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Household Waste Arisings in Rural Areas

A Landfill Tax Credit Scheme Project Sponsored by ABERDEENSHIRE COUNCIL

Prepared by: NICHOLAS BROOKS, TIM CURTIS, AND STEVE TAYLOR
Report No: Cordah/COR.003/04/01/2000
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Approved and authorised for issue:

Richard Hoare,
Managing Director

Tim Curtis,
Project Manager

Member of the BMT Group of Companies

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Executive Summary

In 1997 Cordah Research was sponsored by Aberdeenshire Council to conduct a study of household waste in the Deeside area. The aim of the study was to yield data on the weight and composition of refuse discarded by households, and seasonal and geographical fluctuations in waste arisings, in order to facilitate future waste management decisions and overcome the problems of Aberdeenshire's peripheral status.

The study was undertaken from July 1998 to June 1999 in Banchory and Ballater, and along a route that encompassed isolated dwellings and the small scattered settlements of Netherley and Durris. Data collection involved weighing refuse sacks and dustbins at the kerbside, once a month on each of the three sample routes. Approximately $1m^3$ of refuse was randomly selected from households to be sorted at a local landfill depot into predetermined categories. Population census statistics were used to assess the socio-economic and demographic characteristics of each route and to explain patterns and trends in the waste arisings.

More intensive surveying would make the statistical results of the project more reliable, however the data obtained provides a good indication of the trends in waste arisings.

Over the sample year the average weight of household waste per week was 18.93 kg, compared with 22.44 kg for Scotland. Monthly means fluctuated between 12.30 kg in Banchory in February and 27.47 kg on the Netherley - Durris route in September. Netherley - Durris has the highest average weight, of 23.87 kg, followed by Ballater (19.07 kg) and Banchory (15.58 kg). Ballater showed little seasonal variation in weight, while Banchory and Netherley - Durris saw a slight decrease in total waste arisings over the winter months. With regard to the composition of waste a broadly similar pattern emerged in all three of the sample areas. The categories of putrescibles, newspapers and fine waste (under 20mm) accounted for 60% of all the waste produced, with glass and mixed waste also of significance. Other categories, such as ferrous and non-ferrous metals, made up a very small proportion of the waste. Ballater and Banchory had a higher proportion of putrescibles than Netherley – Durris, while the latter had a greater percentage of mixed waste.

Reasons are suggested for the variation in the quantity and composition of household waste. If exact reasons for the variation in waste are to be fully understood, an output which was beyond the scope of this project, more detailed examination of socio-demographic and economic parameters must be undertaken. Methods for this research could include household questionnaires, targeted surveys or focus groups. The report concludes that geographic, economic and socio-demographic factors are all likely to have a significant impact upon household waste generation in rural areas.

Acknowledgements

Cordah Research are very grateful to Aberdeenshire Council for providing the Landfill Tax Credit Scheme funding to enable this project to be undertaken and for giving valuable support and assistance to the project at all stages of this project. This included the use of Council property for the compositional audit and provision of sorting equipment. In particular Cordah Research acknowledges George Niblock, Head of Waste Management at Aberdeenshire Council for his constant support during the project and for reviewing previous drafts of this report.

1 Introduction

Cordah Research was sponsored by Aberdeenshire Council to undertake a detailed analysis of the domestic waste streams in the Deeside area of Aberdeenshire. Undertaken over a period of twelve months from July 1998 to June 1999, the project entailed the weighing of household waste placed by the roadside along a series of collection routes, and the detailed analysis of the characteristics of waste arising from a random selection of these households. This report contains the presentation of these data, quantitative and qualitative analysis, and a discussion of the dominant issues. Two further reports in the series deal with the implications of these data. *Rurality and Waste* (Cordah Research, 2000a) reviews previous research into influences of household waste arisings, and examines whether 'rural' is itself a valid causal factor. In the light of an evolving waste policy agenda *Moving Waste Forward* (Cordah Research, 2000b) utilises the data generated during the research programme to formulate guidelines for a waste strategy for rural areas.

Integrated management of household waste is a relatively recent concept in the UK, prevalent especially in the last twenty years. Previously, waste was treated as unwanted, useless, and having no tangible financial value (Petts and Eduljee, 1994). There was a philosophy of *out of sight, out of mind* (Coleman, 1985). Local authorities were primarily concerned with waste disposal, at the cheapest price. However recognition of various issues has led to the entire waste system becoming an important political issue in the UK. These issues can be summarised as:

- Increases in the levels of waste production due to, for example, rising levels of affluence, increased packaging, demand for convenience products, and the advent of built-in obsolescence (Gandy, 1994);

- Increased awareness of the depletion of natural resources caused by mass consumption, and where the wastes produced by this consumption should go;

- Recognition that space in existing landfill sites is running out and supply of suitable locations for new landfill and incinerator developments is limited. This increases the cost of waste disposal (a factor exacerbated since 1996 by the imposition of the Landfill Tax);

- International obligations to fulfil EU Directives requiring higher standards of environmental protection. These include reductions in the levels of landfill and increases in recycling and waste minimisation (SEPA, 1999).

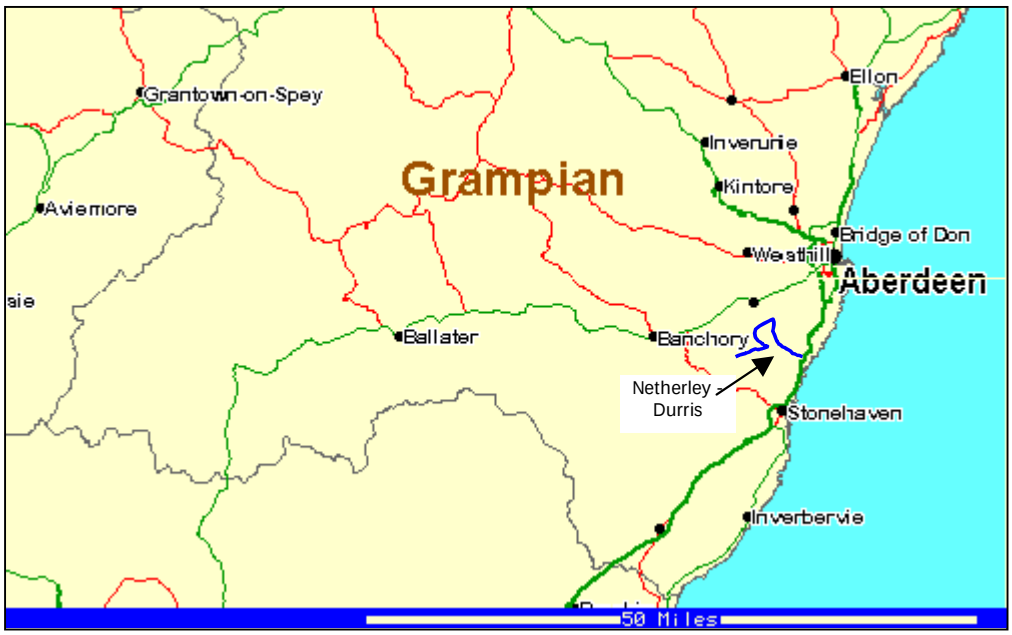
To endorse evolving waste management policies there is a need for research into the quantity and composition of waste produced around the UK. The majority of previous research has been undertaken in urban areas and therefore waste management options have been developed to deal with essentially urban waste problems.

The thesis of this investigation is that rural household waste arisings differ significantly from urban waste statistics, and that the profile of waste produced is influenced by factors applicable specifically to rural areas, such as the type of settlement and distance from municipal and retail services.

2 Objective

The project's objective was to obtain data on the yield, composition, and geographical and seasonal variation of household waste arisings from dispersed dwellings and small settlements in the rural area of Deeside in Aberdeenshire (see Figure 1). The project researched household waste arisings in rural areas to identify the extent they differ from urban waste and provide statistics to facilitate waste management planning.

Figure 1 The Study Area



Aberdeenshire is defined as a rural area by Randall (1985), as a local authority district with a population density of less than one person per hectare. Bone and Coggins (1993) identify three problems and opportunities for waste management specific to rural areas:

- Size and population density (a dispersed settlement pattern over a larger area);
- Socio-demographic characteristics (stable communities, a generally older population, high environmental awareness, community spirit and likelihood of practising home composting);
- Access (scattered households, long driveways and accessibility to waste disposal sites).

A further problem, which is of particular relevance to Aberdeenshire, concerns the minimal opportunities for economically viable recycling due to low reprocessing capacity and high transportation costs. The qualitative analysis of the data refers to these issues in the context of waste arisings in Aberdeenshire. A more detailed consideration of rural and infrastructure issues can be found in Cordah Research, 2000a and 2000b respectively.

3 Methodology

The methodology adopted aimed to yield data on the weight of refuse per household, and the characteristics of waste generated, from locations in Deeside that are representative of the different types of settlement in the area, and to statistically analyse these data. Waste from households along three Aberdeenshire Council refuse collection routes was weighed once a month, on three separate days, over twelve consecutive months. The same streets were sampled each month (these are listed in Appendix 8). This was done to ascertain the average weight of waste discarded by households in the three different sample areas. A pre-determined amount of refuse was then selected from random households and audited in order to ascertain the weights and volumes of accepted categories of waste. The following schedule was adhered to for the duration of the study:

- Monday — Netherley – Durris (average 40 houses sampled)
- Tuesday — Ballater (average 70 houses sampled)
- Wednesday — Banchory (average 80 houses sampled)

3.1 Area of Study

Three locations in the Deeside area of Aberdeenshire were surveyed:

- **Netherley - Durris.** This route covers dispersed dwellings and hamlets, running inland from Stonehaven. A number of these dwellings are newly built to accommodate commuters to Aberdeen and the land use is predominantly agricultural (Figure 2).

- **Ballater.** A village with a population of 1,582 at the time of the Census of Population, 1991 (GRO, 1995). It lies at the western end of Deeside, outside Aberdeen's travel-to-work area. A mixture of small terraced and large detached dwellings were used for the survey (Figure 4).

- **Banchory.** A small town, with a population of 6,160 (ibid.), located 19 miles west of Aberdeen on the A93, which is an established commuter settlement for the city. The survey utilised a mixture of Council-owned terraced and semi-detached houses and private semi-detached and detached dwellings (Figure 6).

Figure 2 Netherley - Durris Sample Route 1:75 000

Figure 3 Data Collection near Netherley village

Figure 4 Ballater Sample Route 1:12 500

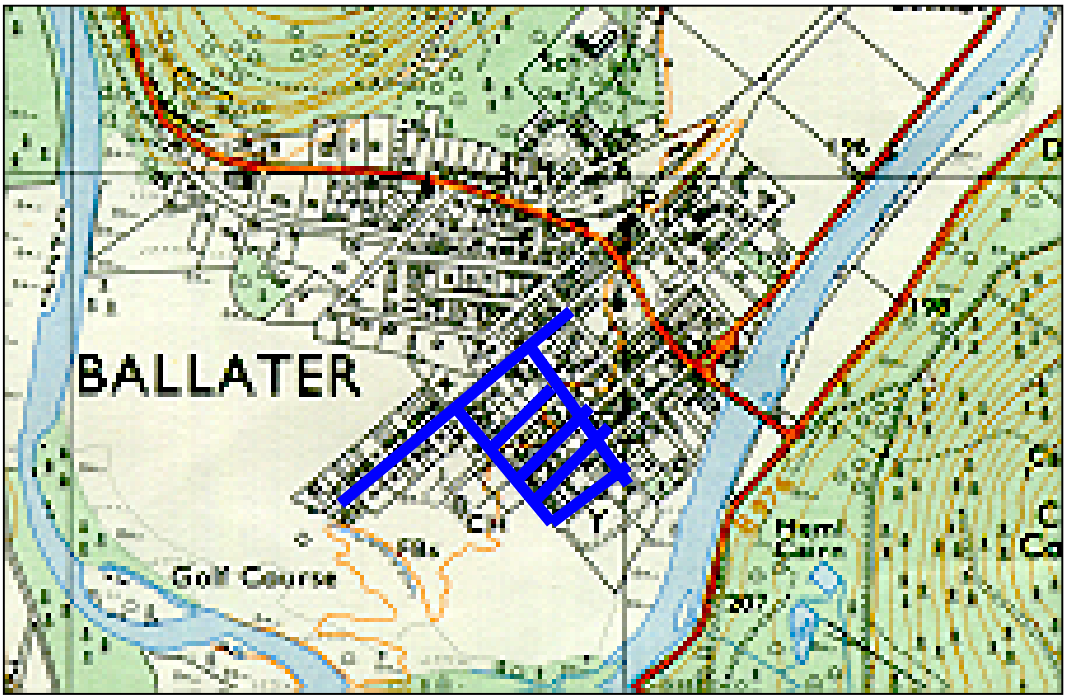


Figure 5 Weighing Refuse Sacks, Ballater

Figure 6 Banchory Sample Route 1:20 000

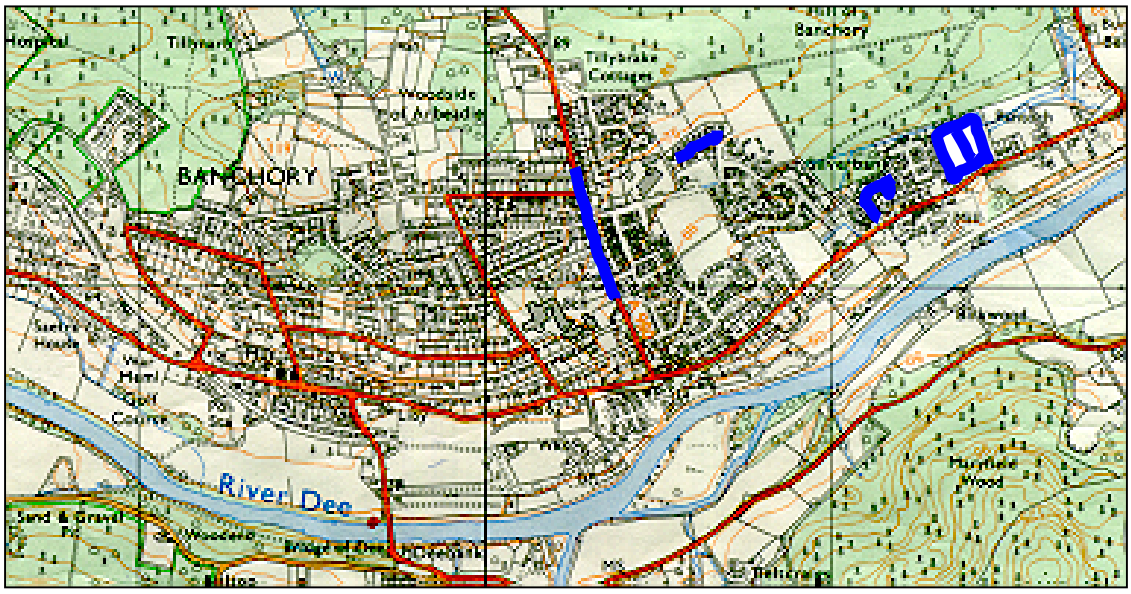


Figure 7 Weighing Waste in Plastic Bins, Banchory

3.2 Establishing Representativeness of Sample Areas

It was important to gauge the representativeness of the three sample populations (number of households) relative to the total populations (households) of the areas from which the sample was drawn (parent population), i.e. the correlation of the sampled waste collection routes compared to the rest of that part of Aberdeenshire. This estimation is necessary for two reasons:

- To allow assumptions to be drawn from the sample population concerning its surrounding area; and,

- To give confidence that future extrapolations from the data will be representative.

For these comparisons data from the 1991 Census of Population were used. These were taken from Key Statistics for Localities in Scotland and Report for Grampian Region, Part 1 (GRO, 1993 and 1995), and the Census on CD-ROM (1994).

The exact waste collection routes sampled in the Netherley-Durris area and around Ballater and Banchory were aggregated into user-defined areas of the relevant census output areas. Data concerning certain socio-demographic and economic parameters were extracted from Small Area Statistics (SAS) Census records for the user-defined areas of the three samples. These were then compared with published data for the localities of Ballater and Banchory (GRO, 1995). To estimate the socio-demographic and economic characteristics of dispersed settlements in rural areas (for comparisons with the Netherley-Durris sample), data for built-up areas over 1,000 persons were aggregated and subtracted from the Kincardine and Deeside District total, the remainder representing all settlements of under 1,000 persons. Kincardine and Deeside was used for this comparison due to the age of the Census data (pre-local government reorganisation) and to ensure a more representative characterisation of dispersed settlements similar to the Netherley-Durris sample.

The parameters chosen (see Table 1) correspond with those identified by Jones et al. (1998a & b) and Parfitt and Flowerdew (1997), as having a positive correlation with the quantity and composition of household waste arisings (for more detail see Cordah Research, 2000a). Households with pensioners were included as there is often a high proportion of elderly people in rural areas (Scottish Office, 1996a).

Table 1 Comparisons of Socio-Economic Parameters between Sample Areas and Parent Populations (Source: GRO, 1993 and 1995)

Area	Kincardine and Deeside District	Netherley-Durris sample	Rural Kincardine and Deeside	Ballater sample	Ballater	Banchory sample	Banchory
Household size (%)							
1 person	21	15	20	27	31	17	22
2 people	32	29	31	39	37	31	30
3 people	18	20	16	11	13	20	18
4 people	20	23	19	14	13	24	21
5 people	7	9	8	6	4	7	7
6 people	2	3	2	1	1	2	2
7+ people	0	1	0	1	1	0	0
Household tenure (%)							
Owned (outright or buying)	64	77	57	60	54	70	64
Rented privately	9	12	16	15	8	2	3
Rented from LA	19	1	17	15	28	27	22
Car ownership (%)							
No car	18	6	32	30	32	17	19
2+ cars	34	56	49	20	18	37	37
Households with residents aged 0-4 (%)	15	23	14	16	9	22	13
Households with pensioners (%)	21	21	20	45	40	29	24

The comparison exercise demonstrated that the sample areas in Ballater and Banchory were broadly representative of their parent populations in terms of household size and tenure, car ownership and the presence of young children and pensioners. A notable exception is that our sample area in Ballater contained a lower proportion of houses rented from the local authority than Ballater as a whole.

However, certain parameters for the Netherley - Durris sample are significantly different from rural Kincardine and Deeside as a whole. There is a 20% higher proportion of 'owner occupied' households than the parent population and houses rented from the local authority account for just 1% of households as opposed to 17%. There is also a large difference in the level of car ownership: only 6% of households do not own a car compared to 32% for the parent population. These indicators suggest a higher level of affluence in the Netherley - Durris sample, this is consistent with its location as a commuter area for Aberdeen. The significance of these differences will be discussed later in the report.

3.3 Pilot Surveys

Between February and April 1998 a pilot study was undertaken in order to develop and test the methodology and choose appropriate sample areas. Data was collected on fifteen occasions and various weighing and sorting techniques trailed. Refuse collection routes in a number of locations in Deeside were sampled.

3.4 Weighing of Waste

The objective was to weigh refuse left at the side of the road for collection, along the aforementioned routes, using a set of electronic scales accurate to 1/100 kg. The methodology aimed to:

- Collect data on the maximum number of households commensurate with the nature of the route and the timing of collection by council employees;
- Note the date, and weather conditions that may potentially affect the weight of waste;
- Weigh either refuse sacks directly, or waste in dustbins, subtracting a standardised amount to account for the weight of the bin (3 kg for a metal dustbin or ashbin, 2 kg for a plastic dustbin – ascertained from averaging bin weights during the pilot study);
- Record all weights to an accuracy of 1/100 kg;

Figure 8 Recording Weight Data, Banchory

- Note the number of households from which waste was weighed;
- Retrieve, at random, from each route, a quantity of waste to fill a $1m^3$ wooden box for sorting and classifying.

3.5 Sorting of Waste

The objective was to sort the waste into eleven categories (see Table 2), which were then weighed and an assessment made of the volume of material in each category. The equipment used was a set of electronic scales accurate to 1/100 kg, twelve 240 litre wheeled bins and a $1m^3$ wooden sorting box fitted with a 2 cm mesh lid. On return to the sorting location the following actions were undertaken:

- Removal of the collected waste from wooden sorting box;
- Emptying of small quantities of waste onto the surface of the mesh;
- Sorting the waste into nine categories, by placing the appropriate items without compaction into each wheeled bin;
- Sifting the waste so that the fines, the tenth and eleventh categories, fall through the mesh and collect in the sorting box;
- Weighing the waste in their respective categories, re-weighing the bin after emptying to give a net weight accurate to 1/100 kg;
- Weighing the fines and estimating the proportions that are organic and inorganic;

Figure 9 Sorting Waste at Crow's Nest Landfill Site, Banchory

Table 2 Categories of Waste

Material	Examples
1. Paper and card	Newspapers, card board
2. Plastic film	Shopping bags, Clingfilm, cellophane
3. Dense plastic	Plastic bottles and containers
4. Textiles	Clothes, carpet
5. Glass	Bottles and jars (without lids)
6. Non-ferrous metals	Drinks cans, aluminium foil
7. Ferrous metals	Cans, scrap metals
8. Putrescibles	Miscellaneous biodegradable matter
9. Mixed/unclassified	Cigarette packets, batteries
10. Compostable fines	Material < 2 cm, such as grass cuttings
11. Non-compostable fines	Material < 2 cm, such as ash

These categories differ from the classification schemes devised by Warren Spring Laboratory and MEL Research by looking at compostable rather than combustible waste. Data concerning compostable waste arisings is currently more valuable for the planning of waste management in Aberdeenshire as the feasibility of central composting facilities is being researched by the Council (Carolynn Michie, personal communication, 31st May 1999).

3.6 Statistical Analysis

3.6.1 Analysis of Total Waste Arisings

Total weight data collected monthly in each sample area have been averaged to highlight spatial and temporal differences. To assess the monthly distribution of weight values in the different areas the standard deviation, variance and standard error were calculated. These allowed the lower and upper values for future predictions of total weight to be calculated to 95% and 99% confidence levels (the probability that the sample weight will be between the lower and upper value brackets).

3.6.2 Analysis of the Composition of Waste Arisings

The data relating to the composition of the waste have been analysed by the percentage weight of the total sample collected for sorting. Comparisons have been undertaken to assess strength of seasonal patterns and differences in composition between the three sample areas. The relative importance of different categories of waste has been emphasised by ranking.

3.6.3 Comparative Analysis with Scottish Office Data

It was also important to compare the data from the sample Aberdeenshire areas with published national statistics from the Scottish Office (1996b) to analyse similarities or differences in the total weight and composition of waste produced per household. The comparison entailed graphical presentation and basic statistics. The averages for the sample areas have been statistically compared to the national data using t-tests. This basic statistical test is used to assess the difference between two groups of data. The results from the procedure show the significance of the differences between the sample areas and Scotland as a whole.

3.7 Data Constraints

A number of factors constrained the data collected:

- This report was concerned only with household waste put out for collection in dustbins or plastic sacks, similar to the methodology adopted by the National Household Waste Analysis Programme. It must be noted that in general up to one third of household waste is collected by means of outlets other than local authority house-to-house collection rounds (such as Civic Amenity Sites, street cleansing and bulky waste collections) (Parfitt and Flowerdew, 1997). (Note: in Aberdeenshire this may not be as relevant as elsewhere; there are no special collections and there is a low level of use of Civic Amenity Sites (personal communication, George Niblock), thus almost all waste is collected by the weekly refuse collections);

- There were differences in the sample size between the different locations. The settlements of Ballater and Banchory have a concentration of population and it was therefore possible for a large number of households to be included in the study. The low population density of Netherley-Durris dictated that a smaller number of households were able to be surveyed before refuse was collected by council workers;

- Within each route fluctuations existed in the quantity of households sampled, due to factors which were beyond the control of the research team; for example, people

putting out their refuse later in the day or poor weather dictating that refuse was not left out at all;

- The rural nature of the collection locations meant that in some instances refuse from a number of households was placed together at the side of the road. If the houses were visible and the field team were reasonably able to distinguish between waste from each household then it was weighed per household accordingly. Where it was not possible to identify the source of the waste, these locations were skipped.

3.8 Ethical Issues

Any research project which collects data that is of a personal nature (such as household waste) must consider the ethical issues involved, and attempt to adapt the methodology to limit potential harm. The key ethical question for this research was whether to inform the residents living in the sample areas whether their waste was going to be analysed. The arguments for and against this can be summarised as:

- **For**: basic politeness; prevents any misunderstanding as to what is happening to householder's waste.

- **Against**: residents may specifically alter their pattern of waste arisings (increase or decrease); communication would have been a costly operation.

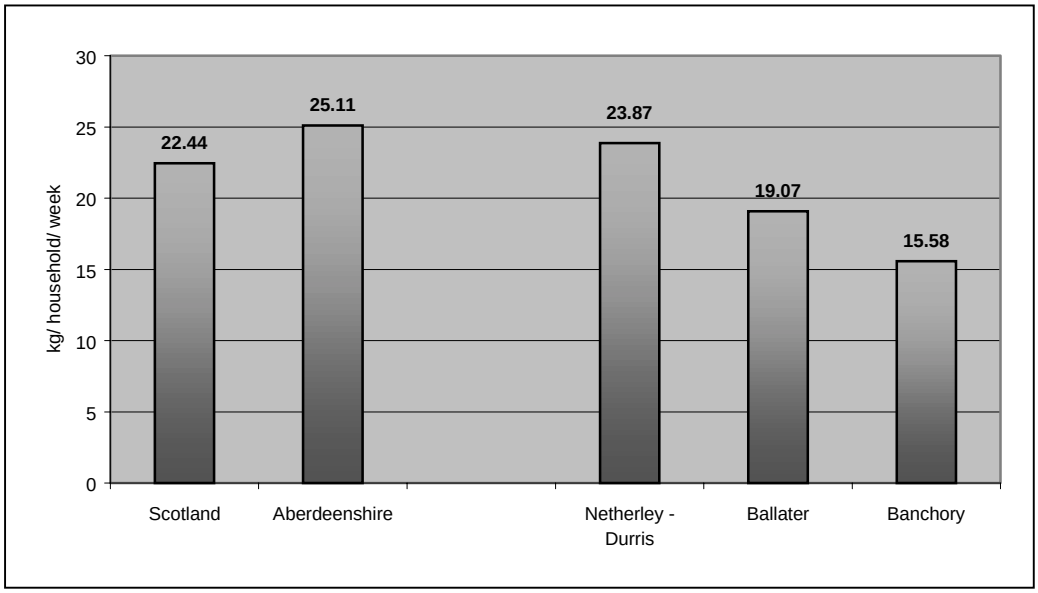
After careful consideration and consultation of similar methodologies (see Cordah Research, 1999a) it was decided not to inform householders. Instead a formal authorisation letter from the Head of Waste Management at Aberdeenshire Council was carried at all times. This was usually adequate to satisfy enquires from the public.

4 Summary of Results

4.1 Weight Data

The mean weight of household waste was highest for the Netherley - Durris sample route (23.87 kg) followed by Ballater (19.07 kg) and Banchory (15.59 kg) (Figure 10). Households surveyed on the Netherley - Durris route occasionally discarded very heavy items of waste, such as furniture or kitchen appliances. The weight of waste arisings in the Netherley - Durris sample area was most similar to the figure for Scotland as a whole (22.44 kg) (Scottish Office, 1996b). This was confirmed by the t-test results for sample months (August, November, February and May), the results for Netherley - Durris ranging from 0.474 to 0.558[1]. The results for Ballater (between 0.025 and 0.246) and Banchory (from 0 to 0.003) showed that waste arisings in these locations were significantly lower than the Scottish mean (Appendix 3).

Figure 10 Comparison of Household Waste Arisings in the 3 Study Areas with Scottish Office Figures.



(source: SO, 1996b) (* Data for Aberdeenshire is the 1994 average for Kincardine and Deeside, Banff and Buchan and Gordon Districts summed)

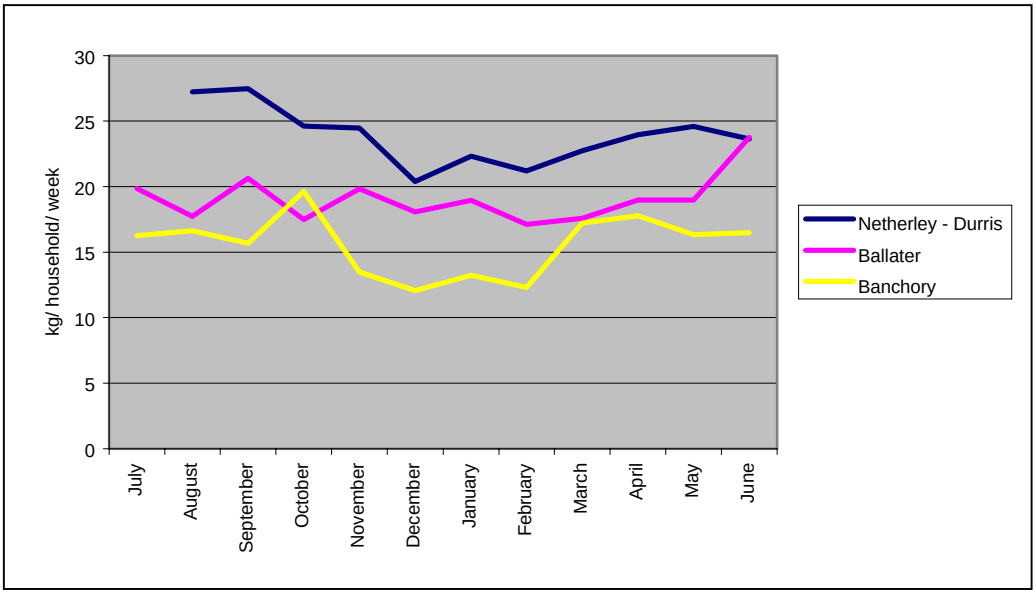
[1] Note: the value will be in the range from -1 to 0 to 1; a value of between -0.05 and 0.05 indicates a significant difference in the averages of the two data sets. Conversely a value of + or - 0.95 shows no significant difference between the data. This assumes the standard confidence levels of 95%.

Figure 11 shows the seasonal variation in mean weight of arisings for the three sample areas. Relative positions were constant throughout the year; indicating seasonality is not the predominant factor causing variations in mean weight of waste between the sample areas.

Netherley - Durris and Banchory display marked seasonal variation, with a general decreasing trend during the winter and lowest mean weight of arisings in December (20.39 kg and 12.07 kg respectively). Ballater had its lowest mean in February (17.10 kg) although the general trend of winter decrease is less pronounced. Highest means for Netherley - Durris (27.47 kg) and Banchory (19.63 kg) were in the autumn (September and October respectively) while Ballater peaks in June (23.75 kg). This degree of seasonal variation is less marked than is generally experienced by Aberdeenshire Council (George Niblock, personal communication), however this study could not identify the reason for this inconsistency.

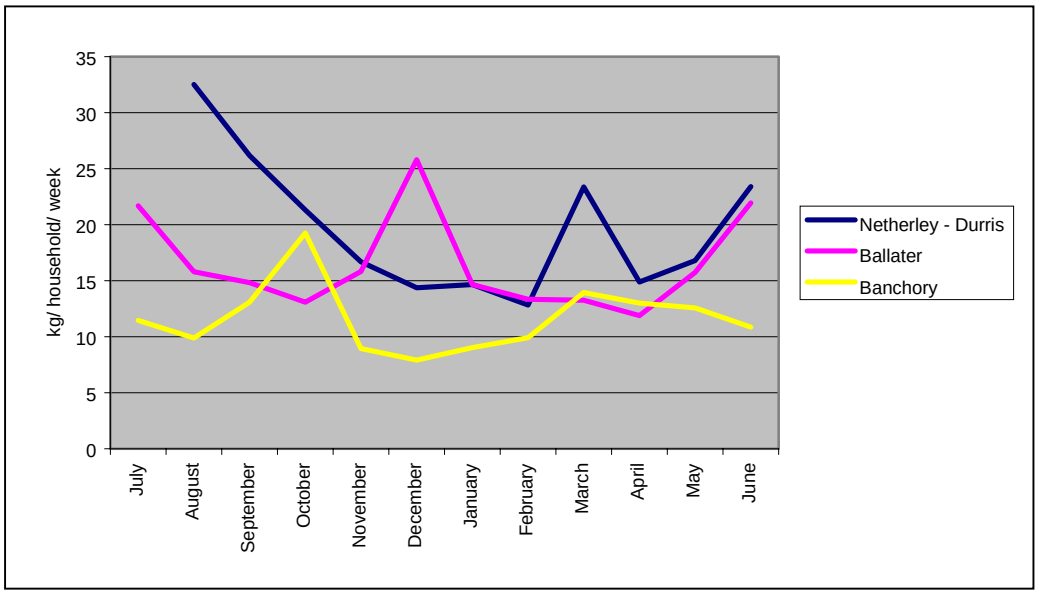
Monthly data collection did not permit more detailed temporal analysis, for example the effect of public holidays on waste arisings. However, the slight increase in mean arisings for all areas in January could be associated with the Christmas break. The significant rise in Ballater's mean weight in June could be due to large quantities of garden waste being discarded (see Section 4.2).

Figure 11 Variation in Mean Waste Arisings



The degree of variation around the mean is shown by Figure 12. The standard deviations vary dramatically over the year. It further demonstrates the significance of outlying results in affecting sample statistics; with these removed the standard deviations are dramatically reduced. It should be noted that the standard deviation is inversely related to the size of the sample (which was smaller for Netherley - Durris). The variability in data could also be related to the relatively low intensity of sampling (monthly). More intensive sampling may help to reduce this variability.

Figure 12 Average Monthly Standard Deviations



95% confidence intervals for weight of waste have been calculated and are shown in Appendix 5. Inevitably the confidence interval for all sample areas has some seasonal variation, however this is minimal. More importantly, the confidence interval range is lower (and thus more accurate) for Banchory (average 13.12 kg - 18.05 kg), and to a certain extent Ballater (15.13 kg - 23.00 kg), than Netherley - Durris (17.40 kg - 30.14 kg). The confidence intervals have also been calculated with outlying results removed. These results show a smaller, more accurate range, especially for Netherley - Durris; the confidence interval fell to 17.77 kg - 25.82 kg.

Figures 13-15 show the frequency distributions for individual weight values for each sample area. All distributions are positively skewed; i.e. weight for the majority of households was less than the mean. These findings are consistent with other household waste arisings research which has calculated frequency distribution (see Cordah Research, 2000b) and show the influence of households which occasionally generate large quantities of waste. Table 3 supports these findings; the median for each sample area is significantly lower than the mean. The median could be more useful for waste planning as it is more representative than the mean (although it has not been used as a headline indicator in this study to ensure comparability with other research). The skewness statistic is also shown; values of greater than 0 demonstrating positive skewness.

Table 3 Sample Statistics for Weight of Waste

	Netherley – Durris	Ballater	Banchory
Lower quartile	11.99	8.27	7.58
Median	18.63	14.68	12.06
Upper quartile	29.36	24.24	19.68
Skewness	3.1	3.45	2.34
Mean	23.87	19.07	15.58

Figure 13 Frequency Distribution for Netherley – Durris (1*140 kg and 2 *163 kg omitted)

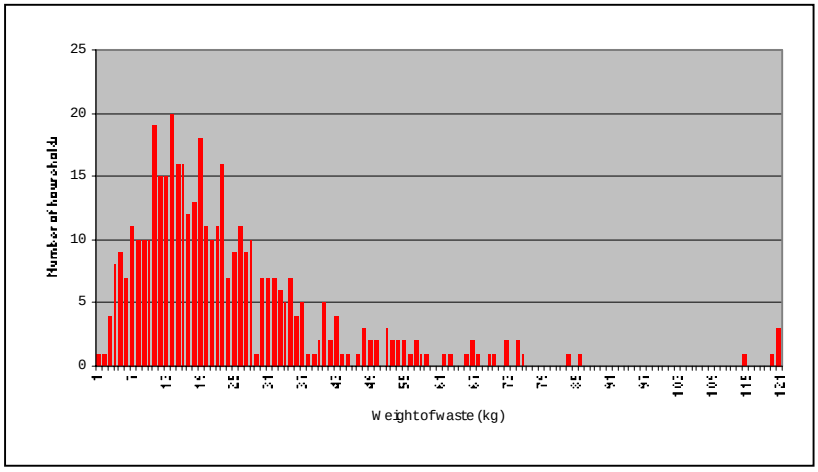


Figure 14 Frequency Distribution for Ballater (1*203 kg and 1 *158 kg omitted)

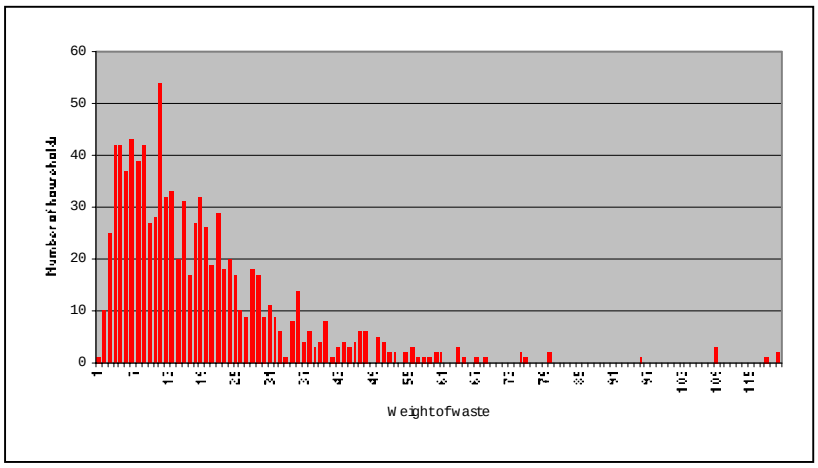
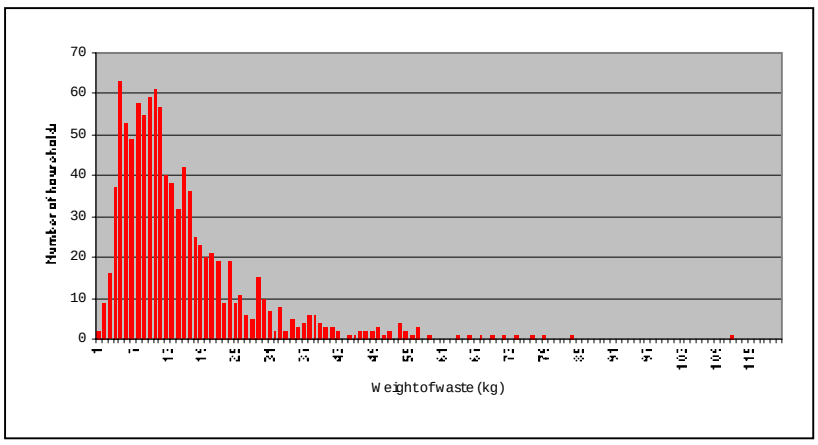


Figure 15 Frequency Distribution for Banchory

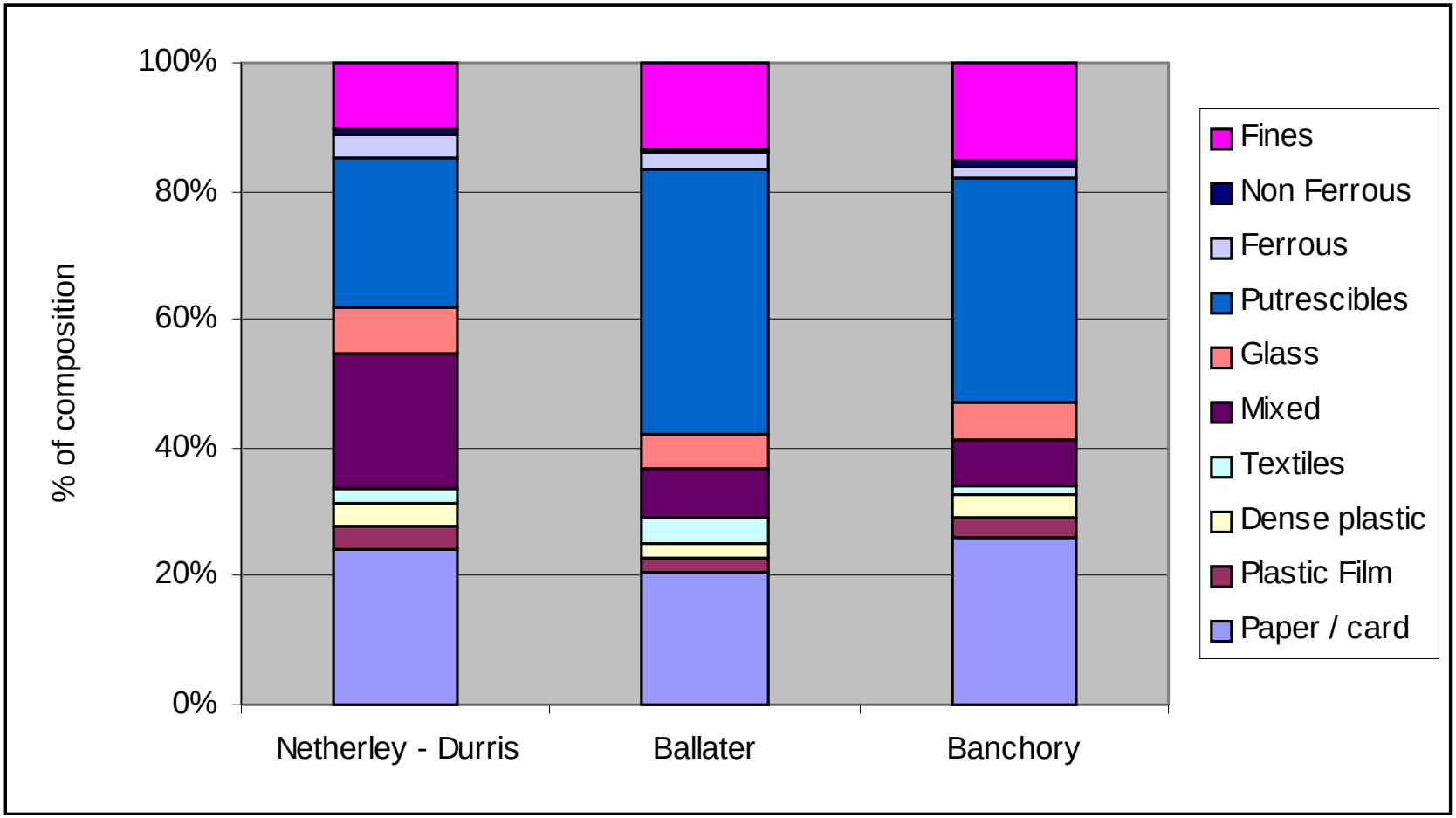


4.2 Compositional Data

Compositional data for each sample area has been analysed by mean percentage of composition and mean weight per category. Figure 17 shows the mean percentage of composition of waste. For all sample areas compositions are broadly similar; putrescible and paper/ card dominate, miscellaneous and fine waste are also significant. Ballater generated the highest quantities of putrescible waste (41.29%), while Banchory had 35.01%. These levels could be due to the large gardens in these sample areas. However, this does not explain why Netherley - Durris has less putrescible waste (approximately 20% lower than Ballater) unless the greater predominance of farms accounts for less focus on gardening. The higher proportion of waste classified as miscellaneous in Netherley - Durris (21.02%) could be attributed to the frequent occurrence of child-related waste (e.g. nappies) in the audited waste (24% of households on this route have children aged 0-4 according to the 1991 Census). A second possible explanation could be the occasional presence of household appliances in the waste stream (possibly linked to the affluence of Netherley - Durris households). Categories of waste that made up low proportions of the total composition, including plastic, textiles, glass and metals, showed little variation between the sample areas.

Comparison of compositional data for the three samples with national statistics (Scottish Office, 1996b) using t-tests shows that a large number of categories are significantly different (at the 95% confidence level) (Appendix 7). Plastic film is significantly different for all three sample areas with values of 0.010, 0.001, and 0.003 in Netherley - Durris, Ballater and Banchory respectively, whilst ferrous and non-ferrous metals are significantly different in two sample areas. On the other hand textiles (in Ballater; 0.941), paper/card (Banchory; 0.659) and glass (Netherley - Durris; 0.780) show little difference from the Scottish average.

Figure 16 Mean Composition of Waste in the Sample Areas



Monthly variation in the composition of waste has been plotted for each sample (Figures 17-20). All sample areas have a definite trend of decreasing composition of putrescible wastes during the winter months. This trend is reversed for the popular gardening seasons: late spring and early summer (May for Netherley - Durris and April and June for Ballater and Banchory); and to a lesser extent late autumn. There are also random compositional fluctuations, the reasons for these are less clear, for example, 45.53% of miscellaneous in Netherley - Durris in December and 56.66% paper/card in Banchory in February. These variations are probably caused by the dominant presence of a certain category in the sample of waste collected for audit. This highlights the problem of sampling a small number of households. Analysis of categories make up a small proportion of waste also reveals fluctuations which cannot be credited to specific factors. Again, this variation is attributed to the collection of sample waste from a small number of houses. Proportions of glass, ferrous and non-ferrous metals, and textiles all vary by more than 5% in certain months. Plastic film and dense plastic are consistent throughout the year in all sample areas, this is likely to be due to the consistent nature of use of these products (for example, plastic shopping bags).

Figure 17 Monthly variation in waste composition; Netherley - Durris

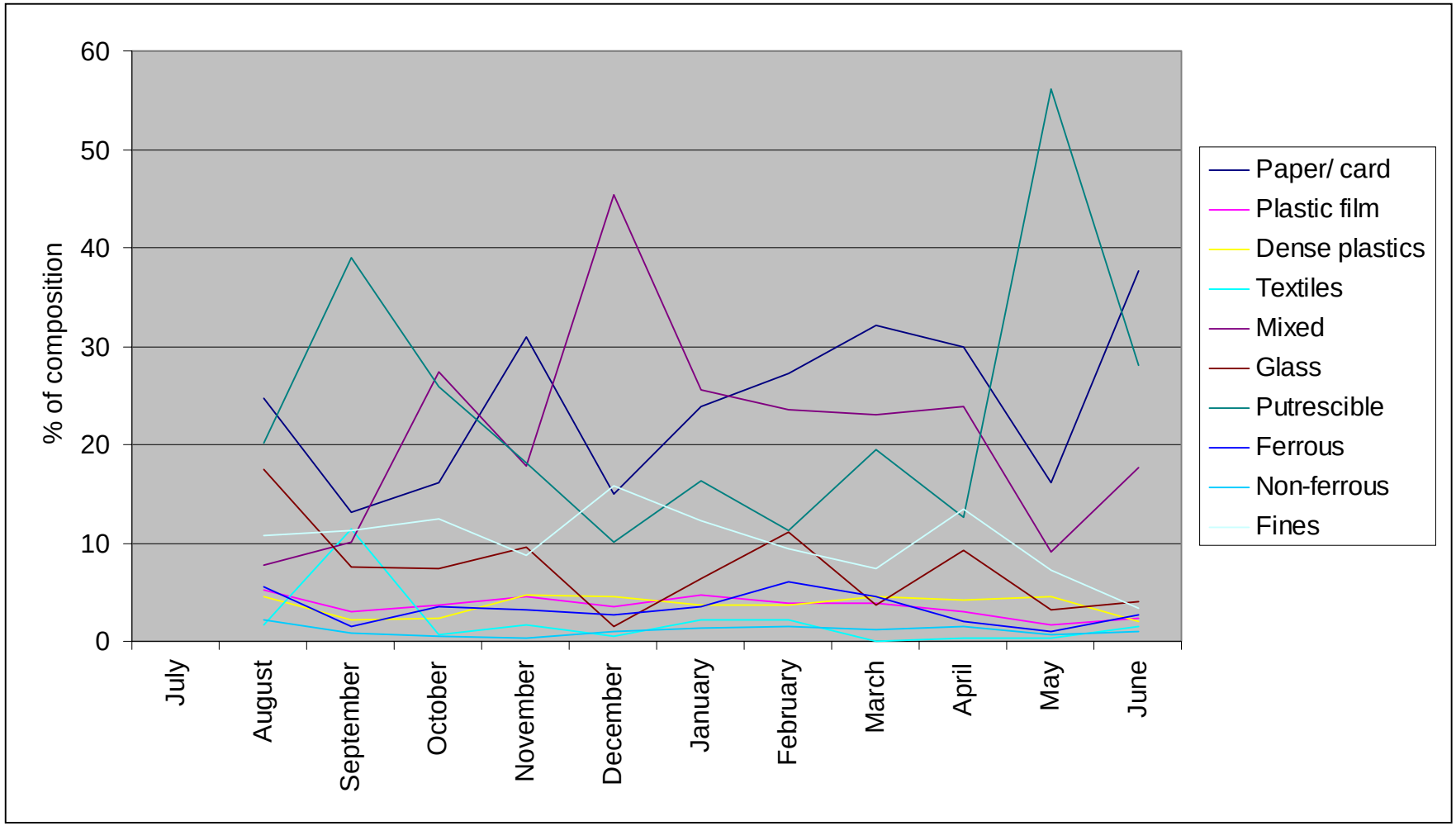


Figure 18 Monthly variation in waste composition; Ballater

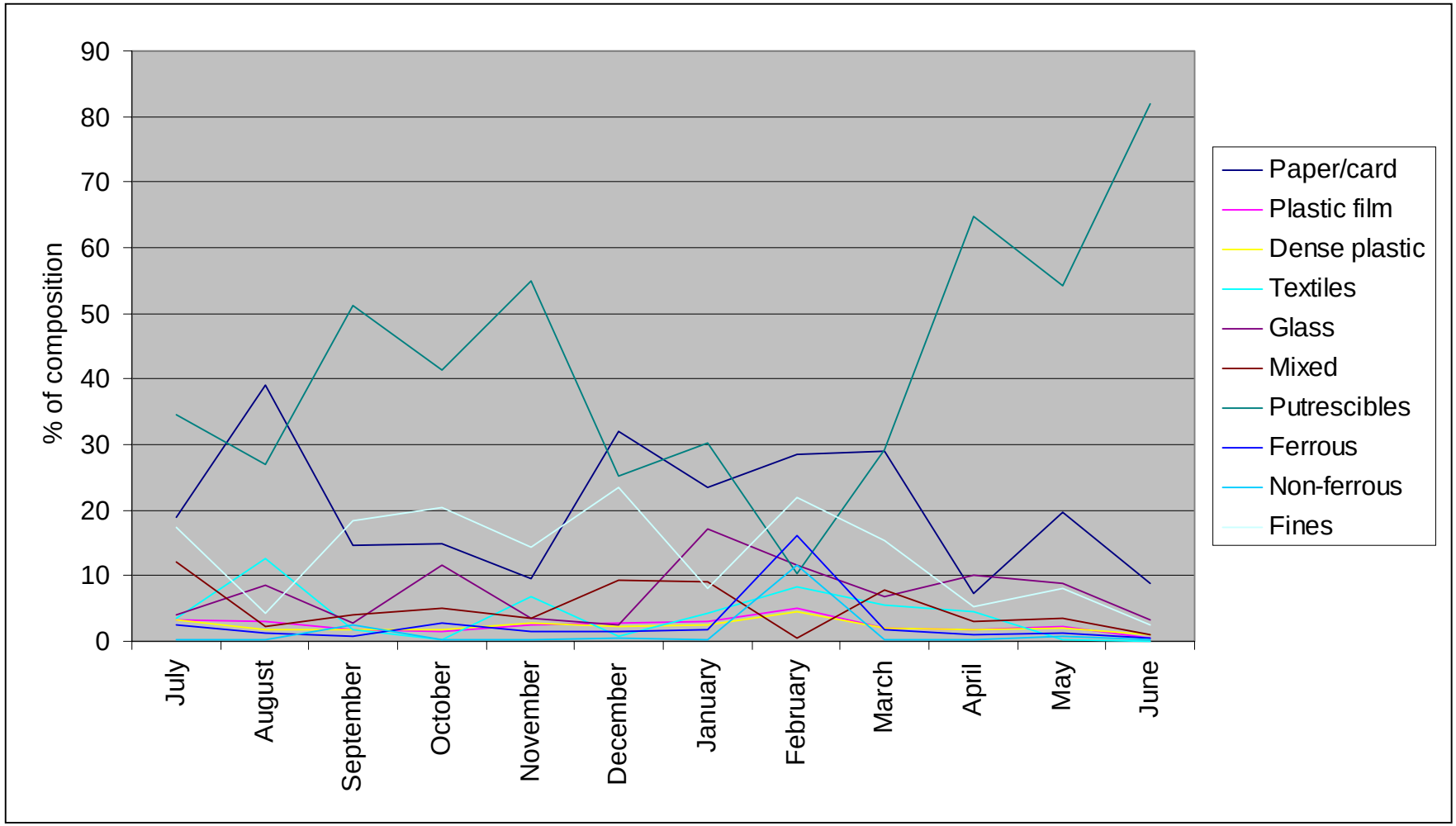
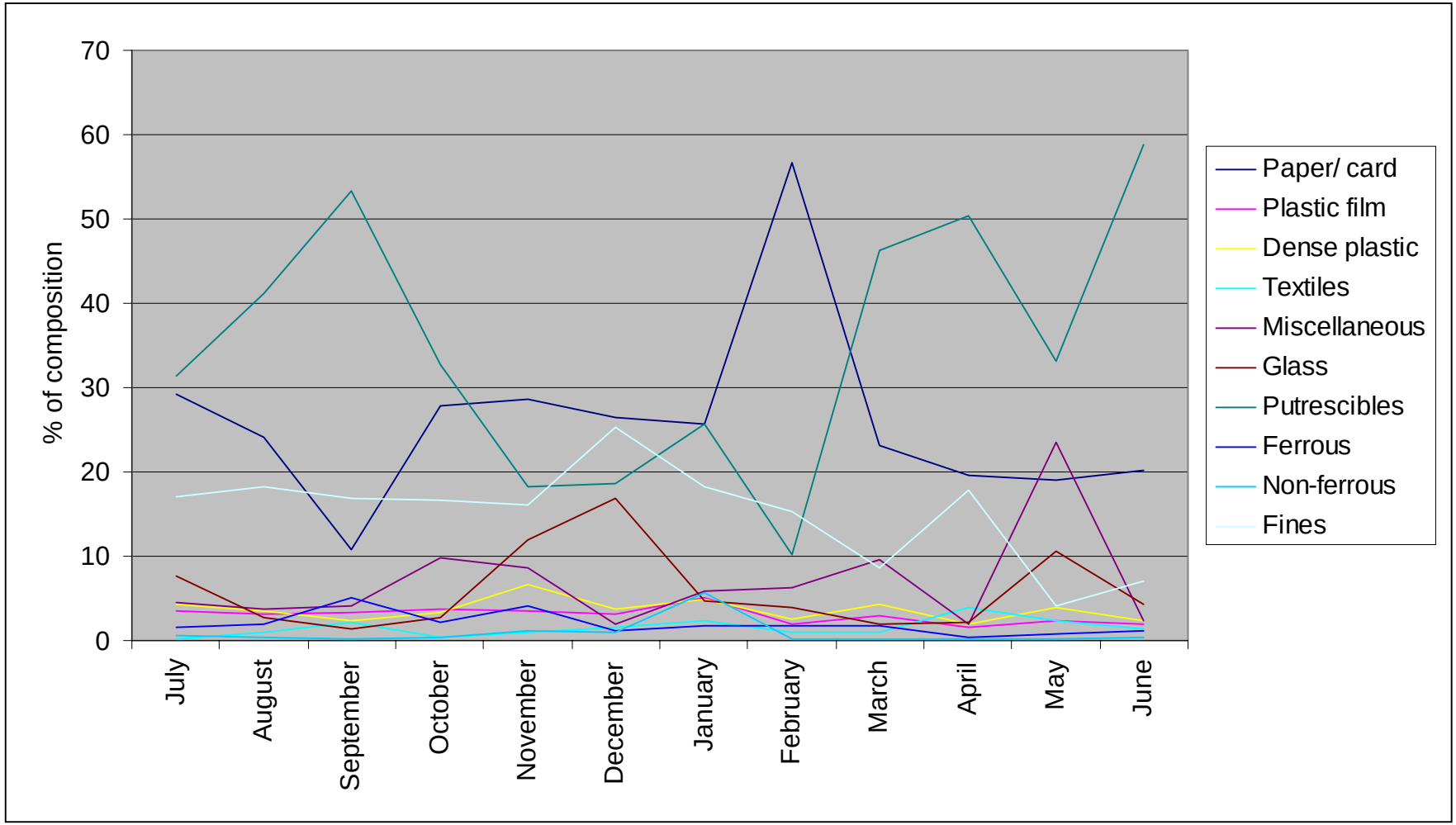


Figure 19 Monthly variation in waste composition; Banchory



5 Discussion and Conclusions

While there is a broadly similar pattern of household waste production across the three sample areas, it is apparent that there are both significant differences and minor sub-patterns in the weight and composition of arisings. These are:

- The average weight of household waste was higher in Netherley - Durris and Ballater than in Banchory; this is consistent with the presence of large and bulky arisings in these areas. It was observed that waste placed for collection along the Netherley - Durris route occasionally contained large household appliances such as fridges or beds, while in Ballater a high proportion was formed by garden waste (see below). It is suggested that this is because both of these sample areas are some distance from a Civic Amenity Site, while the residents of Banchory have the use of a local site at Crow's Nest Landfill.

- There was a much greater proportion of organic material in the waste produced by households in Ballater and Banchory. It is suggested that this correlates with the large gardens found in these locations. The difference (of 6%) between Ballater and Banchory could be attributable to the presence of a Civic Amenity Site in Banchory providing an alternative outlet for bulky garden waste (although it is reported that this site has low levels of utilisation (George Niblock, personal communication). The smaller proportion of putrescibles on the Netherley - Durris route suggests that dispersed settlements are more likely to compost such matter (Bone and Coggins, 1993).

- On the Netherley - Durris route there was a much higher proportion (21.02%) of mixed waste than in Ballater and Banchory. This category was 114% higher than the Scottish average (Scottish Office, 1996b). It was observed that Netherley - Durris had a large amount of waste that could be associated with affluence and/or the presence of small children, for example small household appliances, batteries, toys and nappies. All these are categorised as mixed waste.

- Newspapers contributed a lower percentage of the waste in Netherley - Durris. This could be explained by the comparative inaccessibility of rural households to shops dictating less opportunity to buy newspapers locally, fewer hand-delivered free newspapers or a higher number of open-fires in these homes.

- The results show that households in the Netherley - Durris area also produced less fines than in Ballater and Banchory. Again this may be due to the greater composting of organic material or differing attitudes towards gardening in rural

areas, and the reuse of inorganic material, for example ash as a fertiliser. There is no discernible pattern in the composition of the fines to explain differences between the three sample areas.

- A greater proportion of glass and ferrous and non-ferrous metals was produced in Netherley - Durris. Although the differences are not great, this is consistent with the lack of opportunity for the local recycling of these materials.

It has been observed that the study area generally produces less household waste than the Scottish average, a figure largely measured in urban areas, as 71% of the Scottish population was described as urban by Randall (Scottish Office, 1996b). The exception is the sample route covering Netherley - Durris which has the highest degree of correlation with the national average. This shows that certain indicators of rurality such as the isolation of settlements or the presence of agricultural land use do not necessarily have the principal impact on the amount of waste produced, but may be a contributory factor for certain types of waste arisings, such as bulky items. Just as influential are certain socio-demographic and economic factors, such as a younger population (fewer pensioners and more young children), greater affluence (higher car ownership and more owner-occupiers), and the proximity of Aberdeen encouraging a more urban lifestyle among the high proportion of commuters living in the area.

Households in Ballater and Banchory both produced significantly less waste than the Scottish average. In Ballater it is suggested that rurality in terms of distance to large towns and services such as supermarkets and Civic Amenity Sites could well be an influential factor determining the amount of waste produced, as residents lead less of an urban lifestyle. However, the importance of socio-demographic indicators must also be observed: Ballater has a high percentage of elderly residents (the sample area is comprised of 45% pensioners) and lower rates of car ownership and owner-occupancy suggest a less affluent population.

In Banchory the average weight of waste produced was significantly lower than the Scottish average and the lowest of the sample areas. However, it would be hard to describe the residents of Banchory as leading a rural lifestyle: there is a population of over 6000, a supermarket, and Aberdeen is less than 30 minutes drive on a main road. The main differences in waste production in Banchory was a 6% lower proportion of putrescible wastes than Ballater and less observed disposal of bulky items. It is suggested that this is due to the easy access to a Civic Amenity Site in the town. Again, socio-demographic factors must also be regarded; Banchory has lower affluence in terms of car ownership than the Netherley - Durris sample. However socio-demographic and economic factors cannot explain all differences; Banchory has a similar pattern of tenure and household size to Netherley – Durris, but significant differences in waste arisings.

To conclude, the sample areas in Aberdeenshire generally produce a lower weight of household waste than the national average. To understand this difference it is necessary to examine socio-demographic and economic factors and the geographic characteristics of the rural area concerned. These factors are also responsible for the differing composition of waste within Aberdeenshire, however quantification of this variation has not been possible. If exact reasons for the variation in waste between sample areas are to be fully understood, an output which was beyond the scope of this project, more detailed examination of socio-demographic and economic parameters must be undertaken. Methods for researching this could include household questionnaires, targeted surveys or focus groups. Such an understanding would then allow socio-demographic, economic and geographic attributes to be taken into account in waste management planning in Aberdeenshire.

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Appendices

Appendix 1: Average Monthly Weight (kg/household)

	Netherley - Durris	Ballater	Banchory
Average	**23.87**	**19.07**	**15.58**
July	N/A	19.85	16.26
August	27.24	17.71	16.61
September	27.47	20.64	15.66
October	24.61	17.47	19.63
November	24.47	19.83	13.48
December	20.39	18.06	12.07
January	22.34	18.94	13.23
February	21.20	17.10	12.30
March	22.72	17.58	17.20
April	23.95	18.98	17.78
May	24.59	18.96	16.32
June	23.62	23.75	16.46

Average weight across all 35 collections 18.93

Appendix 2: Average Monthly Standard Deviation (kg)

	Netherley - Durris	Ballater	Banchory
July	N/A	21.68	11.46
August	32.52	15.81	9.89
September	26.18	14.83	13.10
October	21.32	13.10	19.25
November	16.70	15.83	8.94
December	14.36	25.80	7.92
January	14.67	14.65	9.03
February	12.82	13.35	9.92
March	23.36	13.25	13.95
April	14.90	11.89	13.01
May	16.79	15.73	12.58
June	23.40	21.93	10.86

Appendix 3: T-Test Results for Waste Arisings

	Average weight (kg)	T-test score
Scotland*	**22.44**	
Netherley - Durris	**23.87**	
Ballater	**19.07**	
Banchory	**15.58**	
Netherley-Durris August	27.24	0.474
Netherley-Durris November	24.47	0.566
Netherley-Durris February	21.20	0.558
Netherley-Durris May	24.59	0.526
Ballater August	17.71	0.067
Ballater November	19.83	0.246
Ballater February	17.10	0.025
Ballater May	18.96	0.106
Banchory August	16.61	0.003
Banchory November	13.48	0.000
Banchory February	12.30	0.000
Banchory May	16.32	0.002

* Source: Scottish Office (1996b)

Appendix 4: Confidence Levels for Waste Arisings (kg)

	Netherley - Durris			Ballater			Banchory		
	Average	Lower (95%)	Upper (95%)	Average	Lower (95%)	Upper (95%)	Average	Lower (95%)	Upper (95%)
July	N/A	N/A	N/A	19.85	14.81	24.89	16.26	13.61	18.91
August	27.24	15.19	39.29	17.71	13.62	21.80	16.61	14.29	18.93
September	27.47	19.65	35.29	20.64	17.47	23.81	15.66	12.92	18.40
October	24.61	17.65	431.59	17.47	14.40	20.54	19.63	15.44	23.82
November	24.47	19.01	29.93	19.83	16.01	23.65	13.48	11.57	15.39
December	20.39	15.56	25.22	18.06	11.74	24.38	12.07	10.45	13.69
January	22.34	16.47	25.93	18.94	15.00	22.88	13.23	11.36	15.10
February	21.20	17.23	25.17	17.10	13.32	20.88	12.30	10.23	14.37
March	22.72	15.29	30.15	17.58	14.65	20.35	17.20	14.53	19.87
April	23.95	19.55	28.35	18.98	16.27	21.69	17.78	15.15	20.40
May	24.59	19.39	29.79	18.96	15.55	22.37	16.32	13.69	18.93
June	23.62	16.37	30.87	23.75	18.75	28.75	16.46	14.18	18.74

Appendix 5: Average Composition of Household Waste (%)

	Average	Netherley - Durris	Ballater	Banchory
Paper and Card	23.56	24.26	20.43	25.99
Plastic Film	3.03	3.59	2.48	3.02
Dense Plastic	3.24	3.75	2.30	3.66
Textiles	2.56	2.05	4.11	1.52
Mixed	11.82	21.02	7.57	6.87
Glass	6.13	7.38	5.11	5.91
Putrescibles	33.22	23.37	41.29	35.01
Ferrous metals	2.68	3.30	2.75	1.99
Non-Ferrous Metals	0.88	1.08	0.66	0.91
Fines	12.88	10.20	13.30	15.13

Appendix 6: Monthly Composition Data (average %)

	Paper and Card	Plastic Film	Dense Plastic	Textiles	Mixed	Glass	Putrescibles	Ferrous metals	Non-Ferrous Metals	Fines	Fines (% organic)
Netherley – Durris											
July	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
August	24.66	5.22	4.58	1.67	7.71	17.54	20.17	5.50	2.22	10.73	85
September	13.11	3.09	2.26	11.39	10.09	7.53	39.05	1.45	0.84	11.20	90
October	16.08	3.71	2.29	0.73	27.42	7.36	25.87	3.57	0.51	12.46	30
November	31.00	4.52	4.77	1.76	17.89	9.61	18.13	3.16	0.41	8.74	90
December	15.01	3.48	4.59	0.48	45.43	1.59	10.10	2.65	0.94	15.75	30
January	23.89	4.75	3.77	2.13	25.63	6.47	16.32	3.47	1.30	12.29	90
February	27.23	3.83	3.77	2.25	23.56	11.16	11.21	6.08	1.45	9.47	60
March	32.18	3.94	4.60	0.04	22.99	3.62	19.45	4.60	1.18	7.41	50
April	29.89	2.98	4.19	0.30	23.82	9.24	12.63	2.08	1.49	13.39	60
May	16.14	1.71	4.49	0.36	9.09	3.13	56.08	1.04	0.65	7.31	50
June	37.64	2.31	1.98	1.48	17.61	3.95	28.02	2.67	0.93	3.40	80
Ballater											
July	18.97	3.35	3.27	3.56	4.07	12.11	34.49	2.51	0.22	17.44	98
August	39.01	3.03	1.84	12.61	8.54	2.27	26.91	1.32	0.30	4.17	95
September	14.59	1.80	1.83	1.88	2.72	4.12	51.21	0.83	2.56	18.47	90
October	14.94	1.48	1.86	0.32	11.5	5.15	41.23	2.80	0.29	20.43	5
November	9.68	2.59	2.83	6.88	3.50	3.53	55.01	1.46	0.25	14.27	50
December	31.97	2.78	2.15	0.69	2.51	9.29	25.14	1.46	0.60	23.43	50
January	23.46	3.13	2.48	4.23	17.23	9.12	30.29	1.71	0.16	8.17	60
February	28.44	4.96	4.63	8.43	11.67	0.53	10.34	16.24	11.67	21.94	40
March	29.02	2.06	2.13	5.67	6.80	7.77	29.12	1.67	0.35	15.39	60
April	7.26	1.72	1.76	4.60	10.09	2.99	64.81	1.12	0.30	5.37	40
May	19.76	2.25	1.99	0.34	8.90	3.46	54.15	1.20	0.70	7.99	30
June	8.82	0.62	0.89	0.07	3.37	1.00	81.93	0.62	0.19	2.50	30
Banchory											
July	29.23	3.50	4.36	0.10	4.55	7.70	31.35	1.56	0.63	17.01	85
August	24.21	3.05	3.51	1.03	3.70	2.74	41.08	1.97	0.48	18.24	90
September	10.83	3.38	2.36	2.25	4.03	1.43	53.39	5.17	0.21	16.95	90
October	27.85	3.74	3.42	0.31	9.81	2.72	32.76	2.16	0.49	16.73	35
November	28.60	3.62	6.58	0.89	8.71	11.87	18.22	4.03	1.26	16.12	40
December	26.51	3.15	3.72	1.63	2.05	16.9	18.60	1.16	0.97	25.29	50
January	25.73	5.01	4.89	2.35	5.84	4.65	25.73	1.82	5.72	18.26	75
February	56.66	2.03	2.62	0.97	6.26	3.87	10.26	1.81	0.14	15.37	50
March	23.23	2.96	4.26	0.98	9.62	2.05	46.23	1.75	0.22	8.69	40
April	19.68	1.49	1.88	3.94	1.95	2.06	50.47	0.47	0.27	17.78	30
May	18.99	2.29	3.99	2.42	23.49	10.57	33.14	0.81	0.21	4.09	70
June	20.14	1.97	2.33	1.39	2.41	4.32	58.90	1.19	0.32	7.04	75

*Source: Scottish Office (1996b)

Appendix 7: T-Test Results for Composition Data

	Scotland	Netherley - Durris		Ballater		Banchory	
	Average composition (%)	Average composition (%)	T-test score	Average composition (%)	T-test score	Average composition (%)	T-test score
Paper and Card	27.00	24.26	0.269	20.43	0.045	25.99	0.659
Plastic Film	6.20	3.59	0.010	2.48	0.001	3.02	0.003
Dense Plastic	4.10	3.75	0.061	2.30	0.000	3.66	0.054
Textiles	4.10	2.05	0.072	4.11	0.941	1.52	0.000
Mixed	9.80	21.02	0.004	7.57	0.346	6.87	0.261
Glass	7.90	7.38	0.780	5.11	0.042	5.91	0.236
Putrescibles	25.80	23.37	0.385	41.29	0.053	35.01	0.140
Ferrous metals	5.40	3.30	0.009	2.75	0.069	1.99	0.000
Non-Ferrous Metals	1.90	1.08	0.005	0.66	0.556	0.91	0.041
Fines	7.70	10.20	0.128	13.30	0.035	15.13	0.002

Appendix 8: Streets Sampled in Ballater and Banchory

Ballater	Braichile Road
	Dee Bank Road
	Golf Road
	Salisbury Road
	Victoria Road
Banchory	Pantoch Drive
	Silverbank Crescent
	Scolty Place
	Raemoir Road