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Sustainable Failure: Why Portland's Polystyrene Foam Ban Should Be Repealed

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November 2007

I. Introduction

In the summer of 1988, Portland City Commissioner Bob Koch introduced an ordinance to ban the use of polystyrene foam (PSF) for prepared food in restaurants, grocery stores and other retail establishments. He hoped that this would address perceived environmental issues with PSF, commonly known by the trade name Styrofoam. However, the proposal was quickly withdrawn when Commissioner Koch discovered that the alleged problems with PSF did not actually exist and that the measure had the potential to increase rather than decrease environmental impacts.

However, Commissioner Earl Blumenauer, backed by some local environmentalists, took up the fallen banner. After more than a year of debate, Portland's City Council passed an ordinance requiring food vendors to discontinue the use of PSF and to switch to the only available substitutes for PSF at that time: #6 clear plastic (polystyrene) and coated paper.¹ The ordinance went into effect January 1, 1990 and covers bakery and deli products, fruits, vegetables, frozen yogurt, ice cream, coffee, tea and soft drinks that are processed or prepared on-site.

Eighteen years later, overwhelming evidence shows that Commissioner Koch was correct. Alternatives to PSF food service containers actually carry more environmental impacts than PSF. At the same time, the law drives up costs to businesses and consumers and negatively affects the business environment in Portland. As a means of educating the public, the ban fails because it encourages the perpetuation of misunderstanding among the citizens of Portland.

This paper will discuss the current effects of the PSF ban, contrast the arguments for the ban with its real damaging impacts on the environment, and finally look at the mis-educational effects of the ban and offer opportunities for change.

II. Economic Effects

The PSF ban-related issues that Portland citizens must deal with are not trivial. The problems for local business owners ensuing from the PSF ban have continued for the past eighteen years.

While the food service industry has worked around the ban, it has been a discouraging and expensive experience.

“Eighteen years later, overwhelming evidence shows that Commissioner [Bob] Koch was correct. Alternatives to [polysytrene foam] food service containers actually carry more environmental impacts than PSF.”

II.1. The cost of paper cups versus foam cups

Because polystyrene foam requires fewer raw materials and less energy to produce than alternatives, it is far less expensive. Many grocery stores, marketing to individuals who are not forced to choose one product over the other, do not even stock paper cups suitable for hot beverages.

A 12-ounce PSF hot/cold cup costs roughly 1.7 cents, while a 12-ounce paper hot cup costs approximately 4.5 cents. The clear plastic cups that many local coffee shops use for cold drinks cost even more, at about 7.7 cents apiece.² Thus, without the ban, a Portland coffee shop using 4,000 paper cups a week could save at least \$3,950 per year by replacing these with foam cups. If a coffee shop chose to substitute PSF cups for clear plastic cups as well, possible savings would be even greater, approximately \$8,940 per year total.³

While additional cup costs may not be an issue for a large franchise, for a small neighborhood coffee shop owner it could be a significant contributing factor in whether or not a business is successful.

According to the county health department, there are 3,000 licensed food distributors in Multnomah County. Assuming that the area where the ban is in place (Portland and the



county's unincorporated areas) comprises approximately 82 percent of the population of Multnomah County,⁴ possible estimates for the total direct costs to local food vendors range from \$3.9 million to \$4.7 million per year as a result of the ban.⁵

II.2. The cost of poor insulation

These figures do not reflect some businesses in violation of the ban, and it is likely that not every business would switch to PSF if the ban were repealed. However, the cost estimates still may be low, simply because paper products are notoriously poor insulators. Thus, paper and PSF products are not consumed at an equal rate. Simply stepping into a few coffee shops in downtown Portland and watching consumer behavior shows that customers in Portland routinely request (or receive without request) double paper cups, extra napkins or “java jackets” to protect their hands from burning.

Double paper cups for hot beverages:
a common practice in popular Portland coffee shops.



II.3. The opportunity costs

The ban hurts not only individual entrepreneurs, but also Portland as a whole, because of its opportunity costs. Restaurant revenues wasted on the ban are not invested elsewhere for things more highly valued by business owners, such as improving food service, hiring more employees, raising wages or increasing dividends to shareholders. If the costs are simply passed on to consumers, then customers have less disposable income.

Regardless of who ultimately pays, forcing restaurants to spend twice or four times the market rate for food containers destroys wealth, because that capital is no longer available to be invested in higher-valued activities.

The ban also stifles technological innovation in PSF recycling, thereby eliminating opportunities for economic development in that sector.

II.4. The cost of enforcement

Since the ban is a regulatory program, there are enforcement costs that must be borne by taxpayers. Employees from both the Multnomah County Health Department and Portland's Office of Sustainable Development are involved in enforcement procedures. Tax revenues spent on this enforcement are not available for other activities that would generate higher net benefits to local citizens.

III. Environmental myths and realities

While the economic problems ensuing from the ban may be potentially significant, proponents have continued to claim that the benefits outweigh the costs, pointing to supposed environmental gains. However, most of these arguments were not relevant in 1988 and have become even less so in subsequent years. In contrasting the main concerns underlying the ban with PSF's true effects on the environment, it is clear that the ban in fact might have damaged, rather than improved, environmental quality.

III.1. Ozone Depletion

Proponents of the ban argued that PSF production released chlorofluorocarbons (CFCs), thought to be a cause of stratospheric ozone depletion. Even today, some will argue against PSF use based on the need to protect the ozone layer. However, according to the 1988 Task Force Report on PSF, 90 percent of all foam cups have never been made with CFCs, and foam products made with CFCs comprised less than 2 percent of national CFC use.⁶ Thus, even in 1988, the outlawing of PSF was an unrealistic way to address CFC concerns.

Since then, the plastics industry has exceeded regulatory goals and timetables in the worldwide drive to phase out CFC use, and CFCs have not been used in PSF production since 1990.⁷

III.2. Landfill Capacity and Post-Consumer Waste

At the time the ban was passed, the St. John's Reidell landfill was quickly approaching capacity, making the PSF ban part of a larger program to look for a solution to the landfill problem. But after local officials signed a long-term contract to dispose of Portland's solid waste at a large landfill in the Eastern Oregon community of Arlington, the capacity argument lost its urgency.

“Because plastic products have continued to develop since the ban was written, restaurant owners in Portland are allowed to use, and frequently do use, some newer types of foam...with a higher density of plastic.”

Moreover, PSF containers were never a significant part of the waste stream anyway. There has long been a misconception that plastics and fast-food containers are among the main items filling up our landfills. However, this argument has been largely debunked since 1992, when William Rathje, director of the University of Arizona's Garbage Project, showed that fast-food containers of all kinds took up only one-third of one percent of an average landfill by volume.⁸

In 2003, according to the EPA, the whole category of plastics only accounted for 15.4 percent of total discards into the municipal waste stream compared with a much larger proportion of 26.3 percent paper products.⁹ The total amount of discarded plastic nondurable plates and cups is only 0.4 percent of the total, out of which many are made of non-PSF types of plastics. Because a large portion of the PSF products are used by individuals, non-profit organizations, schools and hospitals, all of which are allowed to and do continue to use PSF under the ban, the amount of PSF dishes kept out of the municipal waste stream could be so small as to be inconsequential.

Critics also claimed that polystyrene foam was not recyclable and that substitute products, if mandated, would be widely recycled. Hoping to encourage sustainable recycling practices, they were apparently unaware that their efforts would lead to the exact opposite result. The immediate effect of the foam ban was that PSF food container recycling at the Portland-based Denton Plastics¹⁰ was discontinued, while the substitute paper products were simply thrown out by consumers since they are not recyclable.

“...[P]aper and PSF products are not consumed at an equal rate...[W]atching consumer behavior shows that customers in Portland routinely request...double paper cups, extra napkins or ‘java jackets’ to protect their hands from burning.”

In 1992 the West Linn-based Recycling Professionals Inc. initiated a plastics recycling demonstration project at the Clackamas County Fair. As a result, a number of large corporations requested that the company develop a program that would allow them to provide food service packaging recycling for PSF products for their on-site employees. Led by Tektronix, these companies allowed The Recycling Professionals to develop a financially viable program for distributing and then taking back PSF packaging products, where they are processed into other products.

Today, The Recycling Professionals, operating from a small facility in the Lloyd District of Portland, has a large and growing client list, including Tektronix, Xerox, WaferTech, Synopsys, the

Oregon Zoo and over 70 schools. They serve as a distributor of various polystyrene products such as cups, plates and forks. The price they charge for the products includes the pick-up of those same products as post-consumer waste, under a processing protocol that separates most food from the packages. The used cups and trays are returned to the distributor, where they are processed and used as feedstock for various products such as construction blocks.



The use of polystyrene products by these customers allows them to have inexpensive, lightweight products with high insulation qualities that can be recycled and thereby reduce the solid waste costs that otherwise would be associated with paper products. This process achieves both environmental and economic objectives, in spite of the Portland ban on such products.

Unfortunately, although The Recycling Professionals services more than 70 cafeterias in public school districts such as Salem-Keizer, Silverton, Beaverton and Centennial, they have not been able to work with the Portland Public School district. According to owner Larry McIntire, the top-down bureaucratic structure of PPS has made it infeasible to sign a contract for sale and recycling of PSF products. Instead, the PPS purchases their foam products elsewhere and then instructs the students to simply throw them away. Since PPS is exempt from the Portland foam ban, this behavior is allowed even though it probably would not be accepted at a private sector facility.

While The Recycling Professionals were early adopters of this technology, other players are now getting into the game as well. For example, Plas2Fuel Corporation, based in Kelso, Washington, announced in early October 2006 that it had secured a second round of venture funding to help bring its technology to market that would turn landfill plastic into oil. The company anticipates that small facilities will be built right at landfills and/or transfer stations to use plastic that otherwise would be disposed of.¹¹

In the past year the company has secured additional funding, moved to the second generation of the technology, completed the design and begun the fabrication of the third generation technology. They have had a demonstration facility in operation for 15 months and will have their first production installation with a client within the next 4 months.¹²

Changing World Technologies of West Hempstead, New York hopes to open the nation's first plastics-to-oil plant in Philadelphia by 2008. It expects the operation to process up to 400 tons of plastic into diesel fuel daily. Australia-based Ozmotech has more than 60 similar facilities in the works for locations such as Germany, the Netherlands, Sweden and Poland.¹³

There are many other potential uses for recycled plastic as well. A Tigard start-up, Apex Construction Systems Inc., announced last year that it had secured \$8.6 million in funding to advance its polystyrene recycling technology. The company processes used polystyrene into 51-pound construction building blocks. The most recent round of funding will allow it to turn its small demonstration project into a full-scale factory in Phoenix.¹⁴

As for the biodegradable paper packaging so favored by the Portland City Council, William Rathje found that paper products very rarely, if ever, break down in a landfill. Moreover, biodegradation is not desirable in a landfill. The small amount of degradation that happens poses a threat to groundwater and produces methane,¹⁵ which is a potent greenhouse gas. Although there are some newer packaging technologies that can eventually biodegrade, recent conversations with local vendors indicate that these are cost-prohibitive for many business owners at this time.

“...[A]ccording to the 1988 Task Force Report on PSF, 90 percent of all foam cups have never been made with CFCs, and foam products made with CFCs comprised less than 2 percent of national CFC use.”

Substitute products for PSF are generally not being recycled. In order for paper products to hold liquid, they must have a waterproof coating, which is often petroleum-based. This fact, along with food contamination, makes recycling paper food service products next to impossible. Although Portland city government offers composting for paper dishes, the program is subsidized by a grant from the regional governing organization, Metro, and was mandated by the Portland City Council.¹⁶

Composting can be part of a laudable effort to reduce post-consumer waste, but to mandate and subsidize a paper composting program while banning inexpensive PSF clearly reflects an arbitrary preference for paper products that has no basis in fact.

The litter argument

Dick Schmidt, the self-described “styro-cop” from Portland's Office of Sustainable Development until his retirement last year, stated that “the [original arguments for the ban] are mostly now bogus....Litter is about the only one left.” While it is true that foam containers lining the streets are unsightly, paper and plastic

are no more attractive. Admittedly, paper is eventually biodegradable; but many foam take-out products were replaced by various types of plastic containers, which are not. The beer cans and bottles that litter our streets and trails are neither biodegradable nor illegal.

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From a broader perspective, imposing a ban such as this is clearly counterproductive because virtually all packaging, much of which is indispensable in food delivery and preservation, has the potential to wind up as roadside litter. Banning certain classes of take-out containers may provide momentary satisfaction for interest groups opposed to the use of those materials. But eighteen years after the PSF ban, litter has not stopped in Portland, much in the same way as playing the radio at high volumes on public streets would not stop if any particular genre of music were to be outlawed.

The problem lies not with the individual product but with a cultural problem (litter) that is not being effectively addressed by this ordinance. In fact, the ban's diversion of private and governmental resources results in smaller available means with which to attempt a real solution to the litter problem, and lulls Portlanders into a false sense that something effective is being done to fight it.

Linked to the litter question is the concern that PSF breaks up and poses a threat to wildlife. However, the evidence behind this claim has been shaky since before the ban's passage in the 1988. The Oregon Department of Fish and Wildlife has no official position or policy on the effects of PSF ingestion on animals. Much of the scholarship in this area largely concerns oceans, which has limited applicability to Portland, and focuses on plastics as a broad category, rather than on PSF specifically. The findings of these studies range widely, but do not reach a consensus. In fact, some studies show little or no effect on birds.¹⁷

Other plastic products used in Portland have much more definite associations with harming wildlife and yet are allowed. Plastic bags, for example, are a well-known wildlife hazard. Especially since a very small amount of PSF is actually kept out of the waste stream and off the streets because of the ban, if there were any significant ill effects on local animals they likely would have shown up in Portland before now. These concerns simply are not sufficient justification for a ban.



Environmental Effects of the Ban

In the early 1990s, several studies were done comparing the environmental impacts of various types of containers. All showed PSF as the environmentally friendly choice. One of these studies, done by the research firm Franklin Associates, conducted a “life cycle analysis” comparing the environmental impact of foam and paper containers from production and transportation to disposal. This exhaustive analysis was first done in 1992 and showed that the manufacture of paper containers resulted in 42 percent more water pollution, 46 percent more air pollution and 75 percent more industrial waste than that of PSF products.

Franklin Associates released a new analysis in March 2006 which quantifies the energy use and environmental emissions associated with the life cycle of specific products, namely polystyrene and paperboard foodservice products. The results again showed that in many (but not all cases), PSF products were environmentally superior in terms of air and water pollution, energy consumption, emissions of greenhouse gases and solid waste (by volume and weight).

Tables 1-3 show summaries of key performance measures from the study. In some cases, the results are similar for PSF and coated paperboard cups. However, since PSF is a far better insulator, the common practice in Portland is for vendors to double-cup hot products and/or use a corrugated cup sleeve.



When those factors are taken into consideration, paper requires much more energy use, emits far more air and water pollution, and roughly doubles the amount of solid waste to be disposed of.

The study also examined dozens of air and water emissions for various products. For 32-ounce cold cups, 42 separate air emissions were examined. Wax paperboard cups had significantly higher emissions in 35 of the categories, PSF was higher in one category, and there were inconclusive differences in the others. For 9-inch plates, 41 air emissions and 33 water emissions were examined. Molded pulp paper had higher levels in 24 air categories and 11 waterborne, while foam products were higher in only 2 water categories. There were inconclusive differences in 17 air emissions and 19 water emissions.

The study was hindered by a lack of cooperation by the paper products industry, which means there may be some inaccuracies in the calculations related to paper products. Also, due to the

TABLE 1

Net Energy Consumption 10,000 16-ounce hot cups (including processing and transport)

	Polystyrene	Poly-coated Paperboard	Corrugated cup sleeves	Paper cup + sleeve
Million BTU	6.18	7.39	1.55	8.94

Source: Franklin Associates, 2006

TABLE 2

Greenhouse Gas Emissions 10,000 16-ounce hot cups and secondary packaging

	Polystyrene	Poly-coated Paperboard	Corrugated cup sleeves	Paper cup + sleeve
Lbs of CO2 equivalent:	635	593	338	931

Source: Franklin Associates, 2006

TABLE 3

Solid Waste by Weight and Volume 10,000 16-ounce hot cups

	Polystyrene	Poly-coated Paperboard	Corrugated cup sleeves	Paper cup + sleeve
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Solid waste by weight

Process	5.31	55.4	15.3	70.8
Fuel	49.5	97.3	52.8	150.0
Postconsumer	82.8	235.0	205.0	440.0
Total lb	138	388	273	661

Solid waste by volume (cu.ft.)

Process	0.106	1.11	0.31	1.42
Fuel	0.99	1.95	1.06	3.00
Postconsumer	9.32	8.57	7.36	15.9
Total cu.ft.	10.4	11.6	8.73	20.4

Source: Franklin Associates, 2006

number of assumptions that have to be made in any lifecycle analysis, the authors caution that, “this study should not be used as the sole basis for general comparative assertions (general claims that one system is superior or preferable to a competing system or systems).” Nonetheless, it is clear from the analysis that PSF foam products are equal to or better than most paper products from an environmental standpoint.

Other studies done by University of Victoria professor Martin Hocking came to the surprising conclusion that PSF also can be preferable to reusable ceramic cups, especially if an energy efficient dishwasher is not used. This is due to the original outlay of energy in manufacturing and the risk of loss or breakage of ceramics.¹⁸

Unintended consequences

The ban also affects environmental practices in yet another area. Because of the ban's language, the law only restricts products “having a closed cell air capacity of 25 percent or greater, or a density of less than 0.787 grams per cubic centimeter.”¹⁹ This means simply that only polystyrene products that have more plastic per centimeter than PSF are allowed in Portland. Using more plastic rather than less plastic is clearly not a helpful environmental outcome.

“While it is true that foam containers lining the streets are unsightly, paper and plastic are no more attractive... The beer cans and bottles that litter our streets and trails are neither biodegradable nor illegal.”

Because plastic products have continued to develop since the ban was written, restaurant owners in Portland are allowed to use, and frequently do use, some newer types of foam products resembling Styrofoam with a higher density of plastic. The use of these products is not necessarily problematic in and of itself, and the ban may not be the only cause. However, it is obvious that the law is having unintended consequences in encouraging business owners to use foam products that contain more resources than necessary.

In 1999, it was estimated that from 1974-1994, source consumption in the manufacture of PSF itself had decreased 204,000 tons by more efficient use of smaller amounts of resins in PSF products. PSF can consist of up to 95-99 percent air, making it possible for very small amounts of actual plastic to be used.²⁰ It is unfortunate that in Portland these more environmentally benign containers are banned, while the law encourages a reverse in the trend toward source reduction and the growing usage of containers that require more natural resources.

Portland Reactions

Stopping by and chatting with Gary Herrera in his small coffee shop and restaurant in Portland on a weekday morning revealed his frustration with the Portland PSF ban. “The Health Department is very strict about the 140° zone,” he complains, referring to safety concerns related to food temperatures. “But the moment we put it in a container, it's going to be in the danger zone. This doesn't hold heat,” he explains, holding aloft a clear plastic container, one of his only alternatives under the Portland polystyrene foam ban.²¹

Herrera also finds the ban “extremely, extremely expensive,” and he is not the only one. A Portland-based wholesale distributor of many types of food packaging agrees, saying, “I've been really frustrated with the ban.... We sell a product that costs two-and-a-half times as much, doesn't have the same insulation value and ends up in the same landfill.” He also notes the continued use of PSF by government-sponsored Portland Public Schools as a source of discontent for those affected by the ban, commenting that the situation is “do as I say, but not as I do.”²²

The City of Portland also reports problems with restaurant chain branches in Portland that have deals with packaging companies in their franchise agreements. Facing cost constraints, some businesses in Portland have been observed simply going ahead and using PSF in violation of the ban.

At the same time, consumer comfort is sacrificed to keep the law in place. Dick Schmidt, the former “styro-cop,” is among those unhappy with the problems with paper cups. “I do not appreciate getting a paper cup in Portland,” he explains. “Usually I use my reusable cup, but if I don't have it with me, I don't appreciate getting my hand burned. I would rather have Styrofoam.”²³

Social and Educational Effects

Strangely enough, some in Portland still cling fondly to the idea that the ban promotes education in environmental responsibility. They also take pride in the fact that a few other cities have imitated Portland's action. However, the message of the ban is one based on myths. Therefore, it is difficult to see any educational benefits or reasons to rejoice in similar errors by a few other cities. In fact, to the extent that consumers in Portland

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have been led to believe that foam products are environmentally undesirable, it is likely that they are less informed on environmental issues regarding packaging than consumers in most other regions of the country. In turn, this may lead to personal choices by some Portlanders to avoid PSF for environmental reasons, when in reality these allegations have been proved groundless.

If Portland decided to repeal the ban now, it could have a truly educational and positive social effect. Because Portland is frequently cited as an environmental leader, other parts of the country might scrutinize Portland's environmental laws in order to find ways to improve their own policies.

City of Portland's Response

Portland officials continue to support the ban despite the lack of empirical evidence for it. A draft of this paper was provided to the Office of Sustainable Development prior to publication; Bruce Walker, the city's recycling manager, responded by saying, "I've read through the paper and, as you might expect, find little to agree with. I don't believe the analysis accurately depicts reasons for the ban or the outcomes of the City taking this action."²⁴

However, Mr. Walker did not cite any specific factual errors in the paper, nor did he provide any data sources contradicting the paper's conclusions.

Mr. Walker also requested that Cascade "delete the implication that the Office of Sustainable Development does not support the ban through comments of a former employee. OSD is working to expand our food composting program and are looking to include more compostable food containers, which will not include PSF."²⁵

"Studying the true environmental effects of this law shows that due to the methods used to produce alternatives and their poor insulation qualities, the ban keeps one of the best environmental choices off the market."

Conclusion

Portland politicians have long fostered the public perception that the city is an environmental innovator and that aggressive local action will inspire other communities to follow suit. However, few cities anywhere in the country have chosen to emulate Portland's PSF ban.

The Eugene city council considered it in the early 1990s but voted it down, recognizing that it would be counter-productive.

As a prominent Eugene recycler noted, "Banning a product gives the impression that a 'bad' product is gone and the problem is solved, which is a false assumption. The environmental cost of a product is paid during the extraction of the raw materials that it contains, their manufacture into the product and during distribution. While it is wasteful to throw things away rather than recycle them, the resources saved by recycling are small compared to the resources expended during original production. In order to compare environmental performance of polystyrene versus polyethylene terephthalate, paper or other packaging, it is necessary to do life cycle analysis and compare the costs, including end of life disposition as recycling or landfilling."²⁶

The most comprehensive, peer-reviewed lifecycle analysis shows that most types of PSF packaging have fewer environmental impacts than coated paper, and far superior insulation qualities. Portland's ban on PSF containers has continued based on misconceptions concerning the manufacture, use and disposal of these products. In looking at the facts, it becomes clear that the ban harms local business owners and consumers, encourages needlessly inferior environmental practices and continues to present a now-baseless law as a praiseworthy environmental measure.

Examining the issues one by one shows that the ban clearly fails the "triple bottom-line" test promoted by local "sustainability" advocates, who believe that sustainable business practices will result in financial, environmental and social benefits. Instead it is a triple failure, causing harm on all three counts.

When the ban was enacted in 1989, many of the arguments for the ban had not been fully explored. Now that the issues it was designed to address have either become obsolete or been disproved, it is outdated and unnecessary.

If Portland policy-makers are serious about promoting sustainability as an empirically valid concept, then the PSF ban should be repealed.



Endnotes

1. Multnomah County passed a similar ban on polystyrene foam at the same time, though it only applies to unincorporated areas of the county.
2. Prices obtained from a local Costco store, September 18, 2007.
3. This assumes, conservatively, that a coffee shop uses approximately half as many clear plastic cups as paper cups.
4. Estimated using figures from the 2004 Oregon Population Report, Population Research Center (Portland, Oregon: Portland State University, March 2005).
5. The lower figure assumes ten percent of the estimated 2,460 businesses are high-volume disposable food service users spending \$8,000 per year to comply with the ban, the next ten percent somewhat lower-volume at \$4,000 per year, and eighty percent low-volume users at \$500 per year. The higher estimate includes a ten percent highest user estimate at \$9,000 per year, ten percent at \$4,000, sixty percent midrange at \$1,000 per year, and the last twenty percent virtually unaffected at \$100 per year.
6. City of Portland's Task Force Report on Polystyrene Foam, November 22, 1998.
7. Polystyrene Packaging Council, <http://www.polystyrene.org/>.
8. William Rathje and Cullen Murphy, *Rubbish!: The Archaeology of Garbage* (Harper Collins, New York: 1992), 96-98.
9. United States Environmental Protection Agency, Municipal Solid Waste Generation, Recycling, and Disposal in the United States: 2003 Data Tables.
10. Denton Plastics' PSF recycling ended due to a combination of factors, including Portland's ban and McDonald's ceasing to use foam packaging.
11. Matthew Kish, "Plastics-to-oils concept draws investor," *The Portland Business Journal*, October 6, 2006, 3.
12. Chris Ulum, CEO of Plas2Fuel, personal communication with John A. Charles, Jr., October 23, 2007.
13. Kish, 3.
14. Wendy Culverhill, "Polystyrene dream," *The Portland Business Journal*, October 6, 2006, 1.
15. Rathje and Murphy, 110-130.
16. All information obtained from Portland's Office of Sustainable Development website, <http://www.portlandonline.com/osd/>.
17. Much of the scholarship in this area has been done on sea birds. Examples include P.G. Ryan and S. Jackson, "The lifespan of ingested plastic particles in seabirds and their effect on digestive efficiency," *Marine Pollution Bulletin*, 18:217-219 (1987); and Lucy S. Vlielstra and Joyce A. Parga, "Long-term changes in the type, but not amount, of ingested plastic particles in short-tailed shearwaters in the southeastern Bering Sea," *Marine Pollution Bulletin*, 44:945-955 (2002).
18. Martin B. Hocking, "Reusable and Disposable Cups: An Energy-Based Evaluation," *Environmental Management*, 18(6), 889-899.
19. Portland City Code, Chapter 9.28.
20. Integrated Waste Management Board.
21. Conversation with Margaret Hardy, July 7, 2005. Herrera preferred that the name and location of his restaurant remain undisclosed to avoid any potential backlash from the environmentalist community in Portland. This is an example of the unfortunate educational effects of a law based on misinformation.
22. Conversation with Margaret Hardy, July 7, 2005.
23. Conversation with Margaret Hardy, June 30, 2005.
24. Bruce Walker, Office of Sustainable Development, electronic communication with John A. Charles, Jr., February 20, 2007.
25. Ibid.
26. Julie Daniel, Executive Director of BRING Recycling, *Making a Dent: Polystyrene Foam Recycling in Lane County, OR*, February 2007, 7.

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Acknowledgments: This paper updates an earlier paper on the same subject written by Angela Eckhardt for Cascade in 1998. The authors also wish to thank Nancy Wheaton for field assistance and fact checking and Kathryn Hickok for editorial review.

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