Quantifying Intraspecies Disturbance Interactions

Geospatial Assessment of Wildlife and Vegetation Dynamics

Blue Lake, CA (Leavey Ranch)

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Abstract

The focus of this project was to quantify intraspecies interactions by using biological and vegetative field data in conjunction with PGIS to graphically represent relationships between milk thistle density and gopher populations in on pasturelands located within Leavey Ranch property in Blue Lake, California. Additionally, barn owl presence or absence was interpreted for its influence on resulting vegetation and wildlife dynamics. Bioturbation, or the mixing of soil by organisms, has a direct influence on the physical structure of the soil and its ability to transport water and hold plant-required nutrients (Gabet et al., 2003). Soil transported out of the ground surface can allow undesirable plant species residing in the seed bed to become prolific.

This study was conducted on Leavey Ranch which is a property that has been kindly left to Humboldt State University (HSU) as a resource for natural resource majors to gain experience with suggesting land management actions. Participatory GIS (PGIS) techniques were conducted with the men and women of the Wildlife department at HSU to understand where the transects were placed. The students who originally gathered data did not record GPS locations to relate to the field work, and this gave us reason to use PGIS as an alternative to having the actual points. Polylines and points were digitized based on the PGIS information that was provided by Dr. Matthew Johnson of the Wildlife department. Ultimately, the data proved to be too variable and at too small of a scale for us to appropriately display the data in a way that would be useful to a land manager. In the future, there would need to be a different process of data collection chosen, or a different process of GIS analysis to make these relationships relatable on a map.

Introduction

Leavey Ranch comprises 240 acres adjacent to the Mad River along both sides of West End Road, southwest of Blue Lake, CA. The private property is a working cattle ranch and maintains partnerships with HSU and other local organizations in order to improve understanding of historical and contemporary land management practices as well as preserve and conserve its natural resources. The ranch is located on Native American ancestral territory (Wiyot). The land area includes five 160-acre minimum parcels with Agricultural Exclusive Zone Classification, Dispersed Housing, and a Grazing General Plan designation. The southernmost parcel includes a Timber Production Zone overlay with a Timberlands General Plan designation and a 160-acre minimum parcel size. Figure 1 provides a contour map of the study area.

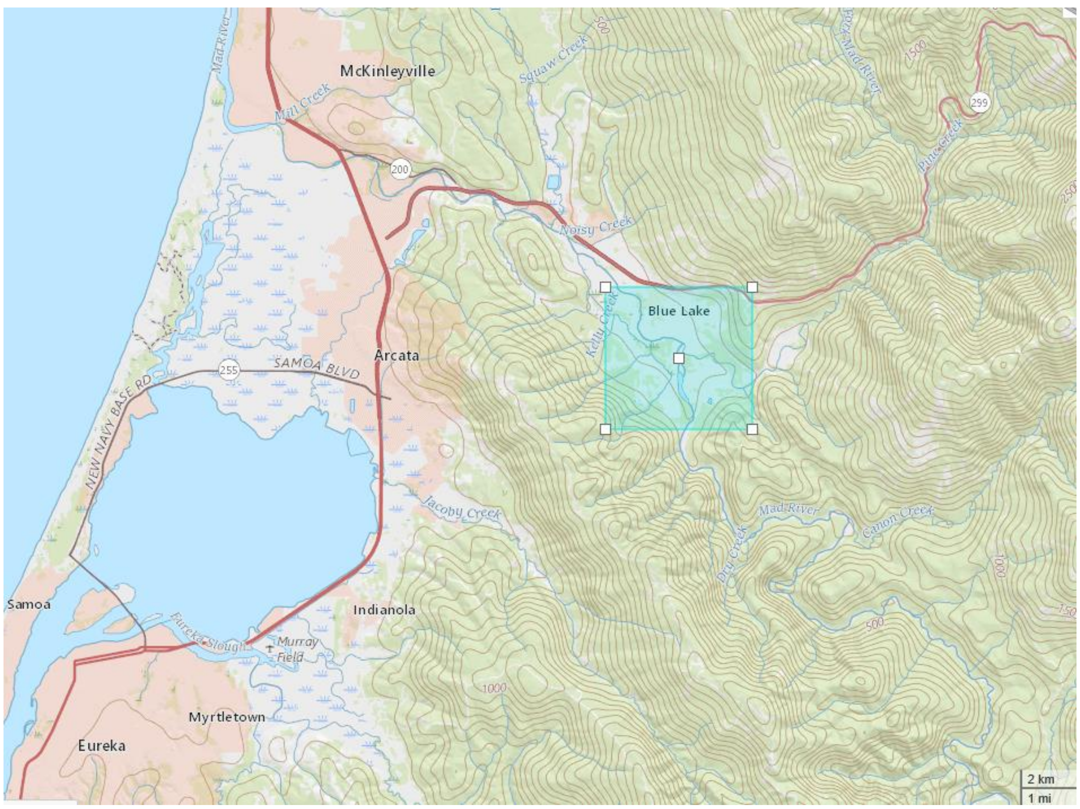

Figure 1: Study Area; Blue Lake, California

Background

The Leavey Ranch property is currently held in a Leavey Family Trust with legacy ownership of the property spanning hundreds of years. The focus of the Leavey Ranch Plan is to uphold the ideals set forth by the Leavey family as well as ensure current partner management objectives will be incorporated. Partners involved in stewardship of ranch operations include a grazing lessee, acting and residing ranch managers, Leavey Ranch Trustees and the Humboldt Area Foundation. Management objectives include upholding the visions of the Leavey family to retain diverse wildlife species, mitigate invasive vegetation concerns, successfully maintain an operating cattle ranch, support ranch operations that are consistent with the current and historic practices, and to preserve and protect distinct natural ecosystems as well as encouraging ranch uses for educational purposes (Ranch Basics, 2014 and Leavey Family Trust, 2016).

Within this view, we elected to geospatially interpret recent data gathered at Leavey Ranch by HSU students in enrolled in the Wildlife Techniques (WLDF 311) course. Biological relationships between avian species, small mammals and non-desirable forage species were evaluated. The residing ranch manager requested the resulting map be produced to display the interrelated dynamics between species, and also be presented in an interpretable manner by interested parties of the public, private, and scientific community members at large.

Project Goals

Spatial and cartographic analysis of the relationships between the presence of barn owls on thistle density and gopher populations could provide Leavey Ranch land managers a planning tool for pest remediation, increasing desirable wildlife species, and addressing invasive species concerns. The goal of the project is to interpret interdisciplinary research lead by Dr. Matthew Johnson of HSU’s Wildlife Department to quantify whether the presence of barn owls may impact gopher populations and thistle abundance on forageable rangelands in the lower reaches of the Mad River Floodplain in Humboldt County, CA. The lower pastures of the ranch comprise

46 total acres and were selected as the location for the wildlife course to collect the owl/gopher/thistle indices data.

Methods

Wildlife Techniques: Experimental Design

The students of HSU's Wildlife Techniques (311) course was led by Dr. Matt Johnson in the Fall of 2015 and 2016 at Leavey Ranch to gather data on gopher mounds and thistle densities. The stated objectives were to estimate the total number of thistle plants in the study area and create an index of gopher activities. Figure 2 shows the approximate locations and orientation of the transects chosen to for analysis (Johnson, 2017).

Two random starting points were selected for two baselines that ran North-South. Along each of the baselines, they systematically distributed 6 50-meter transects that intersected the baseline, heading East-West. The transects were separated by 70-90 meters, depending on which baseline was used. This sampling design was set up to span the full length of the study area. Students stood on the point where the transect intersects the baseline and randomly selected either east or west, then walked that direction and took data. If there was time, they also walked the other direction from the baseline and recorded the data. This technique influenced the randomization and scattering of the data to discourage bias, and data does not exist for every transect and direction.

Figure 2: Study Area; Blue Lake, California

Wildlife Techniques: Data Collection

For thistle abundance, the students randomly selected the starting points for two 2x5 meter plots that were centered on the transect. These two plots were not considered biologically independent so they are allowed to be averaged for analysis. Gopher activity was measured by walking out the entire 50-meters of the transect and measuring the total amount of centimeters that overlaid gopher mounds, holes, or other disturbed soil. Both the gopher activity and the thistle abundance were noted down in a data sheet. Density and total abundance of thistle populations and an index of gopher activity can be inferred from the data and evaluated for correlation with barn owl presence or absence.

Geospatial Analysis

For this project, we anticipated using both vector and raster data. The raster data ended up not being used due to the fact that our site was very flat, and a 10 meter DEM of the region was showing nothing of interest for us. The vector data produced was in the form of polylines, for the transects depicting thistle density and gopher activity as well as points for the barn owl box locations. Once polylines were created, attribute tables were added to associate the ground data with the transect on the map. There were a couple problems with this step.

We had hoped to create a map similar to the inundation-threat map (GSP 270: Lab 8) to show 2015-2017 data in different colored zones around each point of interest such as increased gopher activity or high-density thistle. However, we ended up finding that the small scale of the transect length made it difficult to digitize the densities in a way that would be effectively communicated to the land managers so that they could do mitigation for these invasives. The wildlife class took data in an incomplete fashion, making the assignment of attribute tables difficult as well. They might have had two sets of data for one transect, and no sets of data for the other. Looking forward, efforts could be repeat the same sampling methods that the wildlife folks used, but in a way that would be easier to digitize and convey through ArcMap. Figure 3 shows the resulting map of the Leavey Ranch area with transect locations digitized based on the experimental protocol.

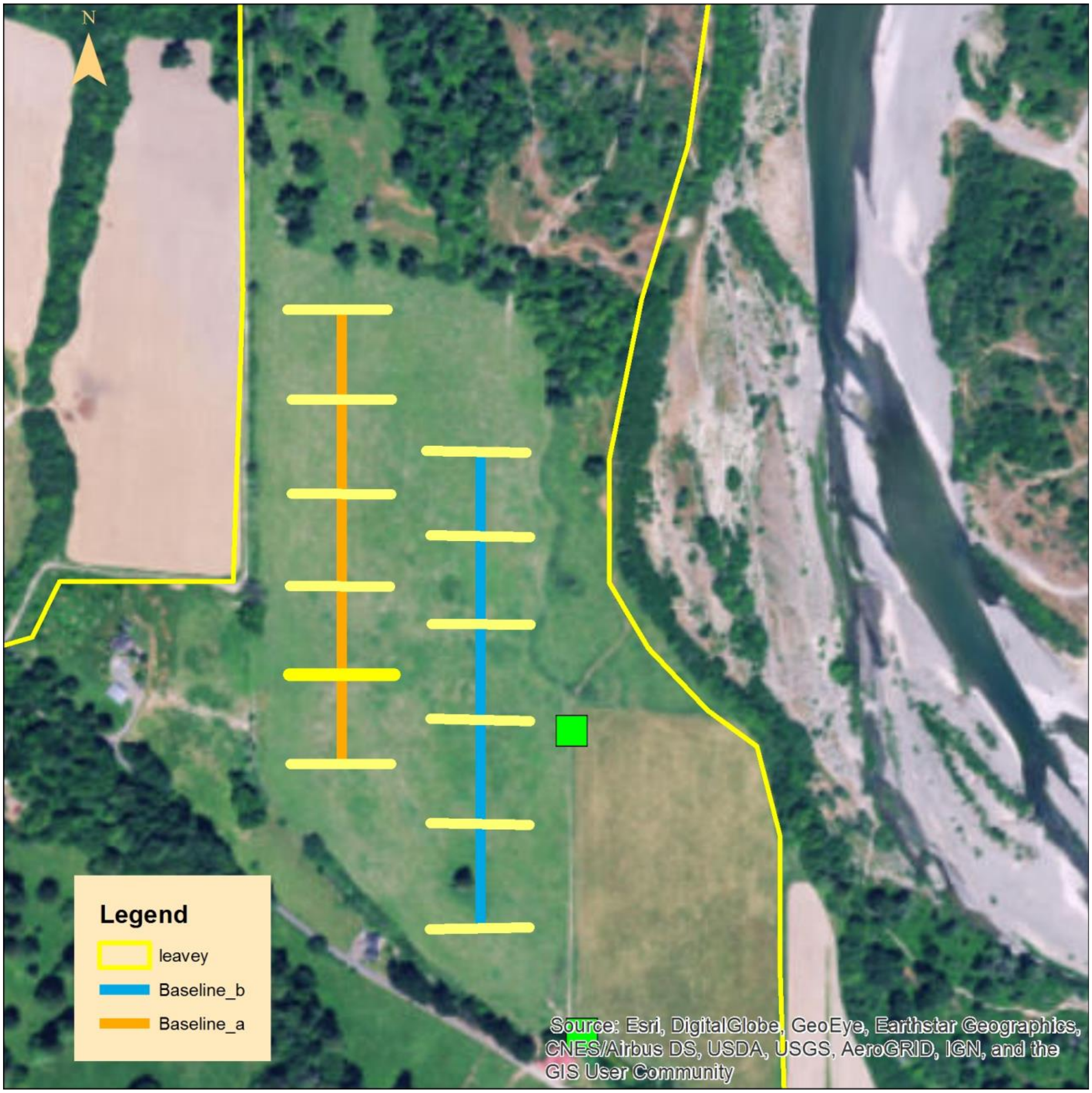

Figure 3: Gopher and Thistle Indices Map

Participatory GIS

Due to unforeseen difficulties in acquiring original GPS points of the transects, we deployed Participatory GIS (PGIS) methods to locate the proximity of the North-South baselines for our mapping purposes. Participatory GIS is a GIS methodology that is used by members of the public; both as individuals and grass-root groups for participation in the public processes affecting their lives. This particular form of GIS requires cultural, moral, and ethical values to be considered before working.

We were aware the baselines were located next to owl boxes, of which there are three located within or directly adjacent to the lower pastures. This required discussions with Dr. Johnson and the Wildlife Techniques class to understand exactly where they set up their baselines in proximity to the owl boxes. Caution was taken within the soggy pasture regions to avoid hot enclosure fences and maneuver around heads of cattle. When it was all said and done, we were pretty satisfied with how our GPS points matched up with our PGIS skills and existing knowledge of the experimental design and protocol.

Data Analysis

Analysis of 2016 data showed mean gopher disturbance was 1,110cm with 11 thistles per transect, resulting in a thistle density of 1.10 thistles per square meter. Data showed mean gopher disturbance in 2015 was 1,384cm with 29 thistles per transect, resulting in a thistle density of 2.86 thistles per square meter. Statistical correlation of the densities and gopher indices did not show strong association with smaller gopher disturbance activity, however the sites are biologically independent. Thus, a practical approach to the coefficient interpretation is recommended as relationships do exist along the shorter range of the index and site observations indicate otherwise. Figures 4-6 show the mean gopher indices and thistle density correlation and analysis (Johnson, 2016).

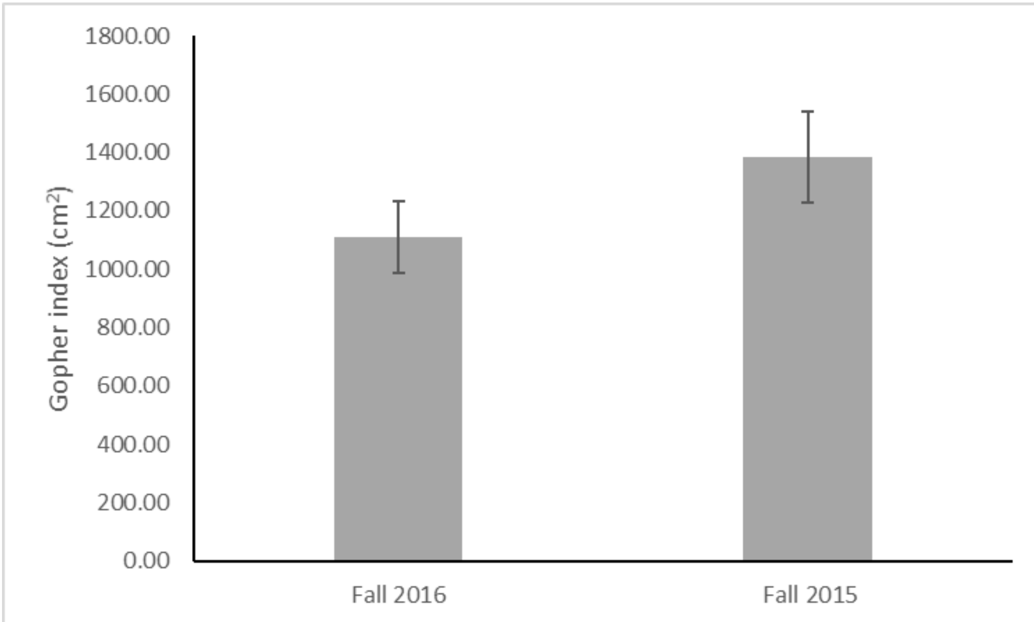

Figure 4: Gopher Index

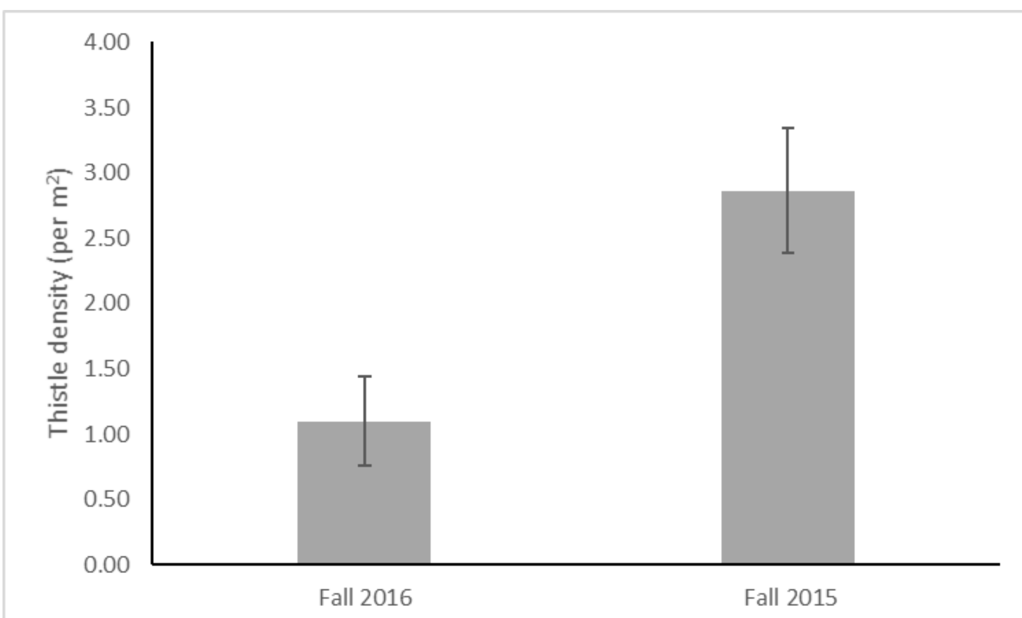

Figure 5: Thistle Density

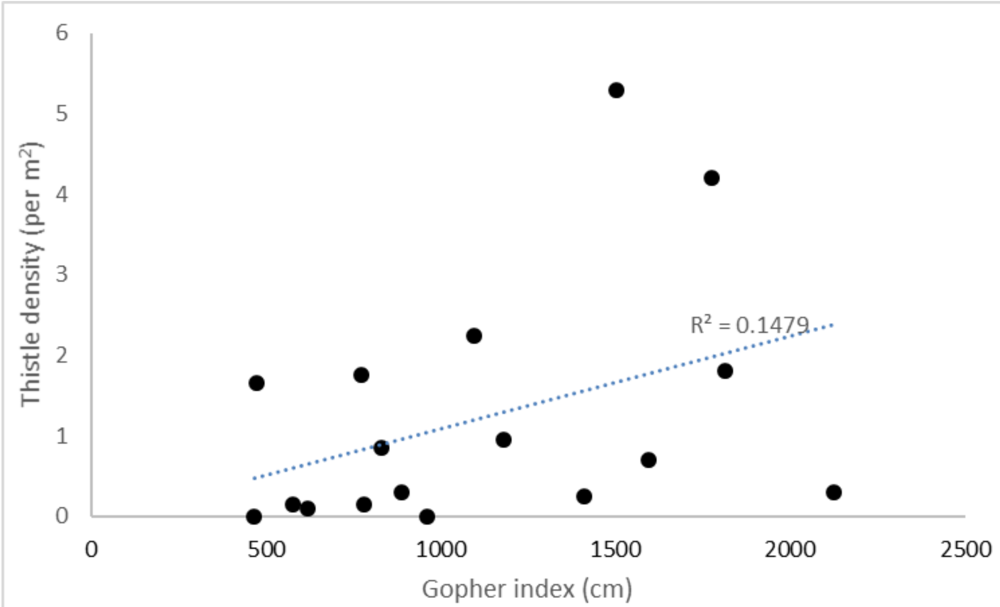

Figure 6: Correlation Analysis

Data sets for 2015 and 2016 are shown in Tables 1 and 2 with an additional data set for 2017 to be incorporated for analysis (if and when available).

Table 1: 2015 Data Set

			# thistles			
Sample unit	Direction	Gopher (cm)	Thistle plot 1	Thistle plot 2	Av. Thistle	Thistle density (thistles/m2)
1a	E	1110.5	14	3	8.5	0.85
2a	E	3130	25	78	51.5	5.15
3a	W	834	45	35	40	4
4a	E	2355	79	92	85.5	8.55
5a	W	1395	15	28	21.5	2.15
6a	W	1188	9	4	6.5	0.65
1b	W	1319.5	3	23	13	1.3
4b	W	2300	26	45	35.5	3.55
5b	E	515	25	22	23.5	2.35
1a	E	2544	109	17	63	6.3
2a	E	713	45	59	52	5.2
3a	E	527	74	7	40.5	4.05
4a	E	1447	23	32	27.5	2.75
6a	E	754	10	2	6	0.6
1b	W	1018	80	56	68	6.8
2b	W	1064.5	0	6	3	0.3
3b	W	992	8	23	15.5	1.55
4b	W	1437	3	4	3.5	0.35
5b	W	1591	18	46	32	3.2
6b	W	1451	1	5	3	0.3
2b	W		8	18	13	1.3
3b	E		49	5	27	2.7
6b	E		19	18	18.5	1.85

Table 2: 2016 Data Set

			# thistles			
Sample unit	Direction	Gopher (cm)	Thistle plot 1	Thistle plot 2	Av. Thistle	Thistle density (thistles/m2)
1a	E	579	2	1	1.5	0.15
1b	W	620	2	0	1	0.1
2a	W	468	0	0	0	0
2b	E	1504	65	41	53	5.3
3a	E	1410	3	2	2.5	0.25
3b	W	887	5	1	3	0.3
4a	W	961	0	0	0	0
4b	E		0	4	2	0.2
5a	W	780	1	2	1.5	0.15
5b	E	2126	6	0	3	0.3
1a	W	830	11	6	8.5	0.85
1b	E	475	27	6	16.5	1.65
2a	E	1775	11	73	42	4.2
2b	W		0	0	0	0
3a	W	1179	7	12	9.5	0.95
3b	E	772	19	16	17.5	1.75
4a	W	1815	23	13	18	1.8
5a	E	1095	23	22	22.5	2.25
6a	W	1596	7	7	7	0.7

Discussion

Landscape potential to sustain and maintain diverse wildlife species populations continues to gain traction with private landowners for personal, political and professional reasons. Management of desirable wildlife populations can successfully blend with other primary objectives. Spatial and temporal scales vary and interpretative methods and research models still developing (Miller, 2002 and Munns, Jr., 2006). Interpretations and ecological implications based on observed environmental conditions indicate an opportunity to manage soil organic matter content and pasture moisture conditions. Continued monitoring and analysis of vegetation community and wildlife species dynamics to assist with mitigation may assist with addressing invasive species concerns (both thistle and gopher-dominance). We recommend to install permanent transect locations and control groups for further observation and include basic GIS protocols with wildlife data collection practices.

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