

Chapter 12. California's Nursery and Cannabis Industries

Part 1. Nursery and Floral Production

by Hoy F. Carman

Abstract

Nursery and floral production is an important component of California's agricultural output, accounting for 7.5 percent of the state's farm sales. Annual sales of \$3.5 billion mean that California accounts for 20 percent of U.S. sales of nursery and floral products. Nursery products and flowers are produced through out California, but production is concentrated in Central Coast and South Coast counties near the largest population centers; a third of sales are in San Diego County.

Authors' Bios

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Nursery and Floral Production

Nursery and floral production is an important component of California's overall agricultural output and annual farm income. California's nursery and flower crops returned average cash returns of over \$3.5 billion annually for the five crop years 2011 through 2015. Only three California crops exceeded this annual average for the five year period: dairy and milk, \$7.57 billion; almonds, \$5.49 billion; and, all grapes, \$4.81 billion. Overall, the annual nursery and floral share of total agricultural sales ranged between 6.5 to 7.8 percent from 2011 to 2015 with a five-year average of 7.5 percent. Nursery and flower production is located throughout California, with at least one farm operation reported in 56 of 58 counties. The industry has a definite urban orientation, with the majority of production taking place in the most populated counties.

Nursery and Floral Industry Sales

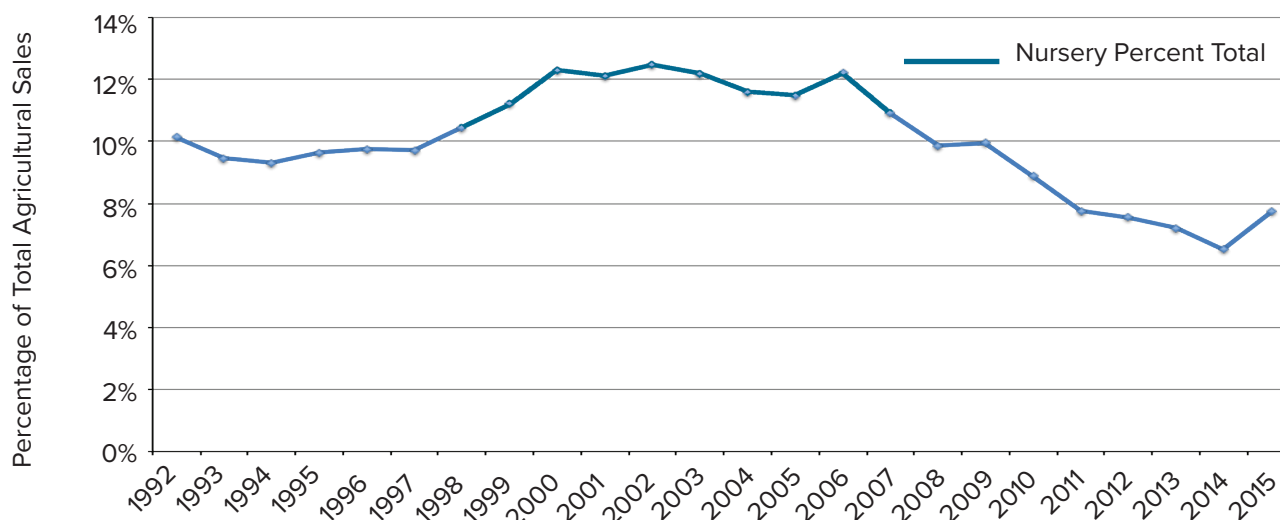
California nursery and floriculture production and sales enjoyed a 15-year expansion extending, with sales rising from \$1.96 billion in 1993 to \$3.98 billion in 2007. Nursery and floral sales were increasing relative to the rest of California production through 2002 when they accounted for 12.5 percent of total California agricultural sales (Figure 1).

While nursery and floral sales continued to grow through 2007, growth of total agricultural sales meant that nursery sales as a percentage of total sales were 11.5 to 12.5 of total farm sales, and their share of total farm sales shrank after the 2008-09 recession, when total farm sales continued to increase. The increase in nursery and floral relative to total agricultural sales between 2014 and 2015 was the result of total agricultural sales decreasing from \$56.61 to \$47.07 billion while nursery and floral sales decreased from \$3.69 to \$3.64 billion.

Annual floral and nursery sales are shown in Figure 1. The largest components of the floral crop category include cut flowers and greens and potted flowering plants. Floral sales ranged from a low of \$0.932 billion in 2000 to a high of \$1.112 billion in 2012. Floral sales were over \$1.0 billion in 11 of the 16 years shown and have exceeded \$1.0 billion for the six years since 2010. The largest components of annual nursery sales are ornamental plants and nursery stock. The split between floral and nursery sales are typically about 30 percent floral and 70 percent nursery.

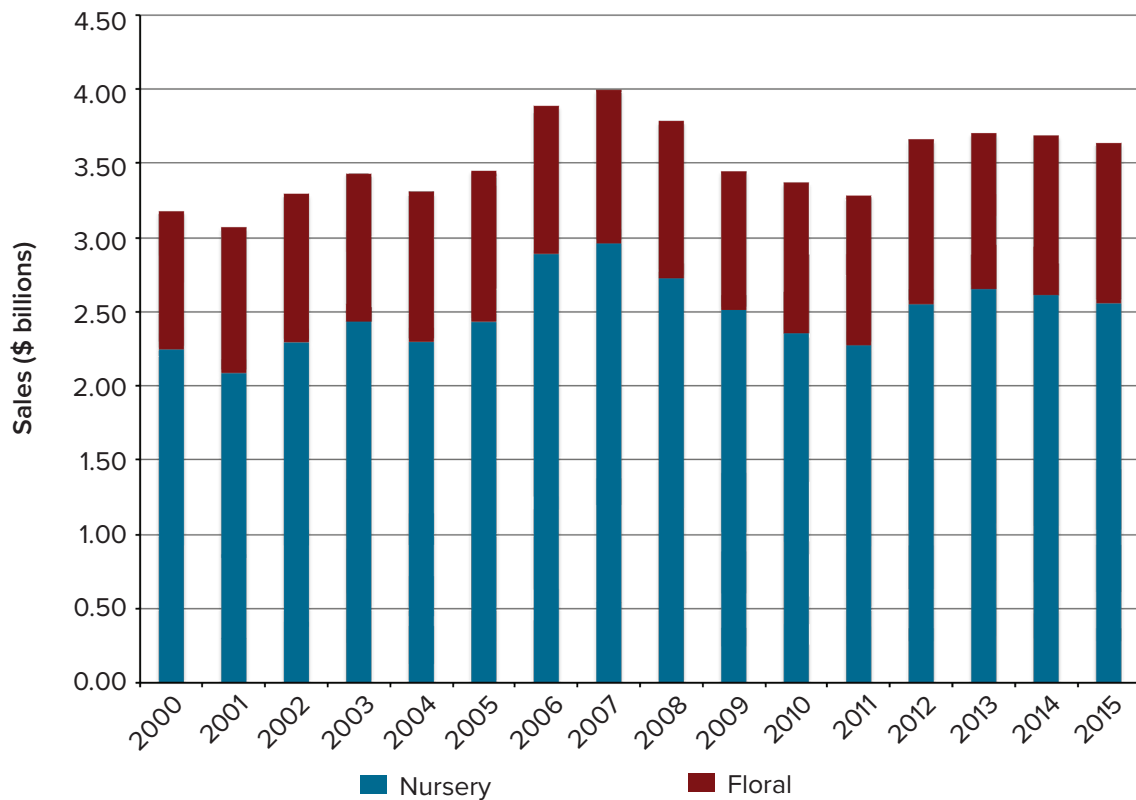
The USDA 2014 Census of Horticultural Specialties, which gathered data for all horticultural operations with sales greater than \$10,000, reported that 1,710

Figure 1. Annual California Floral and Nursery Sales As Percent of Total Agricultural Sales, 1992–2015



Source: USDA, NASS and California Agricultural Statistics, Annual Issues 2003–2016

Figure 2. Annual Value of California Floral and Nursery Production, 2000–2015



Source: USDA, NASS and California Agricultural Statistics, Annual Issues 2003–2016

California operations had 2014 total sales of \$2.878 billion, accounting for almost 20.9 percent of total U.S. sales of \$13.79 billion. California was followed by Florida (13.0 percent), Oregon (6.8 percent), Michigan (4.7 percent), Texas (4.3 percent) and North Carolina (4.1 percent).

Thus, the top six states accounted for 53.8 percent of total U.S. sales of horticultural specialty crops. USDA, NASS annually surveys commercial floricultural operations with sales of more than \$100,000 and found 685 California producers with floricultural sales of \$1.08 billion that accounted for 25 percent of the total wholesale value in 2015. California accounted for 14 percent of bedding and garden plants, 34 percent of potted flowering plants, and 78 percent of the total cut flower wholesale value (*California Agricultural Statistics Review*, 2015–2016).

Structure of California's Nursery and Floral Industry

The census of Agriculture reported that total California sales of nursery and floriculture crops increased from just over \$957 million in 1982 to almost \$3.65 billion in 2007, and then dropped to \$2.51 billion in 2012 (Table 1).

Data in each row of Table 1 describe the changes in the number of farms producing nursery and floriculture products, which increased steadily from 2,845 in 1982 to 4,388 in 2002, and then dropped to 3,390 in 2012. With total sales of nursery products growing relative to the number of nursery farms, average sales per farm rose through 2002 and then jumped significantly in 2007, when total sales increased and farm numbers decreased. However, a significant decrease in total sales, and a small decrease in number of farms in 2012, resulted in average sales returning to 2002 levels. A similar pattern of growth is shown for the average value of land and buildings and the average value of machinery and equipment, although average values remained above 2002 levels. The average age of the principal operator of California nursery and floriculture farms increased from 50.7 years in 1982 to 58.9 years in 2012. This pattern is similar to the average for all California farms, where average age increased from 51.8 years in 1982 to 60.1 years in 2012.

The legal structure of California nursery operations has also changed. The distribution of nursery farms by legal organization in 1982 was sole proprietors, 61 percent; partnerships, 14 percent; corporations, 24 percent; and other, 1 percent.¹ In 1997 this had changed to sole proprietors, 69 percent; partnerships, 11 percent; corporations, 18 percent; and other, 2 percent. In the 2007 census, the legal structure was sole proprietors, 67 percent; partnerships, 9 percent; corporations, 22 percent; and other, 2 percent. The most recent census (2012) reported sole proprietors, 67 percent; partnerships, 9 percent; corporations, 21 percent; and other, 3 percent. The share of corporations that were family-owned corporations remained relatively constant at 81 percent in 1982 and 2012. Note that the corporate share of farms is larger for nursery farms (21 percent) than for any other sector in California agriculture, with corporations accounting for 8.2 percent of all California farms. Nursery and floriculture farms accounted for just 4.4 percent of all California farms in 2012 while at the same time accounting for 11.1 percent of all California farm corporations.

¹ The "other" category includes cooperatives, estates and trusts, institutions, etc.

Table 1. Selected Characteristics of California Nursery and Floriculture Farms, 1982–2012

Selected Characteristics	Census Year						
	1982	1987	1992	1997	2002	2007	2012
Number of Farms	2,845	2,993	3,319	4,285	4,388	3,549	3,390
Total Sales (\$ billion)	0.957	1.413	1.662	2.211	3.287	3.647	2.514
Average Sales (\$/farm)	334,774	470,816	495,688	513,761	756,416	1,025,524	741,489
Average Acres Per Farm	46	45	54	45	50	52	90
Average Value of Land & Buildings (\$/farm)	594,568	612,352	742,937	624,267	866,017	1,995,792	1,133,108
Average Value of Machinery & Equipment (\$/farm)	58,399	70,580	86,284	82,328	101,289	153,103	114,973
Average Age of Operator	50.7	51.5	52.3	54.0	54.8	56.3	58.9

Source: USDA, Census of Agriculture for each census year

The California floral and nursery sector's ties to the real estate industry and the unique nature of its crops contributed to uninterrupted sales growth between 1993 and 2007, despite major challenges presented by shipping restrictions related to pests and diseases, increased competition from imported flowers, the impact of increased energy costs on production and transportation, limited and expensive water supplies, and less than ideal weather conditions. The effects of the 2007 "burst" of the "housing bubble" impacted much of California agriculture and particularly nursery and floral products. Just as sales began to recover in 2012, California experienced drought. The continuing effects of recession and the drought are evident throughout the industry, ranging from which types of plants are sold to structural aspects of wholesale and retail product distribution.

Location of Production

Nursery products and/or flowers and foliage are produced in 55 of California's 58 counties, but production tends to be concentrated in Central Coast and South Coast counties.² Among the 15 California counties with the largest nursery, flower and foliage production in 2016, 10 had over \$100 million of production (Table 2). As shown in Table 2, San Diego County dominates, with 32.4 percent of total state production in 2016. The next five counties, Monterey,

² The gross value of nursery, flower, and foliage production by county is in Appendix Table 1. Note that the County Agricultural Commissioners' Reports do not include nursery and flower sales for four counties that do have producers listed in the CDFA Directory, Nurserymen and Others Licensed to Sell Nursery Stock in California available July 2013 (<http://plant.cdca.ca.gov/nurserylicense/nlmenu.asp>). These counties and the number of producers include Colusa (1), Kings (2), Mono (2) and Plumas (4).

Table 2. California Gross Value of Production of Nursery, Flowers, and Foliage in 2013 through 2016, Top 15 Counties in 2016 with 2016 Share of State Total

Top 15 Counties	Value of Production				Share of State Total (percent)
	2013	2014	2015	2016	
	-----\$1,000 -----				
San Diego	1,139,427	1,182,614	1,146,814	1,233,942	32.42
Monterey	312,346	286,577	313,689	276,423	7.26
Ventura	233,968	228,114	244,339	254,882	6.70
Stanislaus	141,801	138,884	169,887	204,797	5.38
Santa Barbara	196,628	196,271	195,881	160,268	4.21
Riverside	191,215	172,910	158,648	150,426	3.95
Siskiyou	160,301	155,666	149,580	140,085	3.68
Fresno	42,705	62,725	46,773	116,186	3.05
San Joaquin	104,584	96,396	104,820	107,387	2.82
Kern	111,388	93,776	83,274	102,318	2.69
San Mateo	110,381	119,238	94,954	97,922	2.57
Santa Cruz	107,872	119,690	119,120	93,612	2.46
Los Angeles	114,357	133,576	92,399	92,399	2.43
San Luis Obispo	97,651	84,394	100,138	86,933	2.28
Santa Clara	79,783	78,396	67,635	83,292	2.19
Top 15 County Total	3,144,407	3,149,227	3,087,951	3,200,872	84.09
Rest of State	534,172	516,351	524,099	605,402	15.91

Source: California County Agricultural Commissioners' Reports, 2012–2015.

Ventura, Stanislaus, Santa Barbara, and Riverside, combine for 27.5 percent of total California production. The remaining nine of the top 15 counties account for 24.2 percent of production. Eight of the 15 largest producing counties border the Pacific Ocean and Santa Clara County has a coastal type climate. Among the four Central Valley counties (Stanislaus, Fresno, San Joaquin, Kern), each had annual production of over \$100,000 during at least one of the four years. The ten counties with production over \$100 million in 2016 accounted for \$2.75 billion (72.2 percent) of California's 2016 nursery, flower, and foliage production. There were five counties with nursery, flower and foliage production in the range of \$83 to \$100 million. They accounted for 11.9 percent of total 2016 production. Overall, 15 counties produced 84.1 percent of California's total 2016 nursery, flower and foliage crops. Among these top 15 counties, nursery and floral crops was the No.1 ranked crop in value of production in San Diego, Los Angeles, San Mateo, and Santa Clara counties.

Nursery and flower producers continue to be located in the most urbanized areas of the state. The climatic conditions favorable for nurseries are also very attractive to people, and population and housing growth have been high in areas where nurseries have traditionally located. There were nine California counties with population exceeding 1 million persons in 2017. Five of these counties (Los Angeles, Orange, San Diego, Santa Clara, and Riverside) were among the largest nursery and flower producers (Appendix Table 1), and have a combined population of 21.07 million. The 15 largest nursery and flower-producing counties have a population of 23.66 million and accounted for almost 59.9 percent of California's 2017 population. The proximity of nursery and floral production to urban population centers has advantages and disadvantages. Short distribution channels tend to have comparatively low transportation costs while providing fresh and quality product. Many nurseries distribute their product directly to retailers and some are also integrated into retailing. Other costs, however, such as for water and land, are comparatively high. An important consideration for urban locations, given the recent economic issues facing the industry, is that the land resource can easily and quickly be shifted to other uses. Thus, it may be very difficult to re-establish an urban nursery, once closed.

Crops Produced

The wholesale value of California nursery, flower, and foliage production during 2016 totaled almost \$3.81 billion (Table 3). Floral products contributed \$423.3 million while nursery production during the same period was just over \$3.382 billion. Nursery, flower and foliage producers market a wide variety of plant materials, ranging from cut flowers, potted flowering plants, flower seeds, bedding and garden plants, bulbs, and ornamentals to fruit and nut trees and strawberry plants. Buyers include consumers, landscape contractors, institutions, and agricultural producers. The most recent data indicate that the largest wholesale value of plant materials produced by the California nursery, flower, and foliage industry totaled \$3.98 billion in 2008 (Table 3). Values for the various categories of nursery products for the fiscal years ending in 2001, 2008, and 2016 are shown in Table 3. Comparable data for the entire period 2001 through 2016 are available in Appendix Table 2.

The product categories used by the CDFA Nursery Program and shown in Table 3 differ from those reported in annual California Agricultural Statistics Reports and California County Agricultural Commissioners' Reports. Briefly, the latter two reports contain a category for flowers and foliage that includes more products than does the Floral Products Total in Table 3. A comparison for 2015 has the floral products total in Table 3 equal to \$475,298,690, while the Flowers and Foliage category in California Agricultural Statistics reports a value of \$1,083,706,000. The total of nursery products and floral and flower products for the two data series are similar in magnitude but they tend to differ slightly.

There is a considerable range of wholesale values for the 12 categories of floral and nursery products included in Table 3. There are other important differences, including the pattern of changing values over time, variation in customers and target markets, and factors affecting values for each category. Using column 2016 values, the largest five categories account for a value of over \$3.64 billion or 95.8 percent of the 2016 total.

These categories and their percentage of total 2015 wholesale value are: cut flowers and cut greens, 10.8 percent;

potted plants, 16.5 percent; bedding plants, 10.6 percent; ornamentals, 25.2 percent; and nursery stock 32.6 percent. The other seven categories of floral and nursery products individually range from \$4.6 to \$70.6 million and have a combined total of just \$161.59 million (4.2 percent). The wholesale value of California produced floral products reached a maximum of \$521.46 million in 2007, while the maximum wholesale value of nursery products (\$3.46 billion) and the high of combined floral and nursery wholesale value of \$3.98 billion occurred in 2008. While seven of the product categories had higher wholesale values in 2008 than in 2001, only four (cut flowers & cut greens, flower seeds, ornamentals, and nursery stock) had higher values in 2016 than in 2001. Overall, the total wholesale value of California nursery and floral products increased 22.9 percent from 2001 to 2016.

Sales Trends

Total wholesale value and total sales data are reported for California floral and nursery products, without separate observations. Because of this data shortfall, there are no quantitative estimates of supply and demand parameters available. There are no estimates for of the elasticity of demand and the underlying determinants of observed changes in total sales revenues

Given that there are a variety of market segments for the 12 product categories in Table 3, one would expect the sales impact of different factors to vary by product. For example, a significant portion of sales of cut flowers and cut greens are to consumers in retail outlets, while sales of a product such as turf and sod are mainly to landscapers. While incomes or expected incomes are likely a factor in sales of all floral and nursery products, other factors such as housing starts, expected prices for fruit and tree nut crops, rainfall, drought, plant disease, energy prices and other major input costs may also be important.

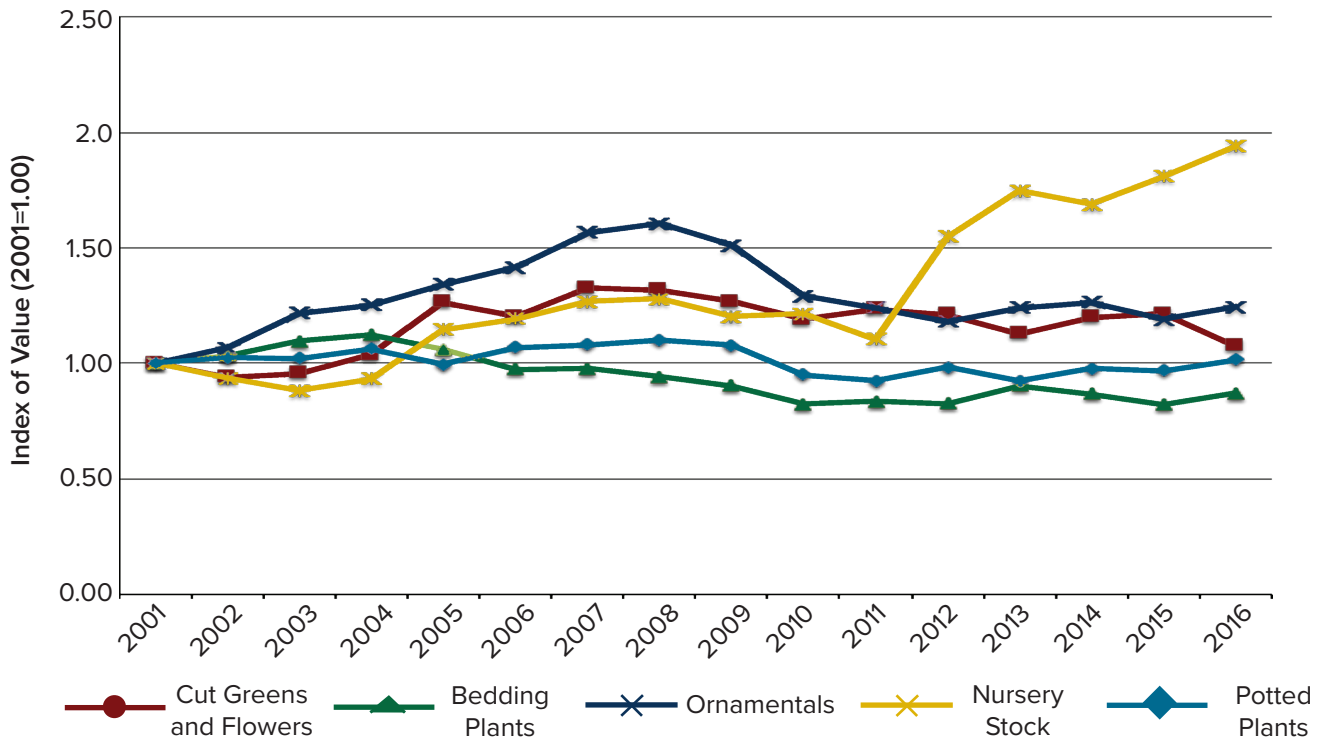
An index of annual sales by crop using a base of 2001 was calculated for each floral and nursery crop included in Table 3 for the years 2001 through 2016. Values of the index for the five crop categories with largest wholesale values (sales) are shown in Figure 3. The sales trends differ

Table 3. Wholesale Value of California Floral and Nursery Products by Major Categories, 2001, 2008, and 2016

Floral Products	2001 Value	2008 Value	2016 Value
Cut Flowers and Cut Greens	383,101,500	505,036,000	412,324,400
Flower Seeds	5,830,700	7,932,100	6,316,000
Christmas Trees	10,685,800	6,547,080	4,662,490
Floral Products Total	399,618,000	519,515,180	423,302,890
Nursery Products			
Potted Plants and Flowering Foliage	615,772,400	677,819,500	626,109,500
Bulbs, Corm, Roots and Tubers	10,295,200	10,455,900	6,737,000
Flowering Propagative Materials	75,590,000	61,011,800	70,655,000
Bedding Plants	465,045,400	438,601,600	404,915,700
Rose Plants	45,936,000	45,703,700	19,885,000
Woody, Deciduous and Evergreen Ornamentals	772,006,300	1,239,918,600	960,000,000
Herbaceous Perennials	30,069,200	46,134,900	21,907,000
Turf and Sod	42,750,300	124,707,600	31,428,000
Nursery Stock other than Ornamentals	639,508,900	817,324,400	1,240,808,260
Nursery Products Total	2,696,973,700	3,461,678,000	3,382,445,460
Grand Total	3,096,591,700	3,981,193,180	3,805,748,350

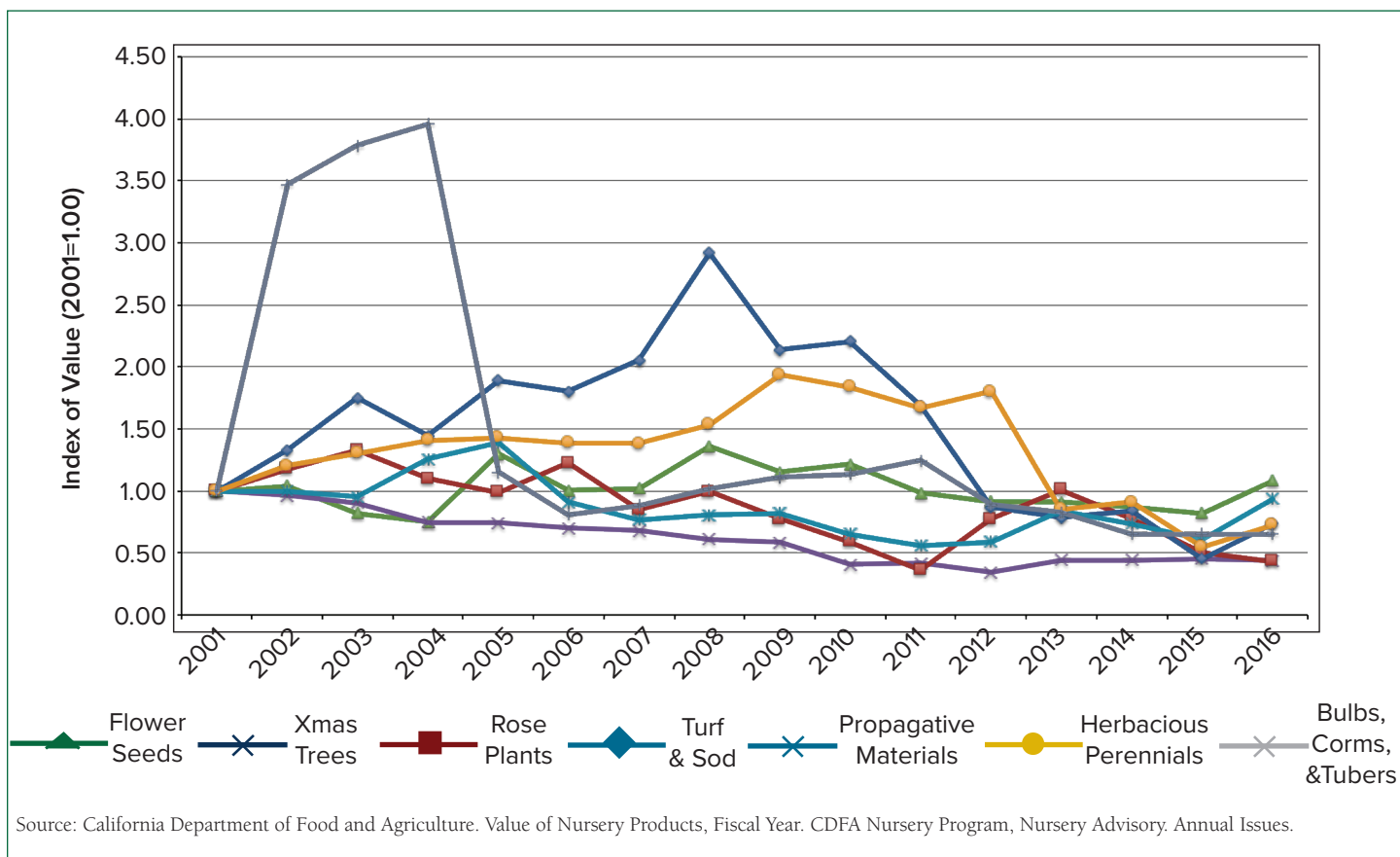
Source: California Department of Food and Agriculture. Value of Nursery Products, Fiscal Year. Cdfa Nursery Program, Nursery Advisory No.01-2002, Nursery Advisory No. 01-2009, January 16, 2009, and Nursery Advisory No. 01-2018, January 24, 2018

Figure 3. Index of Total Wholesale Value by Crop, 2001–2016



Source: California Department of Food and Agriculture. Value of Nursery Products, Fiscal Year. Cdfa Nursery Program, Nursery Advisory. Annual Issues.

Figure 4. Index of Annual Total Wholesale Value by Crop, 2001–2016



for each of the five products, with the largest divergence exhibited for nursery stock. Most nursery stock is sold to producers for replacement or new plantings of fruit and tree nut acreage, and most of the production is under contract between the nursery and buyer. Recent acreage expansions of tree nuts (almonds, walnuts, and pistachios) are reflected in 2016 nursery stock sales that are 1.94 times greater than in 2001.

Sales indexes for the seven floral and nursery crop categories shows that all of the products (except flower seeds) ended the 15-year period with fewer sales (Figure 4). Christmas tree sales fell sharply between 2001 and 2012 before recovering slightly. Turf and sod sales

increased almost threefold to 2008, and then decreased before recovering slightly in 2016. California’s housing collapse, the recession, several cities’ programs that paid homeowners to remove grass lawns, and increased water charges are probably related to decreased sales of turf and sod products. Sales for most of the products decreased after the recession officially began in 2008, although herbaceous perennials’ sales increased and remained high from 2009 through 2012 before collapsing from 2013 to 2016. Flower seeds sales decreased from their 2008 high of 1.36 times their 2001 level to 82 percent of their 2001 level in 2015 and then recovered in 2016. Each of the other minor crops ended 2016 with lower sales relative to their 2001 sales.

Retail Sales

Many nurseries have outlets on premise to serve retail customers. Direct sales to landscape contractors and gardeners purchasing products that range from specimen trees to bedding plants, and agricultural producers purchasing trees and strawberry plants, are also important. California is the largest market for lawn and garden products in the U.S., accounting for about 10 percent of annual retail sales.³ The majority of California floral and nursery production is sold in California, with the distribution of sales varying by product. A survey of California flower growers conducted in 2000 found that 59 percent of California-produced flowers were sold in California, 40 percent were shipped to other states, and 1 percent were exported to other countries (Prince and Prince). The spatial distribution of California nursery product sales, based on industry estimates, is approximately 79 percent in California, 20 percent shipped to other states, and 1 percent exported to other countries.

Sales Tax Data

Partial data on retail floral and nursery product sales in California are available from government statistics. The California State Board of Equalization publishes sales data by type of retail outlet but not by product line, generating annual retail sales data for florists, and farm and garden supply stores. The Board of Equalization revised their “type of business” classification in 2009 from the Standard Industrial Classification (SIC) to the North American Industry Classification System’s (NAICS) classifications. Farm and garden supply stores became “lawn and garden equipment and supplies stores,” while florists continued as “florists.” There are also aggregate sales data for large multi-product retailers such as food stores, hardware stores, and general merchandise stores, but it is not possible to determine the share of floral and nursery product sales for each of these retail store categories.

³ Estimated 2003 California lawn and garden sales totaled \$9.316 billion out of the U.S. total of \$98.69 billion (Morey, 2004, p. 85).

Table 4. Statewide Taxable Sales by California Retail Florists and Farm and Garden Supply Stores, Calendar Year, 2000–2015

Year	Florists	Farm and Garden	Total	Change from Prior Year
-----Thousand Dollars-----				% Change
2000	983,396	2,060,713	3,042,436	5.52
2001	988,022	2,059,040	3,047,062	0.15
2002	998,781	2,135,472	3,134,253	2.86
2003	1,005,452	2,266,142	3,271,594	4.38
2004	1,077,694	2,386,377	3,464,071	5.88
2005	1,133,896	2,662,956	3,796,852	9.61
2006	1,172,658	2,930,230	4,102,888	8.06
2007	1,203,148	2,965,697	4,168,845	1.61
2008	793,882	2,751,233	3,545,115	-14.96
2009	461,349	2,216,767	2,678,116	-24.46
2010	449,893	2,269,297	2,719,190	1.53
2011	464,761	2,392,542	2,857,303	5.08
2012	484,517	2,492,977	2,977,494	4.21
2013	493,526	2,732,246	3,225,772	8.34
2014	537,808	2,857,008	3,394,816	5.24
2015	557,740	3,174,133	3,731,873	9.93

Source: California State Board of Equalization, Annual Reports.

Taxable retail sales reported by California florists and farm and garden supply stores for the 16-year period 2000 through 2015 are shown in Table 4. Note that combined sales for the two types of stores increased from \$3.04 billion in 2000 to over \$3.04 billion in 2000 and further to almost \$4.17 billion in 2007. The steady sales increase was interrupted in 2008, when total sales for the two types of outlets dropped almost 15 percent to \$3.55 billion. Then, 2009 total sales for florists and farm and garden stores were down another 24.5 percent to \$2.68 billion, a total that was below the 2000 level. Retail sales then increased slightly in 2010, with the sales increase for farm and garden stores offsetting the loss for florists. Total sales for both types of retailers then increased annually through 2015.

Changes in store numbers and average annual sales for California florists between 2000 and 2011 are dramatic (Table 5). The number of California florists increased from 5,161 in 2000 to a peak of 6,427 in 2008 (24.5 percent), with store numbers increasing in 2008 even as sales began to plunge.

Annual florists' sales decreased over 34.0 percent from 2007 to 2008, 41.9 percent from 2008 to 2009, and another 2.5 percent from 2009 to 2010. Total sales by California florists in 2010 were only 37.4 percent of their level just three years earlier in 2007. Large numbers of florists began closing in 2008 with total numbers decreasing 25.3 percent by 2011 (from 6,427 in 2008 to 4,798 in 2011). Average sales per florist were highest in 2006, a year before total sales peaked in 2007; average sales then began to increase as the number of florists continued to decrease and total sales increased. Sales per florist took a dive in 2015 with a surprising 44.0 percent increase in store numbers overwhelming the 3.7 percent increase in total sales (Table 5).

Sales for California lawn and garden stores increased from just over \$2.06 billion in 2000 to a high of over \$2.96 billion in 2007 and then decreased over 25.2 percent the next two years before increasing slightly in 2010 (Table 5). However, the number of stores increased each year from 2000 through 2011. Average sales per farm and garden

Table 5. Number of Retailers and Average Sales Per Retailer, California Florists and Farm and Garden Retailers, 2000–2015

Year	Florists			Farm and Garden Stores		
	Number*	Sales (\$1,000)	Sales per Florist	Number*	Sales (\$1,000)	Sales per Store
2000	5,161	983,396	190,544	3,601	2,060,713	572,261
2001	5,338	988,022	185,092	3,711	2,059,040	554,848
2002	5,474	998,781	182,459	3,834	2,135,472	556,983
2003	5,572	1,005,452	180,447	3,943	2,266,142	574,725
2004	5,703	1,077,694	188,970	4,061	2,386,377	587,633
2005	5,708	1,133,896	198,650	4,188	2,662,956	635,854
2006	5,825	1,172,658	201,315	4,188	2,930,230	699,673
2007	6,160	1,203,148	195,316	4,285	2,965,697	692,111
2008	6,427	793,882	123,523	4,715	2,751,233	583,506
2009	5,070	461,349	90,996	5,133	2,216,767	431,866
2010	4,950	449,893	90,887	5,427	2,269,297	418,149
2011	4,798	464,761	96,866	5,600	2,392,542	427,240
2012	4,779	484,517	101,385	5,557	2,492,977	448,619
2013	4,606	493,526	107,149	5,204	2,732,246	525,028
2014	4,504	537,808	119,407	4,977	2,857,008	574,042
2015	6,487	557,740	85,978	6,564	3,174,133	483,567

Source: California State Board of Equalization. Taxable Sales in California, 2000–2015

Note: * Number of licenses, July 1 of each year

store reached a high point in 2006 and then decreased to a low 2010 (as was true for florists) before increasing slightly in 2011. Total sales for lawn and garden stores increased steadily from 2010 through 2015, reaching a high of \$3.71 billion in 2015. Sales per store increased through 2014 but then dropped sharply when the number of stores increased from 4977 in 2014 to 6564 in 2015; a 31.9 percent one year increase in store numbers.

Firms Licensed to Sell Nursery Products

Firms must be licensed by the California Department of Food and Agriculture to sell nursery products in California and licensed firms are listed in the annual Directory of Nurserymen and Others Licensed to Sell Nursery Stock in California.⁴ The numbers of firms were tabulated by category for 2003, 2011 and 2013 in a previous report and data for January 2018 are added for this report.⁵ There was a significant reduction in the number of retailers between 2003 and 2011 with a slight recovery in 2013 and again in 2018. There were also less dramatic decreases in the total

numbers of middlemen (wholesalers, jobbers and brokers) as well as landscapers and producers from 2011 to 2013 and continuing to 2018.

The USDA's 2014 Census of Horticultural Specialties included all operations that reported producing and selling \$10,000 or more of horticultural specialty products. The Census counted a total of 23,221 operations in the U.S. and 1,710 (7.36 percent) of these were in California. U.S. sales were \$13.789 billion with California operations accounting for 20.87 percent of the total. The average California horticultural and specialty crop producer had 2014 sales of \$1,683,030 as compared to the U.S. average of \$593,818. The Census reported wholesale and retail sales by California firms. Among the total 1,710 firms, 1,306 reported wholesale sales of \$2.625 billion for average wholesale sales of \$2,010,487 per operation. There were 835 operations with \$252 million of retail sales for average retail sales of \$302,139 per firm. From total sales of \$2.878 billion, 91.2 percent were at wholesale and the remaining 8.8 percent were retail.

Comparison of the 2009 and 2014 Census of Horticultural Specialties indicates that the number of U.S. producers with annual sales over \$10,000 increased from 21,585 in 2009 to 23,221 in 2014 (a 7.6 percent increase), while total sales increased from \$11.687 billion to \$13.789 billion (18.0 percent increase). The same comparison for California indicates that the total number of producers increased from 1,611 in 2009 to 1,710 in 2014 (6.1 percent increase), while total sales increased from \$2.283 billion to \$2.878 billion (26.1 percent increase).

4 According to the California Food and Agriculture Code (FAC), "It is unlawful to sell any nursery stock without an annual license from the Secretary of Food and Agriculture," and "Exemption from license is allowable to florists and others who only sell plants at retail for the sole purpose of indoor decoration, to persons who sell no nursery stock except seeds, and to persons who only sell cut Christmas trees" (Sections 6721 through 6744, FAC).

5 See Carman, Hoy. 2013. "[Some Impacts of Recession on California's Nursery and Floral Industry](#)." ARE Update 16(5):5-8. University of California Giannini Foundation of Agricultural Economics.

Table 6. Number of California Firms Licensed to Sell Nursery Stock by Category and Total, 2003, 2011, 2013 and 2018

Year	Cut Flowers & Greens Wholesalers	Jobbers & Brokers	Landscapers	Producers*	Incidental Retailers**	Retailers***	Total
2003	853	476	454	2,999	2,715	3,756	9,821
2011	880	460	463	2,959	736	2,158	5,848
2013	854	447	421	2,833	842	2,180	5,834
2018	798	409	426	2790	848	2,270	5,674

Source: California Department of Food and Agriculture, Directory of Nurserymen and Others Licensed to Sell Nursery Stock in California. To source Directory go to: <http://plant.cdfa.gov/nurserylicense/nlmenu.asp>

Notes: * A producer is a commercial producer who grows and sells a total of \$1,000 or more of nursery stock in one year.

** An incidental retailer is an operator of a retail sales outlet for nursery stock that is handled incidental to other merchandise. Retailers such as Home Depot, Wal-Mart, Lowes and supermarkets are in this category.

*** A retailer is an operator of a sales outlet that has no growing grounds except small areas devoted to the production of plants for local distribution and those producing less than \$1,000.

Structural Changes

Data reported by the California State Board of Equalization, CDFA, and USDA provide information on structural changes for the California nursery and floral industry, but there are some differences that require reconciliation. Changing sales and the number of firms producing and distributing nursery and floral products has implications for both producers and consumers.

Using the 1992 Census of Agriculture as a base for discussion, there have been changes in the number of California nursery and floricultural producers, changes in sales per firm and industry sales, and changes in share of total California agricultural sales. In terms of census counts, the number of California farms producing nursery and floricultural products grew to a high of 4,388 in 2002 (Table 1). Nursery and floral sales reached 10.5 percent of total California agricultural sales in 1998, increased to a high of 12.5 percent in 2002, and remained above 10 percent through 2007. The highest combined nursery and floral sales occurred in 2007, when sales totaled \$3.998 billion, accounting for 10.9 percent of total California agricultural sales. Nursery and floricultural sales as a share of total agricultural sales then decreased to 6.5 percent in 2014, before recovering slightly in 2015. Retail sales for California florists and lawn and garden stores also peaked during 2007, with total retail sales of almost \$4.17 billion (Table 4). Then, with the onset of the economic recession in 2008, retail sales for florists and lawn and garden stores plunged over 14.9 percent in 2008 and another 24.5 percent in 2009, reaching a low of almost \$2.68 billion. While total retail sales began to increase slowly in 2010, the total of \$3.73 billion in 2015 was still well below the 2007 peak.

The impacts of the economic recession on the number of firms producing and marketing California nursery and floral products point to some rather basic structural changes, with implications for both producers and consumers. First, is the sharp reduction in the number of California florists and their total sales associated with the recession. The number of florists in 2011 dropped 1,629 (25.3 percent) from the peak of 6,427 in 2008, while sales decreased \$753.26 million (62.6 percent) from 2007 to 2010. The change in farm sales of floral products was much less dramatic. California farm-level floral product

sales reached a high of \$1.036 billion in 2007. Sales then dropped to \$1.015 billion in 2008 and further to \$937.0 million in 2009, before recovering to \$1.015 billion in 2010. The large decrease in sales by florists with only a small change in farm-level sales is presumed to be due to a significant change in retail market shares for floral products. Specifically, other outlets such as supermarkets gained market share for floral products at the expense of individual florists.

The situation for lawn and garden equipment and supplies stores is different. While total sales decreased after the peak occurring in 2007, the number of retail licenses continued to increase throughout the recession, reaching 5,600 in 2011 (Table 5). This is not the case for other retailers handling nursery products, as reported by CDFA. As shown in Table 6, there were fewer licensed producers (including some with direct sales to consumers) as well as incidental and specialized nursery retailers in 2011 as compared to 2003. The number of retailers licensed to sell nursery stock decreased from a total of 6,471 in 2003 to 2,894 in 2011 (55.3 percent) before increasing to 3,022 in 2013 and 3,118 in 2018. Given much smaller reductions in wholesale as compared to retail sales, the surviving retailers are larger on average and probably have smaller operating margins than was typical for either specialized florists or lawn and garden retailers.

Surges in the number of retail florists and farm and garden stores in 2015 as reported by the California State Board of Equalization show the number of retail florists increased from 4,504 in 2014 to 6,487 in 2015 (44 percent increase) while the number of farm and garden stores grew from 4,977 to 6,564 (31.9 percent increase). As reported by CDFA, the number of licensed retailers increased only 96 (3.2 percent) between 2013 and 2018. The difference in number of sales tax licenses and number of CDFA licenses is significant. The best explanation is that most of the new sales tax licenses are to retailers who sell only cut flowers and greens and plants used indoors, and are not required to be licensed by CDFA. There could be some new entrants that are not familiar with CDFA licensing requirements and have not applied for the required licenses.

This very significant reduction in licensed California retailers handling nursery and floral products has implications for both producers and consumers. Some producers undoubtedly lost their major retail customers while many lost important retail outlets. The impact of the loss of outlets was not uniform but it was widespread. Products are not as widely available at the consumer level as before the recession, which tends to reduce consumer choice and negatively impact impulse buying. This consolidation of outlets may offer some economies in distribution but the impact on floral and nursery product sales has been negative. A change from specialized to multiproduct retailers tends to reduce customer service and may reduce product assortments. And, the changes noted may be associated with more market power in the hands of surviving retailers. Recent increases in the number of retail outlets should have a positive effect on production and sales, especially for cut flowers and greens.

Appendix Table 1. Population (2017), Value of Nursery and Floral Production (2016), and Number of Greenhouse, Nursery, and Floriculture Producers (2012) by California County

County	Population Jan. 1, 2017	Value of Nursery Product (\$1,000)	Number of Farms 2012	County	Population Jan. 1, 2017	Value of Nursery Product	Number of Farms 2012
Alameda	1,645,359	7,262	18	Orange	3,194,024	55,685	78
Alpine	1,151	0	0	Placer	382,837	8,313	53
Amador	38,382	192	14	Plumas	19,819	13	9
Butte	226,404	12,091	46	Riverside	2,384,783	150,426	203
Calaveras	45,168	185	20	Sacramento	1,514,770	30,702	50
Colusa	22,043	0	1	San Benito	56,854	7,686	26
Contra Costa	1,139,513	6,649	32	San Bernardino	2,160,256	48,073	67
Del Norte	27,124	10,237	10	San Diego	3,316,192	1,233,942	701
El Dorado	185,062	4,975	119	San Francisco	874,228	0	0
Fresno	995,975	116,186	72	San Joaquin	746,868	107,387	47
Glenn	28,731	5,698	10	San Luis Obispo	280,101	86,933	119
Humboldt	136,953	55,945	76	San Mateo	770,203	97,922	72
Imperial	188,334	6,074	10	Santa Barbara	450,663	160,268	127
Inyo	18,619	1,032	1	Santa Clara	1,938,180	83,292	102
Kern	895,112	102,318	45	Santa Cruz	276,603	93,612	129
Kings	149,537	0	8	Shasta	178,605	14,347	29
Lake	64,945	925	16	Sierra	3,207	4	2
Lassen	30,918	0	5	Siskiyou	44,688	140,085	22
Los Angeles	10,241,278	92,399	265	Solano	436,023	39,754	21
Madera	156,492	29,977	17	Sonoma	505,120	32,699	173
Marin	263,604	360	14	Stanislaus	548,057	204,797	37
Mariposa	18,148	69	3	Sutter	96,956	35,651	10
Mendocino	89,134	1,577	56	Tehama	63,995	18,186	16
Merced	274,665	74,189	15	Trinity	13,628	4	6
Modoc	9,580	0	8	Tulare	471,842	75,618	53
Mono	13,713	20	2	Tuolumne	54,707	272	18
Monterey	442,365	276,423	109	Ventura	857,386	254,882	145
Napa	142,408	2,133	16	Yolo	218,896	18,303	15
Nevada	98,828	502	44	Yuba	74,577	0	8
				STATE	39,523,613	3,806,274	3,390

Source: Population data are from State of California, Department of Finance, Report E-1, Population Estimates for Cities, Counties and the State, January 1, 2016 and 2017. Sacramento, CA, May, 2017. Nursery and floral production from California Department of Food and Agriculture, California County Agricultural Commissioners' Reports, Crop Year 2015-2016, January 19, 2018. Number of greenhouse, nursery and floriculture producers from USDA, NASS, Census of Agriculture 2012, California State and County Data, Vol. 1, Chapter 2: County Level Data, Table 44.

Appendix Table 2. Annual Value of California Nursery Products by Category, 2001–2016

YEAR	Cut Flowers & Cut Greens	Flower Seeds	Xmas Trees	Total Floral Products
-----Dollar Value-----				
2001	383,101,500	5,830,700	10,685,800	399,618,000
2002	359,810,600	6,074,100	10,304,900	376,189,600
2003	365,944,700	4,775,700	9,637,400	380,357,800
2004	396,748,200	4,379,700	7,974,600	409,102,500
2005	484,151,000	7,556,100	7,918,125	499,625,225
2006	460,419,100	5,861,800	7,506,800	473,787,700
2007	508,273,800	5,954,600	7,234,100	521,462,500
2008	505,036,000	7,932,100	6,547,080	519,515,180
2009	485,607,500	6,704,900	6,255,800	498,568,200
2010	456,493,100	7,086,000	4,311,900	467,891,000
2011	473,512,800	5,737,000	4,441,600	483,691,400
2012	464,287,240	5,335,000	3,682,800	473,305,040
2013	431,941,748	5,303,000	4,728,490	441,973,238
2014	459,812,530	5,084,000	4,741,890	469,638,420
2015	465,690,600	4,779,000	4,829,090	475,298,690
2016	412,324,400	6,316,000	4,662,490	423,302,890

Appendix Table 2. Continued

YEAR	Potted Plants & Flowering Foliage	Bulbs, Corms, Roots, and Tubers	Flowering Propagative Materials	Bedding Plants	Rose Plants	Woody, Deciduous, and Evergreen Ornamentals
-----Dollar Value-----						
2001	615,772,400	10,295,200	75,590,000	465,045,400	45,936,000	772,006,300
2002	631,386,400	35,712,300	75,700,800	480,438,100	54,062,000	823,255,600
2003	628,212,900	38,961,600	71,976,600	509,310,000	61,047,000	940,436,400
2004	654,604,800	40,749,700	94,933,600	522,659,600	50,558,000	966,151,800
2005	612,802,500	11,829,800	105,046,600	492,449,200	45,353,000	1,035,597,600
2006	658,588,100	8,329,600	68,870,200	453,664,600	56,251,000	1,092,487,300
2007	665,903,800	9,089,800	57,930,900	454,219,700	38,982,000	1,208,605,100
2008	677,819,500	10,455,900	61,011,800	438,601,600	45,703,700	1,239,918,600
2009	663,092,600	11,415,000	62,085,600	419,378,200	35,627,700	1,164,761,200
2010	585,715,500	11,710,500	49,170,400	383,405,420	27,201,000	996,499,500
2011	569,479,600	12,842,000	42,206,000	387,885,000	16,600,000	956,877,570
2012	604,839,860	9,127,000	44,509,000	384,256,000	35,621,000	912,435,000
2013	569,282,075	8,508,025	63,054,600	420,648,000	46,367,000	958,078,000
2014	601,309,800	6,701,000	55,561,000	403,653,000	35,443,600	975,360,000
2015	595,587,680	6,701,000	46,187,500	381,954,500	22,970,000	918,654,000
2016	626,109,500	6,737,000	70,655,000	404,915,700	19,885,000	960,000,000

Appendix Table 2. Continued

YEAR	Herbaceous Perennials	Turf & Sod	Nursery Stock Other than Ornamentals	Total Nursery Products	Total Floriculture and Nursery
-----Dollar Value-----					
2001	30,069,200	42,750,300	639,508,900	2,696,973,700	3,096,591,700
2002	36,175,500	56,724,700	598,606,600	2,792,062,000	3,168,251,600
2003	39,134,900	74,853,100	564,752,800	2,928,685,300	3,309,043,100
2004	42,369,600	61,826,900	597,499,400	3,031,353,400	3,440,455,900
2005	42,904,500	80,876,900	732,811,240	3,159,671,340	3,659,296,565
2006	41,752,200	76,965,800	763,396,600	3,220,305,400	3,694,093,100
2007	41,576,600	87,844,800	810,578,500	3,374,731,200	3,896,193,700
2008	46,134,900	124,707,600	817,324,400	3,461,678,000	3,981,193,180
2009	58,255,400	91,396,500	769,331,800	3,275,344,000	3,773,912,200
2010	55,272,900	94,197,280	776,988,500	2,980,161,000	3,448,052,000
2011	50,178,000	72,001,000	705,552,150	2,813,621,320	3,297,312,720
2012	54,175,000	37,091,000	990,779,400	3,072,833,260	3,546,138,300
2013	25,564,000	33,460,000	1,117,665,648	3,242,627,348	3,684,600,586
2014	27,277,000	35,925,000	1,079,007,000	3,220,237,400	3,689,875,820
2015	16,443,000	19,303,000	1,157,517,830	3,165,318,510	3,640,617,200
2016	21,907,000	31,428,000	1,240,808,260	3,382,445,460	3,805,748,350

Source: California Department of Food and Agriculture. Value of Nursery Products, Fiscal Year. CDFA Nursery Program, Nursery Advisory. Annual Issues.

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Chapter 12. California's Nursery and Cannabis Industries

Part 2. California's Cannabis Industry

Daniel A. Sumner, Robin Goldstein, and William A. Matthews

Abstract

In November 2016, two decades after legalizing medicinal cannabis, California voted to legalize and regulate “adult-use” (recreational) cannabis. Implementation is being gradually rolled out throughout 2018, but, due to lack of data and a vibrant illegal market, implications of the new regulations and taxes are unusually difficult to model. We first assess the current industry situation, from cultivation through retail. We next project the likely economic situation in 2019, with regulation and taxation in place. The legal California cannabis industry benefits from improved access to management and capital and new demand. However, legal cannabis also faces considerable taxes and compliance costs. We estimate that about 80 percent of California-grown cannabis continue to leave the state. Less than half (about 1.3 million pounds) of the in-state retail sales will be in the legal regulated and taxed segment, with total retail revenue of \$6.7 billion, including about \$1.8 billion in taxes.

Authors' Bios

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Introduction

Cannabis production, processing, sale, purchase, and possession by California residents with a doctor's recommendation has been allowed under California law for more than 20 years. Under the Compassionate Use Act of 1996, medicinal cannabis purchase and possession has been legal for patients over 18, and for younger consumers accompanied by a parent or legal caretaker. Adult-use cannabis purchase and possession has been legal for those over the age of 21 (under state law, but not federal law) since November 2016, when California voters approved Proposition 64, the Adult Use of Marijuana Act (AUMA). Nonetheless, in 2018, big changes are underway for California's cannabis industry.

In June 2017, the California State Legislature enacted the Medicinal and Adult Use Cannabis Regulation and Safety Act (MAUCRSA), which specified the framework for taxing and regulating cannabis in California. The first set of regulations for cultivation, manufacturing, testing, distribution, and retail sale of both medicinal and adult-use cannabis went into effect on January 1, 2018. Regulations implementing MAUCRSA will be more fully implemented beginning July 1, 2018. Full enforcement of the new regulations will be phased in somewhat later.

Economists have an important role of helping policymakers, the public, and market participants understand the economic effects of the rapidly evolving legal and regulatory environment for cannabis in California. However, there are several serious challenges that impede efforts to measure and explain the economics of the cannabis industry in California. First, there are no official price or quantity data. Although medicinal cannabis has been legal to purchase and possess for two decades by those with medical recommendations, the State of California collected no official statistics on the commodity. Most California production and use has been outside the legal channels for medical production, processing, sale, and use. Thus, a large industry developed in California that avoided compliance with auxiliary government regulations such as those administered by environmental, labor, public health, or tax authorities.

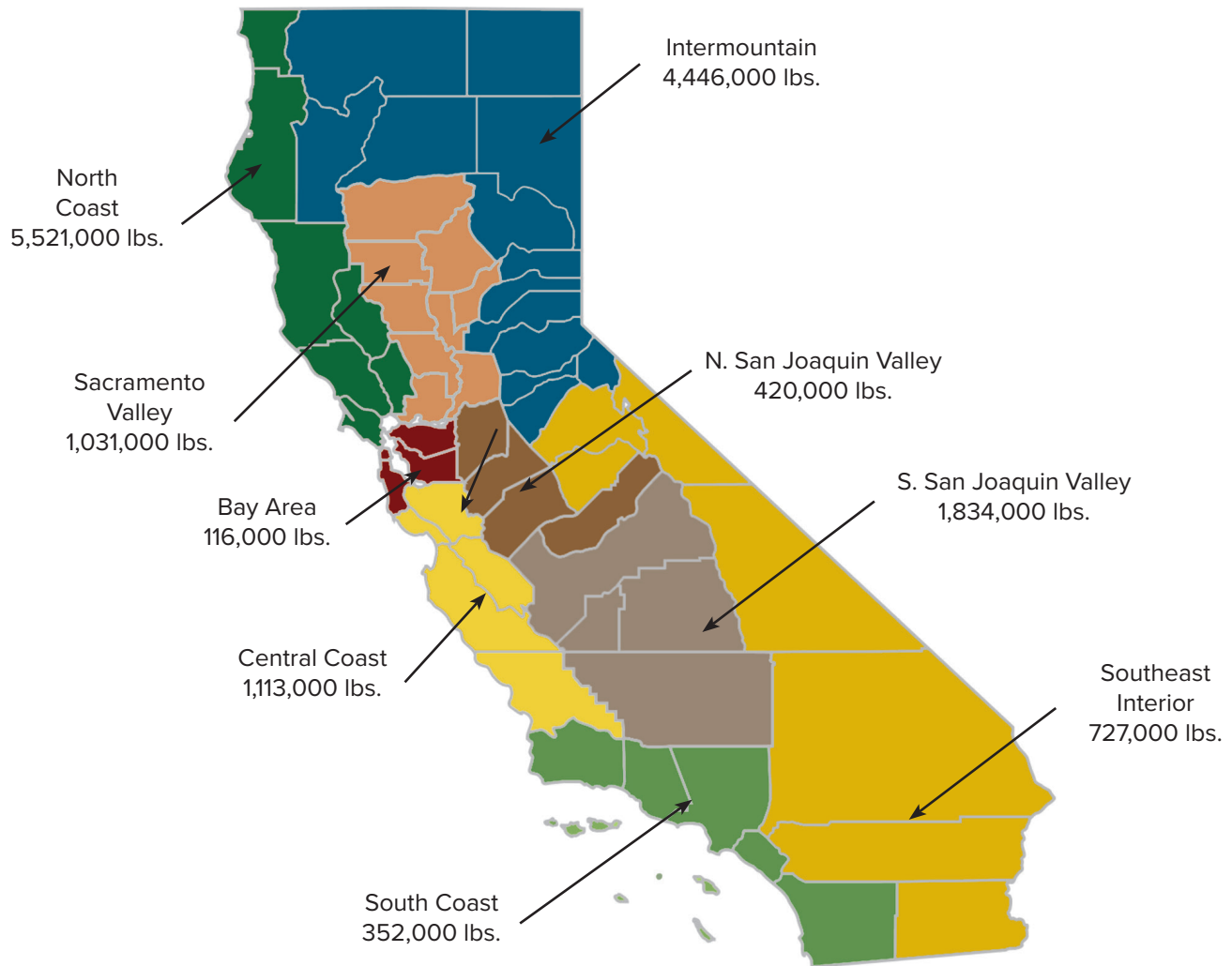
Cannabis sale, purchase, and possession remains prohibited under federal law, with potentially severe penalties. This status of cannabis under federal law continues to mean that cannabis is not a normal farm product in the context of inter-state trade, finance, and banking.

This chapter deals with two broad questions. First, what is the economic situation of the cannabis industry in California from farm cultivation through processing, marketing, and retailing? We describe the industry in terms of prices, quantities, and revenues in the relevant California markets, and we outline the main regulations. Second, the likely situation of the industry in the near future when the regime of regulation and taxation is fully in place? For the discussion of cultivation and manufacturing, we draw on reports prepared to inform the California regulatory process (MacEwan et al., 2017; Eschker et al., 2018). For a discussion of the wholesale and retail markets, we draw on our research developed at the University of California Agricultural Issues Center (AIC) (Sumner et al., 2018). These three reports were provided to the California state government to provide analysis of economic impacts of major regulations.

In broad terms, the dimensions of cannabis in California are as follows. Production is about 15 to 16 million pounds. Consumption in California is about 3 million pounds; this means that about 80 percent of total cannabis production by weight is shipped to destinations outside the state and thus remains outside the legal and regulated system being implemented.

Within California, we estimate that about half the cannabis consumption by weight (about 10 percent of production) is likely to be sold through state-regulated venues. The wholesale farm price of cannabis varies widely by growing method, potency, other product characteristics, and regulation status. As of late 2017, the wholesale price of medicinal cannabis averaged about \$1,600 per pound, with lower prices for cannabis grown outdoors and higher prices for cannabis grown indoors. The price of retail cannabis varies widely by region and location, regulation

Figure 1. Estimated California Cannabis Production by Region, 2017



Source: Adapted from MacEwan et al., 2017

status, and product characteristics. As of late 2017, on a flower-equivalent basis, cannabis outside the regulated system had an average price of about \$2,100 to \$2,600 per pound, and the price of cannabis in the medicinal retail market was about \$3,600 per pound.

The new regulations and taxes are disrupting the cannabis production, processing, and marketing system. These changes are causing some production and marketing costs to decline while imposing substantial new taxes and regulatory costs throughout the supply chain. We anticipate that most of the regulated and taxed cannabis will be grown indoors or in greenhouse (also known in the industry as “mixed-light”) environments, using methods that more readily comply with track-and-trace and testing

regulations. Similarly, manufacturing will more likely be conducted by operations with the resources and physical capacity to meet testing and packaging requirements.

Licensed cannabis retail outlets will have access to regulated and tested products, more business security, more access to management talent, and more access to legal capital than their unlicensed competitors; but they also face compliance costs. Customers in the taxed and regulated market have a secure legal environment for purchases of tracked-and-traced production that has been thoroughly tested. The cost of these products, however, is likely to be almost double the cost of cannabis products from unregulated and untaxed sources.

Farm Production of Cannabis in California

Estimates of the quantity of cannabis production in California must be assembled from a variety of sources. MacEwan et al. (2018) used information from satellite imagery, law enforcement reports, local interviews, and many other sources to estimate 2017 production by region. Figure 1 displays their estimates. The data are displayed in what we term “dried cannabis flower equivalent” units, which includes estimates of a small contribution from leaves and trimmings, which are sold at much lower prices (often less than one-tenth of dried flowers.) Of the 15,560 million pounds of production in 2017, MacEwan et al. (2018) estimates that about 11 million pounds comes from Northern California, where cannabis has long been grown in mountains and valleys, often in remote areas. Another three million pounds comes from the San Joaquin Valley and the mountain and desert interior counties. That leaves about 1.5 million pounds in the coastal regions from San Diego up to San Francisco, where the bulk of the California population resides and where most California cannabis consumption occurs.

Table 1 shows the estimated distribution of production in each region by the share of production method—outdoor, indoor, and greenhouse. The final column in Table 1 shows

the share of California production in each region based on the production quantities reported in Figure 1. Note that more than 70 percent of California production comes from Northern California. These regions, like most others, have the majority of production outdoors, but the 51 percent grown outdoors in the North Coast region is below the statewide average of 58 percent grown outdoors. The share grown in greenhouses ranges from 54 percent in the South San Joaquin Valley and 43 percent in the North Coast region, to only 8 percent in the Southeast interior and 9 percent in the North San Joaquin Valley. Finally, only 9 percent of California cannabis is grown indoors with the highest shares in the more urban regions of the Bay Area and the South Coast.

These production estimates include the roughly 80 percent of cannabis that is shipped outside California, similar to many other California commodities. There are two major differences for cannabis. First, evidence suggests that relatively little cannabis is exported from the United States (with Canada as the potential exception). Second, unlike other farm products, cannabis is illegal to ship to other U.S. states.

Table 1. Share of Production Measured in Pounds by Method by Region, 2016/17

	Outdoor	Indoor	Mixed Light	Total Share
	Percent			
Intermountain	63	9	27	29
North Coast	51	6	43	35
Sacramento Valley	77	8	15	6.6
Bay Area	26	61	13	0.7
North San Joaquin	74	17	9	2.7
Central Coast	74	6	20	7.2
South San Joaquin	43	3	54	12
Southeast Interior	83	8	8	4.7
South Coast	48	30	22	2.4
Total	58	9	33	100

Source: Adapted from MacEwan et al., 2017

Table 2. Production and Costs for Outdoor, Indoor, and Mixed-Light (Greenhouse) for Surveyed Operations in 2016/17

	Outdoor	Indoor	Mixed Light (Greenhouse)
All Values per Operation			
Canopy Square Feet	15,265	9,375	9,875
Production per Square Feet (lbs).	0.019	0.186	0.105
Total Production (lbs)	291.16	1,747.27	1,038.75
Price per Pound (\$/lb)	1,402	2,100	1,575
Flower Revenue (\$ thousands)	408	3,669	1,636
Trimmings Revenue (\$ thousands)	3	17	10
Total Revenue (\$ thousands)	411	3,687	1,646
Reported Expenses (\$ thousands)	218	1,730	875
Return to Management and Risk (\$ thousands)	193	1,956	771

Note: Based on a cultivator survey described in MacEwan et al., 2017.

Source: Adapted from MacEwan, 2017, with additions.

The other difference is that much of the production remaining in California is also being sold outside the regulated and taxed legal market. Although cannabis is legal to buy and possess (buying cannabis from unlicensed sellers is not a crime), selling cannabis outside the licensed, taxed, and regulated system is subject to criminal penalties. Below, we discuss the division of cannabis sold in California between the licensed and unlicensed systems in more detail.

Table 2 summarizes data from a 2017 survey of cannabis growers. We emphasize that because of the difficulties of contacting some growers and concerns of some growers about providing information, these data may be subject to high margins of error. Moreover, the problems of sampling means that the results cannot be said to be based on a random sample of producers.

Table 2 provides data on averages per farm separately for the three cultivation methods: outdoor, indoor, and greenhouse (mixed light). Compared with other agricultural products, cannabis canopy area per farm is small (a fraction of an acre on average for all methods). Cannabis produced per square foot varies significantly by cultivation method.

Outdoor production typically has one harvest per year and, for the surveyed farms, yields an average of only

0.019 pounds, or 0.3 ounces, of dried flowers per square foot of canopy area. Indoor operations average only about 60 percent of the area of outdoor operations, but produce several harvests per year and, in this sample, yield almost 10 times as much cannabis per square foot as outdoor production. Greenhouse production is much closer to indoor in terms of square feet per operation, and averages about 0.105 pounds of cannabis per square foot. Indoor cultivation is much more intense and has very high annual yields of dried flowers per square foot compared to the outdoor operations in this sample. The canopy area per operation is about 60 percent of the outdoor canopy, thus the indoor cultivators averaged about six times as much cannabis as the average outdoor cultivator. The average greenhouse cultivator produced about 3.6 times as much as the outdoor cultivator in this sample.

The prices in 2016/17 were much higher per pound for indoor and greenhouse cannabis. Revenue per farm averaged about \$411,000 for outdoor cultivators, compared to \$3,687,000 for indoor and \$1,646,000 for greenhouse cultivators. Reported direct expenses are only about half of revenue indicating very high returns to management and risk. These high residual earnings reflect the substantial risk of cannabis operation in the illegal market before regulations. Informal reports of regular losses of cash and crop due to criminal activity or business disputes, a lack of

legal recourse, and significant potential for arrest and loss of crop and cash as a result of law enforcement suggest that long-term average returns may be significantly less than indicated in Table 2.

In April 2018, reflecting shifts in the market with more legalization and regulation, wholesale prices are reported to be less than \$900 per pound for outdoor cannabis and less than \$1,600 per pound for indoor cannabis, with greenhouse again in the middle (Cannabis Benchmarks, 2018). Using an average price in the illegal segment of about \$1,000 per pound, we estimate that cannabis shipped out of California has a farm value of about \$13 billion per year, which is roughly the farm revenue of milk and almonds together. The farm value of cannabis sold in California is now in the range of \$3 billion for an annual total of about \$16 billion.

Taxes and regulations being implemented in 2018 affect the cannabis cultivation industry both directly and through market relationships. State taxes are specified as \$148 per pound of dried flower and \$44 per pound of leaves and trim. MacEwan et al. (2018) estimate that leaves and trim will comprise only about 10 percent weight sold.

In addition to these taxes, the state requires a track-and-trace system starting at the farm, as well as surveillance to implement the system and provide security. The California Department of Food and Agriculture (CDFA) is responsible for licensing cannabis growers and issuing several license types based on cultivation method, size, and whether the cannabis is to enter the medicinal or adult-use segment. The cannabis itself may be identical in these license categories. Proposed license fees rise with the area of canopy and are higher for greenhouse and indoor methods to reflect higher production and prices per square foot of canopy. Producers may obtain several licenses. As of the end of April 2018, there were about 2,800 temporary cultivation licenses of all types (which are available with no fee, but which require a complex application and eligibility), with many entities possessing more than one license.

State regulations are expected to add about \$50 per pound to cultivation costs. Local governments, mainly counties and cities, are also implementing taxes and regulations on cultivators. These vary by medicinal versus adult-use

cannabis and by cultivation method—outdoor, indoor, or greenhouse. Although local taxes and regulations are still in flux and much harder to gauge, local taxes are estimated to add another \$128 per pound to the costs of supplying cannabis from the farm (MacEwan et al., 2018). One complication is that growers will tend to avoid high-tax, high-regulation areas. Some taxes are on a per-square-foot basis and thus favor growing systems with high-yields of cannabis per square foot. The overall tax rate per pound thus depends in part on how production methods evolve.

The evolution of a licensed, taxed, and regulated cultivation industry will favor those firms adept at attracting relatively sophisticated management and adequate capital to meet the new regulatory setting. This new setting includes not only cannabis-specific taxes and regulations, but an array of labor, health and safety, environmental, and other regulations and taxes about which many incumbent cannabis growers have not been knowledgeable or compliant. We expect many growers who were well suited to the long-standing unlicensed and unregulated system to be less suited to the new system than many new entrants. Many of these incumbents may therefore choose to remain unlicensed. Since the size of illegal market is likely to remain very large relative to the regulated market, these producers can remain in the cannabis business without attempting to navigate a system in which they may have little comparative advantage.

Manufactured Cannabis in California

Most retail cannabis is sold as dried flowers for smoking, but a significant minority of the retail market is manufactured cannabis products derived from cannabis flowers, leaves, and trim. Manufactured products are made using cannabis materials that are extracted using a variety of methods, including pressurized solvent-based extraction, distillation, pressing, tumbling, and dry sifting. The retail products using these concentrated extractions are roughly divided into three product categories:

(1) Concentrates, e.g., Butane Hash Oil (BHO) and CO₂ oil, typically sold at retail in cartridges for use in vape pens (small portable vaporizers), or as disposable vape pens; or rosin, which has a gum-like consistency. Oil typically has 60–75 percent THC content by volume.

(2) Edibles, e.g., cannabis-infused foods and beverages, and tinctures (drops taken by mouth). These are generally manufactured using cannabis concentrates as ingredients.

(3) Topicals, e.g., creams, lotions, oils, or balms applied to the skin. These are also generally manufactured using cannabis concentrates as ingredients.

Eschker et al. (2018) estimated that manufactured products, including concentrates, edibles, and topicals, comprised about 30 percent of California's legal medicinal cannabis segment (by revenue) in 2017, and will have a similar share of the fully regulated market that includes adult-use cannabis. Using the AIC estimate of a medicinal retail market of about \$2.5 billion in 2017, this would generate a retail value of about \$750 million. Eschker et al. (2018) estimate an average ratio of wholesale to retail prices for manufactured products of 0.4 during 2017. That ratio implies that retail sales value of \$750 means a wholesale revenue of about \$300 million for manufactured products in the medicinal cannabis market.

Sales volumes within manufactured cannabis products in the medicinal segment is about 75 percent concentrates, 22 percent edibles, and 3 percent topicals. Manufactured products in the unregulated segment are almost all concentrates. Moreover the share of manufactured products sold through the medicinal dispensaries has been

much larger than the medicinal share of the dried flowers sold in California. Eschker et al. (2018) assume, with a high degree of uncertainty, that there were approximately 1,000 legal medicinal manufacturing businesses operating in California in 2017, and about 2,000 manufacturers in the unregulated segment. These businesses were generally very small, averaging only about one full-time-equivalent employee per firm.

Starting 2018, manufactured cannabis products are regulated by CDPH. Separate license types are required for extracts using nonvolatile solvents and extracts using volatile solvents. As of the end of April 2018, there are about 720 manufacturing licensees of all types. These temporary licenses are available with no fee, but which require a complex application and eligibility.

CDPH also enforces rules covering food safety, the security of licensed manufacturing premises, compliance with the track-and-trace system, packaging and labeling, and other areas of regulatory oversight. Eschker et al. (2018) estimate costs of the licenses plus state regulations. Applying AIC market size assumptions, we estimate that these costs add about \$95 per pound to costs of cannabis in terms of dried-flower equivalents.

Economics of California Cannabis Wholesale and Retail Activities

The medicinal cannabis segment operated for about 20 years with no significant state regulation and a small and highly variable degree of regulation under local jurisdictions. In many municipalities, no cannabis retail storefronts were allowed, but delivery services made cannabis available to customers with medicinal recommendations. Medicinal cannabis buyers were required to obtain a medical document (not a prescription) signed by a California physician indicating that cannabis was recommended. In practice, such recommendations could be obtained via a very quick in-person visit. A patient would self-report medical symptoms indicating cannabis, and to show that he or she (or his or her parent or legal caretaker) was a California resident aged 18 or over. The typical fee for an in-person appointment was about \$50.

In recent years, some doctors began offering these recommendations via websites with video-chat functionality. No video chat was required—only completion of an on-line form, proof that the patient was a California resident of legal age, and access to payment by credit card. Fees for online appointments were somewhat lower and permission was available within minutes. It is instructive to note that despite the ease of meeting the medicinal requirements, most cannabis remained outside this California-legal retail segment.

Table 3 shows our estimates of the situation of the retail cannabis market within California in 2017. We estimate that about 700,000 pounds of cannabis on a dried-flower-equivalent basis were sold in California through medicinal cannabis retail firms known as dispensaries. Another 2.1 million pounds were sold through the unregulated (illegal) segment. Based on the AIC survey and a number of industry sources, we estimate that the retail price of medicinal cannabis averaged about \$3,600 per pound for total retail revenue of about \$2.5 billion in 2017. The unregulated segment had a price that was about 66 percent of the medicinal price, or about \$2,360 per pound, for estimated revenue of about \$5 billion. Thus, we estimate full retail cannabis sales were about \$7.5 billion in 2017.

Assessments of 2017 cannabis consumption in California are complicated by the mixed legal and illegal situation. Adult possession of cannabis was legal according to state law. At the same time, sales of cannabis remained illegal unless the retailer had a local license and the buyer had a medical permission. Sumner et al. (2018) base their estimates on a large number of sources, including surveys of illegal cannabis use, data from consumption surveys and government records in Colorado and Washington, and industry surveys.

Table 3. Estimated California Retail Cannabis Quantities, Prices, and Revenues, 2017

Segment	Share Percent	Flower Equivalent Thousand Pounds	Retail Price \$/Pound	Retail Revenue \$ Billion
Medical Cannabis	25	700	3,600	\$2.5
Unregulated Cannabis	75	2,100	2,360 (~66% of medical price)	\$5.0
Total Cannabis Market	100	2,800	2,667 (~average)	\$7.5

Sources: UC Agricultural Issues Center retail cannabis price survey; Board of Equalization tax data; AIC market review of public estimates of cannabis prices and quantities.

Table 4. Average California Retail Prices Across Medical Cannabis Dispensaries, November 2017

	Average Low Price	Average High Price
	\$/Package	
One-eighth Ounce Dried Flower Package	31	51
Full Ounce Dried Flower Package	177	305
0.5 gram c\Cartridge	30	43

Source: UC AIC cannabis price survey.

Distribution of consumption by demographic group is available from federal surveys of drug use. These surveys are often adjusted for under reporting, but one common result is that most of the consumption, about 80 percent, is by the 20 percent of those who are heavy users. This estimate is useful in assessing average prices, purchase quantities, and impacts of taxation and regulation.

An AIC retail price survey in November 2017 collected “high” prices (highest listed on the on-line menu) and “low” prices (lowest listed on the on-line menu) at more than 2,600 medicinal cannabis retailers in California that had on-line price lists—both storefront and delivery only—across all regions of the state. AIC surveyed high and low prices for three product categories: a package of one-eighth ounce of dried flowers, a package of one full ounce of dried flowers, and a 500-milligram oil cartridge.

Table 4 presents a summary of these price data. The average of the low one-eighth ounce prices is about \$31, or about 60 percent of the average of the high prices of \$51. For full ounces the range is similar. In both cases, the higher prices tend to be flowers listed with higher-than-average THC concentrations and/or named strains that claim special qualities. Notice that in Table 4, the equivalent price per ounce for the one-eighth-ounce packages is much higher than the average price per ounce listed for the one-ounce sized packages. The low cost per ounce of eight one-eighth-ounce packages is \$248 compared to the low price of a one-ounce package of \$177. The high cost of such a purchase of eight small package is \$408 per ounce compared to the average high price per ounce of \$305.

Based on U.S. government surveys, heavy cannabis users consume more than one ounce per month. Hence, these buyers have a strong incentive to buy larger package sizes.

Cartridge prices have a somewhat smaller range, but are in the same general price range as a one-eighth ounce package of dried flowers. For the cartridges, high prices were generally for relatively more concentrated (75 percent THC) cannabis oil, whereas low prices were generally for relatively less concentrated (60 percent–67 percent THC) cannabis oil.

For estimates of market prices and quantities, we convert manufactured product sales into “dried flower equivalent” units of one pound dried cannabis flower with 20 percent THC. The 30 percent share (by revenue) of manufactured products of the retail market is thus incorporated into other overall cannabis estimates in this chapter.

The wholesale and retail functions for cannabis and the required product testing is being regulated by the Bureau of Cannabis Control (Bureau), a newly formed agency of the California Department of Consumer Affairs. The Bureau formulated a set of regulations to implement the requirements of MAUCRSA and in 2018 is overseeing the phase-in of rules.

As of the end of April 2018, the Bureau had issued almost 2,000 temporary licenses of all types, including 25 licenses for testing laboratories, which must be independent of any other cannabis businesses. It had also issued about 50 cannabis event-organizer licenses, which allows organizing events where cannabis is sold, but requires any such sales to be done by companies with a retail license. About 930 temporary retailer licenses had been issued, including those authorized for only delivery with no store-front premises. These retail licenses include both medicinal and adult-use as separate licenses and most license holders have both. In addition, the Bureau had issued more than 750 distributor licenses (adding those for medicinal and

Table 5. Summary of Taxes and Regulatory Costs for California Cannabis Markets

Value	Medicinal Segment	Adult Use segment	Illegal Segment
\$/Pound (Dried Flower Equivalent)			
State Cultivation Taxes	148	148	0
Local Cultivation Taxes	128	128	0
Cultivation Regulatory Compliance Costs	50	50	0
Manufacturing Taxes and Compliance Costs	95	95	0
Testing Compliance Costs, Including Cost of Rejected Product	257	257	0
Distribution and Retail Compliance Costs	151	151	0
Percent			
Excise Tax Rate	15	15	0
Sales Tax Rate	2.1	8.3	0
Local Percentage Taxes and Fees	7.8	8.2	0
Local Percentage Taxes on Testing Revenue	4.9	4.9	0

Sources: Relevant California laws and proposed regulations, estimates from state agencies and AIC estimates

adult-use), including about 150 for companies that only transport cannabis and cannot do other wholesaling functions to be described below. Finally, about 140 microbusiness licenses have been issued. These allow the licensee to operate as a cultivator with less than 10,000 square feet under canopy; a manufacturer that does not use solvent-based extraction; a distributor; and a retailer. The micro-business must conduct three of these four activities.

An important area of regulation covers implementation of the track-and-trace system, which starts with cultivation and continues through retail sales. A number of security measures require cameras, video archival, record keeping, security guards, specified security in delivery, and secure destruction and disposal of any cannabis that is unsold or not allowed to be sold. Secure childproof packaging is another relatively costly requirement. Even more costly is the requirement that each batch of cannabis (with maximum batch size of 50 pounds) must be tested for a long list of microbial and chemical contaminants as well as for THC levels, moisture, and for some manufactured products, uniformity. The distributors are required to hold the cannabis products during testing and are responsible for submitting excise and cultivation taxes to the State of California authorities.

Sumner et al. (2018) find that tests themselves are likely to cost more than \$50 per pound. However, the largest cost derives from loss of product that fails the required tests. Given zero tolerance for contaminants such as pesticides and microbes and the difficulty for growers to meet the very tight standard, Sumner et al. (2018) expect about 12 percent of product to fail the tests and be destroyed as a result. This rate, which is in line with other industry estimates, assumes that companies pre-test some of the cannabis (which is also a significant expense), and recondition and retest some of the batches that fail for reasons that do not rule out remediation. Nonetheless, a 12 percent failure rate would cost an average of \$200 per pound of the products that pass and are eligible to be sold in the regulated cannabis market.

Table 5 provides a summary of taxes, fees, and regulatory costs including those at the cultivation, manufacturing, wholesale and retail stages. The retail taxes for cannabis are added in several steps from both state and local jurisdictions. The excise tax, as mandated by MAUCSRA, is 15 percent of the estimated retail revenue, which is calculated as 1.6 times the full wholesale cost (including full costs of the products that have passed the required testing). That is, the excise tax is based on data on wholesale costs, and assumes a 60 percent markup from

wholesale to retail. The state and local sales tax applies in full to adult-use cannabis based on the full retail prices, as with other products in California.

The state sales tax is 7.25 percent and the average county sales tax is about 1.05 percent for a total of 8.3 percent. The sales tax does not apply to medicinal cannabis sales if the buyer has a county-issued medical card in addition to the required medical recommendation. Counties are permitted to charge up to \$100 for the county-issued ID card. Heavy cannabis users would likely still find such an exemption worthwhile. For example, assuming the cost of the recommendation and card is about \$150 per year, then a buyer purchasing more than $\$150/0.083 = \$1,800$ per year would benefit from paying this cost. Given average retail prices of more than \$250 per pound, buyers of more than about 8 ounces per year would significantly benefit from this investment. Some medicinal buyers, such as those between 18 and 21 who are not eligible to access the adult-use market, will pay the sales tax. Overall, we assume that about 25 percent of medicinal cannabis will have sales tax assessed.

Local taxes vary widely across the state. A survey of local taxes and fees that were implemented, scheduled, or likely in early 2018 indicated an average of 8.2 percent for adult-use cannabis and 7.8 percent for medicinal cannabis (Sumner et al., 2018). We recognize that retailers will tend to avoid high-tax places for retail operations; especially given that delivery operations are not legally limited to delivering within a particular jurisdiction, we assume that many customers will be willing to travel across (or order across) jurisdictions for a lower price. There are also local taxes that average 4.9 percent on testing lab revenue. This tax is very small as a share of the cost of cannabis, amounting to about \$2.50 per pound (compared, for example, to the excise tax that is likely to add about \$600 per pound to retail cost).

In order to gauge the impacts of taxes, regulations, and legalization on cannabis purchases overall, as well as in the medicinal, adult-use, and illegal segments, we developed a set of equilibrium displacement model simulations based on assumptions about the initial situation; supply and demand shifts; and supply and demand elasticities, including, importantly, substitution for buyers across segments.

Before turning to results, let us very briefly outline the main underlying assumptions. We start with a situation where adult-use cannabis is legal and sales are about 700,000 pounds, while medicinal sales are about 600,000 pounds and illegal sales are 1,300,000 pounds. The supply elasticity of cannabis in each segment is 5.0, which reflects that fact that cannabis requires few specialized resources and will be a very small share of the space available in greenhouses, warehouses, or outdoor plots (Matthews and Sumner, 2017). The demand elasticity for cannabis overall is taken to be quite inelastic. We use -0.2 from Jacobi and Sovinsky (2016), but this parameter is of little importance in the main results.

The important demand parameters are the own-price and cross-price elasticities among the segments. These elasticities are not based on econometric estimates, because we found no useful data on variations in prices and quantities. The experiences of Colorado and Washington have guided our specifications, but did not provide data for econometric demand estimates.

We frame the demand for cannabis in each segment as a part of a separable group with high elasticities of substitution of 5.0 between medicinal and adult-use segments and 2.0 between the illegal segment and the two regulated segments. The conditional expenditure elasticities are all 1.0. The income share is very small for Californians as a whole. The implied own demand elasticities are about -2.5 in the medicinal segment, -2.25 in the adult-use segment and about -1.3 in the illegal segment, given the larger share of illegal cannabis that each of the other two segments. Cross elasticities are about 1.5 between the two regulated segments and below unity between the illegal segment and the two regulated segments.

We assume that adult-use legalization and regulations will shift the marginal cost and demand functions. Our assumptions are as follows. Legalization and regulations cause marginal costs of the two regulated segments to decline by 12 percent because of access to better management, more secure capital, and less threat of crime and law enforcement actions. Costs rise by 10 percent in the illegal segment to reflect reduced access to qualified managers and increased state-level enforcement against non-compliant cannabis businesses. These proportional

Table 6. Simulated Equilibrium California Cannabis Prices, Quantities, Revenues, and Taxes after Full Implementation of Taxation and Regulation

Variable	Medicinal Segment	Adult-Use Segment	All Legal Cannabis	Illegal Segment	Total Cannabis
\$/Pound					
Average Retail Full Price to Buyers	4,841	5,104		2,659	
Thousand Pounds					
Quantity	616	724	1,339	1,535	2,874
\$ Millions					
Revenue Without Tax	2,216	2,609	4,825	4,081	8,906
Total Tax Revenue	764	1,084	1,849	0	1,849
Total Revenue	2,981	3,693	6,674	4,081	10,755

Source: AIC simulations and calculations.

cost shifts apply throughout the supply chain from cultivation through retail.

On the demand side, the regulatory restriction that cannabis retailers must close at 10pm each evening, which reduces access relative to the illegal segment, is assumed to reduce demand for regulated cannabis by 2 percent. Offsetting this demand shift is a shift up in willingness to pay in the regulated segments by 6 percent and a shift down in willingness to pay in the illegal segment due to testing and product security. The notion that safety testing and government assurances of testing and safety can increase willingness to pay is widely incorporated in analysis of demand for other agricultural products (Pouliot and Sumner, 2008; Saitone, Sexton, and Sumner, 2016; and Gray et al., 2005). The final demand shift is a 30 percent shift out in demand for adult-use cannabis which occurs with legalization and easy access through retail markets. This demand shift reflects demand from tourists, publicity, and advertising.

The model applies the tax and regulatory shocks as specified in Table 5 to the prior supply and demand equilibrium. These shocks are accompanied by the supply and marginal cost shifts induced by legalization and regulation. As with common model applications that compares two equilibrium situations, we do not examine the path from one situation to the other. In the case of cannabis legalization and regulation, we expect and (in early 2018) have already begun to observe the considerable flux that accompanies uncertainty and the progressive,

asynchronous nature of implementation and enforcement of some regulations and taxes. In a sense, a new legal industry and a new framework of regulations are being created. The government is phasing in the licensing and regulations over a full year, and thus we will not observe the new situation until 2019 at the earliest. Of course, the market will not be static, and we do not expect a static equilibrium to persist even when all regulations are fully implemented.

Table 6 provides information about the new situation based on the taxes, regulations, and assumptions outlined. We stress that these results are more than usually tentative (Hyde, 2016). We project prices (including all taxes) in the medical and adult-use segments to be about \$5,000 per pound, while the price in the illegal segment will be just over half that. One uncertainty relates to the potential for the farm cost of legal cannabis to decline more than we assume, but we also note that costs must incorporate the added cost of meeting all the regulations that are not specific to cannabis, and that farm cost makes up at most a third of retail price.

Notice that we project that the two legal segments, together, will comprise about 46 percent of total cannabis quantity purchased in California. The retail price differences are enough to more than offset the demand shifts and marginal cost shifts. Our assumptions about lower costs in the two regulated segments and large shifts up in willingness to pay for tested cannabis and security regulation allow the regulated segment to maintain

its size despite severe price differences with the illegal segment. Within the regulated segment, the lower tax in the medicinal segment is enough to allow that segment to retain many relatively heavy users and decline by only 12 percent.

Because of higher prices, taxes, and costs, aggregate revenue in the regulated segments together exceeds that in the illegal segment. Revenue net of all taxes is almost \$5 billion, or about 54 percent of the total cannabis revenue. We estimate that all tax revenue approaches \$2 billion per year. Overall, the tax-inclusive revenue in the two regulated segments is about \$6.7 billion, compared to about \$4.1 billion in the illegal segment, for a total cannabis revenue of about \$10.8 billion when the \$1.85 billion in taxes is included.

Conclusions

About 80 percent of cannabis grown in California remains illegal under both state and Federal law because it is grown to be shipped out of California. Total farm revenue is likely to be about \$16 billion, including \$3 billion within California—about half of which is illegal—and \$13 billion of illegal cannabis shipped out of California. As with other farm products, the retail revenues are much larger.

We conducted a careful review of regulations and taxes that are in the process of being implemented in California. In order to project where the market is likely to be once taxes and regulations are fully implemented in 2019, we made a long list of assumptions about supply and demand elasticities and shifts. All of these assumptions are open to question. Some, such as demand substitution across segments, magnitude of demand, and marginal cost shifts, are based on little evidence. Nonetheless, we hope that our estimates may be useful for those interested in where the cannabis industry is heading in California. We expect that the illegal segments will remain in place, but that the regulated segments will capture a sizeable part of the overall market and generate billions of dollars in revenue, including almost \$2 billion in tax revenue for the state and local jurisdictions.

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