2023 STATEWIDE AVOCADO
ACREAGE & CONDITION ANALYSIS

Prepared for
California Avocado Commission

Prepared by

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EXECUTIVE SUMMARY

Spatial land use information is essential for the California Avocado Commission to make informed decisions for budgeting and marketing of crops. Accurate and timely land use information is the foundation of these analyses and is vital to the decision-making process.

Increased availability of digital satellite imagery, aerial photography and new analytical tools make remote sensing land use surveys possible at the grove scale. These technologies allow accurate, large-scale crop and land use identification to be performed at time increments as desired and make highly accurate and comprehensive statewide avocado mapping possible.

Growers, industry, regulators, government agencies, and commodity groups also benefit from spatial data related to crop type, location, condition, and density. These data are key components for management of environmental resources and proximity to sensitive areas including water quality, air quality, and disease or pest vectors.

For 2023, the total planted avocado acreage in California was 52,534 acres.

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INTRODUCTION

Accurate acreage information is critically important to the work of the California Avocado Commission (CAC). Acreage drives a multitude of activities that range from yield forecasting to member data tracking and budgeting. In response to this need for information, Land IQ was contracted by CAC to develop a comprehensive and accurate statewide spatial land use database of avocado groves and condition on a grove scale using remote sensing, statistical, and temporal analysis methods.

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FORECASTING METHODS

Land IQ integrated crop production knowledge with multiple satellite and aerial image resources to conduct remote sensing land use analysis at the grove scale. The mapping approach employs advanced spatial statistical analysis to determine prediction probabilities and inform QA/QC efforts. A rigorous QA/QC and photo interpretive analysis is employed to improve predictions on all lower confidence groves. In addition, these groves are also back-checked with the CAC industry representatives.

Individual avocado polygon boundaries (areas of homogeneous crop types representing true cropped area rather than legal parcel boundaries) are used so that each independent avocado polygon could be analyzed independently and assigned a condition class. The results represent the true cropped area and not legal or other less detailed boundaries that may be available elsewhere.

The condition legend was developed by CAC and is summarized in Table 1.

Table 1. Avocado Condition Description

Condition	Description
Producing	Groves that are greater than 4 years old.
Topped/Stumped	Groves that have been topped and/or stumped and not producing.
New/Young	Groves that are 4 years old or younger.
Abandoned	Groves previously identified as avocados that do not return to healthy growth statistics as represented by spectral data.

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Data Collection

Satellite data resources were used for the classification. Avocado boundaries from 2022 avocado mapping were used as a base layer for 2023. Multiple Landsat 8 images were used for the initial crop classification. Imagery from the Landsat 8 satellite is free of charge, available every 16 days, and used for temporal analysis throughout the growing season. Following analysis with Landsat 8 images, various sources of localized high resolution imagery were used to further evaluate groves for condition, age, density, and boundary updates. Data provided by Maxar is higher resolution but requires a paid subscription.

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Analysis

The Land IQ avocado mapping unit is a grove-scale layer focused on avocado polygons equal to or greater than 0.5 acres across the state. 18,130 delineated polygons were classified using multiple image sources and dates. The images are used as the base layer data, in which classification algorithms are applied for crop identification.

Classified groves with a lower confidence level are carefully reviewed by assessing image resources using photo interpretation methods. Results are also cross-validated with ancillary data sources such as the coinciding USDA Crop Data Layer, county agricultural surveys and county crop reports to assess and evaluate significant differences.

The geospatial database is attributed with avocado polygon size in acres, relevant county, and the appropriate condition category per the CAC legend (Table 1). Table 2 summarizes the database attributes associated with the final mapping product and their definitions.

Table 2. Definition of Database Fields

Avocado Polygon Attribute	Description
Acres	Area of the avocado polygon
County	Indicates the county that the centroid of each avocado polygon resides in
Crop 2023	Crop classification type for the year 2023
Modified By	Name of person who last modified the record
Date Data Refers To	Date the data refers to
Last Modified Date	Date record was last modified
Condition	Describes condition of the avocado polygon
Year Planted	Year the grove was planted or stumped
Density	Describes the planting density of the grove
Comments	Any user-provided comments
Source	Original source of the boundary and attribute information

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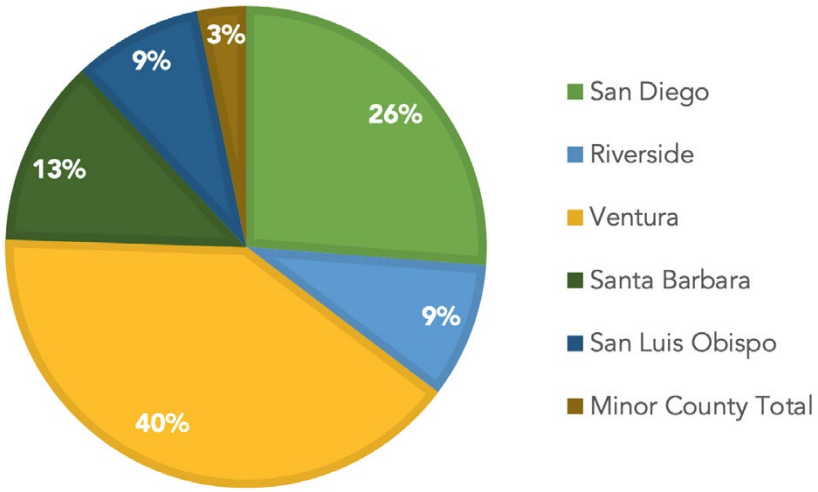
Numeric Results

The avocado acreage classification for the 2023 year totaled 18,130 avocado fields and 52,534 planted acres. The five main avocado growing counties are Ventura, San Diego, Santa Barbara, Riverside, and San Luis Obispo. Small acreages were also present in Orange, San Bernardino, Monterey, Tulare, Los Angeles, Fresno, Kern, and Sacramento Counties. Statewide avocado acreages by county are summarized in Table 3 and Figure 1.

Table 3. Summary of 2023 Statewide Avocado Acreage by County

Five County	Acres	Number of Fields	Minor County	Acres	Number of Fields
San Diego	13,774	5,712	Orange	839	348
Riverside	4,778	2,384	San Bernardino	452	126
Ventura	21,118	6,683	Monterey	281	52
Santa Barbara	6,593	1,858	Tulare	104	36
San Luis Obispo	4,555	907	Los Angeles	16	14
			Fresno	10	4
			Kern	3	1
			Sacramento	11	5
Five County Total	**50,818**	**17,544**	**Minor County Total**	**1,716**	**586**
Overall Total: 52,534 Classified Acres / 18,130 Fields					

Figure 1. Summary of 2023 Statewide Avocado Acreage by County



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Acreage by county and condition for the five main growing areas are summarized in Table 4 and Figures 2 and 3.

Table 4. Summary of 2023 Statewide Avocado Acreage by Condition

County	Producing Acres	Top/Stump Acres	New/Young Acres	Planted Acres
San Diego	12,892	594	288	13,774
Riverside	4,072	594	111	4,778
Ventura	18,882	1,676	561	21,118
Santa Barbara	6,325	219	50	6,593
San Luis Obispo	4,190	316	49	4,555
Five County Total	**46,360**	**3,399**	**1,059**	**50,818**
Minor Counties	1,628	51	37	1,716
Total	**47,988**	**3,451**	**1,096**	**52,534**

Figure 2. 2023 Avocado Acreage by Condition and County

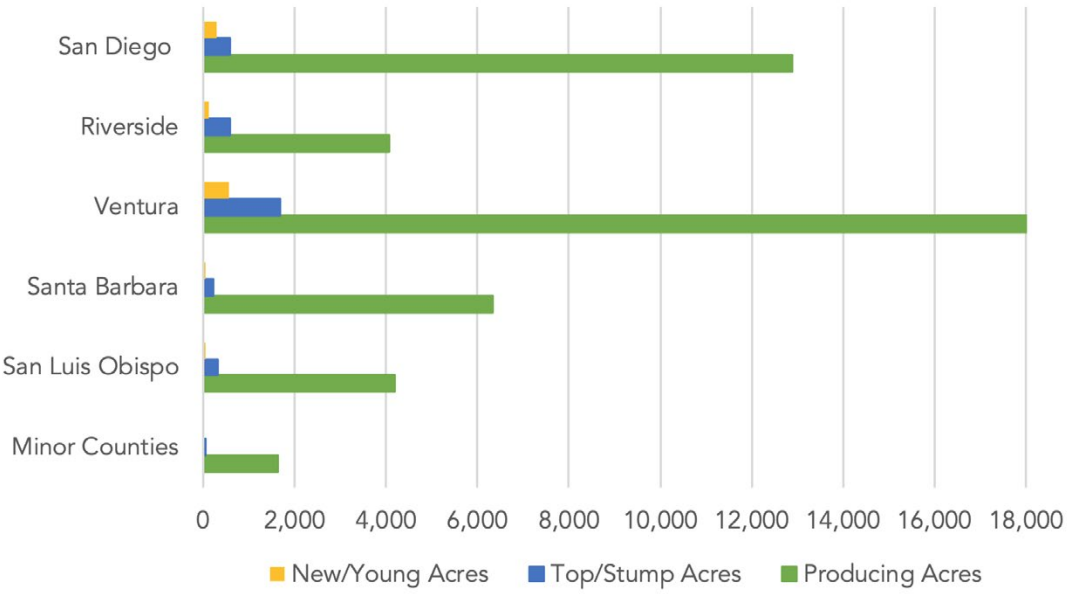

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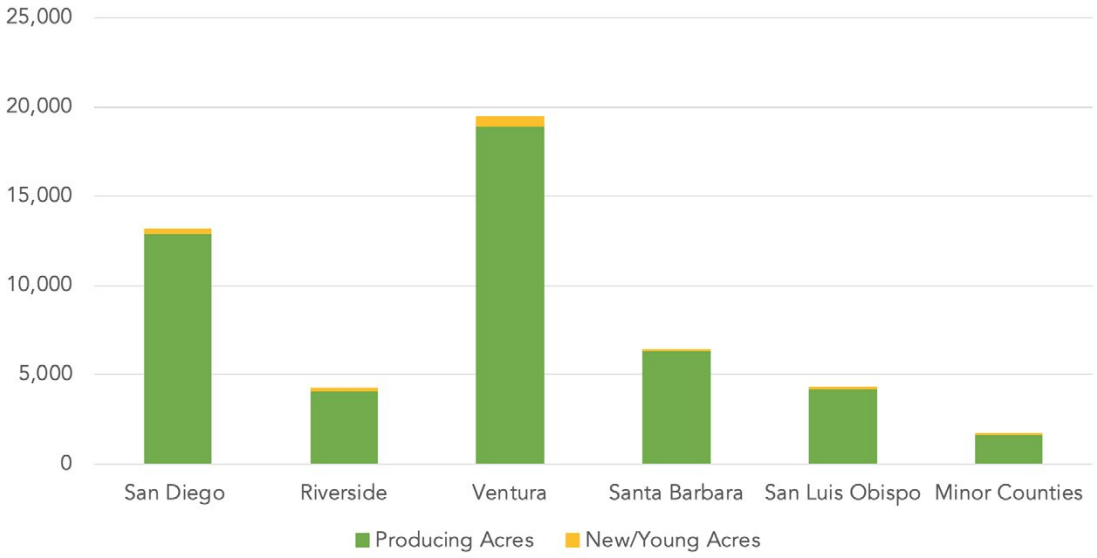
Figure 3. 2023 Avocado Acreage of Producing and New/Young Acreage by County



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In addition to acreage and condition summaries, a spatial analysis was completed to determine acreage by other jurisdictional boundaries including zip code. Acreage by zip code is summarized in Table 5.

Table 5. Summary of 2023 Statewide Avocado Acreage by Zip Code

San Diego	
Zip Code	Producing Acres
91935	0
92003	667
92019	4
92021	268
92025	314
92026	893
92027	1,298
92028	3,449
92029	12
92040	5
92057	252
92059	121
92061	1,283
92064	199
92065	160
92069	216
92078	39
92082	3,188
92084	524

Riverside	
Zip Code	Producing Acres
92028	22
92503	91
92504	102
92506	3
92507	16
92508	0
92521	10
92544	7
92557	12
92562	140
92570	6
92583	9
92590	3,578
92592	17
92595	19
92881	14
92882	14
92883	11

Ventura	
Zip Code	Producing Acres
90265	3
91320	1
91360	23
91361	6
93001	1,372
93003	213
93004	121
93010	253
93012	1,224
93013	34
93015	3,078
93021	2,267
93022	2
93023	830
93030	0
93033	227
93036	102
93040	501
93060	4,592
93065	113
93066	3,919

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Santa Barbara

Zip Code	Producing Acres
93013	1,983
93103	38
93105	261
93108	126
93109	12
93110	15
93111	525
93117	2986
93436	46
93454	34
93455	298

Los Angeles

Zip Code	Producing Acres
90265	4
90631	5
91301	1
91711	1
91768	5

San Luis Obispo

Zip Code	Producing Acres
93401	234
93402	15
93405	147
93420	546
93422	2
93428	207
93430	349
93442	589
93444	483
93452	16
93454	1,556
93465	46

Monterey

Zip Code	Producing Acres
93960	257
95076	8

Kern

Zip Code	Producing Acres
93215	3
93308	0

Orange

Zip Code	Producing Acres
92602	543
92610	54
92618	63
92620	14
92675	102
92705	5
92782	7
92887	1

Fresno

Zip Code	Producing Acres
93622	0
93654	2
93662	1
93725	0

Sacramento

Zip Code	Producing Acres
95615	
95690	1

San Bernardino

Zip Code	Producing Acres
91709	17
91784	7
92313	12
92346	6
92359	114
92373	42
92374	246
92407	4

Tulare

Zip Code	Producing Acres
93221	2
93235	1
93244	3
93247	6
93257	14
93286	17
93292	36
93631	4
93647	21

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In 2023, a separate algorithm was applied to the mapping to determine the year the grove was either planted or stumped. Table 6 shows the acreage that was either planted or stumped within that year. Table 7 and Figure 4 show the age as a percentage of planted acreage.

Table 6. 2023 Planted Avocado Acreage by Year Planted or Stumped

Year Planted	Planted Acres	Year Planted	Planted Acres	Year Planted	Planted Acres	Year Planted	Planted Acres
1984	14,114	1994	499	2004	2,112	2014	1,796
1985	4	1995	104	2005	1,225	2015	1,580
1986	45	1996	130	2006	978	2016	3,092
1987	133	1997	184	2007	1,426	2017	1,153
1988	20	1998	238	2008	889	2018	1,654
1989	38	1999	803	2009	1,102	2019	1,607
1990	523	2000	348	2010	926	2020	1,495
1991	189	2001	988	2011	1,083	2021	2,039
1992	146	2002	2,509	2012	1,100	2022	1,347
1993	135	2003	1,514	2013	2,371	2023	895

Table 7. 2023 Age as a Percentage of Planted Acreage

Age	Acreage	Percentage of Planted Acres
Planting to 4 years	5,776	11%
5 - 8 years	7,506	14%
9 - 15 years	9,958	19%
16 - 20 years	6,630	13%
21 years +	22,665	43%

Figure 4. Age as a Percentage of Planted Acres

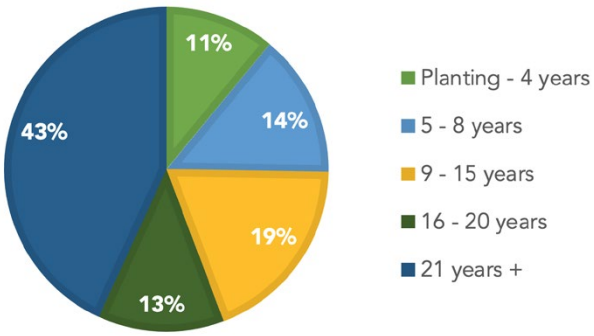

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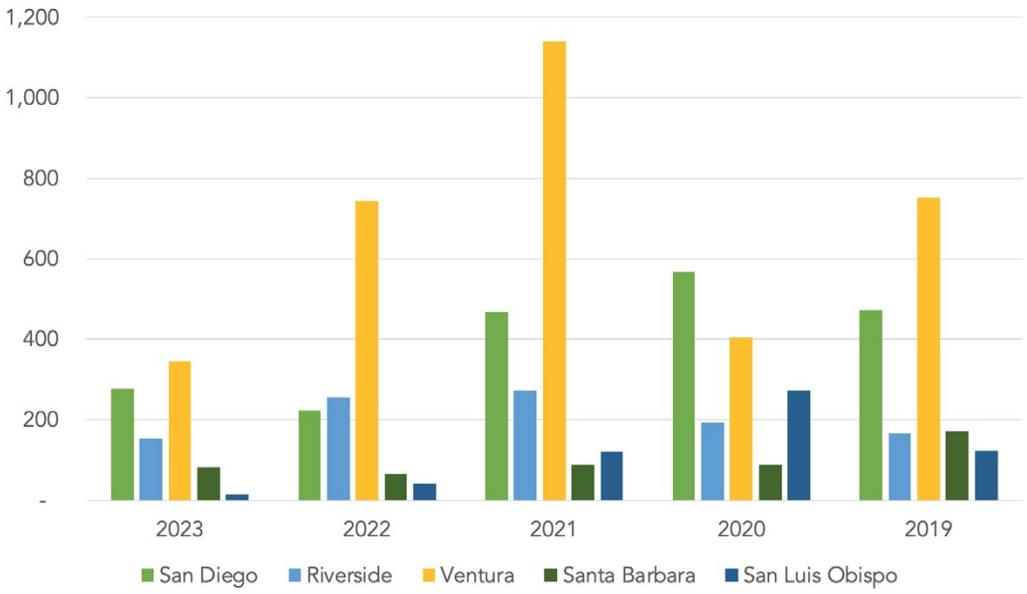
Table 8 and Figure 5 show the amount of new plantings that have occurred over the last five years. The spatial analysis can only be performed once new groves have reached a certain canopy size. Thus, the acres reported for 2022 and 2023 are only those that have been visually confirmed through ground truthing efforts.

Table 8. New Acres by County and Planting Year

County	2023	2022	2021	2020	2019
San Diego	277	224	468	567	473
Riverside	153	255	271	192	165
Ventura	346	744	1,140	405	752
Santa Barbara	82	66	86	87	171
San Luis Obispo	15	41	120	271	122

Figure 5. Young Avocado Acreage by Planting Year



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In addition to age, a density analysis was conducted. Table 9 shows the number of acres by condition and density. Groves were classified according to the following standards:

High Density: 15x15 or closer and 20x10
Standard Density: 15x20 or greater
Sparse Density: Standard density grove that has as many as 50% of the trees missing

Table 9. 2023 Avocado Acreage by Planting Density

County	Condition	High Density	Standard Density	Sparse Density
San Diego	Producing	2,056	9,738	1,097
	Stumped	50	228	10
	Young*	259	324	11
	Abandon	488	3,132	17
Riverside	Producing	1,066	2,667	339
	Stumped	16	96	
	Young*	348	245	1
	Abandon	194	425	
Ventura	Producing	3,963	14,604	314
	Stumped	42	503	16
	Young*	1,064	611	1
	Abandon	120	272	26
Santa Barbara	Producing	1,209	4,851	265
	Stumped	9	40	
	Young*	126	93	
	Abandon	62	222	
San Luis Obispo	Producing	363	3,810	16
	Stumped	3	46	0
	Young*	51	264	1
	Abandon	1	4	
Orange	Producing	58	681	49
	Stumped	3	18	
	Young*	5	24	
	Abandon	10	69	
Monterey	Producing	3	258	3
	Stumped		16	
	Young*			
	Abandon			
San Bernardino	Producing	44	403	2
	Stumped			
	Young*		3	
	Abandon		1	
Tulare	Producing	32	65	6
	Stumped			
	Young*			
	Abandon		10	
Los Angeles	Producing	1	15	
	Stumped			
	Young*			
	Abandon	10	16	
Fresno	Producing		1	
	Stumped			
	Young*	8		
	Abandon	2	1	
Kern	Producing		3	
	Stumped			
	Young*			
	Abandon		3	
Sacramento	Producing		1	
	Stumped			
	Young*	11		
	Abandon			

* A small amount of young acreage could not be analyzed for density because it was so young it did not appear on imagery. These groves were physically confirmed during ground truthing.

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Table 10 demonstrates the percentage of planted acres that are considered high density.

Table 10. Percentage of High Density Plantings by Condition

County	Producing	Young*	Stumped
San Diego	16%	44%	17%
Riverside	13%	14%	26%
Ventura	59%	21%	31%
Santa Barbara	7%	29%	63%
San Luis Obispo	19%	57%	19%
Other	8%	70%	9%

* A small amount of young acreage could not be analyzed for density because it was so young it did not appear on imagery. These groves were physically confirmed during ground truthing.

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A series of maps are provided to demonstrate the avocado classification results. Figures 6 through 11 show the avocado acreage and condition classification example as well as maps of the five CAC districts.

Figure 6. Example of 2023 Avocado Classification Conditions

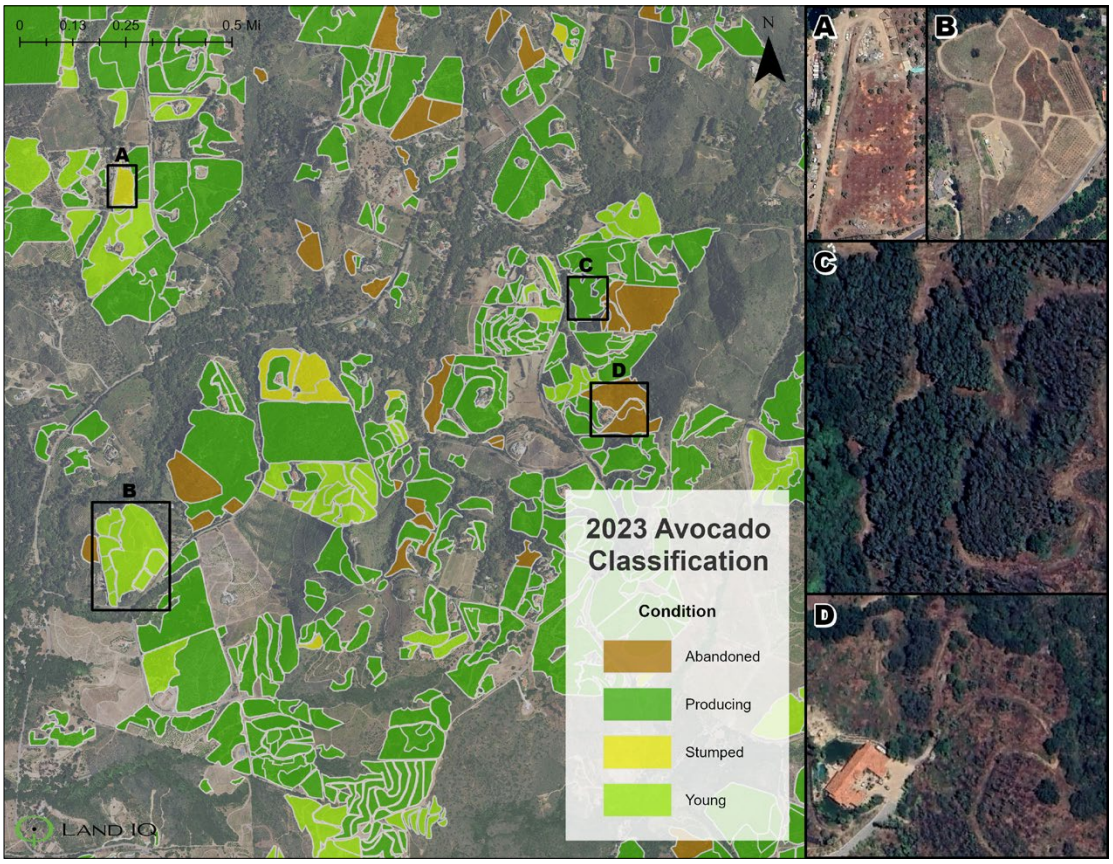

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Figure 7. 2023 Avocado Planted Polygons in CAC District 1

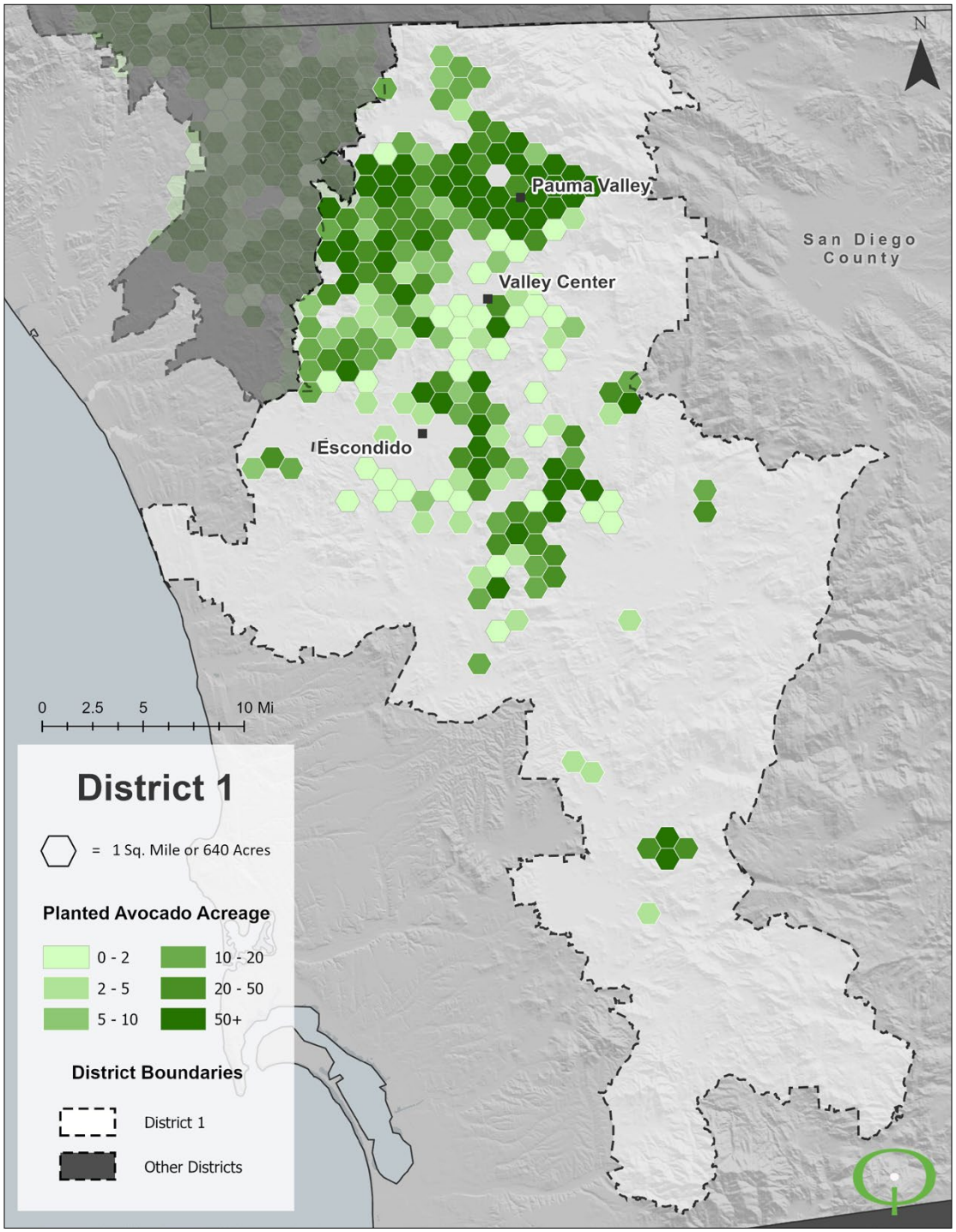

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Figure 8. 2023 Avocado Planted Polygons in CAC District 2

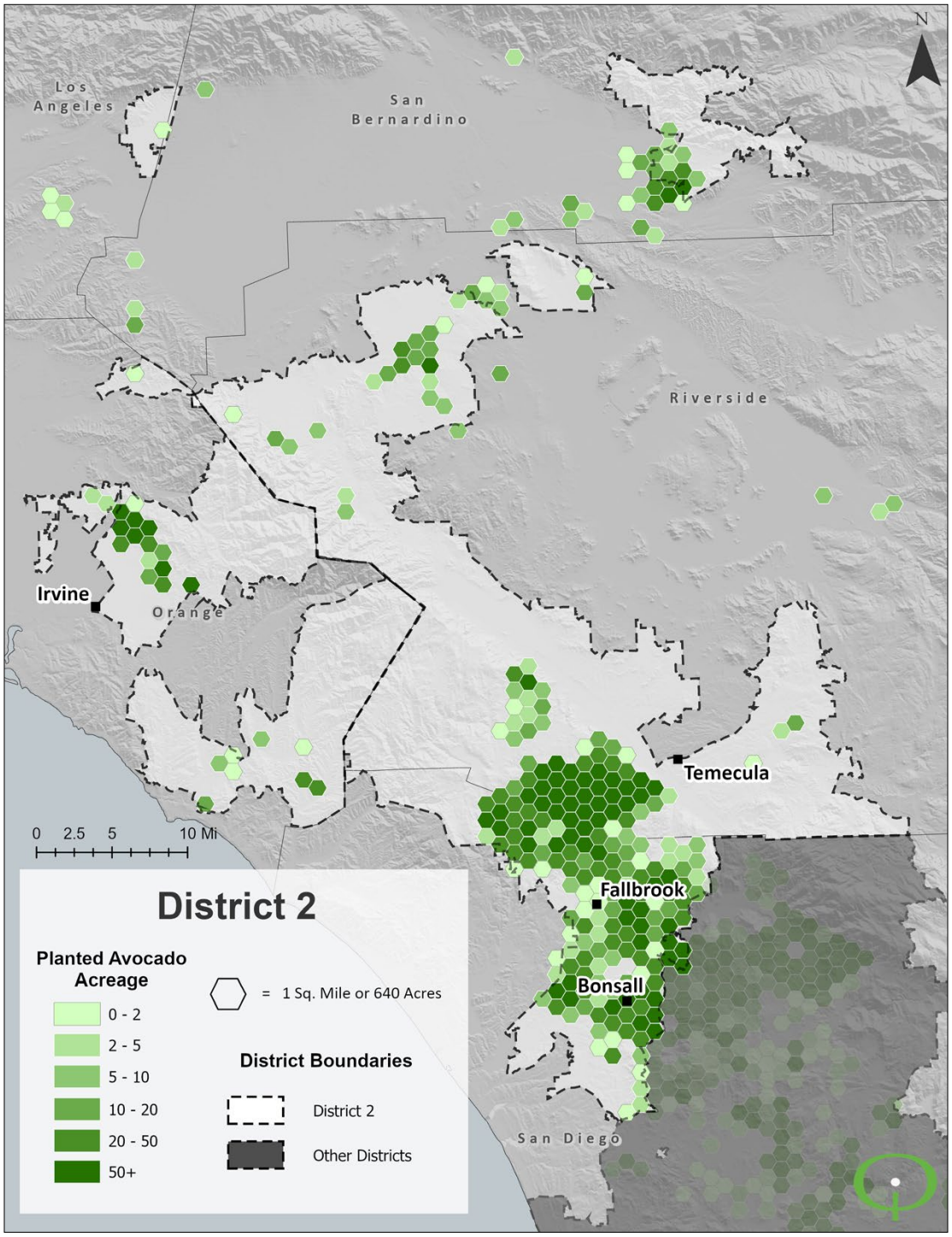

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Figure 9. 2023 Avocado Planted Polygons in CAC District 3

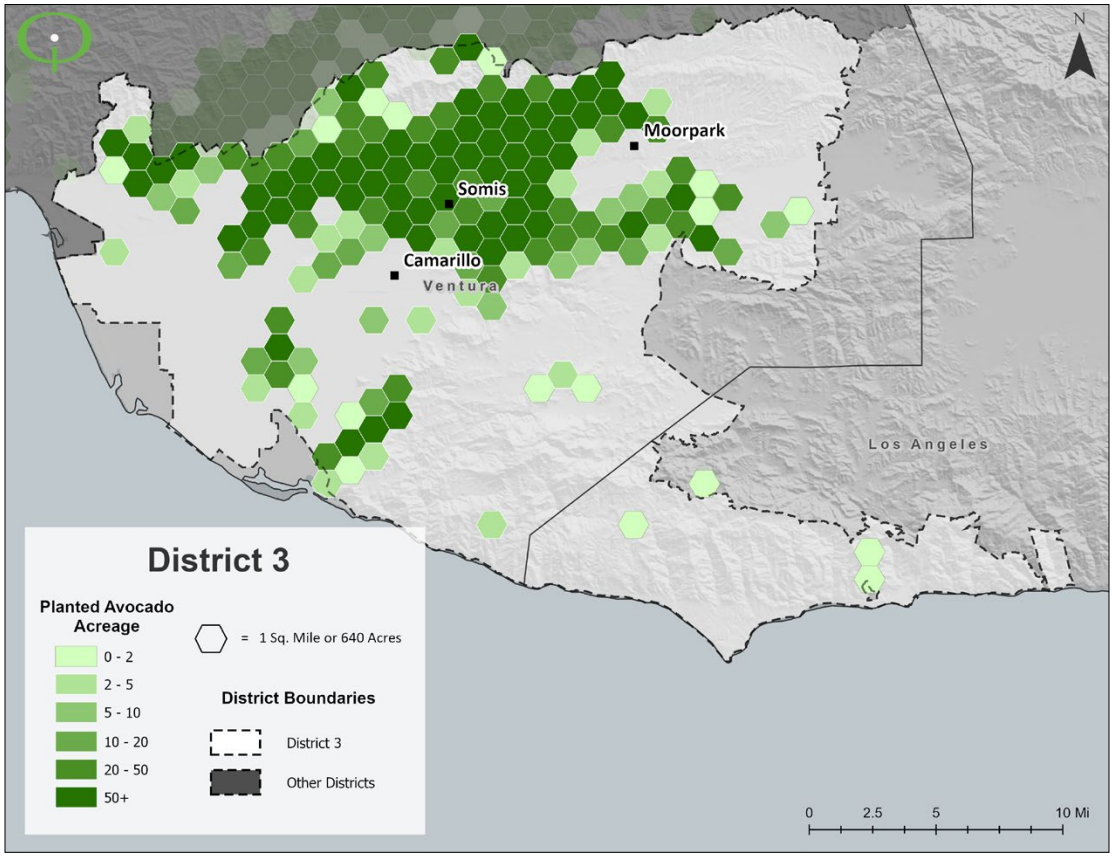

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Figure 10. 2023 Avocado Planted Polygons in CAC District 4

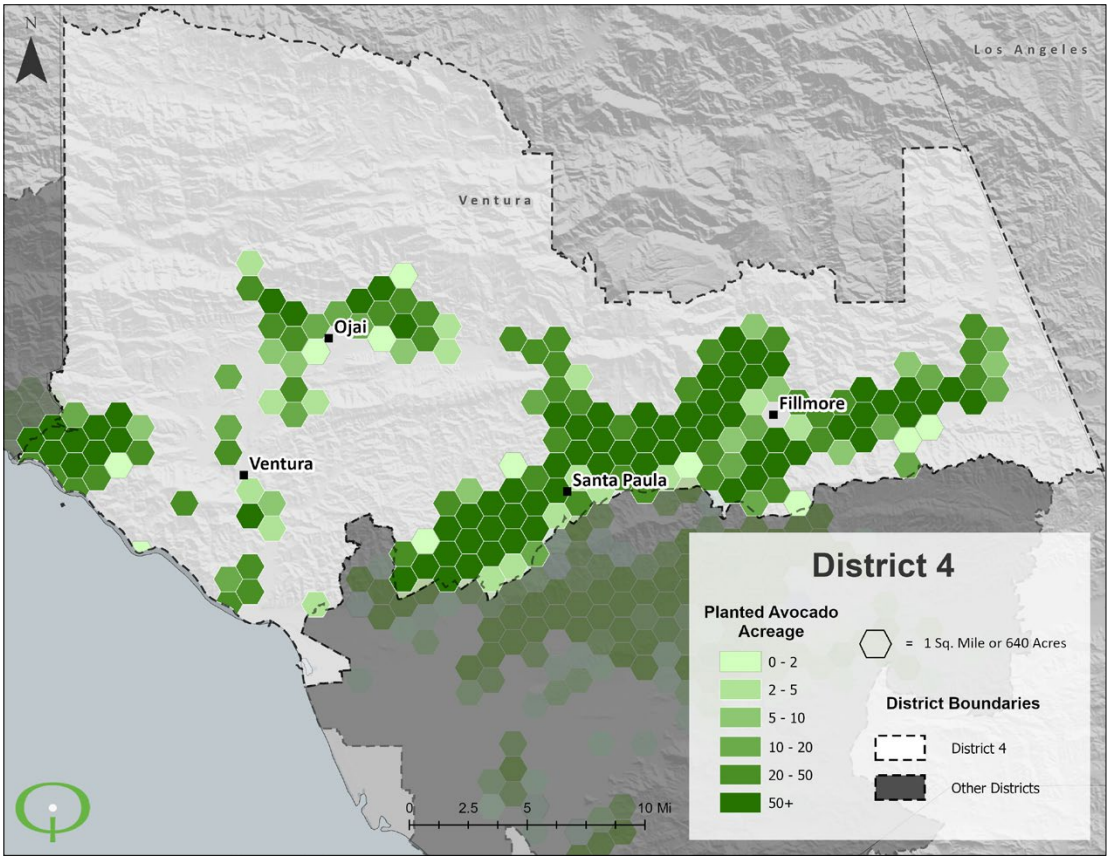

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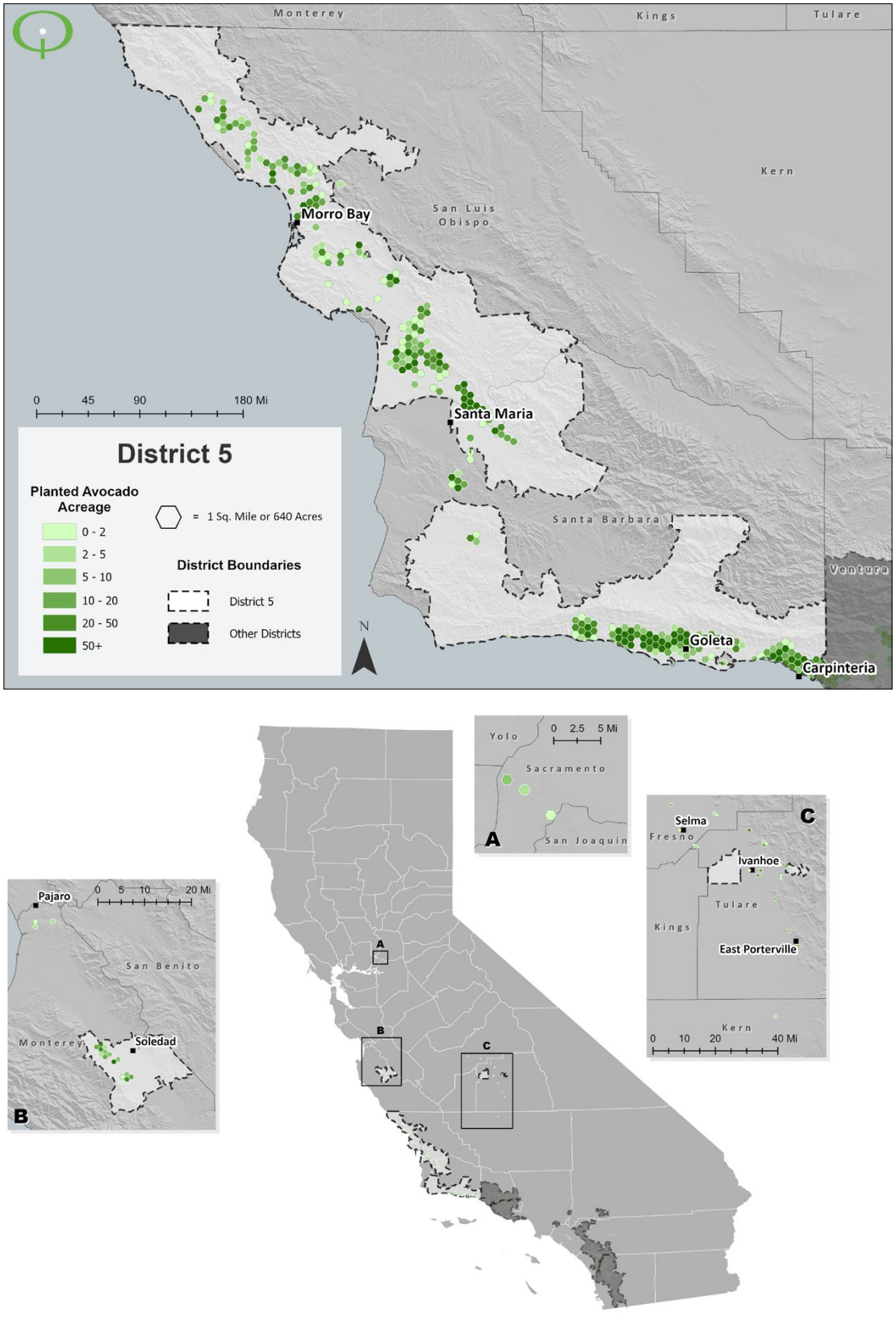
Figure 11. 2023 Avocado Planted Polygons in CAC District 5



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DATA DELIVERABLES

Data delivered to CAC as a part of the 2023 avocado mapping effort are listed and described in Table 11.

Table 11. Summary of 2023 Avocado Acreage Deliverables

File Name	Description
CAC_2023_Avocados_Districts_Zips	Spatial file of statewide avocado acreage with condition, age, density, zipcode and CAC district.
CAC_2023_Avocado_Acreage_Tables	Tabular data summarizing acreage by county, condition, age, density, zip code and CAC district.
2023_Statewide_Avocado_Mapping	Report

The net change in acreage from 2022 to 2023 is summarized in Table 12.

Table 12. Net Acreage Change from 2022 to 2023 by County

County	Producing	Young	Stumped	Abandoned	Total
San Diego	(533)	(19)	(221)	(209)	(983)
Riverside	(67)	196	(105)	(114)	(91)
Ventura	604	(203)	175	(206)	370
Santa Barbara	9	23	(15)	(371)	(354)
San Luis Obispo	351	113	(44)	0	420
Orange	(16)	29	21	(50)	(15)
San Bernardino	47	(35)	(63)	86	35
Monterey	57	(16)	16	(3)	54
Tulare	22	0	(19)	(10)	(7)
Los Angeles	4	(0)	(1)	(7)	(4)
Fresno	2	7	0	(2)	8
Kern	2	(0)	0	1	3
Sacramento	1	11	0	0	11
Total	**483**	**106**	**(257)**	**(886)**	**(554)**

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The change in avocado classification from 2022 to 2023 is summarized in Table 13.

Table 13. Change in California Avocado Acreage Classification from 2022 to 2023

County	2022 Classification	2023 Classification			
		Producing	Top/Stump	New/Young	Abandon
San Diego	Producing	12,120	171	109	612
	Top/Stump	217	106	78	42
	New/Young	267	0	255	17
	Abandon	165	9	29	2,959
	Not Classified	124	2	124	7
Riverside	Producing	3,600	66	40	178
	Top/Stump	74	45	27	14
	New/Young	161		199	3
	Abandon	32		12	423
	Not Classified	205	0	315	1
Ventura	Producing	17,385	465	41	42
	Top/Stump	231	85	21	1
	New/Young	706		926	3
	Abandon	102	5	18	368
	Not Classified	459	5	669	5
Santa Barbara	Producing	6,008	39	63	44
	Top/Stump	27	9	10	0
	New/Young	128		53	
	Abandon	20		2	239
	Not Classified	141	1	90	2
San Luis Obispo	Producing	3,675	34	3	2
	Top/Stump	70	14	1	
	New/Young	37		131	
	Abandon			1	3
	Not Classified	407	1	180	

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