

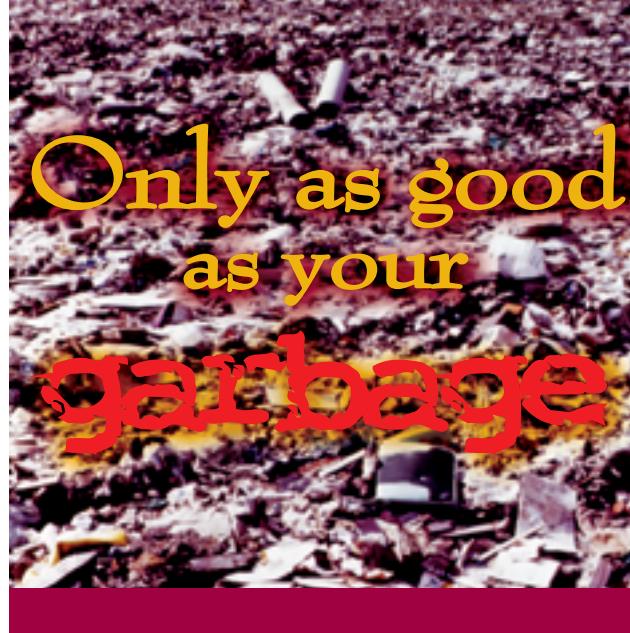
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In these days of stagnating or declining recycling rates, governments, as well as industries relying on recovered materials, are looking for ways to boost collection of recyclables. The question becomes, where to focus our efforts.

Residential areas with high curb-side recycling rates are often assumed to offer limited potential for increasing quantities of recyclables. This assumption is supported by relatively high recycling participation rates observed on city streets, and the fact that most Americans say they recycle more than they did five years ago.

However, falling recycling rates indicate a disconnect between reported behavior and actual behavior. Because recycling is often seen by households in a positive light, answers to recycling survey questions are often skewed to reflect this attitude. As a consequence, research that relies only on answers from survey questions may overestimate actual recycling behavior.

To compensate for this, DSM Environmental Service (Ascutney, Vermont) has collected samples of what recycling and non-recycling households actually set out in their waste and recyclables containers. Having collected and sorted through these samples from high and low recycling residential areas in 13 communities over the past five years, our "capture rate" sorts indicate significant room for increased recycling – especially in areas with high recycling rates. Simply put, folks with high incomes buy a lot of things, much of them recyclable. High consumption leads to high recycling rates, but masks the fact that a significant amount of potentially recyclable material is still going in the refuse.



by Ted Siegler and Natalie Starr

For viable solutions to falling recycling rates, communities need to dig into the garbage and reclaim what is still being thrown away.



Research methodology

Typically, DSM tries to identify neighborhoods, or collection routes, representative of the population of the community being studied. Indicators that appear important with respect to waste and recyclables generation and recovery of recyclables include:

- ◆ Income level
- ◆ Single-family versus multi-family housing
- ◆ Renter versus owner-occupied housing

The more homogeneous the neighborhood, or route, the smaller the sample size; however, limiting factors to large sample size include:

How long it takes to collect the sample, since the regular garbage and recycling trucks must stay off the route until the sample has been collected. Because this often takes 1.5 hours to two hours,

sample collection can have a large impact on the ability of the regular drivers to finish their routes over the course of the day. Therefore, the sample

size needs to be limited to accommodate this impact.

How much garbage and recyclables a group of sorters can reasonably be expected to sort through over the course of the day. In neighborhoods with high set-out rates for garbage and recyclables, sorters are commonly confronted with sorting through two tons of garbage and recyclables from a sample of 50 households. Multiply this by two or three routes and one can see that sample size becomes critical.

For most daily garbage collection routes of 500 to 600 households, a sample size of 50 (or approximately 10 percent) is adequate to characterize the neighborhood, or route, while still remaining manageable for sorting.

Collecting the sample

The primary goal of sample collection is to collect the garbage and recyclables set-out from each of the sampled households. This allows the enumerator to sort through the garbage and see how many recyclables were set out as part of the garbage, as opposed to setout

Ted Siegler is president and Natalie Starr is an associate at DSM Environmental Service, Inc. (Ascutney, Vermont).

Table 1 Range of average recovery rates by material

Material	Average in percent
Paper	
Newspaper	86-87
Corrugated Containers	82-80
Chipboard/Boxboard	65-61
Magazines/Catalogs	50-62
All Other Papers	47-52
All Paper	64-78
Containers	
Glass	57-72
Plastic	57-59
Aluminum and Steel	55-63
All Containers	59-63

Source: DSM, 2004.

for recycling. To assure that the sample collection is not biased by the size of the set out, the sample is collected from a fixed count – i.e., every sixth or eighth setout, no matter what is set out and no matter whether only refuse or only recyclables, or both, refuse and recyclables are set out.

Sorting through the samples

For capture rate studies, the garbage collected at each sampled set out is sorted at the set out, with all recyclables removed and weighed. The recyclables set out also are sorted to separate by material, with each material weighed and recorded before moving to the next sample point.

For recovery rate sorts, all of the garbage from all of the sampled households is placed in one empty truck and all the recyclables in a second empty truck, and then the two loads are sorted separately at a central location to determine what percent of each recyclable material has been placed in the recycling bin as opposed to placed in the garbage can. In each case, recyclables are sorted by material because recovery rates for different materials can vary greatly.

Using the data

The data can be utilized in three ways. First, the data illustrate what percent of recyclables, by material type, on a given route are being thrown away as waste versus set out for recycling.

Second, the data provide valuable information on contamination in the recycling set out. These data can be especially critical for those considering a switch to single-stream collection, or to rolling carts and automated collection, where the feedback loop between the collector and the household is lost.

Third, the data can be annualized by multiplying by 52, assuming weekly collection for recyclables and waste, to estimate pounds per household of recyclables currently being

Table 2 Comparison of annualized household setouts and recycling rates, City of Cambridge, Massachusetts

Neighborhood	Recycling (lbs)	Refuse (lbs)	Total	Recycling Rate
High-income, single-family	1,367	1,791	3,158	43%
Tenant-occupied, large apartments	320	570	890	36%
Lower-income, tenant occupied	273	1,576	1,848	15%
Middle-income, owner/tenant occupied	449	1,430	1,879	24%

Source: DSM, 2004.

Table 3 Annualized pounds per household, recyclables in refuse (in pounds)

Neighborhood	Recyclables		Total Recycling & Refuse	
	In Recycling bin	In Refuse	Refuse	& Refuse
High income, single family	1,367	489	1,302	3,158
Tenant occupied, large apartments	320	180	390	890
Lower income, tenant occupied	273	442	1,133	1,848
Middle income, owner/tenant occupied	449	201	1,229	1,879

Source: DSM, 2004.

thrown away. Multiplying by the number of households on the route, or in the sampled neighborhood, provides a rough estimate of the total tons per year of recyclables being thrown out as waste. Some portion of this is potentially available for recycling based on changes to the collection system, the educational system and/or through pay as you throw (PAYT) implementation.

While one day of data collection is arguably insufficient for generalizations about behavior over the course of the year, in DSM's experience, if the sample is collected during a normal week, then the data can be annualized with results within 15 percent of actual collected quantities. This level of accuracy is sufficient to draw conclusions about neighborhood behavior and ways to change behavior.

Reading into the results

The following tables and conclusions are based on capture and recovery rate analysis conducted over the past five years. Data older than that is becoming less relevant due to changes in recyclables generation and the packaging mix, and to changes in the collection systems that have influenced capture and recovery rates.

Data represents analyses conducted on curb-side routes in:

- ◆ Massachusetts
 - Boston
 - Cambridge

Table 4 Recovery rates for paper in high-income neighborhoods, Cambridge, Massachusetts (in percent)

Material	Recycled
Newspaper	91%
Mixed Paper and Magazines	56%
Corrugated Containers	53%
Chipboard	29%

Source: DSM, 2004.

Worchester

- ◆ Ohio
 - Columbus
 - Dublin
 - New Albany
- ◆ Iowa
 - Cedar Rapids
 - Iowa City
 - Marion
 - Central City
 - Monticello

Limited data also is presented for recovery on two drop-off recycling programs, where refuse is collected curbside, in Traer and Belle Plaine, Iowa.

As illustrated in Table 1, curbside recycling programs are recovering about 70 percent of the paper and 60 percent of the bottles and cans generated by households on curbside collection routes. In general, recovery rates for paper are higher than for bottles and cans, but this is skewed somewhat by the high recovery rate for newspaper. Recovery rates for magazines

Definitions

Lacking universal agreement on the definition of terms used in this article, we have chosen to define them so that all readers understand them in the context of this article.

Capture Rate – The percent of materials set out for recycling by a *participating* household, compared to the amount of recyclables set out for recycling plus the amount of recyclables set out in the refuse for disposal.

Recovery Rate – The percent of recyclables set out for recycling on a route of *participating and non-participating* households compared to the amount of recyclables set out for recycling and the amount of recyclables set out in the refuse for disposal.

Because of the logistics of sorting from participating households only, in most cases DSM conducts *recovery rate* studies.

and mixed paper (or all other paper) are significantly lower.

Factors affecting recovery rates by material include:

- ◆ Special requirements for breaking down corrugated containers – programs that accept corrugated containers of any size and unflattened have significantly higher recovery rates for corrugated containers.
- ◆ No consistent message across programs concerning what is considered chipboard and what materials are not accepted (e.g., pizza boxes, frozen food containers) hurt chipboard recovery.
- ◆ Why recovery rates for magazines and catalogs are as low as they are is unclear. One would expect that magazines would be easy to store and recycle.
- ◆ Mixed paper recycling is hurt by the twin factors of uncertainty regarding what types of papers are included and the worry about identity theft associated with leaving paper with addresses and account numbers in the recycling bin.
- ◆ Recovery rates for bottles and cans consistently lag behind paper recovery rates, a trend that can be attributed to the need to clean containers and the higher storage space requirements.
- ◆ Plastic bottle recovery rates have been increasing over time, while glass and can recovery rates have been falling. Today, no significant difference exists in recovery rates among container types, at least based on DSM's data from curbside setouts.

Table 5 Potential increase in annual recovery of paper, Cambridge, Massachusetts

Income	Households	Pounds per household per year	Tons per year
High	12,422	121	752
Medium	23,546	20	235
Low	6,647	130	432
Total	42,615	NA	1419

Source: DSM, 2004.

Applying the analysis to boost recovery rates

DSM recently completed a recovery rate analysis for the City of Cambridge, Massachusetts with the intent of determining where to look for additional recyclables to boost the Cambridge recycling rate. The results illustrate many of the uses of recovery rate analysis. Recovery rate sampling occurred in four areas of the city:

- ◆ High-income single-family, owner-occupied housing
- ◆ Tenant-occupied large apartments
- ◆ Two-to-six family, lower-income, tenant-occupied apartments
- ◆ Two-to-six family, middle-income, owner-and tenant-occupied households.

As illustrated by Table 2, the high-income households produced the highest recycling rate and the low-income households the lowest recycling rate.

Based on the recovery rate analysis, high-income households are clearly leaving the most

recycling setouts), it represented 45 percent of the total material set out in the Cambridge recycling program.

Looking beyond newspaper, clearly ample room for improvement exists in the recycling program, even in the high-income neighborhoods. This is because recovery rates for other paper grades and for bottles and cans are significantly lower (Table 4).

Applying potentially achievable recovery rates based on recovery rate data from other communities to the household data for Cambridge, DSM estimates that an additional 1,400 tons of paper per year could be recovered in Cambridge. Given that collection costs are fixed (Cambridge pays a flat rate per year for curbside collection to their recycling collection contractor), savings in avoided tipping fees alone would represent \$125,000. Most importantly, 50 percent of the increase in recycling would come from the high-income households (Table 5) that already have the highest recycling rates in the city.

Where and how to look for more

Based on a comparison of recovery rate data with program characteristics in the communities that DSM has conducted recovery rate studies, communities looking to increase recovery should consider the following factors:

- ◆ Increase the container size – recycling generation has outgrown the 14-gallon to 18-gallon set out bins. Larger cart sizes encourage households to set out more of their recyclables in the recycling container as opposed to the trash container.
- ◆ Make sure the collection system is parallel to the refuse collection system. Cities with curbside collection of refuse and drop-off collection of recyclables have recovery rates that are less than one-half those found with curbside collection of recyclables.
- ◆ Consider single-stream collection programs. DSM data comparing cities in the same area of the country with similar demographics show increases of 15 to 20 percentage points in recovery rates for single-stream versus dual-stream collection programs.

Falling recycling rates indicate a disconnect between reported behavior and actual behavior.

recyclable material in the refuse despite the high recycling rate (Table 3). This is because they are generating 3.5 times as much waste and recyclables as the large apartment dwellers, and 1.7 times as much waste as middle-income households with similar household size.

One of the reasons for the high recycling rates for the high-income households is the overwhelming importance of newspaper in the recycling setouts. Despite the fact that newspaper represented only 34 percent of total potentially available recyclables (in refuse and

- ◆ Do not neglect your educational and promotional budget. Households need to be reminded of the need for continued full participation in the recycling program.
- ◆ Consider implementation of a pay as you throw (PAYT) refuse collection system in which residents pay according to how much waste is set out. The impact on recycling associated with PAYT has been well documented throughout the country.

Conducting capture rate and recovery rate studies requires that you get your hands dirty sorting garbage. As a result, many communities shy away from these types of analy-

ses. However, the results provide valuable insights into improving recycling programs, including:

- ◆ High-income neighborhoods with high recycling rates may still be leaving lots of recyclables in the waste stream.
- ◆ High recovery of newspaper may mask low recovery rates for other paper grades, especially magazines and mixed paper.
- ◆ Recycling collection programs that require households to break down cardboard boxes and/or cut them to smaller sizes will recover low levels of this growing part of the residential waste stream.
- ◆ Because recovery rates for bottles and cans

typically lag behind paper recovery, the types of bottles and cans that can be recycled need to be emphasized and simplified.

- ◆ Bigger carts do make a difference in increasing recycling.
- ◆ Single-stream collection, especially when combined with larger recycling set-out containers, can increase recovery rates by 15 to 20 percentage points.

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