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

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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

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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.

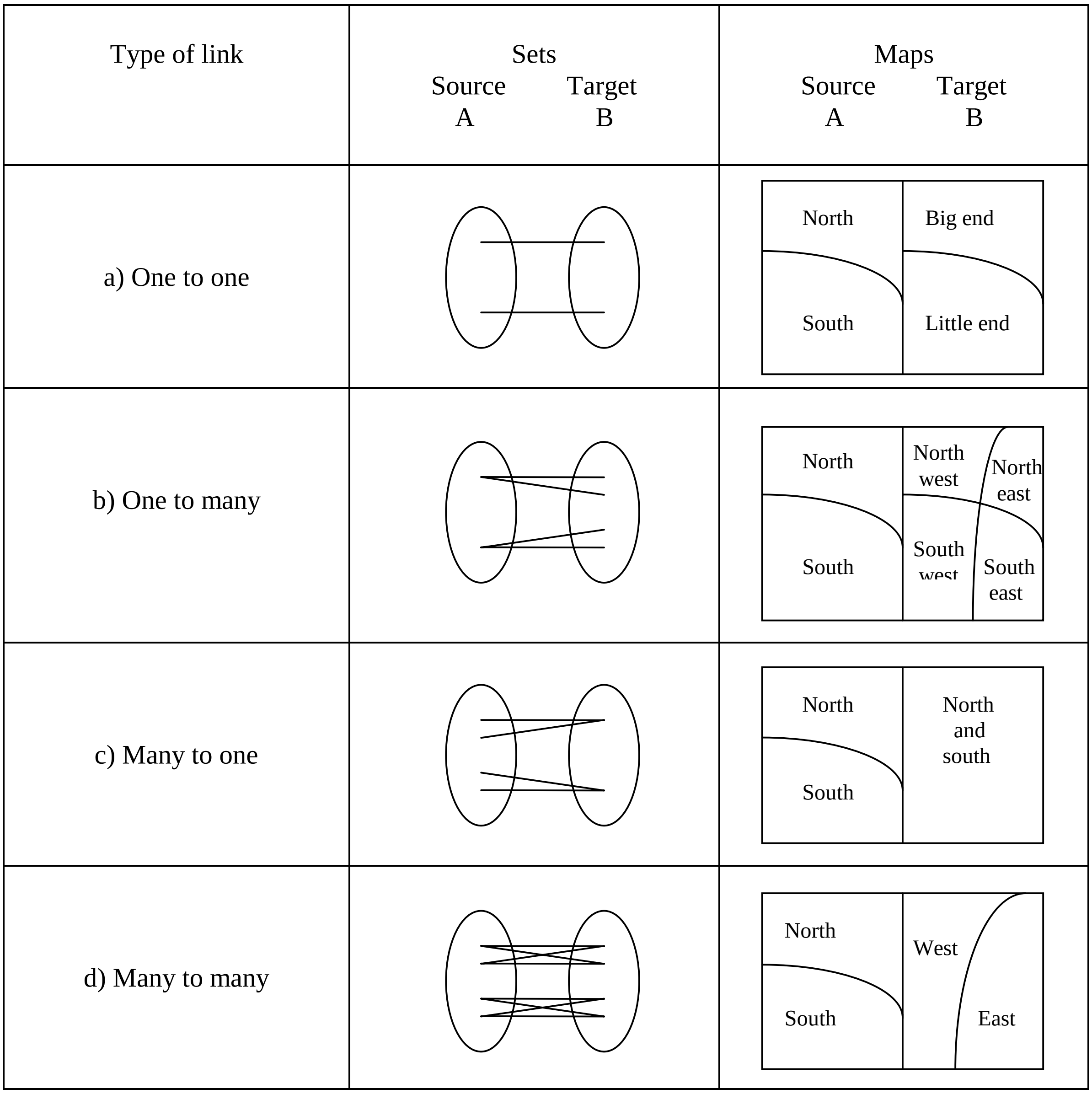


**Figure 1** Types of links between map entities

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 tables[1]. 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) Old code | Weight | New code | New to old (i.e. target to source) 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 | possible, but not advised | | | . | . | |
| | | | | . | . | |
| | | | | . | . | |
| | | | | 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 | |
| | | | | 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.

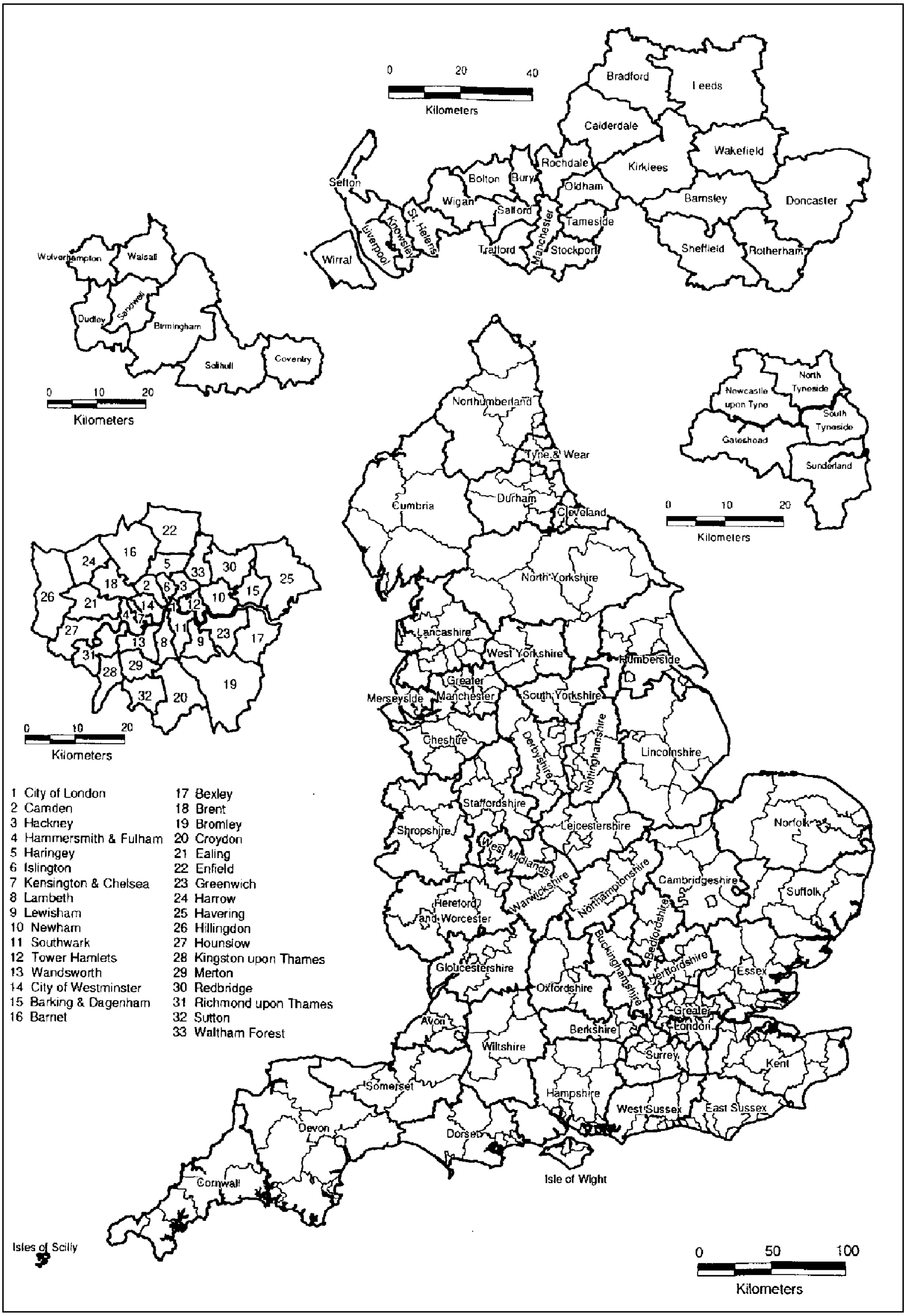


**Figure 3a** The local government geography of England, 1991

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.

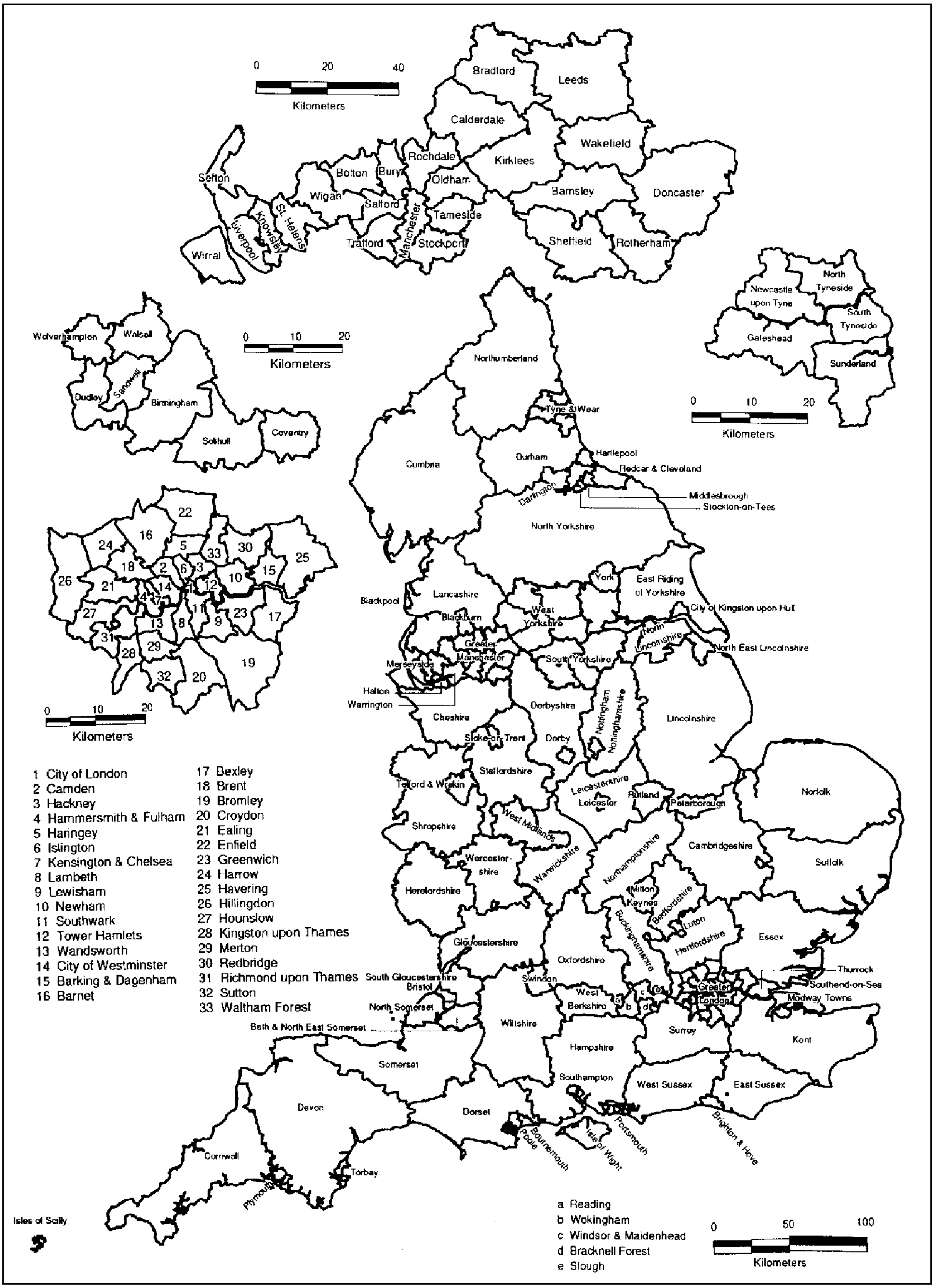


**Figure 3b** The local government geography of England, 1998

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.

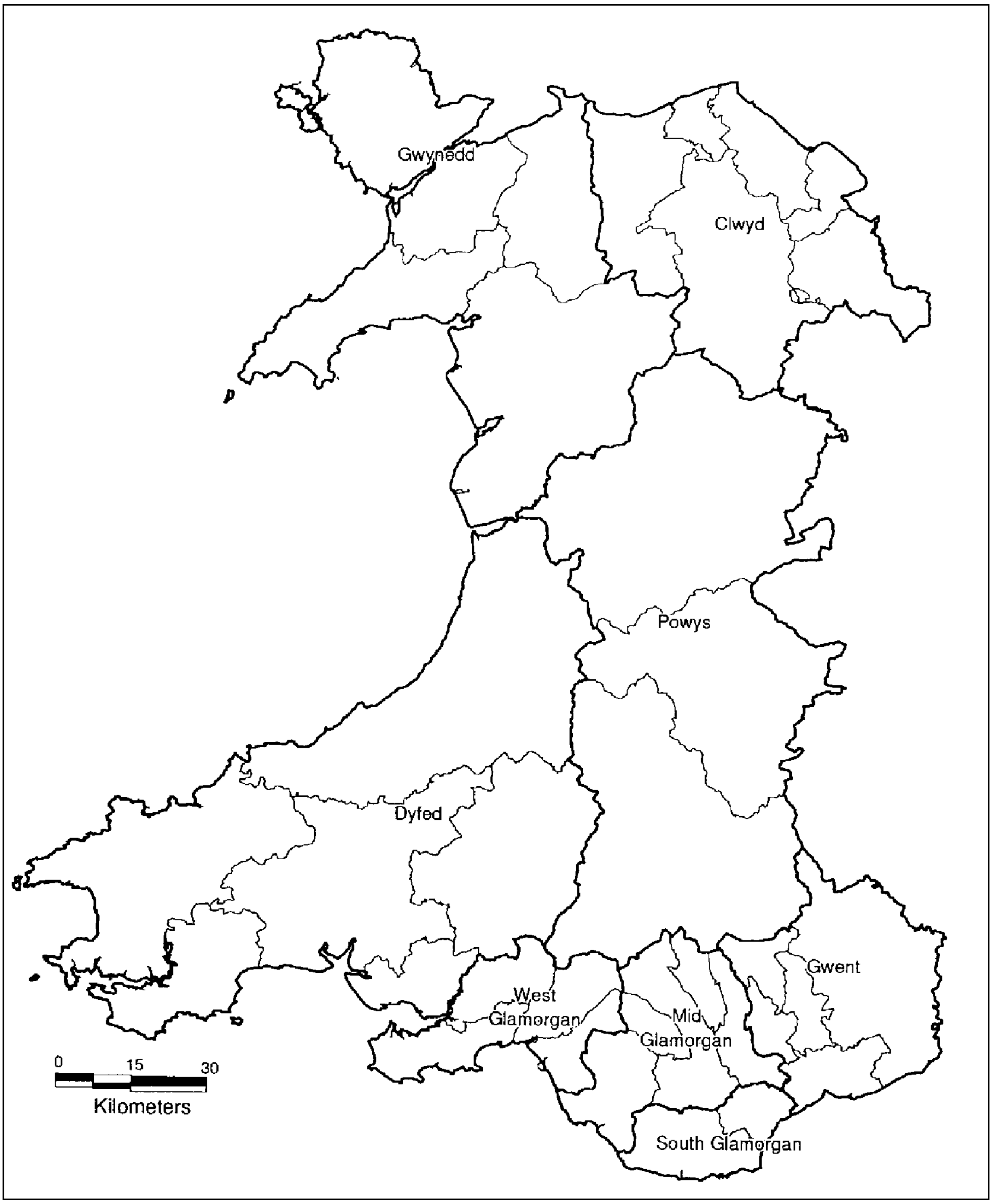


**Figure 4a** The local government geography of Wales, 1991

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.

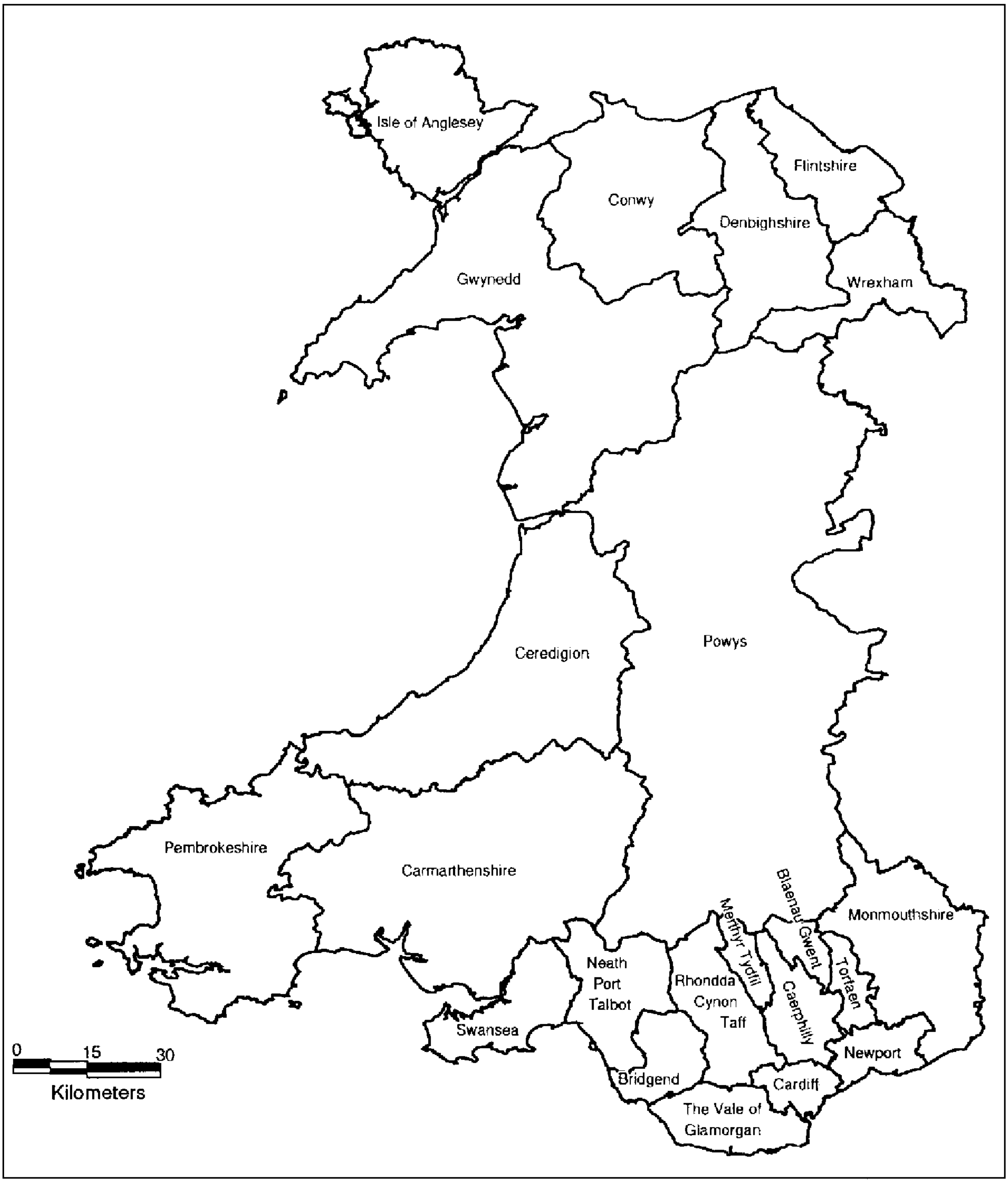


**Figure 4b** The local government geography of Wales, 1998

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.

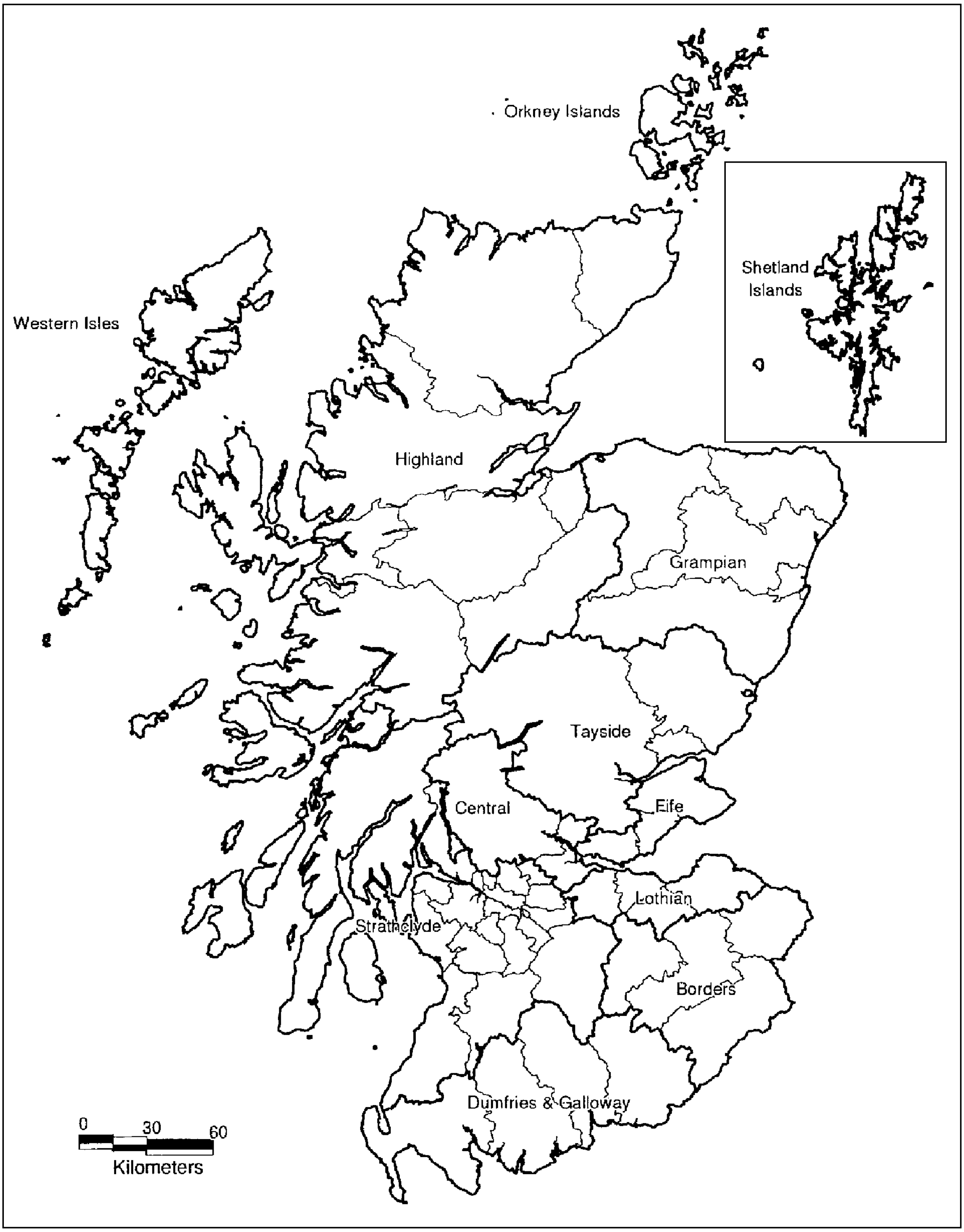


**Figure 5a** The local government geography of Scotland, 1991

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.

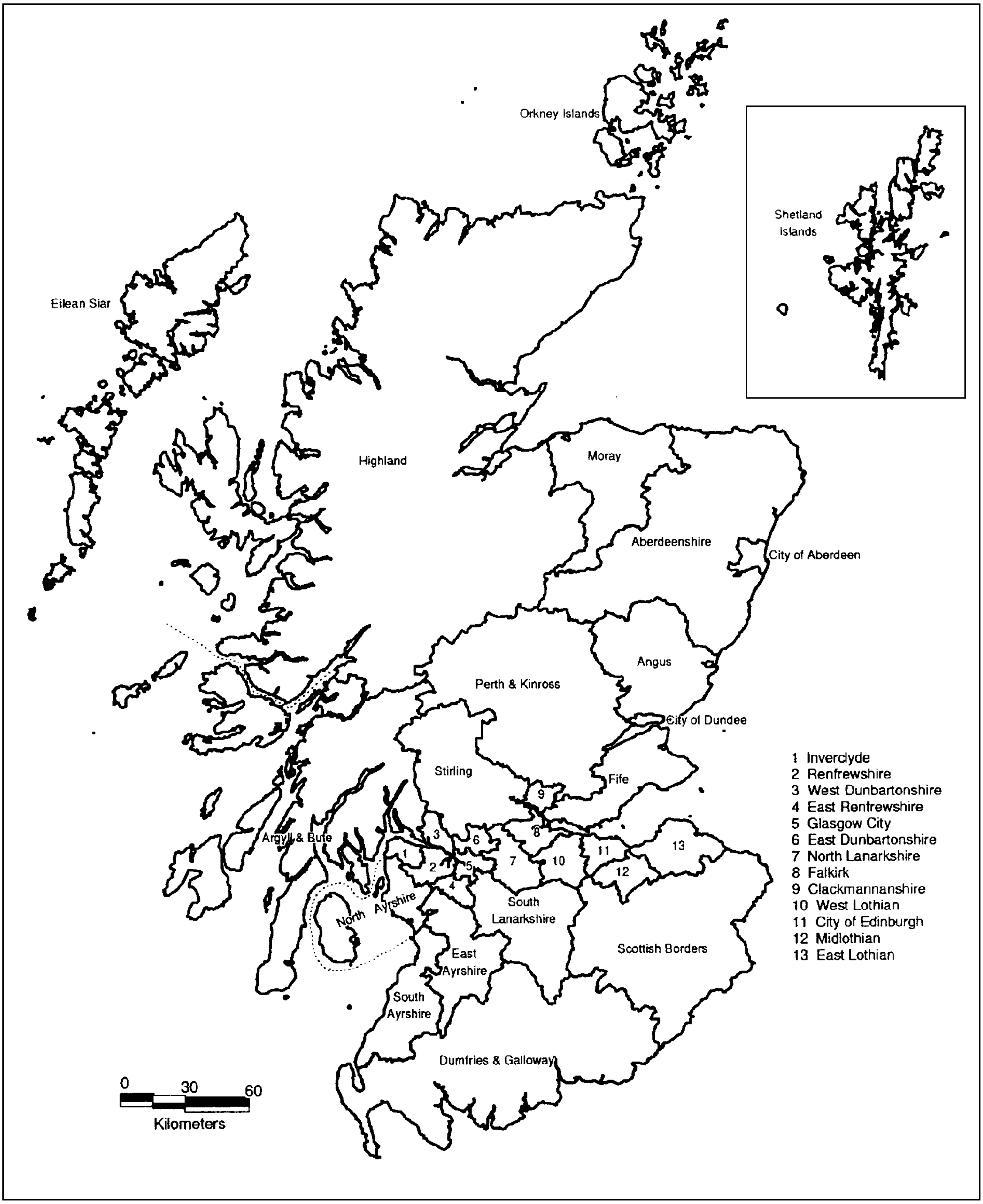


**Figure 5b** The local government geography of Scotland, 1998

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.

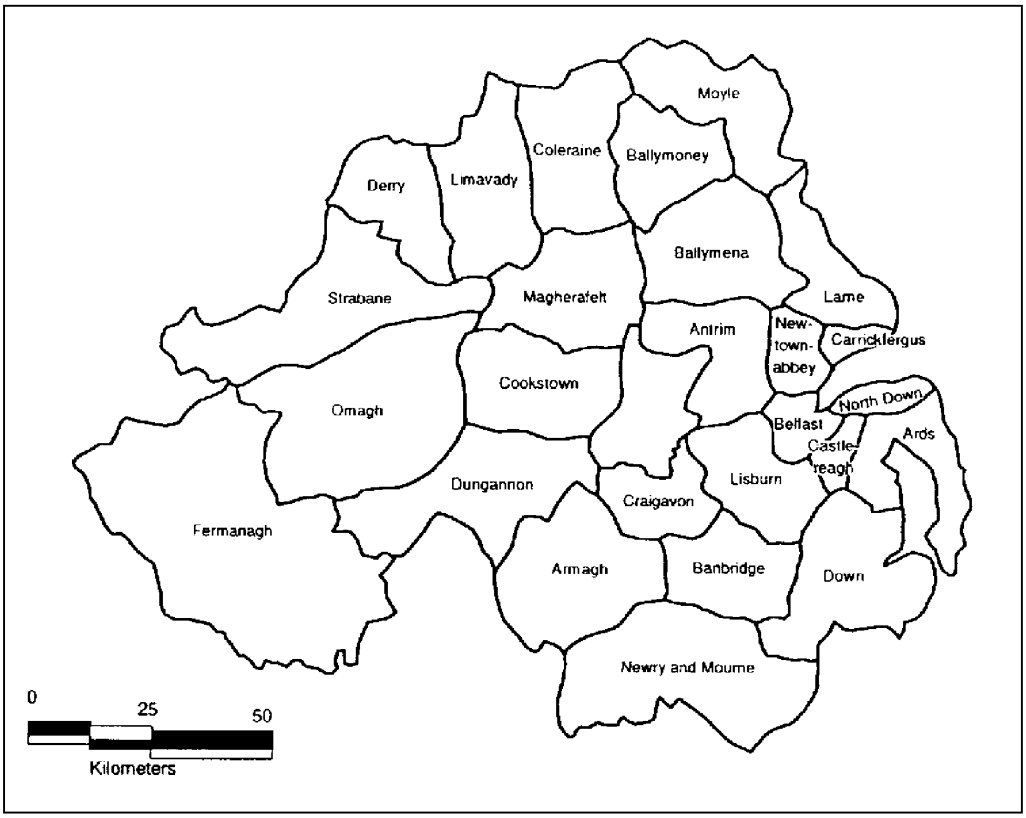


**Figure 6a** The local government geography of Northern Ireland, 1991

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:// 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 x -1),

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

144,982 = 143,971 + (1,011 x +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/JISC[2] 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:

- `nlglbh.sys` for the 100% SAS for London boroughs,
- `nlgmdh.sys` for the 100% SAS for the metropolitan districts,
- `nlgecuah.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.

$$ {}_{5}K_{y}^{s,i} = \sum_{j \in i} {}_{5}K_{y}^{s,j} \qquad (1)$$

where

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

${}_{5}K_{y}^{s,j}$ = 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.

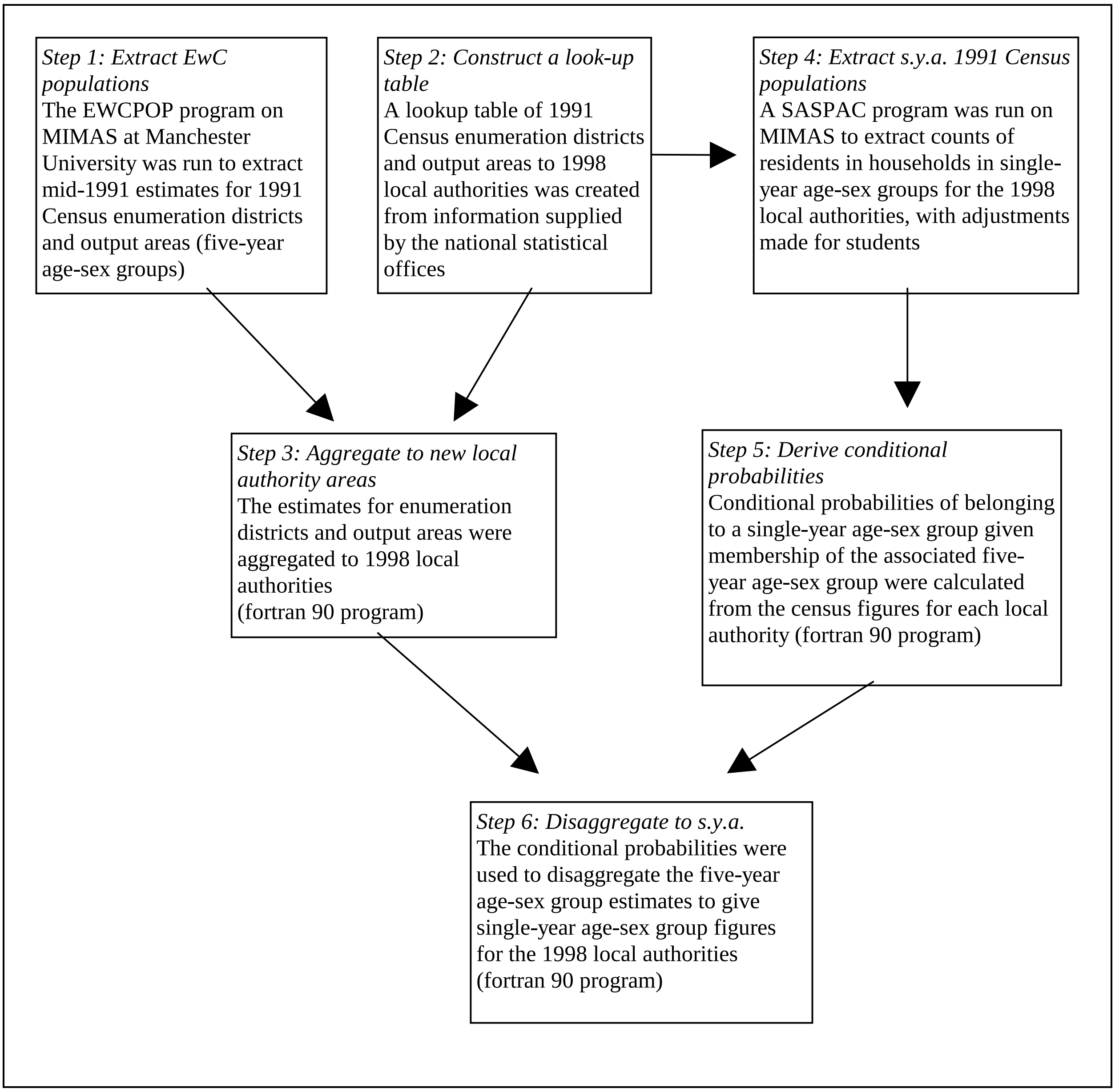


**Figure 10** The method of producing mid-1991 estimates for the 1998 local authorities in Great Britain

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.

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

where

$p({}_1K_x^{s,i} \mid {}_1K_y^{s,i})$ = 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 = 5×2+0, 5×2+1, 5×2+2, 5×2+3 and 5×2+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.

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

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

$$ {}_{5}K_{20}^{m,York} = 8140 . $$

*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:

$$ {}_{1}C_{20}^{m,York} = 1379 $$

$$ {}_{1}C_{21}^{m,York} = 1306 $$

$$ {}_{1}C_{22}^{m,York} = 1435 $$

$$ {}_{1}C_{23}^{m,York} = 1272 $$

$$ {}_{1}C_{24}^{m,York} = 1327 . $$

*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 6179.

$$ p({}_{1}K_{20}^{m,York} \mid {}_{5}K_{20}^{m,York}) = \frac{{}_{1}C_{20}^{m,York}}{{}_{5}C_{20}^{m,York}} = \frac{1379}{6719} = 0.2052 $$

$$ p({}_{1}K_{21}^{m,York} \mid {}_{5}K_{20}^{m,York}) = \frac{{}_{1}C_{21}^{m,York}}{{}_{5}C_{20}^{m,York}} = \frac{1306}{6719} = 0.1944 $$

$$ p({}_{1}K_{22}^{m,York} \mid {}_{5}K_{20}^{m,York}) = \frac{{}_{1}C_{22}^{m,York}}{{}_{5}C_{20}^{m,York}} = \frac{1435}{6719} = 0.2136 $$

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

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

*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).

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

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

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

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

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

### 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.

$$p({}_1K_x^{s,d}|{}_1K_x^{s,h}) = \frac{{}_nC_y^{s,d}}{{}_nC_y^{s,h}} \qquad \text{for } d \in h \text{ and } x = y, y+1, \ldots, y+n \qquad (4)$$

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 $d \in h$),

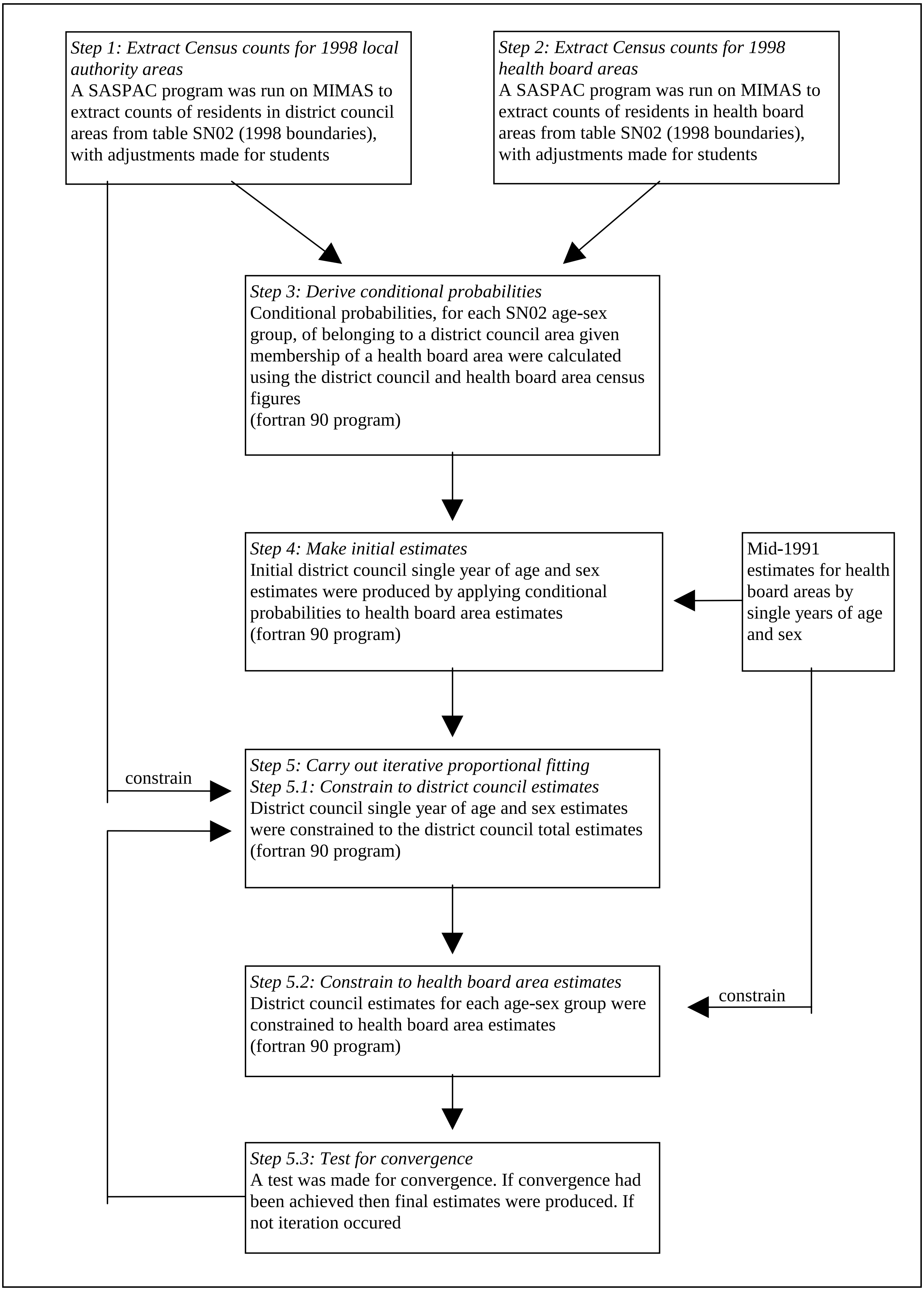


**Figure 11** The method of producing mid-1991 estimates for the 1998 local authorities in Northern Ireland

${}_{n}C_{y}^{s,d}$ = 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 SN02[3], 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

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

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

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

$\dfrac{_1K_x^{s,h}}{\sum_{d\in h} {}_1K_x^{s,d}[1]}$ = 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.

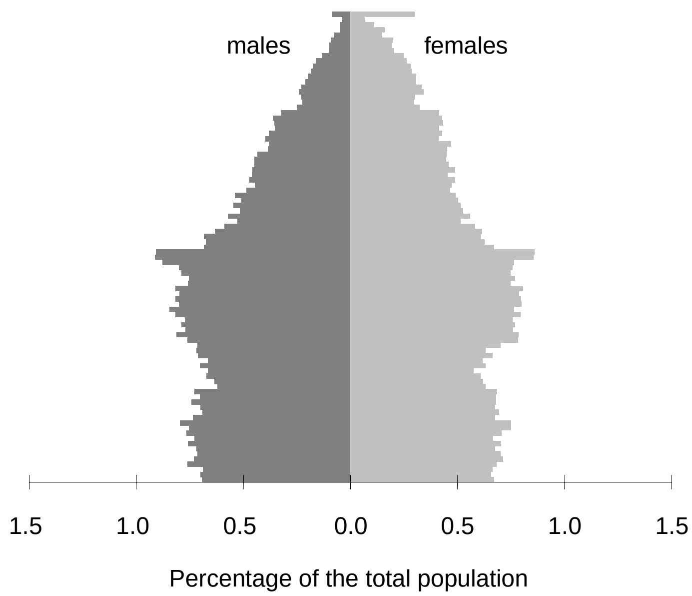


**Figure 12** (a) Aberdeenshire council area

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.

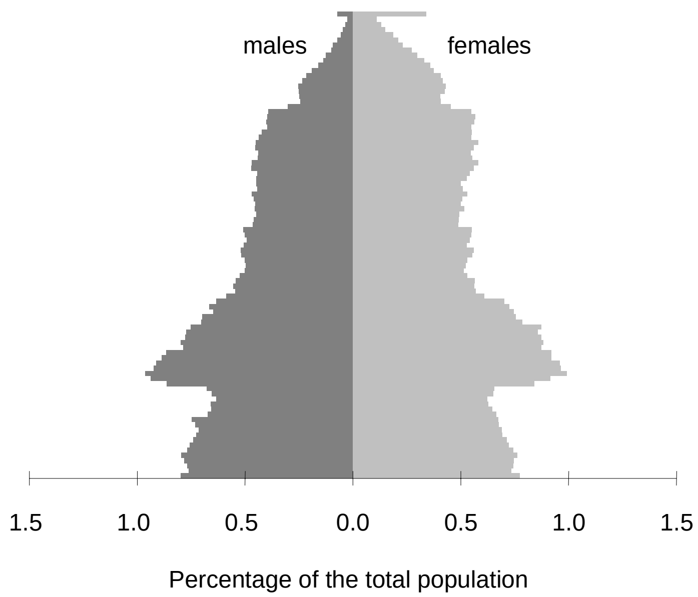


**Figure 12** (b) Belfast district council area

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.

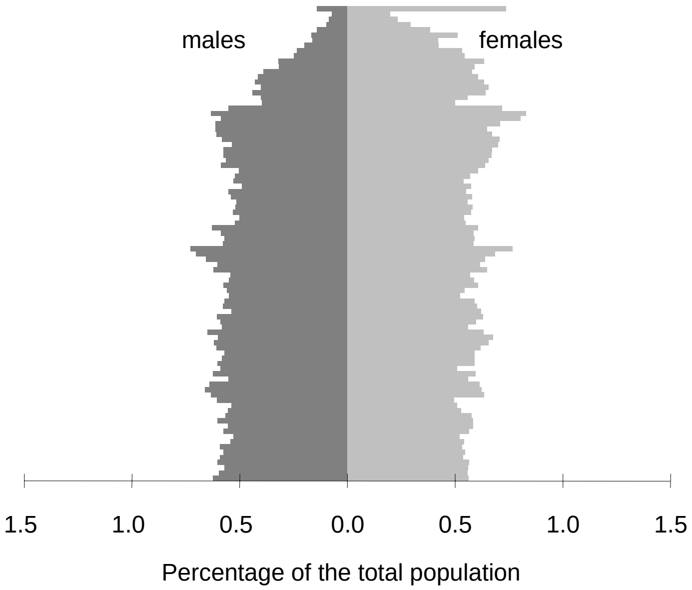


**Figure 12** (c) Conwy unitary authority

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.

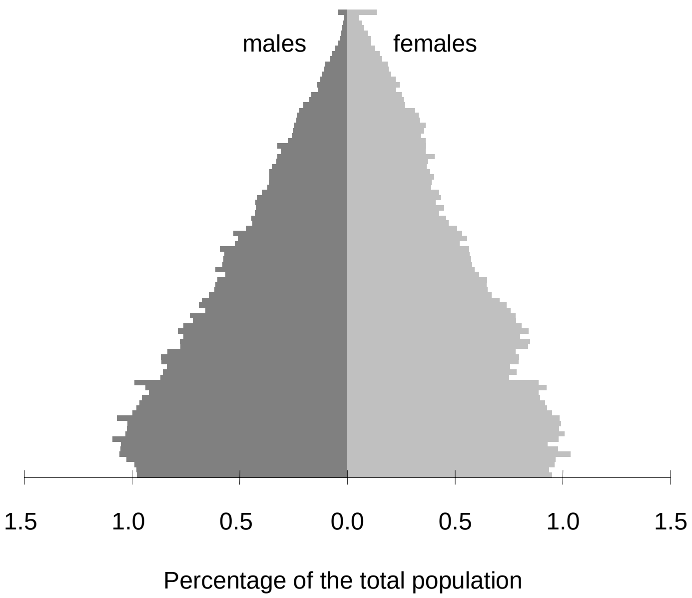


**Figure 12** (d) Derry district council area

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.

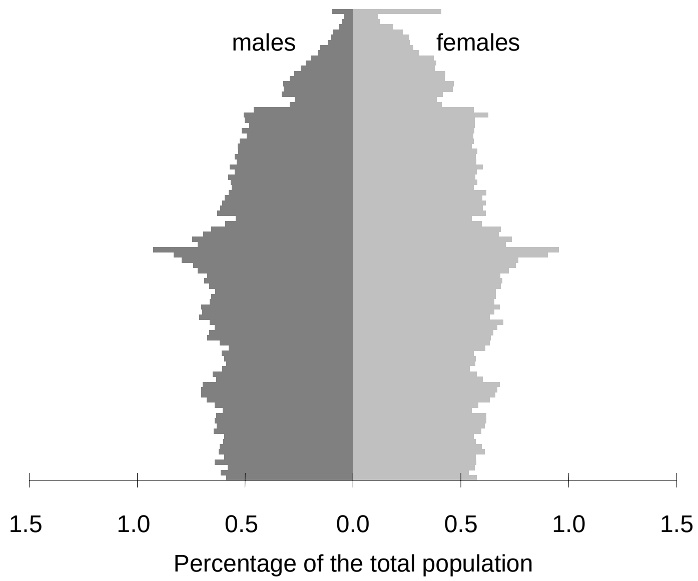


**Figure 12** (e) The East Riding of Yorkshire unitary authority

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.

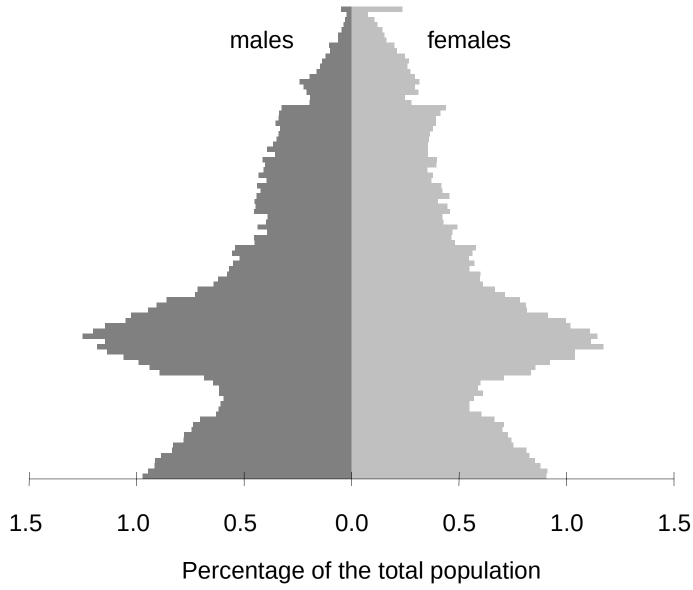


**Figure 12** (f) Newham London borough

# 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:// 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 |
| *ENGLAND* | 47,055,204 | 47,055,204 | 48,208,060 | 48,208,060 |
| *London* | 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 |
| *Metropolitan Districts* | | | | |
| 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 |
| *Unitary authorities* | | | | |
| 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 | - | 376146 | - | 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 |
| *Two-tier counties* | | | | |
| 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 |
| | | | | |
| *WALES* | 2,835,073 | 2,835,073 | 2,891,461 | 2,891,461 |
| *Unitary authorities* | | | | |
| 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 | - | 223190 | - | 231,532 |
| Torfaen | - | 90,527 | - | 91,351 |
| The Vale of Glamorgan | - | 118,039 | - | 119,364 |
| Wrexham | - | 121,296 | - | 122,921 |
| | | | | |
| *SCOTLAND* | 4,998,567 | 4,998,567 | 5,107,000 | 5,107,000 |
| *Council Areas* | | | | |
| 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 |
| | | | | |
| *NORTHERN IRELAND* | 1,577,836 | 1,577,836 | 1,601,350 | 1,601,350 |
| *District Council areas* | | | | |
| 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