

Revised Series of Population Estimates from 1982 to 2000 for Scotland

Each year GROS produce mid-year population estimates for Scotland and its administrative areas using a cohort component method. The cohort component method involves establishing a base population and rolling it forward each year, adding births, subtracting deaths and adding net migration. After adjusting for under-enumeration and differences in timing, the Census is used to give figures for the base year, now 2001. These are updated each year until the series is rebased after the following Census.

This paper explains the methodology used to revise the mid-year population estimates following the results from the 2001 Census. Normally these revisions would only be necessary for one decade, to ensure a consistent historic series is available from one Census to the next. However, the results from the 2001 Census showed that the population estimates made from the 1991 Census were too high, so on this occasion revisions are required for all years from 1982 to 2000.

The Intercensal Discrepancy

The intercensal discrepancy is the difference between the rolled forward 2001 mid-year estimate (MYE) and the 2001 Census based estimate. The 2001 Census results showed that the rolled forward MYE produced in the 90s had overestimated the population of Scotland by around 56,400. This is in part due to underestimation of out-migration in the past but is also due to overestimation of the population in 1991. Therefore, in order to do revisions to past populations the 1991 population estimate had to first be revised as this is the base on which subsequent mid-year estimates are derived.

1991 Revisions

Following the 1991 Census it was concluded that there was a degree of underenumeration, particularly for certain population groups, such as young men. This conclusion was mainly based on observation of the sex ratios. To take account of this underenumeration, adjustments were made to bring the sex ratios in line with the trend seen between 1971 and 1981. Analysis of the data showed that the underenumeration was not uniform, therefore each local authority district in Scotland was grouped into one of five area types and each area type received a different rate of adjustment. Adjustment factors were calculated for 5 year age groups up to the age of 44. It was felt that estimates of people 45 and over were correct.

However, evidence from the 2001 Census indicates that these adjustment factors were not appropriate for all areas, resulting in an overestimate of the 1991 population. The age/sex structure of the 2001 Census data can be taken as reliable because of the scientific steps taken to allow for any underenumeration. The 2001 data confirms that sex ratios for ages around 20 are indeed falling below the levels observed in 1971 and 1981 and it is reasonable to conclude that this trend had begun in 1991.

In order to revise the 1991 population estimate for 0-44 year olds a method of averaging the sex ratio was used. This involved calculating the average of sex ratios in 1981 and 2001 for each council area by 5 year age group. This was then assumed to be the correct sex ratio for 1991. Given the assumption that the 1991 estimates for females are

correct we then used the averaged sex ratios to calculate the revised estimates for males in 1991.

Adjustments were then made to the data so that for all council areas and 5 year age groups the revised population was at least as high as the 1991 raw Census count. It was also felt that, since the original adjustments made to the 1991 estimates were thought to be too high, the revised estimates should be no higher than the 1991 previously published figure for each council and 5 year age group. These quinary estimates were then apportioned down to single year of age using the age distribution shown in the previously published 1991 estimates.

In addition, the results from the 2001 Census also indicated that the previous 1991 estimates for the 85 and over age group were underestimated. No adjustment had been made to this age group in the previously published estimates. Using the 2001 mid-year estimate as a base the population of 95+ was rolled back to 1991 by single year of age and deaths were added back in to give the 85+ population in 1991. The effect of migration in these ages was assumed to be negligible. This process was applied at Scotland level and was then apportioned down to councils based on the distribution from the 1991 population estimates.

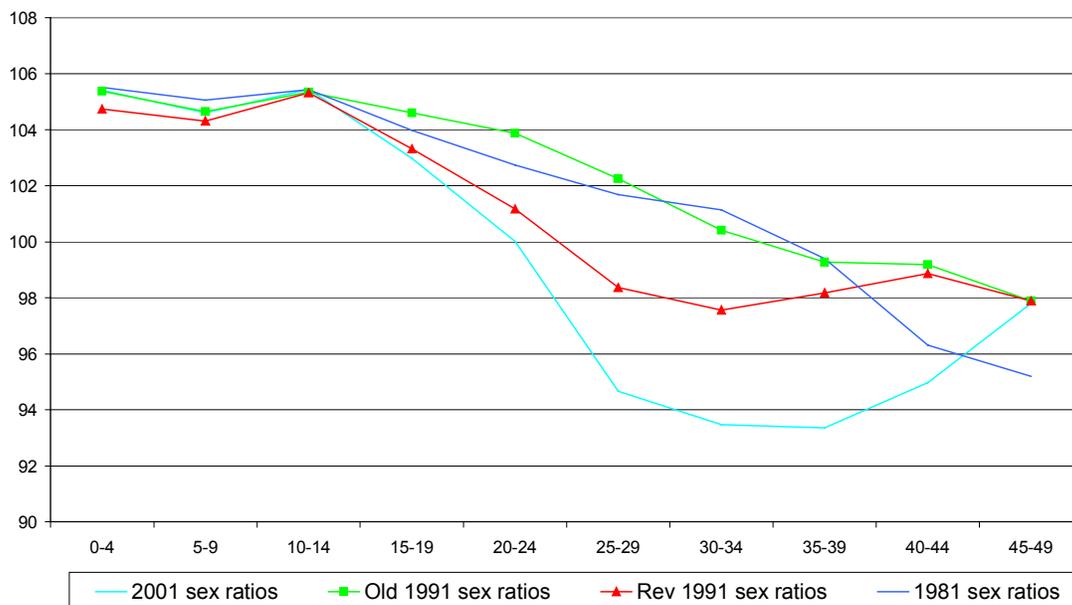
Results of the 1991 Revisions

The revised 1991 mid-year population estimate for Scotland was 5,083,330, which is 23,670 less than the previously published estimate of 5,107,000. The following charts and tables show how these revisions were split by age, gender and geography. A negative revision indicates a reduction from the previously published 1991 estimate and a positive revision shows an increase.

Sex Ratios

The purpose of using the averaging method was to produce 1991 sex ratios that are mid way between the 1981 and the 2001 sex ratios, as can be seen in the chart below.

Comparison of sex ratios, Scotland, 1981-2001, age 0-49



By Age group

The results below show that the age groups with the most revisions, both by absolute number and as a percentage of the population within that age/sex group, are 20-34. These are also the age groups which had the highest adjustments factors in 1991.

1991 Revisions by age

	Revision	% of Total Revision	Revisions as % Old '91 Popn	1991 Adj Factors	Revised 1991 Adj Factors
All Ages	-23,670	100.0	-1.01	1.02	1.02
0-4 Males	-1,002	4.2	-0.60	1.03	1.02
5-9 Males	-525	2.2	-0.32	1.01	1.01
10-14 Males	-35	0.1	-0.02	1.00	1.00
15-19 Males	-2,140	9.0	-1.23	1.03	1.01
20-24 Males	-5,493	23.2	-2.60	1.12	1.09
25-29 Males	-8,048	34.0	-3.79	1.11	1.07
30-34 Males	-5,533	23.4	-2.84	1.06	1.03
35-39 Males	-1,880	7.9	-1.11	1.01	1.00
40-44 Males	-580	2.5	-0.33	1.00	1.00
85+ Males	240	-1.0	1.52	1.00	1.02
85+ Females	1,326	-5.6	2.50	1.00	1.03

By 1991 Area Type

An analysis of the revised 1991 estimates by area type shows that, generally, areas with the highest adjustments in 1991 received proportionately larger revisions (see table below). Although this is true for the broad area types there is more variation at council level. Area type 5, for example, represents Glasgow City only and received proportionately smaller revisions than area types 3 and 4. This indicates that the adjustment factors used in 1991 were more accurate for Glasgow than some of the other areas.

1991 Revisions by Area Type

1991 Area Type	Revision	% of Total Revision	Revisions as % Old '91 Popn
Scotland	-23,670	100	-0.46
1	-2,510	11	-0.24
2	-1,200	5	-0.34
3	-10,210	43	-0.58
4	-7,150	30	-0.58
5	-2,600	11	-0.38

By Council Area

The councils with the highest adjustments were Edinburgh and Glasgow, followed by Fife and North Lanarkshire. This is not surprising given that they are the councils with the highest populations in Scotland. However, when comparing the adjustments as a percentage of the population, Glasgow is only just in the top half of the table of 32 council areas. The areas with the highest percentage adjustments are Midlothian, West Lothian, North Ayrshire and Edinburgh. These councils were all either area type 3 or 4 in 1991, therefore they had relatively high adjustments made in 1991.

1991 Revisions by Council Area

	Revision	% of Total Revision	Revisions as % Old '91 Popn
SCOTLAND	-23,670	100.00	-0.46
Aberdeen City	-830	3.51	-0.39
Aberdeenshire	-590	2.49	-0.27
Angus	-270	1.14	-0.25
Argyll & Bute	-150	0.63	-0.16
Clackmannanshire	-300	1.27	-0.62
Dumfries & Galloway	-530	2.24	-0.36
Dundee City	-690	2.92	-0.44
East Ayrshire	-270	1.14	-0.22
East Dunbartonshire	-460	1.94	-0.42
East Lothian	-480	2.03	-0.57
East Renfrewshire	-290	1.23	-0.34
Edinburgh, City of	-3,160	13.35	-0.72
Eilean Siar	-70	0.30	-0.24
Falkirk	-630	2.66	-0.44
Fife	-2,040	8.62	-0.58
Glasgow City	-2,470	10.44	-0.39
Highland	-310	1.31	-0.15
Inverclyde	-190	0.80	-0.21
Midlothian	-700	2.96	-0.87
Moray	-200	0.84	-0.24
North Ayrshire	-1,000	4.22	-0.72
North Lanarkshire	-1,960	8.28	-0.60
Orkney Islands	-40	0.17	-0.20
Perth & Kinross	-220	0.93	-0.17
Renfrewshire	-1,130	4.77	-0.64
Scottish Borders	-270	1.14	-0.26
Shetland Islands	-10	0.04	-0.04
South Ayrshire	-430	1.82	-0.38
South Lanarkshire	-1,820	7.69	-0.60
Stirling	-550	2.32	-0.68
West Dunbartonshire	-390	1.65	-0.40
West Lothian	-1,220	5.15	-0.83

Discrepancy Split between 80s and 90s

The total discrepancy between the 2001 rolled forward estimates and the 2001 Census based estimates is 56,400. The revisions to the 1991 estimates due to overestimation account for 42% of the total error, which is 23,670. This is equivalent to there being a further migration error in the 80s of 23,670. The remaining discrepancy of 32,730 is due to errors in estimation of migration in the 90s. These two factors vary by council area. The table below shows the extent of each of these issues on the population estimates of all council areas in Scotland.

Discrepancy Split between 80s and 90s

Council	Error in	of which:	
	2001	Error in	Error in
	Rolled	1991	migration
	Forward	Estimates	in the 90s
	Estimates	Estimates	
SCOTLAND	-56,400	-23,670	-32,730
Aberdeen City	2,050	-830	2,880
Aberdeenshire	-340	-590	250
Angus	-390	-270	-120
Argyll & Bute	2,470	-150	2,620
Clackmannanshire	-250	-300	50
Dumfries & Galloway	2,430	-530	2,960
Dundee City	4,080	-690	4,770
East Ayrshire	-820	-270	-550
East Dunbartonshire	-2,090	-460	-1,630
East Lothian	-1,560	-480	-1,080
East Renfrewshire	-730	-290	-440
Edinburgh, City of	-6,220	-3,160	-3,060
Eilean Siar	-530	-70	-460
Falkirk	610	-630	1,240
Fife	-1,870	-2,040	170
Glasgow City	-35,940	-2,470	-33,470
Highland	-250	-310	60
Inverclyde	-160	-190	30
Midlothian	-1,240	-700	-540
Moray	1,880	-200	2,080
North Ayrshire	-3,020	-1,000	-2,020
North Lanarkshire	-5,910	-1,960	-3,950
Orkney Islands	-100	-40	-60
Perth & Kinross	1,450	-220	1,670
Renfrewshire	-4,090	-1,130	-2,960
Scottish Borders	-410	-270	-140
Shetland Islands	-310	-10	-300
South Ayrshire	-2,060	-430	-1,630
South Lanarkshire	-3,800	-1,820	-1,980
Stirling	1,220	-550	1,770
West Dunbartonshire	-850	-390	-460
West Lothian	350	-1,220	1,570

Footnote: A negative revision indicates a reduction from the previously published estimates and a positive revision shows an increase.

Revisions to the 1992-2000 Mid-Year Estimates

The revisions to the 1992-2000 MYEs were done in two stages. Firstly the previously published estimates were rebased to be in line with the revised 1991 estimates. This entailed applying the revisions made to the 1991 estimates to all subsequent years by ageing the adjustments on. For example, an adjustment of -100 for 10 year old males in 1991 would become -100 to 11 year old males in 1992, -100 to 12 year old males in 1993, and so on, until 2001, where the adjustment would be -100 to 20 year old males.

The estimates produced using the revised 1991 base in the first stage were then used to recalculate the intercensal discrepancy. This was then distributed to each of the years between 1992 and 2000 using the time-based method for producing revised estimates (see Appendix A for detail). This method is based on the assumption that the observed

differences accumulate steadily over time. This process was carried out for each council by sex and single year of age.

Revisions to the 1982-1990 Mid-Year Estimates

Since the 1991 MYEs have been revised this produced a new intercensal discrepancy between the previously published 1991 estimates and the revised 1991 estimates. This was applied to the 1982-1990 estimates in the same way as the 1992-2000 estimates were.

Appendix A: Applying the time-based method for producing revised estimates

Using the chosen method, the correction for each year is derived by interpolating linearly between zero at the start of the period (mid-1991) and the observed discrepancy (the difference between the two mid-2001 estimates) calculated at the end of the period. These interpolated corrections are then combined with the original mid-year estimates on a cohort basis (ie the correction for 40 year olds in 2001 is applied to 39 year olds in 2000, to 38 year olds in 1999 etc. As a hypothetical example, consider a particular single year of age by sex in which the ONC based mid-2001 estimate is 2,500 and the 1991 Census based mid-2001 estimate is 2,700. The difference between these estimates (-200) is then divided by the number of years in the intercensal period (10) to produce an adjustment factor. This factor is multiplied by the number of years elapsed since the starting point (mid-1991) to produce an adjustment for each particular mid-year. These adjustments are then added to the mid-1991 based estimates, aged-back, to produce the revised estimates. The process is summarised below.

Difference between ONC-based mid-2001 estimate and 1991 Census based mid-2001 estimate = 2,500 – 2,700 = -200.

Adjustment factor (AF) = -200/10 = -20

Date	1991-based Estimate	Intercensal Adjustment	Revised Estimate
Mid-1991	2200	0	2200
Mid-1992	2250	-20	2230
Mid-1993	2350	-40	2310
Mid-1994	2600	-60	2540
Mid-1995	2450	-80	2370
Mid-1996	2550	-100	2450
Mid-1997	2800	-120	2680
Mid-1998	2500	-140	2360
Mid-1999	2650	-160	2490
Mid-2000	2675	-180	2495
Mid-2001	2700	-200	2500

The revision method maintains the profile of change over the intercensal period but shifts the profile up or down according to the direction of the discrepancy.

SOURCE: Duncan C, Chappell R, Smith J, Clark L, and Ambrose F (2002). Rebasing the annual mid-year population estimates for England and Wales. *Population Trends* 109, pp.9-14.
www.statistics.gov.uk/downloads/theme_population/PT109.pdf