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Look-up Tables to Link 1991 Population Statistics to the 1998 Local Government Areas

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November 1998

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Abstract

Between 1995 and 1998 the local authority structure and geography of the United Kingdom was substantially revised. The two-tier system of local government was abolished in Wales, Scotland, and in parts of non-metropolitan England, and replaced with a single-tier system. This involved the creation of a new set of local authority area boundaries which in many places cut across those of the old districts. In addition, many of the local authorities unaffected by the reorganisation nonetheless had experienced small - though demographically significant - boundary changes since the last census. By the time the final phase of the reorganisation came into effect on 1st April 1998 the local government map of the United Kingdom was very different from that of April 1991. There is a need therefore to provide demographic and other geographically based data for the new geography for years prior to 1998. This paper aims to fill a part of this requirement by focusing on two important issues. First, it describes a look-up table detailing exactly how the 1998 local government geography relates to 1991 Census areas, and second, it sets out methods for producing 1991 Census data and mid-1991 population estimates (including single year age detail) for the new geography. A selection of the results produced by the described methods is included in tables and population pyramids.

Acknowledgements

The authors gratefully acknowledge the support of the University of Leeds for the PhD scholarship which funded the research reported in this paper. Information to create look-up tables was kindly supplied by the Office for National Statistics, the General Register Office for Scotland and the Northern Ireland Statistics and Research Agency. The maps of England, Wales and Scotland were produced from data at UKBORDERS provided with the support of the Economic and Social Research Council and Joint Information Systems Committee of the Higher Education Funding Councils (JISC) using boundary material which is copyright of the Crown, the Post Office and the ED-LINE consortium. The 1991 Census statistics used in the research are Crown copyright; the mid-1991 small area estimates are copyright of the Estimating with Confidence project. Both are made available on the MIMAS service of Manchester Computing, University of Manchester by the Census Dissemination Unit. The 1991 Census data were purchased for academic research purposes by the ESRC and JISC.

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1. INTRODUCTION

The local government map of the United Kingdom in 1998 is significantly different from that existing at the time of the last census in 1991. This is due mainly to the major redrawing of boundaries during the 1995-98 round of local government reorganisation in Great Britain, but it also results from a large number minor boundary changes since 1991, particularly in London. This new geography has created the need to provide for the community of users and producers of population data new demographic statistics based on the 1998 boundaries for the period up to their introduction, and descriptions of suitable methods for preparing these statistics. Some new Census and population estimates for the new areas have been published in summary format by the national statistical offices (such as ONS, 1996a, ONS, 1996b, and GRO(S), 1996) but little age detail is included, and very little is said about methodology. This paper aims to fill a part of this gap by presenting a look-up table of 1998 local authorities to 1991 census areas, and then using this look-up table, methods for producing geographically rebased 1991 Census data and mid-1991 population estimates with single year age detail. In this paper, local authorities are taken to be the London Boroughs, metropolitan districts, counties and unitary authorities in England, unitary authorities in Wales, council areas in Scotland and district councils in Northern Ireland. The districts of the remaining two-tier counties in England are not considered.

The plan of this paper is as follows. First, some general concepts about look-up tables and their application to geography are explained. Second, the structure and geography of the new local authority organisation of the United Kingdom is outlined. Third, the look-up tables are explained and maps of the old and new geographies presented. The fourth and fifth sections of the paper deal respectively with methods for extracting 1991 Census data, and methods for producing mid-1991 population estimates for the new geography. Because of its different data situation, the procedure for producing mid-1991 estimates for Northern Ireland is different from the rest of the UK and so it is considered in a separate subsection. The final section before the conclusion includes some selected highlights of the 1991 population statistics produced using the methods just explained.

2. GENERAL CONCEPTS

Before describing the details of the look-up tables which link 1991 and 1998 geographies, it is useful to spell out the general character of these devices called look-up tables.

A look-up table is a data structure which links one set of entities to another set. The particular entities we are dealing with in this paper are discrete geographical areas. There are many types of links that can exist between the entities, and Figure 1 sets out some of these types which are useful in handling geographical data.

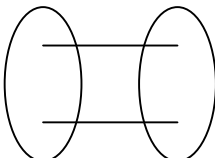
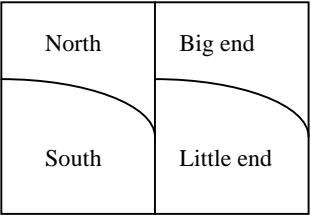
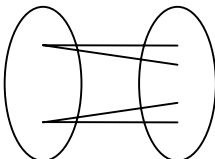
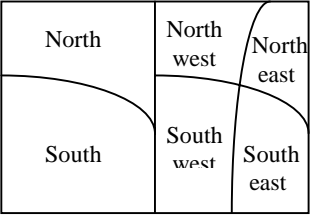
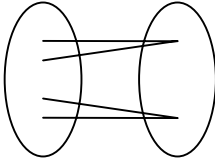
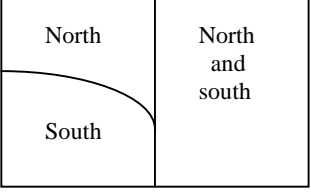
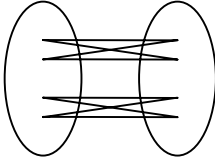
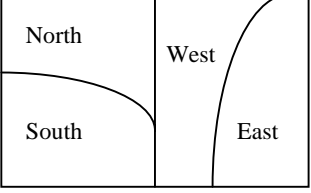
Type of link	Sets		Maps	
	Source A	Target B	Source A	Target B
a) One to one				
b) One to many				
c) Many to one				
d) Many to many				

Figure 1 Types of links between map entities

The simplest is a one to one link between the entities in the two sets (Figure 1a). An area in set A is linked to one area only in set B, for example. An example of this relation is where the names of areas are changed but their boundaries are not. The second type involves a one to many relationship (Figure 1b). A source area may be broken up in the target geography into several smaller areas, which do not violate the boundaries of the source area. A third type involves many to one relationships (Figure 1c). Source areas have been amalgamated to form target areas. This situation is known as perfect aggregation and is often found as a hierarchy within a geographical system defined at one point in time, but is rare between time points. The final type encompasses many to many relationships. An area in the source geography falls into several in the target geography, and an area in the target geography receives contributions from several areas in the source geography.

Figure 2 shows what needs to be done to derive look-up tables for converting statistics from a source to a target geography in the many to many situation. Some five different look-up table formats can be conceived. The first, the intersection table (Figure 2a), is not useful because it would result in double counting (or worse) of the statistics in set A. The second format is the best fit table. This is a list of entities in set A once only, paired up with the entity in set B that they best fit. Although this is crude, it is often used if information needed to apportion source areas is not available. It is much better to try to achieve an intersection list with weights attached that apportion a source area across the relevant target areas. Figure 2c provides the example. Note that the weights must sum to 1 across intersections by source area. Weights should, where possible, be derived from statistics closely linked to those being converted from source to target geography such as total populations in the intersections. The bottom two tables in Figure 2 show the alternative membership list form for look-up tables¹. The target areas are listed, and against each target area is a list of the members of the source geography set which fall into the target area. Figure 2d is the membership list equivalent of the best fit look-up table (Figure 2b) while Figure 2e is the membership list equivalent of the weighted look-up table.

The experienced user of the census extraction package SASPAC (Small Area Statistics PACKage) will have recognised that the weighted look-up table (Figure 2c) corresponds with the gazetteer file aggregation procedure while the weighted membership list table is implemented via the `new zone` and `using areas` commands. As we discuss the look-up tables used to convert 1991 statistics to a 1998 geography base in the rest of the paper, we will identify the general type and format to which it corresponds.

¹ Membership lists are referred to as constitutions in ONS parlance.

a) Intersection table

Set A	Set B
North	West
North	East
South	West
South	East

b) Best fit table

Set A	Set B
North	West
South	East

c) Weighted table

Set A	Set B	Weight
North	West	0.6
North	East	0.4
South	West	0.5
South	East	0.5

d) Best fit membership list

Set B	Set A
West	North
East	South

e) Weighted membership list

Set B	Set A
West	0.6 North, 0.5 South
East	0.4 North, 0.5 South

Figure 2 Formats of look-up tables

3. THE NEW GEOGRAPHY

3.1 New structure

The latest round of local government reorganisation in Great Britain was initiated by the previous government in the early 1990s with the aim of replacing the two-tier structure which existed outside the English metropolitan areas with unitary authorities responsible for all council functions. In Scotland and Wales the government's proposals were subject to little consultation and became law in 1994 (after minor modifications) in the Local Government etc. (Scotland) Act and the Local Government (Wales) Act. This new structure and geography came into effect on 1st April 1996. In Scotland the two-tier system of nine regions and 53 districts and three island areas was replaced by 32 single-tier council areas; in Wales the eight counties and 37 districts were replaced by 22 unitary authorities (Jackson and Lewis, 1996). In England, however, the process was slower and more convoluted (see Chisholm, 1995 and Johnston and Pattie, 1996, for detailed discussions). The Local Government Act 1992 established a Local Government Commission which was given the task of reviewing the local government structure and making recommendations for change to the Secretary of State for the Environment. Unfortunately for the government the review process revealed much opposition to Commission's draft recommendations for change, particularly amongst the County Councils (facing abolition) and, in many areas, the general public. The final reports of the Commission to the Secretary of State therefore recommended no change to the existing structure of local government for 18 counties. However, the new local government organisation failed to be finalised at this stage because despite the extensive consultation and review undertaken by the Commission, the Secretary of State decided not to accept its recommendations for all parts of England, and instructed it to review the case for unitary authority status for several more large towns. This it did, recommending the addition of eight more unitary authorities to the initial proposals. The final outcome for non-metropolitan England was eventually 46 unitary authorities and 34 two-tier counties (containing 239 districts). This contrasts with a pre-reorganisation structure of 39 counties (containing 296 districts). The new unitary authorities and revised counties were implemented in four phases on the 1st April in each of the years 1995 to 1998. Table 1 lists the local authorities in each phase.

Table 1 Implementation dates of England's unitary authorities (UAs) and revised counties

Phase 1: Unitary authorities created on 1st April 1995	Phase 2: Unitary authorities and revised counties created on 1st April 1996	Phase 3: Unitary authorities and revised counties created on 1st April 1997	Phase 4: Unitary authorities and revised counties created on 1st April 1998
Isle of Wight UA	Bath and North East Somerset UA	Bournemouth UA, Poole UA and Dorset	Bracknell Forest UA
	Bristol UA	Brighton & Hove UA and East Sussex	Blackburn with Darwen UA, Blackpool UA and Lancashire
	East Riding of Yorkshire UA	Darlington UA and County Durham	Halton UA, Warrington UA and Cheshire
	Hartlepool UA	Derby UA and Derbyshire	Herefordshire UA and Worcestershire
	Kingston upon Hull UA	Leicester UA, Rutland UA, and Leicestershire	Medway UA and Kent
	Middlesborough UA	Luton UA and Bedfordshire	Nottingham UA and Nottinghamshire
	North East Lincolnshire UA	Milton Keynes UA and Buckinghamshire	Peterborough UA and Cambridgeshire
	North Lincolnshire UA		Plymouth UA, Torbay UA and Devon
	North Somerset UA	Portsmouth UA, Southampton UA and Hampshire	Reading UA
	Redcar and Cleveland UA	Stoke-on-Trent UA and Staffordshire	Slough UA
	South Gloucestershire UA	Swindon UA and Wiltshire	Southend UA, Thurrock UA and Essex
	Stockton upon Tees UA		West Berkshire UA
	York UA and North Yorkshire		Windsor & Maidenhead UA
			Wokingham UA
			Telford & Wrekin UA and Shropshire

Source: DETR, 1998

3.2 Look-up tables

To create any statistics for the 1998 local authorities from the 1991 Census, or in fact for any datasets based on 1991 Census geography, it is vital to know exactly how the 1991 Census geography relates to the 1998 local authority areas. Every 1991 enumeration district and output area must be accounted for in the 1998 areas. Thus, details were obtained from the Office for National Statistics (ONS, 1998a), the General Register Office for Scotland (GRO(S), 1998a), MIMAS, 1996, and the Northern Ireland Statistics and Research Agency (NISRA) (Hyvart, 1998) so that look-up tables could be created. As the look-up tables presented in this paper use the census offices' codes to refer to the 1991 Census areas it is important to understand what the codes mean and how they vary between different levels of output geography and between the constituent countries of the UK.

In England and Wales a county is represented by two numbers, a district within that county by two letters, a ward within the district by a further two letters, and an enumeration district (ED) by two numbers. For example, in 08DAGF44

- 08 is the county code for West Yorkshire,
- DA refers to the district of Leeds,
- GF denotes University ward in the district of Leeds, and
- 44 refers to a particular ED in ward GF which contains part of the University of Leeds.

The county codes were not only assigned to the counties existing at the time of the 1991 Census but also to the former metropolitan counties (such as West Yorkshire). In addition, London was divided into two 'counties' - inner London (01) and outer London (02).

In Scotland the 1991 Census output geography was different. A region is represented by a two number code, a district within that region by a further two numbers, a postcode sector by two letters, and an output area (OA) by two numbers or two numbers and one letter. For example, in 6125AG02A

- 61 is the code for the Highland region,
- 25 refers to the district of Ross and Cromarty,
- AG refers to the postcode sector IV10 8 (where AG refers to the postcode sector), and
- 02A refers to a particular OA in IV10 8.

It is important to note that in Great Britain all the 1991 district codes are unique. Within the United Kingdom, however, they are not: 1991 district code 07, for example, could refer to either Stirling or Belfast. Thus full codes are given in this paper. This practice also avoid potential confusion

between codes for Scottish districts and those for Scottish regions. Perhaps for the 2001 Census the census offices can agree on a geographical coding system that avoids these sorts of problems.

In Northern Ireland counties were not used as Census output entities. There are just main three levels of geography: district council areas, wards, and EDs. District council areas are denoted by a two number code, wards within district council areas by another two numbers, and EDs by a further two numbers. For example, in 222204

22 refers to Newry and Mourne district council area,

22 refers to Rathfriland ward, and

04 refers to ED 04 in Rathfriland ward.

1991 Census to 1998 local authority look-up tables may have different formats depending on the uses to which they are put. A fundamental distinction can be made between those look-up tables which list the new areas in order and the old areas located within them (new to old, i.e target geography to source geography), and those look-up tables which list all the old areas in order and then new area in which they are located (old to new, i.e. source geography to target geography). A new to old look-up table is useful when constructing 1991 Census data for the new areas (as will be explained in section 4), and is also helpful when examining how the new areas relate to the old. Conversely, an old to new look-up table is more useful when creating a gazetteer file (again, explained in section 4) or when creating digital maps of the new areas by aggregating wards or EDs.

The two types of new to old and old to new may be further divided according to the level of geography used for the old areas. Table 2 outlines various possible types of look-up table, and gives brief extracts. Four levels of geography are available for the old areas: counties/regions, districts, wards/postcode sectors and EDs/OAs, although only the last two categories are really of any use. The mix type listed is actually a particular version of the EDs/OAs type, except that where all the 1991 EDs/OAs of a ward/postcode sector or district are included in a new area then the code for the relevant higher level of geography is shown as a shorthand. Both the ward/postcode sector and EDs/OAs types of look-up table contain weights, which are often set at 1.0. As mentioned in section 3, however, it is sometimes necessary to use look-up tables with weights of less than 1.0. A user may require, for example, 1991 Census Local Base Statistics (LBS) for the 1998 areas. Because the LBS are available only down to the ward scale a look-up table involving 1991 wards would have to be constructed, and for those wards spilt between 1998 areas weights would be needed. The drawback of using weights, of course, is that they share out all the population characteristics of the weighted area in accordance with that weight, thus making the

assumption that the area is spatially demographically homogenous. Thus the larger the weighted area, the less reliable the results.

Appendix 1 contains a new to old look-up table for the United Kingdom and is the main look-up table presented in this paper; in it the 1998 local authorities are listed in order.

Table 3 is an extract of an old to new type containing the same information; in this look-up table the 1991 Census EDs and OAs are in alphabetical and numerical order.

3.3 Maps

Maps of the 1991 and 1998 local government geographies for the four constituent countries of the UK are shown in Figures 3 to 6. These were produced in MapInfo using digitised boundary data from UKBORDERS (for Great Britain) and from the authors' own digitisation (for Northern Ireland). The look-up table in table appendix 1 may prove a useful reference when comparing old and new geographies.

Table 2 Types of look-up table for connecting 1991 and 1998 local government geographies, and extracts of examples

Level of geography of old areas	Type of look-up table					
	Old to new (i.e. source to target)			New to old (i.e. target to source)		
	Old code	Weight	New code	New code	Weight	Old code
Counties/regions	possible, but not advised			possible, but not advised		
Districts	possible, but not advised			possible, but not advised		
Wards/postcode sectors	.	.	.	.	.	.
	PBFN	1.0000	113	174	1.0000	51AU
	PBFP	1.0000	113	174	1.0000	51AW
	PBFQ	1.0000	113	174	1.0000	51AX
	PBFR	1.0000	149	174	1.0000	51AY
	PBFS	1.0000	113	174	1.0000	51AZ
	PBFT	1.0000	149	174	0.4541	52AK
	PBFU	1.0000	113	174	0.1239	52AQ
	PBFW	1.0000	149	174	0.1213	52AW
	PBFX	1.0000	113	174	0.1124	52AZ
	PBFY	1.0000	113	174	1.0000	52BA
	PBFZ	1.0000	113	175	1.0000	32AA
	PBGA	1.0000	149	175	1.0000	32AB
	PBGB	0.5663	149	175	1.0000	32AC
	PBGB	0.4337	113	175	1.0000	32AD
	PBGC	1.0000	149	175	1.0000	32AE
	PBGD	1.0000	113	175	1.0000	32AF
	PBGE	1.0000	149	175	1.0000	32AG

EDs/OAs	.	.	.	.	.	.
	PDFP02	1.0000	113	096	1.0000	JYGH04
	PDFP03	1.0000	113	096	1.0000	JYGH05
	PDFQ01	1.0000	149	096	1.0000	JYGH06
	PDFQ02	1.0000	113	096	1.0000	JYGJ01
	PDFQ03	1.0000	113	096	1.0000	JYGJ02
	PDFQ05	1.0000	149	096	1.0000	JYGJ03
	PDFQ06	1.0000	113	096	1.0000	JYGJ04
	PDFR01	1.0000	113	096	1.0000	JYSS01
	PDFR02	1.0000	113	097	1.0000	KCFA01
	PDFR03	1.0000	113	097	1.0000	KCFA02
	PDFR04	1.0000	113	097	1.0000	KCFA03
	PDFS01	1.0000	149	097	1.0000	KCFA04
	PDFS02	1.0000	149	097	1.0000	KCFA05
	PDFS03	1.0000	149	097	1.0000	KCFA06
	PDFS04	1.0000	149	097	1.0000	KCFA07
	PDFS05	1.0000	149	097	1.0000	KCFA08
	PDFS08	1.0000	149	097	1.0000	KCFA09

Mix	.	.	.	.	.	.
				154		TN - TNFC17 + TJFE + TJFQ + TPFJ01
				155		SL + SN + SP
				156		SM
				157		SY + SF - SHFT
				158		SJ + SH - SHFA - SHFB - SHFC - SHFU - SHFX + SFFT
				159		SE + SG
		possible, but not advised		160		SZ + TA + TB
				161		TE
				162		SU + SSFL
				163		TR + TS + TQFA + TQFC + TQFE + TQFL + TQFP + TQFU + TQFX + TQFZ + TQGC
				164		SW
				.	.	.
				.	.	.
				.	.	.

Table 3 An extract of an old to new lookup table for the UK, containing part of 1991 North Yorkshire

1991 Census ED code	1998 area numeric code	1991 Census ED code	1998 area numeric code	1991 Census ED code	1998 area numeric code	1991 Census ED code	1998 area numeric code
	.	37PDFN06	149	37PDGA06	113	37PDGK05	113
	.	37PDFN07	149	37PDGB01	113	37PDGL01	149
	.	37PDFP01	113	37PDGB02	113	37PDGL02	149
37PDFD03	113	37PDFP02	113	37PDGB03	113	37PDGL03	149
37PDFD04	113	37PDFP03	113	37PDGB04	113	37PDGL04	149
37PDFD05	113	37PDFQ01	149	37PDGB05	113	37PDGL05	149
37PDFE01	149	37PDFQ02	113	37PDGB06	113	37PDGM01	113
37PDFE02	149	37PDFQ03	113	37PDGB07	113	37PDGM02	113
37PDFE03	149	37PDFQ04	113	37PDGB08	113	37PDGM03	113
37PDFE04	149	37PDFQ05	149	37PDGB09	113	37PDGM04	113
37PDFE05	149	37PDFQ06	113	37PDGC01	113	37PDGM05	113
37PDFE06	149	37PDFR01	113	37PDGC02	113	37PDGM06	113
37PDFF01	113	37PDFR02	113	37PDGC03	113	37PDGM07	113
37PDFF02	113	37PDFR03	113	37PDGC04	113	37PDGM08	113
37PDFF03	113	37PDFR04	113	37PDGC05	113	37PDGM09	113
37PDFF04	113	37PDFS01	149	37PDGD01	113	37PDGM10	113
37PDFF05	113	37PDFS02	149	37PDGD02	113	37PDGM11	113
37PDFF06	113	37PDFS03	149	37PDGD03	113	37PDGM12	113
37PDFF07	113	37PDFS04	149	37PDGD04	113	37PDSS01	113
37PDFF08	113	37PDFS05	149	37PDGD05	113	37PEFA01	149
37PDFF09	113	37PDFS08	149	37PDGD06	113	37PEFA02	149
37PDFF10	113	37PDFT01	113	37PDGE01	113	37PEFA03	149
37PDFG01	113	37PDFT02	113	37PDGE02	113	37PEFA04	149
37PDFG02	113	37PDFT03	113	37PDGE03	113	37PEFA05	149
37PDFG03	113	37PDFT04	113	37PDGE04	113	37PEFA06	149
37PDFH01	113	37PDFT05	113	37PDGE05	113	37PEFA07	149
37PDFH02	113	37PDFT06	113	37PDGE06	113	37PEFA08	149
37PDFH03	113	37PDFT07	113	37PDGE07	113	37PEFA09	149
37PDFH04	113	37PDFU01	113	37PDGE08	113	37PEFA10	149
37PDFH05	113	37PDFU02	113	37PDGE09	113	37PEFA11	149
37PDFH06	113	37PDFU03	113	37PDGE10	113	37PEFA12	149
37PDFH07	113	37PDFU04	113	37PDGE11	113	37PEFA13	149
37PDFH08	113	37PDFU05	113	37PDGE12	113	37PEFB01	149
37PDFJ01	113	37PDFU06	113	37PDGE13	113	37PEFB02	149
37PDFJ02	113	37PDFW01	149	37PDGF01	113	37PEFB03	149
37PDFJ03	113	37PDFW02	149	37PDGF02	113	37PEFB04	149
37PDFJ04	113	37PDFW03	149	37PDGF03	113	37PEFB05	149
37PDFJ05	113	37PDFW04	149	37PDGF04	113	37PEFB06	149
37PDFK01	113	37PDFW05	149	37PDGG01	113	37PEFB07	149
37PDFK02	113	37PDFW06	149	37PDGG02	113	37PEFB08	149
37PDFK03	113	37PDFW07	149	37PDGG03	113	37PEFB09	149
37PDFK04	113	37PDFW08	149	37PDGG04	113	37PEFB10	149
37PDFK05	113	37PDFW09	149	37PDGG05	113	37PEFB11	149
37PDFL01	113	37PDFW10	149	37PDGG06	113	37PEFB12	149
37PDFL02	113	37PDFW11	149	37PDGG07	113	37PEFB13	149
37PDFL03	113	37PDFW12	149	37PDGH01	113	37PEFC01	149
37PDFL04	113	37PDFX01	113	37PDGH02	113	37PEFC02	149
37PDFL05	113	37PDFX02	113	37PDGH03	113	37PEFC03	149
37PDFL06	113	37PDFX03	113	37PDGH04	113	37PEFC04	149
37PDFL07	113	37PDFX04	113	37PDGH05	113	37PEFC05	149
37PDFL08	113	37PDFY01	113	37PDGH06	113	37PEFC06	149
37PDFL09	113	37PDFY02	113	37PDGJ01	113	37PEFC07	149
37PDFM01	149	37PDFY03	113	37PDGJ02	113	37PEFC08	149
37PDFM02	149	37PDFY04	113	37PDGJ03	113	37PEFC09	149
37PDFM03	149	37PDFZ01	113	37PDGJ04	113	37PEFC10	149
37PDFM04	149	37PDFZ02	113	37PDGJ05	113	37PEFC11	149
37PDFM05	149	37PDFZ03	113	37PDGJ06	113	37PEFC12	149
37PDFM06	149	37PDFZ04	113	37PDGJ07	113	37PEFC13	149
37PDFM07	149	37PDFZ05	113	37PDGJ08	113	37PEFC14	149
37PDFN01	149	37PDGA01	113	37PDGJ09	113	37PEFC15	149
37PDFN02	149	37PDGA02	113	37PDGK01	113	37PEFC16	149
37PDFN03	149	37PDGA03	113	37PDGK02	113	.	.
37PDFN04	149	37PDGA04	113	37PDGK03	113	.	.
37PDFN05	149	37PDGA05	113	37PDGK04	113	.	.

Note: 1991 codes: 37PD = Selby district; 37PE = York district. 1998 codes: 113 = North Yorkshire; 149 = York UA.

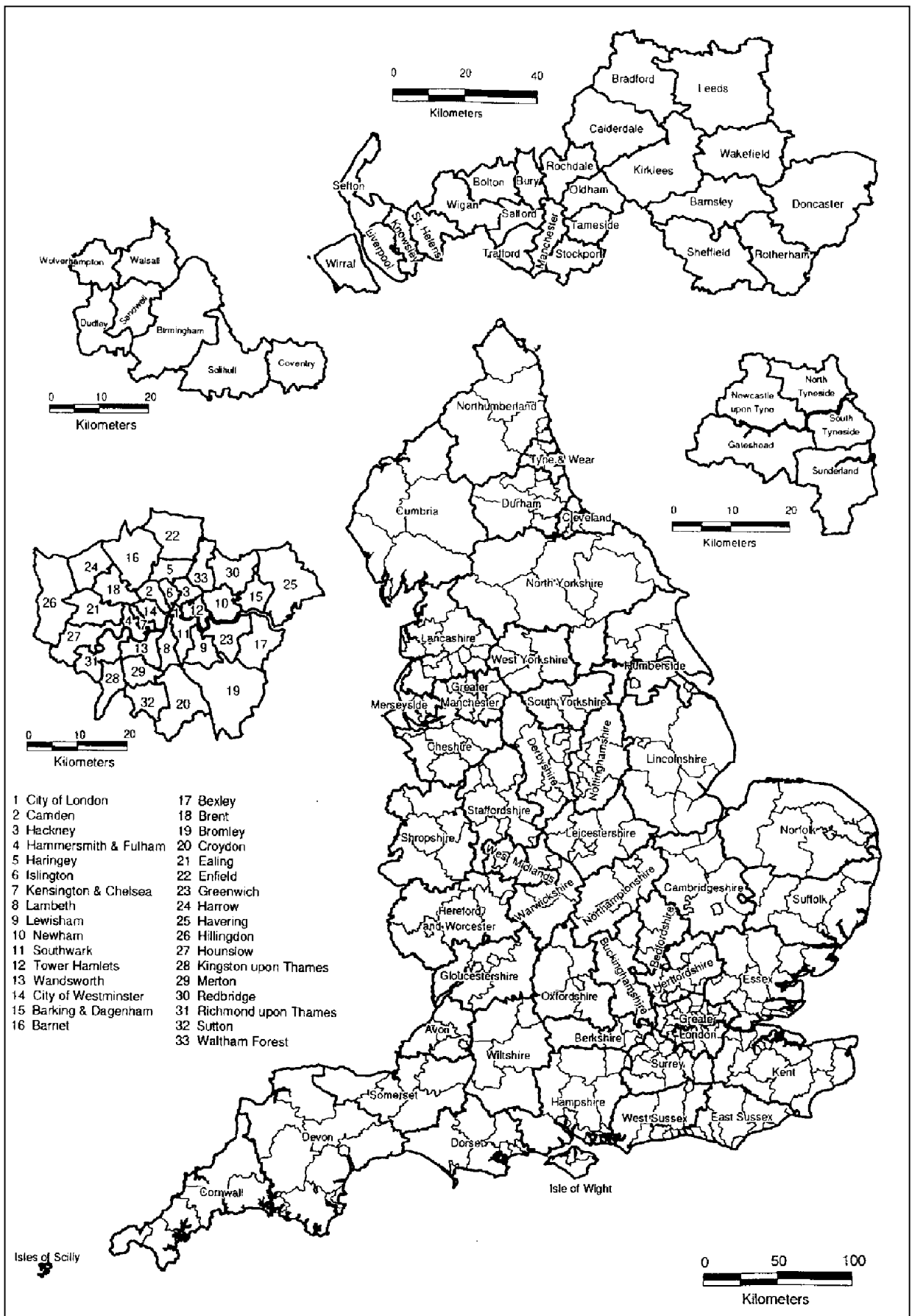


Figure 3a The local government geography of England, 1991

Note: The bold lines on the main map mark the boundaries of counties and former metropolitan counties; the thin lines mark districts. The larger scale maps name the metropolitan districts and London boroughs.

Acknowledgement: This map is based on data provided with the support of the ESRC and JISC and uses boundary material which is copyright of the Crown and the ED-LINE consortium. The data was accessed at UKBORDERS.

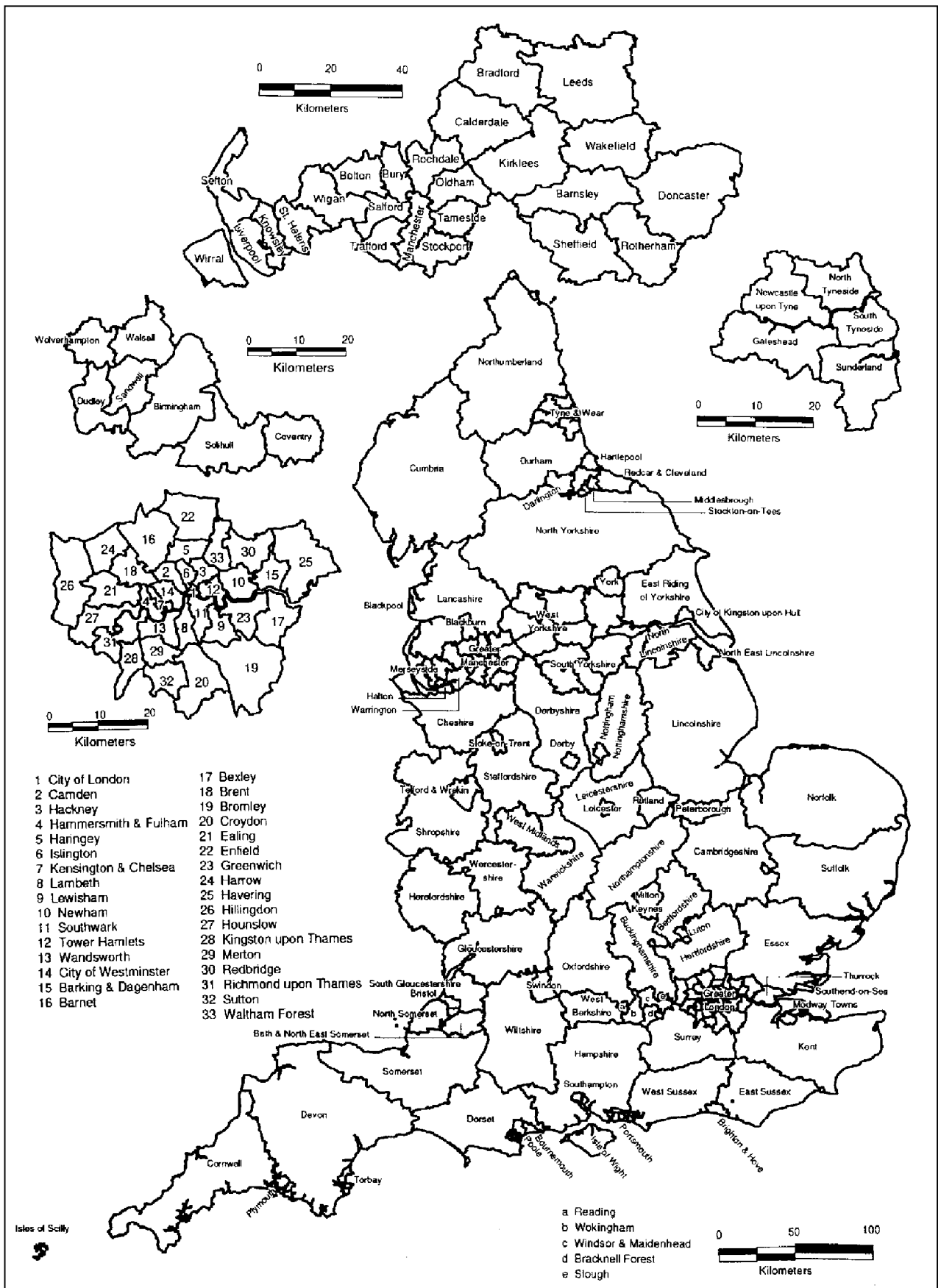


Figure 3b The local government geography of England, 1998

Note: the main map shows counties, former metropolitan counties and unitary authorities. As before, the larger scale maps name the metropolitan districts and London boroughs.

Acknowledgement: This map is based on data provided with the support of the ESRC and JISC and uses boundary material which is copyright of the Crown and the ED-LINE consortium. The data was accessed at UKBORDERS.

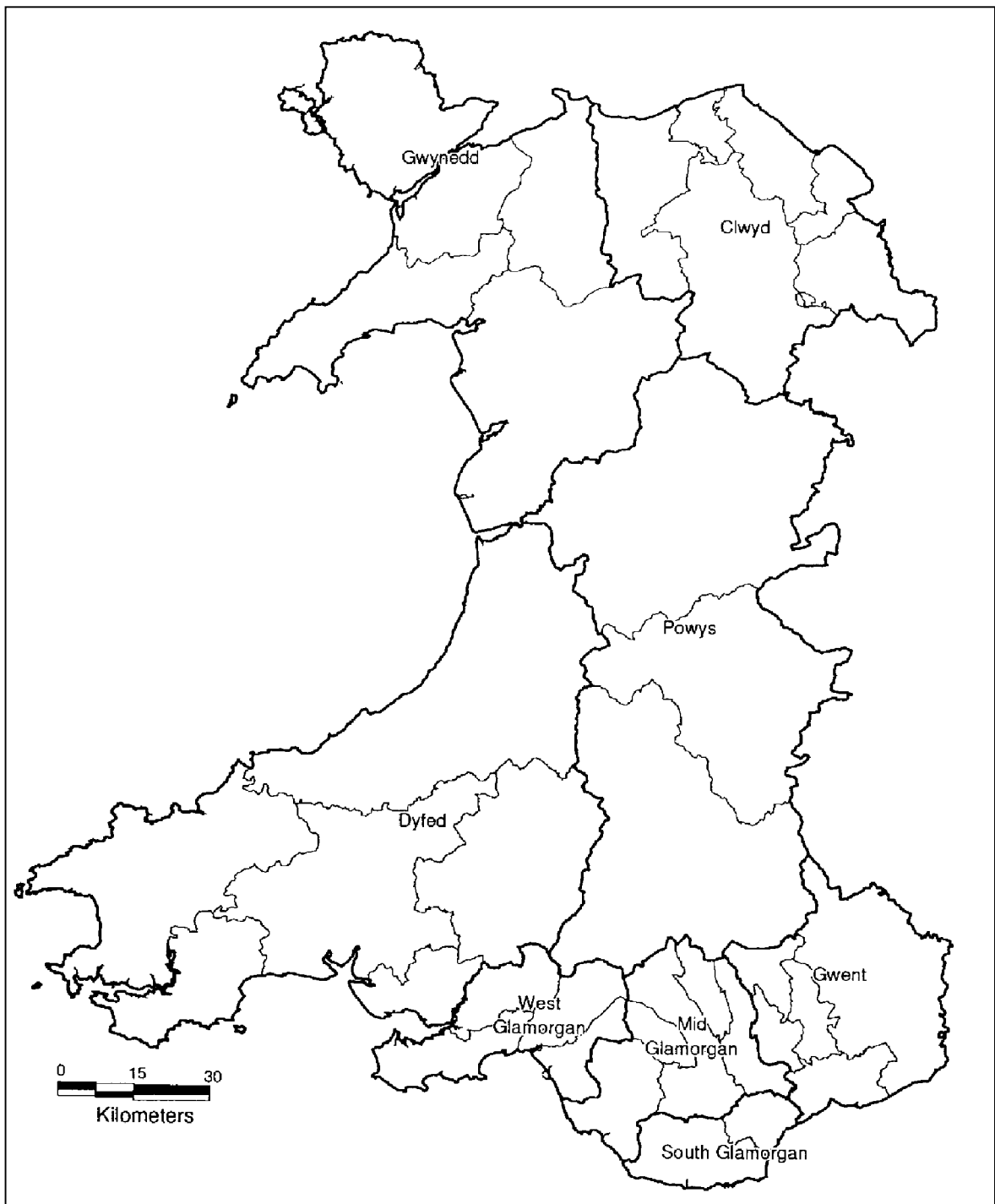


Figure 4a The local government geography of Wales, 1991

Note: the bold lines mark county boundaries; the thin lines denote district boundaries.

Acknowledgement: This map is based on data provided with the support of the ESRC and JISC and uses boundary material which is copyright of the Crown and the ED-LINE consortium. The data was accessed at UKBORDERS.

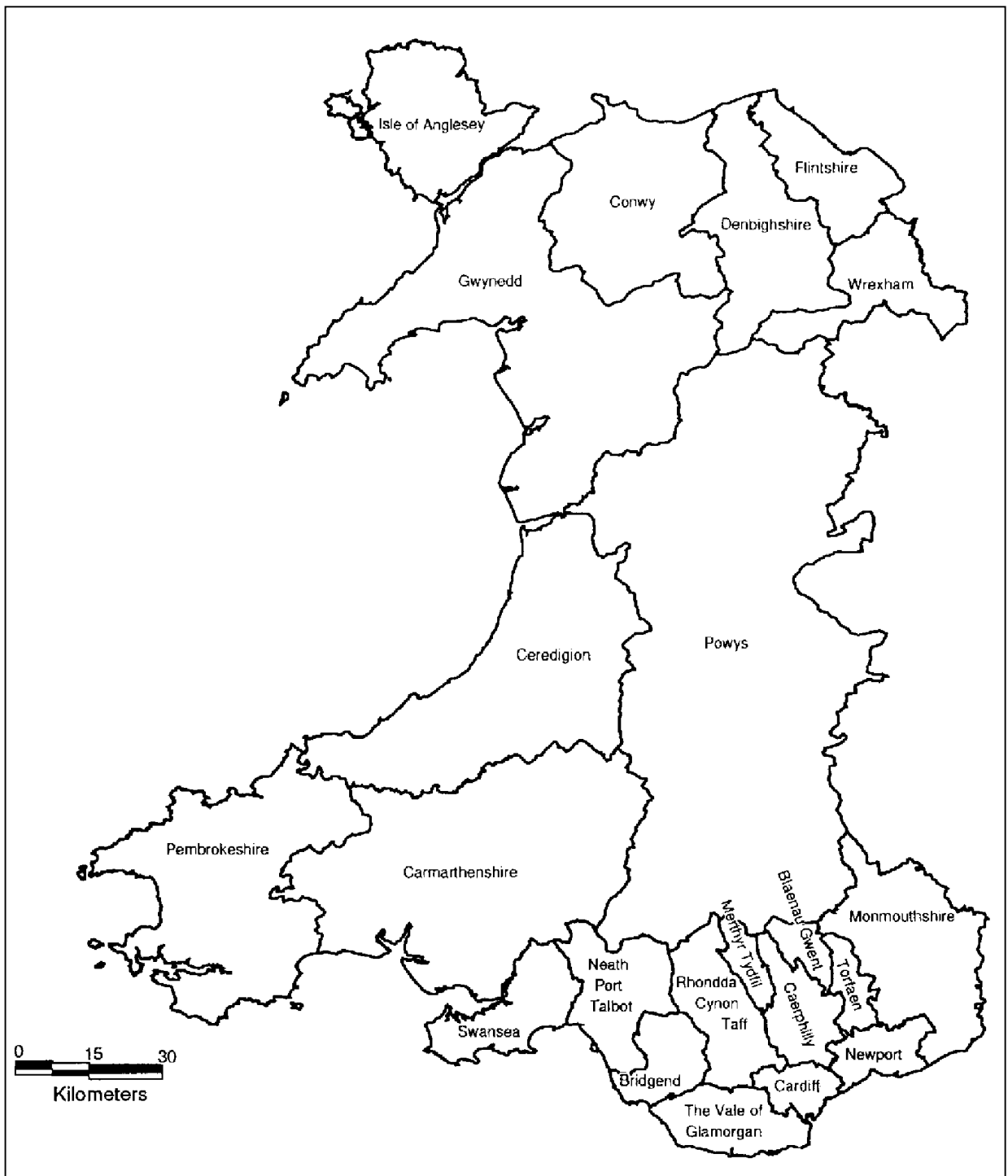


Figure 4b The local government geography of Wales, 1998

Note: the areas shown are unitary authorities

Acknowledgement: This map is based on data provided with the support of the ESRC and JISC and uses boundary material which is copyright of the Crown and the ED-LINE consortium. The data was accessed at UKBORDERS.

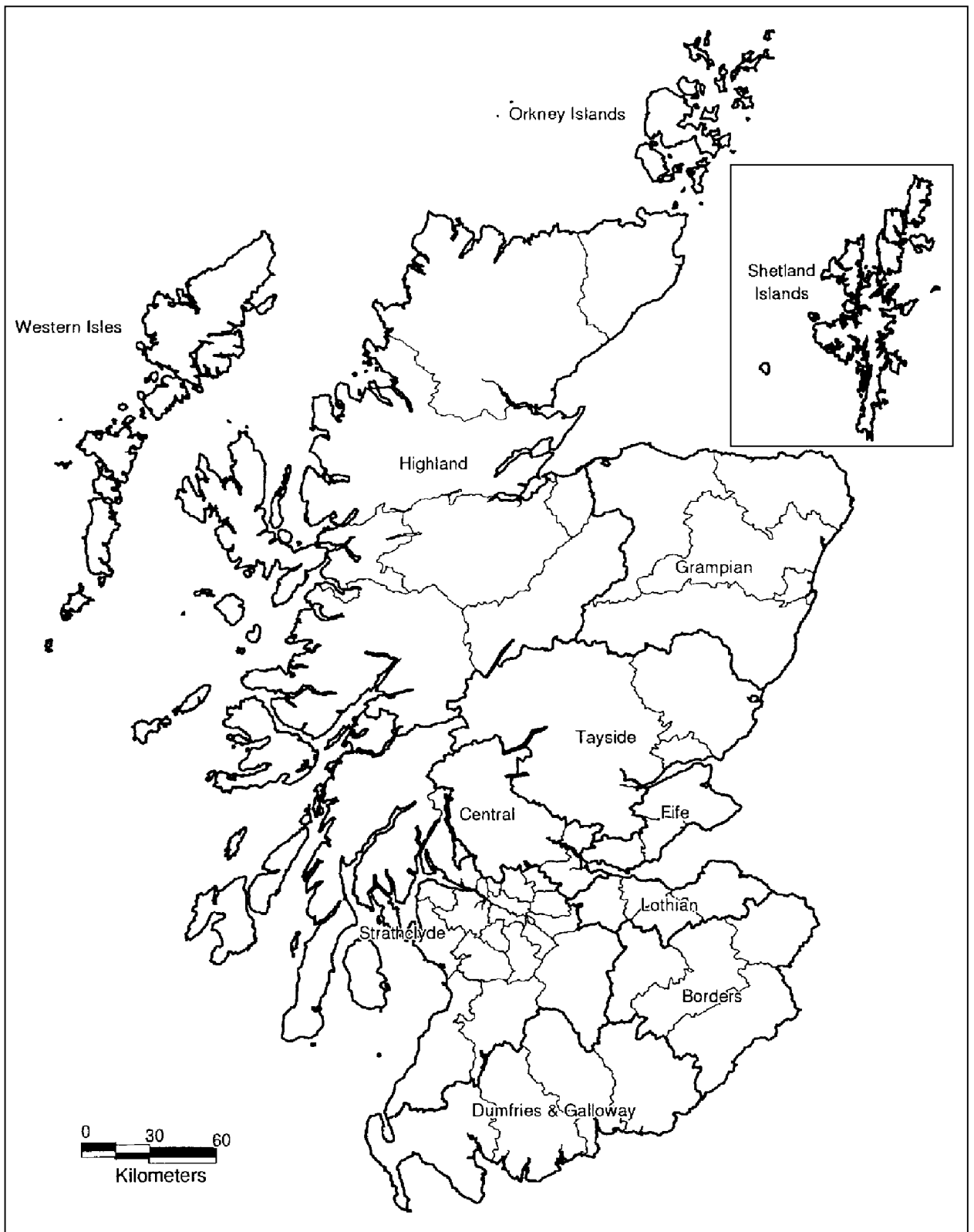


Figure 5a The local government geography of Scotland, 1991

Note: the bold lines mark the boundaries of regions; the thin lines mark the boundaries of districts.

Acknowledgement: This map is based on data provided with the support of the ESRC and JISC and uses boundary material which is copyright of the Crown and the Post Office. The data was accessed at UKBORDERS.

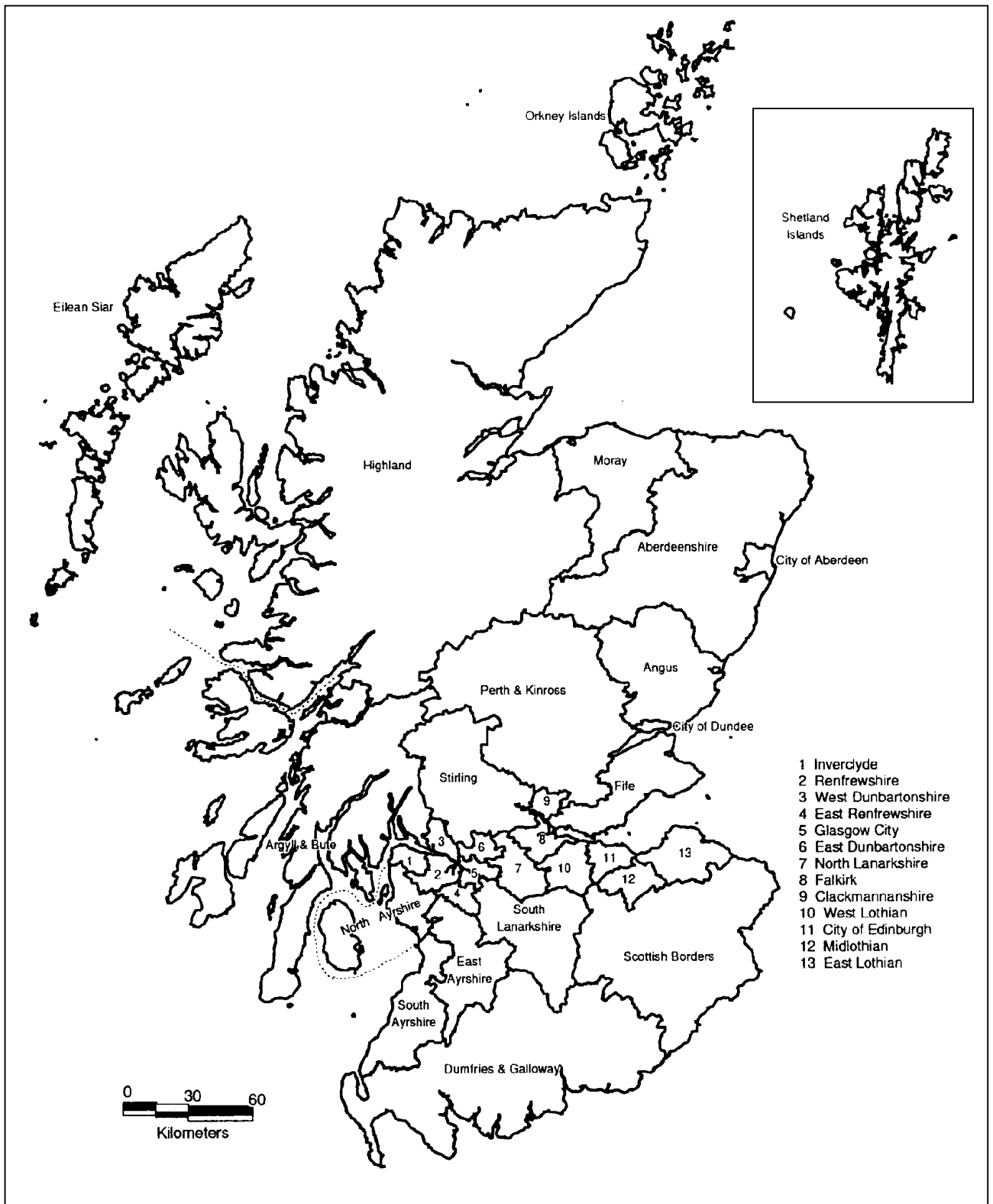


Figure 5b The local government geography of Scotland, 1998

Note: the areas shown are council areas.

Acknowledgement: This map is based on data provided with the support of the ESRC and JISC and uses boundary material which is copyright of the Crown and the Post Office. The data was accessed at UKBORDERS.

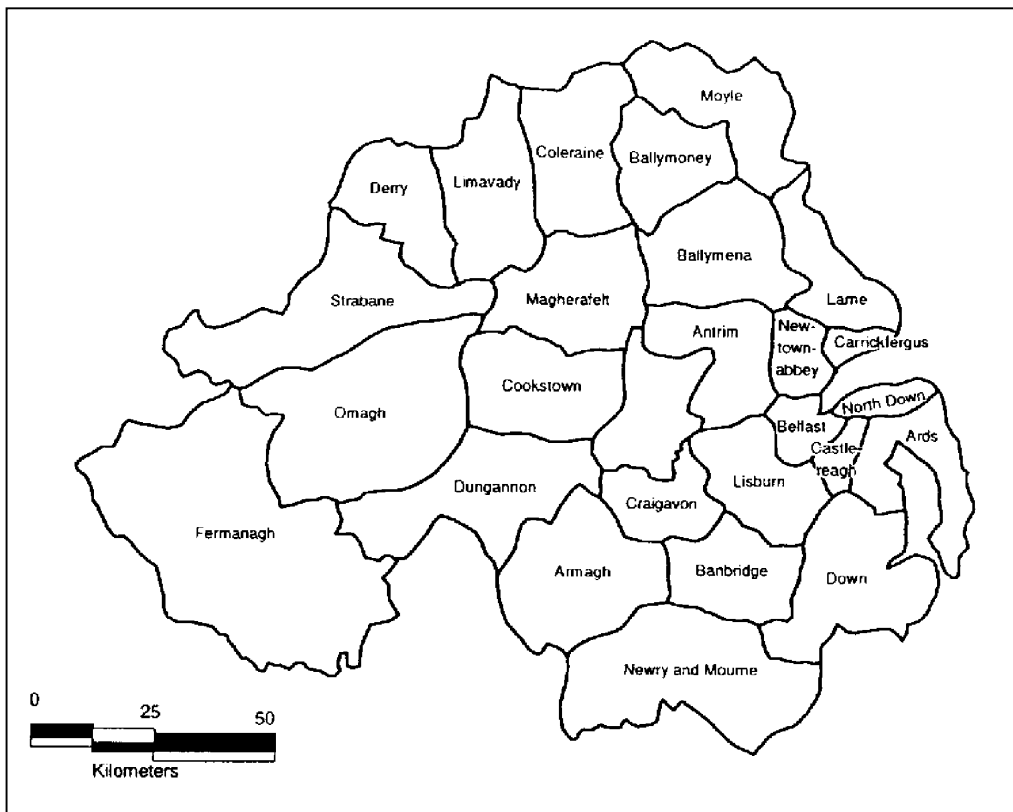


Figure 6a The local government geography of Northern Ireland, 1991

Note: the areas shown are district council areas.

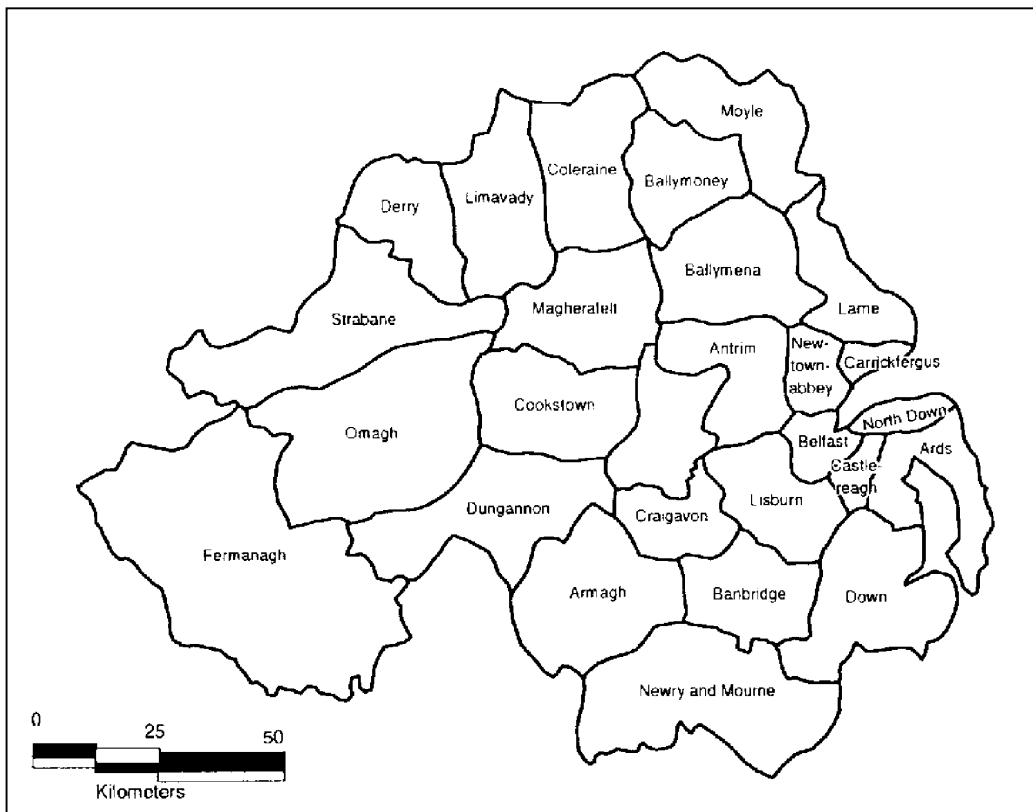


Figure 6b The local government geography of Northern Ireland, 1998

Note: the areas shown are district council areas.

4. METHODS FOR EXTRACTING 1991 CENSUS DATA

1991 Census data is held on the MIMAS server at Manchester University and can be accessed by registered academic users via the internet (as explained in Rees, 1995, and on the MIMAS website at <http://www.census.ac.uk/cdu/registration/>). Users write short programs in the special extraction software, SASPAC, setting out what information they require. To obtain census data for user-defined geographies SASPAC allows the creation of new system files for a set of chosen areas. There are two principal means of achieving this:

- (i) by using a program which reads a gazetteer file, and
- (ii) by using a program based on the `new zone` and `using areas` commands.

A 'gazetteer file' is simply the SASPAC name for a look-up table. When a gazetteer file is used in a program SASPAC will simply add all the old areas allocated to each new area. An extract from a gazetteer file is shown in Figure 7, and the program using this file, `waleswds.cmd`, is shown in Figure 8. This creates a new system file for those Welsh unitary authorities built from whole wards. The `new zone` and `using areas` method, as applied to the local authorities of Yorkshire and the Humber, is shown in `yh.cmd`, Figure 9. Both programs contain two main parts: first, there is the creation of the new system file, and second, there is the extraction of whatever census data is needed - in this case the usually resident population. To extract any other Census data from the Small Area Statistics (SAS) only the second part of the program requires changing.

For most situations the second method (`new zone` and `using areas`) will produce results superior to the first because it allows subtraction as well as addition. This is very important where a new zone is being created from areas smaller than districts, because for these areas the census offices have randomly added -1, 0 or +1 to cell counts to protect confidentiality. Take the new West Lothian council area for example. This comprises the old district of West Lothian minus one OA. Producing a 1991 Census population for the new West Lothian area using an unweighted gazetteer file involves adding together 1,011 blurred OAs. The total population figure using this method is 144,078. Producing the same population using the `new zone` and `using areas` method involves only one blurred area and gives a figure of 143,971. While the difference between these two figures is small, there was the potential for the gazetteer file figure to be much more inaccurate. Had all the output areas been blurred with -1 then the result would have been

$$142,960 = 143,971 + (1,011 \times -1),$$

and if they had all been blurred with +1 then the result would have been

$$144,982 = 143,971 + (1,011 \times +1).$$

The second method was used by the authors to create 1991 usually resident census populations for all the local authorities in the United Kingdom based on the 1998 boundaries. The 1991 Census

areas included in the `using areas` command for each new zone in the SASPAC programs are those listed in appendix 1; the results are shown in appendix 2. The new SASPAC system files of 1991 SAS Census data based on the 1998 geography have been supplied to the ESRC/JISC² holdings of SAS and LBS files on MIMAS. It was not felt necessary to repurchase the files from the census offices because the differences are relatively small. However, part of the ESRC/JISC strategy for the 2001 Census should include purchase of both look-up tables and rebased statistics for new geographies. These purchases should be built into a service level agreement that covers data maintenance and updating after initial purchase. The new system file names are:

- `nlg1bh.sys` for the 100% SAS for London boroughs,
- `nlgmdh.sys` for the 100% SAS for the metropolitan districts,
- `nlgcuah.sys` for the 100% SAS for English counties and unitary authorities,
- `nlgwuah.sys` for the 100% SAS for Wales,
- `nlgscah.sys` for the 100% SAS for Scotland,
- `nlgnidc.sys` for the 100% SAS for Northern Ireland.

Geographically rebased census data has been calculated for England, Wales and Scotland by the relevant national statistical offices. For Wales, ONS produced a volume, *Key Population Statistics 1991-1994*, incorporating reworked census data for the unitary authorities (ONS, 1996a). The census populations of the unitary authorities given in this report match the figures prepared by the authors either exactly or within six persons, suggesting that ONS used the same methodology as method two above but on un-blurred data. A similar volume containing reworked 1991 Census data for the new English local authority geography is being prepared by ONS, but is not yet published. GRO(S) have also produced 1991 Census counts for the new council areas (GRO(S), 1998b) and the figures are very similar to those presented here. Some of the differences are slightly larger than those for England and Wales, but this is probably due to the fact that council areas with larger differences (up to 222) have had to be constructed from a larger number of blurred areas.

² Economic and Social Research Council/Joint Information Systems Committee of the Higher Education Funding Councils of England, Wales and Scotland.

```

151 BLAENAU GWENT
157 CONWY
158 DENBIGHSHIRE
162 MONMOUTHSHIRE
163 NEATH PORT TALBOT
167 RHONDDA CYNON TAFF
168 SWANSEA

SSFA      151
SSFB      151
SSFC      151
SSFD      151
SSFE      151
SSFF      151
SSFG      151
SSFH      151
SSFJ      151
SSFK      151
SSFM      151
SSFN      151
SSFP      151
SSFQ      151
SSFR      151
SSFS      151
SYFA      157
SYFB      157
SYFC      157
SYFD      157
SYFE      157
SYFF      157
SYFG      157
SYFH      157
SYFJ      157
SYFK      157
SYFL      157
SYFM      157
SYFN      157
.
.
.

```

Figure 7 An extract of a SASPAC gazetteer file of wards to unitary authorities in Wales (for those unitary authorities built from whole wards).

```

* waleswds.cmd
* Tom Wilson
* This program creates a new local authority system file for Welsh
* unitary authorities built from 1991 wards, and extracts the total
* usually resident population of each area for census night. A gazetteer
* file is used.
* part 1: creation of new system file
input system file name = waleswsh
input gazetteer file with labels name = wale3.gaz /
existing zone cols 1 to 4 /
new zone cols 8 to 10
save variables zoneid zlabel s020001
output system file name = gazw3 /
label = Wales wards
end
* part 2: extraction of population data
input system file name = gazw3
save variables zoneid zlabel s020001
widths 4 25 10
output formatted file name = gazw3
end
finish

```

Figure 8 A SASPAC command file for creating 1991 Census statistics for Welsh unitary authorities (using a gazetteer file).

```

* yh.cmd
* Tom Wilson
* This program creates a new local authority system file for the region of
* Yorkshire and the Humber and extracts the total usually resident
* population of each area for census night 1991. The 'new zone' and 'using
* areas' commands are used.
* part 1: creation of new system file
input system file name = engladsh
input system file name = humbswsh
input system file name = nyorkwsh
input system file name = nyorkesh
input system file name = wyorkesh
input system file name = syorkesh
read in series
new zone id = e_yk = East Riding of Yorkshire
using areas KQ + KR + KU + KN - KNFB - KNFE - KNFM - KNFR - KNFU - KNFY
new zone id = hull = City of Kingston upon Hull
using areas KW
new zone id = ne_l = North East Lincolnshire
using areas KP + KT
new zone id = n_li = North Lincolnshire
using areas KNFB + KNFE + KNFM + KNFR + KNFU + KNFY + KS + KX
new zone id = n_yk = North Yorkshire
using areas NX + NY + NZ - NZFT01 - NZFT04 - NZFT05 - NZFT06 - NZGD10 - /
NZGF + PA + PB - Pbfd - PbfG - PbfH - PbfL - PbfM - PbfR - PbfT - /
PbfW - PBGA - PBGB04 - PBGB06 - PBGB07 - PBGB08 - PBGC - PBGE + PC + /
PD - PDFA01 - PDFA02 - PDFB01 - PDFB02 - PDFB03 - PDFB04 - PDFE - /
PDFM - PDFN - PDFQ01 - PDFQ05 - PDFS - PDFW - PDGL
new zone id = york = York
using areas PE + NZFT01 + NZFT04 + NZFT05 + NZFT06 + NZGD10 + NZGF + /
Pbfd + PbfG + PbfH + PbfL + PbfM + PbfR + PbfT + PbfW + PBGA + PBGB04 + /
PBGB06 + PBGB07 + PBGB08 + PBGC + PBGE + PDFA01 + PDFA02 + PDFB01 + /
PDFB02 + PDFB03 + PDFB04 + PDFE + PDFM + PDFN + PDFQ01 + PDFQ05 + /
PDFS + PDFW + PDGL
new zone id = brad = Bradford
using areas CX - CXFM01
new zone id = cald = Calderdale
using areas CY
new zone id = kirk = Kirklees
using areas CZ - CZFE09
new zone id = leed = Leeds
using areas DA - DAFS35 + CXFM01 + NZGD10 + CZFE09
new zone id = wake = Wakefield
using areas DB - DBFW32 - DBFW34 + DAFS35
new zone id = barn = Barnsley
using areas CC + DBFW32 + DBFW34 + DBFW35
new zone id = donc = Doncaster
using areas CE
new zone id = roth = Rotherham
using areas CF + CGGD34
new zone id = shef = Sheffield
using areas CG - CGGD34
output system file name = yh /
label = 1991 pops for 1998 geog
end
* part 2: extraction of population data
input system file name = yh
save variables zoneid zlabel s020001
widths 5 27 10
output formatted file name = yh
end
finish

```

Figure 9 A SASPAC command file for creating statistics for the new local authorities in the region of Yorkshire and the Humber (using the new zone and using areas commands)

5. METHODS FOR PRODUCING MID-1991 POPULATION ESTIMATES

While many users of demographic statistics will find geographically rebased 1991 Census data useful, others require mid-year estimates. This section explains how mid-1991 estimates by single years of age and sex for the 1998 set of local authorities were produced. Population estimates for 1991 differ from the census figures in three ways:

1. They are for mid-year (as is standard practice for estimates in the UK).
2. They count students as resident at their term-time addresses (as preferred by many users) rather than at their parental addresses.
3. They allow for the net underenumeration in the census, and are thus a calculation of the ‘true’ population of an area.

The value of a mid-year population figure is that it provides an approximate population at risk which can be used to calculate many demographic rates. The reason for producing a mid-year population for 1991 (rather than any other year) is that it is a census year, good data is available, and it allows comparison with estimates for later years. Indeed, one of the standard methods of making estimates for post-censal years, the cohort component method, takes as its starting point the estimates for a census year and then adds or subtracts the relevant numbers of births, deaths and migrants. For this method, mid-1991 estimates are vital.

It can be argued that the available data provides two broad approaches for producing the new geography estimates for Great Britain and only really one approach for Northern Ireland. The methods for producing the mid-1991 estimates for these two parts of the United Kingdom are now discussed in separate sections.

5.1 Great Britain

The first approach involves aggregation and then estimation, and the second, estimation then aggregation.

1. The first approach starts with the Census counts of the usually resident population for small areas. Using a new to old look-up table in the form of weighted membership lists of the old areas for each new area, the census counts can then be aggregated to give raw census figures for the 1998 local authorities. The process of adjusting these census figures to give mid-year estimates can then be applied in the same way as it was for the 1991 geography (discussed below). Given that census resident counts are not available in single-year age-sex groups disaggregation would be required, using the most suitable single-year data.
2. The second approach is to use the ED and OA mid-1991 estimates produced by the Estimating with Confidence (EwC) project, discussed below (Simpson et al, 1995; Simpson et al, 1998).

As the estimation process has already been carried out, it is only necessary to use the look-up table to aggregate the correct small areas to give estimates for the new areas. The small area estimates produced by the EwC project are for five-year age-sex groups so, again, disaggregation is required.

5.1.1 The OPCS method of producing subnational estimates for mid-1991

In preparing the subnational mid-1991 estimates, the Office of Population Censuses and Surveys (now ONS) took as its starting point the total estimated population for England and Wales combined (Heady et al, 1994). This was 51.1 millions, a figure based unusually not on the 1991 Census but on the 1981 Census rolled forward by the cohort component method. Shortly after the 1991 Census, a follow-up Census Validation Survey, was carried out with the aim assessing the extent of under- and over-enumeration. When the net underenumeration (as revealed by the survey) was added to the census total (along with adjustments for timing and students) it fell significantly short of the rolled-forward estimate and OPCS took the decision that the rolled-forward estimate was more reliable than the Census figure (OPCS, 1993a). This then left the task of distributing the shortfall to subnational areas. This shortfall was concentrated in the ages 0-44 and 80 and over as the census figures for the 45-79 age groups largely matched the estimates (after allowance for the timing difference). Some adjustments were possible by examining administrative records. The census count of babies aged under one year was raised slightly by examining recent birth records, and the count of armed forces was raised by examining Ministry of Defence records. For both these adjustments good geographical detail was available. For the numbers of elderly aged 80 and over Department of Social Security pension records were examined but because no geographical breakdown of this undercount was available the same scaling factors had to be used for every area. Two other adjustments were made as a result of the Census Validation Survey: it was estimated that over-imputation had wrongly added 115,000 to the England and Wales total whilst 178,000 were not counted due to enumerators missing or misclassifying dwellings. The sample size of the survey meant that these adjustments could only be distributed to six broad types of area. Within those areas the over-imputation adjustment was distributed to districts according to the number imputed people in each area, and for the net underenumeration adjustment according to the number of converted or shared dwellings in each area. After these adjustments had been made this still left over 0.9 million people to be distributed subnationally. It was decided to distribute those aged 1-19, 35-44 and 80 and over in proportion to the census figures adjusted up to this point. For those aged 20-34 the census figures as adjusted so far gave improbable sex ratios, and so adjustments were made to give more plausible ratios. The General Register Office in Scotland similarly took the 1981 estimate rolled-forward to 1991 for the whole country as its starting point and made a number of adjustments to the census figures to distribute the difference between the 1991 census figure and the rolled forward estimate. The principal end result of this process was a

set of mid-1991 estimates for districts by five-year age and sex groups (OPCS, 1993b). An important by-product was a table of adjustment factors which could be used to directly obtain mid-year estimates from census figures by sex, five-year age group and broad area of residence in Great Britain (Heady et al, 1994: 43).

5.1.2 The Estimating with Confidence project estimates

The Estimating with Confidence project produced a set of mid-1991 estimates for Census areas smaller than districts in Great Britain - wards and EDs in England and Wales, postcode sectors and OAs in Scotland (Simpson et al., 1998; EwC team, 1998 [dataset]). While it was felt that the OPCS/GRO(S) district estimates were reasonably accurate, it was clear that the distribution of these district figures pro rata to small areas based on their census populations would produce small area estimates with far too much error. While the EwC team constrained their small area estimates to agree with the OPCS/GRO(S) district totals, they devised a procedure to distribute the district adjustment more accurately across the district. The starting point of the estimation procedure (a procedure which is standard for all Great Britain) is the usually resident census counts from table S02. A computer program written by the EwC team, EWCPop, extracts these counts using SASPAC and then adjusts them in five steps (Simpson et al, 1995):

1. to place students at their term-time addresses,
2. to allow for the 21st April - 30th June timing difference,
3. to allow for the armed forces undercount,
4. to allow for all other non-response, and
5. to allow for data blurring. This very small adjustment is necessary because the random addition of -1, 0 and +1 to counts means that the sum of small area census populations within a district does not quite equal the separate census population for the district.

The EWCPop program can be run at Manchester University by registered users of MIMAS. It is executed simply by typing "ewcpop" and then selecting the county/region of interest and the type of small area - ward/postcode sector or ED/OA. Online details are available at http://www.census.ac.uk/cdu/Datasets/1991_Census_datasets/Area_Stats/Adjusted_data/Undercount_adjusted_census_data/

5.1.3 The approach using the EwC estimates

The second approach, using the EwC figures, was chosen to produce the geographically rebased mid-1991 estimates because of its greater accuracy and relative simplicity. The first approach requires census data for the new geography and then a method of adjustment. Obtaining the census data for the new geography, as already shown, is unproblematic: the adjustment part, however, is not. The OPCS-published adjustment factors are for broad area types and so the use of these would give only approximate figures. An alternative would be to make all the individual adjustments

separately, but given the vast data requirements this would be very time consuming and complex. It also assumes that it would be possible to obtain all the necessary data.

The precise method to produce the mid-1991 estimates by single years of age and sex for the 1998 local authorities is summarised in Figure 10 and explained below. A worked example of this method is given after the equations.

Step 1: Extract the EwC populations

The estimates for all EDs and OAs produced by EWCPOP were extracted from MIMAS. This data contained mid-1991 populations by sex and five-year age groups.

Step 2: Construct a look-up table

An ED/OA old to new look-up table was created from information supplied by the national statistical offices.

Step 3: Aggregate to new local authority areas

Using the look-up table, a computer program aggregated the individual ED and OA estimates into the 203 local authorities of Great Britain, i.e.

$${}_5K_y^{s,i} = \sum_{j \in i} {}_5K_y^{s,j} \tag{1}$$

where

${}_5K_y^{s,i}$ = the mid-1991 estimate population, K, aged y to y+5, of sex s, in 1998 local authority i;

${}_5K_y^{s,j}$ = the mid-1991 estimate population aged y to y+5, of sex s, in 1991 Census ED or OA j.

$\sum_{j \in i}$ = sum variables over all small areas j that are members of 1998 local authority i.

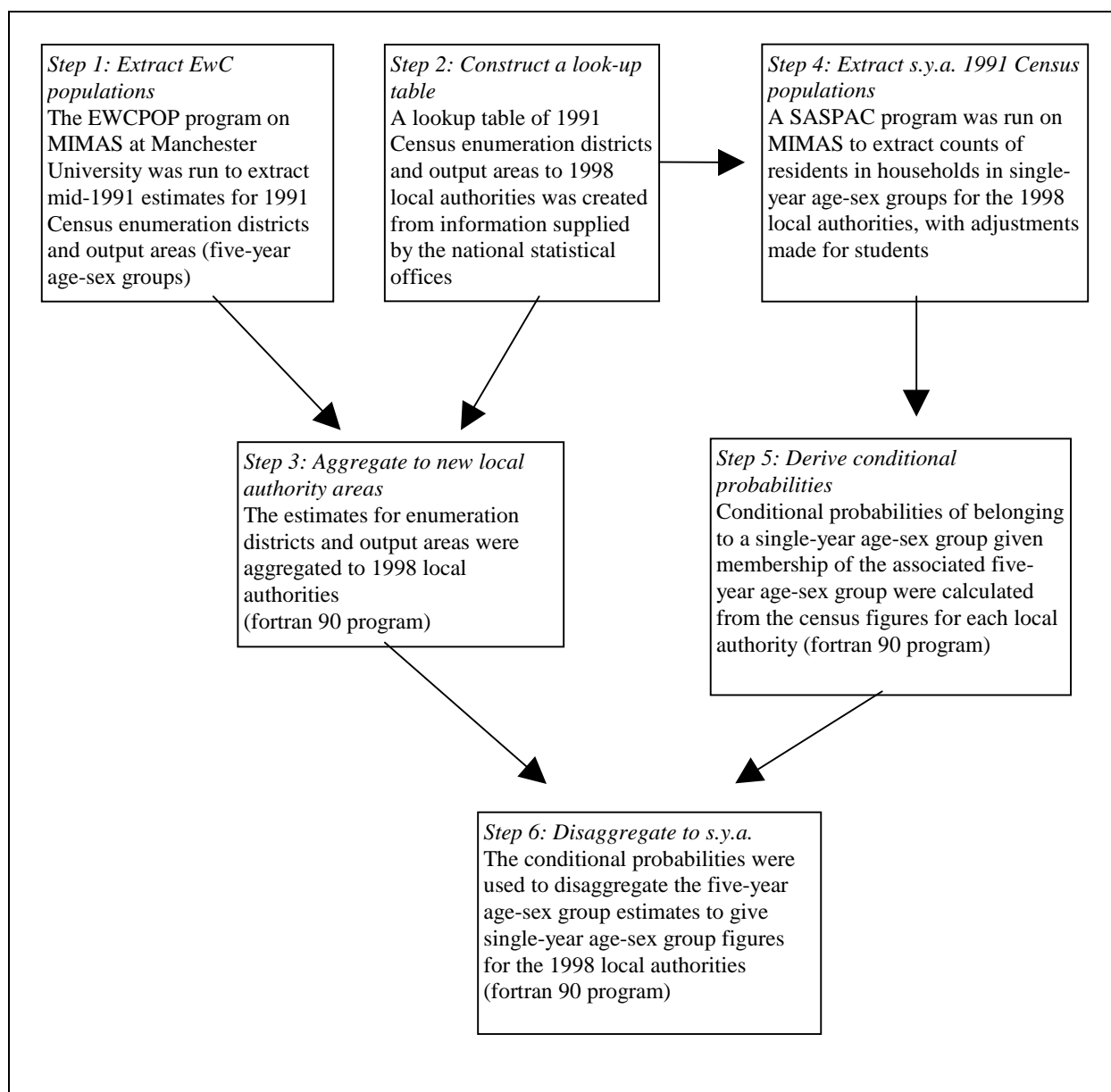


Figure 10 The method of producing mid-1991 estimates for the 1998 local authorities in Great Britain

Because the EwC team had adjusted for data blurring in their estimation procedure it was possible to aggregate large numbers of small area populations without introducing blurring error. Appendix 3 shows part of the program code used to achieve this aggregation.

Step 4: Extract single year of age and sex census data

The 1991 Census counts of residents in households by sex and single years of age were extracted by a SASPAC program using a new to old look-up table. This look-up table had to contain wards with weights because single year of age detail is only available at the ward/postcode sector level.

Using tables L38, L10 and L37, the program calculated census figures for the 1998 local authorities with students moved to their term-time addresses.

Step 5: Derive conditional probabilities of belonging to a single year age-sex group

Conditional probabilities of belonging to single-year age-sex groups given membership of the associated five-year age-sex groups were calculated using a computer program using the student-adjusted census figures. It is simply not acceptable to divide the five-year EwC data into equal sized age-sex groups because of the year by year variation in the size of birth cohorts.

$$p({}_1K_x^{s,i} | {}_1K_y^{s,i}) = \frac{{}_1C_x^{s,i}}{{}_5C_y^{s,i}} \quad \text{for } x = 5y + a \quad \text{where } a = 0, 1, 2, 3, \text{ or } 4 \quad (2)$$

where

$p({}_1K_x^{s,i} | {}_1K_y^{s,i})$ = the conditional probability of belonging to the population aged x to $x+1$ of sex s of local authority i , given membership of the population aged y to $y+5$ of sex s in that same local authority.

Note the relationship between x and y in equation (2): if y is 2, for example, then $x = 5 \times 2 + 0, 5 \times 2 + 1, 5 \times 2 + 2, 5 \times 2 + 3$ and $5 \times 2 + 4$, i.e. 10, 11, 12, 13 and 14. Also note that equation (2) is a model rather than a mathematical statement, because the left-hand side of the equation does not *strictly* equal the right-hand side.

Step 6: Disaggregate to single year of age populations

The conditional probabilities were then applied to the five-year age-sex group estimates to give single-year age-sex group figures. The calculations were again performed by a computer program.

$${}_1K_x^{s,i} = {}_5K_y^{s,i} \times p({}_1K_x^{s,i} | {}_5K_y^{s,i}) \quad (3)$$

where

${}_1K_x^{s,i}$ = the mid-1991 population aged x to $x+1$ of sex s in 1998 local authority i .

5.1.4 A worked example

The estimation procedure is illustrated through a worked example which calculates the number of males in single year age groups between the ages of 20 and 24 in York unitary authority.

Steps 1 and 2

These are not relevant to this example.

Step 3: Aggregate to new local authority areas

The aggregation of the EwC ED estimates for the 20-24 age group for York unitary authority gives a mid-1991 figure of

$${}_5K_{20}^{m, York} = 8140.$$

Step 4: Extract single year of age and sex Census data

The student-adjusted 1991 Census populations for males aged 20, 21, 22, 23, and 24 are respectively:

$${}_1C_{20}^{m, York} = 1379$$

$${}_1C_{21}^{m, York} = 1306$$

$${}_1C_{22}^{m, York} = 1435$$

$${}_1C_{23}^{m, York} = 1272$$

$${}_1C_{24}^{m, York} = 1327.$$

Step 5: Derive conditional probabilities of belonging to a single-year age-sex group

Using equation (2), the conditional probabilities are calculated from the Census data. The Census figure for the whole five-year age group is 6719.

$$p({}_1K_{20}^{m, York} \mid {}_5K_{20}^{m, York}) = \frac{{}_1C_{20}^{m, York}}{{}_5C_{20}^{m, York}} = \frac{1379}{6719} = 0.2052$$

$$p({}_1K_{21}^{m, York} \mid {}_5K_{20}^{m, York}) = \frac{{}_1C_{21}^{m, York}}{{}_5C_{20}^{m, York}} = \frac{1306}{6719} = 0.1944$$

$$p({}_1K_{22}^{m, York} \mid {}_5K_{20}^{m, York}) = \frac{{}_1C_{22}^{m, York}}{{}_5C_{20}^{m, York}} = \frac{1435}{6719} = 0.2136$$

$$p({}_1K_{23}^{m, York} | {}_5K_{20}^{m, York}) = \frac{{}_1C_{23}^{m, York}}{{}_5C_{20}^{m, York}} = \frac{1272}{6719} = 0.1893$$

$$p({}_1K_{24}^{m, York} | {}_5K_{20}^{m, York}) = \frac{{}_1C_{24}^{m, York}}{{}_5C_{20}^{m, York}} = \frac{1327}{6719} = 0.1975$$

Step 6: Disaggregate to single year of age populations

The conditional probabilities are used to disaggregate the five-year estimate of 8140, given by equation (3).

$${}_1K_{20}^{m, York} = {}_5K_{20}^{m, York} \times p({}_1K_{20}^{m, York} | {}_5K_{20}^{m, York}) = 8140 \times 0.2052 = 1670$$

$${}_1K_{21}^{m, York} = {}_5K_{20}^{m, York} \times p({}_1K_{21}^{m, York} | {}_5K_{20}^{m, York}) = 8140 \times 0.1944 = 1582$$

$${}_1K_{22}^{m, York} = {}_5K_{20}^{m, York} \times p({}_1K_{22}^{m, York} | {}_5K_{20}^{m, York}) = 8140 \times 0.2136 = 1739$$

$${}_1K_{23}^{m, York} = {}_5K_{20}^{m, York} \times p({}_1K_{23}^{m, York} | {}_5K_{20}^{m, York}) = 8140 \times 0.1893 = 1541$$

$${}_1K_{24}^{m, York} = {}_5K_{20}^{m, York} \times p({}_1K_{24}^{m, York} | {}_5K_{20}^{m, York}) = 8140 \times 0.1975 = 1608.$$

5.1.5 Approximations

It is important to stress that a number of unavoidable approximations were included in the estimation procedure.

- It was assumed that the initial enumeration district and output area estimates supplied by the EwC team were fairly accurate, and implicit in this was the acceptance of the OPCS district estimates, to which the EwC small area figures were constrained.
- The look-up table information supplied by ONS was on a best-fit ED/OA basis. This meant that wherever an enumeration district or output area had been split between two or more 1998 local authority areas it was assigned to the new authority which contained the largest share of its population. The populations of 1998 local authorities built from part wards/postcode sectors are therefore less accurate.
- The creation of student-adjusted residents in households involved adding to the resident counts of table L38 non-resident students whose term-time address was recorded as “this address”, and subtracting residents whose term-time address was recorded as “elsewhere”. The problem was

that the table of students, L10, is only for those aged 16 and over, and so misses out boarding-school pupils.

- In step 5, the probabilities of belonging to single-year age groups given membership of five-year age groups were calculated from the student-adjusted census data. This assumed, however, that the net underenumeration between single-year age groups *within* associated five-year age groups was the same. Furthermore, no account was taken of the impact of the timing difference between census night and mid-year on the relative sizes of single-year age groups.

5.1.6 The National Statistical Offices' estimates

The National Statistical Offices have recently published reports which include geographically rebased mid-1991 estimates (ONS, 1996a, ONS, 1996b, ONS, 1997, ONS, 1998b, GRO(S), 1996, and GRO(S), 1998c). These volumes have shown only population totals or populations by broad age-sex group, and have included very brief accounts of the methods used to produce the estimates.

ONS makes mid-year population estimates in England and Wales for areas termed building bricks, the boundaries of which are the intersections between local government districts and district health authorities. This enables the production of estimates for two sets of geographies from just one set of estimates. Many of the new local government areas coincided exactly with whole building bricks (as defined under the old boundaries) rendering it unnecessary to make new estimates for these areas. For those new local authorities containing part building bricks, however, new estimates had to be produced. In England ONS used the EwC aggregation method (as described in section 5.1.3) to obtain estimates for the part-building bricks. These figures were then simply added to the whole building brick estimates to obtain the new local authority population (ONS, 1996b). For Wales a different method was used to calculate part-building brick estimates (ONS, 1996a) which involved going back to the census data and adjusting it using the same procedure as for the old geography (as described in section 5.1.1). Similarly in Scotland, GRO(S) went back to the census data to calculate estimates for part-districts, rather than using the EwC aggregation method (Compton, 1998).

5.2 Northern Ireland

For Northern Ireland the available data for producing single year age-sex group estimates for district council areas consisted of census data and estimates produced by NISRA. The appropriate census data is in table SN02, the usually resident population by sex and five-year age group, table SN10, the term-time address of students aged 16 and over, and table SN37, residents in households aged 16-24 by single-year age-sex groups. No single year of age census data is available for all ages for Northern Ireland, unlike the rest of the United Kingdom. The available mid-1991

estimates consisted of district council area totals and health board area figures by sex and single years of age. The 26 district council areas aggregate perfectly to the four health board areas. The estimation procedure is summarised in Figure 11 and explained below.

5.2.1 The method used

Step 1: Extract census counts for the 1998 local authority areas

A SASPAC program extracted counts of the usually resident population by five year age-sex groups for each of the district council areas using table SN02. Allowance was made for the boundary change by using the new zone and using areas SASPAC commands. Students were transferred to their term-time addresses by using counts in table SN10, which were sex disaggregated using table SN37.

Step 2: Extract census counts for the 1998 health board areas

A second SASPAC program extracted similar student-adjusted census counts for the four health board areas. These have not undergone boundary changes.

Step 3: Derive conditional probabilities

The census figures produced in step 1 were used to calculate conditional probabilities of belonging to a district council area population given ‘membership’ of a health board area population.

i.e.

$$p({}_1K_x^{s,d} | {}_1K_x^{s,h}) = \frac{{}_n C_y^{s,d}}{{}_n C_y^{s,h}} \quad \text{for } d \in h \text{ and } x = y, y+1, \dots, y+n \quad (4)$$

where

$p({}_1K_x^{s,d} | {}_1K_x^{s,h})$ = the conditional probability of being in district council area d age x to $x+1$ and sex s given membership of health board population h age x to $x+1$ and sex s , where $d \in h$),

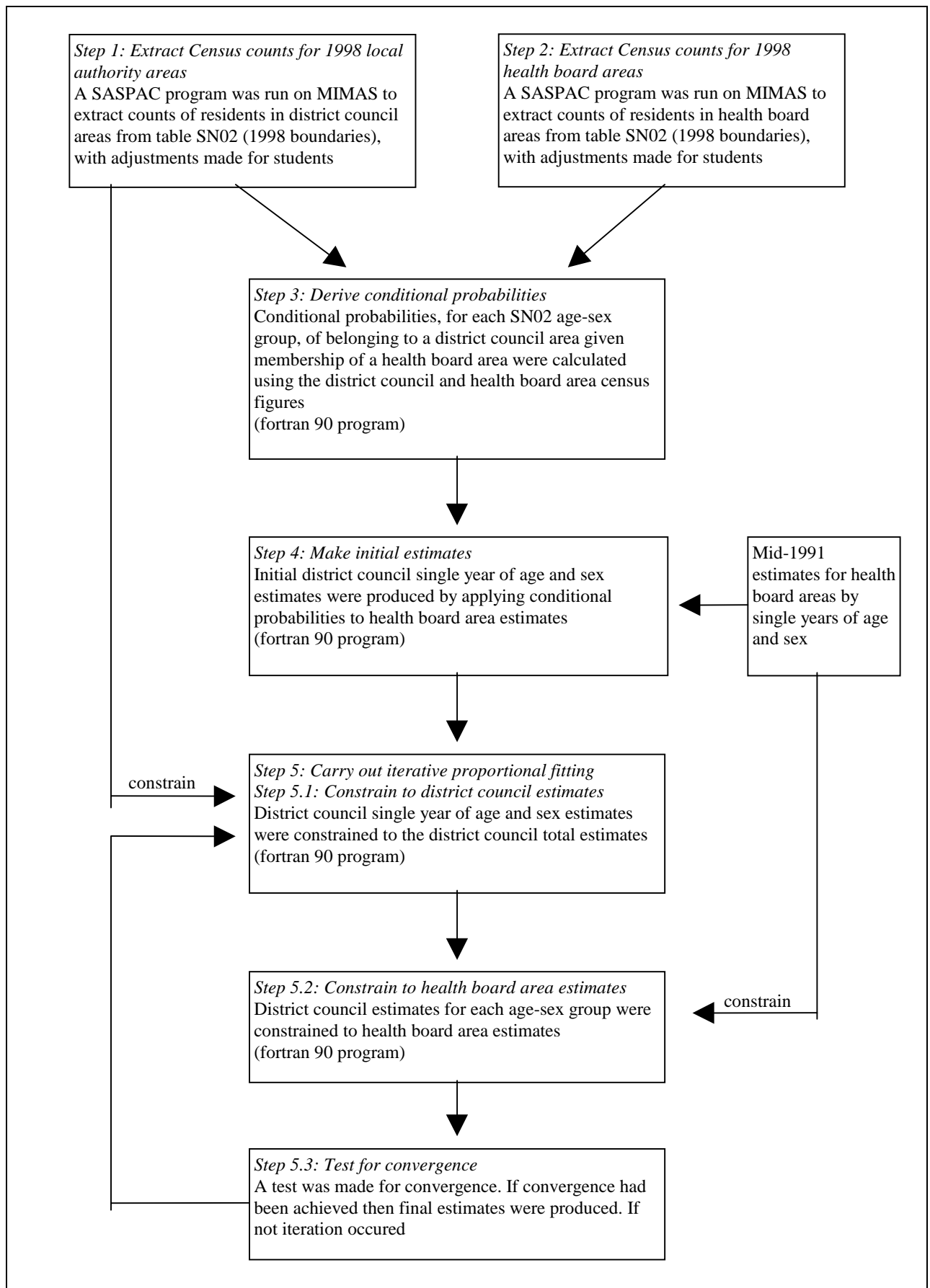


Figure 11 The method of producing mid-1991 estimates for the 1998 local authorities in Northern Ireland

${}_n C_y^{s,d}$ = the student-adjusted 1991 Census population of those in district council d age y to y+n and of sex s, where n is the size of the variable age groups given in table SN02³, and

${}_n C_y^{s,h}$ = the student-adjusted 1991 Census population of those in health board h age y to y+n and sex s.

Step 4: Make initial estimates

The single year of age and sex health board area mid-1991 estimates were multiplied by the conditional probabilities to give initial single year of age and sex district council estimates, i.e.

$${}_1 K_x^{s,d}[0] = {}_1 K_x^{s,h} \times p({}_1 K_x^{s,d} | {}_1 K_x^{s,h}) \quad (5)$$

where

${}_1 K_x^{s,d}[0]$ = the provisional mid-1991 population aged x to x+1 of sex s in district council area d; and

${}_1 K_x^{s,h}$ = the mid-1991 population aged x to x+1 of sex s in health board area h.

Step 5: Carry out iterative proportional fitting

The initial estimates needed to be constrained so that (a) the sums of the age-sex groups for each district council area agreed with the district council totals, and (b) so that the sums of individual age-sex groups of district council areas within a particular health board area agreed with the individual age-sex totals for the health board area.

Step 5.1: Constrain to district council estimates

The provisional single year of age and sex district council area populations were constrained so that they summed exactly to the district council totals, i.e.

$${}_1 K_x^{s,d}[1] = {}_1 K_x^{s,d}[0] \times \frac{K^d}{\sum_{x=0}^{90+} \sum_{g=1}^2 {}_1 K_x^{s,d}[0]} \quad (6)$$

where

³ 0-4, 5-9, 10-14, 15, 16-17, 18-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80-84, 85-89, 90+

${}_1K_x^{s,d} [1]$ = the district council mid-1991 estimates by sex and single years of age constrained to sum to the given district council totals, and

$\frac{K^d}{\sum_{x=0}^{90+} \sum_{g=1}^2 {}_1K_x^{s,d} [0]}$ = the scaling factor.

Step 5.2: Constrain to health board estimates

The populations constrained in step 5.1 to match district council totals were then constrained so that single year age-sex group district council populations summed for a health board area matched the given health board area estimates, i.e.

$${}_1K_x^{s,d} [2] = {}_1K_x^{s,d} [1] \times \frac{{}_1K_x^{s,h}}{\sum_{d \in h} {}_1K_x^{s,d} [1]} \tag{7}$$

where

${}_1K_x^{s,d} [2]$ = the district council mid-1991 estimates by sex and single years of age constrained to both district council totals and health board area single years of age-sex figures, and

$\frac{{}_1K_x^{s,h}}{\sum_{d \in h} {}_1K_x^{s,d} [1]}$ = the scaling factor.

Step 5.3: Test for convergence

A check was made for convergence. If

$$| {}_1K_x^{s,d} [2] - {}_1K_x^{s,d} [0] | < 0.5$$

then the estimates were accepted and the IPF routine was stopped. If not, then step 5 was run again with the values of ${}_1K_x^{s,d} [0]$ in step 5.1 of the next run replaced by ${}_1K_x^{s,d} [2]$ of step 5.2 of the previous run.

5.2.2 Approximations

As with the Great Britain estimation procedure, a number of approximations can be identified.

- It was not possible in the student-adjusted census populations to adjust for boarding school students aged under 16.

- Given that the census data ${}_n C_y^{s,d}$ and ${}_n C_y^{s,h}$ was available mostly in five-year age groups, the conditional probabilities for each single year age group within that five-year age group were the same. This involved the assumption that the conditional probability of belonging to a single-year age group in a particular district council area did not vary between single-year age groups within the relevant five-year age group. In this method was also the implicit assumption that between district council areas within a particular health board area, the undercount and timing adjustments did not vary within five-year age groups.

6. RESULTS

6.1 Total populations

Appendix 2 shows the Census and mid-1991 estimate total populations of the current 229 local authorities of the United Kingdom. As the table shows, the largest of the new unitary authorities in England is the City of Bristol, with a mid-1991 population of 379 thousand, and the smallest is Rutland with just 33 thousand. In Wales the largest and smallest unitary authorities are respectively Cardiff and Merthyr Tydfil with populations of 300 thousand and 60 thousand. In Scotland the equivalent council areas are Glasgow City (631 thousand) and the Orkney islands (19 thousand), and in Northern Ireland the district council areas are Belfast (294 thousand) and Moyle (15 thousand).

6.2 Age-sex structures

The age-sex structure of some selected local authorities is displayed in a series of population pyramids in Figure 12. Some comments on these pyramids are appropriate. They show the considerable variety of demographic structures at local level. The structures are 'explained' in full by the population history of each birth cohort contributing to the corresponding single year of age population. The past history of fertility fluctuations is important in ages up to 65; migration is important in young adult ages; mortality experience is influential in the elderly ages.

Figure 12(a) shows the population pyramid of Aberdeenshire. It resembles the national profile but has surplus numbers in the middle working ages, reflecting the attraction to the region of oil service workers.

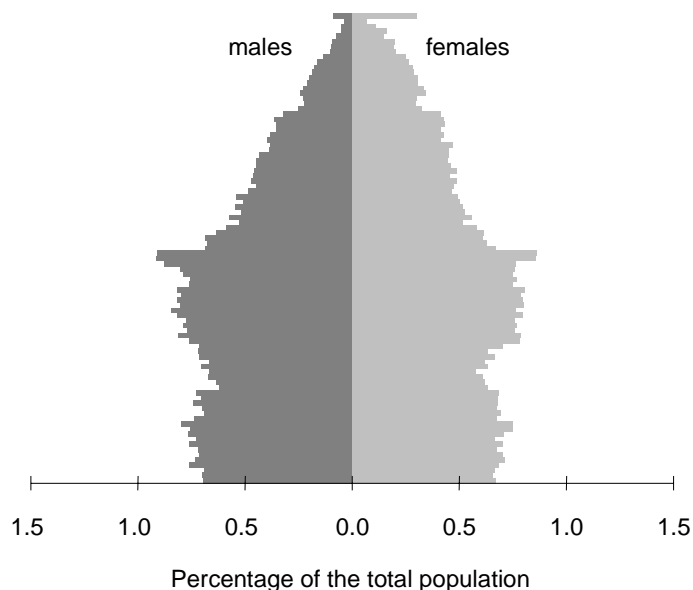


Figure 12 (a) Aberdeenshire council area

Figure 12(b) shows the age-sex structure of Belfast's population. There is a considerable surplus in the late teens and twenties. This reflects the attraction of Northern Ireland's largest city to the province's young adults, seeking tertiary level education in the city's further and higher education institutions and jobs in government and the service industry.

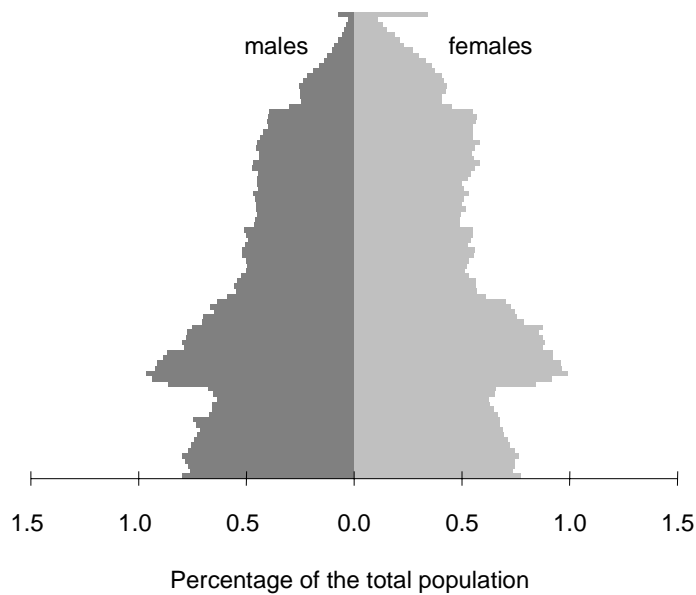


Figure 12 (b) Belfast district council area

Figure 12(c) displays the very regular population pyramid for the north Wales unitary authority of Conwy. The continuance of substantial sized age groups into the elderly ages means that these ages are heavily over-represented compared with the nation. Conwy attracts migrants around retirement. Note the heavy female surplus which develops at the elderly ages reflecting the higher mortality experience of the male population.

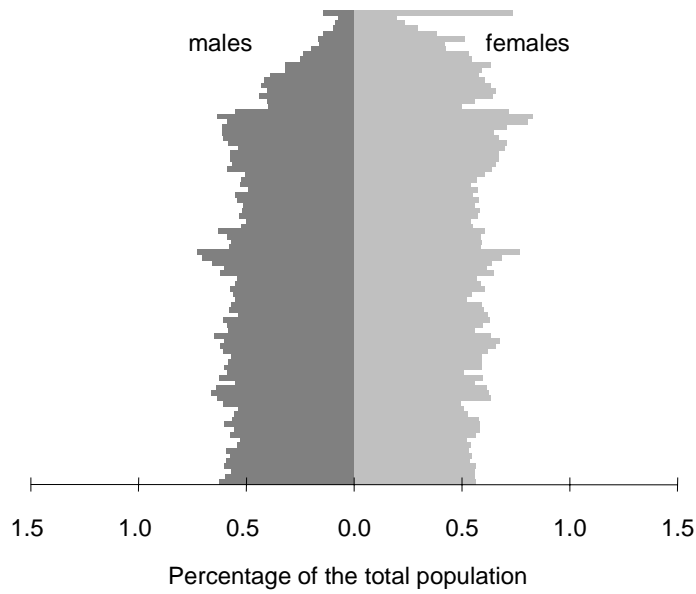


Figure 12 (c) Conwy unitary authority

The next pyramid, figure 12(d), shows the youngest age profile out of the 229 local authorities of the United Kingdom, that of Derry district council area in the western part of Northern Ireland. The youthful profile reflects a history of much higher than average fertility and a preponderance of high fertility Catholic residents (Compton, 1995). Note, however, that a reduction in fertility has set in over the decade prior to 1991.

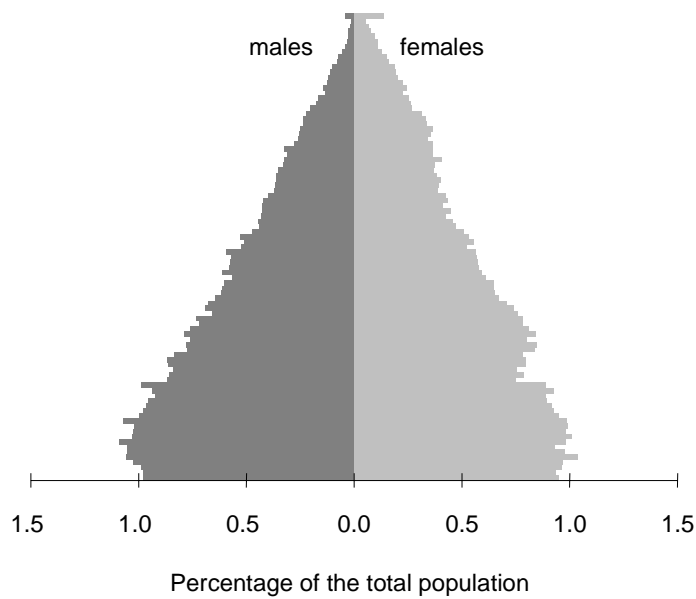


Figure 12 (d) Derry district council area

Figure 12(e) shows the profile for the East Riding of Yorkshire unitary authority, the small town and rural remainder of the East Riding, less its largest urban centre, Hull. Such districts attract migrants looking for lower density milieu but fertility is relatively low. The middle age peak at 43 and 44 shows the survival in this unitary authority area of the very large birth cohorts of 1947 and 1948 generated by the reunion of couples kept apart by the Second World War.

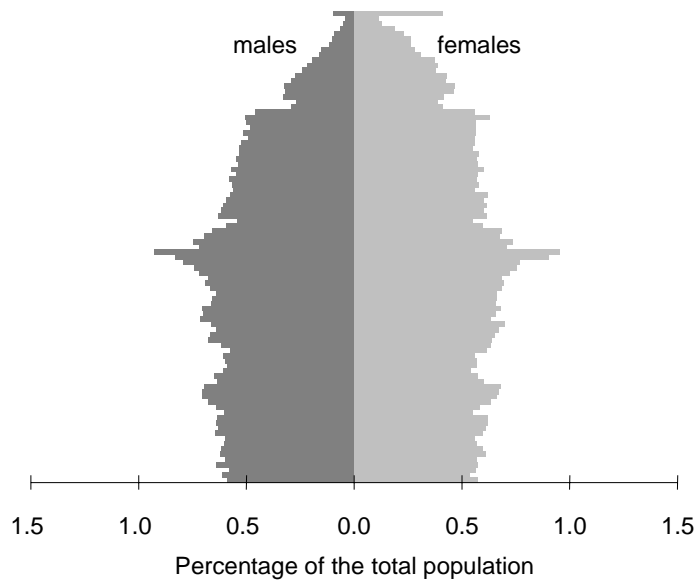


Figure 12 (e) The East Riding of Yorkshire unitary authority

The population age profile of Newham borough in inner London (Figure 12(f)) resembles closely the typical schedule of migration intensity by age. A closer examination reveals that the young adult bulge is older than the migration norm, peaking in the early thirties. This profile is the product of large recent immigration to the borough of Bangladeshis, either direct from their country of origin or moving out from the neighbouring borough of Tower Hamlets - the most important focus of Bangladeshi migration to the UK (Owen, 1996). The shape of the age profile in the childhood ages reflects the high fertility of Bangladeshi immigrants.

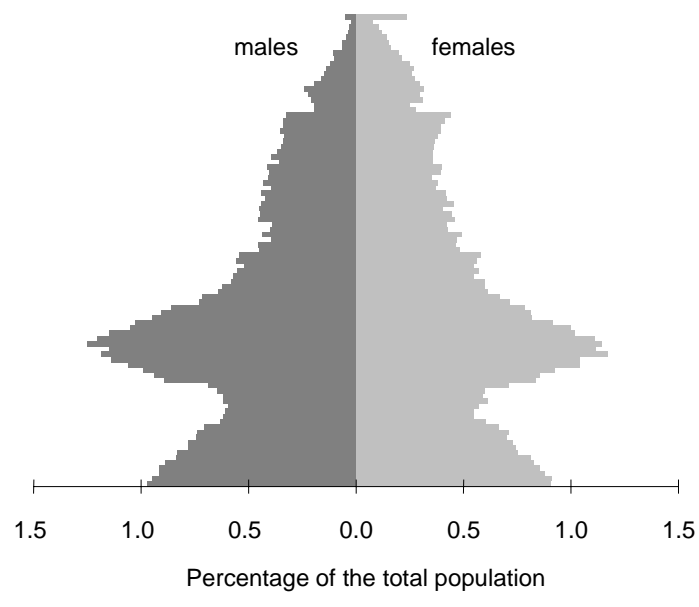


Figure 12 (f) Newham London borough

7. SUMMARY

This paper has described how the 1991 and 1998 local government geographies can be linked through the use of look-up tables. Maps of the old and new geographies and a new to old look-up table covering the whole of the United Kingdom have been presented. Section 4 described methods for extracting geographically rebased 1991 Census data, and included an example of a SASPAC program used to extract usually resident 1991 Census populations for the local authorities of the Yorkshire and the Humber region. Similar SASPAC programs covering the rest of the United Kingdom have been supplied to MIMAS, and new SAS system files based on the 1998 geography are now available (see http://www.census.ac.uk/cdu/Software/SASPAC/Naming_conventions/System_files.htm#administrative_geography). Methods for producing mid-1991 population estimates by single years of age and sex for the 1998 areas were described in section 5, and some selected results of those estimation procedures were displayed in section 6. The method for producing local authority estimates for Great Britain (section 5.1) used the Estimating with Confidence mid-1991 five-year age-sex group estimates for enumeration districts and output areas. These were then aggregated to give five year age-sex estimates for the 203 local authorities. Single-year age-sex disaggregation was provided by student-adjusted census data from table L38. The estimation procedure for Northern Ireland (section 5.2) was more complex because no EwC data was available. Detailed mid-1991 estimates for health board areas, population total estimates for district council areas, and some 1991 Census data was used to produce the single year age-sex figures for the district council areas. Iterative proportional fitting was employed so that the sums of various populations matched their totals.

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Appendix 1

A look-up table of 1998 local authorities in terms of 1991 Census areas

This table is available to UK academics (staff and students) registered to use the 1991 Census area statistics at the Census Dissemination Unit, MIMAS Service, Manchester Computing. See <http://census.ac.uk/cdu/> for details of how to access the files. Equivalent information is also available from ONS Geography Customer Support. See <http://www.ons.gov.uk/> for details.

Appendix 2

Local authority populations in 1991

Date	1991 Census	1991 Census	Mid-1991	Mid-1991
Population definition	usually resident	usually resident	estimate	estimate
Geography	1991	1998	1991	1998
<i>ENGLAND</i>	47,055,204	47,055,204	48,208,060	48,208,060
<i>London</i>	6,679,699	6,679,945	6,889,948	6,890,365
City of London	4,142	5,614	4,124	5,640
Barking & Dagenham	143,681	153,119	146,167	155,921
Barnet	293,564	293,951	299,946	300,334
Bexley	215,615	215,615	219,443	219,443
Brent	243,025	236,572	248,607	242,311
Bromley	290,609	290,869	294,710	295,086
Camden	170,444	170,444	181,707	181,707
Croydon	313,510	313,679	319,187	319,357
Ealing	275,257	279,532	281,795	285,880
Enfield	257,417	257,417	263,156	263,156
Greenwich	207,650	206,554	213,590	212,442
Hackney	181,248	181,653	187,879	188,278
Hammersmith & Fulham	148,502	148,273	156,200	155,962
Haringey	202,204	201,799	211,755	211,356
Harrow	200,100	200,905	203,767	204,746
Havering	229,492	229,492	232,507	232,507
Hillingdon	231,602	231,602	236,756	236,756
Hounslow	204,397	201,428	209,061	206,031
Islington	164,686	163,684	173,532	172,512
Kensington & Chelsea	138,394	138,623	145,321	145,559
Kingston upon Thames	132,996	133,503	137,533	138,058
Lambeth	244,834	243,371	256,590	255,033
Lewisham	230,983	232,154	240,760	241,882
Merton	168,470	168,470	171,831	171,831
Newham	212,170	211,307	221,268	220,405
Redbridge	226,218	218,874	231,217	223,573
Richmond upon Thames	160,732	162,661	164,259	166,225
Southwark	218,541	219,602	227,193	228,317
Sutton	168,880	168,880	171,357	171,357
Tower Hamlets	161,064	160,594	168,097	167,601
Waltham Forest	212,033	211,697	217,663	217,318
Wandsworth	252,425	252,827	265,258	265,692
City of Westminster	174,814	175,180	187,712	188,091

Appendix 2 *continued*

Date	1991 Census	1991 Census	Mid-1991	Mid-1991
Population definition	usually resident	usually resident	estimate	estimate
Geography	1991	1998	1991	1998
<i>Metropolitan Districts</i>				
Barnsley	220,937	221,621	224,423	225,136
Birmingham	961,041	970,442	1,006,511	1,016,159
Bolton	258,584	258,584	262,888	262,888
Bradford	457,344	456,929	475,436	475,018
Bury	176,760	177,288	179,139	179,678
Calderdale	191,585	191,585	193,982	193,982
Coventry	294,387	293,917	305,574	305,100
Doncaster	288,854	288,854	293,302	293,302
Dudley	304,615	305,070	309,426	309,878
Gateshead	199,588	199,588	203,078	203,078
Kirklees	373,127	372,730	381,489	381,082
Knowsley	152,091	151,941	156,853	156,696
Leeds	680,722	681,319	717,388	717,982
Liverpool	452,450	452,450	480,749	480,749
Manchester	404,861	400,491	438,500	434,056
Newcastle upon Tyne	259,541	259,541	278,161	278,161
North Tyneside	192,286	192,286	195,456	195,456
Oldham	216,531	216,531	219,596	219,596
Rochdale	202,164	202,164	204,758	204,758
Rotherham	251,637	252,168	254,926	255,468
Salford	220,463	222,529	230,936	233,005
Sandwell	290,091	290,091	294,788	294,788
Sefton	289,542	289,542	295,165	295,165
Sheffield	501,202	500,671	529,268	528,727
Solihull	199,859	200,329	201,242	201,716
South Tyneside	154,697	154,697	157,210	157,210
St Helens	178,764	179,218	180,863	181,338
Stockport	284,395	286,531	288,288	290,470
Sunderland	289,040	290,105	296,446	297,511
Tameside	216,431	216,431	219,759	219,759
Trafford	212,731	214,437	215,756	217,479
Wakefield	310,915	310,709	316,211	315,988
Walsall	259,488	259,488	263,391	263,391
Wigan	306,521	304,001	310,864	308,320
Wirral	330,795	330,795	336,048	336,048
Wolverhampton	242,190	243,586	248,513	249,922

Appendix 2 *continued*

Date	1991 Census	1991 Census	Mid-1991	Mid-1991
Population definition	usually resident	usually resident	estimate	estimate
Geography	1991	1998	1991	1998
<i>Unitary authorities</i>				
Bath & North East Somerset	-	158,692	-	164,835
Blackburn with Darwen	-	136,612	-	137,865
Blackpool	-	146,069	-	149,827
Bournemouth	-	151,302	-	158,796
Bracknell Forest	-	95,949	-	98,768
Brighton & Hove	-	228,946	-	243,881
City of Bristol	-	376,146	-	397,017
Darlington	-	98,906	-	99,942
Derby	-	218,802	-	225,411
East Riding of Yorkshire	-	291,974	-	295,504
Halton	-	123,716	-	124,931
Hartlepool	-	90,409	-	91,467
Herefordshire	-	159,850	-	161,349
City of Kingston upon Hull	-	254,117	-	266,501
Leicester	-	270,493	-	284,736
Luton	-	171,671	-	174,559
Medway	-	240,228	-	243,334
Middlesborough	-	140,849	-	146,445
Milton Keynes	-	176,330	-	179,232
North East Lincolnshire	-	159,662	-	161,661
North Lincolnshire	-	152,287	-	153,636
North Somerset	-	177,472	-	179,830
Nottingham	-	263,522	-	280,929
Peterborough	-	152,697	-	154,557
Plymouth	-	243,373	-	254,399
Poole	-	133,050	-	135,068
Portsmouth	-	174,697	-	188,766
Reading	-	128,877	-	136,214
Redcar & Cleveland	-	145,123	-	146,431
Rutland	-	31,489	-	33,228
Slough	-	104,231	-	105,627
South Gloucestershire	-	220,364	-	223,219
Southampton	-	196,864	-	207,301
Southend-on-Sea	-	158,517	-	162,511
Stockton-on-Tees	-	173,912	-	175,387
Stoke-on-Trent	-	244,637	-	253,097
Swindon	-	170,850	-	172,948

Appendix 2 *continued*

Date	1991 Census	1991 Census	Mid-1991	Mid-1991
Population definition	usually resident	usually resident	estimate	estimate
Geography	1991	1998	1991	1998
Telford & Wrekin	-	139,516	-	141,898
Thurrock	-	127,819	-	129,571
Torbay	-	119,674	-	122,584
Warrington	-	182,685	-	185,187
West Berkshire	-	136,700	-	139,328
Isle of Wight	-	124,577	-	126,338
Windsor & Maidenhead	-	132,465	-	134,241
Wokingham	-	139,189	-	142,032
York	-	166,304	-	173,585
<i>Two-tier counties</i>				
Bedfordshire	524,105	352,434	532,417	357,858
Buckinghamshire	632,487	454,691	639,129	458,404
Cambridgeshire	645,125	492,428	668,713	514,156
Cheshire	956,616	650,215	966,113	655,995
Cornwall	468,425	468,425	474,144	474,144
Cumbria	483,163	483,163	489,202	489,202
Derbyshire	928,636	709,834	943,135	717,725
Devon	1,009,950	646,903	1,038,704	661,721
Dorset	645,166	361,215	660,495	367,036
Durham	593,430	493,459	605,775	504,769
East Sussex	690,447	461,501	715,582	471,701
Essex	1,528,577	1,240,818	1,546,882	1,253,365
Gloucestershire	528,370	528,370	539,381	539,381
Hampshire	1,541,547	1,168,004	1,581,901	1,184,243
Hertfordshire	975,829	977,510	988,652	990,189
Kent	1,508,873	1,268,645	1,536,111	1,292,777
Lancashire	1,383,998	1,101,317	1,409,874	1,122,339
Leicestershire	867,521	565,539	894,406	576,442
Lincolnshire	584,536	584,536	591,025	591,025
Norfolk	745,613	745,613	759,373	759,373
Northamptonshire	578,807	578,807	586,624	586,625
Northumberland	304,694	304,694	306,678	306,678
North Yorkshire	702,161	535,857	719,071	545,225
Nottinghamshire	993,872	730,350	1,020,214	739,285
Oxfordshire	547,584	547,584	580,917	580,917
Shropshire	406,387	266,871	411,629	269,731
Somerset	460,368	460,368	468,362	468,363

Appendix 2 *continued*

Date	1991 Census	1991 Census	Mid-1991	Mid-1991
Population definition	usually resident	usually resident	estimate	estimate
Geography	1991	1998	1991	1998
Staffordshire	1,031,135	784,647	1,049,785	794,827
Suffolk	636,266	636,266	653,810	653,810
Surrey	1,018,003	1,014,349	1,033,641	1,029,903
Warwickshire	484,247	484,247	489,198	489,198
West Sussex	702,290	703,553	712,320	713,605
Wiltshire	564,471	395,390	571,789	400,219
Worcestershire	-	507,500	-	514,431
<i>WALES</i>	2,835,073	2,835,073	2,891,461	2,891,461
<i>Unitary authorities</i>				
Isle of Anglesey	-	69,149	-	69,435
Blaenau Gwent	-	72,250	-	72,987
Bridgend	-	128,242	-	129,321
Caerphilly	-	169,577	-	171,524
Cardiff	-	285,291	-	299,788
Carmarthenshire	-	168,364	-	170,490
Ceredigion	-	63,094	-	66,557
Conwy	-	106,321	-	108,522
Denbighshire	-	90,548	-	91,664
Flintshire	-	141,344	-	142,678
Gwynedd	-	113,331	-	116,038
Merthyr Tydfil	-	59,317	-	59,928
Monmouthshire	-	79,940	-	80,389
Neath Port Talbot	-	138,238	-	139,510
Newport	-	133,318	-	136,899
Pembrokeshire	-	112,085	-	112,971
Powys	-	119,019	-	120,163
Rhondda, Cynon, Taff	-	232,592	-	237,424
Swansea	-	223,190	-	231,532
Torfaen	-	90,527	-	91,351
The Vale of Glamorgan	-	118,039	-	119,364
Wrexham	-	121,296	-	122,921
<i>SCOTLAND</i>	4,998,567	4,998,567	5,107,000	5,107,000
<i>Council Areas</i>				
Aberdeen City	-	204,885	-	214,950
Aberdeenshire	-	215,387	-	216,460
Angus	-	107,853	-	108,282

Appendix 2 *continued*

Date	1991 Census	1991 Census	Mid-1991	Mid-1991
Population definition	usually resident	usually resident	estimate	estimate
Geography	1991	1998	1991	1998
Argyll & Bute	-	92,046	-	93,517
Clackmannanshire	-	47,679	-	48,400
Dumfries & Galloway	-	147,805	-	147,700
Dundee City	-	149,911	-	156,470
East Ayrshire	-	122,455	-	124,290
East Dunbartonshire	-	109,405	-	110,664
East Lothian	-	84,114	-	84,920
East Renfrewshire	-	85,353	-	86,348
City of Edinburgh	-	418,747	-	439,496
Eilean Siar	-	29,600	-	29,225
Falkirk	-	141,146	-	143,096
Fife	-	341,199	-	349,400
Glasgow City	-	606,655	-	631,179
Highland	-	204,004	-	204,100
Inverclyde	-	90,103	-	91,580
Midlothian	-	79,012	-	80,215
Moray	-	83,616	-	84,190
North Ayrshire	-	136,875	-	139,060
North Lanarkshire	-	323,821	-	328,716
Orkney Islands	-	19,612	-	19,469
Perth & Kinross	-	126,226	-	127,758
Renfrewshire	-	173,208	-	176,572
Scottish Borders	-	103,881	-	104,100
Shetland Islands	-	22,522	-	22,582
South Ayrshire	-	112,658	-	113,550
South Lanarkshire	-	300,143	-	304,843
Stirling	-	78,833	-	81,480
West Dunbartonshire	-	95,984	-	97,793
West Lothian	-	143,971	-	146,294
<i>NORTHERN IRELAND</i>	1,577,836	1,577,836	1,601,350	1,601,350
<i>District Council areas</i>				
Antrim	44,516	44,516	45,652	45,652
Ards	64,764	64,764	64,929	64,929
Armagh	51,817	51,817	51,539	51,539
Ballymena	56,641	56,641	56,164	56,164
Ballymoney	24,198	24,198	24,028	24,028

Appendix 2 *continued*

Date	1991 Census	1991 Census	Mid-1991	Mid-1991
Population definition	usually resident	usually resident	estimate	estimate
Geography	1991	1998	1991	1998
Banbridge	33,482	35,779	33,424	35,728
Belfast	279,237	279,237	294,430	294,430
Carrickfergus	32,750	32,750	33,138	33,138
Castlereagh	60,799	60,799	61,527	61,527
Colerane	50,438	50,438	52,961	52,961
Cookstown	31,082	31,082	30,735	30,735
Craigavon	74,986	74,986	75,156	75,156
Derry	95,371	95,371	97,582	97,582
Down	58,008	58,008	58,525	58,525
Dungannon	45,428	45,428	45,034	45,034
Fermanagh	54,033	54,033	54,101	54,101
Larne	29,419	29,419	29,334	29,334
Limavady	29,567	29,567	29,555	29,555
Lisburn	99,458	99,458	101,045	101,045
Magherafelt	36,293	36,293	35,841	35,841
Moyle	14,789	14,789	14,617	14,617
Newry & Mourne	82,943	80,646	82,663	80,359
Newtownabbey	74,035	74,035	75,987	75,987
North Down	71,832	71,832	72,432	72,432
Omagh	45,809	45,809	45,585	45,585
Strabane	36,141	36,141	35,366	35,366

Note:

- = local authority not in existence at that date.

Sources:

1. 1991 Census usually resident population, 1991 boundaries: OPCS, GRO(S) and CONI, 1998a [dataset]
2. 1991 Census usually resident population, 1998 boundaries: OPCS, GRO(S) and CONI, 1998b [dataset]
3. Mid-1991 estimate population, 1991 boundaries: Wilson, 1998a [dataset]
4. Mid-1991 estimate population, 1998 boundaries: Wilson, 1998b [dataset]

Appendix 3

```
program newewc

  implicit none

  ! Tom Wilson

  ! Variable declarations
  real(kind=selected_real_kind(p=10,r=10)) :: oldpop(146586,39)
  real(kind=selected_real_kind(p=10,r=10)) :: newpop(203,39)=0.0
  integer :: col,i
  integer :: sn98a(146586) ! Serial number 0-203 of new areas in LUT
  integer :: sn91(146586) ! Serial number 0-146586 of EDs/OAs in LUT
  integer :: sn98b(203) ! Serial number 0-203 of new areas in ukreg.lst
  character(len=29) :: areaname(203)

  ! Format statements
  100 format(t121,39f8.2)
  101 format(t62,i6,t105,i3)
  102 format(f10.2/7f10.2/7f10.2/5f10.2/7f10.2/7f10.2/5f10.2)
  103 format(a29,t31,i3)
  104 format(/i3,2x,a29)
  105 format(/a16,f12.2)

  ! Files are opened
  open(unit=1,file='ewcpop.dat',recl=433,status='old')
  open(unit=2,file='ewclut.dat',status='old')
  open(unit=3,file='newpop.dat',status='unknown')
  open(unit=4,file='ukreg.lst',status='old')

  ! EwC ED/OA population data is read in
  do i=1,146586
    read(unit=1,fmt=100) (oldpop(i,col),col=1,39)
  end do
  close(unit=1)

  ! LUT is read in
  do i=1,146586
    read(unit=2,fmt=101) sn91(i),sn98a(i)
  end do
  close(unit=2)

  ! List of area names is read in
  do i=1,203
    read(unit=4,fmt=103) areaname(i),sn98b(i)
  end do
  close(unit=4)

  ! Aggregation takes place
  do i=1,146586
    do col=1,39
      newpop(sn98a(i),col)=newpop(sn98a(i),col)+oldpop(sn91(i),col)
    end do
  end do

  ! New area EwC estimates are written out
  do i=1,203
    write(unit=3,fmt=104) sn98b(i),areaname(i)
    write(unit=3,fmt=102) (newpop(i,col),col=1,39)
  end do
  close(unit=3)

end program newewc
```

The fortran 90 program code used to aggregate the EwC ED and OA mid-1991 population estimates to the 1998 local authorities