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INTRODUCTION

The study of household wastes has historically been conducted by anthropologists in the effort to determine past lifestyles. More recently, however, scientists from a wide range of backgrounds have been analyzing household waste in order to obtain information relevant to waste management. Many of these studies focused on assessing recycling options although other purposes have existed such as analyzing the relation between stated household waste disposal behavior and actual household waste disposal behavior.

Drs. George Criner and Chet Rock of the University of Maine, and students from their Waste Management class analyzed household wastes from 33 residences in Orono. The purpose of the analysis was to obtain an estimate of total weekly residential waste weight and its composition by category (paper versus glass, etc.).

COLLECTION AND ANALYSIS PREPARATION

On Friday, September 28, 1990, George Criner, along with two Orono town trucks and three Orono town workers, collected waste from 50 Orono residences. On Fridays garbage is collected from roughly one-half of Orono's residences. Criner and the Orono personnel collected the waste from homes as it was awaiting pickup by Orono's contracted waste disposal company.

Only trash contained in plastic bags or corrugated cardboard boxes was collected. Each bag or box collected was labelled and numbered according to residence.

Due to the relatively low-budget of the research project, no attempt was made to randomly select waste pickups throughout Orono. Although a few stops at two- or three-unit apartments were included in the analysis, apartments where generally avoided. Essentially, the waste came from single-family households located in middle-income neighborhoods. Since a few of the waste pickups were from apartment buildings (multi-family households), the term residence is used herein to refer to both multi- and single-family households.

The following Saturday the waste was taken to a large parking lot at the University of Maine for analysis. The trash bags were organized in pickup order; all "residence 1" bags, all "residence 2" bags, etc.

Drs. Criner and Rock, along with a dozen students from their Waste Management class and Orono Town Engineer, Bruce Crawford, analyzed the waste categories from 33 of the 50 residences. Not all 50 of the waste samples could be analyzed due to a time constraint. A total of 125 garbage bags were collected from the 33 residences. The total weight of the bags equaled 1,359 pounds or 3.8 pounds per bag. On average, each bag weighed 10.9 pounds.

The outdoor laboratory set up to analyze the waste consisted of three 4-by-8 tables, an old farm "milk scale," a 100-pound capacity electric scale, and several containers for weighing. Two of the tables were placed back-to-back and covered with a sturdy plastic sheet. This provided an 8-by-8 area for opening the garbage bags and separating the waste. The electric scale was placed on the third table.

The waste from each residence was analyzed in turn. First, the total weight for each residence was determined by weighing all of its bags on the milk scales. Next, the bags were emptied on the large table and separated by component. For the major waste categories (e.g., glass, plastic, etc.), one or two workers were assigned to collect the material and place it in the containers used for weighing. For

example, two workers in one corner of the table were responsible for collecting all the food wastes. Once separated into categories the waste was weighed and the data recorded.

COMPONENT ANALYSIS

Wastes were separated into eleven categories according to material. Some of these categories were glass, plastics, and textiles. For items such as glass, the material components were further subdivided into green, clear, and brown containers, and other categories. The following is a description of each category including statistics on the number of observations, pounds per observation, pounds per residence, percentage of material category, and percentage of all waste.

Paper

Three basic subcategories of paper were used: newspaper, corrugated cardboard, and other. Table 1 shows the percentage of total paper by paper category, as well as the paper categories compared to the total. Originally it was intended to have an "office paper" category, but the overall filth of the rubbish made even the separation of newspaper and corrugated cardboard difficult at times.

The other paper sub-category was comprised of a wide range of paper types and in some cases was a "catch all," containing a pound or so of cigarette butts, facial tissue, etc. Based on this limited sample, it was evident that paper quality is very poor once mixed with all other trash and has severely limited recycling value.

Table 1. Paper by Paper Category

Paper Category	Obser-vations	Lbs per Observation	Lbs per Residence	Percentage of All Paper	Percentage of All Waste
Newspaper	12	4.1	1.48	11.6	3.6
Corrugated	7	4.1	0.88	6.9	2.1
Other	32	10.8	10.46	81.6	25.4
Total			12.82	100.0	31.1

Glass

Glass, which accounted for 5.51% of the total weight, was separated into four categories; *clear containers*, *green containers*, *brown containers*, and *other glass* (all other colors of glass as well as non-container glass of various colors). As was expected, clear glass containers comprised the vast majority of all glass (89%). Twenty-

one of 33 residences had clear glass. The bulk of glass within this category consisted of food jars (mayonnaise, peanut butter, etc.). Table 2 shows the glass by categories as a percentage of all glass and as a percentage of total waste.

Table 2. Glass by Glass Category

Glass Category	Obser-vations	Lbs per Observation	Lbs per Residence	Percentage of All Glass	Percentage of All Waste
Green[a]	3	1.2	0.11	4.9	0.27
Clear	21	3.2	2.02	89.2	4.92
Brown	3	0.2	0.02	0.9	0.05
All Other	4	0.9	0.11	4.9	0.27
Total			2.27	100.0	5.51

[a]The three "colors" of glass used here, green, clear, and brown, are often referred to as green, flint, and amber, respectively. These three glass categories are used for container glass only (e.g., jars and bottles). All other non-container glass, such as window pane glass, are categorized under "all other".

Metals

Metal cans, aluminum packaging, and other metals were the three categories of metals used in the analysis. Table 3 shows the metal categories as a total of all metals and as a percentage of total weight. The largest of these metal categories, metal cans, consisted primarily of food and pet food cans. All food and beverage cans, with the exception of aluminum beverage cans, were included within the metal cans category. All aluminum beverage cans and aluminum foil were classified as aluminum packaging. No attempt was made to separate aluminum food cans from the metal cans category. The other metals category consisted primarily of metal scrap from broken household or automotive items. No attempt was made to separate these by metal type.

Table 3. Metal by Metal Category

Metal Category	Obser-vations	Lbs per Observation	Lbs per Residence	Percentage of All Metal	Percentage of All Waste
Metal Cans	24	2.3	1.69	66.8	4.11
Alum. Pck.	19	0.4	0.21	8.3	0.51
Other	7	3.0	0.63	24.9	1.53
Total			2.53	100.0	6.15

Plastics

Three plastic categories were used in the analysis; *HDPE* (high-density polyethylene) *containers*, *other packaging*, and *non-packaging*. Due to the time constraint on the waste analysis, the researchers did not separate plastics beyond this limited separation. For instance, no attempt was made to separate PET (polyethylene terephthalate) plastics from other packaging. The HDPE plastics consisted primarily of milk jugs and laundry detergent bottles. Plastic bags, including the residential trash bags, were included in other packaging. The non-packaging category consisted exclusively of household and automotive discards such as dolls, plastic auto interior molding, etc. Table 4 shows plastics by subcategory and plastics relative to total waste weight.

Table 4. Plastic by Plastic Category

Plastic Category	Observations	Lbs per Observation	Lbs per Residence	Percentage of All Plastic	Percentage of All Waste
HDPE Cnt.	28	0.9	0.77	22.1	1.88
Other Pckg.	33	2.3	2.28	65.1	5.54
Non-Pckg.	5	3.0	0.45	12.8	1.09
Total			3.50	100.0	8.50

Other Waste Categories

Table 5 shows the waste component statistics for the remaining nine categories. Each category is discussed in detail below.

Table 5. Observations, Pounds per Observation, Pounds per Residence, and Percentage of Total Waste for Nine Waste Categories

Waste Category	Observations	Lbs per Observation	Lbs per Residence	Percentage of All Waste
Wood/Yard Waste	6	11.8	2.15	5.22
Diapers	10	6.3	1.92	4.65
Leather and Rubber	2	3.3	0.20	0.48
Cat Litter	5	25.4	3.85	9.35
Textiles	23	1.3	0.89	2.16
Demolition Debris	1	11.6	0.35	0.85
Miscellaneous Junk	10	2.8	0.85	2.07
Fines	6	1.9	0.35	0.85
Hazardous	5	2.3	0.35	0.85

Food wastes

Food wastes was the second largest category after paper, but was undoubtedly the most memorable. Words cannot describe the stench and filthiness of the food category. Aside from its own foul condition, the food wastes made other materials slimy and difficult to handle. Much of the paper contained in the trash was severely contaminated by food wastes.

Only three of the 33 residents did not have any food wastes. It is unknown whether these residents produced food wastes or how they may have disposed of them. Perhaps these residents compost their food wastes, use garbage disposals, or dine out frequently. For the 30 observations of food waste, the average weight per residence equaled 10.1 pounds; the average for all residents equaled 9.14 pounds. One residence had 42.7 pounds of food waste. Figure 1 shows a frequency distribution of food waste weight for the 33 residences.

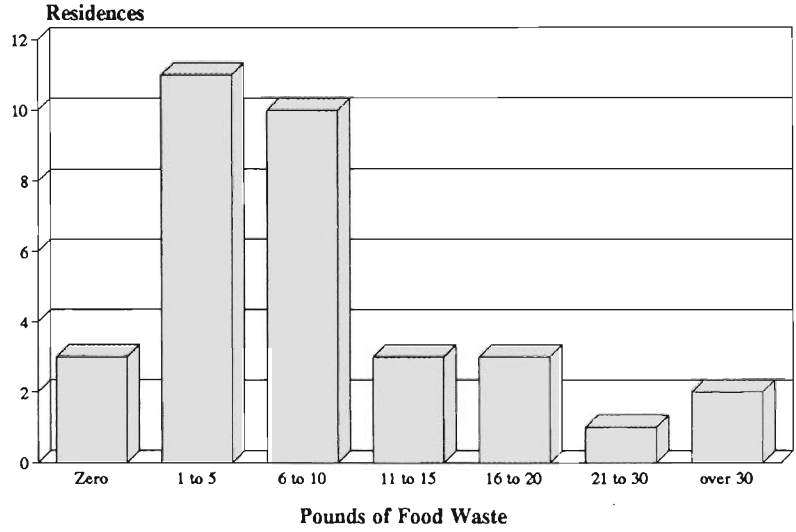

Figure 1. Frequency Distribution of Food Waste Weight for 33 Residences in Orono, Maine

Wood and yard waste

Although wood and yard waste are usually separate categories, they are combined here due to their organic similarity and relatively low rate of occurrence. The portion of MSW that consists of yard waste varies greatly by geographic area and by season. Overall, however, yard waste is estimated to equal 20 % of MSW (and therefore an even higher percentage of residential waste). For the week that this analysis was conducted only one household had any yard waste, but this one observation weighed 42.5 pounds (3.14% of the total waste weight for all residences).

In New England, yard waste volume is concentrated in the fall and to a lesser extent in the summer. Had this residential waste analysis been conducted following the major fall leaf drop, it is possible that half of all garbage bags collected could have contained leaves.

Five of the residences disposed of wood, primarily lumber scraps. For these residences, the average wood waste weight was 5.69 pound. Together, yard waste and wood waste comprised 5.22% of all household waste collected in the analysis. Any one-week sample cannot accurately estimate yard waste quantities in residential waste. Certainly, yard and wood waste constitute a much higher percentage of residential waste than the 5.22% reported here, perhaps even as high as 35%. Table 6 shows the relevant statistics for wood and yard waste as well as the remaining eight primary waste categories.

Diapers

Ten of the 33 residences had thrown out disposable diapers. The average disposable diaper weight for residences disposing of diapers was 6.3 pounds, while the average over all 33 residences was 1.92 pounds. For all residences, diapers were 4.65% of total weight. This agrees with national estimates that disposable diapers constitute roughly four percent of residential solid waste (OTA 1989:116).

Leather and rubber

Only two residences had either leather or rubber items. These two observations combined to 6.5 pounds or 0.48% of the total.

Cat litter

The biggest surprise of the waste analysis was the large quantity of cat litter found in the waste stream. Five of 33 residences (15%) disposed of some cat litter. The cat litter weights (in pounds) were: 69.5, 27, 13.5, 9.2, and 7.8. The average for houses having cat litter equaled 25.4 pounds and the average over all 33 residences

equaled 3.85 pounds. For the total waste weight cat litter constitute 9.35%. Even if one reduces the abnormally high 69.5 pound observation to the average of the four lower observations (14.38 pounds), cat litter still represents 5.6% of the residential waste.

In previous studies, cat litter has not been reported as a notable fraction of the waste stream. In Epp and Mauger's 1989 study, cat litter, when present in a resident's waste, "frequently weighed from 15 to 20 pounds" (1989:49). This category of waste deserves more attention since the number of cats continues to increase, and therefore national estimates of cat litter may be underestimated. In addition, cat litter can contain two dangerous parasites (*Toxoplasma gondii* and *Toxocara cati*) that can be harmful to humans.

The EPA recommends that discarded cat litter be placed into the trash. This, however, does not address the problem since the cat litter must then go somewhere. Once recycling and safe disposal options are adopted for the larger portions of our waste stream, cat litter will probably receive new attention.

Textiles

Twenty-three of the 33 residences disposed of a total of 29.3 pounds of textiles. For these 23 residences, textiles averaged 1.3 pounds. For all 33 residences the average weight of discarded textiles was 0.89 pounds or 2.16% of all residential waste. The EPA/Franklin model estimates that textiles account for 2% of MSW which would equate to roughly 4% of residential waste. Thus, our estimates may be a little under the true percentage.

Household hazardous waste

The EPA defines household hazardous waste as "products disarded from residences which contain substances already regulated under RCRA [Resource Conservation and Recovery Act] as an industrial hazardous waste" (OTA 1989:103). In this analysis, two items were found that were classified as household hazardous waste. Four of the 33 residences disposed of dry cell batteries and one residence disposed of flamable paint. Dry cell batteries may contain a variety of metals, and all flamable liquids are considered hazardous. The average weight of hazardous materials for the five residences was 2.3 pounds; the average for all 33 residences was 0.35 pounds.

National MSW Components

The results from this analysis of Orono's residential waste stream are not directly comparable to national MSW composition averages. First, the orono waste sample was drawn from residences and is best termed residential solid waste, not MSW, since MSW includes wastes from businesses and institutions. Secondly, the national MSW composition is not based on actual sampling and weighing, rather it is derived from a waste generation model.

The national MSW composition figures that are generally accepted as the most representative, are derived from the EPA/Franklin model. This model uses a "materials flow" methodology which "traces the flow of materials from production, through consumption and on to disposal" (OTA 1989:75). These EPA/Franklin estimates are presented in Table 6. Since the Orono waste stream analysis includes only residential wastes, the Orono and the EPA/Franklin data are not directly comparable.

Table 6. EPA/Franklin Model Estimates of Materials and Products in MSW

Material	Percentage of Materials by Weight
Paper and paperboard	35.6
Glass	8.4
Metals	8.9
Plastics	7.3
Rubber and leather	2.8
Textiles	2.0
Wood	4.1
Food wastes	8.9
Yard wastes	20.1
Miscellaneous inorganics	1.8

SUMMARY

This single analysis of residential wastes for the town of Orono has revealed some useful information. The overall composition of the waste stream for this analysis is listed in Table 7 and shown in Figure 2. The two largest categories are paper and food, which together constitute over half of the waste. On average, residences disposed of over 40 pounds of waste in a single week. One surprising note was the high quantity of cat litter observed. While only three of thirty-three households disposed of cat litter, it is the third largest waste category. It was also noticed that the high incidence of food wastes made it nearly impossible to salvage any clean paper from the waste for recycling, and the odor from the food wastes made it nearly unbearable to perform the sorting tasks. Clearly, for effective recycling of materials to take place, the recyclables need to be kept separate from other wastes at the household level.

Table 7. Household Waste Components from 33 Residences in Orono, Maine, September 28, 1990.

Component	Percentage by Weight	Lbs per Residence
Paper	31.15	12.82
Food	22.21	9.15
Cat Litter	9.35	3.85
Plastics	8.50	3.50
Metals	6.15	2.53
Glass	5.51	2.27
Yard and Wood	5.22	2.15
Diapers	4.65	1.92
Other	4.25	1.75
Textiles	2.16	0.89
Hazardous	0.85	0.35
Total	100.00	41.18

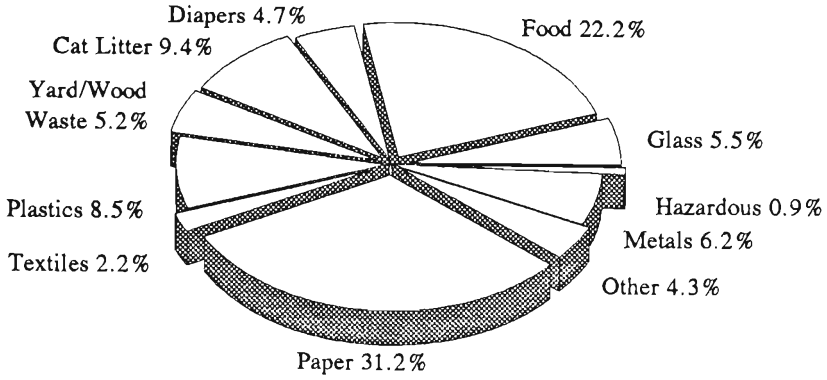

Figure 2. Household Waste Components, by weight, from 33 Residences in Orono, Maine, September 1990.

IMPLICATIONS

More waste analysis studies need to be conducted. It is unknown how the composition of waste components vary by week, season, or location. Yard and wood waste is certainly poorly represented by this single analysis. A similar analysis at the peak of fall season cleanup would exhibit a much higher quantity of leaves. An accurate assessment of the MSW composition would assist municipalities in estimating the appropriate level of recycling infrastructure and potential recycling materials and quantities.

Through this single analysis, it is obvious that much of the waste stream consists of organic materials (food, paper, yard and wood waste represent over 50% of the waste stream). Through household and/or municipal composting most of these organic materials could be properly treated and utilized. Household composting should be encouraged through education and/or incentives. Some municipalities have banned leaf and yardwaste from the waste stream, forcing alternative handling methods, usually composting, for these materials.

Many materials being disposed can be recycled. Orono has a recycling drop-off center, but it is not being used to its fullest extent since most households were disposing of recyclable materials. Undoubtly most other towns with drop-off centers have a similar participation situation. More publicity and recycling incintives could increase the amount of recycling.

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