

# Information paper

## Quality and Methodology Information

### General details

Title of output:	National Population Projections
Abbreviated title:	NPP
Designation:	National Statistics
Geographic Coverage:	UK
Date of last SQR or QMI <sup>1</sup> :	November 2013
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### Executive summary

This paper is part of a rolling programme of quality and methodology information papers introduced by the Office for National Statistics (ONS). The full programme of work being carried out on [Statistical Quality](#) is available on the ONS website. Quality and Methodology Information papers summarise key qualitative information on the various dimensions of quality as well as providing a summary of methods used to compile the output.

This paper relates to the [National Population Projections \(NPP\)](#) and aims to provide users with information on the usability and fitness-for-purpose of these statistics. From 1954 these National Statistics were produced by the Government Actuary's Department (GAD). A review of the UK actuarial profession recommended that responsibility for producing the NPP should be transferred to ONS and this transfer was completed on 31 January 2006. Further details on the methods used to produce the NPP can be found in the reference volume [National Population Projections \(series PP2\)](#). A summary of the methods used and the detailed results from the most recent projection set can also be found on the [NPP](#) page of the ONS website.

This document contains the following sections:

- Output quality
- About the output
- How the output is created
- Validation and quality assurance
- Concepts and definitions
- Other information relating to quality trade-offs and user needs
- Sources for further information or advice.

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<sup>1</sup> Quality and Methodology Information' (QMI) replaced 'Summary Quality Reports' (SQR) from 04/11

## Output quality

This document provides a range of information that describes the quality of the data and details any points that should be noted when using the output.

ONS has developed [Guidelines for Measuring Statistical Quality](#) based upon the 5 European Statistical System (ESS) Quality Dimensions. This document addresses the quality dimensions and important quality characteristics, which are:

- Relevance
- Timeliness and punctuality
- Accuracy
- Coherence and comparability
- Output quality trade-offs
- Assessment of user needs and perceptions
- Accessibility and clarity

More information is provided about these quality dimensions in the sections below.

## About the output

### Relevance

(The degree to which the statistical output meets users' needs.)

This product is the official set of National Population Projections for the UK and its constituent countries. It provides projections of the future population for a period of 25-100 years by age and gender for:

- England
- Wales
- Scotland
- Northern Ireland
- plus the combinations of:
- England and Wales
- Great Britain
- UK

The projections are based on assumptions regarding future levels of fertility, migration and mortality considered to be the best that could be made at the time they are adopted. However, due to the inherent uncertainty of demographic behaviour, any set of projections will inevitably be proved wrong to a greater or lesser extent, as a forecast of future demographic events or population structure. To give users of the projections an indication of this uncertainty, a number of variant population projections are produced, based on alternative assumptions regarding fertility, mortality and migration.

The projections are produced at the request of the National Statistician and the Registrars General of Scotland and Northern Ireland. As such, their content and method of production have been formally agreed, and are regularly revisited to see if changes are required by the statistical offices of the constituent countries. The projections process is overseen by a NPP committee, accountable to the National Statistician and Registrars General. The constituent country statistical offices use the national projections as the base for their subnational projections, so are well placed to ensure that the product meets their user needs.

The projections are used as inputs, or as control totals, for other sets of projections produced both by ONS and other government departments.

Within the projection process the ONS and the Devolved Administrations consult key stakeholders, including representatives from relevant government departments and other parties such as the Bank of England and the Local Government Association. Consultation meetings are

held where stakeholders have the opportunity to discuss proposed assumptions, highlight potential new data requirements or request changes to presentation or the publication timetable. ONS takes into account stakeholder views and suggestions as far as possible, within the [Code of Practice for Official Statistics](#).

Population Statistics Division within ONS routinely considers what user needs are not being met by their published statistics - this includes user needs not being met by current national population projections outputs. Unmet user needs are identified using the processes described in the Assessment of user needs and perceptions section below. In addition, an analysis of the number, type and nature of customer queries is routinely assessed. In June 2015 an assessment was held of unmet user need across the Population Statistics Division. This was reviewed at the Divisional Outputs Delivery Board. The issue of unmet user need within Population Statistics Division is now being taken forward alongside a review of research and outputs.

### **Timeliness and punctuality**

(Timeliness refers to the lapse of time between publication and the period to which the data refer. Punctuality refers to the gap between planned and actual publication dates.)

The national population projections are currently published in 2 parts. The first part, published around October/November following the reference year, consists of the principal projection and the nine main variant projections, while the remaining standard "combination" and "special case scenario" variant projections are published a month later, around November/December. The starting point for the projections is the population estimates for [England and Wales](#), [Scotland](#) and [Northern Ireland](#), which are produced by ONS, National Records of Scotland (NRS) and the Northern Ireland Statistics and Research Agency (NISRA) respectively. The last of these estimates become available at the end of June of the year following the reference year. So publication of the NPP is approximately 4 months after receipt of the final set of data required for production.

The planned date of publication is calculated at the start of each projection process and would only not be met if essential data from another party were delayed significantly, for example, if population estimate data were not received. The planned publication date, as entered into the [Statistics Release Calendar](#) has always been met.

The reference volume [National Population Projections \(series PP2\)](#) contains full details of the results of the projections, the assumptions made for future fertility, mortality and migration, and also the methodology behind the calculations. This is published in March/April of the year following the publication of the projection results, or about 21 months after the end of the reference year. For the mid-year 2012-based projections the report was published on 28 March 2014. The 2014-based reference volume is due to be published in March/April 2016.

For more details on forthcoming releases of population statistics, the [Statistics Release Calendar](#) is available online and provides 12 months' advance notice of release dates. In the unlikely event of a change to the pre-announced release schedule, public attention would be drawn to the change and the reasons for the change explained at the same time, as set out in the [Code of Practice for Official Statistics](#).

### **How the output is created**

The National Population Projections are calculated using a number of standard demographic methods. Full details can be found in the reference volume [National Population Projections \(series PP2\)](#). Some of the main methodological points are detailed below.

The projections are made for successive years running from 1 mid-year to the next using the cohort component method, which can be summarised as:

$$\text{Population (year } x) + \text{Births (between yrs } x \text{ and } y) - \text{Deaths (between yrs } x \text{ and } y) + \text{In-Migrants (between yrs } x \text{ and } y) - \text{Out-Migrants (between yrs } x \text{ and } y) = \text{Population (year } y).$$

For each age, the starting population plus or minus the net number of migrants (immigrants-emigrants) less the number of deaths produces the number in the population, 1 year older, at the end of the year. To this has to be added survivors of those born during the year. Age is defined as completed years at the last birthday. Migration, deaths and births are all assumed to occur evenly throughout the year.

The mid-year population estimates from each country are used as the starting population. The numbers of births, deaths and migrants are calculated using the assumptions of future levels of fertility, mortality and migration. They are determined by a mixture of trend observation & extrapolation, and consideration of expert opinion, with actual data included in the calculation for the first year of the projection.

In 2013, ONS published a [migration assumptions methodology review](#); this reviewed and set out a new methodology for setting the migration assumptions in the national projections. In the 2012-based projections, a [revised methodology for setting the migration assumptions in the 2012-based NPPs](#) was implemented. This resulted in migration assumptions being modelled as gross flows rather than nets which fulfilled a key recommendation from the review. Net migration is a summary measure. By modelling gross migration flows rather than nets, differences in the propensity to migrate and differences in the age sex structure of those entering the country compared to those leaving the country are taken into account. This provides an improvement to the quality of the migration assumptions. ONS are now also able to provide users with a more detailed breakdown of the underlying migration assumptions used in the projections which they can use for their own modelling work.

For the 2014-based projections, a new [method for incorporating cross border migration rates into the UK National Population Projections](#) has been adopted. This involves calculating average rates of movement by age and sex between countries of the UK based on recent data. These rates are then applied to the projected populations. Using rates rather than fixed numbers of migrants in the projections means that cross border flows are responsive to the underlying population size and age structure of each country. It also means that the projections cannot produce implausible values, such as negative population stocks, when projected fixed levels of emigration are bigger than the initial population size.

The mortality assumptions were last reviewed as part of the national statistics quality reviews in 2001. The [review of methodology for projecting mortality](#) assessed various projection methods being used at that time, and concluded that there were no grounds to believe that an alternative method would be likely to outperform the present method. Some amendments to the methodology were recommended such as setting a target year at 25 years hence and using UK rather than England & Wales data to analyse past trends. These changes were implemented in subsequent projections. In January 2015, a new review into the methodology for setting mortality assumptions for the national population projections was initiated. Some enhancements were implemented for the 2014-based projections, including a new method of smoothing historical mortality data to analyse past trends and determine the rates of mortality improvement for 2014, the initial year of the projections. Any future recommendations from the review will be considered and implemented, if appropriate, in future projections rounds.

For the 2014-based projections the population is computed for each of the constituent countries of the UK and the results are added together to produce projections for England and Wales, Great Britain and the UK. Variant projections are produced using the same method but using alternative assumptions of future levels of fertility, mortality and migration. Details about these are published alongside the [NPP](#) release. Previously some variant projections were calculated on a non-additive basis.

## Validation and quality assurance

### Accuracy

(The degree of closeness between an estimate and the true value.)

The NPPs use the latest available official population estimates as their base year and are inevitably dependent on the accuracy of these estimates. The accuracy of these estimates can be assessed after a Census has been carried out. The population estimates are calculated using the internationally recognised cohort component method - starting with the population data from the last decennial census and updated each year with the available data on births, deaths and migration. The population estimates [comparison of data sources and methods](#) paper compares the population estimates methodology used across the 4 UK countries.

In October 2015, National Records of Scotland (NRS) announced small errors in the mid-year population estimates for areas in Scotland. Whilst these errors do not affect the total population of Scotland, or other parts of the UK, they do have a small effect on the age and sex distribution of the population. The impact of these errors is much smaller than the uncertainty around the estimates due to sampling error from the Census. NRS will publish corrected MYEs in April 2016.

The 2014-based NPP are based on the original release of the Scottish MYE in April 2015 and thus do not reflect the correction to the MYE for Scotland used as the base population for the projection. The errors will also have a small effect on the projected age distribution of cross-border migration flows from Scotland to England and Wales. These effects are very small compared to other sources of uncertainty in the projections.

NRS have published more information on these errors on their [website](#).

Each product produces a new set of projected figures so it is impossible to quantify, at the time of their publication, how accurate the most recent population projections will prove to be. Each component of the projections - fertility, migration and mortality - is considered very carefully to try to ensure that the best possible assumptions are made. However, inherent uncertainty of future demographic behaviour means that from some point in the projection, assumptions of key variables are often held constant. How far into the future this occurs is likely to depend on the stability of that particular component.

Migration numbers are particularly unpredictable, with recent actual figures varying widely, so a constant annual migration assumption is usually assumed just a few years into the projection period. Fertility measures are less volatile, although as a period measure the Total Fertility Rate (TFR) is affected by when women choose to have their children as well as the number that they choose to have. The TFR is usually assumed to be static about 10 to 15 years into the projection. Mortality is measured in terms of improvements in mortality rates and, as changes are more gradual and stable, the current rates are assumed to gradually converge to a standard rate of improvement at the same level, for all but the oldest ages, 25 years into the projection. All these time periods are reconsidered for each projection set.

The assumptions are largely based on extrapolation of past trends with established models of, for example, the International Passenger Survey (IPS) component of migration flows. Inevitably, there is some element of subjective judgement and choices of key assumptions are also informed by the views of an Expert Advisory Panel. This is discussed in more detail in the Expert Advisory Panel section of the Background and Methodology report published with the first release. This can be found on the [NPP](#) page of the ONS website.

It would be impossible for any projections to be entirely correct - changes in the economy, in individual, family and household behaviour and events outside the UK will occur and will influence the 3 main components of population change. Possible effects of this uncertainty are shown by producing both a principal projection and a number of variant projections. These variants give

alternative plausible scenarios according to high or low assumptions about the trajectories of fertility, migration and mortality; they can also be combined to see the effect on the projections of, for example, a “young” population assumption (high fertility, high migration and low life expectancy assumptions). Other variants are useful in allowing users to decompose the projections to increase understanding on how changes in the assumptions affect the projected population. For example, by comparing the zero net migration variant with the principal projection, the impact of the level of assumed migration in the principal projection can be assessed. The variant projection results are also available on the [NPP](#) page of the ONS website.

The cohort component method used to produce the projections does not enable statements of probability to be attached to them, or for confidence intervals to be ascribed to the variant projections described above. Therefore, the levels of uncertainty for the fertility, mortality and migration assumptions are not directly comparable. However, it is possible to make some general comments about the relative importance of fluctuations in fertility, mortality and migration at different points in the projection period. This is illustrated in the Variant chapter of the reference volume [National Population Projections \(series PP2\)](#).

Important lessons can be learnt by looking back at earlier projection sets and comparing them with what subsequently happened. In July 2015, ONS published an [accuracy report](#) which compared national population projections with population and migration estimates and births and deaths data up to 2013, where available. In 2006/07 ONS completed a detailed analysis looking back over 50 years of projections, and the results were published in an article in [Population Trends](#) no.128. A previous analysis covering the projections made during the period 1971 to 1991 was published in [Population Trends](#) no. 77, details of which can be found in the [Index to Articles 1975-2003](#).

All of these articles consider how accurate the National Population Projections have been, the errors for each of the 3 individual assumptions, and whether accuracy has improved in more recent projections. The variant projections are also discussed. These analyses are inevitably dependent on comparisons with the latest population estimates. Revisions to estimates of the past and current population (for example, the revisions made to population estimates following the 2001 Census) also play a part in explaining projection error. This is likely to be a continuing factor especially if obtaining accurate results from a traditional census becomes more difficult (for example, because of higher non-response levels). This issue needs to be taken into account when considering projection error, as revisions may otherwise have the effect of making the projections look more or less accurate than they really were.

An article in [Population Trends](#) no.129 by an international expert in population projections considers the accuracy of projections across a number of European countries.

One of the limitations of the traditional deterministic approach to projecting the population is that no probabilities are attached to the principal projections, so users are not given information about the uncertainty associated with them. ONS started addressing this issue by developing a stochastic forecasting model for the United Kingdom. A [Progress Report](#) on this work describes how uncertainty about future demographic behaviour can be taken into account by expressing fertility, mortality and migration assumptions in terms of their assumed probability distributions. It discusses how these can be derived using a combination of three recognised approaches: analysis of past projection errors, expert opinion and time series analysis. This report outlines the early findings of this research.

### **Administrative data quality assurance toolkit**

In January 2015, the UK Statistics Authority issued the [Regulatory Standard](#) for the quality assurance of administrative data. This new standard applies to all official statistics where administrative data are used in the production of these statistics. All producers of official statistics that use administrative data

need to implement this requirement, by embedding good practice into their production to assure the quality of the data. The Authority has produced a toolkit to help ONS to do this.

Work has begun within Population Statistics Division to pilot approaches to meeting the regulatory requirements. In time, an approach to quality assuring the administrative data used to produce population statistics, including the population estimates, their components of change and the national population projections will ensure they meet the standards required by the UK Statistics Authority.

### **Coherence and comparability**

(Coherence is the degree to which data that are derived from different sources or methods but refer to the same topic, are similar. Comparability is the degree to which data can be compared over time and domain, for example, geographic level.)

Each set of NPPs is unique, comprising assumptions made using the best information available at a point in time. Thus each new set of projections, using the most up-to-date background data available, supersedes the previous set. Although the results of subsequent projections can be compared, this will not be comparing like-with-like but instead observing what effect the most recent demographic trends, when built into projections for the future, will have on the expected future population of the country.

Data for the 2006-based and subsequent sets of projections are available on the [NPP](#) page of the ONS website. Data from the 1954-based to 2004-based projections are available on the [NPP historical series](#) page.

The datasets produced within the NPP include standard demographic figures. As well as overall population totals, figures provided are: the projected number of births, deaths and migrants; age specific and total fertility rates (and births by age of mother); mortality rates (and deaths by age and sex) and expectation of life; migration by age; and dependency ratios. These are all datasets which would be produced as part of any population projection created by the cohort component method. For the 2014-based NPPs, rates of migration between countries of the UK are also available to users.

The NPPs are used both within and outside Government as the definitive set of population projection figures for the UK and constituent countries. They are used as the base for other official projections such as marital status projections, subnational projections, household projections and in the calculation of life tables. Other government departments use the projections directly to calculate information such as future school place requirements, expected future cost of state pensions and potential demand for health services. Throughout the UK the projections are considered the authoritative set of data on future population levels and no other national projections are, to ONS's knowledge, produced within the UK.

The only known official population projections for the UK apart from those produced by ONS are those produced by Eurostat and the United Nations (UN). [Eurostat EU population projections](#) refer to population as at 1 January, rather than at mid-year as for the NPP. Each time Eurostat creates a projection, ONS supplies a 1 January population estimate by single year of age and sex to use as the base population. Responsibility for the production of these base estimates falls within the Population Estimates Unit of ONS. Eurostat has no fixed timetable for their population projections, but their stated aim is to produce a projection set every 3 to 4 years. The most recently published are 2013-based population projections, EUROPOP2013, published March 2014.

Eurostat also use the cohort component approach to calculate their projections, but use their own methods to decide their assumptions for fertility, mortality and migration which are different to those used by ONS.

The UN produces [worldwide population projections](#) every 2 years. They publish a combination of population estimates and projections. The UN uses a Bayesian method to project the fertility and

mortality assumptions and then the standard cohort-component model to project the population forward.

Individual countries such as the UK have no input into the UN population projections, for which the assumptions are decided on a more general basis. For example, the fertility assumptions are made for just 9 regions of the world - so all of the countries of Europe are assumed to have the same fertility rate, despite the differing fertility experiences across Europe at the current time. Thus, the usefulness of the UN projections is in terms of providing a broad view across a number of countries, or where individual country projections cannot be obtained. The latest UN population projection is the 2015 Revision, published in July 2015.

### **Concepts and definitions**

(Concepts and definitions describe the legislation governing the output and a description of the classifications used in the output.)

The [overview of population and migration statistics](#) explains the concepts and definitions used in population projections.

**Conceptual framework:** a [conceptual framework](#) for population and migration statistics (including the population estimates) is available on the ONS website.

**Usually resident:** population estimates and projections include the "usually resident" population only. This is the standard [United Nations \(UN\) definition](#) including only people who reside in a country for 12 months or more. As such, short-term migrants are excluded.

**Components of change:** population changes between 1 year and the next are due to 3 components - births (fertility), deaths (mortality) and migration. The 2 categories of population change are:

- natural change, the difference between births and deaths
- net migration, covering movements of people between the UK and the various countries of the world and between the constituent countries of the United Kingdom

By making assumptions about future levels of fertility, mortality and migration, projected estimates of these various components of the population can be made and their effects can be added together to provide projected estimates of the population at selected points into the future.

**Fertility:** in a demographic or projections context fertility relates to how many children a group of women have, rather than their ability to conceive (which is the common understanding of fertility).

**Mortality:** the number of deaths in a given period.

**Mid-year:** 30 June of any given year, where the period from 1 mid-year to the next is from the first day of July year x until 30 June of year x+1.

### **Other information**

#### **Output quality trade-offs**

(Trade-offs are the extent to which different dimensions of quality are balanced against each other.)

National population projections are calculated as estimates of the future resident population of the UK and its constituent countries by sex and single year of age. It is currently not possible to calculate projections for any further breakdowns such as ethnicity or marital status due to limitations in the availability of data and the lack of a robust methodology required for such projections.

Although national projections are available up to 100 years ahead, users are advised that population projections become increasingly uncertain the further they are carried forward, so the

long-term figures should be treated with great caution. Projections by single year of age, particularly for those over 100 should be treated with extreme caution when looking beyond 25 years.

### **Assessment of user needs and perceptions**

(The processes for finding out about uses and users and their views on the statistical products.)

Information on users' needs for, and perceptions of, the population projections is collected in a number of ways:

- meetings with key stakeholders, such as government departments and the Bank of England
- user groups, for example, the [Central and Local Information Partnership](#) and the [Population Theme Group](#) - allowing key users to comment on existing plans and to put forward changes in their requirements
- user events, such as the [Local Insight Reference Panels](#): open to a range of users, and held in different parts of the country to encourage discussion on plans and existing products
- contact with individual users - drawing on the evidence provided by users who contact the Population Projections Unit with requests for, or queries on, the projections
- web analytics data showing use made of specific parts of a release

Reports from these events are published where appropriate. The information collected through these methods feeds into decisions on content and formats of outputs.

Users are encouraged to email feedback and suggestions regarding the projections to the national population projections team at [projections@ons.gsi.gov.uk](mailto:projections@ons.gsi.gov.uk).

### **Sources for further information or advice**

#### **Accessibility and clarity**

(Accessibility is the ease with which users are able to access the data, also reflecting the format in which the data are available and the availability of supporting information. Clarity refers to the quality and sufficiency of the release details, illustrations and accompanying advice.)

National population projections are available online from the National Statistics website. Links from the [National Statistics Publication Hub](#) provide the release date and location of each new set of projections. The projections can be downloaded free of charge in Microsoft Excel format from the National Statistics website page for [National Population Projections](#). For the 2014-based projections, open datasets in XML format are also available. These contain more detailed data than have previously been released to provide users with the data they need for their own modelling work. Graphs, textual background information and supporting documents are available as part of each release. Also available are interactive tools such as the population pyramids, to aid users' understanding of the projections.

Basic summary figures for historic sets of projections (2004-based back to 1954-based) which were previously only available via the GAD website, have now been moved across to the ONS website. Users requiring further detail for historical projections can request these from the national population projections team at [projections@ons.gsi.gov.uk](mailto:projections@ons.gsi.gov.uk).

The reference volume [National Population Projections \(series PP2\)](#) is produced for each set of main projections and is published about 5 months after the principal projections. It gives further information on the results and methodology by which the projections are produced.

Any additional enquiries regarding the national population projections can be made via email to [projections@ons.gsi.gov.uk](mailto:projections@ons.gsi.gov.uk) or by telephone: +44(0)1329 444652.

ONS's recommended format for accessible content is a combination of HTML web pages for narrative, charts and graphs, with data being provided in usable formats e.g. CSV and Excel. The ONS website also offers users the option to download the narrative in PDF format. In some

instances other formats may be used, or may be available on request. For further information please refer to the contact details at the beginning of this document.

For information regarding conditions of access to data, please refer to the links below:

- [Terms and conditions \(for data on the website\)](#)
- [Copyright and reuse of published data](#)
- [Pre-release access \(including conditions of access\)](#)
- [Access to unpublished data](#)
- [Accessibility](#)

### **Useful links**

The NPPs were assessed along with other population projections and estimates by the UK Statistics Authority for their compliance with the Code of Practice for Official Statistics. The findings were published in [Report number 309](#) on 30 July 2015.