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RESOURCE RECYCLING

SIDE by SIDE

A recovery rate study in Boston illustrates how much of a boost recycling efforts experience when refuse and recycling are collected together.

by Ted Siegler and Susan Cascino

The City of Boston provides weekly curbside trash and recycling collection services to all its residents. However, the densely populated downtown neighborhoods receive additional trash collections. Certain areas receive refuse collection three times per week and once-per-week recycling collection, while other areas have refuse picked up two times per week and once-per-week recycling. In each case, single-stream-recycling collection occurs alongside one of the trash pickups.

This situation gave researchers a golden opportunity to test a long-standing theory among recycling advocates that residents are more apt to put recyclables in the correct curbside bin or cart if recycling collection happens the same day as trash collection. Boston's collection contracts for refuse and recycling are expiring in 2014, so it made sense to conduct a test to decide if the city should make changes to the levels of service offered as a way to increase recycling.

Neighborhood approach

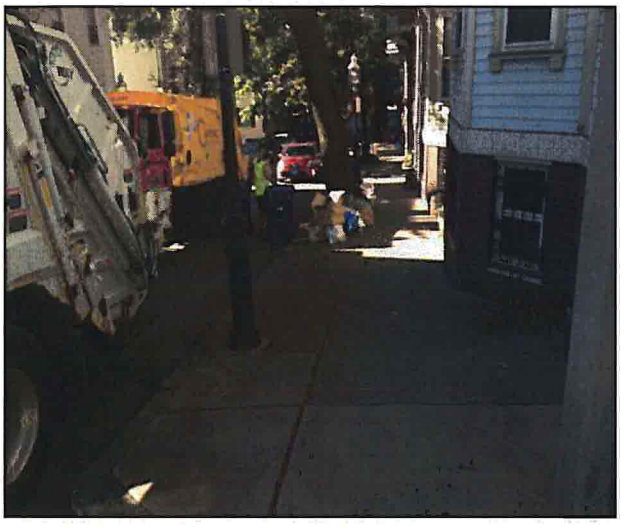
Boston contracted with DSM Environmental Services, Inc. and DSM's sub-contractor, Mid Atlantic Solid Waste Consultants, to carry out a two-week recovery rate sort in September 2013 to learn whether there was a difference in recovery rates between different areas of the city with different levels of service.

Informal observations by the Department of Public Works showed residents in areas of the city with three refuse collections but only one recycling collection per week set out less recyclables than people in areas with a single day of refuse and recycling – we call this second scenario true parallel collection. Boston asked DSM to conduct a valid sampling program to determine if that was in fact the case.

Representative samples of trash and recyclables were collected from the following areas:

- Bay Village, North End, Beacon Hill: sections of the city with three trash collections per week
- Back Bay and South End: sections with twice-per-week trash collection
- Charlestown: the control section, which offers once-per-week trash and recycling collection; both pickups happen on the same day

Typical set-out



Two trucks being used on recycling day

The right rate

First, an explanation on why we tracked "recovery rates," not "recycling rates." Materials recovery rates differ from recycling rates, and tend to be a better indicator of the performance of recycling programs. This is because they filter out income and other variables that tend to skew comparisons of recycling efforts among residents.

For each material that Boston collects for recycling, the materials recovery rate (expressed as a percent) can be calculated as follows:

$$\frac{\textit{Material Set Out for Recycling}}{\textit{(Material Set Out for Recycling + Material Placed in Trash)}}$$

For example, Boston residents can set out all newspaper for recycling. The materials recovery rate for newspaper would equal the quantity of newspaper set out for recycling on a collection route divided by the quantity of newspaper set out for recycling plus the quantity of newspaper thrown away on the same route.

This can be compared with a recycling rate calculation which is defined as all the material set out for recycling divided by the material set out for recycling plus all of the trash set out. The problem with comparing neighborhoods using recycling rates is that different neighborhoods generate different amounts of recyclables and trash when compared on an average per-household basis.

For example, a wealthy neighborhood typically generates much larger quantities of newspaper, magazines and wine bottles but in some cases might recycle only some of the material, disposing the rest. Because these materials are heavy and represent a large portion of total refuse generation, this neighborhood could be full of poor recyclers but still show a high recycling rate because residents did recycle are a large portion, by weight, of the total refuse, and recycling, set out.

Table 1 | Charlestown (Control) recovery rates, by material type

Material	Refuse – Total pounds	Recycling – Total pounds	Refuse and recycling – Total pounds	Recovery rate
Paper	**463.0**	**859.4**	**1,332.4**	**65.0 percent**
1. Corrugated cardboard	84.6	350.9	435.5	80.6 percent
2. Mixed paper	342.8	358.9	701.6	51.1 percent
3. Newspaper and inserts	35.7	149.6	185.3	80.7 percent
Plastic	**95.3**	**106.0**	**201.3**	**52.7 percent**
4. No. 1 PET bottles, containers and thermoforms	19.0	41.9	60.9	68.8 percent
5. No. 2 HDPE bottles and jars	26.6	29.9	56.4	52.9 percent
6. Tubs, cups, trays and lids	44.6	29.9	74.4	40.1 percent
7. Bulky rigid plastics	5.2	4.4	9.6	46.1 percent
Metal	**28.9**	**25.1**	**54.0**	**46.5 percent**
8. Aluminum beverage cans	5.2	7.0	12.2	57.4 percent
9. Aluminum tins/foil	10.3	2.6	12.8	20.1 percent
10. Steel cans	13.5	15.5	29.0	53.5 percent
Glass	**111.3**	**379.5**	**490.8**	**77.3 percent**
11. Glass bottles and jars	111.3	379.5	490.8	77.3 percent
Other	**1,881.5**	**157.4**	**2,038.9**	**N/A**
12. All other trash	1,881.5	157.4	2,038.9	N/A
Total	**2,579.9**	**1,527.4**	**4,107.3**	**N/A**
Contamination rate		10.3 percent		
Targeted recyclables	**698.4**	**1,369.9**	**2,068.4**	**66.2 percent**

A lower income neighborhood, on the other hand, may generate much smaller quantities of newspapers, magazines and wine bottles, but in some cases might be doing an excellent job of setting out the majority of their recyclables. However, they would show a lower recycling rate because the recyclables, by weight, are a much smaller portion of the total trash, and recycling, being set out.

Ready, set, collect

The first goal in implementing the study was collecting a random sample of set-outs of trash and recycling from representative neighborhoods in each designated section of the city. DSM met with Boston DPW staff and the route supervisor at Capitol Waste Services, Boston's collection contractor, to select representative streets.

On each collection day DSM rode with a Capitol driver, starting in an empty truck, to count set-outs and designate the set-outs for collection. The primary goal was to make sure the set-outs collected were entirely random and that the total amount of refuse and/or recyclables collected was capable of later being sorted by the sort crew in a single day. Typically, the enumerator riding with the truck would begin the route by choosing a stop count based on the estimated number of buildings along the entire set of streets that were being sampled. The enumerator would then count set-outs on the street, and would designate each "xth" set-out for collection.

All trash and/or recyclables were collected from each designated set-out regardless of the set-out size or the type of material on the curb at that particular stop. On the day for both recycling and refuse, the designated samples were all collected even if only trash or only recyclables had been set out at certain stops.

On routes with multiple trash days and only one recycling day, the same number of stops were collected on each trash/recycling collection day, including the recycling day, based on the assumption that the samples were entirely random and therefore the behavior of the households along the route was representative of the entire route.

On days when only refuse was being collected on the route, one truck was used and the sample represented random set-outs of refuse only. On days both refuse and recycling were set out, two trucks were

Table 2 | Bay Village, Beacon Hill, North End recovery rates, by material type

Material	Refuse – Total pounds	Recycling – Total pounds	Refuse and recycling – Total pounds	Recovery rate
Paper	**883.7**	**647.9**	**1,531.6**	**42.3 percent**
1. Corrugated cardboard	311.9	194.6	506.4	38.4 percent
2. Mixed paper	414.8	323.0	737.7	48.3 percent
3. Newspaper and inserts	157.1	130.4	287.5	45.4 percent
Plastic	**180.5**	**72.8**	**253.3**	**28.7 percent**
4. No. 1 PET bottles, containers and thermoforms	58.3	16.9	75.2	22.4 percent
5. No. 2 HDPE bottles and jars	49.1	27.3	76.4	35.7 percent
6. Tubs, cups, trays and lids	62.1	22.3	84.3	26.4 percent
7. Bulky rigid plastics	11.1	6.4	17.4	36.5 percent
Metal	**43.0**	**15.9**	**58.8**	**26.9 percent**
8. Aluminum beverage cans	12.3	2.7	15.0	26.9 percent
9. Aluminum tins/foil	13.1	1.8	14.8	11.8 percent
10. Steel cans	17.6	11.5	29.1	39.4 percent
Glass	**410.8**	**310.9**	**721.7**	**43.1 percent**
11. Glass bottles and jars	410.8	310.9	721.7	43.1 percent
Other	**2,906.0**	**102.6**	**3,008.5**	**N/A**
12. All other trash	2,906.0	102.6	3,008.5	N/A
Total	**4,423.9**	**1,150.0**	**5,573.9**	**N/A**
Contamination rate		8.9 percent		
Targeted recyclables	**1,518.0**	**1,047.4**	**2,565.4**	**40.8 percent**

Table 3 | Back Bay recovery rates, by material type

Material	Refuse – Total pounds	Recycling – Total pounds	Refuse and recycling – Total pounds	Recovery rate
Paper	**810.8**	**853.1**	**1,663.9**	**51.3 percent**
1. Corrugated cardboard	169.9	265.2	435.1	61.0 percent
2. Mixed paper	500.5	411.3	911.8	45.1 percent
3. Newspaper and inserts	140.4	176.7	317.1	55.7 percent
Plastic	**148.5**	**58.6**	**207.1**	**28.3 percent**
4. No. 1 PET bottles, containers and thermoforms	38.6	23.2	21.8	37.5 percent
5. No. 2 HDPE bottles and jars	33.6	12.1	45.7	26.4 percent
6. Tubs, cups, trays and lids	65.1	23.2	88.2	26.3 percent
7. Bulky rigid plastics	11.3	0.2	11.4	1.3 percent
Metal	**36.8**	**12.3**	**49.1**	**25.0 percent**
8. Aluminum beverage cans	7.9	2.0	9.9	20.2 percent
9. Aluminum tins/foil	11.7	3.4	15.1	22.8 percent
10. Steel cans	17.3	6.8	24.1	28.3 percent
Glass	**232.8**	**287.6**	**520.4**	**55.3 percent**
11. Glass bottles and jars	232.8	287.6	520.4	55.3 percent
Other	**2,254.4**	**188.5**	**2,442.9**	**N/A**
12. All other trash	2,254.4	188.5	2,442.9	N/A
Total	**3,483.2**	**1,400.0**	**4,883.2**	**N/A**
Contamination rate		13.5 percent		
Targeted recyclables	**1,228.8**	**1,211.5**	**2,440.3**	**49.6 percent**

used. One truck collected refuse, and the second truck collected recyclables – but both trucks collected from the same set-outs.

Sorting the details

Once the sample had been collected for the day, the trucks were driven to the Casella Materials Recovery Facility in Charlestown. The trucks were weighed in full and then directed to the assigned sorting location where the contents were dumped. After dumping, the trucks were weighed empty to determine the net weight of the sample.

Refuse loads were divided into 200-pound segments and recycling loads were divided into 125-pound segments. A sort crew sorted all of the recyclables out of each segment by material category, and all non-recyclable material was designated as trash.

For neighborhoods with multiple instances of trash collection each week, the weight of the recyclables sorted from the trash from the two or three days was combined and then compared with the weight of the recyclables set out for recycling on the one day of recycling.

Table 4 | South End recovery rates, by material type

Material	Refuse – Total pounds	Recycling – Total pounds	Refuse and recycling – Total pounds	Recovery rate
Paper	**376.9**	**508.0**	**884.9**	**57.4 percent**
1. Corrugated cardboard	78.9	167.9	246.7	68.0 percent
2. Mixed paper	258.8	256.0	514.8	49.7 percent
3. Newspaper and inserts	39.3	84.2	123.4	68.2 percent
Plastic	**80.5**	**49.7**	**130.1**	**38.2 percent**
4. No. 1 PET bottles, containers and thermoforms	20.0	15.3	35.3	43.3 percent
5. No. 2 HDPE bottles and jars	12.5	12.4	24.9	49.7 percent
6. Tubs, cups, trays and lids	41.0	18.8	59.8	31.5 percent
7. Bulky rigid plastics	7.1	3.2	10.3	31.2 percent
Metal	**25.7**	**10.6**	**36.2**	**29.2 percent**
8. Aluminum beverage cans	8.7	1.4	10.1	13.9 percent
9. Aluminum tins/foil	5.0	1.6	6.5	23.9 percent
10. Steel cans	12	7.6	19.7	38.8 percent
Glass	**98.8**	**221.6**	**320.4**	**69.2 percent**
11. Glass bottles and jars	98.8	221.6	320.4	69.2 percent
Other	**1,433.2**	**72.2**	**1,505.4**	**N/A**
12. All other trash	1,433.2	72.2	1,505.4	N/A
Total	**2,015.0**	**832.0**	**2,876.9**	**N/A**
Contamination rate		8.4 percent		
Targeted recyclables	**581.8**	**789.8**	**1371.6**	**57.6 percent**

Proving the theory

The results of the analysis (see Tables 1-4) appear to bear out the expected recycling behavior. Neighborhoods with multiple trash collection days each week but only one recycling day dispose of a greater percentage of their recyclables in the trash when compared to the control neighborhood where trash and recycling are collected at the same frequency and on the same day. Further, the greater the number of trash collection days, the lower the recovery rate, with the Bay Village/Beacon Hill/North End route having the lowest overall recovery rates, Charlestown the highest recovery rates, and Back Bay and South End falling in the middle.

Other key findings include:

- The results for Charlestown, with true parallel collection, demonstrate recovery rates of 65 percent or greater are achievable with single-stream collection, even with minimal use of carts (carts are optional and only about one-third of the households on this route used them, with the remaining participants using either a bin or clear plastic bags for the recycling). Also, the results came without unit based pricing (PAYT).
- Contamination rates for recyclables fall within the low to mid-range of single-stream programs across all of the neighborhoods.
- Recyclables in all neighborhoods were extremely clean – it was clearly the case that most households were washing out all of their recycling containers before storing them for collection.
- The aluminum beverage container recovery rates (and to some extent the PET rates) are artificially low due to the amount of scavenging for beverage deposit containers. Massachusetts has a deposit system that offers a nickel for many beverage containers. **RR**

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