THE ECONOMIC IMPACT OF SOLID WASTE DISPOSAL AND DIVERSION IN CALIFORNIA

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Abstract

This study develops economic impact models of solid waste system in California and determines statewide and regional economic impacts of waste disposal and diversion. The study estimates that the 1999 economic impacts of waste disposal and diversion were approximately $9 billion in output, $21 billion in output impacts, $8 billion in total income impacts, $11 billion in value-added impacts, and 179,000 additional jobs. The study also finds that if all waste generation were disposed instead of being diverted at the 1999 rates, the statewide economic impacts would be 17 to 20 percent lower. While the relative impacts for individual regions vary because of differences in material flows and business and industrial infrastructures, generally, diversion in California generates larger economic impacts than disposal. Average output and value-added impacts more than double when materials are diverted rather than disposed statewide, and output impacts, total income impacts, and job impacts also nearly double. Differences in regional impact suggest that creating markets to accept more recyclable and greenwaste materials is the key to stimulating more economic activities and higher economic impacts in the state.

Introduction

In 1989, the California legislature passed the California Integrated Waste Management Act (AB 939), which required all jurisdictions in the state to reduce solid waste disposal by 25 percent by the year 1995 and 50 percent by the year 2000. In 1990, there was approximately 51 million tons of waste generated statewide, and the waste diversion rate was 17 percent (CIWMB, 2000). Since then, the mandates of AB 939 greatly expanded the number and scale of diversion opportunities offered by local communities and state. The Act encouraged the shifting of materials from disposal-based to diversion-based activities and also created numerous marketing opportunities for diverted materials to be used by the state's manufacturers and agricultural producers. The California Integrated Waste Management Board (Waste Board) reports that the goal of 25 percent diversion rate was met on schedule by most jurisdictions in 1995 as required, and the statewide diversion rate in 1999 was 37 percent (CIWMB, 2000).

Diversion-based activities not only have an environmental impact on the communities involved, but also have an important economic dimension. In addition to the benefits of reduced potential of environmental hazard from bioactive landfill sites, there are immediate, easily quantifiable economic benefits to diverting waste from disposal sites. The diversion saves communities from paying tipping fee at the disposal site, which was on average $35 per ton in 1999. Additional diversion activities create jobs, add revenues, and help stimulate other economic sectors. To date, there has been no tool available in California at the state or local level that would allow the examination or measurement of the economic impacts of solid waste disposal or diversion.

This study estimates the total economic impacts of waste disposal and diversion for the year 1999 in California. The study specifically divides California into 6 economic regions

(North, East, South, Central Valley, Central Coast, and Bay Area), develops a general model of solid waste disposal and diversion system, and estimates and compares the economic impacts of disposal and diversion for the state and for each of the regions. The data are collected using secondary data sources and survey and analyzed using the input-output model, IMPLAN system. Because it is difficult to identify and assign their economic values, diversion sectors such as source reduction and reuse are not included in the study.

Literature Review

There are several studies done nationwide that measured the costs and impacts of recycling and disposal in the economy. Some studies (e.g. Platt and Morris, 1993; Deyle and Schade, 1991; North Carolina Department of Environment, Health and Natural Resources, 1997; and Sound Resource Management Group, Inc., 1993) compared recycling and disposal costs and showed that recycling was more cost-effective compared to disposal and had the potential for further growth. Other studies examined diversion industries only and found that recycling generated large impacts in the economy, increasing net employment and value-added in the economy. Using the input-output IMPLAN system, a study in Maine estimated the total economic impact per ton of recyclables as $1,539 in value-added, and 10.22 jobs were created for every 1,000 tons of materials recycled (1 job for every 98 tons) (Land & Water Associates and Market Decisions, Inc, 1993). Of the total impacts, manufacturing sectors generated $1,365 in value-added and 7.90 jobs per 1000 tons of recyclables (1 job for every 127 tons). The study done in Florida used the Regional Input-Output Modeling System II (RIMS II) of the US Department of Commerce and estimated that 13,000 were employed in recycling industries and 28,558 jobs (including the 13,000) were created in the overall economy from recycling in 1995

(Florida Department of Commerce, Division of Economic Development. 1996). Minnesota estimated from its REMI model system that the economic impacts of recycling manufacturing were $1,197 per ton in value-added, with 16.14 new jobs created for every 1,000 tons of recyclables (1 job for every 62 tons) (Minnesota Office of Environmental Assistance, 1997).

While there are differences in assumptions and results for each of the above studies, the overall trends from these studies are similar. Cost-effective recycling activities increase value-added and create additional jobs in the economy. In fact, the multiplier effects throughout the economy were as much as 2 to 3 times the direct effects. A few studies, however, compared the economic impacts of disposal to diversion of waste. The methods used in estimating the impacts of disposal and diversion are slightly different from those traditionally used, since diversion sectors add values but disposal sectors subtracted values of input products (waste) from final output. Prior studies also lacked a comprehensive analysis of all economic impacts of diversion activities because of limited model designs or the inability to find good data. This study tracks the flows of solid waste that are generated in California and measures the economic impacts of all waste-related activities using the best available, most consistent data.

Data

A majority of data was found in the published documents and database maintained at the California Integrated Waste Management Board (Waste Board), the Division of Recycling, the Department of Conservation (DOR/DOC), Federal and local governments, and waste and recycling industry associations. Many of these data were combined or averaged and used as the inputs for the economic impact model. California data sources for the study year, 1999, were

primarily used in the study when available, and data from other states and from other years than 1999 were also used for estimation of 1999 California numbers. Some industries in California were surveyed to cross check data accuracy and to assign quantitative values to production functions for all the sectors.

Most data on waste generation and disposal was obtained from the Waste Board. The Board has information on types of waste generated in California by jurisdiction and tipping fees charged at selected facilities. The SWIS database of the Waste Board maintains data on daily permitted capacities of facilities that are required to file operating permits with the Board[2]. The DRS database specifies jurisdictions of origin of all California waste and its final destinations and uses, including disposal and diversion at all California and out of state Board-permitted landfills and Board-permitted Waste To Energy (WTE) facilities.

The secondary data sources supplied only limited information on volumes and flows of diverted materials. Various California and industry studies estimated the rates of recycling and diversion by material type in California and nationwide. Limited data on recycling manufacturers were available in previous reports, industry organization summaries and contacts, IMPLAN data, and 1997 U.S. Manufacturing Census. The IMPLAN model has county level sales data for all manufacturing sectors, while the manufacturing census lists volumes of recyclable materials used in manufacturing for each sector.

Several past studies also estimated the costs of waste collection services and operations of different facilities (Alder, Green & Hasson LLP, 1998; Miller, 1993; EDF, 1991; Bolton, 1995, Biocycle, 1994; and the Waste Board, 1990), but most data on cost and revenue allocation were not available in previous studies and reports, nor the data on some regional volumes and

[2] There were 237 landfills, 36 MRFs, 295 transfer stations, 7 Board-permitted transformation facilities, 111 compost facilities, and 290 tire facilities.

flows of waste materials. A survey was mailed to a sample of waste haulers and operators of waste-related facilities with the Waste Board and Air Board permits and also to recyclers and brokers listed in the DOC/DOC database[3]. Since all operations involved in the waste and diversion industries were not included in the sample, survey estimates were subject to sampling variability.

Study Methods

The IMPLAN system was used to analyze economic impacts of both the disposal and diversion sectors. Because consistent state and regional data were limited, various methods were used to calculate the state and regional material flows, outputs of economic sectors, and costs of operations. For any region, the IMPLAN software system creates an input-output model and estimates total economic impacts of the sectors of interest by using the input-output relationships and deriving multipliers for output, employment, income, and value-added. Figure 1 depicts the volumes of disposal and diverted materials handled at different sectors and flows of all the materials for the state. Straight arrows indicate the flows of municipal solid waste (MSW) that are disposed, and dotted arrows indicate the flows of diverted materials. The SWIS, DRS, and Waste Characterization Study data of the Waste Board, as well as the survey results were used to track each of the volume flows. Similar figure was created for each region. Whenever the regional flow data was not available, the state estimates of material flow were used proportionately for all regions[4].

[3] The DOR/DOC database maintains information only of those recyclers who collect redemption materials and not of those who collect only paper and paperboard and the metals with no redemption values.
[4] More details on regional flows are discussed in Goldman and Ogishi (2001).

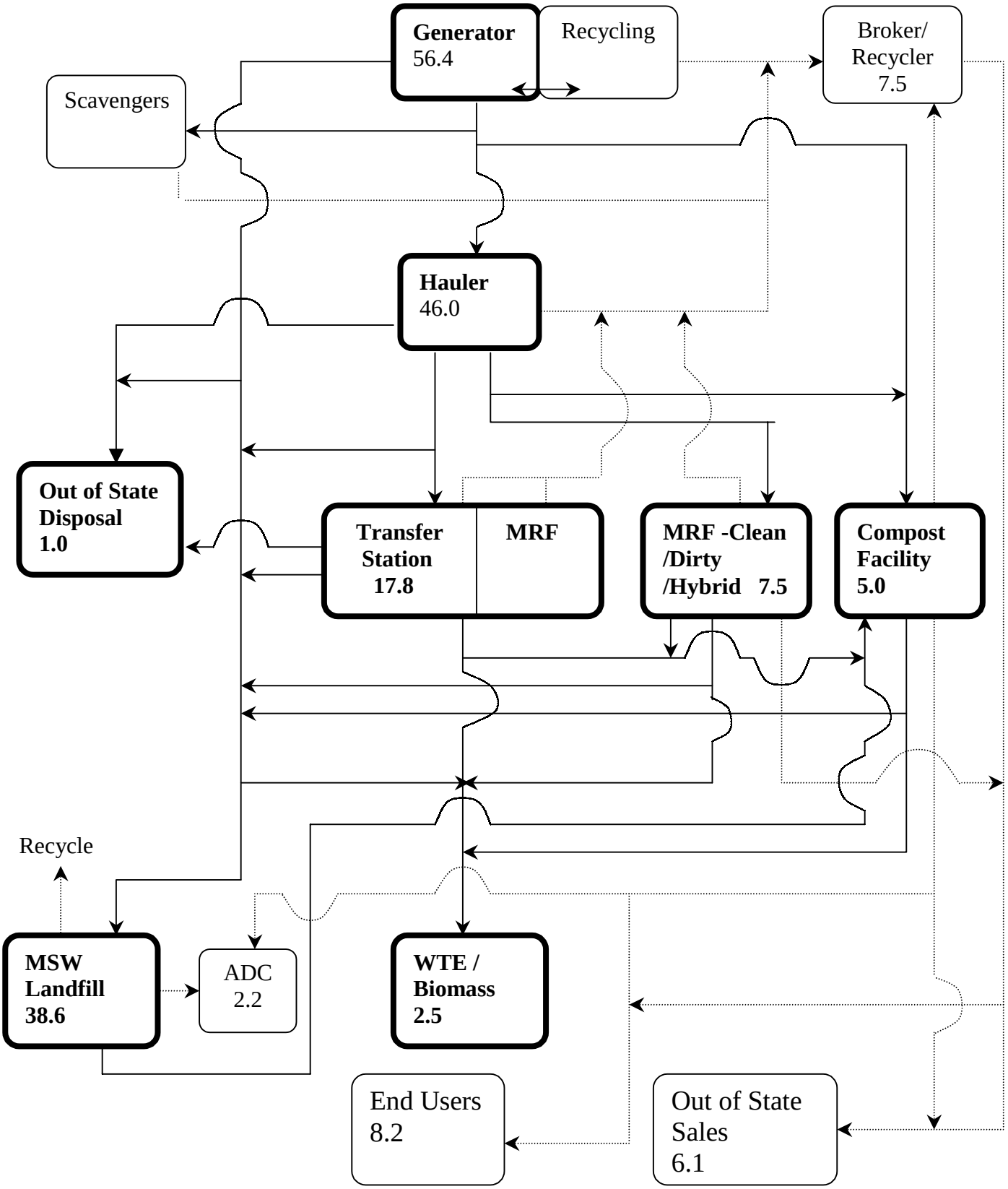

Figure 1 California 1999 Waste and Recyclables Volume Flow (in million tons)

Table 1 summarizes the 1999 state and regional outputs of different sectors. Output were calculated by multiplying volumes by collection or tipping fees plus any proceedings from material sales and adjusted by the survey results. The volumes of recycling were calculated using the estimated rates of recycling, disposal volumes of California waste, and volumes of materials collected for DOR/DOC's used beverage containers programs. This study considered only the manufacturers that used recyclable materials extensively in their production. Their recyclable material uses were estimated from the 1997 IMPLAN data and the 1997 Census of Manufactures. The amounts of sales values that were attributed to recyclable materials were calculated using the Census' percentage of costs of recyclable materials used versus the costs of virgin materials for different sectors. Because many manufacturers not included in the study also use recyclable materials, the dollar volume and impacts of manufacturers in the study are underestimated.

Table 1 Regional Output by Sector, 1999

Sector	All California (in $1,000)	North (in $1,000)	Bay Area (in $1,000)	Central Coast (in $1,000)	Central Valley (in $1,000)	South (in $1,000)	East (in $1,000)
Waste Collection	4,469,216	110,359	854,306	169,341	543,089	2,786,937	5,185
Recycling Collection	1,329,491	29,563	309,655	48,464	352,982	588,826	-
Yardwaste Collection	918,400	42,924	212,074	52,580	310,941	299,836	-
Transfer Station	821,167	38,958	197,592	10,857	127,035	445,910	815
MRFs	443,807	9,869	103,368	16,178	117,832	196,560	-
Compost Facility	221,392	10,352	51,123	12,675	74,956	72,826	-
ADC	153,287	4,420	60,707	5,636	5,002	77,344	178
Landfills	1,273,436	27,536	239,696	550,644	164,741	789,415	1,385
Incineration	234,429	7,055	34,841	8,638	77,726	106,161	-
Recycling Broker	619,910	23,386	147,352	20,763	120,475	307,366	568
Recycling Manufacturers	19,403,448	388,506	3,505,771	283,754	1,940,122	13,277,120	7,251

Source: CIWMB SWIS; DRS; DOR/DOC

Most waste disposal and diversion sectors are not categorized in the current IMPLAN system, but they were assumed to have similar production function to some existing sectors in the IMPLAN system. The production functions of these related sectors were used instead of those of the waste sectors for analysis, and various data sources, including survey and secondary data, were used to adjust the cost data of existing sectors. When the secondary cost data came from different years, all employment compensation data were adjusted to a common year using average hourly earnings for production workers and all other cost data using the Producer Price Index (PPI) for finished goods.

Estimation Methods

Economic models were constructed for the state and for each of the regions, and then customized by introducing variables for different scenarios. The first scenario assumes that all the waste generated in the state and in each of the regions in 1999 went to disposal and there was no diversion activity (disposal-only model). The second scenario assumes that both disposal and diversion occurred at the estimated 1999 rates (disposal-diversion model).

In the disposal-only model, output values for the sectors were calculated by multiplying the volumes of waste generated by per-ton collection costs, transfer costs, or average tipping fees. The DRS was used to estimate the disposal flow, which indicated that 97.5 percent of waste disposed in the state went to landfills and WTE facilities within the state, while 2.5 percent were used as ADC at landfill sites. The next set of models included diversion sectors, thus reducing the amount of waste that was going to disposal sectors by diverted volumes. These models most resemble the current disposal and diversion situations in California. Combined impacts of the diversion and disposal sectors for California and each region were estimated,

using data on output values, material flows, and costs of production. The combined disposal and diversion models were then compared with the disposal-only models to analyze the net impacts of having diversion sectors in the economy instead of having all the waste disposed at landfills.

Average economic impacts of each additional ton of waste disposed or diverted were also estimated to measure the differences in their impacts. Total output, income, value-added, and jobs generated in the disposal and diversion sectors were divided by the tons of waste disposed or diverted to derive the average impacts. Average impacts were used in the study instead of marginal because the marginal impact function could not be estimated from the IMPLAN system.

Results

Table 2 presents estimated economic impacts for disposal-only models that included only waste collection, transfer station, landfill, and WTE facility sectors. The second column displays the total sales of the disposal sectors adjusted to remove any double counting, and the third to sixth columns display the multiplier effects of the sectors. The third column of Table 2 shows that the California disposal sectors add a total output impact of $18.08 billion to the economy if all generation is disposed. The total income impacts from disposal-only models are estimated as $6.83 billion, while value added impacts are estimated at $8.99 billion and 154,200 jobs are created in all sectors of the economy.

Regional results and multiplier effects are also presented in Table 2. Because most waste is disposed in the same region as the points of waste generation, as specified in DRS, economic impacts of disposal sectors are closely correlated with the volumes of waste generated in each region. The Southern California region has the largest population and commercial sectors, and

thus has the largest volumes of waste generated within the region. Table 2 shows that the region has the largest output from disposal sectors as well as the largest multiplier effects. Total output of disposal sector is $4.14 billion, and the region generates $9.58 billion in output impacts, $3.61 billion in total income impacts, $4.72 billion in value-added impacts, and it creates 82,000 jobs in the economy.

Table 2. Economic Impacts Of All 1999 Waste Generation Going Only To Disposal

Region	Estimated Final Sales 1999 (in $1 million)	Impact on Economy			
		Output (in $1 million)	Total Income (in $1 million)	Value Added (in $1 million)	Number of Jobs (1,000)
All California	7,516.7	18,076.6	6,829.7	8,994.7	154.2
North	219.7	494.4	181.4	236.8	5.0
Bay Area	1,564.9	3,641.8	1,409.8	1,851.6	29.4
Central Coast	294.5	637.2	242.8	313.0	5.9
Central Valley	1,290.3	2,917.0	1,082.1	1,421.3	27.2
South	4,138.0	9,580.7	3,608.2	4,722.8	82.0
East	6.6	12.2	4.4	5.8	0.1

Table 3 presents the economic impacts of the scenario when both disposal and diversion sectors are operating at the 1999 rate of diversion. According to columns three, five and six of Table 3, these combined sectors are generating a total output impact of $21.20 billion, producing value-added impacts of $10.74 billion, and creating 179,300 jobs. The Southern California, Bay Area, and Central Valley regions specifically are experiencing large impacts, gaining $5.63 billion, $2.21 billion, and $1.76 billion in value-added, and creating 95,800, 33,900, and 32,200 jobs, respectively.

Table 3 Economic Impacts of All Waste Generation Going to Both Diversion and Disposal at 1999 Rates

Region	Estimated Final Sales 1999 (in $1 million)	Impact on Economy			
		Output (in $1 million)	Total Income (in $1 million)	Value Added (in $1 million)	Number of Jobs (1,000)
All California	9,179.9	21,202.3	7,899.6	10,739.2	179.3
North	238.6	517.5	188.8	257.2	5.2
Bay Area	1,904.8	4,223.9	1,627.9	2,207.1	33.9
Central Coast	315.9	666.3	255.9	337.6	6.2
Central Valley	1,597.2	3,462.4	1,292.6	1,755.8	32.2
South	5,117.3	11,348.0	4,168.3	5,634.8	95.8
East	5.9	10.7	3.9	5.2	0.1

When comparing Tables 2 and 3, we find that all the measures of impact are higher for the combined disposal and diversion models, statewide. Total output impacts are $3.13 billion or about 17 percent higher than the disposal-only model, value-added impacts are $1.74 billion or about 19 percent higher and job creation is 25,000 jobs or about 16 percent higher. The Southern California, Bay Area, and Central Valley regions specifically are experiencing large differences. They gain $1.77 billion, $0.58 billion, and $0.55 billion in output impacts, $0.91 billion, $0.36 billion, and $0.33 billion in value-added impacts, and creating 13,800, 4,500, and 5,100 jobs, respectively. These regions have more business and industrial and/or agricultural infrastructure relative to other regions, and a high percentage of the outputs generated by the diversion activity are re-spent in the same regions. Relatively more recycled material users and/or recycling manufacturers are located in these areas, and they create more value-added and jobs within the regions.

Because different regions have different economic activities and business and industrial infrastructures, there are also differences in the economic impacts from various diversion

activities. For example, the Northern California region has more forestry industries, and thus has relatively more paper-related manufacturing activities. The Central Valley region has more agricultural sectors that make more use of greenwaste as compost for crop production.

Study Implication from the Two Scenarios

If all waste were disposed, large impacts would be created in the California economy because collection and landfill sectors require more labor and other inputs to operate. When waste is diverted, the economic impacts related to disposal are lost, due to the decreased amount of waste collection and disposal activities; however, additional large economic impacts are created from diversion activities. In all the regions except for the Eastern California region, when the impacts of limited disposal are combined together with those of diversion, the total surpasses the economic impacts produced by the disposal only model. There is a lack of recycling infrastructure and facilities in the Eastern California region which leads to the movement of disposal and diverted materials into other regions and out-of-state.

The above findings suggest that diversion is good for the California economy, as it creates additional economic impacts compared to the disposal-only model. The actual impacts of having diversion sectors would be larger than the estimated 17-20% if all manufacturing sectors could be identified and captured in the study. The economic impacts would also increase when the diversion business and industrial infrastructures become more established, as seen in the Southern California and Bay Area regions. Creating markets to accept more recyclable and compostable materials would be the key to stimulating more economic activities and higher impacts in the state.

Average Economic Impacts per Ton for Changes in Disposal verses Diversion

Table 4 summarizes the average economic impacts of each additional ton of waste disposed or diverted beyond the present diversion rate for the state and each region. In California as a whole, the total economic impacts per ton from diversion are close to twice as much as the impacts from disposal. Typically, a change of one additional ton of waste disposed in California would generate $289 of total output in the state economy from the multiplier effects, while a change in one additional ton of waste diverted as recyclables would generate as much as $564. For every ton of waste disposed, $108 in total income and $144 in value-added would be created in the state economy. For every ton of waste diverted, $209 in total income and $290 in value-added would be created. Table 4 also shows that only 2.46 jobs would be

Table 4 Average Economic Impacts of Additional Waste Disposal and Diversion in 1999

Region		Total Sales 1999 ($/ton)	Impacts on Regional Economy			
			Output ($/ton)	Total Income ($/ton)	Value Added ($/ton)	Number of Jobs (Per 1,000 tons)
All California	*Disposed*	119	289	108	144	2.46
	Diverted	254	564	209	290	4.73
North	*Disposed*	115	260	94	125	2.62
	Diverted	186	388	143	199	3.90
Bay Area	*Disposed*	118	275	106	140	2.22
	Diverted	224	476	184	254	3.78
Central Coast	*Disposed*	115	250	94	123	2.30
	Diverted	189	387	152	203	3.61
Central Valley	*Disposed*	105	241	88	118	2.23
	Diverted	276	587	222	303	5.49
South	*Disposed*	123	287	108	142	2.46
	Diverted	265	557	200	278	4.62
East	*Disposed*	131	241	87	114	2.42
	Diverted	55	85	31	51	0.92

created for every 1,000 tons of waste disposed (1 job for every 400 tons), while 4.73 jobs would be created if the same volume of waste is diverted as recyclables (1 job for every 213 tons).

The results for regional impacts are similar to the ones of state, but they vary among regions. The Central Valley region's total output impacts are close to $350 per ton more when the waste is diverted than when disposed. In the Southern region the difference is $270 per ton, and in the Bay Area it is $200 per ton. Only in the Eastern region, the average impacts for diversion are less than the impacts for disposal.

Conclusion

This study found that the waste diversion would generally result in larger economic impacts and job creation than disposal. While some past studies showed higher indirect economic impacts and jobs created from recycling, mainly in manufacturing, the difference in impacts between this study and those of other studies came from our conservative estimation methods of impacts in the manufacturing sectors. Past studies examined a sample of manufacturers and applied the behaviors of their uses of recycling materials across the state. This study used the Census results and IMPLAN data to estimate the rates and volumes of recycled material uses for selected manufacturers. As the result, this study covers the entire state and is more consistent across regions in estimating impacts, but it may not capture all manufacturers' impacts, compared to other survey-oriented studies. Nevertheless, the key results of high economic impacts from diversion were the similar for this study and past analysis.

The study also found that the economic impacts varied by region. Waste diversion would stimulate the regional economy more than disposal in all regions but the Eastern California region. Limited infrastructure that supports recycling business forces the Eastern California to

deliver most recyclables out of the region for further processing and use in manufacturing. This suggests that the market development for recyclable and greenwaste materials is critical in stimulating the local economy to extend the benefits from diversion and achieve larger economic impacts in the state.

Limitations and extensions

This study examined only the selected diversion activities. There are no accepted measurement standards or secondary data yet available to estimate the amount and value of source reduction and reuse activities. A survey of waste generators would be necessary to gain a sample of practices by industry type and an estimate of the average dollar savings from these activities. It is also difficult to identify which activities are considered source reduction and reuse. For example, repairing and reselling used cars are a normal part of the ownership cycle, but it can also be considered reuse in some sense, since the vehicles were not disassembled for parts and ground up for scrap. In addition, waste sent to inert material facilities and waste tire facilities were not included in this study. To this extent, the study underestimates the actual impact of all diversion.

Because of limited secondary data and survey participation, as well as variations in input uses from facility to facility, only one set of input coefficients was specified for each sector and was applied for all regions. There are many situations that input costs and uses can vary across the state. Some facility designs can be more labor intensive than others, and they may feature unique processes, locally fabricated machinery, and special relationships between companies. This is especially true of the waste industry, which is currently in a period of rapid change featuring much experimentation and consolidation.

The volumes of recyclables used in manufacturing sectors were estimated from the material uses described in the national Census of Manufacturers. This estimation method assumes that the same industries used the same percentage of recyclable materials (versus virgin materials) across the state, which best approximates the real input uses, but may not accurately measure the regional impacts of manufacturing sectors. Some facilities are known to use more recyclable materials than others even in the same industries, but this behavior was not captured in the study. In addition, not all manufacturers that used recycled materials were included in the study as discussed earlier, since only limited census data was available on the use of recycled materials. It was also not possible to track the flow of all recyclable materials with the scope of this study, and some recycling manufacturers were left out of the study that might generate large local economic impacts in a particular community. A survey of diverted material volume and use by manufacturers during local waste audits could be valuable in determining the flows and end uses of materials.

In addition, overall environmental benefits and costs from waste diversion have not been discussed in this study. Much work needs to be done to assign any economic value of environmental protection in California.

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