establishment of young aspen stands; 2) livestock/ungulate grazing, which often leads to trampled and degraded forest understories and the loss of aspen recruitment; and 3) perturbations (e.g., induced by logging activity) to local hydrological patterns, which may alter or reduce stream flow, especially during the late summer brood-rearing period.

Recent timber harvest data suggest that logging of aspen stands on Region 2 national forests occurs at low (and diminishing) levels and may, therefore, not present a substantial direct threat to ruffed grouse. However, forest inventories also show that the proportions of aspen on the three Region 2 national forests where ruffed grouse occur are exceptionally low. One potential explanation for the apparent regional decrease in aspen coverage is a reduction in disturbance factors (e.g., active suppression of wildfires and reduced logging programs) that help to regenerate aspen. Because of the increasing scarcity of aspen on Region 2 forests, measures to increase aspen cover will most likely lead to improved habitat conditions for and, thus, enhanced population viability of, ruffed grouse.

TABLE OF CONTENTS

ACKNOWLEDGMENTS 2
AUTHOR'S BIOGRAPHY 2
COVER PHOTO CREDIT 2
SUMMARY OF KEY COMPONENTS FOR CONSERVATION OF RUFFED GROUSE 3
LIST OF TABLES AND FIGURES 6
INTRODUCTION 7
Goal 7
Scope and Limitations of Assessment 8
Treatment of Uncertainty 8
Publication of Assessment on the World Wide Web 8
Peer Review 8
MANAGEMENT STATUS AND NATURAL HISTORY 8
Management Status 8
Existing Regulatory Mechanisms, Management Plans, and Conservation Strategies 8
Biology and Ecology 10
Systematics 10
Distribution and abundance 10
Global perspective 10
Regional perspective 10
Regional discontinuities in distribution 14
Population trend 14
Activity pattern and movements 15
Habitat 16
Structural components of habitat 17
Brood-rearing habitat 17
Foraging microhabitat 17
Food habits 17
Breeding biology 17
Courtship and pair formation 17
Nesting, clutch and brood size, and hatching success 18
Nestling growth and parental care and offspring behavior 18
Demography 19
Genetic characteristics and concerns 19
Life history characteristics 19
Social patterns and spacing 19
Factors limiting population growth 20
Community ecology 21
CONSERVATION 24
Potential Threats 24
Lack of suitable habitat 24
Fire suppression 24
Herbivory 24
Timber harvest 25
Changes in hydrology 26
Pesticides 26
Hunting 26
Summary 26
Conservation Status of Ruffed Grouse in Region 2 26
Management of Ruffed Grouse in Region 2 27
Implications and potential conservation elements 27
Tools and practices 28
Inventory and monitoring 28

Habitat management tools 28
Information Needs 29
REFERENCES 30

EDITOR: Gary Patton, USDA Forest Service, Rocky Mountain Region

LIST OF TABLES AND FIGURES

Tables:

Table 1. Management status of ruffed grouse within USDA Forest Service Region 2 and surrounding states based on Partners in Flight bird conservation plans. 9

Table 2. Ruffed grouse population trend results based on North American Breeding Bird Surveys..... 14

Table 3. Clutch size and reproductive success of ruffed grouse in North America. 18

Table 4. Extent of aspen cover within USDA Forest Service Region 2 national forests and the number of acres of aspen logged in 1999 and 2000. 20

Table 5. Estimated number of grouse hunters, number of hunter days, and number of ruffed grouse harvested in Wyoming in 2003. 22

Figures:

Figure 1. National forests and grasslands within USDA Forest Service Region 2. 7

Figure 2. Status of ruffed grouse in North America based on the Natural Heritage Program database. 9

Figure 3. Range of ruffed grouse in North America. 11

Figure 4. Relative abundance of ruffed grouse based on Breeding Bird Surveys from 1994 to 2003. 12

Figure 5. Trends in number of ruffed grouse observed on Breeding Bird Surveys between 1966 and 2003. 13

Figure 6. Potential suitable habitat for ruffed grouse in Wyoming based upon GAP analysis. 16

Figure 7. Envirogram representing the web of linkages between ruffed grouse and the ecosystem in which they occur. 23

Figure 8. Acres of aspen harvested on USDA Forest Service Region 2 land from 1992 to 2000. 25

INTRODUCTION

This conservation assessment is one of many being produced to support the Species Conservation Project for the Rocky Mountain Region (Region 2) of the USDA Forest Service (USFS) (**Figure 1**). The ruffed grouse is the focus of an assessment because it is a Management Indicator Species on two national forests in Region 2. Within the National Forest System, Management Indicator Species (MIS) serve as barometers for species viability at the forest level. By monitoring MIS, managers can 1) estimate the effects of planning alternatives on fish and wildlife populations [36 CFR 219.19 (a)(1)]; and 2) monitor the effects of management activities on species via changes in population trends [36 CFR 219.19 (a)(6)].

This assessment addresses the biology, ecology, conservation, and management of ruffed grouse throughout its range, with an emphasis on Region 2. The broad nature of the assessment leads to some constraints on the specificity of information for particular locales. This introduction defines the goal of the assessment, outlines its scope, and describes the process used in its production.

Goal

Species conservation assessments produced for the Species Conservation Project are designed to provide land managers, biologists, other agencies, and the public with a thorough discussion of the biology, ecology, conservation status, and management of selected species based on current scientific knowledge. Assessment goals are to provide critical summaries of scientific knowledge, discussion of implications of that knowledge, and outlines of information needs. The assessment does not seek to prescribe management. Instead, it provides the ecological framework upon which management must be based and focuses on the consequences of changes in the environment that result from management (i.e., management implications). Management recommendations proposed or implemented elsewhere are also discussed.

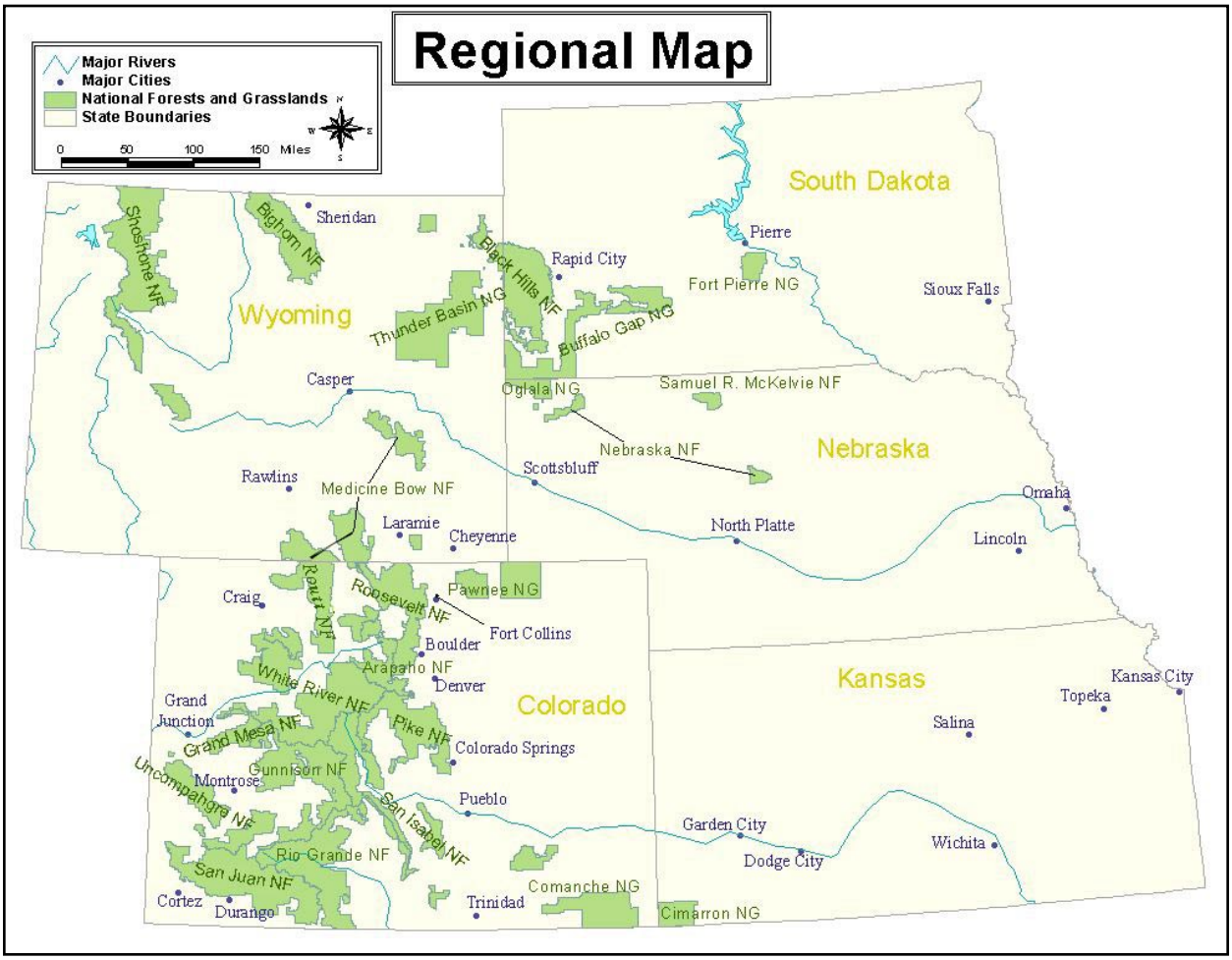

Figure 1. National forests and grasslands within USDA Forest Service Region 2.

Scope and Limitations of Assessment

This conservation assessment examines the biology, ecology, conservation, and management of ruffed grouse with specific reference to the geographic and ecological characteristics of the central and southern Rocky Mountains. Although a majority of the literature on the species originates from field investigations outside the region, to the extent possible, this document places that literature in the ecological and social contexts of the Rocky Mountain Region. This assessment discusses the ecology of ruffed grouse in the context of the current environment. The evolutionary environment of the species is considered in conducting the synthesis, but placed in current context.

In producing the assessment, I reviewed refereed literature, non-refereed publications, research reports, and data accumulated by resource management agencies. Not all publications on ruffed grouse are referenced in the assessment, nor were all published materials considered equally reliable. The assessment emphasizes refereed literature because this is the accepted standard in science. While non-refereed publications or reports were regarded with greater skepticism, I used some non-refereed literature in the assessment when refereed information was unavailable.

Treatment of Uncertainty

In this assessment, the strength of evidence for particular ideas is noted and, when appropriate, alternative explanations are described. While well-executed experiments represent a strong approach to developing knowledge, alternative approaches such as modeling, critical assessment of observations, and inference are accepted as sound approaches to understanding. As most of the published literature on ruffed grouse biology is based on studies from outside Region 2, some degree of uncertainty exists when applying the results of such studies to the situation in Region 2. Where appropriate in this assessment, such uncertainty is noted.

Publication of Assessment on the World Wide Web

To facilitate their use, species conservation assessments are being published on the Region 2 World Wide Web site (http://www.fs.fed.us/r2/projects/scp/). This makes them available to agency personnel and the public more rapidly than publishing them as reports. More importantly, Web publication will facilitate updates to and revision of the assessments, which will be based on protocols established by USFS Region 2.

Peer Review

In keeping with the standards of scientific publication, assessments developed for the Species Conservation Project have been externally peer reviewed prior to their release on the Web. This assessment was reviewed through a process administered by the Society for Conservation Biology, which chose two recognized experts (on this or related taxa) to provide critical input on the manuscript.

MANAGEMENT STATUS AND NATURAL HISTORY

Management Status

Ruffed grouse are generally considered secure through most of their North American range (www.natureserve.org). It is listed as critically imperiled in Nebraska, imperiled in Kansas, apparently secure in South Dakota, secure in Wyoming, and it is unranked in Colorado. State and provincial Natural Heritage Program designations for this species are shown in **Figure 2**. Although not listed as a Priority Species within the Colorado or Wyoming Partners in Flight state bird conservation plans, the ruffed grouse is a priority species in nearby Montana and Idaho (**Table 1**). Within Region 2, the USFS lists the ruffed grouse as a Management Indicator Species on the Shoshone and Black Hills national forests.

Existing Regulatory Mechanisms, Management Plans, and Conservation Strategies

The ruffed grouse is a widespread, popular gamebird in many northern states and Canadian provinces, where hunting of the species is closely regulated. Because of its popularity as a gamebird, there has long been considerable interest in the effects of hunting on local population viability. In response to declining numbers, at least three states (Minnesota, Wisconsin, Michigan) have imposed hunting bans of various duration at various times in the 20th century. While the effects of such bans on grouse population dynamics have received considerable attention, little resolution has been achieved (Small et al. 1991, Stoll and Culbertson 1995, Rusch et al. 2000). Ruffed grouse reintroduction programs have been attempted in Alaska, Illinois, Indiana, Ohio, Missouri, Arkansas, Kansas,

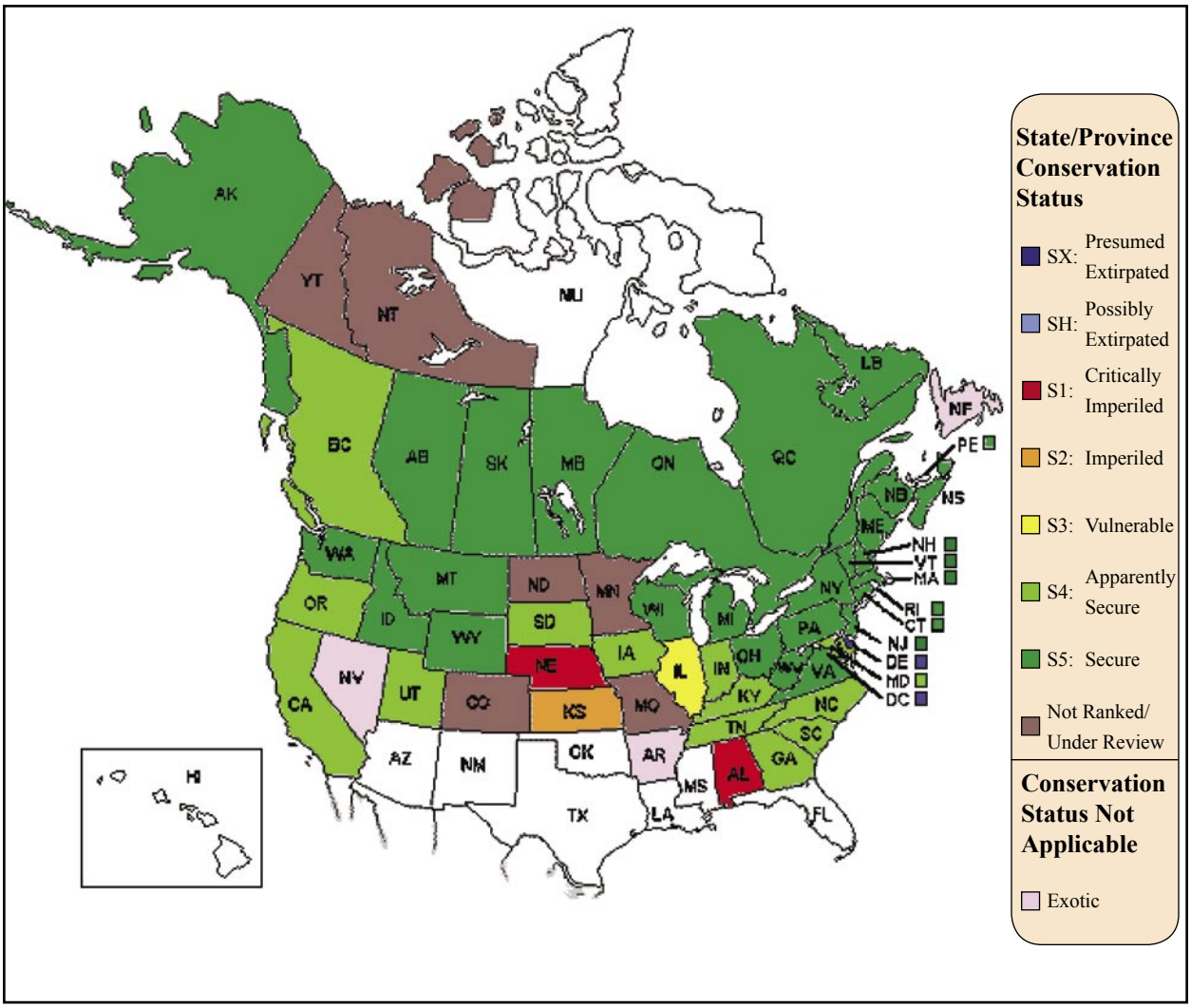

Figure 2. Status of ruffed grouse in North America based on the Natural Heritage Program database (NatureServe Explorer 2004).

Table 1. Management status of ruffed grouse within USDA Forest Service Region 2 (in bold font) and surrounding states based on Partners in Flight (PIF) bird conservation plans.

State	Status	Citation
Colorado	Not a Priority Species	Beidleman 2000
Kansas	State PIF plan not published	
Wyoming	Not a Priority Species	Nicholoff 2003
Nebraska	State PIF plan not published	
South Dakota	State PIF plan not published	
Montana	Priority Species (Level II*; Aspen)	Casey 2000
Utah	Not a Priority Species	Parrish et al. 2002
Idaho	High Priority Species (aspen, riparian, and high-elevation mixed conifer forests)	Ritter 2000
Nevada	Not a Priority Species	Neel 1999

*Level II priority species are those requiring monitoring for changes in status.

and Nebraska (Rusch et al. 2000). While most of these reintroductions have succeeded to various extents, the program in Nebraska failed, and success was limited in Kansas (see Distribution and abundance section).

One problem in establishing conservation strategies for this species is that some populations of ruffed grouse (but not, apparently, those in Region 2) undergo population cycles of approximately 9 to 10 years (Gullion 1970, Lauten 1995). Consequently, in areas with cyclic populations, conservation efforts are complicated by the ability to detect population declines against this backdrop of natural variability.

Biology and Ecology

Systematics

The ruffed grouse is a widespread species in North America, with most systematics studies suggesting approximately 15 subspecies (Aldrich and Friedmann 1943, American Ornithologists' Union 1957, Hubbard and Banks 1970, Godfrey 1986, Ouellet 1990). The subspecies occurring in Region 2 is *Bonasa umbellus incana* Aldrich and Friedmann (1943). Recent molecular genetic studies (Ellsworth et al. 1995, 1996) suggest that the ruffed grouse is most closely related to the spruce grouse (*Falcipennis canadensis*).

Nominate race: *Bonasa umbellus* Linnaeus.

Distribution and abundance

Global perspective

Ruffed grouse are widespread across heavily forested areas of Canada and mostly northern United States, reaching their southern range limit in north-central Utah and northwestern Colorado, as well as the southern Appalachians (**Figure 3**). Introduced and restored populations have been established in Alaska, northeastern Nevada, and various Midwestern states (Rusch et al. 2000). Rusch et al. (2000) concluded that ruffed grouse populations are likely declining in the eastern United States but stable elsewhere.

Population density tends to decrease to the south, with fewer birds detected on Breeding Bird Surveys in those areas (**Figure 4**). In areas where they are sympatric with snowshoe hares (*Lepus americanus*) (e.g., Alaska, most of Canada, Great Lakes states), ruffed grouse vary annually in numbers, with populations cycling over approximately 10-year periods, similar to the cycles of snowshoe hares. These cycles are at least in part driven by concurrent cycles of snowshoe hares and their primary predators, Canada lynx (*Lynx canadensis*), northern goshawks (*Accipiter gentilis*), and great horned owls (*Bubo virginianus*) (Balzer 1995, Lauten 1995). In other areas of their range, including Region 2, ruffed grouse do not follow a clear temporal pattern of population variability (Rusch et al. 2000).

Regional perspective

Ruffed grouse reach their southern range limits in Region 2, where they are relatively widespread in northwestern Wyoming and have isolated populations in extreme northwestern Colorado and the Black Hills of Wyoming and South Dakota (**Figure 3**, **Figure 4**). There has been little study of ruffed grouse abundance within Region 2, and it is unclear to what extent the species varies in abundance across the region. However, they are generally considered common in the main area of their range in western and northern Wyoming (Dorn and Dorn 1999), rare in northwestern Colorado (Righter et al. 2004), and uncommon in the Black Hills area (Pettingill and Whitney 1965).

Regionally, the distribution of ruffed grouse has changed since the early 1800's, with extirpation of eastern populations in Nebraska and Kansas. Historically, ruffed grouse appear to have been a resident along the Missouri River woodlands in eastern Kansas, eastern Nebraska, and possibly into eastern South Dakota. However, human settlement appears to correlate with widespread extirpation of grouse in these areas (Thompson and Ely 1989, Sharpe et al. 2001). Reintroductions over the past 50 years have met with limited success (see below). Ruffed grouse also appear to have declined in abundance in the Black Hills (**Figure 5**), where they were formerly considered common (Pettingill and Whitney 1965).

The historical and current distribution and abundance in Region 2 states are as follows:

South Dakota: Over and Thoms (1921) described ruffed grouse as abundant in the Black Hills while Pettingill and Whitney (1965) considered it an uncommon resident. The South Dakota Breeding Bird Atlas (Peterson 1995) reported three confirmed and three possible breeding attempts (all in the Black Hills), adding that ruffed grouse are currently considered rare in the Black Hills. Recent breeding bird monitoring suggests that ruffed grouse occur in low abundance, primarily in the northern Black Hills (Panjabi 2001, 2003). Thus, although quantitative data are lacking, the picture drawn from all accounts suggests that ruffed

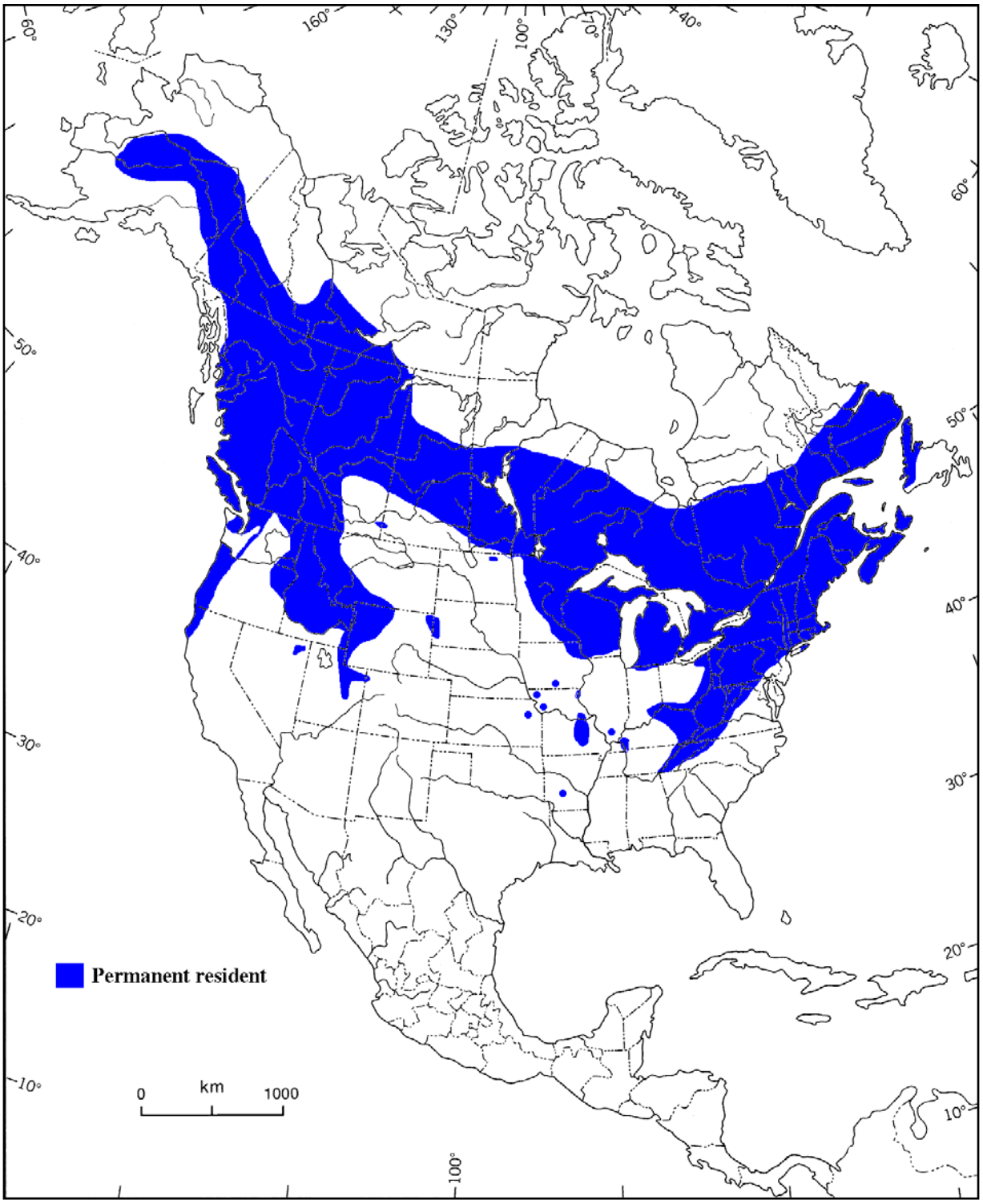

Figure 3. Range of ruffed grouse in North America (modified from Rusch et al. 2000).

grouse are now much less common in the Black Hills than they were historically.

Wyoming: Recent summaries have described ruffed grouse as common (Scott 1993) or uncommon (Dorn and Dorn 1999) in northwestern Wyoming, the Wind River Range, the Bighorn Mountains, and the Black Hills area in the northeast. Knight (1902) classified ruffed grouse as common residents in these same areas.

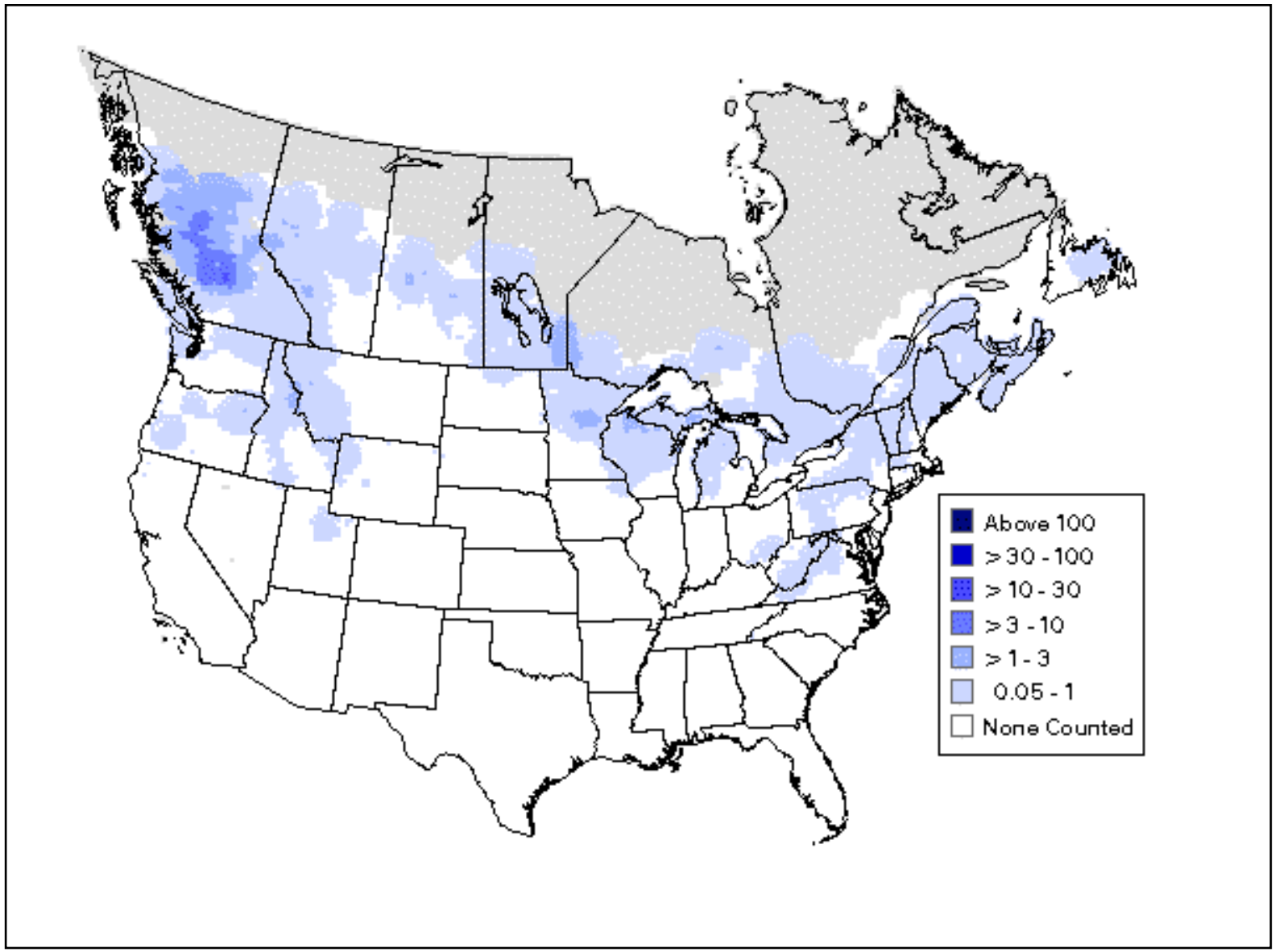

Figure 4. Relative abundance of ruffed grouse based on Breeding Bird Surveys from 1994 to 2003 (Sauer et al. 2004).

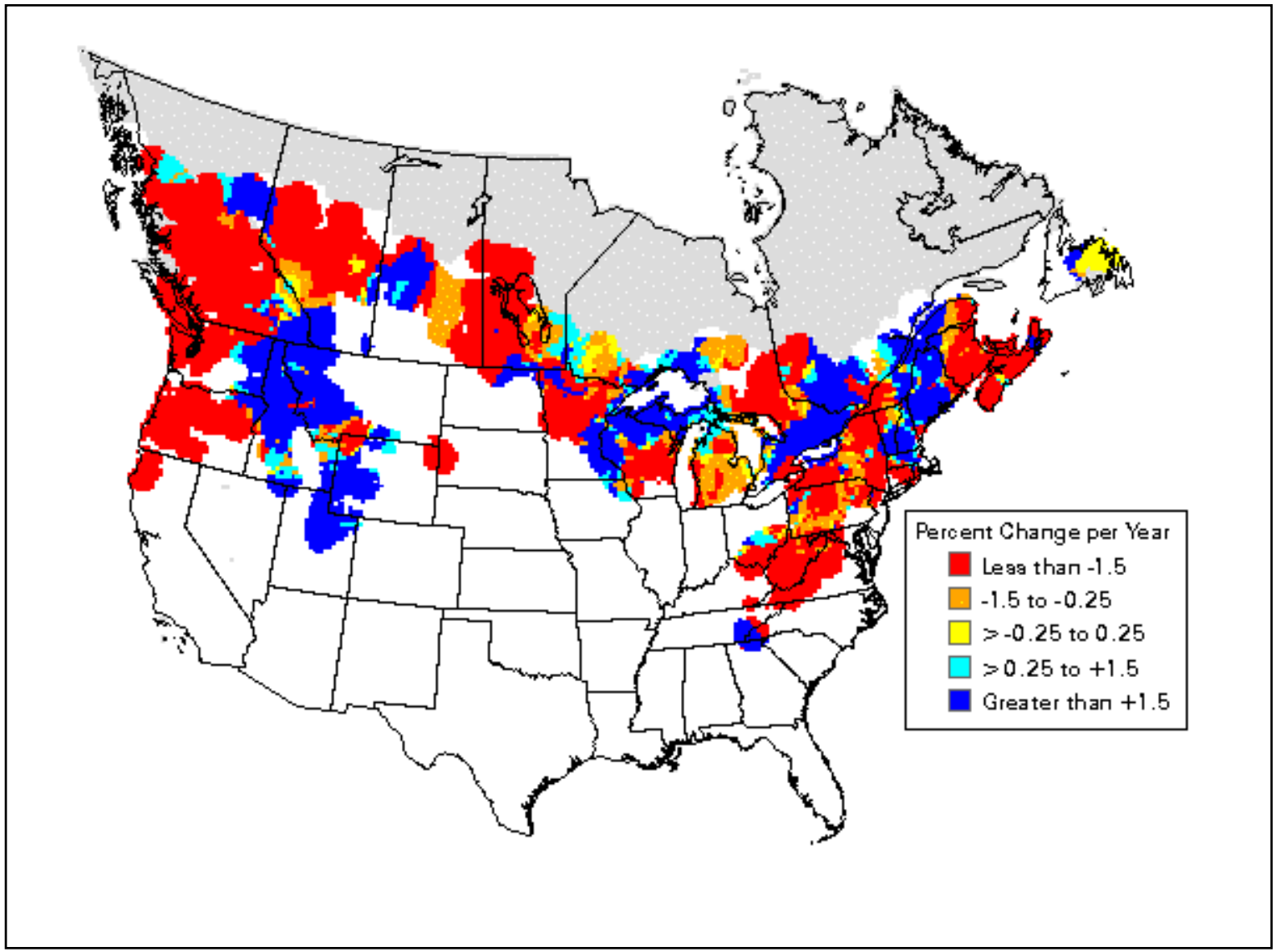

Figure 5. Trends in number of ruffed grouse observed on Breeding Bird Surveys between 1966 and 2003 (Sauer et al. 2004).

Colorado: In Colorado, ruffed grouse were only recently discovered in the extreme northwestern corner of the state (Braun et al. 2003). The first purported sighting occurred in 1971 in Routt County (Martin et al. 1974) but was later found to be invalid (Hoffman and Braun 1978). Subsequently, specimens, including juvenile birds, were collected on Hoy Mountain in northwestern Moffat County (Braun et al. 2003). The species is currently considered a rare resident in that area (Kingery 1998, Righter et al. 2004).

Nebraska: The status of ruffed grouse in Nebraska has changed over the past 200 years. Ducey (2000) notes that the species was formerly an uncommon resident along the Missouri River in eastern Nebraska, and it began to decline in numbers in the late 1800's. The last specimens were taken in the state around 1916, and the species apparently became extirpated shortly thereafter. The species is currently considered extirpated in Nebraska (Sharpe et al. 2001). Recent attempts to reintroduce ruffed grouse into Nemaha County failed (Sharpe et al. 2001). A similar reintroduction attempt in northwestern Missouri also failed. However, continued reintroductions in northwestern Missouri and northeastern Kansas may eventually result in established populations there and a possibility that the species may return to the Missouri River area of southeastern Nebraska.

Kansas: Ruffed grouse were formerly resident in wooded areas of eastern Kansas, but were extirpated sometime in the 1800's. Goss (1886) suggested that human settlement of the eastern portion of the state led to the degradation of riparian woodlands, primarily through cattle grazing, resulting in the extirpation of ruffed grouse in the state. Reintroductions have been attempted in several eastern counties, with only limited success (Thompson and Ely 1989).

Regional discontinuities in distribution

There is no indication of any recent change in this species' distribution in Region 2. Ruffed grouse are currently widespread in forested areas of western and north-central Wyoming, with isolated populations in the Black Hills and in northwestern Colorado. However, even in Wyoming, populations do not appear tightly linked, as large gaps of unsuitable habitat occur between occupied mountain ranges. In addition, ruffed grouse show relatively strong philopatry, and movements between isolated breeding populations (i.e., mountain ranges) are probably rare. Currently, it is unclear to what extent these populations are genetically isolated.

Population trend

Data from the North American Breeding Bird Survey (BBS; Sauer et al. 2004) are summarized in **Table 2**. Within Region 2, there are so few data available that low statistical power hampers analyses. The only state with marginally sufficient data is Wyoming, where the data suggest population stability since 1980. In general, the BBS data show no indication of population declines anywhere in the species' range. However, BBS survey methods are not well-suited to detecting ruffed grouse, and the data are thus of limited value in assessing long-term population trends. Christmas Bird Count (CBC; National Audubon Society 2004) data are also insufficient, with few areas in Wyoming regularly reporting ruffed grouse and almost no reports from the Black Hills area since 1960.

Table 2. Ruffed grouse population trend results based on North American Breeding Bird Surveys. Data are from Sauer et al. (2004). Trend indicates the percentage change per /year. There were insufficient data for trend analyses for most states within Region 2.

	1966-1979			1980-2003			1966-2003		
State/Region	***N***	**Trend**	***P***	***N***	**Trend**	***P***	***N***	**Trend**	***P***
Wyoming	—	—	—	6	5.3	0.27	6	8.0	0.21
Montana	—	—	—	17	-3.1	0.67	17	0.3	0.96
Idaho	—	—	—	9	17.0	0.10	9	12.1	0.14
Utah	—	—	—	2	30.2	0.67	3	10.4	0.72
Central Rocky Mountains	7	-37.1	**<0.01**	57	0.5	0.80	60	-2.3	0.30
U.S. Fish and Wildlife Service Region 6	—	—	—	27	-2.5	0.72	28	0.9	0.87
United States	100	-4.9	**0.01**	271	0.2	0.89	323	-1.6	0.14
Canada	79	12.2	**0.05**	198	-0.9	0.45	236	-2.4	0.06
North America	179	8.1	0.10	469	-0.7	0.50	559	-2.2	**0.03**

At least two recent studies have shown significant long-term trends in ruffed grouse populations in and just outside Region 2. Using BBS data, Hejl et al. (2002) found an annual decrease of 5.4 percent in the abundance of ruffed grouse in the central Rocky Mountains (Idaho, Montana, Wyoming) from 1966 to 1998, and Casey (2000) noted a significant long-term negative trend in the northern Rocky Mountains. The composite BBS trend map (**Figure 5**) shows a mosaic of population trends in Region 2, with declines in abundance in the Black Hills and northwestern Wyoming, but increases in most other areas of Wyoming.

In summary, because ruffed grouse occur at relatively low population density and are not well-sampled with conventional survey methods, the BBS results are difficult to interpret and provide an uncertain picture of the long-term population trend of ruffed grouse in Wyoming. Scott (1993) and Dorn and Dorn (1999) suggest that the species ranges from uncommon to common in portions of northeastern and northwestern Wyoming. Historical references suggest that ruffed grouse were formerly much more common in the Black Hills region than they are today. Over and Thoms (1921) described ruffed grouse as abundant in the Black Hills, and Knight (1902) suggested they were common in riparian areas of the Wyoming portion of the Black Hills. By the 1960's, Pettingill and Whitney (1965) listed the species as uncommon in the Black Hills. More recently, standardized point counts throughout the Black Hills National Forest suggest that ruffed grouse are widespread but occur so uncommonly that density estimates could not be made (Panjabi 2001, 2003).

Activity pattern and movements

Ruffed grouse are permanent residents, generally remaining on or near the breeding territory throughout the year. However, during winter the size of the home range may expand to more than 150 percent of the summer home range. Radiotracking data from Missouri have shown mean daily movements of 392 m (SD = 336 m) in fall and winter, and 263 m (SD = 73 m) during spring and summer (Thompson and Fritzell 1989). Age and gender appear to be only weakly correlated with movement rates (Rusch et al. 2000). Movement is most pronounced around dawn and dusk (Archibald 1976, Maxson 1977), but this may vary geographically as grouse in Virginia showed no strong diurnal movement patterns (Hewitt and Kirkpatrick 1997).

Male ruffed grouse produce a characteristic drumming sound by rapidly rotating the wings forward and backward. Drumming is most common around dawn and dusk and may occur throughout the year, but it is more pronounced during spring (April-May) and again in fall (October). Males typically drum from a raised platform, such as a fallen log stump or boulder (Gullion 1967). Drumming apparently functions both as an advertisement to females and as a territorial signal to other males (Johnsgard 1983).

Male grouse actively defend breeding territories, but females are not territorial and may have overlapping home ranges (Maxson 1989). Studies of marked males have shown that territories average 2.1 ha in Alberta and Wisconsin (Rusch et al. 2000) and 2.3 ha in Minnesota (Archibald 1975). However, in most populations some percentage (on average 33 percent) of males are not successful in obtaining territories (Gullion 1981).

Ruffed grouse typically roost alone, but they may form loose aggregations of a few birds during fall and winter (Rusch et al. 2000). Ruffed grouse wintering in areas with deep snow may spend much of the day roosting in snow, with little time (e.g., <30 minutes) spent foraging (Huempfner and Tester 1988).

Dispersal has been relatively well-studied in ruffed grouse. Males are strongly site faithful and typically remain on their territories throughout the year (Gullion and Marshall 1968, Rusch and Keith 1971a). In Alberta, only 7 percent of males changed drumming sites (i.e., territories) more than 200 m between years (Rusch and Keith 1971a), and in Minnesota, only 12 percent of territorial males moved more than 100 m between years (Gullion and Marshall 1968). There is limited (typically 200 m or less) seasonal movement by males as they may move outside their breeding territory during autumn (Rusch and Keith 1971a). Although females are not faithful to breeding sites, they normally move less than 1 km between years (Rusch et al. 2000). In autumn, movements by females averaged 500 m (Rusch and Keith 1971b).

Studies of banded chicks have shown that natal dispersal distance is greater for females than for males. In Wisconsin, radio-marked males and females dispersed an average of 2.4 and 4.9 km (Small and Rusch 1989), respectively; values were comparable in Ohio (2.8 and 5.6 km, respectively; J. Yoder, cited in Rusch et al. 2000). In Wisconsin, dispersal by first-year grouse is concentrated in two periods, late September to October in autumn, when both sexes disperse, and March to early April in the spring, when only males disperse (Small and Rusch 1989). Thus, juvenile females

typically breed in the same areas they settle following autumn dispersal whereas males make a further spring dispersal before settling on their breeding site.

Habitat

Ruffed grouse exhibit a strong association with aspen forest throughout much of their range. Although they also nest in boreal conifer forest in Canada, they occur in lower density and show lower survival in such habitat (Gullion and Marshall 1968, Gullion 1970, Rusch and Keith 1971a). In the eastern United States, ruffed grouse also occur in mixed deciduous-coniferous forests, and in the southern portions of the range, in young deciduous forests (Wiggers et al. 1992, Rusch et al. 2000).

There have been few studies of ruffed grouse habitat relationships in Region 2, but regional ornithological works suggest that they primarily inhabit aspen forests in Utah (Hayward et al. 1976) and Wyoming (Scott 1993, Dorn and Dorn 1999). Potentially suitable ruffed grouse habitat in Wyoming is depicted in **Figure 6**. The actual distribution in the state mirrors that shown in **Figure 6**, with the exception that the species is not known to occur in the habitat depicted along the Colorado border. In the Black Hills, recent monitoring studies during the summer found ruffed grouse in a number of habitats, including aspen, pine, and spruce forests (Panjabi 2001, 2003). The small population in extreme northwestern Colorado occurs in an area characterized by mixed conifer-aspen forest with patches of Utah serviceberry *(Amelanchter utahenis*; Braun et al. 2003).

Just outside Region 2, Marshall (1946) found ruffed grouse primarily in Douglas-fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa*) on the Boise National Forest in southern Idaho, with a strong tendency for females with broods to use riparian areas during summer. In a broad-scale study of breeding bird habitat relationships in western Montana and northern Idaho, ruffed grouse were found in a wide variety of habitats, with the highest percentage (12 percent) of point count observations in aspen, followed by ponderosa pine (7 percent), and riparian shrub (6 percent) habitats (Hutto and Young 1999). However, the majority of these observations were made in or near riparian corridors, suggesting that riparian woodland (especially aspen) is the key habitat for ruffed grouse in the central Rocky Mountains.

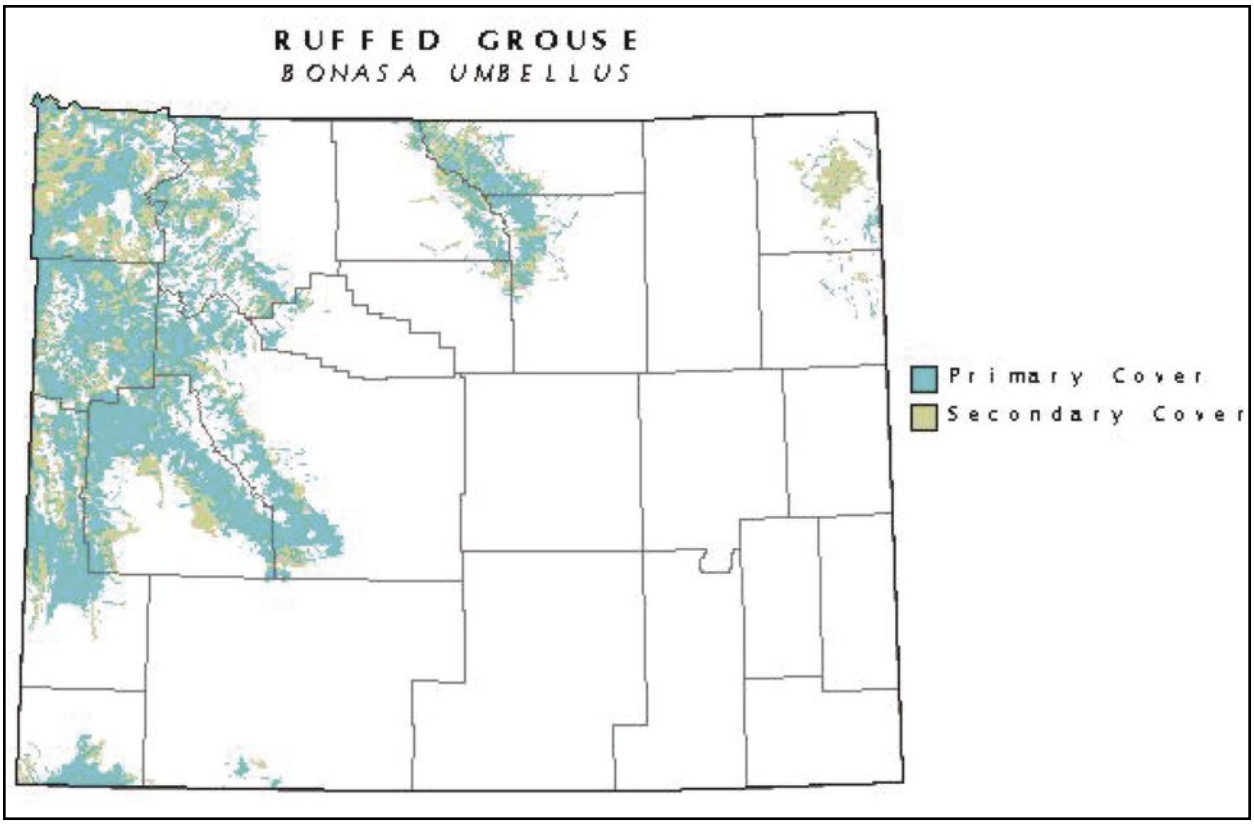

Figure 6. Potential suitable habitat for ruffed grouse in Wyoming based upon GAP analysis.

Structural components of habitat

Ruffed grouse territories typically include a number of drumming sites at logs, rocks, exposed roots or other elevated perch sites (Palmer 1963, Gullion 1967). However, drumming sites appear to be sufficiently common that their abundance does not appear to affect choice of territory. Early seral stage forests with a dense understory appear to be optimal habitat for ruffed grouse. Such forests provide vertical cover and protection from avian predators. Several studies have measured understory stem densities, which have varied from highs of about 30,000 per ha in the Great Lakes region (Gullion 1970, DeStefano and Rusch 1984) to 3000-5,000 stems per ha in Alberta (Rusch and Keith 1971b). Closer to Region 2, Stauffer and Peterson (1985) found understory stem densities of 11,432 per ha in pure aspen, and 6,445 per ha in mixed aspen-conifer forests in southeastern Idaho. The structure of the understory is also a key habitat variable, as ruffed grouse prefer understories with over 60 percent canopy closure, but with good visibility at ground level, presumably to aid in detecting ground predators (Palmer 1963, Boag and Sumanik 1969, Rusch and Keith 1971a, Boag 1976).

Brood-rearing habitat

There is little information on brood-rearing habitat from the western United States, but in general, ruffed grouse broods use aspen stands of various ages, typically with a dense understory of shrubs, ferns, and herbaceous cover (Rusch et al. 2000). Stauffer and Peterson (1985) found broods in aspen and mixed aspen-conifer stands in southeastern Idaho. During late summer, when conditions were hot and dry, broods used relatively wet drainage areas along creeks and rivers. In the southeastern United States (likely including populations along the eastern margins of Region 2), ruffed grouse broods are found in oak (*Quercus* spp.), poplar, and various hardwood forest stands, especially in areas with small (<1 ha) forest clearings (Haulton 1999, Rusch et al. 2000).

Foraging microhabitat

Ruffed grouse foraging microhabitat preferences change as individuals age. Juveniles tend to feed in areas with tall and dense ground cover, and in sites containing high densities of fruit, various buds, and invertebrates (Haulton 1999, Rusch et al. 2000). In autumn, adults concentrate their foraging effort on berries when available, and thus spend a significant amount of foraging time on or near the ground. During winter in Minnesota, adults fed in the upper canopy of mature aspen forests (Huempfner and Tester 1988).

Food habits

Adult ruffed grouse feed on a variety of plants and invertebrates. Their diet shifts seasonally as various food sources become available (Rusch et al. 2000). During the breeding season (spring), adults feed primarily on leaves of herbaceous plants (Norman and Kirkpatrick 1984). In late summer and autumn, acorns and berries (e.g., *Smilax*, *Vitis*, *Viburnum*, *Cornus*, *Rosa*) make up a considerable portion of the diet, with a shift to aspen and willow buds and twigs from late October onward. Buds of quaking aspen (*Populus tremuloides*) are preferred over those of bigtooth aspen (*P. grandidentata*) and birch (*Betula* spp.; Svoboda and Gullion 1972). In southern Idaho, Marshall (1946) found that wintering ruffed grouse fed on a variety of plants including leaves and buds of *Phalecia* spp., mountain ash (*Sorbus scopulina*), serviceberry (*Amelanchier alnifolia*), Douglas maple (*Acer douglasii*), western chokecherry (*Prunus demissa*), willow (*Salix* spp.), black cottonwood (*Populus trichocarpa*), snowberry (*Symphoricarpus oreophilus*), and snowbrush (*Ceanothus velutinus*). Invertebrates make up a large proportion of the diet for young (<5 weeks of age) grouse, with vegetative material becoming increasingly important as the juveniles age (Bump et al. 1947, Houlton 1999).

Jakubas and Gullion (1991) studied the relationship between the nutritional value of aspen species buds and ruffed grouse foraging preferences and found that grouse appeared to select trees with low levels of coniferyl benzoate, a secondary metabolite that ruffed grouse avoid ingesting. Grouse accomplished this avoidance by selecting clones that had relatively low levels of the metabolite, or by selecting individual (e.g., young or damaged trees) trees that had low levels of coniferyl benzoate levels.

Breeding biology

Courtship and pair formation

Females are attracted to drumming males in early spring, but there is essentially no pair-bond, with only a brief association between the sexes when copulation occurs (Johnsgard 1989). Males continue to drum after copulation and may attract and copulate with additional females. Females may visit the territory of more than one male but remain receptive for a period of only 2 to 3 days (Brander 1967). In all ruffed grouse populations,

some proportion of the males (typically first-year males) does not breed or even attempt to defend a territory (Gullion 1981). Among females, however, the pattern is less clear. In a Minnesota-Wisconsin study, every radio-marked female (n = 29; including yearlings) bred every spring. In the southern Appalachians, however, 24 of 136 hens skipped a breeding season (Haulton 1999).

Nesting, clutch and brood size, and hatching success

The female alone builds the nest, with nest-building taking place within a week of copulation (Rusch et al. 2000). Nests are placed in a slight depression on the ground and lined with dead leaves and other vegetation from the immediate area (Allen 1934). Ruffed grouse raise a single brood per season, but they will re-nest if an early nesting attempt fails.

The timing of clutch initiation has not been closely studied, but in Minnesota and Wisconsin, egg laying starts as early as late April and peaks in late May. The only clutch initiation data from Region 2 are from the Black Hills, where egg laying takes place in May and June with an apparent peak in June (Johnsgard 1979). There is no information on ruffed grouse clutch size from populations within Region 2, but clutch size data from areas outside Region 2 are summarized in **Table 3**. Mean clutch size averaged 11.5 eggs in New York (n = 1473 clutches; Bump et al. 1947), 11.0 in Wisconsin (n = 77 clutches; Holzwart 1990, Balzer 1995), 10.1 in Ohio (n = 13; J. Yoder, in Rusch et al. 2000), and 9.5 in the Appalachians (n = 60 clutches; Haulton 1999). Second clutches, which may occur if the first clutch is lost, are smaller, averaging seven eggs in New York and Wisconsin (Bump et al. 1947, Holzwart 1990, Balzer 1995). Eggs hatch synchronously within a 24-hour period. Females leave the eggshells and any unhatched eggs in the nest (Maxson 1977, Johnsgard et al. 1989).

Hatching success (**Table 3**) has been carefully measured in two studies, with 94 percent of 482 eggs hatching in the southern Appalachians (Haulton 1999), but only 45 percent of 256 eggs hatching in Wisconsin (Rusch et al. 2000). In these same two studies, the percentage of females that successfully escorted broods from the nest was 69 percent and 60 percent, respectively. In Haulton's (1999) study, female age affected nesting success, with yearling females (n = 32) being marginally more successful (84 percent) than older females (n = 68; 68 percent). Two other studies of the nesting success (percent of nests in which at least one chick left the nest) of radio-marked females found 48 percent success in both Wisconsin (Small et al. 1996) and Minnesota (Larson 1998).

Nestling growth and parental care and offspring behavior

Ruffed grouse chicks are precocial. Young hatch with their eyes open and leave the nest within 24 hours

Table 3. Clutch size and reproductive success of ruffed grouse in North America (from Rusch et al. 2000).

Area	Clutch size	Range	Hatching success	Citation
Wisconsin				Small et al. 1996
First clutch	10.9	7-13	48%[1]	
Replacement clutch	7.4	6-9		
Michigan				Larson 1998
First clutch	12.8	10-16	48%[1]	
Replacement clutch	7.3	6-8		
southern Appalachians				Haulton 1999
First clutch	9.5	—	94%[2]	
New York				Bump et al. 1947
First clutch	11.5	—	61%[1]	
Replacement clutch	7.5	—		
Alberta				Rusch et al. 2000
First clutch	11.0	1-20		
Replacement clutch	7.5	1-10		

[1]Percentage of clutches that hatched at least one egg.

[2]Percentage of all eggs laid (n = 482) that hatched.

(see details of chick growth in Johnsgard et al. 1989). Young grouse weigh about 11 to 13 grams at hatching and grow relatively rapidly, gaining 80 to 120 grams of mass during the first two weeks of life. Chicks develop contour feathers at two weeks of age, complete their juvenile plumage at about four weeks, and complete molt into adult plumage at 16 to 17 weeks of age. Data from hand-reared birds (Bump et al. 1947) show that at 20 weeks of age, male chicks weigh approximately 579 grams while females weigh 511 grams. Chicks are capable of short flights within a week of hatching.

Males take no part in caring for the young. Females lead the brood away from the nest shortly after the eggs hatch and continue to escort the brood until the young have reached approximately 12 to 15 weeks of age, at which time they disperse (Small et al. 1996). Until the young are capable of thermoregulating (at 3 to 4 weeks of age), the female broods the young at night and during inclement weather (Johnsgard et al. 1989). When a terrestrial predator threatens the brood, the female may adopt one of two strategies: rush forward with feathers erected and wings spread, or feign an injury and attempt to lure the predator away from the brood (Johnsgard et al. 1989). Young grouse remain together until the brood disperses, with few observed instances of adoptions or exchanges of young between broods (Bump et al. 1947).

Demography

Genetic characteristics and concerns

Ruffed grouse are restricted to mid-elevation forests in the northern and western portions of Region 2, resulting in a patchy distribution. The small population on Hoy Mountain in extreme northwestern Colorado is an extension of the Utah population. Braun et al. (2003) suggested that a lack of suitable habitat near the Hoy Mountain site, together with the species' poor dispersal abilities (Palmer 1962, Moran and Palmer 1963), will keep this population from expanding in Colorado. This same dispersal problem has probably limited the species' range in other areas of Region 2, with large expanses of shrubsteppe (in Wyoming) and other xeric habitats (western Colorado) acting as dispersal barriers. Given the lack of dispersal by adult and juvenile ruffed grouse, genetic exchange among Region 2 populations (e.g., on different mountain ranges) is probably minimal.

Life history characteristics

Ruffed grouse lay large clutches, but because they nest on the ground, nest depredation is relatively frequent. In populations to the north and east of Region 2, only about 50 percent of yearling males attempt to hold a territory (Gullion 1984, Rusch et al. 2000). The situation for females is less clear, with all yearlings in Wisconsin and Minnesota attempting to breed (Maxson 1977, Small et al. 1996), but with some proportion of females (of unknown age) not breeding in other populations (Haulton 1999). The post-fledging survival of ruffed grouse chicks is poor; one study documented 38 percent (13 of 34 broods) total brood loss in the first week after hatching (Haulton 1999). Estimates of adult survival rates vary widely, often depending on the phase of the population cycle. Survival rates of adult males from Alberta to the Great Lakes Region have varied from 18 to 46 percent, with the lower estimates occurring during population declines (Rusch et al. 2000). In general, the adult male survival rate in cyclic populations appears to average about 36 percent (Rusch et al. 2000). There are no published estimates of adult female survival rates, as no individual hens have been tracked for more than one year (Rusch et al. 2000). The only study of survival of juvenile grouse during their first year (Balzer 1995) may have been compromised by the use of radio-transmitters, which are thought to increase mortality rates (Rusch et al. 2000). Consequently, there are no reliable estimates of juvenile survival rates in ruffed grouse.

Given the lack of these critical life history data, analyses of life cycle diagrams and associated demographic matrices (Caswell 1989, McDonald and Caswell 1993) were not conducted for this assessment. While such analyses can provide valuable insights into which life history stages may be most critical to population growth, constructing models based on incomplete and/or poor quality data may have little relevance (Reed et al. 2002).

Social patterns and spacing

During the breeding season, most ruffed grouse males defend territories, but yearling males may spend their first breeding season as floaters (i.e., not defending a territory). While territory size has not been carefully measured, it has been inferred from distances between drumming sites and nests. The mean distance between neighboring male drumming sites averaged over 150 m in Alberta, with the closest sites only 52 m apart (Rusch et al. 2000). In New York, most nest sites were at least 150 m apart, but some were as near as 15 m (Bump et al. 1947). Male territoriality wanes in late summer and fall, and some males may roost in close proximity during winter. Winter roosting aggregations are typically small (two to 10 individuals), but more than 100 birds have

been recorded at a single roost site (Bent 1932). Such roosting aggregations are typically comprised of only one gender (Rusch et al. 2000), and the group may forage together during the day (Doerr et al. 1974). Females are not territorial and often have overlapping home ranges (Maxson 1989).

Factors limiting population growth

In Region 2, a lack of optimal habitat may be hampering population growth of ruffed grouse. At the landscape level, a mixture of aspen stands in differing seral stages is an essential component of optimal grouse habitat. Data from national forest units in Region 2 (**Table 4**) suggest that especially in Wyoming, the proportion of habitat composed of aspen forest is unusually low. In addition, a lack of regeneration has been raised as an issue in the downward trend in the health of aspen forests in Region 2 and elsewhere in the western United States (Romme et al. 1992, Shepperd et al. 2001). Factors that may be limiting the expansion of aspen forests in Region 2 are discussed in the Threats and Habitat management sections of this assessment.

Northern populations (i.e., Canada, Alaska, northern Great Lakes states) of ruffed grouse show pronounced population cycles (Figure 4 in Rusch et al. 2000) that are closely associated with similar cycles in snowshoe hares (Keith 1963). These cycles appear to be primarily driven by avian predators (mainly northern goshawks and great horned owls) switching their primary prey source from hares to grouse. When hare populations crash, these predators shift their focus to grouse, decreasing grouse survival, particularly among juveniles (Balzer 1995, Lauten 1995).

In Region 2, grouse populations do not appear to cycle as they do in more northern regions. In these more southern regions, predation and/or hunting pressure are thought to regulate ruffed grouse populations (Rusch et al. 2000). Bergerud and Gratson (1988) suggested that density-dependent nesting success (i.e., lower success at higher population densities) imposed limits to population growth in non-cyclical grouse populations. To date, a rigorous data set with which to test the idea is lacking. Using artificial ground nests, Hewitt and Kirkpatrick (1993) found no differences in nest depredation rates between sites with varying ruffed grouse densities. It is important to note, however, that in addition to poor nesting success, density-dependent effects may also act by reducing juvenile and/or adult survival rates during periods of high population density.

There is some evidence, albeit mostly correlational, that ruffed grouse populations in the eastern United States first increased but more recently have declined as a result of changes in habitat (Schorger 1945, Stoll and Culbertson 1995, Rusch et al. 2000). In that area, ruffed grouse primarily occupy early-successional deciduous forests. Such forests are thought to have declined in extent in the last 50 to 100 years due to fire suppression and a decrease in logging activity (Stoll and Culertson 1995, Rusch et al. 2000). However, there are no long-term quantitative measures of ruffed

Table 4. Extent of aspen cover within databases. USDA Forest Service Region 2 national forests and the number of acres of aspen logged in 1999 and 2000. Forests in bold type are within the range of ruffed grouse. Data from Region 2 forest inventory databases.

			Acres logged	
National forest (State)	**Acres of aspen**	**Aspen cover**	**1999**	**2000**
Bighorn (WY)	10,289	<1%	0	0
Black Hills (WY, SD)	48,683	3%	210	24
Shoshone (WY)	5,977	<1%	0	0
Grand Mesa (CO)	690,058	22%	25	130
Medicine Bow (WY)	83,168	6%	19	0
Routt (CO, WY)	279,422	21%	61	89
Rio Grande (CO)	277,881	14%	18	49
Arapaho/Roosevelt (CO)	51,215	3%	0	0
Pike/San Isabel (CO)	180,796	7%	0	0
San Juan (CO)	307,144	15%	103	449
White River (CO)	422,957	17%	424	7

grouse population levels, and it is therefore difficult to assess which factors set limits to population growth in the species.

It is possible that hunting pressure may locally constrain populations where ruffed grouse are not common. The recent data available from Wyoming (**Table 5**) suggest an increase in the total number of ruffed grouse shot by hunters from 2002 to 2004, as well as an increase in the total hunting effort. However, until more data are available on grouse abundance, the effects of increased hunting pressure on grouse population viability will remain unknown.

Community ecology

Interactions between ruffed grouse and their predators and competitors, and how these factors interact with habitat use, are shown in **Figure 7**. The primary factors affecting ruffed grouse abundance and breeding success appear to be habitat quality and availability (Rusch et al. 2000). In Region 2, aspen forests, particularly in mid-elevation riparian areas, are a key habitat for ruffed grouse. The suitability of riparian aspen groves appears to be most affected by the density of the understory, with a high density of shrubs with thick canopy cover being the preferred habitat. Consequently, livestock grazing in aspen stands may represent an important threat to regional ruffed grouse populations as livestock typically severely degrade the forest understory (Marshall 1946, Tewksbury et al. 2002). There appears to be little to no interspecific competition for resources with other grouse species (Rusch et al. 2000), perhaps due to a lack of habitat overlap with other grouse species.

Predation pressure by goshawks and other avian predators may play an important role in some areas, but it does not appear to be an important long-term role in regulating grouse populations (Rusch et al. 2000). Rusch et al. (2000) summarized the published studies of predation on adult and juvenile ruffed grouse in North America, from studies in Alberta, the Great Lakes states, and east to Massachusetts. Their analysis indicated that the most significant source of mortality was avian predation, which accounted for 61 percent of all known mortality (averaged over seven studies). The next most important mortality source was mammalian predation (20 percent), followed by hunting (17 percent). Hunting pressure varies geographically, with a study in Wisconsin reporting 30 percent of annual mortality due to hunting, 46 percent due to avian predation, and 20 percent due to mammalian predation (Rusch et al. 2000). The primary mammalian predators of adults and chicks are red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*), coyote (*Canis latrans*), Canada lynx, and bobcat (*Lynx rufus*). The primary avian predators on adults and chicks include goshawk, great horned owl, Cooper's hawk (*Accipiter cooperi*), sharp-shinned hawk (*A. striatus*), red-tailed hawk (*Buteo jamaicensis*), and barred owl (*Strix varia*).

Predation of ruffed grouse by northern goshawks has been relatively well-studied in areas outside of Region 2. Latham (1950) examined the stomach contents of over 1,000 goshawks in the northeastern United States and found ruffed grouse remains in 23 percent of those examined. In Minnesota, Eng and Gullion (1962) found that 42 percent of all (n = 232) known causes of ruffed grouse mortality were due to goshawk predation, and drumming males were particularly susceptible, with 1.4 males taken for every female. Overall, predation by goshawks occurred primarily during the spring drumming period, with 81 percent of grouse taken during the March-May period (Eng and Gullion 1962). Meng (1959) also noted that predation by goshawks appeared to vary with season.

Predation of eggs can be a significant source of local reproductive failure in ruffed grouse (Bump et al. 1947, Small et al. 1996, Larson 1998, Haulton 1999, Rusch et al. 2000). Known mammalian predators of ruffed grouse eggs include red fox, striped skunk (*Mephitis mephitis*), weasels and mink (*Mustela* spp.), and raccoon (*Procyon lotor*). Other known egg predators are American crows (*Corvus brachyrhynchos*), common ravens (*C. corax*), and various snakes.

Disease has been widely reported, but is not typically cited, as an important source of mortality, or as a factor in cyclical patterns of population density (Bump et al. 1947, Rusch et al. 2000). A large number of internal parasites have been identified, some with a high frequency of occurrence. For example, 80 percent of ruffed grouse in Tennessee had cecal worms (*Heterakis bonasae*), and tapeworms (*Hymenolepis* spp., *Echinolepis* spp.) occurred in 15 percent of individuals sampled in New York (Bump et al. 1947) and 27 percent of individuals in Tennessee (Kalla et al. 1997). Ticks (*Haemaphysalis* spp.) are the most commonly identified external parasite of ruffed grouse, occurring on 12 percent of individuals in a study in New York (Bump et al. 1947).

Table 5. Estimated number of grouse hunters, number of hunter days, and number of ruffed grouse harvested in Wyoming in 2003. Data are from the Wyoming Game and Fish Department website (http://gf.state.wy.us/downloads/pdf/04uplandharvest.pdf). The number of hunting days is a product of the estimated number of hunters multiplied by the estimated number of days hunted.

	2002		2003		2004	
Wyoming Harvest Area	**# hunter days**	**Grouse killed**	**# hunter days**	**Grouse killed**	**# hunter days**	**Grouse killed**
Teton	2571	1705	1889	1000	2114	1077
Grey's River	1500	1090	1176	624	1249	775
Bridger	2148	925	862	414	1504	649
Seedskadee	1242	489	1064	602	2107	1127
Uinta	59	7	99	56	129	36
Flaming Gorge	—	—	—	—	15	14
Eden	562	225	287	26	165	75
Beaver Rim	568	363	419	156	716	218
Bitter Creek	—	—	65	26	80	36
Clark	667	436	357	271	228	127
Cody	225	66	210	207	118	99
Thorofare	—	—	—	—	15	15
Wind River	397	66	248	11	322	72
Lovell	192	132	423	499	535	295
Greybull River	26	0	165	115	72	116
Grass Creek	—	—	—	—	20	0
Copper Mountain	—	—	—	—	14	10
Shell	20	0	257	249	388	214
Hyattville	99	0	158	123	230	151
Kirby Creek	59	7	45	25	19	27
Shirley Mountains	—	—	156	33	55	15
Snowy Range	—	—	2290	1711	2478	1484
Sierra Madre	—	—	1834	1565	3889	3236
Laramie Peak	—	—	434	460	625	473
Iron Mountain	—	—	199	111	77	77
North Natrona	—	—	8	0	14	15
Rattlesnake	6	0	70	30	142	17
Pine Ridge	26	0	13	0	—	—
Southern Big Horns	—	—	264	213	591	341
Big Horn Mountains	—	—	1483	1985	2155	1710
Spotted Horse	52	0	134	81	—	—
Black Hills	146	53	—	—	—	—
Ferris	—	—	206	51	110	19
Unknown	436	278	752	677	—	—
TOTAL	10565	5564	15566	11421	20176	12550

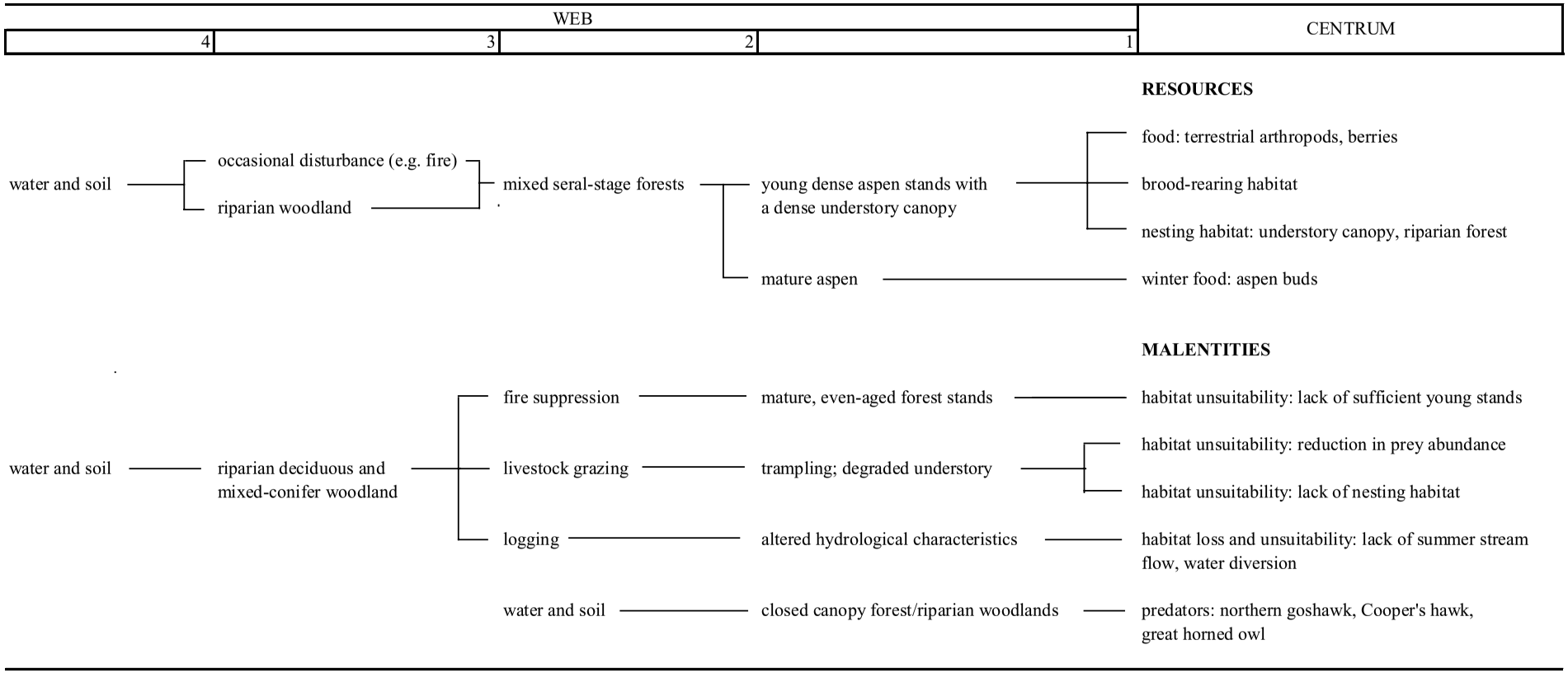

Figure 7. Envirogram representing the web of linkages between ruffed grouse and the ecosystem in which they occur.

CONSERVATION

Potential Threats

Lack of suitable habitat

Ruffed grouse are closely tied to early successional deciduous habitats, and the degradation or loss of such habitats constitutes a serious threat to population viability. Several recent summaries of the effects of habitat degradation on the woodland avifauna of the western United States have shown negative effects on ground-nesting species in general (Saab et al. 1995, Tewksbury et al. 2002). Optimal ruffed grouse habitat in Region 2 is likely comprised of a mosaic of forest types (i.e., young, dense stands of aspen, intermixed with mature forested stands with dense undergrowth). In Region 2, stands of aspen are thought to occur at levels far below their historical abundance (**Table 4**; Romme et al. 1992), and the relative scarcity of aspen on the Black Hills, Bighorn, and Shoshone national forests may help to explain the apparent decline in abundance of ruffed grouse in the region. This hypothesis, however, assumes that ruffed grouse in Region 2 have the same nesting and feeding preferences as populations in other portions of the species' range. While the available evidence (e.g., Marshall 1946, Hutto and Young 1999, Panjabi 2001, 2003) suggests this is the case, studies of habitat use by ruffed grouse in Region 2 are clearly needed (see Information Needs section).

There may be a number of reasons for the lack of suitable ruffed grouse habitat, but the primary reason is probably a lack of aspen stand regeneration. Romme et al. (1992) reported that, although aspen stands comprised approximately 15 percent of the total forest cover on the San Juan National Forest in southwestern Colorado, aspen showed relatively poor regeneration, especially at mid-elevations (2,800 m [9,240 ft.]). Fire suppression and excessive herbivory by livestock or large populations of wild cervids have been cited as factors in poor recruitment in aspen stands in Region 2 (see discussion below).

Fire suppression

Aggressive fire suppression policies appear to have reduced aspen recruitment in at least some forests, and they represent a threat to future aspen regeneration across the Intermountain West. Romme et al. (1992) predicted a subsequent long-term decline in the overall cover of aspen on the San Juan National Forest, largely because of a lack of disturbance (e.g., fires). Several studies have now concluded that strict fire control practices in western forests have led to a decline in the prevalence of aspen (see Shepperd et al. 2001), including research at various forests in Colorado (Benedict 2001, Johnston 2001) and Wyoming (Kilpatrick 2001). These studies suggest that the frequency and size of fires have declined since the 1800's, and that maintaining healthy aspen stands requires land management programs that allow for some form of occasional fire disturbance on the landscape.

Fire suppression and the consequent negative effects on aspen recruitment may be a factor in the apparent long-term decline in abundance of ruffed grouse in the Black Hills. Aside from its effects on aspen regeneration in the West, fire suppression has been viewed as a problem for ruffed grouse range-wide. Rusch et al. (2000) cite fire suppression as a leading contributor to ruffed grouse population declines in the eastern United States over the past century. Regardless of forest type, fire suppression typically leads to over-mature forests and a lack of dense, young forest stand characteristics that nesting and brood-rearing grouse require.

Benedict (2001) suggested that prescribed fire and relaxed wildfire control on the San Isabel National Forest (Colorado) would reverse the decline in aspen regeneration, as well as decrease the extent of conifer invasion into aspen stands. Aspen stands of at least 10 acres in size were the suggested minimum size, as smaller stands appear to be much more vulnerable to damage by grazing cattle and herbivores.

Herbivory

In the West, cattle grazing of forested lands is common and may result in both localized and widespread degradation of ruffed grouse habitat. During the breeding season, ruffed grouse prefer forests with a tall, dense understory of shrubs, and heavy livestock grazing (and consequent understory trampling) may have significant negative effects on local population viability (Bock et al. 1993). Likewise, browsing by cattle may impede regeneration of aspen.

In an early study, Marshall (1946) identified the negative effects of livestock grazing on ruffed grouse nesting and brood-rearing habitat in Idaho. More recently, Tewksbury et al. (2002) found that ruffed grouse occurred at a ratio of 6:1 in ungrazed vs. grazed woodlands along the Snake River in Idaho. Research in Wyoming (Hart and Hart 2001, Kilpatrick 2001, Smith et al. 2001) and Colorado (Benedict 2001, Johnston 2001, Weisberg and Coughenour 2001) suggests that

regeneration of aspen is often hampered by heavy browsing by elk, deer, and cattle. In particular, herbivores use recently disturbed sites such as clearcuts and burns, especially during the summer growing season. Johnston (2001) suggested that such effects were particularly severe in areas where elk were common and where livestock grazing was not carefully controlled. On the Uncompaghre National Forest in western Colorado, Kilpatrick (2001) found that restricted cattle grazing led to significantly improved aspen regeneration. Grazing by elk and cattle tended to be especially deleterious to aspen regeneration in stands/sites that were less than 10 acres in size. Renner (1930) and Spence (1937) noted that sheep grazing also seriously degraded riparian habitats in southern Idaho. Although these habitats were not heavily used by ruffed grouse throughout the year, they were key habitats during the brood-rearing period of mid to late summer, when ruffed grouse often remained close to wet, riparian habitats. Although the full extent to which grazing by livestock may threaten ruffed grouse habitat in Region 2 is not known, negative effects are apparent.

Timber harvest

It is difficult to assess how current logging practices in Region 2 may affect ruffed grouse. Ruffed grouse are typically associated with early successional forest types, and logging can create conditions that promote the regeneration of young forest stands and thus have beneficial effects on ruffed grouse. However, as ruffed grouse habitat requirements vary seasonally, the effects of logging may not be so simple. For example, logging of mature aspen stands may have negative effects as mature aspen represents a critical food resource for wintering grouse. In addition, logging activity may alter local hydrology and degrade local riparian woodlands. However, because over-mature forests may reduce the abundance of ruffed grouse, small-scale logging implemented in a patchwork fashion may help to create the optimal landscape mosaic of woodlands with a variable age structure.

Data from recent forest inventories indicate that the total land cover occupied by aspen ranges widely within Region 2 forests, from 22 percent to less than 1 percent (**Table 4**). The level of aspen harvest has recently declined significantly in Region 2 (**Figure 8**), limiting the threat of logging to loss of mature aspen forest, at least on National Forest System land. However, given the relative rarity of aspen on some national forests (e.g., Shoshone, Bighorn, Black Hills) occupied by ruffed grouse in Region 2, logging of aspen should probably be discouraged on those forests.

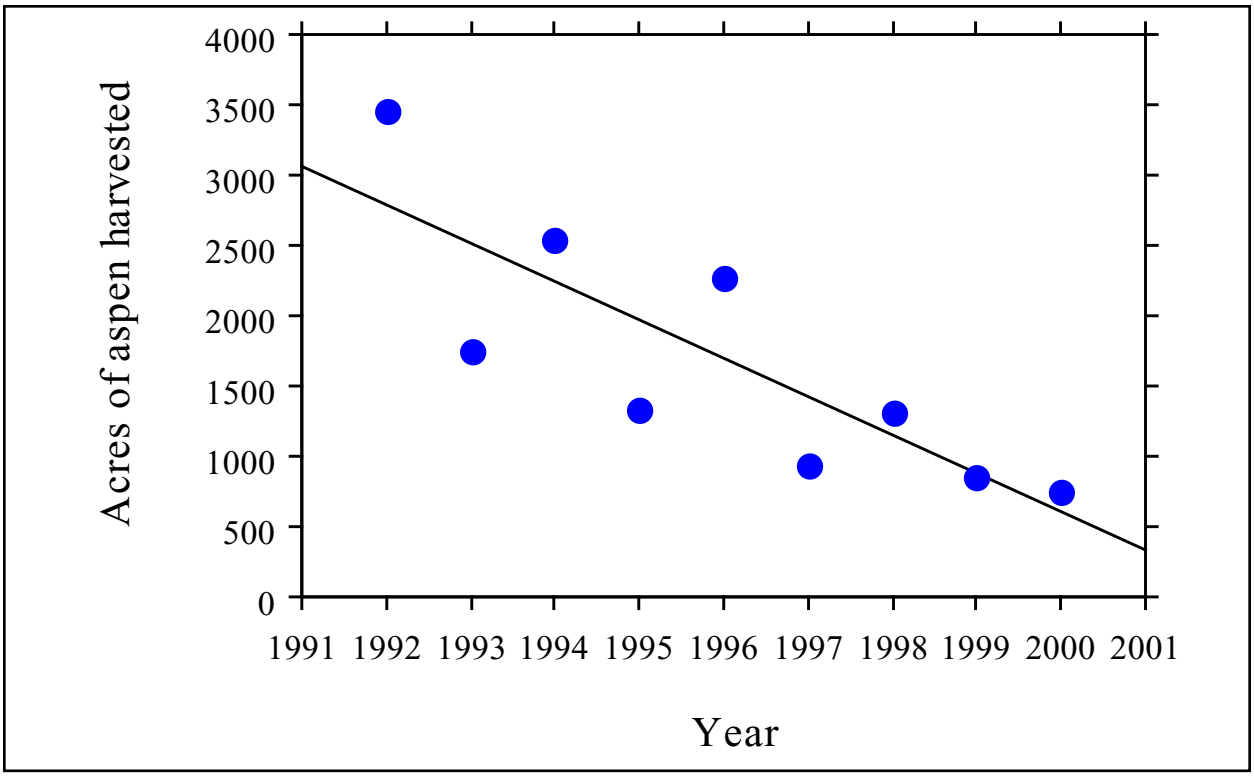

Figure 8. Acres of aspen harvested on USDA Forest Service Region 2 land from 1992 to 2000. The negative trend is statistically significant (R_s = - 0.90, P = 0.011).

Within other forest types, small-scale logging (or other forms of disturbance that promote regeneration) may act to improve habitat conditions for ruffed grouse by stimulating regeneration of aspen where it has been crowded out by conifers. The low relative abundance of ruffed grouse in the western United States has meant that the species has typically not been included in large-scale studies of habitat degradation including edge effects (George and Brand 2002), fire effects (Kotliar et al. 2002), habitat fragmentation (Hejl et al. 2002), or logging (Hejl et al. 1995).

Changes in hydrology

Ruffed grouse are tightly linked to riparian deciduous forests in Region 2 and may be susceptible to land management practices that alter local stream flow. Irrigation and water development projects, for example, may reduce flow and affect the quality of riparian habitats. Perhaps a more serious factor affecting local hydrology within ruffed grouse habitat is logging activity. Logging can alter the pattern of snow accumulation and runoff, and decrease the retention of water within watersheds. Logging roads may also alter the natural water flow regime by expediting the flow of water through the system. Therefore, road building and other forms of forest manipulation may indirectly degrade riparian habitats used by ruffed grouse.

Pesticides

In the 1960's, DDT spraying in New Brunswick had serious effects on ruffed grouse, typically leading to death in young chicks (Neave and Wright 1969). While Rusch et al. (2000) noted that pesticides used in forested habitats would decrease invertebrate abundance and thereby reduce ruffed grouse foraging success, there are no recent studies assessing the effects of pesticides on ruffed grouse.

Hunting

Ruffed grouse are a popular gamebird in most areas of their range, and the effects of hunting pressure have been widely studied. In northern Wisconsin, McCaffrey et al. (1996) reported that hunters took 28 percent of the fall population. Balzer (1995) summarized studies at four sites in Wisconsin and reported that fall hunters took between 10 and 60 percent of the local population. In Ohio, hunting mortality accounted for an average of 18 percent of the annual population (Stoll and Culbertson 1995). Although there are no data available on the number of ruffed grouse taken by hunters in Region 2, the estimated take by hunters was 14,000 birds in Utah in 1981, 23,000 birds in Montana in 1982, and 170,000 birds in Idaho in 1983 (all data from Rusch et al. 2000). Still, most studies have concluded that hunting has negligible effects on the population viability of ruffed grouse (Rusch et al. 2000).

Summary

In order of importance, the current threats to viable ruffed grouse populations in Region 2 are:

1. **Lack of mixed-seral stage forest habitat.** Current levels of aspen woodlands on national forests in Region 2 are thought to be well below historical levels. The reduction of certain primary disturbance factors (e.g., wildfire) has hindered aspen (and other forest types) regeneration, resulting in a lack of dense, young aspen stands in most forests. In general, the lack of forest regeneration has meant that older forests dominate, and that younger forests, including aspen, do not occur at levels that are optimal for ruffed grouse. This is a problem particularly on northern units within the range of ruffed grouse.

2. **Degradation of existing habitat due to fire suppression and overgrazing by livestock and elk.** These two factors represent a continuing problem on most land in Region 2.

3. **Perturbations to local hydrology.** Ruffed grouse are often associated with riparian woodlands in Region 2 and the interior western United States. Consequently, hydrology patterns are critical elements of the landscape. While small-scale logging activity may benefit ruffed grouse by creating patches suitable for aspen regeneration, most forms of logging also have the potential to significantly alter and/or decrease local hydrological flow.

Conservation Status of Ruffed Grouse in Region 2

The overall range of the ruffed grouse within Region 2 does not appear to have changed; this species is still found in all areas where it was documented in the late 1800's and early 1900's. Available data also suggest that ruffed grouse populations in Region 2 are currently stable. However, using slightly different data sets, several authors have suggested that ruffed grouse populations in the northern (Casey 2000) and central (Hejl et al. 2002) Rocky Mountains have experienced

significant long-term declines of over 5 percent per year since the 1960's. Although ruffed grouse were formerly common in the Black Hills (and probably also in the Bighorn Mountains and northwestern Wyoming), an apparent decline in abundance appears to have occurred in the first half of the 1900's. Ruffed grouse now appear to be uncommon and declining in the Black Hills, and their status further west in Wyoming is less clear. The isolated population recently discovered in northwestern Colorado may have existed there for some time, as access to the Hoy Mountain area is difficult (Braun et al. 2003).

One of the primary threats to the population viability of ruffed grouse in Region 2 is loss and degradation of habitat. A lack of suitable aspen habitat is likely the most significant factor limiting the population growth of ruffed grouse in Region 2. Researchers (e.g., Romme et al. 1992) have expressed concern over a lack of regeneration of aspen stands in western Colorado and other areas of the region. Long-term forest fire suppression policies appear to have reduced the primary natural agent of disturbance that is crucial to creating conditions for colonization by or regeneration of aspen. Reduced logging programs in much of the region may also contribute to lower levels of disturbance in forests, leading to crowding out of aspen by conifers.

Although logging has the potential to reduce mature aspen forest, it does not appear to pose a significant threat at current logging levels, at least on National Forest System lands in Region 2. The situation on other federal and private lands, however, is unknown. Consequently, small-scale logging of conifer stands can open areas of the forest, contributing to aspen regeneration. On National Forest System lands where ruffed grouse occur, aspen is relatively rare, and measures to increase aspen cover would improve habitat conditions for ruffed grouse.

Management of Ruffed Grouse in Region 2

Implications and potential conservation elements

Several studies have suggested that at the landscape level, habitats that support viable populations of ruffed grouse are those that provide dense, young aspen stands (for breeding, nesting, and brood-rearing) and adjacent areas of mature aspen (for feeding in winter). While aspen is a key habitat for ruffed grouse, adjacent areas of lodgepole pine (*Pinus contorta*), ponderosa pine, and mixed-conifer forest may also be important locally (Marshall 1946, Panjabi 2001, 2003). Still, the degree to which ruffed grouse depend on aspen in Region 2 needs further investigation (see Information Needs section). For example, the diversity of habitats within which ruffed grouse were detected in the Black Hills (Panjabi 2001, 2003) does not necessarily reflect preferred breeding areas. Hens are known to prefer dense, young aspen stands with a tall understory for nesting. Breeding bird surveys involving the detection of drumming males may not accurately reflect preferred nesting habitat if males are drumming in habitats adjacent to those used by nesting hens. However, the exact nesting habitat preferences of ruffed grouse in Region 2 will be difficult to identify as nesting females are difficult to detect.

The range of ruffed grouse in Region 2 does not appear to have changed significantly over the past century. However, there are indications that in some areas the species is now less common than it was formerly. A reduction in aspen cover suggests a long-term lack of disturbance. Aspen is a colonizer of disturbed and edge areas, and under natural conditions, aspen stands typically establish quickly following disturbances that leave open areas. Romme et al. (1992) identified fire suppression as the most significant factor responsible for the lack of aspen generation in western forests. Inventories on Region 2 forests suggest that aspen forests are under-represented on the Shoshone, Bighorn, and Black Hills national forests (**Table 4**). Even in forests with relatively large proportions of aspen, like the San Juan National Forest, Romme et al. (1992) suggested that most stands were mature and that a lack of recruitment would lead to a long-term decline. The increasing scarcity of aspen in most national forests within the range of ruffed grouse suggests that aspen recruitment in those areas has been significantly reduced.

Logging of mature aspen forest does not appear to represent a serious threat based on the data in **Table 4** and **Figure 8**; however, reduced logging programs also further limit disturbances in coniferous forest that could provide the conditions necessary for aspen regeneration. Reducing livestock grazing pressure and improved livestock management on western public lands would increase the value of riparian areas as ruffed grouse habitat (Bock et al. 1993). Especially in the western United States, brood-rearing hens heavily utilize streamside riparian woodlands during the summer, and degradation of the riparian forest understory by livestock grazing may lead to a significant reduction in

the local abundance of ruffed grouse (Marshall 1946). Improved management of livestock grazing can also reduce the pressure on regenerating aspen.

There are few data available to assess how ruffed grouse respond to habitat modifications in Region 2. Although it is possible to draw inferences from studies outside of Region 2, differences in habitat structure, population isolation, and predator communities may lead to different ecological outcomes. This represents a critical lack in our understanding – without knowledge of the mix of habitat elements necessary (on the landscape level) to maintain healthy populations of ruffed grouse, attempts to formulate management plans will be handicapped. Currently, the best available information suggests that increasing the availability of both early and late seral-stage aspen, reducing livestock grazing along riparian corridors and in aspen forests, and relaxing stringent fire suppression policies are likely to have the greatest positive impacts on ruffed grouse populations. Thus, a regional conservation plan for ruffed grouse would ideally include not only an overall increase in aspen cover, but also land management strategies that would act to promote the regeneration of aspen.

Tools and practices

Inventory and monitoring

The primary problem in attempting to construct a conservation strategy for ruffed grouse is the lack of data on long-term population trends. Without this information, it is difficult to judge if ruffed grouse population viability may be threatened regionally or to assess how current habitat management in Region 2 may be affecting ruffed grouse population viability. Consequently, establishing a standardized protocol for monitoring ruffed grouse populations should be a priority management action in Region 2.

The most accurate survey method for detecting ruffed grouse is to listen for drumming males early in the breeding season (Petraborg et al. 1953). Ruffed grouse males drum in the early spring (in Region 2, generally in April) and are therefore not accurately censused by BBS surveys conducted later in May and June. CBC methodology is not effective in detecting quiet, forest interior species such as ruffed grouse, so CBC data are of limited value. However, drumming surveys conducted in the early spring should provide a reasonable estimate of the local population density. For most areas in Region 2, surveys for breeding ruffed grouse should be conducted in April and early May. A basic survey strategy should consider that:

- surveys should be conducted in mid-elevation forests comprised of aspen, lodgepole pine, ponderosa pine, and mixed-conifer
- drumming surveys should involve stops of 4 minutes duration to listen for drumming males approximately every mile along pre-established 10 mile transect routes; the number and length of transect routes will vary according to road access and local habitat availability
- because drumming is most common around dawn, surveys should be conducted from approximately 1 hour before until 2 hours after sunrise; if necessary, surveys can also be conducted during the last hour of daylight.

These survey techniques have been used during long-term (40+ years) ruffed grouse population monitoring programs in Minnesota and Wisconsin and have been shown to provide accurate measures of local population abundance. However, the accuracy of these methods may be reduced in Region 2 due to the relative lack of roads within preferred ruffed grouse habitat.

Measuring the abundance and breeding status of female ruffed grouse is problematic as females are cryptically colored and difficult to see in thick, forested vegetation. In addition, disturbance at or near the nest site may induce females to abandon the clutch. Thus, surveys of drumming males are the standard technique for measuring ruffed grouse abundance. In some states, sightings of females with broods are collected on a random basis by forest managers and may provide crude, long-term information on local reproductive success and brood-rearing habitat.

Habitat management tools

Habitat management for ruffed grouse has received intensive study outside of Region 2 (e.g., Marshall 1946, Gullion 1977, McCaffrey et al. 1996, Kubisiak and Rolley 1998), resulting in a number of suggested habitat conditions/treatments that may favor ruffed grouse population viability. In order of importance, these recommendations include the following:

1. **Action:** Maintain a mix of young and mature aspen stands within the local landscape (Gullion 1977).
   Rationale: Ruffed grouse prefer dense, young aspen stands as breeding and nesting areas, to provide optimal protection from predators, and as preferred brood-rearing areas later in the summer. During winter, however, ruffed grouse preferentially feed on mature aspen buds; thus, mature aspen stands are also a critical habitat component.

2. **Action:** Restrict livestock grazing in mountainous riparian zones, especially during spring and summer (April through August), and in areas of aspen regeneration.
   Rationale: Livestock grazing may have significant negative effects on ruffed grouse abundance. Grazing may seriously degrade forest understories, including suppression of regenerating aspen.

3. **Action:** Allow occasional small-scale disturbances (e.g., fires) in and near aspen and riparian woodlands.
   Rationale: In western forests, widespread fire suppression policy has led to a decrease in aspen woodlands (Romme et al. 1992). Small-scale fires may have short-term negative effects on local ruffed grouse abundance, but they will benefit the species over time as aspen recolonize disturbed areas. Likewise, patch cuts in coniferous forest create openings in which aspen can regenerate.

Information Needs

The primary information need for ruffed grouse in Region 2 is an accurate, long-term measure of changes in abundance. Dedicated spring drumming surveys on the Shoshone, Bighorn, and Black Hills national forests would provide valuable data allowing land managers to assess trends in grouse numbers, as well as effects of local disturbances or land management activities. These surveys would likely have to be along relatively short routes, as 10-mile transects along roads in mountainous terrain may be difficult to achieve in Region 2.

Within Region 2, and especially on the Bighorn and Black Hills national forests, aspen forests currently are relatively rare (**Table 4**). Local drumming surveys conducted concurrently with attempts to increase the extent of aspen woodlands in these areas would provide valuable data on the effects of aspen regeneration on ruffed grouse population viability. Data from outside Region 2 suggest that long-term increases in aspen abundance on Region 2 forests will result in increased ruffed grouse abundance. However, factors such as intensive livestock grazing may act to reduce any positive effects from increased aspen cover.

To date, there have been few studies of ruffed grouse in Region 2, and knowledge of the species' responses to local habitat modifications would be particularly valuable. Assessing the species' response to habitat modifications will require standardized population monitoring techniques. Once such methods are in place, studies of ruffed grouse responses to local fires, livestock grazing, logging, and various levels of human recreational activity should provide land managers with sufficient data with which to plan long-term forest management plans that will support viable populations of ruffed grouse.

Forest management techniques vary among and within the national forests in Region 2, with different parcels receiving different grazing pressure, periodic prescribed burns, and mowing. The known management history of regional forests provides an excellent habitat baseline against which ruffed grouse abundance and foraging ecology could be quantified. These studies would best be conducted on the Shoshone, Bighorn, and Black Hills national forests, where aspen regeneration schemes should provide an ideal backdrop to measure the effects of habitat improvement on grouse ecology.

A quantitative study of foraging habitat choice, in spring and winter, would provide useful information for the conservation of ruffed grouse in Region 2. All of the available information on ruffed grouse foraging habitat use has come from studies outside of Region 2. Without such data (e.g., use of grazed vs. ungrazed areas, forest successional stage), establishing priority habitats for conservation as well as formulating management plans will necessarily depend on information taken from studies on nesting habitat.

REFERENCES

Aldrich, J.W. and H. Friedmann. 1943. A revision of the ruffed grouse. Condor 45:85-103.

Allen, A.A. 1934. Sex rhythm in the ruffed grouse (*Bonasa umbellus* Linn.) and other birds. Auk 51:180-199.

American Ornithologists' Union. 1957. Checklist of North American Birds. Fifth edition. American Ornithologists' Union, Washington, D.C.

Archibald, H.L. 1975. Temporal patterns of spring space use by ruffed grouse. Journal of Wildlife Management 39: 472-481.

Archibald, H.L. 1976. Spring drumming patterns of ruffed grouse. Auk 93:808-829.

Balzer, C.C. 1995. Survival, hunting mortality, and natality of ruffed grouse in northwestern Wisconsin. Master's thesis. University of Wisconsin, Madison, WI.

Beidleman, C.A. 2000. Colorado Partners in Flight Land Bird Conservation Plan. Version 1.0. Estes Park, CO.

Benedict, T. 2001. Aspen regeneration in south-central Colorado, San Isabel National Forest. Pages 377-386 *in* W.D. Shepperd, D. Binkley, D.L. Bartos, T.J. Stohlgren, and L.G. Eskew, compilers. 2001. Sustaining aspen in western landscapes: Proceedings RMRS-P-18. Fort Collins, CO.

Bent, A.C. 1932. Life histories of North American gallinaceous birds. U.S. National Museum Bulletin 162. Washington, D.C.

Bergerud, A.T. and M.W. Gratson, editors. 1988. Adaptive strategies and population ecology of northern grouse. University of Minnesota, Minneapolis, MN.

Boag, D.A. 1976. The effect of shrub removal on occupancy of ruffed grouse drumming sites. Journal of Wildlife Management 40:105-110.

Boag, D.A. and K.M. Sumanik. 1969. Characteristics of drumming sites selected by ruffed grouse in Alberta. Journal of Wildlife Management 33:621-628.

Bock, C.E., J.H. Bock, and H.M. Smith. 1993. Proposal for a system of federal livestock exclosures on public rangelands in the western United States. Conservation Biology 7:731-733.

Brander, R.B. 1967. Movements of female ruffed grouse during the mating season. Wilson Bulletin 79:28-36.

Braun, C.E., R.J. Delpiccolo, R.W. Hoffman, and T.E. Remington. 2003. First specimen records for ruffed grouse in Colorado. Western North American Naturalist 63:105-107.

Bump, G., R.W. Darrow, F.C. Edminster, and W.F. Crissey. 1947. The ruffed grouse: life history, propagation, management. New York State Conservation Department, Albany, NY.

Casey, D. 2000. Montana Partners in Flight Bird Conservation Plan. Version 1.0. American Bird Conservancy, Kalispell, MT.

Caswell, H. 1989. Matrix population methods. Sinauer Associates, Inc. Sunderland, MA.

DeStefano, S. and D.H. Rusch. 1984. Characteristics of ruffed grouse drumming sites in northeastern Wisconsin. Journal of Wildlife Management 50:361-367.

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 38:601-615.

Dorn, J.L. and R.D. Dorn. 1999. Wyoming Birds. Second edition. Mountain West Publishing, Cheyenne, WY.

Ducey, J.E. 2000. Birds of the untamed West: the history of birdlife in Nebraska, 1750 to 1875. Making History, Omaha, NE.

Ellsworth, D.L., R.L. Honeycutt, and N.J. Silvy. 1995. Phylogenetic relationships among North American grouse inferred from restriction endonuclease analysis of mitochondrial DNA. Condor 97:492-502.

Ellsworth, D.L., R.L. Honeycutt, and N.J. Silvy. 1996. Systematics of grouse and ptarmigan determined by nucleotide sequences of the mitochondrial cytochrome-b gene. Auk 113:811-822.

Eng, R.L. and G.W. Gullion. 1962. The predation of Goshawks upon ruffed grouse on the Cloquet Forest Research Center, Minnesota. Wilson Bulletin 74:227-242.

George, T.L. and L.A. Brand. 2002. The effects of habitat fragmentation on birds in coast redwood forests. Studies in Avian Biology 25:92-102.

Godfrey, W.E. 1986. The birds of Canada. Revised edition. National Museum of Natural Sciences, Ottawa, Ontario, Canada.

Goss, N.S. 1886. A revised catalogue of the birds of Kansas. Kansas Publishing House, Topeka, KS.

Gullion, G.W. 1967. Selection and use of drumming sites by male ruffed grouse. Auk 84:87-112.

Gullion, G.W. 1970. Factors influencing ruffed grouse populations. Transactions of the North American Wildlife and Natural Resources Conference 35:93-105.

Gullion, G.W. 1977. Forest manipulation for ruffed grouse. Transactions of North American Wildlife and Natural Resources Conference 42:449-458.

Gullion, G.W. 1981. Non-drumming males in a ruffed grouse population. Wilson Bulletin 93:372-382.

Gullion, G.W. 1984. Grouse of the North Shore. Willow Creek Press, Oshkosh, WI.

Gullion, G.W. and W.H. Marshall. 1968. Survival of ruffed grouse in a boreal forest. Living Bird 7:117-167.

Hart, J.H. and D.L. Hart. 2001. Interaction among cervids, fungi, and aspen in northwest Wyoming. Pages 197-206 *in* W.D. Shepperd, D. Binkley, D.L. Bartos, T.J. Stohlgren, and L.G. Eskew, compilers. 2001. Sustaining aspen in western landscapes: Proceedings RMRS-P-18. Fort Collins, CO.

Haulton, G.S. 1999. Ruffed grouse natality, chick survival, and brood micro-habitat selection in the southern Appalachians. Master's thesis. Virginia Polytechnic Institute and State University, Blacksburg, VA.

Hayward, C.L., C. Cottam, A.M. Woodbury, and H.H. Frost. 1976. Birds of Utah. Great Basin Naturalist Memoirs. Number 1. Brigham Young University, Provo, UT.

Hejl, S.J., D. Evans-Mack, J.S. Young, J.C. Bednarz, and R.L. Hutto. 2002. Birds and changing landscape patterns in conifer forests of the north-central Rocky Mountains. Studies in Avian Biology 25:113-129.

Hejl, S.J., R.L. Hutto, C.R. Preston, and D.M. Finch. 1995. Effects of silvicultural treatments in the Rocky Mountains. Pages 220-244 *in* T.E. Martin and D.M. Finch, editors. Ecology and Management of Neotropical Migratory Birds. Oxford University Press, Oxford, United Kingdom.

Hewitt, D.G. and R.C. Kirkpatrick. 1993. Ground nest predation and ruffed grouse densities in southwest Virginia. Wilson Bulletin 105:521-523.

Hewitt, D.G. and R.C. Kirkpatrick. 1997. Daily activity times of ruffed grouse in southwestern Virginia. Journal of Field Ornithology 68:413-420.

Hoffman, R.W. and C.E. Braun. 1978. Characteristics and status of ruffed grouse and blue grouse in Colorado. Western Birds 9:121-126.

Holzwart, J.C. 1990. Survival and reproduction of ruffed grouse in central Wisconsin. Master's thesis. University of Wisconsin, Madison, WI.

Hubbard, J.P. and R.C. Banks. 1970. The types and taxa of Harold H. Bailey. Proceedings of the Biological Society of Washington. 83:321-332.

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. University of Minnesota Press, Minneapolis, MN.

Hutto, R.L. and J.S. Young. 1999. Habitat relationships of landbirds in the Northern Region, USDA Forest Service. General Technical Report RMRS-GTR-32. USDA Forest Service, Rocky Mountain Research Station, Ogden, UT.

Jakubas, W.J. and G.W. Gullion. 1990. Coniferyl benzoate in quaking aspen: a ruffed grouse feeding deterrent. Journal of Chemical Ecology 16:1077-1087.

Jakubas, W.J. and G.W. Gullion. 1991. Use of quaking aspen flower buds by ruffed grouse: its relationship to grouse densities and bud chemical composition. Condor 93:473-485.

Johnsgard, P.A. 1979. Birds of the Great Plains. University of Nebraska Press, Lincoln, NE.

Johnsgard, P.A. 1983. The grouse of the world. University of Nebraska Press, Lincoln, NE.

Johnsgard, P.A. 1989. Courtship and mating. Pages 112-117 *in* S. Atwater and J. Schnell, editors. Ruffed grouse. Stackpole Books, Harrisburg, PA.

Johnsgard, P.A., R.O. Kimmel, S.J. Maxson, J.G. Scott, R.J. Small, and G. Storm. 1989. The young grouse. Pages 140-159 *in* S. Atwater and J. Schnell, editors. Ruffed grouse. Stackpole Books, Harrisburg, PA.

Johnston, B.C. 2001. Multiple factors affect aspen regeneration on the Uncompahgre Plateau, west-central Colorado. Pages 395-414 *in* W.D. Shepperd, D. Binkley, D.L. Bartos, T.J. Stohlgren, and L.G. Eskew, compilers. 2001. Sustaining aspen in western landscapes: Proceedings RMRS-P-18. Fort Collins, CO.

Kalla, P.I., R.W. Dimmick, and S. Patton. 1997. Helminths in ruffed grouse at the hosts's southeastern range boundary. Journal of Wildlife Disease 33:503-510.

Keith, L.B. 1963. Wildlife's ten-year cycle. University of Wisconsin Press, Madison, WI.

Kilpatrick, S. 2001. Aspen response to prescribed fire and wild ungulate herbivory. Pages 387-394 *in* W.D. Shepperd, D. Binkley, D.L. Bartos, T.J. Stohlgren, and L.G. Eskew, compilers. 2001. Sustaining aspen in western landscapes: Proceedings RMRS-P-18. Fort Collins, CO.

Kingery, H.E., editor. 1998. Colorado breeding bird atlas. Colorado Bird Atlas Partnership and Colorado Division of Wildlife, Denver, CO.

Knight, W.C. 1902. The birds of Wyoming. University of Wyoming Agricultural Experiment Station Bulletin Number 55, Laramie, WY.

Kotliar, N.B., S.J. Hejl, R.L. Hutto, V.A. Saab, C.P. Melcher, and M.E. McFadzen. 2002. Effects of fire and post-fire salvage logging on avian communities in conifer-dominated forests of the western United States. Studies in Avian Biology 25:49-64.

Kubisiak, J.F. and R.E. Rolley. 1998. Habitat relationships of deer and ruffed grouse in central Wisconsin. Wisconsin Department of Natural Resources Research Report 176. Madison, WI.

Larson, M.A. 1998. Nesting success and chick survival of ruffed grouse (*Bonasa umbellus*) in northern Michigan. Master's thesis. Michigan State University, Lansing, MI.

Latham, R. 1950. The food of predaceous animals in the northeastern United States. Final Report, P-R Project 36-R, Report 1, Pennsylvania Game Commission, Harrisburg, PA.

Lauten, D.J. 1995. Survival, demography, and behavior of ruffed grouse of different color phase during a cyclic decline in northwestern Wisconsin. Master's thesis, University of Wisconsin, Madison, WI.

Marshall, W.H. 1946. Cover preferences, seasonal movements, and food habits of Richardson's grouse and ruffed grouse in southern Idaho. Wilson Bulletin 58:42-52.

Martin, S.G., P.H. Baldwin, and E.B. Reed. 1974. Recent records of birds from the Yampa Valley, northwestern Colorado. Condor 76:113-116.

Maxson, S.J. 1977. Activity patterns of female ruffed grouse during the breeding season. Wilson Bulletin 89:439-455.

Maxson, S.J. 1989. Patterns of activity and home range of hens. Pages 118-129 *in* S. Atwater and J. Schnell, editors. Ruffed grouse. Stackpole Books, Harrisburg, PA.

McCaffrey, K.R., J.E. Ashbrenner, W.A. Creed, and W.M. McCown. 1996. Integrating forest and ruffed grouse management: a case study at the Stone Lake area. Wisconsin Department of Natural Resources Technical Bulletin No. 189. Madison, WI.

McDonald, D.B. and H. Caswell. 1993. Matrix methods for avian demography. Current Ornithology 10:139-185.

Meng, H. 1959. Food habits of nesting Cooper's hawks and goshawks in New York and Pennsylvania. Wilson Bulletin 71:169-174.

Moran, R.J. and W.L. Palmer. 1963. Ruffed grouse introductions and population trends on Michigan islands. Journal of Wildlife Management 27:606-614.

National Audubon Society. 2004. The Christmas Bird Count Historical Results. Available online at: http://www.audubon.org/bird/cbc.

NatureServe Explorer. 2004. An online encyclopedia of life [web application]. Version 1.9. NatureServe, Arlington, VA. Available online at: www.natureserve.org/explorer.

Neave, D.J. and B.S. Wright. 1969. The effects of weather and DDT spraying on a ruffed grouse population. Journal of Wildlife Management 33:1015-1020.

Neel, L. 1999. Nevada Partners in Flight Bird Conservation Plan. Available online at: http:www.blm.gov/wildlife/plan/pl-nv-10.pdf.

Nicholoff, S.H., compiler. 2003. Wyoming Bird Conservation Plan, Version 2.0. Wyoming Partners In Flight. Wyoming Game and Fish Department, Lander, WY.

Ouellet, R. 1990. A new ruffed grouse (Aves, Phasianidae, *Bonasa umbellus*) from Labrador, Canada. Canadian Field-Naturalist 104:445-449.

Over, W.H. and C.S. Thoms. 1921. Birds of South Dakota. Bulletin University of South Dakota. Series 21, Number. 9. Vermilion, SD.

Palmer, W.L. 1962. Ruffed grouse flight capability over water. Journal of Wildlife Management 26:338-339.

Palmer, W.L. 1963. Ruffed grouse drumming sites in northern Michigan. Journal of Wildlife Management 27:656-663.

Panjabi, A. 2001. Monitoring the birds of the Black Hills: Year 1. Annual report submitted to the Black Hills National Forest. Rocky Mountain Bird Observatory, Brighton, CO.

Panjabi, A. 2003. Monitoring the birds of the Black Hills: Year 2. Annual report submitted to the Black Hills National Forest. Rocky Mountain Bird Observatory, Brighton, CO.

Parrish, J.R., F. Howe, and R. Norvell. 2002. Utah Partners in Flight Avian Conservation Strategy. Version 2. Utah Partners in Flight Program, Utah Division of Wildlife Resources, Publication Number 02-27, Salt Lake City, UT.

Peterson, R.A. 1995. The South Dakota Breeding Bird Atlas. South Dakota Ornithologists' Union, Aberdeen, SD.

Petraborg, W.H., E.G. Wellein, and V.E. Gunvalson. 1953. Roadside drumming counts: a spring census method for ruffed grouse. Journal of Wildlife Management 17:292-295.

Pettingill, O.S and N.R. Whitney. 1965. Birds of the Black Hills. Cornell University, Ithaca, NY.

Reed, J.M., L.S. Mills, J.B. Dunning Jr., E.S. Menges, K.S. McKelvey, R. Frye, S.R. Beissinger, M-C.Anstett, and P. Miller. 2002. Emerging issues in population viability analysis. Conservation Biology 16:7-19.

Renner, F.G. 1930. Conditions affecting erosion on the Boise River watershed. USDA Forest Service, Technical Bulletin 528. Boise, ID.

Righter, R., R. Levad, C. Dexter, and K. Potter. 2004. Birds of western Colorado plateau and mesa country. Grand Valley Audubon Society, Grand Junction, CO.

Ritter, S. 2000. Idaho Partners in Flight Bird Conservation Plan, Version 1.0. Unpublished report. Available online at: www.partnersinflight.org.

Romme, W.H., D.W. Jamieson, J.S. Redders, G. Bigsby, J.P. Lindsey, D. Kendall, R. Cowen, T. Kreykes, A.W. Spencer, and J.C. Ortega. 1992. Old-growth forests of the San Juan National Forest in southwestern Colorado. Pages 154-165 *in* M. R. Kaufmann, W. H. Moir and R. L. Bassett, editors. Old growth forests in the southwest and Rocky Mountain Regions – Proceedings of a workshop. USDA Forest Service, Fort Collins, CO.

Rusch, D.H. and L.B. Keith. 1971a. Seasonal and annual trends in numbers of Alberta ruffed grouse. Journal of Wildlife Management 35:803-822.

Rusch, D.H. and L.B. Keith. 1971b. Ruffed grouse-vegetation relationships in central Alberta. Journal of Wildlife Management 35:417-429.

Rusch, D.H., S. DeStefano, M.C. Reynolds, and D. Lauten. 2000. Ruffed grouse (*Bonasa umbellus*). *In*: A. Poole and F. Gill, editors. The Birds of North America, No. 515. The Birds of North America, Inc., Philadelphia, PA.

Saab, V.A. 1998. Effects of recreational activity and livestock grazing on habitat use by breeding birds in cottonwood forests along the South Fork Snake River. USDI Bureau of Land Management Technical Bulletin No. 98-17, BLM/ID/PT-99/004-1150. USDI Bureau of Land Management, Boise, ID.

Saab, V.A., C.E. Bock, T.D. Rich, and D.S. Dobkin. 1995. Livestock grazing effects in western North America. Pages 311-353 *in* T.E. Martin and D.M. Finch, editors. Ecology and management of neotropical migratory birds: a synthesis and review of the critical issues. Oxford University Press, New York, NY.

Sauer, J.R., J.E. Hines, and J. Fallon. 2004. The North American Breeding Bird Survey, Results and Analysis 1966 - 2003. Version 2004.1, USGS Patuxent Wildlife Research Center, Laurel, MD. Available online at: www.mp2-pwrc.usgs.gov/bbs/.

Schorger, A.W. 1945. The ruffed grouse in early Wisconsin. Transactions of the Wisconsin Academy of Sciences, Arts and Letters 37:35-90.

Scott, O.K. 1993. A birder's guide to Wyoming. American Birding Association, Colorado Springs, CO.

Sharpe, R.S., W.R. Silcock, and J.G. Jorgensen. 2001. Birds of Nebraska. University of Nebraska Press, Lincoln, NE.

Shepperd, W.D., D. Binkley, D.L. Bartos, T.J. Stohlgren, and L.G. Eskew. 2001. Sustaining aspen in western landscapes: symposium proceedings; 13-15 June 2000; Grand Junction, CO. Proceedings RMRS-P-18. USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Small, R.J. and D.H. Rusch. 1989. The natal dispersal of ruffed grouse. Auk 106:72-79.

Small, R.J., J.C. Holzwart, and D.H. Rusch. 1991. Predation and hunting mortality of ruffed grouse in central Wisconsin. Journal Wildlife Management 55:512–520.

Small, R.J., J.C. Holzwart, and D.H. Rusch. 1996. Natality of ruffed grouse *Bonasa umbellus* in central Wisconsin. Wildlife Biology 2:49-52.

Smith, B.L., J.S. Dieni, R.L. Rogers, and S.H. Anderson. 2001. Effects of ungulate browsing on aspen regeneration in northwestern Wyoming. Page 163 *in* W.D. Shepperd, D. Binkley, D.L. Bartos, T.J. Stohlgren, and L.G. Eskew, compilers. 2001. Sustaining aspen in western landscapes: Proceedings RMRS-P-18. Fort Collins, CO.

Spence, L.E. 1937. Root studies of important range plants of the Boise River watershed. Journal of Forestry 35:747-754.

Stauffer, D.R. and S.R. Peterson. 1985. Seasonal micro-habitat relationships of ruffed grouse in southeastern Idaho. Journal of Wildlife Management 49:605-610

Stoll, R.J., Jr. and W.L. Culbertson. 1995. Ruffed grouse hunting pressure and harvest on an Ohio public hunting area. Ohio Fish and Wildlife Report 12. Ohio Department of Natural Resources, Division of Wildlife, Columbus, OH.

Svoboda, F.J. and G.W. Gullion. 1972. Preferential use of aspen by ruffed grouse in northern Minnesota. Journal of Wildlife Management 36:1166-1180.

Tewksbury, J.J., A.E. Black, N. Nur, V.A. Saab, B.D. Logan, and D.S. Dobkin. 2002. Effects of anthropogenic fragmentation and livestock grazing on western riparian bird communities. Studies in Avian Biology 25:158-202.

Thompson, M.C. and C. Ely. 1989. Birds in Kansas. Volume I. University of Kansas Museum of Natural History, Lawrence, KS.

Thompson, F.R. and E.K. Fritzell. 1989. Habitat use, home range, and survival of territorial male ruffed grouse. Journal of Wildlife Management 53:15-21.

U.S. Fish and Wildlife Service. 2003. Birds of conservation concern 2003. USDI Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, VA. Available online at: http://migratorybirds.fws.gov/reports/bcc2002.pdf.

Weisberg, P.J. and M.B. Coughenour. 2001. Model-based assessment of aspen responses to elk herbivory in Rocky Mountain National Park. Page 183 *in* W.D. Shepperd, D. Binkley, D.L. Bartos, T.J. Stohlgren, and L.G. Eskew, compilers. 2001. Sustaining aspen in western landscapes: Proceedings RMRS-P-18. Fort Collins, CO.

Wiggers, E.P., J.K. Laubhan, and D.A. Hamilton 1992. Forest structure associated with ruffed grouse abundance. Forest Ecology and Management 49:211-218.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, DC 20250-9410, or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.