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EFFICACY OF TWO VARIATIONS ON AN AERIAL LEK-COUNT METHOD FOR GREATER SAGE-GROUSE

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ABSTRACT.—Greater Sage-Grouse (*Centrocercus urophasianus*) is a species of concern, and accurate population data are needed to monitor conservation management efforts. Conventional, ground-based lek counts are labor-intensive, expensive, and have several sources of potential error and bias, including the practical limits on number and distribution of leks counted. We tested aerial methods for photographing multiple leks during a single morning. We completed 14 aerial approaches to 6 leks in 2 different years using 2 different airplanes and altitudes. Grouse flushed from leks on 12 approaches when the airplane was within 200–300 m of the lek. In 2 instances, strutting grouse crouched and stayed on the lek. Our highest-resolution images increased our confidence in grouse identification but also decreased field-of-view coverage to the detriment of count accuracy. The methods we tested do not allow sage-grouse to be accurately counted, but the results provide information about sage-grouse responses to low-altitude airplane approaches and about useful image resolutions and fields of view.

Key words: aerial approach, aerial photography, behavior, Centrocercus urophasianus, *crouching, flushing, overflight, Greater Sage-Grouse.*

Sage-grouse populations are monitored by counting male birds on strutting grounds, or leks (Patterson 1952, Connelly et al. 2003). Lek counts by single observers are not verified and are frequently influenced by problems resulting from observers not following accepted techniques, as when counts are made during windy, overcast, or rainy conditions or when counts are begun too late in the morning (Connelly et al. 2003). Some grouse frequent multiple leks during a breeding season, and counting multiple leks on successive days may result in double-counting (Connelly et al. 2003 citing Dalke et al. 1963). Yet without better methods, ground-observer counts remain the most practical means of indexing breeding populations of grouse (Connelly and Braun 1997). Airplanes and helicopters have been used to identify and count leks (Connelly et al. 1981) but rarely to count grouse. Aerial-count methods have been tried by various people and have been discussed informally (personal communication with R. Breckenridge, Idaho National Laboratory; S. Espinosa, Nevada Department of Wildlife, Reno; and S.J. Stiver, Western Association of Fish and Wildlife Agencies). Light sport airplanes can safely fly slowly (68 kph ground speed) and inexpensively ($150 per hour with pilot) and therefore may be useful in obtaining aerial counts of sage-grouse. Our objective was to test the light sport airplane and high-resolution digital aerial photography (Booth and Cox 2008) as a protocol for counting sage-grouse on leks. Our specific research questions were (1) whether grouse would remain on the lek during an overflight and (2) whether we could make accurate counts from aerial images.

We tested 2 variations of an aerial-count method by photographing Greater Sage-Grouse (*Centrocercus urophasianus*) leks located within the Rock Creek watershed, Elko County, north central Nevada (41°15′N, 116°37′W) at 1675–1875 m elevation in 2005 and 2007. Using our initial protocol, we surveyed 6 leks on 23 April 2005. Using an altered protocol in 2007 (3 and 4 April), we surveyed 5 leks in 8 overflights. (The lower number of leks surveyed in 2007 was due to inactive leks [Table 1].) Aerial photography methods followed Booth and Cox (2008). Lek size ranged from 1.2 to 5.7 ha as determined by measuring polygons of 4 straight lines drawn between 4 coordinates collected around the area where males were displaying. Wildfires burned 19,170 and 38,330 ha of the watershed in 2005 and 2006,

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TABLE 1. Ground counts of all sage-grouse (males and females) shortly before (count 1) and coincident with (count 2) the aerial overflights on 23 April 2005 and on 3 and 4 April 2007. The same crew that conducted ground counts made aerial counts from multiple aerial images of each lek. The final column shows the percentage of birds known to be on the lek that were actually counted using the aerial imagery.

		Preoverflight			Postoverflight			
Date and lek	Size (ha)	Ground count 1	Ground count 1 time[a]	Aerial photo time[a]	Ground count 2	Ground count 2 time[a]	Aerial count	% Aerial count
23 April 2005								
Midas	1.2	12	–27	–10	0	–10	0[b]	—
Buffalo Springs	0.9	8	–1	10	2	13	0	0
Scraper Springs	0.6	32	8	14	0	17	0	—
Willow Creek 6	5.8	81	37	39	6	41	3	50
Willow Creek 1	2.2	57	28	47	14	49	2	14
Willow Creek 19	1.5	55	51	59	2	61	1	50
3 April 2007								
Midas	1.2	0	0	87	0	87	0	—
Scraper Springs	0.6	12	66	70	12	72	0	0
Willow Creek 6	5.8	40	29	36	0	40	0	—
Willow Creek 1	2.2	25	40	45	0	46	0	—
Willow Creek 19	1.5	21	49	57	5	58	1	20
4 April 2007								
Scraper Springs	0.6	15	60	69	12	70	1	8
Willow Creek 6	5.8	33	41	46	0	48	0	—
Willow Creek 19	1.5	21	40	58	6	59	3	50

[a]Times are given in minutes before (negative number) or after (positive number) official sunrise.
[b]Lighting was insufficient to obtain a usable photographic image.

respectively, including 25 of 30 known leks. In 2005 we used an 11.1-megapixel digital single-lens reflex color camera with a 100-mm f/2.0 autofocus lens (Canon USA, Lake Success, NY), and flights were from the south/southwest (160°–260° azimuth) at 200 m above ground level (AGL). Image resolution was 18-mm ground sample distance (GSD: linear dimension of a pixel's ground coverage) with a 72 × 48-m field of view (FOV). During 4 weekends prior to the 2005 flight, volunteers counted sage-grouse on all 6 leks, recorded the start and stop times of strutting displays, and placed markers through the centers of highest sage-grouse activity to facilitate image analysis. On flight dates, volunteers arrived at leks 60 minutes before sunrise, obtained a concealed position from which to observe a lek through field glasses, and recorded grouse numbers (males and females) at 15-minute intervals before and after flights. We report the maximum count recorded pre- and postflight as our sample statistics (Beck and Braun 1980). We made 6 protocol changes for our 2007 surveys in an effort to decrease the number of birds flushing at airplane approach: (1) the leks were photographed earlier in the season to test whether birds were then less likely to be flushed, (2) the airplane was powered by a 4-stroke engine with a lower RPM and a lower operating tone than a 2-stroke engine, (3) we used a 16-megapixel camera with a 100-mm f/2.0 lens, (4) flight altitude was 150 m AGL, resulting in an 11-mm GSD with a 54 × 36-m FOV, (5) the approach was from the east/northeast (48°–111° azimuth; S. Espinosa, Nevada Department of Wildlife, Reno, personal communication), and (6) the airplane came over each lek in a glide (engine idling) from 3 km out. The ability of the airplane to approach each lek without causing birds to flush was assessed by calculating the proportion of the pre- to postoverflight bird counts. Confidence intervals were calculated for each proportion using the normal approximation (Steel and Torrie 1980:478–479). We used the confidence intervals to compare across all leks the proportion of birds remaining on each lek postoverflight to determine if grouse from all leks reacted to the approaching airplane in the same way and to determine if the 2007 protocol changes had a positive effect. The efficacy of the aerial method for counting grouse was assessed by examining the percentage of birds present on the lek that were captured in the imagery.

We made 14 aerial approaches to birds on leks. In 12 of these (6 in 2005 and 6 in 2007), the lek observers reported that strutting ceased around the time observers heard the airplane and that birds flushed when the airplane drew within 200–300 m of the lek. We counted 385 birds on the ground preoverflight with 35 birds (9% ± 9%) remaining on leks after the 12 overflights (Table 1). Twice (3 and 4 April 2007 at Scraper Springs), birds remained on the lek during an overflight (24 of 27, 89% ± 11%). The difference between 2007 Scraper Springs and all other approaches (including 0 of 33, 2005 Scraper Springs) was significant ($P = 0.05$). The reason for the different responses is unknown. Using the 3D-Analyst extension in ArcMAP 9.2 (ESRI, Redlands, CA), we compared probable grouse line-of-sight with topography, with angles of airplane approach and the rising sun, and with distance to roads, but we found no plausible explanation for the differential behavior. The 2007 flights counted slightly more birds on the leks than the 2005 flights counted (10% ± 4% in 2005, 21% ± 6% in 2007; $P = 0.05$), but if the Scraper Springs results are removed from the 2007 data set, then only 8% ± 4% of grouse remained on the leks after the overflight.

Ground counts showed 59 birds on the leks postoverflight, but only 19% of those were captured in the imagery (Table 1). In all cases, the ground method counted more birds than the aerial method. Higher resolution in the 11-mm GSD imagery allowed greater confidence in grouse identification than the 18-mm GSD imagery, but the wider FOV (72 × 48 vs. 54 × 36 m) at 18-mm GSD covered more of the leks and thus resulted in more birds being counted.

The utility and storability of high-resolution digital aerial images are attractive for verifying counts and for improving lek-count efficiency and distribution. Our methods yielded potentially useful information but inaccurate counts. We predict that 85% to 90% of sage-grouse will flush from leks when the above methods are used and the airplane is 200–300 m out on an aerial approach. With the possible exception of the Scraper Springs lek in 2007, timing of approach (both seasonally and daily) did not affect grouse reaction to the airplane, nor did direction and angle of approach or the change in pitch of the airplane's engine noise. However, the flushing response of grouse did differ among area leks, but we were unable to find a consistent determining factor. A resolution of 11-mm GSD allows greater counting confidence, but because of the small FOV, a means must be found to acquire greater image coverage of leks, or the grouse on the lek must somehow be identified and targeted during the aerial approach.

Although we cannot recommend our protocol for counting sage-grouse, we have (1) documented what did not work so that the unworkable protocol will not be repeated and (2) provided protocol details and results that may give clues to a future method that will work. The need for improved methods of determining grouse numbers is real and is becoming more important as conservation efforts increase.

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