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NESTING-AREA FIDELITY OF SAGE GROUSE IN SOUTHEASTERN IDAHO[1]

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Fidelity by grouse to particular areas may act as a survival or reproductive strategy. Fidelity has been shown by male (Hamerstrom and Hamerstrom 1951, Eng 1963) and female grouse to leks (Dunn and Braun 1985, Svedarsky 1988), winter areas (Berry and Eng 1985), and summer areas (Rolstad and Wegge 1988). However, few studies have intensively investigated nest-area fidelity of grouse during consecutive years relative to size of annual ranges. Fidelity to nesting areas may serve to increase fitness and reduce risks associated with uncertainty in new nesting habitat (Bergerud and Gratson 1988). These authors hypothesized that successful females should show nest-area fidelity in subsequent years, but unsuccessful females should shift nesting areas if there is a high probability of nest predation re-occurring. A positive relationship between reproductive success and nest-area fidelity in a variety of bird species (Greenwood and Harvey 1982) supports this hypothesis.

Nest-area fidelity has been documented for territorial nesting species such as Bobolinks (*Dolichonyx oryzivorus*) (Gavin and Bollinger 1988), Willow Ptarmigan (*Lagopus lagopus*) (Schieck and Hannon 1989), and American Pipits (*Anthus rubescens*) (Hendricks 1991), but few data are available for lekking species. To be more meaningful, strength of fidelity should be measured by the distance between consecutive nests relative to the size of a species' annual range. Several studies have reported female grouse movements between consecutive-year nests, including Sage Grouse (*Centrocercus urophasianus*) (Gates 1983, Berry and Eng 1985), Capercaillie (*Tetrao urogallus*) (Wegge 1984, Storaas and Wegge 1987), and Greater Prairie-chickens (*Tympanuchus cupido*) (Svedarsky 1988), but none attempted to relate strength of nest-area fidelity to magnitude of annual movements among seasonal habitats.

Wakkinen et al. (1992a) questioned the validity of hypotheses and management guidelines (Braun et al. 1977) that defined the lek as the center of nesting habitat. They concluded that nests of migratory Sage Grouse in Idaho were distributed randomly with respect to leks, and that current management guidelines may be inadequate to protect Sage Grouse nesting habitat. A better understanding of annual fidelity to nesting areas by females will provide insight to hypotheses regarding nesting strategies of lekking species, as well as the importance of conserving specific areas of nesting habitat. A critical test is needed to determine whether Sage Grouse "shift" nesting areas annually or exhibit fidelity to specific areas.

We investigated the influence of nest fate on the extent of fidelity to nesting areas in consecutive years by nesting female Sage Grouse. We also examined whether hens placed consecutive-year nests randomly with respect to the nearest lek.

STUDY AREAS

The Big Desert portion of the Upper Snake River Plain and the Curlew Valley, both in southeastern Idaho, were chosen for study. Hironaka et al. (1983) classified the Big Desert as a Wyoming big sagebrush (*Artemisia tridentata wyomingensis*)/bluebunch wheatgrass (*Agropyron spicatum*) habitat type, but three-tip sagebrush (*A. tripartita*), sandberg bluegrass (*Poa sandbergii*), and bottlebrush squirreltail (*Sitanian hystrix*) are also abundant. Five thousand of the approximately 20,000 ha of the Big Desert study area were burned during late-summer 1989, and resulted in a 57% removal of plant cover within the burned area (J. W. Connelly, unpubl. data). All portions of the study area were grazed by livestock except for the burned area, which was ungrazed for one year prior to, and two years following the burn. Wakkinen (1990) provided a detailed description of the Big Desert study area.

The Curlew Valley is about 90 km south of the Big Desert and topography consisted of a sagebrush-dominated valley and foothills. Mountain big sagebrush (*A. tridentata vaseyana*) and basin big sagebrush (*A. tridentata tridentata*) were common (Winward and Tisdale 1977). Antelope bitterbrush (*Purshia tridentata*), snowberry (*Symphoricarpus oreophilus*), and wild cherry (*Prunus* spp.) were common in mixed-shrub communities. The area was intensively managed for livestock grazing, and sagebrush control (e.g., burning, discing, spraying) was commonly used by private land-owners and land-management agencies.

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METHODS

We captured Sage Grouse with long-handled nets by spotlighting at night (Giesen et al. 1982, Wakkinen et al. 1992b) on and near leks during March and April 1986 to 1992. We fitted 242 females with either solar- or battery-powered, poncho-mounted (Amstrup 1980) radio transmitters. The radio package (transmitter and poncho) weighed <20 g. All grouse were marked with numbered aluminum leg bands.

We monitored radio-marked birds throughout the nesting season from the ground and from fixed-wing aircraft, but did not purposely flush or otherwise disturb nesting hens. Nest fate was determined after a hen completed her nesting attempt, and was based on egg membrane condition and/or visual documentation of a hen with brood. Egg membrane firmly attached to the shell indicated that the egg did not hatch (Klebenow 1969). A nest was considered successful if at least one egg hatched. We continued to monitor radio-marked birds throughout the summer as they left winter/nesting habitat and moved to summer/fall ranges.

To evaluate fidelity to nest-areas, we first calculated a straight-line distance between all nests of consecutive-year nesting females. To test for directional fidelity of consecutive-year nests relative to a known reference point, the closest lek, we measured the angle (Θ_{nest}) formed from lines between the two consecutive-year nests and the closest lek. For each pair of consecutive-year nests, we also generate a random angle = Θ_{random} (0–180°), to compare with Θ_{nest}. We assumed that females captured as adults showed no behavioral responses based on prior nesting experiences unknown to observers. We felt confident that all leks were identified on the Big Desert and Curlew Valley study areas by aerial and ground searches conducted annually.

We tested for differences between consecutive-year movement distances of successful and unsuccessful females, and Θ_{nest} and Θ_{random}, using a Mann-Whitney U statistic (Zar 1984). We also calculated power of the test ($1 - \beta$) to determine the probability of committing a Type II error.

RESULTS

Thirty-two radiomarked females were monitored for two or more consecutive nesting seasons. Eighteen females were located on 40 nests (35 Big Desert, 5 Curlew Valley), resulting in 22 total movements (14 two-year movements, 4 three-year movements) between consecutive nests. Median distance moved from nests to summer/fall range for consecutive-year nesting females was 20.9 km (range 0.4–63.0 km). Distances moved between consecutive year nests by adults (Median = 740 m, $n = 18$, range 5–2,098 m) and yearlings (Median = 777 m; $n = 4$; range 206–2,585 m) were similar ($U = 39$, $P = 0.47$). Median distance between consecutive-year nests of all females was 740 m ($n = 22$). Movements to new nest sites by female Sage Grouse following unsuccessful nesting attempts (Median = 937 m, $n = 9$) the previous year were similar ($U = 73$, $P = 0.35$) to those following successful nesting attempts (Median = 506 m, $n = 13$). Moreover, distance moved was not related to subsequent reproductive success. Females that were successful during their second documented nesting season did not move significantly farther ($U = 68$, $P = 0.62$) from their previous year's nest sites than unsuccessful females (757 m, $n = 12$ vs. 717 m, $n = 10$, respectively [median reported]). However, the power of our tests to detect a difference between movements of successful and unsuccessful females was low ($1 - \beta < 0.30$).

The location of nests with respect to the nearest lek was highly directional. Median Θ_{nest} from closest lek to consecutive nests (12°, $n = 22$, range 1°–119°) was smaller ($U = 109.5$, $P = 0.002$) than median Θ_{random} (64°, $n = 22$, range = 1°–180°). Median Θ_{nest} of four females located on nests during three consecutive years was 6° (range 1°–65°).

DISCUSSION

Sage Grouse on the Big Desert showed strong fidelity for specific nesting areas, since movements between consecutive-year nests represented only 3.5% of their median annual straight-line movement (20.9 km). Gates (1983) reported fidelity to nesting areas by three female Sage Grouse that all nested <200 m from the previous year's nests. In Wyoming, Berry and Eng (1985) found that the mean distance between successive nests of three female Sage Grouse from a migratory population was 552 m, which was 1.6% of the reported median annual straight-line movement. In Norway, Wegge (1984) reported that mean distance between successive nests of seven Capercaillie females was 213 m. Female Capercaillie in Norway moved an average of 1,878 m from lek to center of summer home range (Rolstad and Wegge 1988), thus, mean distance between consecutive-year nests was 11.3% of their mean annual straight-line movement. Our study area had large, contiguous areas of nesting habitat available (Wakkinen 1990). The availability of homogeneous nesting habitat over large areas and the long distances that females migrate (Wakkinen 1990) indicated that nest-area fidelity in Sage Grouse was strong. Although Wakkinen et al. (1992a) showed that nest distribution was random with respect to leks on the Big Desert, placement of nests by individual females among years, relative to the closest lek, was a non-random event.

Although relationships between nest-site selection and vegetal cover have been shown for lekking grouse (Klebenow 1969, Wallestad and Pyrah 1974, Riley et al. 1992), the choice of a new nesting area in successive years by individual females is not well understood. Storaas and Wegge (1987) observed that four of five successful, and eight of 14 unsuccessful nesting Capercaillie females shifted to a different habitat type in successive years, suggesting that factors other than nest fate were important in determining distance between successive nests. Bergerud and Gratson (1988) argued that successful females should exhibit nest-area fidelity in subsequent years, and unsuccessful females should move if predation risk is high. We found no relationship between nest fate and distances moved between consecutive-year nests. Although the power of detecting a difference was low, our data do not support Bergerud and Gratson's (1988) hypothesis.

Bergerud and Gratson (1988) also hypothesized that distance moved between nests in consecutive years may be related to nest-predator mobility. Because most unsuccessful nests in our study area were likely depre-

dated by Common Ravens (*Corvus corax*), a long-lived and mobile nest predator, it may be beneficial for Sage Grouse to shift nesting areas slightly to avoid being associated with the previous year's nest. However, this "shift" in nesting areas is a relative term and is difficult to quantify in species having non-territorial females. Although fidelity to specific nesting areas was clear, females did not return to nest under the same bush. They typically moved 700–1,000 m from previous nests. We believe nest fate was not influencing the distance moved between consecutive nests. Instead, we suggest that nest locations reflect a strategy to avoid previous nests, regardless of their fate, and areas predators may be more likely to search. Predators of Willow Ptarmigan (*Lagopus lagopus*) nests concentrated within-year searches in areas where they previously found nests (O'Reilly and Hannon 1989), which would support our argument if this behavior persisted among years on our study area.

Greenwood and Harvey (1982) suggested that few female birds return to nest near natal hatching areas. However, Dunn and Braun (1985) found that >50% of both male and female yearling Sage Grouse attended their natal-area lek. If a yearling female Sage Grouse initially returns to her natal area to search for a nest site, experience and familiarity with a general nesting area may dictate the location of her subsequent nests.

Because Sage Grouse hens appear to seek suitable habitat within a relatively small area, nest-area fidelity may reduce nesting if large areas of nesting habitat are destroyed. If hens do nest in an area following manipulation of nesting habitat, they may nest in unsuitable areas and experience lower nest success (Connelly et al. 1991). Our results provided further evidence for the importance of identifying and conserving nesting habitat for Sage Grouse.

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RENESTING BY SAGE GROUSE IN SOUTHEASTERN IDAHO[1]

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Key words: Centrocercus urophasianus; *Idaho; nesting; radio-telemetry; renesting; reproduction; Sage Grouse.*

Renesting in Tetraonidae has been investigated in a number of studies (e.g., Patterson 1952, Zwickel and Lance 1965, Giesen and Braun 1979, Parker 1981, Bergerud 1988, Bergerud and Gratson 1988). Unfortunately, information on renesting by Sage Grouse (*Centrocercus urophasianus*) is limited and highly variable. Both Patterson (1952:105) and Eng (1963) reported that renesting by Sage Grouse is relatively rare (<10%). However, Bergerud (1988) suggested that renesting rates by this species exceed 40%, based on a synthesis of the literature and Petersen's (1980) report that 7 of 17 (41%) radio-marked Sage Grouse renested.

The relative vulnerability of nests and life expectancy of the female may strongly influence renesting rates in grouse (Bergerud and Gratson 1988). Bergerud and Gratson (1988) argued that if predators are active near a Sage Grouse nest, the probability of nest loss is high because of relatively sparse cover. Thus, nest abandonment and renesting would be an advantageous strategy for this species. However, grouse with long life expectancies should renest less often than shorter lived species (Bergerud and Gratson 1988) and yearlings should renest less often than adults (Bergerud 1988). Sage Grouse have relatively long lives (Patterson 1952, Bergerud 1988) which, therefore, should result in lower renesting rates than other grouse species. The objectives of this study are to document renesting rates by Sage Grouse in Idaho and to test the hypotheses that yearling and adult Sage Grouse nest and renest at the same rates.

STUDY AREA

The study was conducted on the Big Desert of the Upper Snake River Plain and in the Curlew Valley, in southeastern Idaho. Topography of the Big Desert is flat to gently rolling with frequent lava outcrops. Annual precipitation averages 23 cm, with 40% falling from April through June. The area is dominated by a sagebrush (*Artemisia tridentata*/bluebunch wheatgrass [*Agropyron spicatum*]) habitat type (Hironaka et al. 1983). Some portions of this area have been burned within the last 12 years but most contain native stands of sagebrush. The area is described in more detail by Wakkinen (1990).

The Curlew Valley is about 90 km south of the Big Desert and consists of a sagebrush dominated valley and foothills. Annual precipitation varies from 28 to 36 cm. Mountain big sagebrush (*A. t. vaseyana*) and

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