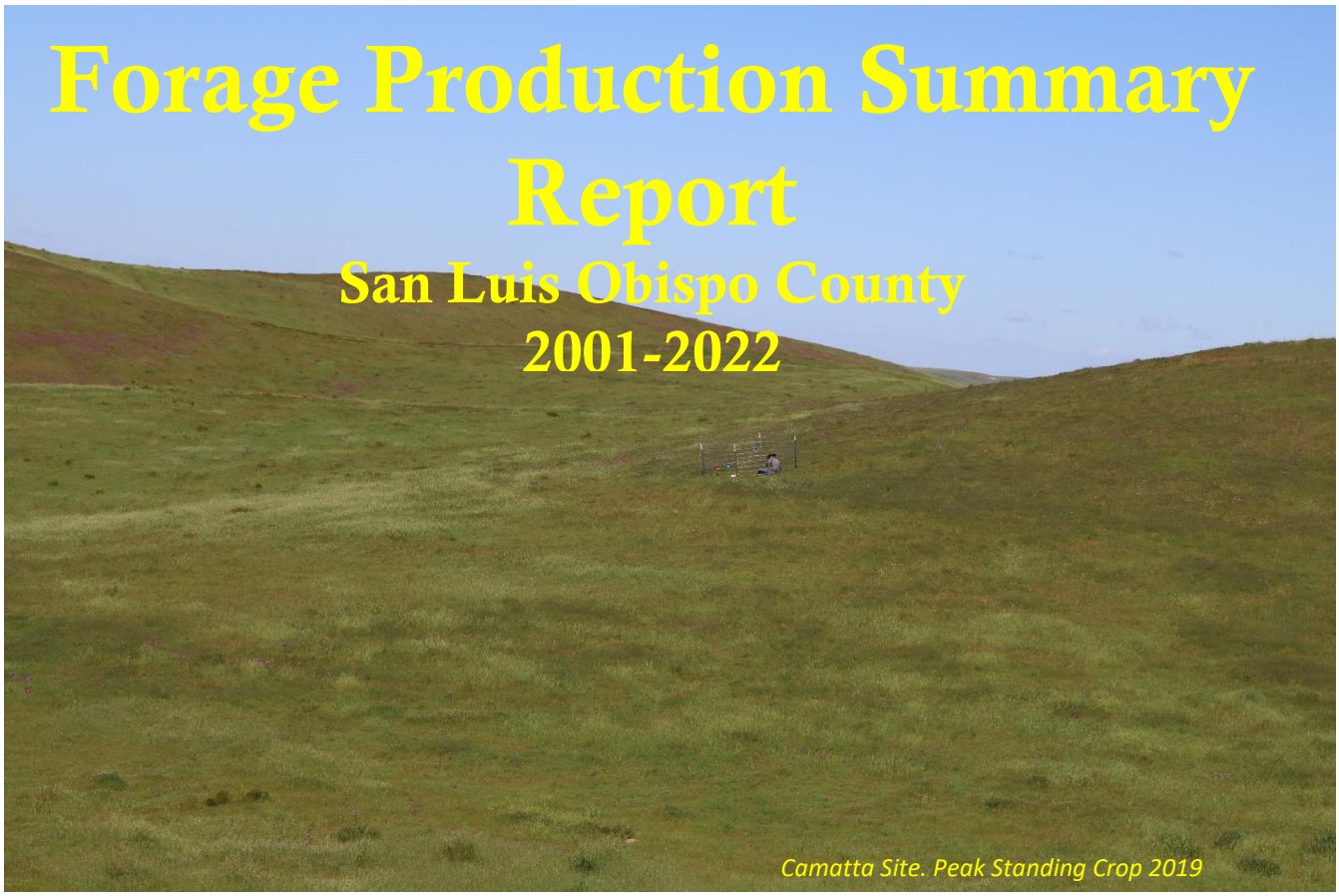
Forage Production Summary Report

San Luis Obispo County

2001-2022



Camatta Site. Peak Standing Crop 2019

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Introduction

This report summarizes forage production in San Luis Obispo County rangelands from 2001 to 2022. These rangelands are dominated by coastal prairies, annual grasslands, oak-woodlands and chaparral vegetation types (George et al. 2014). Since California is at the confluence of several tectonic plates, a diverse geology generated an assortment of soils that vary in their ability to support vegetation (O'Geen and Arroues 2014). In San Luis Obispo County there are over 350 soil map units at elevations ranging from sea level to 5,000 feet.

Average annual precipitation ranges from 42 inches near the coast to less than 6 inches in the eastern side of the county. The coastal mountain range rises over 2500 feet and creates a rain shadow that reduces precipitation east of the range. By 1993, range managers had divided San Luis Obispo County into three broad rainfall zones to facilitate range management decisions and general stocking densities (Weitkamp 1993), Figure 1. These precipitation zones are used by the USDA Farm Service Agency in San Luis Obispo County, and wet, moderate and dry zones.

The coastal precipitation zone (wet zone) receives greater than 18 inches rainfall and has a cool coastal climate influence. Carrying capacity of this zone is rated at 8-15 acres per animal unit year (ac/AUY). The central precipitation zone (moderate zone) receives annual rainfall between 12 and 20 inches and does not benefit from the coastal climate influence. The central zone is rated at 15-30 ac/AUY. The eastern precipitation zone (dry zone) receives average annual rainfall less than 12 inches, and no coastal climate influence. The eastern zone is rated at >30 ac/AUY (Figure 1).

Forage production varies based on rainfall amount and timing, soil type, slope and aspect and temperature (Becchetti et al, 2016). Approximately 0.5 to 1.0 inch of rainfall during a 1-week period is needed to initiate germination and growth in annual rangelands. Annual range plants go through four different stages of growth including germination or break of season, winter slow growth, rapid spring growth and finally peak forage production (Becchetti et al. 2016). Rainfall timing determines the beginning and end of the growing season while temperature (heat units) determines the rate of forage productivity (Becchetti et al. 2016).

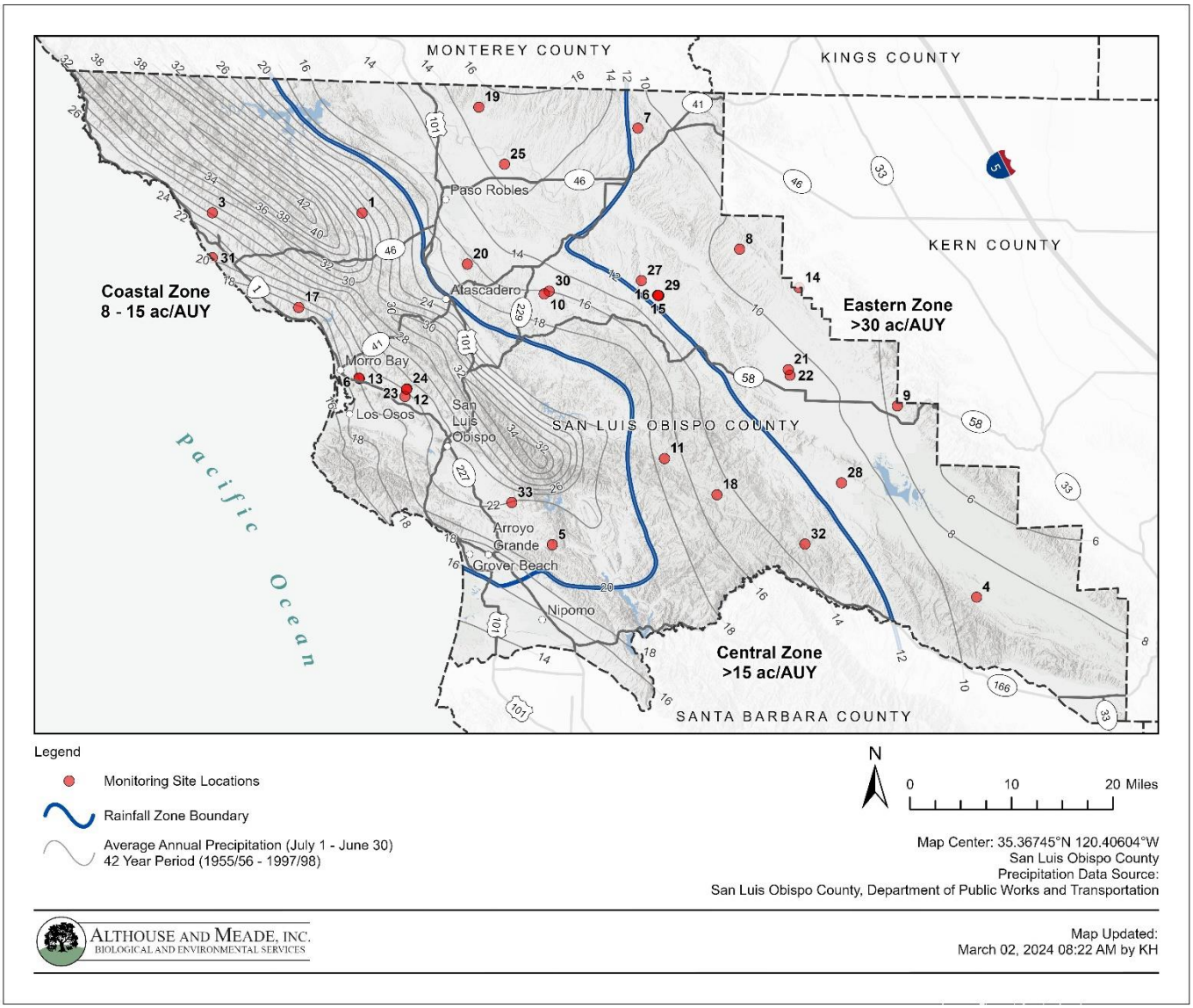

Figure 1. Precipitation Zones and Stocking Rates. Stocking rates (grazing capacity) and related precipitation zones in San Luis Obispo County (Information adapted from Weitkamp 1993). Grey isohyetal lines indicate precipitation averages per year. Blue lines divide the rainfall areas into three zones: Coastal, Central and Eastern with their average-animal unit year (AUY) stocking rate.

Methods and Site Locations

To capture the variability of forage production there were 31 sites established in San Luis Obispo County representing a variety of precipitation zones, soil types, slopes and aspects and varying temperature regimes, Figure 2. For each site there were four livestock exclosures established for sampling purposes, see Appendix 1 for a description. Figure 2 shows the locations of the forage monitoring sites and Table 1 shows the year they were established.

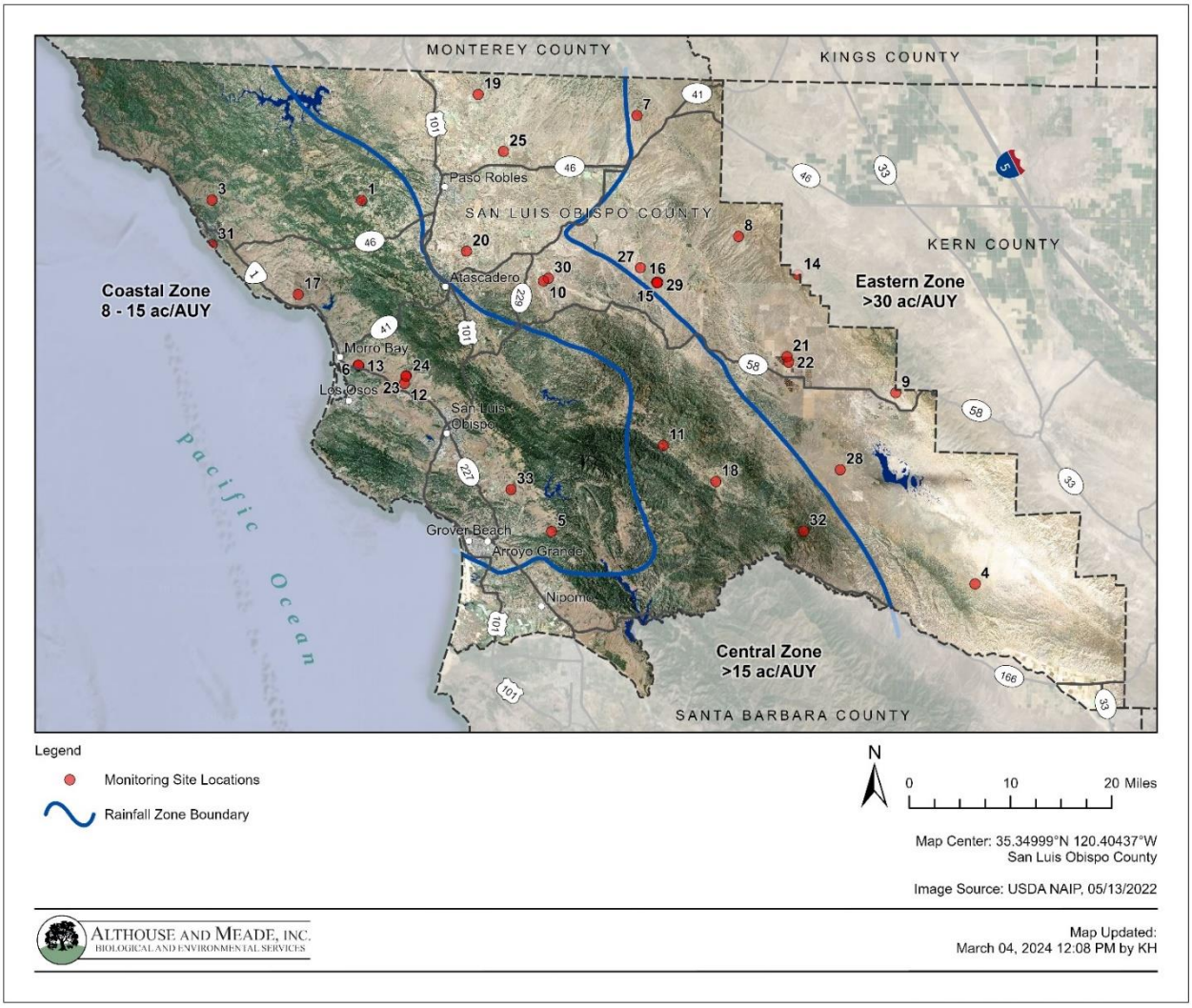

Figure 2. Map showing the 31 monitoring site locations for San Luis Obispo County. (Sites #2 & #26 were not used.)

Table 1. Site name and year each site was established.

Year	Site Name (The Name Describes the General Location of Each Site) and Site Number
2001	Adelaida (1), Cambria (3), Carrizo (4), Huasna (5), MorroBayS (6), Camatta Creek[1] (CamattaN, CamattaS, CamattaT)
2003	Shandon (7)
2004	Bitterwater (8), SodaLake (9)
2010	Creston (10), Pozo (11), CPW6 (12)
2013	MorroBayN (13)
2014	Bitterwater2 (14), CamattaN (15), CamattaS (16), Cayucos (17), RockPileRd (18), SanMiguel (19), Templeton (20), TopazB3 (21), TopazST (22)
2015	CPEU8N (23), CPEU8S (24), Estrella (25), ShellCreek (27), BranchMtn (28), CamattaT (29)
2016	Creston2 (30), Cambria2 (31), GillamFS1 (32), VRSLO (33)
	[1]Camatta Creek was started as one site covering a south slope, north slope and top of the ridge, with one exclosure in each location. In 2014 and 2015 more exclosures were added, the sites were then relabled to better represent the South and North slopes, and the Top of Ridge.

The forage production results are shown as "total production" and "available forage". Available forage is that portion of the forage that can be grazed without damage to the basic resources (Society of Range Management 2016) by depleting organic matter, increasing erosion and otherwise altering conditions necessary for sustaining forage production and ecological health. In California annual rangelands, an important means of sustaining forage production is to leave sufficient plant litter to adequately cover the soil in the fall just prior to the beginning of rainy season. This old plant litter is referred to as residual dry matter (RDM). The RDM functions like a mulch that ensures maximal forage production in the coming season and helps protect soil from erosion at the onset of the fall rains. Recommended minimum levels of RDM in California annual rangelands are given in the publication "Guidelines for Residual Dry Matter on Coastal and Foothill Rangelands in California" (Bartolome et al. 2006) and are shown in Appendix 2.

Total production was measured each spring by clipping three, 1 ft^2 quadrats, within each of the four exclosures at every site at the time of peak standing crop (PSC). PSC is when most of the species have reached their maximum growth stage and seeded out, but still green. Samples were oven dried and weighed. At the time each plot was clipped, species composition was taken. A visual estimate of species composition was recorded for each site at the time of peak production from 2001-2012. Starting in 2013, the dry-weight-rank method (See Appendix 3) was also used to determine species composition for each site (Ratliff, R.D., and W.E. Frost 1990), in addition to the visual estimate. Species composition for 2001-2022 is shown in Appendix 4.

Total production and available forage values are shown in Appendix 5. The calculations used to obtain "available forage" values are shown in Appendix 2. Total forage production included all plants that were palatable to livestock. Plants not palatable, but were present and sampled, included fiddleneck (*Amsinckia* spp.), lupine (*Lupinus* spp.), doveweed (*Croton setiger*), locoweed (*Astragalus* spp.) and tarweed (*Hemizonia* spp.). These were excluded from the "total" and "available" forage values. A visual estimate of species composition was recorded for each site at the time of peak production. Starting in 2013, the dry-weight-rank method (See Appendix 3) was also used to determine species composition for each site (Ratliff, R.D., and W.E. Frost 1990), in addition to the visual estimate.

Rainfall was measured at each site using recording rain gauges starting in 2013. Prior to that, rainfall data was obtained from the nearest weather station operated by the County of San Luis Obispo, Bureau of Land Management's Remote Automated Weather Stations (RAWS), or from the nearest ranch headquarters.

RESULTS

RAINFALL

Rainfall is reported by water year, which is defined as July 1st through June 30th. During 2001 to 2022, rainfall varied from the coastal to eastern sites and from year to year. The lowest rainfall recorded at any site, or year, was 1.85 inches while 40.65 inches was the highest. The years 2006-2007, and 2012 to 2015 were especially low rainfall years. However, as expected, the rainfall from 2001 through 2022 was consistently higher in the Coastal Zone than in the Central and Eastern Zones, Figure 3.

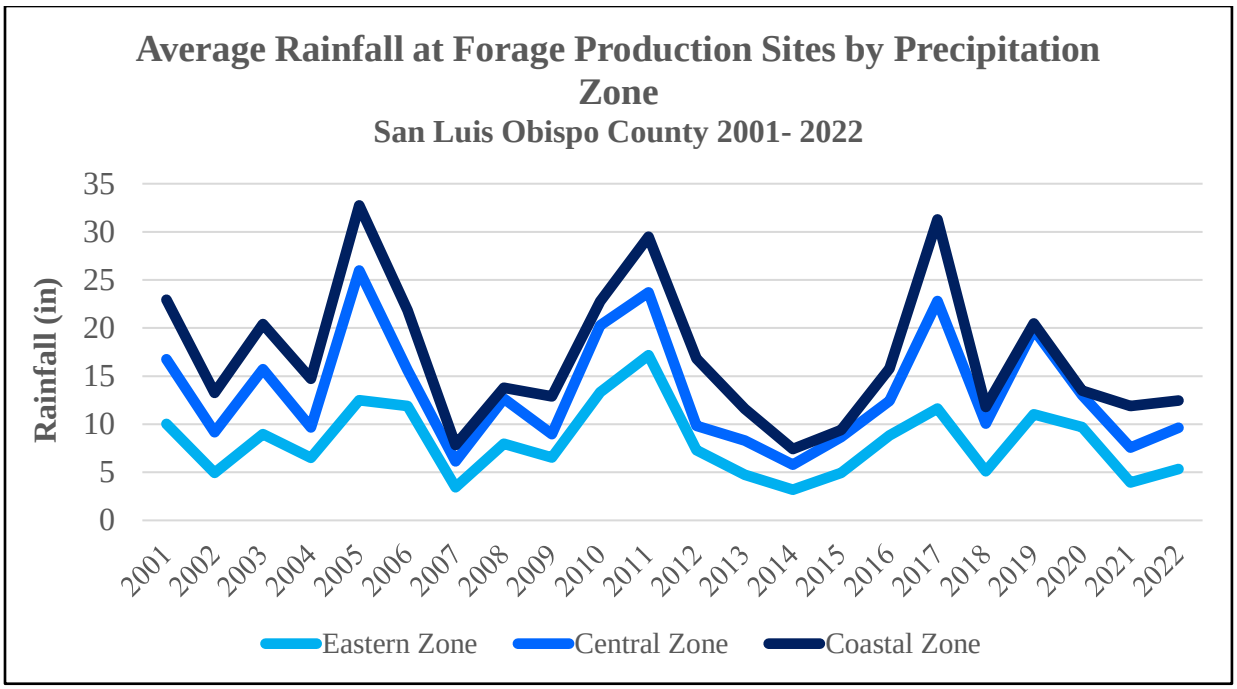

Figure 3. Precipitation Compared Between Zones and Among Years. Average yearly rainfall for the Eastern, Central, and Coastal Precipitation Zones 2001 to 2022. A water year is July through June.

The growing season corresponds closely with the water year, but growth only starts when rainfall begins and ends when the soils dry out in the spring. The growing season usually occurs from October through April in San Luis Obispo County. Figure 4 shows the variation in forage production by precipitation zone since the project began in 2001. There were large variations in available forage production from year to year, and from the coastal (wetter) sites to the eastern (drier) sites. The drought years, especially 2012 through 2016, had high forage losses and were excessively difficult for the livestock industry. During the 2013-2014 growing season, there was a 95% overall forage loss. This high forage loss led to a lot of cattle that were moved or sold due to drought, so much that the lowest number of cattle sold since 1928 occurred in 2016 (San Luis Obispo County Annual Crop Report, 2016). The livestock industry is still trying to recover from that drought.

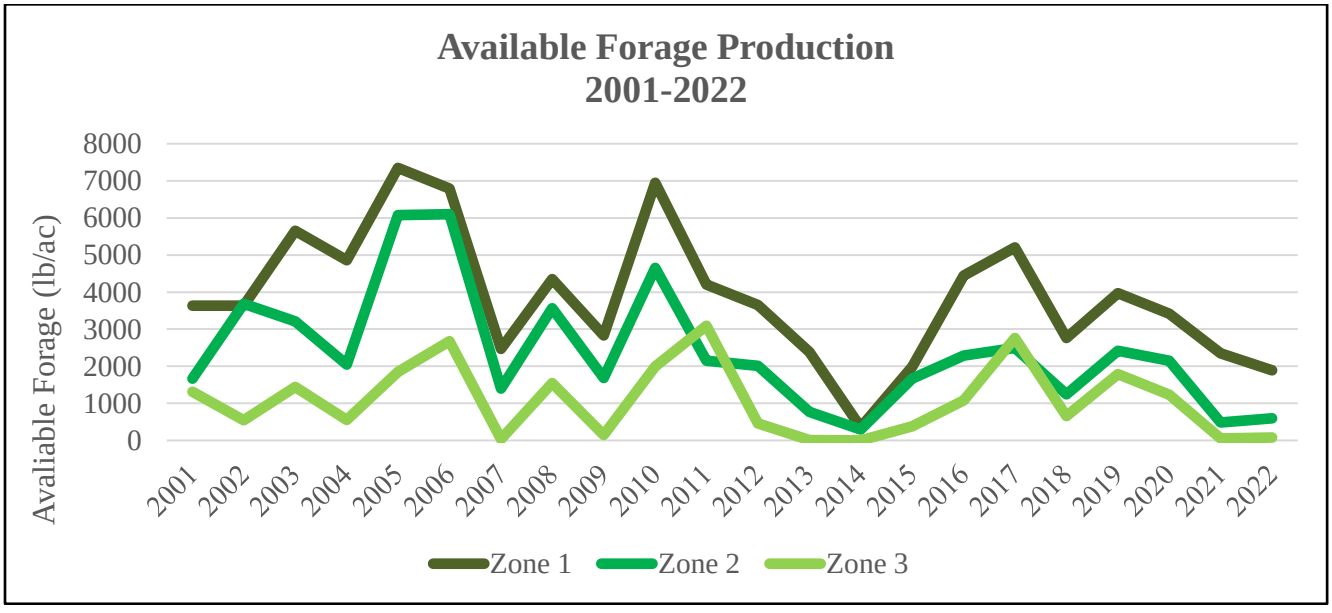

FIGURE 4. Available forage production averaged across all sites by zone in San Luis Obispo County.

FORAGE SPECIES COMPOSITION

After obtaining the species composition, we summed all sites by grasses and forbs. Forbs are broad-leaved flowering plants like filaree, clovers, and the many species of wildflowers. Grasses are the more dominant herbaceous forages on rangelands in the Central Coast, especially in the coastal precipitation zone. Dominant plants observed are listed in Appendix 4.

From 2001 to 2022, the most dominant grasses in the coastal zone were annual ryegrass (*Festuca perennis*) and wild oats (*Avena fatua* or *barbata*), while soft chess brome (*Bromus hordeaceous*), annual fescue (*Vulpia myuros*), and red brome (*Bromus madritensis*) were most common in the central and eastern zones. Filaree (*Erodium cicutarium* or *moschatum*) has been the most common forb found in all three zones, but bur clover (*Medicago polymorpha*) was also common.

Grasses and forbs, two classes of herbaceous forages, competed with each other for dominance through the study period. Rainfall amount and timing, along with temperature, were the major factors contributing to the dominance of either type. Grasses tended to dominate during higher rainfall years while forbs tended to dominate during drier years, see Appendix 4.

Grazing management is another factor that influences grass vs. forb domination (Bartolome et al. 2007). High amounts of residual biomass favors grasses, while low amounts (more bare ground) favors forbs. Grasses usually dominated in the coastal and central precipitation zones each year (e.g., the higher rainfall areas), but in the eastern precipitation zone grasses and forbs changed dominance frequently depending on rainfall amount for any given year.

CRUDE PROTEIN OF FORAGE

The nutritional value of forage for livestock depends on the species growing and season of use. Central Coast annual forage species generally germinate in mid-late October. They then remain in a slow growth phase, perhaps growing two to four inches, throughout the colder months of November, December, January and February in a pre-peak or early vegetative state. The rapid growth phase typically begins after warming starts in March, with the onset of seed production and plants reaching maturity, or peak production. For annual species, late vegetative stage is followed by senescence (drying period, or post-peak). The few perennial species usually green up in October, stay green longer into the spring, then go dormant during the long hot summer period.

Generally, forbs contain a higher nutrient content than grasses, especially crude protein (CP) concentrations than grasses, particularly at late maturity when the levels of cellulose in grasses are highest. Most annual grasses have about 7% CP once they reach late maturity (peak standing crop), but still green. Mature beef cows (1,200 lbs live weight; moderate milk production potential) need 6% (post-weaning) to 11% (early lactation) of CP to maintain body condition and health (National Research Council, 2000). Forbs generally have a protein content about 14% to 25% (Larsen et al. 2021a), more suitable for livestock production than grasses.

The phenological stage of plants also plays an important role in forage quality for livestock. The CP of composite samples (both grasses and forbs) during the early phenological stages (pre-peak) generally have a higher CP content than during the peak growth stage (Larsen et al. 2021a). And, once plants began their drying phase (post peak period) CP declines significantly as annual plants die proteins associated with photosynthesis in the leaves decompose with tissue death and with progressive weathering (Larsen et al. 2021a).

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Appendix 1. Description of exclosure design at each site. Each site had 4 exclosures. The exclosures were made from 16' welded wire cattle panels. Three of the exclosures were put together using two 16' panels and 4 t-posts to form a 10' diameter exclosure, Figure 1. The fourth exclosure was put together using 3 ¼ cattle panels to form a 16' diameter circle (Fig. 1), which also housed the weather station, Figure 2.

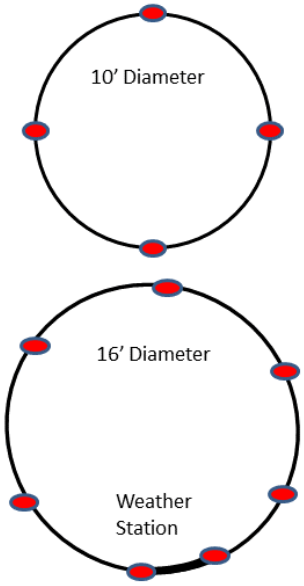

Figure 1. Exclosure design. Symbols illustrate how the four exclosures are designed on each plot. They are made by using welded wire cattle panels and t-posts. Three exclosures are 10 feet diameter, while one exclosure with the weather station is over 16 feet diameter.

Figure 2. Weather Station Set-up. Each weather station had a 6" tipping bucket rain gauge with a solar shield for the temperature sensor, a non-recording 45" tall, 4" diameter rain gauge and a timelapse camera inside exclosure #4. The bird perch helped reduce birds perching on the rain gauge.

Since the amount of Residual Dry Matter (RDM) influences forage growth, the three sample exclosures were moved each fall just prior to the rainy season. They were moved in a random direction and distance between 20 and 60 feet. They were kept on the same soil type, aspect, and slope. Exclosures 1-3 were moved each fall. Exclosure 4 was not moved, since the fourth one had the weather station. That exclosure was weed-whacked to reduce the RDM and to match the surrounding plot condition that existed at the time of movement in the fall, Figure 3. For peak production, three-1 ft^2 quadrats were clipped for production (composite samples), for a total of 12 quadrates for each plot. Composite samples included all forage, grasses and forbs, within the 1 ft^2 quadrats. The dry-eight-rank method was used to determine species composition for each quadrat.

Figure 3. Exclosure example. Pictorial demonstration showing how the exclosures were set up on each site. Exclosures 1-3 were moved each fall, while exclosure 4 was not moved due to the weather station set up. Exclosure 4 was weed-whacked to reduce RDM to match the surrounding area.

Appendix 2.

California rangeland stewardship guidelines emphasize managing for residual dry matter (RDM) levels at the beginning of the rainy season. University of California Division of Agriculture and Natural Resources has published recommended minimum values of RDM (Bartolome et al, 2006). However, many land managers are not aware that even if livestock are removed at the end of spring, forage residue levels continue to decline through the dry season due to physical and chemical breakdown, and losses incurred by small rodents or insects. Larsen et al. 2021, found that dry vegetation can disappear at a rate of 7-10% per month from the end of growing season until the beginning of the rainy season. For this report we assumed a 5-month dry period from the time of peak production to the beginning of the wet period, mid-May to mid-October. It could be shorter or longer. Ranches that remove livestock by early spring, we advise adding an additional 7-10% RDM per month from the time cattle are removed until the rains begin, Larsen et al 2021b). This will ensure that the minimum RDM levels are achieved when the rains return in the fall. Table 1 shows the recommended minimum RDM level for each site, the Peak Forage RDM Equivalent (the amount of forage needed to achieve recommended minimum RDM values by mid-October if not grazed.

Table 1. Minimum RDM for each site, and the Peak Forage RDM Equivalent value.

Site NO.	Sites Name	Minimum RDM lbs/ac	Peak Forage RDM Equivalent lbs/ac
1	Adelaida	500	675
3	Cambria	1200	1620
4	Carrizo	300	405
5	Huasna	500	675
6	Morro Bay-S	500	675
7	Shandon	500	675
8	Bitterwater	300	405
9	Soda Lake	300	405
10	Creston	400	540
11	Pozo	500	675
12	Cal Poly-W6	500	675
13	Morro Bay-N	500	675
14	Bitterwater-2	300	405
15	Camatta Creek-N	400	540
16	Camatta Creek-S	400	540
17	Cayucos	500	675
18	Rock Pile Rd	400	540
19	San Miguel	400	540
20	Templeton	500	675
21	Topaz B3	300	405
22	Topaz ST	300	405
23	Cal Poly-EU8-N	700	945
24	Cal Poly-EU8-S	700	945
25	Estrella	400	540
27	Shell Creek	400	540
28	Branch Mtn	300	405
29	Camatta Creek-T	400	540

30	Creston-2	400	540
31	Cambria-2	1200	1620
32	Gilliam-FS1	400	540
33	SLO	500	675

Appendix 3.

DRY-WEIGHT RANK METHOD - SPECIES COMPOSITION

The dry-weight rank method is described in the global rangelands' website (Global Rangelands, 2019). This method is specifically designed to determine species composition by providing a measure of the relative contribution of various species to the total biomass (based on dry matter content) for a site.

Dry-weight rank results are expressed only as percentage values, and do not quantify the actual biomass for each species. However, this problem can be circumvented by also determining the total biomass for the site, which is then proportioned to various species according to the percentage values derived from the dry-weight rank method.

This technique requires that the observer for each quadrat identify the first, second, and third most abundant species (on a dry weight basis), to which the ranks of 1, 2, and 3, are respectively assigned. When only 2 species occur in the quadrat, one of them should be given two ranks. In an example from global rangelands webs, a quadrat dominated by Lehmann lovegrass (*Eragrostis lehmanianna*) but including a few small croton (*Croton* spp.), shows that the first and second rank may be assigned to Lehmann lovegrass, while croton is allocated the third rank. If only one species is found, it receives all three ranks for that quadrat.

At the end of sampling, ranks are tallied for each species, and weighted by a set of multipliers, which are 0.7 for Rank 1, 0.2 for Rank 2 and 0.1 for Rank 3. The weighted values of the three ranks are then added together for each species, and the result represents species composition. For many observers, the seemingly arbitrary multipliers are a source of bemusement, because it effectively assumes the highest ranked species within the quadrat contributes 70% of the biomass, the second contributes 20%, and the third ranked species 10%, while other less conspicuous species are disregarded. However, these multipliers have been tested across a wide variety of vegetation types in USA, Australia and Southern Africa, and found to provide reasonably accurate and precise results. It is important though to remember that other species may be present.

Appendix 4. Species Composition for the three rainfall zones in San Luis Obispo County from 2001-2022, comprising of Table 1 and Grass vs Forbs with rainfall, Figures 1-3.

Table 1. Species composition for each growing season averaged from 2001-2022, based on the dry-weight rank method. Other species were seen, but only in trace amounts (<1%), and therefore were not included in this table. A few species were grouped by genus, indicated by abbreviation for plural species (spp.).

Scientific Name	Common Name	Coastal Zone	Central Zone	Eastern Zone
Grasses				
Festuca perennis	rye grass	40%	0%	0%
Avena spp.	wild oat	13%	12%	6%
Bromus rubens	red brome	0%	11%	24%
Bromus hordeaceus	soft chess	5%	13%	5%
Brachypodium distachyon	false brome	9%	0%	0%
Festuca (Vulpia) spp.	annual fescue	2%	10%	6%
Hordeum spp.	foxtail	5%	3%	7%
Bromus diandrus	ripgut	2%	3%	1%
Stipa pulchra	purple needle grass	4%	0%	0%
Schismus arabicus	schismus	0%	0%	1%
Other grasses	other	0%	0%	1%
Forbs				
Erodium spp.	filaree	8%	33%	34%
Medicago polymorpha	bur clover	3%	3%	0%
Trifolium spp.	clover	1%	2%	1%
Vicia benghalensis	purple vetch	0%	2%	0%
Acmispon spp.	Spanish clover	0%	2%	4%
Lupinus spp.	lupine	0%	0%	1%
Plantago lanceolatum	plantain	0%	0%	0%
Sisyrinchium atlanticum	blue eyed grass	0%	0%	0%
Convolvulus spp.	morning glory	0%	0%	3%
Calystegia macrostegia	coast morning glory	1%	0%	0%
Chlorogalum pomeridianum	soap plant	1%	0%	0%
Castilleja spp.	owls clover	0%	0%	1%
Plagiobothrys spp.	popcorn flower	0%	1%	0%
Centaurea melitensis	tocalote	0%	1%	0%
Other forbs	other	4%	4%	5%
		100%	100%	100%

Appendix 4, continued.

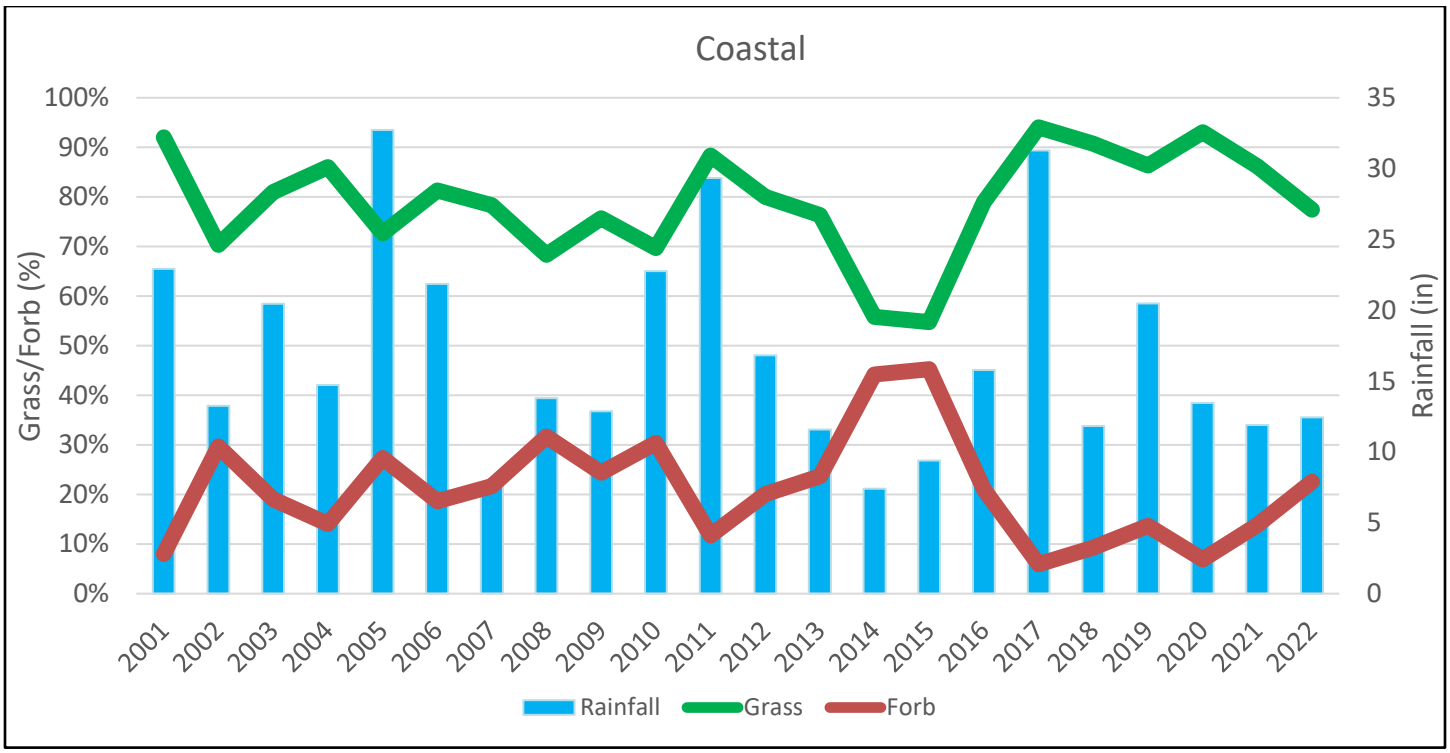

Figure 1. Grass and forb dominance with 2001-2022 rainfall averages for the Coastal zone, San Luis Obispo County.

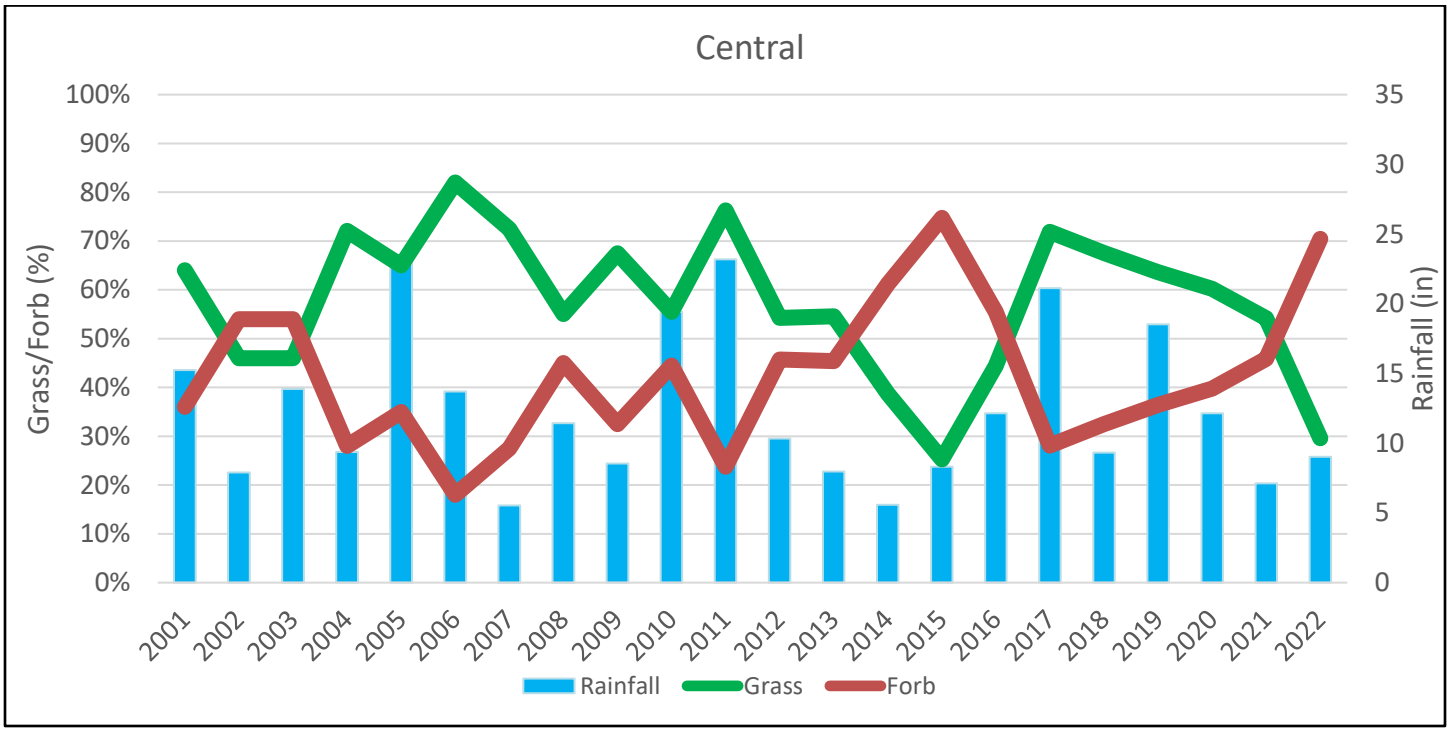

Figure 2. Grass and forb dominance with 2001-2022 rainfall averages for the Central zone, San Luis Obispo County.

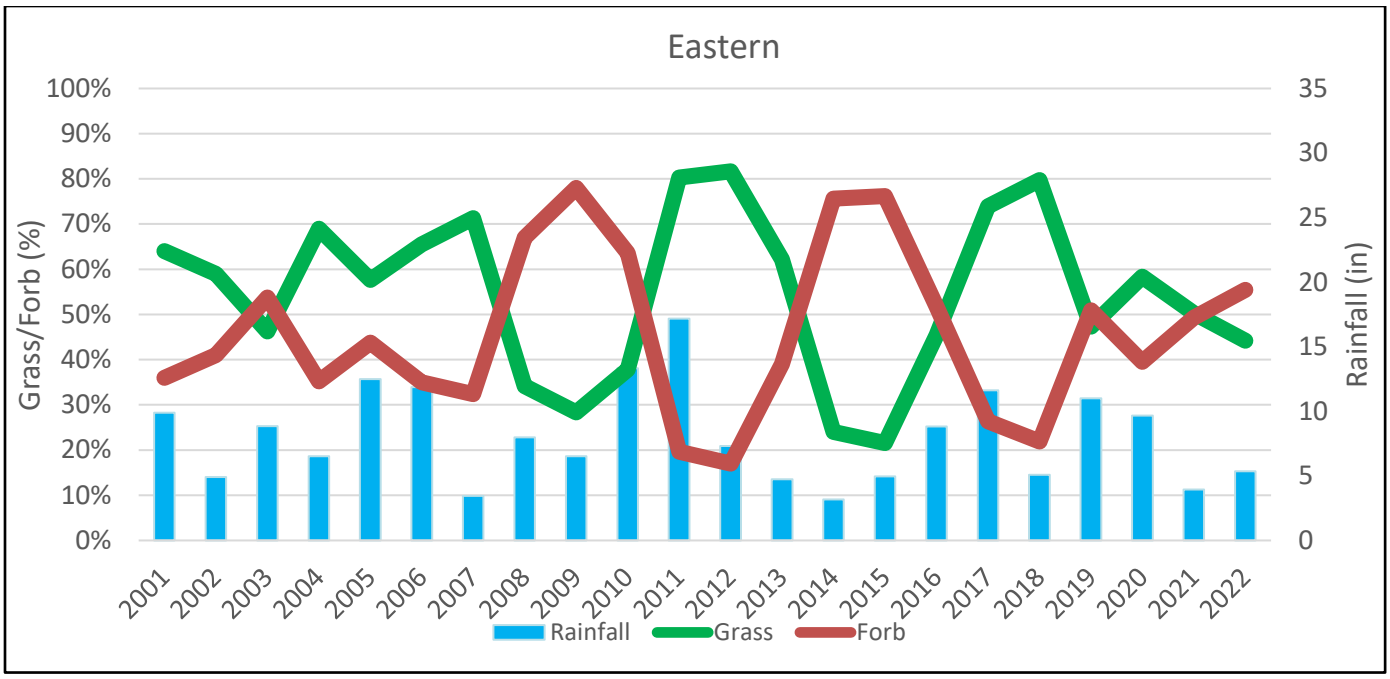

Figure 3. Grass and forb dominance with 2001-2022 rainfall averages for the Eastern zone, San Luis Obispo County.

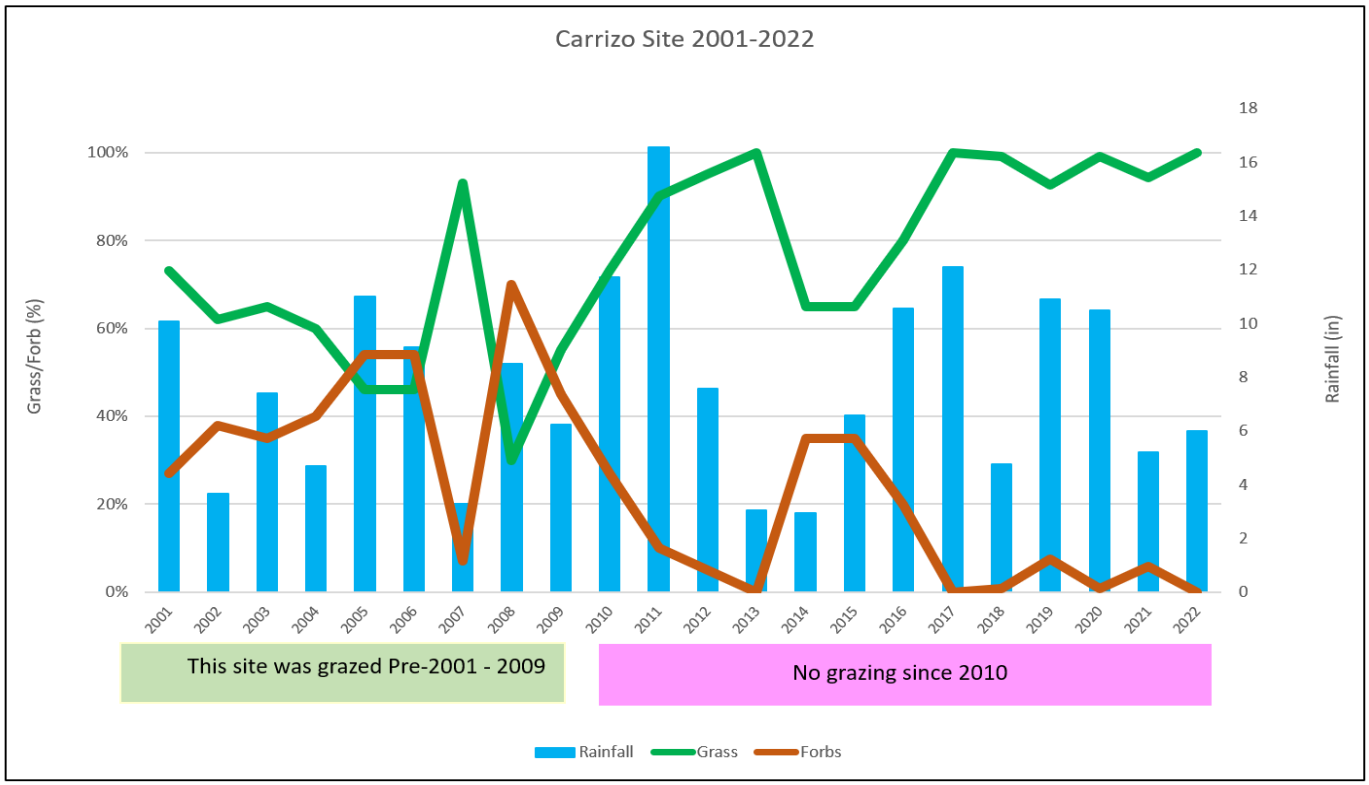

Figure 4. Grass and forb dominance, with 2001-2022 rainfall averages, for the Carrrizo site. This site was grazed prior to 2001 up through 2009, but then excluded since 2010.

Appendix 5. Includes Tables 1-3 for Total Production, Available Forage and Rainfall for each site and year, 2001-2022.

Table 1. Total Production 2001-2022.

Site	Spring 2001 (lb/ac)	Spring 2002 (lb/ac)	Spring 2003 (lb/ac)	Spring 2004 (lb/ac)	Spring 2005 (lb/ac)	Spring 2006 (lb/ac)	Spring 2007 (lb/ac)	Spring 2008 (lb/ac)	Spring 2009 (lb/ac)	Spring 2010 (lb/ac)	Spring 2011 (lb/ac)
Adelaida	2343	4359	5071	3106	7928	4980	1839	4640	3354	9723	2644
Cambria	6122	7334	9454	8135	8409	10261	4312	7324	5257	9786	7332
Carrizo	3457	833	2590	1974	4976	7182	1876	2021	1940	5170	4820
Huasna	4135	4219	4752	6455	9026	8434	4182	5112	3704	9232	4340
MorroBayS	3627	2316	5730	2949	7581	4658	1871	3587	2494	5004	4048
Shandon	n/a	n/a	2693	2328	5578	8571	2309	3844	1370	4914	3102
Bitterwater	n/a	n/a	n/a	1728	3840	3555	176	2907	982	4087	4507
SodaLake	n/a	n/a	n/a	730	2506	3956	29	1281	416	1447	2124
Creston	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1987	1755
Pozo	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	4540	3675
CPW6	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	7396	4724
MorroBayN	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Bitterwater2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
CamattaN	2828	1821	2196	1236	2136	4104	713	2567	668	1519	3454
CamattaS	1190	372	2145	452	1872	3235	208	2013	491	3955	4841
Cayucos	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
RockPileRd	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
SanMiguel	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Templeton	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TopazB3	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TopazST	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
CPEU8N	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
CPEU8S	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Estrella	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ShellCreek	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BranchMtn	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
CamattaT	1545	890	1609	941	1310	951	524	1390	480	1393	2960
Creston2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cambria2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
GilliamFS1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
VRSLO	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 1. Total Production 2001-2022 Continued.

Site	Spring 2012 (lb/ac)	Spring 2013 (lb/ac)	Spring 2014 (lb/ac)	Spring 2015 (lb/ac)	Spring 2016 (lb/ac)	Spring 2017 (lb/ac)	Spring 2018 (lb/ac)	Spring 2019 (lb/ac)	Spring 2020 (lb/ac)	Spring 2021 (lb/ac)	Spring 2022 (lb/ac)
Adelaida	3724	1334	1876	4162	5856	4425	3742	4270	2701	1129	2637
Cambria	5083	6282	3129	5472	10107	11684	6834	4463	5721	6195	4200
Carrizo	5378	537	167	3162	4350	8718	1918	4530	3862	2598	2046
Huasna	3336	1993	656	834	2588	7202	2565	4385	4362	3898	1526
MorroBayS	3248	2175	595	1354	4186	4800	2690	4304	4735	2343	2444
Shandon	1940	1376	274	1261	2534	3625	1800	2982	3410	450	1086
Bitterwater	971	450	51	521	827	3676	1668	2920	1694	249	155
SodaLake	490	141	31	1129	1548	5329	641	2961	1250	266	114
Creston	881	537	238	804	1109	1274	608	1454	1026	395	612
Pozo	4081	2385	1074	2328	3617	4135	1786	2492	3502	1378	1354
CPW6	6589	3981	n/a	6703	8614	5254	3502	4961	5595	3032	4750
MorroBayN	n/a	1807	867	2758	5274	5165	2334	5118	5210	3254	3737
Bitterwater2	n/a	n/a	316	769	3696	7326	1398	4148	2217	686	814
CamattaN	1740	403	90	610	1215	2352	2039	2229	1558	625	849
CamattaS	891	174	139	874	782	2587	410	2580	1447	211	201
Cayucos	n/a	n/a	742	1355	6184	7583	4175	6643	5647	4447	1846
RockPileRd	n/a	n/a	882	1859	3271	3784	2464	3270	3233	1718	2193
SanMiguel	n/a	n/a	294	1969	2534	3363	2213	2847	2644	570	404
Templeton	n/a	n/a	796	1686	4608	4165	2045	5012	3702	1522	1172
TopazB3	n/a	n/a	354	985	1817	1442	414	600	839	252	404
TopazST	n/a	n/a	132	827	1008	1859	962	761	2208	286	406
CPEU8N	n/a	n/a	n/a	3173	3102	3384	2543	2787	2291	1389	1766
CPEU8S	n/a	n/a	n/a	1120	4952	6240	2701	5195	2742	1916	2094
Estrella	n/a	n/a	n/a	4116	2308	2381	1738	4186	3681	1950	1234
ShellCreek	n/a	n/a	n/a	1017	2195	3441	1563	2824	2281	435	418
BranchMtn	n/a	n/a	n/a	950	1086	1764	662	1402	1551	569	495
CamattaT	622	298	106	687	1234	2400	1297	2010	1932	417	203
Creston2	n/a	n/a	n/a	n/a	1776	1923	838	1382	1398	210	397
Cambria2	n/a	n/a	n/a	n/a	5547	5195	6893	5007	3642	3959	3642
GilliamFS1	n/a	n/a	n/a	n/a	1209	1830	1152	2246	2124	767	274
VRSLO	n/a	n/a	n/a	n/a	3078	4682	2592	6056	3458	2192	2063

Table 2. Available Forage 2001-2022.

Site	Spring 2001 (lb/ac)	Spring 2002 (lb/ac)	Spring 2003 (lb/ac)	Spring 2004 (lb/ac)	Spring 2005 (lb/ac)	Spring 2006 (lb/ac)	Spring 2007 (lb/ac)	Spring 2008 (lb/ac)	Spring 2009 (lb/ac)	Spring 2010 (lb/ac)	Spring 2011 (lb/ac)
Adelaida	1668	3684	4396	2431	7253	4305	1164	3965	2679	9048	1969
Cambria	4502	5714	7834	6515	6789	8641	2692	5704	3637	8166	5712
Carrizo	3052	428	2185	1569	4571	6777	1471	1616	1535	4765	4415
Huasna	3460	3544	4077	5780	8351	7759	3507	4437	3029	8557	3665
MorroBayS	2952	1641	5055	2274	6906	3983	1196	2912	1819	4329	3373
Shandon	n/a	n/a	2018	1653	4903	7896	1634	3169	695	4239	2427
Bitterwater	n/a	n/a	n/a	1323	3435	3150	0	2502	577	3682	4102
SodaLake	n/a	n/a	n/a	325	2101	3551	0	876	11	1042	1719
Creston	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1447	1215
Pozo	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	3865	3000
CPW6	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	6721	4049
MorroBayN	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Bitterwater2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
CamattaN	2288	1281	1656	696	1596	3564	173	2027	128	979	2914
CamattaS	650	0	1605	0	1332	2695	0	1473	0	3415	4301
Cayucos	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
RockPileRd	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
SanMiguel	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Templeton	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TopazB3	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TopazST	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
CPEU8N	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
CPEU8S	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Estrella	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ShellCreek	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BranchMtn	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
CamattaT	1005	350	1069	401	770	411	0	850	0	853	2420
Creston2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cambria2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
GilliamFS1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
VRSLO	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 2. Available Forage 2001-2022, Continued.

	Spring 2012	Spring 2013	Spring 2014	Spring 2015	Spring 2016	Spring 2017	Spring 2018	Spring 2019	Spring 2020	Spring 2021	Spring 2022
Site	(lb/ac)	(lb/ac)	(lb/ac)	(lb/ac)	(lb/ac)	(lb/ac)	(lb/ac)	(lb/ac)	(lb/ac)	(lb/ac)	(lb/ac)
Adelaida	3049	659	1201	3487	5181	3750	3067	3595	2026	454	1962
Cambria	3463	4662	1509	3852	8487	10064	5214	2843	4101	4575	2580
Carrizo	4973	132	0	2757	3945	8313	1513	4125	3457	2193	1641
Huasna	2661	1318	0	159	1913	6527	1890	3710	3687	3223	851
MorroBayS	2573	1500	0	679	3511	4125	2015	3629	4060	1668	1769
Shandon	1265	701	0	586	1859	2950	1125	2307	2735	0	411
Bitterwater	566	45	0	116	422	3271	1263	2515	1289	0	0
SodaLake	85	0	0	724	1143	4924	236	2556	845	0	0
Creston	341	0	0	264	569	734	68	914	486	0	72
Pozo	3406	1710	399	1653	2942	3460	1111	1817	2827	703	679
CPW6	5914	3306	n/a	6028	7939	4579	2827	4286	4920	2357	4075
MorroBayN	n/a	1132	192	2083	4599	4490	1659	4443	4535	2579	3062
Bitterwater2	n/a	n/a	0	364	3291	6921	993	3743	1812	281	409
CamattaN	1200	0	0	70	675	1812	1499	1689	1018	85	309
CamattaS	351	0	0	334	242	2047	0	2040	907	0	0
Cayucos	n/a	n/a	67	680	5509	6908	3500	5968	4972	3772	1171
RockPileRd	n/a	n/a	342	1319	2731	3244	1924	2730	2693	1178	1653
SanMiguel	n/a	n/a	0	1429	1994	2823	1673	2307	2104	30	0
Templeton	n/a	n/a	121	1011	3933	3490	1370	4337	3027	847	497
TopazB3	n/a	n/a	0	580	1412	1037	9	195	434	0	0
TopazST	n/a	n/a	0	422	603	1454	557	356	1803	0	1
CPEU8N	n/a	n/a	n/a	2228	2157	2439	1598	1842	1346	444	821
CPEU8S	n/a	n/a	n/a	175	4007	5295	1756	4250	1797	971	1149
Estrella	n/a	n/a	n/a	3576	1768	1841	1198	3646	3141	1410	694
ShellCreek	n/a	n/a	n/a	477	1655	2901	1023	2284	1741	0	0
BranchMtn	n/a	n/a	n/a	545	681	1359	257	997	1146	164	90
CamattaT	82	0	0	147	694	1860	757	1470	1392	0	0
Creston2	n/a	n/a	n/a	n/a	1236	1383	298	842	858	0	0
Cambria2	n/a	n/a	n/a	n/a	3927	3575	5273	3387	2022	2339	2022
GilliamFS1	n/a	n/a	n/a	n/a	669	1290	612	1706	1584	227	0
VRSLO	n/a	n/a	n/a	n/a	2403	4007	1917	5381	2783	1517	1388

Table 3. Rainfall 2001-2022, Water Year July - June.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Site	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
Adelaida	22.79	15.38	24.83	10.91	38.54	25.03	9.25	18.76	12.03	28.09	28.50
Cambria	23.90	20.50	21.53	17.12	40.23	27.84	9.26	18.08	13.93	29.73	35.05
Carrizo	10.09	3.68	7.40	4.69	11.00	9.11	3.28	8.51	6.24	11.71	16.57
Huasna	28.70	14.25	22.30	17.60	35.40	31.45	7.95	21.75	15.25	30.50	37.70
MorroBayS	17.12	9.19	14.91	10.35	29.39	20.08	6.75	16.14	12.29	23.00	29.18
Shandon	15.37	8.92	11.65	8.05	20.60	16.80	5.69	10.50	7.45	16.93	18.52
Bitterwater	11.00	4.85	8.55	7.96	11.31	12.78	4.24	6.72	6.22	13.17	15.97
SodaLake	8.60	4.60	8.10	5.08	12.95	10.56	1.95	5.01	5.22	11.92	18.98
Creston	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	7.45	14.26	17.00
Pozo	n/a	12.14	21.56	n/a	n/a	n/a	n/a	n/a	13.62	29.17	33.57
CPW6	24.54	14.79	22.90	16.02	29.76	15.31	6.03	6.80	13.00	17.72	19.29
MorroBayN	17.12	9.19	14.91	10.35	29.39	20.08	6.75	16.14	12.29	23.00	29.18
Bitterwater2	11.00	n/a	n/a	7.96	11.31	12.78	4.24	6.72	6.22	13.17	15.97
CamattaN	11.09	4.87	9.61	7.15	13.00	10.57	4.30	9.14	6.70	13.39	16.45
CamattaS	11.09	4.87	9.61	7.15	13.00	10.57	4.30	9.14	6.70	13.39	16.45
Cayucos	22.99	8.55	20.84	15.10	39.11	27.75	12.95	20.70	15.25	24.62	40.65
RockPileRd	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	28.00	36.95
SanMiguel	15.41	5.05	11.23	7.30	22.26	12.88	4.35	10.81	6.83	15.81	16.45
Templeton	16.50	7.46	14.53	8.72	24.95	10.47	5.43	12.96	7.68	19.09	21.49
TopazB3	7.90	5.46	10.34	5.80	13.86	14.46	2.32	9.03	6.75	14.16	18.45
TopazST	7.90	5.46	10.34	5.80	13.86	14.46	2.32	9.03	6.75	14.16	18.45
CPEU8N	24.52	14.79	23.35	16.02	29.76	15.26	6.03	6.73	13.00	17.72	19.29
CPEU8S	24.54	14.79	22.90	16.02	29.76	15.31	6.03	6.80	13.00	17.72	19.29
Estrella	13.73	5.98	10.48	6.73	22.32	14.48	4.89	8.31	5.87	13.18	17.52
ShellCreek	11.09	4.87	9.61	7.15	13.00	10.57	4.30	9.14	6.70	13.39	16.45
BranchMtn	7.90	5.46	5.21	5.80	11.15	14.27	2.32	6.16	7.54	14.73	18.69
CamattaT	11.09	4.87	9.61	7.15	13.00	10.57	4.30	9.14	6.70	13.39	16.45
Creston2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	14.26	17.00
Cambria2	n/a	n/a	n/a	13.94	31.83	22.09	8.82	10.99	10.31	22.38	31.37
GilliamFS1	0.00	0.00	0.00	16.01	27.20	13.96	7.29	14.60	10.83	24.10	30.14
VRSLO	n/a	n/a	n/a	n/a	n/a	23.36	7.67	13.82	10.45	21.21	32.41

Table 3. Rainfall 2001-2022, Water Year July - June, Continued.

Site	2012 (in)	2013 (in)	2014 (in)	2015 (in)	2016 (in)	2017 (in)	2018 (in)	2019 (in)	2020 (in)	2021 (in)	2022 (in)
Adelaida	12.53	11.42	7.59	11.90	15.11	28.45	12.67	24.46	14.90	11.43	14.84
Cambria	16.86	12.77	7.94	13.43	17.36	39.79	13.95	26.62	15.19	15.76	14.37
Carrizo	7.56	3.04	2.95	6.59	10.54	12.11	4.75	10.91	10.50	5.22	5.98
Huasna	19.60	11.50	8.22	8.51	15.23	30.99	11.45	24.05	15.23	9.49	11.54
MorroBayS	12.85	12.64	6.99	7.88	13.35	24.98	10.56	17.58	12.83	10.64	10.31
Shandon	9.54	5.48	4.16	7.88	8.68	14.62	7.25	12.38	11.01	4.29	7.75
Bitterwater	6.80	4.25	2.15	5.12	8.97	12.12	5.17	10.04	9.09	3.68	4.84
SodaLake	8.74	7.47	1.85	5.79	7.95	11.09	4.41	11.48	9.22	3.30	4.77
Creston	9.46	6.46	4.29	6.89	9.79	16.38	7.43	16.20	10.58	6.53	7.31
Pozo	12.68	10.06	8.93	10.29	20.68	36.94	13.52	31.16	15.82	9.08	13.35
CPW6	20.12	11.03	8.24	9.70	16.96	30.82	11.94	20.36	12.28	12.46	13.13
MorroBayN	12.85	12.64	6.99	7.88	13.55	24.87	10.66	17.33	11.27	10.68	10.68
Bitterwater2	6.80	4.25	3.06	4.47	8.85	11.37	4.73	10.10	9.23	3.19	5.49
CamattaN	6.91	5.48	3.37	4.10	8.87	12.21	5.41	11.03	9.77	4.30	4.92
CamattaS	6.91	5.48	3.37	4.10	7.99	10.12	4.28	8.55	8.79	3.97	4.58
Cayucos	17.48	13.95	6.99	8.61	15.28	28.47	11.59	17.74	13.08	9.15	12.40
RockPileRd	14.50	14.85	7.99	10.84	16.80	31.83	11.17	25.75	16.17	7.65	10.95
SanMiguel	7.39	3.98	3.66	6.92	8.69	13.12	8.33	10.80	10.10	6.91	8.56
Templeton	8.59	6.88	5.68	6.62	10.16	20.91	8.89	18.90	11.07	7.56	8.98
TopazB3	7.21	3.53	3.82	4.51	10.20	11.81	5.46	13.48	11.14	3.83	6.11
TopazST	7.21	3.53	3.82	5.12	10.20	10.65	5.38	11.88	11.14	3.83	5.94
CPEU8N	20.12	10.97	6.08	7.57	16.78	33.19	13.12	19.48	13.13	13.60	14.24
CPEU8S	20.12	11.03	6.08	7.57	16.78	32.00	12.13	18.46	12.36	12.65	12.87
Estrella	8.67	4.65	3.66	8.54	9.77	13.74	8.31	13.02	9.99	8.32	7.57
ShellCreek	6.91	5.48	3.22	5.29	8.71	11.40	5.78	10.61	9.32	4.05	5.64
BranchMtn	8.44	4.01	4.05	5.25	6.86	13.41	5.74	13.14	9.66	4.01	6.03
CamattaT	6.91	5.48	3.37	4.10	7.99	11.48	4.87	9.98	8.63	3.97	4.58
Creston2	8.42	6.46	4.29	6.53	9.47	16.38	7.28	14.63	10.13	6.75	7.09
Cambria2	13.19	10.00	7.73	12.00	16.20	35.86	12.42	21.89	14.02	14.77	13.58
GilliamFS1	13.75	12.82	7.64	10.37	15.23	26.08	11.81	23.89	14.42	7.10	9.73
VRSLO	15.01	9.37	8.90	10.82	16.38	31.76	10.41	21.28	15.31	9.88	11.38