2011 Maine Residential Waste Characterization Study

School of Economics Staff Paper #601

by Professor George K. Criner and student Travis L. Blackmer
(contact information: george.criner@umit.maine.edu; 207-581-3154)

of the School of Economics

The University of Maine

Acknowledgments

The researchers would like to thank George MacDonald and Lana LaPlant-Ellis of the Maine State Planning Office for their generous cooperation with this project. We would also like to thank our trash sorting team, especially student project leader Spencer Hathaway, and fall sort leader Karl Chandler. We wish to thank David Silver for helping write the project grant, being liaison with the Maine Department of Environmental Protection, and providing valuable advice. We also acknowledge Greta Schroeder for her editorial assistance, as well as thank reviewers Jeff Jones, Manager of Transmission Services at Bangor Hydro Electric Co, and Ross Nason, Environmental Planner for Kennebec Valley Council of Governments. We are grateful for funding from the Maine State Planning Office, the College of Natural Sciences, Forestry and Agriculture, and the Maine Agricultural and Forest Experiment Station which made this study possible. The researchers would especially like to thank the following municipal programs, whose kind participation was vital for this study: Bath, Boothbay, Central Penobscot, ecomaine, Hatch Hill, Houlton, Lincoln, Lisbon Falls, Mid Maine, Ogunquit, Old Town, Orono, Paris-Norway, Pittsfield, Pleasant River, Scarborough, Skowhegan, and St. George.

Foreword

By George MacDonald, Maine State Planning Office Program Manager

Maine communities have been providing recycling programs for their residents since the early 1990's, and some have been providing them for longer than that. Municipalities and businesses are currently recycling 38.7% of their solid wastes, which is less than the State's 50% recycling goal.

The objective of the Waste Characterization Study was to observe and quantify the impacts of a variety of municipal recycling program styles. By identifying which recyclable materials and products are still being thrown away by Maine residents, we can discover aspects of our solid waste programs that are working well, and those that need improvement.

The municipal solid wastes examined in this study are typical of what would be found in a thirty-gallon plastic trash bag. Larger, "bulky" items, such as furniture, electronics, appliances and corrugated cardboard boxes were not usually found, nor were they expected to be.

The State Planning Office Waste Management & Recycling Program wishes to thank: the municipalities and their staff for assisting with this study, Professor George Criner and Travis Blackmer for undertaking the study, and the members of the two "sorting teams" for their diligence in completing the study.

Background

The handling of waste has changed through the generations as our knowledge, technology, and economic well-being has improved. As a necessary consequence of the production and consumption of food, consumer goods, and other products, our current society generates a substantial volume of material. Most of this material is ultimately discarded and requires collection, re-use or recycling, or disposal.

This report summarizes and discusses the results of two 2011 waste sorts conducted on Maine residential waste, and makes comparisons with previous research. In the discussion of the various waste components, comments on ease of recycling or composting are included. We hope that this report will be useful for state and municipal officials as they design recycling and disposal systems that balance environmental and economic concerns.

Procedure

Municipality Selection

Seventeen municipal waste programs, representing a wide range of community size, geographic location, and solid waste program type, were selected to participate in this study. Table 1 lists the seventeen municipal programs with the approximate population served and county location of each.

This sample represents twelve of Maine's sixteen counties and approximately 11% of the state's total population. Most of the waste programs selected provide service to an individual town or city. Some, however, represent more than one municipality. In these cases, we have listed the facility and municipality in which the facility is located. The population service size ranged from Ogunquit with 892 to Hatch Hill (Augusta region) with 41,326. Waste from the University of Maine was sampled for demonstration purposes, but was not considered when performing statistical analysis.

Table 1. Municipality, service population, and county.

Municipality, facility	**Approximate 2010 Service Population**	**County**
Bath	8,514	Sagadahoc
Boothbay	3,120	Lincoln
Central Penobscot (Dexter area)	6,531	Penobscot
Hatch Hill (Augusta region)	41,326	Kennebec
Houlton	6,123	Aroostook
Lincoln	5,085	Penobscot
Lisbon Falls	9,009	Androscoggin
Mid Maine (Corinth region)	9,306	Penobscot
Ogunquit	892	York
Old Town	7,840	Penobscot
Orono	10,362	Penobscot
Paris-Norway	10,197	Oxford
Pittsfield	4,215	Somerset
Pleasant River (Columbia Falls)	1,072	Washington
Scarborough (ecomaine[1])	18,919	Cumberland
Skowhegan	8,589	Somerset
St. George (Tenants Harbor)	2,591	Knox
Total	153,691	

Note: Numbers obtained from 2010 Census data.

Table 2 lists the solid waste management system characteristics of each of the municipalities sampled. Eight of the municipalities had full or partial curbside garbage collection, and eight also had curbside collection of recyclables. Some of the municipalities had PAYT (pay-as-you-throw) programs where residents pay for each bag they discard. Under these programs residents buy specially marked garbage bags, or tags to affix to the garbage bags at retail outlets or the town office.

Regarding recycling programs, "single stream" refers to residents placing all of their recyclable material in one bin rather than separating these recyclables by material (which is known as source separated). The single stream method is gaining proponents because it simplifies the work required by residents. It can also allow for economies in sorting, which is often done with mechanization at large centralized facilities. Three participating municipalities used single stream recyclable collection.

[1] The facility ecomaine is a regional nonprofit waste management company owned by Southern Maine communities. The facility is located in Portland, Maine and offers single stream recycling, Waste-to-Energy, and a landfill/ashfill site.

Table 2. Municipal solid waste system characteristics.

Municipality	Curbside Garbage Collection	Curbside Recyclable Collection	Single-Stream	Pay-as-you-throw (PAYT)	Mandatory Recycling Ordinance
Bath	Yes	Yes	Yes	Yes	Yes
Boothbay	Yes (Partial)	Yes (Partial)	No	No	Yes
Central Penobscot (Dexter area)	No	No	No	Yes	No
Hatch Hill (Augusta region)	Yes (Partial)	Yes (Partial)	No	No	No
Houlton	No	No	No	No	No
Lincoln	Yes (Partial)	No	No	No	Yes
Lisbon Falls	No	No	Yes	No	No
Mid Maine (Corinth region)	No	No	No	No	Yes
Ogunquit	Yes (Partial)	Yes (Partial)	No	No*	No
Old Town	Yes	Yes	No	No	No
Orono	Yes	Yes	No	No	Yes
Paris-Norway	No	No	No	No	Yes
Pittsfield	No	Yes	No	No	Yes
Pleasant River (Columbia Falls)	No	No	No	Yes	No
Scarborough (at ecomaine)	Yes	Yes	Yes	No	Yes
Skowhegan	No	No	No	No	Yes
St. George (Tenants Harbor)	No	No	No	No	No

*One free bag a day then $1.00 per bag beyond that.

Waste Sample Selection

The waste sample selection process was designed to ensure as much random selection as possible, while matching the collection system used by each municipality. At facilities where residents dropped off their garbage, the project team requested that every n^{th} individual include their trash in the sample. The number between individuals sampled (n) was determined by the expected amount of total trash that would be dropped off that day, as predicted by the site's facility manager. In municipalities where trash was collected curbside, an attempt was made to select from multiple neighborhoods, and again, trash from every n^{th} household was collected. Usually this was from residencies at least five houses apart. In total, ten tons of trash were collected and sorted.

A more detailed discussion of the waste sorting procedure is available upon request**.**

Sort Dates

The waste sorts were conducted in two seasons (summer and fall) to allow for seasonal variation. The summer sort began August 8 and ran through September 10. The fall sort began October 14 and ran through November 14. Although not part of the municipal sort, the University of Maine waste

was sampled for demonstration purposes on November 17, 2011. The following table shows the dates in which the sorts were completed for each municipality.

Table 3. Municipality and sort dates.

Municipality	Sort 1, Summer	Sort 2, Fall
Bath	8/27/2011	11/2/2011
Boothbay	8/12/2011	11/1/2011
Central Penobscot (Corinth region)	8/15/2011	10/21/2011
Hatch Hill (Augusta region)	8/21/2011	11/10/2011
Houlton	9/10/2011	11/14/2011
Lincoln	9/5/2011	10/29/2011
Lisbon Falls	9/3/2011	11/3/2011
Mid Maine (Dexter region)	8/14/2011	10/17/2011
Ogunquit	8/29/2011	11/4/2011
Old Town	8/13/2011	10/20/2011
Orono	8/8,9/2011	10/14/2011
Paris-Norway	8/26/2011	11/8/2011
Pittsfield	8/22/2011	10/18/2011
Pleasant River (Columbia Falls)	8/23/2011	10/26/2011
Scarborough (at ecomaine)	8/28/2011	11/9/2011
Skowhegan	9/9/2011	10/25/2011
St. George (Tenants Harbor)	9/1/2011	10/24/2011
University of Maine	N/A	11/17/2011

Waste Composition

The waste examined in this study is typical of what would be found in a regular thirty-gallon plastic trash bag and does not include larger "bulky" items such as furniture, appliances, car tires, and corrugated cardboard boxes. This non-bulky waste stream is often referred to as "baggable trash".

The project team sorted the baggable trash into nine major categories and over sixty subcategories. These classifications correspond to those used by other states in recent waste characterization studies, allowing for possible comparisons. As is the convention with waste management studies, all measurements were made by weight.

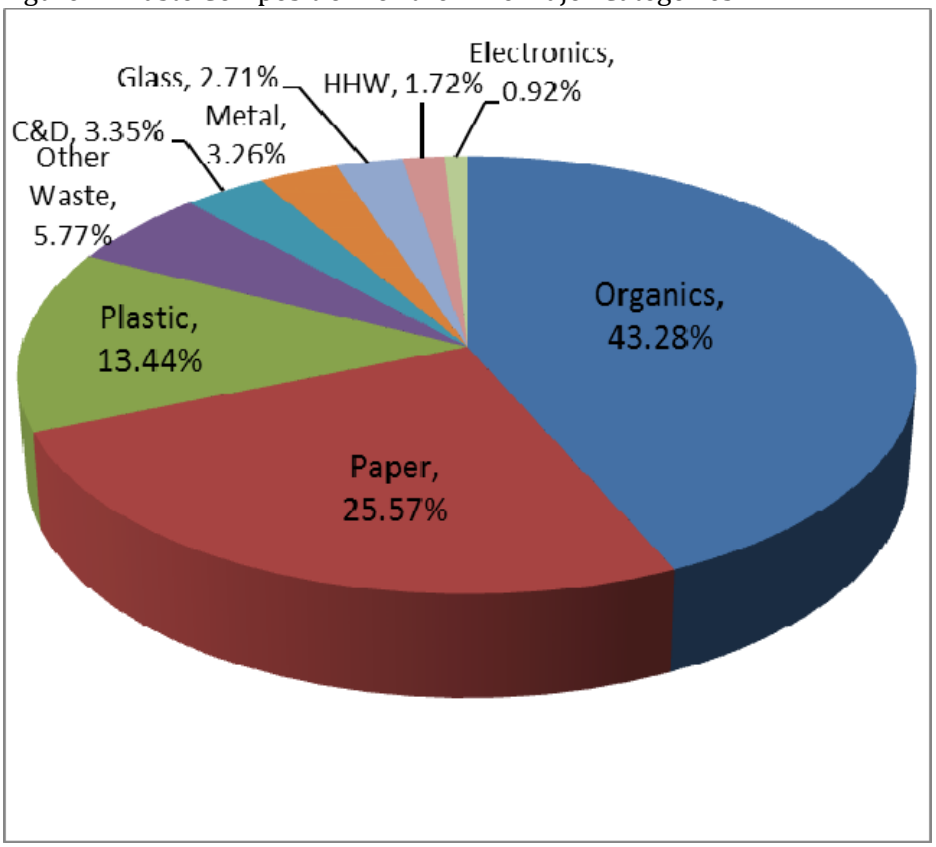
Table 4 below shows the percent of all waste sampled for the nine major waste categories. The largest component was Organics with 43.28%, and the smallest component was Electronics with 0.92%. Figure 1 below shows these percentages. Next, we will discuss each category, from the largest component to the smallest.

Table 4. Waste Composition for the Nine Major Categories.

Major Category	Category %
Organics	43.28
Paper	25.57
Plastic	13.44
Other Waste	5.77
Construction and Demolition Debris (C&D)	3.35
Metal	3.26
Glass	2.71
Household Hazardous Waste (HHZ)	1.72
Electronics	0.92

Note: See Appendix A for a complete category breakdown.

Figure 1. Waste Composition for the Nine Major Categories.



Organics

The phrase "organic" has different meanings depending on usage. From a chemistry standpoint, "organic" technically includes all carbon-based materials such as food, paper, leaves and grass, and even plastics, as plastics are made from and contain hydrocarbons. However, following the convention of others, our Organics category includes only the subcategories: Food Waste, Diapers, Leaves & Grass, Prunings & Trimmings, and Other Organics. Paper and plastic materials comprise their own categories. Table 5 contains a brief description of the five Organics subcategories.

Table 5. Organic waste subcategories and description.

Subcategory	Description
Food Waste	Material resulting from the storage, preparation, and consumption of food. Discarded meat scraps, dairy products, eggshells, coffee grounds, and fruit or vegetable peels.
Other Organics	Organic material that cannot be classified in any other category. Feces-soiled cat litter, cork, hemp rope, cigarette butts, sawdust, bath and body products.
Diapers	All diapers.
Leaves & Grass	All plant material except woody plant material. Fresh grass clippings, leaves, and small plants.
Prunings & Trimmings	All woody plant material up to four inches in diameter. Plant and tree prunings and small branches.

As shown in Table 6, food waste made up 27.78% of the total waste sampled. Food waste, which is nitrogen-rich and highly compostable, is sometimes referred to as a "green waste".

The other four Organics subcategories accounted for 15.42% of the total waste stream. The two largest of these subcategories were Other Organics, comprised mainly of cat litter and animal feces, and Diapers. For health and sanitation reasons these materials are not included in composting programs.

The Leaves & Grass and Prunings & Trimmings subcategories accounted for 1.5% of the trash sampled. This waste has a relatively high concentration of carbon, and when combined with food waste yields a carbon-nitrogen ratio generally well-suited for composting.

Table 6. Organic waste percentages.

Sub-Category	% of Total Waste	% of Organic Waste	Cumulative %
Food	27.86	64.38	64.38
Remainder/Composite Organic	10.97	25.35	89.73
Diapers	2.97	6.86	96.58
Leaves & Grass	1.16	2.68	99.26
Prunings & Trimmings	0.32	0.74	100.00

Paper

Paper accounted for just over a quarter of the total waste collected. Paper was sorted into nine subcategories, as described in Table 7.

Table 7. Paper waste subcategories and description.

Subcategory	Description
Compostable Paper	Contaminated food containers or low-grade paper not capable of being recycled. Paper towels, paper plates, waxed paper, and tissues.
Other Recyclable	"Mixed Paper" including manila folders and envelopes, index cards, notebook paper, construction paper, cereal boxes, paperboard glossy containers, and coated cardboard.
Remainder/ Composite Paper	Items made mostly of paper but combined with other materials. Plastic-coated cardboard, polycoated cartons, frozen juice containers, fast-food wrappers, carbon paper, photographs, and books.
Magazines/Catalogs	Items made from glossy coated paper. Magazines, catalogs, brochures, and pamphlets.
Newsprint	Uncoated ground wood paper, mainly in the form of printed newspapers.
High Grade Office	Standard paper free of ground wood fibers. Office paper, envelopes, computer paper, stationary-grade paper.
Uncoated Corrugated Cardboard/Kraft Paper	Boxes and paper bags made from Kraft paper and uncoated corrugated cardboard. Paper towels, grocery bags, fast food bags, cardboard containers, computer packaging cartons.
Phone Books & Directories	Thin paper between coated covers. Yellow Pages, real estate listings, and some non-glossy mail order catalogs.
Offshore Cardboard	Similar to uncoated corrugated cardboard, but lighter in color with a yellow tint.

As shown in Table 8, the two largest paper subcategories were Compostable Paper and Other Recyclable. Together, these subcategories accounted for just over half of the paper waste. Trash sorters observed that paper towels and plates made up the greatest volume of compostable paper, reporting that it was not unusual to receive a garbage bag with over half of its volume consisting solely of these two items. Remainder/Composite Paper, the third largest subcategory, includes items that cannot be easily diverted from the normal waste stream due to their heterogeneity and complexity (i.e. two materials fused together). Examples include foil-covered paperboard and wax-coated paper.

Table 8. Paper waste percentages.

Subcategory	% of Total Waste	% of Paper Waste	Cumulative %
Compostable Paper	7.93	31.02	31.02
Other Recyclable	4.90	19.15	50.17
Remainder/Composite Paper	4.08	15.95	66.12
Magazines/Catalogs	2.88	11.25	77.37
Newsprint	2.43	9.51	86.88
High Grade Office	1.64	6.41	93.29
Uncoated Corrugated Cardboard/Kraft Paper	1.61	6.29	99.58
Phone Books & Directories	0.11	0.42	100.00
Offshore Cardboard	0.00	0.00	100.00
Total Paper	25.57	100.00	

Plastic

Items made of plastic accounted for 13.44% of the total waste stream. Plastic was sorted into eleven subcategories, as listed and described in Table 9.

Table 9. Plastic waste subcategories and description.

Subcategory	Description
All Plastic Film	Contains both food-soiled and non food-soiled film. Also includes shrink wrap, bubble wrap, garbage bags, small plastic bags, and metalized film.
Remainder/Composite Plastic	All plastic that does not fit into the other subcategories or items primarily composed of plastic but combined with other materials. Auto parts, plastic straws, vinyl, linoleum, plastic lids, CDs.
Durable Plastic Items	Items meant to last a few months to many years. Children's toys, furniture, mop buckets, sporting goods.
#3 - #7 Plastics	Items made of Polyvinyl Chloride, Polyethylene, Polypropylene, or non-expanded Polystyrene.
HDPE Bottles	Containers made of high-density polyethylene plastic (a cloudy white or solid-colored plastic). Includes milk jugs and bottles for shampoos and lotions.
Grocery/Merchandise Bags	Bags meant for transporting merchandise from place of purchase. Also includes dry-cleaning bags.
PET Containers (non-bottles)	All Polyethylene Terephthalate containers that are not meant to hold liquids. Mainly food storage units, including peanut butter jars.
Styrofoam	All expanded polystyrene.
PET Bottles	Clear or colored PET bottles used for liquids such as bottled water or salad dressing.
Redeemable Plastic Beverage Containers	Plastic beverage containers subject to Maine's bottle bill.
HDPE Containers (non-bottles)	Buckets and pails made of high density polyethylene plastic, not including mop buckets.

The most common Plastic subcategory was Plastic Film, which constituted over one-third of the plastic waste and nearly 5% of the total waste (see Table 10). While it is possible to recycle non-food plastic film, less than 5% of Maine municipalities currently offer this type of recycling. The second and third largest plastic subcategories were Remainder/Composite Plastic and Durable Plastic. Many durable plastics have the potential to be recycled, although recycling programs for these plastics are not generally available.

The remaining plastic subcategories accounted for roughly 5% of the total waste sampled. Many of these materials are recyclable. The combined amount of recyclable #1-#7 plastics and Styrofoam accounted for 4.74% of the waste stream. Only 0.36% of the waste stream was made up of plastic beverage containers redeemable under Maine's "bottle bill" legislation. A 2011 Container Recycling Institute publication reports that on average only 24% of bottles eligible for deposit are recycled in states without a bottle bill, while over two-thirds are recycled in states like Maine, where bottle bill legislation is long-established.[2]

[2] Container Recycling Institute. March 2011. "CRI Comments on Natural Logic's White Paper on EPR for Packaging."

Table 10. Plastic waste percentages.

Subcategory	% of Total Waste	% of Plastic Waste	Cumulative %
All Plastic Film	4.78	35.61	35.61
Remainder/Composite Plastic	1.68	12.50	48.12
Durable Plastic Items	1.41	10.48	58.59
#3 - #7 Plastics	1.38	10.25	68.85
HDPE Bottles	1.01	7.50	76.35
Grocery/Merchandise Bags	0.82	6.10	82.45
PET Containers (non-bottles)	0.71	5.31	87.76
Styrofoam	0.67	4.99	92.75
PET Bottles	0.47	3.50	96.25
Redeemable Plastic Beverage Containers	0.36	2.68	98.93
HDPE Containers (non-bottles)	0.14	1.07	35.61
Total Plastic	13.44	100.00	

Other Waste

Materials that could not be sorted into any other category were classified as "Other Waste". Other Waste accounted for 5.77% of the trash sampled. This category was separated into four subcategories, as described in Table 11.

Table 11. Other Waste subcategories and description.

Subcategory	Description
Textiles (non-carpet)	All items (excluding carpet) made of natural or synthetic textiles. Fabric, clothing, curtains, blankets, stuffed animals, and cotton q-tips.
Other Miscellaneous	Any type of waste not listed elsewhere, such as rubber or ceramic items.
Bottom Fines & Dirt	Homogenized granulated residue including dirt, sand, tiny bits of paper, and crumbs.
Bulky Items	Any large item not typical of baggable trash.

Table 12, below, shows percentages for the four Other Waste subcategories. Bottom fines and dirt accounted for less than one-half of a percent of the total waste stream. Only one bulky item was found; this was a suitcase weighing 7.8 pounds. The largest component of the Other Waste category was Textiles, which made up 4.26% of the total waste sampled. Many of the clothing items found were in wearable condition, and some in new condition. While some textile recycling programs exist, Maine municipalities may wish to increase their textile recycling options.

Table 12. Other Waste Percentages.

Subcategory	% of Total Waste	% of Other Waste	Cumulative %
Textiles (non-carpet)	4.26	73.86	73.86
Other Misc	1.01	17.50	91.36
Bottom Fines & Dirt	0.46	7.94	99.29
Bulky Items	0.04	0.71	100.00
Total	5.77	100.00	

Construction and Demolition

The total Construction and Demolition (C&D) waste comprised 3.35% of all waste sampled. In accordance with other studies, an initial seven C&D categories were utilized (as described in Table 13). For households, C&D waste is normally generated with home construction projects.

Table 13. Construction and Demolition waste subcategories and description.

Subcategory	Description
Wood	All treated or untreated wood. Does not include particle board, plywood, or yard waste.
Asphalt, Brick, & Concrete	Items made of asphalt, brick, or concrete. Includes pieces of building foundations, cinder blocks, and pavement.
Asphalt Roofing	Asphalt shingles and other attached roofing material such as roofing tar and tar paper.
Drywall/Gypsum Board	Broken or whole pieces of sheetrock, drywall, gypsum board, plasterboard, Gyproc, and wallboard.
Carpet	Flooring applications consisting of various natural or synthetic fibers bonded to a backing material.
Carpet Padding	Plastic, foam, felt, or other material used under carpet to provide insulation and padding.
Remainder/ Composite C&D	Construction and demolition debris that cannot be included in any other subcategory. Includes composite materials that would be hard to separate, such as linoleum glued to plywood.

Perhaps as a result of only collecting and sorting "baggable" waste, a large volume and variety of C&D was not found. In fact, asides from wood wastes, very few items were found that did not belong in the Wood or Remainder/Composite subcategories. To simplify and make weighing manageable, an "All Other C&D" subcategory was created to encompass all of the non-wood C&D waste. These condensed C&D waste percentages are shown in Table 14.

Table 14. Construction and Demolition waste percentages.

Subcategory	% of Total Waste	% of C&D Waste	Cumulative %
All other C & D	2.21	65.93	65.93
Wood	1.14	34.07	100.00
Total C&D Waste	3.35	100.00	

Metal

Metal accounted for 3.26% of the total waste stream. Metal items were sorted into eight subcategories, as listed and described in Table 15.

Table 15. Metal waste subcategories and description.

Subcategory	Description
Tin/Steel Containers	Magnetic metal containers, such as those used for soup, vegetable, and coffee cans, that are made mainly of steel but with a thin coating of tin on the inside.
Other Ferrous	Other magnetic metal items including clothes hangers, empty paint cans, metal pipes, nails, and some cookware.
Other Non-Ferrous	Nonmagnetic metal items including those made of stainless steel, copper, brass, bronze, and lead. Examples include copper wire, shell casings, and brass pipes.
Remainder/Composite Metal	Items made mostly of metal but combined with other materials such as motors, insulated wire, and food-soiled kitchen foil.
Redeemable Aluminum Beverage Containers	Aluminum containers, such as soda and beer cans, that are Maine deposit refundable.
Appliances	Small metal household appliances such as toasters.
Compressed Fuel Containers	Compressed fuel containers such as propane tanks.
Non-Redeemable Aluminum Beverage Containers	Aluminum containers that are not Maine deposit refundable, such as cans brought into Maine from out of state.

Tin/Steel Containers made up almost half of the metal waste sorted. Food-soiled aluminum foil, not deemed recyclable, was the largest component of the Remainder/Composite Metal subcategory. Redeemable Aluminum Beverage Containers, suitable for redemption under Maine's bottle bill, accounted for less than one-tenth of a percent of the total waste sample. Table 16 lists percentages for all metal subcategories.

Table 16. Metal waste percentages.

Subcategory	% of Total Waste	% of Metal Waste	Cumulative %
Tin/Steel Containers	1.45	44.38	44.38
Other Ferrous	0.93	28.58	72.96
Other Non-Ferrous	0.42	12.85	85.81
Remainder/Composite Metal	0.28	8.69	94.51
Redeemable Aluminum Beverage Containers	0.10	3.22	97.72
Appliances	0.04	1.28	99.01
Compressed Fuel Containers	0.03	0.87	99.87
Non-redeemable Aluminum Beverage Containers	0.004	0.13	100.00
Total Metal	3.26	100.00	

Glass

Glass accounted for 2.71% of the waste stream. Glass was sorted into six subcategories, which are described in Table 17.

Table 17. Glass waste subcategories and description.

Subcategory	Description
Clear Glass Containers	Includes all non-redeemable clear wine bottles and beverage containers, mayonnaise jars, salsa jars, and jelly/jam jars.
Redeemable Glass Beverage Containers	Any glass beverage container subject to Maine deposit law.
Green & Other Glass Containers	Green or other colored bottles including wine, beer, and nonalcoholic beverage containers.
Remainder/Composite Glass	Items made primarily of glass but combined with other materials. Examples include crystal tableware, mirrors, non-florescent light bulbs, car windshields, and curved glass.
Flat Glass (uncoated)	Uncoated, flat glass such as that used for windows, doors, and tabletops, and some auto glass (side windows).
Amber Glass Containers	Amber-colored containers not including alcoholic beverage containers.

The top two glass subcategories in Table 18, Clear Class Containers and Redeemable Glass Beverage Containers, are easily recyclable and accounted for 2.38% of the baggable trash sampled. Redeemable Glass Beverage Containers made up only 0.41% of the waste sampled.

Table 18. Glass waste percentages.

Subcategory	% of Total Waste	% of Glass Waste	Cumulative %
Clear Glass Containers	1.96	72.48	72.48
Redeemable Glass Beverage Containers	0.41	15.23	87.71
Green & Other Glass Containers	0.13	4.84	92.55
Remainder/Composite Glass	0.11	4.00	96.54
Flat Glass (uncoated)	0.07	2.69	99.24
Amber Glass Containers	0.02	0.76	100.00
Total Glass	2.71	100.00	

Household Hazardous

The Household Hazardous waste category includes unwanted residential products that exhibit one or more of the following qualities: flammable, corrosive, reactive, or toxic. [3]Household Hazardous waste accounted for 1.72% of the total trash sampled. Table 19 describes the seven subcategories used to classify the Household Hazardous waste.

[3] These are the same qualities that determine hazardous waste under Maine's hazardous waste rules.

Table 19. Household Hazardous waste subcategories and description.

Subcategory	Description
Other Hazardous Waste	All products characterized as “toxic”, “flammable”, or “corrosive”. Also includes waste contaminated with bodily fluid and discarded needles.
Paint	Items containing oil-based, latex, or fine art paint. Does not include dried paint or empty paint cans.
Batteries	Household batteries such as AA, AAA, D, button cell, 9 volt, and rechargeable.
Vehicle & Equipment Fluids	Containers holding fluids, such as antifreeze or oil , that are used in vehicles or engines.
Empty Metal, Glass, & Plastic Containers	Empty containers that once held toxic or hazardous materials such as antifreeze, oil, or lye.
Pesticides & Fertilizers	Products used to control pests or enhance plant growth.
Ballasts, CFLs, & Other Fluorescents	Includes ballasts (devices that electrically control fluorescent light fixtures), compact fluorescent lamps, and other fluorescent lighting such as tubular lamps.

Other Hazardous Waste, the largest subcategory, consisted mainly of items contaminated with bodily fluids. Paint and batteries were also found in large amounts. Items in the Other Hazardous Waste, Paint, and Batteries subcategories accounted for over 81% of the hazardous waste found. Table 20 shows the percentages of all Household Hazardous waste subcategories.

Table 20. Household Hazardous waste (HHZ) percentages.

Subcategory	% of Total Waste	% of HHZ Waste	Cumulative %
Other Hazardous Waste	0.80	46.50	46.50
Paint	0.37	21.70	68.21
Batteries	0.23	13.39	81.59
Vehicle & Equipment Fluids	0.14	8.09	89.69
Empty Metal, Glass, Plastic Containers	0.10	5.54	95.23
Pesticides & Fertilizers	0.07	3.87	99.10
Ballasts, CFLs, & Other Fluorescents	0.02	0.90	100.00
Total Household Hazardous	1.72	100.00	

Electronics

The smallest of the nine major categories was Electronics, accounting for just 0.92% of waste stream. Electronics were sorted into four subcategories, which are listed and described in Table 21.

Table 21. Electronics waste subcategories and description.

Subcategory	Description
Small Consumer Electronics	Hand-held devices such as cellphones, iPODs, and PDAs.
Computer-Related Electronics	Personal computers and related equipment such as processors and keyboards. Does not include hand-held devices such as calculators.
Other Large Electronics	Larger electronic equipment not related to computers. Stereos, DVD players, VCRs.
TVs and Computer Monitors	Any stand-alone display system including CRT, plasma, and LCD units.

Small consumer electronics made up 73.66% of the Electronics category. No TVs or computer monitors were found, which was expected as these are bulkier items not typical of baggable trash. All electronics percentages can be found in Table 22.

Table 22. Electronics waste percentages.

Subcategory	% of Total Waste	% of Electronic Waste	Cumulative %
Small Consumer Electronics	0.67	73.66	73.66
Computer-Related Electronics	0.13	14.26	87.91
Other Large Electronics	0.11	12.09	100.00
TVs & Computer Monitors	0.00	0.00	100.00
Total Electronics	0.92	100.00	

Comparison to 1991/1992 Data

Prior to this analysis, no large-scale survey of Maine's residential waste had been conducted since 1991/1992. The previous study by Criner, Kaplan, Juric, and Houtman analyzed baggable trash collected at fourteen Maine municipalities in fall, winter, spring, and summer waste sorts. The following section compares data from these sorts with data from our current study in an attempt to identify the changes that have occurred to our waste stream over time. Appendix A and Appendix B contain tables of both waste sorts data.

Some waste components cannot be directly compared between 1991/1992 and 2011, as the studies used slightly different trash classification systems. A note of caution is also needed in regard to comparing changes in composition percentages. Percentages of all subcategories must always sum to 100, so an increase or decrease in the weight of one subcategory will alter the percentages of all other subcategories. However, as percentage comparisons should provide some useful information on changes in the composition of our baggable trash, several materials are discussed below.

Selected Comparisons

Paper

The total amount of paper in Maine's residential waste stream decreased considerably, from 33.04% in 1991/1992 to 25.57% in 2011. Percentages of all comparable paper types also decreased, as shown in Table 23.

Table 23. Comparable paper types percentages, 1991/1992 and 2011.

Type of Paper	1991/1992 % of Total Waste Stream	2011 % of Total Waste Steam
Corrugated cardboard	2.92	1.61
High grade office	3.04	1.64
Magazines/ catalogs	2.92	2.88
Newsprint	9.88	2.43
Telephone books	0.19	0.11
Total of all paper	33.04	25.57

Note: The paper types listed above do not sum to total, as not all paper subcategories are included.

The greatest decrease was in the Newsprint subcategory, which made up 9.88% of waste sampled in 1991/1992 but just 2.48% of the 2011 waste. There were also decreases (by roughly one-half each) in amounts of high grade office paper, corrugated cardboard, and telephone books. Improved recycling programs have no doubt contributed to these decreases, but another factor is the overall movement away from printed media (e.g. more people are reading the newspaper online).

Plastic

In the last two decades, the percentage of plastic in Maine's residential waste stream has more than doubled. Many plastic types cannot be directly compared between the studies, as four subcategories were used to classify plastic in 1991/1992 and eleven were used in 2011. However, Table 24 presents the comparisons that are possible.

Table 24. Comparable plastic types percentages, 1991/1992 and 2011.

Type of Plastic	1991/1992 % of Total Waste Stream	2011 % of Total Waste Stream
Plastic bags	1.59	0.82
All HDPE	1.23	1.15
Rigid plastics	1.12	2.92
Total of all plastic	6.69	13.44

Note: The plastic types listed above do not sum to total, as not all plastic subcategories are included.

Between 1991/1992 and 2011 there was an increase by almost two percentage points in the amount of rigid plastics (which here includes the 2011 subcategories #3-#7 Plastics, PET Bottles, PET Containers, and Redeemable Plastic Beverage Containers) in the total waste sampled. There were decreases, however, in percentages of HDPE plastics and plastic bags.

The overall increase in plastics in baggable trash supports the perception that more and more items are being made from, or wrapped in, plastics. Plastic film, which was included in the 1991/1992 Other Plastic subcategory, has since become the principal plastic component of the waste stream. In 2011, plastic film accounted for 35.61% of all plastic waste and nearly 5% of the total trash sorted.

Metal

The percentage of metal was similar in both studies at 3.29% of the waste stream in 1991/1992 and 3.26% of the waste stream in 2011. However, percentages of various metal subcategories changed (see Table 25). There was a decrease in the percentage of tin/steel containers, but an increase in the percentage of other ferrous and non-ferrous metals. The percentage of aluminum also decreased substantially, although at 0.39% in 1991/1992 and 0.10% in 2011, it was not a significant portion of the waste stream in either sort.

Table 25. Comparable metal types percentages, 1991/1992 and 2011.

Type of Metal	**1991/1992 % of Total Waste Stream**	**2011 % of Total Waste Stream**
Tin/steel containers	2.28	1.45
Ferrous	0.55	0.93
Non-ferrous	0.07	0.42
Aluminum	0.39	0.10
Total of all metal	3.29	3.26

Note: The metal types listed above do not sum to total, as not all metal subcategories are included.

Food Waste

Food waste accounted for 27.81% of the sampled baggable trash in 1991/1992 and 27.86% in 2011, remaining essentially unchanged between the two studies. However, food has surpassed paper as the largest major component of the residential waste stream. This change may be the result of the considerable increases in paper recycling since the mid-1990s.

Glass

The percentage of glass in the residential waste stream decreased from 4.06% in 1991/1992 to 2.71% in 2011. A significant reduction can be seen in the Clear Glass Containers subcategory, which accounted for 3.39% of the trash sampled in 1991/1992 and only 1.96% in 2011. This may be due not only to the increased availability of glass recycling but also the general shift away from using glass containers towards using plastic.

Other Waste

Some materials, such as textiles, made up similar percentages of the residential waste stream in 1991/1992 and 2011. Textiles accounted for 4.24% of the trash sorted in 1991/1992 and 4.26% of the trash sorted in 2011. The percentages of hazardous materials in the residential waste stream also did not change significantly. At 1.32% in 1991/1992 and 1.72% in 2011, they stayed within the 1-2% expected range for baggable waste.

Cat litter, the primary component of the Cat Litter/ Pet Bedding subcategory in 1991/1992, and the Other Organics subcategory in 2011, was a noticeable component of the waste stream in both trash sorts. While a perfect comparison between the two studies is not possible, the amount of cat litter in our baggable trash seems to have increased as Cat Litter/ Pet Bedding accounted for 3.86% of the waste stream in 1991/1992, and Other Organics accounted for 10.97% in 2011. Although cat litter

has the potential to be composted, care must be taken as it can contain certain bacteria and parasites harmful to humans, particularly pregnant women.

Variation in Recyclable Material

State policy makers, local solid waste managers, and those with environmental concerns would like to know what potential exists for removing more recyclables from the residential waste stream. They would also like to evaluate the effectiveness of different waste management programs such as single-stream recycling and pay-as-you-throw initiatives. To begin this assessment, the variation in the amount of recyclable materials found in municipal waste streams is examined.

We chose two materials, Clear Glass Containers and Newsprint, to begin this analysis. These were selected because the vast majority of Maine residents know that these materials can be recycled and almost all Maine municipalities have some recycling program for them. To explore the variation of these materials, the summer and fall sort data were averaged for each of the seventeen municipalities. In an effort to eliminate accidental extreme data points and make an easy comparison by thirds, municipalities with the highest and lowest percentages were removed from the analysis. The remaining fifteen municipalities could then be organized into low, medium, and high groups of five municipalities each.

Figure 2 illustrates variation in the percentage of Clear Glass Containers in the municipalities' baggable trash. Averages for the low, middle, and high groups are provided. The difference between the low (1.50%) and high (2.48%) averages shows that some municipalities could be recycling more Clear Glass Containers.

Figure 2. Clear Glass Containers Low, Mid, High Averages.

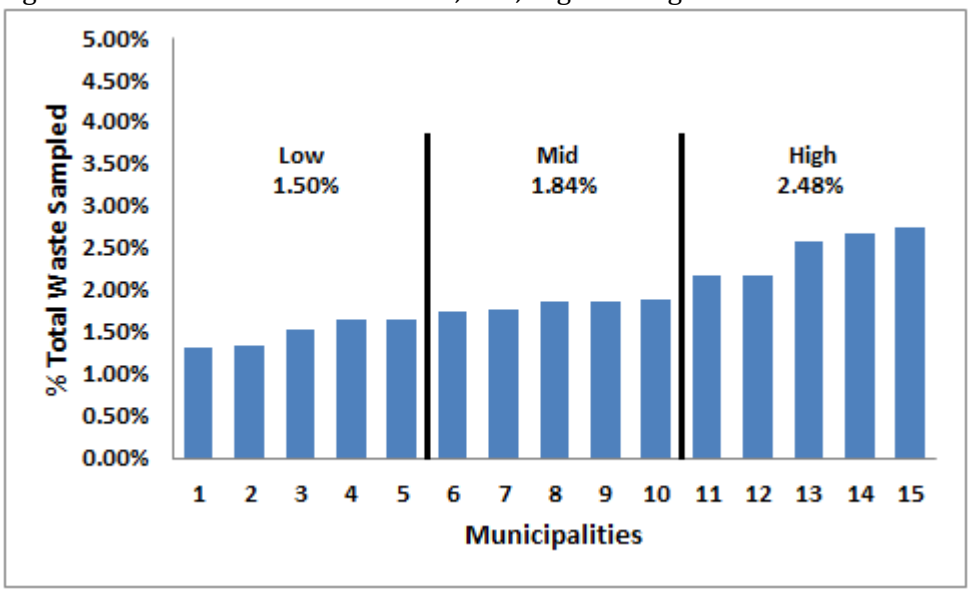
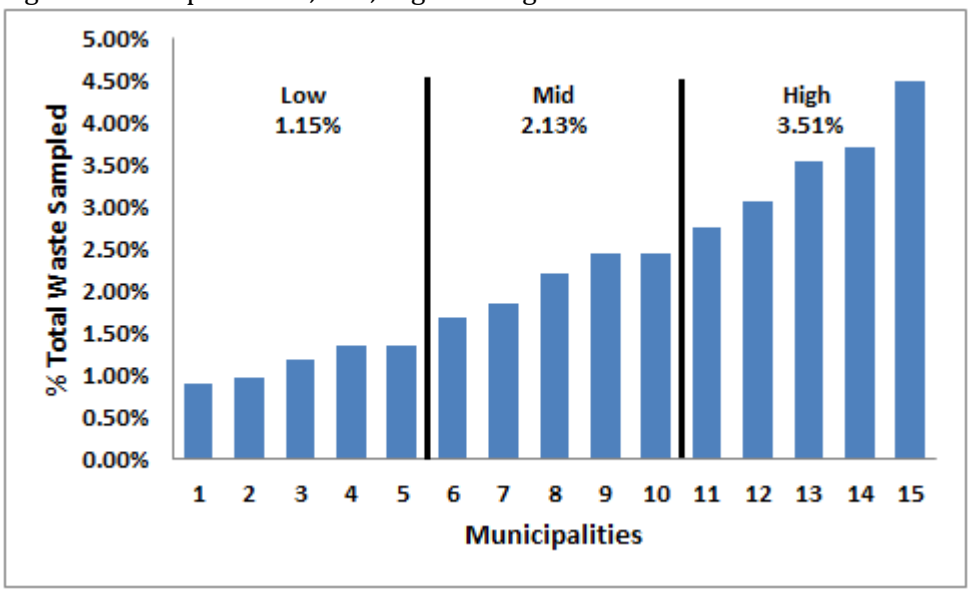


Figure 3 presents a similar graph, illustrating variation in the percentage of Newsprint in the municipalities' baggable trash. Differences between the high, middle, and low averages are greater for this material, with Newsprint comprising 3.51% of the waste stream of the high group, and only 1.15% of the waste stream of the low group.

Figure 3. Newsprint Low, Mid, High Averages.



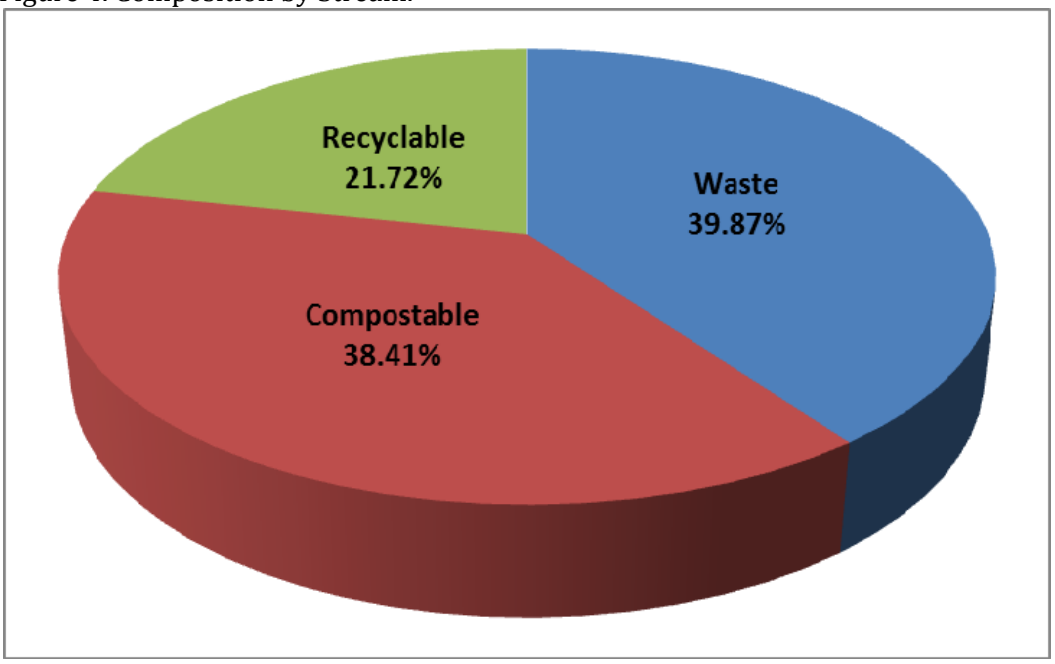
Many factors likely contribute to these variations, including program design (such as pay-as-you-throw and single stream recycling), community involvement and municipal commitment. A preliminary study of the waste/recycling municipal programs supports this conclusion: program design and management appears to make a difference in recycling. Future reports will analyze these factors more closely. However, the variation in the presence of recyclable materials in the waste stream shown above demonstrates the potential for underperforming municipalities to improve their recycling efforts.

Analysis and Discussion

With an eye towards fruitful analysis and the most productive use of these data, we will examine this study's results in two different ways. Doing so may provide additional insights and accompanying recommendations for municipal waste managers.

The first way we analyze the baggable trash sampled in this study is by classifying it into three streams: Waste, Recyclable, and Compostable. These three streams are not exclusive, but are helpful in determining how much of what Maine residents are throwing away could be diverted to better uses. For discussion purposes only, we define "Waste" as materials not easily diverted from the waste stream through current Maine composting or recycling programs. Please see Appendix C for complete details of the waste stream classification used in this analysis. The waste sampled in this study had a roughly 40-40-20 breakdown between Waste materials, Compostable materials, and Recyclable materials, as shown in Figure 4.

Figure 4. Composition by Stream.



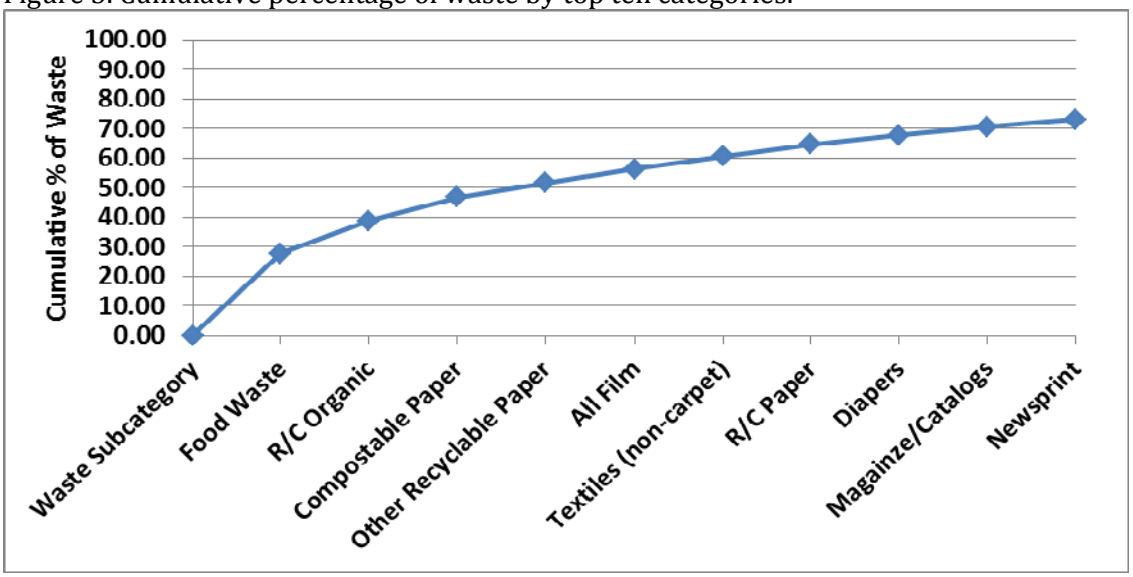
Waste comprised 39.87% of the trash sampled. Efforts could be made to reduce much of this waste at its source by encouraging the use of recyclable materials and/or the use of more reusable items (e.g. refillable razors). The potential also exists for several materials in this category, such as textiles and grocery bags, to be recycled at much higher rates in the future if better recycling programs for these materials can be developed. Compostable materials, at 38.41%, comprised nearly as much of the trash as Waste. Food waste and compostable paper comprised 93.2% of the Compostable stream. Creating municipal or regional composting programs and increasing awareness about backyard composting could greatly reduce the cost of disposing of solid waste in the State of Maine. Recyclable materials comprised just over 20% of the waste sampled. This category contains desirable materials that should be diverted from the normal waste stream to more economical uses. As shown in the previous section, some municipalities could greatly improve their capture of these materials. While Maine communities have been providing recycling programs to residents since the early 1990's, and recycling initiatives have been increasing with time, municipalities and businesses are still recycling much less of their waste than the state's 50% recycling goal that was established by the Maine Congress in 1989. This deadline for this law has been extended each time it is not met.

A second method we use to examine the data relies on identifying the waste subcategories which make up the greatest part of the residential waste stream. The ten subcategories shown in Table 26 made up 73.05% of the waste sampled for this study. Figure 5 shows the cumulative volume of these ten categories.

Table 26. Top ten waste subcategories by percentage.

Waste Subcategory	Category %	Cumulative %	Potential to be Diverted
Food Waste	27.86	27.86	Yes
Other Organics	10.97	38.83	No
Compostable Paper	7.93	46.76	Yes
Other Recyclable Paper	4.90	51.66	Yes
All Plastic Film	4.78	56.44	Yes
Textiles (non-carpet)	4.26	60.70	Yes
Remainder/ Composite Paper	4.08	64.78	No
Diapers	2.97	67.75	No
Magazines/Catalogs	2.88	70.62	Yes
Newsprint	2.43	73.05	Yes

Figure 5. Cumulative percentage of waste by top ten categories.



The three largest components of the waste stream were food waste, other organics, and compostable paper. Food waste and compostable paper have a high potential to be diverted from the normal waste stream, while items in the other organics subcategory do not, as much of these contained fecal matter. Items in several of the other subcategories, such as other recyclable paper, magazines/catalogs, and newsprint, are easily recyclable. Textiles are potentially recyclable, but better textile recycling programs are in need of development. Remainder/composite paper is not currently recyclable, but technical methods may be developed to facilitate this. The majority of plastic film, however is contaminated with food, making it unfit for recycling.

Our knowledge about the recycling potential of each subcategory permits us to focus primarily on those subcategories which have a high potential to be diverted from the normal waste stream. Table 27 lists the ten largest subcategories with a high potential to be diverted, and their percentages of total waste. Together, these ten subcategories constituted over 60% of the baggable trash sampled.

Table 27. Top ten waste subcategories with the potential to be diverted.

Waste Subcategory	% of Total Waste	Cumulative %
Food Waste	27.86	27.86
Compostable Paper	7.93	35.79
Other Recyclable Paper	4.90	40.69
All Plastic Film	4.78	45.47
Textiles (non-carpet)	4.26	49.73
Magazines/Catalogs	2.88	52.61
Newsprint	2.43	55.04
Clear Glass Containers	1.96	57.00
High Grade Office Paper	1.64	58.64
Uncoated Corrugated Cardboard/Kraft Paper	1.61	60.25

Conclusion

This report summarizes the results of a state-wide analysis of Maine's baggable trash. It is our intention that the information provided will be useful in understanding and managing Maine's residential waste. By identifying what materials end up in household baggable trash, municipalities may identify both the areas of their waste management programs that are working effectively as well as those that need improvement. The observed decrease in paper and glass waste from the early 1990's to the present can be explained by the increased use of plastic in packaging and product manufacturing. The composition of plastics and their respective recycling requirements have accordingly become more complex as new types of plastic have been developed.

Importantly, this analysis shows that 38% of current trash has the potential to be composted. Significant revenue loss also appears to occur in the improper disposal of recyclable materials, which make up 21% of the current residential waste stream. Though recycling rates have increased from 32.5% in 1993 to nearly 39% in 2010, vast improvements can still be made, as recycling rates have been stagnant in more recent years. Efforts to increase awareness about composting and recycling, as well as efforts to improve municipal recycling programs, should continue. We anticipate these efforts to be most effective when directed at products from the subcategories shown in Table 27.

Maine has the potential to accomplish its goal of reducing waste through increased recycling, which would lower costs to municipalities and prolong the life of landfills. The research done for this study can provide direction to efforts to improve statewide waste management.

Limitations and Future Research

While this research reports changes since earlier waste studies, more research is needed to assess the impact of particular management programs such as pay-as-you-throw, single stream recycling, mandatory recycling laws, and the availability of curbside pickup. A 1993-1994 Maine study by Seguino *et al.* found that pay-as-you-throw programs reduced per capita residential waste disposal by more than one-half. In this 2011 study, we would accordingly expect to find lower percentages of recyclable material in the trash of municipalities with pay-as-you-throw programs. Similarly, as single-stream systems make recycling easier, we would expect to find less recyclable material in the

household waste of communities where these programs exist. Unfortunately our efforts to sample waste from larger municipalities with pay-as-you-throw and single-stream recycling were not successful.

Another analysis that may be of interest in the future is a comparison of the weight (as opposed to percentage) changes of waste composition. As stated above, examining percentage changes in waste components distorts perceived improvements, since a change in the amount of any one component necessarily changes the percentages of all other components (since percentages must sum to 100). For many of the municipalities sampled, we know the number of houses involved as well as total waste weight. This information would allow us to compare pounds of waste per household in order to determine if average pounds per household vary depending on which waste management programs are in use (e.g. single stream recycling, pay-as-you-throw).

Examining the effectiveness of mandatory recycling ordinances is also a potential area of interest. The waste sorters involved in this study reported substantial anecdotal evidence that mandatory ordinances are not enforced thoroughly and may therefore have little to no actual impact on recycling rates. Finally, while this study examined baggable residential waste, future studies might also include household bulky waste, as well as industrial and commercial waste.

Appendix A. 2011 Waste Composition

Major Category	Subcategory	% of Waste	% of Major Category
Organics		43.28	
	Food	27.86	64.38
	R/C Organic	10.97	25.35
	Diapers	2.97	6.86
	Yard Waste	1.48	3.42
Paper		25.57	
	Compostable Paper	7.93	31.02
	Other Recyclable Paper	4.90	19.15
	R/C Paper	4.08	15.95
	Magazine/Catalogs	2.88	11.25
	Newsprint	2.43	9.51
	High Grade Office Paper	1.64	6.41
	Occ/Kraft	1.61	6.29
	Phone Books	0.11	0.43
Plastic		13.44	
	All Film	4.78	35.61
	All Other Plastic	3.76	27.97
	#3 - #7 Plastics	1.38	10.25
	PETE (#1)	1.18	8.81
	HDPE (#2)	1.15	8.58
	Grocery/Merch Bags	0.82	6.10
	Plastic ME Dep. Bev Cont.	0.36	2.68
Other Waste		5.77	
	Textiles (non-carpet)	4.26	73.86
	Other Waste	1.51	26.14
C&D		3.35	
Metal		3.26	
	Other Metal	1.71	52.40
	Tin/Steel Cont.	1.45	44.38
	Al. ME Dep. Bev Cont.	0.10	3.22
Glass		2.71	
	Clear Glass Cont.	1.96	72.48
	Glass ME Dep. Bev Cont.	0.41	15.23
	Amber & Green Glass	0.15	5.60
	All Other Glass	0.18	6.69
HHW		1.72	
Electronics		0.92	

Appendix B. 1991/1992 Waste Composition

Major Category	Subcategory	% of Waste	% of Major Category
Other		52.91	
	Food Waste	27.81	52.56
	Composites	4.74	8.96
	Textiles	4.24	8.01
	Cat Litter/ Pet Bedding	3.86	7.3
	Diapers	3.78	7.14
	Miscellaneous	3.15	5.95
	Household Demolition Debris	2.14	4.04
	Household Hazardous	1.32	2.49
	Deposit Containers	0.67	1.27
	Cosmetic/Toiletries	0.61	1.15
	Furniture/Carpeting	0.46	0.87
	Batteries	0.13	0.25
Paper		33.04	
	Other	14.09	42.64
	Newspaper	9.88	29.91
	Highgrade	3.04	9.22
	Magazines	2.92	8.84
	Corrugated Cardboard	2.92	8.83
	Telephone Books	0.19	0.56
Plastic		6.69	
	Other	2.75	41.07
	Bags	1.59	23.81
	HDPE	1.23	18.41
	Rigid	1.12	16.71
Glass		4.06	
	Clear	3.39	83.46
	Other	0.5	12.26
	Green/Brown	0.17	4.28
Metal		3.29	
	Tin/Steel Cans	2.28	69.43
	Ferrous	0.55	16.72
	Aluminum	0.39	11.76
	Nonferrous	0.07	2.09

Appendix C. Waste Stream Classification

Paper	Stream	Metal	Stream
High Grade Office Paper	R	Non-Redeemable Aluminum Beverage Containers	R
Magazines/Catalogs	R	Redeemable Aluminum Beverage Containers	R
Newsprint	R	Tin/ Steel Containers	R
Offshore Cardboard	R	Appliances	W
Other Recyclable Paper	R	Compressed Fuel Containers	W
Phone Books & Directories	R	Other Ferrous	W
Uncoated Corrugated Cardboard/ Kraft Paper	R	Other Non-ferrous	W
Compostable Paper	C	Remainder/ Composite Metal	W
Remainder/ Composite Paper	W	**Glass**	
Plastic		Amber Glass Containers	R
#3-#7 Plastics	R	Clear Glass Containers	R
HDPE Bottles	R	Green & Other Glass Containers	R
HDPE Containers (non-bottles)	R	Redeemable Glass Beverage Containers	R
PET Bottles	R	Flat Glass (uncoated)	W
PET Containers (non-bottles)	R	Remainder/ Composite Glass	W
Redeemable Plastic Beverage Containers	R	**Organic**	
Styrofoam	W	Food Waste	C
All Plastic Film	W	Leaves & Grass	C
Durable Plastic Items	W	Prunings & Trimmings	C
Grocery/ Merchandise Bags	W	Diapers	W
Remainder/ Composite Plastic	W	Other Organics	W
Household Hazardous		**Electronics**	
Ballasts, CFLs, & Other Fluorescents	W	Computer-Related Electronics	W
Batteries	W	Other Large Electronics	W
Empty Metal, Glass, Plastic Containers	W	Small Computer Electronics	W
Other Hazardous Waste	W	TVs & Computer Monitors	W
Paint	W	**Other Waste**	
Pesticides & Fertilizers	W	Bottom Fines & Dirt	W
Vehicle & Equipment Fluids	W	Bulky Items	W
Construction & Demolition		Other Miscellaneous	W
Wood	C	Textiles (non-carpet)	W
Remainder/ Composite C&D	W		

*R=Recyclable, C=Compostable, W=Waste.

Appendix D. Waste Sorting Procedure

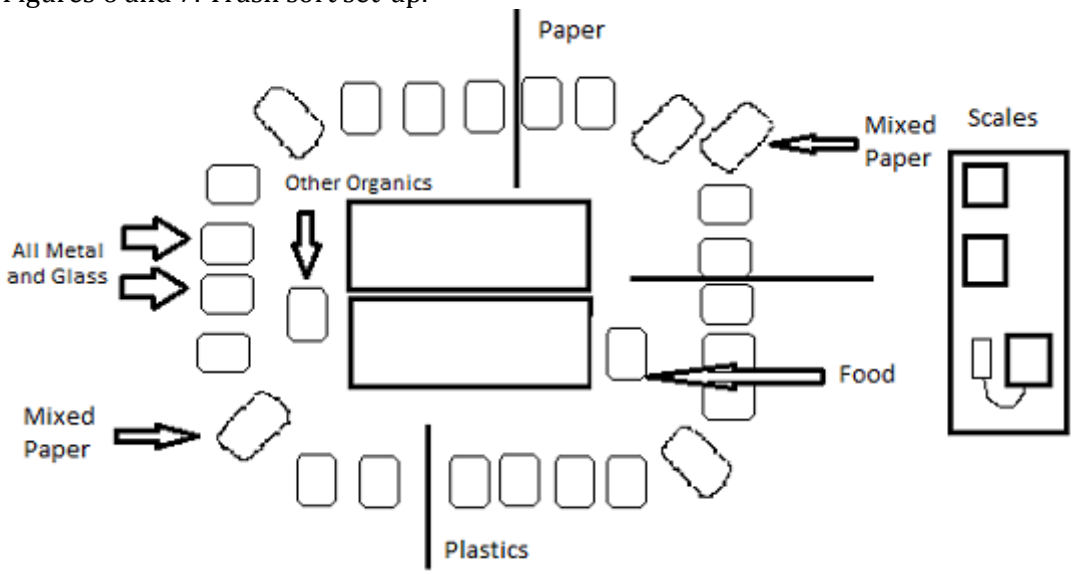
The waste sorting procedure was based on previous studies conducted by the University of Maine and the State of Connecticut. Figures 6 and 7 show the basic trash sort set-up. The project team used two 2'x5' tables covered by an 8'x12' tarp as a sorting surface. Surrounding this were approximately thirty Sterilite storage bins in two sizes, large and small. At one end of the sorting area was a weighing station with three scales. One scale was calibrated for the weight of the large bins, one was calibrated for the weight of the small bins, and one was electronic and used for loose items or for weights that did not register on the other two scales. To protect the sorting are from sun, wind, and rain, a pop-up tent, windscreen, and extra tarps were used at outdoor facilities as needed.

Collecting the sample varied by location. At drop-off facilities, a field supervisor spoke to individuals whose waste was selected for the sample, making sure that this waste could be included in the study and that it qualified as Maine household garbage. In the few instances where individuals did not wish to have their trash sorted, the next individual's trash was chosen for analysis.

Once a trash sample was received, the project team unloaded it on the sorting tables and surveyed the contents for dangerous materials. They worked together to sort the waste into its more general components, then into specific subcategories. Most materials were sorted directly on the table and then placed in designated bins, but some were sorted in two stages. One example of this was mixed paper, which was found in extremely high volumes, and for glass, electronics, and metal which were found in extremely small volumes. It was inefficient to sort these materials directly into their final categories, so they were first grouped together and then resorted. After all of the sorted waste components were removed, the project team used squeegees to collect bottom fines and dirt from the table.

Once a bin was full with a specific subcategory of waste, a field supervisor checked to make sure all of its contents were appropriate. The bin was then brought to the weighing station where a manager weighed the contents, recorded that weight, and discarded the waste.

Figures 6 and 7. Trash sort set-up.



Non-Discrimination Notice
In complying with the letter and spirit of applicable laws and pursuing its own goals of diversity, the University of Maine shall not discriminate on the grounds of race, color, religion, sex, sexual orientation, including transgender status or gender expression, national origin, citizenship status, age, disability, genetic information or veteran's status in employment, education, and all other areas of the University of Maine. The University provides reasonable accommodations to qualified individuals with disabilities upon request.

Questions and complaints about discrimination in any area of the University should be directed to Karen Kemble, Esq., Director of Equal Opportunity, University of Maine, 5754 North Stevens Hall, Room101, Orono, ME 04469-5754, telephone (207) 581-1226, TTY (207) 581-9484 or to the Director of Equity and Diversity for the University of Maine System, who can be reached at telephone (207) 973-3372 or TTY (207) 973-3300, 16 Central Street, Bangor, Maine 04401. Inquiries or complaints about discrimination in employment or education may also be referred to the Maine Human Rights Commission. Inquiries or complaints about discrimination in employment may be referred to the U. S. Equal Employment Opportunity Commission.

Inquiries about the University's compliance with Title VI of the Civil Rights Act of 1964, which prohibits discrimination on the basis of race, color, and national origin; Section 504 of the Rehabilitation Act of 1973 and Title II of the Americans with Disabilities Act of 1990, which prohibit discrimination on the basis of disability; Title IX of the Education Amendments of 1972, which prohibits discrimination on the basis of sex; and the Age Discrimination Act of 1975, which prohibits discrimination on the basis of age, may be referred to Ms. Kemble, who is designated to coordinate campus compliance with these Acts. Inquiries about these issues may also be referred to the U. S. Department of Education, Office for Civil Rights (OCR), 8th Floor, Five Post Office Square, Boston MA 02109-3921, telephone (617) 289-0111, fax (617) 289-0150, TTY (877) 521-2172 or email: ocr.boston@ed.gov. Generally, an individual may also file a complaint with the OCR within 180 days of alleged discrimination.

Bibliography

Container Recycling Institute. March 2011. "CRI Comments on Natural Logic's White Paper on EPR for Packaging." http://www.container-recycling.org/assets/pdfs/2011-CRIResponseToNLOnEPR.pdf

Criner, George K., S.L. Jacobs and C.A. Rock. 1991. "A Residential Waste Stream Analysis: Orono, Maine, 1990." Maine Agricultural Experiment Station, University of Maine, Bulletin 833, 12 pp.

Criner, George K., J.D. Kaplan, S. Juric and N.R. Houtman. 1994. "Maine's Household Garbage." Maine Agricultural and Forestry Experiment Station, University of Maine, Bulletin 841, 23 pp.

DSM Environmental Services, Inc., Cascadia Consulting Group and MidAtlantic Solid Waste Consultants. 2010. "Connecticut State-Wide Solid Waste Composition and Characterization Study, Final Report." State of Connecticut Department of Environmental Protection.

Maine State Planning Office. 2012. "Solid Waste Generation & Disposal Capacity Report for Calendar Year 2010.

Seguino, Stephanie, G. K. Criner, M. Suarez., J. Young, R. McKay, C. Spruce. 1995. "Solid Waste Management (SWM) Options: The Economics of Variable Cost and Conventional Pricing Systems in Maine." *Maine Policy Review*. 4:2:49-58. http://mcspolicycenter.umaine.edu/files/pdf/CostPricingSystems06-1995.pdf

United States Environmental Protection Agency. "Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2010."

United States Environmental Protection Agency. "Municipal Solid Waste Characterization Methodology."