2019 Grouse & Grazing Project
Vegetation Monitoring and Grazing Report
Jim Sage Study Site

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INTRODUCTION

Livestock grazing is a common land use within sage-grouse (*Centrocercus urophasianus*) habitat, and livestock grazing has been implicated as one of numerous factors potentially contributing to sage-grouse population declines (Beck and Michell 2000, Schroeder et al. 2004). However, there are also numerous mechanisms by which livestock grazing might benefit sage-grouse (Beck and Michell 2000, Crawford et al. 2004). Livestock grazing on public lands is often restricted so as to limit negative effects on populations of plants and animals (including sage-grouse), but we lack experimental studies that have explicitly examined the effects of livestock grazing on sage-grouse. The objective of the Grouse & Grazing Project is to document the relationship between cattle grazing and sage-grouse demographic traits, nest-site selection, and habitat features. We focus on grazing regimes that include spring cattle grazing because spring is thought to be the time when livestock grazing is most likely to adversely affect sage-grouse (Neel 1980, Pedersen et al. 2003, Boyd et al. 2014).

Starting in 2018, we split our annual reports for this project into two separate reports: one that summarizes field methods, sage-grouse demographic traits, and other data streams and another that summarizes the habitat measurements and grazing metrics that we collect at each study site. Our goal in the vegetation monitoring and grazing reports (one for each study site) is to: 1) document the plant community at each site, 2) quantify the % biomass removed or utilization of forage species by cattle at each site, and 3) provide detailed data to assist BLM managers and permittees with management of their grazing and adherence to the Grouse & Grazing study design.

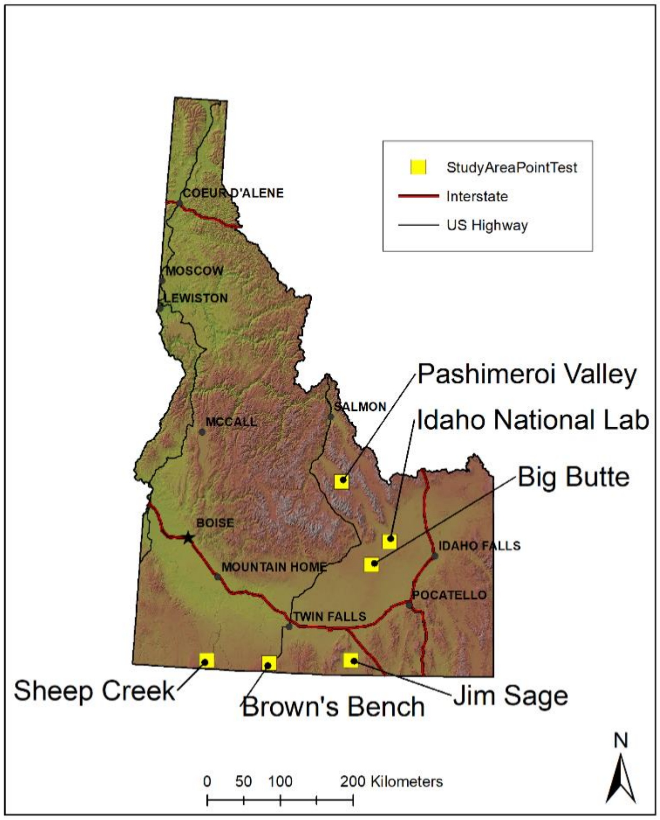

Figure 1. Six study sites in southern Idaho where field work has been conducted for the Grouse & Grazing Project in 2019.

STUDY AREA

Jim Sage

We began work at the Jim Sage study site in 2014. The site is located 8 km south of Malta, ID on the east slope of the Jim Sage Mountains (Figs. 1-2). The site has an east-facing aspect and gently slopes towards the Raft River Valley. Sheep Mountain is a lone butte that sits near the eastern edge of the experimental treatment pastures. Nearby human development includes several large dairies and agricultural fields that are roughly 5 km from the experimental treatment pastures. Soils belong primarily to the Womack, Nibbs, and Darkbull complexes which are characterized by slopes ranging from 1-8%, moderately deep to relatively shallow soil depths, and gravely loam to gravely silt loam textures. The plant community at this site consists primarily of low sagebrush (*Artemisia arbuscula*) on the mountain slopes changing to Wyoming (*Artemisia tridentata wyomingensis*) and basin big sagebrush (*Artemisia tridentata tridentata)* at the toe slopes. A hybridized version of bluebunch wheatgrass (*Pseudoroegneria spicata*) is the primary perennial grass species. The eastern third of the experimental treatment pastures has increasing cheatgrass (*Bromus tectorum*) cover in the understory and it becomes the dominant grass species on the far eastern edge of the pastures.

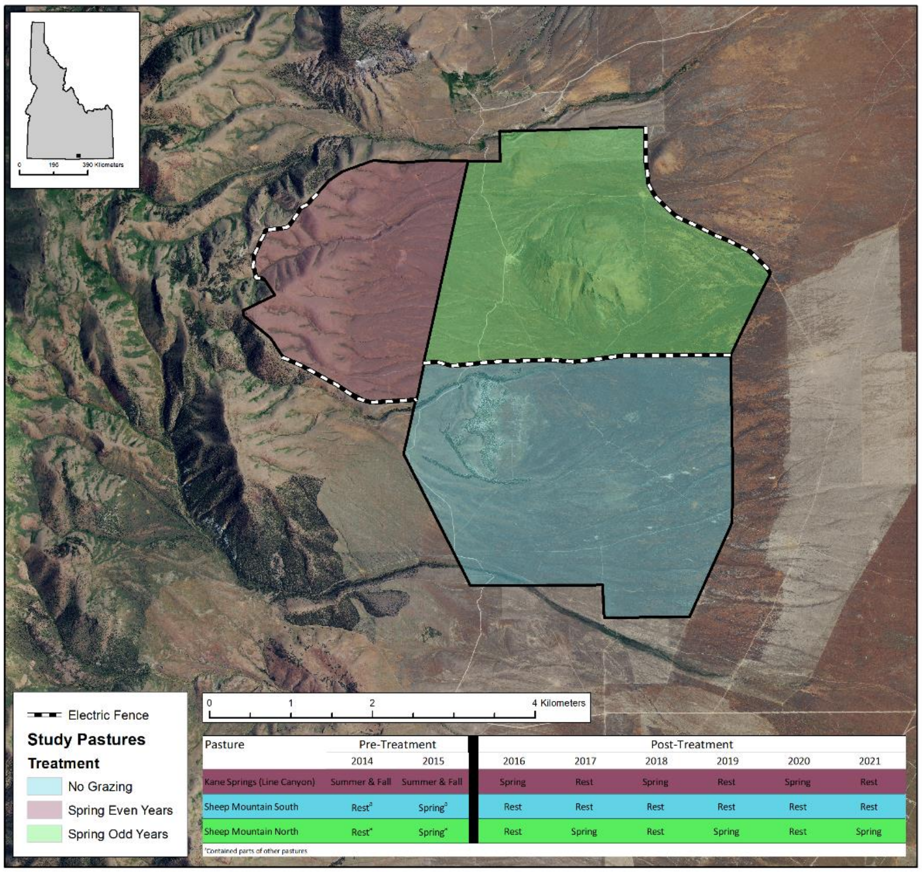

Figure 2. Map of experimental treatment pastures and timeline of treatments at the Jim Sage study site, Idaho 2014-2021.

Elevation at the site ranges from 1,507-2,087 m (mean 1,653 m; USGS National Elevation Dataset). Precipitation comes primarily in the form of snow between November and March with 30-year normal annual amount averaging 247 mm (1980-2010; NOAA Online Climate Dataset). Monthly average temperatures range from a low of -2.5° C (Dec) to a high of 20.7° C (Jul) based on the most recent 30-year normal (1980-2010; NOAA Online Climate Dataset). The Bureau of Land Management (BLM) manages the Jim Sage allotment and livestock grazing is allowed to occur 1 April 1 – 30 November each year. Prior to the study, these pastures were rested at least once every 3rd spring to allow forage species to be undisturbed during the growing season. The permittees in this area run a herd of 100-200 cow/calf pairs each year.

Table 1. Summary of the vegetation data collected for the Grouse & Grazing Project at 6 study sites in southern Idaho, 2014-2019.

Data Stream	Time of Collection	Sample Locations	Years Collected	Purpose
Early Season Vegetation Monitoring	March - April	Nests from previous year and paired random plots	2017 – 2019	Quantify vegetation characteristics when hen is selecting nest site
Nesting Season Vegetation Monitoring	April - July	Nests from current year & random plots[1]	2014 – 2019	Quantify vegetation characteristics of current year nest sites and experimental treatment pastures
Brood Vegetation Monitoring	May - July	Locations where a hen with a brood was confirmed	2016 – 2019	Quantify vegetation at brood locations
Post-Growing Season Vegetation Monitoring	July - August	Random plots	2015 – 2019	Quantify height, obstruction, and utilization of grass
Utilization/Pattern Use Monitoring	July - August	Systematic transects throughout experimental treatment pastures	2015 – 2019	Quantify utilization and grass height
Utilization/Biomass Removal (grazing exclosure cages)	April (cages placed), August (clipped)	Random plots in spring grazed (current year) experimental treatment pastures	2016, 2018-2019	Quantify utilization and biomass removal
Plant Collections	April - August	Experimental treatment pastures and surrounding areas	2017 – 2019	Create a DNA reference database and a library of voucher specimens to confirm plant ID and use as a training guide

[1]From 2014-2017, we also measured nesting season vegetation at paired non-nest plots associated with each nest plot (100-200m away from each nest plot).

FIELD METHODS

We have written detailed field sampling protocols for all aspects of the Grouse & Grazing Project, including vegetation sampling protocols (*Sections 8-9 of* Conway et al. 2019). We are collecting the following vegetation data to help quantify sage-grouse habitat selection and cattle grazing intensity on the experimental treatment pastures associated with the Grouse & Grazing Project (Table 1):

- Early-season Vegetation Surveys
  - Nest plots from prior years
  - Paired random plots
- Nesting-season Vegetation Surveys
  - Nest plots from current year
  - Paired dependent non-nest plots
  - Random plots
- Brood Vegetation Surveys
  - Plots at sites used by hens with broods <42 days of age
- Post-growing Season Vegetation Surveys
  - Random plots
- Utilization Transects
  - Landscape appearance estimates along transects
  - Grass height and percent removal estimates along transects
- Grazing Exclosures
  - Clipping above-ground biomass within grazing exclosure cages
  - Clipping above-ground biomass in paired grazed plots adjacent to cages
- Plant Collection Surveys

For sake of organization, we describe the nesting-season vegetation surveys first because they are the most detailed and subsequently we describe the other types of vegetation surveys since many of them are a reduced version of nesting-season vegetation surveys.

Nesting-Season Vegetation Surveys

We measured nesting-season vegetation (at estimated hatch date for sage-grouse nests) at three types of plots: nest plots, paired non-nest plots (hereafter referred to as non-nest plots; 100-200 m from each nest), and random plots. Nest plots were centered on sage-grouse nests. Each paired non-nest plot was associated with a specific nest plot (100-200m away in a random direction and centered on a sagebrush shrub that was large enough to contain a sage-grouse nest). Each nest plot had only one paired non-nest plot associated with it. Random plots were at randomly generated locations and were also centered on sagebrush shrubs. All random plots were within the experimental treatment pastures. We randomly generated 40 locations within each experimental treatment pasture that were no closer than 100 m from one another to create random locations to use for random plots.

Plot Placement in the Field

Each year, we strived to conduct vegetation sampling at a minimum of 20 random plots in each pasture (except at Pahsimeroi Valley in 2017-2019 because we monitored 7 pastures and did not have the personnel to complete 20 per pasture; we completed 10-15 per pasture instead). Starting in 2017, we only measured paired non-nest plots when time allowed (we placed priority on nest plots and random plots). We completed 50 paired non-nest plots in 2017, 0 in 2018, and 3 in 2019.

Nest plots were centered on the nest. Non-nest and random plots were centered on a focal shrub that was suitable for a sage-grouse nest (based on prior years' nest plot data) because 99% of nests from prior years were at the base of a shrub. At each plot, we spread two 30-m tapes that intersected at the 15-m mark over the focal shrub in each cardinal direction (Fig. 3).

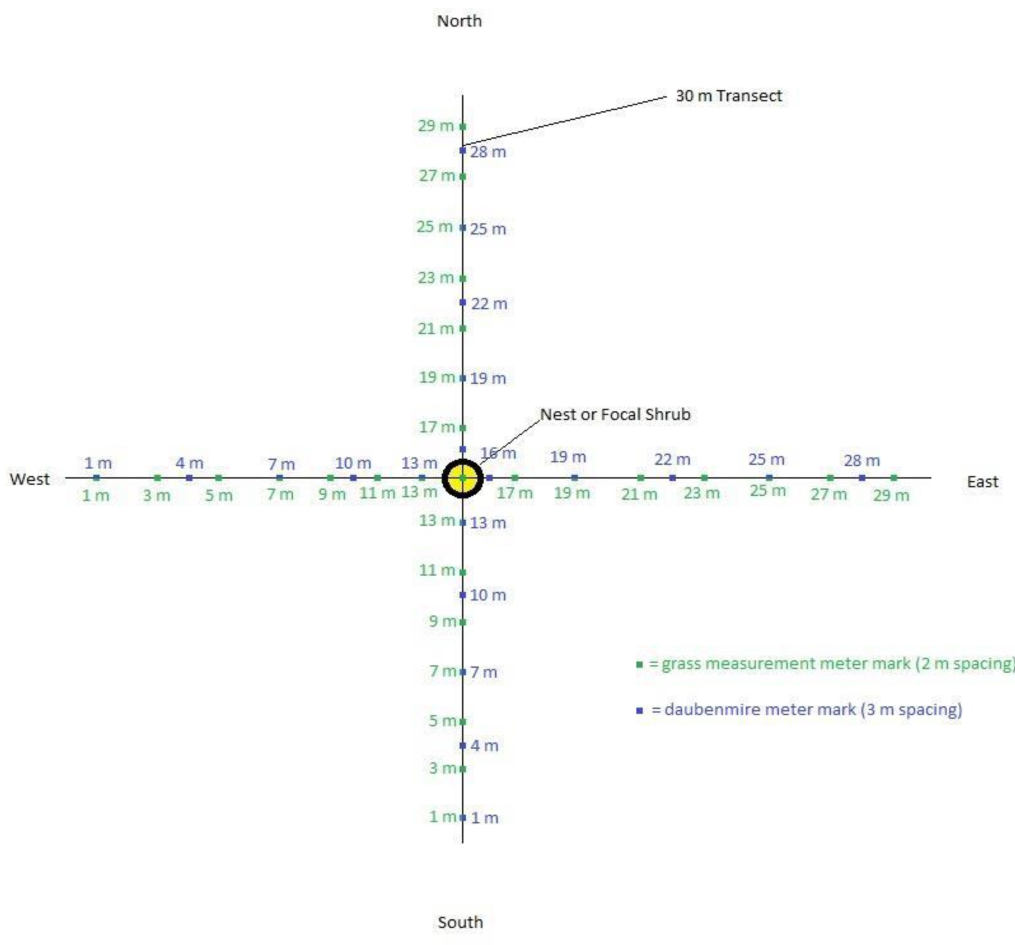

Figure 3. Visual depiction of the placement of two 30-m tapes stretched to conduct vegetation sampling at nest plots, random plots, and paired non-nest plots for the Grouse & Grazing Project in southern Idaho, 2014-2019.

Each plot (nest, non-nest, and random plots) consisted of 6 types of data collection: a set of 5 photographs to estimate percent nest concealment, measurements of the nest or focal shrub (or the patch of shrubs), two line-intercept transects to estimate percent shrub cover, estimates of perennial grass height (we do not measure heights for cheatgrass, *Bromus tectorum*, or other annuals) and grazing intensity (by species) along the line transects, Daubenmire plots to estimate percent ground cover, and a count of herbivore fecal droppings along the line transects. Detailed descriptions of each of these 6 components are in our vegetation sampling protocols (Conway et al. 2019).

Landscape Appearance

We used the landscape appearance method (Coulloudon et al. 1999) to estimate utilization in experimental pastures (and potential experimental pastures at sites where the experimental pastures had not been selected yet). We used ArcGIS to randomly place a grid of north-south transects in experimental pastures and potential experimental pastures. If the pasture was grazed by livestock during spring/summer, we placed transects 300 m apart and sampled at 200-m intervals along each transect. If the pasture was not grazed by livestock during spring/summer that year, we instead placed transects 500 m apart and sampled at 200-m intervals (because we were expecting minimal utilization in pastures that did not have cows in them). At 200-m intervals along each transect, the observer stopped walking and estimated utilization according to the utilization classes in Coulloudon et al. (1999; Table 2) within a 15-m radius half-circle in front of them. The observer also estimated the percent cover of cheatgrass and the most dominant overstory shrub and perennial grass within the same 15-m radius half-circle in front of them at each sample point along the transect (i.e., every 200 m).

Table 2. Utilization classes that we used to estimate percent utilization along landscape appearance transects (based on Coulloudon et al. 1999).

Utilization Class	Description
0-5%	The rangeland shows no evidence of grazing or negligible use.
6-20%	The rangeland has the appearance of very light grazing. The herbaceous forage plants may be topped or slightly used. Current seed stalks and young plants are little disturbed.
21-40%	The rangeland may be topped, skimmed, or grazed in patches. The low value herbaceous plants are ungrazed and 60 to 80 percent of the number of current seedstalks of herbaceous plants remain intact. Most young plants are undamaged.
41-60%	The rangeland appears entirely covered[a] as uniformly as natural features and facilities will allow. Fifteen to 25 percent of the number of current seed stalks of herbaceous species remain intact. No more than 10 percent of the number of low-value herbaceous forage plants are utilized. (Moderate use does not imply proper use.)
61-80%	The rangeland has the appearance of complete search[b]. Herbaceous species are almost completely utilized, with less than 10 percent of the current seed stalks remaining. Shoots of rhizomatous grasses are missing. More than 10 percent of the number of low-value herbaceous forage plants have been utilized.
81-94%	The rangeland has a mown appearance and there are indications of repeated coverage. There is no evidence of reproduction or current seed stalks of herbaceous species. Herbaceous forage species are completely utilized. The remaining stubble of preferred grasses is grazed to the soil surface.
95-100%	The rangeland appears to have been completely utilized. More than 50 percent of the low-value herbaceous plants have been utilized.

[a] "covered" means that foraging ungulates have passed through the area.
[b] "complete search" means that foraging cattle have spent considerable time foraging in the area and were not just passing through.

Cattle Use Metrics

Each year, we record the number and timing of cattle that graze each experimental treatment pasture and adjacent pastures. We communicated with range management specialists and permittees at each study site to document the number and dates for which cattle were turned out and removed from each pasture. We collected this data for every year of the study at a given field site and ≥3 years prior to when we began field work.

SUMMARIZATION METHODS

Pasture Boundaries

The boundary of the pastures in the pre-treatment years was often not the same as the boundary of the pastures after the treatments were implemented. This was typically due to the installation of electric fences to cut existing pastures into two halves so that we could concentrate grazing pressure and allow ranchers more flexibility to meet the needs of the study while also achieving the goals of their operation (i.e., so that they only had to adhere to the study design within one half of a pasture). We used the boundary of the post-treatment pastures for all comparisons, even those that included years prior to the treatments.

Pasture Level

For comparison of grass metrics between pastures, we first calculated a mean for each sampling plot because plots were our primary sampling unit. We then used this plot mean to calculate a mean among all plots for an entire pasture. We compared mean droop height of grasses among pastures and years at each study site. For the current year (2019), we also compared grass droop heights within a pasture based on 4 categories: 1) all perennial species combined, 2) all perennial species excluding Sandberg bluegrass (*Poa secunda*), 3) all perennial grasses that were not under a shrub (out in the open), and 4) all perennial grasses that were under a shrub. For the latter two categories (under and not under a shrub), we used all perennial grass plants measured regardless of species (i.e., we included Sandberg bluegrass).

Grass Height Measurements

We measure the height of each perennial grass plant in an individual transect in 3 separate ways:

- Droop height – The tallest part of an individual perennial grass (including the flowering stalk)
- Leaf height – The tallest part of the grass plant excluding the flowering stalk (i.e., just the leaves)
- Effective height – A visual obstruction measurement created by placing a meter stick behind the grass plant and recording the lowest interval bar that was ≤50% obscured by the grass (Musil 2011; *detailed methods can be found in* Conway et al. 2019).

We used each of these 3 metrics to compare grazed and un-grazed pastures in 2019. We used the individual grass as the sample unit, not the plot, for this comparison.

Shrub Cover

We compared shrub cover from the line-intercept transects among pastures and years. We estimated shrub cover by taking the length of the transects that were intercepted by shrubs and dividing it by the entire length of the 2 transects (60 m).

Utilization

We estimated utilization using three different methods for this report: 1) Average of ocular estimates of biomass removed for individual grass plants on random vegetation plots, 2) proportion of grazed grass plants (i.e., proportion of grass plants with >0 biomass removed), and 3) utilization estimates via the landscape appearance method (Coulloudon et al. 1999). We compared estimates of biomass removed (via ocular estimation) and proportion of grazed plants at the pasture level for the current year (2019). These estimates were generated at the plot level from the post-growing season vegetation surveys. Those plot-level means were used to calculate pasture-level means. This was done to avoid pseudoreplication since the plot is our sampling unit.

For utilization via landscape appearance transects, we obtained pasture-level estimates by taking the mean of all points sampled within that pasture. We used the mid-point of the ranges outlined in Table 2 to represent each of the 6 categories (i.e., the “slight” category was the mid-point between 6 and 20, or 13).

We created maps of pattern use by herbivores in each pasture based on our visual estimates of utilization from the landscape appearance transects. We used the Inverse Distance Weighted (IDW) tool in ArcGIS (version 10.4) to interpolate utilization in areas between sampling points. IDW interpolation is based on the assumption that points closer together are more alike than those further apart. An advantage of using IDW interpolation is that it is an exact interpolator (i.e., the interpolated value at each point where a measurement was taken will line up directly with what was actually measured at that point). We used the 12 nearest neighbors to interpolate each pixel of the resulting raster surface. The resulting maps were then classified into the 6 utilization categories to help visualize the spatial variation in utilization (see categories in Table 2).

Stocking Rate

We calculated stocking rates in head-months (HMs) for all years after our treatments began at each study site. We calculated HMs using the following formula:

$$\frac{n_c \times (t_2 - t_1)}{(\frac{365}{12})}$$

Where n_c is the total number of cow-calf pairs turned out in that pasture, t_1 is the initial turn-out date, and t_2 is the date they were removed from the pasture. If there were different stocking rates across a given season (e.g., 100 cows were added for the first 10 days and then 100 cows were added on the 11th day), we calculated head-months for each separate stocking rate and summed them together to report the stocking rate for the entire season.

RESULTS

Weather

Going into the 2019 growing season, Jim Sage received slightly above-average overwinter precipitation (Fig. 4A) and average to slightly below-average temperatures (Fig. 4B). Pulses of above-average precipitation in Feb, Apr, and May helped spur vigorous vegetation growth across the study site. In recent years, Jim Sage has consistently received higher precipitation amounts during the growing season than the other study sites in the Grouse & Grazing Project.

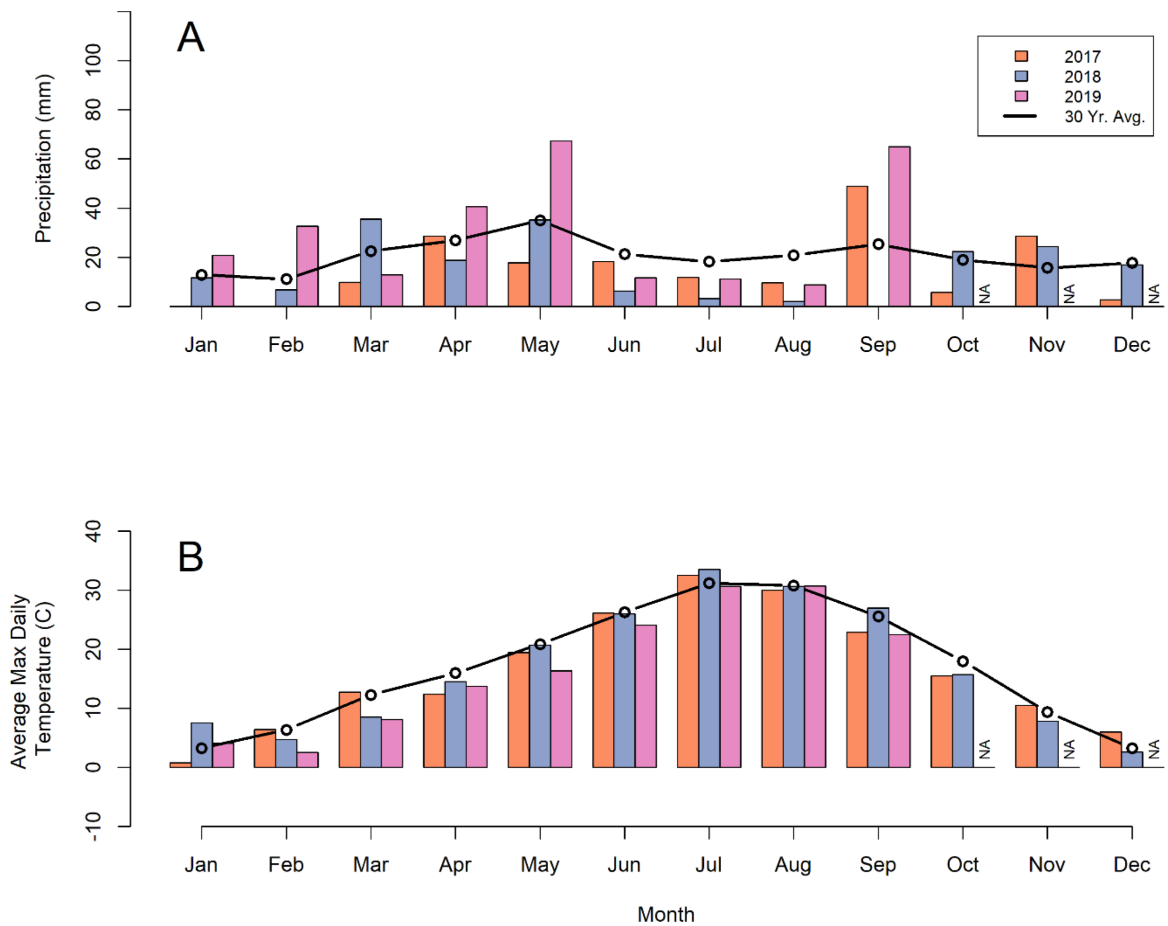

Figure 4. Monthly precipitation totals (A) and average max daily temperature by month (B) with 30-year average (dark line) at Jim Sage, Idaho 2017-2019.

Descriptive Vegetation Characteristics

Pasture-level Comparison

Grass heights varied among years and were generally lower in 2014-2015 than after the treatments began in 2016 (Fig. 5). Grass heights were equal or slightly greater during post-growing season surveys as compared to nesting season surveys for all 3 pastures. The only glaring exceptions to this trend were Kane Springs in 2018 and Sheep Mountain North in 2019. Both of these pastures were grazed between nesting season and post-growing season surveys in those respective years. A thesis by Janessa Julson (2017) documented the extent of variation in grass height among our study sites.

Mean grass height after excluding Sandberg bluegrass (yellow bars) was taller than the other 3 grass height categories (those that did not exclude Sandberg bluegrass) in most pastures for both survey seasons (Fig. 6). Grasses under a shrub (orange bars) were the second tallest category and were very similar to grass heights excluding Sandberg bluegrass in most pastures. In the only grazed pasture at Jim Sage (Sheep Mountain North) in 2019, we saw a slight decrease in height across all 4 categories between nesting and post-growing season surveys. The inverse occurred (grass heights slightly increased across all 4 categories) in both of the ungrazed pastures (Kane Spring and Sheep Mountain North). The Jim Sage study site has less difference in grass height across these 4 categories compared to the other study sites in the Grouse & Grazing Project. This is likely because the primary forage and species overall across the experimental treatment pastures is bluebunch wheatgrass which requires higher grazing pressure to reduce its overall height.

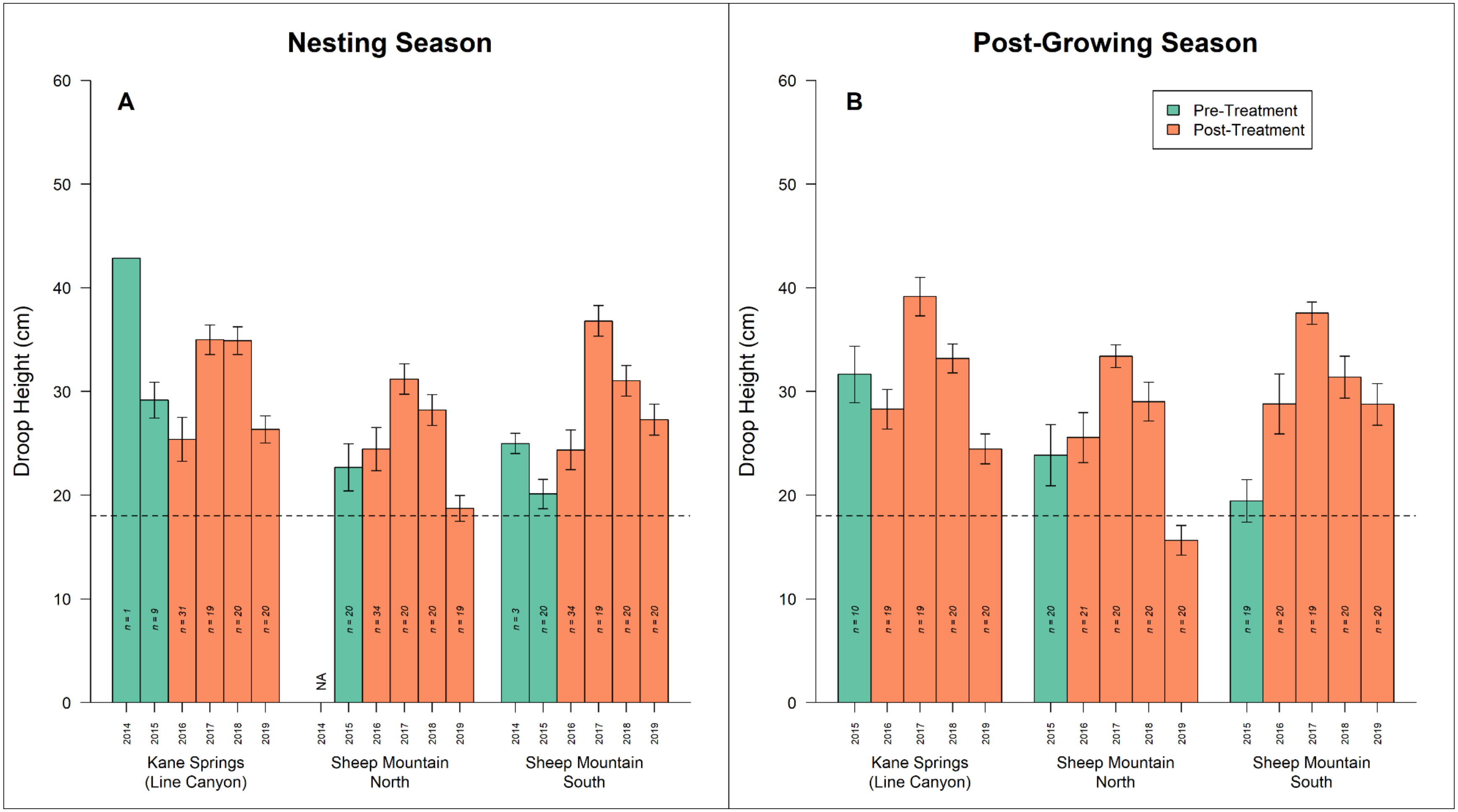

Figure 5. Mean droop height during the nesting season (A; Apr-Jun) and the post-growing season (B; Jul-Aug) for all perennial grass species combined in pre-treatment (green) and post-treatment (orange) years for 3 pastures at Jim Sage, Idaho 2014-2019. Error bars indicate standard errors and means are based on random plots (excludes nest and non-nest plots). NA indicates a pasture that was not measured in that year. The dashed line represents 18 cm (7 in.), the height mentioned as a management target in the sage-grouse habitat guidelines (Connelly et al. 2000).

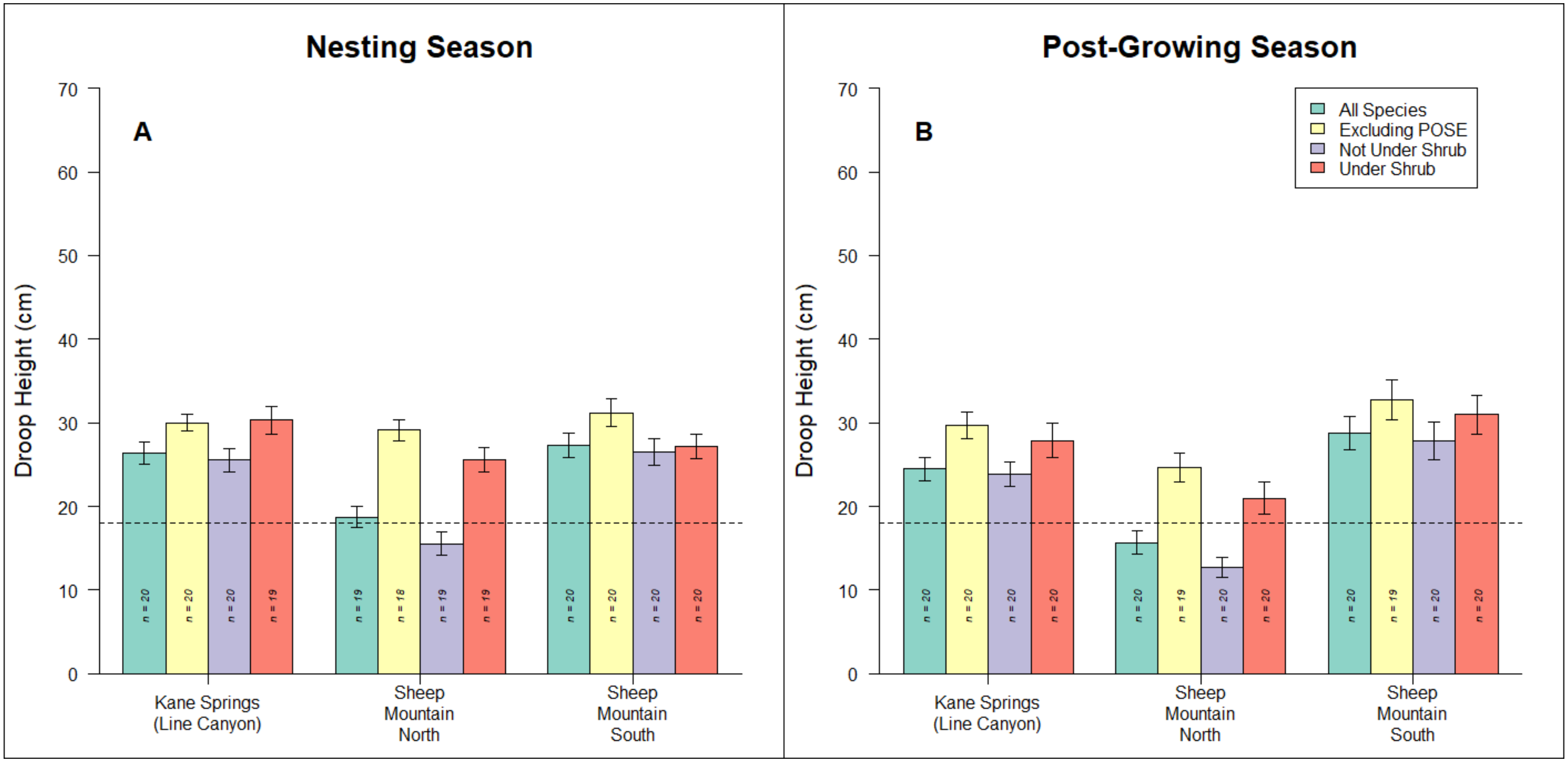

Figure 6. Mean droop height for 4 different subsets of grasses: all perennial grass species within a plot, all perennial grass species excluding Sandberg bluegrass (Poa secunda), all perennial grass plants that were under a shrub, and all perennial grass plants that were not under a shrub in both nesting season (A) and post-growing season (B) plots at Jim Sage, Idaho 2019. Error bars represent ±1 standard error. Sample sizes (n) indicate the number of plots (not the number of grass plants) used to create the mean and standard error. The dashed line represents 18 cm (7 in.), a height mentioned as a management target in the sage-grouse habitat guidelines (Connelly et al. 2000).

Grass Height Measurement Comparison

Sandberg bluegrass, bluebunch wheatgrass, squirreltail (*Elymus elymoides*), western wheatgrass (*Pascopyrum smithii*), and basin wildrye (*Leymus cinereus*) were the most abundant grasses in our post-growing season surveys at Jim Sage in 2019. Grass height differed among species and those differences were also apparent for all three height metrics (Fig. 7). All grasses that were measured in the grazed pasture were shorter than those in the 2 ungrazed pastures for all 3 height metrics. Differences in leaf height and effective height were less prominant between grazed and ungrazed pastures for most species.

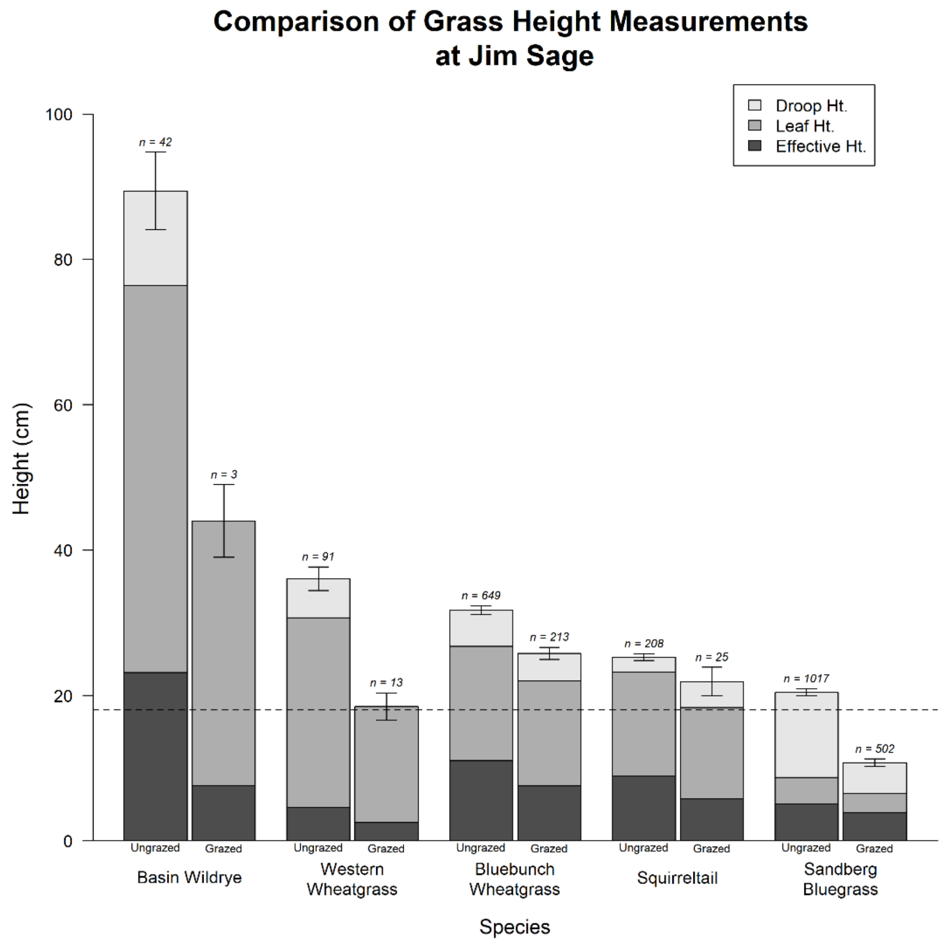

Figure 7. Mean height of the 5 most common species of perennial grasses based on 3 height metrics on post-growing season (Jul-Aug) random plots at Jim Sage, Idaho in 2019. Heights compared were droop height (using highest part of plant) = "Droop Ht.", droop height excluding the flowering stalk = "Leaf Ht", and effective height (modified visual obstruction for an individual plant) = "Effective Ht". Heights were compared seperately for plants in ungrazed and grazed pastures based on whether they were grazed in 2019 prior to post-nesting season surveys (denoted directly below each bar). Sample sizes are just below the top of each bar. Error bars denote ±1 standard error of the droop height only. The dashed line represents 18 cm (7 in.), the grass height mentioned as a management target in the sage-grouse habitat guidelines (Connelly et al. 2000).

Shrub Cover

Shrub cover was fairly consistent across all pastures ranging from a high of 35% in Sheep Mountain South in 2019 to a low of 20% in Kane Springs in 2019 (Fig. 8). In general, shrub cover has increasd slightly in all pastures since the study began. Changes in shrub cover appear to be largest in Sheep Mountain South which is the non-grazing experimental treatment pasture.

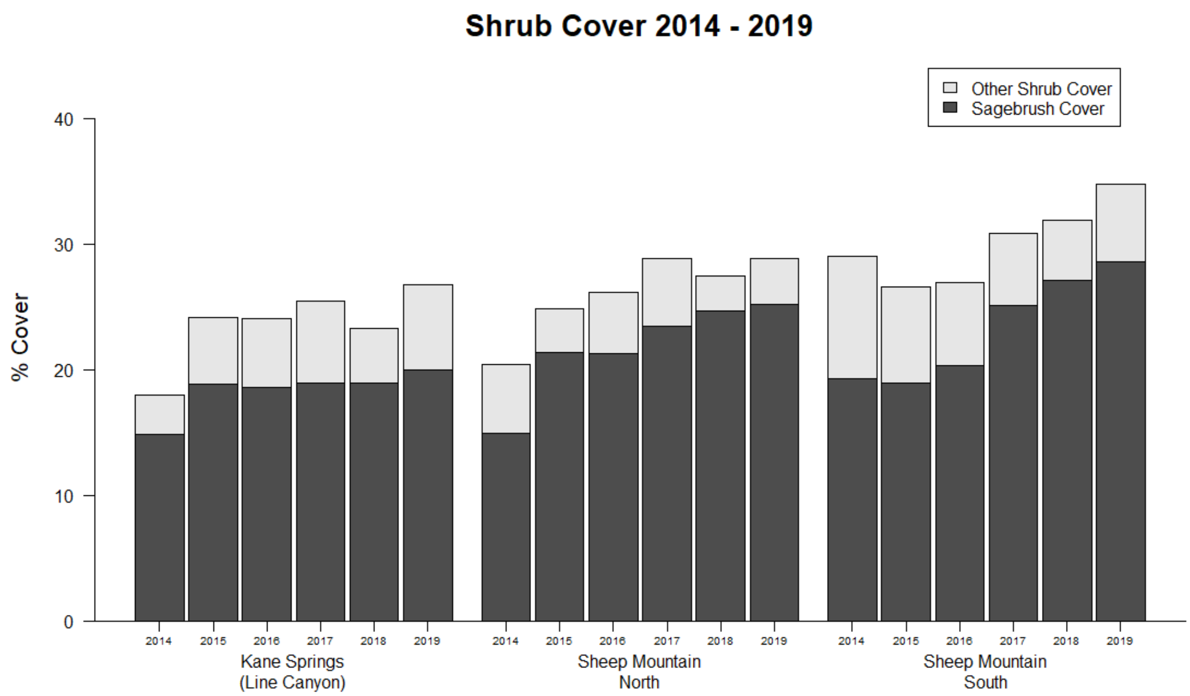

Figure 8. Shrub cover (split into sagebrush and other shrub cover) in each of 3 experimental treatment pastures at Jim Sage, Idaho 2014-2019.

Stocking Rates and Grazing Pressure

Treatments began at Jim Sage in 2016 and have gone the smoothest of any of the Grouse & Grazing Project study sites. Sheep Mountain South is our "no grazing" pasture, while Sheep Mountain North and Kane Springs are our alternating "spring only" treatments. Stocking levels (i.e., head-months) were higher in the Sheep Mountain North pasture in 2017 (Fig. 9D) because that permittee runs a slightly larger herd than the permittee who uses the Kane Springs pasture. Post-treatment head-months ranged from a low of 108 in 2018 to a high of 395 in 2017 in the experimental treatment pastures (Fig. 9C-E).

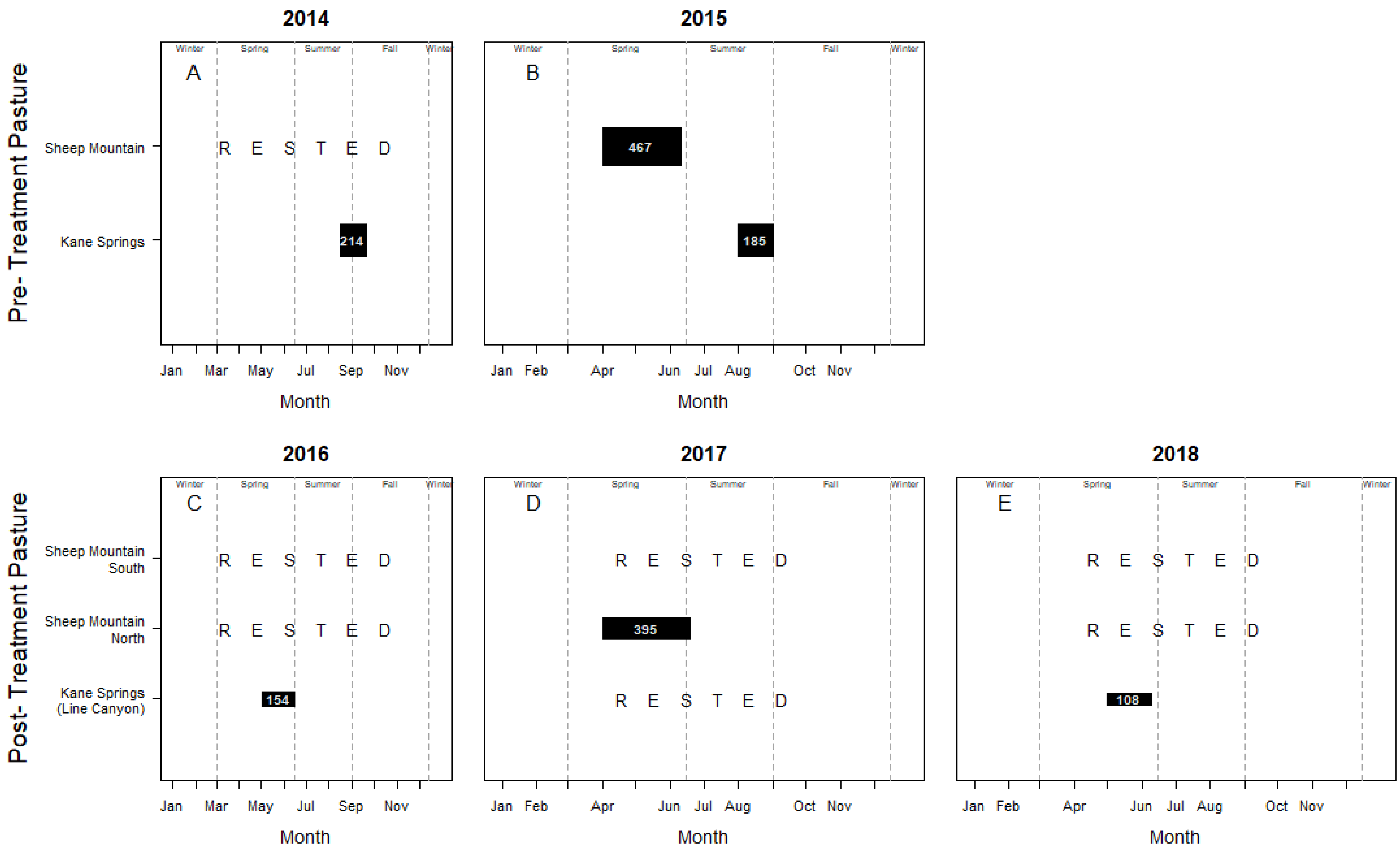

Figure 9. Timing and duration of cattle stocking at Jim Sage during pre- and post-treatment periods of the study 2014-2018 (data for 2019 has not been reported yet). Width of black bars indicate the average number of cattle per day in that pasture. White numbers inside black bars represent the total head-months *during that period.*

At the time of writing, we did not have stocking rate information for the 2019 growing season. In 2018, head-months in the experimental treatment pastures were comparable to surrounding pastures (those not part of the study; Fig. 10). Two of the experimental treatment pastures were rested in 2018. All but one pasture near our treatments were grazed in 2018.

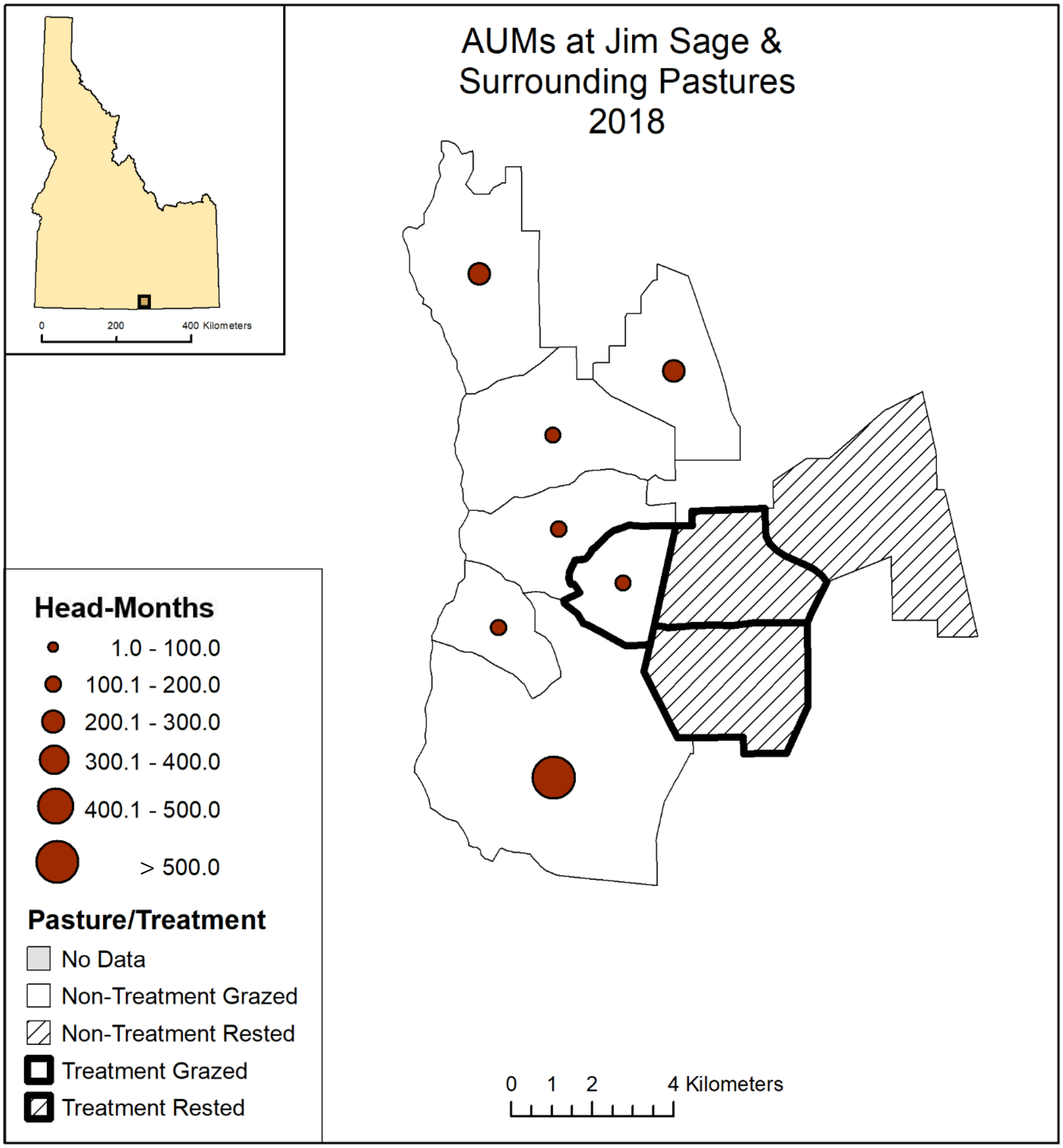

Figure 10. Stocking levle in head-months in treatment pastures and adjacent pastures at Jim Sage, Idaho in 2018.

Estimates of Utilization

Utilization estimates were negligibile in both Kane Springs and Sheep Mountain South based on visual estimates of individual plants (<2%, Fig. 11A). Sheep Mountain North was the only pasture that received any grazing in 2019 and that was reflected in both estimates of utilization and proportion of grazed plants (Fig. 11A-B). The propotion of grazed grass plants always yeilded a higher estimate of use than the visual estimate of percent biomass removed for all pastures and categories. When we compared estimates across the 4 categories, grass plants out in the open (not under shrub category; purple bars) always had the highest use.

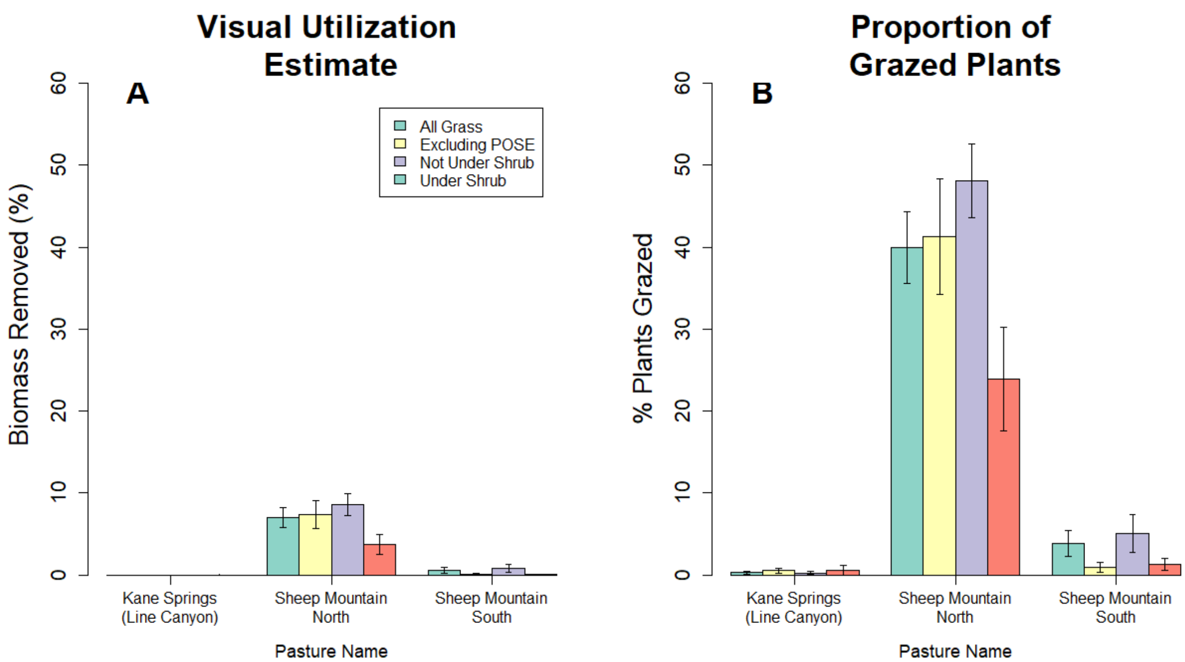

Figure 11. Grazing intensity based on visual estimates of percent biomass removed on individual grass plants and the proportion of grass plants grazed at random plots in 2019 at Jim Sage, Idaho. Estimates were taken from the post-growing season surveys conducted in July – August 2019. In 2019, only Sheep Mountain North was grazed prior to our post-growing season surveys.

Utilization estimates from the landscape appearance method varied among years (Fig. 12). In 2019, Sheep Mountain North had the highest level of use since we began measuring utilization with the landscape appearance method. Estimates of utilization were negligible for both Kane Springs and Sheep Mountain South in 2019 (both pastures were not grazed). Measures of utilization based on the landscape appearance method are potentially subject to observer bias; variability among observers and observer bias is a component of Alex Laurence-Traynor's M.S. thesis (Laurence-Traynor 2019).

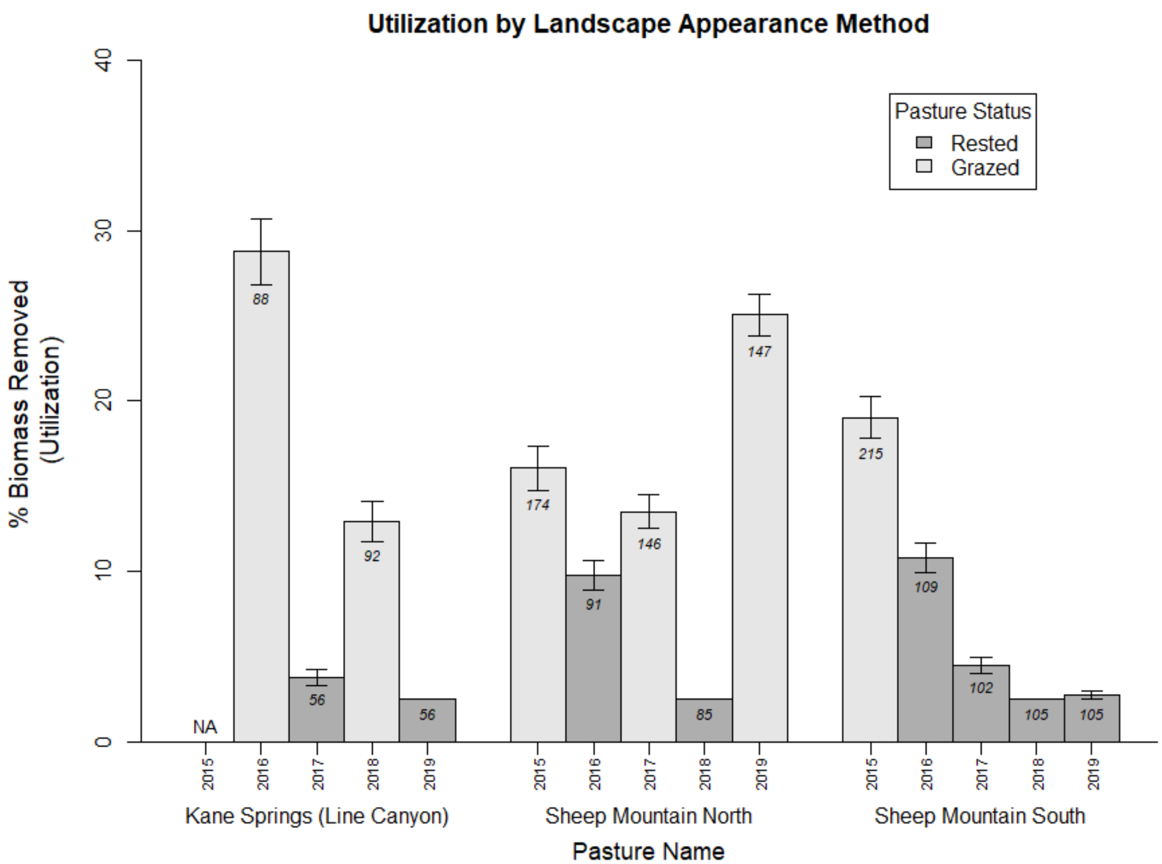

Figure 12. Utilization estimates based on the landscape appearance method for pre- and post-treatment periods at Jim Sage, Idaho 2015-2019. Error bars represent ±1 standard error. NA indicates that pasture was not measured in that particular year.

One of the advantages of using the landscape appearance method is that we can map spatial patterns of cattle use throughout each pasture. Not surprisingly, we found that cattle do not uniformly graze any of our experimental treatment pastures (Fig. 13). This is likely due to spatial variation in availability of water, topography, and grass. This variation was especially apparent in both of the spring grazed pastures (Kane Springs and Sheep Mountain North); cattle had much lower use levels on steep slopes (see the west side of Kane Springs and the south central part of Sheep Mountain North) and areas further from water sources.

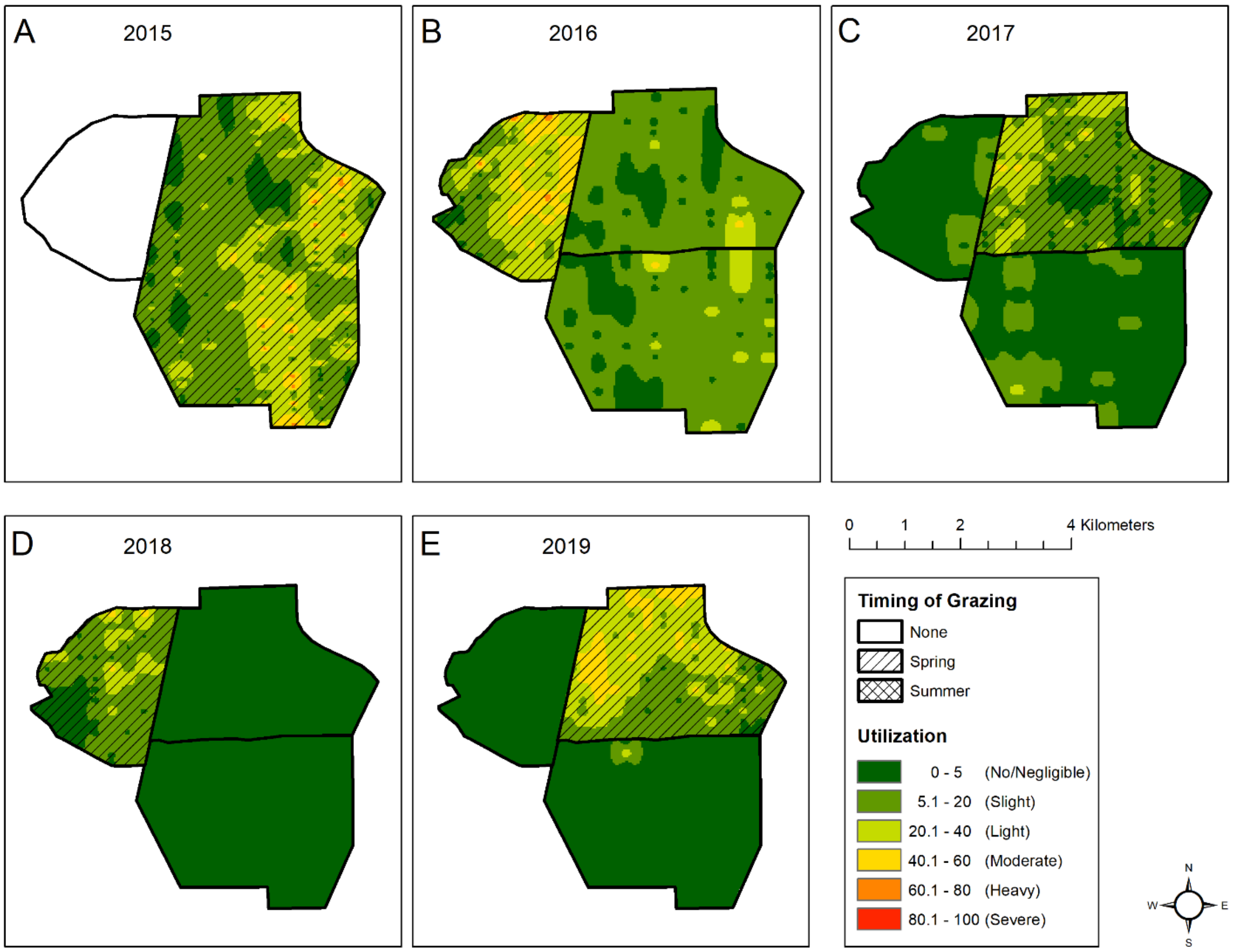

Figure 13. Pattern use mapping based on landscape appearance transects at Jim Sage, Idaho 2015-2019.

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