
**Sage Grouse on the Yakima Training
Center: A Summary of Studies
Conducted During 1989 and 1990**

**L. E. Eberhardt
L. A. Hofmann**

March 1991

**Prepared for the
U.S. Department of the Army
under a Related Services Agreement
with the U.S. Department of Energy
Contract DE-AC06-76RLO 1830**

**Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
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PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE MEMORIAL INSTITUTE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC06-76RLO 1830

Printed in the United States of America

Available to DOE and DOE contractors from the
Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831;
prices available from (615) 576-8401. FTS 626-8401.

Available to the public from the National Technical Information Service,
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SAGE GROUSE ON THE YAKIMA TRAINING CENTER:
A SUMMARY OF STUDIES CONDUCTED DURING
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Pacific Northwest Laboratory
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Yakima Training Center, Washington

SUMMARY

A two-year study, sponsored by the U.S. Department of the Army and conducted by Pacific Northwest Laboratory, was initiated in 1989 to study sage grouse on the Yakima Training Center (YTC). The specific objectives of this study were 1) to obtain detailed information on the distribution and relative density of sage grouse on the YTC, 2) to identify movement and habitat use patterns of sage grouse on the YTC, 3) to identify crucial habitat for sage grouse on the YTC, and 4) to provide management recommendations. Sage grouse were selected for study because they are a U.S. Fish and Wildlife Service candidate species for the threatened and endangered list in Washington, and because the YTC probably contains the largest population of sage grouse left on federally owned lands in this state.

The locations of 11 sage grouse leks, or breeding grounds, were determined on the YTC during extensive spring helicopter surveys. The maximum number of sage grouse observed during ground surveys of these leks varied from 2 to 55 birds. One lek, located near Range 19, was probably used by 40 to 50% of the YTC sage grouse population. Fifteen years of counts of males on leks indicate that the YTC sage grouse population was most numerous during the early to mid 1980s. Since the mid-1980s, sage grouse numbers appear to have declined on the YTC and in other locations in Washington.

Forty-six sage grouse (17 females and 29 males) were captured and fitted with radio transmitters during 1989 and 1990. Movements by these sage grouse were both erratic and large when compared with other studies. We believe that many of the atypical movements were in response to military training activities. Sage grouse appeared to seek out areas on the YTC where human disturbance was low.

Nesting success for radio-marked females (38%) was comparable to that observed in other populations. However, only 15 sightings of broods were made during 2 years of study, and only one radio-marked female successfully raised a brood.

Radio-tracking data indicate that some of the best habitat for sage grouse occurred in the western half of the YTC. The northwest corner of the YTC appeared to be particularly important habitat for both sexes during the spring and for nesting females. Loss of the sagebrush in the northwest corner of the YTC would be

devastating to the YTC sage grouse population. The eastern portions of the YTC were not very good sage grouse habitat.

Based on this study, we recommend the following management actions:

- Conduct annual counts of sage grouse on leks.
- Conduct annual surveys for the presence or absence of grouse on all leks used in the past.
- Conduct aerial surveys for new leks every 2 to 3 years.
- Begin a program to restore and reestablish stands of big sage.
- Reduce the level of sheep grazing during the nesting and early brood-rearing periods in the northwest corner of the YTC and immediately south of the road from Range Central to Range 55.
- Protect a 1-km zone around the major leks from disturbance 24 hours a day from mid-February through the end of March.
- During the nesting and early brood-rearing seasons (mid March through late May), reduce disturbance within a 4-km band around the Range 19 lek and in a 1-km zone south of, and parallel to, the main road between Ranges 5 and 55.

ACKNOWLEDGMENTS

This work was funded by the U.S. Department of the Army through a Related Services Agreement with the U.S. Department of Energy under Contract DE-AC06-76RLO 1830. Mr. R. W. Hanna, Chief of the Environmental and Natural Resources Division at Ft. Lewis, was instrumental in obtaining funding for the project.

Numerous Army and civilian personnel assisted in various aspects of the study. The Yakima Training Center (YTC) base commander, Lt. Col. R. Nelson, and Range Control officers, Mr. J. H. Hoffman and Mr. J. Reddick, provided invaluable and essential assistance in the logistics of working on the YTC. E. N. Andersen, Range Specialist at the YTC, contributed numerous data on the YTC for inclusion in this report. J. Stephenson, Fisheries and Wildlife Biologist at Ft. Lewis, assisted both in the planning phase and in logistical aspects of the study.

Field assistance was provided by M. A. Taaffe, R. E. Fitzner, M. R. Carpenter, S. Pellegrini, and M. C. Anderson.

Historical data on the locations and counts made on sage grouse leks on the YTC and in Douglas County were provided by L. Stream, Washington Department of Wildlife. R. Friesz, Washington Department of Wildlife, provided information on the current distribution of sage grouse in Douglas County, Washington.

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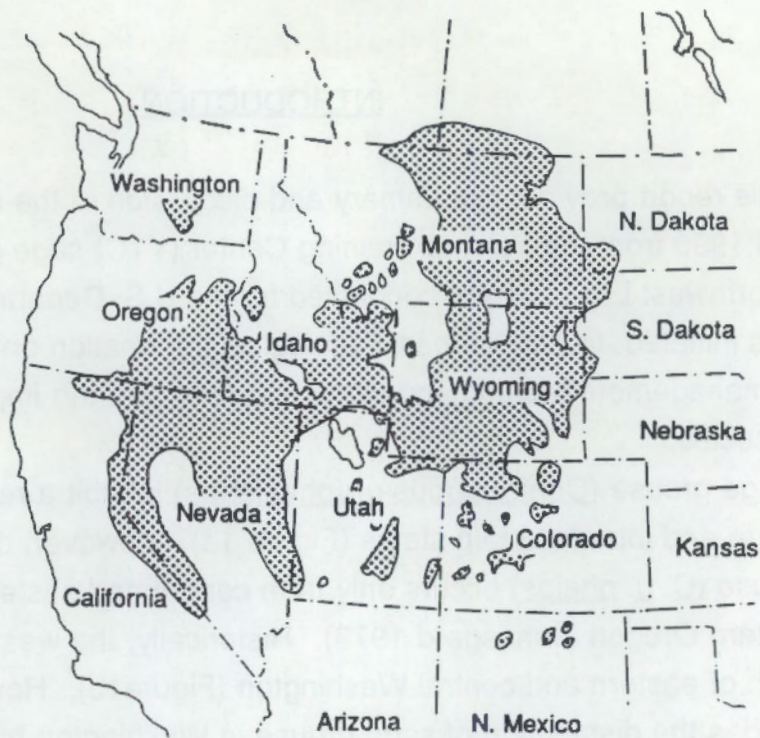
INTRODUCTION

This report provides a summary and discussion of the results obtained during 1989 and 1990 from the Yakima Training Center (YTC) sage grouse study, which Pacific Northwest Laboratory^(a) conducted for the U.S. Department of the Army. This study was initiated to provide basic ecological information on YTC sage grouse and to develop management recommendations that minimize the impact of military activities on this species.

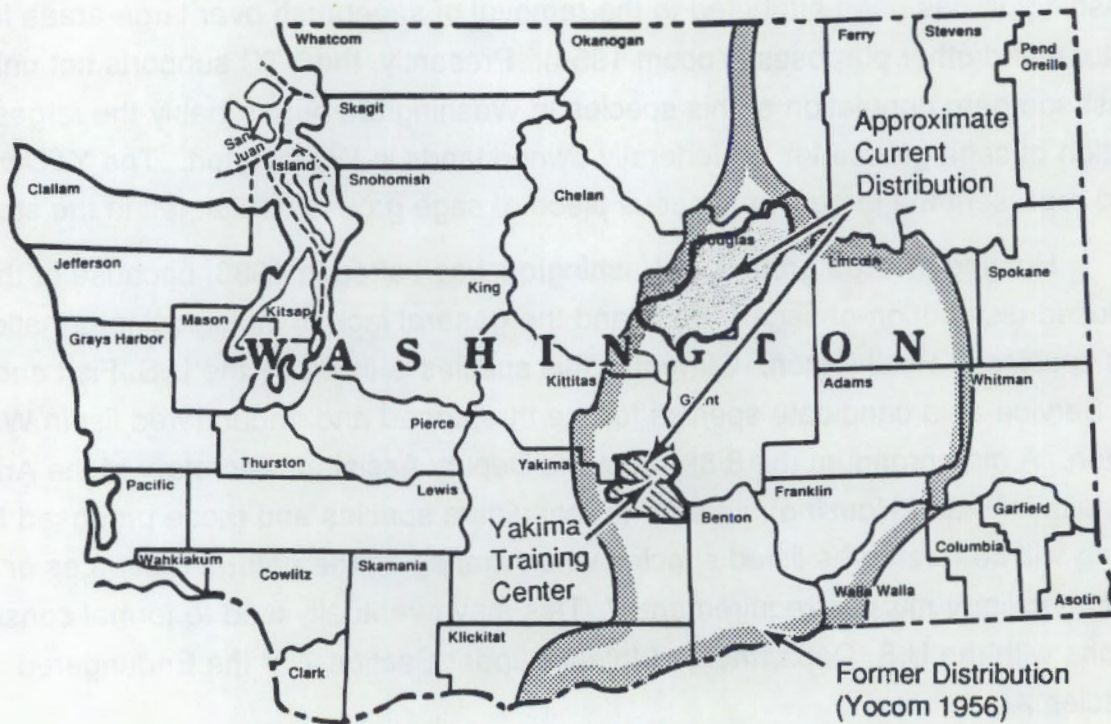
Sage grouse (Centrocercus urophasianus) inhabit a relatively large portion of the western and intermountain states (Figure 1a). However, the western subspecies of sage grouse (C. u. phaios) occurs only from central and eastern Washington south to southeastern Oregon (Johnsgard 1973). Historically, the western sage grouse occupied much of eastern and central Washington (Figure 1b). However, during the last four decades the distribution of sage grouse in Washington has steadily declined (Figure 1b) (Yocom 1956; Pedersen 1981; personal communication, R. Friesz, Washington Department of Wildlife). This reduction in the distribution of sage grouse in Washington has been attributed to the removal of sagebrush over large areas for agricultural and other purposes (Yocom 1956). Presently, the YTC supports not only the most southern population of this species in Washington, but probably the largest population of sage grouse left on federally owned lands in Washington. The YTC may also represent the largest contiguous piece of sage grouse habitat left in the state.

Hunting of sage grouse in Washington was halted in 1988, because of the reduced distribution of sage grouse and the general lack of biological information on this species in Washington. Currently, this species is listed by the U.S. Fish and Wildlife Service as a candidate species for the threatened and endangered list in Washington. A memorandum (8/18/89) from the Deputy Assistant Secretary of the Army (Installations and Housing) stated that "candidate species and those proposed for listing will be treated as listed species when managing the natural resources or supporting military mission requirements." This may eventually lead to formal consultations with the U.S. Department of Interior under Section 7 of the Endangered Species Act.

(a) Operated by Battelle Memorial Institute for the U.S. Department of Energy.



a) In Western States (From Johnsgard 1973)



b) In Washington (From Yocom 1956 and personal communication, R. Friesz, Washington Department of Wildlife)

FIGURE 1. Sage Grouse Distribution

The specific objectives of this study were 1) to obtain detailed information on the distribution and relative density of sage grouse on the YTC, 2) to identify movement and habitat-use patterns of sage grouse on the YTC, 3) to identify crucial habitat for sage grouse on the YTC, and 4) to provide management recommendations. In this report we discuss the methodology used in this study, present our results, and provide management recommendations.

The specific objectives of this study were 1) to obtain detailed information on the distribution and relative density of sage grouse on the YTC, 2) to identify movement and habitat use patterns of sage grouse on the YTC, 3) to identify critical habitat for sage grouse on the YTC, and 4) to provide management recommendations. In this report we discuss the methodology used in this study, present our results, and provide management recommendations.

STUDY AREA

The 1,058-km² YTC is located in south-central Washington in Yakima and Kittitas Counties approximately 11 km north of Yakima. The YTC is bordered by the Columbia River on the east, interstate highway I-82 on the west, Manastash Ridge on the north, and Yakima Ridge on the south (Figure 2). Umtanum Ridge, which bisects the YTC east to west, reaches elevations of 1,249 m. The lowest elevation on the YTC is 183 m.

The climate of the area is characterized by hot, dry summers and cold, dry winters. The annual precipitation is approximately 20 cm per year. Temperatures range from - 4°C in January to 40°C in July.

The YTC supports one of the larger contiguous tracts of native shrub-steppe vegetation left in Washington. Stands of big sagebrush (*Artemisia tridentata*) occur throughout the area. On relatively undisturbed areas bluebunch wheatgrass

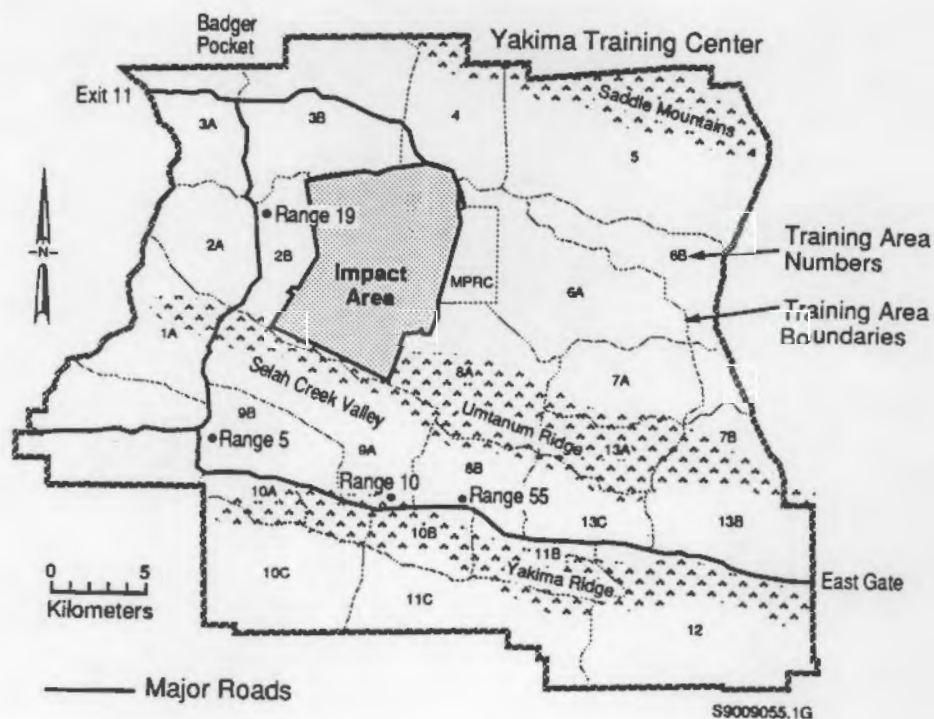


FIGURE 2. Location of the Yakima Training Center

(Agropyron spicatum) is the dominate grass; however, cheatgrass (Bromus tectorum) and knapweed (Centaurea sp.) predominate in heavily disturbed areas.

The YTC is well-suited for training troops for desert warfare and is used by both active and reserve U.S. Army military components for troop maneuver exercises and weapons firing. In 1987 over 800,000 man-days of use (approximately 2,500 soldiers per day) occurred on the YTC (U.S. Department of the Army 1989).



METHODS

LEK SURVEYS

The numbers of male and female sage grouse at leks were counted approximately weekly throughout the breeding season (mid February through early May). Counts were made with binoculars and spotting scopes between first light and 1 h after sunrise from vehicles located at vantage points near the leks. Because of the possibility of interlek movements by individual grouse, attempts were made to count those leks located close together on the same day. Counts of sage grouse were not made on rainy or windy days, because sage grouse attendance at leks during inclement weather was generally low.

During March and April of 1989 and 1990, an Army helicopter (Huey UH-1H) was used to survey the YTC for additional leks. Although emphasis was placed on surveying those areas most likely to have leks, based on physical landscape features or historical information on lek locations, attempts were made to cover the entire YTC in these surveys. Helicopter surveys began at or slightly before sunrise and ran approximately 2 to 3 h. In addition to the pilot, copilot, and crew chief, two to four experienced observers were used during these surveys.

Information on the past use of leks by sage grouse on the YTC was obtained from the Washington Department of Wildlife (WDW) and from the U.S. Army, Directorate of Engineering and Housing (DEH). Personnel making these lek counts included Lee Stream (WDW), Ellis L. Bowhay (WDW), and Eric Andersen (DEH). Generally, two to six counts were made on specific leks each year.

CAPTURE AND MARKING

During the breeding seasons of 1989 and 1990, several methods were used to capture sage grouse on the major leks. During 1989, roads transgressing the leks were driven at night, and sage grouse were located with 1,000,000 candle-power spotlights. Once an individual or a group of sage grouse was located, a team of two researchers approached the bird on foot. One member of the capture team focused the spotlight on the bird while the other member used a long-handled dip net to capture the grouse (Giesen, Schoenberg, and Braun 1982). Recordings of loud background noises (e.g., a helicopter noise) were used to confuse the bird and to hide

noises made during the approach. During 1990, the same method of spotlighting grouse from the roads was used. Once a bird was located, however, the truck was driven within approximately 10 to 20 m of the grouse and a researcher standing in the back of the truck fired a 2.7-m x 2.7-m net over the grouse from a net-firing gun (Mechlin and Shaiffer 1980). In addition, during 1990 a ground-fired net launcher that deployed a 7.6-m x 7.6-m net by remote signal was placed in areas frequented by grouse. When a sage grouse walked within range of the net, it was deployed by an observer located approximately 75 m away.

Once captured, sage grouse were weighed using a spring scale, the sexes of the birds were recorded, and their ages were estimated by observing the wear pattern on the outer two primary feathers of the wing (Beck, Gill, and Braun 1975). All sage grouse captured during 1989 were equipped with a 27-g solar-assisted radio transmitter that was glued and sewn to a herculite poncho (Amstrup 1980). The size of the hole in the poncho for the neck was individually cut for each bird, and the poncho was slipped over its head. During 1990, approximately half of captured birds were fitted with the solar-assisted transmitter, while the other half were equipped with a lighter battery-powered transmitter (21 g).

MONITORING MOVEMENTS

Radio-equipped sage grouse were located from both ground and air. Radio-tracking grouse from the ground was accomplished by first locating the general locale of the marked bird from a vehicle equipped with an omni-directional antenna. The bird was then approached on foot using a hand-held yagi antenna, and its location was determined. Often the marked bird was visually located during this procedure. The location of the bird was recorded in Universal Transverse Mercator (UTM) coordinates estimated from a 1:50,000 scale map. Additional data recorded included the activity of the bird, time, air temperature, percent cloud cover, wind speed, and vegetational cover.

Four permanent ground-tracking towers were used to locate sage grouse when they were in the Impact Area (Figure 2), because human access to this area was restricted. The permanent towers consisted of paired four-element yagi antennae mounted 6 m above the ground on a rotatable mast. Three of the permanent tracking stations were located along Umtanum Ridge, which parallels, and lies above, the

southern boundary of the Impact Area (Figure 2). The fourth tower was located near the western border of the Impact Area. Angular readings obtained from the towers were converted to UTM coordinates with a BASIC computer program (Dodge, Wilkie, and Steiner 1986). Average error from these towers in locating radios placed in known locations was 482 ± 153 m (1 SD).

Aerial radio-tracking was accomplished using strut-mounted yagi antennas on a Cessna 172 or 182. Aerial radio-tracking procedures followed those described by Gilmore et al. (1981). A LORAN C navigational system was used to estimate the marked bird's Cartesian position (latitude/longitude). Average error in relocating marked birds from the air was estimated to be 801 ± 223 m (1 SD). A BASIC computer program was used to convert latitude and longitude coordinates into UTM coordinates (Dodge, Wilkie, and Steiner 1986).

Attempts were made to locate marked grouse twice a week, either from the air or the ground. However, this tracking schedule was seldom achieved, for several reasons. Often birds were in areas that were inaccessible, either because of rugged terrain or, more frequently, because human access was restricted because of either unexploded ordnance or military training sessions. Sage grouse on the YTC often made large erratic movements, which made relocating them from the ground very difficult. We attempted to fly once a week with fixed-wing aircraft to locate birds that we could not find on the ground. However, because the air space over the YTC was frequently restricted to military aircraft on training missions, our weekly flights were often precluded.

During the nesting season, special care was taken to not disturb marked females unnecessarily, because of their tendency to desert their nests (Patterson 1952). Once a female settled down in an area and appeared to be incubating a clutch of eggs, we would visually locate the nest and immediately leave the area. We did not return to the nest until we were sure the female had completed the nesting phase or had abandoned the nest.

Home range size, that is, the area used by sage grouse during their normal activities (Burt 1943), was calculated using the minimum-area-convex-polygon method (Mohr 1947). Home range sizes were calculated as one method of comparing YTC sage grouse movements with the results obtained in other studies. Attempts were made to use additional estimators of home range size; however, most other estimators

were inappropriate because of the small number of locations made on individual grouse during our study (e.g., the harmonic mean estimator [Dixon and Chapman 1980]) or because of failure to meet certain assumptions of the estimator (e.g., elliptical estimator [Jennrich and Turner 1969]). Home range sizes were calculated for all radio-marked sage grouse with greater than 10 locations. Program "Home Range" from the University of Idaho (Ackerman et al. 1990) was used to calculate home range size.

HABITAT ANALYSES

For habitat analyses we used Geographical Resource and Analysis Support System (GRASS) software (U.S. Army Corps of Engineers 1987) on MASSCOMP and SUN computers. GRASS is a public-domain, raster-based software package developed by the U.S. Army Corps of Engineers' Construction Engineering Research Laboratory, Champaign, Illinois.

In evaluating sage grouse habitat, we developed generalized habitat maps that depict habitat areas important to sage grouse, based on the results of our radio-telemetry work. In addition, we estimated the current status of sagebrush (Artemisia spp.) on the YTC relative to potential areas that could support sagebrush but currently do not, because sagebrush is a critical component to the continued survival of sage grouse on the YTC.

Habitat Use

We used GRASS software to develop generalized maps of preferred habitat for sage grouse based on four input map layers (vegetation, elevation, slope, and soils). The development of the final map layer was a four-step process (Figure 3). In the first step, we used GRASS software to calculate the proportion of radio locations of marked grouse that fell within several habitat categories for each of the four maps. Chi-square analyses and Bonferroni confidence intervals were used on each of the four input maps to evaluate whether marked grouse used habitat in proportion to habitat availability and, if not, whether some habitats were either preferred or avoided (Neu, Byers, and Peek 1974). Data for all marked individuals were combined for analysis, because data were insufficient to conduct analyses on individual birds. Based on Bonferroni confidence intervals, we assigned a value of 1 to a habitat type if it was avoided by the marked birds, 2 if no preference was shown, and 3 if the habitat was

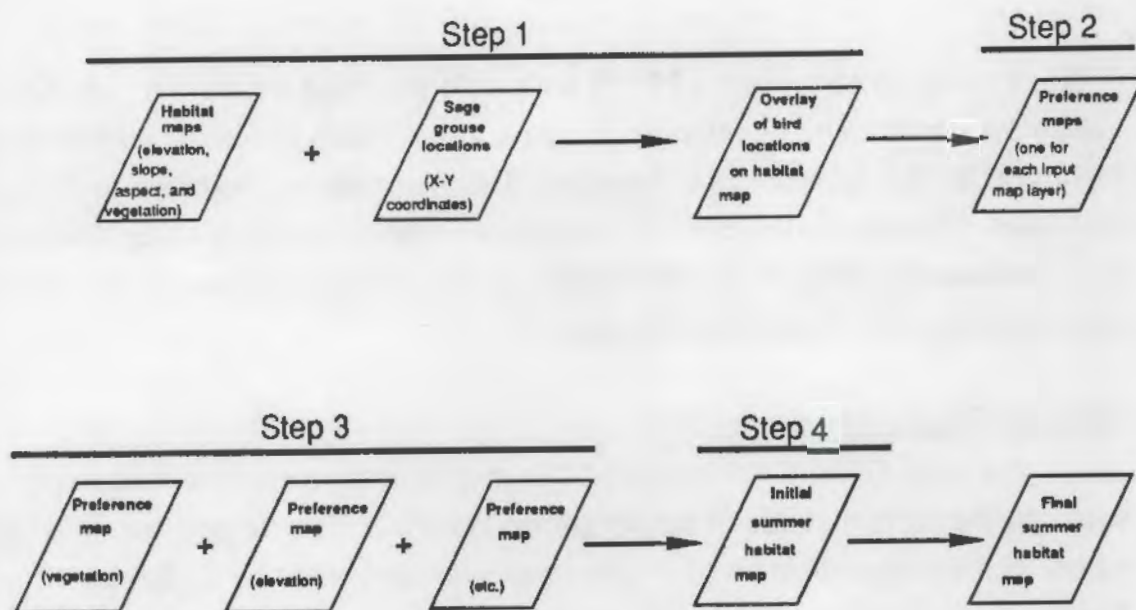


FIGURE 3. Process Used to Develop Generalized Habitat Maps for Sage Grouse Using GRASS

preferred; this was done for all map layers for which the chi-square analysis was significant (Step 2, Figure 3). The map layers were then combined, and the values of the corresponding grid cells were summed (Step 3). In Step 4 the best habitat for sage grouse was subjectively assigned to those grid cells within the upper one third of the range of actual grid cell values obtained in Step 3. The appearance of the final map was then smoothed using the "neighbors" command in GRASS. These habitat analyses were conducted by season for females and males separately.

The vegetation-type map of the sage grouse study area was constructed from satellite (Landsat V thematic maps) and aircraft imagery (Stephan et al. 1990). Vegetation types on known areas were used to initially classify the Landsat imagery. This map was then verified with aircraft imagery and ground surveys conducted at 200 randomly selected points (ground-truthing). This map was shown to be approximately 72% accurate (Stephan et al. 1990). To simplify the map, we used GRASS to combine the nine original vegetation/landcover units (Stephan et al. 1990) into two major categories: shrubland (primarily big sage [*Artemisia tridentata*])/grass and grassland. Digital elevation data obtained from the Defense Mapping Agency were used for the elevation map layer. GRASS software was used to reduce the elevation map layer to four categories: 100 to 499, 500 to 799, 800 to 1099, and 1100 to 1280 m. Slope data were generated from the elevational map with GRASS and reduced to four categories:

0 to 5, 6 to 10, 11 to 15, and >16°. A soils map was digitized from a U.S. Soil Conservation Service map that contained six general soil types (personal communication, H. Gentry, U.S. Soil Conservation Service). This soil map was reduced to four general soil types (Benway-Selah-Brehm, Fortyday-Disage-Sohappy, Vantage-Ralock-Clerf, and Camaspatch-Whiskeydick-Wockum) by eliminating two types that constituted approximately 4% of the total YTC area.

Potential Sagebrush Habitat

We used GRASS software and two map layers (range sites and vegetation) to evaluate the current status of sagebrush on the YTC. The range-sites map layer, which was a reclassification of a soils map layer performed by C. Bagley (Construction Engineering Research Laboratory), contains 25 categories that reflect a combination of soil types, precipitation, and potential vegetation (personal communication, E. Andersen, YTC). We limited our analyses with this map layer to those range sites (N = 4) that had a potential for > 10% coverage by big sagebrush (A. tridentata).

The vegetation-type map of the sage grouse study area was constructed from satellite (Landsat V thematic maps) and aircraft (Stephan et al. 1990) imagery mentioned above. We focused our analyses on the vegetation map layer to those areas that currently support big sagebrush.

The analysis consisted of simply estimating the amount of potential habitat for big sage and comparing this value with the amount of big sage currently present on the YTC in these areas. We also examined the distribution of areas on the YTC that could support sagebrush but currently do not.

VEGETATION SURVEYS OF PROPOSED KNAPWEED SPRAY AREAS

A vegetation survey was conducted near Ranges 10 and 55 in the Selah Creek drainage. This area supports a rapidly expanding population of knapweed (Centaurea spp.) (personal communication, E. Andersen, YTC), which is an introduced weed that grows in dense stands and can replace most other existing vegetation. In 1988 and 1989, respectively, approximately 151 and 253 ha in this area were sprayed from aircraft with a herbicide, picloram. In addition, 1,200 ha were proposed to be sprayed during early spring 1990. Before this spraying program, concern was raised over the impact of this herbicide program on other species of forbs, which are major

spring and summer foods of sage grouse (Wallestad, Peterson, and Eng 1975). The purpose of this survey was to help identify the impacts on forbs of the proposed 1990 aerial spraying program.

We used the point-intercept method (optical-sighting bar) and randomly located transects to determine percent cover. The optical-sighting device consisted of a 1-m bar with 10 ocular scopes with crosshairs mounted at 10-cm intervals along the bar. Readings were made by looking through each of the 10 ocular scopes and recording the first object (vegetation, soil, or litter) sighted under the crosshairs. These readings were made at 5-m intervals along a 50-m transect, for a total of 100 observations per transect. Because 100 observations were made on each transect, percent cover for each transect was simply the number of hits recorded for each vegetation type. Starting locations of transects were randomly selected using the software routine "Grandom" in GRASS. Fifteen transects were read in the area that was proposed for knapweed spraying in 1990, and 14 transects were read in the areas sprayed in 1988 and 1989. All transects ran north-south. Transects were not placed on or adjacent to roads.

Analysis-of-variance (ANOVA) techniques were used to examine the percentage cover data for major vegetation classifications (grasses, forbs, and shrubs) for statistical differences between the sprayed and unsprayed areas. Angular transformations of the data were performed to approximate a normal distribution, which is an assumption of the ANOVA technique.

FOOD HABITS ANALYSIS

Freshly deposited fecal matter from sage grouse that were flushed were collected during May through July 1989 and during October and November 1989. These samples were composited into four monthly samples and analyzed by the Wildlife Food Habits Lab at Washington State University. Major forage plants were identified to species in this analysis.

feeding and summer foods of sage grouse (Hesselt, Peterson, and Eric 1975). The purpose of this survey was to help identify the impacts on food of the grouse in 1985 and 1986.

We used the point-intercept method (point-intercept survey) and randomly located transects to determine percent cover. The point-intercept device consisted of a 10-m transect with 10 equal sections with cross-arms mounted at 10 cm intervals along the transect. Readings were made by looking through each of the 10 equal sections and recording the first object (vegetation, soil, or other) aligned under the cross-arm. These readings were made at 5-m intervals along a 50-m transect for a total of 100 observations per transect. Between 100 observations were made on each transect, normally 100 for each transect. We randomly located the transects for each vegetation type. Standing locations of the transects were randomly selected using the following procedure. In 1985, 10 transects were used in the area that was proposed for the sage grouse. In 1986, 14 transects were used in the same area. In 1985 and 1986, 10 transects were used in the same area. In 1985 and 1986, 14 transects were used in the same area. In 1985 and 1986, 10 transects were used in the same area. In 1985 and 1986, 14 transects were used in the same area.

Analysis of variance (ANOVA) techniques were used to examine the percent cover data for major vegetation classifications (forest, forest, and shrub) or statistical differences between the surveyed and unsurveyed areas. Analysis of variance of the data was performed to approximate a normal distribution with the assumption of the ANOVA technique.

FOOD HABIT ANALYSIS

Freshly deposited fecal matter from sage grouse that were flushed was collected during May through July 1985 and during October and November 1985. These samples were composited into four monthly samples and analyzed by the Wildlife Food Habits Lab at Washington State University. Major large quantities of species in the analysis.

RESULTS AND DISCUSSION

Forty-six sage grouse (17 females and 29 males) were captured and fitted with radio transmitters during 1989 and 1990 (Table 1). Only two females were captured in 1989 (Table 1) because we could not trap at the leks until after March 17, due to military training activities. Unfortunately, this date followed the peak in female attendance at leks (see section on lek attendance).

Males were easily captured with dip nets. However, this technique was not very effective on females, who were considerably more skittish than males. Eleven of the 17 females were captured with the net gun.

Average weight for adult male sage grouse was 2.8 ± 0.2 kg (1 SD) and for juvenile males was 1.3 ± 0.1 kg. Average adult female weight was 1.6 ± 0.1 kg and for juvenile females was 1.3 ± 0.4 kg. These weights were similar to those observed in Douglas County, Washington, for males (Pedersen 1981) and for the eastern subspecies of sage grouse (*C. u. urophasianus*) in Wyoming (Patterson 1952) and in Montana (Wallestad 1975).

TABLE 1. Number of Male and Female Sage Grouse Captured at Major Leks on the Yakima Training Center in 1989 and 1990

<u>Location Captured</u>	<u>1989</u>				<u>1990</u>			
	<u>Male</u>		<u>Female</u>		<u>Male</u>		<u>Female</u>	
	<u>Yrl. (a)</u>	<u>Ad. (b)</u>	<u>Yrl.</u>	<u>Ad.</u>	<u>Yrl.</u>	<u>Ad.</u>	<u>Yrl.</u>	<u>Ad.</u>
Range 19 lek		8	1	1		3	6	6
Range 10 lek	1	1			1	5	2	1
Range 55 lek		2			1	1		
Range 5 lek	1	3				1		
Range 15 lek		1						
Total	2	15	1	1	2	10	8	7

(a) Yearling

(b) Adult

Of the 46 radios placed on grouse, 6 (13%) appeared to have stopped functioning within 1 to 2 weeks after installation and provided no information on grouse movement and habitat use. The reason(s) for the high failure rate are unknown. Seven of the 21 radios placed on sage grouse in 1989 (33%) continued to function until 1990. For the radios installed in 1989, maximum transmitter life was 355 days, and average transmitter life was 200 days.

POPULATION DYNAMICS

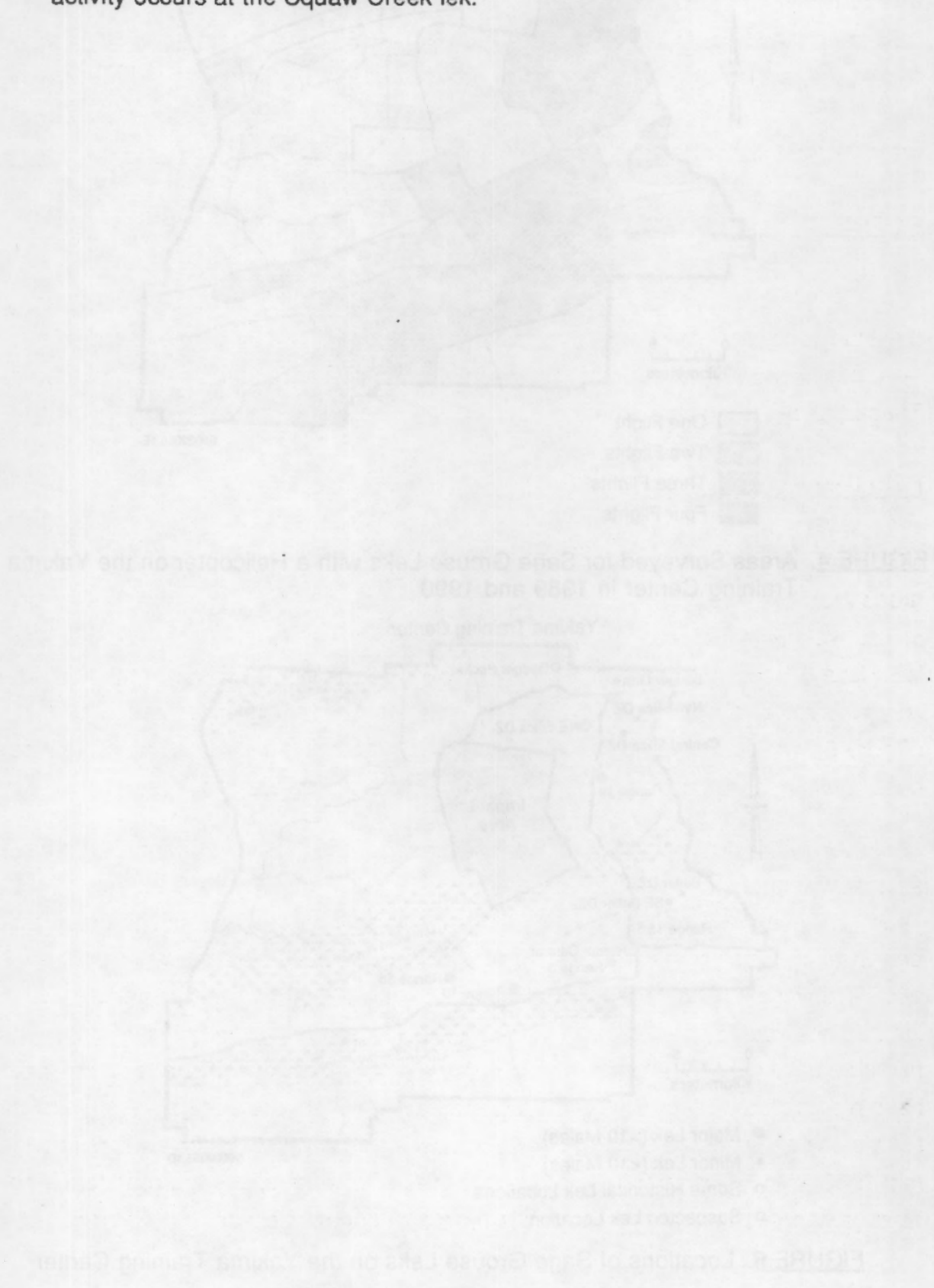
Several aspects of sage grouse population dynamics were examined during this study, including the number of active leks on the YTC, numbers of sage grouse on leks, nesting success, brood-rearing success, and mortality of radio-marked grouse. These topics are presented in this section.

Lek Locations and Physical Characteristics

Helicopter surveys were made during 10 mornings (20 hours total) in 1989 and 1990 to locate new sage grouse leks (Figure 4). These surveys were concentrated in areas most likely to have sage grouse. Eleven leks were located on the YTC (Figure 5, Table 2). The general locations of all but four of these leks (Ranges 5, 10, 55, and NE Silica Drop Zone) had been recorded prior to our surveys. Maps of the four largest leks are provided in Appendix A. The lek located northeast of Silica Drop Zone (Figure 5) was observed from the air in 1989 but could not be located from the ground, despite intensive searches.

Available historical information indicates that the locations of some leks have shifted over time. The location of the lek at Range Central (Figure 5) has made minor yearly shifts in the flats east of Range Control Headquarters (personal communication, Lee Stream, Washington Department of Wildlife). This lek appeared to disappear in 1988, following extensive physical disturbance to the general area. However, we located a lek on Range 5, approximately 2 km from the original location (Figure 5) that might be considered the same lek as Range Central. Similar shifts in locations of a lek have also occurred near Range 19. Historically, most sage grouse breeding activity in the vicinity of Range 19 occurred near Squaw Creek (Figure 5); however, during the mid 1980s this lek became less active and the lek located across the road to the northwest of Range 19 became more active (personal communication, Lee Stream,

Washington Department of Wildlife). Presently, little or no sage grouse breeding activity occurs at the Squaw Creek lek.



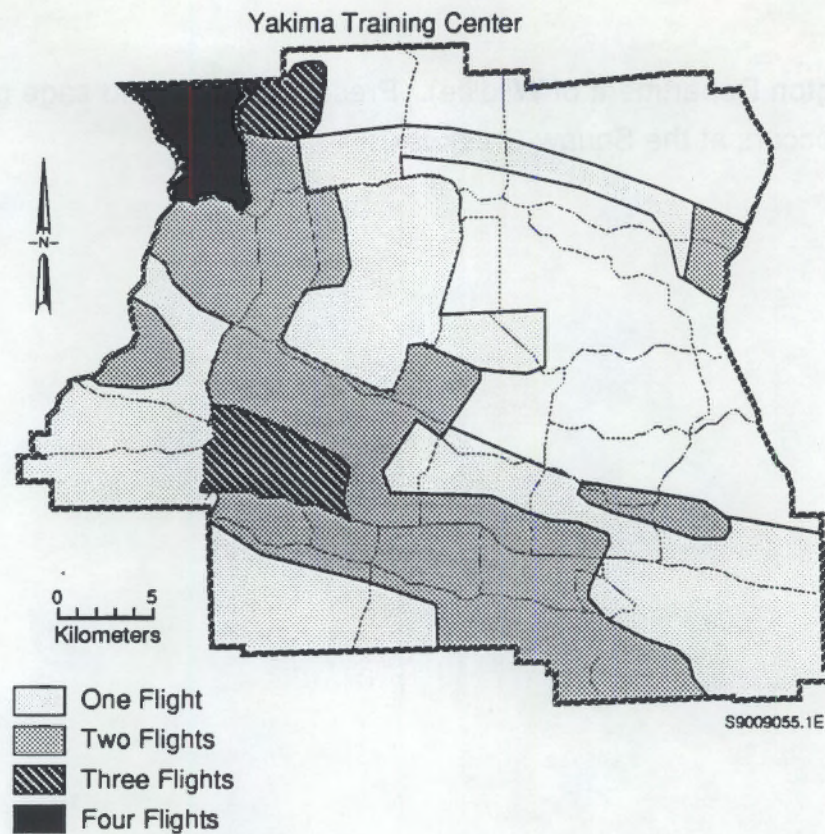


FIGURE 4. Areas Surveyed for Sage Grouse Leks with a Helicopter on the Yakima Training Center in 1989 and 1990

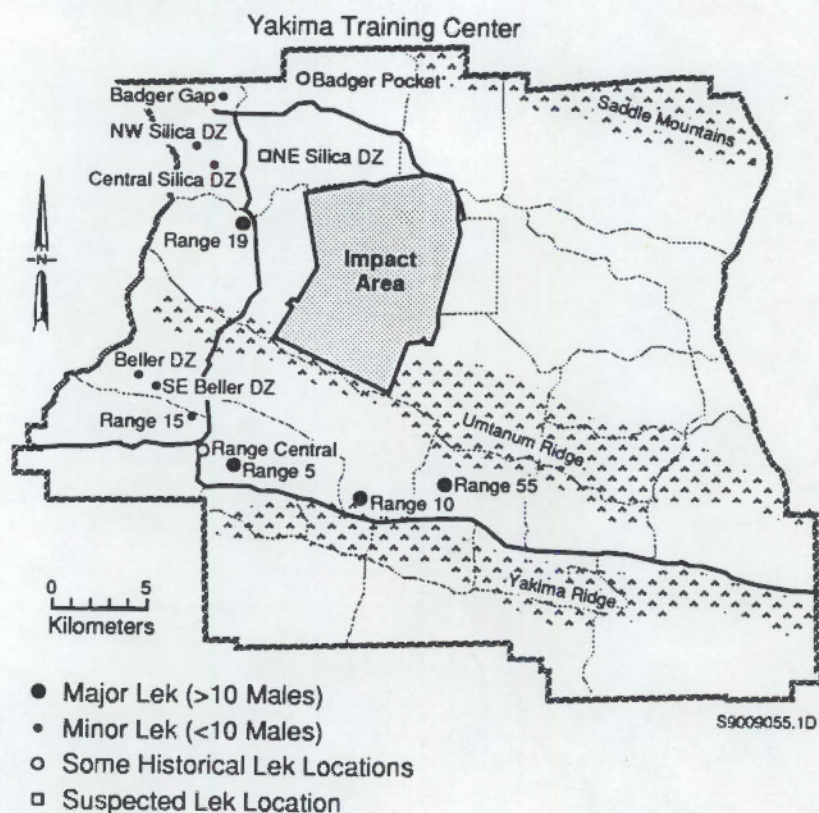


FIGURE 5. Locations of Sage Grouse Leks on the Yakima Training Center

TABLE 2. Physical Characteristics of Sage Grouse Leks on the Yakima Training Center in 1989 and 1990

<u>General Location</u>	<u>UTM Coordinates</u>		<u>Vegetation Type</u>	<u>Size (ha)</u>	<u>Elevation (m)</u>	<u>Slope (%)</u>	<u>Aspect</u>
	<u>Easterly</u>	<u>Northerly</u>					
Range 19	705800	5184400	Sage/wheatgrass	22	585	0-10	NE
Range 15	703100	5173800	Sage/wheatgrass	NA(a)	664	0-15	N
Range 5	705400	5171000	Sage/wheatgrass	29	621	0-10	S
Range 10	712300	5169800	Sage/wheatgrass	39	701	0-15	N
Range 55	716400	5169500	Sage/wheatgrass	53	743	0-10	S
Beller Drop Zone	700400	5176000	Sage/wheatgrass	NA	621	0-10	E
SE Beller Drop Zone	701800	5175400	Sage/wheatgrass	NA	621	0-10	NE
NW Silica Drop Zone	703100	5188100	Sage/wheatgrass	NA	610	0-10	NW
Central Silica Drop Zone	704300	5187300	Sage/wheatgrass	NA	610	0-10	E
NE Silica Drop Zone	707000	5187400	Sage/wheatgrass	NA	671	0-10	SW
Badger Pocket	705400	5191300	Sage/wheatgrass	NA	750	0-10	SW

(a) Not available; only large major leks were measured.

Leks were generally found in big sage/ bluebunch wheatgrass habitats that occur in areas of loamy soils. Slopes at leks were moderate (0 to 10%), and elevations were generally between 500 and 800 m (Table 2). The average size of the four largest leks was 36 ha.

Lek Attendance

Counts of male sage grouse at leks have been used extensively as an index to population size (Patterson 1952). However, the reliability of this measure has been questioned (Beck and Braun 1980), because large variations have been observed in the daily counts made at leks. However, the Western States Sage Grouse Committee, in its guidelines for sage grouse management practices, states that counts of sage grouse at leks provide at least an insight into long-term population trends (Western States Sage Grouse Committee 1982). We also believe that counts made at leks provide at least a rough index of population trends and of the spring distribution of grouse on the YTC.

The maximum number of sage grouse observed at the 11 leks found on the YTC ranged from 1 to 55 during 1989 and 1990 (Table 3, Appendix B). Only four leks

TABLE 3. Maximum Number of Sage Grouse Observed at Leks on the Yakima Training Center in 1989 and 1990

<u>General Location</u>	<u>1989</u>			<u>1990</u>		
	<u>Total</u>	<u>Males</u>	<u>Females</u>	<u>Total</u>	<u>Males</u>	<u>Females</u>
Range 19	55	53	19	51	50	18
Range 15	8	7	1	7	7	0
Range 5	22	22	5	17	17	1
Range 10	16	15	5	18	15	5
Range 55	12	12	0	12	11	4
Beller Drop Zone	7	6	1	8	7	1
SE Beller Drop Zone	2	2	0	0	0	0
NW Silica Drop Zone	5	4	2	0	0	0
Central Silica Drop Zone	4	NA(a)	NA	0	0	0
NE Silica Drop Zone	7	NA	NA	0	0	0
Badger Pocket	4	2	1	1	1	0

(a) Not available, i.e., lek observed from the air, so birds were not categorized by sex.

had more than 10 males displaying at any time (Table 3). The lek located near Range 19 had the largest number of sage grouse displaying. If it is assumed that the number of males observed at a lek is an index to its relative use by the local population, then the lek located near Range 19 was used by about 40 to 50% of the YTC sage grouse population. The Range 19/Squaw Creek lek has been the most important lek on the YTC for at least the last 15 years (Figure 6).

If it is assumed that counts of male sage grouse made at leks provide an index to population trends, then over the last 15 years the YTC sage grouse population was largest during the early to mid 1980s (Figure 6). Since the mid 1980s, sage grouse numbers appear to have declined. This decline also appears to have occurred elsewhere in Washington. Trends in the number of males present at leks on the YTC and in Douglas County (Figure 7) show a remarkable similarity.

During our study, sage grouse began using leks in mid February and continued to use them through early May. Periods of peak attendance at leks occurred in late February and early March for females and in early to mid April for males (Figure 8). A second, but smaller, peak in female attendance appeared to occur at leks approximately 20 to 25 days after the first. This second peak probably results from females attempting to reneest after failing in their first nesting attempt.

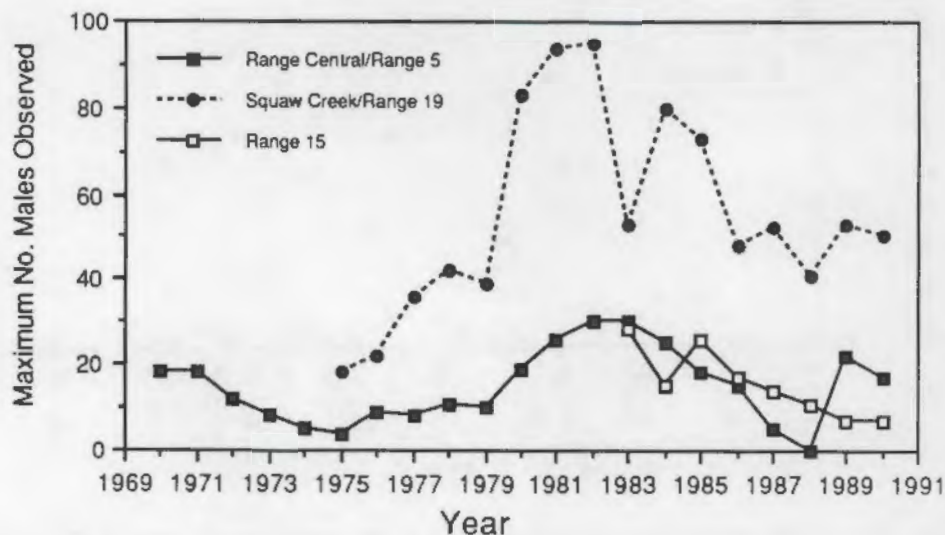


FIGURE 6. Comparison of Annual Maximum Counts Made on Male Sage Grouse on Three Leks Located on the Yakima Training Center Between 1970 and 1990. Data Provided by Lee Stream (Washington Department of Wildlife).

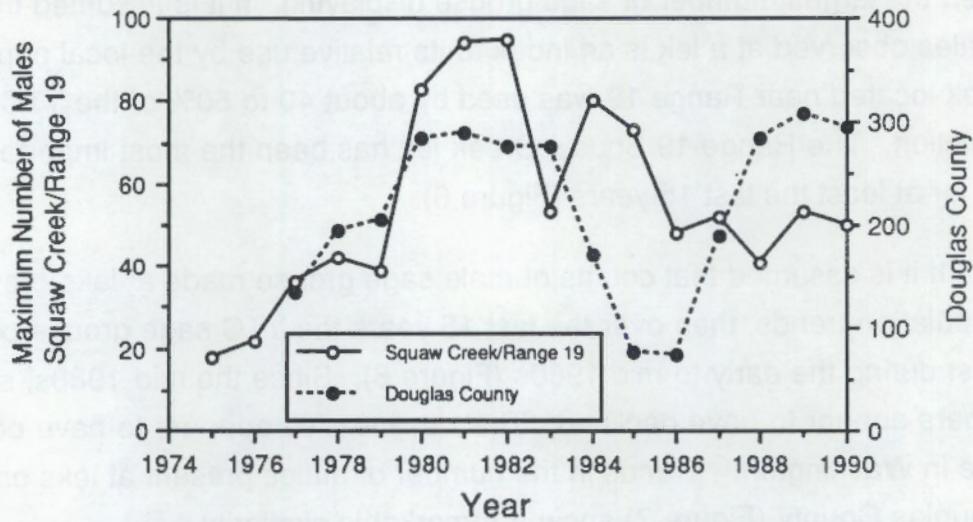


FIGURE 7. Comparison of Annual Counts of Male Sage Grouse Made on Leks Located on the Yakima Training Center and on Leks Located in Douglas County, Washington. Data Provided by L. Stream and R. Friesz (Washington Department of Wildlife).

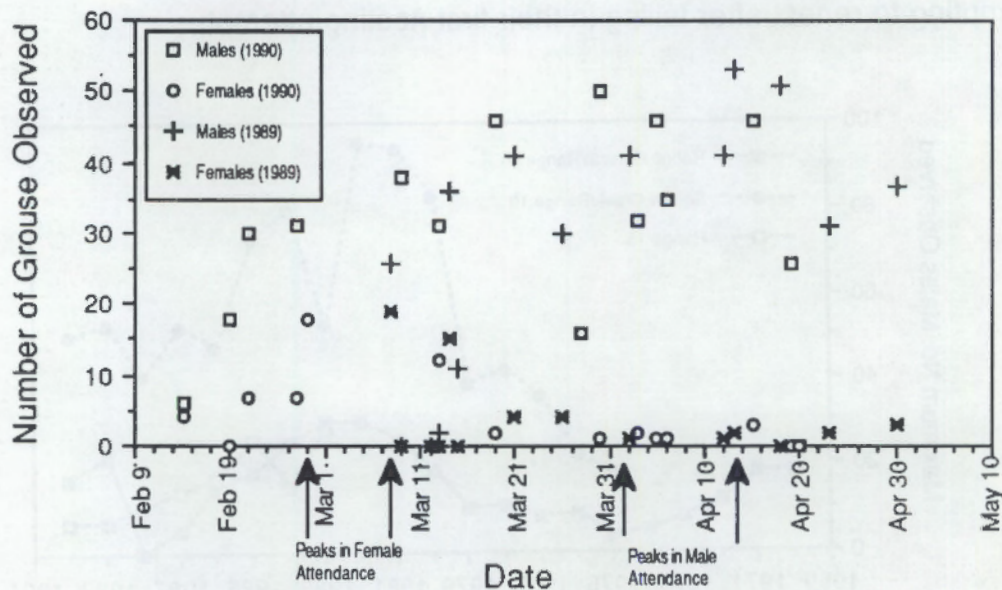


FIGURE 8. Fluctuations in the Numbers of Male and Female Sage Grouse at the Range 19 Lek on the Yakima Training Center in 1989 and 1990

Counts at individual leks varied dramatically from day to day (Appendix B). Occasionally, no sage grouse were observed on some leks during our counting periods, even when weather conditions were favorable. Lack of sage grouse at a lek during the peak of breeding activities was generally caused by the presence of predators, especially golden eagles (*Aquila chrysaetos*) and coyotes (*Canis latrans*), or humans. Breeding activity on the lek located on Range 5 (Figure 5) appeared to be particularly disrupted by predators in 1990; sage grouse were present on the lek only during 6 of 12 visits, and coyotes and golden eagles were observed several times at this lek.

Nesting and Brood-Rearing Success

Of the 17 radios placed on females, 5 appeared to stop functioning shortly after installation. Eight (4 yearlings and 4 adults) of the 12 birds (7 yearlings and 5 adults) with functional radios attempted to nest (1 in 1989 and 7 in 1990). Of the eight initial attempts at nesting, three adult females (38% of the total females and 75% of the adults) successfully hatched young. Because we did not make frequent visits to nest sites, it was difficult to tell the fate of the nests that were unsuccessful in hatching. It appeared that three of the unsuccessful nests were destroyed by predators and that one was abandoned. However, it is possible that the nests that appeared to be destroyed by predators were first abandoned by the female and then later visited by a predator. Only one female, the yearling marked in 1989, attempted to renest after losing her first nest; this nest was also unsuccessful.

Estimates of nesting success for sage grouse are characteristically low. Some estimates of nesting success recorded in the literature are 30% in Colorado (Gill 1965), 39% in Oregon (Nelson 1955), 34% in Wyoming (Patterson 1952), and 64% in Montana (Wallestad and Pyrah 1974). Based on these figures, it does not appear that nesting success on the YTC was abnormal. However, our estimate of nesting success should be viewed with caution because our sample size was very small. In addition, we captured several females late in the breeding season and this may have also distorted our estimate of nesting success (see discussion below).

Based on the behavior of our radio-marked females, we estimated that the peak in nest initiation for radio-marked females on the YTC was April 13, \pm 14 days. However, these data appear to be inconsistent with our estimate of peak breeding by females (i.e., peak attendance at leks), which we estimated to be the first 2 weeks of

March in 1989 and the last week of February through first week of March in 1990. Autenrieth (1981) estimated that females began nesting approximately 7 to 10 days following breeding. This should have resulted in a peak of nest initiation during mid to late March on the YTC, or approximately 2 to 3 weeks earlier than our estimate based on the radio-marked birds. We believe this discrepancy is a result of two factors. First, many of our females were captured after peak attendance at the leks, and therefore would have started their nesting after the majority of females. Second, because our primary focus in the spring was to capture and mark females, we were not able to relocate them consistently until about the second week of April. Therefore, for those females that we caught during the peak in breeding, we may have missed their initial attempts at nesting. As an example, we caught one female on March 2 and thought she initiated her first nest on April 27. In retrospect, this was probably her second attempt at nesting that season.

Breeding and nesting phenology on the YTC appears to occur earlier than for many other populations (Jenni and Hartzler 1978; Emmons and Braun 1984). This may be partially a reflection of the mild winters in 1988-89 and 1989-90. Assuming that females spend approximately 9 days laying their eggs and 25 days incubating them (Patterson 1952) and assuming a mid to late March peak in nest initiation, then the peak in hatching on the YTC would have been mid to late April in 1989 and 1990.

Only three broods were observed with radio-marked females; these broods contained one, two, and six young. Only one brood, the largest, survived through the end of the monitoring period (August 1990), and three of the young in this brood disappeared before August. Unmarked broods were observed on only eight occasions during the 2 years of field work.

Mortality

Nine of the 45 radios placed on sage grouse were recovered. Four of these were from birds killed by predators (three by coyotes and one by an avian predator). One bird appeared to be killed by the poncho, which became wedged in the bird's mouth, apparently during feeding. Two of the nine recovered radios were found lying on the ground with no apparent indications of sage grouse mortality. Two of the recovered radios appeared to have been removed by humans; the fate of these two birds was unknown. The radio from one of these birds was found in Training Area 9A

immediately after a period of intensive troop-training activities. The radio on the second bird was removed during the chukar (*Alectoris chukar*) hunting season.

MOVEMENTS

Sage grouse movements on the YTC were characteristically erratic and large. Analyses of YTC sage grouse movement patterns was based on 691 locations of radio-marked birds made between March 17, 1989 and August 19, 1990.

Home Range Size

Individual radio-marked sage grouse were followed between <1 and 12 months ($\bar{x} = 7 \pm 3$) during this study. The number of locations obtained per marked bird was relatively low ($\bar{x} = 24 \pm 10$), because sage grouse frequently made very large erratic movements on the YTC, and because the rough terrain often attenuated radio signals and resulted in our being unable to relocate some birds from the ground for extended periods. In addition, frequent military maneuvers restricted both aerial and ground access to many areas.

Comparisons of home range size for male and female sage grouse on the YTC could not be made with the entire data set, because home range sizes were significantly correlated with the number of months the birds were radio-tracked (Spearman rank correlation, $Z = 2.41$, $P = 0.02$), and males were generally tracked for longer periods of time than females. When the birds were put on a comparable basis in terms of number of months followed (i.e., locations for the analysis were restricted to April through August) no difference was noted between the size of female and male home ranges ($N = 10$ females and 14 males, Mann Whitney U-test, $Z = -1.41$, $P = 0.16$). (The April through August period was selected to maximize the number of fixes per bird, to result in more reliable home range estimates.) Neither did a significant relationship exist between the home range size and the number of locations made on birds (Spearman rank correlation, $Z = 0.17$, $P = 0.87$). For birds tracked during the same period (April to August), no difference was noted between juvenile and adult home range sizes for females ($N = 6$ juveniles and 4 adults, Mann Whitney U-test, $Z = -1.07$, $P = 0.29$) or males ($N = 3$ juveniles and 12 adults, $Z = 0$, $P = 1$).

Based on the minimum convex polygon, the home range sizes for sage grouse on the YTC were much larger than those recorded in other studies (Table 4). For

comparison purposes, the home range values in Table 4 are presented as averages, but they are probably better described by median values and ranges. Median home range values were 26.6 km² (range 6.0 to 67.3) during the spring, 24.0 km² (range 19.9 to 33.7) during the summer, and 44.2 km² (range 2.5 to 85.8) during the fall.

Seasonal Movements by Males

During the breeding season male sage grouse were located an average of 1.5 km from the leks at which they were captured. The maximum distance a male was located from the lek at which he was captured was 6.1 km. These distances appear to be larger than those recorded elsewhere for males during the breeding season. Wallestad and Schladweiler (1974) and Carr (1967) found the maximum distance males were located from the lek during the breeding season to be 1.8 km in Montana and Colorado, respectively.

The average maximum distance male sage grouse dispersed from the lek during the year was 15.5 ± 5.5 km (N = 14). These distances also appear to be larger than those recorded elsewhere. Pedersen (1981) recorded an average maximum dispersal distance of 7.8 km in Douglas County, north of the YTC.

Male sage grouse demonstrated two typical spring and summer movement patterns on the YTC during both years of study (Figure 9). Typically, at least some

TABLE 4. Comparison of Home Ranges of Sage Grouse on the Yakima Training Center with the Results of Other Studies

Source	Location	Home Range Size (km ²)		
		Spring	Summer	Fall
Connelly and Markham (1983)(a)	Idaho		3.6	
Connelly (1982)(a)	Idaho	8.8		22.5
Oakleaf (1971)(b)	Nevada		0.7	
Pedersen (1981)(a)	Washington	3.7	8.1	
Yakima Training Center(a)	Washington	28.6	25.9	44.2

(a) Home range estimated by minimum-area-convex-polygon method (Mohr 1947).

(b) Method used to estimate home range not reported.

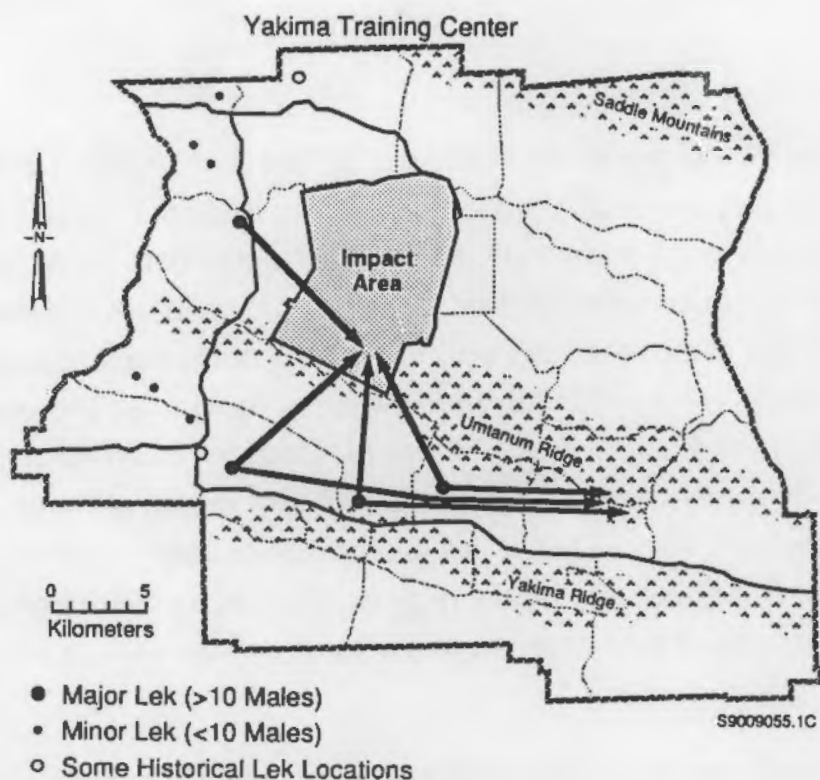


FIGURE 9. Typical Spring and Summer Movements by Male Sage Grouse on the Yakima Training Center

males from all four major leks would move into the Impact Area shortly after the breeding season. Of the 20 males monitored during the spring, 11 (55%) moved into the Impact Area. The second characteristic movement by male sage grouse on the YTC was an eastward summer dispersal into Training Area 13C by some males that used the major leks in the southern portion of the YTC (Figure 9). Six of the 14 birds captured on the major southern leks (43%) made this eastward dispersal.

In the fall and winter, male sage grouse began moving back to the vicinity of the lek where they were originally captured. Of the 11 males monitored during the fall of 1989, 3 returned to areas close to the leks. During the winter, four of the six monitored males had moved back close to the lek at which they were captured.

Seasonal Movements by Females

During the breeding season, females were found further from the leks ($\bar{x} = 3.0$ km) than were males. The maximum distance females were found from the lek at which they were captured was 8.5 km, during the breeding season.

Females ($N = 8$) moved an average of 5.7 ± 4.9 km (range 1.8 to 15 km) from the lek at which they were captured to their nesting location (Figure 10). Peterson (1980) in Colorado and Pedersen (1981) in Washington both found females nesting an average of 4.0 km from the lek they attended; the maximum distance that nesting occurred from leks in these studies was 11 km. Six of the eight known nest locations for marked females were within 3.8 km of the lek at Range 19. (All nesting females were captured at the Range 19 lek.) These data and the observation that approximately 40 to 50% of the sage grouse on the YTC use the lek at Range 19 appear to indicate that the area within 4 km of this lek represents very important nesting habitat for sage grouse. Research by others (Hayden-Wing et al. 1986; Berry and Eng 1985) has shown that females tend to return to the same general area to nest in successive years.

Females did not demonstrate the typical movements of male sage grouse on the YTC, i.e., spring and summer movements into the Impact Area and Training Area 13C. However, females did appear to congregate near the southwest corner of the Impact Area (Figure 2) during the summer. The one female that had a brood that survived until the end of the study moved into the Impact Area within 1 week after the young hatched and remained there until the end of the study.

Offsite Movements

During this study five radio-marked sage grouse (3 females and 2 males) moved off the YTC (Figure 11). Two males moved from the vicinity of the Range 19 lek where they were marked to an area adjacent to the agricultural fields in Badger Pocket, to the northwest of the YTC (Figures 2 and 11). One of these males moved to the Badger Pocket area in July and the other in September; both remained there until January, when they returned to the YTC. Between May and July, two females moved approximately 5 km north of the YTC, into the proposed northern expansion area (Figure 11). One of these females remained in this area until the end of the study, and the other continued on north of Interstate I-90 to the Quillomene Wildlife Area (approximately 12 km north of the YTC), where she remained until the end of the study. A third female was located once offsite just to the south of the YTC (Figure 11). No locations were obtained on this female after this movement.

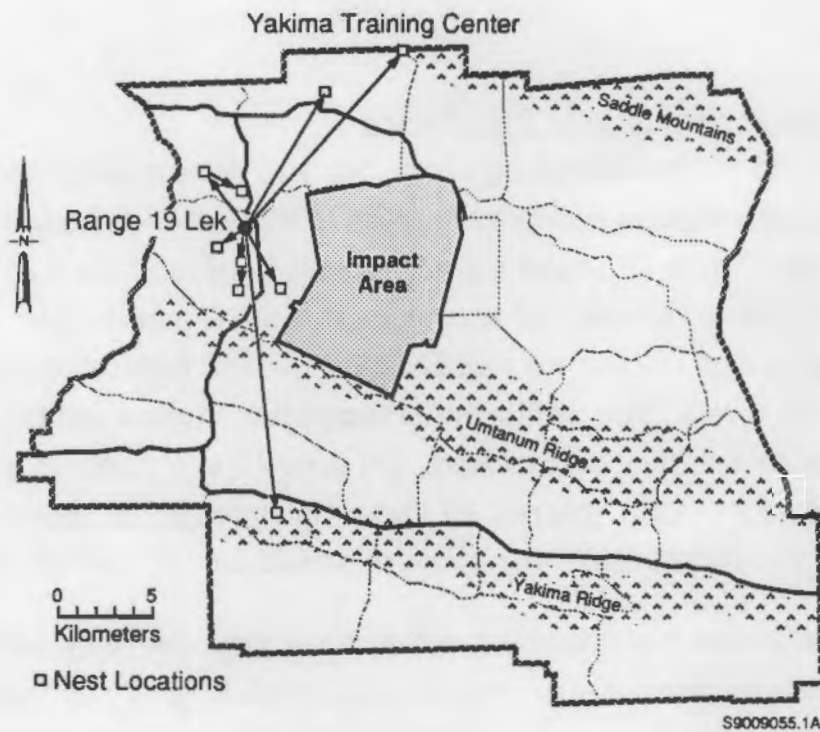


FIGURE 10. Nesting Sites for Radio-Marked Females on the Yakima Training Center

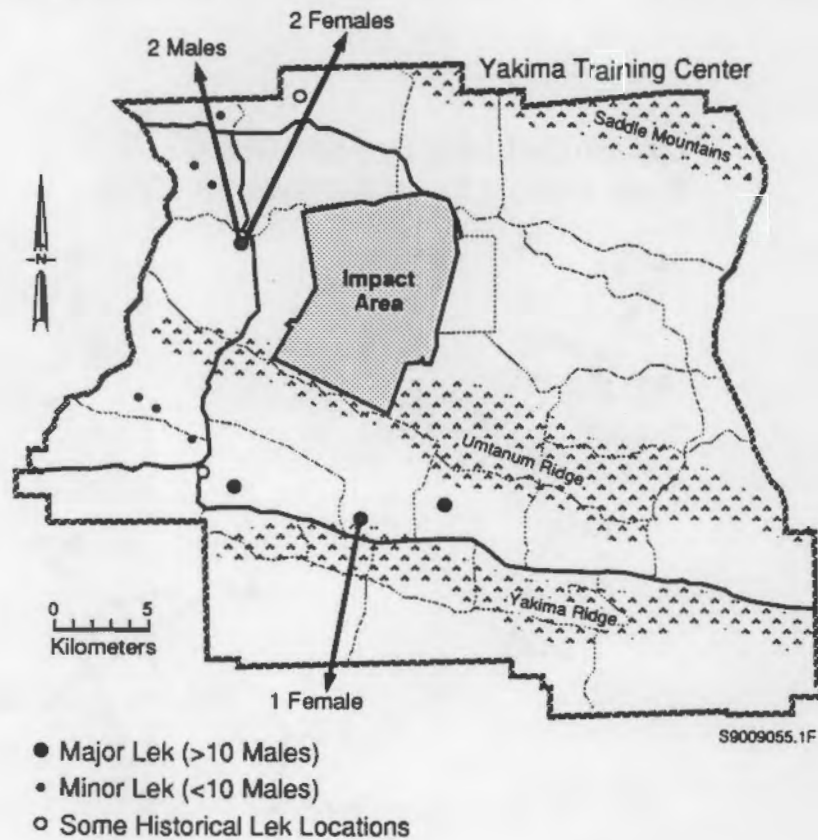


FIGURE 11. Movements by Radio-Marked Sage Grouse Off the Yakima Training Center

Movements in Response to Disturbance

During our radio-tracking efforts, we saw several instances where disturbance by troops and vehicles appeared to result in marked sage grouse leaving the area. As an example, Figure 12 shows the movements between March 21 and August 23, 1989, of a juvenile female that was marked at the Range 19 lek. This female attempted to nest twice in the vicinity of the lek, and both times she was unsuccessful. On June 10 a very large contingent of troops and tracked vehicles moved into the area where her second nest was located. On June 13 she made an atypical and extensive movement to the north, followed by large movement to the south, and then a movement into the Impact Area, where she remained until August 23 (Figure 12).

We believe that the spring and summer movements by males into the Impact Area, where no personnel or vehicles were present, and into Training Area 13C, where only limited troop activity normally occurred, also reflected disturbance of these birds by training activities. In addition, the large home ranges of marked sage grouse observed during this study probably are related to repeated disturbances of these birds.

Movement of Sage Grouse 8775 from March 21 to August 23 1989

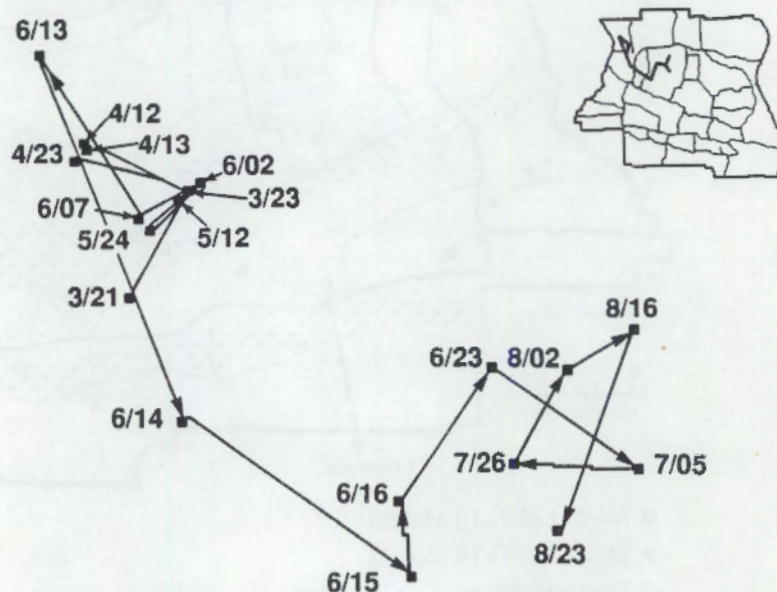


FIGURE 12. Movement of a Radio-Marked Juvenile Female Sage Grouse in Apparent Response to Disturbance

We do not know what impact such disturbance may have on sage grouse on the YTC. Clearly, disturbances and forced movements are not desirable during sensitive times, such as periods of nesting and early brood rearing.

HABITAT USE

In this section we report the results of three types of analyses that are related to habitat use and habitat requirements for sage grouse on the YTC. We present 1) general habitat-use patterns of sage grouse based on our radio-telemetry data and our computer-modeling efforts, 2) information on the estimated potential and current distribution of sagebrush on the YTC, and 3) specific information on the vegetational characteristics of nest sites on the YTC.

General Habitat Use

The primary method of evaluating habitat use by sage grouse during this study was the construction of generalized habitat maps with GRASS (see "Methods" section). We believe this technique was both an accurate and a useful way of presenting sage grouse habitat requirements on the YTC. The input data for these maps was based on field data specific to the YTC (locations of radio-marked grouse). The results we obtained with this computer modeling accurately reflected what we believed the grouse were doing in the field at the time we were following them. This methodology also allowed us to combine information on use of multiple habitat types by grouse into a relatively few maps that should prove useful for managing this species on the YTC.

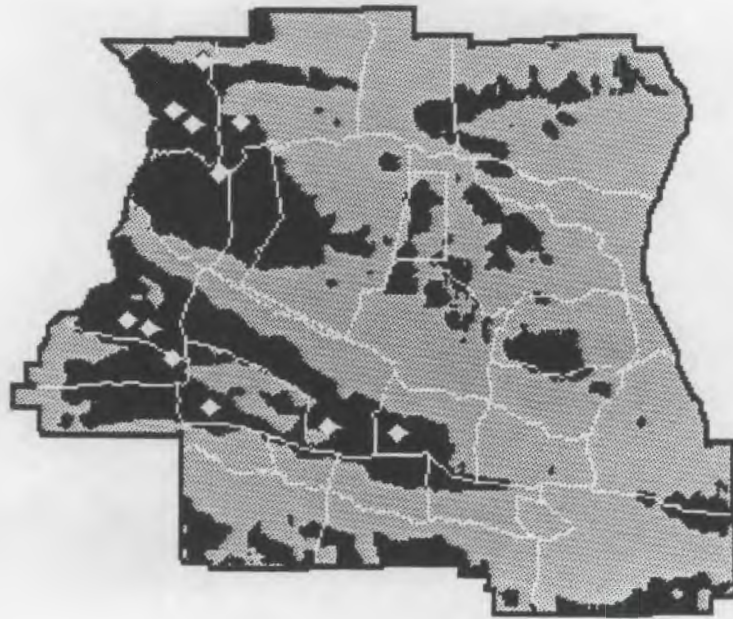
Six generalized habitat-use maps were constructed for sage grouse on the YTC, two for females (spring [breeding and nesting] and summer [brood rearing] periods) and four for males (spring [breeding], summer, fall, and winter periods). Few or no data were obtained for females during the fall and winter, because only one female was radio-tracked in 1989. Breeding and nesting seasons for females were combined, because sample sizes were small during these periods and because the two seasons overlapped considerably. Sample sizes (number of birds followed and number of locations used) in the construction of the habitat maps are presented in Table 5.

TABLE 5. Summary of Input Data (Extent of Seasons and Number of Samples) Used for Construction of Generalized Habitat Maps for Sage Grouse on the Yakima Training Center

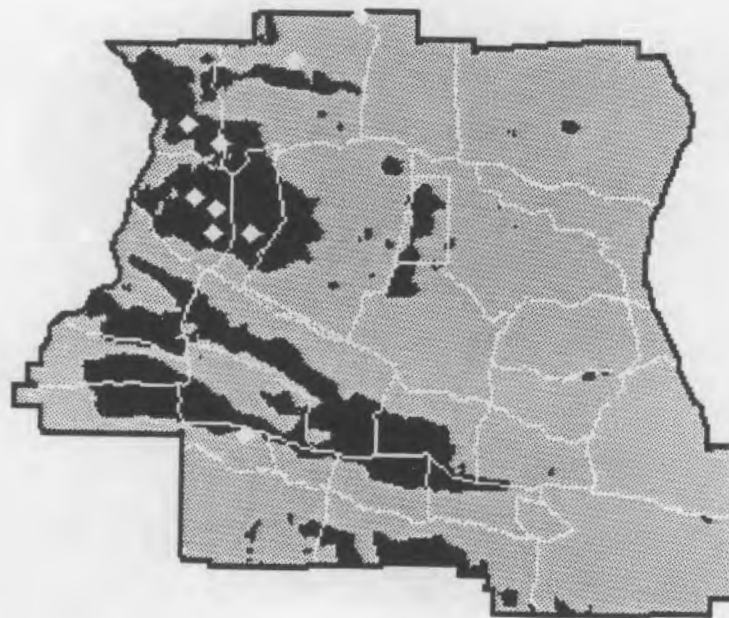
<u>Sex</u>	<u>Season</u>	<u>Dates</u>	<u>Number of Marked Birds</u>	<u>Total Number of Locations</u>
Males	Spring (breeding)	Mar 1 to May 1	25	71
	Summer	May 2 to Sep 20	23	209
	Fall	Sep 21 to Dec 20	11	102
	Winter	Dec 21 to Feb 15	6	75
Females	Spring (breeding and nesting)	Mar 1 to May 30	14	66
	Summer (brood rearing)	Jun 1 to Aug 30	14	39

Male and female sage grouse used the various types of habitat (e.g., the four soil types) within the four major habitat categories considered (soil, elevation, slope, and vegetation) disproportionately to the availability of these habitats during most seasons examined, that is, sage grouse preferred some habitat variables and avoided others. (A summary of the Chi-square analyses for habitat preferences is presented in Appendix C.) The only exception to this general disproportional use of habitats by sage grouse was that in the winter males appeared to use all types of soils and slopes in proportion to their availability. The generalized YTC habitat maps for sage grouse (Figures 13, 14, and 15) reflect the preferences and avoidances (summarized in Appendix D) for various types in the four map layers used (vegetation, elevation, slope, and soils).

Based on the generalized maps, the preferred habitats for males and females during the spring (breeding season) were very similar in shape, size, and location (Figure 13). The best spring habitat for sage grouse occurred in the western half of the YTC. Particularly important areas were Training Areas 3A, 2A, 2B, the Selah Creek drainage, and portions of the Training Areas around Range Central (Figures 2 and 13). As expected, males had more restricted areas of high use than did females (Figure 13a), because males were closely tied to the leks for extended periods, whereas females wandered over larger areas. The location of the active leks matched closely the with the area classified as best habitat on the generalized habitat map for males during the spring (Figure 13a).

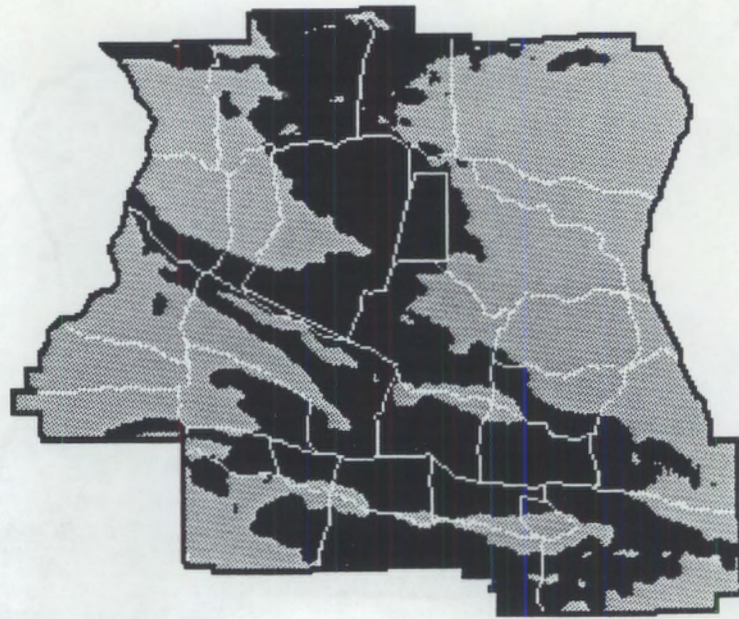


a) Male Sage Grouse

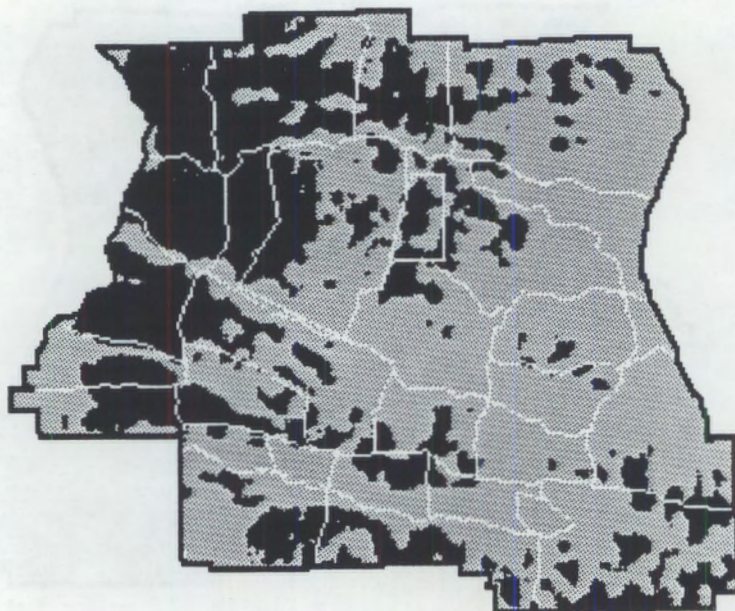


b) Female Sage Grouse

FIGURE 13. Generalized Spring Habitat Map for Sage Grouse on the Yakima Training Center (Black = best habitat. Locations of leks are noted on the male habitat map and nest sites are noted on the female habitat map.)

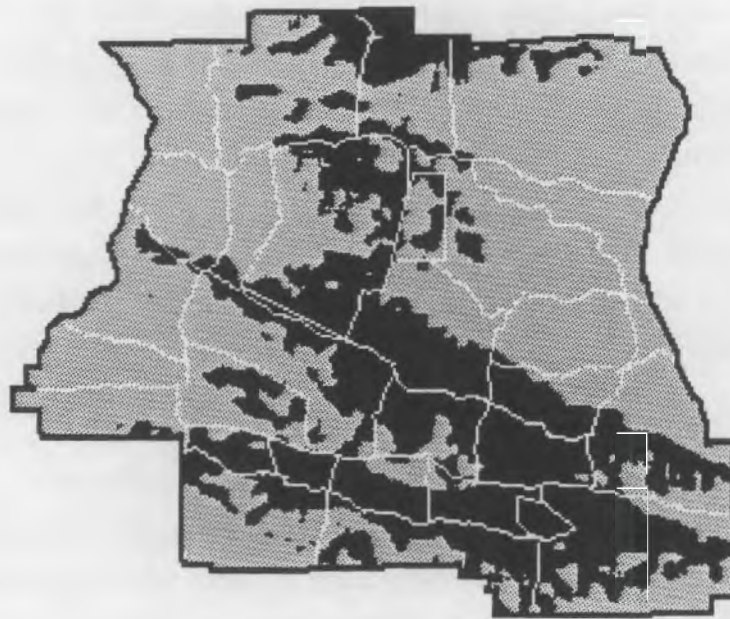


a) Male Sage Grouse

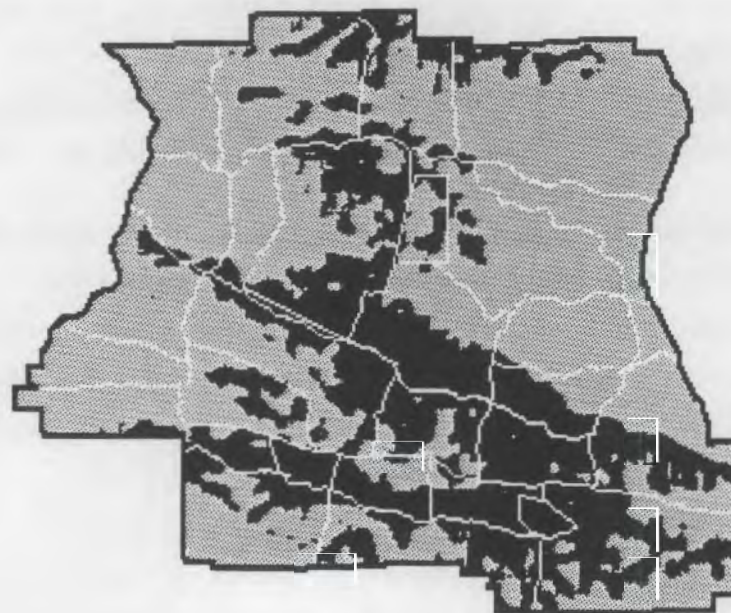


b) Female Sage Grouse

FIGURE 14. Generalized Summer Habitat Map for Sage Grouse on the Yakima Training Center (Black = best habitat.)



a) Fall



b) Winter

FIGURE 15. Generalized Habitat Maps for Male Sage Grouse on the Yakima Training Center (Black = best habitat.)

Known nest-site locations for radio-marked females also showed very close correlation with areas classed as best spring habitat (Figure 13b). Nearly all nesting occurred in the large block of fairly contiguous good habitat in the northwestern corner of the YTC. Somewhat surprising was the large area of good spring habitat for females that occurred in the vicinity of Training Areas 9A, 8B, and 11A (Ranges 10 and 55) (Figures 2 and 13b), because much of this area has been extensively burned, and the sagebrush is sparse or absent. The high classification of this area is probably a reflection of favorable soil, elevation, and slope characteristics for females during the spring.

While following radio-marked grouse, several differences were noted in summer habitat use by males and females, and these differences were reflected in the generalized habitat maps (Figure 14). During 1989 and 1990, male sage grouse shifted much of their activities to the Impact Area and some of the higher ridgelines, especially Umtanum Ridge in Training Area 13C (Figure 2). These summer shifts away from the comparatively low-lying, flat lek areas to higher terrain was reflected in the generalized habitat map (Figure 14a). In contrast, females continued to use many of the areas that they used during the spring (Figures 13b and 14b). The best habitat for females during the summer (the brood-rearing period) was the western one-third of the YTC. The areas of good summer habitat for males and females were considerably different, and generally little overlap occurred (Figures 14a and 14b).

During the fall and winter, male sage grouse continued to show habitat preferences similar to those shown during the summer (Figure 15). The winter of 1989-1990 was relatively mild, and very little snow was deposited on the YTC. If the winter had been more harsh, habitat preferences might have been different. For example, decreased use of areas where snow accumulation was high might have occurred.

Potential Sagebrush Habitat

Based on the map of range sites characteristics, approximately 305 km² of the YTC could support big sagebrush stands with >10% canopy coverage (Figure 16). The vegetation map indicates that only about 174 km² of the potential dense sagebrush areas on the YTC currently support big sagebrush stands (percent canopy coverage is unknown), or approximately 57% of the potential sagebrush area actually supports big sagebrush (Figure 16).

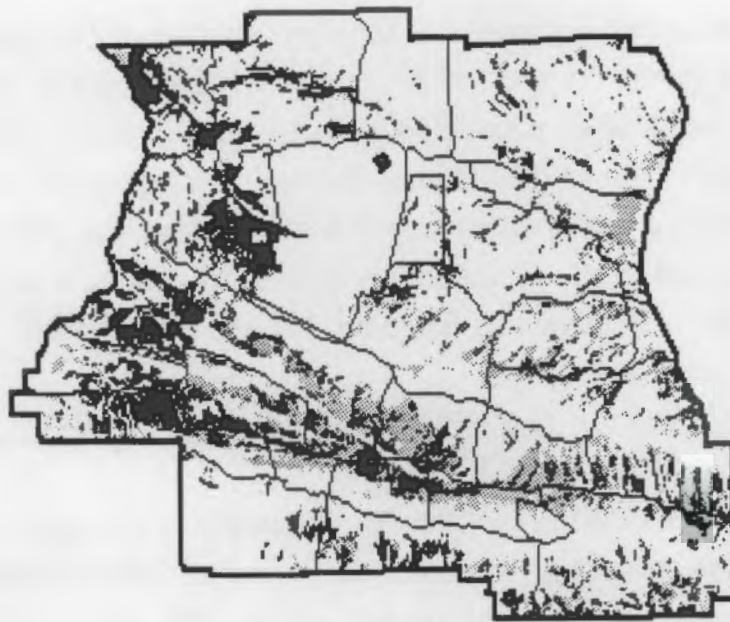


FIGURE 16. Areas that Could Support Sagebrush Stands of >10% Canopy Coverage (Grey and Black) and Areas that Currently Support Sagebrush (Black)

A large proportion of the area that could support sagebrush but currently does not occur east of Range Central in Training Areas 9A, 9B, 8B, 13C, and 11B, especially in the Selah Creek Valley (Figures 2 and 16). These Training Areas also represent important habitat for sage grouse (Figures 13, 14, and 15), and therefore might represent some of the best sites for a sagebrush revegetation program.

Nest Site Habitat

Nests were found in areas where canopy coverage of big sagebrush averaged 20%. The primary understory vegetation at nest locations were grasses, including Sandberg bluegrass (*Poa sandbergii*) (14%), bluebunch wheatgrass (14%), and cheatgrass (*Bromus tectorum*) (3%).

FOOD HABITS

Based on fecal material analysis, sage grouse on the YTC used sagebrush as a principal source of nutrition during the fall, the winter, and much of the spring (Table 6). This is consistent with studies conducted in Wyoming (Patterson 1952), where sagebrush made up 80% of the food consumed during these seasons. In June, birds appeared to shift from a diet of sagebrush to a more varied diet consisting of sagebrush, rabbitbrush, and forbs. Although use of forbs by grouse was high in July (Table 6), it was not as dominant as noted by Call and Maser (1985).

VEGETATION SURVEYS OF THE PROPOSED KNAPWEED SPRAY AREA

The 1990 aerial spraying program for knapweed in the Selah Creek drainage did not take place as proposed. Nonetheless, we conducted vegetation surveys on the area that was proposed for herbicide spraying in 1990 and on the areas that had been sprayed in 1988 and 1989. No significant differences were noted in percent

TABLE 6. Foods Consumed by Sage Grouse on the Yakima Training Center During the Spring, Summer, and Fall Months of 1989

<u>Food Item</u>	<u>Percent in Sample by Month</u>			
	<u>May</u>	<u>June</u>	<u>July</u>	<u>Oct-Nov</u>
Shrubs	91.5	67.8	43.2	91.7
<u>Artemisa</u> sp.	90.3	64.0	25.6	90.0
<u>Chrysothamnus</u>	1.2	3.8	17.6	1.7
Forbs	2.3	12.4	24.7	7.4
<u>Achillea</u>	0.2	9.2	7.6	3.8
Other	2.1	3.2	17.1	3.6
Graminoid			1.1	0.7
Composite flower(a)	6.0	15.9	18.1	0.2
Other flower parts	0.2	3.5	11.1	
Moss			0.4	0.2
Insects			1.6	

(a) Might be a forb or shrub.

composition of the major classifications of vegetation in the two areas (Tables 7 and 8). Forbs, a major spring and summer food for sage grouse, appeared to be as prevalent in the sprayed areas as in the unsprayed areas. However, this should not be interpreted as meaning that herbicide spraying had no effect on forbs. Because no pretreatment-control information was available, it is possible that before the spraying the sprayed areas had higher densities of forbs than the unsprayed areas, and that the spraying reduced the level of forbs on the treatment area. In addition, because the vegetation surveys were conducted 1 and 2 years after the application of the herbicide, it is also possible that the herbicide application reduced forbs on the treated area during the growing season immediately after application. Another complicating factor is that our survey results were probably affected to some unknown degree by grazing of sheep in the area during this year and by past fires, particularly in the sprayed

TABLE 7. Percent Cover for Litter, Bare-Soil, and Major-Vegetation Classes on Herbicide-Treated Areas and Nearby Untreated Areas on the Yakima Training Center

	Percent Cover					
	Unsprayed			Sprayed		
	<u>Average</u>	<u>Median</u>	<u>Range</u>	<u>Average</u>	<u>Median</u>	<u>Range</u>
Grasses	37.5	41	22-53	37.3	34	10-59
Forbs	3.1	2	0-9	2.6	1	0-6
Shrubs	1.6	0	0-10	2.3	0	0-14
Litter	17.8	22	1-27	15.0	16	4-35
Bare soil	40.0	36	16-64	42.8	41	25-56

TABLE 8. Results of Analysis-of-Variance Comparison Between Percent Cover of Major Vegetation Classification on Herbicide-Treated and Untreated Areas on the Yakima Training Center^(a)

<u>Source</u>	<u>df</u>	<u>Mean Square</u>	<u>F-Value</u>	<u>P-Value</u>
Treatment	1	0.00004	0.005	0.9429
Vegetation Group	2	1.839	250.2	0.0001
Interaction	2	0.001	0.125	0.8828

(a) Cover data transformation: $Y' = \arcsin(\sqrt{Y + 0.05})$

areas. We do believe, however, that it is safe to state that the herbicide did not appear to have a major impact on forbs 1 and 2 years post treatment. E. Andersen (Range Specialist at YTC) is collecting more detailed long-term data on the impacts of herbicide treatments on the local vegetation.

MANAGEMENT RECOMMENDATIONS

In this section we address management recommendations for sage grouse on the YTC. We believe that a number of actions can be taken to help ensure the continued survival of sage grouse on the training center. Some of the recommended actions may not be practical financially and/or may compromise the military mission of the site. We did make an effort, however, to present realistic management actions that we believe are beneficial to sage grouse and are achievable without undue difficulty, based on our limited knowledge of the YTC.

LEK COUNTS, SURVEYS, AND SEARCHES

For management purposes, biologists make a distinction between lek counts and lek surveys (Autenrieth, Molini, and Braun 1982). Lek counts are counts of the numbers of male sage grouse made on individual leks, whereas lek surveys document only the presence or absence of male grouse on known leks. Lek searches are the examination of areas for new leks. We believe that all three methodologies should be used on the YTC, and we discuss below the application of these methods.

Background Information

According to Johnsgard (1973), sage grouse are one of the most specialized of the lek-forming species in North America. Leks or strutting grounds are traditional areas where sage grouse gather for breeding in the spring. Specific lek locations are generally used year after year; Wiley (1973) reported that a lek in Wyoming was used for at least 28 years. During the spring, male sage grouse attend leks over a period of several months, while females attend for only a few days (Petersen 1980). On the YTC, male sage grouse often begin moving to the vicinity of leks in early February, when they begin displaying sporadically. However, actual breeding displays do not begin seriously until mid to late February, and continue until mid May (Figure 8). Peak numbers of males on YTC leks occurred in mid April in 1989 and in early April in 1990 (Figure 8). Female sage grouse begin to appear at leks in mid February, and reach peak numbers in early March (Figure 8). Breeding activity at the lek typically occurs only for a few hours each morning (Wiley 1973), after which both males and females disperse to surrounding sagebrush. However, male grouse often return to the leks in the evening to roost (Wallestad and Schladwiler 1974).

Because male sage grouse are highly visible on leks and because leks are used by sage grouse year after year, counts of males at leks are used by all states as an index to relative population size (Western States Sage Grouse Committee 1982). However, counts of male sage grouse made on a daily basis have been shown to be highly variable (Braun and Beck 1976; Beck and Braun 1980; Emmons and Braun 1984), and no direct correlation has been made between counts of male sage grouse at leks and actual population levels (Beck and Braun 1980). We also noted large variations in daily counts of male sage grouse on YTC leks (Appendix B). Because these large daily variations exist, extreme care should be exercised when using counts of males as an index of population levels. Nonetheless, according to the Western States Sage Grouse Committee (1982), counts of males at leks do provide an insight to long-term population trends. Annual counts of males on leks also provide information on the relative importance of an area to sage grouse; on the distribution of sage grouse in the spring; and on the potential nesting habitat, because most nesting occurs in the vicinity of leks (Western States Sage Grouse Committee 1982).

Trends in the counts of males on leks at the YTC and on leks in Douglas County, Washington, appear to be very similar (Figure 7), despite that the areas are widely separated (Figure 1) and that the counts were made by different personnel. We believe that these counts probably reflect actual trends in sage grouse populations for the region. However, we also believe that most if not all leks on the YTC should be counted annually. In the past, only a few of the major YTC leks have been counted each year. When the locations of these leks shifted (e.g., the Range Central lek) the counts at these leks dropped to or near zero. However, these birds probably shifted their breeding activities, for whatever reason, to the nearby Range 5 lek (Figure 5) that was detected during our study.

Because large daily variation in counts of males occurs, Cannon and Knopf (1981) have suggested that the number of active leks is a better index to prairie grouse population levels than are actual counts of males present. Emmons and Bruan (1984) report that the number of active leks increased with increasing sage grouse populations and that therefore numbers of active leks might be a useful index of sage grouse population levels.

Recommendations for YTC

We believe that both counts of males on leks (lek counts) and surveys of all known leks for the presence or absence of sage grouse (lek surveys) should be conducted on the YTC annually. We recommend the following guidelines for counting male sage grouse on leks. These guidelines are based on recommendations made by the Western States Sage Grouse Committee (1982) and by Emmons and Braun (1984).

Time of Year

The objective is to make counts during the peak of attendance at leks by males, which occurred during the first 2 weeks of April during our study (Figure 8). This peak in male attendance may shift slightly later following more severe winters (the winters of 1988-1989 and 1989-1990 both were relatively mild). We believe that a minimum of four counts at all leks should be made each year. To accommodate the shift in peak attendance, we recommend that one count be made between March 15 and March 25, two counts between March 26 and April 10, and one count between April 11 and 20.

Time of Day

Counts should be begin at first light. Because sage grouse may display during periods of full moon and terminate their activities in early morning, counts during periods of full moon should terminate a half hour after sunrise. During the darker phases of the moon, counts should terminate by 1 hour after sunrise.

Weather Conditions

Clear and calm mornings are best for sage grouse counts. Counts should not be made during periods of rain or strong winds, as displaying activities by the birds drop dramatically during inclement weather, particularly during rain.

Leks to be Counted

Attempts should be made to count all known leks on the YTC; however, emphasis should be placed on the major leks (Ranges 5, 10, 19, and 55). Given good weather, good roads, and little military activity, it will take at least two mornings to make a single count of the YTC leks. Because interlek movements occur, counts should be made on all the leks in the Selah Creek drainage (Ranges 5, 10, and 55) during one morning.

What to Record

The total number of males and females present on the lek should be recorded. Because of periodic shifts in lek locations and differences in common names applied to a single area by different personnel, locations of the leks (UTM coordinates) should

be recorded each year. Weather conditions should also be noted, as should the personnel making the counts.

Surveys for sage grouse activity (i.e., presence or absence) should be made at all historical lek locations each year, regardless of whether or not the lek has been active in recent years. This information (i.e., the proportion of active leks) is relatively easy to obtain during routine counts of males. However, leks that have not been used for several years (e.g., Badger Gap and Range Central) should also be visited. The lek locations that have not been used recently can be visited up to 2 hours following sunrise, because the objective is only to confirm that they are still not being used. Those leks that do not appear to be active should be visited at least three times, because the lack of birds during a single visit may be caused by the presence of predators, by human disturbance, or by weather factors. Feces can also be used as an indicator of activity, if the lek is visited later in the day.

We also recommend that aerial surveys for new leks on the YTC be made every 2 to 3 years. These surveys should be made using a helicopter. Surveys should commence at sunrise, when the males are highly visible, and cease 2 hours later. The surveys should be conducted during mid March to early April, the period of peak male attendance at leks. Surveys for new leks should be concentrated in those areas on the YTC that are most likely to have leks; those areas classified as the best spring habitat for males (Figure 13a) should be searched first.

In summary, the following actions should be taken to monitor sage grouse populations on the YTC:

- 1) Conduct annual counts of males and females.
- 2) Conduct annual surveys of all historical leks to detect the presence or absence of grouse.
- 3) Conduct aerial surveys for new leks every 2 to 3 years.

HABITAT PROTECTION

Quality habitat is the key to the survival of sage grouse. The YTC has one of the largest contiguous blocks of shrub-steppe habitat left in Washington. Protection of sage grouse on the YTC should involve a program of habitat protection and

restoration. We discuss here some aspects of habitat protection and restoration that should be addressed on the YTC.

Sagebrush

Sagebrush is a critical component to the survival of sage grouse on the YTC. Based on the results of this study and of other investigations (Wallestad 1975), the winter diets of sage grouse consist almost entirely of sagebrush. In addition, sagebrush provides essential cover for nesting (Wallestad and Pyrah 1974). The removal of sagebrush from the YTC would result in the loss of the sage grouse. In particular, the loss of sagebrush cover in the northwest corner of the YTC (Training Areas 3A, 2A, and 2B) (Figure 2) would be particularly devastating to the YTC sage grouse population. These areas, as shown by our general habitat-use maps (Figures 13, 14, and 15) and our radio-tracking data, are especially important to female sage grouse. One large fire, such as occurred on the Arid Lands Ecology Reserve of the Hanford Site in 1984, could remove all sagebrush from this area. Such a fire could easily be started by natural causes, by the general public on the adjacent I-82 freeway, or by military activities. We believe that this northwest corner of the YTC should receive priority in fire control and fire prevention. In addition, it would be extremely beneficial to reestablish sagebrush in other areas of the YTC that have a high potential for supporting dense stands of sagebrush and that also appear to be favored by sage grouse. Not only would establishing such buffer areas benefit the current population of sage grouse on the YTC, but it also might provide some alternate high-quality habitat should sagebrush stands in the northwest corner of the YTC be severely impacted. One potential buffer area is the region east of Range Central in Training Areas 9A, 9B, 8B, and 13C, particularly the Selah Creek Valley and Ranges 5, 10, and 55. Sagebrush stands in the vicinities of these areas have been severely impacted by repeated fires and by mechanical destruction in the past. Based on our map of potential sagebrush distribution (Figure 16), these areas appear to have a high potential to support dense stands of sagebrush.

We recommend that an effort be started to reestablish and restore stands of big sagebrush. Sagebrush can be reestablished, if started from tublings of native stock and irrigated during the first year (Brandt, Rickard, and Hefty 1990). In addition, fertilization of existing sagebrush plots may be beneficial to sage grouse (Myers 1989). The YTC Range Specialist would have the best idea of where sagebrush replanting and restoring efforts would have the highest probability of succeeding. In addition, the

Range Control Officer should also be involved in the site selection process, to minimize impacts on military training activities and to select a site that can receive some protection from range fires and mechanical disturbances. One potential area for sagebrush reestablishment is the Selah Creek Valley in the central portion of Training Area 9A (Figure 2). This area appears to have a high potential for sagebrush (Figure 16), is located close to some major leks (Figure 5), and shows potential as high-quality sage grouse habitat during much of the year (Figures 13, 14, and 15).

Grazing

We do not know what impact the YTC livestock grazing program has on sage grouse. The grazing program on the YTC is run much better than the program on private lands immediately to the west of the YTC. Radio-marked sage grouse have spent extended periods of time just east of I-82 on the western border of the YTC, yet none of these birds has crossed I-82 onto privately owned lands that are heavily grazed. The grazing of large bands of sheep in Training Areas 2A, 3A, 10A, 10B, and 11A (Figure 2) may be detrimental to nesting sage grouse. These areas were shown to be very important to nesting sage grouse. Grazing by sheep has been reported to be more detrimental to sage grouse than grazing by cattle (Girard 1937). Grazing by sheep can cause nest desertion, nest destruction, and the removal of forbs (Call and Maser 1985), which are important forage to both young and adult sage grouse during the summer. We believe that it probably would be beneficial to sage grouse to reduce the amount of sheep grazing in Training Areas 2A, 3A, 10A, 10B, and 11A, especially during the nesting and early brood-rearing seasons. Recommended dates for reducing grazing in these areas are mid March through mid June.

DIRECT PROTECTION OF SAGE GROUSE

In addition to habitat protection and restoration, we believe that it is important to provide some direct protection to individual sage grouse during crucial periods, e.g., during breeding (mid February to mid April), nesting (mid March to late April), and early brood rearing (mid April to late May).

Leks

Restrictions already are placed on disturbance of leks by military activities on the site from 0400 to 0900 hours during March. We believe that this protection period should be extended to 24 hours a day from mid February through the end of March.

Peak female attendance at leks during our study was during late February and early March, and a secondary, but smaller peak occurred about 25 days later, probably related to renesting attempts. We also believe that a 1-km² area surrounding the lek should be protected, because many birds tend to roost in the vicinity of the lek. This level of protection should be extended to at least the four major leks (Ranges 19, 5, 10, and 55) that presently occur on the site (Figure 5).

The YTC allows viewing of the Range 19 lek by various public organizations (e.g., local Audubon Clubs) under the supervision of YTC personnel. We view this as an important activity that is beneficial both to the general public and to the sage grouse, in that it reawakens people's awareness of this valuable resource. We suggest that such viewing activities should be initiated after the first week in March following mild winters and after the second week in March following severe winters, to avoid any disturbance of the lek during period of peak attendance by females.

Disturbance During Nesting and Early Brood-Rearing

During our radio-tracking efforts on marked sage grouse, we saw several instances where disturbance by troops appeared to directly influence the movements of sage grouse. We believe that the large home ranges, the apparent seeking of low human-disturbance areas (e.g., the Impact Area), and the unusually large erratic movements of marked birds were often directly related to troop activities. For the most part, we do not know what impact such disturbances have on sage grouse. However, disturbances of any type should be avoided during the nesting and early brood-rearing periods. We recommend that troop training activities should be reduced or eliminated within a 4-km band around the lek at Range 19 from mid March to May 30. A zone of this diameter would have protected the majority of nesting birds observed during this study. Research has shown that sage grouse often return to the same area to nest in successive years (Berry and Eng 1985, Hayden-Wing et al. 1986). Because all of the females that we marked at Range 10 were yearlings and none attempted to nest, we are unable to present data on the nesting locations for females from this area. However, because suitable habitat is generally lacking to the north of the leks at Ranges 5, 10, and 55, we believe females from these leks are probably nesting south of the main road that runs from Range Central to the East Gate. One female that we captured and marked at the Range 19 lek did nest in this area. Based on habitat characteristics and our limited nesting information, we recommend that disturbances

south of this road be limited to the existing ranges and that no bivouacking or maneuvering occur for a distance of 1 km south of the main road from mid March to May 30.

ADDITIONAL DATA NEEDS

Based on the analyses of existing data, we believe that a number of aspects of sage grouse ecology on the YTC need further study. These are summarized as follows:

- Additional research on winter habitat requirements of sage grouse should be conducted. We obtained data on sage grouse movements only during one mild winter. Sage grouse habitat use is likely to be considerably different during more typical winters. Research on the feasibility of using winter aerial surveys to take censuses on sage grouse would be useful, if a winter with a more extensive snow cover occurred.
- We obtained no information of the nesting locations of grouse using the southern leks (Ranges 5, 10, and 55). This area is important because of the comparatively large number of leks in the region and the high amount of military training activities it receives.
- Additional work on brood habitat requirements is required. We were able to follow only one brood for any length of time during this study. This work would identify those areas best suited to conduct routine brood surveys.
- A study of the behavioral responses of sage grouse to military training activities is desirable. During our study, sage grouse appeared to be affected by intensive training activities. These observations were incidental, however, to our primary goal of documenting sage grouse habitat use on the YTC. A more structured study with the specific objective of evaluating grouse response to training activities would be useful. Topics of this study could include the following: 1) evaluating the impact of training activities at the remodeled Ranges 10 and 55 on grouse during the mating season; 2) intensive radio-tracking studies of grouse in training areas before, during, and after troop training activities; and 3) determining why grouse use the Impact Area. Is it used because food resources are better, or is it just a place to escape from disturbance?
- Identify and prioritize areas for habitat restoration and improvement.

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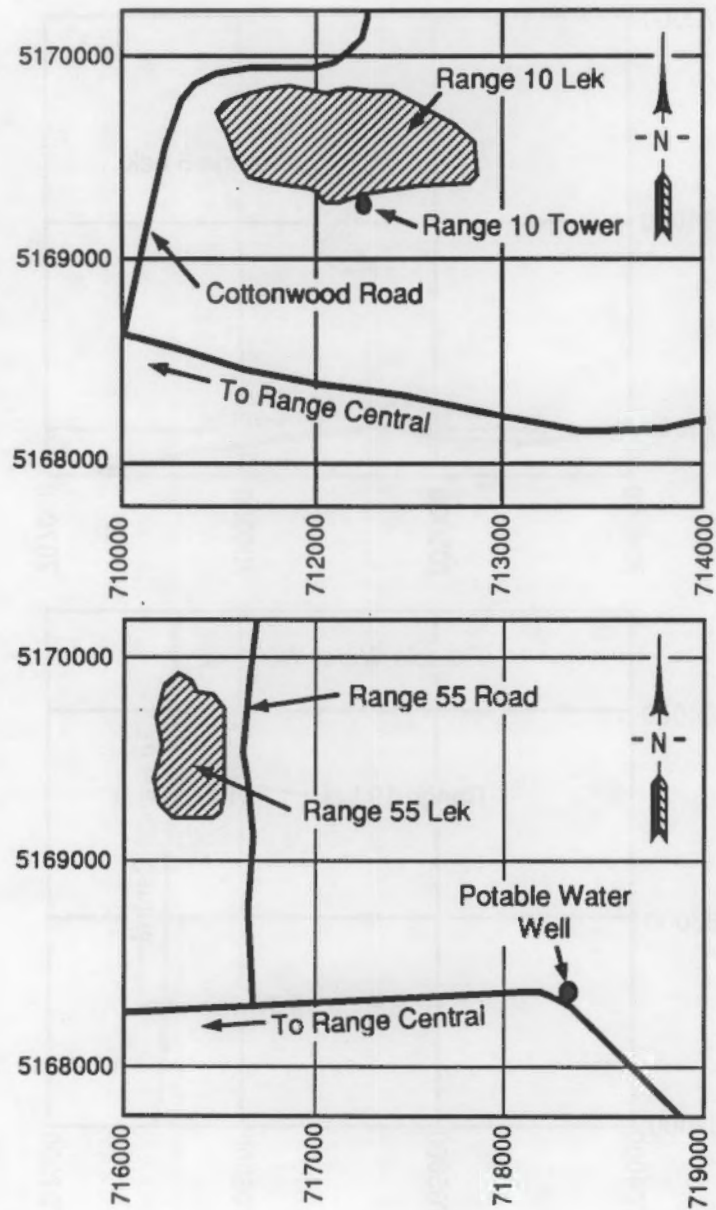
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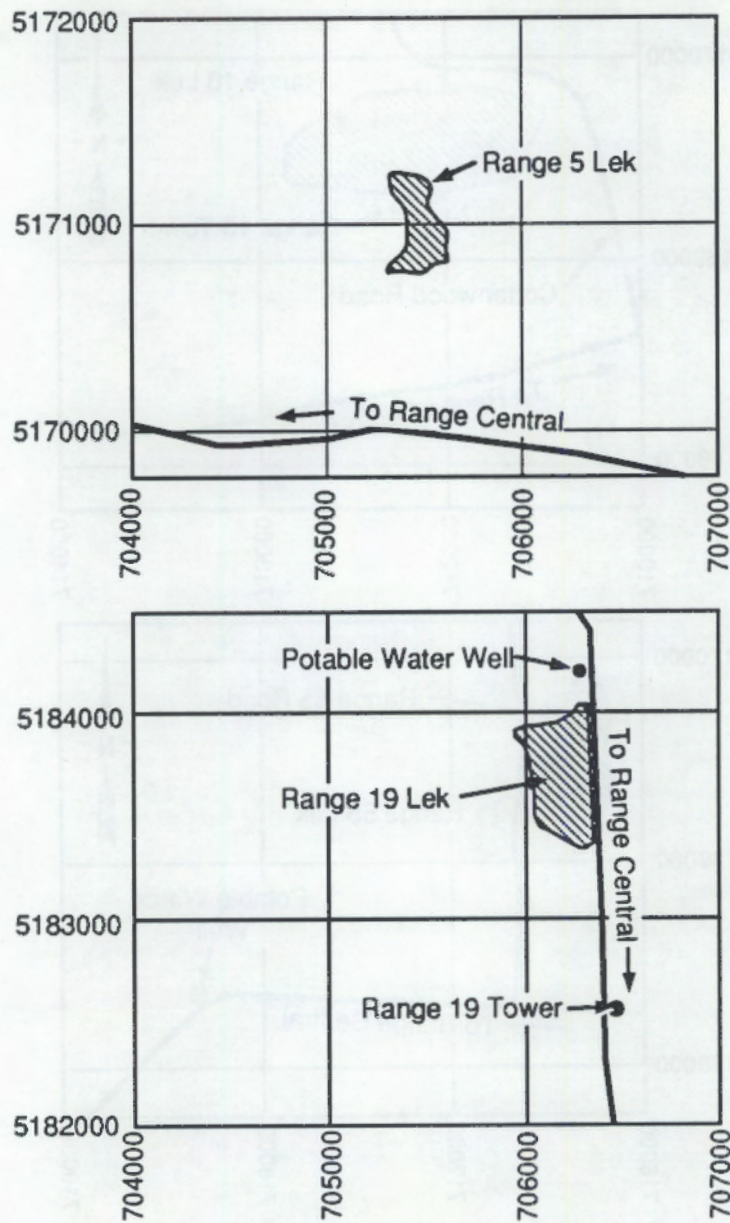
APPENDIX A

MAPS OF THE LOCATIONS AND BOUNDARIES OF
THE FOUR LARGEST LEKS



S9103061.1

FIGURE A.1. Approximate Boundaries of Sage Grouse Leks Located Near Ranges 10 and 55 on the Yakima Training Center



S9103061.2

FIGURE A.2. Approximate Boundaries of Sage Grouse Leks Located Near Ranges 5 and 19 on the Yakima Training Center

APPENDIX B

SUMMARY OF THE MAXIMUM NUMBER OF MALE AND FEMALE
SAGE GROUSE OBSERVED ON LEKS DURING THE WEEKS
THEY WERE MONITORED IN 1989 AND 1990

TABLE B.1. Summary of the Maximum Number of Male and Female Sage Grouse Observed on Leks During the Weeks They Were Monitored in 1989 and 1990

Weeks Monitored	Range 19(a)		Range 15		Range 10		Range 5		Range 55		Beller Dz		Silica N		Badger		Silica S	
	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990	1989	
	M	F ^(b)	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
2/12 - 2/17			6	4		1	0		0	0		0	0					
2/18 - 2/24			30	7						0	0							
2/25 - 3/3			31	18				9	3		13	1		5	0			
3/4 - 3/10	26	19	38		6	1	6	0		10	5		0	0				1
3/11 - 3/17	36	15	31	12	6	2	3	0	16	0	13	5	18	5	16	0		
3/18 - 3/24	41	4	46	2	6	0			6	5	15	3	11	2				
3/25 - 3/31	30	4	51	16	7	0	7	0	13	0	5	0	20	1	17	0		
4/1 - 4/7	41	1	35	2	7	0	2	0	10	0	9	0	19	0	0	0		
4/8 - 4/14	53	2			4	0	0	0	15	1			22	15	0	12	0	
4/21 - 4/27	31	2			7	0			0	0			12	0		4	0	
4/28 - 5/4	37	3			3	0			10	0			5	0		4	0	

(a) Lek location.

(b) M = male and F = female.

APPENDIX C

A SUMMARY OF CHI-SQUARE ANALYSIS FOR HABITAT PREFERENCES

TABLE C.1. A Summary of Chi-Square Analysis for Habitat Preferences

Map Layer	Season	Sex	χ^2	df	P
Soils	Nesting	F	49.5	3	<0.05
	Summer	F	11.3	3	<0.05
	Spring	M	27.2	3	<0.05
	Summer	M	61.1	3	<0.05
	Fall	M	33.3	3	<0.05
	Winter	M	4.7	3	0.20
Slope	Nesting	F	36.2	3	<0.05
	Summer	F	9.8	3	<0.05
	Spring	M	62.5	3	<0.05
	Summer	M	26.1	3	<0.05
	Fall	M	7.1	3	0.07
	Winter	M	7.0	3	0.07
Elevation	Nesting	F	7.9	3	<0.05
	Summer	F	3.9	3	0.27
	Spring	M	24.8	3	<0.05
	Summer	M	63.3	3	<0.05
	Fall	M	33.2	3	<0.05
	Winter	M	14.8	3	<0.05
Vegetation	Nesting	F	18.8	1	<0.05
	Summer	F	7.7	1	<0.05
	Spring	M	6.5	1	<0.05
	Summer	M	3.5	1	0.06
	Fall	M	13.2	1	<0.05
	Winter	M	5.7	1	<0.05

APPENDIX D

SUMMARY OF PREFERENCE VALUES ASSIGNED TO CATEGORIES WITHIN THE
MAP LAYERS USED TO CONSTRUCT GENERALIZED-SEASONAL HABITAT MAPS
FOR MALE AND FEMALE SAGE GROUSE ON THE YAKIMA TRAINING CENTER

TABLE D.1. Summary of Preference Values Assigned to Categories Within the Map Layers Used to Construct Generalized-Seasonal Habitat Maps for Male and Female Sage Grouse on the Yakima Training Center

Map Layer Used	Category Descriptions	Preference Values ^(a)					
		Males				Females	
		Spring	Summer	Fall	Winter	Spring	Summer
Soils	Benway-Selah-Brehm	3	2	2	0	3	2
	Fortyday-Disage-Sohappy	1	1	2	0	1	1
	Vantage-Ralock-Clerf	2	2	1	0	2	2
	Camaspach-Wiskeydick-Wockum	1	3	3	0	2	2
Elevation	100-499 meters	1	1	1	1	1	0
	500-799 meters	3	1	1	1	2	0
	800-1099 meters	2	3	3	3	2	0
	1100-1280 meters	1	2	2	2	2	0
Slope	0-5°	3	3	0	0	3	3
	6-10°	1	2	0	0	1	2
	11-15°	1	1	0	0	1	2
	>16°	1	1	0	0	1	1
Vegetation	Shrubland	3	0	1	1	3	3
	Grassland	1	0	3	3	1	1

(a) 0 = chi-square value (Appendix B.1) not significant and map layer not considered in this analysis, 1 = habitat category avoided, 2 = no preference shown for habitat category, and 3 = habitat category preferred.

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