Project Title: ASSESSMENT OF IMPACTS OF FERAL HORSES AND LIVESTOCK GRAZING ON SAGE-GROUSE AND THEIR HABITATS: LONG-TERM TRENDS IN SAGE-GROUSE DEMOGRAPHY AND HABITATS ON THE SHELDON -HART MOUNTAIN NATIONAL WILDLIFE REFUGE COMPLEX AND ADJACENT BLM LANDS

Project type: Science Project: 1, B, 2.

General Public Summary*: Grazing by livestock and feral horses are hypothesized to negatively impact sage-grouse populations through the impact on vegetation in habitats used by sage-grouse. No controlled studies of grazing impacts on sage-grouse or their habitats exist. We take advantage of historical patterns of grazing by both feral horses and livestock on Sheldon and Hart Mountain National Wildlife Refuges and new data to create a study that contrasts grazing by horses versus livestock. We use historical data collected by Mike Gregg from Hart Mountain before and immediately after livestock were removed in the early 1990s, and historical data from Sheldon before the irruption of feral horses in the mid 2000s. We add data from Hart Mountain (no nonnative ungulates for 20 years), Sheldon (no livestock but substantial feral horse impacts), and BLM land south of Sheldon NWR (grazed by both feral horses and livestock). Gregg collected data on 904 female sage-grouse and 570 nests during the historical period. The historical and new data provide an unprecedented opportunity to assess sage-grouse population dynamics and habitats under all combinations of grazing by nonnative ungulates: no nonnative ungulates (Hart current), livestock only (Hart historical), horses only (Sheldon current), both horses and livestock (BLM land current).

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Project Objective(s): Our principal objective is to estimate sage-grouse demographic responses to grazing by horses and livestock and to relate these responses to key vegetation variables. A secondary objective is to use long term (nearly 30 years) data on vegetation and sage-grouse to relate sage-grouse demography and population dynamics to long term variation in climate.

Management Objective(s): Uncertainty about the effects of gazing by feral horses and livestock on the population dynamics of sage-grouse has produced contentious debate about appropriate management of both feral horses and livestock to support sage-grouse conservation. Our principal management objective is to differentiate the relative effects of the two nonnative ungulates on habitat and sage-grouse demography in the Great Basin. We believe availability of such data from a study in which effects of livestock and horses can be clearly differentiated will facilitate public support for appropriate grazing management. Data from this study will also contribute to development of proper stocking levels for both feral horses and livestock in the northern Great Basin.

Project Description:
Greater Sage-grouse (*Centrocercus urophasianus*) an iconic species of the Great Basin were recently determined to be warranted for listing under the Endangered Species Act by the U.S. Fish and Wildlife Service. An important contributor to declines in sage-grouse populations has been degradation of key habitats associated with energy development, urbanization, climate change and grazing by livestock and feral horses (Connelly et al. 2004). Grazing reduces cover for nests (Beck and Mitchell 2000, Connelly et al. 2000, Crawford et al. 2004) and food for breeding adults and broods (Hagen et al. 2007, Gregg et al. 2008, Gregg and Crawford 2009). Both effects are important because vegetative cover affects nest success (Holloran et al. 2005) and food affects brood survival (Gregg and Crawford 2009). Both recruitment and adult survival are important to local population dynamics in sage-grouse populations (Sedinger 2007).
Feral horses are currently substantially affecting vegetation on Sheldon National Wildlife Refuge (Collins 2011). It has not been possible to separate the effects of feral horses and livestock on Great Basin plant communities and associated wildlife because both types of grazing typically occur together. The Sheldon-Hart Refuge Complex and adjacent federal lands offer a unique opportunity to assess the impacts of feral horses in the absence of livestock grazing because livestock were removed from the refuge in the mid1990s and horses have increased substantially on the Sheldon but not on Hart Mountain over the last decade. Lands adjacent to the Sheldon National Wildlife Refuge have had continuous grazing by both horses and cattle, and, therefore provide a control for reductions in grazing on the Refuge units. Consequently, it is possible to compare vegetation and sage-grouse on the two units of the Refuge and the Vya-Massacre sage-grouse population management units (PMUs) on land immediately southwest of the Sheldon unit; the Sheldon unit has substantial horse impacts, the Hart Mountain unit supports only low densities of horses, and the adjacent lands have both cattle and horses.

Grazing by feral horses is expected to have the greatest impact on recruitment of young because reduced understory vegetation (Collins 2011) could negatively impact nest success

and survival of young. Potential effects on adult survival are unknown because few estimates of survival exist for sage-grouse (Zablan et al. 2003, Anthony and Willis 2009, Sedinger et al. 2010, 2011), making it difficult to understand ecological processes that might impact survival. Two different studies (Zablan et al. 2003, Anthony and Willis 2009) have implicated harsh weather during winter in increased mortality and three other studies have detected increased mortality during the fall period (Blomberg et al. 2010, Sedinger et al. 2011, Farinha unpublished data). Increased fall mortality represents a complex interaction between predation and availability of food (Blomberg et al. 2010).

Evaluation of cattle and horse impacts is substantially strengthened in this case because Mike Gregg has substantial historical data on both vegetation and sage-grouse from both units over the period 1988-2005, which can be combined with data to be collected during the current study. Dr. Gregg radio-tagged 904 female sage-grouse and monitored 491 first nests and 83 renests during this period. I propose to repeat Dr. Gregg's work during three field seasons on the Hart and Sheldon units of the Refuge and on land adjacent to the Refuge. Simultaneous work on nonrefuge land would be funded by the Nevada Department of Wildlife from their Ruby pipeline funds. Work on nonrefuge land is a high priority for the Nevada Department of Wildlife and the Surprise Field Office of BLM. An opportunity may exist for work on private lands and associated grazing allotments, associated with the Vya Ranch (Fig. 1). Combining work on the Vya-Massacre PMUs with that on the Hart-Sheldon Refuge has the advantage that data can be brought into a single analysis that will provide the greatest power to assess grazing impacts on vegetation and sage-grouse. Grazing treatments are summarized in Table 1 and study locations are shown in Fig. 1. A combined study provides an opportunity to separate the effects of cattle grazing from that of horses, and effects of both nonnative ungulates from habitats that are ungrazed.

New data would be combined with those of Dr. Gregg to estimate nest survival, adult female survival and brood survival, in conjunction with vegetation dynamics over a 20+ year period. The combination of historical and new data, combined with differences in dynamics of feral horses on the two refuge units creates a close approximation of a Before-After Control-Impact (BACI) research design, which is typically viewed as the strongest approach for gaining inference about ecological processes.

Hypotheses

1. Nest survival will be influenced by shrub cover and understory vegetation.
2. Understory vegetation will be shorter and provide less ground cover in the presence of feral horses and feral horses and livestock.
3. Brood survival will be lower when understory vegetation or shrub cover are reduced.
4. Survival of adult female sage-grouse will be lower when understory vegetation or shrub cover are lower.
5. Riparian areas will support greater primary productivity in the absence of grazing by nonnative ungulates.

Field Methods

Four person field crews will conduct field studies from March 1 through July during three breeding seasons on each Refuge unit. A three person crew, supervised by the Sheldon unit crew leader, will conduct the work on the Vya-Massacre PMUs. We will conduct an abbreviated field season during the fourth year of the project to take advantage of radio-tagged females remaining from the earlier years of the project. Each refuge crew will be supervised by a Ph.D. student supervised by Jim Sedinger at the University of Nevada Reno. Crews will operate out of remote field camps near study areas to minimize travel and living costs during each field

season. Sedinger and students have maintained a similar camp in Eureka County, Nevada for nine field seasons, while conducting the Falcon-Gondor transmission line study.

The goal will be to capture 60 female sage-grouse using standard nightlighting techniques (Giessen et al. 1982, Wakkinen et al. 1992) at each of the three sites during each spring of the study. Each female will receive a size 14 aluminum leg band and a 22 g necklace-style ATS transmitter. Transmitters have a life of 383-766 days (Blomberg et al. 2010) and will have a mortality mode allowing us to determine when females die. Each female will be checked twice weekly until movements become localized, at which point the female's location will be approached sufficiently closely to determine the nest site. Nests will be checked twice weekly until their fates are determined. After nest fates are determined, shrub cover, and cover and height of understory vegetation, will be estimated at each nest and a corresponding random point using the same methods employed by Gregg et al. (1994). Broods will be monitored weekly using spotlighting (Blomberg et al. 2010). Females will be monitored monthly by aircraft during the nonbreeding season to allow estimation of monthly survival. We will also apply backpack-mounted, 30 g PTT_100 Argos/GPS tags to 10 sage-grouse from each of the Hart and Sheldon units (20 total) to provide more detail about movements of individuals from these two populations.

Analyses and Hypothesis Tests

We will use analysis of variance to evaluate variation in vegetation variables between Sheldon in the current period versus historic data from Sheldon, both periods form Hart Mountain, and the current period for Vya-Massacre.

We will analyze nest survival data using modern maximum likelihood methods (Rotella et al. 2004, Kolada et al. 2009) implemented in Program Mark (White and Burnham 1999), because these methods are less biased than classical approaches (e.g., apparent nest success) and they allow explicit modeling of proposed biological hypotheses. For example, vegetation variables can be incorporated directly into models of nest survival to assess their importance to nest survival. We will incorporate landscape level measures of fire history and shrub cover into models of nest survival (Moynahan et al. 2007, Kolada et al. 2009). The hypothesis about spatial temporal variation in nest survival will be evaluated by comparing nest survival on Sheldon and Vya-Massacre during the current period with that on Sheldon in the past and Hart during both periods. The extensive data available from Dr. Gregg, combined with the nests to be studied in this proposal, will make these among the most powerful assessments of factors affecting nest success of sage-grouse ever conducted.

We will analyze monthly female survival using known-fate survival models implemented in Program Mark. We will assess effects of landscape level vegetation, fire history, and location (Hart versus Sheldon versus Vya-Massacre) by time period (historical versus current) effects on monthly survival. We will include vegetation variables (e.g., shrub cover) as covariates in survival analyses. We will evaluate seasonal variation in survival because three different analyses of survival indicate low survival during early fall, followed by spring (Sedinger et al. 2011, Blomberg et al. 2010, Farinha unpublished).

We will analyze brood survival using methods developed by Lukacs et al. (2004), which allow for variation in detection and lack of independence among brood mates. We anticipate that sample size will restrict this analysis to comparison of new data from Sheldon and Vya-Massacre (current grazing) with historic Sheldon combined with both periods for Hart Mountain.

We will calculate seasonal home ranges and habitat use for the nesting, and early, and late brood-rearing periods and associate home rages with landscape level habitat variables (e.g. Atamian et al. 2010). We will also assess effects of grazing treatments on habitat use, home range size, movements from nesting to brood-rearing areas. Finally, we will use data from both GPS collared sage-grouse and aerial survey to assess connectivity among the Hart, Sheldon, Massacre-Vya and Beatys Butte areas.

We will also take advantage of work to identify and map the history and change of riparian habitat area, vegetation vigor, and associated water use in Nevada by Justin Huntington under contract to BLM (see letter of support). Justin will analyze riparian dynamics back to 1984 and has indicated he can include the Hart Mountain area. Because such habitats are critical for sage-grouse broods, we anticipate their dynamics will have important explanatory power for sage-grouse population dynamics. We intend to use measures of riparian habitat area and vegetation vigor in areas where we had marked sage-grouse as explanatory variables in models of breeding propensity, nest success, and brood survival. We also plan to assess these variables as response variables under different grazing treatments represented in this proposal. The latter analyses will provide a large-scale view of potential impacts of grazing by livestock and feral horses on riparian habitats.

Expected Outcomes: We will develop statistical models of key vegetation variables in relation to grazing treatments and weather variables. We will also develop models linking key sage-grouse demographic rates (breeding propensity, nest success, brood survival, female survival) to vegetation variables and ultimately to grazing treatments. While analyses will be based on data from the Hart-Sheldon-Massacre areas, we believe results will be broadly applicable to the Great Basin. Our ultimate goal is to develop models linking feral horse density and livestock grazing practices (AUMs, season of use, etc.) to vegetation and sage-grouse population dynamics.

Project Products: We are providing annual updates on findings to key partners (Nevada Department of Wildlife, BLM [California and Nevada], U. S. Fish and Wildlife Service, Greater Hart Sheldon Conservation Fund, Oregon Department of Fish and Wildlife) and we provide an annual report with detailed analysis to these partners. We anticipate multiple presentations at regional and national conferences. A minimum of eight peer-reviewed publications are planned in addition to two Ph.D. dissertations. The Greater Hart Sheldon Conservation Fund is funding conversion of Mike Gregg's sage-grouse and vegetation data to digital format. These data will be combined with data being collected in the current project to produce a data base expected to have data on 1400 sage grouse and a similar number of vegetation points.

Communication & Engagement: Mike Gregg is a full collaborator in the project. He has trained current field personnel in vegetation sampling protocols to ensure new data are consistent with historical data. He has also participated in spring captures. Mike is active in the transfer of data into digital format. David Dobkin, Executive Director of the Greater hart Sheldon Conservation Fund, is actively coordinating this project with assessment of changes in vegetation following livestock removal on Hart Mountain. We have had one coordinating meeting and another is planned for Sacramento in August. We meet annually with other partners to discuss findings, logistics and other issues related to the project. We disseminate a detailed annual report to all partners and other interested parties each December.

A-133 Single Audit Reporting Statements: The University of Nevada, Reno is required to submit an annual A-133 Single Audit Report. UNR's fiscal year runs July – June. The 2013 Fiscal Year audit report is available on the Federal Audit Clearinghouse Single Audit Database website (http://harvester.census.gov/sac/) and can also be viewed on the institution's website here: http://www.unr.edu/Documents/research/OSP/reports/a133/FY13_A133_AuditReport.pdf

Figures and Tables*

Table 1. Location and time period associated with non-native herbivore treatments to be studied in this proposal.

Treatment	Location-time period
Livestock only	Hart Mountain (1988-1991)
Horses only	Sheldon proposed
Livestock+Horses	Massacre proposed
Post livestock	Hart Mountain (1991-2005), Sheldon (1991-2005)
Low density horses	Hart Mountain proposed

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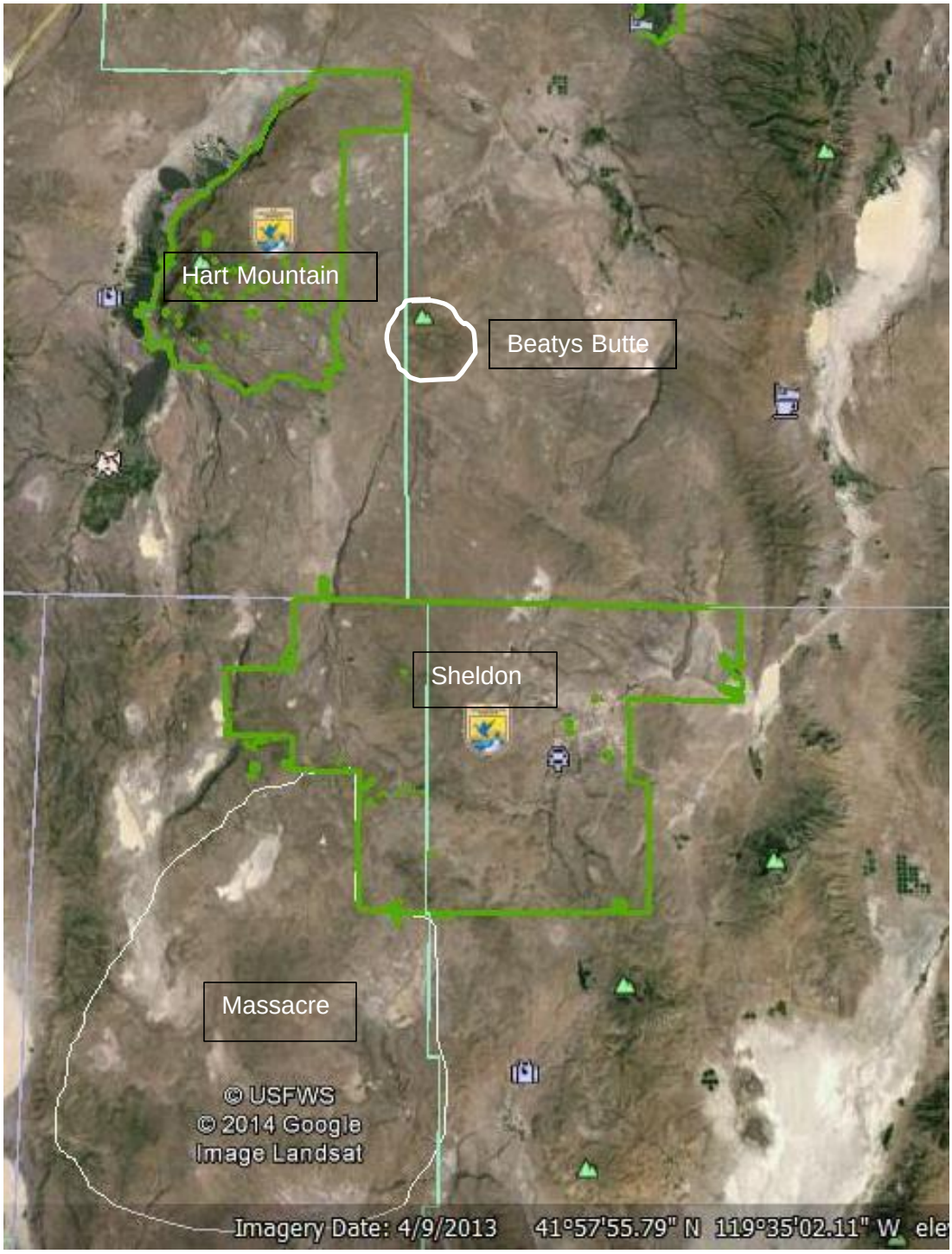

Fig. 1. Location of proposed study units. Work on the Hart and Sheldon Units provide data on sage-grouse and their habitats with low densities of non-native herbivores (Hart) and in the presences of feral horses (Sheldon). These sites build on Mike Gregg's earlier work pre- and post-removal of livestock from Hart, and pre-invasion of horses on Sheldon. The Massacre has horses and livestock grazing. Sage-grouse from both Hart and Sheldon move to Beatys Butte and there is interest in connectivity among these three areas.

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Greater Sage-grouse Publications:

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Synergistic Activities:

Nevada Governor's Sage Grouse Task Force. (2003-2011).

Bureau of Land management, Sage Grouse Habitat management Guidelines, Technical Review Team (2005-2008)

California Energy Commission Wind Energy policy Technical Review Team (2006-2007).

Oversight Committee, Sage-grouse Research Collaborative, National Wind Coordinating Collaborative (2010-present)

Technical Team, Research protocols for assessing transmission line impacts on sage-grouse, Utah Wildlife in Need (2011)

Science Working Group, Nevada Sagebrush Ecosystem Council (2013-present)

Technical Review Group Conservation Credit System for Greater Sage-grouse in Nevada (2014)

Expert Review Team, Habitat Suitability Modeling for Greater Sage-grouse in Nevada (2014)

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Disclaimer regarding data sharing *: NO restrictions on data sharing.