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Conversion from dual stream to single stream recycling results in nuanced effects on revenues and waste stream amounts and composition

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ABSTRACT

Single stream recyclables collection (residents set out all recyclables in one container without sorting them further) has become the dominant means of curbside recycling in the United States. Proponents claim it motivates residents to set out more materials for recovery because it is more convenient than other collection strategies; others claim it may also lead to poorer quality materials sent to market. Here we report on a conversion on Long Island (New York) from dual stream collection (paper and container recyclables collected in separate passes) to single stream collection. No other major change was made to the waste program, unlike other documented switches from single stream to dual stream, which means changes we document appear to be due solely to the collection processes change. Waste composition studies before and after the conversion added important information. We found significant (25%) increases in set outs for recycling, but also more inclusion of non-recyclable items in the recycling bins. Residents increased their separation rates of targeted recyclable materials, but because waste composition changed from 2012 to 2014, the increased separation rates resulted in about the same amount of recyclable materials being set aside. However, we estimate that the residual waste stream contained much less recyclable material concurrent with the change to single stream recycling, primarily due to the changes to the waste stream composition and size.

1. Introduction

Recycling is well established as a major component of US waste management processes, accounting for 21% (73.0 million tons year^{-1}, or 66.4 million tonnes year^{-1}) (Staley and Kantner, 2016) or 25.5% (64.7 million tons year^{-1} or 58.8 million tonnes year^{-1}) (USEPA, 2015) of US municipal solid wastes (MSW) in 2013. Nearly all of the US is provided with recycling services; about three quarters of the population has curbside collection of some materials. Single family curbside recycling used to be dominated by a dual stream (paper one time, containers the next) collection approach, but reportedly 90% of all curbside programs now use single stream (commingled) recyclables collection (Resource Recycling Systems and Moore Recycling Associates, undated). Single stream recycling programs are said to have introduced in 1997 (O'Malley, 2002); however, Gamba and Oskamp (1994) and Oskamp et al. (1998) reported on earlier single stream programs in California.

1.1. Literature search

Typically, a conversion to single stream recycling is accompanied by other programmatic or collection process changes such as adding more recyclable materials to the collection list, and/or moving to a Pay-As-You-Throw (volume-based) billing format, and/or automating collection, and/or adding a food waste or other organics waste collection, which may affect the set outs of residents in waste and recyclables categories. This difficulty in isolating the effect of a conversion to single stream recycling may be the reason there are few papers discussing such changes in the peer-reviewed literature. A model for a hypothetical California city (based on Berkeley) found that single stream recycling should provide systems savings over dual stream recycling and greater environmental benefits (reduced energy use and greenhouse gas emissions) (Chester et al., 2008). A study of 223 recycling systems across Ontario found higher recycling rates but also higher overall costs for single stream recycling (Lakhan, 2015). Fitzgerald et al. (2012), found increased recovery rates, decreased collection intensities, and lower

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emissions and greater greenhouse gas benefits when looking at three Materials Recovery Facilities (MRFs) and two jurisdictions in Minnesota. An economic analysis of the conversion in Madison WI found increases in economic benefits, but this was also in conjunction with a change to automated collection (Jamelske and Kipperberg, 2006). A MRF design life-cycle analysis assumed better recovery rates for paper and lower overall residuals because non-paper materials would not be "lost" on the wrong processing line. Single stream MRFs were found to use more electricity and have greater overall combined operating and capital costs (Pressley et al., 2015). A study of Spanish paper mills found single stream results in deliveries of too much unsuitable materials, resulting in mills declining single stream sourced paper (Miranda et al., 2013). The earliest study on single stream collection found increased participation rates compared to dual stream recycling (Gamba and Oskamp, 1994), which should translate into increased set out amounts.

There are more articles on conversions in the technical literature but as with the peer-reviewed literature the reports are not uniform. Most explicitly mention system changes besides switching to single stream (Cuyler, 2002; O'Malley, 2002; Farrell, 2003; Kinsella and Gleason, 2003; O'Connell, 2003; Snow, 2003; Emerson, 2004; Merrill, 2004; Ryan, 2004; Fickes, 2005; Averett, 2006; Gesell, 2006; Fickes, 2009; Morawski, 2009; Hildebrandt, 2012), which makes assignment of cause of changes difficult. Single stream seemed to collect less material than dual stream for paired programs in Ontario (Lantz, 2008, 2010; Lantz and Morawski, 2013), and increased residuals were thought to reduce overall recyclable output for single stream (Cuyler, 2002). A Container Recycling Institute monograph critical of single stream focused on impacts to paper recycling (Morawski, 2009), and degraded paper quality due to glass fragments in paper and plastics included in paper bales has been noted often (O'Malley, 2002; Farrell, 2003; Kinsella and Gleason, 2003; Fickes, 2006; Egosi and Weitzman, 2010). A 2004 study (commissioned by the American Forest and Paper Association) reported additional costs for paper mills when dealing with single stream recycling output (reported on by White, 2004). However, more articles find overall program savings (O'Malley, 2002; Snow, 2003; Emerson, 2004; Merrill, 2004; Ryan, 2004; Fickes, 2005, 2009). Residents are said to put more non-recyclables in recycling bins (O'Connell, 2003; Merrill, 2004; Fickes, 2005; Gesell, 2006; Hildebrandt, 2012), but single stream leads to increased participation rates and therefore greater recyclables set outs (Cuyler, 2002; O'Malley, 2002; Farrell, 2003; Kinsella and Gleason, 2003; O'Connell, 2003; Snow, 2003; Emerson, 2004; Merrill, 2004; Ryan, 2004; Fickes, 2005; Averett, 2006; Gesell, 2006; Fickes, 2009; Morawski, 2009; Hildebrandt, 2012). Solid waste managers are clearly motivated to transition to single stream judging from recent system dominance by single stream (Resource Recycling Systems and Moore Recycling Associates undated). Improvements in MRF technologies that assist in separating materials more easily, such as disc screens, are encouraging changes to single stream (Messenger, 2016).

1.2. Research setting

The Town of Brookhaven (Long Island, New York, USA) (located ~125 km east of New York City) has a waste collection program that services 115,000 households through 35 distinct districts. Services are provided under rules specified by Town managers but are performed by private companies selected through a public bidding process. The Town commissioned two engineering reports on the feasibility of changing its collection program to single stream; the economics did not appear to be positive in light of expected large capital expenditures although the reports found it probable that large increases (up to 100%) in materials collection might result (Dvirka and Bartilucci, 2007, 2008). The Town owns its MRF, but contracts for the operation of the facility. When a private company offered to buy out the contract of the then current operator of the Town MRF and pay for all capital costs associated with changes required to convert the MRF to a single stream facility, the Town agreed. The Town intended to increase its recovery rates which had been stagnating due to declining paper recyclables collections, and to upgrade the processing equipment in the MRF, at no cost to itself.

Thus, in 2014 Brookhaven changed its recyclables collection from alternating collection of paper recyclables and container recyclables (weekly dual stream collection) to weekly single stream collection of all paper and container recyclables. Here, unlike all other studies of conversions to single stream recycling, all other aspects of the Town waste program remained the same (and had been constant since 2002), except for the change in mode of recyclables collection. There was one small programmatic change: the definition of recyclable plastic containers was expanded from #1 and #2 plastic containers to all numbered plastic containers. Therefore, this case offers an opportunity to determine the effect of a conversion to single stream recycling without other complicating factors. In addition, because we sorted wastes before and after the change, we were able to better document the effect of the conversion on resident behavior.

2. Materials and methods

Please note that all data were originally collected in standard US units (tons, lbs., etc.). All US-value data were converted to metric units using standard conversions. We report both formats whenever feasible.

2.1. Measuring programmatic changes

In January 2002, the Town implemented separate yard waste collection and instituted a ban on the collection of grass clippings, the last consequential change to the structure of the collection program until 2014. Scale house data for the Town waste districts from 2002 to 2013 under the constant program and from 2014 to 2016 under single stream recycling were obtained.

2.1.1. Programmatic tonnage data processing

Data were bundled into annual totals for paper and container recyclables, yard waste, and discards. We aggregated the two recyclables streams (Eq. (1)) and also created a "total waste stream" amount by combining discards and recyclables (measured in tons) (Eq. (2)). This amount excluded source separated yard wastes. We also collected facility specific data for the MRF for annual throughputs and residues.

$$RR = RP + CR \quad (1)$$

with

RR = total curbside recyclables (2002–2013 collected dual stream as RP and CR, 2014+ collected single stream, on Wed.)

RP = recyclable paper collected curbside

CR = container recyclables collected curbside

$$TW = RR + \text{discards} \quad (2)$$

with

TW = total waste stream collected curbside

RR = curbside recyclables (2002–2013 collected dual stream, 2014+ collected single stream on Wed.)

Discards = materials collected twice weekly for disposal on M/Th. or Tu./F

2.1.2. Programmatic household rate data processing

Related percentages and per household per week (HH/wk) values were computed (Eq. (3)). Household numbers are carefully computed by both the contract carters and the Town, as they are the basis for payments, and so these annual data are believed to be very accurate (HH records were only available for 2004–2016). Because the Town does not collect from every residence in the Town (multi-family housing, condominium and homeowner associations, cooperatives, and