Forage Production Report

San Luis Obispo County
2001-2017

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Introduction

The purpose of this report is to discuss forage production in San Luis Obispo (SLO) County. Rangeland in San Luis Obispo County is 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, there is a diverse geology leading to an assortment of soils that vary in their ability to support vegetation (O'Geen and Arroues 2014). In San Luis Obispo County there are 109 soil series and 354 soil map units with elevations ranging from sea level to 5,100 feet at the summit of Caliente Mountain.

Average annual precipitation ranges from 42 inches to less than 6 inches, see Figure 1. The coastal mountain range rises over 2500 feet, creating a rain shadow reducing precipitation east of the range. As early as 1975, range managers divided San Luis Obispo County into three broad rainfall zones to facilitate range management (Weitkamp 1975) (Fig.1). This division is also used by the USDA Farm Service Agency.

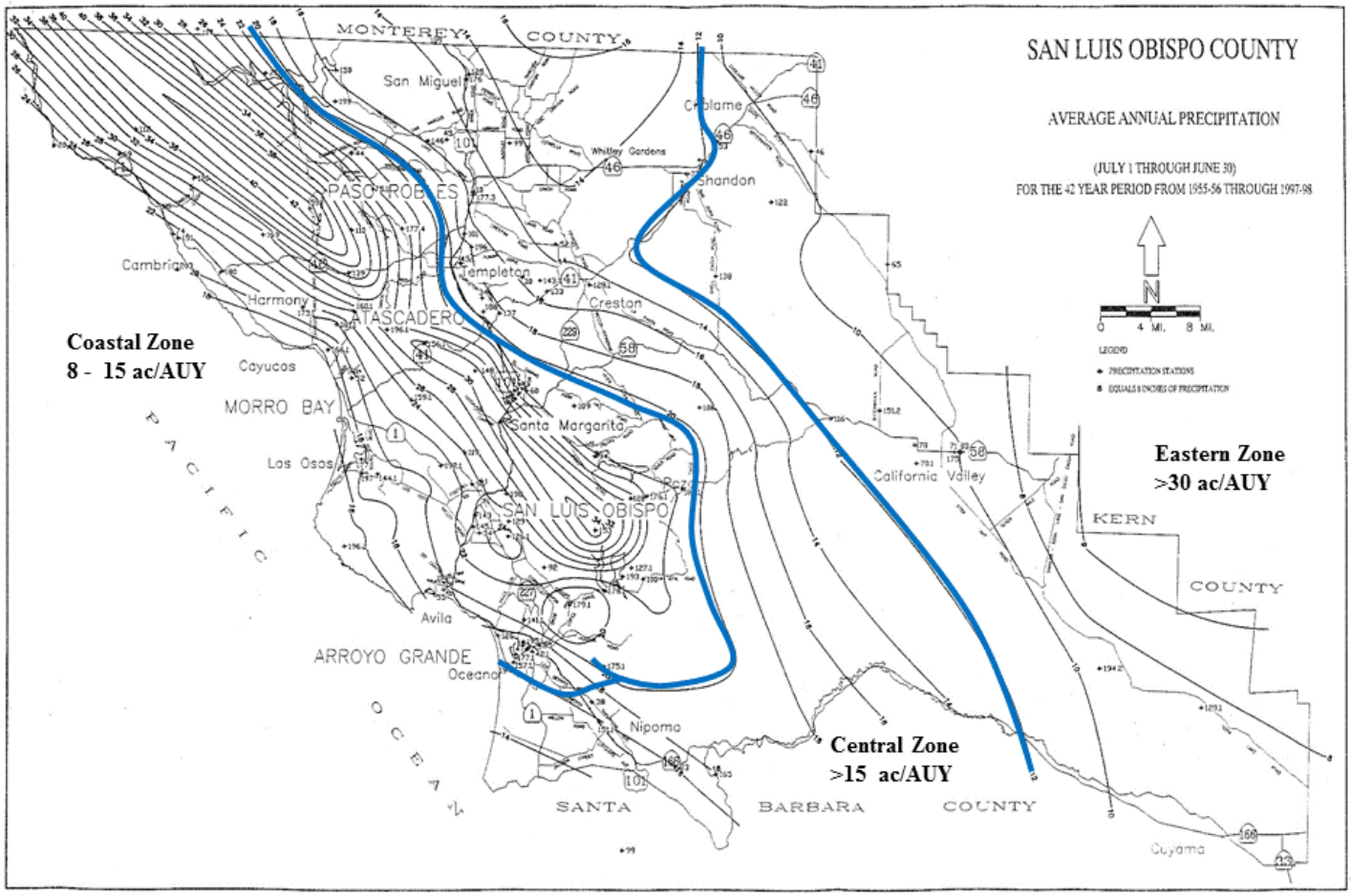

Figure 1. Stocking rates (grazing capacity) and related rainfall zones in San Luis Obispo County (information adapted from Weitkamp 1993). This division is defined as: 1) coastal zone (greater than 20 inches; 8-15 acres per animal unit year (ac/AUY), 2) central zone (between 20 and 12 inches; 15-30 ac/AUY), and 3) eastern zone (less than12 inches; >30 ac/AUY). Definitions: ac = acre, AUY = Animal Unit Year (the amount of forage needed to support a 1,000 lb cow for one year, which is 9,490 lb forage, dry matter basis).

METHODS

Forage production varies across the county based on rainfall amount and timing, soil type, slope and aspect. Annual rainfall amount and timing is probably the most important factor in determining forage production, but soil type is also important (Becchetti et al, 2016). Each year, forage production is quantified at 32 plots around the county representing a variety of rainfall zones, soil types, slopes and aspects, Figure 2. Each plot consists of 4 exclosures, see Appendix 1 for a description of the exclosures and how they are setup. Figure 2 shows the locations of the forage monitoring plots and Table 1 shows the year they were established. For the newest sites, information from the USDA soil survey was used to estimate the expected normal production. On-site data was used to evaluate the other sites where a longer history of forage production data exists.

For this report, the results are shown as "usable forage" production. Usable forage is that portion of the forage that can be grazed without damage to the basic resources (SRM Glossary 2015) by depleting organic matter, increasing erosion and otherwise altering conditions necessary for sustaining forage production and ecological health. In the California annual rangelands, an important means of accomplishing this is leaving enough leftover forage so that sufficient residual dry matter (RDM) remains to cover the soil in the fall. This ensures maximal forage production in the coming season and improves soil protection at the onset of the rainy season. 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). The current year's forage production and minimum recommended RDM values for each plot are shown in Appendix 2.

Total forage 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 growth. Samples were oven dried and weighed. Total forage production values are shown in Appendix 2 along with the calculations used to obtain "usable forage" values. Total forage production included all plants that are palatable to livestock. Plant species not palatable to livestock which included fiddleneck (*Amsinckia* spp.), lupine (*Lupinus* spp.), turkey mullen (*Eremocarpus setiger*), locoweed (*Astragulus* spp.) and tarweed (*Hemizonia* spp.) were excluded from the "total" and "usable" forage estimates. Rainfall was measured at each site using recording rain gauges starting in 2013, previous 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 nearest ranch headquarters. A visual estimate of species composition was recorded for each site at the time of peak growth. In addition, the dry-weight-rank method was used to determine species composition for each quadrat (Ratliff, R.D., and W.E. Frost 1990).

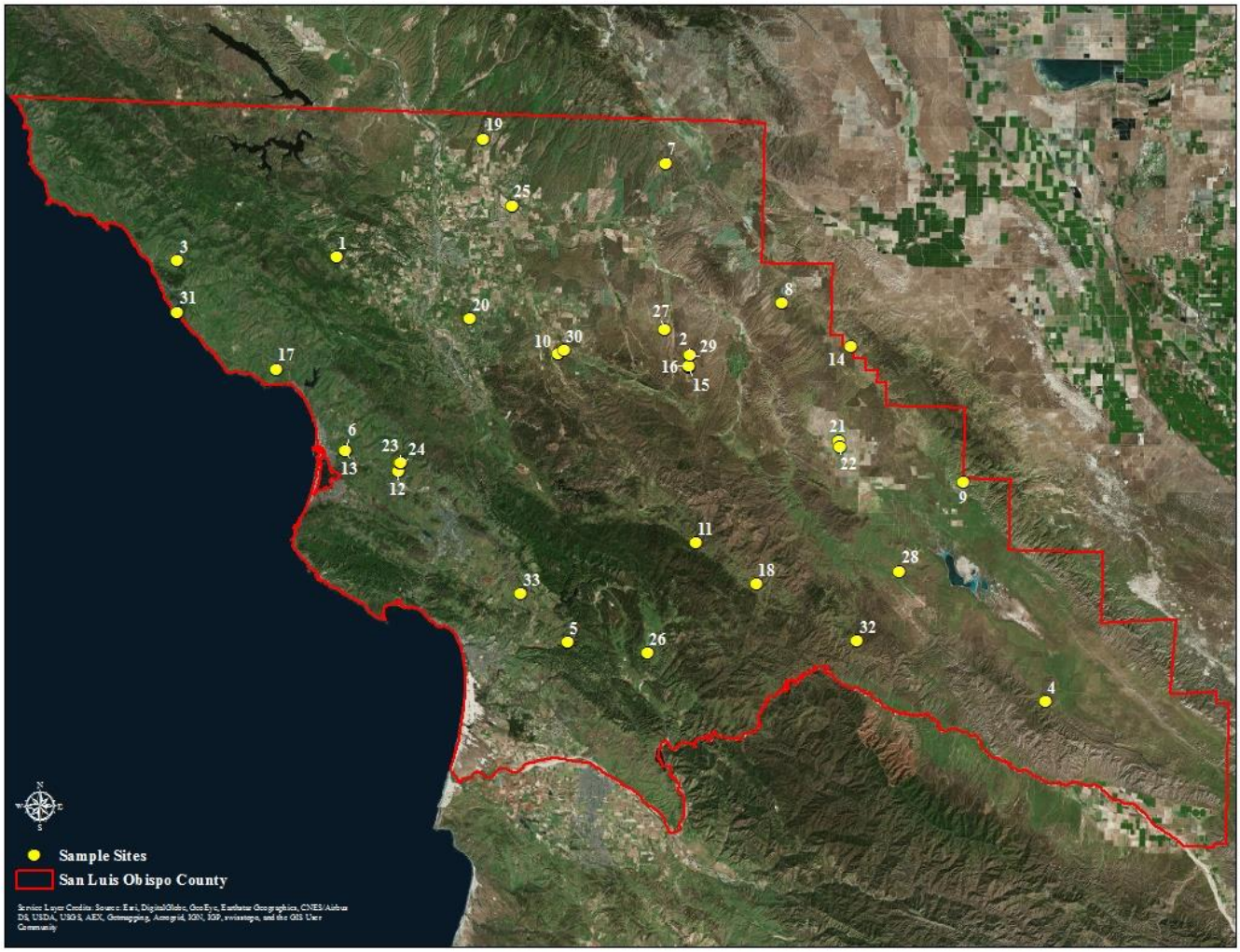

Figure 2. Location of the 32 forage monitoring sites in San Luis Obispo County. These sites were established between 2000 – 2015, see Table 1 for years. *(Figure prepared by Jessica Boone, Althouse and Meade, Inc.)*

Table 1. Year that each plot was established.

	Plot Name (with number as shown on map)
2000	Adelaida (1), [1]Camatta (2), Cambria (3), Carrizo(4), Huasna (5), Morro Bay-S (6)
2003	Shandon (7)
2004	Bitterwater (8), Soda Lake (9)
2010	Creston (10), Pozo (11), Cal Poly-W6 (12)
2012	Morro Bay-N (13)
2013	Bitterwater-2 (14), Camatta-N (15) Camatta-S (16), Cayucos (17), Rock Pile Rd (18), San Miguel (19), Templeton (20), Topaz B3 (21), Topaz ST (22)
2014	Cal Poly-EU8-N (23), Cal Poly-EU8-S (24), Estrella (25), Huasna-2 (26), Shell Creek (27), Branch Mountain (28), Camatta-T (29)
2015	Creston-2 (30), Cambria-2 (31), FS 1 (32), SLO (33)

[1] (The original Camatta site was expanded to Camatta-N, Camatta-S, and Camatta-T).

RAINFALL

The weather pattern 2016-2017 watery year showed neutral conditions, e,g, there was no El Niño or La Niña that developed, making winter rainfall hard to predict (Sabalow, 2016). However, we received rainfall that almost equaled the El Niño of 1997-1998, Figure 3. This was an unexpected, but welcome relief on the Central Coast. There were streams that flowed for the first time in the last 5 years.

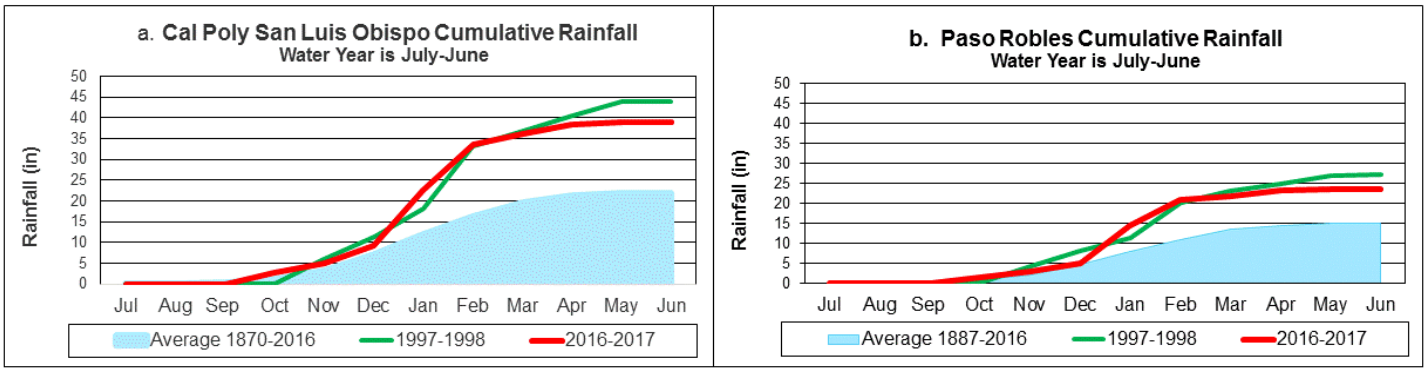

Figure 3. Graph (a) shows rainfall for San Luis Obispo (at Cal Poly), while graph (b) shows rainfall for Paso Robles, both sites having over 100 years' data. The long term average is compared to rainfall totals for the 1997-1998 El Niño and current water year. Rainfall was about 50% above the normal for 2016-2017 water year. *(Data from City of Paso Robles, Cal Poly Irrigation Training and Research Center, and SLO County Public Works Department).*

Overall, rainfall for the 32 monitored sites around the county was about 54% above the average, Figure 4. Rainfall normally starts in October, and increases each month through January, then decreases until May. Normal rainfall started last October, then January and February were very wet months, Figure 5. Precipitation for remainder of the rainfall season was about average.

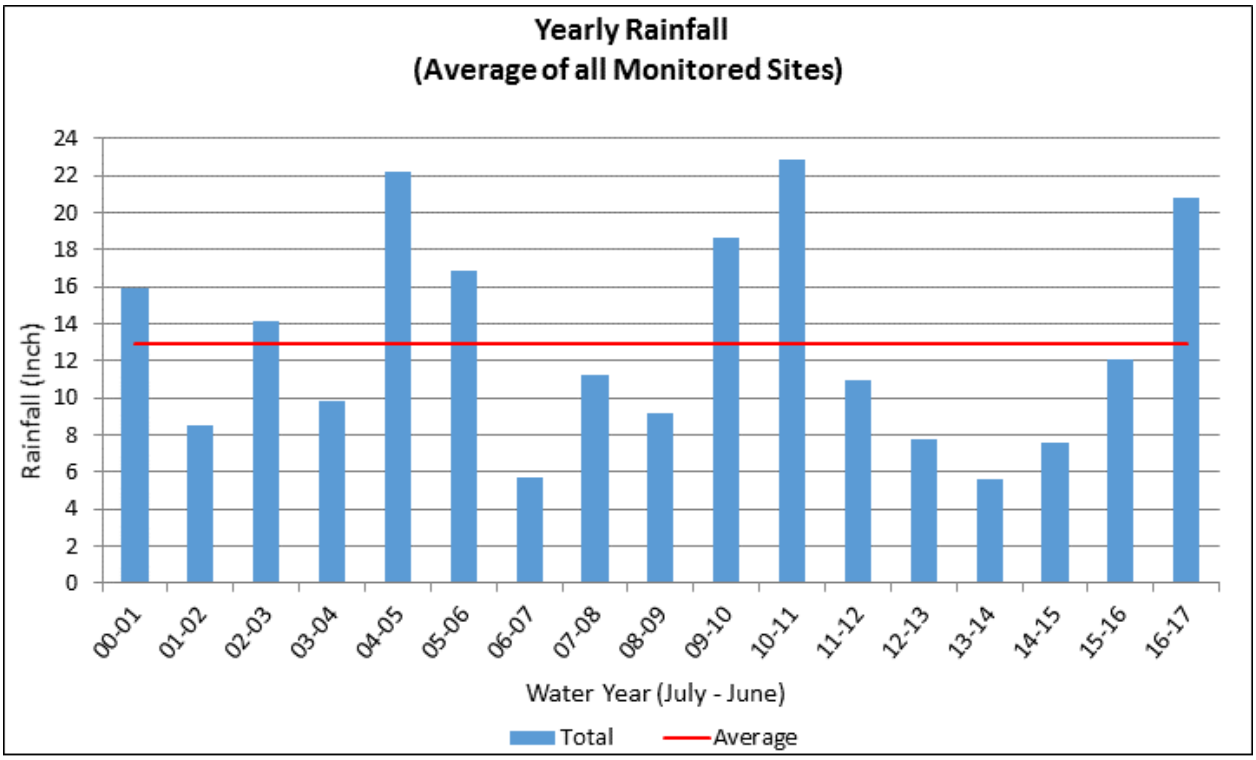

Figure 4. The Average rainfall of the 32 monitored sites from 2000-2001 through current water year.

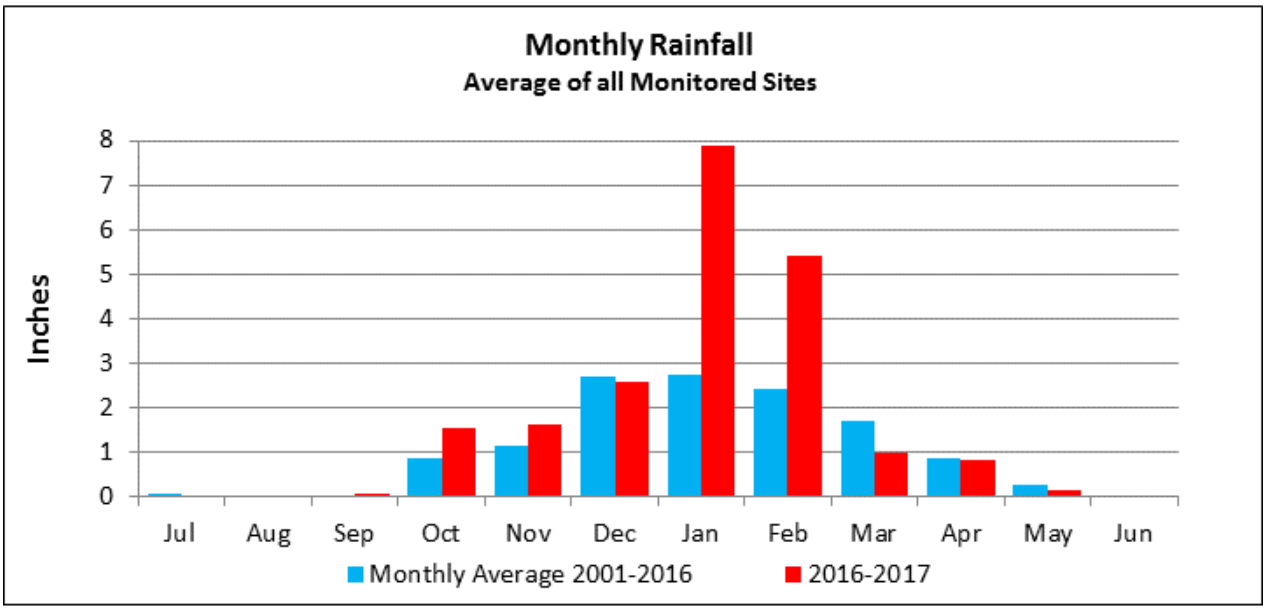

Figure 5. The 2016-2017 average monthly rainfall for the Eastern, Central, and Coastal Zones, compared to the compared to the long term monthly average.

The rainfall pattern was consistent across the three different zones of the county, with the coast receiving the most rainfall and the eastern zone the least since monitoring began in 2001, Figure 6. Though rainfall in each zone showed a similar pattern each year, the total amount of rainfall each year was different, Figure 6. Total rainfall each year is the most significant factor determining forage production.

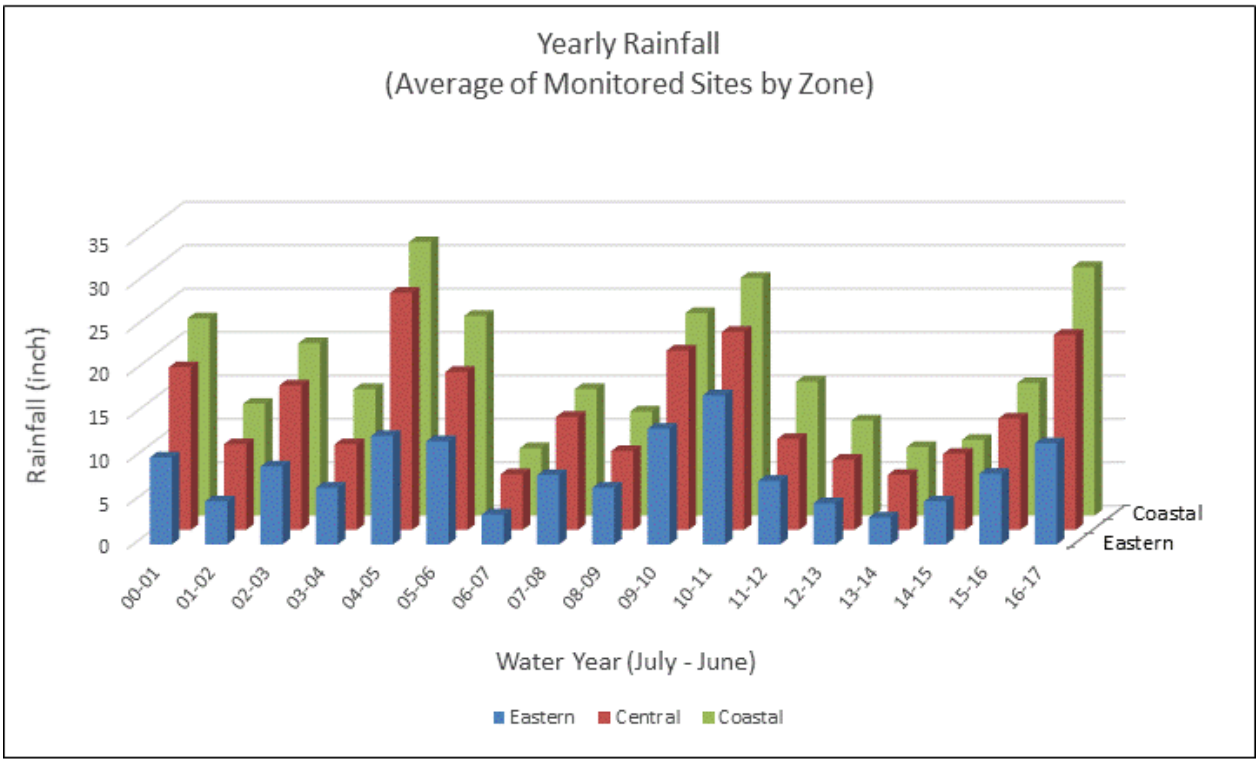

Figure 6. Average yearly rainfall for the Eastern, Central, and Coastal Zones, 2001 through 2017, for the 32 monitored sites.

USABLE FORAGE PRODUCTION

Even though we had a slow start this year, with widespread germination not occurring until November (mid-October has been common in the past), the average usable forage produced across all sites was about 83% greater than the long-term average. This we think was due to the unusually wet January and February which likely made more moisture available into the rapid growth period in March and April. This extra production was not evenly distributed across the county though. The coastal zone produced 62% more than average, and the central zone increased by 31% above average. However, production in the eastern zone of the county more than doubled (Figure 7).

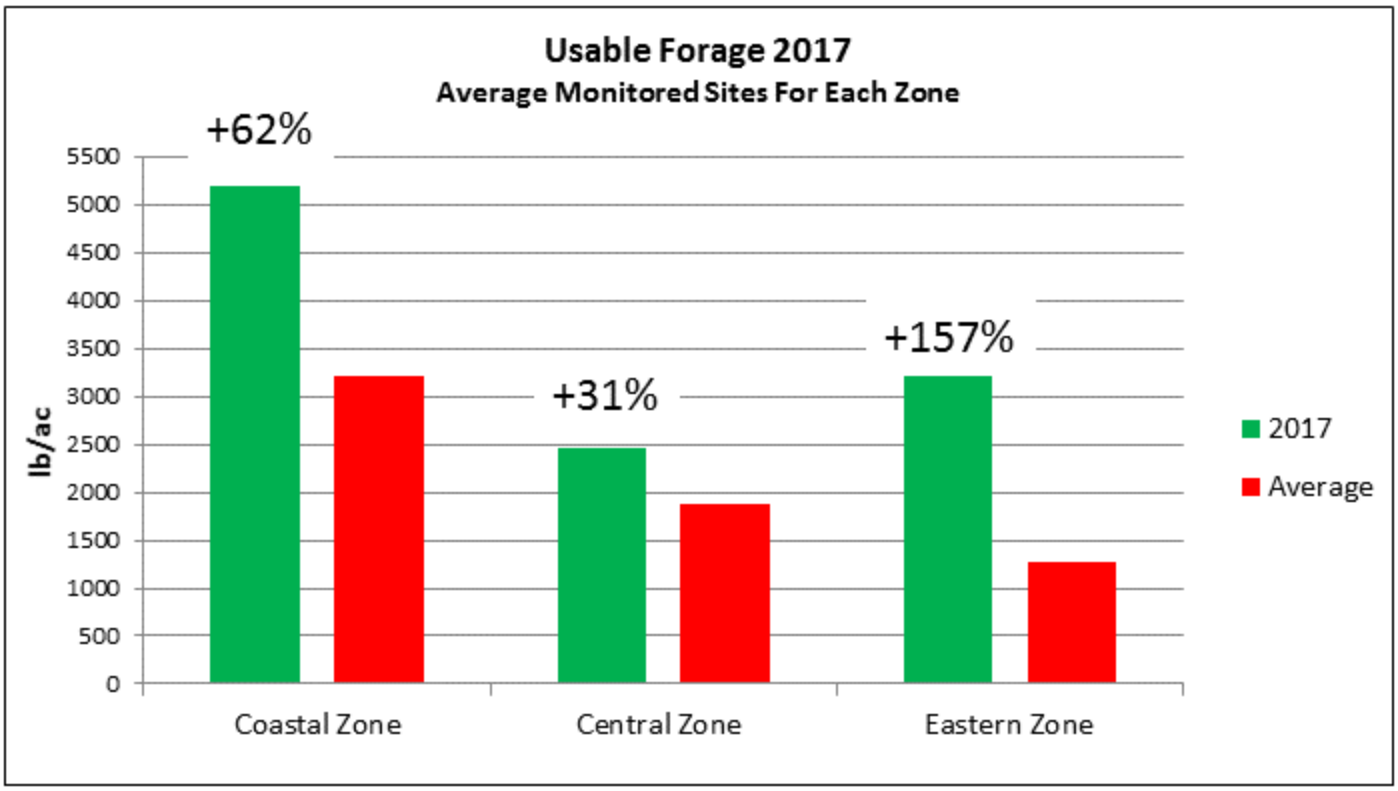

Figure 7. Usable forage production was above average this year, especially in the eastern zone.

Figure 8 gives the variation in forage production by zone within the county since the project began in 2001. For 2016-2017 water year, usable forage production ranged from a high of 10064 lb/ac on the coast near Cambria to a low of 734 lb/ac in the central part of the county at a site near Creston. The values for each plot are shown in Figure 8.

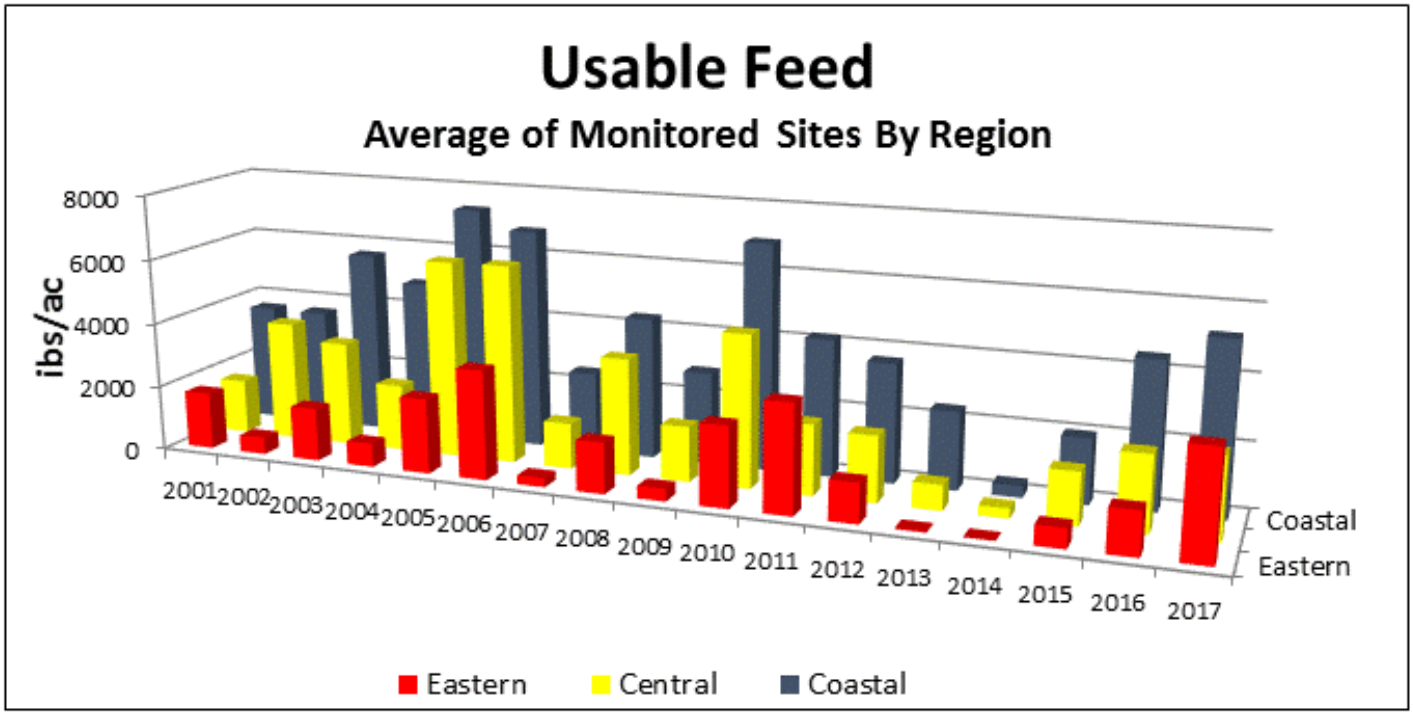

Figure 8. Usable forage production by zone from 2001-2017. The usable forage production was higher this year compared to the last 5 years.

FORAGE SPECIES COMPOSITIONAL CHANGES

There were two major classes of herbaceous (non-woody) forages: grasses and forbs. "Forbs" are broad-leaved flowering plants like filaree, clovers, and the many species of wildflowers. Grasses have been the more dominant herbaceous forages on rangelands in San Luis Obispo County, especially in the coastal zone, Figure 9.

<u>Common forages by precipitation zone</u>

Eastern zone:

Grasses soft chess brome (*Bromus hordeaceus*), wild oats (*Avena spp*), foxtail (*Hordeum spps*), annual fescue (*Fesctuca spp*), ripgut brome (*Bromus diandrus*), and red brome (*Bromus madritensis* sub spp. *rubens*).

Forbs filaree (*Erodium* spp), bur clover (*Medicago polymorpha*), and fiddleneck (*Amsinckia spp*).

Central zone:

Grasses soft chess brome, wild oats, annual fescue, foxtail, red brome, and some ryegrass (*Lolium spp*).

Forbs filaree, purple vetch (*Vicia americana*), Spanish clover (*Lotus purshianus)*, bur clover, and fiddleneck.

Coastal zone:

Grasses annual ryegrass, soft chess, wild oats, California oat grass (*Danthonia californica*), California brome (*Bromus carinatus*), annual fescue, purple needlegrass (*Stipa pulchra*), and false brome (*Brachypodium sylvaticum*).

Forbs filaree, bur clover, plantain (*Plantago spps*), lupine (*Lupinus spps*), mustard (*Brassica spps*), pepper grass (*Lepidium spp*), owls clover (*Castilleja spp*), and morning glory (*Ipomoea spp).*

Since 2001 to present, the most dominant grasses in the coastal zone have been ryegrass and wild oats, while soft chess brome, annual fescue, and red brome were most common in the central and eastern zones. Filaree has been the most common forb found in all three zones, but bur clover was also common.

These two classes of herbaceous forages competed with each other for dominance through the years 2001 - 2017. Environmental conditions, rainfall amount and timing, is the major factor contributing to the dominance of either grasses or forbs. The grasses tend to dominate during higher rainfall years while forbs tend to dominate during drier years. For 2017, grass was the dominate forage type in all three zones of the county. Grazing management is another factor that can determine the grass forb domination. High amounts of residual dry matter (RDM) favors grasses, while low amounts of RDM favors forbs. Grasses usually dominated in the coastal and central zones, e.g. the wetter portions of the county, but in the eastern zone grasses and forbs changed dominance much more frequently, Figure 9.

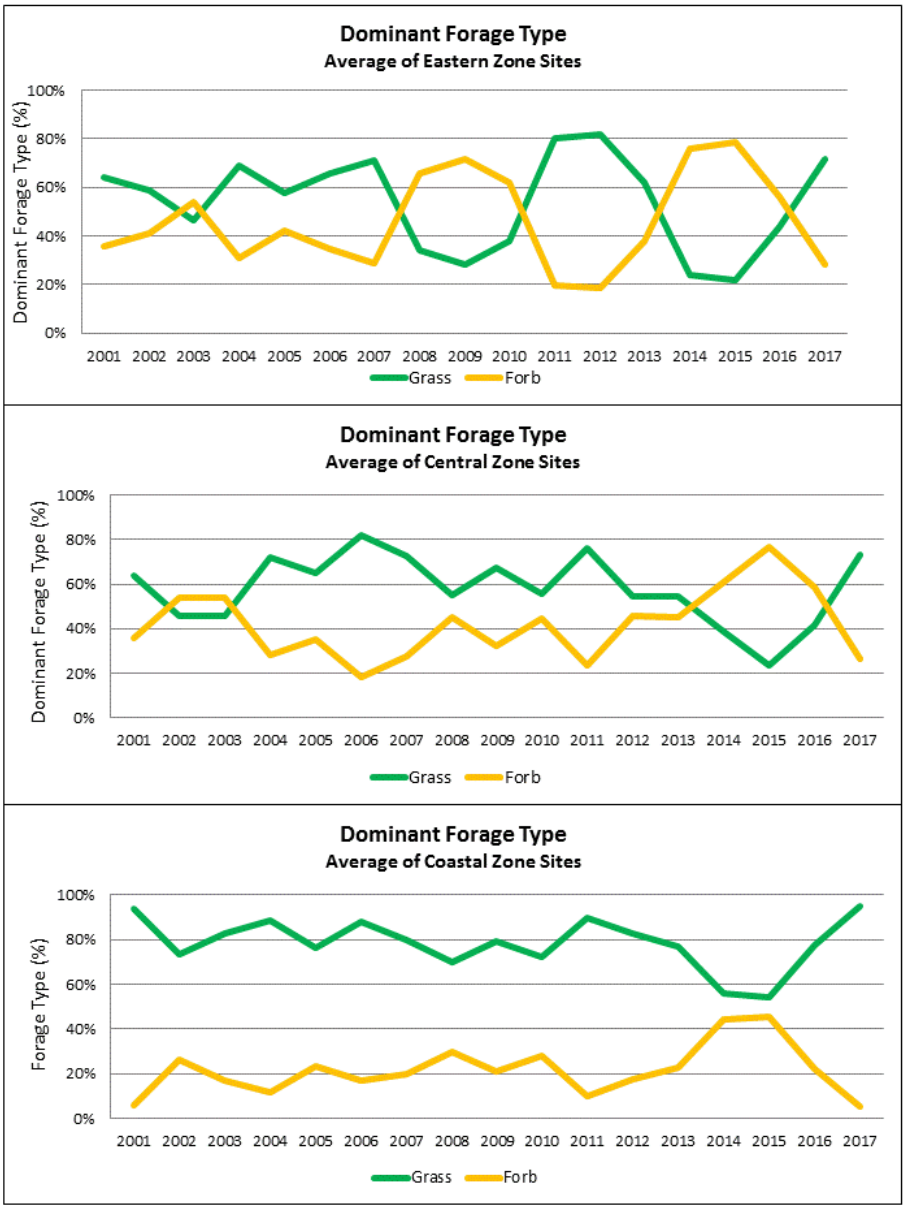

Figure 9. Average of dominant forage type, grass versus forbs, for each zone. Note that the grass and forbs added together equal 100% during each year.

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Appendix 1.

Each plot has 4 exclosures. The exclosures are made from 4-gauge, 16 foot welded wire cattle panels. Three of the exclosures are made from two 16' panels that are put together with t-posts to form a 10' diameter exclosure. The forth exclosure is larger and includes a recording rain gauge, solar shield and air temperature sensor, and a non-recording rain gauge, Figure 1. There is also a bird perch for the purpose of keeping larger birds away from the recording rain gauges (see Figure 1). Bird spikes are used on the recording rain gauges to keep smaller birds from getting into the rain gauge and clogging the screens and funnels by defecating, and dropping insects, cattle pats, and other debris.

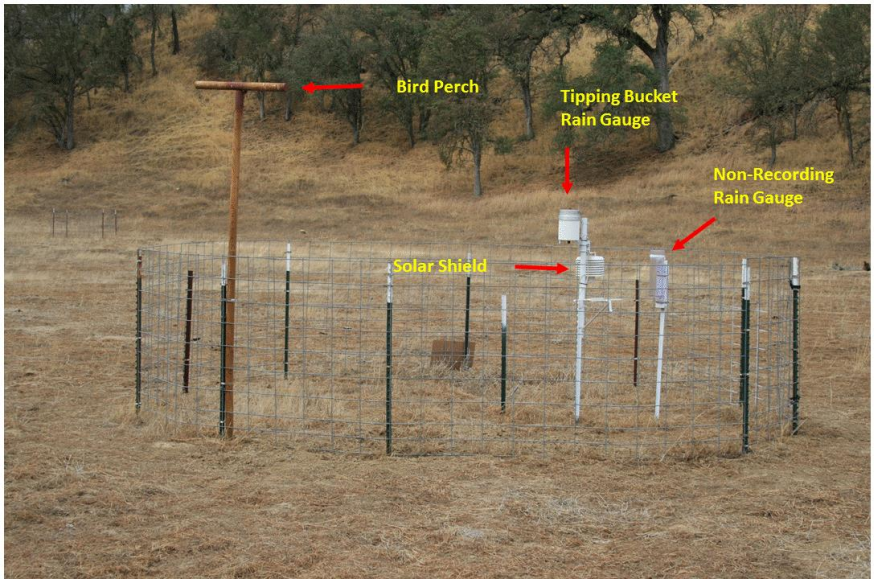

Figure 1. Pictorial showing the tipping bucket rain gauge, a non-recording rain gauge, a solar shield for the temperature sensor, inside exclosure #4. The bird perch helps reduce bird use of the rain gauge as a perch.

Since the amount of Residual Dry Matter (RDM) influences forage growth, the exclosures are moved each fall just prior to the rainy season. They are moved in a random direction and distance between 20 and 60 feet. They are kept on the same soil type, aspect, and slope. Exclosures 1-3 are moved each fall. Exclosure 4 is not moved, since the fourth one has the weather station. That exclosure is weed-whacked to reduce the RDM and to match the surrounding plot condition that exists at the time of movement in the fall, Figure 2. For peak production, three-1 ft^2 quadrats are clipped inside each exclosure for production, for a total of 12 quadrates for each plot. In addition, the dry-weight-rank method is used to determine species composition for each quadrat *(Sampling Vegetation Attributes - Interagency Technical Reference – 1999, BLM/RS/ST-96/002+1730).*

Figure 2. Pictorial demonstration showing how the exclosures are set up on each plot. Exclosures 1-3 are moved each fall, while exclosure 4 is not moved due to the weather station set up. Exclosure 4 is 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. Frost el al., 2008, found that dry vegetation can disappear at a rate of 7% per month from the end of growing season until the beginning of the rainy season. For this report we assume 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. For ranches that remove livestock by early spring, we advise adding an additional 7% RDM per month from the time cattle are removed until the rains begin. 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 in mid-May to achieve recommended minimum RDM values by mid-October. The last two columns represent Total Forage Production and Usable Forage Production (Total Forage Production – Peak Forage RDM Equivalent).

Table 1. Minimum recommended RDM values for each site, Peak Forage RDM Equivalent. Total Forage Production and Usable Forage Production values for each site are also included. Peak Forage RDM Equivalent assumes a 5 month period without rainfall, mid-May (beginning of forage desiccation) until the first germinating rain which is usually in mid-October, or an additional 35% increase in the minimum recommended RDM values.

Plot NO.	Plot Name	Recommended Minimum RDM Values (lb/ac)	Peak Forage RDM Equivalent (lb/ac)	2017 Total Forage Production (lb/ac)	2017 Usable Forage Production (lb/ac)
1	Adelaida	500	675	4425	3750
3	Cambria	1200	1620	11684	10064
4	Carrizo	300	405	8718	8313
5	Huasna	500	675	7202	6527
6	Morro Bay-S	500	675	4800	4125
7	Shandon	500	675	3625	2950
8	Bitterwater	300	405	3676	3271
9	Soda Lake	300	405	5329	4924
10	Creston	400	540	1274	734
11	Pozo	500	675	4135	3460
12	Cal Poly W6	500	675	5254	4579
13	Morro Bay-N	500	675	5165	4490
14	Bitterwater-2	300	405	7326	6921
15	Camatta-N	400	540	2352	1812
16	Camatta-S	400	540	2587	2047
17	Cayucos	500	675	7583	6908

Plot NO.	Plot Name	Recommended Minimum RDM Values (lb/ac)	Peak Forage RDM Equivalent (lb/ac)	2017 Total Forage Production (lb/ac)	2017 Usable Forage Production (lb/ac)
18	Rock Pile Rd	**400**	**540**	**3784**	**3244**
19	San Miguel	**400**	**540**	**3363**	**2823**
20	Templeton	**500**	**675**	**4165**	**3490**
21	Topaz B3	**300**	**405**	**1442**	**1037**
22	Topaz ST	**300**	**405**	**1859**	**1454**
23	Cal Poly EU8-N	**700**	**945**	**3384**	**2439**
24	Cal Poly EU8-S	**700**	**945**	**6240**	**5295**
25	Estrella	**400**	**540**	**2381**	**1841**
26	Huasna-2	**500**	**675**	**2887**	**2212**
27	Shell Creek	**400**	**540**	**3441**	**2909**
28	Branch Mtn	**300**	**405**	**1764**	**1359**
29	Camatta-T	**400**	**540**	**2400**	**1860**
30	Creston 2	**400**	**540**	**1923**	**1383**
31	Cambria 2	**1200**	**1620**	**5195**	**3575**
32	FS 1	**400**	**540**	**1830**	**1290**
33	SLO	**500**	**675**	**3828**	**4007**