RESAS RD 3.4.1: Demographic change in remote areas

Objective 3.5 (Milestone 1)

September 2020 (updated: April, June 2022)

Population projections and an introduction to economic-demographic foresight for Scotland's sparsely populated areas (2018-43)

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This report was funded by the Rural and Environment Science and Analytical Services Division of the Scottish Government

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Key messages

Updated population projections find that the population of sparsely populated areas of Scotland (more than 41% of the country by area) is projected to decline by 18.6% from 2018-43. The working age population of this region is projected to fall by 25.5% in the same period. However, the estimated demographic changes vary within the sparsely populated area.

Geographical differences in economic activity, and variation in commuter flows and regional economic linkages, could have considerable implications for population levels in sparsely populated Scotland. An economic-demographic foresight method, for enhancing population projections, is described. Updated population projections from economic-demographic foresight will be produced, using a 'baseline' economic scenario, to deliver place-based insights for different parts of sparsely populated Scotland.

In future, this model could be used to identify the effects of updated economic assumptions - potentially including the regional and nationwide effects of Covid-19, Brexit and policy change - on sparsely populated areas.

Introduction and research background

This research brief has been produced as part of strategic research on demographic change in remote areas of Scotland, which aims to assess the question "*What are the links between trends in farming/crofting/key rural industries and population change, and how do these affect… the resilience of rural communities?*". To achieve this, the research has used a definition of population sparsity to identify a core spatial framework – sparsely populated areas (SPA) – and used this to analyse variation in demographic, economic and service provision change across Scotland.

This note introduces a novel model: **economic-demographic foresight**, which aims to investigate the potential impacts of economic change in different industries, on the demography of the SPA in Scotland. The modelling of small area population change in peripheral areas is challenging, and is not routinely carried out by statistics offices; however, sub-national projections for council areas (and other geographies) have been produced at two year intervals by National Records of Scotland, and the Office for National Statistics, in addition to national projections[1]. In this note, we outline the background data for this process – including updated population projections for

[1] For sub-national projections, see: https://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/population/population-projections/sub-national-population-projections, https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/subnationalpopulationprojectionsforengland/previousReleases (Accessed 10th September 2020)

the SPA - and an overview of the methodology for producing a foresight model to evaluate the potential impacts of economic restructuring on population in sub-regions, initially using a 'baseline' scenario of employment change. The advantages of this method, including the potential to re-run the model with refined economic assumptions (possibly developed using stakeholder consultation and inclusion of regional economic change), will be highlighted.

Which parts of Scotland are sparsely populated? Defining key subregions for projections and foresight

Remote and peripheral regions have been defined in a number of ways, however this work has focused on 'sparsely populated' Scotland. Following a definition developed by researchers in northern Europe (Gløersen et al., 2005: 2-3), sparsity is defined as poor access to people – often arising from low population density and scattered settlements. Sparsity presents direct difficulties for the viability of communities, businesses and services, and therefore represents a particularly relevant concept to study these issues within rural Scotland.

The first version of the Scottish SPA was defined in 2017. However, partly due to the availability of more recent population estimates for Scottish Data Zones (6,976 small areas), the SPA was re-defined in 2020 using an updated, improved transport network[2]. Data Zones were classified as sparsely populated if (in 2011) it was estimated that less than 10,000 people[3] lived within 30 minutes' travel, by roads and ferries, from their centre. The SPA covers 32,305 km^2, or 41.5% of the area of Scotland[4]. In 2018, the population[5] of this area was 126,471 people (2.3% of Scotland's population), a population decline of 2.4% from 2011.

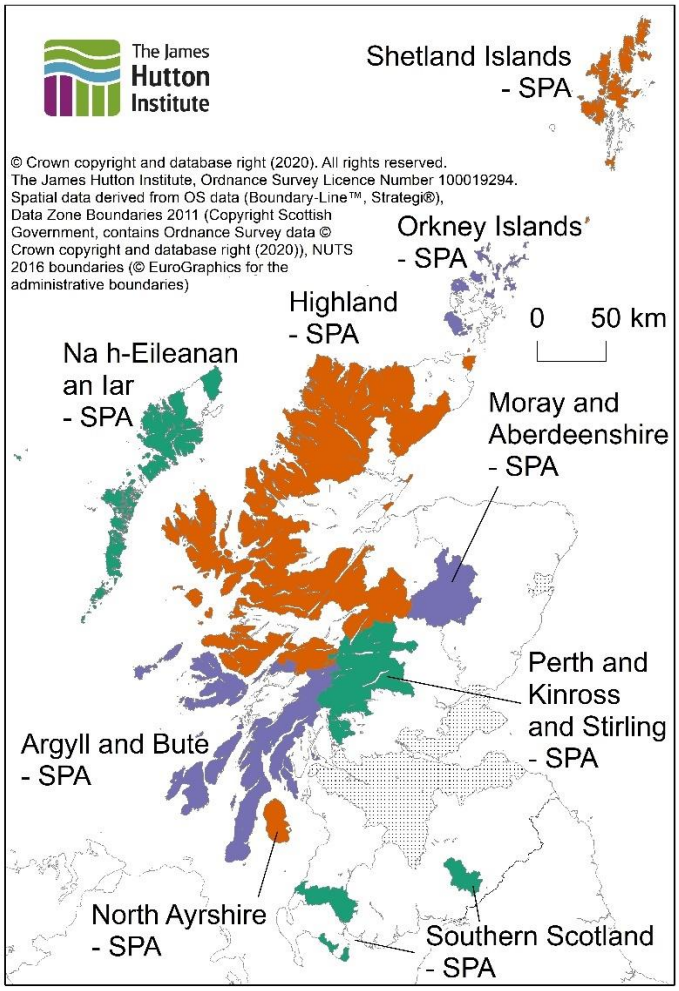
Outside of the SPA, the population of Central Scotland, Aberdeen and Dundee was 3.69 million in 2018 (2011-18 change: +3.5%), and the other smaller cities, towns and rural areas in Scotland had 1.62 million residents in the same year (+1.0% from 2011). Notably, the SPA's population structure is distinctive compared with those of other regions: 27.3% of residents were aged 65 or over in 2018, compared with

[2] Data sources used to construct the transport network, and limitations of the travel time calculations involved in the SPA definition, are described in the Appendix.
[3] The population data for these calculations was at the level of Output Areas, a smaller geographical unit than Data Zones.
[4] Area calculations using Data Zone Boundaries 2011 (Copyright Scottish Government, contains Ordnance Survey data © Crown copyright and database right (2020))
[5] Population data source: National Records of Scotland Population Estimates (Current Geographic Boundaries). http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/.

17.2% in the mostly urban regions outside the SPA and 22.0% of residents of other non-sparsely populated areas.

For the purposes of identifying spatial variation in demographic change, and producing population projections and foresight, the SPA and other parts of Scotland have been divided into subregions. Figure 1 shows the SPA (bright colours) and subregions defined within it, and subregions outside the SPA. This definition was driven by the economic-demographic modelling approach and consideration of commuting patterns and differences in economic activity across Scotland. Therefore, subregions were defined using local authority boundaries, with logical combinations in some geographical areas. Outside of the SPA, subregions include remote towns and nearby areas, surrounded by sparsely populated peripheries in the islands, Argyll and Bute and Highland: this definition was informed in places by Travel to Work Area boundaries. A 'Central Scotland' subregion contains Glasgow, Edinburgh and the largely urban local authorities surrounding these, which do not share a border with the SPA. The cities of Aberdeen and Dundee share similar characteristics. These three subregions are indicated by dotted shading on Figure 1.

Figure 1: The Scottish SPA (coloured area) and subregions across Scotland.



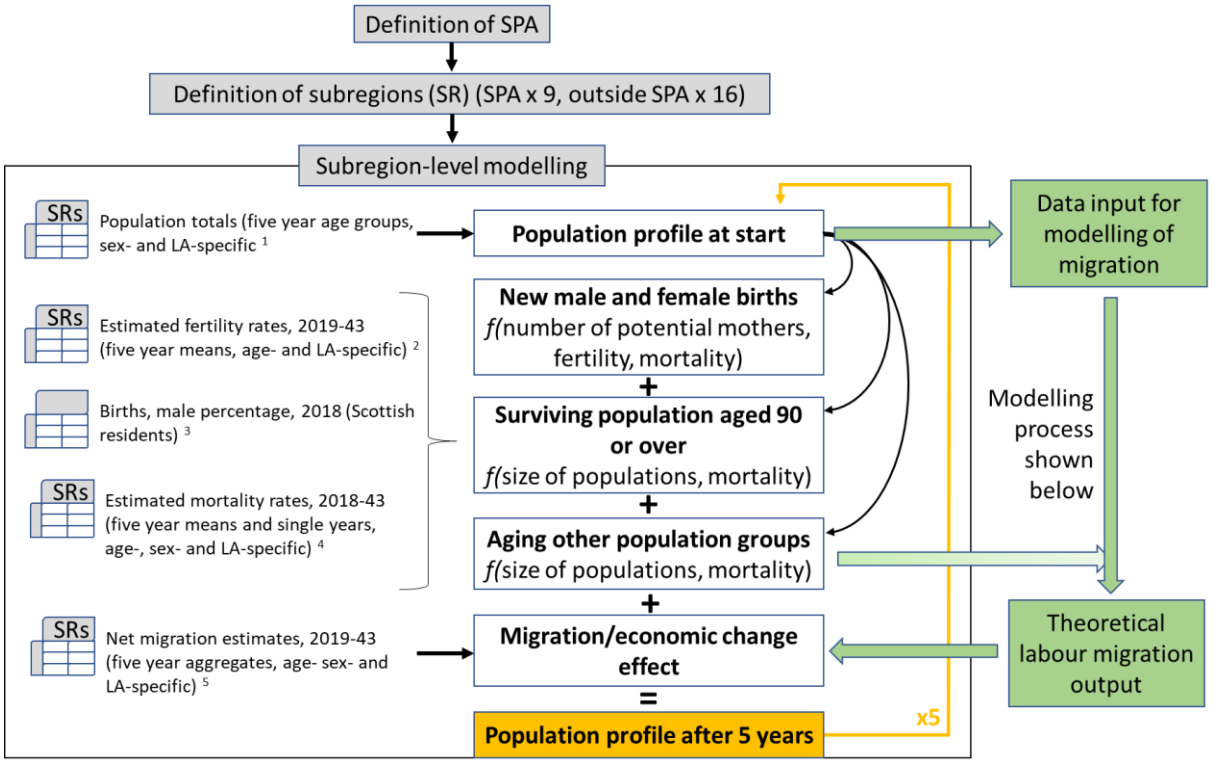
Areas in dotted shading are the subregions of Central Scotland, Dundee and Aberdeen, all outside the SPA.

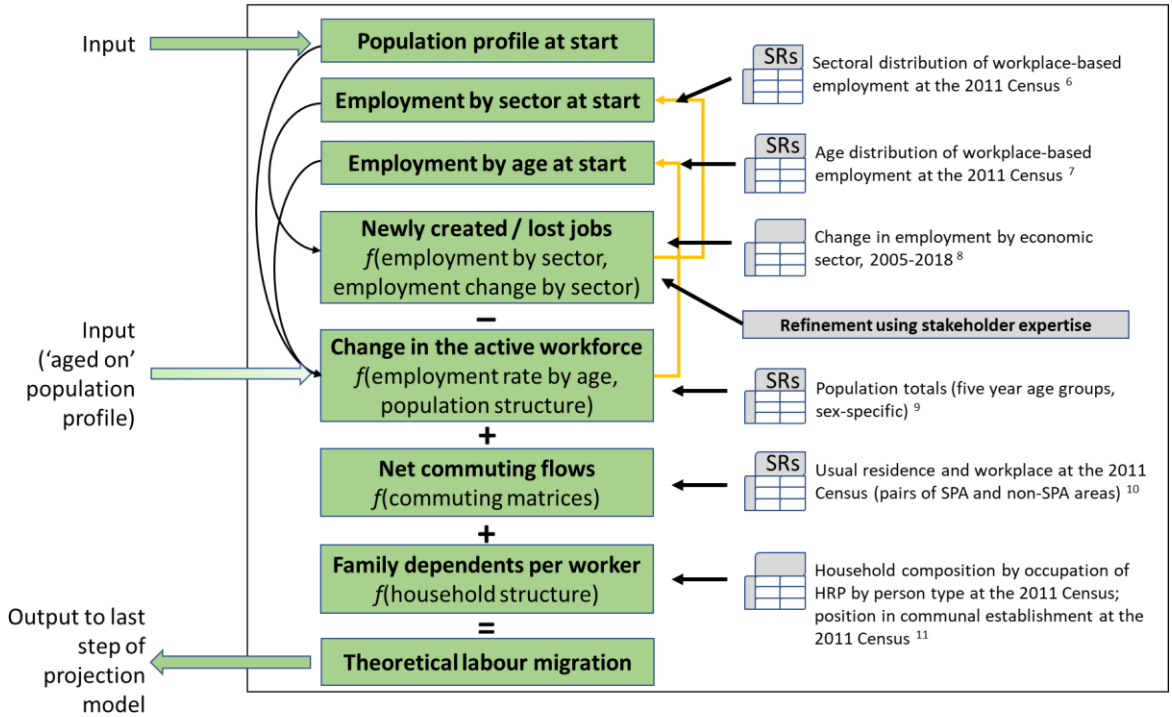
The basis for economic-demographic foresight: updated population projections (2018-43)

In 2018, the projected future evolution of the population of sparsely populated regions in Scotland was modelled from a 2011 base (Copus, 2018; Copus and Hopkins, 2018). This approach uses detailed population structures and projected future rates of births, deaths and migration for different population groups (five year age groups of men and women). Following the release of more recent (2018) small area-level population data and additional demographic information by National Records of Scotland and the Office for National Statistics, a revised series of projections has been produced for the 25 year period from 2018-43. This method - summarised on the top of Figure 2 - uses a version of the 'cohort-component'

projection methodology (an example of this is described in National Records of Scotland, 2020a: 13-4). The 'Demographic Foresight Model', developed within the REGINA project (Copus, 2017), is a version of this approach developed for use with smaller populations: this was used in this project for the earlier 2011-based projections, and the population structure and key stages of this are used here. Age-, sex- and local authority-specific data (and projected evolutions in these over time) are used to produce estimates of subregion-level population structures in five year periods up to 2043. This projection method forms the basis of the final economic-demographic analysis. All data used in this work (and in the economic-demographic analysis) were available at the time of analysis: some datasets have been updated since (e.g. small area population estimates).

Figure 2: Modelling of demographic change. Top: data and methods used in the population projections described. Bottom: potential enhancement of projections by integration of migration data from economic-demographic modelling.





Sources of subregion-level and other data (numbered) are summarised at the end of this report.

These projections (Table 1) suggest that the SPA population is projected to fall by over 18% (from 126,471 to c. 102,902 people) from 2018 to 2043, and the working age (15-64)[6] population is projected to fall by more than a quarter. By contrast, the population of the four largest cities in Scotland, and the rest of Central Scotland, are projected to see a slight population increase of around 1.4%, and a very small decline in the number of people of working age. The total and working age populations of the rest of Scotland 'not in SPA' are projected to decline, but to a much lesser degree than in the SPA.

Additionally, the projected changes in dependency ratios suggest that the SPA population structure may evolve at a faster rate than elsewhere. In 2043, the estimated dependency ratio is over 84 children (age: 0-14) and older people (age: 65 and over) for every 100 working age residents in the SPA: a much higher number than in other regions, and a larger increase. These figures are supported by analysis which projects a c. 3.8% decline in the size of Scotland's population aged 16-64 from 2018 to 2043 (derived from data[7] in National Records of Scotland and Office for National Statistics, 2019), and a concentration of population growth in central and urban Scotland by 2028 (National Records of Scotland, 2020b).

[6] Definitions of the 'working age' population, and other age groups, were based on the resolution of demographic data available. The working age range is a proxy, reflecting a standard definition of this group (see OECD, 2020) and an age group in labour market statistics (see '16-64' group used in Office for National Statistics, 2020): it is kept constant in the analysis and does not reflect future state pension entitlement.

[7] Data in table '2018-based projected population summary table, Principal projection, Scotland, 2018-2118'. (© Crown Copyright 2019)

Table 1: Regional population projections, 2018-43, summary

	Total population change (%), 2018-43	Working age population change (%), 2018-43	Dependency ratio, 2043 (*change*)*	Old age dependency ratio, 2043 (*change*)*
SPA	**-18.6**	**-25.5**	**84.4 (*+15.6*)**	**58.7 (*+12.7*)**
not in SPA – Central Scotland, Aberdeen, Dundee	1.4	-1.0	53.4 (*+3.6*)	31.1 (*+5.3*)
not in SPA – remaining areas	-5.9	-11.4	70.7 (*+9.8*)	44.9 (*+9.6*)

*Dependency ratio: the number of children (0-14) and older residents (65 and over) per 100 people of working age. Old age dependency ratio: the number of older residents per 100 people of working age. 'change' figures show the difference (number of people) between 2018 and 2043.

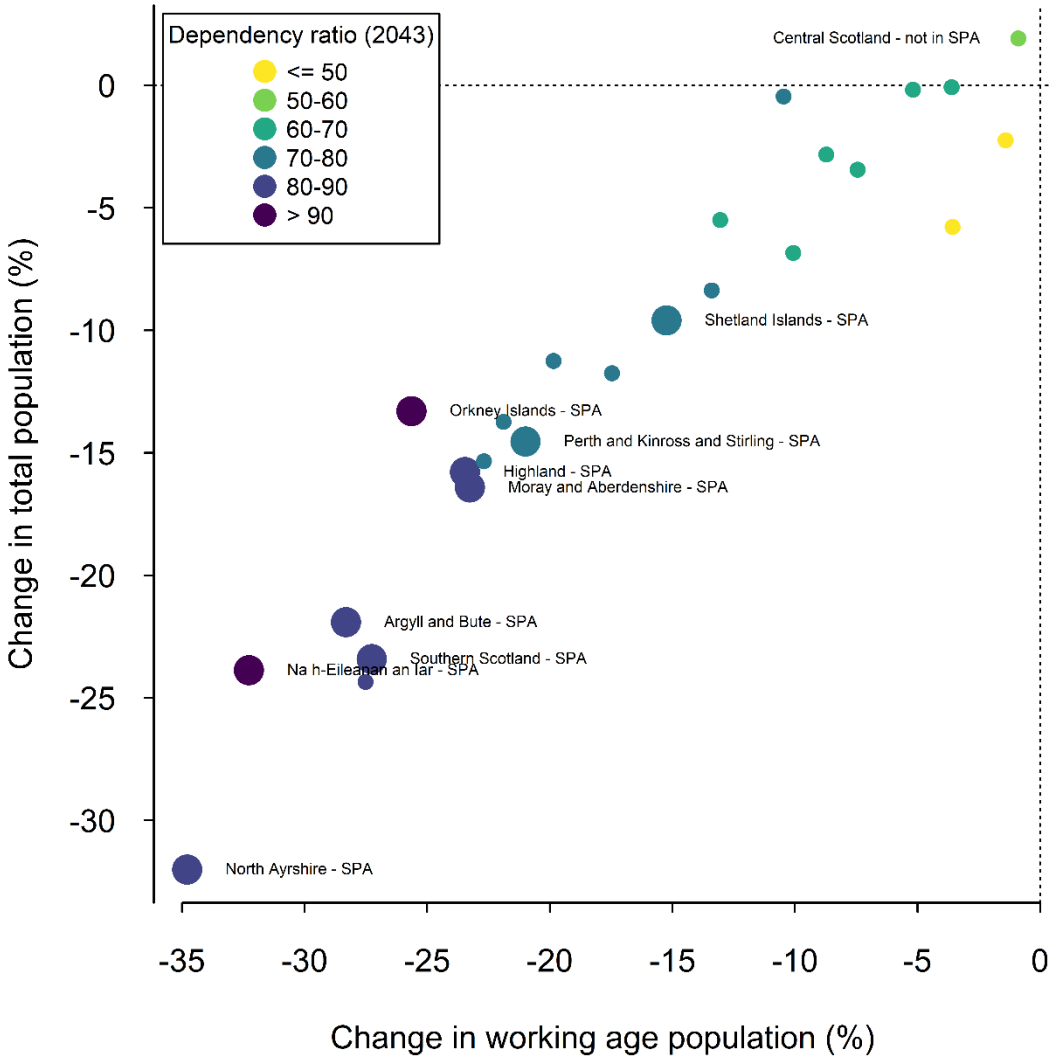
These regional projections disguise considerable variation at subregion level, visualised on Figure 3. Subregion-level projections emphasise that population changes are estimated to be more negative in SPA subregions than in other subregions, with some exceptions. However, considering projections within the SPA, we can identify two clusters of subregions with similar characteristics, and two other outliers:

- The sparsely populated parts of the **Shetland Islands** are projected to lose less than 10% of their total population, and just over 15% of the working age population by 2043; these are the most positive (or 'least negative') projections within the SPA. In 2043, there is an estimate of c. 74 children and older people for every 100 people of working age within this subregion.
- Parts of the Highlands and northern Scotland (**Perth and Kinross and Stirling – SPA**, **Highland – SPA**, **Moray and Aberdeenshire – SPA**) and **Orkney Islands – SPA** are projected to lose between 13% and 17% of their overall populations, and more than 20% of their working age populations, from 2018 to 2043. The projected 2043 dependency ratios for the mainland subregions are around 80, although the Orkney Islands has the highest estimated ratio (c. 102) of any subregion.
- **Argyll and Bute – SPA**, **Southern Scotland – SPA**, and **Na h-Eileanan an Iar – SPA** are projected to experience a somewhat larger population decline by

2043 (total: 21-24%, working age: 27-33%). Estimated dependency ratios for 2043 are c. 86, c. 87, and c. 95, respectively.

- Finally, **North Ayrshire – SPA** (the Isle of Arran) is projected to lose c. 32% of its population by 2043, and c. 35% of its working age population in the same time.

Figure 3: Summary of projected demographic change for subregions, 2018-43



Subregions within the SPA are shown with larger circles.

These projections, which forecast a considerable fall in population within the SPA from 2018 to 2043, reflect the projections from the earlier 2011-based analysis. The present population structure in the SPA features a relatively small number of people of working age, and a relatively large older population; this could exacerbate the effects of population aging and lead to a more negative projection for this region,

than elsewhere. However, the estimated population changes indicate that other regions of Scotland are not without demographic challenges.

Economic-demographic foresight: investigating the potential impact of economic change on population levels in the SPA

As a second stage of analysis, the above projections will be enhanced through an alternative modelling of migration which is more closely tied to economic development. Broadly, the development of economic-demographic foresight in the context of sparsely populated and remote areas is important for two key reasons:

- **Regional and sub-regional variation in economic structures, with differing degrees of economic specialisation and diversification, imply that future economic change is likely to generate places which are relative 'winners' and 'losers', with a strong association between change in employment and population change.** *As population sparsity theoretically presents multiple barriers to development (Gløersen et al., 2005: 23-7), many related to lack of access to the considered economic advantages of agglomeration observed in cities (Rauhut and Hatti, 2017), a further investigation of the economic-demographic relationship in the geographical context of the Scottish SPA is highly valuable.*
- **People employed at a workplace do not necessarily live locally, and economic activity and employment in one place can support population levels in another. This is most obvious in the 'commuter belts' around large cities, however remote towns and economic centres (e.g. Stornoway, Kirkwall, Lerwick, Fort William, Oban), as concentrations of economic activity, are also likely to benefit adjacent sparsely populated regions. However, this effect is difficult to quantify without a subregion-level perspective.** *This issue is linked to the question of whether different sparsely populated areas form "...self-contained labour markets..." or are "...the outer fringes of functional areas centred upon towns and cities elsewhere...", and thus whether economic activity in sparsely populated areas is driven by local (endogenous development) or external (exogenous development) processes (cited from Copus, 2019: 16; see Slee, 1994: 184 for outline definition of endogenous/exogenous development).*

Therefore, a novel method will be taken forward to estimate potential future net migration for subregions within the SPA, and elsewhere in Scotland. Practically, this involves the calculation and analysis of subregion-level data on economic structure (Table 2), the demographic characteristics of employees (Table 3), commuting

patterns (based on the locations of workers' residence, and their workplaces) (Figure 4), and forming a ‘baseline’ scenario of future economic change.

The key input datasets visualised below highlight the variability in economic structures of subregions both across Scotland, and within the SPA (Table 2). This is supported by the findings of previous analysis (Hopkins and Copus, 2018), which revealed differences in the employment structures of the SPA and other rural areas and small towns, faster restructuring in the agricultural sector outside of the SPA than within it, and evidence of centralisation of some types of economic activity in urban and accessible rural regions. Employment demographics (Table 3), show differences in the age structure and gender balance of employees, and considerable variability between subregions.

Table 4 shows that within the SPA, some subregions feature very little out-commuting: in North Ayrshire - SPA and Argyll and Bute - SPA, 90.6% and 87.5% (respectively) of employed residents work within the subregion. By contrast, in Southern Scotland - SPA, only 58.3% of employed residents work within the area: almost all of the remainder are employed in non-SPA parts of Scotland and elsewhere within the UK. In the SPA overall, there were more employed residents than jobs (63,069 vs 57,392); this was true for all single SPA subregions apart from North Ayrshire, suggesting that SPAs have an ‘attracting power’ beyond economic reasons, and therefore they could benefit in demographic terms from jobs created in nearby regions. These characteristics show inequality in economic potential across Scotland, and differences in the ability of areas outside the SPA to provide employment for residents within it, emphasising the value of a linked economic-demographic approach.

Table 2: Workplace-based 'daytime' employment structure, regions (dark grey) and subregions, 2011

Sector(s)	SPA total	Argyll and Bute - SPA	Highland - SPA	Moray and Aberdenshire - SPA	Na h-Eileanan an Iar - SPA	North Ayrshire - SPA	Orkney Islands - SPA	Perth and Kinross and Stirling - SPA	Shetland Islands - SPA	Southern Scotland - SPA	not in SPA - outside CSAD total	Ayrshire - not in SPA	Dunoon area (Argyll and Bute) - not in SPA	Fort William area (Highland) - not in SPA	Helensburgh area (Argyll and Bute) - not in SPA	Inverness area (Highland) - not in SPA	Na h-Eileanan an Iar - not in SPA	North East Scotland - not in SPA	Oban area (Argyll and Bute) - not in SPA	Orkney Islands - not in SPA	Perth and Kinross and Stirling - not in SPA	Shetland Islands - not in SPA	Southern Scotland - not in SPA	Thurso and Wick area (Highland) - not in SPA	not in SPA - CSAD total	Aberdeen City - not in SPA	Central Scotland - not in SPA	Dundee City - not in SPA
Agriculture and land-based industries	**9**	9	7	5	9	2	29	4	13	20	**5**	3	3	4	1	3	3	7	6	8	3	5	8	8	**2**	10	1	0
Utilities	**3**	2	3	1	2	4	3	4	3	5	**2**	2	1	2	0	1	1	1	2	1	3	1	2	4	**1**	1	2	1
Manufacturing	**5**	6	4	7	6	9	5	3	7	9	**9**	10	3	10	4	7	5	12	3	5	6	6	10	7	**8**	7	8	7
Construction	**11**	10	11	6	12	12	11	9	12	12	**9**	9	10	10	6	9	11	10	9	11	9	11	9	9	**7**	6	8	6
Wholesale, retail, vehicle repair	**14**	11	16	25	11	20	10	24	9	13	**15**	16	12	18	7	15	12	15	15	14	16	13	16	12	**15**	14	15	17
Accommodation and food service	**9**	10	10	9	6	8	5	13	4	5	**7**	7	11	11	6	9	7	6	14	7	9	6	7	8	**6**	6	6	6
Transport, information and communication	**8**	7	7	5	9	7	8	4	19	5	**6**	6	8	8	5	8	10	5	9	10	5	8	6	7	**8**	9	8	7
Finance and insurance, real estate, professional and admin.	**9**	9	10	13	9	8	8	12	7	9	**11**	10	11	9	14	11	8	11	11	9	14	8	10	12	**17**	18	17	11
Public administration, education and health	**26**	30	26	18	33	24	17	18	23	16	**30**	33	36	25	51	31	39	28	27	31	29	36	29	29	**31**	25	31	39
Arts, entertainment and recreation	**5**	5	6	10	4	6	4	7	3	6	**5**	5	5	5	4	5	4	4	4	4	5	5	5	3	**5**	4	5	5
Other activities	**0**	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0

Figures show % of employment within sector/'macro sector' (to nearest whole %, '0' values may not be actual 0s), shading in proportion to value. 'CSAD' = 'Central Scotland, Aberdeen and Dundee'. Includes data for Scottish residents (aged 16-74) and residents of England, Wales, Northern Ireland working in Scotland (aged 16+). Calculated from analysis of 2011 Census data (© Crown copyright. Data supplied by National Records of Scotland) (Data: see appendix 'Population and economic data used within population projections and foresight': 6)

Table 3: Workplace-based employment age structure (top table) and gender balance within age groups (lower table), regions (dark grey) and subregions, 2011

	SPA total	Argyll and Bute - SPA	Highland - SPA	Moray and Aberdenshire - SPA	Na h-Eileanan an Iar - SPA	North Ayrshire - SPA	Orkney Islands - SPA	Perth and Kinross and Stirling - SPA	Shetland Islands - SPA	Southern Scotland - SPA	**not in SPA - outside CSAD total**	Ayrshire - not in SPA	Dunoon area (Argyll and Bute) - not in SPA	Fort William area (Highland) - not in SPA	Helensburgh area (Argyll and Bute) - not in SPA	Inverness area (Highland) - not in SPA	Na h-Eileanan an Iar - not in SPA	North East Scotland - not in SPA	Oban area (Argyll and Bute) - not in SPA	Orkney Islands - not in SPA	Perth and Kinross and Stirling - not in SPA	Shetland Islands - not in SPA	Southern Scotland - not in SPA	Thurso and Wick area (Highland) - not in SPA	**not in SPA - CSAD total**	Aberdeen City - not in SPA	Central Scotland - not in SPA	Dundee City - not in SPA
16-24	**10**	11	9	10	9	10	8	11	11	11	**13**	12	11	12	14	12	12	13	12	14	14	15	12	12	**13**	16	13	16
25-34	**14**	15	14	12	14	12	13	17	17	14	**18**	18	15	19	19	19	18	18	18	17	19	19	16	18	**22**	24	22	21
35-49	**35**	36	35	36	37	33	32	34	34	34	**37**	38	36	36	38	36	37	36	36	36	36	35	37	36	**37**	33	37	35
50-64	**35**	33	36	34	35	37	38	33	34	35	**30**	30	34	29	27	29	30	30	30	29	27	27	32	30	**26**	25	26	26
65-74	**5**	5	5	8	5	7	8	5	5	7	**3**	3	5	3	3	3	3	4	4	4	3	3	4	4	**2**	2	2	2
16-24	**0.7**	0.7	0.7	0.7	0.6	0.7	0.6	0.9	0.6	0.5	**0.9**	1.0	0.9	0.8	0.4	0.9	1.0	0.8	0.8	1.0	1.1	1.0	1.0	0.8	**1.1**	1.1	1.0	1.2
25-34	**0.8**	0.8	0.9	0.8	0.9	0.9	0.5	0.9	0.5	0.6	**1.0**	1.0	1.0	0.9	0.5	1.0	1.1	0.9	0.9	1.1	1.0	1.1	1.0	1.1	**1.0**	0.9	1.0	1.1
35-49	**0.9**	1.0	1.0	1.0	0.9	1.0	0.7	1.0	0.7	0.7	**1.1**	1.1	1.1	1.0	0.6	1.1	1.1	1.0	1.0	1.0	1.1	1.0	1.0	1.0	**1.0**	0.8	1.0	1.1
50-64	**0.9**	0.9	0.9	0.9	0.8	1.0	0.6	0.9	0.6	0.7	**0.9**	1.0	1.0	0.9	0.7	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.8	**0.9**	0.7	0.9	1.0
65-74	**0.6**	0.6	0.6	0.7	0.7	0.6	0.6	0.6	0.5	0.6	**0.6**	0.7	0.7	0.8	0.5	0.6	0.8	0.6	0.7	0.6	0.6	1.0	0.6	0.5	**0.7**	0.6	0.7	0.7

Figures show (top) % of employment within age group (to nearest whole %), shading in proportion to value; (bottom) ratio of female to male employees within age group (to one decimal place), dark shading shows ratio > 1, light shading shows ratio from 0.8 to 1. 'CSAD' = 'Central Scotland, Aberdeen and Dundee'. Includes data for Scottish residents (aged 16-74) and residents of England, Wales, Northern Ireland working in Scotland (aged 16+). Calculated from analysis of 2011 Census data (© Crown copyright. Data supplied by National Records of Scotland) (Data: see appendix 'Population and economic data used within population projections and foresight': 7)

Figure 4: Workplace locations for subregion residents, 2011. SPA subregions shown by white circles.

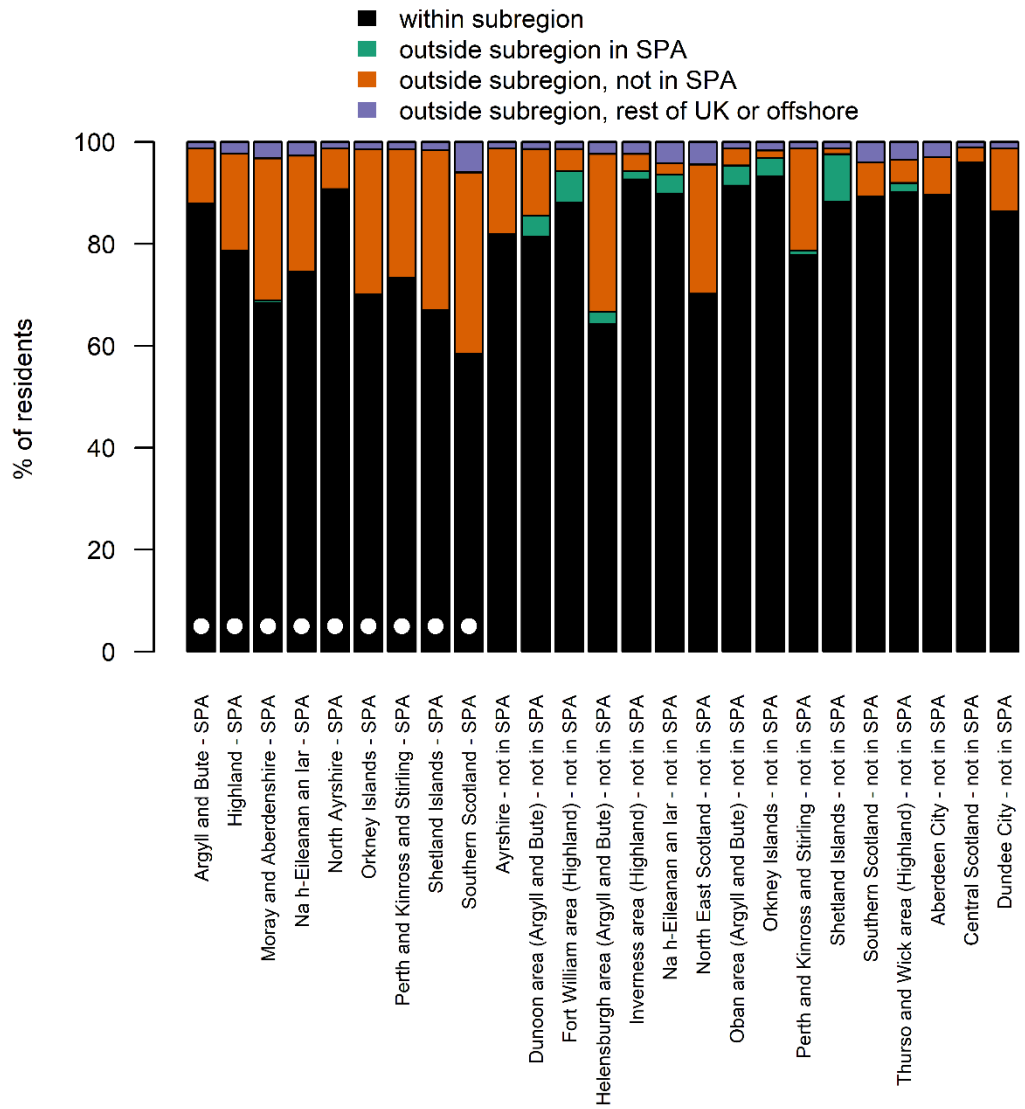


Diagram shows a summary of origin-destination data, only: for example commuters from the rest of the UK to Scotland are not shown, and 'flows' between individual subregions are included in the analysis but not shown here for clarity. Includes data for Scottish usual residents aged 16 and over in employment. Calculated from analysis of 2011 Census data (© Crown copyright. Data supplied by National Records of Scotland) (Data: see appendix 'Population and economic data used within population projections and foresight': 10).

The goal of economic-demographic foresight is to assess the estimated future labour demand within different subregions, produce estimates of the potential shortage or surplus of labour, and then the resulting in- or out-migration required. The latter will be produced as detailed estimates (by sex and age group) for five year periods, which can be used within population modelling. While demographic indicators related to 'natural change' in population (resulting from births and deaths)

are well-documented, migration is more challenging to model, and this is usually done by splitting it into several components, of which labour-related migration is the main one. Here, we focus on labour migration. Our baseline simulation of future economic change (2018-43) will be based on a time series of sectoral employment (2005-18); however this assumption can be adjusted in the future via stakeholder consultation and consideration of expert views on future economic development. Such 'fine tuning' is essential in the context of the current Covid-19 disruption, the Scottish Government's commitment to 'net zero' carbon emissions by 2045, and continuing uncertainty over Brexit.

The working logic of the baseline model is shown on the bottom half of Figure 2. Estimated migration is calculated for SPA and non-SPA subregions using the following steps, for each five year period until 2043 (the first is 2019-23):

- The estimated change in employment is calculated using the initial employment by economic sector and its assumed change, the latter modelled from 14 years of employment data from the Annual Population Survey, produced by ONS[8].
- The estimated change in the number of jobs is reduced or increased based on each area's projected population structure, by considering whether 'new entrants' are over- or under-compensating for the retirement of elderly employees. This allows us to generate the potential surplus or shortage of jobs in each area, which is assumed to be compensated through commuting. We assume that the labour supply will meet demand (in other words, no positions will remain vacant, and people losing their job will leave the area).
- Next, we assign an area of residence to each new (or lost) employee using commuting (origin-destination) flows, adjusted by the relative change in the size of the economy of each area. Then, using household composition data, the theoretical number of dependents per each new (or lost) employee are estimated.
- Employees and dependents are assigned a sex and an age, generating the estimated amount of in-migration or outmigration during the period.
- This data is then added to the projected population obtained from the demographic 'cohort component' model, after accounting for births, deaths and aging within the resident population.

Due to the complexity of the migration phenomenon and the uncertainty behind it, some assumptions are necessary within this model to produce demographic

[8] Data: ONS Crown Copyright Reserved [from Nomis]

estimates. We adopted preservative assumptions, e.g. that the age structure of migrants will align to the age structure[9] of the current employees and population, or that employment rates by age will remain constant during the modelled period.

Summary and next steps

The revised population projections included in this note emphasise the demographic challenges faced by sparsely populated parts of Scotland. The projection methodology builds on approaches developed earlier in this project, and in other analyses, and uses updated data to deliver specific projections for remote regions. The population of Scotland's SPA – over 40% of the country by area – is projected to decline by over 18% from 2018 to 2043. This, and the estimated slightly larger rate of decline (over a quarter) for the working age population, appears concerning, given the Scottish Government's commitment "…to stem rural depopulation and attract more people to live and work in rural and island communities" (Scottish Government, 2019 - Programme for Government, 2019-20: page 14). It must be emphasised that this is a projection which assumes continuation of recent trends: it presents a picture based on these assumptions, and cannot be (and is not) a certain view of the future. Additionally, the projected population trend should not be interpreted as a uniform change across all areas, and the projections are less negative for the northern Isles and parts of the Highlands. The nature of regional projections will also not capture local- or community-level population change, including positive 'green shoots' recently highlighted in the islands[10].

This note has also outlined a method to enhance the population projections for the SPA, by examining the potential impact of estimated economic change on regional economic strength, employment levels and the economic linkages between different areas of Scotland. This 'economic-demographic' approach will produce a more nuanced understanding of estimated future migration patterns, which (when added into the projection model described above) could offer an updated projection of population change in sparsely populated Scotland. These updated projections, for a 'baseline' or 'pre-Covid-19' economic scenario, will be reported in a separate research brief. This work will highlight the extent to which the

[9] Note that there are some differences in age group classification between demographic and economic data: due to the resolution of population data, we define children as aged 0-14 and 'working age' people as aged 15-64, while employment data often reports on people aged 16-74. The definition of the 'working age' population is not tied to actual employment. Many people aged 65 or over are economically active, although only a small proportion of employed people are aged 65-74 (see Table 3). In the economic-demographic modelling of migration, an adjustment is made due to the small difference in the child age range.

[10] https://islandsrevival.org/the-islands-revival-declaration/ (Accessed 13th September 2020)

integration of estimated economic change affects the demographic projections for different parts of sparsely populated Scotland. Potential implications of these projections will be highlighted, as will the opportunity to refine the economic assumptions within the model, by capturing more recent regional and place-based expertise.

Acknowledgements: We are happy to acknowledge the considerable contribution made by Andrew Copus (RD3.4.1 lead to the end of 2019) to this research project, especially his work developing population projections in the SPA. Thanks to Ruth Wilson and Christina Noble for being part of the 3.4.1 team discussions about this work. We thank National Records of Scotland for provision of data related to their population projections for 2018, and for providing feedback on this work.

This work was funded by the Rural & Environment Science & Analytical Services Division of the Scottish Government as part of the 2016-2021 Strategic Research Programme. Any views expressed are those of the authors and do not necessarily represent those of the Scottish Government or RESAS. Any errors in analysis or interpretation are those of the authors.

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Copus, A. and Hopkins, J. (2018) Demographic change in the Sparsely Populated Areas of Scotland (1991-2046). Available at https://www.hutton.ac.uk/sites/default/files/files/research/srp2016-21/RD3.4.1%20Note%20WP1-3%20web%20-%20published.pdf (Accessed 13th September 2020)

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Appendix

Data sources used within definition of SPA and subregions used in analysis:

Update April 2022: The network dataset and SPA and subregion definitions for Data Zones were produced before this report was published in September 2020, and then reproduced in 2021-22.

Data sources which were used to create the reproduced network dataset and SPA and subregion definitions have been added in green text below. Several datasets were re-downloaded in 2021, and many are acknowledged with a different wording. The acknowledgement for the average speeds data has been updated to include the Department for Transport source.

Transport network created from analysis of the following data:

- GI-SAT (Geographic Information Science and Analysis Team), Scottish Government: Scottish Ferry Ports, Scottish Ferry Routes. Copyright Scottish Government, contains Ordnance Survey data © Crown copyright and database right (2019, 2020).
- A small number of ferry journey times were imputed/estimated, or infilled from online sources. The latter was the case for three passenger ferries: Mull (Tobermory) – Drimnin, Fort William – Causnagaul, Lerwick (Esplanade) - Fair Isle). Infilled journey times can be found at Drimnin Sealink Limited (https://www.facebook.com/317606168417686/photos/pb.317606168417686.-2207520000../1418398411671784/?type=3&theater), Lochaber Transport Forum (http://www.lochabertransport.org.uk/TransportinLochaber/PublicTransport/Ferries/CamusnagaulFerry.aspx), Shetland Islands Council Inter-Island Ferry Service Timetable Summer 2019 (https://www.shetland.gov.uk/ferries/documents/FairIsleSummer2019.pdf) (Links accessed 21st August 2020).
- National Records of Scotland: Settlements (Urban Areas) - Settlements 2016 boundaries. Contains NRS data © Crown copyright and database right (2019), contains Ordnance Survey data © Crown copyright and database right (2019).
- Office for National Statistics - ONS Geography: Built-up Areas (December 2011) Boundaries V2. Contains National Statistics data © Crown copyright and database right [2017] http://www.nationalarchives.gov.uk/doc/open-government-licence/
- Ordnance Survey (OS): Open Roads (version: April 2019). Contains OS data © Crown copyright and database right (2019)
- Ordnance Survey (OS): Boundary-Line™: High water mark. Contains OS data © Crown copyright and database right (2019)
- "Road classes and average speed applied in the classification" given in Scottish Government Geographic Information Science & Analysis Team, Rural and Environment Science and Analytical Services Division (2018) Scottish Government Urban Rural Classification 2016. Scottish Government (page 13). Original source of figures: Department for Transport.

- GI-SAT (Geographic Information Science and Analysis Team), Scottish Government: Scottish Ferry Ports, Scottish Ferry Routes. Copyright Scottish Government, contains Ordnance Survey data © Crown copyright and database right (2020).
- A small number of ferry journey times were infilled from online sources. Mull (Tobermory) – Drimnin: Drimnin Sealink Limited https://www.facebook.com/317606168417686/photos/pb.317606168417686.-2207520000../1418398411671784/?type=3&theater (09/07/2021); Fort William – Causnagaul: Lochaber Transport Forum http://www.lochabertransport.org.uk/TransportinLochaber/PublicTransport/Ferries/CamusnagaulFerry.aspx (09/07/2021); Lerwick (Esplanade) - Fair Isle: Shetland Islands Council

Inter-Island Ferry Service Timetable Summer 2021 https://www.shetland.gov.uk/downloads/file/3011/summer-2021-inter-island-ferry-timetable. (If missing estimated journey times for four year-round passenger ferries are infilled using regression, rather than using the online sources, the Data Zone-level definition of sparsely populated areas is identical)

- National Records of Scotland: Settlements – Scotland: Settlements 2016 boundaries. Contains NRS data © Crown copyright and database right [2021]; Contains Ordnance Survey data © Crown copyright and database right [2021]
- Office for National Statistics - ONS Geography: Built-up Areas (December 2011) Boundaries V2. http://www.nationalarchives.gov.uk/doc/open-government-licence/, Contains National Statistics data © Crown copyright and database right [2017]
- Ordnance Survey (OS): Open Roads (version: April 2019). Contains Ordnance Survey data © Crown copyright and database right 2019. Data provided by Ordnance Survey in July 2021 (Open Government License applies to use)
- Ordnance Survey (OS): Boundary-Line™ (version: 2021-05). Contains OS data © Crown copyright and database right 2021. Used: high_water_polyline.shp
- "Road classes and average speed applied in the classification" given in Scottish Government Geographic Information Science & Analysis Team, Rural and Environment Science and Analytical Services Division (2018) Scottish Government Urban Rural Classification 2016. Scottish Government (page 13). Original source of figures: Department for Transport.

Data Zone centroid locations and local authority areas for lookup:

- Data Zone Centroids 2011. Copyright Scottish Government, contains Ordnance Survey data © Crown copyright and database right
- Ordnance Survey (OS) Boundary-Line™. Contains OS data © Crown Copyright [and database right] (2020)

- GI-SAT (Geographic Information Science and Analysis Team), Scottish Government: Data Zone Centroids 2011. Copyright Scottish Government, contains Ordnance Survey data © Crown copyright and database right (2021)
- Ordnance Survey (OS): Boundary-Line™ (version: 2021-05). Contains OS data © Crown copyright and database right 2021. Used: district_borough_unitary_region.shp

Output Area centroid locations, Output Area population data, information to identify Data Zones outside of larger settlements (population >= 20,000) to include in analysis:

- ONS Geography Lower Layer Super Output Areas (December 2011) Population Weighted Centroids. http://www.nationalarchives.gov.uk/doc/open-government-licence/, Contains National Statistics data © Crown copyright and database right [2016]
- National Records of Scotland 2011 Census Output Areas (OAs) Population Weighted Centroids. © Crown copyright. Data supplied by National Records of Scotland
- Census 2011 population data: tables KS102SC (© Crown copyright. Data supplied by National Records of Scotland), KS102EW (Source: Office for National Statistics).

- National Records of Scotland Settlements (Urban Areas). Contains NRS data © Crown copyright and database right (insert year), contains Ordnance Survey data © Crown copyright and database right (2020)
- National Records of Scotland Table 2a: Estimated population of settlements by broad age groups, mid-2016. © Crown Copyright 2018.

- Office for National Statistics - ONS Geography: Lower Layer Super Output Areas (December 2011) Population Weighted Centroids. http://www.nationalarchives.gov.uk/doc/open-government-licence/, Contains National Statistics data © Crown copyright and database right [2016]
- National Records of Scotland: Census 2011 - Output Area Centroids. Copyright National Records of Scotland, contains Ordnance Survey data © Crown copyright and database right (2021).
- National Records of Scotland: Census 2011 (2011 census table data: Output Area 2011). (Table KS102SC). © Crown copyright. Data supplied by National Records of Scotland
- Office for National Statistics: Census 2011 (Table KS102EW: All usual residents). ONS Crown Copyright Reserved [from Nomis on 23 August 2021] Source: Office for National Statistics.
- National Records of Scotland: Settlements – Scotland: Settlements 2016 boundaries. Contains NRS data © Crown copyright and database right [2021]; Contains Ordnance Survey data © Crown copyright and database right [2021]
- National Records of Scotland: Table 2a: Estimated population of settlements by broad age groups, mid-2016. © Crown Copyright 2018

Source of information on Travel To Work Area boundaries:

- Office for National Statistics Travel to Work Areas (December 2011) Map in the United Kingdom. Available at https://geoportal.statistics.gov.uk/datasets/b248db54996c469c917ac3421d8e2975. http://www.nationalarchives.gov.uk/doc/open-government-licence/, Contains National Statistics data © Crown copyright and database right [2015]

Additional data used in subregion definitions:

- GI-SAT (Geographic Information Science and Analysis Team), Scottish Government: Data Zone Boundaries 2011. Copyright Scottish Government, contains Ordnance Survey data © Crown copyright and database right (2022)
- Ordnance Survey (OS): Boundary-Line™ (version: 2021-05). Contains OS data © Crown copyright and database right 2021. Used: district_borough_unitary_region.shp
- Office for National Statistics – ONS Geography: Travel to Work Areas (December 2011) Full Clipped Boundaries in United Kingdom. http://www.nationalarchives.gov.uk/doc/open-government-licence/, Office for National Statistics licensed under the Open Government Licence v.3.0.

Notes on travel time calculations involved in SPA definition

The SPA was defined using a GIS-based analysis, involving a transport network. The analysis in this project involved assumptions: immediate transfers from roads to ferries, no traffic delays, estimates of travel speeds on different road types, and travel by cars and ferries only. The travel time calculations using the network constructed in this project should be acknowledged as estimates, due to a) calculations based on road segments of different lengths; b) some inaccuracies in junctions and routing directions; c) selection and editing of vehicle and passenger ferries, including infilled travel times; d) assumption of two-way travel along ferry links. Therefore, the SPA definition was based on highly detailed spatial information for Scotland (and Northern England), but for these reasons the 30 minute 'service areas' are estimates, subject to uncertainty, rather than exact measurements. Additionally, total populations within 30 minutes' travel of Data Zone centroids were calculated using Output Area populations, linked to Output Area centroids.

Population and economic data used within population projections and foresight

Numbers refer to the data sources shown on Figure 2.

1 Base data: National Records of Scotland Population Estimates (Current Geographic Boundaries), 2018. http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/.

2 Calculated from: National Records of Scotland Fertility rates by council area 1991 to 2018. https://www.nrscotland.gov.uk/files//statistics/time-series/birth-18/births-time-series-18-bt.10.xlsx. © Crown Copyright 2019; Office for National Statistics Past and assumed age-specific fertility rates, UK, 1973 to 2043. https://www.ons.gov.uk/generator?uri=/peoplepopulationandcommunity/populationandmigration/populationprojections/methodologies/nationalpopulationprojectionsfertilityassumptions2018based/aac5e0bf&format=csv. http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/.

3 Calculated from: National Records of Scotland Vital Events Reference Tables 2018, Table 1.04: Births, deaths and death rates by administrative area, resident and not resident in Scotland, 2018. https://www.nrscotland.gov.uk/files//statistics/vital-events-ref-tables/2018/vital-events-18-ref-tabs-1.xlsx. © Crown Copyright 2019.

4 Calculated from: National Records of Scotland Vital Events Reference Tables 2018, Table 5.02: Deaths, by sex, age, and administrative area, Scotland, 2018. https://www.nrscotland.gov.uk/files//statistics/vital-events-ref-tables/2018/vital-events-18-ref-tabs-5.xlsx. © Crown Copyright 2019; National Records of Scotland Mid-2018 Population Estimates Scotland, Table 3: Estimated population by sex, five year age group and administrative area, mid-2018. https://www.nrscotland.gov.uk/files//statistics/population-estimates/mid-18/mid-year-pop-est-18-tabs.xlsx. © Crown Copyright 2019; Office for National Statistics Figure 3a: Mortality improvements for males in their 30s and 40s are lower in Scotland than in the UK as a whole, Figure 3b: Mortality improvements for females in their 30s and 40s are lower in Scotland than in the UK as a whole. https://www.ons.gov.uk/generator?uri=/peoplepopulationandcommunity/populationandmigration/populationprojections/methodologies/nationalpopulationprojectionsmortalityassumptions2018based/632e206d&format=csv, https://www.ons.gov.uk/generator?uri=/peoplepopulationandcommunity/populationandmigration/

populationprojections/methodologies/nationalpopulationprojectionsmortalityassumptions2018based/b7f39a7c&format=csv. http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/.

5 Calculated from: National Records of Scotland 2018-based principal total net migration projections for 2018-2043, by sex, council area and single year of age. © Crown Copyright 2020. Data supplied by NRS.

6 Calculated from data in Census Table DT603SCdz - Industry - Daytime population - 2011 Data zones (Crown copyright 2018), also using data in tables DT603SCca - Daytime population by industry - All people that work or study in the area, or who are resident in the area but are not working or studying - Council Areas (Crown copyright 2017), QS605SC. © Crown copyright. Data supplied by National Records of Scotland. Note that sector/macro sector definitions are based on sections in the Office for National Statistics Standard Industrial Classification (2007) (see: https://www.ons.gov.uk/file?uri=/methodology/classificationsandstandards/ukstandardindustrialclassificationofeconomicactivities/uksic2007/sic2007summaryofstructurtcm6.xls).

7 Calculated from data in Census Table WP103SCwz - Sex by age - Workplace population - 2011 Workplace zones (Crown copyright 2018). Allocation of workplace zone data to subregions using fixed postcode lookup (Frozen Postcode 2011 to Workplace Zone 2011 lookup https://www.nrscotland.gov.uk/files//geography/products/frozen-postcode-2011-to-workplace-zone-2011.xlsx. © Crown copyright. Data supplied by National Records of Scotland; Frozen Postcode Grid References 2011 Contains NRS data © Crown copyright and database right (2020), contains Ordnance Survey data © Crown copyright and database right (2020); Data Zone Boundaries 2011. Copyright Scottish Government, contains Ordnance Survey data © Crown copyright and database right).

8 Base data for modelling future economic change: Office for National Statistics Annual Population Survey (ONS Crown Copyright Reserved [from Nomis]), employment in some sectors calculated using Census 2011 Table QS605SC (© Crown copyright. Data supplied by National Records of Scotland).

9 Base data: National Records of Scotland Population Estimates (Current Geographic Boundaries), 2018. http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/.

10 Calculated from data in Census Table WF01BSC_DZ2011_Scotland - Location of usual residence and place of work - All usual residents aged 16 and over in employment the week before the census - 2011 Data Zones; and data on workplace employment (summarised above, using Census Tables DT603SCdz, DT603SCca, QS605SC). © Crown copyright. Data supplied by National Records of Scotland

11 Calculated from Census Table CT_0093a_2011 - Bespoke household composition by Occupation of HRP by Person type (Crown copyright 2015). © Crown copyright. Data supplied by National Records of Scotland; and Census Table QS419SC - Position in communal establishment (Crown copyright 2013). © Crown copyright. Data supplied by National Records of Scotland.

Software used

Update April 2022: Software used to create the reproduced network dataset and SPA and subregion definitions in 2021-22 is given in green text below.

Esri Inc. ArcGIS Desktop 10.7.1 (most recent version used), includes Network Analyst 10.7.1 extension. Copyright © 1995-2019 Esri. All rights reserved. Published in the United States of America.

Hadley Wickham and Jennifer Bryan (2019). readxl: Read Excel Files. R package version 1.3.1. https://CRAN.R-project.org/package=readxl (Accessed 13th September 2020)

MATLAB (2018). 9.7.0.1190202 (R2019b). : The MathWorks Inc., Natick, Massachusetts.

R Core Team (2019). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/ (Accessed 13th September 2020)

R Core Team (2018). foreign: Read Data Stored by 'Minitab', 'S', 'SAS', 'SPSS', 'Stata', 'Systat', 'Weka', 'dBase', ... R package version 0.8-71. https://CRAN.R-project.org/package=foreign (Accessed 13th September 2020)

Simon Garnier (2018). viridis: Default Color Maps from 'matplotlib'. R package version 0.5.1. https://CRAN.R-project.org/package=viridis (Accessed 13th September 2020)

StataCorp. (2017). Stata Statistical Software: Release 15. StataCorp LLC, College Station, TX.

Note: the economic part of the economic-demographic model was developed in MATLAB, and the model to forecast employment change was carried out using Stata. Results of this analysis are not included within this research note.

Esri Inc. ArcGIS Desktop 10.7.1 (includes Esri ArcMap Version 10.7.1.11595, Esri ArcCatalog 10.7.1.11595, Network Analyst 10.7.1 extension). Copyright © 1995-2019 Esri. All rights reserved. Published in the United States of America.

R Core Team (2020). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

R Core Team (2020). foreign: Read Data Stored by 'Minitab', 'S', 'SAS', 'SPSS', 'Stata', 'Systat', 'Weka', 'dBase', ... R package version 0.8-81.

RStudio Version 1.2.5042. © 2009-2020 RStudio, Inc.

Some code/analysis derived from https://support.esri.com/en/technical-article/000022370 (accessed 05/12/21) and https://pro.arcgis.com/en/pro-app/latest/tool-reference/data-management/calculate-field-examples.htm (accessed 01/09/21)

Note (updates: April, June 2022)

April 2022: The Appendix of this note was updated following reproduction of the network dataset and SPA and subregion definitions, this includes the addition of an acknowledgement to the Department of Transport. June 2022: Acknowledgement to additional Census data table added and

references to data in Figure 2 and Appendix updated; addition (point d) made to ‘Notes on travel time calculations involved in SPA definition’ within Appendix.