The Ecology and Status of Sage Grouse in Montana

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Abstract

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

Key Words: *Artemisia* spp.,*Centrocercus urophasianus,* ecology, greater sage grouse, management, Montana, sagebrush, status

Introduction

Loss of presettlement sagebrush (*Artemisia* spp.) rangeland in the West has approached or exceeded 50 percent as a result of agricultural practices and other human-related activities (Dobler 1994, Braun 1998, Knick 1999). Despite efforts directed at reducing this loss of habitat, Connelly and Braun (1997) reported declines in breeding populations and production of the greater sage grouse (*Centrocercus urophasianus*) after1985 from long-term averages across several western states. They reported a decline in breeding populations in Montana of about 30 percent of a long-term average and a decline in production (chicks/hen) of 17 percent. These and other published findings (e.g., Braun et al. 1977, Swenson et al. 1987) suggested continuing loss and degradation of the sagebrush steppe.

Montana sportsmen and resource managers became concerned about the status of sage grouse and sagebrush-grasslands in the 1950s and 1960s with knowledge of the effectiveness of chemical treatment to eliminate or reduce sagebrush and increase production of grasses. Out of this concern, a 10-year research project was initiated in central Montana in 1965 to determine the effects of treatment of sagebrush on associated vegetation and wildlife from which findings have been reported by Wallestad (1975), Jorgensen (1979), Pyrah (1987), and others. Growing concern about the status of sagebrush steppe, declines in sage grouse numbers, and long-term survival of sage grouse resurfaced again in the 1990s. A Memorandum of understanding (MOU) for conservation and management of sage grouse between member states of the Western Association of Fish and Wildlife Agencies (WAFWA) and natural resource management agencies among the U.S. Departments of Agriculture and Interior formally initiated an effort to develop conservation strategies by member states. Each state member of WAFWA agreed to convene a working group to develop state or local conservation plans by July 2000. More than 25 people with widely diverse perspectives, of which all hold an interest in the issue, constitute the Montana Sage Grouse Working Group (SGWG).

We describe the ecology and status of sage grouse in Montana based on what is known about past and present land uses, anecdotal accounts of distribution and abundance, a review of pertinent research, and estimates of population trends and vital rates based on long-term monitoring. This, along with identifying the need of additional information, is fundamental to developing strategies to guide conservation of the sagebrush steppe and maintain or enhance populations of sage grouse in the northern Great Plains and intermountain valley habitats that have historically supported sage grouse.

Geographical Distribution

Sage grouse, native to the sagebrush steppe of western North America, originally occupied portions of 16 states and three provinces (Braun 1998). The species presently occurs in 11 western states and two provinces having disappeared from scattered areas around the periphery of its original range, including Arizona, British Columbia, Kansas, Nebraska, New Mexico, and Oklahoma.

Current distribution of sage grouse in Montana, based on the best local information available to area biologists (Fig. 1), includes the eastern one-half and southwest corner of Montana. Available sources of information for historical distribution of sage grouse in Montana are from minutes of the Fish and Game Commission dated 1926-1956 (unpubl.) a map from a biennial report to the Fish and Game Commission, 1941-1942, and a GIS layer developed by Schroeder (2000). Figure 1 represents an edited version of those sources having been reviewed by FWP field personnel (L. Bailey, GIS Programmer, FWP, personal communication).

During the 1970s sage grouse occupied approximately 4.4 million ha of sagebrush-grassland in 39 counties in the state (Wallestad 1975) and are still known to occur in 39 counties. Distribution of sage grouse along a portion of the Hi-Line, primarily Chouteau, Hill, and Blaine counties include small and scattered populations corresponding to the distribution of sagebrush. Liberty and Teton counties may have sage grouse, but sightings are unconfirmed (G. Taylor 2001, FWP Wildlife Manager for Region 4, personal communication). The Milk River valley in Phillips County probably represents the northernmost limit of the distribution of big sagebrush.

Habitat Requirements

Yearlong

In eastern Montana, where close interspersion of wintering, nesting, and

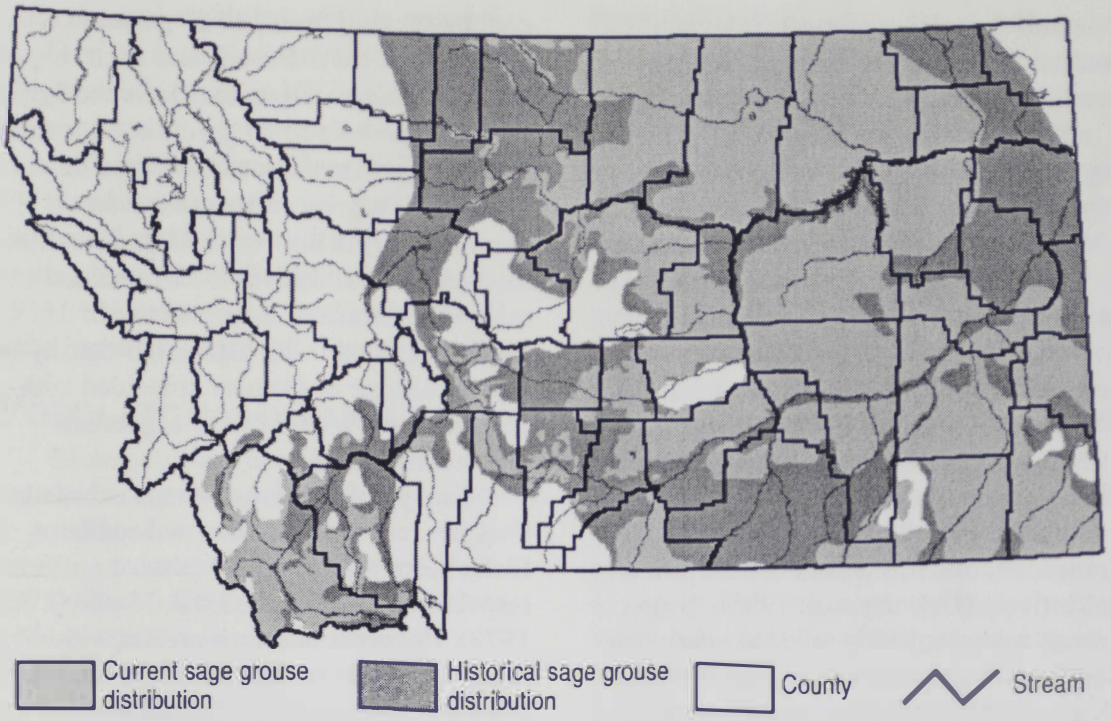

Figure 1. Current and historical distribution of sage grouse in Montana (FWP, Information Services). The entire shaded area represents historical distribution of sage grouse, and the light-shaded area represents their current distribution.

brooding habitat rarely requires large seasonal movements, sage grouse are essentially nonmigratory (Eng and Schladweiler 1972); birds rarely move more than 17 km. Meeting yearlong habitat needs, however, may require comparatively long seasonal movements between disjunct habitat patches. North of the Milk River in north-central Montana, sage grouse primarily occupy silver sagebrush (A. cana)-grassland habitats similar to those described for southeastern Alberta (Aldridge 1998).

Some sage grouse in southwestern Montana migrate between separate summer and winter areas (Martin 1970) as similarly observed among sage grouse on the Snake River plains in Idaho where 48-80 km may separate seasonal ranges (Dalke et al. 1963, Connelly et al. 1988). Migration also can be elevational and related to availability of succulent herbaceous vegetation during late summer and early fall. Ongoing research has documented such summer migratory movement of sage grouse from an area in eastern Idaho, including Crooked Creek, Lidy Flats, and Medicine Lodge, to Big Sheep Creek Basin in southwestern Beaverhead County, Montana (J. W. Connelly 2001, personal communication, Roscoe this issue).

Seasonal

Breeding.—Wallestad (1975) found strutting grounds or "leks," where breeding actually occurs, to be key activity areas within wintering-nesting complexes. Leks most often consist of clearings surrounded by sagebrush cover. Such areas may include natural clearings, old burns, or ground cleared by homesteaders. In Idaho, sage grouse used recent burns or man-made clearings as leks only in the absence of natural openings (Connelly et al. 1981).

Wallestad and Schladweiler (1974) measured sagebrush at feeding and loafing sites of strutting cocks on the Yellow Water Triangle (YWT) in central Montana; 80 percent of these sites had a sagebrush canopy of 20-50 percent. Average sagebrush canopy overall was 32 percent (Eng and Schladweiler 1972). Slightly more

than half the total sagebrush plants measured at sites used by sage grouse occurred in the 15- to 30-cm height class.

Sage grouse invariably prefer sagebrush for nesting cover across their inhabited range (Patterson 1952, Klebenow 1969, Wallestad and Pyrah 1974, Sveum et al. 1998). Results from various studies in Montana and elsewhere documented a positive relationship between quality of nesting cover and nesting success (Wallestad and Pyrah 1974, DeLong et al. 1995, Sveum et al. 1998). Concealment was the basic requirement of nesting cover; nest fate may be positively associated with tall grass cover and medium-height shrub cover collectively (DeLong et al. 1995). Sage grouse most frequently selected sagebrush stands with a canopy of 15-31 percent (Klebenow 1969, Wallestad and Pyrah 1974). Most nesting (≥60%) occurs within 3 km of a lek in Montana and Colorado (Wallestad and Pyrah 1974, Braun et al. 1977) although Wakkinen et al. (1992) reported a random distribution of nests relative to lek location in Idaho. Sage grouse exhibit high nest-area fidelity but do not nest under the same bush from year to year, which might reduce the risk of nest predation (Fischer et al.1993).

Brood-rearing.—Succulent forbs, the preferred food of sage grouse broods, provide key summer habitat for sage grouse (Klebenow 1969, Martin 1970, Peterson 1970a, Wallestad 1971). As palatability of forbs declines, sage grouse move to moist areas that still support succulent vegetation including alfalfa fields, roadside ditches, and other moist sites. During summers of high precipitation, sage grouse in Montana may remain widely distributed throughout the entire summer due to the wide distribution of succulent forbs in both time and space (Peterson 1970a). Elsewhere, grouse moved to mountain meadows during late summer where elevation influences forb succulence (Dalke et al. 1963, Connelly et al. 1988).

Sage grouse broods in the YWT preferred relatively open stands of sagebrush during summer, generally with a canopy ranging from 1 to 25 percent (Wallestad 1975). Broods also used roadside ditches throughout June and July. About 65 percent of all grouse observations during August and September were in alfalfa fields, greasewood (*Sarcobatus vermiculatus*) in bottomlands, and roadside ditches where succulent forbs remained relatively abundant. Increased use of sagebrush stands with high shrub density in late September or October coincided with transition to a winter diet of sagebrush (Wallestad 1971).

Canopy of sagebrush stands at brood sites in southwest Montana and southern Idaho averaged 14 and 8.5 percent, respectively (Klebenow 1969, Martin 1970). However, adults used sites with relatively dense canopy (25%) during the same period (Martin 1970); relative to canopy height, big sagebrush ranged from 23 to 38 cm at brood sites compared with 18-64 cm at adult locations.

Males remained segregated from broods and hen flocks through summer and early fall. Because adult cocks utilized the same types of areas used by broods and hen flocks, segregation probably was more social than habitat-related. Most male flocks in the YWT utilized areas within 3-5 km of a lek. Flocks of broodless hens typically utilized areas of dense sagebrush throughout summer (Wallestad 1975).

The importance of "free water" to sage grouse has not been widely documented or quantified (Connelly and Doughty 1990). Although some have suggested that distribution of open water is important to sage grouse, studies of radio-marked grouse in central Montana and southeastern Idaho failed to demonstrate the importance of open water to grouse, even during dry years (Wallestad 1971, Connelly and Doughty 1990). Grouse apparently redistribute themselves in response to a lack of succulent vegetation rather than to absence of open water.

Winter.—Sage grouse generally select relatively tall and dense stands of sagebrush during winter. Winter ranges in eastern Montana included large expanses of dense

(20% canopy) sagebrush with an average height of 25.4 cm on relatively flat sites (Eng and Schladweiler 1972). This association with dense stands of sagebrush usually begins in September (Wallestad 1971) and continues through the breeding (Wallestad and Schladweiler 1974) and nesting seasons (Wallestad and Pyrah 1974). No adult males were observed in areas having <10 percent canopy coverage.

Population Dynamics

Biologists have used counts of males on leks during spring since the mid-1950s to provide an index of relative size of breeding populations (Eng 1954, Wallestad 1975). Based on these spring counts from 1966 to 2001, sage grouse numbers probably increased, at least at a statewide scale, from the mid 1960s through 1973 when the average number of males/lek exceeded 30 and fluctuated about that level until reaching a peak in 1984 (Table 1). The average number of males attending leks declined rather sharply from 1991 through 1996 and increased to a level above 30 males/lek during 2000 and 2001. Although we cannot assume that all sage grouse leks have been located, monitoring male attendance on comparable leks would appear to provide a reasonable index of relative change in breeding populations in response to prevailing environmental conditions. Yearly variation in chick productivity and survival account for dramatic short-term population fluctuations, whereas habitat loss, as reflected by loss or abandonment of leks, influences gradual, long-term population declines (Eustace this issue).

Harvest trends, based on post-hunt surveys of hunters, roughly follow that of spring counts of males on leks (Fig. 2), and interpreted along with lek counts, also provide insight to short-term changes in sage grouse numbers at a statewide scale. For example, years of high harvest generally followed a spring of high average numbers of males/lek. Conversely, years of relatively low harvest followed a spring of low numbers of males/lek.

Reproduction

Trends in sage grouse productivity have been estimated using ratios of young/hen from examination of wings of birds taken by hunters (Eng 1955). Results of statewide wing collections from hunter-killed birds appear in Table 2. From 1962 to 1979 statewide productivity averaged 2.63 juveniles/hen and 2.08 juveniles/hen during 1980-1992, a decline of 21 percent. Production and survival of chicks/hen followed a similar trend in FWP's Region 5 in south-central Montana during the same period of time (Table 2).

Timing of precipitation may affect annual production and population dynamics of sage grouse. In central Montana Wallestad and Watts (1972) reported an inverse relationship between productivity and rainfall during the egg-laying period; rainfall >2.5 cm during the egg-laying period delayed the hatch and reduced productivity. Total spring precipitation, as it potentially affects spring green-up of vegetation, further explained variations in productivity (Wallestad and Watts 1972). Even with optimal rainfall during the egg-laying period, production was poor if total spring precipitation during the growing season was <7.6 cm from mid-April through mid-June. They observed neither a relationship between productivity and rainfall during hatching that typically peaked during the 2nd week in June nor a relationship between temperature and productivity.

Drought cycles, as expressed by the Palmer Drought Severity Index (PDSI; NOAA 1962-1992), also may affect productivity of sage grouse. Because drought severity often varies across the state, we examined only production data for south-central Montana. The period of nesting and brood-rearing (May-August) were characterized by mild to severe drought conditions during only three of 18 years during 1962-1979 (Table 2). South-central Montana experienced drought conditions during the same period in seven of the 13 years from 1980 to 1992. A least

Table 1. Summary of sage grouse lek surveys in Montana, 1955-2001, that were surveyed ≥10 consecutive years.

Year	No. leks surveyed	No. males	No. males/lek
1955-1965[a]	≤7	$\bar{x}$ = 169	$\bar{x}$ = 31.5
1966[b]	12	249	20.8
1967	12	237	19.8
1968	12	304	25.3
1969	19	606	31.9
1970	20	568	28.4
1971	20	574	28.7
1972	27	826	30.6
1973	32	1078	33.
1974	35	1009	28.8
1975	45	1140	25.3
1976	45	1230	27.3
1977	47	1500	31.9
1978	52	1663	32.0
1979	56	1733	30.9
1980	64	2208	34.5
1981	72	2185	30.3
1982	74	7525	34.8
1983	73	2599	35.6
1984	73	2673	36.6
1985	72	1493	20.7
1986	72	1398	19.4
1987	74	1809	24.4
1988	74	2484	33.6
1989	74	2291	31.0
1990	79	2370	30.0
1991	72	2429	33.7
1992	73	1667	22.8
1993	73	1444	19.8
1994	70	1200	17.1
1995	65	1230	18.9
1996	64	1305	20.4
1997	65	1343	20.7
1998	65	1538	23.7
1999	68	1696	24.9
2000	70	2325	33.2
2001	72	2391	33.2

[a] Surveys were conducted only in north-central Montana (Region 6) during 1955-59. Surveys began in south-central Montana (Region 5) in 1960 and in southwest Montana (Region 3) in 1962.
[b] Surveys were initiated in central Montana (Region 4) in 1966 and in southeastern Montana (Region 7) in 1969.

squares linear regression suggested an inverse relationship between the PDSI and productivity for each of the four months although only the relationship during May was significant ($r^2 = 0.14$, $P = 0.04$). Eustace (this issue) demonstrated that drought severity over an extended period has a more profound effect on sage grouse productivity; relative drought severity over a 22-month period prior to and including the month of hatch explained 58 percent of the variability in chick survival.

Findings from research in central Montana suggested that years of chick survival of <3.60 juveniles/hen were accompanied by population declines (Wallestad 1975). However, from a statewide perspective chick survival was

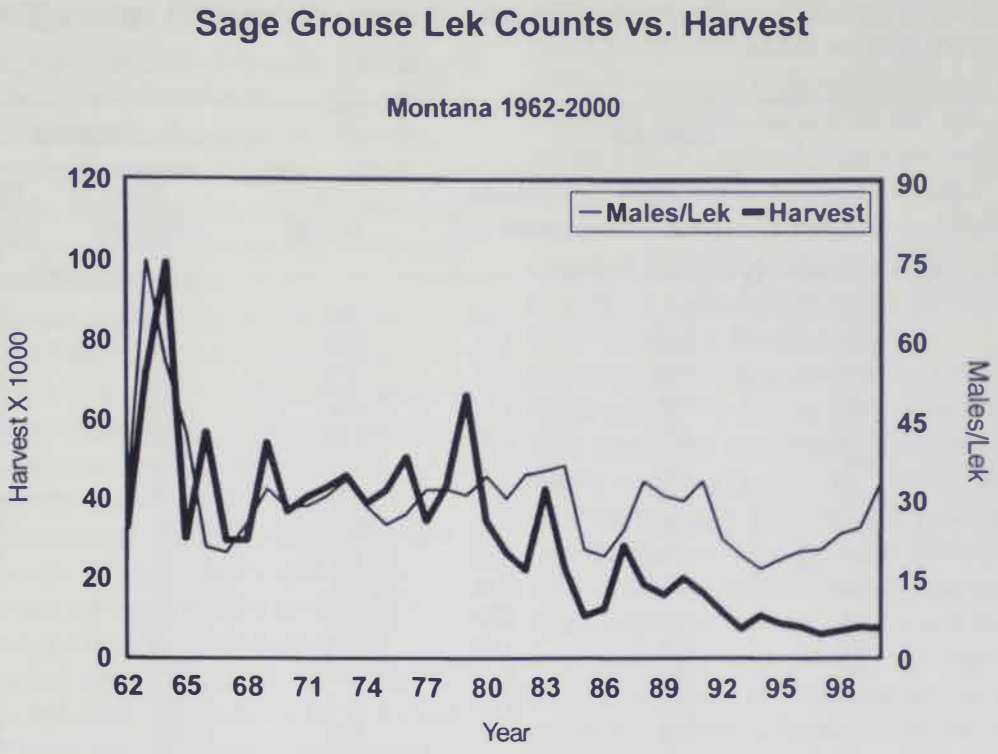

Figure 2. Sage grouse lek attendance and harvest in Montana, 1962-2000.

≥3.60 juveniles/hen in only two of 31 years (Table 2). The average number of males attending leks over the same period of ≥30 males/lek occurred during 14 of those years (Table 1). Thus, a threshold value for chick survival at a broad scale that would coincide with short-term population declines, reflected by numbers of males attending leks, probably would occur closer to the 31-yr mean of 2.40 juveniles/hen (Table 2). For example, years in which productivity was >2.40 juveniles/hen were followed by increased numbers of males/lek the following spring 86 percent of the time (12 of 14 yrs; Tables 1 and 2). If productivity was <2.40 juveniles/hen, there was a decrease in the lek count during the following spring 75 percent of the time (9 of 12 yrs).

Mortality

Over a 10-yr period, Wallestad and Watts (1972) documented an average mortality rate of 56 percent in central Montana from the egg-laying period in April to the opening of the upland bird season in September. This included an average nest mortality of 30 percent and an average juvenile mortality to 1 September of 37 percent. Assuming a juvenile mortality rate from 1 September to 1 April (fall-winter) at least equal to that of yearling hens (65%) would yield an annual juvenile mortality rate of 85 percent.

Both avian and mammalian predators take sage grouse. Predators destroyed 13 percent of known nests on the Yellow Water Triangle (Wallestad and Pyrah 1974). Nest predators included coyotes (*Canis latrans*), badgers (*Taxidea taxis*), and magpies (*Pica pica*). In the same study, approximately 40 percent of juvenile sage grouse succumbed to some form of mortality between hatching and early fall although the proportion attributable to predation was unknown. Golden eagle (*Aquila chrysaetos*) and hawks, including the marsh (*Circus cyaneus*), Swainson's (*Buteo swainsoni*), red-tailed (*B. jamaicensis*) and rough-legged (*B. lagopus*) posed the most probable threat to young birds. Although eagles commonly take sage grouse on leks

Table 2. Sage grouse production from statewide collection of wings from hunter-killed birds, 1962-1992.

Year	Statewide			South-central Montana[a]		
	No. chicks	No. adult hens	Chicks/ adult hen	No. chicks	No. adult hens	Chicks/ adult hen
1962	849	271	3.13	122	32	3.81
1963	1593	496	3.21	359	75	4.79
1964	1213	752	1.61	331	161	2.06
1965	1149	490	2.34	204	64	3.19
1966	1044	420	2.49	120	59	2.03
1967	844	293	2.88	97	34	2.85
1968	1333	368	3.52	196	45	4.36
1969	1299	535	2.43	109	54	2.02
1970	1009	379	2.66	187	42	4.45
1971	1409	496	2.84	211	52	4.06
1972	1188	411	2.89	223	68	3.28
1973	793	434	1.83	222	80	2.78
1974	972	452	2.15	257	116	2.22
1975	1189	516	2.30	476	161	2.96
1976	1349	610	2.21	387	178	2.17
1977	872	443	1.97	243	85	2.86
1978	1256	404	3.11	338	103	3.28
1979	1950	528	3.69	392	81	4.84
1980	851	598	1.42	242	161	1.50
1981	1122	499	2.25	286	125	2.29
1982	798	398	2.01	241	117	2.06
1983	1371	403	3.40	461	105	4.39
1984	462	314	1.47	159	123	1.29
1985	130	95	1.37	20	20	1.00
1986	158	96	1.65	51	21	2.43
1987	306	95	3.22	79	31	2.55
1988	70	77	0.91	45	53	0.85
1989	278	135	2.06	129	61	2.12
1990	437	110	3.97	142	44	3.23
1991	135	100	1.35	72	79	0.91
1992	77	39	1.97	77	39	1.97
$\bar{x}$ chicks/ hen			2.40			2.73

[a] Data are from FWP Region 5 for years from which a string of long-term statewide data were available.

during spring, predation on adult birds appeared minor. Predators killed only three of about 70 radio-equipped adult sage grouse on the Yellow Water Triangle (Wallestad 1975).

Diseased birds have occasionally been observed in Montana, particularly in the vicinity of irrigation ditches and alfalfa fields (Wallestad 1975). Necropsy revealed coccidiosis. Outbreaks may occur in late July and August when sage grouse concentrate on areas where forbs remain succulent that include open water. The problem will generally subside with dispersal of birds to fall and winter ranges.

Simon (1940) described parasites commonly found in sage grouse in Wyoming. The incidence and infestation of all parasites except the protozoan *Tritrichomonas* was higher in young birds than in adults. Most sage grouse were infected with tapeworms but exhibited no serious ill effects.

Population Status

Sage grouse were seemingly declining throughout the species' range during and prior to the 1930s (Braun 1998). However, systematic surveys were lacking before the late 1950s, and estimates, or perceptions, of sage grouse abundance were derived largely from anecdotal accounts.

Annual and biennial reports of the Montana Fish and Game Commission during the first decade of the 20th Century expressed alarm about the relative scarcity of sage grouse across Montana (C. D. Eustace, personal communication). A recommendation that the upland game bird season open 1 September and close 15 December appeared in a report dated December 1900. Perceived effects of market and subsistence hunting on sage grouse and other upland game birds during that period concerned both policy-makers and sportsmen. Scarcity of big game throughout eastern Montana in the early 1900s might have exacerbated any adverse effects that these largely unregulated activities had on sage grouse. The federal Lacey Act, enacted in 1900, prohibited the interstate traffic of game animals with the intent to address impacts of market hunting.

From about 1913 through the 1930s landowners, sportsmen, and agency personnel perceived sage grouse to be abundant in at least a portion of their inhabited range—most notably in Fergus, Petroleum, Rosebud, Garfield, Custer, and Powder River counties. Limited information suggested that sage grouse again started to decline in about 1943 and continued downward for several years despite closed seasons during 1945-1951 (Martin and Pyrah 1971). Harvest, and presumably grouse numbers, increased substantially during 1958-1964, a period over which daily bag limits varied from three to four birds.

Regional Status

Southwest Montana.—Sage grouse still occur in Meagher County but appear in a state of decline (G. Taylor 2001, FWP Wildlife Manager for Region 4, personal communication). Sage Grouse in nearby Park County declined in the 1970s and 1980s in response to significant losses in sagebrush habitat—primarily through conversion to cropland (Swenson et al. 1987). Populations have recovered somewhat since the late 1980s and have remained relatively stable during the 1990s. In extreme southwest Montana, primarily Beaverhead and Madison counties, populations declined from those of the 1960s and 1970s during a period of large-scale sagebrush manipulation programs, i.e., mostly spraying (J. Peterson 2001, FWP Wildlife Manager for Region 3, personal communication). A significant number of birds in southwest Montana migrate to Idaho winter ranges, much of which has been converted to cropland. Populations now appear more stable, seemingly as a result of a reduction in sagebrush control programs. However, small declines have occurred in recent years in some locations.

Eastern Montana.—Sage grouse populations across north-central Montana support relatively high numbers of birds with the exception of Chouteau and Hill counties (A. Rosgaard, personal communication). South Valley and Phillips counties support comparatively high numbers of birds compared to portions of the respective counties lying north of the Milk River. An incomplete survey of leks in Valley County during spring 2000 yielded 1300 male sage grouse that included 250 males in a 36,000-ha block of south Valley (Gunderson 2001). During spring 2000, 1600 male sage grouse were counted on leks in Fergus and northern Petroleum counties in central Montana (T. S. Stivers, personal communication).

Sage grouse occupying portions of the Hi-Line north of the Milk River are primarily associated with stands of silver sagebrush in a grass-dominated community. Although effort is underway to monitor sage grouse populations in that portion of the state, little information currently is available. The historical range of sage grouse in Alberta and Saskatchewan, entirely silver sagebrush-grassland on the

northern fringe of the species' range, has been reduced by about 90 percent (Aldridge 2002).

In south-central Montana, sage grouse densities are highest in Big Horn, Carbon, Golden Valley, Musselshell and Yellowstone counties that contain fairly contiguous stands of big sagebrush (C.D. Eustace, personal communication); leks are scattered randomly with an average spacing of 5.5 km between leks. Grouse occur at lower densities in Stillwater, Sweet Grass, and Wheatland counties with widely spaced leks across sparse to highly fragmented sagebrush habitat.

Habitat Status

The abundance and distribution of sagebrush steppe in Montana has not been well defined or quantified. Sage grouse seemingly are one of the more habitat-specific of North American grouse (Aldrich 1963) and rely on sagebrush for forage and/or cover throughout the year. A potential of about 11 million ha of sagebrush occurs in the portion of the state currently occupied by sage grouse, all of which has been influenced by human use in varying degrees since early settlement of the region.

Habitat Loss or Degradation

As the Great Plains were homesteaded, sage grouse habitat deteriorated rapidly in some areas under intensive cropping and/or over grazing. Sage grouse habitat had been fragmented or severely reduced in many areas by the 1930s although some abandoned homesteads reverted back to native rangeland during the 1930s that eventually improved habitat for sage grouse (Wallestad 1975).

Sage grouse in several counties in central and southeastern Montana were perceived as abundant from about 1913 through the 1930s and is noteworthy because much of that part of the state has remained in native rangeland up to the present time. In the 1950s efforts to remove or alter stands of sagebrush became more efficient with the advent of the herbicide 2,4-D. By the early 1960s elimination or reduction of sagebrush to increase grass production became a common practice on public as well as private rangeland (Martin 1970). Pyrah (1972) reported that adverse effects of treatment on sage grouse winter range were proportional to severity of treatment, i.e., partial kill strips<block partial kill<mechanical treatment<total kill. Those treatments doing the least damage to sagebrush affected sage grouse use the least, and duration of the adverse effects was shortest.

The federal farm program encouraged conversion of private rangeland to cropland, or "sodbusting," that affected an untold amount of sagebrush steppe during the 1970s and 1980s. For example, Swenson et al. (1987) documented a significant habitat loss with subsequent decline in grouse numbers in the Shields Valley. A similar loss of habitat and decline in sage grouse populations had occurred in Meagher County during 1950-1970 as a result of both mechanical, e.g., plowing, and chemical treatment (Peterson 1970b).

Current Mapping Efforts

Effort to update estimates of sagebrush/sage grouse distribution based on the evolving technology of geographical information systems (GIS) began in 1997. A cooperative effort between the Wildlife Spatial Analysis Lab at the University of Montana and FWP created the Land Cover Type spatial layer (SILC-2) for eastern Montana based on supervised classification of LANDSAT TM imagery (J. Herbert 2002, personal communication). However, sagebrush classifications had a mean accuracy rate of 65 percent and incorporated an arbitrary minimum canopy coverage rate of 20 percent. This process likely underestimated the occurrence of sagebrush communities, particularly those occurring at canopy coverages <20 percent.

In 2001 FWP mapped sage grouse habitat distribution in cooperation with the Montana Natural Heritage Program and USDI Bureau of Land Management (BLM) using the Montana GAP Land Cover types as a base layer (J. Herbert 2002, personal communication). Polygons were created for

areas surveyed for sage grouse and areas that remain unsurveyed but where sage grouse potentially occur. FWP refined this distribution layer in May 2002 using the Natural Resource Conservation Service (NRCS) Legend for SILC-2 by removing land cover types, e.g., agricultural, wooded areas, and urban or developed lands, that likely would not provide habitat for sage grouse. This refinement generated an estimate of about 10.9 million ha of potentially occupied sage grouse habitat that compared to the estimate of 4.4 million ha reported by Wallestad (1975). The more recent estimate likely will be reduced as additional training data are acquired and further separation can be made of sagebrush communities at canopy rates of <20 percent from upland grassland and xeric shrub communities.

Conservation Status

Sage grouse are currently protected exclusively under state authority including the statutory authority granted to the Fish, Wildlife and Parks Commission to regulate harvests. Legislative mandate designates sage grouse as an upland game bird (87-2-101, MCA).

In 1870 the first regulations that affected hunting of prairie grouse in Montana, i.e., sage and sharp-tailed grouse, prohibited hunting from March 1 to August 15 (Montana Fish, Wildlife and Parks 1991). By 1897 Montana shortened hunting seasons for prairie grouse further —August 15 to December 15—with a daily bag limit of 20 birds but no possession limit. Regulations in the early 1900s became progressively more restrictive. By the 1930s and 1940s hunting seasons for sage grouse were of short duration—generally about 1-4 days. The state of Montana prohibited sage grouse hunting during 1938 and 1945-1951. FWP has increased the area open to hunting of prairie grouse since 1960 and increased season length. Seasons were about 107 days in length by 1990, except the southwest portion in which seasons were of shorter duration.

Management Activities in Montana

Population Monitoring.— FWP monitors prairie grouse populations during spring through census of displaying males on leks (Montana Fish, Wildlife and Parks 1991). Annual sage grouse production has been correlated to weather conditions (Wallestad and Watts 1973). Initial lek census included trend areas of approximately 130 km^2 in size from which complete aerial coverage was conducted during the breeding season (Martin and Pyrah 1971). Counts of maximum numbers of birds also were made on selected leks to provide year-to-year trends in relative abundance. Annual lek surveys do not currently provide the basis for annual harvest regulations because seasons are now set in advance of the period in which surveys are conducted (Montana Fish, Wildlife and Parks 1991). However, regional personnel have continued lek surveys to monitor long-term population trends, evaluate habitat projects and refine distribution of sage grouse in Montana.

The post-harvest telephone survey provides an estimate of harvest for all upland bird species, trend in hunter numbers, and number of birds taken by hunter by species. Wings from harvested sage grouse were used to estimate composition of the harvest by sex and age (Eng 1955) although collections discontinued on a statewide scale during the mid-1980s. Wing collections have continued in south-central Montana to provide an estimate of sex ratios among birds of breeding age and numbers of young hen.

Habitat Acquisition and Protection.— FWP's habitat management initially emphasized preservation and maintenance of existing habitat that required investigation of proposed sagebrush control projects by agency personnel (Martin and Pyrah 1971).

The 1987 Montana Legislature created a process and funding source for FWP to acquire easements or purchase important

wildlife habitat in Montana (87-1-241 and 242, MCA). Referred to as "H.B. 526," it generates approximately $2.8 million/year from an earmarked portion of license revenue and provides an innovative and effective tool to protect habitat at the state level.

The state-funded Upland Game Bird Habitat Enhancement program (87-1-246, MCA) also was enacted in 1987 and amended in 1989 authorizing FWP to use funds for habitat improvement for upland game birds (Montana Fish, Wildlife and Parks 1997). A cooperative program has evolved to help private landowners implement habitat projects that benefit upland game birds. FWP provides technical assistance and reimbursement for seed, plants, materials, and practices conducted by the landowner. In addition to establishing nesting cover and food plots, these projects also include range improvements on private land, i.e., managed grazing systems. Since initiation of the program in 1989, emphasis on habitat improvement for upland game birds has increased with approximately 233,283 ha enrolled in the program since 1989. FWP has implemented grazing systems on more than 121,406 ha of rangeland under the Upland Game Bird Habitat Enhancement Program that includes sagebrush steppe.

In January 2000 FWP held an interest in 200,690 ha of private and public land for administering its wildlife programs. FWP has jurisdiction over about 20,000 ha sagebrush steppe through conservation easements under H.B. 526 (S. Knapp 2002, personal communication). Protection of shrub grasslands has carried a high priority since 1993.

FWP establishes long-term vegetation monitoring sites on all wildlife management areas and conservation easements where a grazing system has been implemented. FWP currently monitors 58 sites, and each site is monitored on a rotating basis once every 5 years. Numbers of sites monitored should increase as new lands are enrolled in the program. The effort will document the effectiveness of land management actions, i.e. livestock grazing systems, designed to improve range condition and trend. Monitoring addresses FWP's overall wildlife management goal of providing healthy vegetation communities for a diversity of bird and mammal species.

Research.—Research on sage grouse in Montana during the 1950s focused on monitoring strategies to determine population status and trend (Eng 1954, 1955). Efforts during the 1960s and 1970s addressed the effects of chemical and mechanical treatment of sagebrush on associated plant and animal communities (Martin 1970, Wallestad 1975, Jorgensen 1979, Pyrah 1972, 1987) that included sage grouse and other sagebrush-dependent wildlife. These studies provided a biological basis for managing sagebrush steppe in the northern Great Plains and intermountain valleys. Current research in eastern Montana includes determining the nature of interaction between population status of sage grouse, as expressed by estimated vital rates, and habitat condition (Moynahan et al. 2001). Another study in eastern Montana is designed to assess survivorship of sage grouse both in the presence and absence of hunting. An ongoing effort in southwest Montana attempts to identify resident and migratory populations of sage grouse, key habitats, and movements relevant to local conservation efforts (Roscoe this issue).

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