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Economic Analysis of SB568's Proposed Polystyrene Ban

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Introduction and Summary

A product ban must be considered in terms of its cost and what it achieves from an environmental and social point of view.[1] Based on a preliminary analysis, the costs of banning polystyrene food and beverage containers in California could easily be over $500 million per year and lead to the loss of hundreds of jobs in the state. Costs to already financially strapped public schools, in particular, could exceed $112 million annually. At the same time, the social benefits of the ban are highly uncertain and quite possibly very modest. According to recent life cycle cost comparisons, substitute products will result in higher energy and water consumption and, depending on the mix of substitutes preferred by consumers, higher greenhouse gas emissions. The impact on litter—a main objective of the ban—also appears to be small. The impact of polystyrene on marine ecosystems is yet unknown, and available evidence does not provide justification for significant environmental and economic costs the ban will entail.

The Costs of a Polystyrene Ban Are Likely to be Large

Based on our preliminary analysis, the costs of the proposed polystyrene ban are likely to be substantial. The cost to California consumers including households, public school districts, and other government institutions that provide food services could easily reach $500 million annually.

Costs to Households

Household expenditures on food and meals away from home will clearly increase. Based on a recent comparison of posted prices, the price differential between polystyrene food service items (cups, lids, plates, and trays) and compostable items is large. According to distributor price lists, the price for substitute cups, for example, is on average 3 times the cost of equivalent polystyrene cups. As shown in Table 1, based on this price differential and the average per capita consumption of 16oz polystyrene cups, California consumer spending could increase by as much as $355 million per year. This cost is only for cups. Similar increases are likely for the other food service items replaced by higher cost substitutes Consequently, the total cost to households accounting for plates, clamshells, and trays as well as cups could be several times higher reaching perhaps $500 million or more.

[1] SB 568 allows school districts and cities and counties to opt out of the ban if they establish recycling programs that they show "based on empirical data" will result in the recycling of at least 60 percent of polystyrene food containers in their jurisdiction. The deadline for school districts to make such a finding is 2017 and the deadline for cities and counties is 2016. The proponents of SB 568 have not shown that it is feasible for cities, counties, and school districts to meet the limited exceptions to the ban. It is reasonable to assume that few jurisdictions will be able to meet SB 568's limited exceptions.

Table 1: Average Total Costs of Polystyrene Cup and Lid Substitution in California

ASSUMPTIONS

Polystyrene Cups Disposed of in US per Year	25,000,000,000	[1]
US Population	307,000,000	[2]
CA Population	37,000,000	[3]
CA Share of Population	12%	[4]
CA Share of Disposed Polystyrene Cups	3,000,000,000	[5]

PRICE COMPARISON

	Cost (per 1000)	Vs. Average Substitute Price	Cost for CA Substitution of Polystrene Cups & Lids
	[6]	[7]	[8]
Polystyrene Cups			
Dart 16 oz. Impulse Stock Printed Cups	$45.78	-76.44	
Dart Big Drink Foam Cup - 16 oz. RPI	$37.55	-84.67	
Dart Foam Cup Flush Fill 16 oz.	$31.95	-90.27	
Dart Cafe G Printed Foam Cups - 16 oz.	$51.75	-70.47	
Average Polystyrene Cup Price	**$41.76**	-80.47	
Lids for Polystyrene Cups			
Dart Translucent Lids with Straw Slot RPI	$16.23	-39.68	
Dart Lift n Lock Wide Lid w Straw Slot RPI	$19.73	-36.18	
Average Lid Price for Polystyrene Cups	**$17.98**	-37.93	
Alternative Cups			
Dixie 16 oz. PLA Paper Hot Cups	$129.18	87.42	$262,267,500
PerfectTouch Paper Coffee Cup - 16 oz.	$118.60	76.84	$230,527,500
World Centric 16oz. PLA Paper Hot Cup	$112.29	70.53	$211,597,500
World Centric 16oz. PLA Clear Cold Cup	$128.82	87.06	$261,187,500
Average Alternative Cup Price	**$122.22**	80.47	$241,395,000
Alternative Lids			
White Dixie Drink Thru Lid	$40.00	22.02	$66,060,000
World Centric Compostable Lids	$71.82	53.84	$161,520,000
Average Alternative Lid Price	**$55.91**	37.93	$113,790,000
		Average Cost of Polystyrene Cup & Lid Substitution in CA	**$355,185,000**

Notes:

[1]: U.S. Environmental Protection Agency, "Fact Flash" <http://www.epa.gov/superfund/students/clas_act/haz-ed/ff06.pdf>
[2]: U.S. Census Bureau
[3]: U.S. Census Bureau
[4]: [3] / [2]
[5] [1] x [4]
[6] Costs obtained from www.reliablepaper.com and www.worldcentric.org
[7] Item cost from [6] less average substitute item cost from [6].
[8] [5] x [7] / 1000

Costs to Public Institutions

School districts and other public institutions that provide food services would experience substantial cost increases. While it is difficult to calculate these costs precisely, the Long Beach Unified School District has estimated that it will cost between $0.84 and $1.5 million annually to replace polystyrene trays with compostable products. Taking the midpoint of this range and the number of students enrolled in the District results in a cost of about $18 per pupil per year. As shown in Table 2, extrapolating this cost to all public school children in California results in annual cost of $61 to $112 million. While not all public schools necessarily use polystyrene trays, this may still under estimate state level costs since this estimate is only for one food service item. Total costs could be considerably higher if polystyrene plates, cups, or clamshells are used in schools. For, example, if one assumes that one plate and one cup are used with each tray, the savings from using polystyrene could be as high as $148 million per year.[2]

Table 2: Costs to Public School Districts from Polystyrene Tray Substitution

Long Beach Unified School District Cost to Substitute Polystyrene Trays	$0.12 to $0.22 per tray	[1]
Number of Trays Used per Year	7,000,000	[2]
Annual Cost	$840,000 to $1,540,000	[3]
Number of Students Enrolled in District	85,257	[4]
Cost Per Student	$9.85 to $18.06	[5]
Statewide Public School Enrollment	6,191,566	[6]
Statewide Cost of Polystyrene Tray Substitution in Public Schools	**$61,002,797 to $111,838,461**	[7]

Notes:

[1]: "Recyclable foam trays a cure for Long Beach schools' headache", Long Beach Press-Telegram, May 19, 2011. <http://www.presstelegram.com/ci_18100171?source=rv>

[2]: Ibid.

[3]: [1] x [2]

[4]: 2010-2011 Enrollment. Long Beach Unified School District, "Adopted Budget: Fiscal Year 2011-2012", Overview, p. 1 <http://www.lbschools.net/Main_Offices/Business_Services/pdf/FY12%20Adopted%20Budget%20Book.pdf>

[5]: [3] / [4]

[6]: California Department of Education, CALPADS, 2011

[7]: [5] x [6]

Although similar cost data is not readily available for other institutions including public colleges, universities, and hospitals, the additional costs imposed by the ban will be considerable. For example, California Community Colleges enroll about 2,700,000 students annually, the California State College system enrolls over 400,000 students per year and the

[2] Assuming 6,191,566 students, a 184 day school year and a $0.13 premium per cup and plate combined.

University system enrolls another 219,000. [3] Even if only a quarter of these students rely on university food services, and the cost per student are similar to the public schools then the ban could easily cost these institutions over $17 million annually. Again this is for a single food service item—trays. Accounting for additional items including cups and plates would undoubtedly increase total costs to public colleges and universities.

Using information on the number of polystyrene cups disposed by the Gould Medical Foundation, a health care organization administering to 631,000 patient visits per year, we are able to estimate the average number of polystyrene cups in use relative to patient visits. By extrapolating this calculation to account for all patient visits within California each year, we can generate an estimate of the number of polystyrene cups used annually by California's health care industry. Comparing this total to the average cost of substitution calculated in Table 1, we find an estimated statewide cost to health care of around $8 million assuming substitution of all polystyrene cups. This calculation is depicted in Table 3 below. This is once again the cost of substitution for a single food service item, and total costs would likely be higher.

Table 3: Costs to California Health Care Industry from Polystyrene Cup and Lid Substitution

Gould Medical Foundation Polystyrene Cups Used per Year	300,000	[1]
Gould Medical Foundation Patient Visits	631,000	[2]
Polystyrene Cups Used per Patient Visit	0.475	[3]
Total Patient Visits in US	1,189,619,000	[4]
California Share of US Population	12%	[5]
Estimated California Patient Visits	142,754,280	[6]
Total Polystyrene Cups used in CA Health Care Industry	67,870,498	[7]
Average Cost of Polystyrene Cup & Lid Substitution	$0.1184	[8]
Statewide Cost of Polystyrene Cup & Lid Substitution in Health Care Industry	**$8,035,867**	[9]

Notes:

[1]: Sutter Gould Medical Foundation, "Facts at a Glance", 2006 <http://www.sutterhealth.org/about/snapshots/gould2.pdf>

[2]: CalRecycle, "Waste Reduction Awards Program Winners" <http://www.calrecycle.ca.gov/WRAP/search.asp?VW=APP&BIZID=5848&YEAR=2010&CNTY=>

[3]: [1] / [2]

[4]: US Department of Health and Human Services, *Health, United States, 2010* . Table 91. <http://www.cdc.gov/nchs/data/hus/hus10.pdf>

[5]: U.S. Census Bureau

[6]: [4] x [5]

[7]: [3] x [6]

[8]: See Table 1

[9]: [7] x [8]

[3] Chancellor's Office, California Community College Datamart; California State University Chancellor's Office; and University of California Office of the President, Statistical Summary and Data on UC Students, Faculty, and Staff, Fall 2010.

The Benefits of a Polystyrene Ban Are Uncertain

Measuring the benefits of a ban requires special attention to the available substitutes. The substitutes can be worse than the banned product with respect to the intended objective of the ban. In fact, based on several life-cycle assessments, polystyrene food service products consume less energy and water and generate less greenhouse gases in production and transport than substitutes such as wax coated paper and polyethylene.[4] Consequently a ban is likely to substantially increase energy and water consumption and possibly generate more greenhouse gases.

Impacts on Energy and Water Consumption

For example, if 16 oz polystyrene cups were replaced by any one of several substitutes identified in a recent lifecycle cost analysis, the resulting additional energy consumption would be equivalent to the additional energy consumption of between 3,130 and 12,500 homes for 16oz hot cups, and 2,700 to 39,000 homes for 32oz cold cups.[5] This is shown in Figure 1.[6]

Substitutions could also lead to increased water consumption by the equivalent of 3,700 to 9,300 average US households for 16oz hot cups and 2,200 to 41,000 households for 32oz cold cups.[7] This is shown in Figure 2.

Impacts on Greenhouse Gas Emissions

Greenhouse gas emissions from the same substitutions could decrease by the equivalent of 27,000 autos or increase by the equivalent of 21,000 autos for 16oz hot cups, and decrease by 50,000 autos or increase by 64,000 autos for 32oz cold cups. [8] This is shown in Figure 3 The result depends on which polystyrene substitutes consumers prefer and what assumptions are made about whether substitute products are fully compostable. For example, if consumers use two paper cups as a substitute for one polystyrene cup for hot beverages, which is common because polystyrene cups are excellent insulators and paper cups are not, the paper cup substitutes will emit more greenhouse gases.

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[4] We reviewed Franklin Associates (2011) and Herrera Environmental Consultants (2008).

[5] These calculations rely on Franklin Associates (2011). Assumes Average household energy consumption is 77 million BTU. See appendix table A-1.

[6] The lifecycle cost analysis did not consider that unlike polystyrene cups, which contain heat effectively, other cups do a poor job resulting in many consumers using double cups. The study did account for the addition of paper sleeves to contain heat in some non-polystyrene cups.

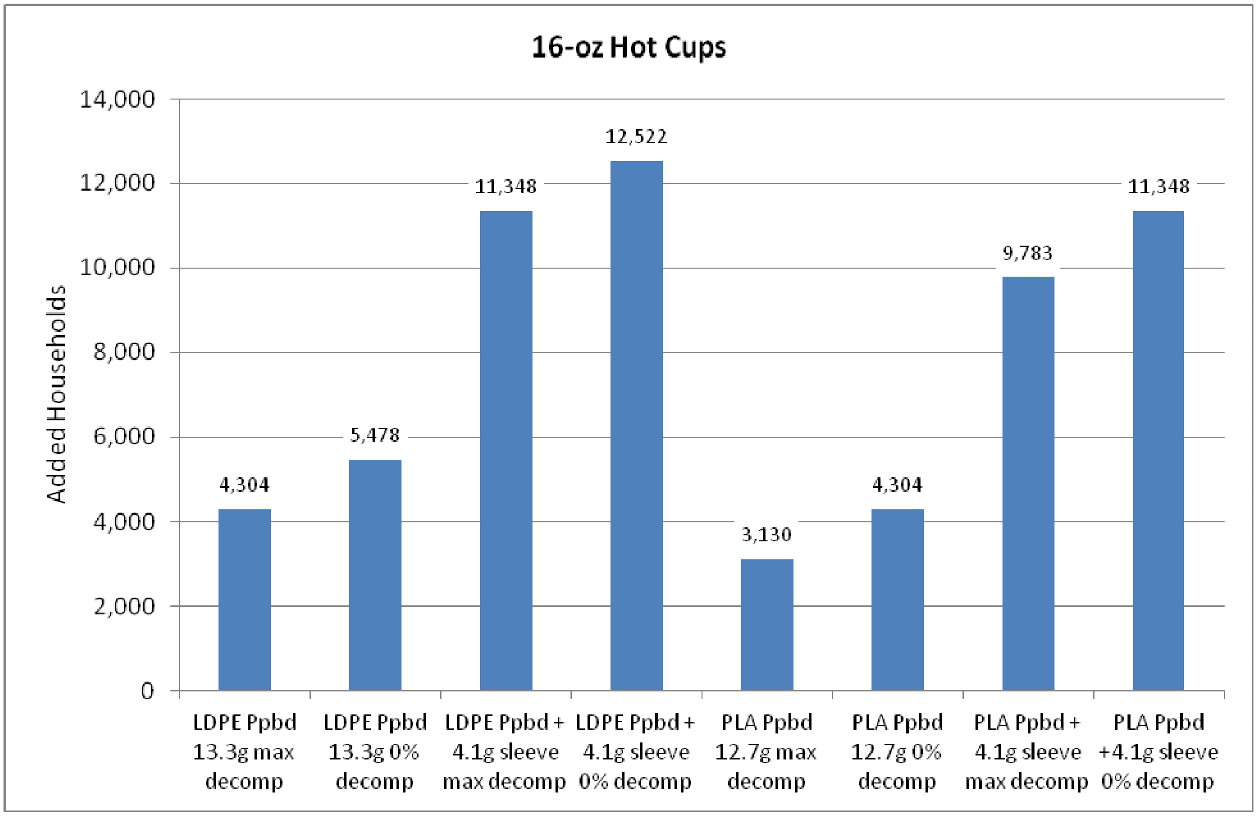
[7] These calculations rely on Franklin Associates (2011). Assumes average household water consumption is 114,464 gallons. See appendix table A-2.

[8] These calculations rely on Franklin Associates (2011). Assumes average auto fuel emissions used are 7064 lbs CO2 equivalent. See appendix table A-3.

If one assumes that substitute products are fully compostable, then polystyrene products have lower greenhouse gas emissions than the substitute products. If one assumes that the substitute products are not compostable, then the substitute products may have lower greenhouse gas emissions; however, this negates one of the asserted advantages of these products (i.e., that they are compostable). The measurement of greenhouse gas emissions highlights how uncertain the measurement of the benefits of a polystyrene ban can be.

In addition, the greenhouse gas analysis assumes that neither polystyrene food containers nor their substitutes are recycled. This is a conservative assumption, because polystyrene food containers are readily recyclable and their substitutes may not be.

Figure 1: Added Energy Consumption in Average Household Equivalents from Substitution of EPS 16-oz Hot Cups and 32-oz Cold Cups



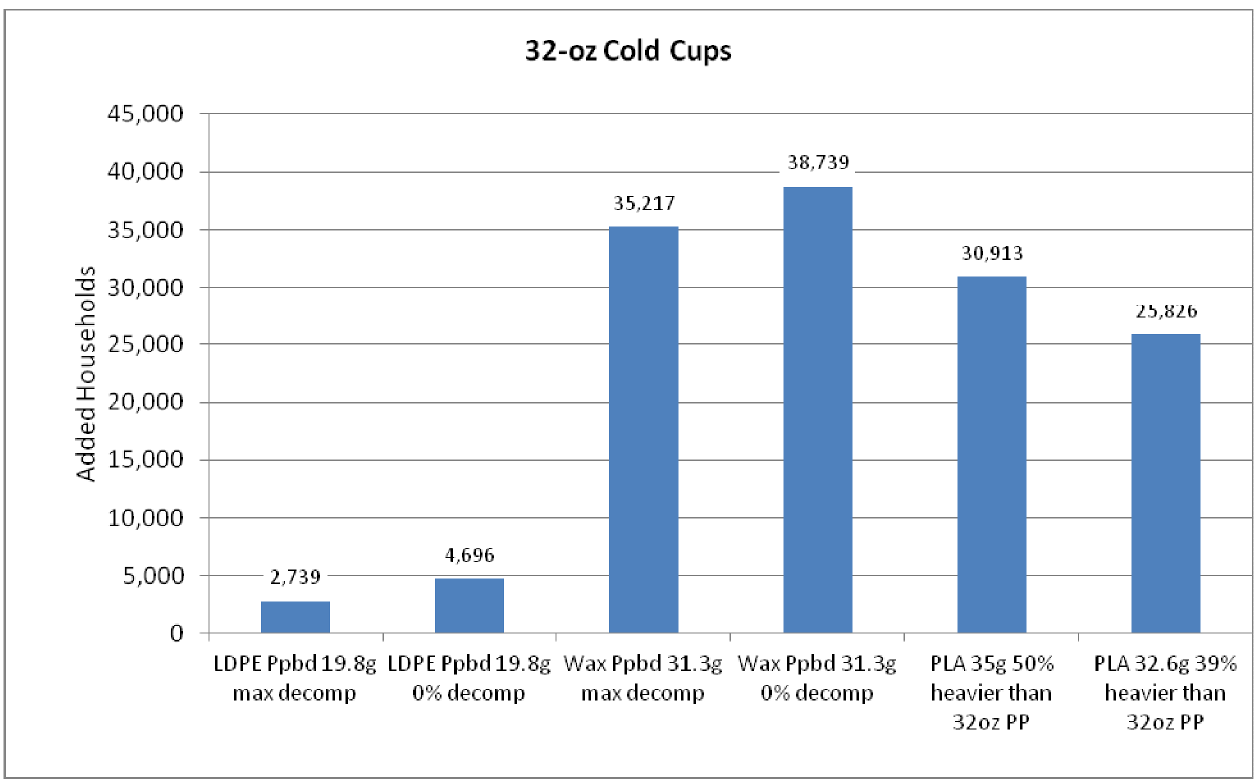
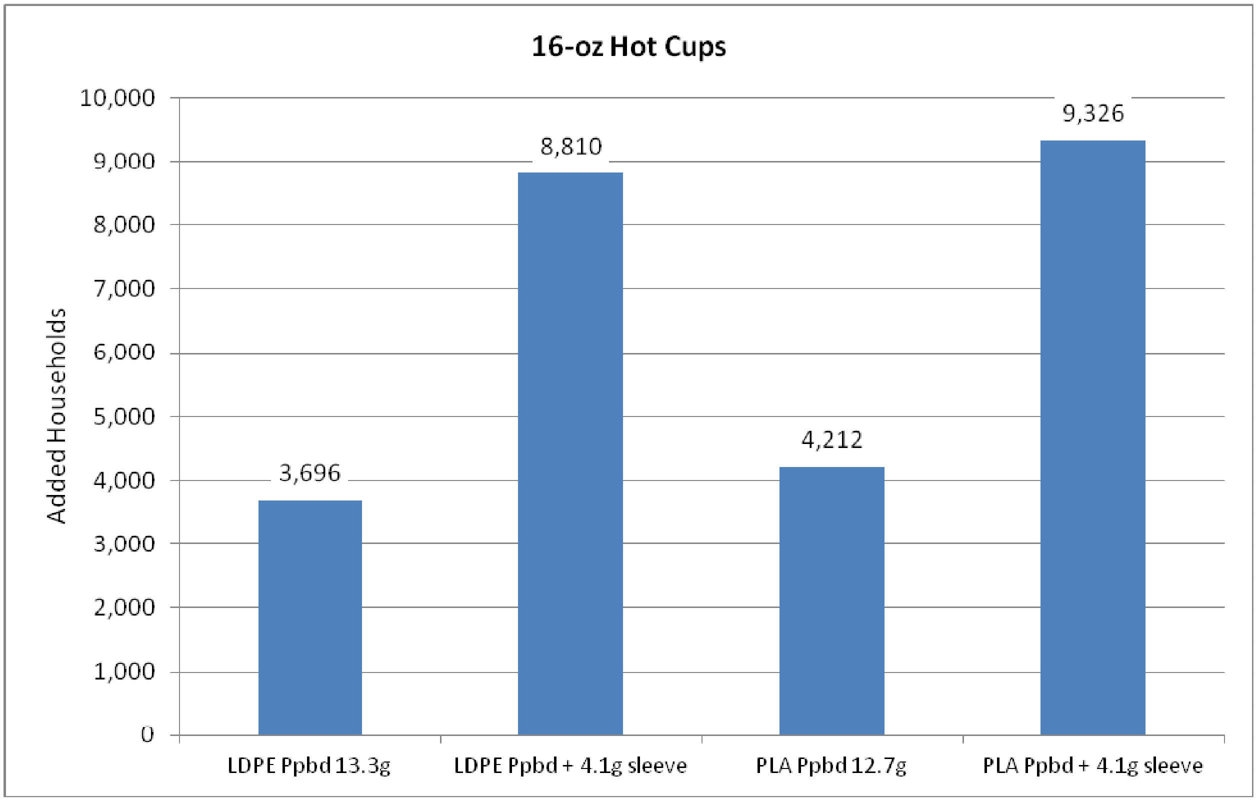


Figure 2: Added Water Consumption in Average Annual Household Use Equivalents from Substitution of EPS 16-oz Hot Cups and 32-oz Cold Cups



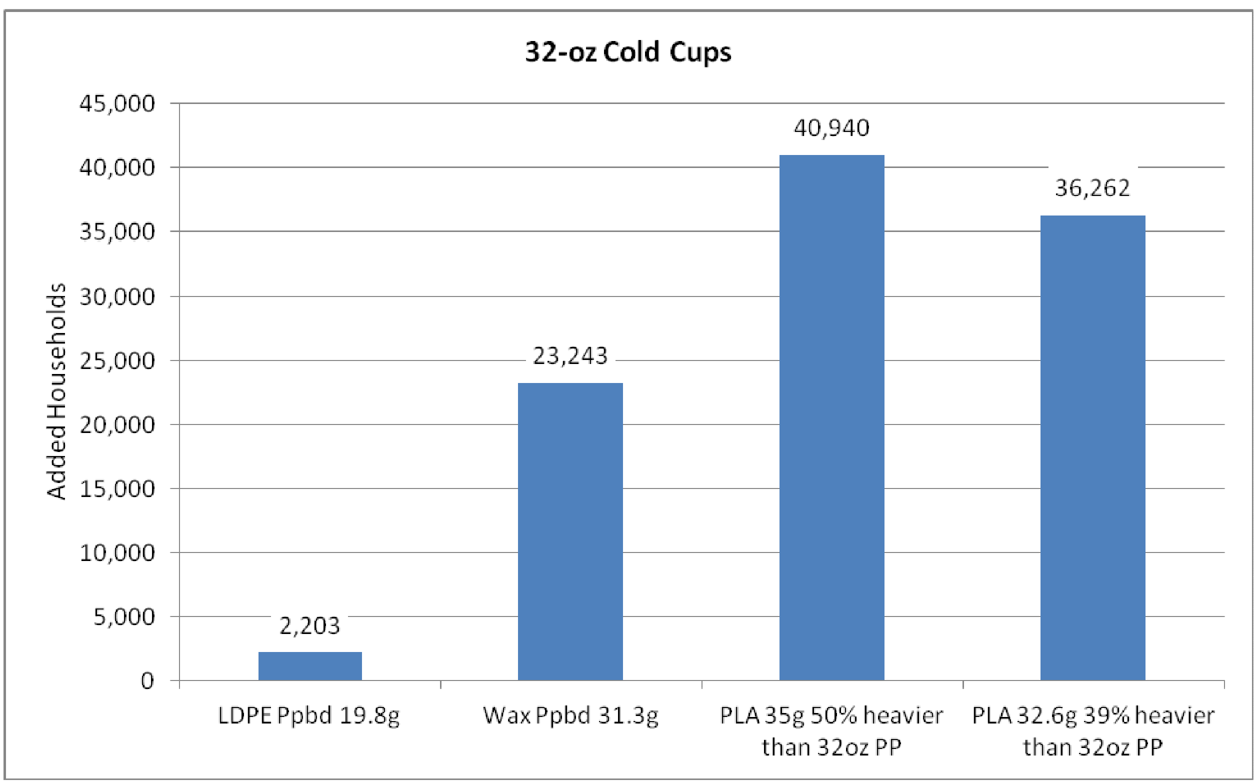
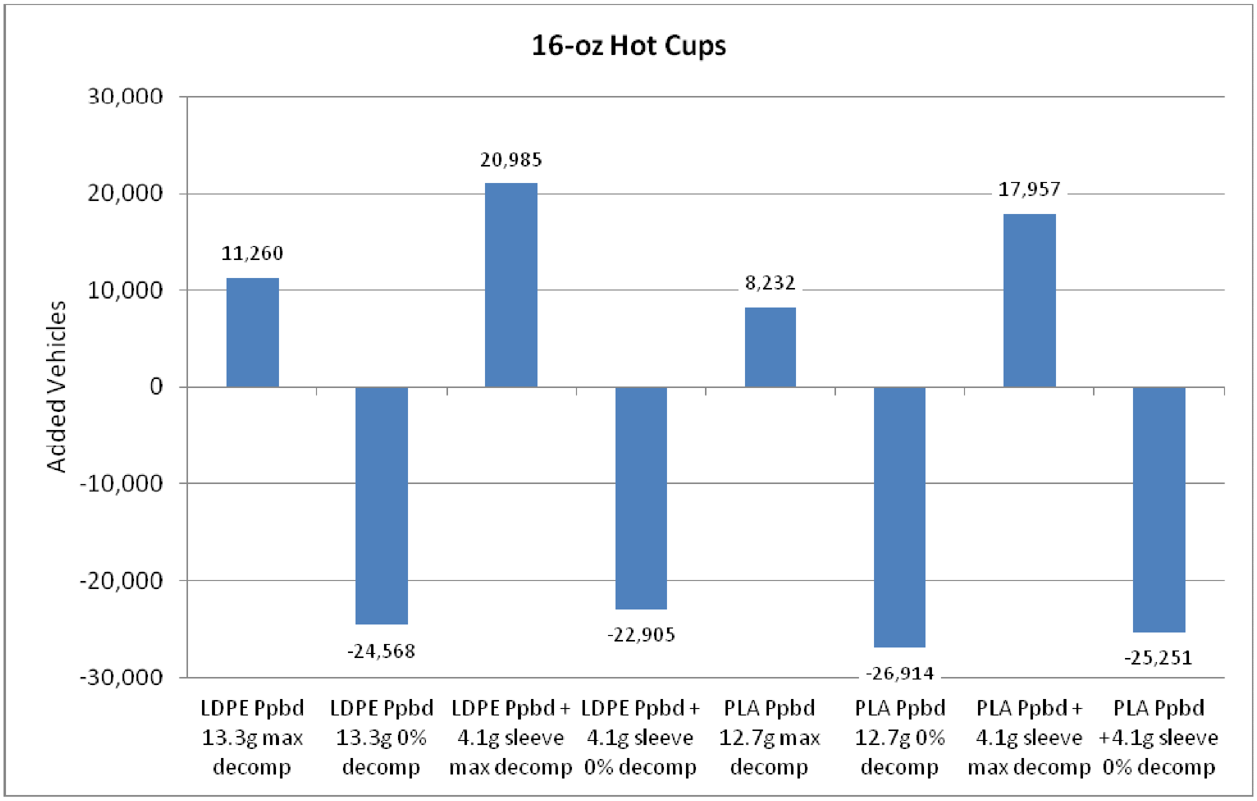
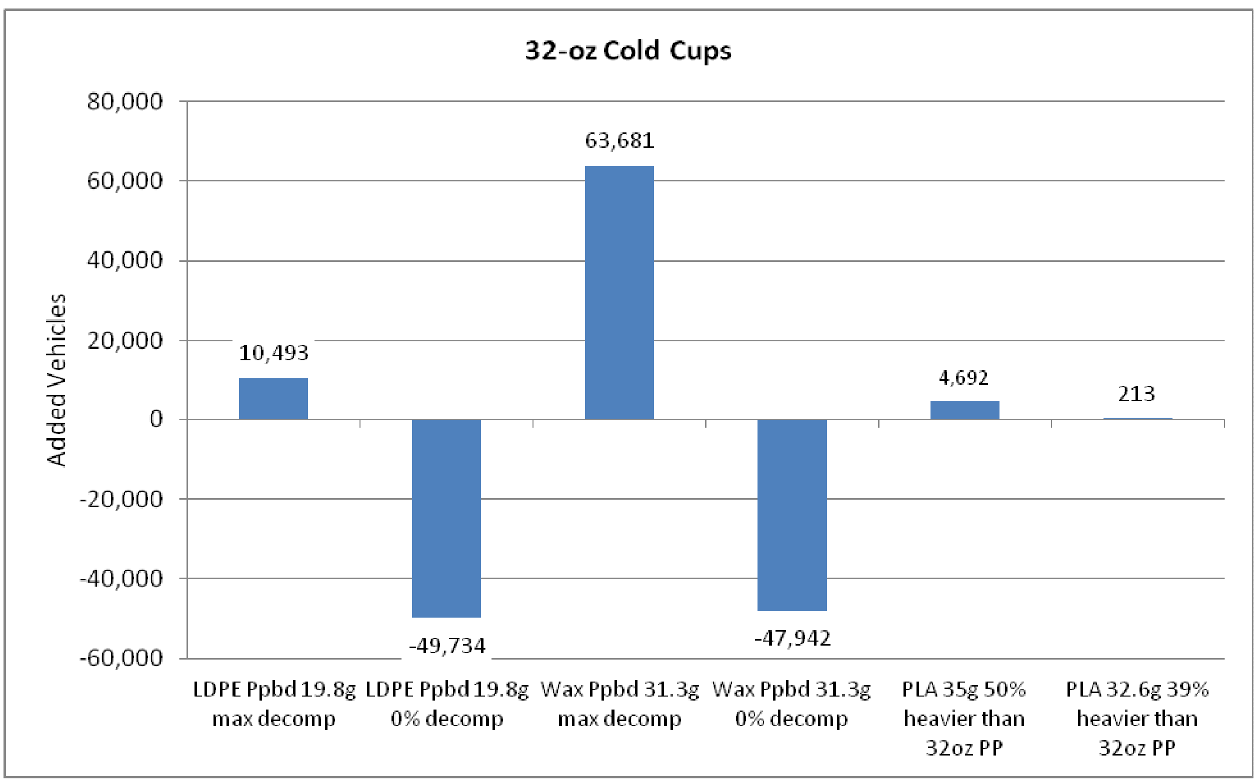


Figure 3: Added GHG Emissions in Average Vehicle Equivalents from Substitution of EPS 16-oz Hot Cups and 32-oz Cold Cups





Impact on Marine Environments

Polystyrene has been identified as a possible source of damage to marine life (birds, fish, and plants, but to date, as described by the National Oceanic and Atmospheric Administration (NOAA), research has not shown any clear link[9]. NOAA observes that the source of the small plastics (microplastics) that are of greatest concern is unknown. Some comes from primary sources (plastics in a small state at the time of discharge) while other small plastic comes from the breakdown of larger plastic sources including litter and other marine debris. [10]NOAA further notes the "paucity of data" on the impacts of small plastic debris on the marine environment.[11] NOAA observes that " … overall the impact on entire seabird populations is either unknown or not considered large enough to warrant further investigation at this time."[12] NOAA concludes that:

> Altogether, the science suggests that microplastics deserve further scrutiny in the laboratory and the field…. Only then will it be possible for the best science to inform management decisions for the remediation and prevention of microplastic pollution in the marine environment.[13]

In addition, polystyrene substitutes are not clearly less of a problem to marine life than some of the available substitutes that contain other plastics. Given the significant environmental and economic costs of a ban on polystyrene food containers, the unknown, speculative potential benefits to the marine environment cannot justify the a ban on polystyrene food containers.

Impact on Litter Reduction

It is also not clear that banning polystyrene food service items will reduce litter – a prime objective of the ban. What is more likely to happen is a change in the composition of litter. We have found no evidence that litter control costs have declined in cities where polystyrene items have been banned. It is also worth noting that polystyrene does not appear to be a major litter component. A 2007 San Francisco survey conducted before the City

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[9] Courtney Arthur, Joel Baker, and Holly Bamford, editors, "Proceedings of the International Research Workshop on the Occurance, Effects, and Fate of Mircroplastic Marine Debris," Department of Commerce, National Oceanic and Atmospheric Administration, Technical Memorandum NOS-OR&R-30, January, 2009.
[10] Arthur, et. al. p. 5 of the Executive Summary.
[11] Arthur, et. al. p. 2 of the Executive Summary.
[12]Arthur, et. al. p. 2 of the Executive Summary.
[13] Arthur, et.al. p 5 of the Executive Summary.

implemented a ban on polystyrene service items, for example, found that polystyrene cups accounted for less than 2% of observed litter.[14]

Other litter reduction strategies may prove far more effective. A recent study by Keep American Beautiful, for example, found that litter levels have fallen dramatically since the late 1960s. Much of this reduction is attributed to better education, more street cleaning, and recycling.[15]

There are alternatives to the polystyrene ban to reduce litter. Los Angeles has elected to encourage polystyrene recycling. Other California cities have also rejected polystyrene bans, and presumably are pursuing other approaches.

Since other California cities including San Francisco, Oakland, and Berkeley have introduced bans, there is a great opportunity to conduct an important social experiment. Different approaches to litter reduction (and marine protection) can be compared regarding litter volume, composition, and cost and effectiveness provided enough time has elapsed to collect the necessary data. At the same time, research regarding the impacts of polystyrene and other plastics on the marine environment is likely to progress.

Conclusion

The available evidence does not support the introduction of a polystyrene ban. The costs are likely to be large without clear corresponding benefits. At the same time, the different approaches to litter reduction taken by various California cities and counties provide the opportunity to study the costs and benefits of multiple approaches.

[14] "The City of San Francisco Streets Litter Audit." Prepared for the City and County of San Francisco Department of Environment by HDR, Brown Vence & Associates, and MGM Management, June 2007. P. 27. The survey was completed in April 2007, the ban went into effect on June 1, 2007.

[15] Midatlantic Solid Waste Consultants, 2009 National Visible Litter Survey and Litter Cost Study, prepared for Keep America Beautiful, Final Report, September 18, 2009.

APPENDICES

Table A-1: Energy Use Comparison for Polystyrene Foodservice Product Alternatives

Product	Million BTU	Net vs. Polystyrene	Net Difference as % of Annual Average Household Consumption	Converted Products Required to Consume Energy of 1 Additional Household	Added Households of Energy Consumption from Substitution of EPS
	[1]	[2]	[3]	[4]	[5]
Energy Use for 16-oz Hot Cups (10,000 average weight cups)					
EPS 4.7g	5.4				
LDPE Ppbd 13.3g max decomp	6.5	1.1	1.43%	700,000	4,304
LDPE Ppbd 13.3g 0% decomp	6.8	1.4	1.82%	550,000	5,478
LDPE Ppbd + 4.1g sleeve max decomp	8.3	2.9	3.77%	265,517	11,348
LDPE Ppbd + 4.1g sleeve 0% decomp	8.6	3.2	4.16%	240,625	12,522
PLA Ppbd 12.7g max decomp	6.2	0.8	1.04%	962,500	3,130
PLA Ppbd 12.7g 0% decomp	6.5	1.1	1.43%	700,000	4,304
PLA Ppbd + 4.1g sleeve max decomp	7.9	2.5	3.25%	308,000	9,783
PLA Ppbd +4.1g sleeve 0% decomp	8.3	2.9	3.77%	265,517	11,348
Energy Use for 32-oz Cold Cups (10,000 average weight cups)					
EPS 8.8g	9.6				
LDPE Ppbd 19.8g max decomp	10.3	0.7	0.91%	1,100,000	2,739
LDPE Ppbd 19.8g 0% decomp	10.8	1.2	1.56%	641,667	4,696
Wax Ppbd 31.3g max decomp	18.6	9	11.69%	85,556	35,217
Wax Ppbd 31.3g 0% decomp	19.5	9.9	12.86%	77,778	38,739
PLA 35g 50% heavier than 32oz PP	17.5	7.9	10.26%	97,468	30,913
PLA 32.6g 39% heavier than 32oz PP	16.2	6.6	8.57%	116,667	25,826
Energy Use for 9-inch Plates (10,000 average weight plates)					
Heavy-Duty Plates					
GPPS 10.8g	8.4				
LDPE Ppbd 18.4g max decomp	10.3	1.9	2.47%	405,263	
LDPE Ppbd 18.4g 0% decomp	9.7	1.3	1.69%	592,308	
Mold Pulp 16.6g max decomp	10.9	2.5	3.25%	308,000	
Mold Pulp 16.6g 0% decomp	11.3	2.9	3.77%	265,517	
PLA 20.7g	10.4	2	2.60%	385,000	
Lightweight Plates					
2009 GPPS 4.7g	3.6				
2009 LDPE Ppbd 12.1g max decomp	6.1	2.5	3.25%	308,000	
Energy Use for Sandwich-size Clamshells (10,000 average weight clamshells)					
GPPS 4.8g	3.8				
Fluted Ppbd 10.2g max decomp	5.8	2	2.60%	385,000	
Fluted Ppbd 10.2g 0% decomp	6	2.2	2.86%	350,000	
PLA 23.3g	14.4	10.6	13.77%	72,642	

Notes:

Net expended energy = total energy requirements - energy recovery - energy content of landfilled material

[1]: Franklin Associates, "Life Cycle Inventory of Foam Polystyrene, Paper-Based, and PLA Foodservice Products", 4 February 2011.

[2]: [1] - Equivalent Polystyrene Product Energy Use in [1]

[3]: Assumes 2005 Western census region annual household energy consumption.
<http://www.eia.gov/totalenergy/data/annual/txt/ptb0204.html>

[4]: 1 / [3] * 10,000

[5]: Assumes 3 billion cups disposed of in CA per year. See Table 1.

Table A-2: Water Use Comparison for Polystyrene Foodservice Product Alternatives

Product	Gallons	Net vs. Polystyrene	Net Difference as % of Annual Average Household Consumption	Converted Products Required to Consume Water of 1 Additional Household	Added Households of Water Consumption from Substitution of EPS
	[1]	[2]	[3]	[4]	[5]
Water Use for 16-oz Hot Cups (gallons per 10,000 average weight cups)					
EPS 4.7g	4748				
LDPE Ppbd 13.3g	6152	1404	1.23%	815,271	3,696
LDPE Ppbd + 4.1g sleeve	8095	3347	2.92%	341,990	8,810
PLA Ppbd 12.7g	6348	1600	1.40%	715,400	4,212
PLA Ppbd + 4.1g sleeve	8291	3543	3.10%	323,071	9,326
Water Use for 32-oz Cold Cups (gallons per 10,000 average weight cups)					
EPS 8.8g	8441				
LDPE Ppbd 19.8g	9278	837	0.73%	1,367,551	2,203
Wax Ppbd 31.3g	17271	8830	7.71%	129,631	23,243
PLA 35g 50% heavier than 32oz PP	23994	15553	13.59%	73,596	40,940
PLA 32.6g 39% heavier than 32oz PP	22217	13776	12.04%	83,089	36,262
Water Use for 9-inch Plates (gallons per 10,000 average weight plates)					
Heavy-Duty Plates					
GPPS 10.8g	7466				
LDPE Ppbd 18.4g	8898	1432	1.25%	799,330	
Mold Pulp 16.6g	9017	1551	1.36%	738,001	
PLA 20.7g	14208	6742	5.89%	169,778	
Water Use Emissions for Sandwich-size Clamshells (gallons per 10,000 average weight clamshells)					
GPPS 4.8g	3873				
Fluted Ppbd 10.2g	4951	1078	0.94%	1,061,818	
PLA 23.3g	15996	12123	10.59%	94,419	

Notes:

[1]: Franklin Associates, "Life Cycle Inventory of Foam Polystyrene, Paper-Based, and PLA Foodservice Products", 4 February 2011.

[2]: [1] - Equivalent Polystyrene Product Water Use in [1]

[3]: Assumes average domestic per capita water use at average household size of 3.2 individuals, equal to 114,464 gallons per year. <http://ga.water.usgs.gov/edu/wateruse/pdf/wudomestic-2005.pdf>

[4]: 1 / [3] * 10,000

[5]: Assumes 3 billion cups disposed of in CA per year. See Table 1.

Table A-3: Greenhouse Gas Emissions Comparison for Polystyrene Foodservice Product Alternatives

Product	Pounds CO2 Equivalents	Net vs. Polystyrene	Net Difference as % of Average Annual Vehicle Emissions	Converted Products Required to Generate Emissions of 1 Additional Vehicle	Added Average Vehicle Emissions Added from Substitution of EPS
	[1]	[2]	[3]	[4]	[5]
Greenhouse Gas Emissions for 16-oz Hot Cups (lb CO2 eq per 10,000 average weight cups)					
EPS 4.7g	723				
LDPE Ppbd 13.3g max decomp	987	264	3.74%	267,576	11,260
LDPE Ppbd 13.3g 0% decomp	147	-576	-8.15%	-122,639	-24,568
LDPE Ppbd + 4.1g sleeve max decomp	1215	492	6.96%	143,577	20,985
LDPE Ppbd + 4.1g sleeve 0% decomp	186	-537	-7.60%	-131,546	-22,905
PLA Ppbd 12.7g max decomp	916	193	2.73%	366,010	8,232
PLA Ppbd 12.7g 0% decomp	92	-631	-8.93%	-111,949	-26,914
PLA Ppbd + 4.1g sleeve max decomp	1144	421	5.96%	167,791	17,957
PLA Ppbd +4.1g sleeve 0% decomp	131	-592	-8.38%	-119,324	-25,251
Greenhouse Gas Emissions for 32-oz Cold Cups (lb CO2 eq per 10,000 average weight cups)					
EPS 8.8g	1309				
LDPE Ppbd 19.8g max decomp	1555	246	3.48%	287,154	10,493
LDPE Ppbd 19.8g 0% decomp	143	-1166	-16.51%	-60,583	-49,734
Wax Ppbd 31.3g max decomp	2802	1493	21.14%	47,314	63,681
Wax Ppbd 31.3g 0% decomp	185	-1124	-15.91%	-62,847	-47,942
PLA 35g 50% heavier than 32oz PP	1419	110	1.56%	642,182	4,692
PLA 32.6g 39% heavier than 32oz PP	1314	5	0.07%	14,128,000	213
Greenhouse Gas Emissions for 9-inch Plates (lb CO2 eq per 10,000 average weight plates)					
Heavy-Duty Plates					
GPPS 10.8g	1142				
LDPE Ppbd 18.4g max decomp	1406	264	3.74%	267,576	
LDPE Ppbd 18.4g 0% decomp	206	-936	-13.25%	-75,470	
Mold Pulp 16.6g max decomp	1712	570	8.07%	123,930	
Mold Pulp 16.6g 0% decomp	532	-610	-8.64%	-115,803	
PLA 20.7g	840	-302	-4.28%	-233,907	
Lightweight Plates					
2009 GPPS 4.7g	497				
2009 LDPE Ppbd 12.1g max decomp	927	430	6.09%	164,279	
Greenhouse Gas Emissions for Sandwich-size Clamshells (lb CO2 eq per 10,000 average weight clamshells)					
GPPS 4.8g	529				
Fluted Ppbd 10.2g max decomp	681	152	2.15%	464,737	
Fluted Ppbd 10.2g 0% decomp	216	-313	-4.43%	-225,687	
PLA 23.3g	1492	963	13.63%	73,354	

Notes:

[1]: Franklin Associates, "Life Cycle Inventory of Foam Polystyrene, Paper-Based, and PLA Foodservice Products", 4 February 2011.

[2]: [1] - Equivalent Polystyrene Product Emissions in [1]

[3]: Assumes annual vehicle emissions at average California CAFE Standard levels and 12,000 driving miles per year. <http://www.dieselnet.com/standards/us/ca_ghg.php>

[4]: 1 / [3] * 10,000

[5]: Assumes 3 billion cups disposed of in CA per year. See Table 1.

References

California State University Chancellor’s Office. Accessed 24 June 2011. <www.calstate.edu/executive>

CalRecycle, "Waste Reduction Awards Program Winners". Accessed 24 June 2011. <http://www.calrecycle.ca.gov/WRAP/search.asp?VW=APP&BIZID=5848&YEAR=2010&CNTY=>

Chancellor’s Office, *California Community College Datamart.* Accessed 24 June 2011.

Courtney Arthur, Joel Baker, and Holly Bamford, editors, “Proceedings of the International Research Workshop on the Occurance, Effects, and Fate of Mircroplastic Marine Debris,” Department of Commerce, National Oceanic and Atmospheric Administration, Technical Memorandum NOS-OR&R-30, January, 2009.

DieselNet, “California Fleet Average GHG Emission Standards”. Accessed 24 June 2011. <http://www.dieselnet.com/standards/us/ca_ghg.php>

Energy Information Administration, “Household Energy Consumption by Census Region, Selected Years, 1978-2005.” Accessed 24 June 2011. <http://www.eia.gov/totalenergy/data/annual/txt/ptb0204.html>

Franklin Associates, “Life Cycle Inventory of Foam Polystyrene, Paper-based, and PLA Foodservice Products.” Prepared for The Plastic Foodservice Packaging Group, 4 February 2011.

Herrera Environmental Consultants, “Alternatives to Disposable Shopping Bags and Food Service Items: Volume 1.” Prepared for Seattle Public Utilities, 29 January 2008.

Long Beach Unified School District, "Adopted Budget: Fiscal Year 2011-2012", Overview, p. 1. Accessed 24 June 2011. <http://www.lbschools.net/Main_Offices/Business_Services/pdf/FY12%20Adopted%20Budget%20Book.pdf>

Midatlantic Solid Waste Consultants, 2009 National Visible Litter Survey and Litter Cost Study, prepared for Keep America Beautiful, Final Report, September 18, 2009.

"Recyclable foam trays a cure for Long Beach schools' headache", Long Beach Press-Telegram, May 19, 2011. Accessed 24 June 2011.
<http://www.presstelegram.com/ci_18100171?source=rv>

Sutter Gould Medical Foundation, "Facts at a Glance." Accessed 24 June 2011.
<http://www.sutterhealth.org/about/snapshots/gould2.pdf>

"The City of San Francisco Streets Litter Audit." Prepared for the City and County of San Francisco Department of Environment by HDR, Brown Vence & Associates, and MGM Management, June 2007. P. 27. The survey was completed in April 2007, the ban went into effect on June 1, 2007.

United States Geological Survey, "Estimated Use of Water in the United States in 2005." Accessed 24 June 2011. <http://ga.water.usgs.gov/edu/wateruse/pdf/wudomestic-2005.pdf>

University of California Office of the President, "Statistical Summary and Data on UC Students, Faculty, and Staff." Fall 2010.

US Department of Health and Human Services, Health, United States, 2010. Table 91. Accessed 24 June 2011.
<http://www.cdc.gov/nchs/data/hus/hus10.pdf>

US Environmental Protection Agency, "Fact Flash"
<http://www.epa.gov/superfund/students/clas_act/haz-ed/ff06.pdf>

Author Bios

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Biography

Dr. Mark Berkman is an expert in applied microeconomics. His experience spans the areas of the environment, energy, and natural resources; environmental health and safety; labor and employment; intellectual property; antitrust; commercial litigation and damages; and public finance. He has assisted both public and private clients and provided testimony before state and federal courts, arbitration panels, regulatory bodies, and legislatures.

His environmental work has involved the review of proposed air, water, solid waste, and worker and product safety regulations. Dr. Berkman has quantified the costs and benefits of these regulations, as well as toxic tort and product liability claims. In addition, he has valued natural and water resources as well as property damages associated with pollution from Superfund sites, landfills, and power plants.

His work on energy matters includes the valuation of coal resources, power plants, and transmission rights-of-way. He has also prepared energy demand and price forecasts. He has extensive experience working with Native American tribes on energy valuation matters.

Clients in a variety of industries ranging from computer chip to shoe manufacturers have sought Dr. Berkman's assistance to value patents, trade secrets, and trademarks. He has also been called on to address questions of market power in a variety of industries including solid waste, computer manufacturing, and medical devices. He has testified regarding market definition and market power and participated in Hart-Scott-Rodino proceedings.

Dr. Berkman also has substantial experience in labor and discrimination litigation. He has conducted statistical analyses of alleged discrimination in hiring, promotion, pay, and contracting, and completed damage analyses regarding these allegations. He has also conducted statistical analyses regarding mortgage lending discrimination.

Prior to joining *Brattle* he was a co-founder and director at Berkeley Economic Consulting and a vice president at both Charles River Associates and NERA Economic Consulting.

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Biography

Dr. David Sunding has extensive experience as a researcher, consultant, and expert witness in matters related to natural resources, environmental quality, energy, and the economics of regulation. His expertise includes experience in complex litigation, regulation, and transactions. He has testified in state and federal courts and in regulatory proceedings around the country.

He has assisted corporations, utilities, and government agencies in developing economic testimony in a variety of matters concerning environmental damages, product liability, risk assessment, resource planning, cost allocation, and project financing. Dr. Sunding has played a central role in several prominent water resource matters, including the landmark Quantification Settlement Agreement for the Colorado River, interstate water disputes before the U.S. Supreme Court, and the Federal Energy Regulatory Commission's relicensing of hydropower facilities. He has authored several widely cited studies on the economics of water quality regulation and has served as an expert in cases involving regulation and litigation under the Clean Water Act, the Endangered Species Act, and other statutes.

Dr. Sunding is the Thomas J. Graff Professor in the College of Natural Resources at UC Berkeley, where he is also the co-director of the Berkeley Water Center. He has received numerous awards for his research, including grants from the National Science Foundation, the U.S. Environmental Protection Agency, and private foundations. He is currently a Visiting Professor in the Woods Institute of the Environment at Stanford University.

Prior to joining *The Brattle Group*, Dr. Sunding was a founding director of Berkeley Economic Consulting. Previously, he was a senior consultant at Charles River Associates and NERA. He served as a senior economist for President Clinton's Council of Economic Advisers, and is a member of the American Economic Association, the Association of Environmental and Resource Economists, the Econometric Society, and the American Law and Economics Association.