

CHANGES IN THE DISTRIBUTION AND ABUNDANCE OF SAGE GROUSE IN WASHINGTON

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ABSTRACT

Sage grouse (*Centrocercus urophasianus*) historically occurred in shrub-steppe and meadow-steppe communities throughout much of eastern Washington. The decline in distribution has been dramatic; 73% of 67 lek complexes documented since 1960 are currently vacant. Many vacant lek complexes (53%) are in areas where sage grouse have been recently extirpated. The current range is about 8% of the historic range, occurring in 2 relatively isolated areas. Based on changes in number of males counted on lek complexes, the sage grouse

population size in Washington declined at least 77% from 1960 to 1999; the 1999 spring population was estimated to be about 1,100 birds. Historic and recent declines of sage grouse are linked to conversion of native habitat for production of crops and degradation of the remaining native habitat. Although declines in populations of sage grouse appear to be slowing, the small size and isolated nature of the 2 remaining populations may be a long-term problem.

Management should be directed toward protecting, enhancing, expanding, and connecting the existing populations.

KEY WORDS: Sage grouse, *Centrocercus urophasianus*, abundance, distribution, shrub-steppe, survey, Washington, habitat fragmentation

Sage grouse historically occurred in California, Oregon, Washington, Nevada, Idaho, Arizona, Utah, Montana, New Mexico, Colorado, Wyoming, Oklahoma, Kansas, Nebraska, South Dakota, North Dakota, British Columbia, Alberta, and Saskatchewan (Aldrich 1963). They have been extirpated from British Columbia, Arizona, New Mexico, Oklahoma, Kansas, and Nebraska (Connelly and Braun 1997; Braun 1998). All remaining populations have been reduced in size and distribution. Although populations in Wyoming, Montana, Colorado, Idaho, Utah, Oregon, California, Nevada, and North Dakota are considered sufficient to support hunting seasons (each \$ 5,000 birds during breeding season except North Dakota), those in Washington, South Dakota, Alberta, and Saskatchewan are too small (each # 2,000 birds) (Braun 1998).

The range-wide reduction of sage grouse has been caused by 3 primary factors. First,

several million ha of native sagebrush-dominated shrub-steppe have been converted to cropland, primarily for production of wheat (Yocom 1956; Swenson et al. 1987; Dobler et al. 1996; Connelly and Braun 1997). Second, several million ha of the remaining shrub-steppe have been manipulated to remove sagebrush (Carr and Glover 1970; Klebenow 1970; Martin 1970; Wallestad 1975; Braun et al. 1977). Third, the quality of remaining shrub-steppe habitat has declined as a result of grazing pressure from livestock (Dalke et al. 1960, 1963; Klebenow 1969; Eng and Schladweiler 1972; Wallestad and Pyrah 1974; Wallestad and Schladweiler 1974; Beck 1977; Connelly et al. 1991).

Abundance and distribution of sage grouse have clearly declined within Washington (Yocom 1956; Washington Department of Fish and Wildlife 1995; Hays et al. 1998). These declines led to the elimination of legal harvest in 1988 and state listing of sage grouse as a threatened species in 1998 (Hays et al. 1998). Sage grouse in Washington are also being considered for federal listing as a threatened or endangered species by the U.S. Fish and Wildlife Service (C. D. Warren, pers comm.). The objective of this paper is to describe historic changes in distribution and abundance of sage grouse that resulted in their 1998 listing and relate them to changes in habitat quantity and quality. An additional objective is to discuss the significance of this information in relation to development of management strategies necessary to recover sage grouse in Washington.

METHODS

Lek Surveys

Male sage grouse congregate on lek sites during spring to perform breeding displays and to mate with females (Schroeder et al. 1999). Although most lek sites are traditional, some leks occasionally change or ‘shift’ locations, as documented with observations of marked individuals between years (MAS, unpubl. data). In addition, some males may attend temporary ‘satellite’ leks until they are able to become established on relatively permanent ‘core’ leks. Many of these specific sites form clusters defined here as ‘lek complexes’. Although the definition of lek complexes is somewhat arbitrary, lek sites within a complex are usually < 3 km from one another. Lek complexes are clearly spatially separated from adjacent lek complexes by ≥ 6 km.

We examined survey results of lek complexes conducted between 1960 and 1999 (Washington Department of Fish and Wildlife 1995; Hays et al. 1998) to obtain information on sage grouse distribution and populations. Most complexes surveyed prior to 1970 were relatively large and opportunistically visited by members of bird-watching organizations and personnel of the Washington Department of Fish and Wildlife (Department of Game previously). These surveys typically consisted of a single count of males attending a complex during the breeding season and did not represent a standardized effort. The Washington Department of Fish and Wildlife expanded surveys from 1970 to 1991, including additional searches for new and/or previously undiscovered lek complexes and multiple (≥ 3) visits to specific complexes. Some original data from the 1970s were lost so that only single ‘high’ counts remain, despite many complexes having been observed on more than one occasion. During 1992–99 personnel of the

Washington Department of Fish and Wildlife and the U.S. Army attempted to visit all sage grouse lek complexes in Washington on \$ 3 occasions each year.

Distribution

We examined historic information on distribution of sage grouse throughout Washington based on direct observations and published literature (McClanahan 1940; Yocom 1956; Aldrich 1963; Connelly and Braun 1997; Schroeder et al. 1999). Since most early descriptions of their range in Washington were based on relatively large-scale North American maps, they were often inaccurate. We refined the historic range of sage grouse in Washington on the basis of occupancy information within areas not included on previous maps. We also removed some areas from the historic range that were unlikely to have supported sage grouse.

Locations of lek complexes and > 900 miscellaneous observations of sage grouse between 1990 and 1999 were used to define current distributions. All active lek complexes and virtually all recent observations were within the boundaries for the current populations. The current distribution excludes 21 observations associated with recently vacated leks or birds that appeared to be 'wandering' long distances from existing populations.

Abundance

Numbers attending lek complexes were analyzed using the highest number of males observed on a single day for each complex for each year. Although this technique is used throughout the North American range of sage grouse, it may have numerous biases (Jenni and

Hartzler 1978, Emmons and Braun 1984). First, yearling males appear to visit lek complexes less frequently than adults. Second, the number (or proportion) of yearlings in the population is unknown. Third, attendance at complexes tends to peak relatively late in the breeding season. Fourth, the number of males not visiting complexes is unknown. Fifth, the maximum count of males on a complex tends to be positively correlated with the number of counts. Sixth, some males (particularly yearlings) visit more than 1 lek complex within a breeding season. All but the last of these potential biases would tend to produce relatively low estimates of the number of males in the population. Consequently, counts of males on leks are used to produce conservative estimates of population size.

Average attendance at all complexes was used to evaluate annual population changes and to provide a technique for comparing populations of sage grouse in Washington with those in other regions (Willis et al. 1993, Braun 1995, Connelly and Braun 1997). Rates of change were estimated by comparing total number of birds counted at all lek complexes in consecutive years. Because sampling was occasionally biased by effort and/or size and accessibility of lek complexes, those not counted in consecutive years were excluded from the sample for a given interval. Annual rates of change were used to estimate spring populations between 1999 and 1960. The 1999 population was estimated by multiplying total number of males counted on all lek complexes in that year by 2.6; this assumes all males are counted and the male:female ratio is approximately 1.0:1.6 (Washington Department of Fish and Wildlife 1995; Hays et al. 1998; Schroeder et al. 1999). This male:female ratio was based on ratios in the literature ranging between 1.0:1.1 and 1.0:2.6 (Girard 1937, Patterson 1952, Rogers 1964, Braun 1984).

Habitat

Primary habitats used by sage grouse include shrub-steppe and meadow-steppe (Daubenmire 1970) as determined from research on radio-marked sage grouse (Schroeder et al. 1999). Range-wide changes in habitat were examined with aid of the Thematic Mapper (TM) sensor on the Landsat satellite. Digital data (1993) from TM channels 3, 4, 5, and 7 representing reflective light energy from the red, near-infrared, and 2 mid-infrared wavelength bands, respectively, were used in an unsupervised cluster analysis which produced 175 possible habitat types (JEJ, in prep.). Field data from ground reconnaissance during 1995–97 provided characterization of these habitat types, and that information was used to combine slightly varying habitats into 4 general types including: 1) shrub-steppe (including meadow-steppe and steppe, Daubenmire 1970); 2) cropland; 3) CRP (federal Conservation Reserve Program in which cropland was converted to perennial grass; usually crested wheatgrass, *Agropyron cristatum*); and 4) other (wetland, barren, forest/shrub, and sand dunes).

RESULTS

Distribution

Most available evidence indicates that sage grouse were once widely distributed throughout much of central and eastern Washington (Fig. 1). Early explorers and naturalists such as Meriwether Lewis, William Clark, and David Douglas observed large numbers of sage grouse along the Columbia including the mouths of the Snake and Yakima rivers and in the Priest Rapids and Grand Coulee regions (Jewett et al. 1953; Yocom 1956). Early descriptions of the

historic sage grouse range were not consistent, particularly in southeastern Washington. Although Jewett et al. (1953) and Aldrich (1963) believed they once occupied all of Whitman, Columbia, and Walla Walla counties and most of Spokane, Garfield, and Asotin counties, Yocom (1956) suggested the original range was smaller. Our revised map differs from previous maps in numerous ways including addition of the Methow River corridor and reduction of the occupied area along the Washington-Idaho border. The estimated historic distribution of sage grouse in Washington spanned 57,741 km².

Although changes in distribution of sage grouse in Washington were noted as early as 1920 (Jewett et al. 1953), populations were not consistently monitored until 1960. We documented 67 lek complexes with 2,424 observations of displaying males between 1960 and 1999 (Fig. 2). Sage grouse also were observed on 1,338 additional occasions in the same period. Forty-nine lek complexes (73.1%) active for at least 1 year during 1960-99 are now vacant, 26 (53.1%) are outside the current distribution (Fig. 2). The remaining 23 vacant complexes (46.9%) appear to reflect declines in density within currently occupied portions of the range.

Based on distribution of active lek complexes and 983 miscellaneous observations during 1990-99, sage grouse persist in 2 relatively isolated populations separated by about 50 km; Yakima/Kittitas (1,154 km² northeast of Yakima) and Douglas/Grant (3,529 km² northeast of Wenatchee) (Figs. 1, 2). The current range of sage grouse covers approximately 4,683 km² or about 8.1% of the historic range; they have been observed on 2,485 occasions within their current range since 1990. In contrast, they have been observed on only 21 occasions outside the current range in this period. There are at least 3 possible reasons for observations outside the

current range. First, sage grouse may move long distances between seasonal ranges and/or during dispersal (Connelly et al. 1988; Schroeder et al. 1999). For example, some observations may represent dispersal movements by sage grouse through otherwise unacceptable habitat. Second, because of a relatively rapid contraction of known populations, some sightings in former portions of their range may represent small, remnant, declining, and/or poorly understood populations. Third, some observations outside core areas may be misidentifications.

Abundance

The first declines in abundance were noted in the late 1800s on the western edges of the Palouse Prairie, with more recent declines observed throughout the Columbia Basin (Jewett et al. 1953; Yocom 1956). Although early declines in abundance were poorly documented, they resulted in increased hunting restrictions (Yocom 1956) with hunting closed throughout the state from 1933 through 1949. Although restrictive hunting seasons (season length, 2-11 days; bag limit, 1 bird) were reestablished between 1950 and 1987 (excluding 1957), all hunting was again closed in 1988 (Washington Department of Fish and Wildlife 1995).

An average of 12 active lek complexes were counted each year, 1960-99, even though 9 of the first 10 years included counts of only 1 to 4 complexes (Fig. 3). Although males on active complexes were counted an average of 5 times each year, some were counted more than 20 times, others only once. Because some original data for those counted on multiple occasions were lost, the average number of counts is a low estimate.

The average maximum count of males on lek complexes was 22.8 (95% CI = 21.2 - 24.4)

for 483 annual counts between 1960 and 1999. Average attendance at complexes between 1960 and 1999 declined at an annual rate of 1.4% ($r = -0.484$, $P = 0.002$). The 1999 population estimate, based on counts of 418 male sage grouse, was 1,087: 421 in the Yakima/Kittitas population and 666 in the Douglas/Grant population. The population declined an average of 2.5% (SE = 2.3%) per year from 1960 to 1999; it declined in 22 of 39 (56.4%) year-to-year intervals. These annual changes were used to 'back-estimate' population size; the estimated population in 1960 was 4,682 (Fig. 4). The estimated decline was 76.8% between 1960 and 1999. The largest declines were observed during the 1960s and early 1970s.

Regional comparisons of populations revealed striking differences. The Lincoln/Grant County population declined 100% from an estimated 361 birds in 1970 to zero in 1985. The Yakima/Kittitas County population declined 40.8% from 711 birds in 1970 to 421 birds in 1999. The Douglas/Grant County population declined 60.0% from 1,665 birds in 1970 to 666 birds in 1999. A dramatic annual variation in population size is illustrated by the Yakima/Kittitas County population which was smaller in 1974-76 than in 1999. Similarly, estimated population size in the Douglas/Grant County population was lower in 1985-86 and in 1992-97 than in 1999.

Habitat

Although habitat within the original range of sage grouse in Washington was clearly dominated by shrub- and meadow-steppe (about 90%; Dobler et al. 1996), most habitat has been converted to cropland and is now used for the production of crops or is in CRP (Table 1). The first declines in distribution were related to cultivation of the Palouse Prairie, primarily for

production of wheat. Declines continued as cultivation expanded throughout the Columbia Basin, initially for production of wheat and secondarily for irrigated crops including fruit. Irrigation was supported and expanded with reservoirs behind dams along the Columbia River, including the first and largest, Grand Coulee, completed in 1942. Many remaining areas of uncultivated habitat are unsuitable for sage grouse because of the lack of sagebrush, perennial grasses, and/or forbs (Schroeder et al. 1999).

The current range of sage grouse in Washington is characterized by 57.0% shrub-steppe (including meadow-steppe), 26.6% cropland, 13.0% CRP, and 3.4% other (Table 1). This is in contrast to areas where sage grouse are extirpated; 42.3% shrub-steppe, 42.8% cropland, 5.5% CRP, and 9.4% other. The Yakima/Kittitas range is dominated by shrub-steppe habitat (96.6%) in a substantially higher proportion than in the Douglas/Grant distribution (44.3%). Sage grouse appear to exist in the Douglas/Grant area due to the high quality and configuration of remaining shrub-steppe and relatively abundant CRP (16.7%).

DISCUSSION

Although the current estimates of abundance (about 1,100) and distribution (2 isolated populations) likely are conservative, the dramatic nature of the sage grouse declines in Washington are clear. For example sage grouse are no longer regularly observed in portions of the range that were recently occupied. Most lek complexes documented since 1960 are now vacant. Similarly, although the population decline between 1960 and 1999 was estimated to be about 77%, it is likely that this estimate was too low. Sixteen lek complexes were not included in the analysis of past populations because there were no counts of males on them. Most of these

complexes appear to have become vacant prior to 1980. If the 1960 population were re-estimated assuming that these 'extra' complexes were of average size (22.8 males) in 1960 and vacant in 1999, the revised population decline would be closer to 95%.

Although over-harvest may have been a factor in the historic decline of sage grouse in Washington (Yocom 1956), the clearest explanation for the decline is conversion of native shrub- and meadow-steppe habitat to cropland (Washington Department of Fish and Wildlife 1995, Dobler et al. 1996). The vast majority of cultivated land no longer supports sage grouse. Cultivated land in the northern distribution of sage grouse (Douglas/Grant County area) is a partial exception because of its favorable juxtaposition with the remaining native shrub- and meadow-steppe habitat. Sage grouse have also benefitted in the Douglas/Grant County area because of re-vegetation of about 600 km² of cropland as part of the CRP. Although CRP habitat is often dominated by introduced species such as crested wheatgrass, some areas provide useful cover for nesting sage grouse, especially when invaded by a diversity of plant species including sagebrush and forbs.

Most remaining shrub- and meadow-steppe habitat in Washington is associated with relatively steep topography and/or shallow soils that are difficult to cultivate (Dobler et al. 1996; JEJ, in prep.). Intensive grazing by horses, sheep, and cattle is one explanation for the inability of native habitats to support sage grouse. Many areas that are lightly grazed now illustrate the aftereffects of a long legacy of heavy livestock grazing (such as reduced cover of forbs and perennial grasses); livestock were common in many areas of Washington long before 1900 (Daubenmire 1970). In the Douglas/Grant area, nesting sage grouse typically avoid habitat with a

history of heavy grazing (MAS, in prep.). In other large areas of shrub- and meadow-steppe such as the Yakama Indian Reservation, the Hanford Site (U.S. Department of Energy), and Lincoln County, sage grouse have been extirpated in the last 40 years. In all 3 cases, grazing by livestock has been exacerbated by large wildfires. An exception is the region dominated by the Yakima Training Center (YTC, U.S. Department of Defense) in the Yakima/Kittitas area. Sage grouse have persisted here for 3 apparent reasons. First, steep, irregular topography has made some areas less accessible to livestock, safeguarding isolated pockets of native habitat. Second, military activities have closed some areas to grazing, which may have protected important habitats. Third, grazing frequency and/or intensity were limited in traditional military use areas to avoid compounding the impact of both training and grazing.

The future for sage grouse on the YTC is uncertain. Although livestock grazing is no longer permitted, habitat restoration in areas with long histories of grazing is a long and difficult process (Daubenmire 1970). Additional risks include direct damage to habitat caused by military vehicles and increased risk of fires. Despite potential problems, the YTC is adjacent, or close, to other large tracts of federal and state land that have potential to be managed for the benefit of sage grouse. These areas include the Hanford Site (U.S. Department of Energy); Arid Lands, Saddle Mountain, and Columbia National Wildlife refuges (U.S. Department of Interior); Yakima Indian Reservation; and Oak Creek, Wenas, Wahluke Slope, and Quilomene Wildlife areas (Washington Department of Fish and Wildlife).

The Douglas/Grant County population contrasts dramatically with the Yakima/Kittitas County population in that it is virtually all on private land. Nevertheless, many critical habitats

are not at immediate risk. First, the best remaining shrub- and meadow-steppe habitats are relatively small and considered scablands; shallow soil and/or steep terrain have made them difficult to cultivate. Second, although some heavily grazed rangelands no longer support healthy communities of bunch grasses that are needed by nesting sage grouse, they still provide critical winter habitat. Third, enrollment in CRP has been expanded by about 30% and extended until at least 2008; planting requirements have been strengthened to include greater plant diversity and emphasis on native species. Whether the CRP represents a long-term step toward the protection of sage grouse is dependent on renewal of CRP in 2008.

Population viability also is an issue for sage grouse in Washington. Research on greater prairie-chickens (*Tympanuchus cupido*) in Illinois indicates that small populations may have negative genetic and fertility responses to isolation (Bouzat et al. 1998; Westemeier et al. 1998). Since some have suggested breeding populations should contain at least 500 individuals (Franklin 1980; Frankel and Soulé 1981; Frankel 1983), it is clear that Washington populations are at risk; 421 in Yakima/Kittitas County and 666 in Douglas/Grant County. Because most male and some female sage grouse do not breed successfully in their lifetime (MAS, in prep.), viable sage grouse populations should probably include more than 1,000 individuals (385 counted males). Increased population viability of sage grouse in Washington may be obtained by increasing the density of sage grouse on currently occupied range, expanding the range into adjacent unoccupied habitats, and/or connecting the 2 existing populations with additional breeding habitat or substantial dispersal corridors.

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Table 1. Potential habitat quantity (1993 Thematic Mapper) in relation to current and historic distribution of sage grouse in Washington.

Range or population	Proportion of area dominated by each habitat (%)				Area (km ²)
	Shrub-steppe ^a	Cropland	CRP	Other	Total
Douglas/Grant population	44.3	35.1	16.7	3.9	3,529
Yakima/Kittitas population	95.6	0.5	1.9	1.9	1,154
Total occupied range	57.0	26.6	13.0	3.4	4,683
Unoccupied range	42.3	42.8	5.5	9.4	53,058
Historic range	43.5	41.5	6.1	8.9	57,741

^aShrub-steppe includes shrub-steppe, meadow-steppe, and steppe habitats described by Daubenmire (1970).

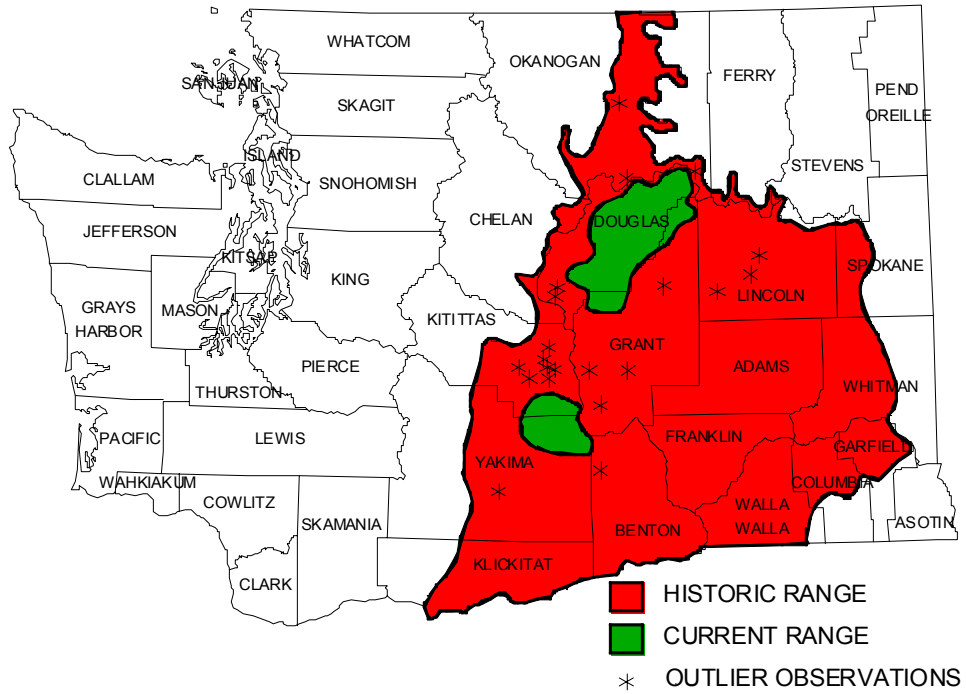


Figure 1. Historic and current (1999) sage grouse range in Washington.

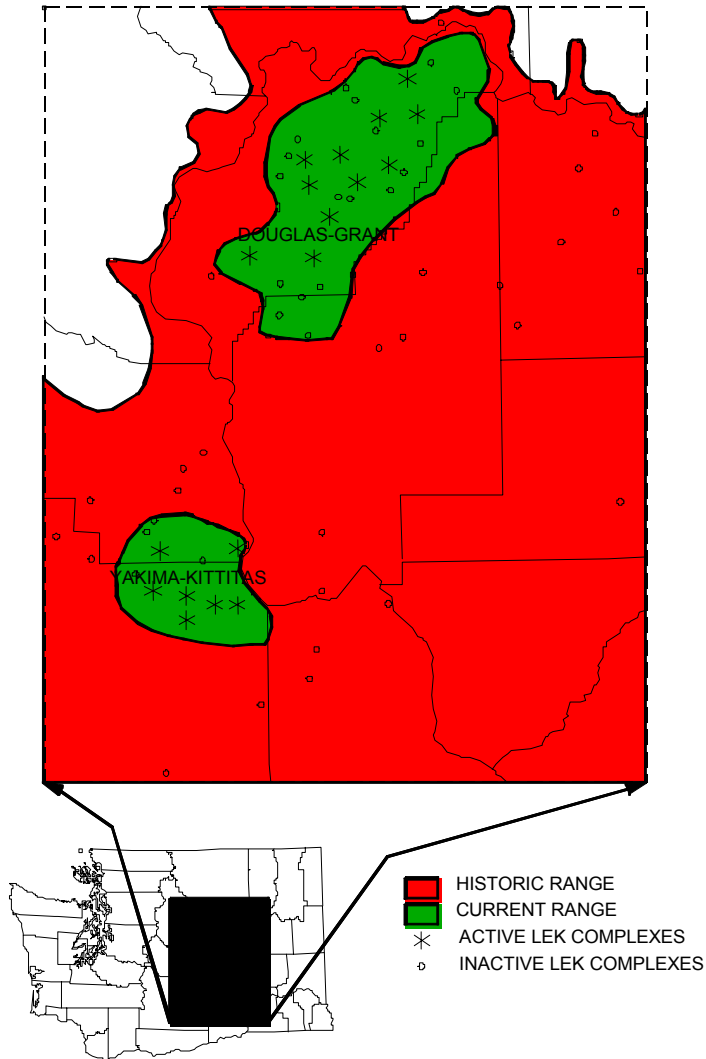


Figure 2. Distribution of active and inactive lek complexes in relation to historic and current sage grouse distribution in Washington, 1999. Inactive lek complexes were active for \$ 1 year between 1960 and 1998.

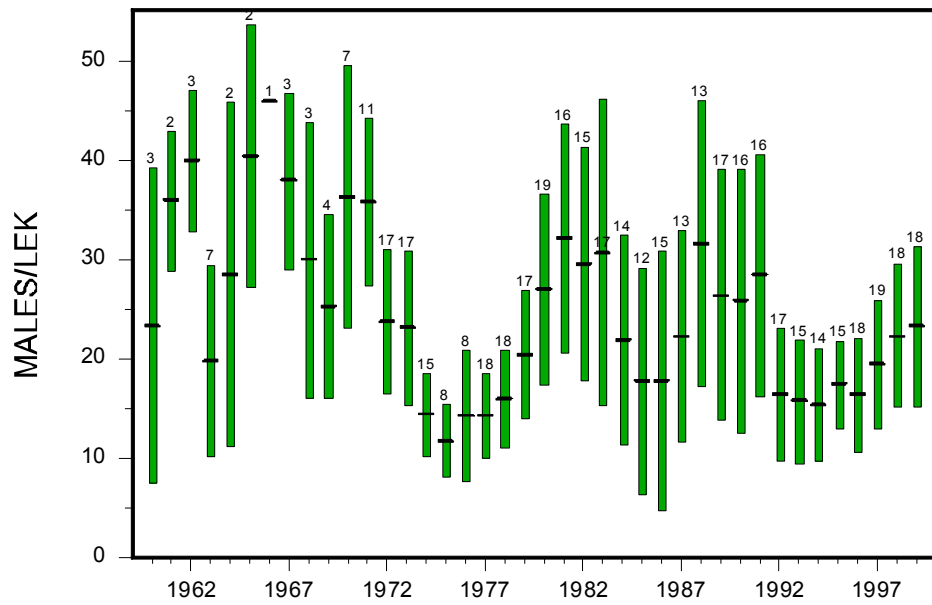


Figure 3. Average maximum number of male sage grouse observed on lek complexes in Washington, 1960-99. Means are represented by horizontal lines and 95% confidence intervals by rectangles; the number of sampled lek complexes is given for each year.

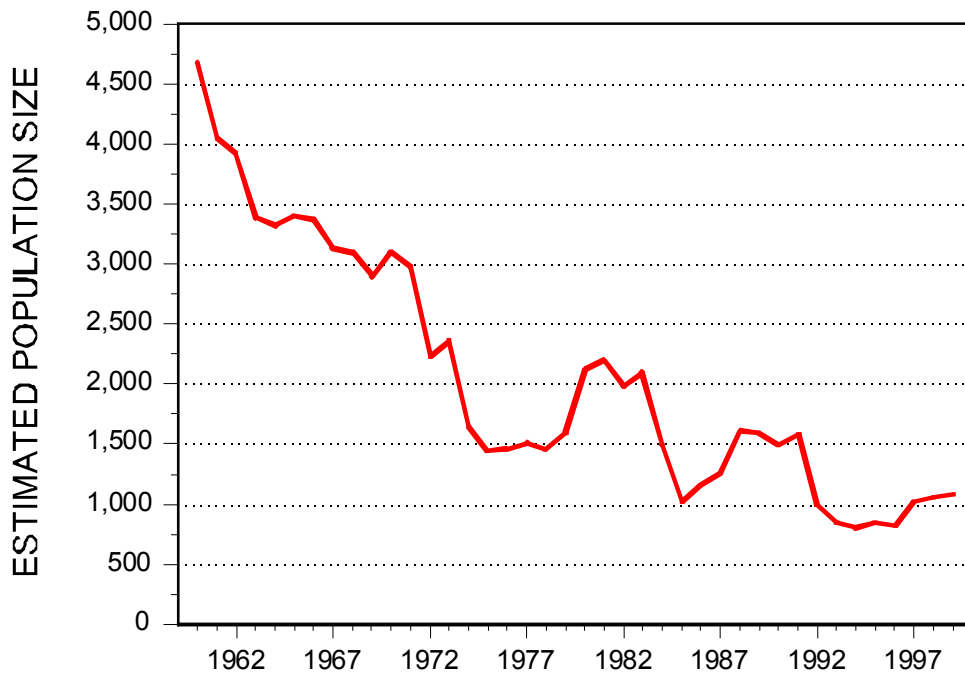


Figure 4. Estimated sage grouse population size in Washington, 1960-99.