Johnson, D.J., Holloran, M.J., Connelly, J.W., Hanser, S.E., Amundson, C.L., and Knick, S.T. 2010. Influences of environmental and anthropogenic features on greater sage-grouse populations, 1997-2007. Chapter 17 in Studies in Avian Biology. No. 38.

Abstract. The Greater Sage-Grouse (*Centrocercus urophasianus*) is endemic to western North America and of great conservation interest. Its populations are tracked by spring counts of males at lek sites. We explored the relations between trends of Greater Sage-Grouse lek counts during 1997–2007 and a variety of natural and anthropogenic features. We found that trends were correlated with several habitat features, but not always similarly throughout the range. Lek trends were positively associated with proportion of sagebrush (*Artemisia* spp.) cover, within 5 km and 18 km. Lek trends had negative associations with the coverage of agriculture and exotic plant species. Trends also tended to be lower for leks where a greater proportion of their surrounding landscape had been burned. Few leks were located within 5 km of developed land and trends were lower for those leks with more developed land within 5 km or 18 km. Lek trends were reduced where communication towers were nearby, whereas no effect of power lines was detected. Active oil or natural gas wells and highways, but not secondary roads, were associated with lower trends. Effects of some anthropogenic features may have already been manifested before our study period and thus not have been detected in this analysis. Results of this rangewide analysis complement those from more intensive studies on smaller areas.

The authors stated the following regarding interpretation of the results of their study. A potential bias is that agencies may have discontinued surveys of leks that had become inactive. In that event, inactive leks would tend to have fewer years in which surveys were conducted and would not be included in the analysis if that number of years (during 1997–2007) was less than four, and would be down weighted even if they were included. We investigated the possibility of a discontinuation bias by calculating the percentage of occasions during 1997–2007 for which a zero count was followed by a missing and the percentage of occasions for which a non-zero count was followed by a missing count. If the two percentages are roughly similar, there is no evidence of a discontinuation bias. In fact, non-zero counts were following by missing counts 19 % (4,226/22,517) of the time, whereas zero counts were followed by missing counts 36 % (4,467/12,532) of the time. So the data provide strong evidence of a discontinuation bias: leks on which no sage-grouse were observed in one year were less likely to be surveyed the following year. As an aside, a missing count was followed by another missing count 82 % of the time, indicating a rather low probability that a missing count would be resumed the following year. The net effect of the discontinuation bias is that the data set includes disproportionately fewer abandoned leks than would be representative, and our average lek trend estimates may be biased high.

Our analysis is but a snapshot in time, the time period selected because it had the highest quality data. In many instances, the lek count data we used may not temporally relate to when the anthropogenic stressors examined were added to the landscape. As examples, most of the conversion of fertile soils supporting sagebrush to agriculture occurred during the first half of the 20th century, cheatgrass was well-established throughout much of the Intermountain West by the 1920s, and the majority of paved interstate highways were opened to traffic in the 1960s and 1970s (Connelly et al. 2004). These developments may have caused the extirpation of populations from a region (Aldridge et al. 2008), or leks that remained active may have been isolated from effects of the disturbances (Braun et al. 2002). The results we report here therefore may not accurately reflect the total response of populations to the addition of these factors. A final caveat is that ours is an observational, rather than experimental, study (Shaffer and Johnson 2008). We were not able to assign treatments (reflected by the various explanatory variables: elevation, landscape composition, roads, towers, etc.) in a balanced, random manner. Of the three cornerstones of inference, we lack control and randomization, but have fair to excellent replication both within management zones and among them. One consequence of this is confounding of the explanatory variables, which makes it difficult, at best, to determine which of them is responsible for any effect on the response variable. A more severe consequence is a greater risk incurred by presuming that associations observed in the data reflect causation.