

SPRUCE GROUSE

CONTINENTAL CONSERVATION PLAN



**Association
of Fish
& Wildlife
Agencies
Resident
Game Bird
Working
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TABLE OF CONTENTS

Introduction.....	5
Species Description.....	6
Habitat and Population Assessment.....	14
BCR 2.....	29
BCR4.....	31
BCR 5.....	33
BCR 6.....	35
BCR 7.....	37
BCR 8.....	39
BCR 9.....	41
BCR 10.....	44
BCR12.....	47
BCR14.....	50
Recommended Management Practices.....	54
Research Needs.....	60
Review and Update Process.....	64
Literature Cited.....	65

EXECUTIVE SUMMARY

The Spruce Grouse Continental Conservation Plan was created to provide a range-wide estimate of population and habitat and to assemble current assessments of threats, management recommendations and research needs. The development of this Plan is part of a continuing effort to establish species-specific or species-group-specific conservation strategies to guide resource planning and on-the-ground habitat management initiatives.

INTRODUCTION

The Spruce Grouse Continental Conservation Plan (Plan) has been developed under the auspices of the Resident Game Bird Working Group of the Association of Fish & Wildlife Agencies. The development of this Plan is part of a continuing effort to establish species-specific or species-group-specific conservation strategies to guide resource planning and on-the-ground habitat management initiatives.

This Plan utilizes the North American Bird Conservation Initiative Bird Conservation Regions (BCR) as the geographic assessment unit to ensure consistency with other planning efforts that focus on avian species. BCR boundaries may be viewed at <http://www.nabci-us.org/bcrs.html>. Assessments are provided for 10 BCRs that represent the core of spruce grouse continental range.

The primary objectives of this Plan are to provide a range-wide estimate of population and habitat and to assemble current assessments of threats, management recommendations and research needs. Habitat conditions and population densities were based on available data or the expertise of resource professionals knowledgeable of regional conditions and populations. In some BCRs, the lack of forest inventory data or the lack of published data on population density by forest type compromised the precision of assessments.

SPECIES' DESCRIPTION

The spruce grouse (*Falcapennis canadensis*, formerly *Dendragapus canadensis*) is widely distributed and secure through much of its range but declining or rare along the southern fringe, particularly in the east. The species is a resident of northern conifer forests ranging from Alaska to Labrador and south into New England and the northern states of the western United States. One subspecies is recognized over most of its range (*F. c. canadensis*); a second (*F.c. franklinii*) inhabits the cordilleran ranges mostly in BCR 10, and a third is tentatively identified as *F.c. isleibi* (Prince of Wales spruce grouse) in the Alexander Archipelago in southeast Alaska. The vast distribution of spruce grouse is misleading -- within conifer forest spruce grouse select discontinuous microhabitats that meet specific vital needs. Spruce grouse are sedentary with some restricted movements between individual summer and winter ranges.

Description

The spruce grouse is a medium-bodied, dark-colored bird. Sexes are dimorphic in color and size, and there is a clear female sex bias in dispersal, across different populations in their range (Keppie and Towers 1992). Males are dark, slightly larger than females, with a black throat and breast, red comb over the eye; tails are black in *franklinii* birds or are mottled with a broad rufous terminal band in *canadensis*. Females are generally a mottled gray-brown or red-brown plumage, and have white barring on the underparts, with dark brown tails.

The reproductive system is a male dominated polygyny. Both males and females exhibit territoriality during breeding, nesting, and, to a lesser extent, brood rearing (Herzog and Boag 1977, Robinson 1980, Boag and Schroeder 1992). Eighteen percent of males were not known to be territorial in dense and sparse populations in central Ontario (Szuba and Bendell 1988). Males

tend to cease their courtship displays when the females begin nesting, possibly due to a decreased reproductive gain if nest success is high (Keppie 1991). During the breeding season, males choose areas with moderate to high tree density and canopy cover but display in open areas. Female density tends to be high where the herb-shrub layer is dense. When females have broods they choose more open areas where food availability is high (Boag and Schroeder 1992).

Female spruce grouse begin to nest about 17 days after the ground becomes 50% free of snow (Keppie and Towers 1990) although this may vary across regions. Spruce grouse are ground nesting birds, often at the base of trees but also under shrubs and occasionally logs (Boag and Schroeder 1992). Nests are usually partly covered with overhanging branches, but some lack any concealment except for the adjacent bole of a tree. Although nests are widely spaced ($\leq 0.3/\text{ha}$ in the densest population studied), spruce grouse females show synchronous nesting with 2/3 of all females hatching clutches within 7 days of each other (Keppie 2000). Clutch sizes average 5.6 in Canada spruce grouse and 4.8 in Franklin's spruce grouse (Boag and Schroeder 1992).

Incubation begins when the last egg has been laid and lasts approximately 21 to 23.5 days (Boag and Schroeder 1992). After chicks hatch, the hens brood their chicks all night and lead them to feeding sites during the days. Mortality is highest for spruce grouse chicks in the two weeks after hatching and is primarily due to predation although exposure does contribute to the mortality rate (Hannon and Martin 2006). As the chicks grow older they spend more time feeding and less being brooded. Spruce grouse chicks generally remain in broods for 70 to 100 days at which time males begin to disperse first (Boag and Schroeder 1992). Keppie and Towers (1992) found that juvenile dispersal rates are comparable with or without pressure of adults in the population and that emigration is constant over different densities. In central Ontario, 92 %

of females and 74% of males dispersed from the brood range, with females dispersing greater median distances than males in each of 2 years (Beaudette and Keppie 1992). In fragmented forest, both juveniles and adults make larger movements and have poorer survival (Whitcomb et. al. 1996a, Harrison 2001). The poorer survival appears due to fragmentation rather than longer movements themselves.

Spruce grouse are associated closely with conifer forests. The species utilizes a variety of forest types but most occupied habitats share similar structure including an adequate density of trees to provide cover and the ability to supply adequate food. The density of breeding females increases as representation of low shrub and herb layers increase due to the increased availability of preferred foods (Naylor and Bendell 1989). Spruce grouse food staples include the tips, leaves, flowers and berries of ericaceous plants and conifer needles. Spruce grouse rely heavily on conifer needles, eating these exclusively in winter. Where available and where studied, spruce grouse appear to prefer short-needled pine over spruce and fir, and white spruce over black spruce; tamarack is used in spring through autumn (Allan 1985, Boag and Schroeder 1992). Intriguing questions remain for a species with such a broad distribution, as well as for birds in unique local situations such as the Prince of Wales spruce grouse in southeastern Alaska.

Habitat

Spruce grouse occupy forest dominated by short-needled conifers. Boag and Schroeder (1992) found that typical habitat of the spruce grouse consisted of boreal and cordilleran range forests, especially fire series dominated by pine and spruce-fir areas with extensive insect disturbances. But spruce grouse also use wet lowland spruce and tamarack edges with bogs, and this is especially prevalent in southern and southeastern edges of their continental range. In

different regions, spruce grouse are found in other forest types such as subalpine forests in Washington, and coastal hemlock and Sitka spruce in southeast Alaska, and conifer dominated mixed woods throughout (Boag and Schroeder 1992).

Within conifer-dominated forests, spruce grouse use a wide range of forest ages, from jack pine only 10 years old in central Ontario to mature spruce-fir, for example in coastal Maine (Whitcomb et al. 1996b). Spruce grouse appear to use relatively young to mid-age successional stands with similar structure in pine-dominated regions. They appear to select relatively dense stands (2500-3500 stems/ha) with a well developed midstory (Boag and Schroeder 1992). Huggard (2003) found that in subalpine areas with Engelmann spruce and subalpine fir, sites highly used by spruce grouse had higher densities and greater basal area of fir and spruce trees, indicating a preference for smaller trees. Within these areas, spruce grouse used areas with greater canopy cover and shorter trees and were found in greater occurrence on knolls than other topographic types. In all stand types, spruce grouse are found in trees that are branched between $\leq 4-8\text{m}$ from the ground and are common where live canopy is greater than 50% of the tree height (Boag and Schroeder 1992, Keppie 1995). During winter, trees for roosting have higher numbers of lateral branches and are nearer to neighboring trees than trees used less; birds use stands with higher tree density than in summer (Allan 1985). During summer in the eastern forest, fewer birds are found where mid to tall rank shrubs are dense ($>40\%$, Naylor and Bendell 1989, Keppie 1995, Whitcomb et al. 1996b).

Prince of Wales spruce grouse are the most unique. They inhabit temperate rainforest on a small number of islands in southeast Alaska with a history of low-intensity, gap-size natural disturbances. Only here are birds known to eat Sitka spruce and western hemlock, and birds are found most in the complex, high-volume, old-growth forest (Russell 1999).

Spruce grouse attain the greatest densities in areas with at least some early seral stages and populations have been shown to rise and fall with plant succession; locally large population sizes have been found in early stages of post-fire succession (Boag and Schroeder 1987, Schroeder and Boag 1991) and following planting (Szuba and Bendell 1983). Populations in jack pine decrease as canopy height increases unless a spruce understory provides dense cover. Mature fir stands tend to be poor habitat because of self-pruning; mature pine stands are only utilized when subdominant spruce is present (Boag and Schroeder 1987, Keppie 1995). Potvin and Courtois (2006) studied the short-term effects of clear-cuts with residual strips in large areas (23-256 km²) 70% clear-cut in boreal forest of Quebec. Male spruce grouse were absent from clear-cut patches but were present in 50% of 51-132m wide residual strips and buffers. In high-elevation, subalpine, clear-cut landscapes, spruce grouse show low use near clear-cut openings, perhaps a response to winter thermoregulation problems and snow loading on branches (Huggard 2003).

Estimated densities of spruce grouse are generally low (below 10 birds per km²) but vary over the range of the species and may fluctuate between years. Densities of spruce grouse also fluctuate because of different seasonal preferences and local movements. In New Brunswick, autumn dispersal resulted in a decline of the number of young birds from 18.8 to 8.3 per 100 ha (Boag and Schroeder 1992). The lowest densities are found at the fringe of the species range where spruce grouse are uncommon in small patches of conifer forests (Whitcomb et. al. 1996a). Densities of spruce grouse are best predicted in jack pine in Ontario by a measure of the total canopy and midstory cover while density in lodgepole pine is best predicted by a regression based on canopy height (Schroeder and Boag 1991). In New York, spruce grouse prefer cool, moist spruce-fir forest adjacent to open peat mat wetlands and appear to prefer the forest

conditions found at elevations between 385-550 m (NY DEC 2003). Near wetlands in western forests, the peak observed occurrence of spruce grouse is at 20-35 m from the wetland edge with occurrence declining at distances less than 15 m from the wetlands (Huggard 2003).

Highest population densities (9-80 adults in summer/100 ha) are found in Ontario in jack pine plantations with highest numbers where trees are 10-25 years old and 4-10 m tall (Szuba and Bendell 1983, 1993). High densities were also found in New Brunswick with breeding densities of 9.8-21.9 adults/100 ha in spruce fir forest (Keppie 1997). Long term research in lodgepole pine dominated forest in southwestern Alberta showed densities of total adults ranging from 4.6-29.1/ 100 ha (Boag et al. 1979), and 0.0-28.0 males/ 100 ha (Boag and Schroeder 1987, Schroeder and Boag 1989, 1991). In insular patches of forest in northeastern United States, spruce grouse have been found in total densities of 15 birds/100 ha in spruce-fir, 1.0-9.6 birds /100 ha in spruce-fir-tamarack, and 11.5-14.0 birds/100 ha in black spruce-tamarack wetlands in Vermont, New York, and Maine, respectively (Pence et al. 1990, Bouta and Chambers 1990, Whitcomb et al 1996b). Additional density estimates have been 5-9 birds/100 ha in Michigan (Robinson 1980), 4.3 “pairs”/100 ha at Grasse River in New York (Fritz 1985), 4.9-8.7 males/100 ha and 4.9-5.8 females/100 ha in New Brunswick (Keppie 1987), 3.5-6.3 females/100 ha and 2.7-5.0 males/100 ha in Alaska (Ellison 1974), 3.3-15.0 males/100 ha in Quebec (Potvin and Courtois 2006), and 2.5 birds/100 ha on Prince of Wales Island, Alaska (Russell 1999).

Densities of spruce grouse vary temporally and spatially, and may greatly be affected by production from the previous year (Boag and Schroeder 1987). Nest success is the most influential, direct factor upon productivity (Keppie 1982), and perhaps population size changes of spruce grouse (Bergerud 1988). Spruce grouse in patchy black spruce forest in mid-coastal Maine have low productivity (<1) compared with pine-dominated regions elsewhere, and this

may be a consequence of maturing conifer forest with sparse ground cover; presumably breeding habitat quality decreases when only patches of black spruce are available (Whitcomb et. al. 1996b).

Legal Status and Harvest

Information on spruce grouse legal status and harvest was assembled for 12 states and 11 provinces and territories based on hunting regulations published for 2006 and other sources (Table 1). Spruce grouse hunting was prohibited in 7 states, and 1 province. Two of the 7 states (Vermont and New York) protected spruce grouse as an endangered species and one state (Wisconsin) listed it as a threatened species. Daily bag and possession limits were generally higher in the western and northern provinces/territories in comparison to the other provinces and states that allowed hunting. The longest seasons were found in Alaska, Labrador, and the Northwest Territories. Newfoundland and Labrador permit snaring during extended seasons. Of the 15 states and provinces/territories that allowed spruce grouse hunting, estimates of spruce grouse harvest were found for 3 states and 3 provinces. Two states and 3 provinces combine spruce grouse with other forest grouse species for harvest regulations.

Table 1. State and provincial spruce grouse legal status and harvest regulations.

State/Province	Special Status	Max Daily Bag	Max Possession	Earliest Start	Latest End	Harvest Est.
Alaska		15	30	1-Aug	15-May	No
Alberta		10	20	15-Sep	30-Nov	7761 ^a
British Columbia		10	30	1-Sep	15-Dec	Forest grouse only
Idaho		4	8	1-Sep	31-Dec	Forest grouse only
Maine		0	0	Closed	Closed	NA
Manitoba		6	12	1-Sep	17-Dec	No
Montana		3	12	1-Sep	15-Dec	5279 ^b
Michigan	Special Concern	0	0	Closed	Closed	NA
Minnesota		5	10	16-Sep	1-Jan	9000-27000 ^c
New Brunswick		6	12	1-Oct	1-Dec	Forest grouse only
Newfoundland and Labrador ^h		20	40	15-Sep	29-Dec	Forest grouse only
New Hampshire	Conservation concern	0	0	Closed	Closed	NA
New York	State endangered	0	0	Closed	Closed	NA
Northwest Territories ⁱ		10	40	1-Sep	30-Apr	4203 ^d
Nova Scotia	Protected	0	0	Closed	Closed	NA
Saskatchewan		10	20	15-Sep	9-Dec	3047 ^e
Ontario		5	15	5-Sep-	31-Dec	No
Oregon	State sensitive	0	0	Closed	Closed	8 ^f
Quebec		5	15	1-Sep	15-Jan	No
Vermont	State endangered	0	0	Closed	Closed	NA
Washington		3	9	1-Sep	31-Dec	3117 ^g
Wisconsin	State threatened	0	0	Closed	Closed	NA
Yukon		10	30	1-Sep	30-Nov	No



- a) 2000
- b) 2003
- c) 1994-2006 (Dexter 2006)
- d) 1993-1994
- e) 2004, resident hunters only
- f) 2005-2006 (4.8 per year, 1997-2006); submitted in wing bee
- g) 1992-1995; recent years combine all forest grouse
- h) regulations generally more liberal in Labrador, and snaring is legal.
- i) Data are separate from the new Nunavut, created in 1999. In Nunavut, sport hunting is not legal but native Inuit can take spruce grouse for need.

HABITAT AND POPULATION ASSESSMENT

Range-wide Habitat Estimation Methods

Forest inventory data were assembled from various sources to describe spruce grouse distribution. Forest inventory data were not standardized, were discontinuous across the range of spruce grouse, and were collected at widely varying intervals during 1940-2004; therefore the distribution and occurrence of habitat types presented here should be viewed as only a best-available approximation of reality.

Canadian forest inventory data were obtained from Canada's Forest Inventory 2001, Canadian Forest Service, Natural Resources Canada (Katja Power, Natural Resources Canada, personal communication, 2006). Data collected spanned 1940-2003. Data were organized by

forest region and by province. Data were divided proportionately when a BCR boundary split a forest region within a province.

For spruce grouse habitat in the United States, Forest Inventory and Analysis data (FIA) (<http://www.fia.fs.fed.us>, accessed 2 February 2007) were generally available at the county level for the entire United States portion of spruce grouse range exclusive of Alaska. County boundaries did not precisely coincide with BCR boundaries but were approximated by comparing county maps to the most recent published spruce grouse range map (Boag and Schroeder 1992) and to BCR boundaries. Data collected represented the time period 2000-2005. For Alaska, only the south-central coastal portions of BCR 5 were available at FIA. Other inventory data for Alaska were collected from inventories spanning 1968-1980 from Carroll et al. (1985), Hegg (1975, 1979, 1982, 1983), Setzer (1987), Van Hees (1983, 1987), and Winterberger (1983). Coverage of Alaska was not complete; therefore BCR 5 is underrepresented in and BCR 2 is absent from the habitat and population assessment.

Habitat types for spruce grouse were defined by forest type (Smith et al. 2004). A forest type for any field location is defined by FIA (<http://www.fia.fs.fed.us>, accessed 2 February 2007) as “a classification of forest land based upon and named for the tree species that forms the plurality of live-tree stocking; hardwoods and softwoods are first grouped to determine predominant group, and forest type is selected from the predominant group.” Some forest types were lumped for the spruce grouse habitat analysis (e.g. aspen/birch/cottonwood group includes all forest types with any of these species predominating). Canadian forest inventory types and FIA forest types were aggregated where possible.

The area of inventoried forest within mapped spruce grouse range was aggregated by forest type and BCR; total area covered by forest within spruce grouse range that had been

inventoried to type was estimated at 2.55 million square kilometers (Table 2). Forest types within the inventories were classified as either “potentially occupied” or “not used” (i.e., not known to be used) by spruce grouse (Table 3). Classifications were based on documented use by spruce grouse of lodgepole pine and jack pine across the range of spruce grouse (Boag and Schroeder 1992); white spruce and black spruce bogs in Alaska (Dublin and Taras 2005; Ellison 1966 *in* Boag and Schroeder 1992); coastal forests of Sitka spruce, hemlock and cedar in southeast Alaska (Weeden and Ellison 1968 *in* Boag and Schroeder 1992, Russell 1999, Dublin and Taras 2005); Engelmann spruce and lodgepole pine in north-central Washington (Ratti et al. 1984); open subalpine forests dominated by subalpine fir in the Cascade Mountains of Washington (Boag and Schroeder 1992); alpine fir, Engelmann spruce and lodgepole pine in summer and Douglas fir, ponderosa pine, lodgepole pine and larch in winter in Montana (<http://fwp.mt.gov/fieldguide/speciesDetail.aspx?elcode=ABNLC09010>, accessed July 2007); black spruce in Minnesota (Anderson 1973 *in* Boag and Schroeder 1992); black spruce and balsam fir in Quebec and New Brunswick (Potvin and Courtois 2006, Keppie 1987, respectively), red spruce and balsam fir in Maine (Allan 1985 *in* Boag and Schroeder 1992), and black spruce and tamarack in Maine (Whitcomb et al. 1996a) and New York (Fritz 1979).

Table 2: Forest type area (km²) inventoried by Canadian and U. S. inventory systems within mapped spruce grouse range. A blank cell indicates either a forest type not used by spruce grouse or the absence of a forest type (or type classification) in a BCR.

FOREST TYPE	BCR									Total
	4	5	6	7	8	9	10	12	14	
Alaska-yellow-cedar	3,114	467								3,581
Alpine, amabilis, and grand fir	5,308		1,529			437	32,459			39,733
Aspen / Birch /Cottonwood	39,679	1,149	124,734	27,159	152,573	733	18,146	112,976	16,791	493,940
Balsam fir			400	2,348	56,532		1	37,465	22,300	119,046
Black spruce	43,867	86	61,017	58,560	295,133		1,138	89,652	21,919	571,372
Cedar	232				1	12	4,962			5,207
Conifer			176,121	85,469						261,591
Douglas-fir	896	3,764	6			16,366	78,917			99,949
Eastern hemlock					4			3,355	1,916	5,274
Eastern Mixed Forest								1,550	1,129	2,678
Engelmann spruce	407		106			751	13,437			14,701
Engelmann spruce / subalpine fir						292	5,501			5,794
Hardwood	40	1,837	580	4,813	10,836	2,783	1,177	84,094	79,230	185,390
Hybrid jack and lodgepole pine			1,894				593			2,488
Jack pine			34,007	6,295	76,666			21,080	1,946	139,994
Larch and Tamarack	794		1,542	1,294	2,598	406	7,402	3,910	981	18,926
Lodgepole pine	29,573	94	37,382		9	4,598	134,075			205,731
Misc. western softwoods						13	9			22
Noble fir	200	881				2,401	7,472	778	222	11,955
Non stocked								6,637	4,084	10,721
Northern white-cedar								1	6	7
Other	19						460	32	163	674
Other softwoods/other conifers									564	564
Other spruce		288				1,994				2,282
Pacific silver fir			11		549		331	16,988	3,568	21,447
Pine	18					4,830	14,004			18,853
Ponderosa pine		15					11			26
Port-Orford-cedar									8,592	8,592

Red and white spruce					33			354	5,266	5,652
Red spruce	12	2,585				48	80			2,724
Sitka spruce	14,708	1,972	9,289		36	177	44,542	143	168	69,062
Spruce									4,592	4,592
Spruce and Fir Mixture	3,650		370			1,196	36,377			41,593
Subalpine fir	19					172	2,150			2,341
Subalpine larch	13,096									13,096
Unclassified			584	54						638
Western and Mountain Hemlock	2,273	4,879	15			3,396	20,456			31,020
Western redcedar	40	1,750	9	35	3,757	402	2,921	11,240	1,875	22,030
Western white pine	6						462			468
White fir							205			205
White pine / hemlock								101	580	680
White spruce	48,770	187	31,567	194	6,085		11,622	4,531	2,601	105,556
Whitebark pine	86					192	3,362			3,640
Total	206,807	17,983	481,164	186,222	604,811	41,200	442,273	394,885	178,492	2,553,837

Table 3. Forest types potentially occupied by spruce grouse (X for major and x for marginal types) for Bird Conservation Regions inhabited by spruce grouse and for which forest inventory data were available. A blank cell indicates either a forest type not known to be used by spruce grouse or the absence of a forest type (or type classification) in a BCR.

FOREST TYPE	BCR										
	2	4	5	6	7	8	9	10	12	14	
Alaska-yellow-cedar											
Alpine, amabilis, and grand fir											
Aspen / Birch /Cottonwood											
Balsam fir					X	X			X	X	
Black spruce	X	X		X	X	X	X	X	X	X	
Cedar					x	X			X	X	
Douglas-fir							x	x			
Eastern hemlock											
Eastern Mixed Forest											
Engelmann spruce		X					X	X			
Engelmann spruce / subalpine fir							X	X			
Hardwood											
Hybrid jack and lodgepole pine				X							
Jack pine				X	X	X			X	X	
Larch and Tamarack		X	X	X	X	X	X	X	X	X	
Lodgepole pine		X	X	x			X	X			
Misc. western softwoods											
Noble fir											
Non stocked											
Northern white-cedar											
Other											
Other softwoods/other conifers											
Other spruce										X	
Pacific silver fir											
Pine											
Ponderosa pine											
Port-Orford-cedar											
Red and white spruce									x	X	
Red spruce						X				X	
Sitka spruce			X								
Spruce		X	X	X	X	X	X	X	X	X	
Spruce and Fir Mixture					x	X			X	X	
Subalpine fir		X	X				X	X			
Subalpine larch		X	X				X	X			
Unclassified											
Western and Mountain Hemlock		X	X					X			
Western redcedar			X								
Western white pine											

White fir										
White pine / hemlock										
White spruce	X	X	X	X	X	X		X	X	X
Whitebark pine										

Habitat Estimate

Spruce grouse habitat occurrence was estimated for each BCR by summing the area of forest types known to be or likely occupied by spruce grouse. Because forest inventory data were lacking for BCR 2, no habitat estimate was available. Forest inventory for Alaska and the Northwest Territories was incomplete, so the estimates for BCR 4, BCR 5, BCR 6, and BCR 7 are an under-representation of forest types available. Forest inventory data for Canada and for parts of Alaska were not current, so habitat availability may be different currently.

BCR 8 – the Boreal Softwood Shield contains the largest occurrence of continental spruce grouse habitat, with 24% of the potentially occupied continental forest occurring in the BCR (Table 4). BCR 10 – Northern Rockies, and BCR 6 – Boreal Taiga Plains are also important BCRs for spruce grouse. These 3 BCR’s collectively contain over 60% of continental spruce grouse range.

Of the forest types defined as potentially occupied forest, black spruce has the widest occurrence, with 36% of the continent’s potentially occupied forest (Table 4). Other notable forest types important for spruce grouse are lodgepole pine and jack pine, representing 13% and 9% of continental spruce grouse forest, respectively (Table 4).

Population Estimate

Density estimates for spruce grouse were obtained from the literature (Table 5). Density estimates were averaged and low- and high-density estimates were assigned to each BCR (Table

6). Density estimates represent the number of total spruce grouse per 100 ha of potentially occupied habitat, generally representing adults in spring and summer. Spruce grouse populations are not uniformly distributed in all areas of available habitat, and different age classes of potentially occupied forest types also have different spruce grouse carrying capacities. Because no method was available to estimate occupied habitat, habitat patch occupancy was modeled at 33% for all BCR's, based generally on Bouta (1991) and Fritz (1979, 1985). Estimates of abundance for spruce grouse were obtained by multiplying the predicted density of spruce grouse times the estimated area of potentially occupied habitat in each BCR (and or state/province), times the estimate of habitat occupancy. Resulting population estimates should be viewed with a great deal of caution due to the inherent inaccuracies of the estimation procedure, notably because of the small number and wide range of estimated densities used, the distinction between potentially-occupied and occupied forest types, and problems with estimating rates of patch occupancy across the range of spruce grouse. The arguably simplistic model used to estimate population size may be skewed because researchers often have studied only dense populations and birds are possibly more patchily distributed than we have learned. Also current estimates of occupied area are based on old stand types that may not incorporate recent, extra large disturbances (insects, fire, etc.) and disregard the changes to age composition. Population estimates made here are included to provide a baseline for future improvements to estimation.

The abundance of spruce grouse across the continent is estimated to fall between 5.0 and 16.5 million birds (Table 7). As reflected in estimates of potentially occupied habitat, the majority of spruce grouse reside in BCR 8 and BCR 6, with the two BCRs together representing habitat for over 50% of the continental population of spruce grouse. With the caveat that Alaska forests are underrepresented in present analyzes, the majority of the continent's spruce grouse

reside in the provinces of Quebec (24% of the continental population), Ontario (20%), Northwest Territories (15%) and British Columbia (11%) (Table 8).

Table 4. Area (km²) of forest types potentially occupied by spruce grouse occurring in Bird Conservation Regions within spruce grouse range.

FOREST TYPE	BIRD CONSERVATION REGION									TOTAL
	4	5	6	7	8	9	10	12	14	
Alaska-yellow-cedar	3,114	467								3,581
Black spruce	43,867	86	61,017	58,560	295,133		1,138	89,652	21,919	571,372
Conifer			176,121	85,469						261,591
Douglas-fir							78,917			78,917
Engelmann spruce	407		106			751	13,437			14,701
Engelmann spruce / subalpine fir						292	5,501			5,794
Hybrid jack and lodgepole pine			1,894				593			2,488
Jack pine			34,007	6,295	76,666			21,080	1,946	139,994
Larch and Tamarack	794		1,542	1,294	2,598	406	7,402	3,910	981	18,926
Lodgepole pine	29,573	94	37,382		9	4,598	134,075			205,731
Other spruce									564	564
Ponderosa pine							14,004			14,004
Red and white spruce									8,592	8,592
Red spruce					33			354	5,266	5,652
Sitka spruce		2,585					80			2,665
Spruce	14,708		9,289		36	177	44,542	143	168	69,062
Spruce and Fir Mixture									4,592	4,592
Subalpine fir	3,650		370			1,196	36,377			41,593
Subalpine larch	19					172	2,150			2,341
Western and Mountain Hemlock	2,273	4,879	15			3,396	20,456			31,020
White spruce	48,770	187	31,567	194	6,085		11,622	4,531	2,601	105,556
Total	147,174	8,298	353,311	151,812	380,559	10,988	370,295	119,669	46,629	1,588,736

Table 5. Density estimates for spruce grouse per 100 ha.

Citation	Location	Habitat/forest-type	Sex/Age	Low Density ¹	High Density ¹
Ellison 1975	Alaska	Pre- and Post- Fire, Kenai Peninsula	Adults	40.0	97.0
Ellison 1974	Alaska	White spruce-birch	Females	3.5	6.3
Ellison 1974	Alaska		Males	2.7	5.0
Ellison 1974	Alaska	Kenai Peninsula	Total	7.7	11.6
Russell 1999	Alaska	Prince of Wales Island, temperate rainforest	Total	2.5	2.5
McCourt 1969; McLachlin 1970	Alberta	Lodgepole pine	Total	4.6	8.9
Boag et al. 1979	Alberta	Lodgepole pine	Total	10.5	19.3
Boag and Schroeder 1987	Alberta		Total	4.9	29.1
Schroeder and Boag 1989, 1991	Alberta		Males	0.0	28.0
Wilson 2007	British Columbia		Total	4.0	8.0
Whitcomb et al. 1996b	Maine	Black spruce-tamarack	Total	11.5	14.0
Robinson 1980	Michigan	Jack pine	Total	5.0	9.0
Mt FWP 2007	Montana	Lodgepole pine	Males	1.9	1.9
Stoneberg 1967	Montana		Total	3.1	3.1
Keppie 1987	New Brunswick	Spruce-fir	Adults	9.8	21.9
Keppie 1987	New Brunswick		Females	4.9	5.8
Boag and Schroeder 1992	New Brunswick	Pre and post dispersal	Juvenile	8.3	18.8
Keppie 1987	New Brunswick		Males	4.9	8.7
Fritz 1979	New York	Black spruce-tamarack	Adults	3.5	8.8
Fritz 1985	New York	Black spruce-tamarack	Adults	8.6	8.6
Bouta and Chambers 1990	New York		Total	1.0	9.6
Szuba and Bendell 1983	Ontario	Jack Pine 11-32 years old	Total	12	80
Szuba and Bendell 1983	Ontario	Black Spruce	Total	0.0	30.0
Keppie 1995	Ontario	Jack Pine 10-25 year old	Total	40.0	80.0
Turcotte et al. 2000	Quebec	Black Spruce-Jack Pine uncut patches	Males	5.0	5.0
Potvin and Courtois 2006	Quebec	Black spruce residual strips	Males	3.3	15.0

Pence et al. 1990	Vermont	Spruce-fir	Total	15.0	15.0
Boutin et al. 1995	Yukon	White Spruce	Total	5.0	30.0
Average	All	All Potentially occupied	Male	3.0	10.6
Average	All	All Potentially occupied	Female	4.2	6.1
Average	All	All Potentially occupied	Adults	15.5	34.1
Average	All	All Potentially occupied	Total	8.5	23.3

Table 6. Low- and high-population density estimates per 100 ha, for potentially occupied habitat in Bird Conservation Regions inhabited by spruce grouse. Estimates were made at the BCR level by averaging published density estimates from studies conducted within the BCR (Table 5).

BCR	Low Density¹	High Density¹
4	12	30
5	3	3
6	5	30
7	15	40
8	15	40
9	3	8
10	4	15
12	10	40
14	10	40

¹ Density expressed as number of birds per 100 ha of potentially occupied habitat.

Table 7. Estimates of numbers of spruce grouse in inhabited BCRs. Population estimates generated by multiplying the area of potentially occupied habitat within each BCR by the predicted density of spruce grouse (low and high) and by an estimate of habitat patch occupancy.

BCR	Spruce Grouse Population Estimate	
	Low	High
4	728,513	1,942,703
5	8,278	8,327
6	582,963	3,497,779
7	751,470	2,003,921
8	1,883,769	5,023,383
9	10,878	29,008
10	488,364	1,833,040
12	394,908	1,579,630
14	153,874	615,497
Total	5,003,017	16,533,287

Table 8. Estimates of spruce grouse populations within provinces and states in spruce grouse range. Estimates are usually from surveys in spring, generated by multiplying the area of potentially occupied forest within each state or province by the estimated density of spruce grouse (low and high) and by an estimate of habitat patch occupancy (See table notes for disclaimer).

Jurisdiction	Spruce Grouse Population Estimate	
	Low	High
AK	277,110	727,203
ALB	172,170	981,968
BC	620,683	2,181,041
ID	53,177	199,296
LAB	65,364	174,303
MAN	293,503	976,421
ME	33,523	134,091
MI	8,385	33,540
MN	22,022	88,090
MT	71,432	267,869
NB	70,590	282,360
NEWF	54,348	144,927
NH	1,936	7,745
NS	43,238	172,952
NWT	713,673	2,871,795
NY	1,523	6,092
ONT	967,447	2,691,624
OR	5,039	18,809
QUE	1,161,575	3,471,769
SAS	123,406	431,919
VT ¹	0	0
WA	21,741	70,855
YUK	215,224	573,931
Total	5,003,487	16,533,287

Notes:

1. Estimates are generated by a simple mathematical model and do not represent actual survey estimates.
2. NY: estimate high based on population surveys
3. OR: model estimates are believed to be overly exaggerated
4. VT: estimate is low. VT supports a small population in the Northeast Kingdom.
5. WI: model estimates zero but the state supports a spruce grouse population
6. WY: model estimates suggest spruce grouse occur in the state but no population has ever been verified

BCR 2

Western Alaska

Dale Rabe

Alaska Department of Fish and Game

There is little quantitative information about spruce grouse distribution throughout Alaska, but particularly in the western portions of the state (BCR 2). Birds are distributed irregularly through forested areas of the region and the hunting harvest limit is liberal.

Important Habitat Types

Much of western Alaska and the Aleutian Islands (BCR 2) are comprised of coastal non-forested wetlands and tundra characterized by poorly drained soils, harsh climates, and limited growing seasons. Eastern portions of the region progress into the boreal forests of interior Alaska. Within the BCR, spruce grouse are largely associated with scattered stands of black and white spruce that generally persist as forested islands and stringers along riverine systems. Though spruce grouse are found in parts of this region, it is at the western extent of their range.

Spruce Grouse Range in the BCR

Within this BCR dispersed populations of spruce grouse are limited by the distribution of tall forest cover. Spruce grouse are not found in the western portion of the Seward Peninsula and southward along coastal regions to the Alaska Peninsula, nor do they occur on the Aleutian Islands or on Kodiak Island. Though populations in this area are largely unstudied, densities are likely low compared to other parts of their range.

Status of the Species

Grouse hunting is permitted throughout the region, except for Kodiak Island and the Aleutian Islands. In the remainder of the BCR, harvest is unknown but assumed to be minimal. There is no road network in this region of Alaska and resident human populations are limited to a small number of remote largely coastal villages. Access to

this region by non-locals is infrequent and largely limited to bush aircraft.

Conservation Actions

No specific conservation actions for spruce grouse are required at this time.

BCR 4

Northwestern Interior Forest

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Alaska Department of Fish and Game

Spruce grouse range over most of BCR 4, generally in association with conifer forests. In northern tundra-dominated portions of the BCR, grouse are limited to scattered islands of forest and riparian areas that support larger trees. Forest fires, timber harvest and, more recently, forest pathogens or insect irruptions attributed to climate change may have local or short-term impacts on bird abundance. In the future, regional climate change may permit conifer forests to expand into tundra and alpine areas, creating new habitat for spruce grouse.

Important Habitat Types

Spruce grouse habitat associations vary across the BCR. Though they are primarily found in conifer areas, at certain times of the year they also may be found in mixed deciduous (birch and aspen) – white spruce forests. In Alaska and western Yukon Territory, spruce grouse frequently are associated with white spruce and paper birch forests and black spruce bogs. In northern British Columbia, birds are associated with white spruce swamps, lodgepole pine, Douglas fir, and tamarack. Throughout this range, birds can be found from low elevation to sub-alpine forests.

Spruce Grouse Range in the BCR

There are few data about the historical range of spruce grouse in the BCR, and much of what there is comes from recent breeding bird surveys which are generally conducted along roads or river systems. Northern-most portions of the BCR in Alaska and Yukon Territory contain significant areas of tundra where spruce grouse numbers are generally low and associated with isolated pockets of black spruce. Bird densities increase where conifer trees become larger and denser; this includes much of central Alaska, central and

southern Yukon Territory and the western portion of the Northwest Territories. In this part of their range, spruce grouse are often the most common of the forest grouse (also includes blue grouse, sharp-tailed grouse, and ruffed grouse). As dominant conifer forest types transition in southern Yukon Territory and northern British Columbia, spruce grouse are considered widespread but less common than farther south (Campbell et. al. 1990).

Status of the Species

State, provincial, and territorial management agencies within the BCR generally do not survey spruce grouse populations or rigorously monitor harvest, in part because birds are widespread, they are not highly sought by hunters, and limited road systems make human access difficult to vast areas of the species habitat. For these reasons, harvest regulations are liberal. When harvest is monitored it may be for forest grouse in aggregate and not specifically for spruce grouse, as in British Columbia. Spruce grouse is the second most harvested upland game bird in BC, but it also occurs in other BCR's. In spite of liberal hunting seasons, spruce grouse harvest is generally low in this BCR, and largely occurs near towns, settlements, and close to roads.

Conservation Actions

There is no information to indicate historical changes in distribution or abundance. Change caused by human harvest or forest harvesting likely minimal. Spruce grouse are considered secure within the BCR and there is no special conservation action needed at this time.

BCR 5

Northern Pacific Rainforest

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This BCR consists of extremely wet coastal forests that are largely void of spruce grouse. Consequently, management plans for the region focus on characteristic and more widespread species rather than the patchily distributed spruce grouse (Andres 1999). Despite the lack of abundant spruce grouse, some of the most important conservation concerns for spruce grouse may occur in this region.

Important Habitat Types

This BCR is dominated by Douglas fir, balsam fir, western hemlock, western red cedar, and, also, redwood forests in the south, where spruce grouse are absent. In the northern portions of this region, western hemlock and Sitka spruce are more prevalent. Other common species include shore pine (subspecies of lodgepole pine), mountain hemlock, and western red cedar in the Alexander Archipelago, and paper birch, white spruce, black spruce, and mountain hemlock in south-central Alaska. Spruce grouse appear to have a close relationship with white spruce in south-central Alaska. Spruce grouse in southeastern Alaska appear most associated with Sitka spruce, western hemlock, and shore pine in an area with annual precipitation of up to 5 m. Because of the low density of birds and difficult terrain, the habitat relationships in the Alexander Archipelago are poorly understood.

Spruce Grouse Range in the BCR

Spruce grouse are found in only 2 portions of this BCR: in the Alexander Archipelago in southeastern Alaska, and in south-central Alaska. In the latter case, spruce grouse are widely distributed in the Northwestern Interior Forest of BCR 4, they are contiguous with but only marginally distributed in the drier portions of BCR 5 adjacent to BCR 4. Spruce

grouse in south-central Alaska overlapping BCR 4 and 5 are both the same subspecies (Canada spruce grouse). In contrast, birds in southeastern Alaska are isolated from spruce grouse elsewhere in North America, appear morphologically and behaviorally distinct, and have been described as a unique subspecies (Prince of Wales spruce grouse; Dickerman & Gustafson 1996, Russell 1999). The Prince of Wales spruce grouse is found on a few islands (e.g., Prince of Wales, Heceta, Kosciusko, Warren, Suemez, Zarembo) in the southwestern Alexander Archipelago. The northern and eastern islands in the archipelago, the Queen Charlotte Islands, and the adjacent mainland all appear to be void of spruce grouse.

Status of the Species

Spruce grouse are considered a game species wherever they are found in this region. They receive little conservation attention except in the Alexander Archipelago where their distribution is small and their populations appear low. Russell (1999) estimated 10,500 total spruce grouse on Prince of Wales Island. The accuracy of this estimate is unknown but, at first appearance, seems high. The high level of timber harvest in southeastern Alaska has been listed as a concern for spruce grouse in the area. Unfortunately, except for Russell (1999), research in the BCR has done little to provide a solid indication of population size and/or trend.

Conservation Actions

There is no special conservation status or actions within the BCR (Altman and Holmes 2000).

BCR 6

Boreal Taiga Plains

Suzanne Carrière

Government of the Northwest Territories

The Boreal Taiga Plains (BCR 6) is a transition zone between the Aspen Parklands to the south, the western Canadian Boreal Shield to the east, the tundra to the north, and the mountains to the west. Spruce grouse occur in all the forested regions up to the tree line across all of Boreal Taiga Plains (BCR 6).

Important Habitat Types

Spruce grouse use all forested areas, with jack and lodgepole pine, and white and black spruce, mixed with paper/Alaskan birches and tamarack, especially important (Table 9). Fire is an important natural disturbance in this region. For example, about 0.2-0.5 % of forest burns every year in the Northwest Territories, and relatively few fires are suppressed. This creates a natural mosaic of re-growth, remnant and mature forests used by spruce grouse.

Spruce Grouse Range in the BCR

The range does not appear to have changed from historical distribution. Spruce grouse are found in conifer forests in most of the region, with more sparse and irregular distribution near the tree line and at the northern edge of the region. Estimates show that about 50% of total numbers of spruce grouse in BCR 6 are in the Northwest Territories (Table 10). Records show great variability in hunting success over recent years (Fig. 1). This may be indicative of fluctuations in densities of spruce grouse in this range. These fluctuations are typical of many prey species in northern ecosystems (Boag and Schroeder 1987). Martin et al. (2001) show indices of spruce grouse abundance to be synchronous with cyclic snowshoe hare densities in southwestern Yukon (BCR 4). Conversely, data in the NT show that peak years in spruce grouse occurred during lows in snowshoe hares during the past two cycles (Carrière pers. data 2008).

Status of the Species

Spruce grouse are considered widespread and abundant, hence, populations are not monitored closely in BCR 6. Harvest is monitored only in some sections of the region and/or only for some segment of the hunting population.

Conservation Actions

Spruce Grouse are considered secure (common or abundant) in all provinces and territories in BCR 6: Alberta -S5, British Columbia -S5, Manitoba - S4, S5, Saskatchewan - S5B, S5N, Yukon Territory -S5B (Nature Serve 2007); Northwest Territories - “Secure” (WGGSNW 2006). There is no indication that the distribution has changed from historical range. There are currently no special conservation actions.

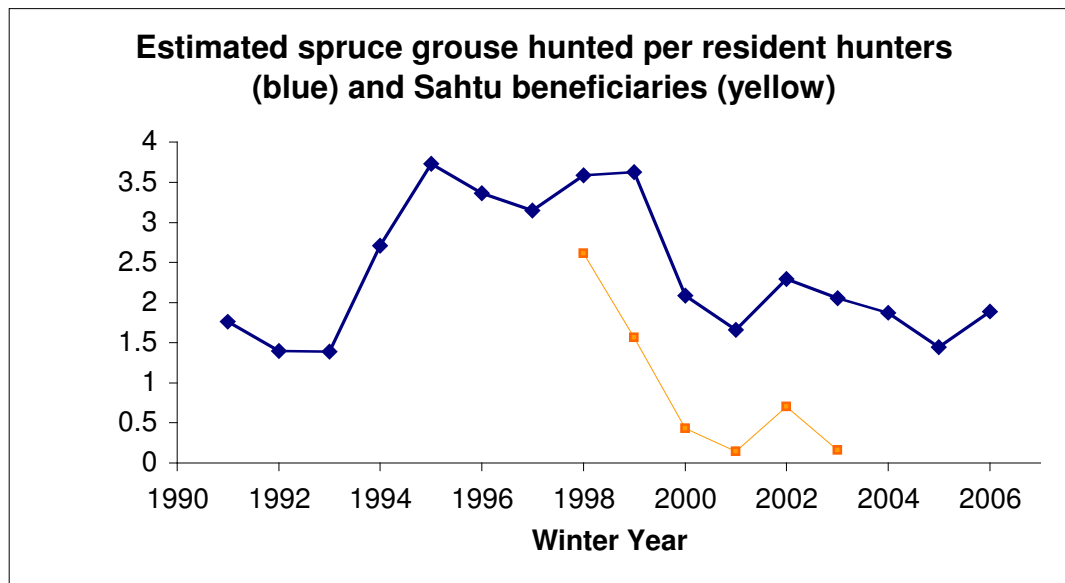


Figure 1. Number of spruce grouse killed, estimated from questionnaire returns (Resident hunters, GNWT, ENR, 2007) and Hunter interview techniques (Sahtu Renewable Resources Board 1998-2003 www.srrb.nt.ca). Latter hunters are at the northern ecological limit of spruce grouse range.

BCR 7

Taiga Shield and Hudson Plains

Dan Keppie

University of New Brunswick

Distributed throughout this region where short-needled conifer forest predominates; occupied forest may contain a low frequency of intolerant deciduous species such as white birch and trembling aspen. Tree species composition of the Taiga Shield similar to further south in BCR 8, but tree density, height, and growth diminish gradually northward as soils thin, climate becomes increasingly subarctic, and fires historically more frequent. Spruce grouse are limited in the region by the extensive wetlands of the Hudson Plains surrounding the Hudson and James Bays. There is little documentation of spruce grouse in this region, but birds are widely distributed, across the extensive black and white spruce, and jack pine forests. Experience elsewhere predicts that birds inhabit the open woodlands of sparse, slow growing black spruce and tamarack along the northern tier of the region. Upland forests along the entire northern edge of the spruce grouse distribution usually contain abundant foliose lichens and ericaceous shrubs. It is likely that there has been little change from historical range, except, perhaps losses around local settlements.

Important Habitat Types

Black and white spruce, jack pine, and tamarack are principal trees and forest communities in the Taiga Shield portion of the region and all are inhabited by spruce grouse.

Spruce Grouse Range in the BCR

Conifer forest comprises the majority of forestland within spruce grouse range (83%, Table 2). Birds likely become less abundant and more irregular as forests thin northward. Nunavut is a new political jurisdiction created in 1999 from much of the eastern

Northwest Territories. Nunavut encompasses BCR 7 north of Manitoba and Saskatchewan and BCR 3. Spruce grouse are likely present in subarctic BCR 7 to tree line, and their presence is unknown but possible in southern portions of BCR 3.



Status of the Species

Spruce grouse appear secure within the BCR, and are hunted in all jurisdictions. There is no information to indicate historical changes in distribution or abundance. In Nunavut, sport hunting is not legal for spruce grouse but Inuit may harvest for personal need; total harvest likely low.

Conservation Actions

There is no special conservation status or actions within the BCR.

BCR 8

Boreal Softwood Shield Forest

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Similar to BCR 7, the long east-west axis to this region attests to moderate changes in climate and physical conditions that occur with latitude. Spruce grouse are found throughout much of the short-needled conifer forests of this region, from the low-lying and poorly drained black spruce and tamarack communities to the better drained and more productive upland black and white spruce and balsam fir communities, and in the well-drained, sand and gravel outwash plains with extensive jack pine beginning in central Quebec westward. Mixed species stands, with trembling aspen, white birch, and white pine are locally common particularly in the south but are not large enough to interrupt the broad distribution of birds. There probably has been little change from historical distribution except possibly around local communities. Natural fires and insects remain to be important natural changes to forest structure and composition but forest harvesting is now extensive. Principal changes in spruce grouse distribution are the successful introductions to the island of Newfoundland (1964), and to Anticosti Island, Quebec (1985-86), both black/white spruce-fir dominated communities, and where, in both, birds have established well.

Important Habitat Types.

Highest recorded densities of spruce grouse across the continent occur in the aerially seeded jack pine flats, with trees only 3-8 m tall, in east central Ontario in the northern limit of BCR 12 (Boreal Hardwood Transition), immediately south of the southern boundary of BCR 8. Similar forests occur in BCR 8. Forest management that promotes well-distributed, immature stands of jack pine should support abundant spruce grouse. Ericaceous shrubs are important for spruce grouse and inhabit much of the conifer and mixed wood forest of the region. Moderate densities of spruce grouse also occur throughout the extensive black spruce forests; in Quebec, spruce grouse densities perhaps

at least as high as in jack pine (J. Ferron, pers. comm. 2007).

Spruce Grouse Range in the BCR

Conifer forest comprises the majority of forestland within spruce grouse range in the BCR (~73%, Table 2), and it is likely that birds are distributed throughout much of the BCR.

Status of the Species

Spruce grouse appear secure within the BCR, with some possible local exceptions along its southern border. Birds are hunted in all major jurisdictions. There is no information to indicate historical changes in distribution or abundance except for recent introductions into insular Newfoundland (134 birds in 1964) and onto Anticosti Island (343 birds in 1985-1986). In general, in Quebec, abundance of spruce grouse thought to be greater in BCR 8 than in BCR 12 and 14 (J. Ferron, pers.comm. 2007).

Conservation Actions

There is no special conservation status or actions within the BCR.

BCR 9

Great Basin

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The Great Basin Region is dominated by relatively arid landscapes (primarily shrub-steppe). Consequently, management attention within this region is focused on the dominant types and their associated avian species, with only minimal consideration of spruce grouse (Altman and Holmes 2000). Despite this generality, spruce grouse are not only present, but abundant in a portion of this region, defined as the northern portion of the East Slopes of the Cascades.

Important Habitat Types

Within the subregion defined as the East Slopes of the Cascades, spruce grouse are primarily found in high elevation forests, the subalpine fir zone, with occasional incursions into lower elevation mixed conifer forest types. Despite generalities in habitat types, the highest densities of spruce grouse are associated with successional types in which lodgepole pine is present. These forests tend to be relatively mesic with an understory of shrubs, herbaceous vegetation, and/or young trees (e.g., subalpine fir or Engelmann spruce). These lodgepole pine forests appear to be maintained by relatively frequent fires or other types of disturbance. Although lodgepole pine also occurs in relatively arid forest types, these do not tend to support large numbers of spruce grouse and often appear to be unoccupied. Other common species of trees in spruce grouse forests include quaking aspen, western larch, Douglas fir, grand fir, mountain hemlock, western white pine, and Ponderosa pine, but these species are rarely dominant.

The mountainous areas of this region are characterized by variable topography and, therefore, widely diverse habitat types. Consequently, it is not unusual for spruce grouse

to be observed in strikingly different habitat types (including shrub steppe dominated by sagebrush). The diversity of tree species tends to be higher closer to the crest of the Cascades. This variability extends to typical patterns of weather. Spruce grouse forests close to the Cascade crest may average > 10 m of snow per year while those 50 km east of the crest may average < 2 meters of snow. Temperatures in this BCR are generally moderate due to proximity to the Pacific Ocean.

Spruce Grouse Range in the BCR

Spruce grouse found in this BCR are all the Franklin's subspecies. Spruce grouse are found in Washington and British Columbia within the Great Basin BCR, but probably not in Oregon except occasionally along the border with BCR 10 in the Wallowa Mountains. Although there has been little published research within the region, anecdotal information from surveys suggests that spruce grouse are present at relatively low densities in high elevation forests immediately east of the crest of the Cascades, from the eastern foothills of Mount Adams northward. Observations of spruce grouse are so infrequent in some areas that it is possible populations immediately east of the Cascade crest are discontinuous. Highest densities and most continuous populations appear to be present in the Okanogan Highlands of north-central Washington and south-central British Columbia ('highlands' defined here as the expansive area of mountains west of the Okanogan River and east of the Cascade crest). There is little evidence that spruce grouse are regularly found west of the Cascade crest (Northern Pacific Rainforest BCR).

Status of the Species

Spruce grouse are considered a game species throughout this BCR and are hunted in most locations, except within national park boundaries (primarily North Cascades National Park), and in Oregon where they are listed as a state sensitive species with undetermined status. Spruce grouse have received very little conservation attention within this BCR, primarily due to the high elevation of their habitats and the perceived lack of disturbance within those habitat types (Altman and Holmes 2000).

This lack of concern for the status of spruce grouse within this BCR is probably unjustified. Timber harvest, fire suppression, over-grazing by livestock, and incursions by noxious weeds have all been listed as concerns for other avian species within the 'East Slopes of the Cascades' (Altman and Holmes 2000). Because spruce grouse are year-round residents, all of these issues have potential to impact spruce grouse. Alteration in the frequency and intensity of fires is probably the most dramatic management concern for spruce grouse within this BCR. Between 1994 and 2007, wild fires burned more than 3,000 km² within the 'East Slopes' subregion in Washington, and many of these fires impacted spruce grouse habitat. The possible reasons for this recent increase in fire frequency and expansiveness are numerous, but include the previous 100 years of fire suppression, drier weather, increased ignition sources, and increases in infestations by bark beetles (e.g., mountain pine beetle, spruce beetle) on pine and spruce. Even if a diseased forest does not burn, it is not known how the prevalence of diseased trees will impact populations of spruce grouse. When forest disease, harvest, and fire are considered together, the potential for negative impacts on quality, quantity, and configuration of habitats is substantial

Conservation Actions

There is no broad, special conservation status or actions within the BCR (Altman and Holmes 2000). However, in Oregon, spruce grouse are listed as a state sensitive species with undetermined status, with few if any birds in BCR 9, along its border with BCR 10. The state has begun to enjoy public interest in the species with formal record keeping by community and public school groups.

BCR 10

Northern Rockies

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The Northern Rockies BCR extends from NW Colorado to central British Columbia. Spruce grouse have been well studied within portions of this BCR, but it is not clear whether specific observations can be applied across the broader region.

Important Habitat Types

The distribution of spruce grouse within the Northern Rockies BCR corresponds to the subalpine fir-spruce zone (sometimes considered mixed subalpine forest). Despite the generalities in habitat types, highest densities of spruce grouse are associated with successional forest types in which lodgepole pine is at least present, if not dominant. These forests tend to be relatively mesic and/or high elevation, with an understory of shrubs, herbaceous vegetation, and/or young trees (e.g., fir or spruce). The lodgepole pine types appear to be maintained by relatively frequent fires or other types of disturbance. Although lodgepole pine can also be found in relatively arid forest types, these types do not appear to support large numbers of spruce grouse. Common species of trees in spruce grouse habitats include white spruce, black spruce, Engelmann spruce, quaking aspen, western larch, Douglas fir, and Ponderosa pine, but these species are rarely dominant.

The mountainous areas of this region are characterized by variable topography and, therefore, widely diverse habitat types. Consequently, it is not unusual for spruce grouse to be observed in different forest types within localized areas. Central British Columbia is somewhat different from the rest of the BCR in that there are extensive areas of gently rolling topography rather than steep mountains. Average annual snowfall varies from about 1 m on the east slopes of the Rocky Mountains to about 4 m in the higher elevations in the northwestern portion of the BCR in British Columbia. Average

temperatures vary dramatically within this region. The east slopes of the Rocky Mountains in Montana and Alberta are characterized by a continental climate with extended periods of extremely cold temperatures, while the west slopes of the Rocky Mountains and central British Columbia tend to be more moderate.

Spruce Grouse Range in the BCR

Spruce grouse are found in western Montana, northeastern Oregon, Northern Idaho, southwestern Alberta, and southeastern and central British Columbia. There is no evidence that spruce grouse are found in the southern portion of this BCR in either western Wyoming or northwestern Colorado. Although spruce grouse have been reported in the Grand Teton and Yellowstone national parks, most photographed 'spruce grouse' in Wyoming are actually dusky grouse (formerly known as blue grouse). Virtually all spruce grouse found within this region appear to be the Franklin's subspecies. In fact, the dividing line between the Franklin's and Canada subspecies appears to be close to the northern boundary of this BCR with the Northwestern Interior Forest BCR (BCR 4) and close to the northeastern boundary with the Boreal Taiga Plains BCR (BCR 6).

Status of the Species

Spruce grouse are considered a game species where found, throughout this BCR, and are hunted in most locations except within national park boundaries (primarily the national parks such as Banff, Jasper, Glacier and Waterton (British Columbia and Montana). Spruce grouse have received little conservation attention within this BCR, primarily due to the high elevation of their habitats and the perceived lack of disturbance within those habitat types (Casey 2000, Ritter 2000).

This lack of concern for the status of spruce grouse within this BCR is probably unjustified. Timber harvest, alteration in fire frequency, and infestation by bark beetles are having a dramatic effect on the forest types upon which spruce grouse depend,

particularly in the relatively warm climates where bark beetles have established. This problem is particularly severe in central British Columbia, where beetles have killed vast tracts of lodgepole pine, wildfires have burned dead and dying trees, or people have cut trees for timber and/or to slow the spread of bark beetles.

Conservation Actions

For the most part there is no special conservation status or actions within the BCR that have been directed toward spruce grouse (Casey 2000, Ritter 2000, Nicholoff 2003). A notable exception is in Oregon, where the species is listed as state sensitive with undetermined status. Observations there are limited to the Wallowa Mountains, with collaborative record keeping of birds observed by community and state groups.

BCR 12

Boreal Hardwood Transition

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This region shows a wide variety of forest types and land uses, overall representing an area of mixed deciduous and conifer forests with transition from the greater open grasslands and agriculture to the south to the more extensive, forested lake regions in the north. Urbanization and agriculture have caused many changes in long-term reduction of forest cover; but just as important to spruce grouse are the natural changes in forest composition occurring over time or brought about by human harvests for wood. As is generally true across the spruce grouse range that overlaps the United States – Canadian border, the increasing preponderance of conifer forests moving toward the northern United States border gives way to increasing preponderance of cities and agriculture along Canada's southern border, before land returns again to preponderantly forest cover in northern parts of this BCR. Conifer represents about 48 percent of total forest area.

Important Habitat Types

Similar to other BCR's, notably 8 and 14, forest types important to spruce grouse are the low-lying black spruce, tamarack, and cedar forests, upland jack pine mixed principally with white and black spruce, and spruce-fir forests, all with abundant ericaceous shrubs. In Minnesota, where available, spruce grouse use jack pine in winter and low elevation black spruce in summer (Pietz and Tester 1982). In Wisconsin, surveys in 2006 in the Chequamegon-Nicolet National Forest found most spruce grouse near edges between white spruce-jack pine-red pine uplands and black spruce-tamarack swamps (Worland et al. 2006). Two nests have recently been found, both in lowland black spruce swamps. Areas of both jack pine forest and lowland conifers have decreased over the long term, concurrent with a general decrease in abundance of spruce grouse (Kreitinger and Paulios 2007). The degree to which jack pine forest in Wisconsin differs, if at all, from that of grouse-inhabited pine forest in Michigan, Minnesota, and elsewhere remains unknown. In

Michigan, on the Yellow Dog Plains, a favored area for spruce grouse with preponderantly jack pine on glacial outwash soils, most birds are found where jack pine is mixed with spruce (Robinson 1969).

Spruce Grouse Range in the BCR

Spruce grouse vary from being patchily distributed and at relatively low densities in southern edges of the BCR to their highest recorded densities at the northern edge bordering BCR 8 in central Ontario. Spruce grouse are distributed irregularly in Michigan and Wisconsin. In Michigan, birds primarily occur in the Upper Peninsula. In Wisconsin, spruce grouse occur across the northern two tiers of counties, most abundant in two distinct clusters in the northwest and northeast near the Upper Peninsula of Michigan; systematic state-wide surveys are still lacking (Worland et al. 2006). In Minnesota, as in much of this BCR, spruce grouse inhabit a mixture of jack pine and spruce forest (Pietz and Tester 1982). Birds in Minnesota are limited to the Laurentian Mixed Forest, which covers much of the southern half of this BCR. In Ontario, spruce grouse occur irregularly in the southern portion of BCR 12 but are increasingly common northward, from Algonquin Provincial Park, and in the northern half of this BCR in Quebec westward into Manitoba, excepting those areas surrounding towns, agriculture zones and deciduous forest.

Status of the Species

Spruce grouse are not legally harvested in Wisconsin, where they are classed as Threatened (ranked S1S2B, S1S2N; www.dnr.wi.gov/org/land/er/wlist/statelisted.asp), listed as a Species of Greatest Conservation Need (SGCN), and are designated as a Regional Forest Sensitive Species in the Chequamegon-Nicolet National Forest. In Michigan, spruce grouse are classed as a species of Special Concern. Spruce grouse are hunted in Minnesota, although also classed as SGCN, and in Manitoba, Ontario, and Quebec.

In Wisconsin, a short-term research project was conducted in 2006 (Worland et al. 2006) with a two-fold purpose to increase the understanding of spruce grouse habitat use and as a precursor for additional research. Specific objectives (abbreviated) are: to survey for

spruce grouse in the Chequamegon-Nicolet National Forest; to develop a preliminary model for identifying potential habitat; and to develop a standard survey protocol for spruce grouse in Wisconsin.

Conservation Actions

There is active conservation research in Wisconsin, with a joint effort supported financially by the Wisconsin Department of Natural Resources, the U.S. Forest Service, and the Wisconsin Bird Conservation Initiative (Worland et al. 2006). There appears to be interest in building from this work.

BCR 14

Atlantic Northern Forest

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The Atlantic Northern Forest is a transitional forest between deciduous-dominated regions to the south and conifer-dominated land to the north. The result is that spruce grouse change from being very patchily distributed in northern New York, Vermont, and New Hampshire, to being more extensively distributed from northern Maine through New Brunswick and Quebec. In the south, where deciduous trees predominate, birds are localized to the patchy, wet, lowland conifer communities (black spruce, tamarack, eastern white cedar). Progressing northward, where soil fertility generally decreases, spruce grouse are more widely distributed at generally low to moderate densities, not only in the lowlands but also in the extensive, upland black and white spruce, balsam fir, and jack pine forests.

Current distribution in the north is likely not much reduced from historical range except for some local occasions. It is uncertain but questionable whether spruce grouse were ever present in Prince Edward Island (R. Curley, pers. comm. 2007). Active forest management probably has not contributed much to any changes in distribution in the north. It may be that distribution and/or abundance of spruce grouse were negatively affected as a result of major salvage operations on Cape Breton (NS) following a large scale spruce budworm epidemic in the late 1970's (M. O'Brien pers. comm. 2007). Effects were not documented and may have occurred elsewhere in the northern part of the region. Spruce grouse range is reduced in the south. Important in the south has been the increased maturity of forest brought on by a general reduction in timber harvests in many local areas and loss of forest to agriculture and urban development. In northern industrial forests, total inhabited area may have increased where new plantations have been put on previously mixed deciduous - conifer land.

Important Habitat Types.

Loss of conifer forest in southern areas puts greater importance to the maintenance of birds in low-lying black spruce and tamarack communities. In northern range, birds are distributed widely, especially across black and white spruce, balsam fir, and jack pine forests, including many spruce and jack pine plantations. Shade-intolerant deciduous trees, such as white birch and red maple, are typical of inhabited forest but only as minor species. We would expect that anthropogenic effects on population viability could be great in this region, with, overall, high spatial variation to tree species composition. Effects appear to be greatest along southern edges of the spruce grouse distribution.

Spruce Grouse Range in the BCR

Conifer forest comprises approximately half of forestland within spruce grouse range in the BCR (46%, Table 2); birds are distributed widely throughout northern portions of the BCR but only in scattered conifer patches in the south.

Status of the Species

Spruce grouse populations are fragmented and vulnerable to extirpation in the southeastern portions of the BCR. In the north (New Brunswick and Quebec), birds are hunted and appear secure over their broad range, but with some possible local exceptions near communities or where forests have changed to mixed-species and to deciduous species, or because of changes to agriculture. Except for southern regions there is little to indicate major changes in distribution and abundance.

Conservation Actions

There is no special conservation status for spruce grouse in the northern part of the BCR. Hunting is not legal in Nova Scotia and Maine southward.

Vermont Fish and Wildlife Department (Alexander and Parren, in draft) have developed a recovery plan for spruce grouse. Spruce grouse is classified as an endangered species in Vermont. Currently, breeding spruce grouse are restricted to a 62 km² (25 mi²) area of spruce-fir forest in northern Essex County (Royar and Alexander 1987). This land is

principally owned by the U.S. Fish and Wildlife Service (Nulhegan Division of the Silvio Conte Refuge) and the State of Vermont, Department of Fish and Wildlife (Wenlock Wildlife Management Area). It is believed that between 150 and 300 adult birds occur in this population and periodic surveys since 1990 show a stable if not slightly increasing population. The Vermont Recovery Plan for Spruce Grouse (Alexander and Parren, in draft) requires the establishment of a second sub-population with at least 30 nesting females in order to down list the bird to threatened status (delisting requires a third sub-population). Reintroductions to Vermont of spruce grouse captured in Quebec and/or New Brunswick is recommended as the priority management action to advance recovery of the species. The Draft Recovery Plan also calls for comparison of genomes from Vermont's population and potential donors (e.g., Quebec, Ontario, New Brunswick, Maine) to determine which possible source of birds might be most suitable.

In New Hampshire, spruce grouse primarily occur in three areas: Connecticut Lakes, Mahoosuc-Rangely region, and the White Mountains (Kelly 2006). All three regions have a high percentage of land protected from development through public ownership or conservation easements. Threats to continued viability include unsustainable timber harvest and unregulated take. A management plan for lowland spruce-fir habitat is in development, which will provide guidance on habitat management of spruce grouse (Kanter, pers. comm. 2007).

The New York State Wildlife Comprehensive Plan attributes the decline of spruce grouse in New York due to maturation of the forest and prohibitions on forest management in the Adirondack Forest Preserve. The total Adirondack population of spruce grouse was estimated at only 175-315 birds in 1990 (Bouta and Chambers 1990), noticeably less than the estimates in Table 8 based on potential occupied habitat alone. Spruce grouse are likely to be extirpated in 20 years without active intervention and management (Post 2005). A recovery plan is in preparation and a Recovery Team has been formed (G. Johnson, pers. comm., 2007). Preliminary analysis suggests the existence of 178,000 – 210,000 acres of potential habitat in the Adirondacks (Halasz et al., 2000). As a precursor to the recovery plan, state wildlife grants are being used to complete a survey of

historically occupied sites, estimate population size in the Adirondack Mountains, examine macro- and micro-habitat use, and evaluate post-breeding season movement patterns by juveniles and adults. In addition, DNA microsatellite variation in New York populations will be characterized, as an indirect measure of population structure and gene flow and to compare New York spruce grouse with neighboring Canadian populations.

RECOMMENDED MANAGEMENT PRACTICES

General Management Considerations

J. Soule (1992) suggests that protection, in form of compatible timber management practices, is needed along southern fringe of range, particularly where logging continues or is expanding into grouse habitat. At least in the northern half of the distribution of spruce grouse, it is not known that forest management activities have had any major negative effects on the species (a possible exception could be the timber harvests of old-growth forest in southeast Alaska, notably Prince of Wales Island). Nevertheless, perhaps excepting BCR 7 and northern portions of BCR's 4, 6, and 8, recent increases of the intensity of forest harvest with increases in fire and insect disturbances may affect spruce grouse abundance and distribution greater than known previously. In general (and this may not be the case in southeast Alaska), for long-term maintenance of the species, a large area with a mosaic of even-aged stands of pine and pine-spruce is ideal, including an array of different age classes across the forest (Boag and Schroeder 1992). Note that, even in a large conifer region, abundance of spruce grouse undoubtedly varies spatially among stands of different age classes within the same covertype. In the southern parts of spruce grouse distribution, particularly Wisconsin eastward, where birds appear threatened, extensive areas of high-quality forest (young – mid age short-needled pines and spruces) are not prevalent. Protection of lowland spruce forest is also important. In some areas, spruce grouse use both upland pines and lowland spruce in the course of a year (Pietz and Tester 1982). Preservation efforts should also focus on connectivity of habitat patches to decrease mortality during dispersal. The study of Potvin and Courtois (2006) in an intensely managed region in BCR 8 in Quebec is one to note: even narrow corridor strips (51-132 m wide) can be occupied. In this study, males in spring occurred in strips that were wider, with lower tree canopy and a denser shrub layer, than strips not occupied.

Insular populations in small habitat patches will be particularly difficult to maintain (Bouta and Chambers 1990, Whitcomb et al. 1996b, Soule 1992). In a habitat assessment for Vermont, Keppie and Beaudette (Appendix II in Pence et al. 1990) concluded that a

female spruce grouse needs 5 to 15 ha of habitat, depending on quality, to raise a brood. From this, it can be extrapolated that a population of 100 birds (both male and female) would require up to 250-750 ha. Note that this may be a maximum estimate of area because females with broods can use overlapping land. But note also that, to set a particular density of broods for a management objective it must account for the fact that not all females will produce juveniles.

Habitat Management Guidelines

The Vermont Fish and Wildlife Department (Alexander and Parren, In draft; Alexander and Chipman 1991) has taken considerable action toward developing habitat management guidelines for spruce grouse in Vermont. An abbreviated overview of the guidelines follows:

1. Manage habitat in 50 ha. (124 acres) units, to accommodate the upper range of home range size for females with broods. Suitable habitat should be at least 100 ha.
2. Even-age or all-age management systems may be used, however, 37% to 50% of all trees within the habitat management unit (HMU) should be in age classes between 20-50 years at all times.
3. Whether the management is described as even-age or all-age, the area of regeneration in each HMU is calculated by the formula:
$$\text{Cutting Interval/Rotation Age} = \text{Amount of Area Regenerated}$$
4. Rotation age should range from 60 years for predominately fir stands to 80 years for predominately spruce stands. Cutting intervals should be 10-15 years, resulting in the creation of 4-8 age classes.
5. Softwood regeneration is a critical goal. Clearcut only when softwood regeneration is adequate. Otherwise employ shelterwood techniques to obtain necessary softwood regeneration. Spruce regeneration is preferred over fir.
6. Silvicultural treatment should occur during snow-free periods if scarification is necessary to establish softwood regeneration. However, preferably, cutting

- should not occur during spruce grouse courtship and breeding seasons (mid-April to mid-July).
7. If even-age management is employed, regeneration cuts should be no larger than 12.5 ha (31 acres), as larger cuts would result in the inability to provide equal distribution of at least 4 age classes over time within the HMU. Smaller regeneration cuts of 0.4-1 ha (1-2.5 acres) are preferred as they should allow for more thorough utilization of openings by hens with broods.
 8. Employing true all-age stand management (periodic single-tree or group selection cuts from all diameter classes) across an entire HMU may not provide optimum spruce grouse habitat. While continuous forest cover with adequate vertical stratification should be provided by all-age management, sparse canopy brood openings will be lacking. To prevent this deficiency, at least 20% of each HMU should receive even-age regeneration treatments [defined as an area at least 0.4 ha (one acre) in size with a residual basal area $\leq 6.8\text{m}^2/\text{ha}$ (30 sq. ft./acre) following the final regeneration cut].
 9. Hardwood composition should be kept below 10% of the composition of the HMU. Tree species to encourage during management activities include black, red, and white spruce, balsam fir, and larch.
 10. Larch should be maintained at 10-20% of stand composition where it occurs.
 11. Pre-commercial thinnings are acceptable only up to age 30.

The Vermont plan appears to be developed well. Nevertheless, two points are noteworthy. While natural regeneration may be desirable for numerous reasons, spruce grouse do not require it. Spruce grouse are found in managed, planted forest, for example, note the high densities in aerially seeded jack pine in central Ontario (Szuba and Bendell 1983) and that they are abundant in many spruce and jack pine plantations across BCR 14. In addition, while dynamics of tree growth and regeneration are important, it may be that spruce grouse are influenced substantially by attributes other than trees themselves. For example, many lodgepole pine stands in the west (BCR 10) and many planted spruce stands in the east (BCR 14) appear void of spruce grouse despite having trees that appear structurally appropriate for spruce grouse. The value of ericaceous shrubs and other low-

lying vegetation is well known for its food value and perhaps predator protection (Ratti et al. 1984, Naylor and Bendell 1989, Boag and Schroeder 1992).

■
It must be emphasized that the collective intensity of several disturbances is now increasing. Because of extensive fires, recent, extensive mortality of trees from beetles, and very large clearcuts, the Franklin's spruce grouse in much of British Columbia may face substantive population declines. Fires are often > 50,000 ha in size and a small cumulative clearcut may be 1000 ha. The issue should be to retain as much of the successional mesic lodgepole pine forest as possible. Total forest not supporting spruce grouse could be quite large in another 10 years. It is also likely that some areas, notably subalpine forest (e.g., British Columbia; Huggard 2003), and the temperate rainforest in southeast Alaska (Russell 1999) will require individual attention.

■
Land Protection

Control over land ownership is probably not as directly important for ensuring preservation of spruce grouse as are the ways that management proceeds on the land. However, the issue may differ in northern versus southern areas. In the north, particularly northern parts of BCR's 10, 12, and 14, southern parts of BCR's 4 and 6, and all of BCR 8, spruce grouse principally inhabit publicly owned land with much of it managed by large industrial companies for wood supply. The challenge is to conduct appropriate harvest and silvicultural practices for spruce grouse over the long term all within economic bounds. North of these areas, forest management is variable and becomes less intense. In southern range, notably southern portions of BCR's 10, 12, and 14, a greater fraction of spruce grouse range is on private land or on public land in which active management operations are limited. New York shows a unique situation, in which natural, historical changes of tree species composition along with selective softwood logging has caused a substantive decrease in suitable conifer forest (Bouta and Chambers 1990). Most birds are presently in isolated patches on private land. They are at risk if tree composition continues to favor deciduous species without encouraging successional conifer development and if practices do not retain connectivity of conifer patches.

Across the entire range of spruce grouse, from Prince of Wales Island to the northeastern

states, there is no evidence that birds require only a single age class of dominant tree species composition; they occur in sandy, well-drained jack pine stands barely 10 years old (Szuba and Bendell 1983) to old-growth temperate rainforest (Russell 1999).

Although spruce grouse in any one area may show apparent selection for a particular age class or dominant tree species, they appear able to use a diverse set of species and age classes. A key point, however, may be that for any management area of interest, that it be large enough in order to provide for successional changes, either natural or induced by management actions, without causing significant declines in abundance of spruce grouse over time.

Translocations and Reintroductions

Spruce grouse have been successfully introduced to Anticosti Island and to insular Newfoundland in BCR 8. Although genetic research was not conducted for either of these introductions, such can be highly instructive. Experience in New York shows that fate of even historically viable populations is at risk given changes in forest composition and connectivity. The Vermont recovery plan includes an expected addition of spruce grouse in 2008 from a nearby Canadian or American location (C. Alexander pers. comm).

Harvest Management

Spruce grouse are hunted in 16 of the 24 states, provinces, and territories in which they are found, including legal snaring in 1 province. There is no legal harvest in all 6 states east of Minnesota. The ability to track the effects of legal harvest on population change is hindered because of the general lack of surveys of numbers of birds by management agencies, and because five of the 16 jurisdictions with legal hunting lump spruce grouse harvests with other forest grouse species.

Hunting success, where estimated, is generally not high, for example: a maximum of 3.5 birds per hunter in northern BCR 6 (Figure 1); 1.1-2.7 birds per hunter in Minnesota (1992/93-2006/07; Table 4, Dexter 2006); 2-12 shot per hunter and 0.5-0.9 birds per day in central Ontario (both in areas with high spruce grouse densities; Lumsden and Weeden 1963, Bendell and Bendell-Young 1995, respectively); 2.0 birds per successful hunter in

New Brunswick in 1967-1969 (Renouf undated). Despite many sampling problems with such hunting estimates, large fractions of total birds probably do not succumb to hunting mortality. Estimates are 5-15% in central Ontario (Bendell et al. 1983), $\leq 13\%$ in Alaska (Ellison 1974), and 4-16% in northern Michigan (where all was accidental and/or illegal; Johnston 1969). Hunting is not legal in any jurisdiction in which the species is said to be at risk. There may be local exceptions to the generalization that hunting is of little worry, particularly near communities. The birds' general tameness can make them vulnerable. This is often notable in northern areas where spruce grouse are attracted to gravel roads for grit, for example, one hunter in the Kenai Peninsula, Alaska, taking 273 birds and two hunters taking 320 birds in one season (Ellison 1969). Vulnerability may be countered because of a common perception that spruce grouse are not flavorful and usually not purposefully sought after, and spruce grouse are easily missed by hunters not using dogs. Where spruce grouse and ruffed grouse are generally sympatric and both are harvested, ruffed grouse predominate in harvests (e.g., 2-6:1 and 2:1 in central Ontario and in Minnesota [Lumsden and Weeden 1963, Dexter 2006, respectively]).

RESEARCH NEEDS

Population Monitoring

The only known way to obtain accurate estimates of density of spruce grouse is with intensive field searching with dogs, either for a complete count or to use grouse per hour as an index (Szuba and Bendell 1983). This is impractical for management purposes. However, audio-indexes may be possible on small to moderate-sized areas following Schroeder and Boag (1989) and Keppie (1992). Across a large swath of the northern range of spruce grouse, birds are probably hunted little, human access is limited, and conservation worries non-existent. However, across much of the southern half of the distribution range, access is easy and land use can change rapidly. In jurisdictions where spruce grouse are not legally hunted and are protected (ME, MI, NH, NS, NY, OR, VT, WI), only in Wisconsin is there yet a purposeful attempt to establish standardized, recurring surveys of population trend, at least in a part of the bird's range over the short term. The history of conservation has shown that efforts to retain species are much more difficult and costly when populations become low. Particularly in areas in which spruce grouse can be misidentified with other sympatric species (e.g., ruffed grouse), where hunting occurs but harvests are not reliably tracked, and where forest composition and/or land use can change rapidly, it is now appropriate to develop a formal system for monitoring population change, even if only on a periodic schedule. Suitable methodology might not need to focus on traditional spring-summer surveys of breeding adults and broods. For example, Ratti et al. (1984) in Washington, provide background for developing an index of abundance of spruce grouse or of their habitat use based on numbers of "activity trees" used for feeding and roosting. Surveys in winter may be productive by taking advantage of fecal pellets on snow, particularly in small to moderate sized areas with an active conservation effort.

A recent improvement in conservation research and planning has been to use genetic research to learn the degree of relatedness and genetic diversity among spatially separated populations, including several species of grouse, one well-known example being the problem with declining numbers of greater prairie chickens in Illinois (e.g., Westemeier et al. 1998). Morphological and behavioral differences do occur among spruce grouse,

even within only part of their range, e.g. southwest Alberta to southeast Alaska. Genetic research across the entire range of spruce grouse should be very helpful to elucidate such differences. Genetic research may point to appropriate source areas for birds used in transplant operations, perhaps most notable for isolated populations such as in the northeastern states (BCR 14) and Prince of Wales Island (BCR 5).

Habitat Monitoring

In addition to the recognized need for monitoring forest changes in southern areas of the species range where spruce grouse appear to be the most vulnerable, we need more information about the distribution of spruce grouse in core habitats in northern Canada. For example, are spruce grouse *really* distributed throughout those vast regions and if so at what densities? Large areas burn every year and other natural disturbances occur, such as insect outbreaks, causing forest vegetation changes that could dramatically bring about changes in numbers of spruce grouse. Ellison's (1975) study in south-central Alaska provides one of the few examples of effects of fire: birds were not known to have been killed directly by fire, but density of spruce grouse decreased about 60% in the burned region. In that area, periodic fire may be necessary to prevent the closed canopy spruce-white birch forest from developing into a more poorly drained black spruce community with expected lower abundance of spruce grouse. With long-range planning, it should be possible to establish a widely distributed, stratified random sample for spruce grouse occupancy and abundance across core forest cover types. Northern regions appear to show few problems compared with the south, but there are very few estimates of abundance of spruce grouse to support this across such a vast region.

Impacts of Accidental or Incidental Harvest Mortality

It is probable that spruce grouse are killed illegally in all jurisdictions where they are not legally hunted. Spruce grouse are reasonably unwary and in snow-free periods are often attracted to roads (Ellison 1969, Johnson 1973), making illegal, and accidental mortality possible. A small number of spruce grouse wings appear every year in Oregon wing collections to monitor harvest, and they probably were misidentified as dusky grouse or ruffed grouse by hunters. If these returns are multiplied by the same return rate as used

for dusky grouse (6% of estimated harvest), the estimated harvest of spruce grouse becomes meaningful (~80 per year over the past decade; D. Budeau pers. data 2008). In northern Michigan, a similar problem occurs because of misidentification with ruffed grouse (Johnston 1969); the effect of this kill is likely low, perhaps affecting 4% of total birds. There is no evidence that illegal hunting has been a principal cause to decline of spruce grouse in regions where the birds are protected. Nevertheless, management agencies should assess the value of monitoring spruce grouse harvest, perhaps building on Oregon's and Minnesota's methods of monitoring harvest, or using road-checks or wing barrels as in Ontario by Bendell and Bendell-Young (1995). In particular areas this would help measure the efficacy of aggregating species into a single forest grouse harvest limit and it may help elucidate the distribution of spruce grouse in areas where the species is rare.

Impacts of Fragmentation of Habitat

Changes in land use and forest management practices may cause an outright loss of habitat for spruce grouse or an increase in fragmentation of remaining suitable patches. These two consequences are often not separated in ecological research. Nevertheless, fragmentation was the principal issue addressed in early studies of spruce grouse in the Adirondacks of New York (Fritz 1979, 1985; also Bouta and Chambers 1990). Fritz argued that relatively short dispersal distances by spruce grouse, rather than their general low abundance, was the likely cause for some isolated patches of forest not being recolonized following loss of the birds. This was noted in more general terms for conservation problems with several species of grouse (Braun et al. 1994).

Land use and forest management practices differ considerably north to south across spruce grouse range. Where forest harvesting occurs, operations are often large in the north and very small in the south. Because breeding males do not principally use recent cutover land for breeding territories, densities of males can be low in extensively harvested northern forest (e.g., Turcotte et al. 2000). But sizes of forest management operations themselves appear not to be a sole cause to decreasing abundance of spruce grouse: in south central Quebec (BCR 8, Potvin and Courtois 2006), about 70% of the

forest, across very large areas, was recently clear cut, yet spruce grouse still occupied half of the residual strips surveyed (51-132m wide), at estimated levels of abundance approximating those found in many other regions. Potvin and Courtois (2006) advise that, despite birds continuing over the short term following extensive clear cutting, a long term goal for the species may require that residual patches of >25 ha be left within harvested blocks, that residual strips be >80 m wide, and that strips remain uncut at least until cutovers are old enough to be occupied by grouse. It is clear that, across spruce grouse range, forests in the north and south are not the same, differing at least in species composition, plant species diversity, probable average patch sizes, soil drainage, and in some regions, physical characteristics associated with elevation. Despite such differences, opportunity exists in the north to experimentally learn about relationships between spruce grouse dispersal, distances between and pattern of suitable patches, and colonization of these patches. There appears to be little opportunity for experimentation in southern ranges, yet that is where great conservation effort is needed.

Impacts of Global Climate Change

There is no doubt about climate changing. It is not possible, however, to predict the magnitude of quantitative changes upon forest conditions pertinent to spruce grouse, nor the consequential effects upon numbers of birds. Possible changes within spruce grouse range might be the loss of red spruce in the southeast (BCR 14), loss of jack pine and lowland spruce in the south (notable in BCR 12?), expansion northward of the tree line, and reduction of subalpine. It may also be that changing climate will exacerbate beetle infestations in western forests, which, with any increase in fire occurrence or timber harvesting, may generate even greater declines in numbers of spruce grouse at least in local areas. While conceivable, there is no effort to measure the impacts. As demands and pressures on the systems become more complex, the risks from management being a post-hoc, catch-up process become ever greater. The need now is to recognize the available opportunity to promote research on explicit management scenarios that will provide options for management while there still is time.

REVIEW AND UPDATE PROCESS

Authors of the Spruce Grouse Conservation Plan recommend that the Resident Game Bird Committee of the Association of Fish and Wildlife Agencies consider revision to the Plan when forest inventory data for Canada is updated.

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