

Appendix 1: Projection methodology for Remote Service Delivery Areas

Population projections: Overview

A variant of the standard Cohort Component Projection model is used for the projection of the Indigenous population of each Remote Service Delivery Area (RSDA). The necessary inputs to the model include hazard rates of births (fertility), deaths (mortality), and mobility (net migration). With estimates of projected fertility, mortality and migration, and base population estimates by five year increments in age for group and sex, the population of each region is projected over a 20-year period (2006–2026) using the standard cohort-component method. The population aged 5 years and over and the population aged under 5 years are calculated as follows:

$$A(r, g, x+5, y+5) = [A(r, g, x, y)][s(r, g, x, y)][1 + m(r, g, x, y)], \quad x \geq 0, (0) \text{ and}$$

$$A(r, g, 0, y+5) = \frac{SR(g)}{2} \left\{ \begin{array}{l} \sum_{x=15}^{49} [b(r, x, y)A(r, f, x, y)] + \\ \sum_{x=15}^{49} [b(r, x, y+5)A(r, f, x, y+5)] \end{array} \right\} [s(r, g, -5, y)][m(r, g, -5, y)]$$

(0)

where

- $A(r, g, x, y)$ is the population in region r of sex g aged x in year y
- $A(r, f, x, y)$ is the female population in region r aged x in year y
- $b(r, x, y)$ is the fertility rate at age x in year y
- $m(r, g, x, y)$ is the migration ratio in region r for sex g ; that is, the factor by which a cohort changes through migration in its transition from age x in year y to age $x+5$ in year $y+5$
- $s(r, g, x, y)$ is the mortality survival ratio in region r for sex g ; that is, the probability that a person aged x in year y will survive to age $x+5$ in year $y+5$, and
- $SR(g)$ is the proportion of births that are of sex g .

The standard model above is altered to enable: (1) the inclusion of Indigenous and non-Indigenous births (see Chapter 1); and (2) the solving of a series of linear equations to estimate the effect of a 10 per cent diagonal migration scenario

(see Chapter 1). This alteration to the standard model results in a simultaneous population projection of three populations. The first is the projection of the RSDA population of Indigenous persons only. The second is the projection of the RSDA population of non-Indigenous females only. The final comprises projections of survivors of the Indigenous population projections.

Four sets of scenarios are included in this modelling framework. Combining the migration, fertility and mortality scenarios leads to projection scenarios for each region shown in Table A1.1

Table A1.1 Indigenous population projection scenarios

Scenario ID	Migration	Fertility	Mortality
1	0	Constant	Constant
2	10% diagonal	Constant	Constant
3	0	25-year convergence	25-year convergence
4	10% diagonal	25-year convergence	25-year convergence

The remaining components of the projection methodology are outlined below.

Components of population change

Creating baseline Estimated Resident Population by sex by age by Indigenous status

As only total population counts are available, it is necessary to disaggregate these counts by age, sex and Indigenous status. Estimation of the age structure is imputed from ABS estimates of the age structure of the broader Indigenous region of which each RSDA is a member (ABS 2008a). A further complication is that Estimated Resident Population (ERP) counts by Indigenous Region (IREG) are upper censored to age 65+. To maintain the heterogeneity in the mortality estimates from the ABS Life Tables (ABS 2009b, 2009c), the upper censoring is split into 5-year age groups 65–85+ years. This is estimated using counts of Indigenous/non-Indigenous status by age at the relevant State level (ABS 2008b). ERP estimates are for June 2006.

Births

The projection of births by RSDA requires three separate estimates of fertility: (1) Indigenous births to Indigenous mothers; (2) Indigenous births to non-Indigenous mothers; and (3) non-Indigenous female births to non-Indigenous mothers. The final fertility estimate is necessary for female births only, as the

Indigenous projections only require the input of total births from the non-Indigenous population. An initial investigation was undertaken to see whether area-specific births data could be used to calculate the relevant fertility rates. Doing so resulted in too large a variation to be driven by fertility differences, and hence State-level births data was used for each of the three measures of fertility outlined above. To smooth out irregularities in the data, three year-averaged fertility rates are used based on data for 2005–2007. Two fertility assumptions were used in the projections. The first series keeps fertility rates (Indigenous and non-Indigenous) constant throughout the projection period. The second series results in a convergence of Indigenous and non-Indigenous fertility over a 25-year time frame. That is, the convergence occurs outside the projection period. The convergence results in the same fertility level (Total Fertility Rate) and well as fertility probability distribution (Age Specific Fertility Rates).

Deaths

State level Life Tables were used to calculate five-year survival ratios for both Indigenous and non-Indigenous populations (ABS 2009b, 2009c). For the projections, two scenarios are used: (1) Keeping non-Indigenous survival ratios at 2006 levels over the full projection period; and (2) converging the age-specific survival ratios of Indigenous and non-Indigenous persons over a 25-year period. The Indigenous survival ratios are increased linearly to the non-Indigenous rates over this time. That is, the average rate of change is constant over the projection period.

Migration

The final inputs required for the projection are estimates of migration, both in terms of level and age distribution. Two migration scenarios are used in the projections. The first sets net migration to zero for both the Indigenous and non-Indigenous population projections. The second assumption is more complicated, and is set out below.

This assumption results in a 10 per cent diagonal increase in the Indigenous population of each age cohort (excluding births), above that which would have been achieved with zero migration. As an example, Table A1.2 displays two age groups, 5–9 and 10–14 in 2006 and 2011. The ratio B/A represents the survival of the 5–9 cohort to 10–14 years in 2011, assuming no migration. To calculate the migration assumption, B/A is increased by 10 per cent (i.e. $B/A + 0.1$). An iterative linear search algorithm is then used to estimate the level of migration (net of survival) necessary to increase the 2011 population aged 10–14 by approximately 10 per cent. This approach has the advantage of imputing both an age structure of migration and an absolute level of migration.

This is particularly pertinent given the poor data quality at the RSDA level. The estimated migrants are projected as a subset of the population for future years, subject to both population decline through survival and population increase through fertility.

Table A1.2 Example migration table

	2006	2011
5–9	A	
10–14	B	

Summary of results

The projection results are summarised by grouping all ages together in Tables A1.3, A1.4 and A1.5. In Table A1.3, the estimated non-Indigenous population in 2006 is given, as well as a projected population in 2026, calculated by applying the non-Indigenous annualised growth rate of 0.96 per cent per annum from Biddle and Taylor (2009). These are presented alongside the estimated Indigenous population in 2006 as well as the projected Indigenous population in 2026 for each of the four scenarios.

In Table A1.4, these population estimates/projections are used to calculate a projected annualised growth rate between 2006 and 2026. These are presented alongside the projected growth rates between 2006 and 2026 for the Indigenous Region that the community is located in, based on the zero migration scenario in Biddle and Taylor (2009). The main point to note in Table A1.4 is that in the absence of migration, all communities have a projected growth rate that is less than that for the region as a whole. This is driven mainly by the higher levels of births of Indigenous children to non-Indigenous mothers in the less remote parts of the regions which, demographically, dominate the results for the region as a whole. It is important to note, however, that the projected growth rates in the RSDAs are comparable to those for remote and very remote Australia in Biddle and Taylor (2009)—1.74 and 1.63 per cent per annum respectively—and larger than the non-Indigenous growth rate (0.96).

The proportion (percentage) of the population in the area estimated/projected to be Indigenous in 2006 and 2026 is given in Table A1.5.

Table A1.3 Estimated/projected non-Indigenous and Indigenous population in 2006 and 2026 by RSDA

Region Name	Non-Indigenous		Indigenous				
	2006	2026	2006	2026-S1	2026-S2	2026-S3	2026-S4
Amata	29	35	341	462	663	455	657
Angurugu	33	40	1 013	1 372	1 972	1 356	1 958
Ardayaloon	31	38	243	328	470	324	467
Aurukun	70	85	1 059	1 451	2 081	1 423	2 051
Beagle Bay	24	29	238	320	459	317	456
Coen	60	73	239	330	473	324	466
Doomadgee	61	74	1 102	1 546	2 211	1 507	2 168
Fitzroy Crossing	444	537	733	1 028	1 467	1 014	1 454
Galiwinku	147	178	2 158	2 930	4 208	2 895	4 178
Gapuwiyak	52	63	1 208	1 637	2 352	1 618	2 336
Gunbalanya	88	107	1 141	1 584	2 271	1 556	2 243
Halls Creek	261	316	1 092	1 515	2 168	1 492	2 145
Hermannsburg	68	82	938	1 261	1 811	1 246	1 798
Hope Vale	45	54	797	1 092	1 565	1 071	1 543
Lajamanu	105	127	735	1 010	1 446	991	1 427
Maningrida	176	213	2 600	3 610	5 174	3 545	5 111
Milingimbi	49	59	1 086	1 506	2 159	1 479	2 132
Mimili	36	44	289	393	563	387	558
Mornington Island	94	114	1 028	1 446	2 067	1 409	2 026
Mossman Gorge	0	0	165	233	333	227	327
Nguiu	85	103	1 463	2 031	2 911	1 994	2 875
Ngukurr	73	88	1 055	1 446	2 072	1 418	2 043
Numbulwar	64	77	713	968	1 391	957	1 381
Umbakumba	21	25	434	589	845	582	839
Wadeye	146	177	2 074	2 880	4 128	2 828	4 077
Walgett	1 002	1 213	1 220	1 748	2 488	1 696	2 429
Wilcanda	154	186	453	637	910	618	888
Yirrkala	212	257	1 472	2 005	2 877	1 981	2 857
Yuendumu	92	111	701	946	1 358	935	1 348

Source: Authors' own calculation; Biddle & Taylor 2009

Table A1.4 Projected annual Australian Indigenous growth rates between 2006 and 2026 by RSDA and IREG

Region name	Remote Service Delivery Area				Indigenous Region	
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Name	Growth rate
Amata	1.53	3.38	1.45	3.33	Port Augusta	1.75
Angurugu	1.53	3.39	1.47	3.35	Nhulunbuy	1.69
Ardyaloon	1.51	3.35	1.45	3.32	Broome	1.82
Aurukun	1.59	3.43	1.49	3.36	Cape York	1.79
Beagle Bay	1.50	3.35	1.44	3.32	Broome	1.82
Coen	1.63	3.46	1.53	3.39	Cape York	1.79
Doomadgee	1.71	3.54	1.58	3.44	Mt Isa	1.93
Fitzroy Crossing	1.71	3.53	1.63	3.48	Derby	1.89
Galiwinku	1.54	3.39	1.48	3.36	Nhulunbuy	1.69
Gapuwiyak	1.53	3.39	1.47	3.35	Nhulunbuy	1.69
Gunbalanya	1.66	3.50	1.56	3.44	Jabiru	1.79
Halls Creek	1.65	3.49	1.57	3.43	Kununurra	1.92
Hermannsburg	1.49	3.34	1.43	3.30	Apatula	1.63
Hope Vale	1.59	3.43	1.49	3.36	Cape York	1.79
Lajamanu	1.61	3.45	1.51	3.38	Katherine	1.76
Maningrida	1.65	3.50	1.56	3.44	Jabiru	1.79
Milingimbi	1.65	3.50	1.56	3.43	Jabiru	1.79
Mimili	1.54	3.39	1.46	3.34	Port Augusta	1.75
Mornington Island	1.72	3.55	1.59	3.45	Mt Isa	1.93
Mossman Gorge	1.72	3.56	1.59	3.46	Cairns	2.03
Nguiu	1.65	3.50	1.56	3.44	Jabiru	1.79
Ngukurr	1.59	3.43	1.49	3.36	Katherine	1.76
Numbulwar	1.54	3.40	1.48	3.36	Nhulunbuy	1.69
Umbakumba	1.53	3.39	1.47	3.35	Nhulunbuy	1.69
Wadeye	1.65	3.50	1.56	3.44	Jabiru	1.79
Walgett	1.81	3.63	1.66	3.50	Bourke	1.58
Wilcanda	1.72	3.55	1.56	3.42	Bourke	1.58
Yirrkala	1.56	3.41	1.50	3.37	Nhulunbuy	1.69
Yuendumu	1.51	3.36	1.45	3.32	Apatula	1.63

Source: Authors' own calculation; Biddle & Taylor 2009

Table A1.5 Proportion of Australian population estimated/projected to identify as Indigenous in 2006 and 2026 by RSDA

	2006	2026–S1	2026–S2	2026–S3	2026–S4
Amata	92.2	92.9	95.0	92.8	94.9
Angurugu	96.8	97.2	98.0	97.1	98.0
Ardyaloon	88.7	89.7	92.6	89.6	92.6
Aurukun	93.8	94.5	96.1	94.4	96.0
Beagle Bay	90.8	91.7	94.0	91.6	94.0
Coen	80.0	82.0	86.7	81.7	86.5
Doomadgee	94.8	95.4	96.8	95.3	96.7
Fitzroy Crossing	62.3	65.7	73.2	65.3	73.0
Galiwinku	93.6	94.3	95.9	94.2	95.9
Gapuwiyak	95.9	96.3	97.4	96.3	97.4
Gunbalanya	92.8	93.7	95.5	93.6	95.5
Halls Creek	80.7	82.7	87.3	82.5	87.2
Hermannsburg	93.2	93.9	95.7	93.8	95.6
Hope Vale	94.7	95.2	96.6	95.2	96.6
Lajamanu	87.5	88.8	91.9	88.6	91.8
Maningrida	93.7	94.4	96.0	94.3	96.0
Milingimbi	95.7	96.2	97.3	96.1	97.3
Mimili	88.9	90.0	92.8	89.9	92.8
Mornington Island	91.6	92.7	94.8	92.5	94.7
Mossman Gorge	100.0	100.0	100.0	100.0	100.0
Nguiu	94.5	95.2	96.6	95.1	96.5
Ngukurr	93.5	94.2	95.9	94.1	95.9
Numbulwar	91.8	92.6	94.7	92.5	94.7
Umbakumba	95.4	95.9	97.1	95.8	97.1
Wadeye	93.4	94.2	95.9	94.1	95.8
Walgett	54.9	59.0	67.2	58.3	66.7
Wilcanda	74.6	77.4	83.0	76.8	82.7
Yirrkala	87.4	88.7	91.8	88.5	91.8
Yuendumu	88.4	89.5	92.4	89.4	92.4

Source: Authors' own calculation; Biddle & Taylor 2009

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