Forage Production Report

San Luis Obispo County
2001-2016

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Introduction

The purpose of this report is to discuss forage production in San Luis Obispo County. The 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). 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 1993) (Fig.1). This division is also used by the USDA Farm Service Agency.

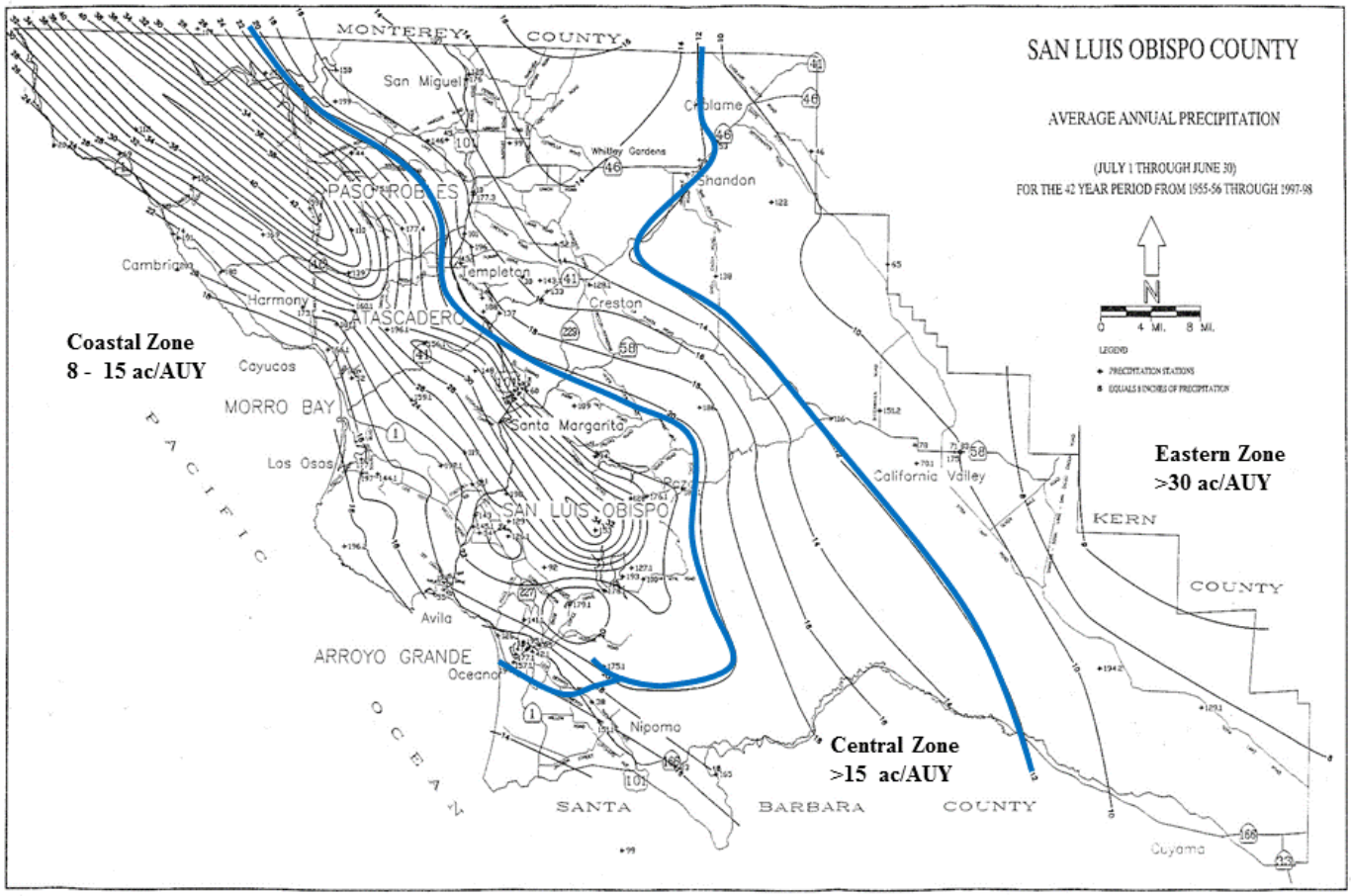

Figure 1. Stocking rates (grazing capacity) and related rainfall zones in San Luis Obispo County (information adapted from Weitkamp 1993). This division is defined as: 1) coastal zone (greater than 20 inches; 8-15 acres per animal unit year (ac/AUY), 2) central zone (between 20 and 12 inches; 15-30 ac/AUY), 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 lbs forage, dry matter basis).

2016 has seen the continuation of an unprecedented drought along the California Central Coast. Due to a strong El Niño, above average rainfall was expected. However, the drought continued along the Central Coast, where rainfall fell just short of the average. Figure 2 shows the United States Drought Monitor listing much of San Luis Obispo County in the exceptional drought (D4) rating, as it has for the last several years. (Fenimore 2016).

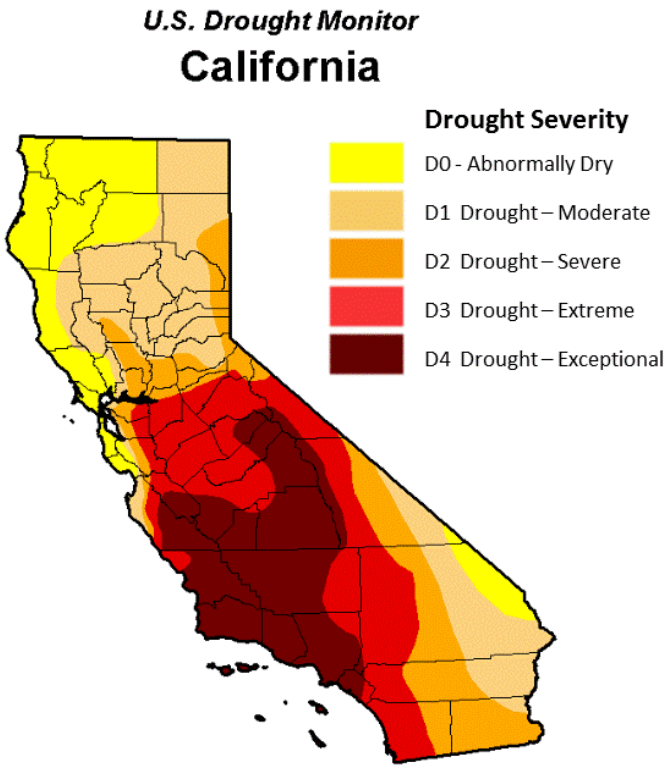

Figure 2. US Drought Monitor showed much of San Luis Obispo County in the D4 drought severity rating during 2015-2016.

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. Each year, forage production is quantified at 32 plots around the county representing a variety of rainfall zones, soil types, slopes and aspects, Figure 3. Each plot consists of 4 exclosures, see Appendix 1 for a description of the exclosures. Figure 3 shows the locations of the forage monitoring plots and Table 1 shows the year they were established. There were several new plots added to the annual monitoring locations the last couple of seasons. Information from the USDA soil survey was used to estimate the expected normal production for newer plots. On-site data was used to evaluate the other sites where a longer history of forage production data existed.

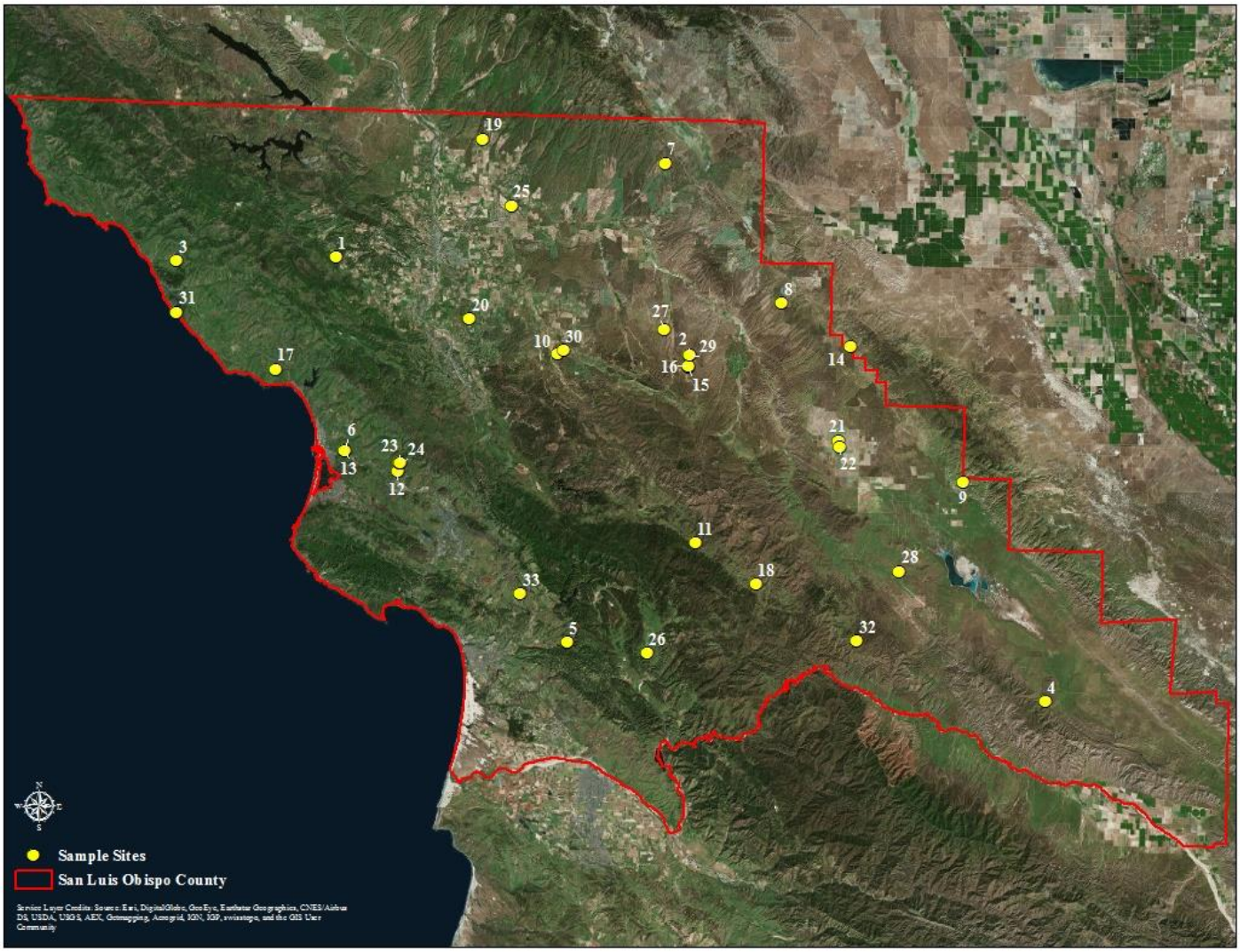

Figure 3. Location of the 32 forage monitoring plots in San Luis Obispo County. These sites were established between 2000 – 2015, see Table 1 for the establishment date. *(Figure prepared by Jessica Boone, Althouse and Meade, Inc.)*

Table 1. Year that each plot was established.

	Plot Name (with number as shown on map, Fig. 3)
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).

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). In an annual rangeland, that means leaving enough residual forage so that sufficient residual dry matter (RDM) remains to cover the soil in the fall to ensure maximal forage production and soil protection with the onset of the rainy season. The recommended minimum RDM levels are given in the publication "Guidelines for Residual Dry Matter on Coastal and Foothill Rangelands in California" (Bartolome et al. 2006). The forage production and RDM values for each plot are shown in Appendix 2. Total forage production was measured each spring by clipping 3- 1 ft^2 quadrats, within each of the four exclosures for 12 quadrats, at each 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 setigerus*), 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., W.E. Frost 1990).

Rainfall

With this year's strong El Niño, rainfall was expected to be above average, but less than average was received. This was also much less than the previous two El Niño's, Figure 4. However, there was record setting rainfall during the month of July, about 2.8 inches in Paso Robles and 1.4 inches in San Luis Obispo, due to hurricane Delores and unusual monsoonal rainfall patterns.

Overall, the rainfall in each zone of the county was near the 15 year average, Figure 5. Rainfall normally starts in October, and increases each month through January, then decreases until May. Normal rains did not begin this year until November, Figure 6. Precipitation for most of the rainfall season was below the monthly average, but January and March were wetter than normal (Fig. 6).

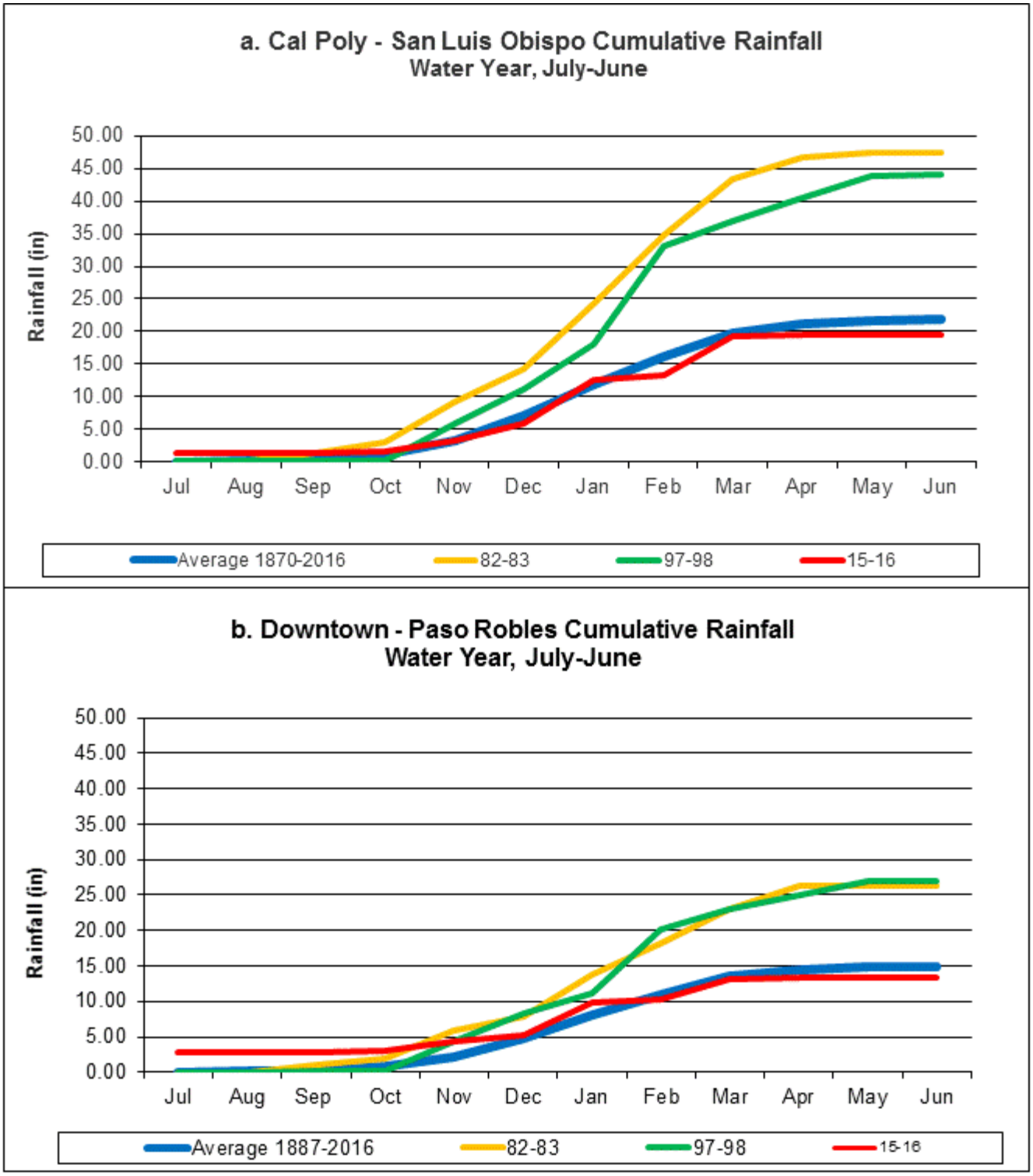

Figure 4. Top graph (a) shows rainfall for San Luis Obispo, while (b) shows rainfall for Paso Robles, both sites having over 100 years data. The long term average is compared to rainfall totals for the 2015-2016 El Niño, and the two previous El Niño's, 1982-1983 and 1997-1998. *(Data from City of Paso Robles, Cal Poly Irrigation Training and Research Center, and SLO County Public Works Department).*

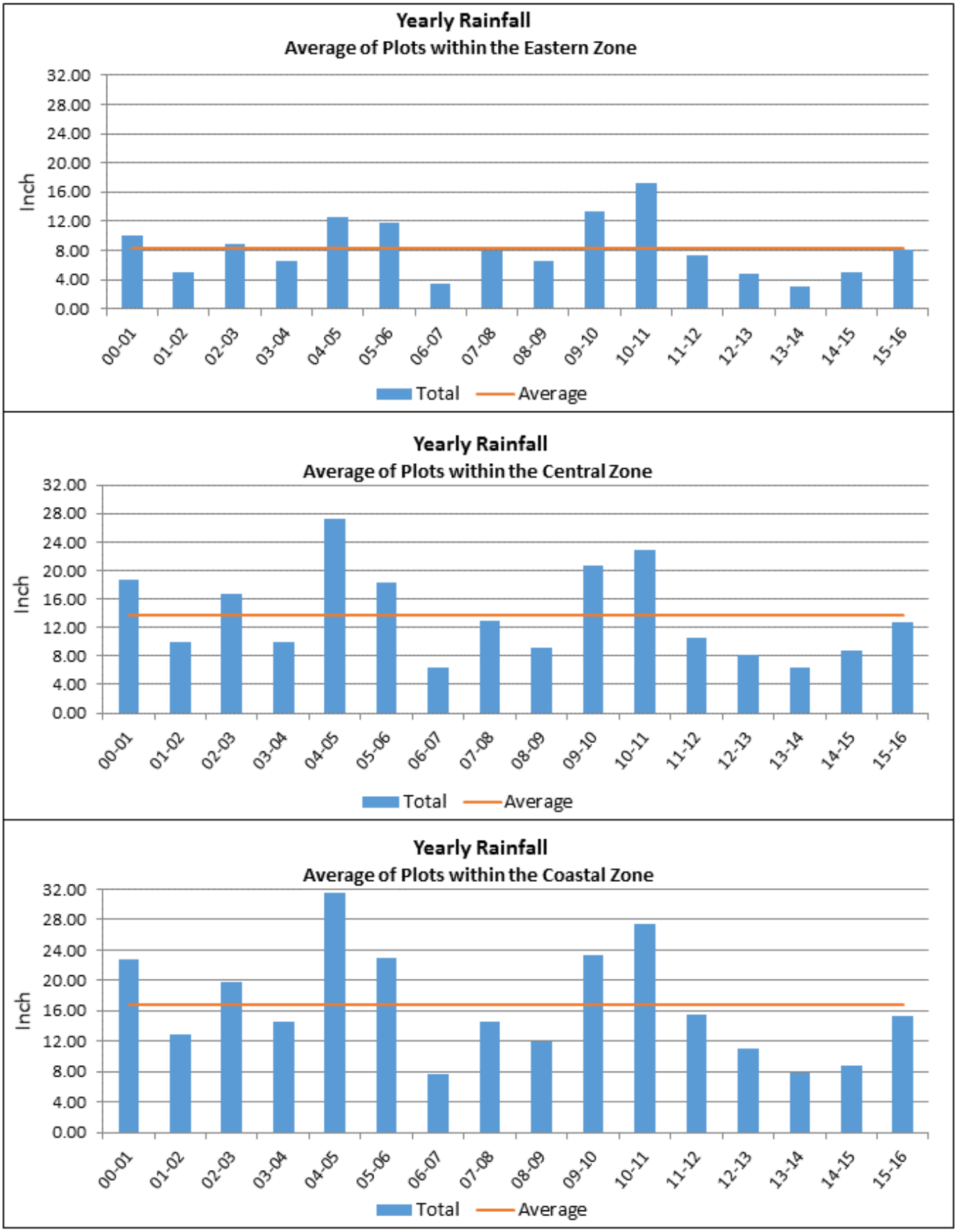

Figure 5. Yearly rainfall for the Eastern, Central, and Coastal Zones, 2001 through 2016. Based on the water year, June – July.

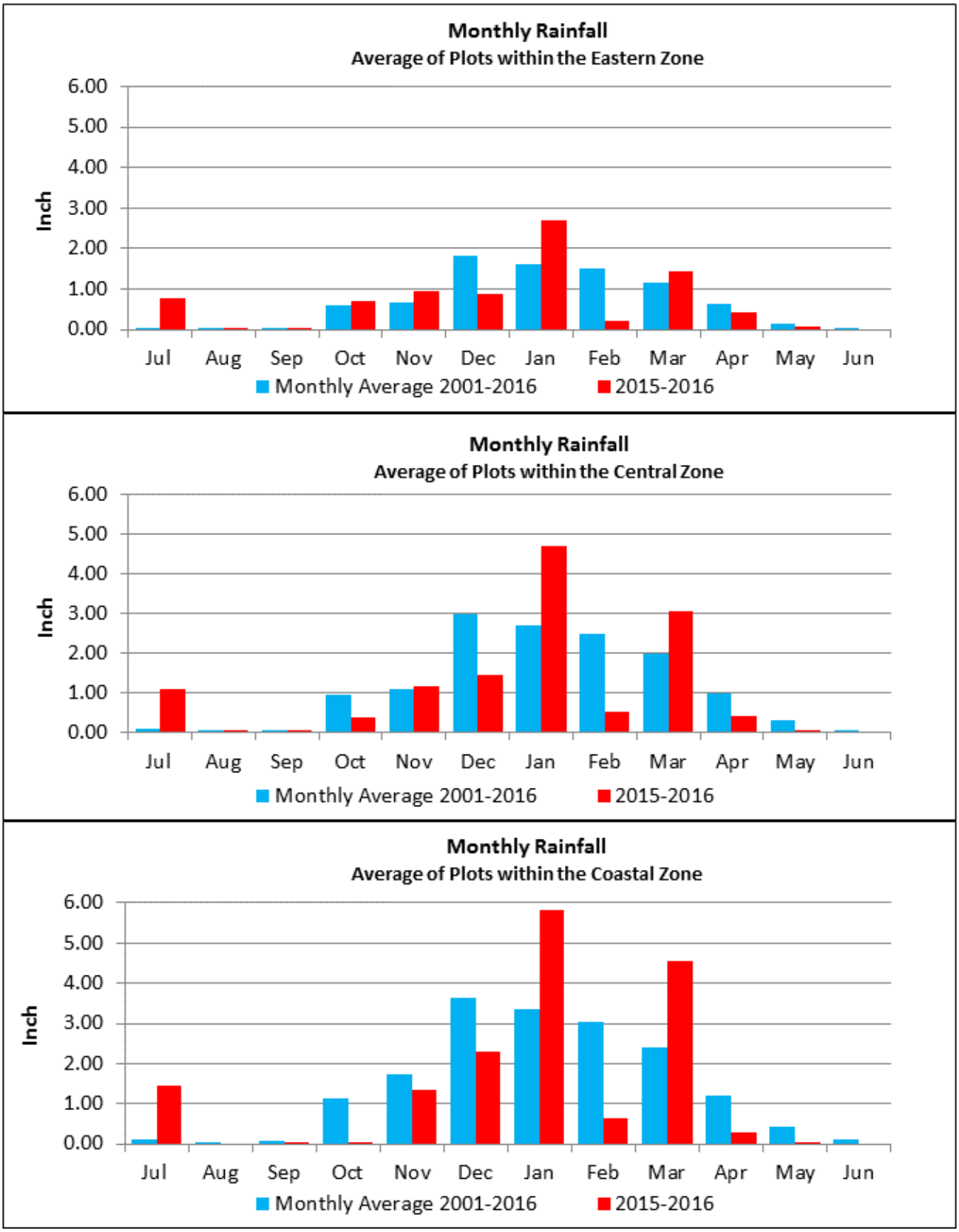

Figure 6. Average monthly rainfall for the Eastern, Central, and Coastal Zones, compared to the 2015-2016 water year.

USABLE FORAGE PRODUCTION

The unusual rains in July 2015 initiated germination, which normally begins in late September or October. However, there was no sustained rainfall, so all the annuals that germinated in July perished. The second germination this year began in November, or December, 2015 and produced usable forage that was highly variable across the county. In general, by averaging all plots within each zone, this year's production was near the average, Figure 7. All zones within the county had significantly more forage in 2016, than the previous two years (Fig. 7).

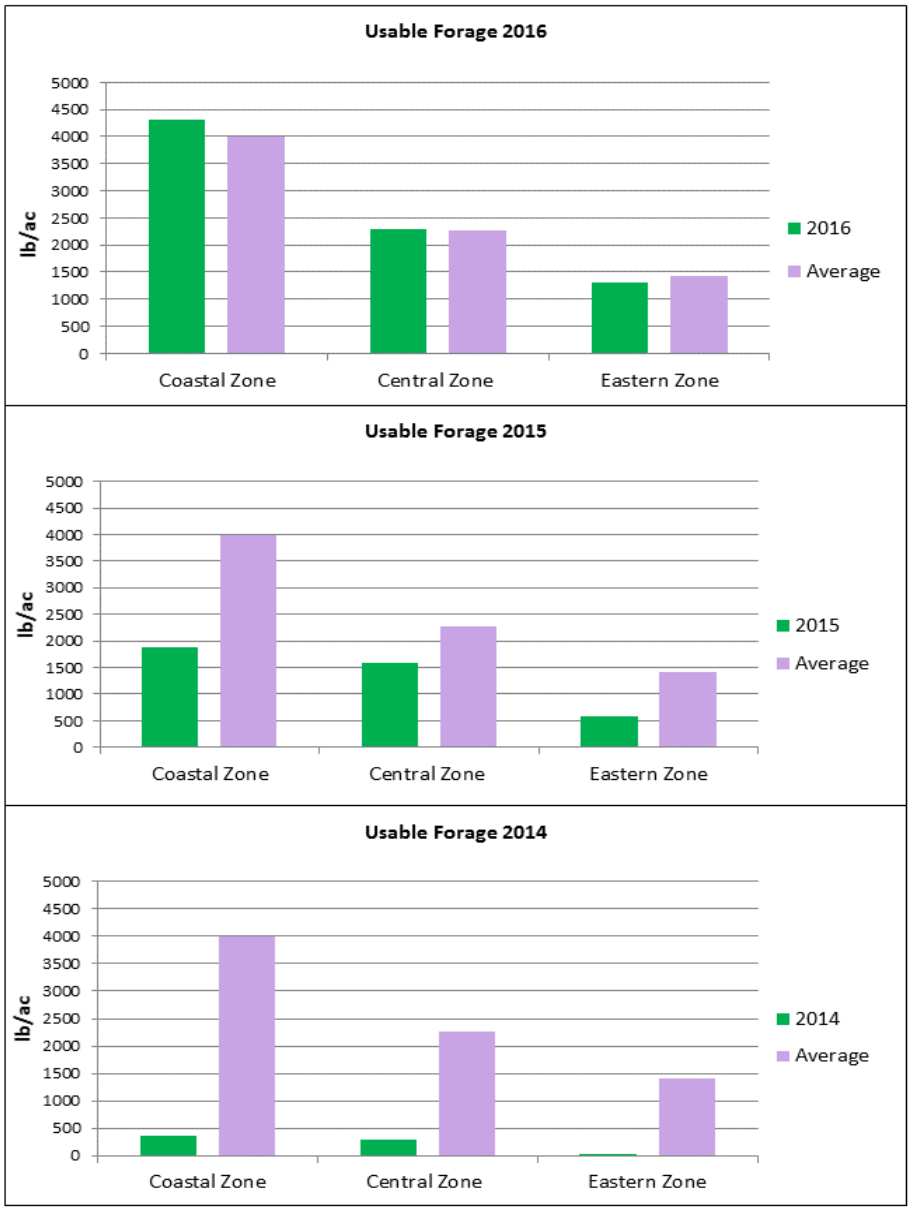

Figure 7. Usable forage production for each zone for 2014, 2015, and 2016.

However, usable forage production of individual plots varied greatly due to the unusual lightning and thunder storms experienced this year. Usable forage production ranged from high of 8545 lb/ac on the coast near Cambria to a low of 238 lb/ac in the central part of the county near Camatta Creek. The values for each plot are shown in Figure 8. Production at some plots was almost twice the average for that particular plot, while other plots were as much as 75% below, Figure 9. Some plots from all three precipitation zones had values that were “above-average” and some that were “below-average” production this year (Fig 9).

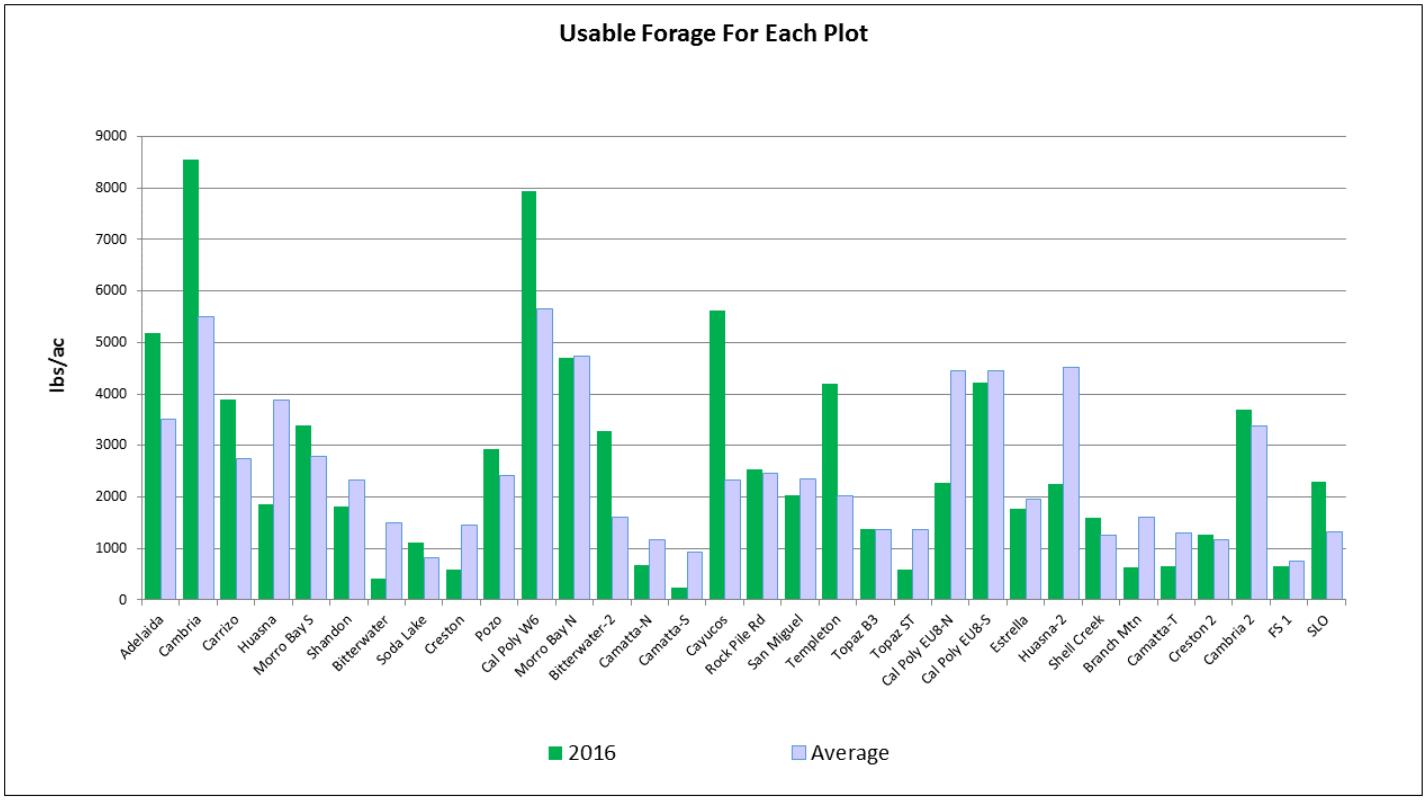

Figure 8. Usable forage production of each plot during 2016, compared against the average for 2001-2016.

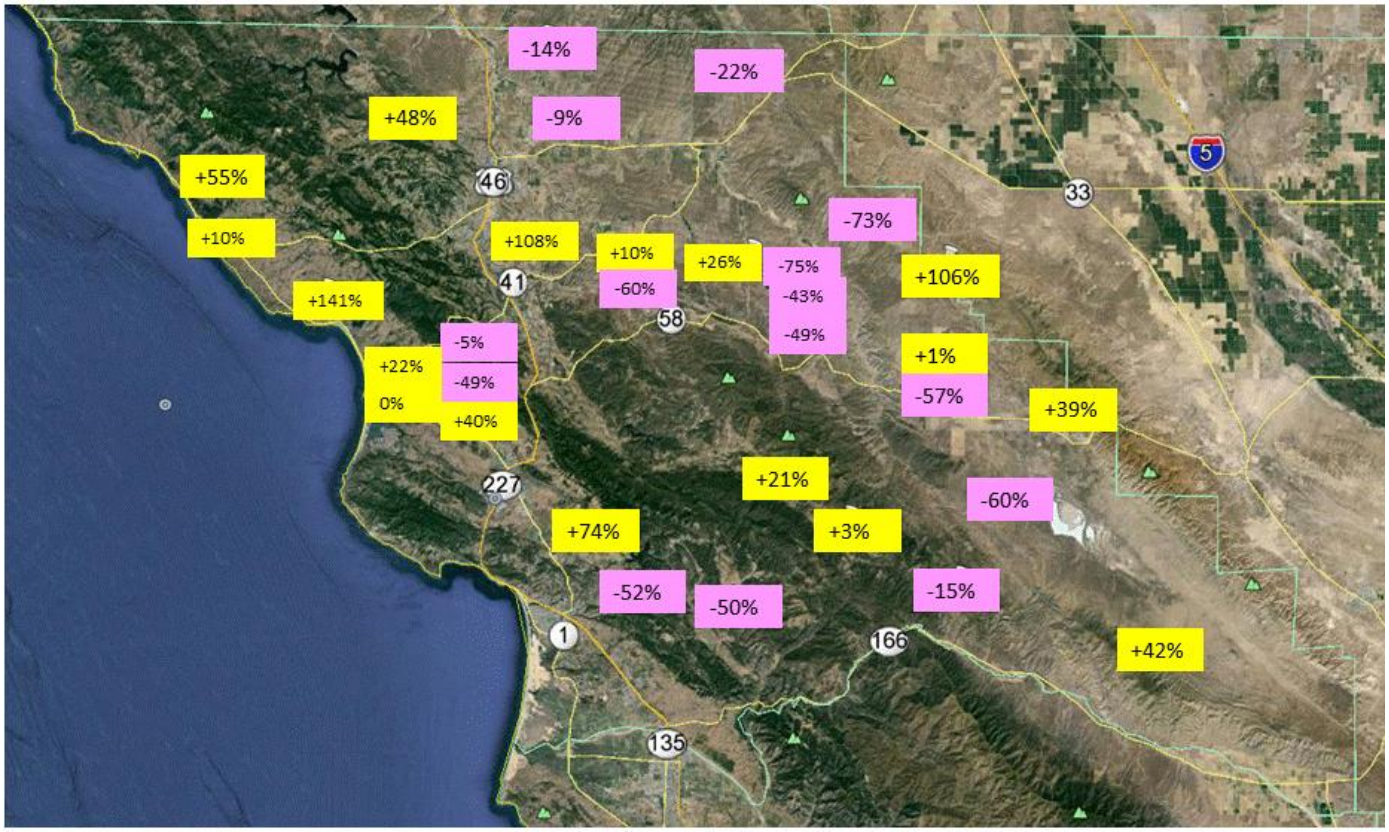

Figure 9. The distribution of the values above (positive value, yellow) or below (negative value, purple) from the average for each plot, shown as a percentage.

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 10.

<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).*

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

These two classes of herbaceous forage types competed with each other for dominance through the years 2001 - 2016. Environmental conditions, and possibly grazing management actions, may have contributed to this change in dominance. Grasses usually dominated in the coastal and central zones, but in the eastern zone grasses and forbs changed dominance much more frequently. Forbs were more dominant in dry years and grasses were more dominant in wetter years in the eastern zone (Fig. 10). Of the grasses, red brome increased in dominance, especially within the eastern zone during the last 4 years of drought.

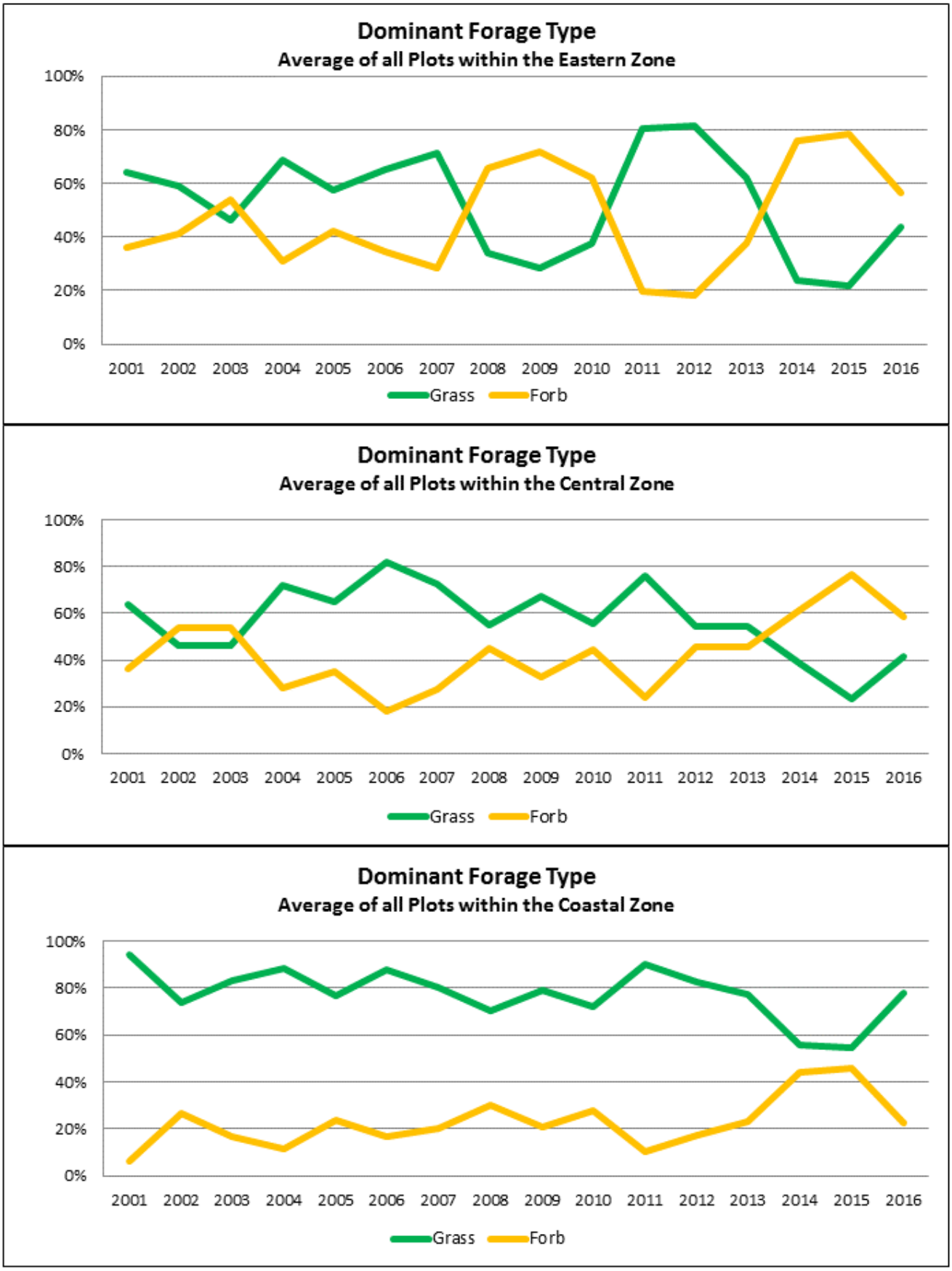

Figure 10. Dominant forage type, grass and forbs, for each zone. Note that the grass and forbs added together equal 100% during any one year.

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Appendix 1.

Each plot has 4 exclosures. The exclosures are made from 16’ 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, Figure 1. The forth exclosure is made by putting 3 ¼ cattle panels together to form a 16’ diameter circle (Fig. 1) which also houses the weather station, Figure 2.

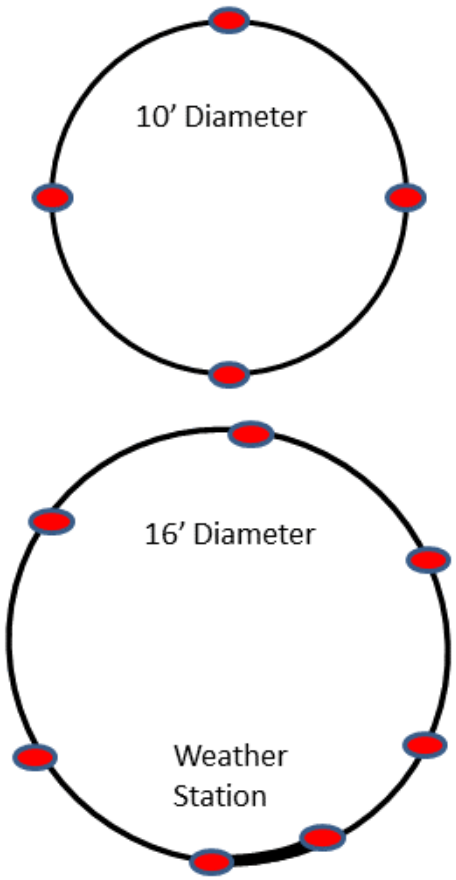

Figure 1. Four exclosures are used at each plot, three exclosures that are 10’ diameter circles, and one exclosures that is a 16’ diameter circle. The 16’ diameter exclosure is larger to house the weather station.

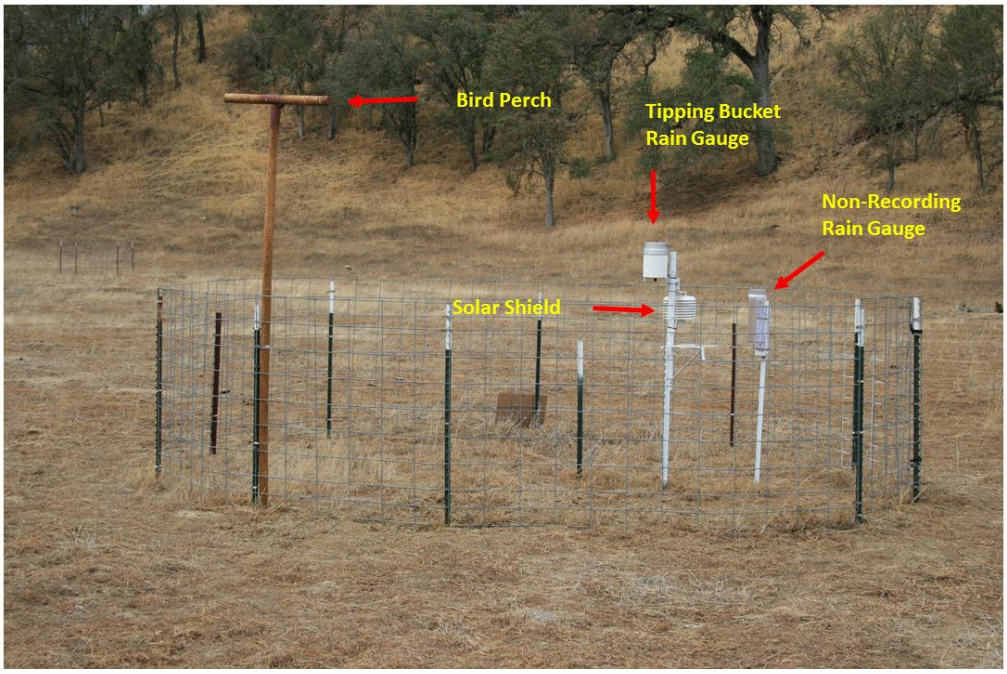

Figure 2. Typical weather station setup consisting of tipping bucket rain gauge, a non-recording rain gauge, and a solar shield for the temperature sensor, inside exclsoure #4. The bird perch helps reduce bird use of the rain gauge as a perch.

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 3. For peak production, three 1 ft^2 quadrats are clipped for production, for a total of 12 quadrates for each plot. In addition, the dry-eight-rank method is used to determine species composition for each quadrat.

Figure 3. Pictorial demonstration showing how the exclosures are set up on each plot (top). Exlcosures 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 (bottom).

Appendix 2.

Proper stewardship of rangeland would suggest that proper soil cover, residual dry matter (RDM), at the beginning of the rainy season is very important. The University of California Division of Agriculture and Natural Resources has published recommended minimum values of RDM. However, there is a loss of forage through the dry season due to physical and chemical breakdown, and losses incurred by small rodents or insects. Some studies have shown 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 (Frost et al., 2008). For this report we assume a 5 month dry period from the time of peak production to the beginning of the wet period, May – September. It could be shorter or longer. Since there is a natural loss of forage each month, an additional 35% (7% per month) needs to be added to the minimum RDM values to account for forage lost through the dry period in order to achieve the minimum recommended RDM levels. Table 1 shows the recommended minimum RDM level for each site, the amount needed to reach that minimum RDM level in the fall. Therefore this forage, which is part of the peak production values, should not be utilized throughout the dry season. So to reach the RDM target, that amount needs to be subtracted out, hence showing the usable forage production value.

Table 1. Minimum RDM values for each site, peak forage RDM equivalent, and the total forage production and usable forage production values for each site.

Plot NO.	Plot Name	Minimum Recommended RDM Values (lb/ac)	Peak Forage RDM Equivalent (lb/ac)	2016 Total Forage Production (lb/ac)	2016 Usable Forage Production (lb/ac)
1	Adelaida	500	675	5853	5178
3	Cambria	1200	1620	10165	8545
4	Carrizo	300	405	4303	3898
5	Huasna	500	675	2527	1852
6	Morro Bay-S	500	675	4063	3388
7	Shandon	500	675	2496	1821
8	Bitterwater	300	405	808	403
9	Soda Lake	300	405	1529	1124
10	Creston	400	540	1123	583
11	Pozo	500	675	3611	2936
12	Cal Poly W6	500	675	8609	7934
13	Morro Bay-N	500	675	5384	4709
14	Bitterwater-2	300	405	3687	3282
15	Camatta-N	400	540	1208	668
16	Camatta-S	400	540	778	238
17	Cayucos	500	675	6284	5609
18	Rock Pile Rd	400	540	3069	2529
19	San Miguel	400	540	2561	2021
20	Templeton	500	675	4879	4204
21	Topaz B3	300	405	1778	1373
22	Topaz ST	300	405	991	586
23	Cal Poly EU8-N	700	945	3210	2265
24	Cal Poly EU8-S	700	945	5173	4228
25	Estrella	400	540	2320	1780
26	Huasna-2	500	675	2926	2251
27	Shell Creek	400	540	2131	1591
28	Branch Mtn	300	405	1045	640
29	Camatta-T	400	540	1195	655
30	Creston 2	400	540	1816	1276
31	Cambria 2	1200	1620	5323	3703
32	FS 1	400	540	1185	645
33	SLO	500	675	2974	2299