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WORKING PAPER NO. 883

AN ANALYSIS OF THE HORTICULTURAL ECONOMY IN CALIFORNIA

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DEPARTMENT OF AGRICULTURE AND
RESOURCE ECONOMICS AND POLICY
BERKELEY

CALIFORNIA AGRICULTURAL EXPERIMENT STATION

University of California

DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS AND POLICY
DIVISION OF AGRICULTURE AND NATURAL RESOURCES
UNIVERSITY OF CALIFORNIA AT BERKELEY

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An Analysis of the Horticultural Economy in California

Abstract–Californians spent $8.5 billion on environmental horticulture and generated $10.1 billion of horticultural sales in 1995. These sales directly supported 129,000 jobs. These estimates cover both market and in-house activities. Horticultural landscapes covered almost 1.37 million acres in the state. Expenditures per acre, which range from $927 for vegetation under electrical power lines to $11,718 for arboreta and botanical gardens, tend to increase as the importance of plant variety and quality in the landscape for the associated consumption activity increases. California farmers had $1.8 billion and $20.3 billion in sales, respectively, from horticultural and agricultural crop production in 1995. Forecasts of nominal horticultural expenditures and sales in 1998 are $9.8 billion and $11.5 billion, respectively. Information on the estimated size of the industry and its breakdown by landscape type can help businesses to develop marketing strategies and new products. Policy makers can use results of this study to estimate water and chemical use by landscape type and justify more budgetary support for education, extension, research, and regulation that address important issues related to this growing industry.

JEL Classification Codes: Q10, Q24, R12, R14, R15

Keywords: economic impacts, environmental horticulture, horticulture and landscaping services,. regional economics, spatial impacts, turfgrass industry,

Communicate questions or comments about the contents of this paper to
Scott R. Templeton
Department of Agricultural and Resource Economics
207 Giannini Hall, MC# 3310
University of California at Berkeley
Berkeley, California 94720-3310
510-642-3349 (w), temple@are.berkeley.edu

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An Analysis of the Horticultural Economy in California

Introduction

Horticulture involves the use of plants or planted landscapes to enhance indoor or outdoor environments for human activity. Private benefits include aesthetic pleasure, recreation, safer playing surfaces and roadsides, stress reduction, quicker convalescence, higher workplace productivity (Beard and Green, 1994), lower cooling expenses due to shade (McPherson and Rowntree, 1993), and gains in property values (Henry, 1993). As income and population increase, the demand for consumption activities dependent on horticulture increases and the industry becomes a source of growth in profits and jobs. As the industry grows, more areas are converted into landscapes that often contain non-native plants, are maintained through intensive use of water, mechanical, and chemical inputs, and require disposal of green waste. Although horticulture can create environmental benefits, some land conversions, non-native plants, intensive input use, and waste disposal can adversely affect environmental quality or human health (e.g., Balogh et al., 1992; Beard and Green, 1994; Kross et al., 1996; Templeton et al., 1998). As a result, the industry becomes more regulated (e.g., EPA, 1996). Thus, economic information about horticulture becomes important for determining the industry's contributions to the economy relative to other industries, assessing land use changes or regulatory impacts, and establishing priorities for public and private policy makers.

The purpose of this paper is to analyze the size, associated impacts, and expenditure intensity of the horticultural economy in California. Some previous research has focused on segments of the industry, such as urban forestry (Templeton and Goldman, 1996), wholesale nurseries (Schuch and Klein, 1996), or turfgrass (Cockerham and Gibeault, 1985). Other research (e.g., Pittenger et al., 1991) has focused on private sellers for which secondary market data are readily available but not on most of the institutions that provide in-house horticultural services. Some studies (e.g., Tootelian, 1993) also do not distinguish between wholesale and retail sales and, as a result, over-estimate economic impacts. None of the studies presents confidence intervals for estimates of industry size, none of the studies except Templeton and Goldman (1996) utilize primary data or auxiliary information, and most are outdated.

In this paper, 'horticulture' is synonymous with 'environmental horticulture'. The term includes 'ornamental horticulture', 'landscaping', 'turfgrass management', 'floriculture', and 'arboriculture'. The term excludes the cultivation of fruits and vegetables for home consumption, which is part of agriculture. In the next section, data and estimation methods are discussed. Thirteen sections of the paper then highlight our estimates of total expenditures, sales, jobs, and area, if any, associated with design, installation, and maintenance of twelve landscape types and horticultural waste. The landscapes are private residential yards, interior environments, golf courses, public parks, vegetation along roadsides and other right-of-ways, school yards, cemetery grounds, vegetation under electric power lines, arboreta and botanical gardens, zoos, other landscapes in California, and landscapes outside of the state. A fourteenth section presents estimates of jobs directly associated with marketed goods and professional services. Economic impacts of sales are estimated with multipliers derived from three horticultural sectors in the IMPLAN model for California and discussed in the third from the last section. Area and expenses per acre are analyzed in the second from the last. Horticultural and agricultural crop production are compared in the penultimate section. Forecasts for the state's horticultural economy in 1998 and implications of our findings for future research and policy are discussed in the conclusion.

Estimation Methods and Data

Estimators of total expenditures, jobs, or area associated with eight of the landscape types and estimators of the standard deviations of these population estimators incorporate the finite number of management units of the landscape type and the fact that sampling of these units occurred without replacement. These estimators are discussed in Cochran (1977) and in 'Endnotes'.[1] In almost all cases, estimates of expenditures for a particular landscape are also estimates of in-house or contractual sales to people within the state who provide horticultural goods or services. Primary data come from National Gardening Association's household survey (NGA, 1996) that was augmented with questions about yard size, benchmark surveys of California State University campuses (NACUBO, 1996), our updates of previous surveys of electric utilities

(Templeton and Goldman, 1996), the State Controller's Office, and our mail surveys of the California Department of Transportation, University of California campuses, public school districts, private schools, cemeteries, arboreta, and zoos. Sources of secondary data include the California Department of Water Resources, California Integrated Waste Management Board, National Christmas Tree Association, State Board of Equalization, National Golf Foundation, Golf Course Superintendents Association of America, Employment Development Department, California Department of Food and Agriculture, and, as a last resort, the 1994 IMPLAN database. These secondary data, however, do not permit estimation of standard deviations.

Estimates of three population totals are based on auxiliary data. In particular, let X_{jk} and Y_{jk} be horticultural expenditures and jobs, respectively, in which k = city or county if j = parks and k = city if j = street landscapes. Let W_k and Z_k be arboricultural expenditures and jobs, respectively, associated with k (= city or county) government's management of trees along streets and in parks. Assume $\frac{Y_{jk}}{X_{jk}} = \frac{Z_k}{W_k}$. Given this assumption and relevant formula in Cochran (1977, 30-34 and 153-155), one can show that a consistent, ratio-based estimator of horticultural jobs associated with city parks, county parks, or city streets is $\hat{Y}_{R_{jk}} = X_{jk}\frac{\bar{z}_k}{\bar{w}_k}$. The variance of this estimator is $V\left(X_{jk}\frac{\bar{z}_k}{\bar{w}_k}\right) = X_{jk}{}^2 V\left(\frac{\bar{z}_k}{\bar{w}_k}\right) \cong X_{jk}{}^2 \frac{(N_k - n_k)}{N_k}\frac{1}{\overline{W}_k^2}\frac{1}{n_k}\frac{\sum_{i=1}^{N_k}(z_{ik} - R_k w_{ik})^2}{N_k - 1}$. A traditional estimator of this variance is $v\left(X_{jk}\frac{\bar{z}_k}{\bar{w}_k}\right) = X_{jk}{}^2 v\left(\frac{\bar{z}_k}{\bar{w}_k}\right) \cong X_{jk}{}^2 \frac{(N_k - n_k)}{N_k}\frac{1}{\bar{w}_k^2}\frac{1}{n_k}\frac{\sum_{i=1}^{n_k}(z_{ik} - \hat{R}_k w_{ik})^2}{n_k - 1}$. The ratios, $\frac{Z_k}{W_k}$, are estimated for cities and counties with data from the 1992 California Community and Urban Forestry Survey (Bernhardt and Swiecki, 1993, 56-61).

Residential Yards

Households in California spent an estimated \$3.579 billion on planted yards in 1995 (Table 1). There were 10.97 million households in the state at the end of 1995 (DF, 1996, 129). Answers from the California respondents (n=127) to various questions in NGA's survey indicate that almost 80% of all households had planted yards. Their planted yards covered about 679.4

thousand acres (n=83, s.d.=82.6, Table 3). These households spent about $1.864 billion (n=101, s.d.=0.329) on do-it-yourself yard activities and about $1.185 billion (n=101, s.d.=0.308) for 'professional lawn care, landscape maintenance, and tree care' in 1995 (Table 1). Owners of newly constructed residences paid an estimated $169 million for professional installation of their front yards in 1995, given 85,293 new residential units in that year (Anonymous, 1999) and, according to three residential real estate developers, an average installation cost of $2,000 per unit. Households spent $361 million (1995 $s) to water their yard plants (n=60, s.d.=46) in 1991, a drought year. This figure is estimated with data on average monthly water bills of single family residences for sixty selected agencies (DWR, 1994, F-2) and under assumptions that single-family residences spend 14% more than multiple-family residences, the summer season lasts six months, and the excess of the average monthly bill in the summer over the average monthly bill in the winter reflects water use for yards.

Cut Flowers, Indoor Houseplants, and Christmas Trees

Individuals and other consumers in California spent about $1.661 billion on plants for indoor decoration and about $1.605 billion circulated within the state economy (Table 1). Most of this expenditure was for cut flowers and greens. There were 4,914 florists who had retail sales of $714 million in 1995, according to sales tax data (CSBE, 1995, 2). Home centers, discount stores, supermarkets, and other diversified retailers are not considered florists for tax purposes but represent at least half of the cut flower market, according to both professional judgment (Kellogg, 1998) and marketing evidence for related products (Templeton et al., 1998). Given a 50% market share of retail florists, retail sales of cut flowers and greens were $1.429 billion in 1995. Net exports of these products by retailers are assumed to be zero.

People also use potted plants and Christmas trees to enhance indoor environments. According to NGA data, 21% of all households in California cared for indoor houseplants and spent an estimated $102 million (n=101, s.d.=37) for these plants and their care in 1995.[2] In addition, a different survey conducted by Gallup indicated that 48% of all households in California and other states in the 'West' purchased real Christmas trees (NCTA, 1996, 8 and 10). Given this percentage and a national average retail price of $25.00 per tree (NCTA, 1996, 11), households spent about $131 million for these trees. Since California growers sold about $19 million of cut-and-carry Christmas trees (CDFA, 1996, 9), the remaining $112 million was spent on imported real Christmas trees, primarily from Oregon. Give the typical retail markup of 100% (Wade, 1996), about 50% of this remainder, or $56 million, stayed within the state. In total, about $75 million of household spending on Christmas trees stayed within the state's economy.

Golf Courses

Golf courses are important horticultural landscapes in California. In 1995 the state had 898 golf courses, 306 private and 592 public (NGF, 1999). Private and public golf facilities in the western U.S. spent, on average, $771,330 and $645,583, respectively, for landscape maintenance and $87,945 and $63,424, respectively, for landscape-related capital expenses in 1995 (GCSAA, 1996, 6). Hence, golf facilities in the state spent a total of $618.2 million for maintenance and $64.5 million for capital expenses, or $683 million for horticulture in 1995 (Table 1). The median size of private 18-hole courses was 146 acres and the median number of employees was 15 in 1995 (NGF, 1999). These figures are assumed to be the mean employment and planted area for the population of private and public courses in California. Given this assumption, horticultural management of golf courses in the state entailed 13,470 jobs (Table 2) and course vegetation covered about 131,108 acres (Table 3).

Public Parks

California had 23 national and 277 state parks, reserves, beaches, historic parks, historic monuments, and recreation areas as of June 30, 1995 (DF, 1996, 3-6). Although these national and state properties covered 8.1 and 1.3 billion acres, respectively (DF, 1996, 4), only a small portion were intensively managed as horticultural landscapes. For example, Golden Gate National Recreation Area and Muir Woods National Monument account for 73,185 and 554 respective acres (DF, 1996, 3), but had only about 244 and 10 acres of maintained landscapes (Weeks, 1998). City, county, and district parks numbered 7,738 and covered more than 157,432 acres in 1987 (Anonymous, 1989). In total, public parks covered at least 157,686 acres in 1995 (Table 3).

Agencies that manage public parks in California spent an estimated $600 million on horticulture in FY94-95 (Table 1). The federal government spent about $1.2 million for horticultural landscapes in the Golden Gate National Recreation Area and Muir Woods National Monument (Wood, 1998). The state's Department of Parks and Recreation spent $0.5 million for landscape maintenance materials in FY96-97 (Bradshaw, 1996). Under the assumption that this expense represents 15% of total expenses, which also include irrigation, labor, and administration (Anonymous, 1989, 12), the Department spent $3.3 million (1995 $s) for maintenance of landscapes in state parks. Local governments reported expenditures of $1.337 billion for city parks and recreation (Connell, 1997a, 485) and $175 million for county recreational facilities (Connell, 1997b, 12). According to three parks and recreation officials, local governments spend 39% of their budgets and, by implication, spent almost $526.6 million and $68.9 million in FY94-95 for horticulture at city and county parks.

Estimates from surveys of park administrators concerning full-time equivalent jobs attributable to design, installation, and maintenance of vegetation in public parks were not available. However, data from Bernhardt and Swiecki (1993, 56-61) indicate that city and county agencies had about 1.7 and 1.4 full-time equivalent, in-house jobs per $100,000 of expenditure for arboriculture, respectively. Given these ratios, the expenditures of cities and counties for horticulture imply the equivalent of 8,819 (n=260, s.d. =347) and 970 (n=33, s.d.=186) full-time jobs. Under the assumption that the unknown ratio for state parks is the same as the ratio for county parks, the expenditure of the Department of Parks and Recreation implies 47 FTEs (n=33, s.d.=9) for landscape maintenance at state parks. The two federal parks surveyed paid for person-days of in-house work that were the equivalent of about 35 full-time jobs in FY95-96. In total, then, people worked the equivalent of 9,871 full-time jobs related to horticulture in city, county, state, and two federal parks (Table 2).

Street and Highway Landscapes

Government agencies manage landscaped vegetation along streets and highways. In total (Tables 1-3), city governments and the California Department of Transportation (CALTRANS) spent about $326 million for design, installation, and maintenance of 71,968 acres of roadside vegetation (s.d.=406) and engaged in horticultural-related work that was the equivalent of 4,401 full-time, in-house jobs (s.d.=144). These estimates break down as follows.

According to 470 fiscal reports (Connell, 1997a), city governments in California spent $204.2 million for street trees and roadway-related landscaping and $14.5 million on weed abatement in FY94-95. Given 1.7 full-time equivalent, in-house jobs per $100,000 of expenditure by cities for arboriculture, the expenditure of almost $219 million implies 3,663 full-time equivalent jobs (n=260, s.d.=144, Table 2). According to data from CALTRANS (1992) that were compiled by Bernhardt and Swiecki (1993), there were 63,457 miles of streets in 458 of the state's 468 cities in 1991. The state had two more incorporated cities by 1995. City governments have jurisdiction over strips of land that are typically ten feet wide from the curb on each side of the street (Kelly, 1998; Sachs, 1998). The planted landscape portion of these strips is assumed to be three feet wide, on average, because sidewalks are typically five feet wide and certain parts of this right-of-way--e.g., driveways and street corners--have no plants at all. Given this assumption, the population in California's cities in 1995, and a ratio of about 2.58 miles per 1,000 city residents, the roadside vegetation along city streets covered an estimated 49,190 acres (n=458, s.d.=406).[3]

CALTRANS manages 22,778 acres of landscapes around roadways and employs people to fill the equivalent of 738 full-time positions for landscape design, installation, and maintenance (Koe, 1998; Shields, 1998). Total horticultural maintenance expenditures for FY 1994-95, which include in-house labor, equipment, materials, and contracts, were $95.2 million. CALTRANS also spends $12.5 million a year, on average, for landscape design and installation.

School Yards

Planted landscapes beautify schools, enable recreation, and, thereby, enhance educational environments in California. Public universities and all primary and secondary schools in the state spent almost $312 million (n=55, s.d.=57 million) to manage 108,948 acres (n=61, s.d.=15,314) of horticultural landscapes with the equivalent of 14,288 (n=57, s.d.=2,816) full-time employees, including associated supervisors and administrators (Tables 1-3).

California's two public university systems, the University of California (UC) and California State University (CSU), had more than one half of a million students and almost 180,000 faculty and staff, all of whom could be considered potential consumers of the campus landscapes. In FY94-95 (Tables 1-3), facilities and grounds superintendents at nine UC campuses and twenty CSU campuses spent $26.7 million (n=19, s.d.=1.70) for maintenance and installation of horticultural landscapes that covered 8,700 acres (n=24, s.d.=851). This expenditure directly supported the equivalent of 672 full-time, in-house jobs (n=19, s.d.=33). The sample consists of five responses from UC campuses and, depending on the questions, 14 or 19 of the twenty CSU campuses that operated during FY94-95 (NACUBO, 1996).

Decisions about sizes of budgets and numbers of full-time equivalent jobs for elementary and secondary school yards are made by administrators at the district level for public schools but at the school level for private schools. There were 993 public school districts (Connell, 1997c) and 4,152 private schools in California in FY94-95 (Calderone, 1997). Surveys were sent to 196 public school districts and 257 private schools. The response rate was 14% and 4%, respectively. Respondents were grouped into the following sub-samples: the two largest unified school districts, the next eighteen largest unified districts, other unified and common administration districts, high school districts, elementary school districts, and private schools. According to survey responses, public and private schools employed people to fill the equivalent of 13,616 full-time jobs (n=38, s.d.=2,816) and spent $285.6 million (n=36, s.d.=57) for installation and maintenance of planted school yards that covered 100,248 acres (n=37, s.d.=15,290). These estimates reflect estimates of totals and variances for each of the sub-samples.

Landscape under Electric Power Lines

Prior to recent deregulation, California had 37 electric utilities, but five of them accounted for more than 90% of all customers (Fay, 1991). To ensure unfettered delivery of electricity, these utilities or their contractors regularly inspect a twenty-foot diameter, aerial corridor around power lines for intrusions of tree branches, prune back branches that are too close, remove all vegetation on the ground within ten feet of power poles, and restore power after outages that are caused by fallen or damaged trees in accordance with fire and safety regulations (Cieslewicz, 1998). Utilities also sponsor shade tree programs, educate customers about proper selection and location of trees near power lines, beautify company property with trees, settle legal claims related to tree fires, and promote tree-related research. In 1995 electric utilities spent about $147 million for these activities, the most significant of which was tree inspection and pruning (n=5, s.d.=$22, Table 1). This work entailed the equivalent of 272 in-house, full-time jobs in 1995 (n=5, s.d.=84, Table 2). Two of the five utilities had in-house tree crews. Other jobs were for supervising or providing support services for tree crews, whether in-house or contractual.

Three of the largest five utilities reported 175,000 miles of electrical lines of which 155,000 miles were for distribution and 20,000 were for transmission. The estimated total lengths of distribution and transmission lines are 197,727 and 25,513 miles, respectively. We assume that the twenty-foot diameter aerial corridor around transmission lines translates into a vegetative strip on the ground of at least the same width because these lines typically run through forests, pastures, deserts, and other areas with vegetation (Cieslewicz, 1998). The diameter of the aerial corridor around distribution lines, however, does not imply a twenty-foot wide vegetative strip on the ground. Distribution lines typically run along one side of a street, one foot from the curb. Road pavement and sidewalks respectively cover nine and another five of the twenty foot strip. To account for this fourteen foot width, driveways, and other hardscape underneath, we assume that the vegetation inside the twenty foot projection and the trunks of trees outside of it but with overlapping branches represent an area the equivalent of a four-foot wide vegetative strip under distribution lines. Given these assumptions, the estimated vegetative area that contains trees and other vegetation for which utilities are responsible is 157,717 acres (n=3, s.d.=39,077, Table 3).[4]

Cemetery Grounds

Cemetery grounds are another important horticultural landscape. Economic reasoning suggests that the location, turf grass health, and overall appearance of the planted landscape affect the market value of burial plots. There were 198 licensed cemeteries in California in 1996 (CLB, 1997). Private cemeteries that were established before 1939 and are less than ten acres or cemeteries run by religious institutions, city or county districts, historical societies, or military organizations are not licensed. Records from telephone, religious, and Internet directories indicate 554 licensed and unlicensed cemetery operators in California in 1996. A few of these were pet cemeteries. We surveyed this entire population. According to their responses, these operators employed people for 3,218 full-time equivalent jobs (n=74, s.d.=609) and spent $141 million (n=72, s.d.=24.7 million) on installation and maintenance, including irrigation, of 921 cemeteries (n=77, s.d.=81) that occupied 17,931 acres (n=76, s.d.=2,857) in 1995. (See Tables 1-3.)

Arboreta and Botanical Gardens

Arboreta and botanical gardens provide recreation, education, and, in some cases, *ex situ* conservation of rare plants. There are at least 51 arboreta and botanical gardens in California (Mulligan, 1991; Sunset, 1995). According to data from our survey of all of them, these 51 arboreta and gardens had horticultural expenses of $13 million (n=12, s.d.=3.9, Table 1), vegetation that covered 1,133 acres (n=13, s.d.=255, Table 3), and employed people for 331 full-time equivalent jobs (n=13, s.d.=54, Table 2).

Zoos

Planted landscapes enhance recreation for people who visit zoos and habitat for some of the animals. Internet directories and travel guides (e.g., AAA, 1997) indicate that California had 18 zoos. According to responses to our survey, these zoos spent $7.25 million (n=5, s.d.=3.6) for installation and maintenance of 702 planted acres (n=5, s.d.=335) in 1995. Horticultural activities at these zoos accounted for 150 full-time equivalent jobs (n=5, s.d.=73) in the same year.

Other Horticultural Landscapes in California

Airports, hotels, hospitals, business parks, military organizations, and numerous other organizations paid $467 million ($1995) for contractual design, installation, and maintenance of planted landscapes around their facilities in 1994 (Table 1). This estimate is essentially the sales of companies that provide 'landscape and horticultural services' (IMPLAN sector 27, or SIC 078) to all other domestic IMPLAN sectors except owner-occupied dwellings (sector 461), funeral homes (sector 467), schools (sectors 495-497 and 522), electric utilities (sectors 443 and 511), state and local government (sectors 512 and 523), and buyers outside of California. This estimate also reflects $0.26 million of sales of lawn and garden equipment (sector 310, or SIC 3524) to the federal government (MIG, 1997).

Horticultural Waste

Use of ornamental plants and planted landscapes requires management of plant waste. Californians spent an estimated $582 million on horticultural waste in 1995 (Table 1). This estimate is based on the following information. The California Integrated Waste Management Board estimates that 4.9 million tons of horticultural waste were disposed as trash at landfills, 0.9 million tons was composted at composting facilities, and 0.4 million tons were used as alternative daily cover at landfills in 1995 (Schmidle, 1997). The average cost of collecting this waste, if mixed with other trash that went to landfills, was $67 per ton in 1995 in the U.S. (ACC, 1996, 20). The weighted average tipping fee, or charge, for horticultural waste disposed as trash or alternative daily cover at landfills was $31.02 per ton in 1995 (Kakutani, 1995). The average cost of collecting yard waste that was separated from other trash and, by implication, was used for composting or alternative daily cover was $54 per ton in 1995 in the U.S. (ACC, 1996, 20). Composting facilities in California and four other western states charged, on average, about $5.30 per cubic yard to accept yard waste in 1995 (Markets Page™, 1996). Given an approximate weight of 500 lbs. per cubic yard (Padia, 1998), this charge is equivalent to $21.20 per ton. Hence, in 1995 Californians spent an estimated $479 million for collection of yard waste and its disposal as trash at landfills, $69 million for its collection and disposal at composting facilities, and $33 million for its collection and use as alternative daily cover.

Horticulture Outside of California

Nurseries, flower growers, and other producers sold an estimated $1.619 billion of horticultural goods and services to customers outside of California in 1994, or $1.645 billion in 1995 prices (Table 1). The 1994 estimate is the sum of four sub-estimates. Providers of 'landscape and horticultural services' and manufacturers of lawn mowers, lawn and garden tractors, and other yard-care equipment exported $874 million of services and $7.3 million of goods, respectively, in 1994, primarily to other states (MIG, 1997). Californian growers of 'flowers and nursery products' had sales of $2.172 billion in 1995, according to County Agricultural Commissioner Reports (CDFA, 1996, 9). Since 17% was sales of vegetable, fruit, and nut plants (CASS, 1996), these producers sold $1.797 billion of horticultural plants. Exports of these products outside of the U. S., exclusive of mushroom spawns and edible fruit or nut trees, was $22 million in 1995 (CDFA, 1996, 117). Definitive data on sales of horticultural plants to other states are missing. Schuch and Klein (1996, 19) report that 10% and 52% of all nursery plants were sold out-of-state in 1988 and 1993, respectively. Sector 23 in IMPLAN, which is called 'Greenhouse and Nursery Products' but includes mushrooms and other products not used for landscaping, exported 61% of its Californian production to other states in 1994 (MIG, 1997). If we assume that 41% of sales were domestic and foreign exports, then growers sold $715 million of horticultural plants to buyers in other states.

Other Jobs

The employment figures discussed thus far are associated with institutions that provide in-house horticultural services. Yet, jobs directly associated with retail or export sales of horticultural goods and professionally contracted horticultural services are economically important. According to the Employment Development Department (EDD, 1998), there were 54,015 jobs in 'landscape and horticultural services' (SIC 078), 10,850 jobs with florists (SIC 5992), and 8,125 jobs at lawn and garden centers and retail nurseries (SIC 5261) in 1995 (Table 2). California production of flowers and nursery products, SIC 0181, and manufacture of lawn and garden equipment, SIC 3524, entailed 28,753 and 662 respective jobs in 1995 (EDD, 1998). However, only 9,756 and 95 jobs can be directly attributed to exports of horticultural production to other states or countries and to sales of lawn and garden equipment to the federal government and buyers outside of California, respectively. Not all of these jobs are necessarily full-time, however, because the official data do not separately count temporary, part-time, and seasonal workers.

Economic Impacts

In total, Californians had expenditures of $8.518 billion and sales of $10.108 billion for horticultural goods and services at the final-demand or end-user level in 1995 or a twelve-month period close to that year (Table 1). The 95% confidence interval is plus or minus $1.035 billion of the expenditures and sales estimates. In contrast, Californians spent $64.2 billion for food in 1995 and sold $68.5 billion of food in 1996 ($1995).[5] The difference between expenditures and sales is net exports to other states or countries. Horticultural sales directly accounted for at least 128,842 jobs, most of which were the equivalent of full-time positions (Table 2). The standard deviation of this estimate is 2,914 and, thus, the 95% confidence interval is 123,130 to 134,554 jobs. These estimates are conservative, however, because jobs associated with in-house provision of horticulture for 'other landscapes in California' were not estimable and expenditures and sales associated with this category were estimated with IMPLAN data, which often understate sales for 'landscape and horticultural services' (e.g., Templeton and Goldman, 1996).

Suppose all exports of nursery products and yard equipment from California ceased, all horticultural products and services consumed and produced within the state were imported instead, and all of the production inputs were not employed in other activities. The direct impact of this export loss, importation, and factor unemployment would be a decrease in sales of $10.1 billion in the state's economy and a loss of 128,842 jobs. However, there would be 'indirect' and 'induced' impacts too because sales of businesses that supply inputs to the horticultural sector would decrease and households would spend less income. The best available estimates of the impacts on California's economy of a dollar change in nursery product exports, imports of all horticultural goods and services used and previously produced within the state, and yard equipment exports are $1.2232, $2.0786, and $.7461, which are the impacts for IMPLAN sectors 'Greenhouse and Nursery Products' (23), 'Landscape and Horticultural Services' (27), and 'Lawn and Garden Equipment' (310) (MIG, 1997). Hence, the indirect and induced sales impacts of this counterfactual export loss, importation, and unemployment would be $20.359 billion and total sales in California's economy would decrease by $30.467 billion. This counterfactual elimination of California's horticultural economy would also cause a reduction in household income and jobs. Given total income impacts of $1.3430, $1.8282, and $.6737 for Sectors 23, 27, and 310, respectively (MIG, 1997), household income would decrease by $18.107 billion. Given total employment multipliers (Type III) of 2.21, 1.77, 2.88 for Sectors 23, 27, and 310, respectively (MIG, 1997), there would be 232,817 fewer jobs.

Horticultural Landscape Area and Expense Intensity

There were 1.369 million acres of horticultural landscapes, of which 67,125 acres were for production of flowers and nursery goods (Table 3). The standard deviation is 92,726 acres. Thus, the 95% confidence interval is 1.187 to 1.551 million acres. Total estimated area does not include one-half of the area of roadside vegetation managed by city governments because the landscape below power lines within cities, the area of which is already included, parallels one side of a road. This estimate also does not include the area of 'other landscapes in California'.

Expenses per acre for installation and maintenance of horticultural landscapes have a significant statistical and economic pattern (Table 3).[6] Statistical tests of pair-wise differences between expenses per acre of vegetation near electric power lines, roadside vegetation, school yards, private residential yards, cemetery grounds, landscapes in zoos, and arboreta are extremely significant. Data for other landscapes do not permit such tests. Expenses per unit area increase as the contribution of plant quality and variety to the associated consumption activity increases. Thus, costs per acre of utility landscapes are low relative to expense intensities for other landscapes because utilities prune or trim only those branches of trees and large shrubs that would interfere with power lines, not all branches, and remove, not grow, vegetation around the base of some power poles. Similarly, expenses per acre are lower for school yards and roadsides than golf courses and cemeteries because planted landscapes of high variety or quality do not contribute as much to formal education and transportation as they do to enjoyment of golfing or solace of visiting graves of loved ones. Arboreta and botanical garden have the highest expense intensity of the horticultural landscapes considered. People visit arboreta and botanical gardens to enjoy and learn about plants; the greater the variety and quality of plants, the better the recreational and educational experience.

Caution should be used, however, in analyzing estimated expense intensities. For example, the estimated area of responsibility for electric utilities overestimates the area of active management and, thus, underestimates expenses per managed acre because some types of vegetation do not interfere with safe provision of electricity. People's preferences might not be adequately reflected in the political processes that determine budgetary support for park and other public landscapes. Expenditure and area data for parks were secondary. Both estimates for private yards and golf courses might also be low. The estimate of $5,268 per acre of private residential planted yard does not reflect $168 million that households in the state spent on vegetable gardening, fruit trees, and growing berries. Also, garden space is included in the area of planted yards but some of the area might be used for growing vegetables or fruits. The work of Watson et al. (1992, 73) and Balogh et al. (1992, 10-13) suggest that the estimate of 146 acres for the average area of golf courses in the state might be high. If the average vegetative area were 133 acres, then expenses per acre would be $5,716 instead of $5,207. Either figure underestimates management intensity on greens, tees, and fairways because roughs account for two-thirds to three-fourths of the vegetative area but receive the least care (Balogh et al., 1992, 10-13).

Comparisons between Agricultural and Horticultural Crop Production

In 1995 California farmers earned $1.8 billion and $20.3 billion in sales from horticultural and agricultural crop production, respectively (CDFA, 1996, 9; CASS, 1996). Horticultural and agricultural crop production entailed 28,735 and 351,496 jobs, respectively (EDD, 1998; Rosenberg, 1997). Farmgate sales of nursery products ranked third and flowers and foliage ranked tenth among all crops in 1995 (CDFA, 1996, 7). Production of floricultural crops, bulbs, nursery crops, sod, and seeds for flowers covered 64,120 acres outdoors and 3,105 acres under glass or other protection in 1992 (Bureau of the Census, 1994, 43-44; CASS, 1996). This total of 67,125 acres (Table 3) does not include the equivalent of 428 acres of space for production of vegetables and mushrooms in greenhouses, our estimate of 908 acres for production of vegetable bedding plants, or our estimate of 7,490 acres for production of fruits or nut trees and vines in nurseries (Bureau of the Census, 1994, 43-44; CASS, 1996). In comparison, there were 7.7 million acres of harvested cropland that excludes the horticultural crops and 18.1 million acres of pasture, grazing land, and rangeland in 1992 (Bureau of Census, 1994, 17).

Conclusion

California's horticultural economy has grown since 1995. The number of households increased by 258, 517 units during 1995-1998 (DF, 1999). If these households were the same, on average, as sample households, then the data in Tables 1 and 3 imply that Californians in 1998 spent an additional $39 million ($1995) for indoor plants and $84 million ($1995) for new residential yards that occupied about 16,000 acres. Real income per capita increased 7.9% during 1995-1998 (BEA, 1999; Annis, 1999). If people increase their spending for yard-related horticulture and indoor plants by 1% with each 1% increase in real income, then the data in Table 1 imply a separate increase of $423 million in expenditures ($1995) for these purposes. In response to growth of population and real per capita income, sales of products and services for yards and indoor plants increased an estimated $540 million. The data in this paper also imply that California's 57 new golf courses (NGF, 1999) spent at least $43 million ($1995) for horticulture and covered about 8,300 acres in 1998. Electric utilities spent an estimated $121 million ($1995) more for horticulture in 1998 because a new regulation requires more clearance around power lines and tree growth substantially increased two to three years after the drought ended (Cieslewicz, 1998). In real terms ($1995), then, forecasted horticultural expenditures and sales of Californians increased $0.71 billion between 1995 and 1998. In nominal terms, forecasted expenditures and sales were $9.8 billion and $11.5 billion in 1998.

Sales and jobs associated with horticulture are likely to represent larger shares of the whole economy in California than in most other states because the state has one of the longest growing seasons and the largest share of people living in 'urban' areas among the fifty states in the U.S. (Bureau of the Census, 1996). These direct economic impacts are also likely to be absolutely larger in California than other states for the same reasons and for the reason that state has the biggest 'urban' population economy in the country (Bureau of the Census, 1996). The methods of this study can be used to estimate absolute and relative economic contributions of horticulture in other states and, thereby, make interstate comparisons.

Increasing percentages of householders who hire professionals for application of pesticides and fertilizers during the past two decades (Templeton et al., 1998) and increasing shares of the arboricultural budgets of cities and counties that were allocated for contracts with tree service companies between 1988 and 1992 (Bernhardt and Swiecki, 1993) suggest that contractual horticulture has grown faster than and, perhaps in some cases, at the expense of in-house horticulture. Future analysis of the breakdown of horticultural sales into contractual and in-house activity would provide useful information. However, the sales and job information in this study can still be used by private and public officials to judge limits on market opportunities.

The estimates of areas of different horticultural landscapes can improve planning for water conservation (DWR, 1998, 6-8) and regulation of environmental risks of pesticide or fertilizer use (Balogh et al., 1992, 12). Water or chemical 'requirements' for different landscape types can be multiplied by their corresponding statewide acreage and reasonable percentages of area irrigated or treated to obtain estimates for water or chemical use in total or by landscape type. However, future estimation should include areas of maintained grounds in all federal parks in the state, roadside vegetation managed by counties, turf at sports facilities and airports, and landscapes around corporate offices, retail shopping centers, hospitals, hotels, and amusement parks. Quantitative estimation of the proportions of horticultural landscapes that are irrigated or receive chemical treatments should also be subjects of future research.

Expansion of residential yards, golf courses, and other horticultural landscapes occurs through contraction of habitat and, in some cases, economic activity associated with agricultural farms (Medvitz, 1998), wetlands (Balogh et al., 1992, 23), forests (Templeton et al., 1997, 14), or other landscapes. Habitat alteration, green waste disposal, and use of pesticides and fertilizers, leaf blowers, lawn mowers, non-native plants, and water on horticultural landscapes have become contentious policy issues. Although more research is needed, policy makers can use our results to broadly assess net economic impacts of changes in land use or policies that affect management of horticultural landscapes and judge them in light of concomitant impacts on the environment and human health. Moreover, private and public policy makers could use our results to justify allocation of more resources for research, product development, education, extension, and regulation that could resolve these contentious issues and enable the horticultural industry to continue its economic growth.

Endnotes

1. An unbiased, mean-based estimator of total expenditures, jobs, or area, if any, associated with private residential yards, houseplants, school yards, cemeteries, arboreta and botanical gardens, and zoos is $\hat{Y}_j = N_j \bar{y}_j$, in which N_j = total number of decision-making units for j, $\bar{y}_j \equiv \sum_{i=1}^{n_j} \frac{y_{ij}}{n_j}$, y_{ij} is the value of expenditures, jobs, or area for the ith sample member for landscape type j and n_j = sample size of those finite units (Cochran, 1977, 20-22). The variance of this estimator is $V(\hat{Y}_j) = N_j^2 V(\bar{y}_j) = N_j^2 \frac{S_j^2}{n_j} \frac{(N_j - n_j)}{N_j}$, in which $S_j^2 \equiv \sum_{i=1}^{N_j} \frac{(y_{ij} - \bar{Y}_j)^2}{N_j - 1}$ and an unbiased estimator of this variance is $v(\hat{Y}_j) = N_j^2 \frac{s_j^2}{n_j} \frac{(N_j - n_j)}{N_j}$, in which $s_j{}^2 \equiv \sum_{i=1}^{n_j} \frac{(y_{ij} - \bar{y}_j)^2}{n_j - 1}$ (Cochran, 1977, 23-27).

2. Estimates are slightly different if the sample size for one category of expenditure includes households who answered 'don't know' to one or more questions for the other two categories. In this case, households spent about \$1.788 billion (n=108, s.d.=0.315) on do-it-yourself yard activities, \$1.287 billion (n=105, s.d.=0.303) for 'professional lawn care, landscape maintenance, and tree care', and \$119 million (n=123, s.d.=40) for household plants and their care in 1995.

3. A consistent, ratio-based estimator of the area of roadside vegetation in California's cities in 1995 is $\hat{Y}_{\hat{R}} = X_{95} \frac{\bar{y}_{91}}{\bar{x}_{91}}$, in which X_{95} is the total population of those cities in 1995, $\bar{x}_{91}$ is the sample mean population in 1991, and $\bar{y}_{91}$ is mean acres in the 1991 sample. The variance of this estimator is $V\left(\hat{Y}_{\hat{R}}\right) = X_{95}^2 V\left(\frac{\bar{y}_{91}}{\bar{x}_{91}}\right) \cong X_{95}^2 \left(\frac{N-n}{N}\right) \frac{1}{\bar{X}_{91}^2} \frac{1}{n} \frac{\sum_{i=1}^{N} (y_{91i} - R_{91} x_{91i})^2}{N-1}$ and an estimator of this variance is $v\left(\hat{Y}_{\hat{R}}\right) = X_{95}^2 v\left(\frac{\bar{y}_{91}}{\bar{x}_{91}}\right) \cong X_{95}^2 \left(\frac{N-n}{N}\right) \frac{1}{\bar{x}_{91}^2} \frac{1}{n} \frac{\sum_{i=1}^{n} (y_{91i} - \hat{R}_{91} x_{91i})^2}{n-1}$ (Cochran, 1977, 30-34).

4. Ratio-based estimators of population totals associated with electric utilities are the same as

the estimator of roadside vegetation area in cities except that X is the total number of customers in the market, $\bar{x}$ is the sample mean, and $\bar{y}$ is mean expenditures, in-house jobs, or acres of landscape under electric power lines of utilities in the sample. The 32 utilities that accounted for 7% of all customers in 1991 were treated as one unit for statistical purposes (Fay, 1991, 369-370).

5. U.S. consumers spent 9.66% of their disposable income on retail food, food service, alcoholic drinks, and packaged alcoholic beverages in 1995 (USDA, 1996). Disposable income was 86.9% of personal income in the U.S. in 1995 (CEA, 1999). Personal income in California was $764.435 billion in 1995 (DF, 1997). These figures imply the expenditure estimate. The sales estimate equals, after adjusting for 2% inflation, the total California sales of food and fiber to final demand in 1996 minus sales of 'cotton and fabric/yarn/thread mills' and 83% of sales of 'greenhouse/nursery products' (Carter and Goldman, 1998, 55). Sales of vegetable, fruit, and nut plants were 17% of sales of flower and nursery production in 1995 (CASS, 1996).

6. Let R_j and R_k be expenses per acre for landscape j and k. A consistent estimator of expenditures per acre, $\frac{Y_j}{X_j}$, is $\hat{R}_j = \frac{\bar{y}_j}{\bar{x}_j}$ (Cochran, 1977, 30-31). The null hypothesis is that these ratios are equal for any $j \neq k$ and the sample units come from one population of the two landscapes. Under this null, the t statistic with n_j - n_k - 2 degrees of freedom is $\frac{\hat{R}_j - \hat{R}_k}{s\sqrt{\frac{1}{n_j} + \frac{1}{n_k}}}$, in which $s = \sqrt{\frac{(n_j - 1)s_j^2 + (n_k - 1)s_k^2}{n_j + n_k - 2}}$ and $s_j^2 \equiv v\left(\hat{R}_j\right) \cong \frac{(N_j - n_j)}{N_j} \frac{1}{\bar{x}_j^2} \frac{1}{n_j} \frac{\sum_{i=1}^{n_j} (y_{ij} - \hat{R}_j x_{ij})^2}{n_j - 1}$ (Cochran, 1977, 39 and 180). To calculate s_j^2 or s_k^2, any sample unit in landscape j or k had to report both expenditures and acres. Under this restriction, the estimated expenses per acre are $923 for landscapes under electric power lines (n=3, s.d.=$148), $3,055 for all school yards (n=54, s.d.=$322), $4,460 for roadside vegetation (n=459, s.d.=$44), $5,542 for private yards (n=63, s.d.=$976), $7,748 for cemetery grounds (n=72, s.d.=$785), $10,329 for landscapes in zoos (n=5, s.d.=$1,603), and $12,260 for arboreta (n=12, s.d.=$2,549).

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TABLE 1:

ANNUAL EXPENDITURES AND SALES RELATED TO HORTICULTURE IN CALIFORNIA IN THE MID-1990s

Landscape or Plant Type	Expenditures (millions $s)	Sales (millions $s)	Standard Deviation
Residential Yards (1995) Subtotal:	$3,579	≤$3,579	$510
Do-It-Yourself Care and Installation	$1,864	≤$1,864	$329
Professional Care and Installation	$1,354	$1,354	$308
Landscape Water (1991 in 1995 $s)	$361	$361	$46
Indoor Environments (1995) Subtotal:	$1,661	$1,605	$37
Cut Flowers	$1,429	$1,429	n.e.
Houseplants	$102	≤$102	$37
Christmas Trees	$131	$75	n.e.
Golf Courses (1995)	$683	$683	n.e.
City, County, Two Federal Parks (FY94-95), and State Parks (FY96-97 in 1995 $s)	$600	$600	n.e.
Roadways and Right-of-Ways (FY94-95) Subtotal:	$326	$326	$0
City Streets and Weed Abatement	$218	$218	$0
State Highways	$108	$108	$0
School Yards (FY94-95) Subtotal	$312	$312	$57
Public and Private, K-12	$286	$286	$57
Universities, CSU and UC	$27	$27	$2
Vegetation near Electric Power Lines (1995)	$147	$147	$22
Cemetery Grounds (1995)	$141	$141	$25
Arboreta and Botanical Gardens (1995)	$13	$13	$4
Zoos (1995)	$7	$7	$4
Other Landscapes in California (1994 in 1995 $s)	$467	$467	n.e.
Horticultural Waste (1995)	$582	$582	n.e.
Out-of-State Landscapes (1994 in 1995 $s)		$1,645	n.e.
TOTAL	$8,518	$10,107	$528

'n.e.' means not estimable with available data

TABLE 2:

ANNUAL EMPLOYMENT IN HORTICULTURE IN CALIFORNIA

Employer	Jobs	Standard Deviation
Professional Horticultural Services (1995)	54,015	n.e.
Retail Florists (1995)	10,850	n.e.
Retail Nurseries, Lawn and Garden Stores (1995)	8,125	n.e.
Growers of Flowers and Nursery Products (1995)	9,756*	n.e.
Manufacturers of Lawn and Garden Equipment (1995)	95*	n.e.
City, County, Two Federal Parks (FY94-95), and State Parks (FY96-97)	9,871	394
Golf Courses (1995)	13,470	n.e.
City and State Roadway Agencies	4,401	144
City Street Agencies (1995)	3,663	144
CALTRANS (FY94-95)	738	0
Schools (FY94-95) Subtotal:	14,288	2,816
Public and Private, K-12	13,616	2,816
Universities, CSU and UC	672	33
Cemeteries (1995)	3,218	609
Electric Utilities (1992)	272	84
Arboreta and Botanical Gardens (1995)	331	54
Zoos (1995)	150	73
TOTAL	128,842	2,914

'n.e.' -- not estimable with available data
* -- only jobs attributable to exports

TABLE 3:

AREA AND EXPENDITURE INTENSITY FOR HORTICULTURE IN CALIFORNIA

Landscape or Production Site	Area (acres)	Standard Deviation (acres)	Expenditure Intensity ($s/acre)
Private Residential Yards (1995)	679,426	82,632	$5,181
Flower and Nursery Product Outdoor Farms and Greenhouses (1992)	67,125	n.e.	$26,473*
Golf Courses (1995)	131,108	n.e.	$5,207
City, County, and Two Federal Parks (FY94-95)	157,686	n.e.	$3,784
City and State Roadways Subtotal:	71,968	406	$4,335
City Streets (1995)	49,190	406	$4,152
State Highways (FY94-95)	22,778	0	$4,730
School Yards (FY94-95) Subtotal:	108,948	15,314	$2,867
Public and Private, K-12	100,248	15,290	$2,849
Universities, CSU and UC	8,700	851	$3,074
Cemetery Grounds (1995)	17,931	2,857	$7,859
Landscape under Electric Power Lines (1995)	157,717	39,077	$927
Arboreta and Botanical Gardens (1995)	1,133	255	$11,718
Zoos (1995)	702	335	$10,329
TOTAL	1,369,148	92,726	$5,499

'n.e.'--not estimable with available data
*--1995 revenues per acre