

ESTIMATING ECONOMIC ACTIVITY AND IMPACTS OF URBAN FORESTRY IN CALIFORNIA WITH MULTIPLE DATA SOURCES FROM THE EARLY 1990s

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Abstract. Urban forests provide tree products and aesthetic, recreational, health, and environmental benefits. Yet the expenditures that people make to secure these benefits are difficult to estimate for lack of comprehensive published data. Based on various sources of data, we estimate that Californians spent at least \$947 million to obtain these benefits and the state's urban forestry "sector" had sales of at least \$1.115 billion in a 12-month period in the early 1990s. As a result of direct, indirect, and induced effects, urban forestry accounted for at least \$3.384 billion in total sales. This level of sales became about \$1.869 billion in annual income to individuals and supported about 57,200 jobs in this period within the state. Knowledge of this economic activity is important, in principle, to voters and public decision-makers who allocate human resources, tax revenue, and water for the management of community forests and other natural resources in California.

Urban forests provide people a number of benefits. These benefits include aesthetic enhancement, recreational opportunities, energy conservation through shade, reduction in local particulate and gaseous pollution, carbon sequestration, noise abatement, better control of water runoff and improved water quality, habitat for wildlife, and tree products, such as firewood, mulch, and compost. Californians incur monetary costs, i.e., spend money, to secure these benefits. People in other states do the same thing, and some of their urban forestry purchases come from sellers within the state. Purchases of products and services related to urban forests from sellers in California create economic impacts throughout the state's economy. Economically sound arboricultural management, particularly in a period of intense competition for water and financial support, requires knowledge of these purchases and their economic impacts. However, California voters and public officials lack quantitative information about this economic activity and its impacts.

In this paper, we explain how to estimate market transactions between buyers in the United States and sellers in California of urban forestry-

related products and services for 12 months and the effects of these transactions on sales, employment, and personal income in the state's economy. For our study, "urban forestry" refers to growing, planting, maintaining, removing, disposing, and studying trees that are usually located in incorporated cities, towns, and other human settlements and that are used primarily to meet needs and enable activities of people. "Urban forestry" also refers to activities undertaken as a direct consequence of these trees, such as repairs of infrastructure damaged by tree roots. However, "urban forestry" does not refer to tree-related range management or to the production of timber, other industrial forest products, or Christmas decorations.

Each monetary transaction involves a buyer and a seller, or a purchase and a sale. Major sellers of products and services related to community forests include tree nurseries and landscape planning, lawn service, horticultural, and arboricultural companies. Although not typically considered sellers, government institutions, electric utilities, and community tree groups "sell" urban tree-related services when they perform these services and receive money—tax revenues, sales revenues, grants, and donations—for this work rather than hire private contractors. Many city, county, and state government institutions care for street, highway, or landscape trees, repair sidewalks and sewers damaged by tree roots, unclog storm inlet drains blocked with tree leaves, remove and replace old trees, plant new trees, and take part in other activities related to urban forests. Electric utilities have relatively small groups of employees who coordinate line clearance and shade tree programs. Some electric utilities even perform their own line clearance or trim trees around company property. Community tree groups receive money from various sources to organize tree

planting efforts in their community and to educate people about urban forestry.

Estimating economic impacts is difficult because individual sales data are hard to find. Thus, we deliberately focus on expenditures by major buyers of urban trees and tree-related products and services from sellers located in California during 1991–92, 1992, or 1992–93. Our focus on the “buying side” reflects the ready availability of data from two important surveys: 1) the National Gardening Association’s 1992–93 survey of households, and 2) the California Department of Forestry and Fire Protection’s 1992 survey of city and county governments and their community and urban tree programs.

Our estimates of expenditures on products and services related to urban forestry also are based on 2 other major sources of information: 1) the 1991 IMPLAN databases of regional consumption demand and of sales and purchases of companies in 528 sectors of the California economy, and 2) our own surveys of the 5 largest utilities in the state, 14 community tree groups, 2 city governments, and the city arborist in San Jose. However, with the possible exception of household purchases of tree plants or tree-care equipment from businesses located outside the state, the major buyers purchase urban forestry-related products and services from sellers located within the state. Thus, our focus on the buying side still enables us to estimate the sales of major sellers who are located within the state.

In much of the rest of this paper, we present estimates of the expenditures of major buyers of urban forestry services and the methods used to arrive at these figures. The major buyers considered are: households, local government, state government, state and local government enterprises, federal government, electric utilities, schools, community tree groups, other buyers in California, and U.S. buyers outside of California. We also estimate expenditures for certain urban forestry activities that are not accounted for in the available data on purchases by these major buyers.

The impacts of these expenditures on total sales, employment, and personal income in California are then discussed next. Since comprehensive data on economic activity directly connected

with urban forestry are not collected, our expenditure estimates based on various existing sources of data are incomplete. Some of the missing types of data to be collected in the future are discussed in the penultimate section. Nonetheless, our research indicates larger economic activity and associated impacts than we originally expected.

Urban Forestry Expenditures

Households. Some households purchase trees to plant and also buy fertilizer, pesticides, spades, water, and pruning equipment to care for trees around their houses. The mean 1992 expenditure per household in the Pacific region for do-it-yourself, tree-related landscaping and insect control, tree care, and fruit tree management was about \$17.32, \$1.34, \$24.40, and \$5.17, respectively (10). These average tree-related expenditures of Pacific region households are the best available estimates of average expenditures of California households. There were 10,667,451 households in the state in 1992 (4). Thus, the estimated expenditure by households in California on do-it-yourself tree planting, insect controls for trees, tree care, and planting and care of fruit trees in 1992 was \$514.47 million (Table 1).

Homeowners also purchase certain professional, tree-related services from companies that are classified into Standard Industrial Classification (SIC) Industry Group No. 078. The Standard Industrial Classification is the Office of Management and Budget’s standard that underlies all establishment-based federal economic statistics classified by industry (12). SIC 078 is composed of 3 industries: establishments primarily engaged in landscape planning and in performing landscape architectural and counseling services (SIC 0781), companies primarily engaged in performing a variety of lawn and garden services (SIC 0782), and businesses primarily engaged in performing a variety of ornamental shrub and tree services (SIC 0783). (We shall refer to all companies in SIC 078 as landscape service companies.) California homeowners paid \$352.23 million in 1991 to companies that belonged to SIC 078 and that submitted employment and payroll reports to appropriate government agencies (7). Part of this figure represents contractual payments for the following

tree-related services: planning and designing landscapes with trees, tree planting, trimming, pruning, spraying, removal, surgery, and other arborist services.

We estimated these contractual payments for tree-related services using the following procedures. First, we multiplied \$352.23 million by 70%, which is an estimate of the percentage decrease in sales from 1991 to 1992 due to economic recession and the sixth year of drought in the state. The result is an estimate of purchases by homeowners in 1992 from landscape architectural, lawn service, horticultural, and arboricultural companies. Second, to allocate this estimate into separate estimates of homeowner purchases from landscape architectural (SIC 0781), lawn and garden service (0782), and arboricultural (0783) companies, we multiplied the estimate of homeowner purchases in 1992 from SIC 078 companies by each industry's share of total 078 payroll expenses. We assume that the ratio of sales to payroll expenses is the same for these three industries in 078. Under this assumption, each industry's share of payroll expenses equals each industry's share of sales. The payroll expenses of landscape planners and architects account for about 13% of all payroll expenses of business establishments that sell landscape management services. The payroll expenses of companies that sell lawn and garden services account for about 77% of payroll expenses in industry group 078. The remaining 10% are payroll expenses of ornamental shrub and tree service companies.

Third, we multiplied the estimates of homeowner purchases in 1992 from landscape management companies by estimates of the fractions of purchases that are attributable to trees. Based on discussions with managers of a few landscape and tree service companies, we assume that 10% of the sales to households by landscape architects and counselors and 10% of the sales to households by companies that primarily provide lawn and garden services are attributable to tree management in residential landscapes. Based on these same discussions, we also assume that, on average, 90% of sales to households by companies that are primarily engaged in selling ornamental shrub and tree services is attributable to

tree care. Thus, California homeowners spent about \$3.14, \$19.07, and \$22.46 million for tree-related contractual work of landscape planners and architects, of lawn and garden service companies, and of ornamental shrub and tree service companies, respectively, in 1992. The sum of these 3 figures equals our estimate of total purchases by homeowners in 1992 of tree-related services from these companies (Table 2).

In short, California households spent an estimated \$514.47 million for do-it-yourself activities related to trees and \$44.67 million for contractual work attributable to trees in residential landscapes in 1992. Thus, the total household expenditure in the state in 1992 for tree planting and tree care was \$559.14 million (Table 1).

City and county government. Cities and counties were recently surveyed about their urban forestry programs (1). The survey was sponsored by the California Department of Forestry and Fire Protection (CDF). The total amount for urban forestry budgets of survey respondents for either calendar year 1992 or fiscal year 1991–92 was \$80,077,272. This figure understates expenditures on tree programs by local government for two reasons. First, 121 out of a total of 468 incorporated cities and 12 out of a total of 57 counties in the state did not respond at all to the survey. (We treat San Francisco only as a city.) Second, agencies or departments of 74 cities and 9 counties did not report their tree budgets even though evidence from their answers to other survey questions or from secondary sources indicated that they engaged in urban forestry activities.

In general, the estimated urban-forestry expenditure of a city or county that did not provide the information but evidently engaged in relevant activities equals the probability of expenditure for the city's or county's population group times the expenditure per capita in that group times the population of that city or county. The probability that a nonresponding city or county in a particular population group made expenditures equals, by assumption, the number of cities or counties in the population group that reported positive expenditures or for which evidence indicates positive expenditure divided by the sum of all cities or counties in the population group that definitely did or did not spend money.

Table 1. Expenditures on urban forestry in California by major buyers, 1992.

Buyer	Urban forestry activities	Expenditures (to nearest \$1,000)
Households	Equipment, supplies and plant material for do-it-yourself maintenance and planting	514,467,000
Households	Contractual maintenance, planting, and tree-related landscape planning	44,669,000
	<i>Subtotal, households</i>	<i>559,136,000</i>
City govt.	In-house and contractual maintenance and planting	110,062,000
County govt.	In-house and contractual maintenance, planting, research, and education	7,101,000
State govt.	In-house and contractual maintenance, planting, research, and education	15,012,000
State and local govt. enterprises	Contractual maintenance, planting, and tree-related landscape planning	4,240,000
Fed. govt. and its enterprises	Contractual maintenance, planting, research, education, and tree-related landscape planning	2,470,000
	<i>Subtotal, all government</i>	<i>138,885,000</i>
PG&E, SCE LADWP, SMUD, and SDB&E	Line clearance, restoration of power after tree-induced outages, trimming, planting tree-related legal expenses, and research	108,640,000
Other elec. utilities	Same activities as five largest utilities	9,089,000
	<i>Subtotal, all electric utilities</i>	<i>117,729,000</i>
Public and private schools	Contractual maintenance, planting, and tree-related landscape planning	10,947,000
Community tree groups	Planting and education	2,542,000
Other Calif. buyers	Contractual maintenance, planting, and tree-related landscape planning	110,279,000
Other expnd. in Calif. not broken down by buyer	Repair of sidewalks, sewers, and storm drains disposal of tree waste, unclogging storm inlets, and tree-related legal fees and liability claims only in San Jose	7,092,000
Buyers in other states	Contractual maintenance, planting, and tree-related landscape planning	168,366,000
	<i>Grand total, all buyers</i>	<i>1,114,976,000</i>

This estimation procedure was not appropriate, however, for 1 county and 4 cities that had 1 or more departments that reported tree budgets but that had 1 department or agency that responded but did not report tree budgets. In these cases, the estimated expenditure of a responding but not reporting department or agency equals the probability of expenditure for the city's or county's population group times the average expenditure per tree for the same population group times the number of trees under the management of the agency or department that did not provide the in-

formation. As a result of both procedures, the estimated expenditures for those cities and counties that did not provide budget information for the CDF-sponsored survey are \$31,745,377 and \$4,215,776, respectively.

Moreover, in the Bernhardt-Swiecki data set (1), a particular county reported a tree budget of \$172,195, which was 31 times larger than the average budget per capita and 17 times larger than the budget per capita in counties of similar population size. Because of this figure's unreliability, we reduce \$2,892,327 by \$172,195, estimate this particular county's expenditure as the product of the county's population times the expenditure per capita for that population group, and include the estimate with those for other counties. In the same data set, 2 respondents did not provide the name of their cities even though they reported \$197,000 of tree budgets. Since this figure corresponds to 2 unknown cities, we subtract it from \$77,184,945. However, we add \$1,328,766 to the result because 2 other cities, which did not respond to the Bernhardt-Swiecki survey, reported to us these expenditures on urban forest-related activities. As a result of these calculations for data reliability, the adjusted reported expenditures of cities and counties are \$78,316,712 and \$2,720,132, respectively.

If the adjusted reported budgets are added to estimated expenditures of nonreporting cities, their governments spent about \$110.06 million for tree care and planting in 1992. County governments in FY93 also spent about \$164,629 for urban tree-related research and educational services that the University of California Cooperative Extension provided to the community. This figure represents 20% of our estimate of the Cooperative Extension's budgetary expense for urban forestry. If this small expenditure is added to the corresponding estimated expenditures and adjusted reported budgets, county governments spent about \$7.10 million for urban forestry in the same period (Table 1).

State government. The state government spends money on urban forestry because various departments, commissions, and institutions either manage state-owned landscapes or provide grants for urban forestry tree planting, research, and education. The California Department of

Table 2. IMPLAN sectoral purchases of tree-related and other services from landscape companies.

Purchaser	Purchases in 1991 from SIC 078 (IMPLAN sector 27)	Estimated purchases in 1992 from SIC 078 ¹	Estimated purchases in 1992 from SIC 0781 and 0782	Estimated purchases in 1992 from SIC 0783	Fraction of 0781 and 0782's sales related to trees	Fraction of 0783's sales related to trees	Tree-related purchases in 1992 from SIC 0781 and 0782	Tree-related purchases in 1992 from SIC 0783	Estimated tree-related purchases in 1992 from SIC 078
Households ²	352229700 ¹⁰	247017008	222057979	24959028	0.1	0.90	22205798	22463126	44,668,923
Federal Government ³	10127700	7102508	6384858	717650	0.1	0.50	638486	358825	997,311
Federal Government Enterprises ⁴	5431100 ¹⁰	3808776	3423931	384845	0.1	0.50	342393	192423	534,816
State and Local Government Enterprises ⁵	43061200 ¹⁰	30198593	27147275	3051318	0.1	0.50	2714727	1525659	4,240,387
Public Schools ⁶	30156700	21148750	19011843	2136906	0.1	0.75	1901184	1602680	3,503,864
Private Schools ⁷	64058300 ¹⁰	44923780	40384603	4539177	0.1	0.75	4038460	3404383	7,442,843
Other U.S. Buyers ⁸	1498162000	1050653861	944493966	106159895	0.1	0.70	94449397	73917088	168,366,485
Other CA Buyers ⁹	1010786900 ¹⁰	708859994	637235547	71624448	0.1	0.65	63723555	46555891	110,279,446

¹To get these estimates multiply purchases in 1991 by 70%, which is an estimate of the percentage decrease in sales from 1991 to 1992 due to economic recession and the sixth year of drought in the state

²Sector 461, Owner-Occupied Dwellings

³Final Demand subcomponents "Federal Military" and "Federal Nonmilitary"

⁴Sector 513, U.S. Postal Service, and Sector 515, Other Federal Government Enterprises

⁵Sector 510, Local Passenger Transit, and Sector 512, Other State and Local Government Enterprises

⁶Final Demand subcomponent "State and Local Government Purchases, Educational"

⁷Sector 495, Elementary and Secondary Schools, Sector 496, Colleges and Universities, and Sector 497, Other Educational Services

⁸Final Demand subcomponent "Domestic Exports"

⁹Intermediate Demand less Purchases of Sectors 443, 511, and 514, which are electric utilities, and Sectors 461, 495-497, 510, 512, and 513

¹⁰See IMPLAN's interindustry transaction table

Transportation, known as CALTRANS, managed about 21,000 acres of landscape in 1987 (11). CALTRANS's landscape management includes a number of tree-related activities: pruning, trimming, removing, replacing, fertilizing and mulching existing trees, controlling tree pests, cleaning up fallen trees and tree vegetation, planting new trees, and creating landscape designs that include trees. Based on data from the Division of Maintenance and the Office of Landscape Architecture, we estimate that CALTRANS spent an estimated \$9.40 million for tree-related activities in 1992-93.

The Resources Agency and the California Transportation Commission (CTC) provide grants from Proposition 111 bonds to various state agencies, local governments, and nongovernmental organizations to mitigate environmental damage caused by transportation projects. CTC approves 3 kinds of grants: highway landscape and urban forestry, roadside recreation, and resource lands.

There were 36 recipients of these grants in 1991-92. Of this total, 14 recipients were city governments, 5 were county governments, and the remainder were CALTRANS, Parks and Recreation Departments, the Department of Fish and Game, and nongovernmental organizations. Available information indicates that the city and county government recipients of these grants definitely did not or most likely did not count these funds as part of their tree budgets. Based on discussions with a Resources Agency staff member familiar with the grant program and with the specific projects that were funded in 1991-92, we assume that urban tree-related activities, primarily planting and maintenance, account for 90% to 100% of the amount of each highway landscape and urban forestry grant, 20% to 25% of the amount of each roadside recreation grant, and 15% of the amount of each resource lands grant that was not for land acquisitions. Given these assumptions and

the total amounts of all relevant grants in 1991–92, the state government spent about \$4.16 million of Proposition 111 funds for urban forestry.

The California Department of Forestry and Fire Protection (CDF) also spends money for tree planting, education, research, and other urban forestry programs. Proposition 70 is the largest source of money that CDF spends. General revenues account for the remainder. In FY 1992–93, CDF spent \$826,608 on urban forestry. Of this total, \$683,000 was spent on contracts, most of which went to city governments to enhance their management of city forests. Our estimate of urban forestry expenditures of city governments did not include this \$683,000 to avoid double counting.

The state government, through the University of California, also spends money for research and education related to urban forestry. For example, the University of California paid about \$493,887 for urban-forestry-related research and educational services that the Cooperative Extension provided in FY 1993. This figure represents 60% of \$823,145, our estimate of the total urban-forestry-related budgetary expense of the Cooperative Extension. The University of California also pays U.C. Experiment Stations to conduct research on urban forests and primarily biophysical aspects thereof. U.C. Experiment Stations had about \$255,000 to conduct this research in FY 1993. We assume that the state government, through the University of California, contributed 50% of this total amount.

All together, these departments and agencies of the state government spent a total of \$15.01 million on tree maintenance, tree planting, education, and research (Table 1). However, these expenditures do not include those made by state government enterprises.

State and local government enterprises.

Local government passenger transit (sector 510) and other state and local government enterprises (sector 512) are 2 of the 3 sectors in the IMPLAN database that refer to state and local government enterprises. To avoid double counting, we ignore the third state and local government enterprise, state and local electric utilities (sector 511), because we already have independent, and more reliable, data on electric utilities. For the same rea-

son, we also ignore the expenditures by non-educational departments, agencies, commissions, and districts of state and local government for services of companies in industry group SIC 078 because most of the tree-related expenditures of government entities that take care of parks, recreation facilities, highways, streets, and natural resources are tree expenditures for which we have independent, and more reliable, information.

As a rule, state and local government enterprises produce a good or service that has a private sector counterpart. In practice, "other state and local government enterprises" includes airports, liquor stores, housing and community development agencies, and utilities that provide sanitation, sewage treatment, water, and gas. According to IMPLAN's interindustry transaction table, these government enterprises spent \$43.06 million on contractual services of landscape planning and counseling, lawn service, and arboricultural companies in 1991 (7). As in the case of homeowner purchases from companies in SIC 078, we assume that, on average, 10% of purchases by state and local government enterprises from landscape planners, architects, and counselors and from companies that primarily provide lawn and garden services is attributable to trees in landscapes. However, we assume that only 50%, rather than 90%, of purchases by state and local government enterprises from companies primarily engaged in selling ornamental shrub and tree services is attributable to tree care. We use this lower percentage because residential landscapes tend to have more trees and fewer shrubs per unit area than do the landscapes of government institutions. Based on these assumptions, we estimate that state and local government enterprises spent \$4.24 million in 1992 for tree-related contractual services (Table 1 and Table 2).

Federal government. The Forest Service of the United States Department of Agriculture (U.S.D.A.) is the other major contributor to the expendable income of U.C.'s Experiment Stations. We assume that the U.S.D.A. paid for the other half of U.C. Experiment Station's total urban forestry-related income of \$255,000. The U.S.D.A. also paid \$164,629, which represents 20%, of the Cooperative Extension's estimated budgetary ex-

pense in 1992–93 that was attributable to urban forestry. But the largest expenditure that the U.S.D.A. makes on urban forestry in California is for the National Urban Forestry (NUF) program. The Forest Service of the U.S.D.A. provided \$253,400 in grants administered by California ReLeaf to various community tree groups primarily to promote volunteer participation in these groups. The Forest Service also provided \$391,908 in NUF funds to the California Department of Forestry (CDF). In turn, CDF used \$304,000 of these funds to contract with California ReLeaf for a statewide program and with other urban forestry organizations for research projects. In total, we estimate that the Forest Service and other divisions of the U.S.D.A. spent \$937,437 on urban forestry in California in 1992–93.

Similar to households, federal government institutions in California also purchase tree-related services from landscape, lawn service, horticultural, and arboricultural companies primarily for the purpose of caring for trees on federal government landscapes. To estimate tree-related expenditures of the federal government, we consider 4 different federal sectors in the IMPLAN database: 1) the U.S. Postal Service 2) other federal government enterprises, 3) the Department of Defense, and 4) all nonmilitary institutions of the federal government in the state. These sectors purchased products and services worth \$15.59 million from SIC 078 companies. Based on the same assumptions and procedures as those used for state and local government enterprises, we estimate that the federal government spent \$1.53 million for tree-related contractual services in 1992 (Table 2).

In total, these federal government institutions and the U.S.D.A. together spent an estimated \$2.47 million for California urban forests and related activities in 1992 (Table 1).

All government. Various agencies, departments, commissions, and other institutions of government at the local, state, and federal level spent an estimated \$138.88 million for tree maintenance, planting, research, education, and landscape planning in 1992. The spending on urban forestry decreases as the government's authority becomes more removed or the jurisdiction more encom-

passing. That is, local government spends more than state government, which spends more than the federal government (Table 1).

Electric utilities. Privately owned and consumer-owned electric utilities spend more money on tree-related activities than any other business spends. Their largest urban forestry expenditure is for clearance of utility lines because delivery of electricity depends on lines unfettered by trees. Line clearance involves a special kind of tree trimming and, on occasion, tree removal. Electric utilities also spend money to restore power after outages caused by fallen or damaged trees. Some electric utilities pay for tree planting, which is usually part of a shade tree program, but which also may be part of tree replacement or the beautification of company property. Tree trimming around company property is another beautification activity for which utilities incur costs. Legal fees and liability claims related to tree fires account for a small share of all tree-related expenditures of electric utilities. Tree-related research is the smallest expenditure category.

The 5 largest electric utilities in the state are Pacific Gas and Electric (PG&E), Southern California Edison (SCE), Los Angeles Department of Water and Power (LADWP), San Diego Gas and Electric (SDG&E), and Sacramento Municipal Utility District (SMUD). We surveyed these utilities about their expenditures on trees and tree-related services in 1992. They reported expenditures of \$96,470,385 in 1992: \$77,090,385 for line clearance and \$19,040,000 for restoration of power due to tree-related outages, tree trimming, tree planting, tree-related legal expenses, and urban forestry research.

Although all 5 utilities spent money on line clearance, not every one of these 5 spent money on each of the non-line-clearance activities. Moreover, not every utility was able to provide information for some of these activities. Only 1 utility was able to provide information about the costs of tree-induced power outages and tree-related legal expenses. The estimated expenses of 3 of the other 4 utilities for these 2 items equals, by assumption, the miles of transmission lines or the number of electric customers of each these 3 utilities multiplied, respectively, by the best available estimate

of the costs per transmission line mile or per customer. Based on this method, our estimate of tree-related legal expenses and costs of tree-induced power outages for 3 of the other 4 utilities in 1992 is \$12,858,010. Considering both reported and estimated costs, the 5 largest utilities had expenses of \$108.64 million for line clearance and other tree-related activities.

In addition to LADWP and SMUD, 29 other consumer-owned, or municipal, electric utilities and 4 rural electric companies operate in the state (3). These other utilities had about 899,756 customers at the start of the 1990s (3). (This number does not, however, include the number of electricity customers of the municipal utilities in San Francisco and Inglewood.) The average tree-related expenses per customer of PG&E, SCE, LADWP, and SMUD in 1992 was about \$10.17. The tree-related expenses of the other municipal and rural electric utilities is estimated by multiplying the number of customers of these 33 utilities by the expenses per customer of the big 4. The result is \$9,148,643. In total, the costs that electric utilities incurred in 1992 for line clearance and other tree-related activities were \$117.73 million (Table 1).

Public and private schools. Educational institutions of local and state governments and private schools spend money on tree care, tree planting, and other tree-related services. While some schools hire themselves to perform these services, we believe that many schools hire others, which include horticultural and arboricultural companies. Our belief notwithstanding, the only available source of relevant information is contained in the IMPLAN database. In 1991, public and private schools purchased, respectively, \$30.16 and \$64.06 million worth of goods and services from landscape counseling, lawn- and garden-service, and shrub- and tree-care companies (7). To estimate how much of these expenditures are attributable to urban forests, we made these assumptions: 1) 10% of purchases by schools from landscape planners, architects, and counselors is attributable to the care of trees in surrounding landscapes, 2) 10% of the purchases by schools from companies that primarily provide lawn and garden services is attributable to tree

care, and 3) 75% of purchases by schools from companies that are primarily engaged in selling ornamental shrub and tree services is attributable to tree care. Based on these assumptions and procedures similar to those used for homeowners, state and local government enterprises, and the federal government, we estimate that California's public and private schools spent \$10.95 million for urban-tree-related goods and services from these landscape management companies in 1992 (Table 1 and 2).

Community tree groups. Community tree groups exist throughout California and play an important role in promoting tree planting and awareness about the importance of urban forests and their care in the state. Nonprofit and local volunteer tree groups are both sellers and buyers of tree-related services. They are sellers in the sense that individuals, utilities, Geo-Chevrolet and other corporations, government entities, nonprofit foundations, and local businesses and organizations donate money or pay them, i.e., enter into implicit or explicit contracts with them for their tree-related services. Community tree groups are buyers in the sense that they spend their income to plant trees, conduct educational programs on the importance of trees and their care, and perform other urban forestry services.

In keeping with our focus on the buying side, we examined the annual expenditures that community tree groups made in 1992 or 1993. In cooperation with California ReLeaf, we sent a survey to over 40 community tree groups. Fourteen responded and reported income and expenditures. Lack of time and money prevented us from following up with the nonrespondents. However, the 14 respondents include the 5 largest community tree groups in the state—Tree People in Los Angeles, the Sacramento Tree Foundation, Friends of the Urban Forest in San Francisco, Tree Fresno, and California Oak Foundation in Oakland—and most of the groups with any substantial budgets. The total annual expenditure of these groups in 1992, 1993, or 1992–93 was \$4,401,831. However, \$1,859,721 of the money spent came from National Urban Forestry (NUF) grants, California Department of Forestry grants, Proposition 70 and 111 grants, and electric utilities. Hence, commu-

nity tree groups spent \$2,542,110 from sources other than electric utilities or grants from state and federal sources (Table 1). Incidentally, these 14 community tree groups also reported that people volunteered 127,972 hours of their time in 1992-1993 for urban forestry activities.

Other buyers in California. Real estate companies, hotels and lodging places, amusement and recreation service companies, nursing and health care facilities, religious organizations, and many other businesses and organizations in California spend money on tree care and other tree-related services. We believe that these businesses and organizations in California contract out most of their tree-related work to private companies. Given this belief and lacking any better alternative source of information, we estimate the expenditures of these other buyers in the following manner. From the total sales of IMPLAN sector 27 (i.e., SIC 078) to the economy's 528 sectors we subtract the purchases of owner-occupied dwellings (IMPLAN sector 461), state and local government enterprises (IMPLAN sectors 510 and 512), federal government enterprises (IMPLAN sectors 513 and 515), electric utilities (IMPLAN sectors 443, 511, and 514), and private schools (IMPLAN sectors 495, 496, 497). The result for 1991 is \$1,010,786,900, the expenditures of all other buyers for goods and services of landscape management companies. As in all other cases, we assume that 10% of purchases by other California buyers from landscape planners, architects, and counselors and from companies that primarily provide lawn and garden services is attributable to trees in surrounding landscapes. However, we assume that 65% of other buyers' purchases from companies primarily engaged in selling ornamental shrub and tree services is attributable to tree care. Then we used the same procedures that we use to estimate the tree-related expenditures of homeowners, state and local government enterprises, federal government institutions, and schools. As a result, we estimate that other California buyers spent \$110.28 million on tree-related services from SIC 078 companies in 1992 (Tables 1 and 2).

Expenditures not counted in breakdowns by major buyers in California. A number of important expenditures by households, businesses,

and government entities for services related to urban forests in California have not yet been considered or counted. The uncounted expenditures for which we have limited data are the following:

- payments for repairs of sidewalks damaged due to trees
- payments for disposal of tree waste
- expenditure for repair of sewers and storm drains damaged by trees
- expenditure for clearing storm inlet drains clogged with tree leaves
- city government payments for legal services and liability claims for tree-induced injuries.

Our information about these expenditures comes from 2 sources: the city arborist in San Jose and an article by Wagar and Barker (13). Wagar and Barker report the finding of another study that 22 northern California cities spent, on average, approximately \$27,000 per city for repair of root-damaged sidewalks per year in the early 1970s. Thus, these cities annually spent about \$594,000 in total for these repairs in that period. If we account for the 207% increase in the consumer price index from 1974 through 1992, and if these cities only increased their repair expenditures for inflation, their expenditure becomes \$1.231 million in 1992 dollars.

Citizens and the City of San Jose spent an estimated \$1,224,000 and \$225,000, respectively, on sidewalks repairs in 1992-93, and 68% of this expenditure was for repairs of damages that were attributable to trees. Homeowners and the City of San Jose spent about \$59,000,000 for collection and disposal of garbage in the same period; 7.35% of garbage is tree waste. The same parties spent \$1,400,000 on repair of sewers and storm drains in 1992-93, and 55% of this expense was attributable to trees. Approximately \$700,000 was spent by these parties in the same period to clear storm inlet drains that were clogged with tree leaves. The City of San Jose also spent approximately \$300,000 in tree-related legal fees and liability claims. Thus, in total, citizens of San Jose and their government spent an estimated \$7,091,820 for these tree-related repairs, disposal costs, legal fees, and liability claims. Given the population of San Jose in 1992 of 806,200 (5), the expendi-

ture per capita was \$8.80 for that period. (Because they are not paid from the cities' tree budgets, these repair and disposal costs, legal fees, and liability claims are not included in the Bernhardt-Swiecki data on city expenditures.)

The information from San Jose and the study of 22 northern California cities indicates the importance of accounting for these expenditures. However, for lack of time and money we were not able to survey households or local governments about these expenditures. What is the magnitude of this missing expenditure? Suppose that, on average, the expenditure per capita for these repair and disposal costs, legal fees, and liability claims in other cities and unincorporated areas of the state is half that of San Jose, i.e., is \$4.40. We would at least expect the expenditure per capita to be less because San Jose has a well-developed urban forest and related management program. Given the population in the rest of the state in 1992 of 30,175,800 (5) and this assumption about expenditure per capita, the rest of the state spent an estimated \$132.72 million in 1992–93 for these tree-related repairs, disposal costs, legal fees, and liability claims. Thus, the magnitude of this missing expenditure is in the high tens of millions to low hundreds of millions of dollars. To be conservative, however, we count only San Jose's expenditures in our final estimate of total urban forestry expenditures (Table 1).

U.S. buyers outside California. Private companies that sell landscape architectural, lawn care, horticultural, and arboricultural services in California also sell them to buyers in other states. Out-of-state domestic buyers can be households, government institutions, and businesses. According to IMPLAN (7), the out-of-state sales, or domestic exports, of companies in California that belong to SIC 078 were \$1,498,162,000 in 1991. Some of these sales were for tree-related services. Our estimate of the tree-related fraction of sales of 0783 companies is 70%. To get this estimate, we take a weighted-average of the assumed tree-related fractions of purchases by in-state households, government, and businesses from companies that are primarily engaged in selling ornamental shrub and tree services (SIC 0783). The weights are the purchases by in-state house-

holds, government, and businesses of services from 0783 companies. Our estimates of the tree-related fractions of sales of 0781 and 0782 companies remain the same, namely 10%. With the same procedures as those used for other major purchasers, we estimate that U.S. buyers outside of California spent \$168.37 million for tree-related services from California-based landscape management companies in 1992 (Table 1 and Table 2).

Economic Impacts of Urban Forestry Expenditures

In total, we estimate \$1.12 billion of expenditures in 1992 for California-related urban forestry products and services. With the possible exception of some purchases by Californian households from out-of-state sellers, this amount also represents urban forestry sales of sellers located within the state. Although \$1.12 billion in sales is, by itself, a contribution to the California's economy, these urban forestry sales create economy-wide indirect and induced effects on sales, employment, and personal income in the state. These "ripple" effects occur because sellers of products and services related to urban forestry buy inputs from other industries and because households, the primary income recipients in the economy, spend some of their additional income on more goods and services.

Economic impacts are typically calculated with multipliers derived from input-output models. Urban forestry is not, however, a sector in the IMPLAN or any other input-output model. IMPLAN sector 27, which consists of companies that sell landscape services (SIC 078), bears closest resemblance to the urban forestry sector. We calculate the sales, employment, and income multipliers from IMPLAN's 1991 database and input-output model and use the multipliers to assess the statewide economic impacts of these urban forestry sales.

The total sales multiplier for landscape, lawn service, horticultural, and arboricultural companies is 3.0351. In technical jargon, the total sales multiplier is the sum of the direct, indirect, and induced multipliers. This multiplier indicates that a dollar of urban forestry-related sales leads to an additional \$2.04 worth of sales throughout the California economy. In other words, \$1.12 billion of urban-forestry-related sales leads, through

numerous linkages among industries and between consumers and industries, to \$2.27 billion in additional sales. Thus, the total sales impact of urban forestry in the state is \$3.38 billion.

The total income multiplier for landscape planning, lawn service, horticultural, and arboricultural companies is 1.6759. This multiplier indicates that a dollar increase in urban forestry sales leads to an increase in income of individuals of \$1.68. In other words, buyers and sellers of products and services related to urban forests in California generated an estimated \$1.87 billion in income to individuals throughout the state.

The biggest source of income for most people is employment. We lack sufficient data to count the number of jobs that are directly connected with urban forestry. However, the direct and total employment multipliers suggest the orders of magnitude of jobs. According to the IMPLAN database, a million dollars of sales in the landscape, horticultural, and arboricultural sector supports a total of 51 jobs throughout the economy and about 23 of those jobs within the sector itself. Applied to urban forestry, the total and direct employment multipliers suggest that the \$1.12 billion in sales in 1992 supported a total of 57,213 jobs in California and 25,325 of them are directly associated with urban forestry.

In short, if buyers had spent this \$1.12 billion outside of California, total sales in the state would have been about \$3.38 billion less, the income of individuals in the state would have been lower by \$1.87 billion, and there would have been about 57,213 fewer jobs.

Limitations of Current Study and Directions for Future Research

To put \$1.12 billion into perspective, the state's commercial forest products industry and agricultural sector had sales of \$12.56 billion and \$18.86 billion, respectively, in 1992 (2,9). Our estimate of \$1.12 billion of sales of products and services related to urban forestry in California reflects certain assumptions that we have spelled out and is probably less than the true sales magnitude. We have chosen procedures and estimates that are likely to error on the low side. The IMPLAN data also tend to understate sales. For example, the

IMPLAN database indicates that electric utilities purchased only \$2,832,900 from landscape, horticultural, and arboricultural companies in 1991. However, our own survey of the 5 largest utilities indicates that they paid \$62,250,949 for line clearance in 1992 to tree-service companies, companies that belong to sector 27 (SIC 078). Finally, we were not able account for all types of expenditures on urban forests for lack of data.

In addition to collecting information for other cities about expenditures similar to those calculated for San Jose, researchers in the future should also estimate expenditures on as many as possible of the following important activities. First, homeowners and other property owners spend money on equipment or contractors to clear or repair lateral sewer lines that have been clogged with leaves or damaged by tree roots. Second, property owners also pay plumbers or local water utilities to repair water lines damaged by tree roots. Third, government institutions, particularly those at the local level, spend money to repair curbs and gutters that have been damaged by tree roots.

Fourth, individuals and businesses pay legal fees and liability claims for injuries, disabilities, or deaths that are attributable to trees. Fifth, individuals pay medical bills for allergies, in addition to injuries, that are tree related. Sixth, households and businesses spend money on tree relocation and preservation. However, some sales of tree relocation and preservation are not included in the sales of SIC 078 companies. Large nurseries are among those that usually do this work but are not classified into SIC 078. Seventh, landscape contractors are paid to plant trees and install landscapes with trees. Our estimates of the expenditures of government institutions other than government enterprises, utilities, and community tree groups include payments to landscape contractors for tree planting and tree-related landscape installation, but our other estimates do not.

Eighth, government enterprises, schools, "other buyers in California," and buyers in other states purchase trees from nurseries and growers when they plant trees or install landscapes with trees themselves. Our estimates of the urban forestry expenditures of government enterprises, schools, "other buyers in California," and

buyers in other states do not include their purchases of trees and other tree-planting inputs from nurseries or growers. Our estimates of the expenditures of households, government institutions other than government enterprises, utilities, and community tree groups do, however, include such purchases.

Finally, certain professional associations spend money on training, certification, research, and lobbying to promote the interests of their members, some or all of whom reside in California and grow nursery trees, design and install landscapes with trees, or provide various arborist services. These associations include the California Association of Nurserymen, the California Landscape Contractors Association, the California Association of Landscape Architects, Associated Landscape Contractors of America, the American Society of Consulting Arborists, the Council of Tree and Landscape Appraisers, and the Western Chapter of the International Society of Arboriculture.

Expenditure information on these activities will undoubtedly create large estimates of the economic contributions of urban forestry in the state.

Conclusion

The figure of \$1.12 billion less the \$168 million of expenditures by buyers in other states equals \$947 million and represents expenditures by California buyers on urban forests in the state. These expenditures exemplify annual costs that people incur to use these natural resources. Knowledge of these expenditures and their economic impacts is important for efficient and equitable allocation of time, money, and water for urban forestry management. For example, decision-makers can judge whether government spends too little on urban forestry given their qualitative assessment of the benefits of these expenditures or their information about expenditures for other purposes. Knowledge of the multiplier effects of these expenditures provides a basis to estimate the economic impacts on the California economy if government or private spending priorities change.

In principle, sound economic management of urban forests also requires quantitative information on the benefits of these resources. Estimating current and future benefits of community forests is an

active area of applied ecological-economic research (6,8). If individuals, businesses, and government institutions undertake urban forestry activities with discounted benefits that are at least as great as discounted costs, then the present-value benefits of urban forests in California are at least \$947 million. Moreover, the annual benefits of these urban forests are at least \$947 million if, in addition to this premise, in-state buyers are not adding to or subtracting from the overall number and quality of trees and if their expenditures remain constant in real terms. (Of course, these premises are not necessarily true.) Finally, the value of the unpaid time that people spend planting, caring for, and dealing with the consequences of trees in residential landscapes and throughout their communities indicates additional benefits. For example, if people gave up \$5.00 per hour on average when they volunteered for community tree groups, then their annual contribution of 127,972 hours was equivalent to \$639,862 and indicates additional annual benefits at least as great. Once the benefits and costs of urban forests in a particular area are known, policy makers and taxpayers in that area will be in an even better position to manage these natural resources.

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Résumé. Les forêts urbaines constituent une source de produits du bois et fournissent des bénéfices d'ordres esthétique, récréatif, environnementaux et pour la santé humaine. Cependant, les dépenses engagées par les gens pour préserver ces bénéfices sont difficiles à estimer en raison du manque de disponibilité de données exhaustives. En se basant sur diverses sources de données, on a estimé que les Californiens ont dépensé au moins 1,010 milliard de dollars pour acquérir ces bénéfices et que le secteur forestier urbain de l'état a connu des ventes pour au moins 1,248 milliards de dollars sur une période de 12 mois au début des années '90. Du résultat des effets directs, indirects et induits, la foresterie urbaine compte pour au moins 3,789 milliards de dollars en ventes totales, 2,090 milliards de dollars en revenus aux individus et 64062 emplois au cours de cette période pour cet état.

Zusammenfassung. Stadforste liefern Holz- und Baumprodukte und weitere Vorteile im Bereich der Ästhetik, Freizeitgestaltung, Gesundheit und Umwelt. Die finanziellen Mittel, die zur Sicherung dieser Vorteile aufgewendet werden, sind mangels des veröffentlichten Zahlenmaterials schwierig zu schätzen. Basierend auf verschiedenen Datenquellen schätzen wir, daß die Kalifornier mindestens \$1.010 Milliarden ausgegeben haben, um diese Vorzüge zu erhalten. Der staatliche Forstsektor hat in den frühen 90er Jahren während einer Periode über zwölf Monate Umsätze von wenigstens \$1.248 Milliarden zu verzeichnen. Die Stadforstwirtschaft hat als Ergebnis von direkten, indirekten und induzierten Einwirkungen mindesens \$3.789 Milliarden aus Verkäufen erwirtschaftet, \$2.090 Milliarden als individuelle Einkommen ausbezahlt und 64.062 Arbeitsplätze allein innerhalb des Staates während dieses Zeitraums zu Verfügung gestellt.