**THIS DOCUMENT WILL BE ADDED TO AS DATA COLLECTION CONTINUES.

Wyoming Range Allotment Complex

Trend Analysis

Prepared For:
United States Forest Service
Wyoming Game and Fish Department
Wyoming Wild Sheep Foundation
Wyoming Governors Big Game License Coalition

Prepared By:

Sublette County Conservation District

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Author & Affliliation

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I. Introduction

This document includes an allotment/site history, and a summarized analysis of the soils and vegetation monitoring data collected per the ROD. This 2019 Trend Analysis is the 2nd and most up to date report which includes 2018 & 2019 data cooperatively collected during the RHAP process. This analysis contains updated 2019 Line Intercept data and canopy cover comparisons that can be directly compared to thresholds specified in the ROD. There have also been changes made to the 2018 Frequency data displayed throughout the report after a data calculation error was discovered in the 2018 data. In response, all graphical displays and comparisions have been corrected. Nested Frequency data for all additional upland sites monitored in 2019 as well as Winward Greenline data for 3 riparian locations inc is included in this updataed analysis.

Allotment History/Record of Decision (ROD)

The Wyoming Range Allotment Complex (WRAC) is comprised of seven United States Forest Service (USFS) allotments. The WRAC encompases 67,521 acres within the Big Piney, Greys River, and Jackson Ranger Districts, Bridger-Teton National Forest (BTNF), Wyoming (Clark et al. 2004). A Record of Decision (ROD) signed on September 1, 2004 for a Final Environmental Impact Statement (FEIS) authorized the closure of four of the seven allotments (Pickle Pass, Grizzly Cr, Corral Cr, and Upper Greyback/Phosphate) due to overlap between Bighorn Sheep core area and domestic livestock (sheep) grazing within these allotments (Clark et al. 2004). By closing these allotments, physical separation of domestic and Bighorn sheep could be obtained (Clark et al. 2004). In 2005, the current permittee waived his permit back to the USFS without preference which placed the remaining three allotments (Mule Creek, North Horse and Prospect Peak) that make up the WRAC.

The ROD specifies that effectiveness monitoring will need to occur on vacant forage reserve allotments (Mule Creek, North Horse Creek, and Prospect Peak) on a 5 year cycle. Closed allotments will need to be collected on a 10 year cycle (Upper Grayback/Phophate, Pickle Pass, Grizzly Creek, and Corral Creek)(Clark et al. 2004).

According to Forest Service representative Chad Hayward:

> closed allotments are "closed to scheduled grazing and would need a NEPA document to open allotments to any grazing," while vacant allotments "Allow for a temporary permit. These allotments would need a document sufficient to NEPA to get a 10 year permit."

The objectives in the ROD were set by the proper functioning condition of tall forb plant communities described in the "Indicators of Rangeland Health and Functionality in the Intermountain West". In order to address watershed objectives (ground cover) and vegetative concerns, Mule Cr, N. Horse and Prospect Peak allotments would remain vacant until the following objectives are met:

1) Ground cover of 80% or greater on all sites

2) At least one of the listed key plant species is at 5% canopy cover. The following key plant species will be used in determining the 5% canopy cover objectives: *Geranium visossimumi* (Sticky geranium), *Liqusticum filicnum* (Fernleaf liqusticum), *Helianthella uniflora* (Single flowered sunflower), *Valeriana edulis* (Tobacco root), *Bromus carinatus* (Mountain brome). (The scientific name of Mountain Brome is now *Bromus marginatus* (BRMA4) and will be presented this way throughout the document. On sites where plants were not identified to species, generic genus plant codes were used instead.)

According to the ROD, grazing would not be permitted to resume on the three vacant allotments until data collected on all of the monitoring locations reach the objectives stated above. All three allotments would be needed in order to graze two bands of sheep (Clark et al. 2004). If in the future objectives are being met and the allotments open to grazing again, allotments within the forage reserve would only be grazed 3 out of every 10 years on a rest rotation system so they can be available for any future grazing due to catostrophic wildfire or prescribed fire on an allotment (Clark et al. 2004). Annual implementation monitoring requirements on all three allotments would also need to be met once grazing resumes (Clark et al. 2004).

In 2018, the Sublette County Conservation District (SCCD) applied for and was awarded a Rangeland Health Assessment Program (RHAP) Grant through the Wyoming Department of Agriculture (WDA). This RHAP Grant as well as additional funds from the Wyoming Governor's Big Game License Coalition (WBGLC), and the Wyoming Wild Sheep Foundation (WWSF) have allowed SCCD and the cooperating partners to assist with vegetation monitoring requirements across the WRAC. In-Kind partnerships include the Wyoming Game and Fish Department (WGFD), USFS Big Piney Ranger District and the Sublette County Conservation District (SCCD).

	Allotment	Monitoring Site	Location	Monitoring Year	Methods Completed
WRAC Forage Reserve	Mule Creek S&G	D2-27	-110.591054 42.965292	1983 1996 2008 2013 2018 2019 2023*	NF NF; LI NF NF NF; LPI LI
		D2-38	-110.534740 42.936946	2003 2008 2013 2018 2019 2023*	NF NF NF NF; LPI LI
		N. Horse Creek T5	-110.610646 42.976029	2002 2019	WG WG
	N. Horse Creek S&G	D2-16	-110.610402 42.952342	1985 1996 2001 2011 2016 2021*	NF NF NF NF NF
		D2-43	-110.609878 42.966874	2004 2009 2014 2019 2024*	NF NF NF NF; LI; LPI
		S. Fork N. Horse Creek T1	-110.545885 42.922046	2002 2019	WG WG
	Prospect Peak S&G	D2-26	-110.550395 42.906634	1984 2001 2008 2013 2019 2024*	NF NF NF; LI NF NF; LI; LPI
		N. Horse Creek T4	-110.521888 42.928910	2002 2019	WG WG
		S. Horse Creek T3	Needs verified in 2020	2002 2020**	WG
WRAC BH Sheep Closure	Corral Creek S&G	D2-29	-110.610118 42.977951	1983 2003 2004 2008 2013 2018 2019 2023*	NF; LI NF GC NF NF NF; LPI LI
	Grizzy Creek S&G	D2-50	-110.595173 43.025716	2001 2011 2021*	NF NF
	Pickle Pass	D2-39	-110.602716 43.049452	2003 2008 2018 2023*	NF; LI NF NF; LPI
	Upper Greyback/ Phosphate	D2-17	-110.606666 43.117273	1987 1996 2011 2021*	NF NF NF

* Planned future monitoring dates NF - Nested Frequency LI - Line-Intercept LPI - Line-Point Intercept GC - partially read NF for ground cover only WG- Winward Greenline

Figure 1: Table of all WRAC monitoring locations including GPS location, allotment, years monitored, and methods completed.

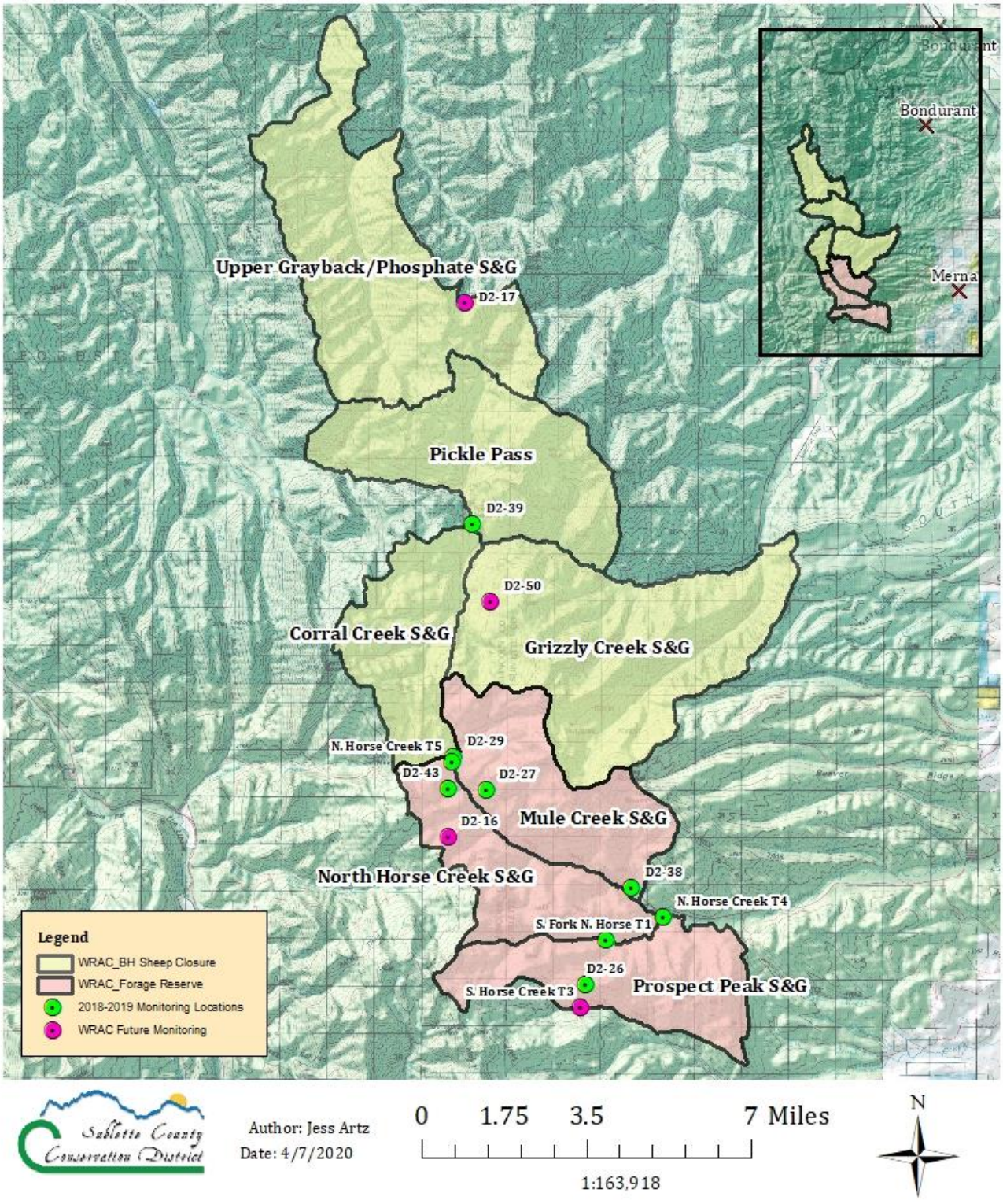


Figure 2: Map of all WRAC monitoring locations. Green points represent sites sampled in 2018 & 2019. Pink represents sites that will be sampled in the future. For future monitoring schedule see Figure 1.

II. Methods

Effectiveness Monitoring: According to the Forest Service Handbook, effectiveness monitoring is **long-term monitoring** that occurs over an extended period of time. It is used to determine if management practices are effective in meeting Forest Plan, NEPA, or biological opinion goals, standards, and objectives. At the time of the ROD, Region 4 accepted trend methodologies included the following: Nested Frequency, Line Intercept, and Photo Monitoring. Since, Line-Point Intercept has become widely accepted to inform trend and plant composition values on upland sites. Methodologies implemented to-date for monitoring in the WRAC are described below.

Nested Frequency data collection was established between 1983-2004 on nine key areas within the 7 allotments. Since establishment, nested frequency has been consistently read on the established sites including in 2018. Nested Frequency was historically collected using either the baseline technique or the beltline spoke wheel techniques. Transect layouts were decided based on the area of site location. Additional methodology information can be found in "Sampling Vegetation Attributes: Interagency Technical Reference 4400-4."

a. Baseline technique consists of a baseline with set perpendicular transects placed on either side of the halfway mark on the baseline (Figure 3). Some historic baselines were set up using transects that have the zero-end starting at the baseline (Figure 4). Methodology for setting up a baseline transect can be found in the "Sampling Vegetation Attributes: Interagency Technical Reference 4400-4."
b. Beltline spoke wheel technique consists of 5 Lines (100 feet each) that are set up in a spoke fashion and read on a 1-foot interval (Figure 5). Each spoke is read at predetermined compass directions set by the Forest Service Handbook. Methodology can be found in Region 4 Forest Service Handbook Section 44.16 a-e. Site specific transect set up will be noted in each sites attributes.

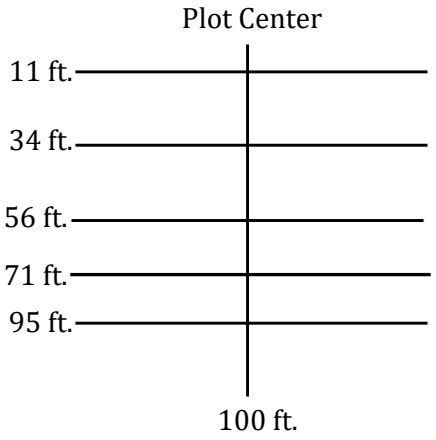


Figure 3: Transect layout #1 for the baseline technique method.

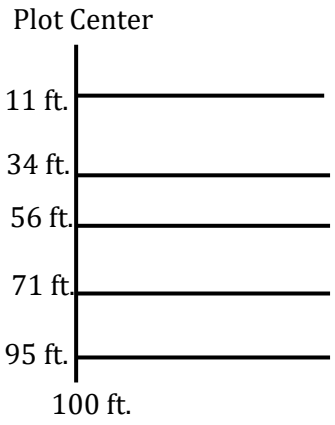


Figure 4: Transect layout #2 for the baseline technique method.

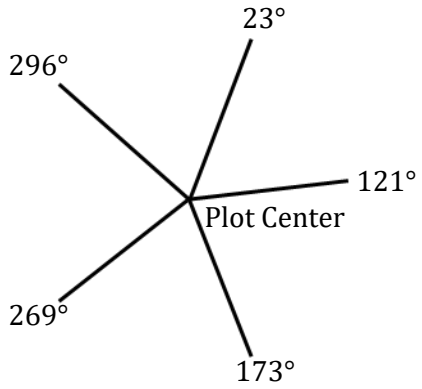


Figure 5: Transect layout for the beltline technique method

Line-Point Intercept data collection was first read in 2018 on 4 of the 9 sites. Line-Point Intercept was read on the layout previously established for nested frequency on each site in order to maintain consistency. Methodology for the Line-Point Intercept Method can be found in the "Sampling Vegetation Attributes: Interagency Technical Reference 4400-4."

Winward Greenline riparian data collection was established and first read in 2002 within the TPFR. Two riparian sites were re-read in 2019 within the Triple Peak S&G allotment. Riparian monitoring within N. Piney S&G will be completed in 2020. Methodology for the Winward Greenline Method can be found in the "Monitoring the vegetation resources in riparian areas. Gen. Tech. Rep. RMRSGTR-47."

Plant Code Reference Table		
USDA Plant Code	**Scientific Name**	**Common Name**
ACMI2	*Achillea millefolium*	common yarrow
BRMA4	*Bromus marginatus*	mountain brome
CHAT	*Chenopodium atrovirens*	pinyon goosefoot
COLI2	*Collomia linearis*	tiny trumpet
COPA3	*Collinsia parviflora*	maiden blue eyed
DEOC	*Delphinium occidentale*	western larkspur
EUIN9	*Eurybia integrifolia*	thickstem aster
GABI	*Galium bifolium*	twinleaf bedstraw
GEVI2	*Geranium viscosissimum*	sticky purple geranium
HELIA	*Helianthella spp.*	helianthella
HEUN	*Helianthella uniflora*	oneflower helianthella
LIFI	*Ligusticum filicinum*	fernleaf licorice-root
LUAR3	*Lupinus argenteus*	silvery lupine
MAGL2	*Madia glomerata*	mountain tarweed
MESP	*Melica spectabilis*	purple oniongrass
OSOC	*Osmorhiza occidentalis*	western sweetroot
PODO4	*Polygonum douglasii*	Douglas knotweed
POGL9	*Potentilla glandulosa*	sticky cinquefoil
POGR9	*Potentilla gracilis*	slender cinquefoil
PSJA2	*Pseudostellaria jamesiana*	tuber startwort
VAED	*Valeriana edulis*	tobacco root
WYAM	*Wyethia amplexicaulis*	mule-ears

Figure 6: Table of the plant codes, scientific and common names reference throughout this document.

Site Attributes: Elevation for sites was collected using elevation maps and PRISM elevation data. PRISM provides climate and elevation data based on coordinates and is made available by the Northwest Alliance for Computational Science and Engineering based at Oregon State University. Geology (bedrock and surface), slope, aspect, landform (Figure 8), and parent material were collected using a combination of site observations, GIS geology information and slope shapefiles. Slope shape is defined by first describing the vertical shape of the slope, and then the horizontal shape that is perpendicular to the slope (Figure 7).

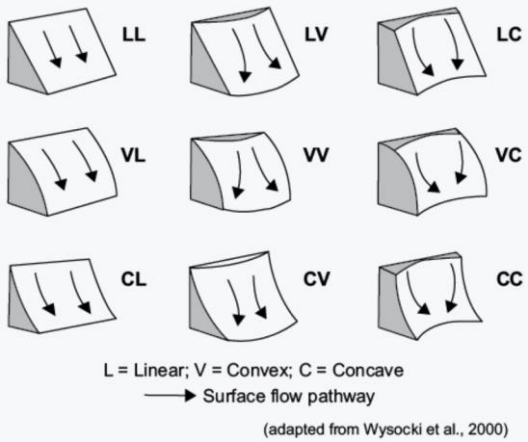


Figure 7: Description of different slope shapes (Schoeneberger, Wysocki, Busskohl, & Libohova).

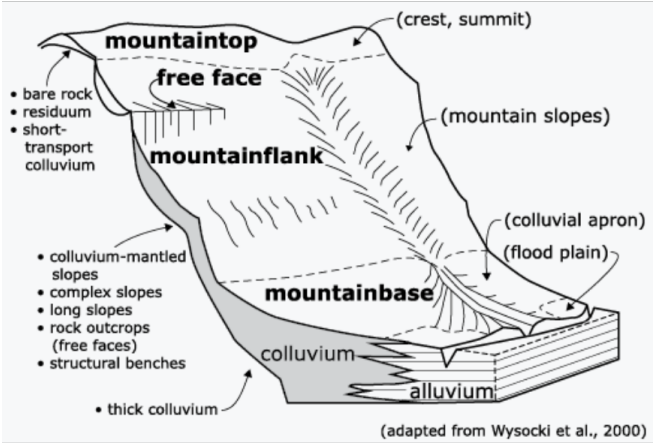


Figure 8: Descriptions of the different landforms (Schoeneberger, Wysocki, Busskohl, & Libohova).

Soils Data: Soil pits were described to a depth of 20 inches at all sites and soil samples were collected from each horizon. These samples were brought back from the field for further analysis completed by the Soil, Water and Plant Testing Lab at Colorado State University. Soil samples were tested for pH, Phosphorus, Potassium, Zinc, Iron, Copper, Manganese, lime, nitrate, organic matter, and texture estimates (Figures 9 & 10).

Soil Codes	
Code	**Texture**
SL	Sandy Loam
L	Loam
SCL	Sandy Clay Loam
CL	Clay Loam
C	Clay Loam
Structure	
pl	Platy
sbk	Subangular Blocky
Effervesence	
NE	noneffervescent

Figure 9: Table of soil codes referenced throughout the document.

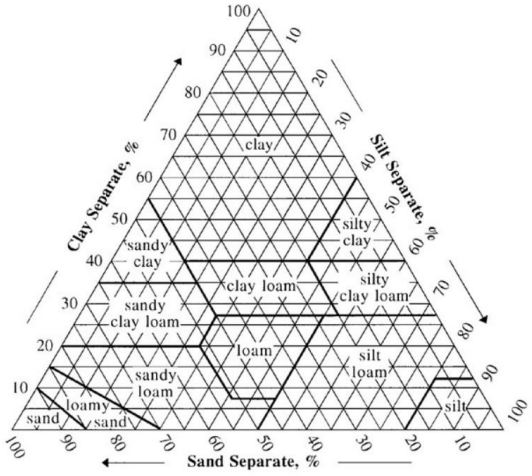


Figure 10: Soil texture triangle for texture references (Natural Resource Conservation Service, 2019).

Climate Data: Climate data (including precipitation and temperature) will be documented in the report to reflect changes and potential impacts to monitoring results. PRISM climate data is a tool which interpolates climate datasets from nearby airport weather stations which then provides modeled site-specific climate information. PRISM data is provided from the Northwest Alliance for Computational Science and Engineering based at Oregon State University. Water year totals were used for annual precipitation data. Precipitation graphs were extended 5 years prior to monitoring establishment because precipitation and temperatures in previous seasons impact future growing seasons. 2018 PRISM data for precipitation and temperature was preliminary when this report was written. These numbers will be updated in the fall/winter of 2019.

Photos: Trend sites using the baseline technique (Figures 3 & 4) have a total of 3 photos (soil pit, baseline, and overall plot photo). Sites using the beltline technique (Figure 5) have a total of 7 photos (soil pit, one along each line and overall plot photo).

III. Results

Presented below are graphs comparing all the monitoring data collected to date against the predetermined vegetation benchmark objectives set forth in the Record of Decision (ROD). Total frequency is also compared for each sampling year to show vegetative trend for each key species. See Figure 1 for location information, monitoring years, and % ground cover by monitoring year for each site.

As stated in the introduction, **percent canopy cover** of key species was selected as a threshold measurement within the Record of Decision (ROD). Canopy cover is defined as the area of ground covered by the vertical projection of the outermost perimeter of the natural spread of foliage of plants. Small openings within the canopy are included and canopy cover can exceed 100% (Coulloudon, et al., 1985). This measurement can only be obtained using the Line-Intercept method, which has not been historically read to collect forb related data on these sites. Historically Line-Intercept data collection was done intermittently only being collected on shrubs for D2-26 in 2008, D2-27 in 1983 and 1996, and on site D2-39 in 2003. Line-Intercept data was collected on shrubs and *Geranium viscosissimum* (GEVI2) for one year on site D2-39 leaving holes in the data. The Region 4 Forest Service Rangeland Ecosystem and Analysis Handbook states that Line-Intercept is best used to measure shrub canopy cover.

In 2019, the Line- Intercept method was used to collect vegetation data. Canopy cover for each key species could then be compared to the 5% benchmark set forth in the ROD.

It is important to note that Canopy Cover and Foliar Cover are two different references to cover, are collected using two different monitoring methods, and cannot be used synonymously. However, there is a relationship between the two as they both refer to plant cover. Foliar cover excludes overlap and small openings in the canopy which means it is usually a more conservative measurement of vegetative cover (Figure 11). According to the "Guidelines and Terminology for Range Inventories and Monitoring," referenced in "A Guide for Estimating Cover," foliar cover is always less than canopy cover. Both canopy cover and foliar cover will be referenced throughout this document.

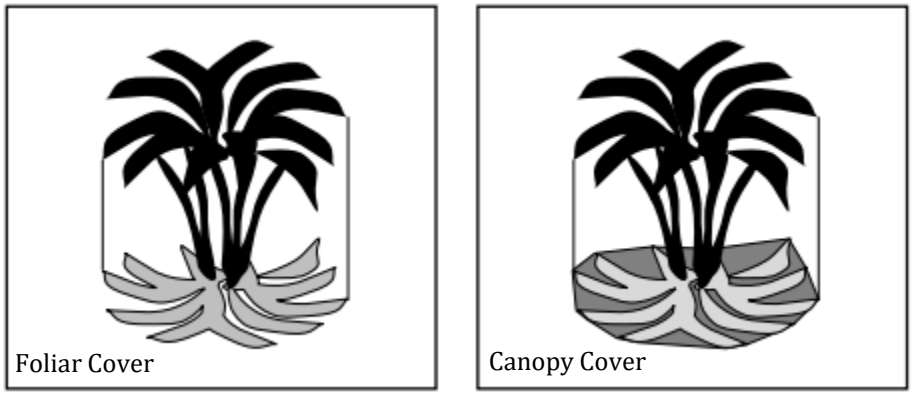


Figure 11: Comparison of vegetative canopy measurements of foliar cover and canopy cover (Coulloudon, et al., 1985, p. 25).

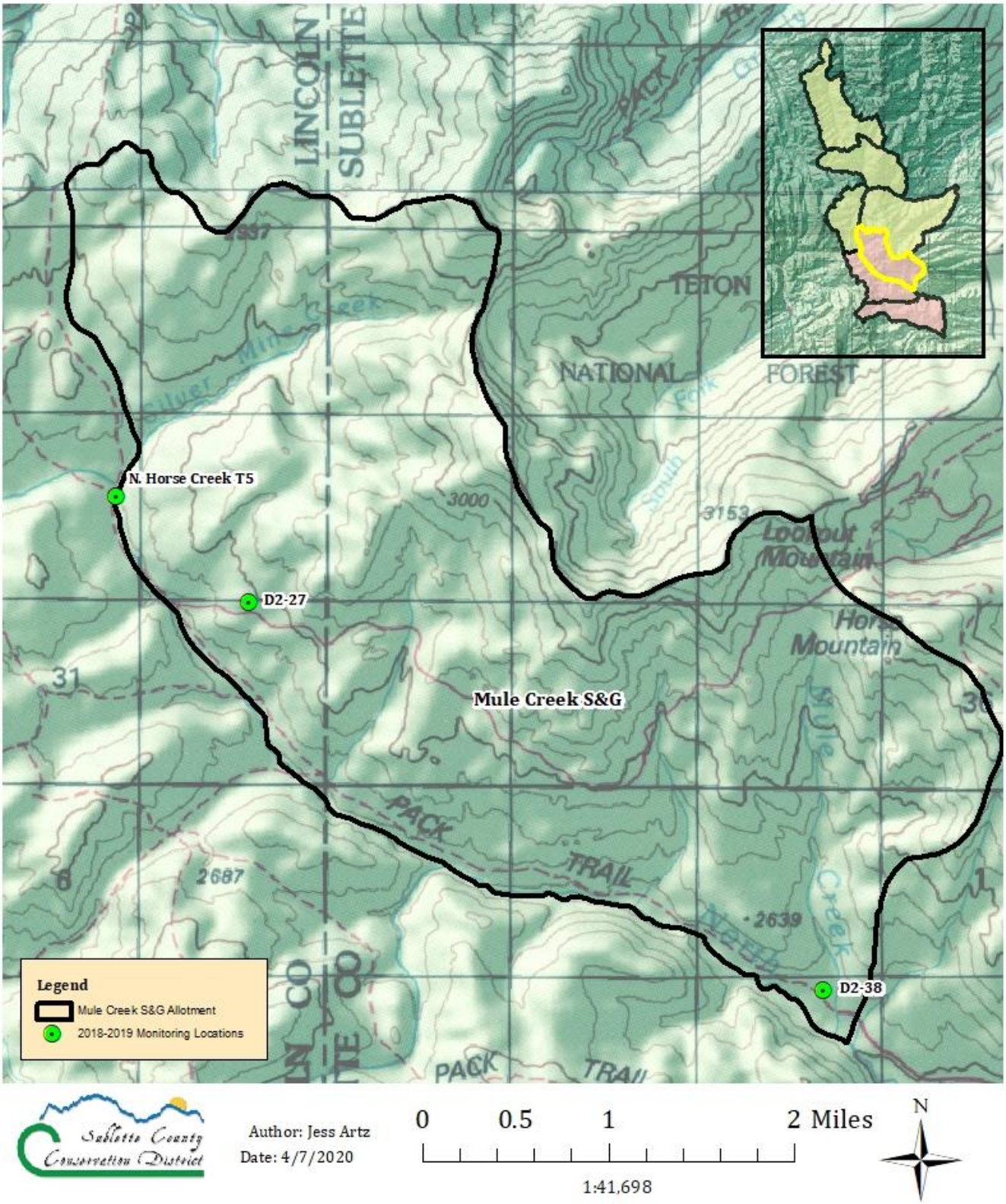


Figure 12: Map of monitoring locations within the Mule Creek S&G Allotment.

D2-27

Mule Creek S&G
Forage Reserve Allotment

Location: 42.967861, -110.596458 **Original Baseline Azimuth:** NA

Monitoring Technique: Site was monitored using the baseline technique (refer to Figure 3 for transect configuration).

Site Attributes:

ELEVATION (ft)	BEDROCK GEOLOGY	SURFACE GEOLOGY	SLOPE CLASS	SLOPE SHAPE	ASPECT	LAND FORM	PARENT MATERIAL
9000	Ka*	srR**	13%	linear - convex	SW	mountain flank	slope alluvium

*Ka – Aspen shale; siltstone, claystone some quarzitic sandstone and porcelanite
**srR – slope wash, rock outcrop, residuum

Vegetation Data:

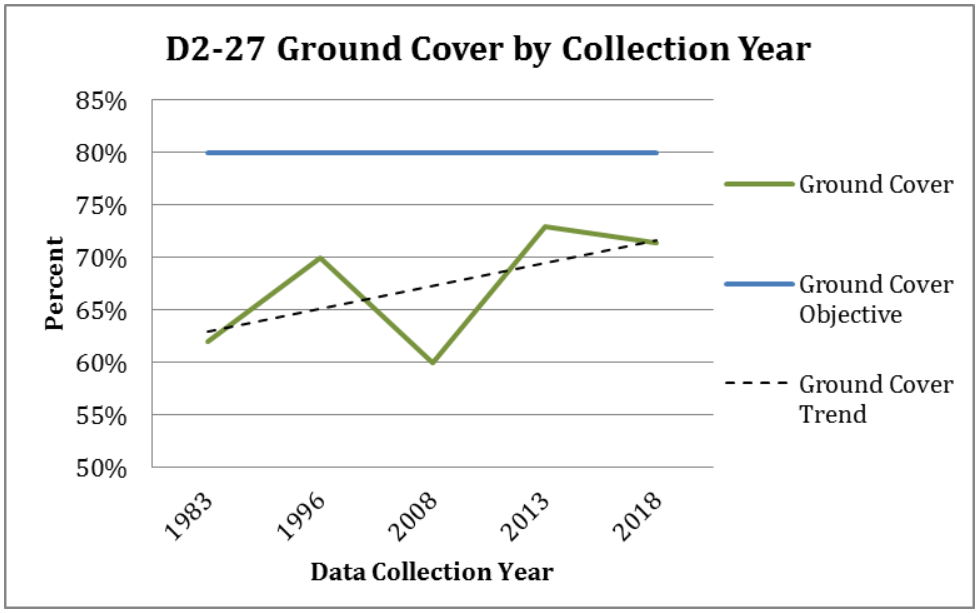


Figure 13: Nested frequency data was used to calculate ground cover (%) by monitoring year compared to the ground cover objective of 80% specified in the ROD.

Data presented in the figure above shows an upward trend in ground cover for the site, however ground cover has remained below the 80% objective (Figure 13). There was a decrease in ground cover during the 2008 monitoring. This could be attributed to lower precipation and vegetative growth in years leading up to monitoring (Figure 18).

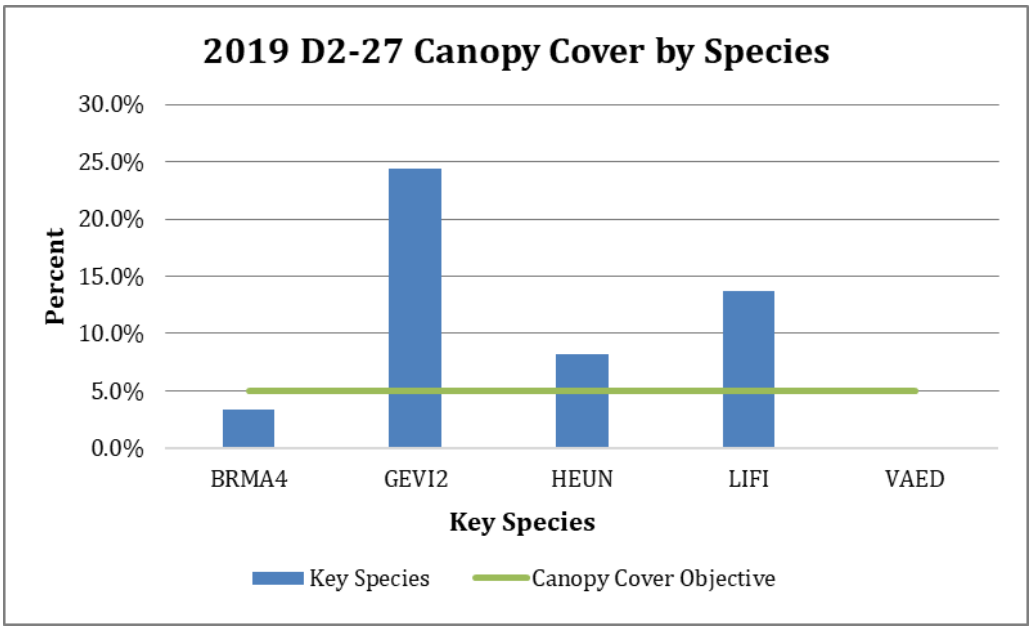


Figure 14: Line-Intercept data was used to compare (%) canopy cover for each key species found on the site.

Geranium viscosissimum (GEVI2), *Lingusticum filicinum* (LIFI) and *Helianthella uniflora* (HEUN) are all above 5% canopy cover (Figure 14). While *Bromus marginatus* (BRMA4), is slightly above 3% foliar cover. *Valeriana edulis* (VAED) is not present on this site.

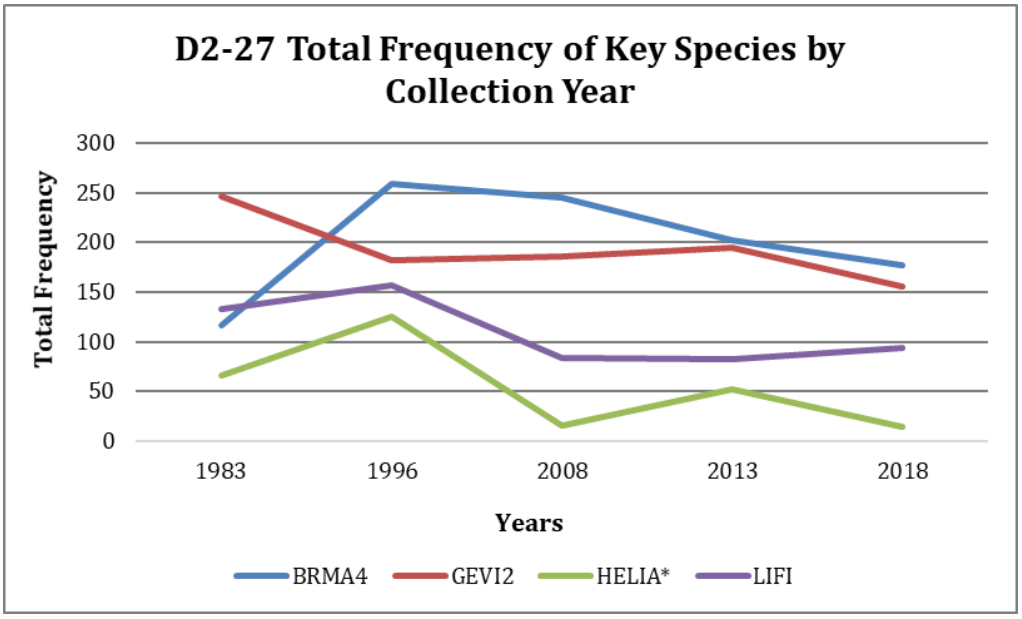


Figure 15: Nested frequency data was used to display the total frequency of the five key species identified in the ROD for each year monitored. * *Helianthella uniflora* (HEUN) was identified to species in 1996, 2013, & 2018. The remaining monitoring years *Helianthella* genus (HELIA) was recorded for the site. For the purposes of showing trend, all HELIA species are included in this graph.

The total frequency of *Geranium viscosissimum* (GEVI2), *Helianthella* (HELIA) and *Lingusticum filicinum* (LIFI) is in a downward trend (Figure 15). *Bromus marginatus* (BRMA4) was increasing from 1983 to 1996 but has seen a decrease in subsequent years (Figure 15).

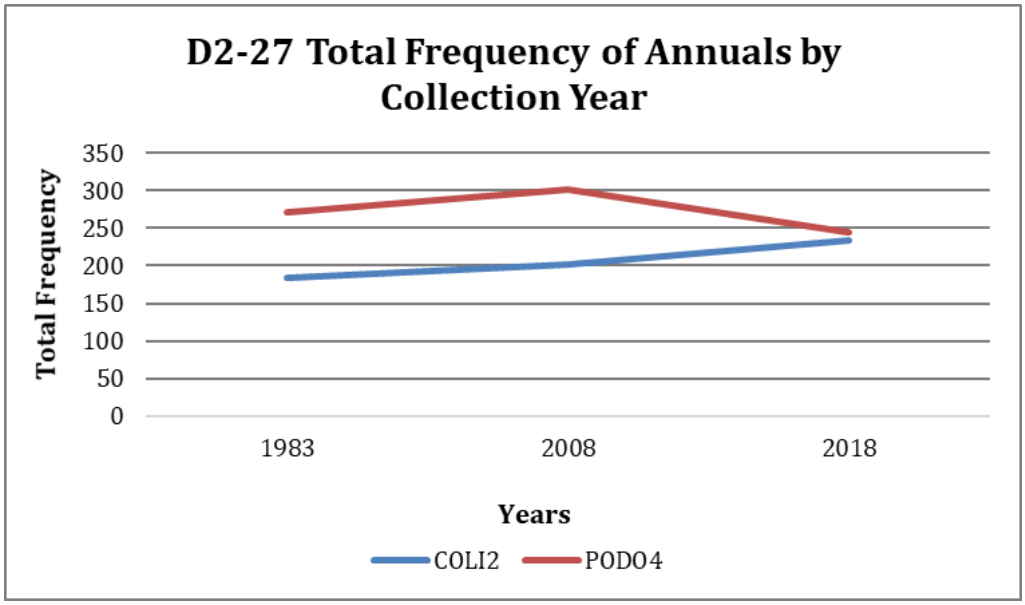


Figure 16: Nested Frequency data was used to display the total frequency of annual species identified on the site for each year annuals were monitored. In 1996 no annuals were monitored and in 2013 only the key species were monitored.

The total frequency of *Polygonum douglasii* (PODO4) has decreased from intial monitoring establishment to the 2018 monitoring year. Total frequency of *Collomia linearis* (COLI2) has increased over time (Figure 16).

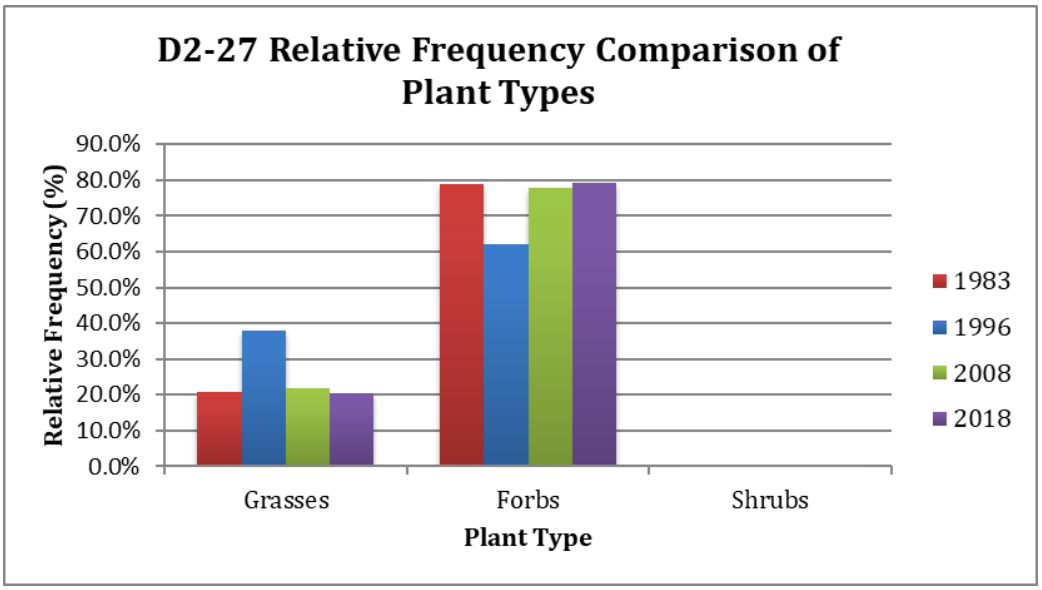


Figure 17: Nested Frequency data used to display the relative frequency of grasses, forbs, and shrubs for each year monitored.

Since monitoring was established to current day there does not appear to be much change between the relative frequency of grasses vs. forbs within the plant community (Figure 17). There was a fluctuation of approximately 17% in 1996 but subsequent readings remained similar to when the site was established in 1983.

Soils Data:

SOIL PROFILE																				
Depth (inches)	Rock Fragment Type & Vol (%)				Texture	%Clay (+/- 5%)	Effervescence	Moist Color	Structure	pH	EC	OM (%)	Nitrate	Phosphorus	Potassium	Zinc	Iron	Manganese	Copper	Lime
	0-5%	5-15%	15-35%	>35%																
0-2	X				SCL	16	NE	10YR 4/2	pl	6.0	0.6	6.0	4.1	48.3	357	5.15	69.5	48.7	6.86	low
2-11		X			SCL	22	NE	2.5YR 4/3	sbk	5.7	0.2	3.8	9.1	35.2	315	2.38	84.4	10.3	4.38	low
11-20	X				SCL	26	NE	2.5YR 4/3	sbk	5.6	0.1	3.2	7.6	26.7	175	1.29	75.8	1.66	2.28	low
Family particle size class: Fine-Loamy																				

Soils on this site are considered deep since parent material was not reached while digging in the top 20 inches. Nitrate levels in the top horizon are elevated. Elevated nitrate levels indicate higher rates of decomposition producing more organic matter (Chapin et. al., 2012). Therefore more nutrients in the soil for plant assimilation. Althought nitrate levels in the second horizon are greater than that of the top horizon indicating that nitrate is leaching down the soil profile. Leaching of nitrate can be related to a decrease in diversity of plant functional groups (Scherer-Lorenzen et. al., 2003).

2018 – Soil pit

Climate Data:

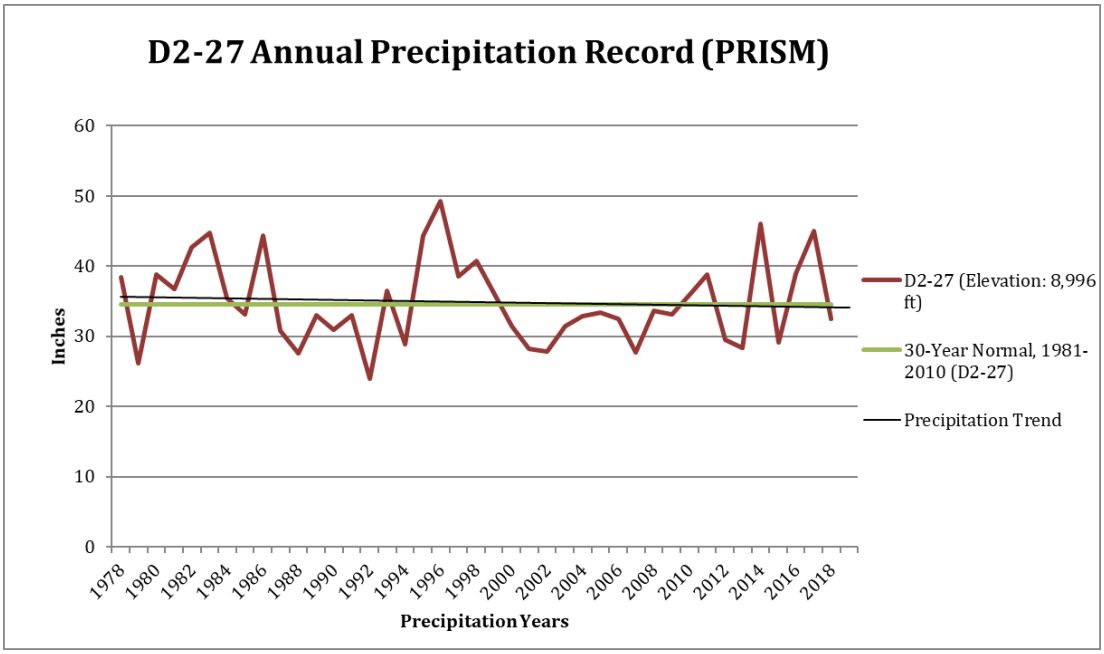


Figure 18: PRISM data was used to display annual precipitation, the 30-year normal for the site from 5 years prior to monitoring established to the present, and precipitation trend.

Climate data for D2-27 shows a downward trend for annual precipitation over the 30-year normal for the site (Figure 18).

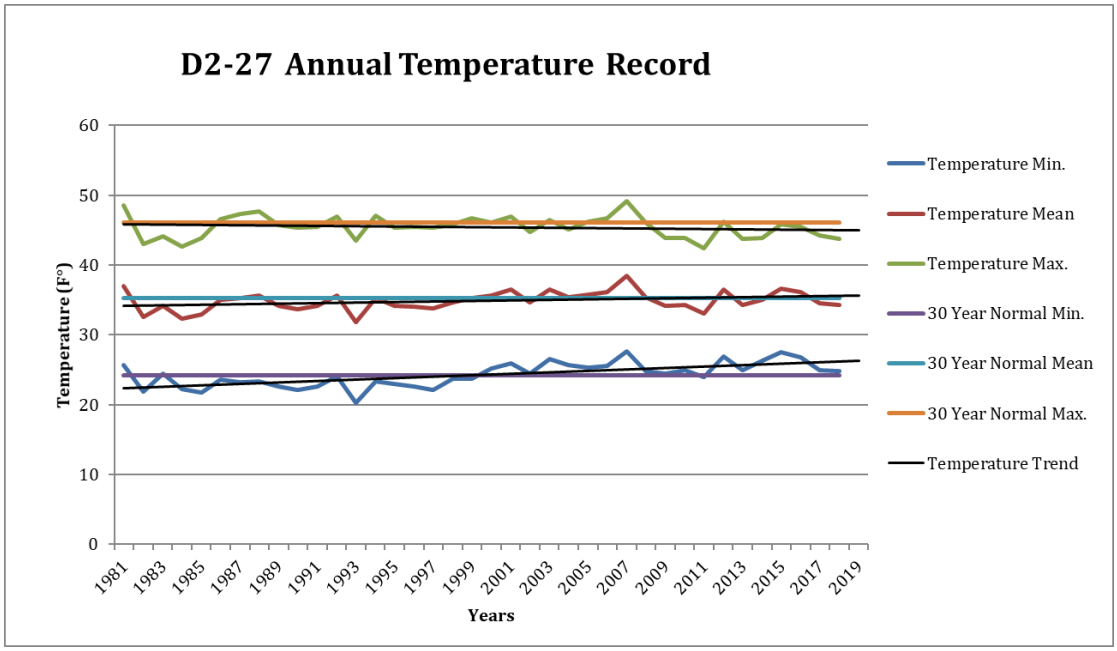


Figure 19: PRISM data was used to display annual temperature, the 30-year normal for the site 1981 to present, and temperature trend.

Climate data for this site shows an increasing trend for the minimum and mean annual temperatures, while maximum annual temperature is on a downward trend for this site (Figures 19).

Discussion:

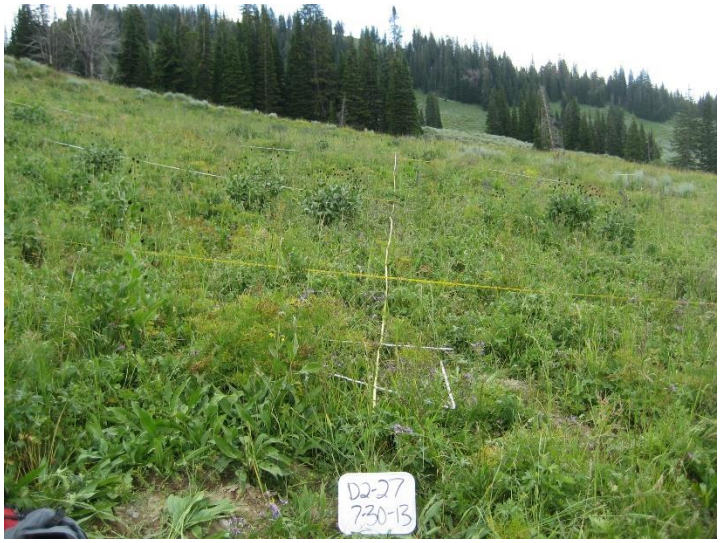
Line-Point Intercept data tells us that this plant community has 96% foliar cover, and bare ground of approximtely 2%. This site sits on a Southwest facing 13% slope. By looking at these attributes combined with the vegatative community composition it can be concluded that this site has characteristics similar to the *Lingusticum filicinum-Delphinium occidentale* (LIFI-DEOC) tall forb community type (Gregory 1983). LIFI has a higher presence on this site with a foliar cover of 12%. DEOC is also present at 6% foliar cover, and *Osmorhiza occidentalis* (OSOC) has 4.2% foliar cover. Other associated plants, as described by Gregory 1983, include *Potentilla gracilis* (POGR9), *Eurybia integrifolia* (EUIN9), *Lupinus argenteus* (LUAR3), *Geranium viscosissimum* (GEVI2), *Melica spectabilis* (MESP), and *Bromus marginatus* (BRMA4) all of which are present in the D2-27 plant community. The soil on this site is within the range of organic matter, pH, and soil textures for a LIFI-DEOC site. However, the site is not on an east aspect where most LIFI-DEOC sites have been described. Using the nested frequency data, ground cover on this site is 71.4%, which is below the 80% threshold set in the ROD.

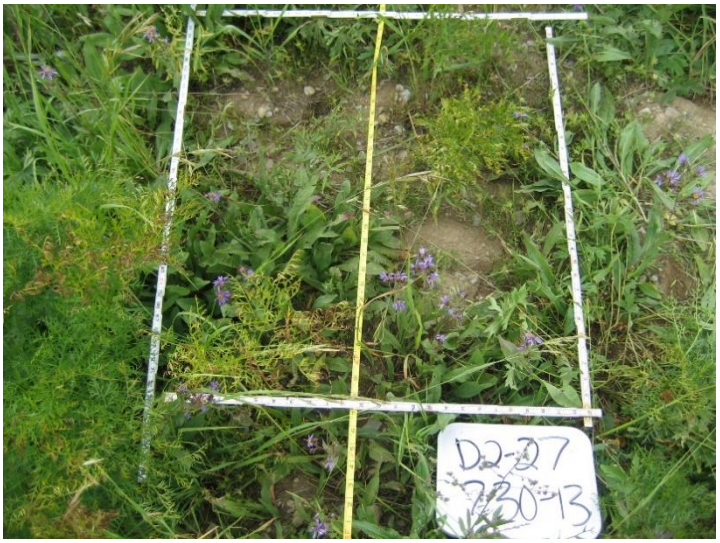
Photos:

1983

1996

2008





2013

2018

D2-38

Mule Creek S&G
Forage Reserve Allotment

Location: 42.937913, -110.535316 **Original Baseline Azimuth:** 340°

Monitoring Technique: Site was monitored using the beltline technique (refer to Figure 5 for transect configuration).

Site Attributes:

ELEVATION (ft)	BEDROCK GEOLOGY	SURFACE GEOLOGY	SLOPE (%)	SLOPE SHAPE	ASPECT	LAND FORM	PARENT MATERIAL
8996	gravel	alluvial terrace	9%	linear -linear	SW	alluvial fan	alluvium

Vegetation Data:

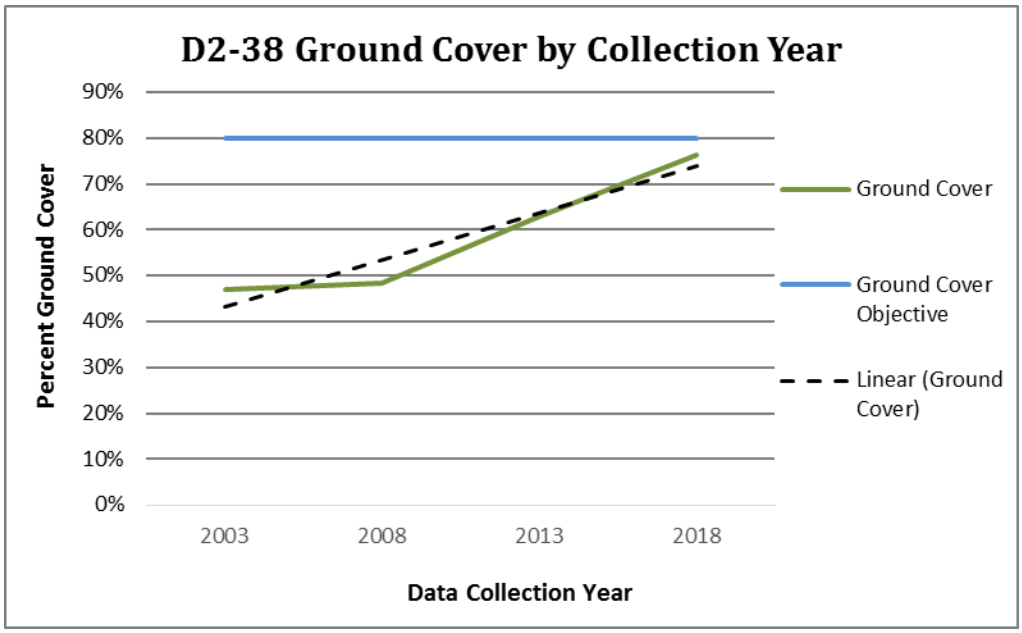


Figure 20: Nested frequency data was used to calculate ground cover (%) by monitoring year compared to the ground cover objective of 80% specified in the ROD.

Data presented in the figure above shows an upward trend in ground cover for the site, however ground cover has remained below the 80% objective.

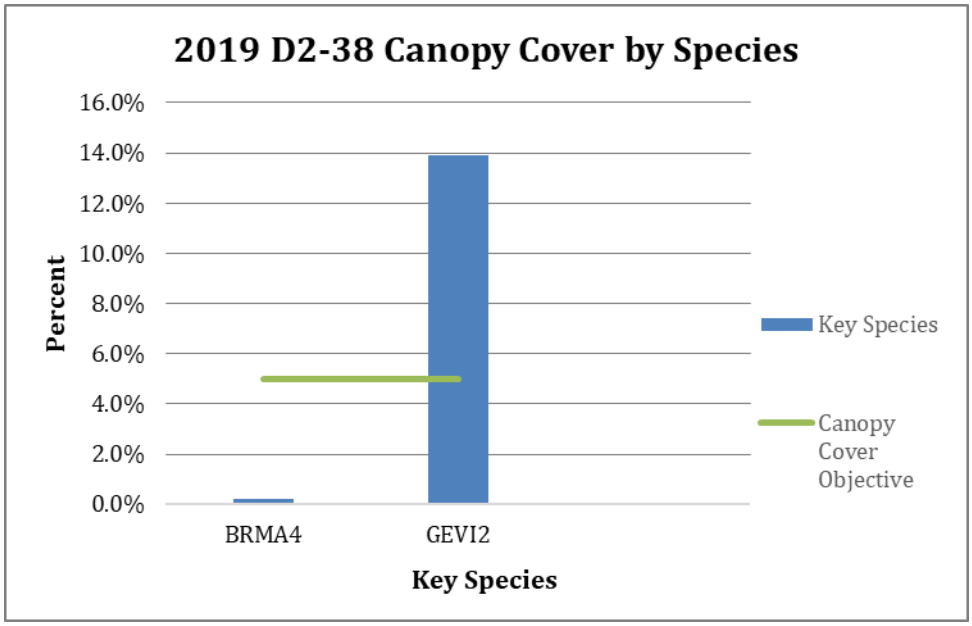


Figure 21: Line-Point Intercept data was used to compare (%) foliar cover for each key species found on the site.

Geranium viscosissimum (GEVI2) and *Bromus marginatus* (BRMA4) were the only key species present on site. GEVI2 was the only species above 5% canopy cover (Figure 21). The other key species have not been historically recorded on the site.

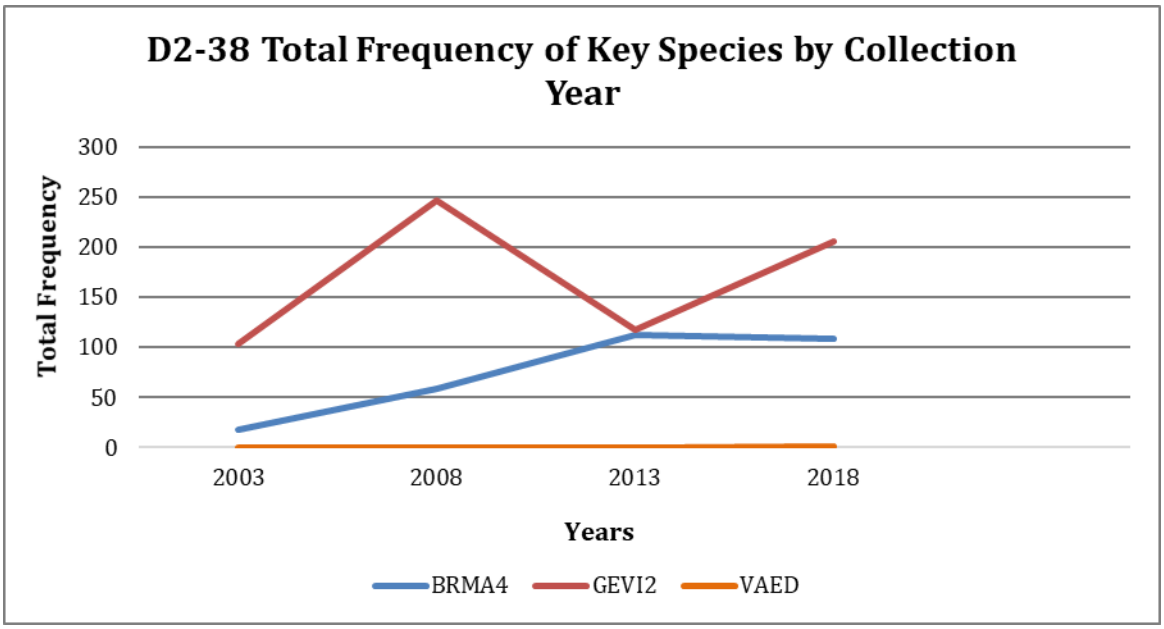


Figure 22: Nested frequency data was used to display changes in the total frequency of the five key species identified in the ROD. Three of the five key species were detected on this site.

The total frequency of *Bromus marginatus* (BRMA4) and *Geranium viscosissimum* (GEVI2) appears to be trending upward (Figure 22). In 2018 there was a presence of *Valeriana edulis* (VAED) in the nested frequency data where in other years it was not detected.

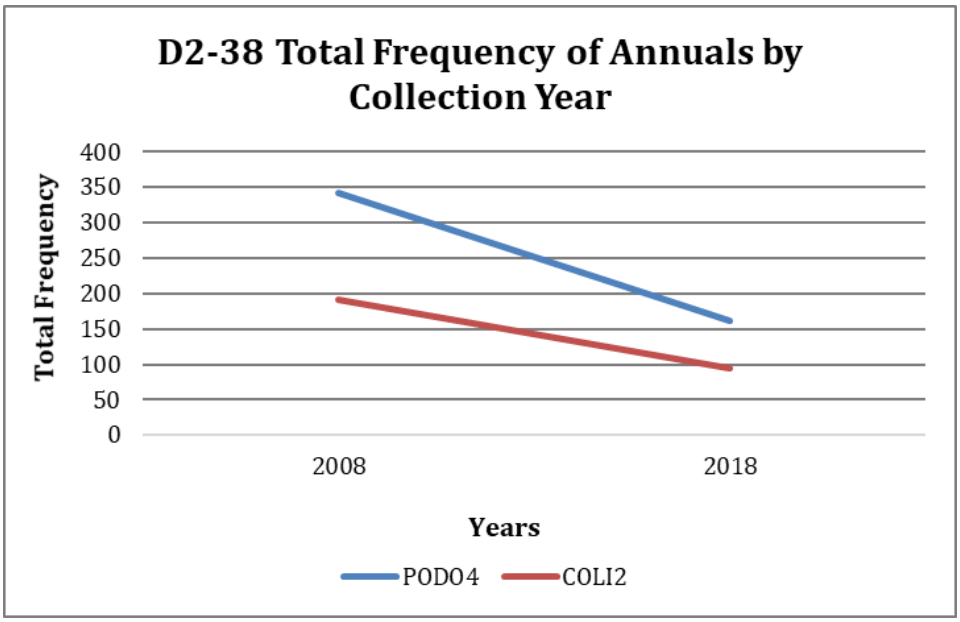


Figure 23: Nested frequency data was used to display the total frequency of annuals identified on site for each year annuals were monitored. In 2003 annuals were not included in the monitoring.

The total frequency of annuals including *Polygonum douglasii* (POD04) and *Collomia linearis* (COLI2) have decreased from initial montioring establishment to present (Figure 23).

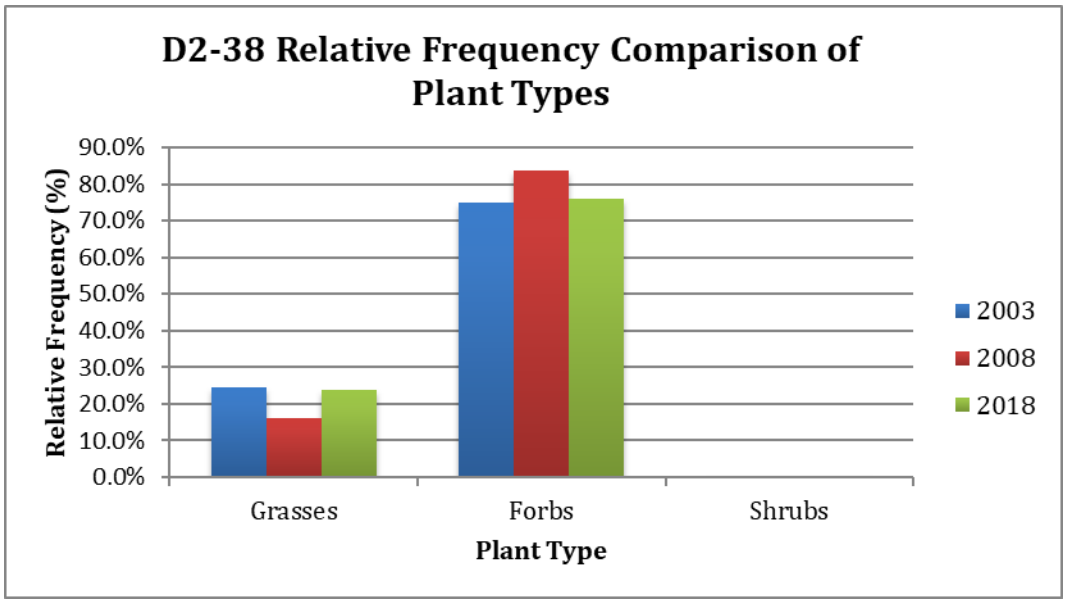


Figure 24: Nested frequency data was used to display the relative frequency (%) of grasses, forbs, and shrubs for each year monitored.

Since monitoring was established in 2003 to current day there has been very little change in the relative frequency of grasses and forbs (Figure 24). There was a flucuation between grasses and forbs in 2008 but that leveled out again in 2018.

Soils Data:

SOIL PROFILE																				
Depth (inches)	Rock Fragment Type & Vol (%)				Texture	%Clay (+/- 5%)	Effervescence	Moist Color	Structure	pH	EC	OM (%)	Nitrate	Phosphorus	Potassium	Zinc	Iron	Manganese	Copper	Lime
	0-5%	5-15%	15-35%	>35%																
0-6		X			SL	16	NE	10YR 3/2	NA	5.6	0.2	6.2	2.1	35.6	197	2.86	117	16.4	2.66	low
6-21		X			SCL	26	NE	7.5YR 2.5/2	NA	5.3	0.2	4.4	0.6	20.0	79.5	0.6	88.8	5.31	2.14	low
Notes: Clay films present in the second horizon. Could not tell structure from baggie sample														No soil pit photo available						

Soils on this site are considered deep since digging continued without reaching parent material within the top 20 inches. Clay films that are present in the second horizon are attributed to the increase in clay content. This site also has more iron present which readily binds to clay particles (Hurt et al, 2014). This reaction then lowers the pH level in this soil.

Climate Data:

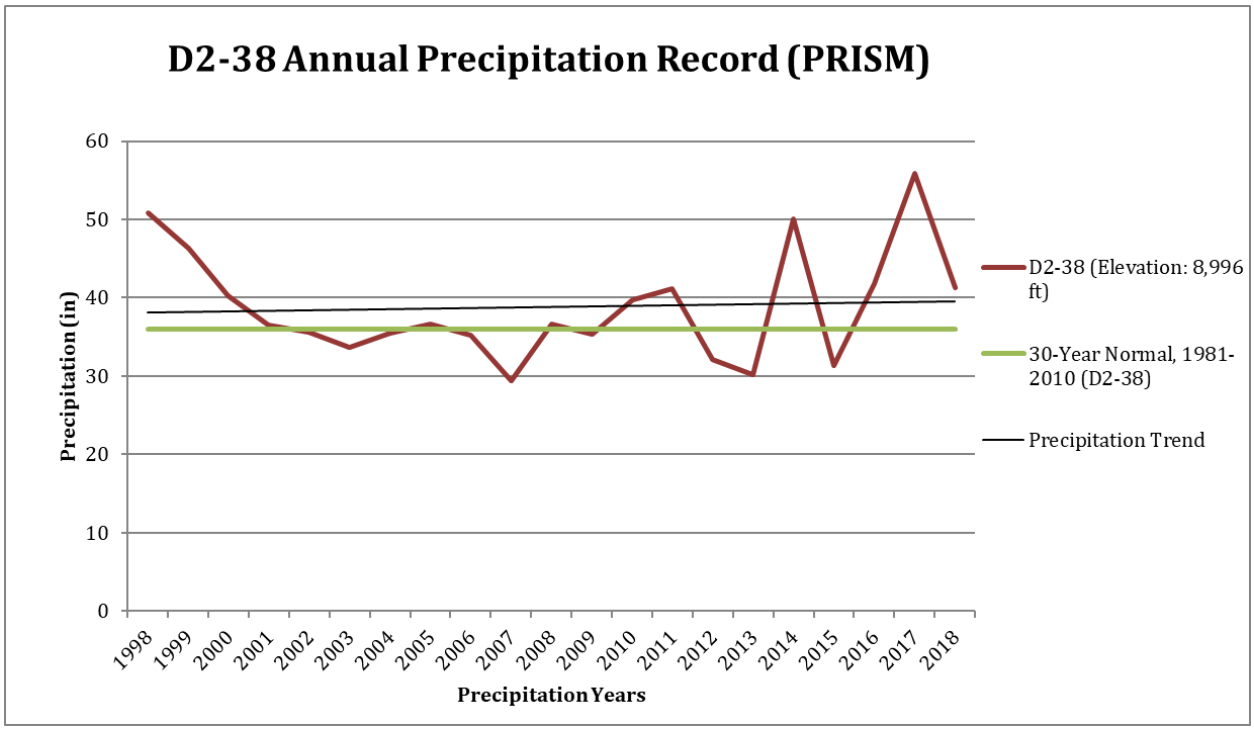


Figure 25: PRISM data was used to display annual precipitation, the 30-year normal for the site from 5 years prior to monitoring established to the present, and precipitation trend.

Climate data for site D2-38 shows a slight increase in the annual precipitation over time (Figures 25).

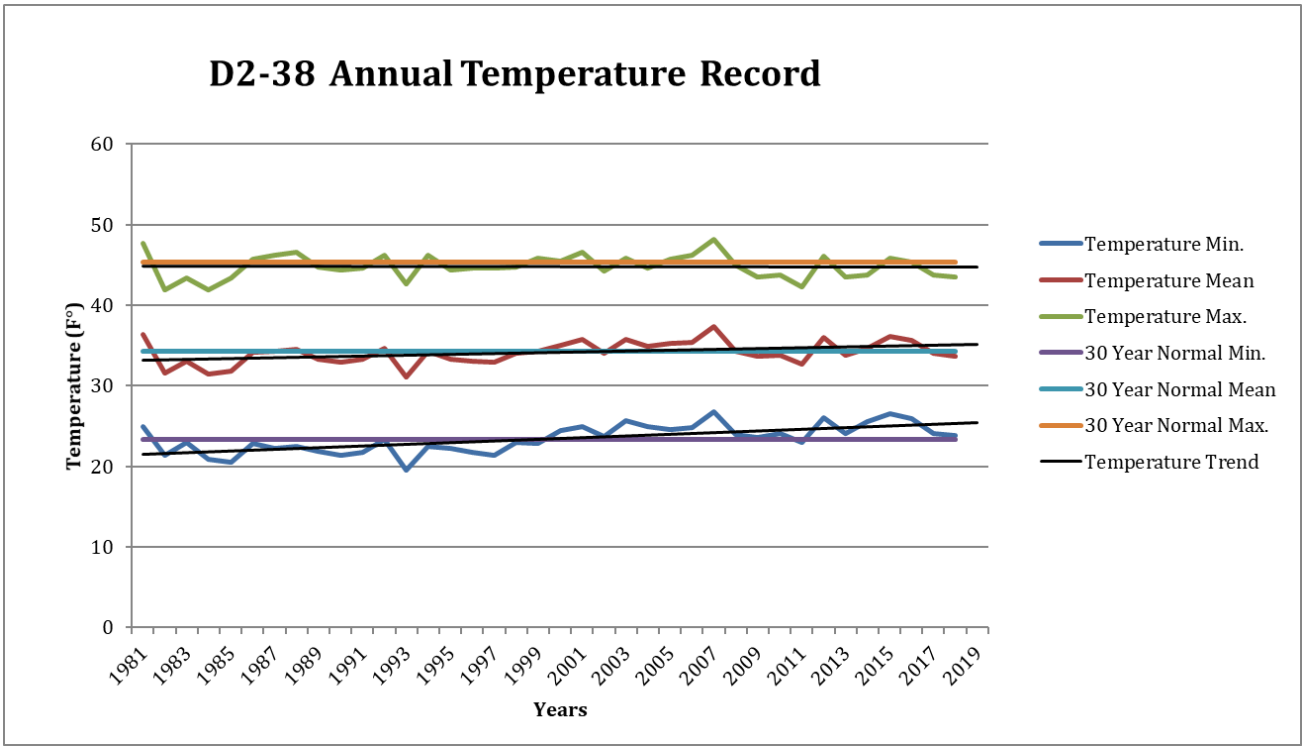


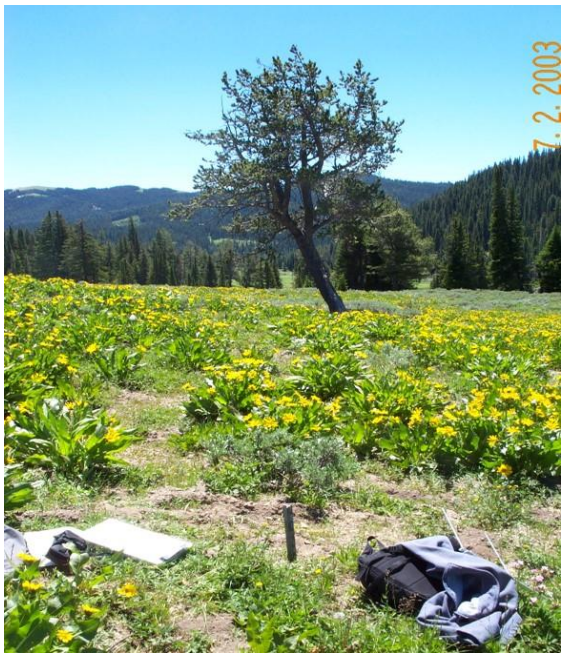
Figure 26: PRISM data was used to display annual temperature, the 30-year normal for the site 1981 to present, and temperature trend.

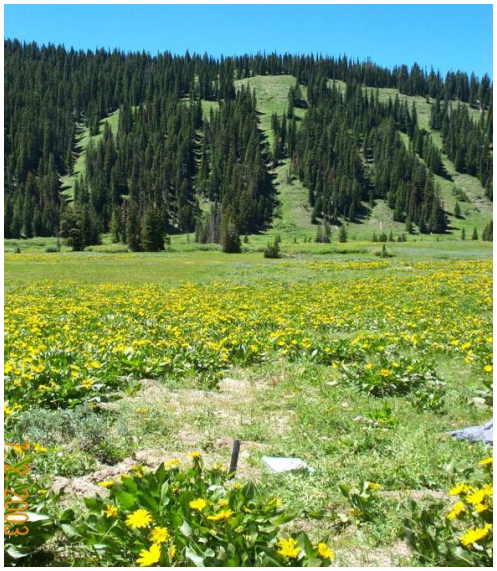
Climate data for site D2-38 shows an increasing trend in the annual temperature (min, mean, and max) over time (Figure 26).

Discussion:

Line-Point Intercept data shows this site has 80% foliar cover, and bare ground of approximtely 8%. This site sits on a 9% slope on a Southwest aspect. The relative frequency of *Wyethia amplexicaulis* (WYAM) has decreased by approximately 3% since monitoring was established in 2003. In 2018, WYAM was still the most dominant plant on site at 42% foliar cover. By looking at these attributes combined with the vegatative community composition it can be concluded that this site has characteristics similar to a WYAM tall forb community type (Svalberg et. al., 1997). Gregory 1983 states, the presence of WYAM is higher in these sites and includes other associated plants such as *Achillea millefolium* (ACMI2), *Geranium viscosissimum* (GEVI2), *Bromus marginatus* (BRMA4), *Collomia linearis* (COLI2), and *Potentilla gracilis* (POGR9), all of which are present in the D2-38 plant community. The soils on this site have higher clay content which is a characteristic of WYAM tall forb plant communities. Soil textures and organic matter content was within the range described by Gregory 1983. WYAM plant communities tend to have a more basic pH than what was recorded at this site. Using the nested frequency data, ground cover on this site is 76%, which is below the 80% threshold set in the ROD.

Photos:

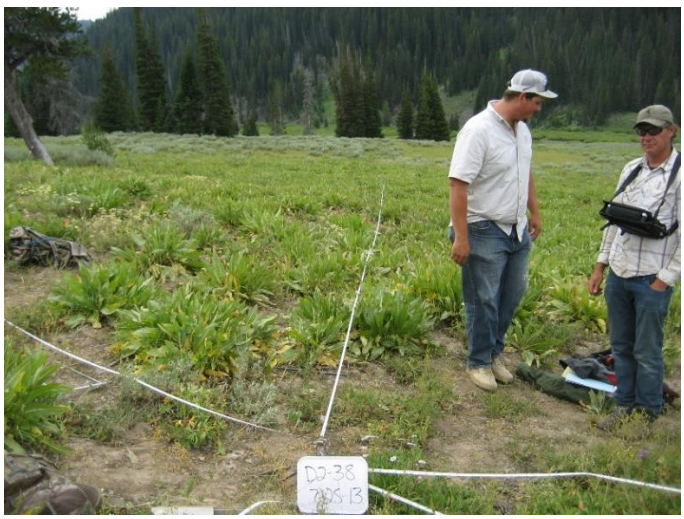




2003

2008

2013



2013

2013

2018

2018

2018 cont.

N. Horse Creek T5

Mule Creek S&G

Location: 42.976029, -110.610646

Site Attributes: This site represents a mixed willow plant community. Based upon the Winward Greenline methodology, this stream is defined as a cobble system with a 2-4% gradient placing it in Capability Group 5. In group 5, 85+% of the greenline should be represented by late seral community types or anchored rocks/logs when the riparian area is functioning properly (Winward, 2000).

Riparian Greenline Summary	Monitoring Year	
	2002	2019
Greenline Stability Rating	8.09 (Good (High))	7.53 (Good (High))
Greenline Ecological Status	103.8% (PNC)	106.2% (PNC)
Early	11.8	9.7
Late	88.2	90.3

Ecological status data suggests that this site is in PNC (Potential Natural Community). Early seral species have slightly decreased along the green line while late seral species have seen a slight increase since the initial reading in 2002.

2019 Field Notes: Site is a bedrock-controlled cobble system. A meander formed since last reading causing an island or bar at the lower end of the transect. The start of transect is located at the confluence and ends at the large rock slab downstream. Far river left was read in 2019, not newly created channel bar.

Photos:

2002- Upper View

2002- Lower View

2002- Overview

2019- Upper, Looking Downstream

2019- Lower, Looking Upstream

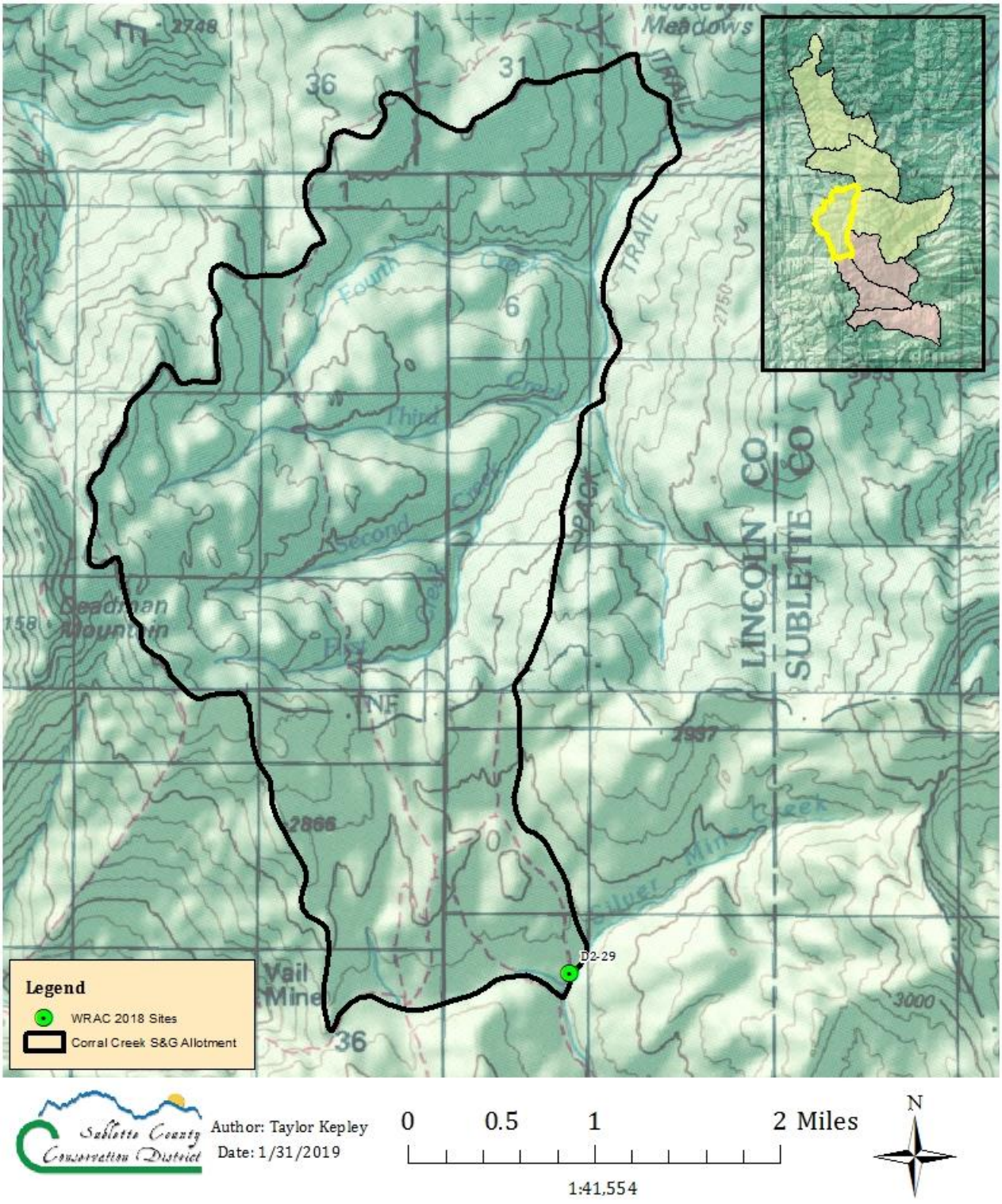


Figure 27: Map of WRAC monitoring locations within the Corral Creek S&G Closure Allotment

D2-29

Corral Creek S&G
BH Sheep Closure Allotment

Location: 42.977997, -110.610117 **Original Baseline Azimuth:** NA

Monitoring Technique: Site was monitored using the baseline technique (refer to Figure 3 for transect configuration).

Site Attributes

ELEVATION (ft)	BEDROCK GEOLOGY	SURFACE GEOLOGY	SLOPE CLASS	SLOPE SHAPE	ASPECT	LAND FORM	PARENT MATERIAL
8855	Qal*	rRs**	5%	linear - linear	SE	alluvial fan	alluvium

*Qal – poorly sorted, unconsolidated gravel, sand, and silt in channels and floodplains
**rRs – rock outcrop, residiuum, slope wash

Vegetation Data:

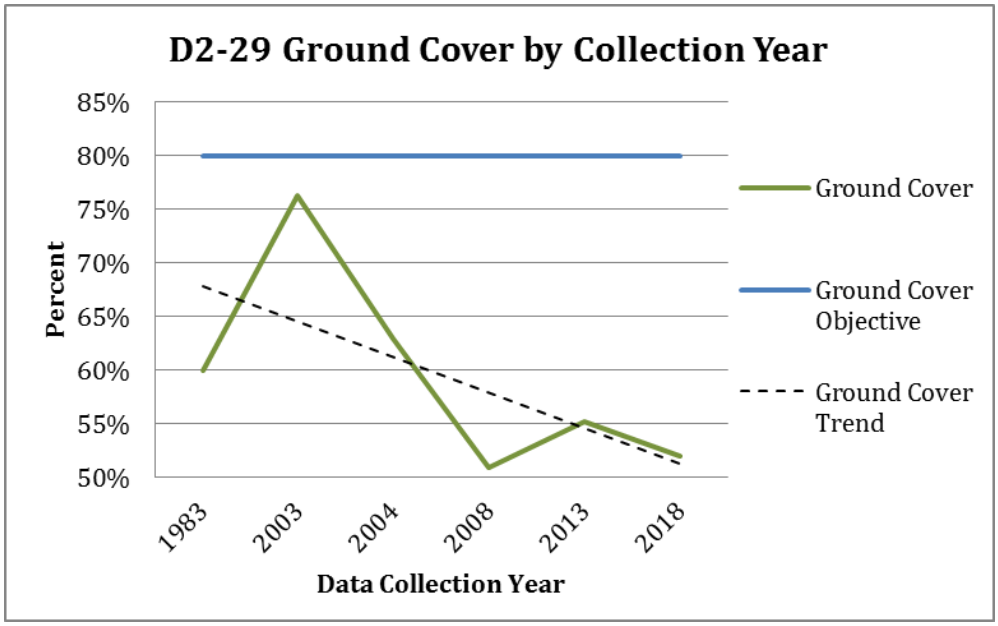


Figure 28: Nested frequency data was used to calculate ground cover (%) by monitoring year compared to the ground cover objective of 80% specified in the ROD.

Data presented in the figures above shows a downward trend in ground cover for the site, and thus far data shows that ground cover on the site has remained below the 80% objective (Figure 28).

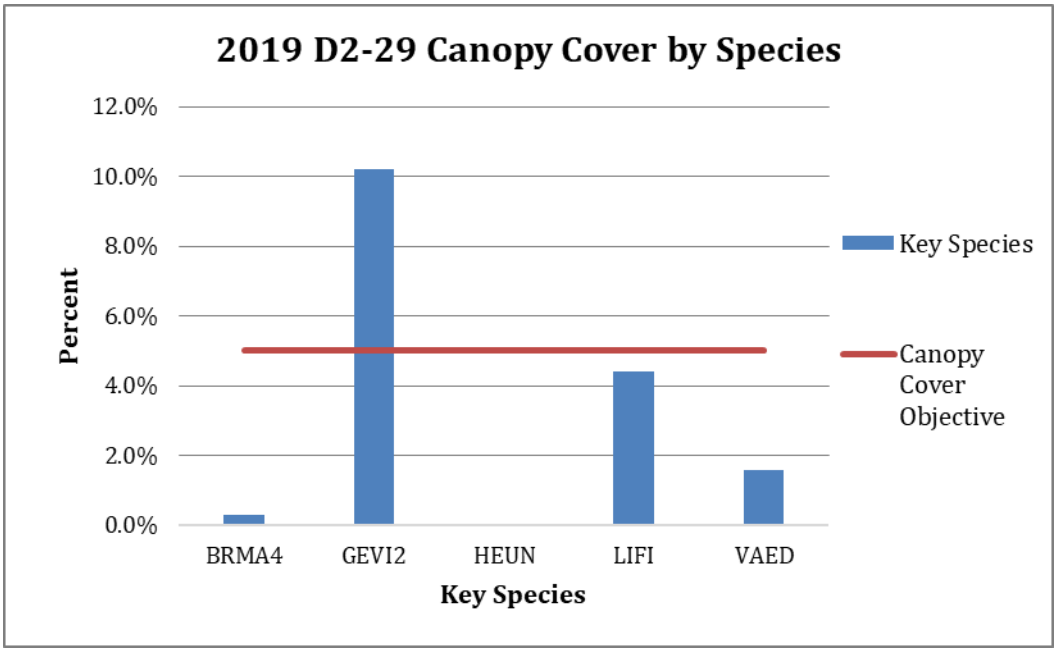


Figure 29: Line-Intercept data was used to compare (%) canopy cover for each key species found on the site.

Geranium viscosissimum (GEVI2) is the only key species currently above the 5% canopy cover objective (Figure 29). *Ligusticum filicinum* (LIFI) is currently at 4.4% canopy cover. *Helianthella uniflora* (HEUN) is the only key species that has not been recorded on site thus far.

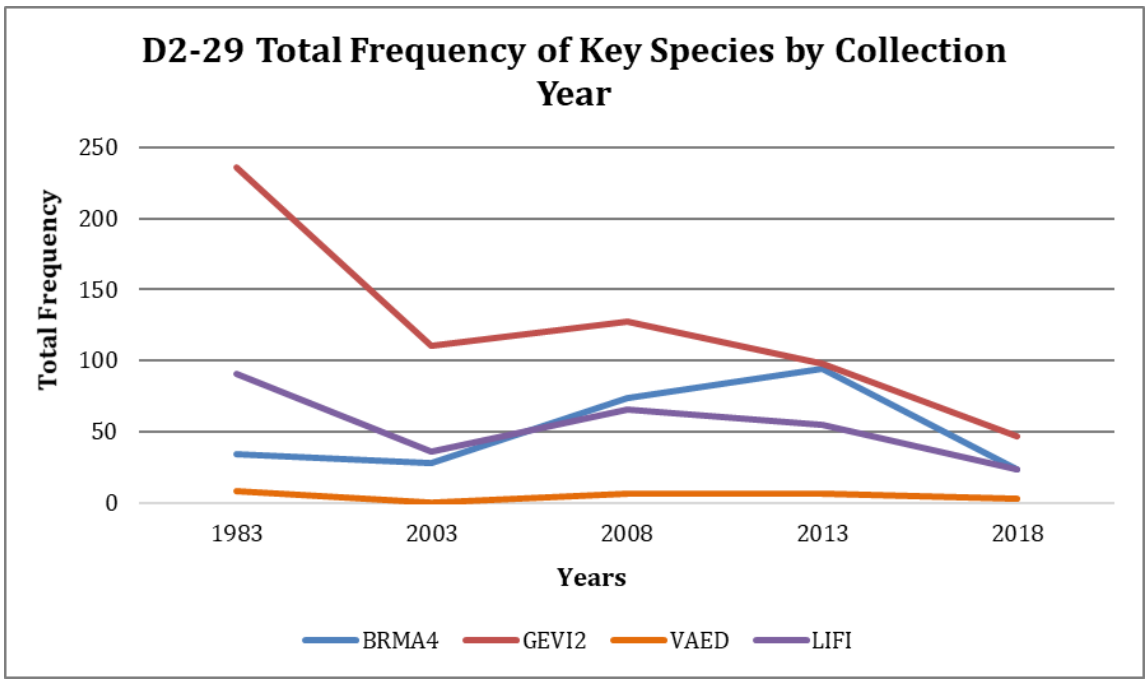


Figure 30: Nested frequency data was used to show the total frequency of key species identified in the ROD by collection year.

Total frequency of all key species except for *Bromus marginatus* (BRMA4) appears to be trending downward from intial monitoring (Figure 30). BRMA4 appears to have a slight upward trend even though total frequency has decreased from 2013 to 2018.

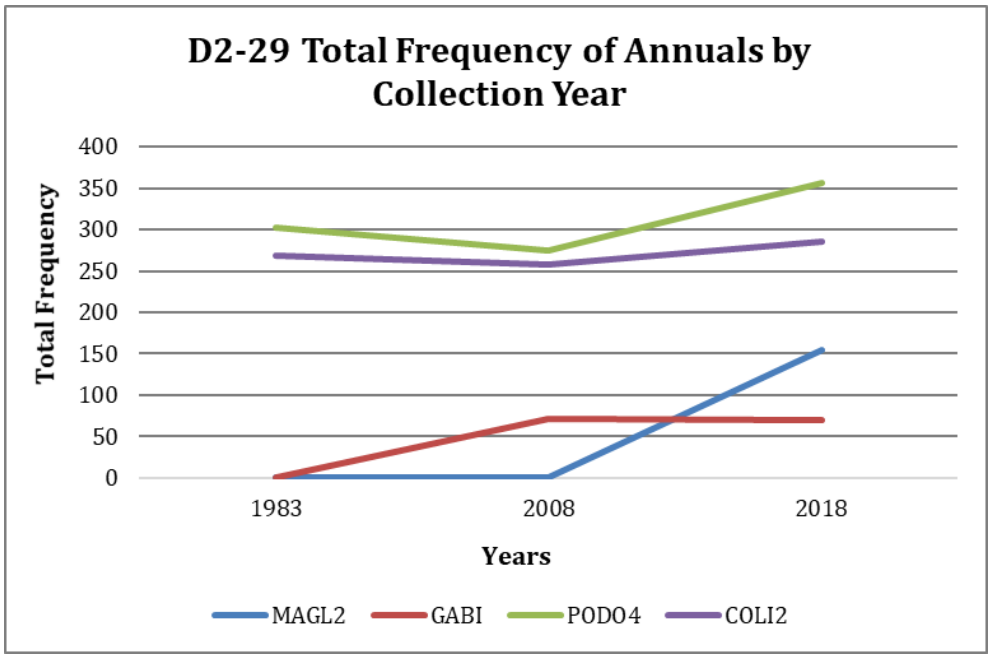


Figure 31: Nested Frequency data was used to display the total frequency of the annual species identified on site for each year annuals were monitored.

The total frequency of annuals including; *Galium bifolium* (GABI), *Polygonum douglasii* (PODO4), *Collinsia parviflora* (COPA3) and *Collomia linearis* (COLI2) have increased from initial monitoring establishment to the 2018 monitoring year (Figure 31). *Madia glomerata* (MAGL2) was present on the site in 2018 and noted to be on the site for the first time in 2013. MAGL2 is known to become weedy on disturbed areas or in overgrazed rangelands (Ross et. al., 2012). This plant is known to displace desirable vegetation if not managed properly. Studies have shown there is a chemical substance found in tarweed plants which can inhibit normal germination and growth of surrounding plants (Carnahan et. al, 1962). This could make it harder for sites with large amounts of Madia established to move towards a more desirable plant community. Chemical properties of the plant also cause it to be avoided by livestock and wildlife. (Ross et. al., 2012). On this site MAGL2 was at 4% foliar cover and had a relative frequency of 7%.

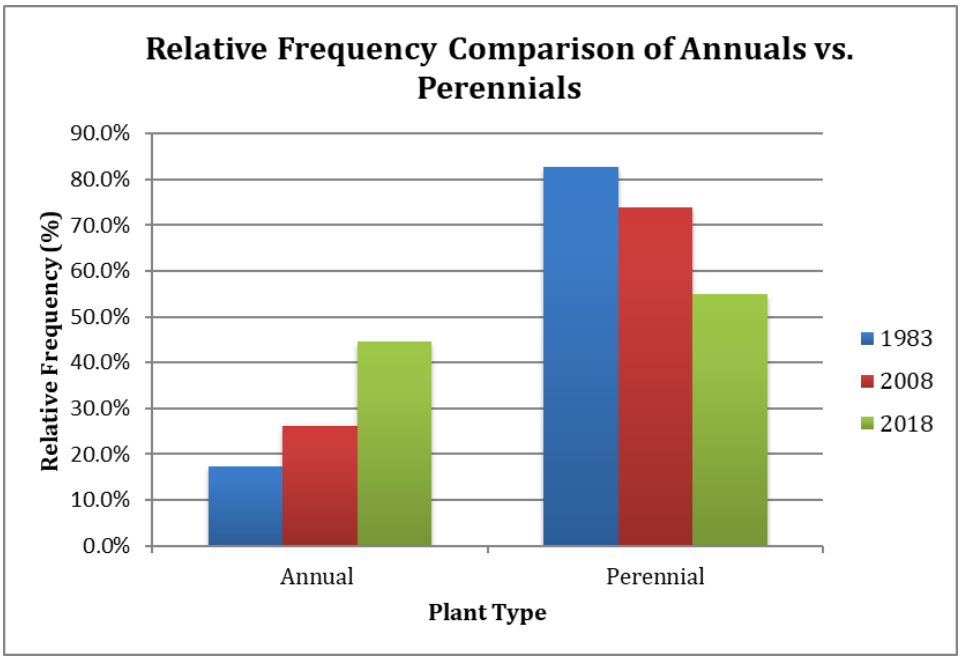


Figure 32: Nested frequency data was used to show the relative frequency of annuals vs perennials for each year monitored. In 2004 and 2013 the annual plant species data is not available.

Since monitoring was established in 1983 there has been a steady increase in annuals and decrease in perennial plant species present on site (Figure 32). Annuals still make up almost half of the plant community in 2018 (Figure 32). This annual to perennial relationship may be contributing to the decline in ground cover. Since monitoring was established in 1983 to present day there has been a 12.1% decrease in the relative frequency of grass, a 12.5% increase in forbs and a 0.4% decrease in shrubs on site.

Soils Data:

SOIL PROFILE																				
Depth (inches)	Rock Fragment Vol (%)				Texture	%Clay (+/- 5%)	Efferv esence	Moist Color	Structure	pH	EC	OM (%)	Nitrate	Phosphorus	Potassium	Zinc	Iron	Manganese	Copper	Lime
	0-5%	5-15%	15-35%	>35%																
0-6	X				CL	27	NE	10YR 4/2	sbk	5.4	0.1	6.2	3.3	36.8	172	2.39	146	12.2	4.32	low
6-14	X				CL	30	NE	10YR 4/2	sbk	5.2	0.1	4.2	4.4	36.4	94.1	1.46	164	5.17	3.92	low
14-20	X				CL	34	NE	10YR 4/2	sbk	5.2	0.2	3.2	6.7	24.5	61.9	1.12	110	1.20	1.94	low
Family particle size class: Fine-Loamy																				

Soils on this site are considered deep since digging continued without reaching parent material in the top 20 inches. This site has high iron amounts which is related to higher amounts of clay in this soil. The high clay and iron in the soil explains the lower pH on this site because iron readily binds with clay particles (Hurt et al, 2014). Nitrate levels in the second horizon are greater than that of the top horizon indicating that nitrate is leaching through the soil profile. Leaching of nitrate can be related to a decrease in diversity of plant functional groups (Scherer-Lorenzen et. al., 2003).

2018 – Soil pit

Climate Data:

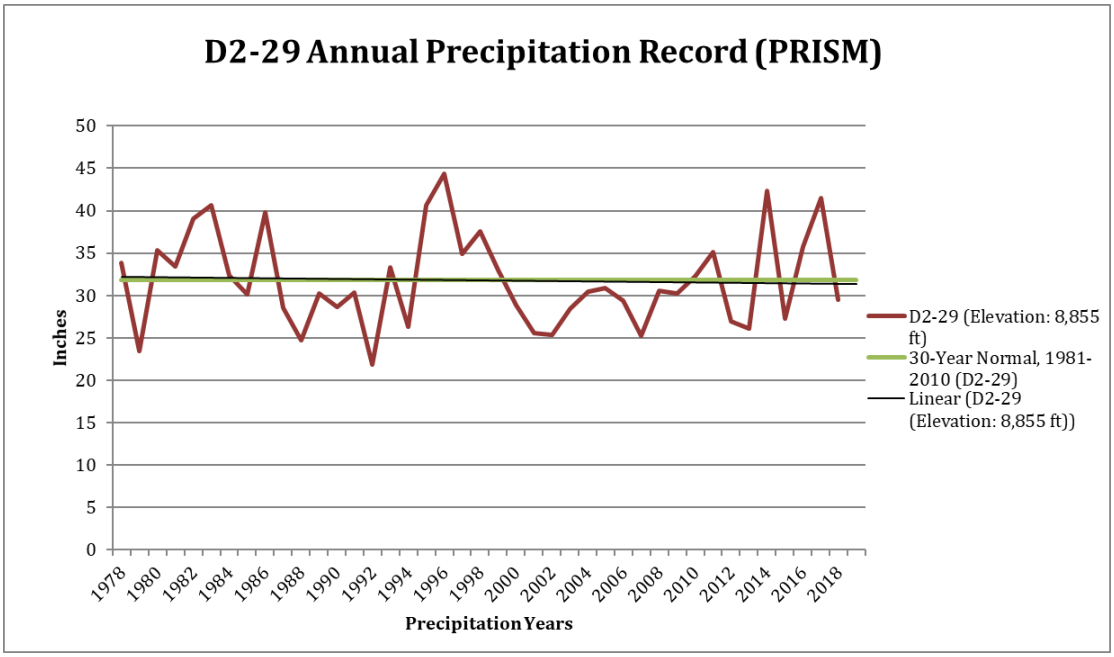


Figure 33: PRISM data was used to display annual precipitation, the 30-year normal for the site from 5 years prior to monitoring established to the present, and precipitation trend.

Climate data for D2-29 shows a decreasing trend in annual precipitation over time (Figure 33)

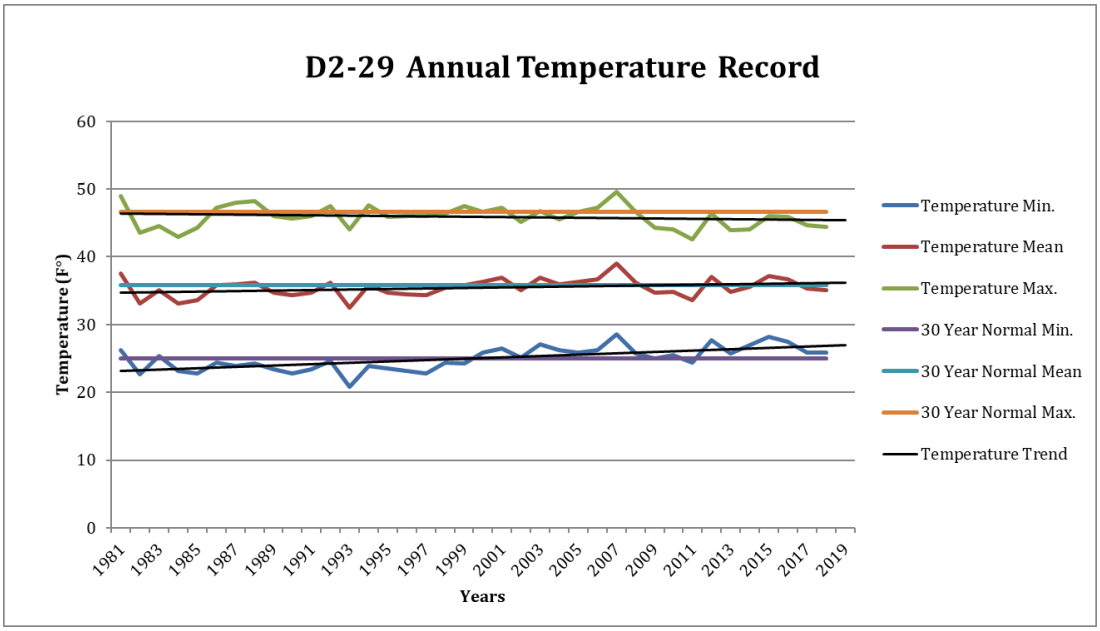


Figure 34: PRISM data was used to display annual temperature, the 30-year normal for the site 1981 to present, and temperature trend.

Climate data for this site shows an increasing trend for the minimum and mean annual temperatures, while maximum annual temperature is on a downward trend for this site (Figure 34).

Discussion:

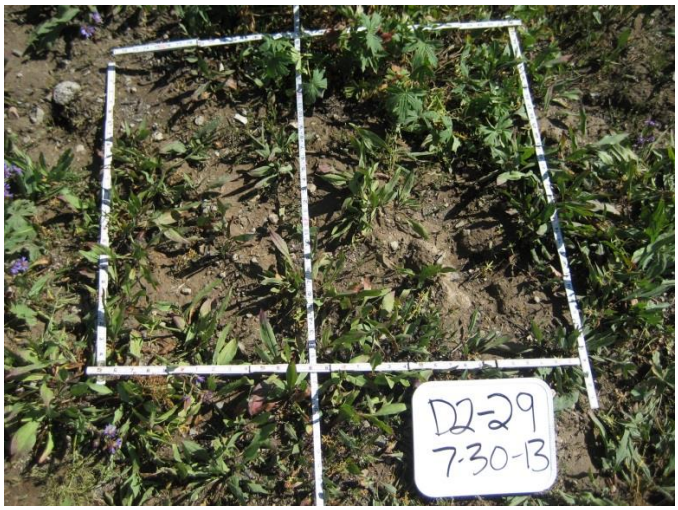
Line-Point Intercept data tells us that this plant community has 76% foliar cover, and bare ground of approximtely 18%. This site sits on a SouthEast facing 5% slope. This site had 22.4% foliar cover of *Eurybia integrifolia* (EUIN9) and more *Melica spectabilis* (MESP) at 4.2% than any other site monitored in the 2018 field season. This site also has 8.2% of *Ligusticum filicinum* (LIFI), but that is not enough cover to consider this plant community a LIFI-DEOC plant community (Gregory, 1983). Other plant species that have a higher presence on site are *Pseudostellaria jamesiana* (PSJA2) at 5.8% foliar cover, and *Potentilla glandulosa* (POGL9) at 6.2% foliar cover. These site characteristics don't seem to correspond to any of the plant communities previously described in Gregory 1983 or the Ecological Unit Inventory Vol. 2. Using the nested frequency data, ground cover on this site is 52.2%, which is below the 80% threshold set in the ROD.

Photos:

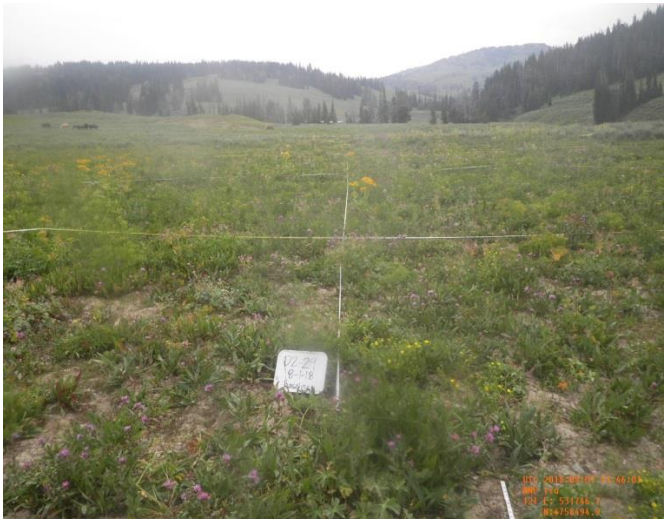
1983

2003

2008



2013



2018

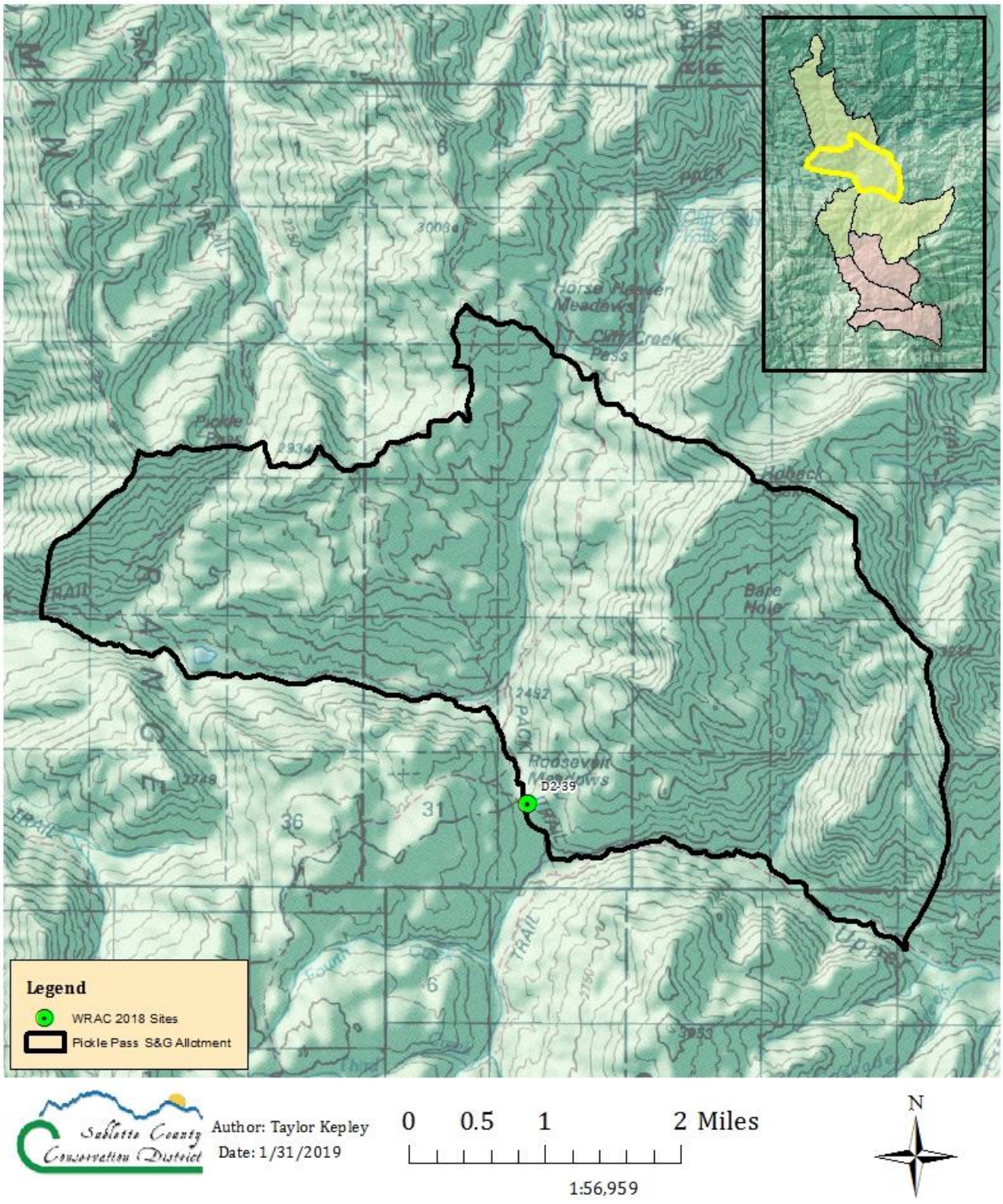


Figure 35: Map of monitoring locations within the Pickle Pass S&G BH Sheep Closure Allotment

D2-39

Pickle Pass
BH Sheep Closure Allotment

Location: 43.049480, -110.602770 **Original Baseline Azimuth:** NA

Monitoring Technique: Site was monitored using the beltline technique (refer to Figure 5 for transect configuration).

Site Attributes:

ELEVATION (ft)	BEDROCK GEOLOGY	SURFACE GEOLOGY	SLOPE CLASS	SLOPE SHAPE	ASPECT	LAND FORM	PARENT MATERIAL
8802	Qls*	li**	17%	convex - convex	WSW	mountain base	colluvium

*Qls – Landslide deposits
**li – landslide

Vegetation Analysis:

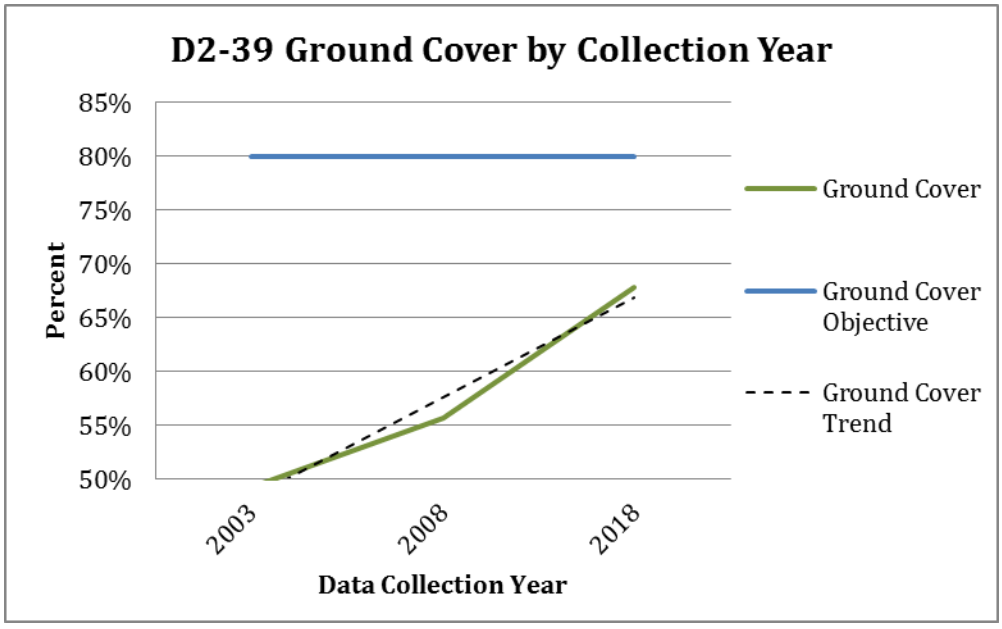


Figure 36: Nested frequency data was used to show ground cover (%) by monitoring year compared to the ground cover objective of 80% specified in the ROD.

Data presented in the figure above shows an upward trend in ground cover for the site, however data shows that ground cover has remained below the 80% objective (Figure 36).

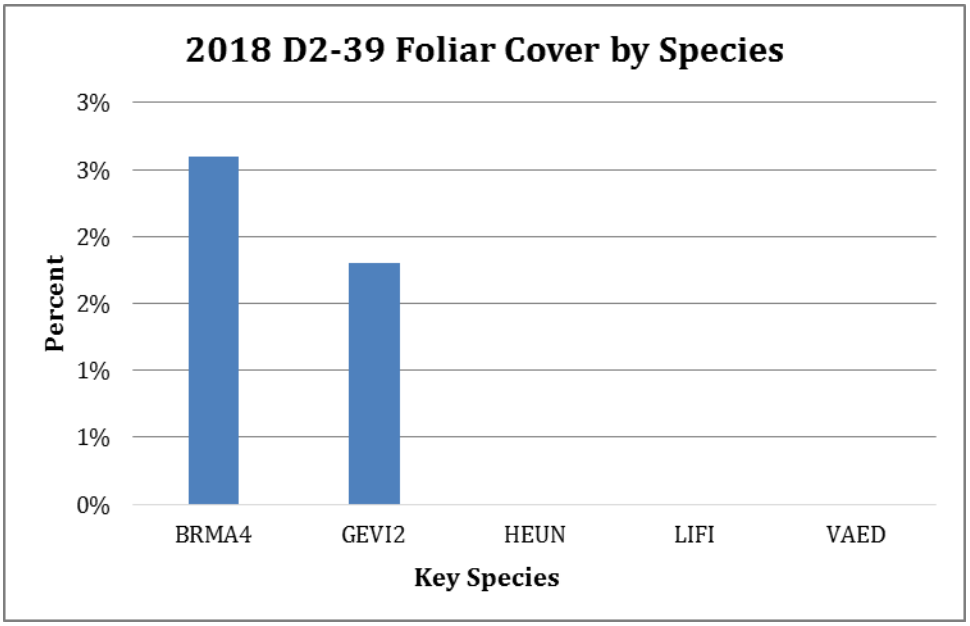


Figure 37: Line-Point Intercept data was used to compare (%) foliar cover for each key species found on the site. Line-intercept was read in 2003 on GEVI2. A that time GEVI2 had 9.6% canopy cover. **Line intercept was not read in 2019 along with the other WRAC sites because of the lack of key species found in the frequency data. Line intercept will be incorporated into future monitoring on the site.**

None of the five key species are above 5% foliar cover (Figure 37).

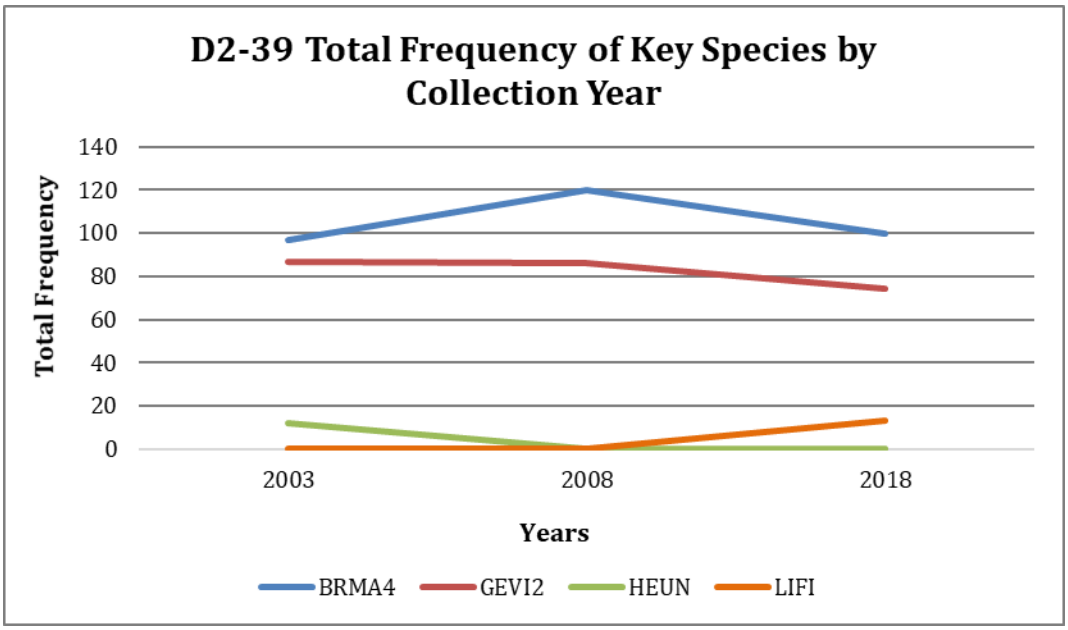


Figure 38: Nested frequency data was used to display the total frequency of the five key species identified in the ROD by collection year.

The total frequency of *Geranium viscosissimum* (GEVI2) and *Helianthella uniflora* (HEUN) appears to be trending downward (Figure 38). *Bromus marginatus* (BRMA4) has a relatively static trend. *Ligusticum filicinum* (LIFI) had not been found on the site until the 2018 monitoring (Figure 38).

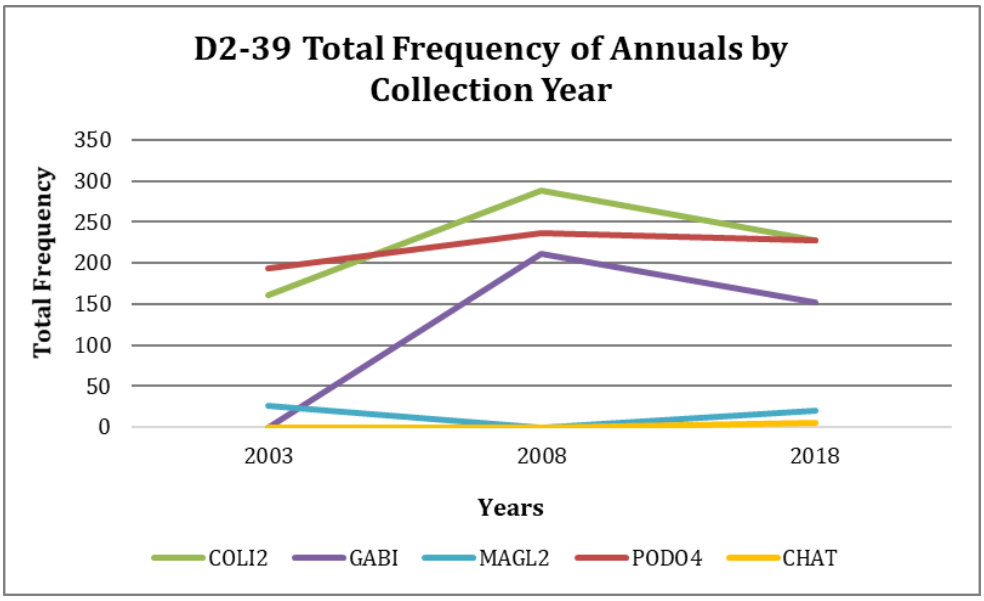


Figure 39: Nested frequency data was used to display changes in the total frequency of annuals species for each year annuals were monitored.

The total frequency of annuals including; *Collomia linearis* (COLI2), *Polygonum douglasii* (PODO4), and *Galium bifolium* (GABI) have increased from initial monitoring establishment to the 2018 monitoring year (Figure 39). The 2018 monitoring recorded a presence of *Chenopodium atrovirens* (CHAT) which has not been historically present on this site.

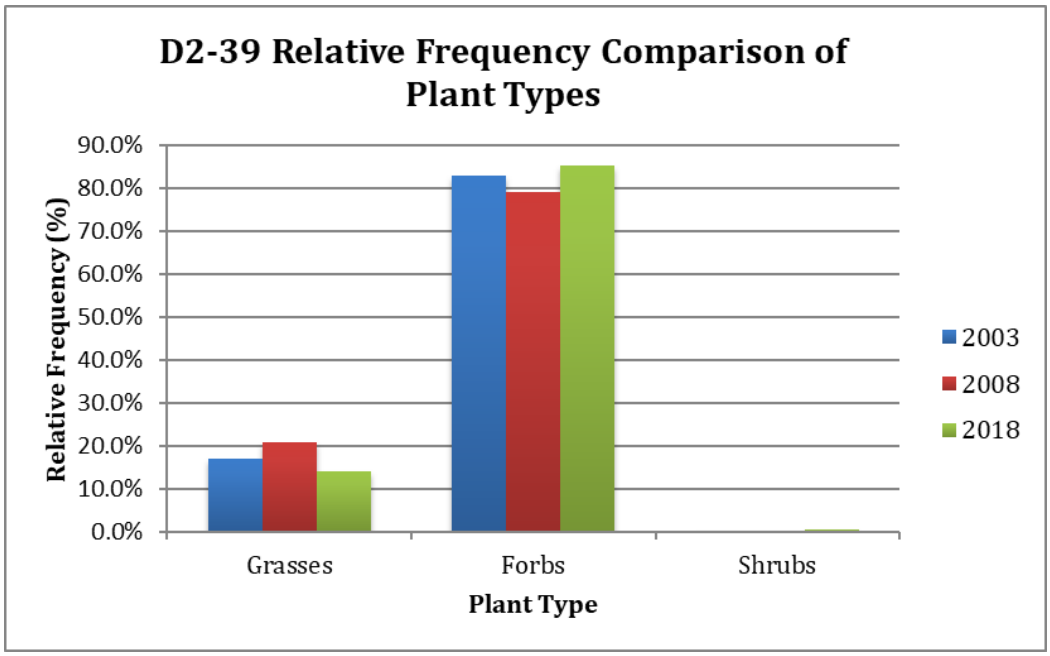


Figure 40: Nested frequency data was used to display changes in the relative frequency (%) of grasses, forbs, and shrubs for each year monitored.

Since monitoring was established in 2003 to current day there has been a decrease of 3% in the relative frequency of grasses, a 2.5% increase in forbs and a 0.4% increase in shrubs (Figure 40).

Soils:

SOIL PROFILE																				
Depth (inches)	Rock Fragment Vol (%)				Texture	%Clay (+/- 5%)	Effervescence	Moist Color	Structure	pH	EC	OM (%)	Nitrate	Phosphorus	Potassium	Zinc	Iron	Manganese	Copper	Lime
	0-5%	5-15%	15-35%	>35%																
0-6		X			CL	27	NE	5YR 3/3	sbk	6.5	0.2	6.8	1.4	21.0	560	2.81	41.2	17.3	2.94	low
6-16	X				CL	30	NE	2.5YR 3/3	sbk	6.0	0.1	3.8	3.5	13.1	217	3.72	56.7	1.88	11.9	low
16-20	X				CL	35	NE	2.5YR 3/3	sbk	6.1	0.1	3.2	1.3	11.5	175	0.93	47.1	2.20	3.45	low
First horizon has strong structure and smells like OM; second horizon has clay films, strong structure, and has depletions; the third horizon has clay films. Family particle size class: Fine-Loamy																				

Soils on this site are considered deep since digging continued without reaching parent material in the top 20 inches. The depletions present in the second horizon indicate that there is a water table present at some point during the year. The dark color is indicative of the high organic matter in this soil. Organic matter is important to water retention, aeration, soil structure, and creates a pool of nutrients for plants (Coleman et al., 2009). Also nitrate levels in the top horizon are elevated. Elevated nitrate levels indicate higher rates of decomposition producing more organic matter (Chapin et. al., 2012). Therefore more nutrients in the soil for plant assimilation. Althought nitrate levels in the second horizon are greater than that of the top horizon indicating that nitrate is leaching through the soil profile.

2018 – Soil pit

Climate Data:

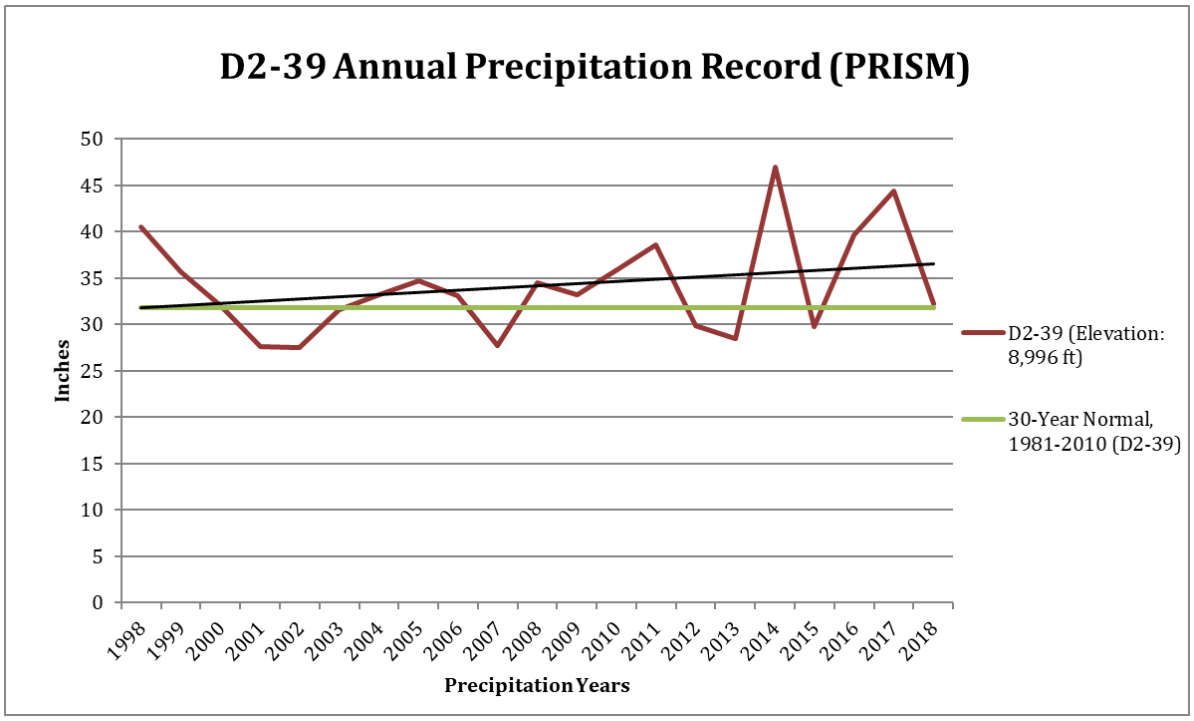


Figure 41: PRISM data was used to display annual precipitation, the 30-year normal for the site from 5 years prior to monitoring established to the present, and precipitation trend.

Climate data for site D2-39 shows an increasing trend for annual precipitation (Figure 41).

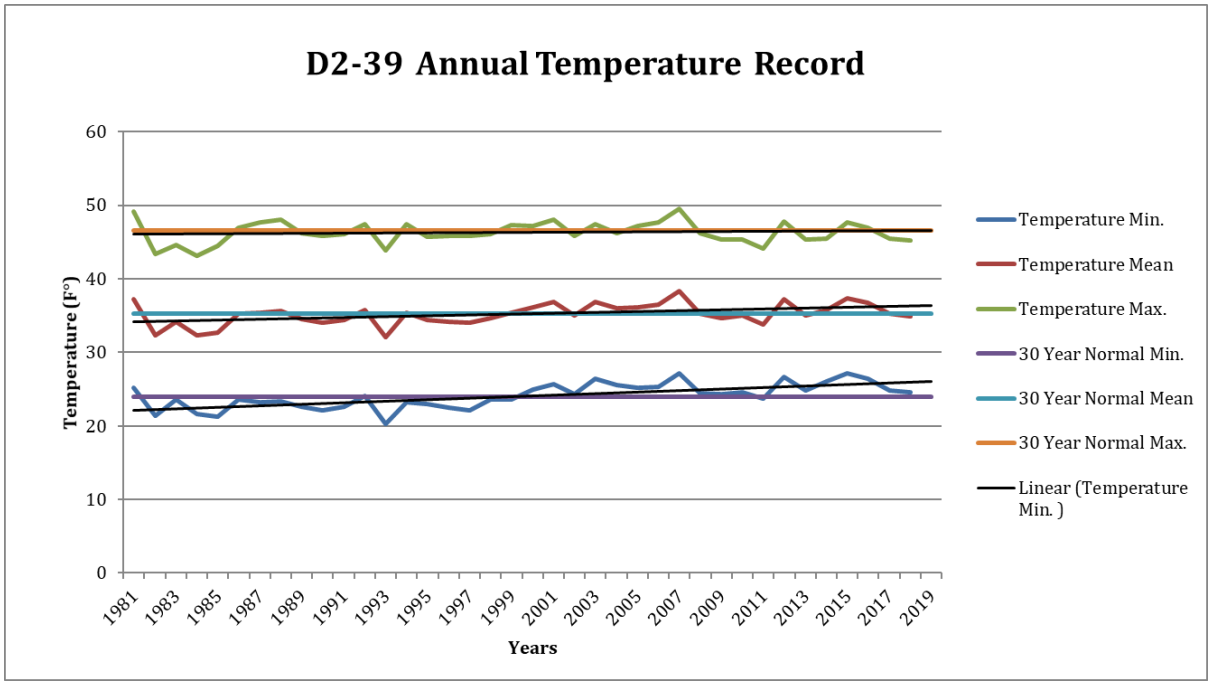


Figure 42: PRISM data was used to display annual temperature, the 30-year normal for the site 1981 to present, and temperature trend.

Climate data for site D2-39 shows an increasing trend in the annual temperature (min, mean, and max) over the 30-year normal (Figure 42).

Discussion:

Line-Point Intercept data tells us that this site has 82% foliar cover, with a bare ground of 11%. This site sits on a West to Southwest facing 17% slope. In 2018 WYAM was at 52% foliar cover on site. By looking at these attributes combined with the vegatative community composition it can be concluded that this site has characteristics similar to a WYAM tall forb community type (Svalberg et. al., 1997). According to Gregory 1983, the presence of WYAM is higher in these sites and other associated plants include *Achillea millefolium* (ACMI2), *Geranium viscosissimum* (GEVI2), *Bromus marginatus* (BRMA4), *Collomia linearis* (COLI2), and *Potentilla gracilis* (POGR9), all of which are present in the D2-39 plant community. The soils on this site have high clay content which is a characteristic of WYAM tall forb plant communities. Soil textures, pH, and organic matter content were within the range described by Gregory 1983 for this plant community. Using the nested frequency data, ground cover on this site is 67.8%, which is below the 80% threshold set in the ROD.

Photos:

2003

2008

2018 – Line 1 (left) and plot photo (right)

2018 – Start of line 2 (left) and start of line 3 (right)

2018 – Start of line 4 (left) and start of line 5 (right)

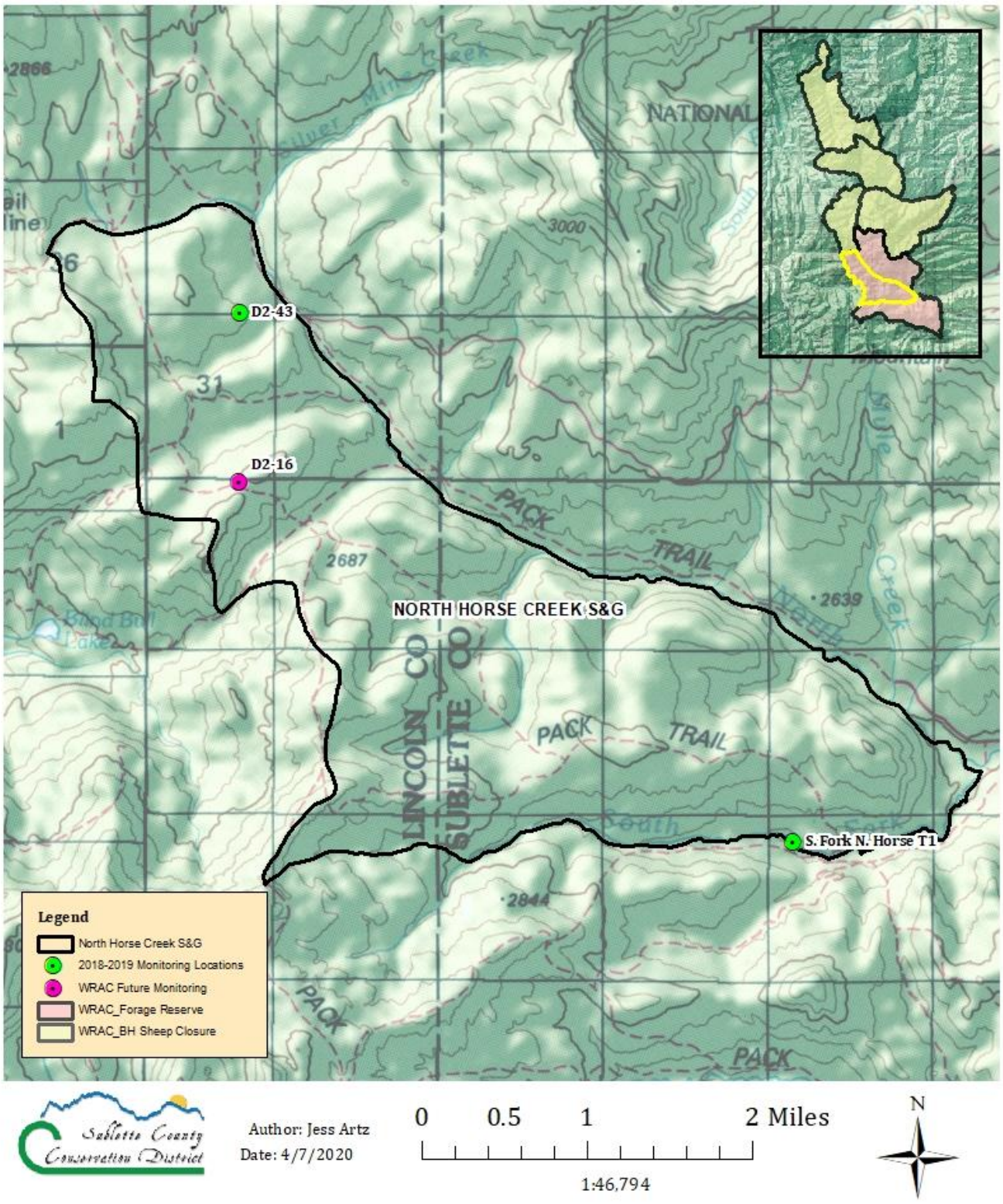


Figure 43: Map of WRAC monitoring locations within the North Horse Creek S&G Closure Allotment.

D2-43

North Horse Creek S&G
BH Sheep Closure Allotment

Location: 42.968381, -110.612159 **Original Baseline Azimuth:** NA

Monitoring Technique: Site was monitored using the #2 baseline technique (refer to Figure 4 for transect configuration).

Site Attributes:

ELEVATION (ft)	BEDROCK GEOLOGY	SURFACE GEOLOGY	SLOPE (%)	SLOPE SHAPE	ASPECT	LAND FORM	PARENT MATERIAL
8,855	*Kbb	residuum mixed	11%	convex-linear	NE	Mountain Flank	slope alluvium/residuum

*Kbb – conglomeratic sandstone, siltstone, claystone, coal and bentonite

Vegetation Data:

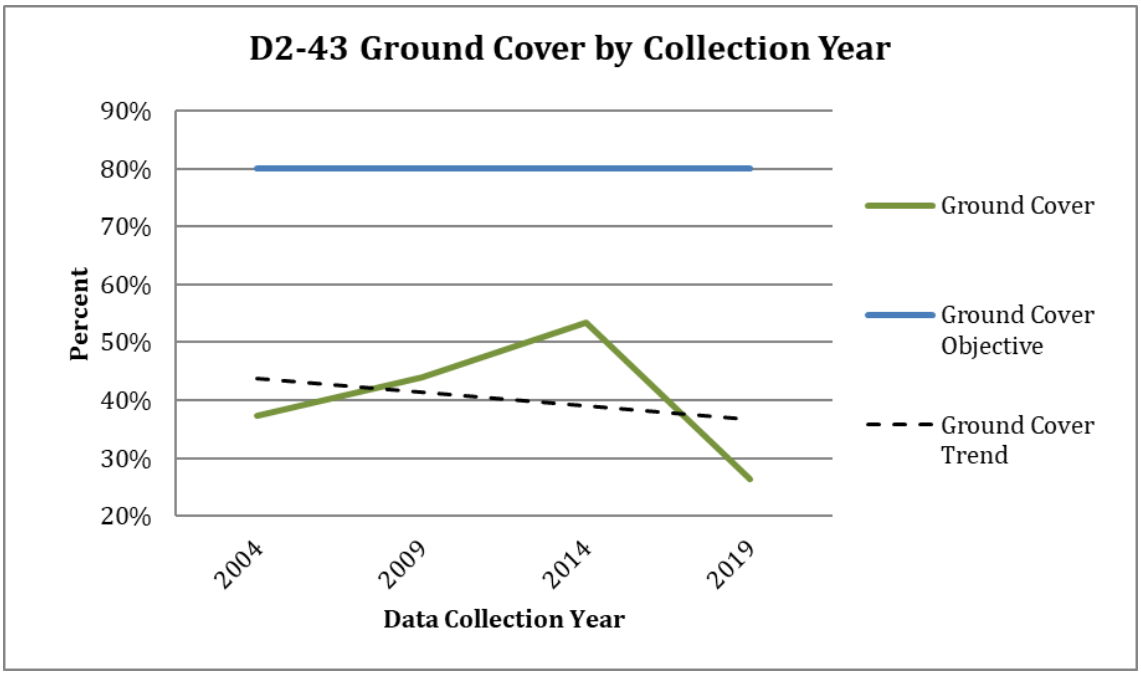


Figure 44: Nested frequency data was used to calculate ground cover (%) by monitoring year compared to the ground cover objective of 80% specified in the ROD.

Data presented in the Figure 44 shows a downward trend in ground cover for the site, and thus far data shows that ground cover on the site has remained below the 80% objective.

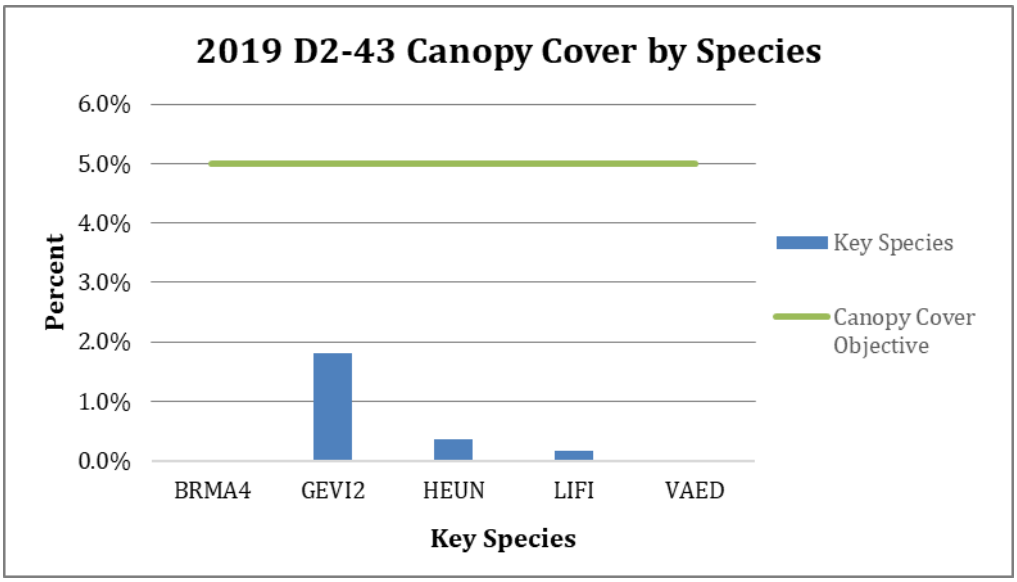


Figure 45: Line-Intercept data was used to compare (%) canopy cover for each key species found on the site.

Geranium viscosissimum (GEVI2), *Ligusticum filicinum* (LIFI) and *Helianthella uniflora* (HEUN) were all found on site. However, none of the key species are above the 5% canopy cover objective (Figure 44).

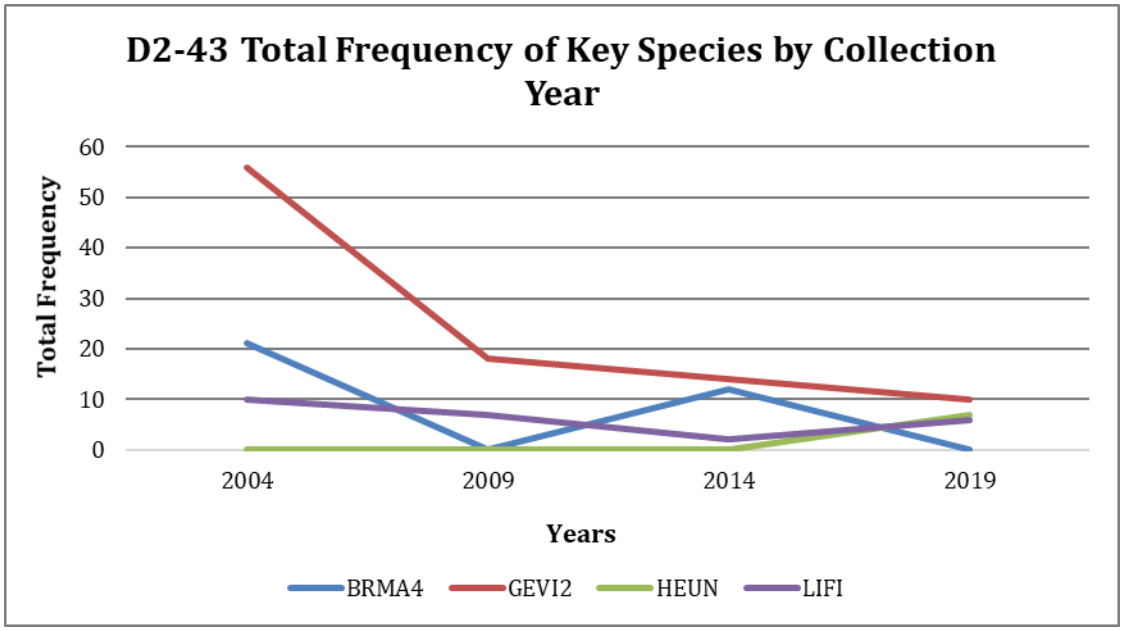


Figure 46: Nested frequency data was used to show the total frequency of key species identified in the ROD by collection year.

Total frequency of all key species except for *Helianthella uniflora* (HEUN) appears to be trending downward from intial monitoring (Figure 46).

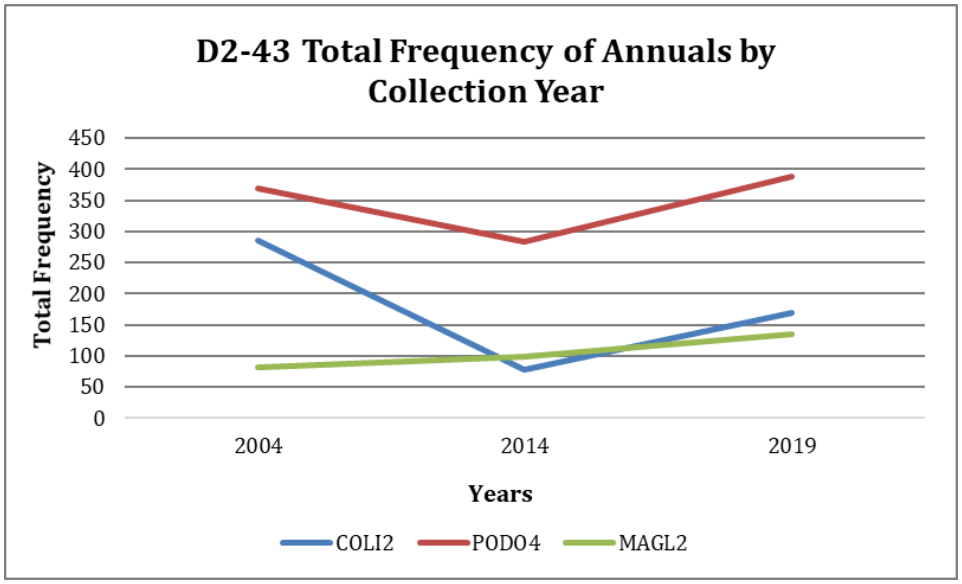


Figure 47: Nested Frequency data was used to display the total frequency of the annual species identified on site for each year annuals were monitored.

The total frequency of annuals including; *Polygonum douglasii* (PODO4) and *Madia glomerata* (MAGL2) have increased from initial monitoring establishment to the 2019 monitoring year (Figure 47). *Collomia linearis* (COLI2) has seen a decrease over time. On this site PODO4 was at 18.2% foliar cover and had a relative frequency of 27.1%. MAGL2 had a relative frequency of 9.4%. MAGL2 is known to become weedy on disturbed areas or in overgrazed rangelands (Ross et. al., 2012). This plant is known to displace desirable vegetation if not managed properly (Ross et. al., 2012). Madia appear to be more prolific in this specific drainage. Seed dispersal could be a result of many recreational uses as well as being moved by ungulates. Annuals currently make up close to half of the plant community. This annual to perennial relationship may be contributing to the decline in ground cover.

Soils Data:

SOIL PROFILE																			
Depth (inches)	Rock Fragment Vol (%)				Texture	%Clay (+/- 5%)	Effervesence	Moist Color	Structure	pH	EC	OM (%)	Nitrate	Phosphorus	Potassium	Zinc	Iron	Manganese	Copper	Lime
	0-5%	5-15%	15-35%	>35%															
A 0-3			GR		L	22		7.5 YR 4/3	3 GR	5.3	0.1	4.4	3.0	31.6	221	1.2	79.9	15.7	2.1	low
Bt1 3-12			GR		CL	29		7.5 YR 4/3	3 SBK	5.3	0.1	3.5	5.0	27.4	161	1.0	76.0	4.4	1.7	low
Bt2 12-20			GR		CL	32		7.5 YR 4/3	3 SBK	5.1	0.1	2.4	6.0	22.1	141	0.8	66.1	1.9	2.2	low
Large boulder >24" on side of pit starting at 12" down.																			

Soils on this site contained 15-35% gravels throughout the profile. This site has the lowest amount of Organic Matter across the WRAC. This could be do to the high amount of annuals on site and low ground cover. Without ample production there is less plant material breaking down on site adding to the organic matter content. Also, the low ground cover can also lead to higher erosion potential and therefore more loss of organic matter within the surface soils. Nitrate levels in the second horizon are greater than that of the top horizon indicating that nitrate is leaching down the soil profile. Leaching of nitrate can be related to a decrease in diversity of plant functional groups (Scherer-Lorenzen et. al., 2003).

2019 – Soil pit

Climate Data:

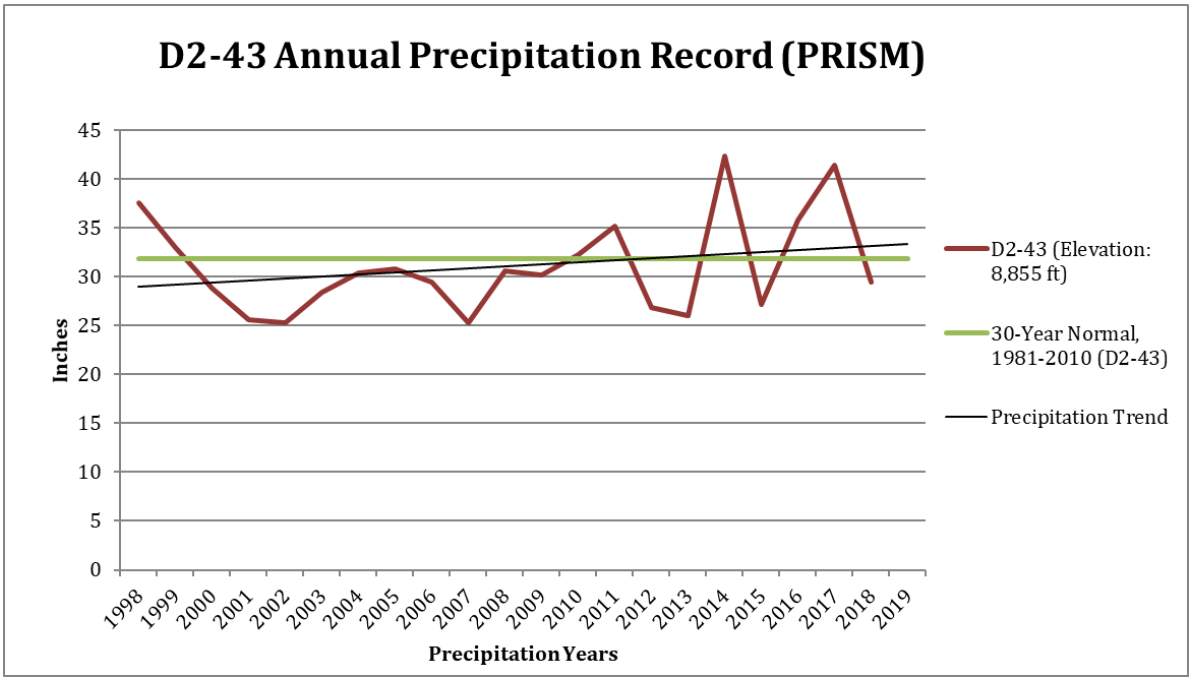


Figure 48: PRISM data was used to display annual precipitation, the 30-year normal for the site from 5 years prior to monitoring established to the present, and precipitation trend.

Climate data for D2-43 shows an increasing trend in annual precipitation over time (Figure 48)

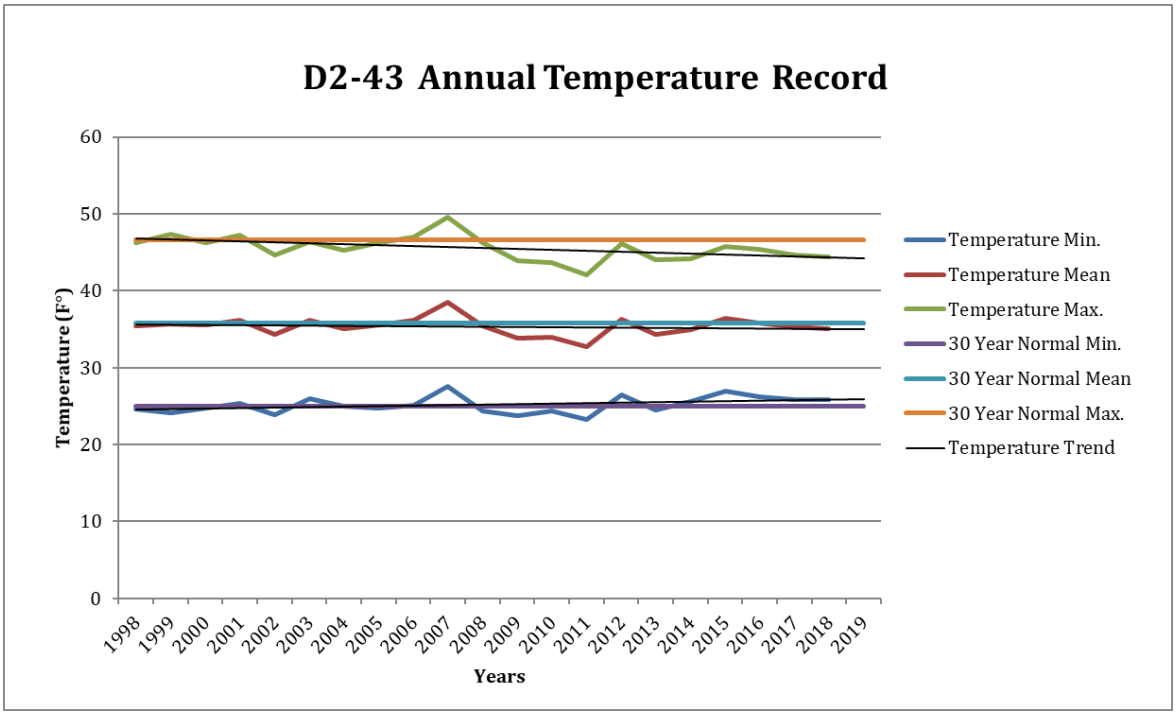


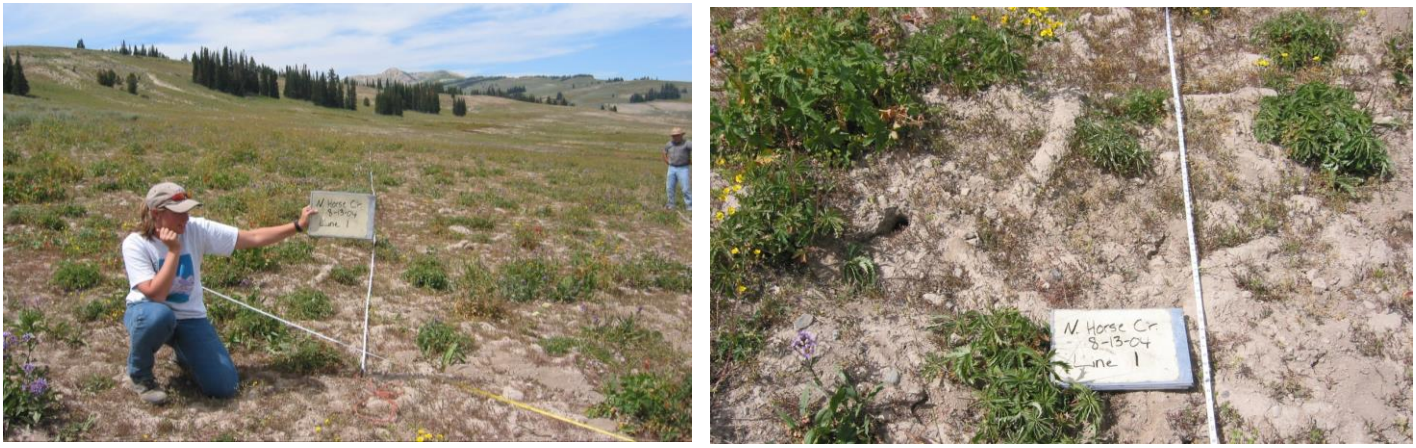
Figure 49: PRISM data was used to display annual temperature, the 30-year normal for the site 1998 to present, and temperature trend.

Climate data for this site shows a decreasing trend for the maximum and mean annual temperatures, while minimum annual temperature is on an upward trend for this site (Figure 49).

Discussion:

Line-Point Intercept data tells us that this plant community has 46% foliar cover and bare ground is approximtely 42%. This site sits on a Northeast faacing 10%. This site had 18.6% foliar cover of *Pseudostellaria jamesiana* (PSJA2) and *Polygonum douglasii* (PODO4) at 18.2% foliar cover. These site characteristics don't seem to correspond to any of the plant communities previously described in Gregory 1983 or the Ecological Unit Inventory Vol. 2. Using the nested frequency data, ground cover on this site is 26.0%, which is below the 80% threshold set in the ROD.

Photos:



2004- General view from Line 1 (left) and plot photo (right)

2009- General view from Line 1 (left) and plot photo (right)

2014- General view from Line 1 (left) and plot photo (right)


2019- General view from Line 1 (left) and plot photo (right)


2019 – General view of baseline (left) and Line 2 (right)


2019 – Line 3 (left) and Line 4 (right)

2019 – Line 5

S. Fork N. Horse Creek T1

N. Horse Creek S&G

Location: 42.922046, -110.545885

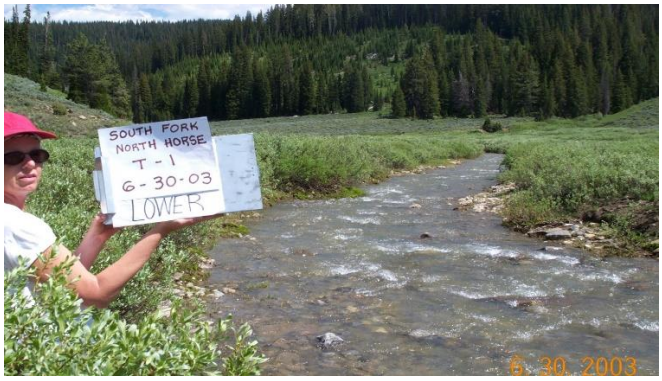
Site Attributes: This site represents a mixed willow/sedge plant community. Based upon the Winward Greenline methodology, this stream is defined as a cobble system with a 0.5-2% gradient placing it in Capability Group 3. In group 3, 90+% of the greenline should be represented by late seral community types or anchored rocks/logs when the riparian area is functioning properly (Winward, 2000).

Riparian Greenline Summary	Monitoring Year	
	2003	2019
Greenline Stability Rating	8.92 (Good (High))	8.92 (Good (High))
Greenline Ecological Status	96.6% (PNC)	96.4% (PNC)
Early	13.1	13.2
Late	86.9	86.8

Ecological status data suggests that this site is currently in PNC (Potential Natural Community). Early seral and late seral species have stayed relatively the same since the initial reading in 2002. The greenline stability rating has remained the same.

Photos:

2003- Upper View



2003- Lower View

2003- Overview

2019- Upper view, Looking upstream

2019- Lower view, Looking downstream

2019- Overview

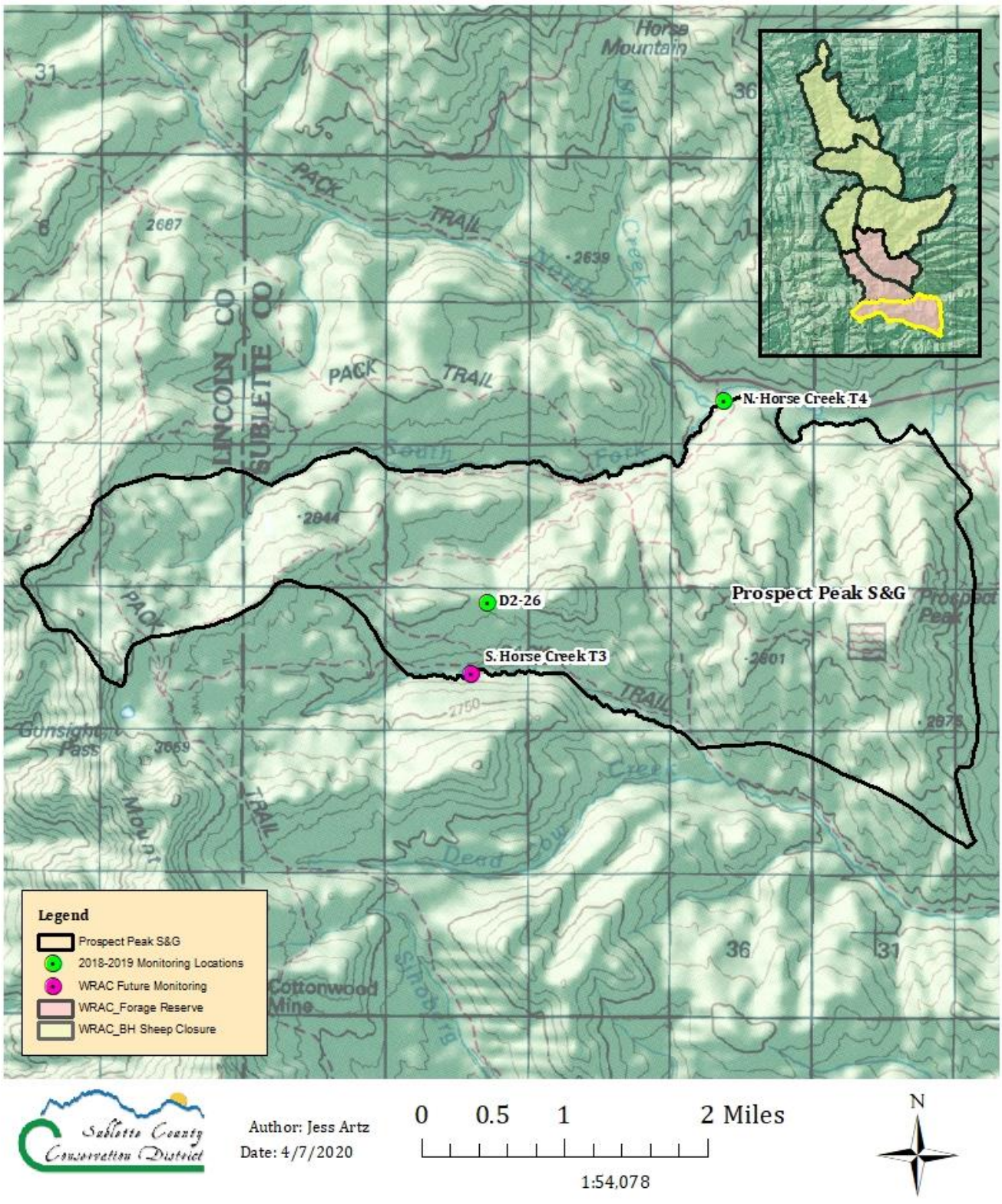


Figure 50: Map of WRAC monitoring locations within the Prospect Peak S&G Closure Allotment

D2-26

Prospect Peak S&G
BH Sheep Closure Allotment

Location: 42.908529, -110.554530 **Original Baseline Azimuth:** NA

Monitoring Technique: Site was monitored using the baseline technique (refer to Figure 3 for transect configuration).

Site Attributes:

ELEVATION (ft)	BEDROCK GEOLOGY	SURFACE GEOLOGY	SLOPE (%)	SLOPE SHAPE	ASPECT	LAND FORM	PARENT MATERIAL
8,691	Kbb*	srR**	22	li-cv	S	mountain top	colluvium

*Kbb – conglomeratic sandstone, siltstone, claystone, coal and bentonite
**srR – slope wash; rock outcrop; residiuum

Vegetation Data:

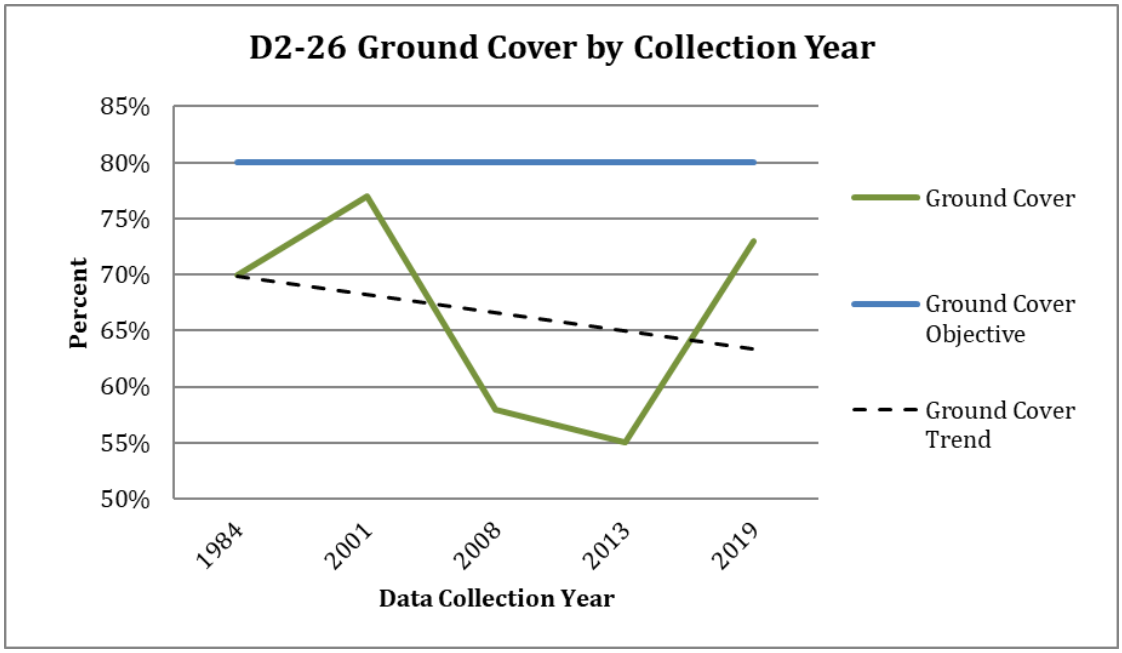


Figure 51: Nested frequency data was used to calculate ground cover (%) by monitoring year compared to the ground cover objective of 80% specified in the ROD.

Data presented in the figures above shows a downward trend in ground cover for the site, and thus far data shows that ground cover on the site has remained below the 80% objective (Figure 51).

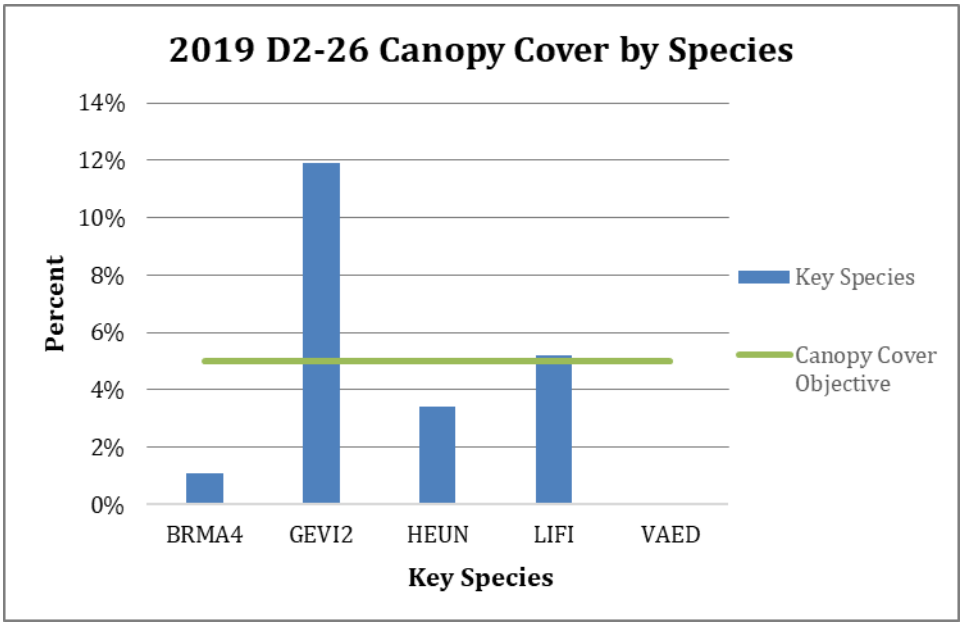


Figure 52: Line-Intercept data was used to compare (%) canopy cover for each key species found on the site.

Geranium viscosissimum (GEVI2) and *Ligusticum filicinum* (LIFI) are the two key species that are above 5% canopy cover (Figure 52). *Valeriana edulis* (VAED) is the only key species that has not been recorded on site thus far.

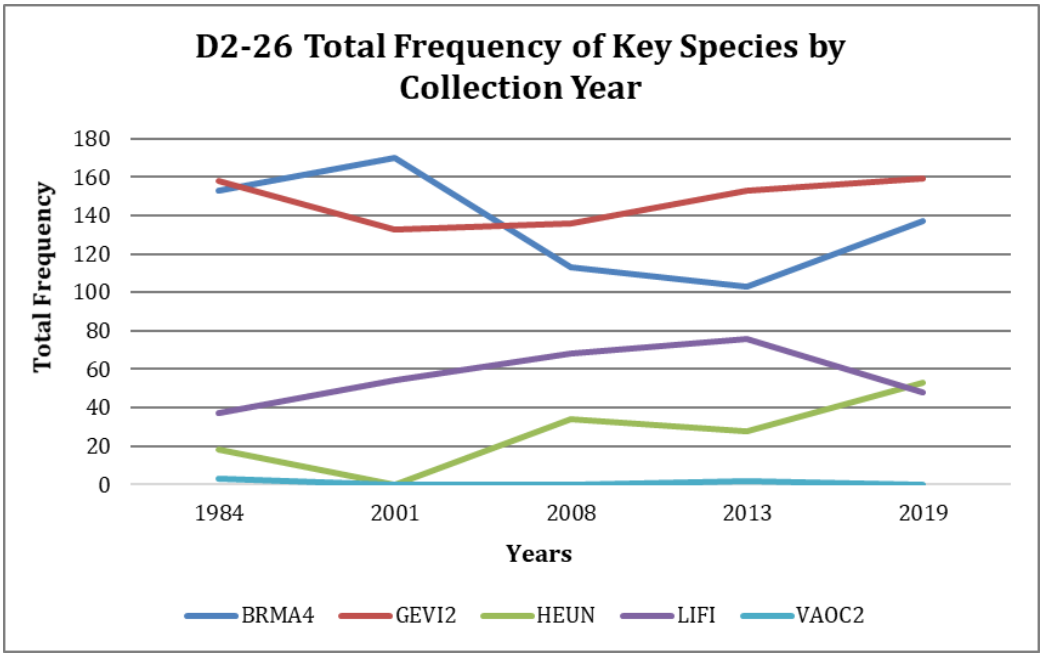


Figure 53: Nested frequency data was used to show the total frequency of key species identified in the ROD by collection year.

Total frequency of *Valeriana occidentalis* (VAOC2) & *Bromus marginatus* (BRMA4) appear to be trending downward while *Ligusticum filicinum* (LIFI), *Helianthella uniflora* (HEUN), and *Geranium viscosissimum* (GEVI2) are trending upward from intial monitoring (Figure 53).

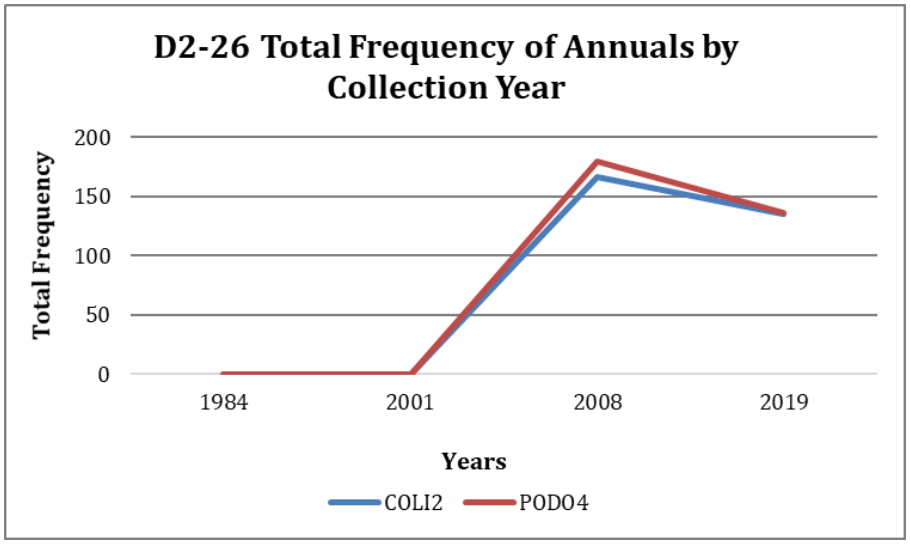


Figure 54: Nested Frequency data was used to display the total frequency of the annual species identified on site for each year annuals were monitored. Only key species were collected in 2013 so that data is not displayed.

The total frequency of annuals including; *Polygonum douglasii* (PODO4) and *Collomia linearis* (COLI2) have increased from initial monitoring establishment to the 2019 monitoring year (Figure 54).

Soils Data:

SOIL PROFILE																				
Depth (inches)	Rock Fragment Type & Vol (%)				Texture	%Clay (+/- 5%)	Efferve sence	Moist Color	Structure	pH	EC	OM (%)	Nitrate	Phosphorus	Potassium	Zinc	Iron	Manganese	Copper	Lime
	0-5%	5-15%	15-35%	>35%																
0-3	X				CL	28	NE	10YR 4/1	gr	6.6	0.2	6.1	0.3	39.1	838	3.85	79.7	6.27	3.21	low
3-7	X				CL	33	NE	2.5YR 3/2	sbk	6.3	0.2	6.2	9.0	15.3	437	2.02	91.7	0.89	6.70	low
7-21	X				C	42	NE	10YR 4/2	sbk	6.5	0.3	2.4	1.8	5.54	154	1.15	64.0	0.41	5.02	low
Notes: Second and third horizons have clay films present. Family particle size class: Fine																				

Soils on this site are considered deep since digging continued without reaching parent material in the top 20 inches. This site has the highest potassium amounts of any site which is most likely related to higher amounts of clay in this soil. Potassium readily binds to clay particles and therefore can become unavailable for plant uptake (Noble Research Institute, 2004). This site has the lowest surface soil nitrate levels of any sites. Nitrate levels in the second horizon are much greater than that of the top horizon indicating that nitrate is leaching through the soil profile. Leaching of nitrate can be related to a decrease in diversity of plant functional groups (Scherer-Lorenzen et. al., 2003).

2018 – Soil pit

Climate Data:

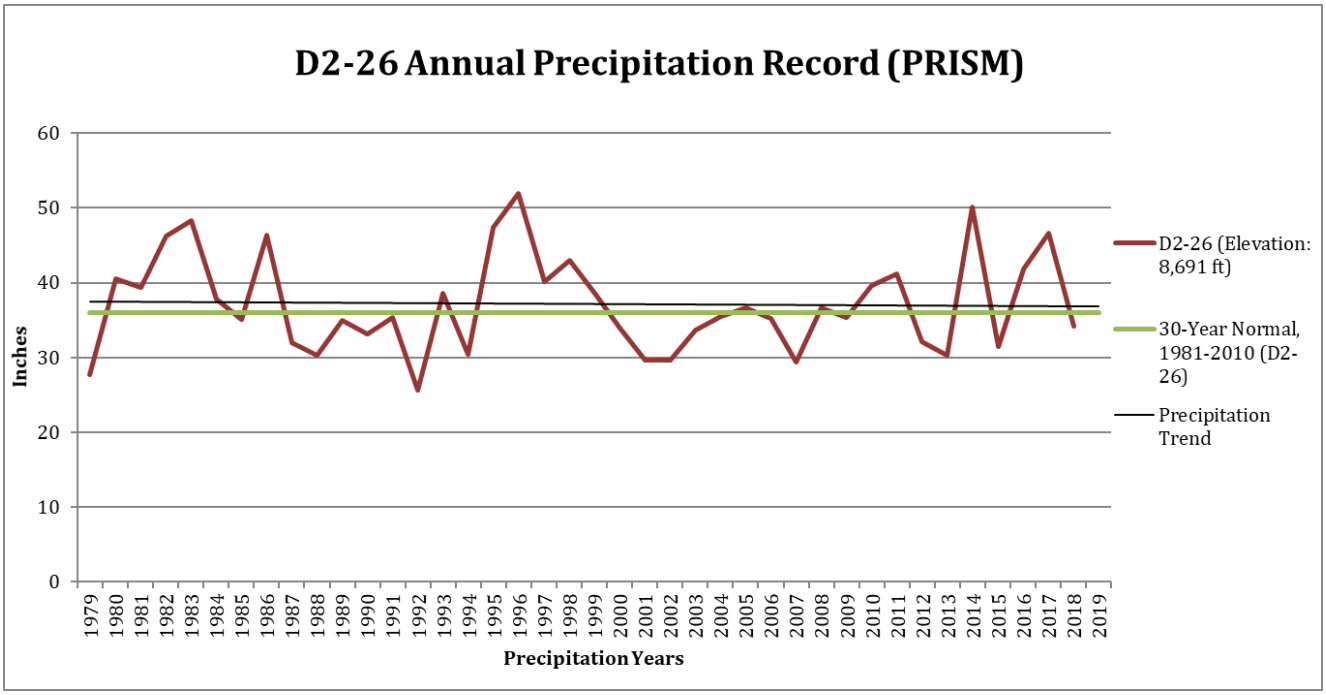


Figure 55: PRISM data was used to display annual precipitation, the 30-year normal for the site from 5 years prior to monitoring established to the present, and precipitation trend.

Climate data for D2-26 shows a relatively static trend in annual precipitation over time (Figure 55)

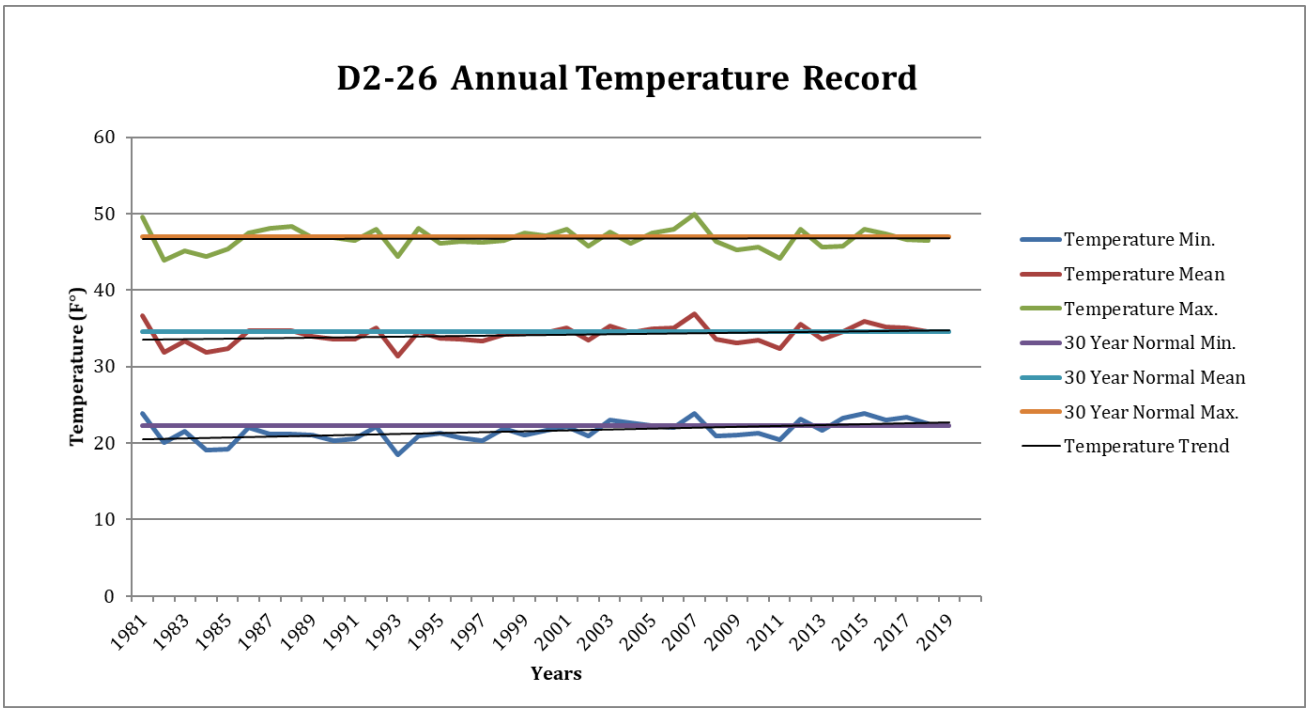


Figure 56: PRISM data was used to display annual temperature, the 30-year normal for the site 1981 to present, and temperature trend.

Climate data for this site shows an increasing trend for the minimum and mean annual temperatures, while maximum annual temperature is static for this site (Figure 55).

Discussion:

Line-Point Intercept data tells us that this plant community has 89% foliar cover and bare ground of approximtely 3.2%. This site sits on a South-facing 22% slope. This site had 13.2% foliar cover of *Balsamorhiza macrophylla* (BAMA4) and *Melica bulbosa* (MEBU) at 15.6%. This site also has 9.2% of *Ligusticum filicinum* (LIFI) and HEUN at 8.2% foliar cover. Other plant species that have a higher presence on site are *Pseudostellaria jamesiana* (PSJA2) at 3.6%, and (GEVI2) at 10.6% foliar cover.

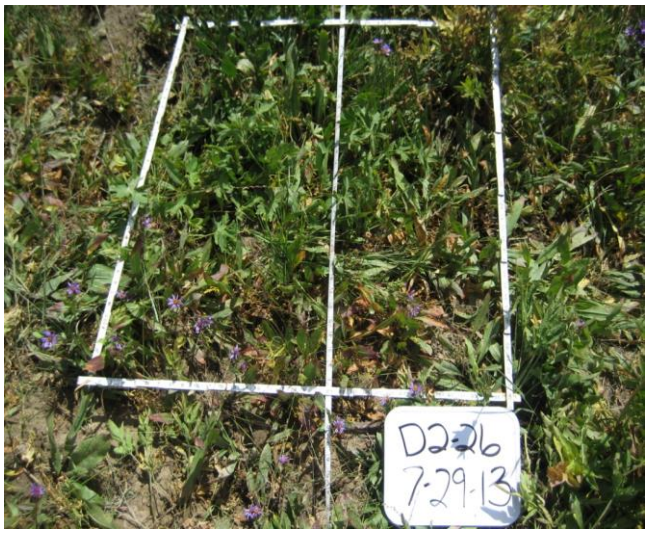
By looking at these attributes combined with the vegatative community composition it can be concluded that this site has characteristics similar to a *Balsamorhiza macrophylla* (BAMA) tall forb community type (Svalberg et. al., 1997). According to Gregory 1983, the presence of BAMA4 is higher in these sites (average cover of 42%). Some of the other associated plants include *Geranium viscosissimum* (GEVI2), Delphinium occidentale (DEOC), Pseudostellaria jamesiana (PSJA2). With an occasional abundance of *Helianthella uniflora* (HEUN) and Lupinus sp. (LUPIN). *Melica spectabilis* (MESP) was recorded in every plot studied of this type (Gregory 1983). All of these listed plants are present in the D2-26 plant community except for MESP. Instead D2-26 had a high amount of *Melica bulbosa* (MEBU). The soils on this site have a higher clay content which is a characteristic of BAMA tall forb plant communities. Although clay percentages were a little lower than expected, soil pH and organic matter content were within the range described by Gregory 1983 for this plant community. Using the nested frequency data, ground cover on this site is 73%, which is below the 80% threshold set in the ROD.

Photos:

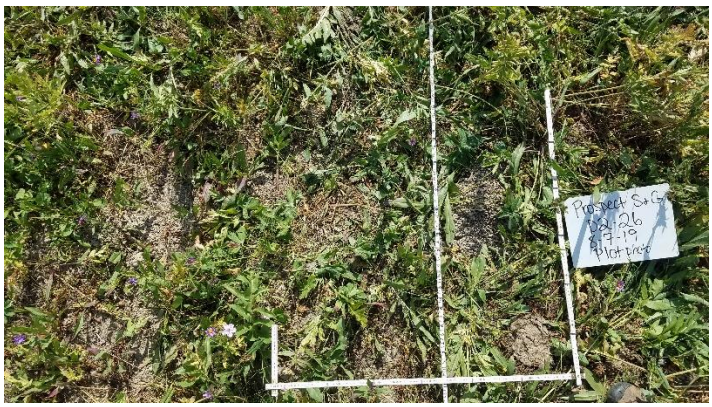
1984 – General view of baseline (left) and plot photo (right)


2001 – General view of baseline (left) and plot photo (right)


2008 – General view of baseline (left) and plot photo (right)



2013 – General view of baseline (left) and plot photo (right)

2019 – General view of baseline (left) and plot photo (right)


2019 – Line 1 (left) and Line 2 (right)


2019 – Line 3 (left) and Line 4 (right)

2019 – Line 5

N. Horse Creek T4

Prospect Peak S&G

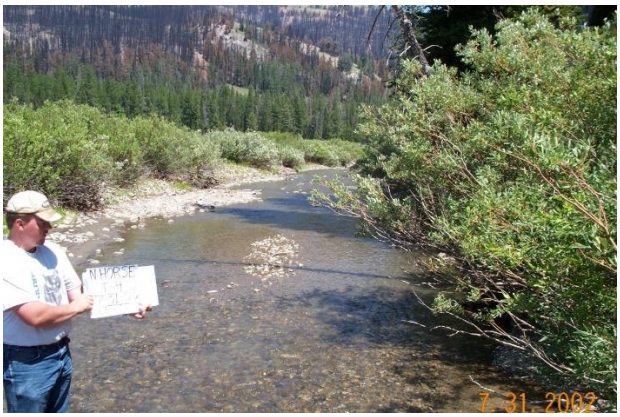
Location: 42.928910, -110.521888

Site Attributes: This site represents a mixed willow plant community. Based upon the Winward Greenline methodology, this stream is defined as a cobble system with a 0.5-2% gradient placing it in Capability Group 3. In group 3, 90+% of the greenline should be represented by late seral community types or anchored rocks/logs when the riparian area is functioning properly (Winward, 2000).

Riparian Greenline Summary	Monitoring Year	
	2002	2019
Greenline Stability Rating	6.90 (Good (High))	7.48 (Good (High))
Greenline Ecological Status	74.5% (Late Seral)	106.2% (PNC)
Early	32.9	4.4
Late	67.1	95.6

Ecological status data suggests that this site is currently in PNC (Potential Natural Community). Early seral species have decreased along the green line while late seral species have seen a dramatic increase since the initial reading in 2002.

Photos:



2002- Upper View

2002- Lower View

2002- Overview

2019- Upper View, Looking Downstream

2019- Lower View, Looking Upstream

IV. All Sites Summary

Upland Vegetation

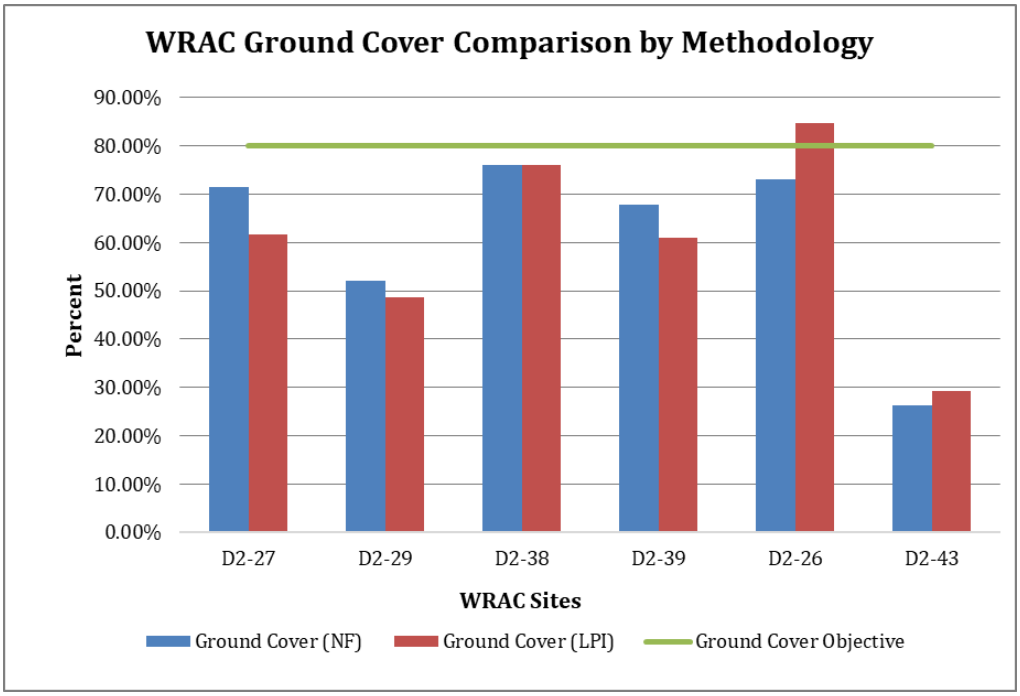


Figure 57: Nested frequency (NF) and Line-Point Intercept (LPI) data was used to compare ground cover (%) by WRAC site to the ground cover objective of 80% specified in the ROD.

The ground cover objective of 80% specified in the ROD is not currently being met on any of the sites within the WRAC based upon the Nested Frequency data collected. (Figure 57). Ground cover is trending upward on D2-27, D2-38 and D2-39 and is trending downward on sites D2-29, D2-43 and D2-26 (Figures 28, 44 & 51). This decrease may be due to the presence of MAGL2 on sites D2-29 and D2-43 and an increase in annuals on site D2-26. All sites that contained Ground cover data collected using LPI and Nested Frequency methodologies were compared against each other to determine how results can vary across methodologies. Data collected during this study may not be robust enough to determine statistically whether or not there is a difference. However, the graphical comparisons displayed in Figure 57, indicate variabilities and differing results from each type of method.

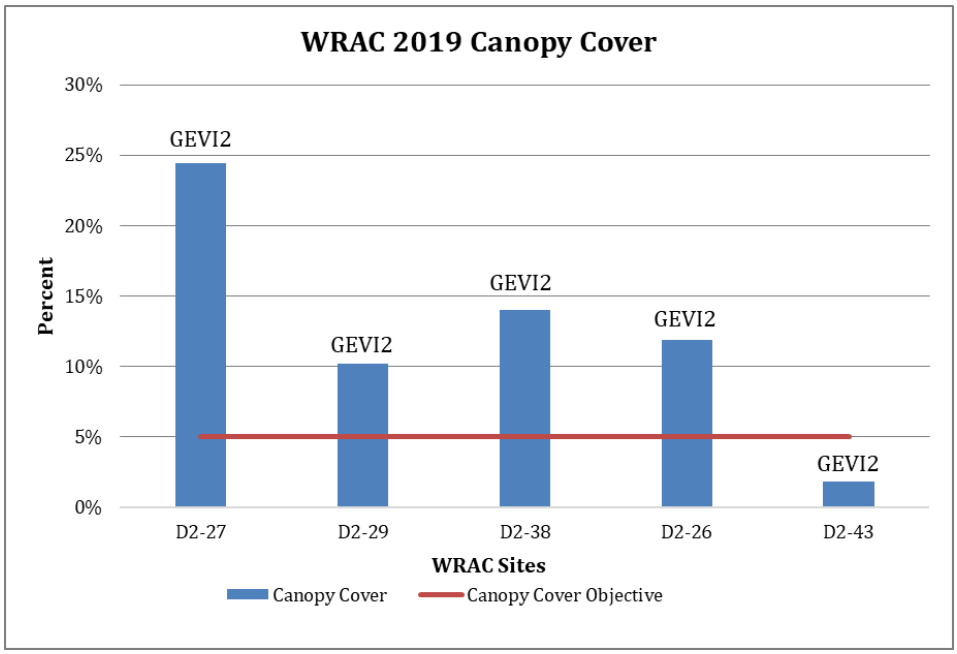


Figure 58: The graph above uses Line-Intercept data to show the highest amount of canopy cover for each site and which key species corresponds with that canopy cover. The only site not displayed in Figure 58. is D2-39. This site did not have Line Intercept completed in 2019 because of a lack in key species.

All sites are at or above the 5% canopy cover objective except for D2-43. *Geranium visccosissimum* (GEVI2) appears to be trending downward on all sites except D2-38 and D2-26 in the WRAC even though it is the key species with the highest canopy cover on all of the sites.

Soils

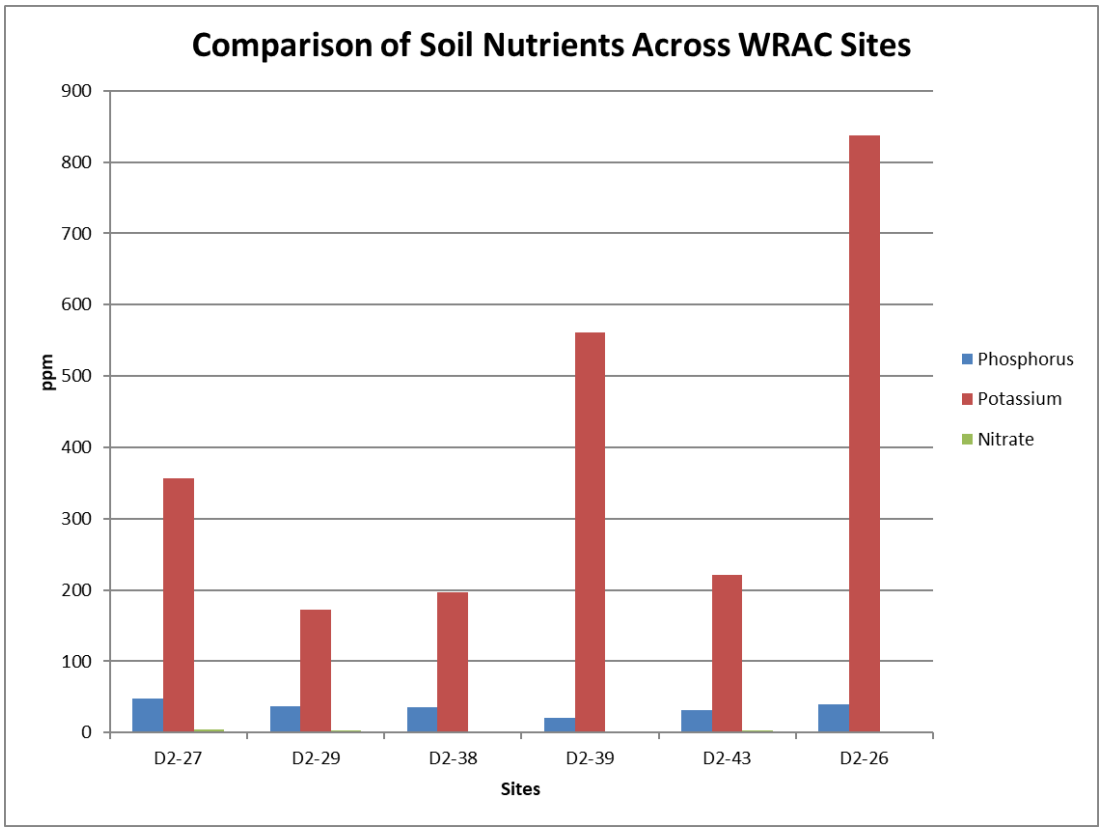
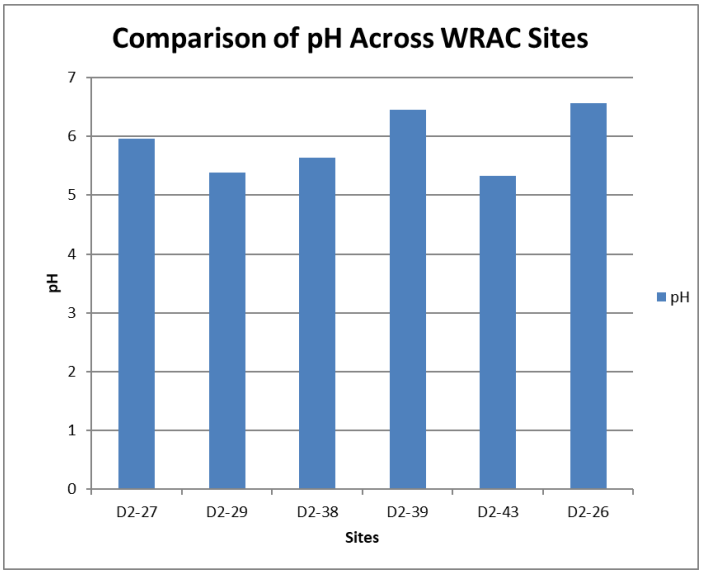


Figure 59: Analyzed soil lab data was used to compare Phosphorus, Potassium, and Nitrate levels found on WRAC sites.



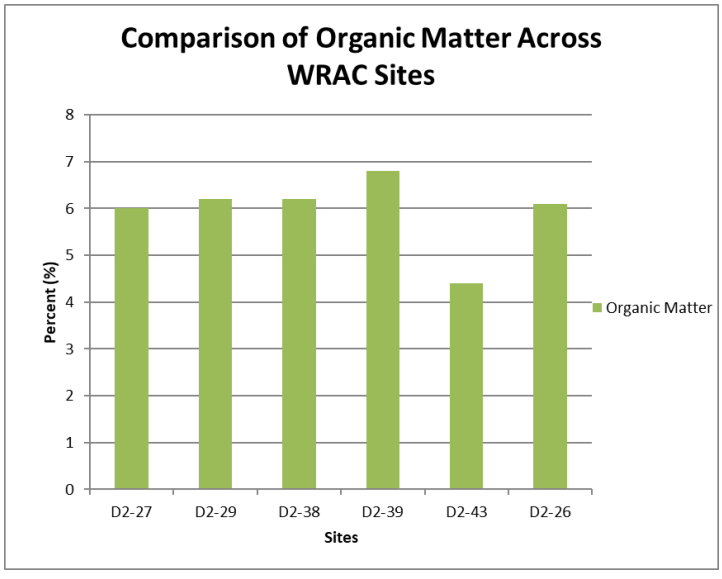


Figure 60: Using the topsoil, lab data was used to analyze pH levels (left) and organic matter content (right) found on WRAC sites.

Site D2-26 contains a noticeably higher amount of Potassium and a reduced amount of Nitrate (Figure 59). Potassium assists plants in the uptake of nitrogen in the nitrate form needed for plant assimilation (Rufty et. al. 1982). The lower amount of nitrate within the top horizon in sites D2-26 and D2-39 is indicating the leaching of

nitrogen throughout the soil profile. Nitrate is a vital soil component of the soil ecosystem because it is the most mobile form of nitrogen (Chapin et. al., 2012). Nutrient availability in the soil is one of the major constraints of production in terrestrial ecosystems (Chapin et. al., 2012). Nitrogen is able to transform into a more readily assimilated form for plants through microorganisms in the soil ecosystem and nitrogen fixing plants. Site D2-39 and D2-43 soil properties may also be affected by the presence of *Madia glomerata* (MAGL2) which is known to inhibited germination of plant species and leach secondary chemicals into the soil environment (Carnahan et. al, 1962).

Riparian

Winward Greenline transects within the WRAC were established in 2002-2003 by USFS Range Staff. These sites were cooperatively located and re-read in 2019 as result of Rangeland Health Assessment Grant. Changes in stream stability have been noted in the results of greenline monitoring (see Figure 60).

Figure 61, shows that all sites within the WRAC are currently in a stable state (PNC status). According to 2019 datasets, N. Horse Creek T4 appears to have a much greater amount of late seral species on the banks as compared to previous datasets. This has caused a more susbtantial shift in greenline stability rating compared to the other two sites. Apparent trend based on two years of data is displayed below. However, once a third year of data is collected trend can be more accurately assessed.

Wyoming Range Allotment Complex

	2002/2003			2019				
	Greenline	Successional Status		Greenline	Successional Status			
	Stability Rating	Early Seral	Late Seral	Stability Rating	Early Seral	Late Seral	Current Status	Apparent Trend
Mule Creek S&G								
N. Horse Creek T5	8.1	11.8	88.2	7.5	9.7	90.3	PNC	Static
N. Horse Creek S&G								
S. Fork N. Horse Creek	8.9	13.1	86.9	8.9	13.2	86.8	PNC	Static
Prospect Peak S&G								
N. Horse Creek T4	6.9	32.9	67.1	7.48	4.4	95.6	PNC	Up

Figure 61: Data in the table above shows a summary of all greenline sites that have been monitored to date. Data presented shows changes in Greenline Stability Rating and changes is successional status from 2002/2003 to current day.

V. Additional Findings of Interest

Ground Cover Threshold

To understand the objectives set by the ROD, SCCD researched a document referenced in the ROD called "Indicators of Rangeland Health and Functionality in the Intermountain West". In this study they inventoried 557 plots including these four plant communities: aspen, alpine, mountain big sagebrush, and tall forb. Each plant community has its own thresholds set in the document (O'Brien 2003). These thresholds were set to determine whether a plant community is functioning or functioning at risk (O'Brien 2003). Throughout the study aspen plots were the only plant community type that was able to reach the thresholds set in the study (O'Brien 2003). None of the tall forb data collected and analyzed within the document met the 80% ground cover objective set by the document itself (O'Brien 2003). This led us to question why the 80% ground cover threshold was used to assess the tall forb sites within the WRAC.

Incorporation of Foliar Cover

Foliar cover comparisons were made for all of the WRAC sites (Figure 62). On three of the sites foliar cover was over 80%. The plant canopy is significant when it comes to the impact of moisture hitting the soil surface. Foliar cover has been selected for studies because of its ability to predict the intercept of a raindrop reducing the splash effect and measuring response of plant communities (Gamougoun et. al, 1984) (Ralphs et. al., 1989). Foliar cover is especially important in large broad leaf forb dominated communities where the basal vegetation hits can be much lower than canopy hits due to the growth form of tall forbs. It may be important moving forward to not only focus on ground cover objectives set in the ROD, but other forms of soil surface protection such as overall site observations, and foliar cover as it relates to erosion (site stability), and plant health.

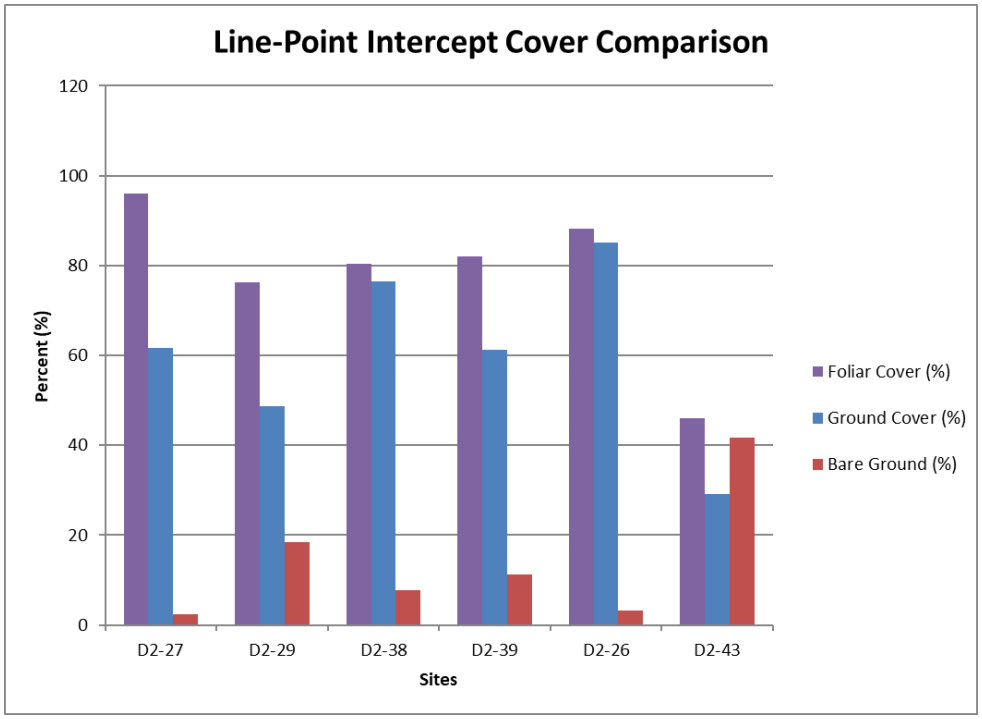


Figure 62: Line-Point Intercept data was used to compare foliar cover, ground cover, and bare ground for each WRAC site.

Foliar cover is the area of ground covered by the vertical projection of the aerial portions of plants. Small openings in the canopy and intraspecific overlap are excluded (Figure 11) (Coulloudon, et al., 1985). Ground cover is comprised of vegetation, rock, bare soil, litter, and does not take into account any of the vegetative canopies (Coulloudon, et al., 1985). Bare ground is considered gravel less than 1/12 of an inch in diameter (Coulloudon, et al., 1985).

Key Species Thresholds

Throughout the Wyoming Range Allotment Complex, two sites have been described as *Wyethia amplexicaulis* (WYAM) plant communities, one site as a *Ligusticum filicinum* (LIFI-DEOC) plant community and one site that does not match any plant community descriptions previously described by Gregory. These plant communities contain a wide range of variability and differing attributes making it hard to compare them to one another. In the "Indicators of Rangeland Health and Functionality in the Intermountain West", only 37% of tall forb communities had one of the key species present. In this document, they suggest that species lists may need to be revised for site specific health or other management objectives (O'Brien et al. 2003). They also mention that not all potential natural plant communities will meet the desired plant community compositions (O'Brien et al. 2003). This shows that these differing and unique tall forb communities may not be compatible with key species or plant community thresholds and criteria specified in the ROD.

Past Site Tours

According to Alma Winward's 1998 paper title "The Tall Forb Type", Soils and vegetation characteristics need to be carefully assessed to determine if sites once were or are currently able to support tall forb communities. Understanding a site's current potential allows land managers to better make decisions as it pertains to management and improving the functionality of these plant communities. For example, if soils have a strong argillic layer at the surface which supports mostly clay loving species this could be indicating a site that over time has lost important soil surface horizons which may no longer allow for the support of tall fob communities (Winward, 1998). Looking at vegetation characteristics like species composition and interspaces between "desirable" species helps in determining if a site is capable of reseeding tall forbs under appropriate management. According to Winward, if you can step from one desirable plant to another in a given area, the site may be capable of reseeding itself with the proper amount of time and rest. This all comes down to understanding site attributes and if too much severe alteration has occurred, that desirable tall forb species cannot be supported. If so some of these areas will likely have to be managed as a new (non-tall forb) type (Winward, 1998).

Notes from previous site tours also included important discussion related to plant community phases and succession of tall forb communities as well as recovery time estimates needed for these unique plant communities. Alma Winward, asked by the WGFD, took a tour of tall forb communities within the North Horse region of the WRAC in 2004. He noted that current trend sites looked like they had been placed in areas where only moderate grazing damage had occurred historically and they may not be fully representative of other tall forb areas that had been more severely impacted and are at a lower stage of recovery (A. Winward, North Horse Creek- Tall Forb Type field notes, September 6th, 2004). However, according to Winward, all visited areas of the allotment appeared to be in a gradual upward trend in 2004. Dr. Winward did state that in his experience sites that had been altered to the point that they currently had 30-40% bare ground and few remaining tall forb species will have a much slower successional process as they move towards climax tall forb (A. Winward, North Horse Creek- Tall Forb Type field notes, September 6th, 2004). According to Winward, some of these degraded sites may have successional processes that are able to be measured in 20-40-year increments while sites with desired perennials on site and other important soil characteristics may see successional processes that can be measured in 5-10 year increments.

Winward led another tour in 2009 that had stops within the Wyoming Range, Middle Range and Salt River Range. When visiting some of the tall forb sites within the tour a discussion was had regarding gopher activity. Dr. Winward explained that the better condition a tall forb community is in, the lesser effects gophers will have. Sites

that are already in a declined state can have gopher activity that can suppress their ability to rebound. However, gophers are generally not the reason for the declined state (A. Winward, field notes, September 23rd-24th, 2009). Discussion was also had regarding two sites that most likely resulted from overgrazing of tall forb communities: One site that was now dominated by subalpine big sagebrush and another that was now a grass-dominated community. Winward explained that subalpine big sagebrush tends to occupy tall forbs sites that have seen drying over time. Subalpine big sagebrush is not a true climax on tall forb sites; it moves into tall forb communities when there have been dramatic changes in soil conditions (A. Winward, field notes, September 23rd-24th, 2009).

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