

Spatiotemporal variation in the risk of out-of-hospital cardiac arrests in Queensland, Australia

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Supplementary Materials

Bayesian analysis

We employed the models of Peluso et al.¹ and Auricchio et al.² that accounted for spatial heterogeneity, temporal heterogeneity, space-time interactions and demographic features. We chose local government areas (LGA) boundaries to be the spatial cells, motivated by the fact that annual demographic data on total population and age composition by sex were available and complete at the LGA level. A finer grid, for example at suburb level, would have posed challenges with regards to missing suburb-specific demographic data, extensive computation times, and overcrowded maps.

Let Y_{it} be the observed number of out-of-hospital cardiac arrest (OHCA) cases occurring in LGA i for year t , where $i = (1, \dots, 78)$ for the 78 LGAs, and $t = (t_1, \dots, T)$ with $t_1 = 2007$ and $T = 2019$. Let E_{it} be the expected number of cases in LGA i for year t , representing the number of cases that expected if the population of LGA i had the same OHCA risk as the overall state-wide population across the study period. E_{it} can be calculated as $E_{it} = n_{it} \times r$, where n_{it} is the population of LGA i in year t , and r is the rate of OHCA in the overall state-wide population, calculated as total number of cases across the years divided by population as follows:³

$$r = \frac{\sum_i \sum_t Y_{it}}{\sum_i \sum_t n_{it}} \quad (\text{eq. 1})$$

Y_{it} is modelled following a zero-inflated Poisson distribution with mean $E_{it}\mu_{it}$, where μ_{it} represents the relative risk (RR) of OHCA of LGA i in year t .³ In our study, RR quantifies whether a specific LGA in a specific year has higher ($RR > 1$) or lower ($RR < 1$) risk of OHCA

occurrence than the overall state-wide risk. This is a point of difference between our model and those of Peluso et al.¹ and Auricchio et al.² In Peluso et al.¹ and Auricchio et al.,² E_{it} refers to the resident population of region i in year t , and μ_{it} is OHCA incidence rates.

The zero-inflated Poisson distribution was used instead of the Poisson distribution due to the presence of zero counts in our data.³ The model takes the following form:

$$Y_{it} \sim \frac{\exp(\pi_0)}{1 + \exp(\pi_0)} \mathbb{1}_{Y_{it}=0} + \frac{1}{1 + \exp(\pi_0)} \text{Poisson}(E_{it}\mu_{it}) \quad (\text{eq. 2})$$

where π_0 is the zero-inflated hyperparameter, E_{it} acts as an offset, and μ_{it} can be expressed as follows:

$$\begin{aligned} \log(\mu_{it}) = & (\text{intercept}) + (\text{covariates}) + (\text{structured spatial} + \\ & \text{unstructured spatial}) + (\text{structured temporal} + \text{unstructured temporal}) + \\ & (\text{spatiotemporal}) \quad (\text{eq. 3}) \end{aligned}$$

The intercept, μ , represents the overall OHCA risk in the state, common to all LGAs and years. All other variables in the model describe how OHCA risk varies between LGAs and over time. The covariates, X_{it} (and corresponding coefficients β), are demographic covariates, including male/female population proportions, and sex-specific proportions of the age groups for each LGA in each year. We considered three age groups 0-14, 15-64 and 65+ years old, representing children, working-age population and senior citizens, respectively, according to the Queensland Government Statistician's Office and the Australian Bureau of Statistics.^{4,5} The coefficient β is the fixed effect that covariate X has on μ_{it} .

The spatial component consists of two random effects: structured u_i and unstructured v_i . The structured component models spatially-correlated heterogeneity in RR, μ_{it} ; whereas the unstructured component models spatially-uncorrelated heterogeneity. Following Riebler et al.,⁶ Simpson et al.,⁷ and Peluso et al.,¹ a reparameterised version of the Besag, York and Mollie (BYM) model (called BYM2) was used for the spatial (both structured and unstructured) components of the model. The BYM2 model overcomes the limitations of the original BYM

model with regards to the marginal variance of the structured component not scaled.^{1,6,7} By using a scaled spatially structured component and a spatially unstructured component, the BYM2 makes parameters interpretable.^{1,6,7} It also facilitates a broad, useful framework for building priors for complex hierarchical models (called Penalised Complexity or PC priors).^{1,6,7} Under the BYM2 model, the spatial components take the following form:

$$\frac{1}{\sqrt{\tau_s}} \left(\sqrt{\phi} u_i + \sqrt{1 - \phi} v_i \right) \quad (\text{eq. 4})$$

where $\tau_s > 0$ is the precision parameter, accounting for the marginal variance contribution of the weighted sum of u_i and v_i . The mixing parameter $0 \leq \phi \leq 1$ measures the proportion of spatial variability explained by the structured component. The proportion of spatial variability explained by the unstructured component is $1 - \phi$.

To account for possible temporal variability in the distributions of μ_{it} , temporal effects were modelled through a temporally structured component γ_t (and precision parameter τ_γ) and temporally unstructured component δ_t (and precision parameter τ_δ). The temporally structured effect was modelled dynamically using a random walk of order two.

The spatiotemporal component ω_{it} models space-time interactions, with τ_ω representing the precision parameter. This interaction term represents the difference between the global temporal trend and the area-specific trend.

Putting together, the RR in LGA i for year t , μ_{it} , can be expressed as follows:

$$\log(\mu_{it}) = \mu + \beta X_{it} + \frac{1}{\sqrt{\tau_s}} \left(\sqrt{\phi} u_i + \sqrt{1 - \phi} v_i \right) + \frac{1}{\sqrt{\tau_\gamma}} \gamma_t + \frac{1}{\sqrt{\tau_\delta}} \delta_t + \frac{1}{\sqrt{\tau_\omega}} \omega_{it} \quad (\text{eq. 5})$$

The parameters and hyperparameters to be estimated in this model are:

$$\text{Parameters: } \theta = \{\mu, \beta, u, v, \gamma, \delta, \omega\}$$

$$\text{Hyperparameters: } \psi = \{\pi_0, \phi, \tau_s, \tau_\gamma, \tau_\delta, \tau_\omega\}, \text{ with } \tau = \frac{1}{\sigma^2} \text{ defines its precision.}$$

The parameters and hyperparameters of the model can be conveniently inferred using the integrated nested Laplace approximation (INLA) method.^{1,8} This method was proposed by Rue et al.⁸ as a more efficient alternative to traditional Markov chain Monte Carlo algorithm for parameter inference for Bayesian hierarchical spatiotemporal models. INLA was implemented in the INLA package for the R programming language (the *R-INLA* package).

We used noninformative prior distributions on the parameters and hyperparameters. For the precision hyperparameters $\tau_s, \tau_\gamma, \tau_\delta, \tau_\omega$, we used PC prior with parameters $U = 1$ and $\alpha = 0.01$ as motivated by Riebler et al.⁶ and Peluso et al.¹ For the mixing parameter \emptyset , we used PC prior with parameters $U = 0.5$ and $\alpha = 2/3$ according to Riebler et al.⁶ The prior on the intercept was a uniform distribution; and the prior on the coefficients was a Gaussian distribution $N(0, 0.001)$ as per the default specification of the INLA.⁹ We specified a Gamma(1, 0.0005) prior on the precision of the random walk. Default specification for priors of the INLA was placed on the remaining parameters.

We also calculated the posterior probabilities of RR estimates being greater than a given threshold value. A threshold of 1.5 was used as suggested in the literature.¹⁰ These probabilities are called exceedance probabilities and are useful to identify areas where there is an unusual elevation of risk. We validated the model by comparing the differences between model-estimated and observed numbers of events. All analysis was performed in R (version 3.6.1).

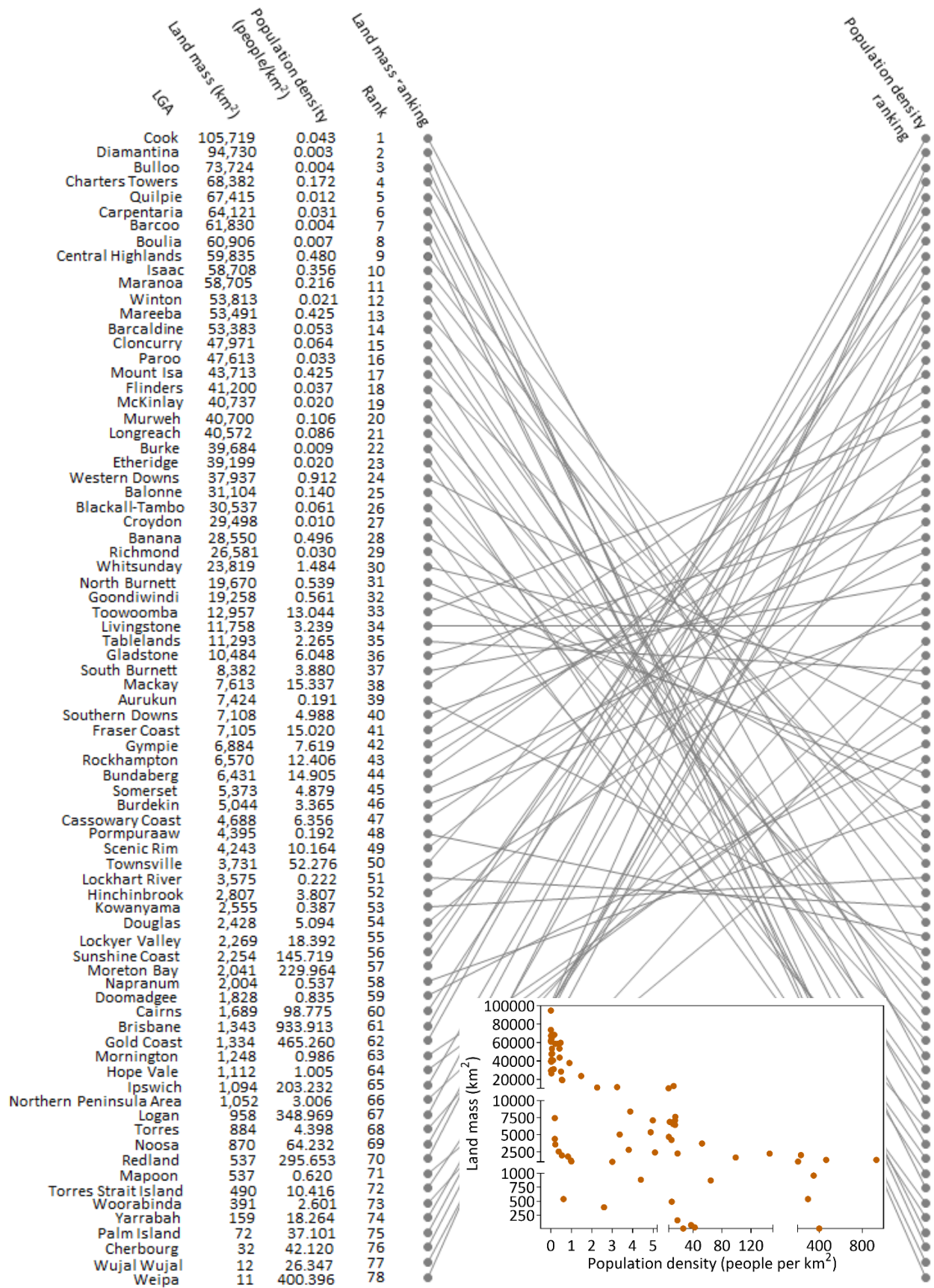
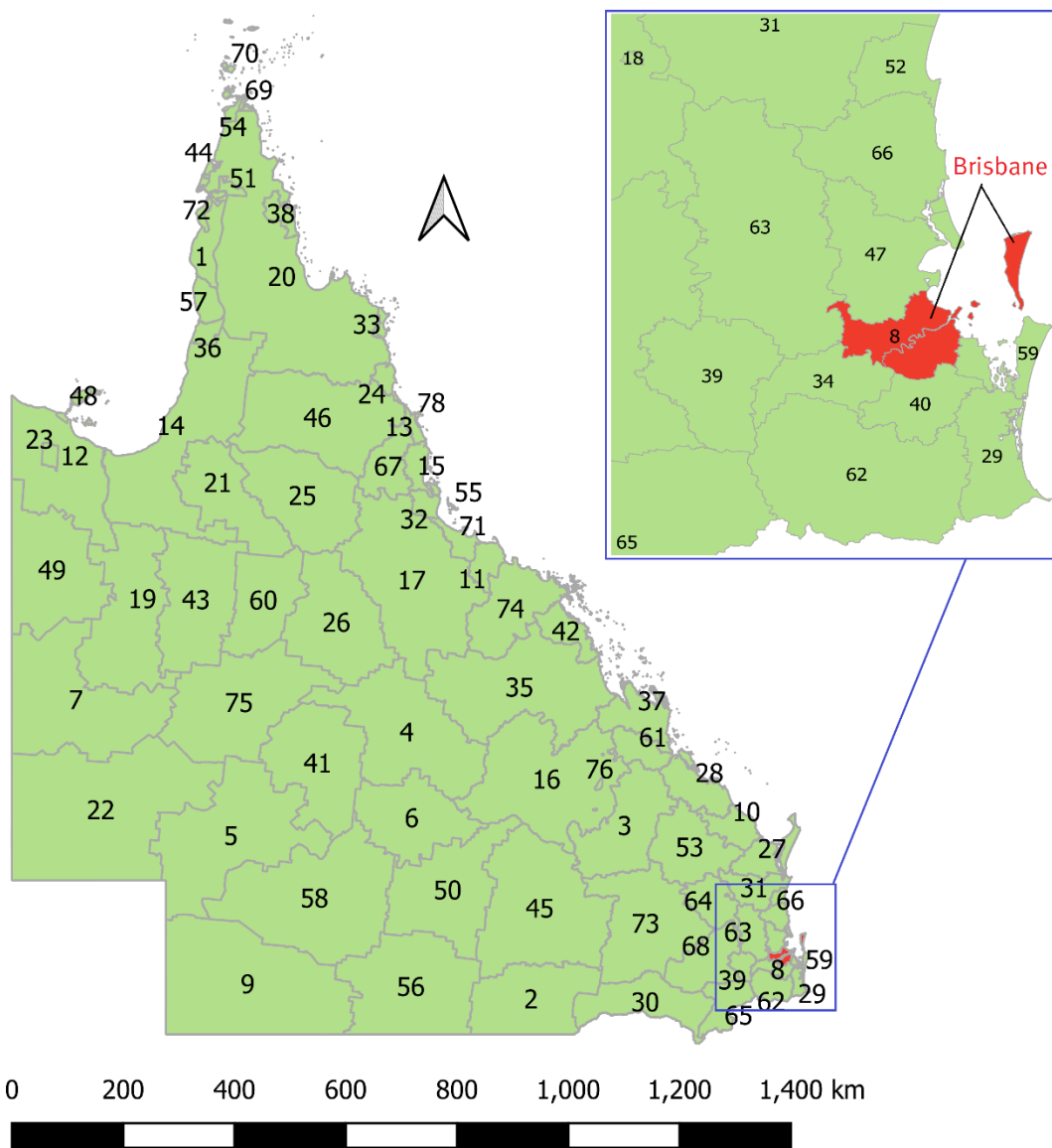


Fig. S1 – Land mass (km²), population (people), population density (people per km²), ranking by land mass, and ranking by population density of the 78 Local Government Areas (LGA) in Queensland.



Fig. S2 - Location of the state of Queensland in the Australia map.



ID	LGA	ID	LGA	ID	LGA	ID	LGA
1	Aurukun	21	Croydon	41	Longreach	61	Rockhampton
2	Balonne	22	Diamantina	42	Mackay	62	Scenic Rim
3	Banana	23	Doomadgee	43	McKinlay	63	Somerset
4	Barcaldine	24	Douglas	44	Mapoon	64	South Burnett
5	Barcoo	25	Etheridge	45	Maranoa	65	Southern Downs
6	Blackall-Tambo	26	Flinders	46	Mareeba	66	Sunshine Coast
7	Bouli	27	Fraser Coast	47	Moreton Bay	67	Tablelands
8	Brisbane	28	Gladstone	48	Mornington	68	Toowoomba
9	Bulloo	29	Gold Coast	49	Mount Isa	69	Torres
10	Bundaberg	30	Goondiwindi	50	Murweh	70	Torres Strait Island
11	Burdekin	31	Gympie	51	Napranum	71	Townsville
12	Burke	32	Hinchinbrook	52	Noosa	72	Weipa
13	Cairns	33	Hope Vale	53	North Burnett	73	Western Downs
14	Carpentaria	34	Ipswich	54	Northern Peninsula	74	Whitsunday
15	Cassowary Coast	35	Isaac	55	Palm Island	75	Winton
16	Central Highlands	36	Kowanyama	56	Paroo	76	Woorabinda
17	Charters Towers	37	Livingstone	57	Pormpuraaw	77	Wujal Wujal
18	Cherbourg	38	Lockhart River	58	Quilpie	78	Yarrabah
19	Cloncurry	39	Lockyer Valley	59	Redland		
20	Cook	40	Logan	60	Richmond		

Fig. S3 - Names and boundaries of the 78 local government areas (LGAs) of Queensland. ID, identification number.

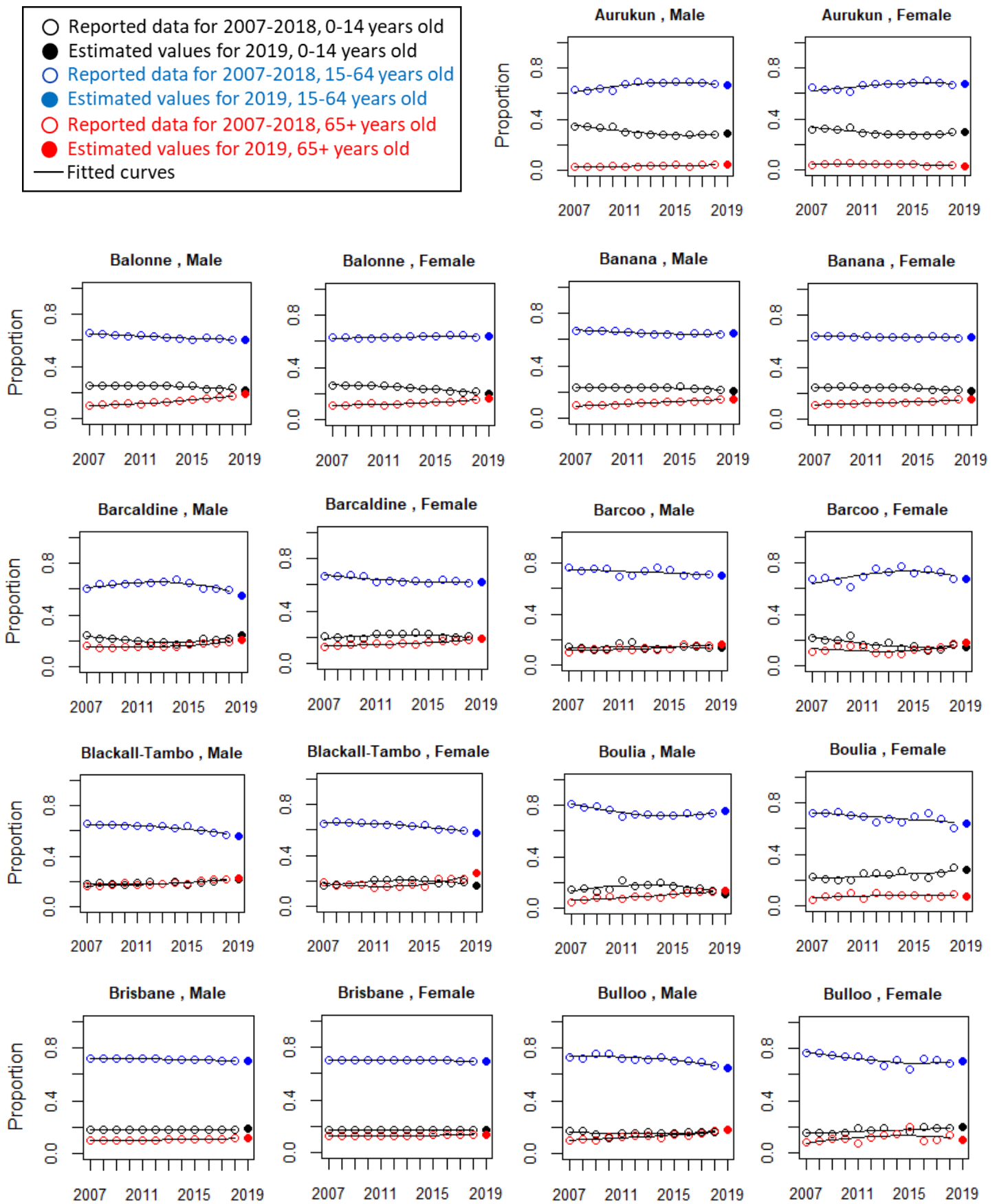


Fig. S4 - Nonlinear least-squares (NLS) fitting to LASN-specific demographic data from 2007 to 2018, and estimated values for 2019 from the NLS models. The figure continues into the next 8 pages.

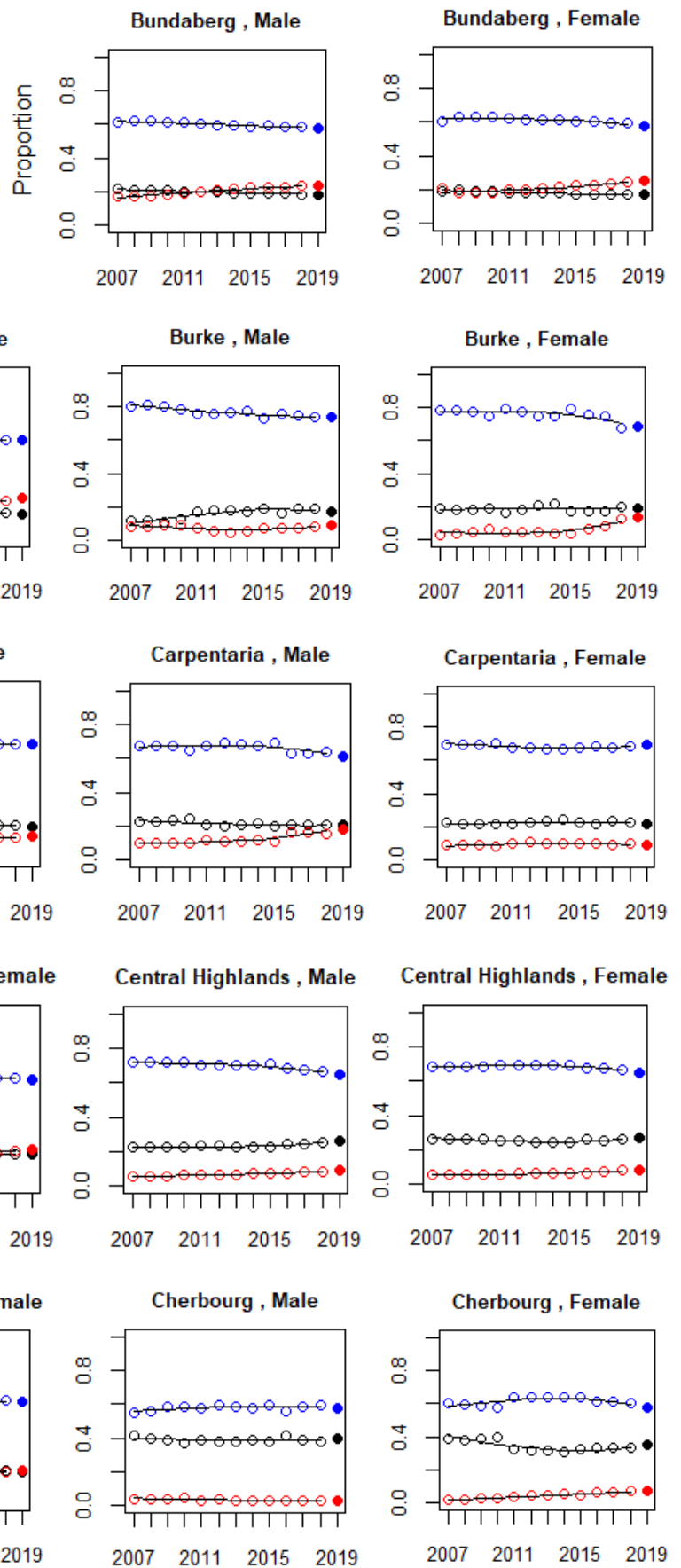
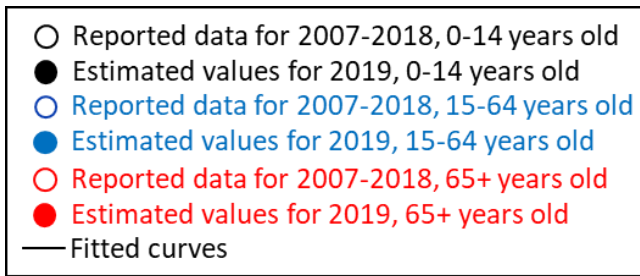


Fig. S4 (continued) - Nonlinear least-squares (NLS) fitting to LASN-specific demographic data from 2007 to 2018, and estimated values for 2019 from the NLS models.

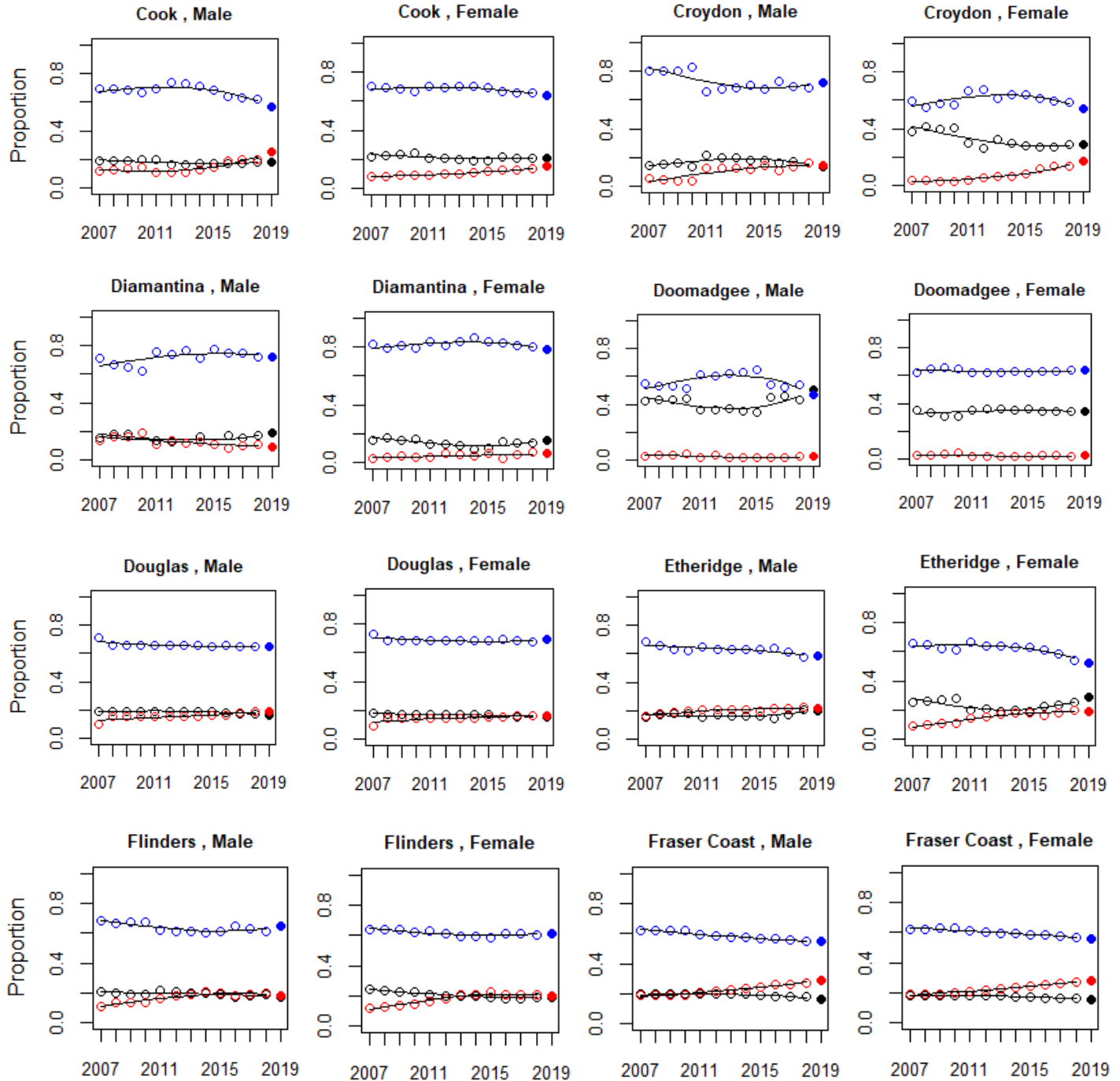
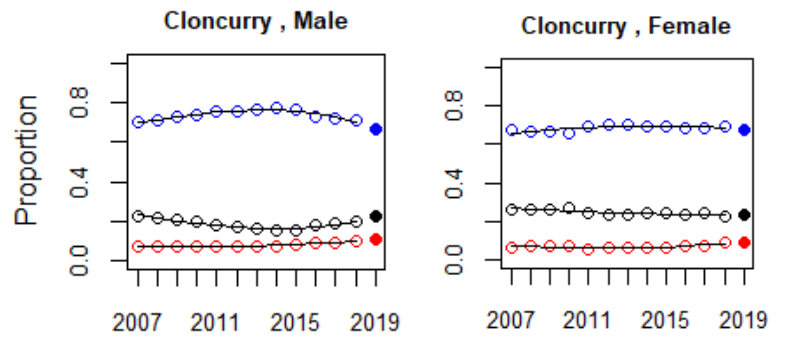
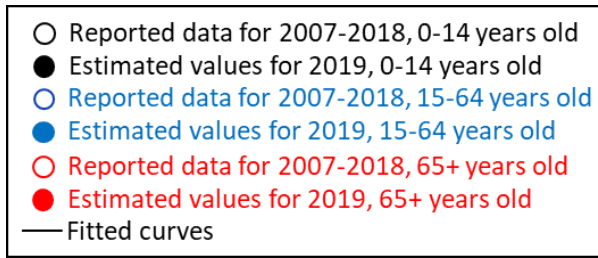


Fig. S4 (continued) - Nonlinear least-squares (NLS) fitting to LASN-specific demographic data from 2007 to 2018, and estimated values for 2019 from the NLS models.

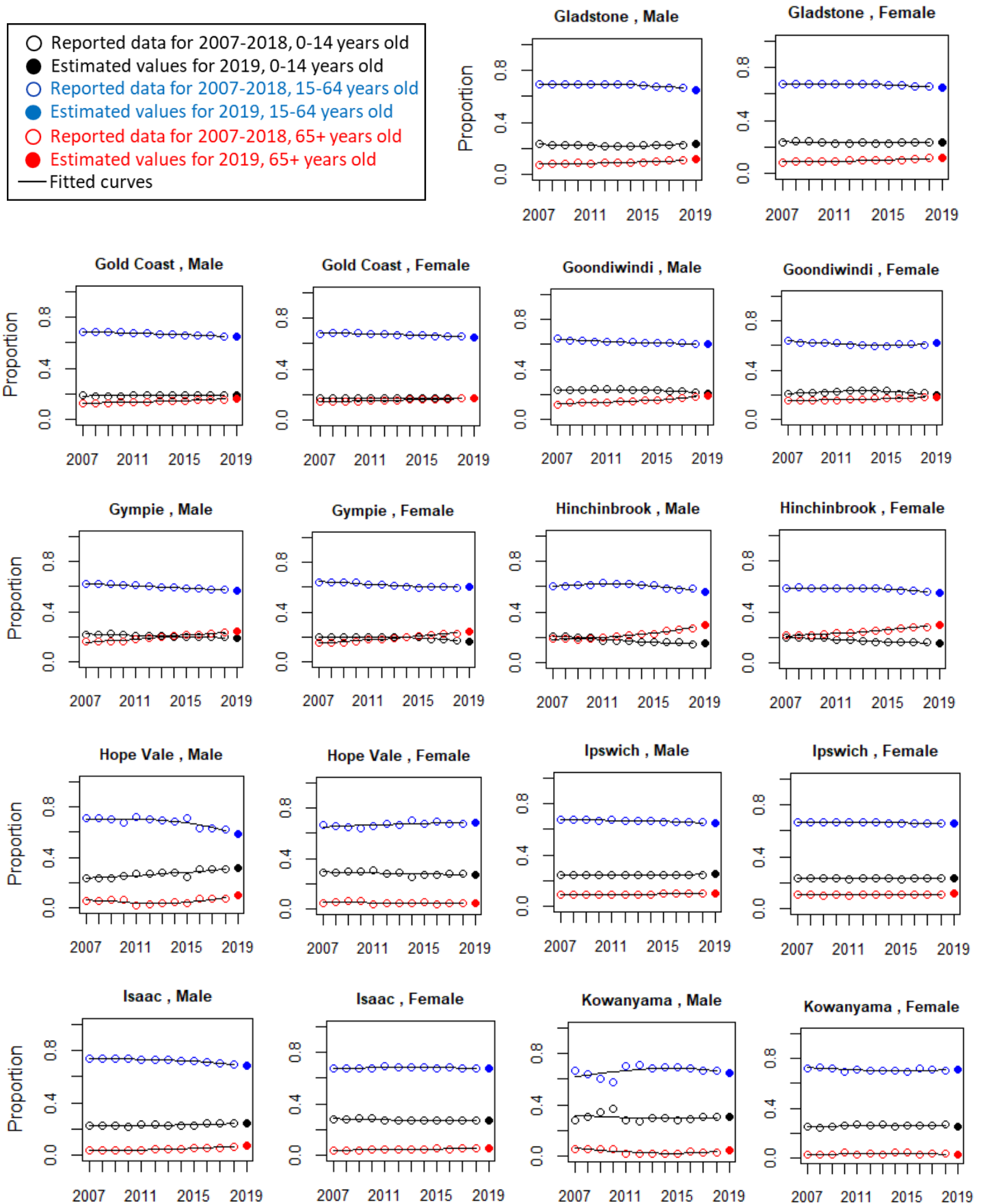


Fig. S4 (continued) - Nonlinear least-squares (NLS) fitting to LASN-specific demographic data from 2007 to 2018, and estimated values for 2019 from the NLS models.

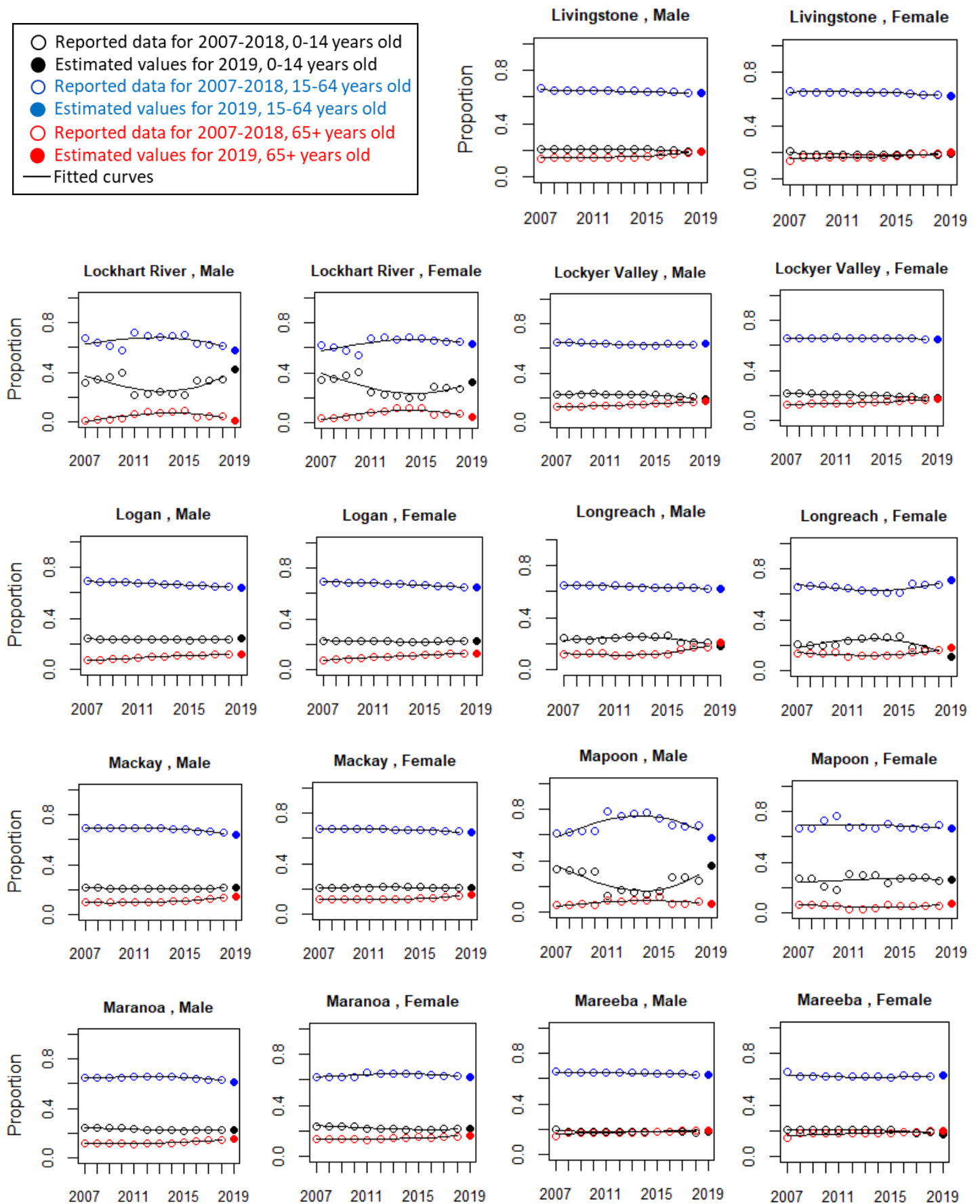
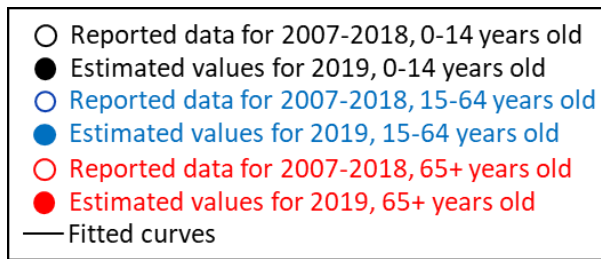


Fig. S4 (continued) - Nonlinear least-squares (NLS) fitting to LASN-specific demographic data from 2007 to 2018, and estimated values for 2019 from the NLS models.

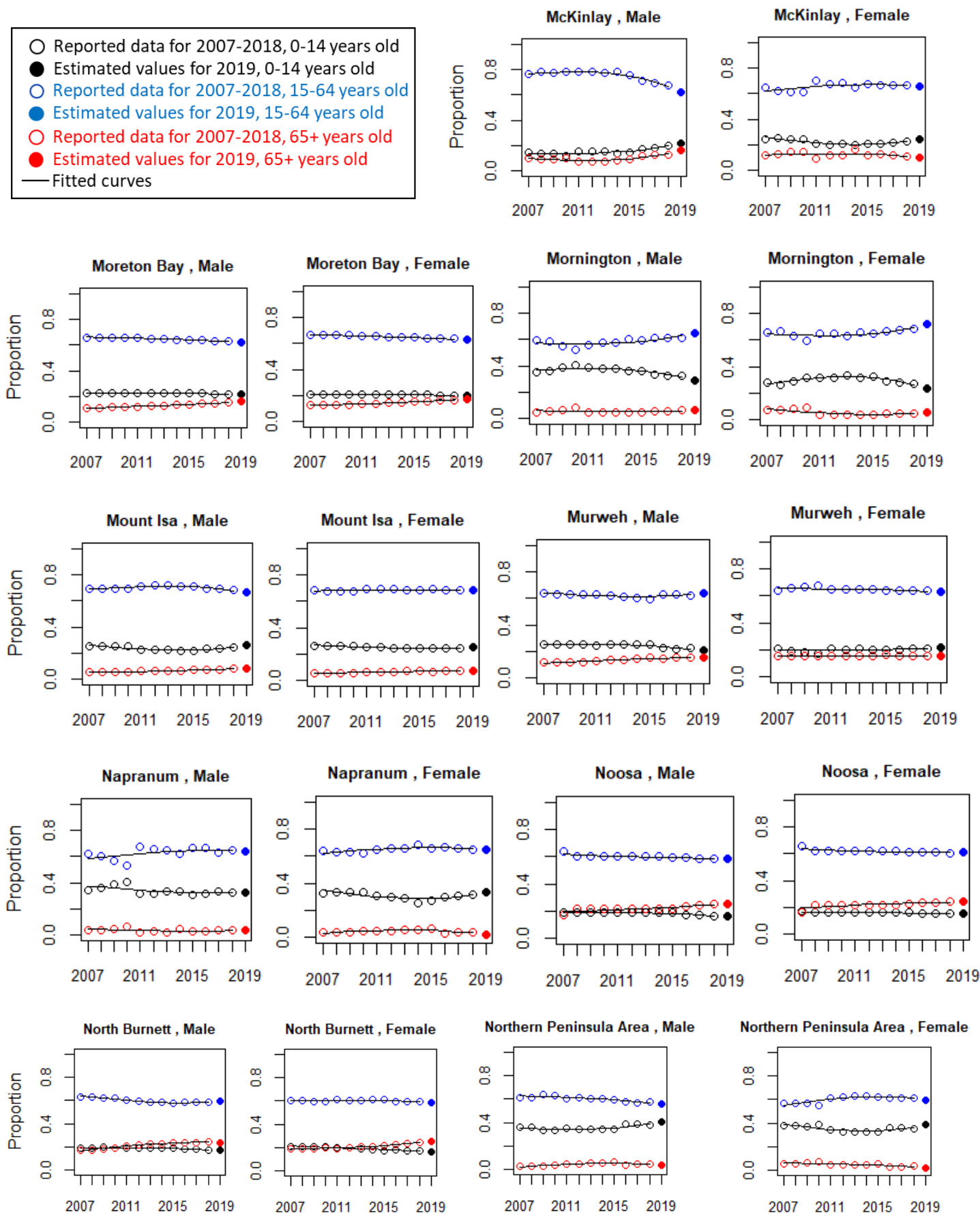


Fig. S4 (continued) - Nonlinear least-squares (NLS) fitting to LASN-specific demographic data from 2007 to 2018, and estimated values for 2019 from the NLS models.

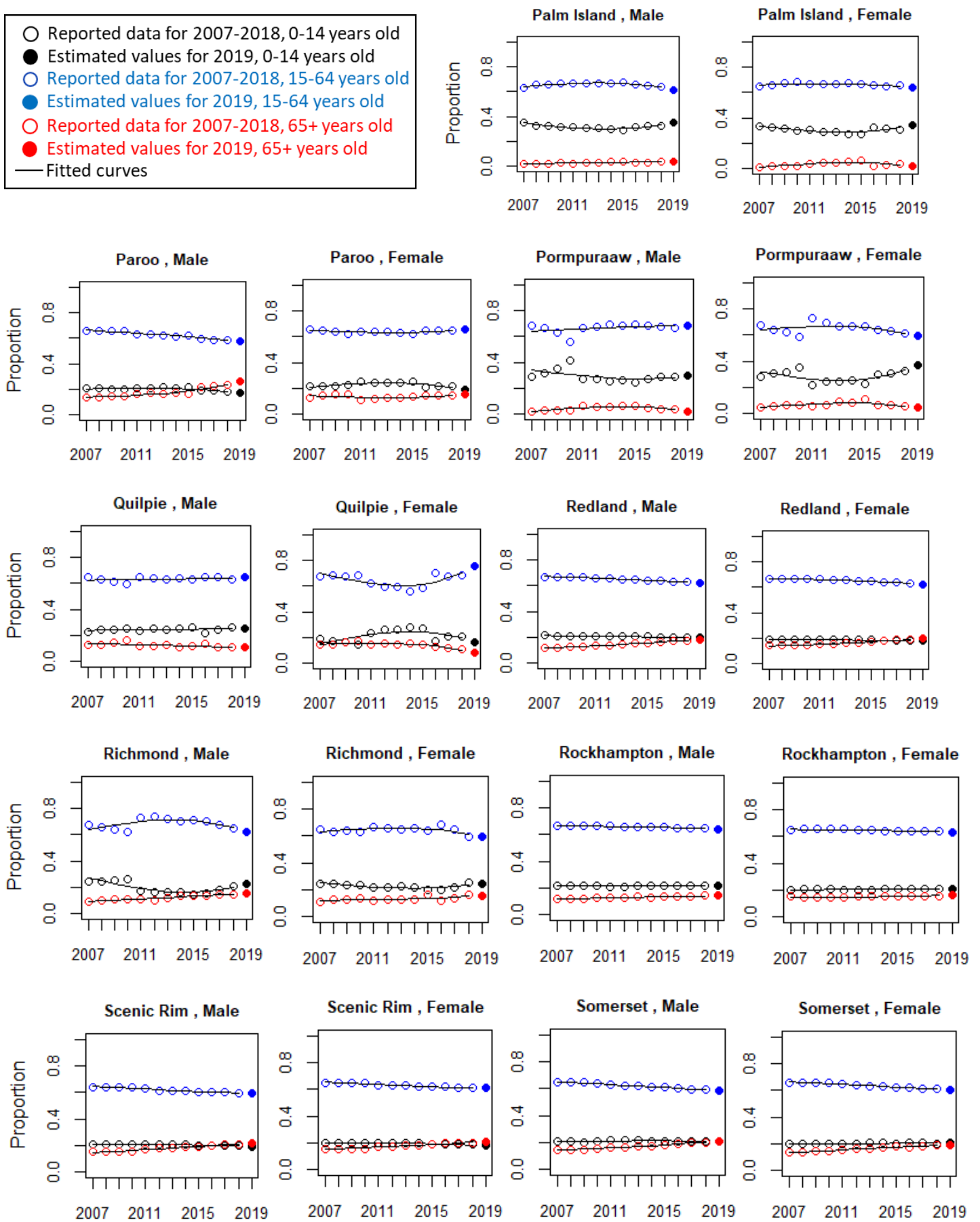
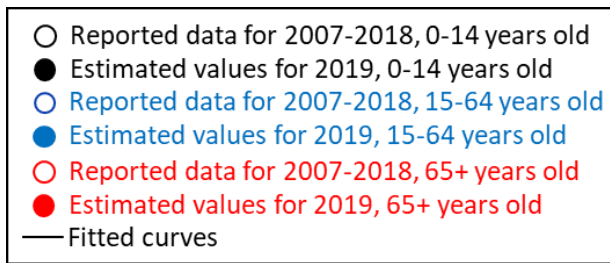


Fig. S4 (continued) - Nonlinear least-squares (NLS) fitting to LASN-specific demographic data from 2007 to 2018, and estimated values for 2019 from the NLS models.

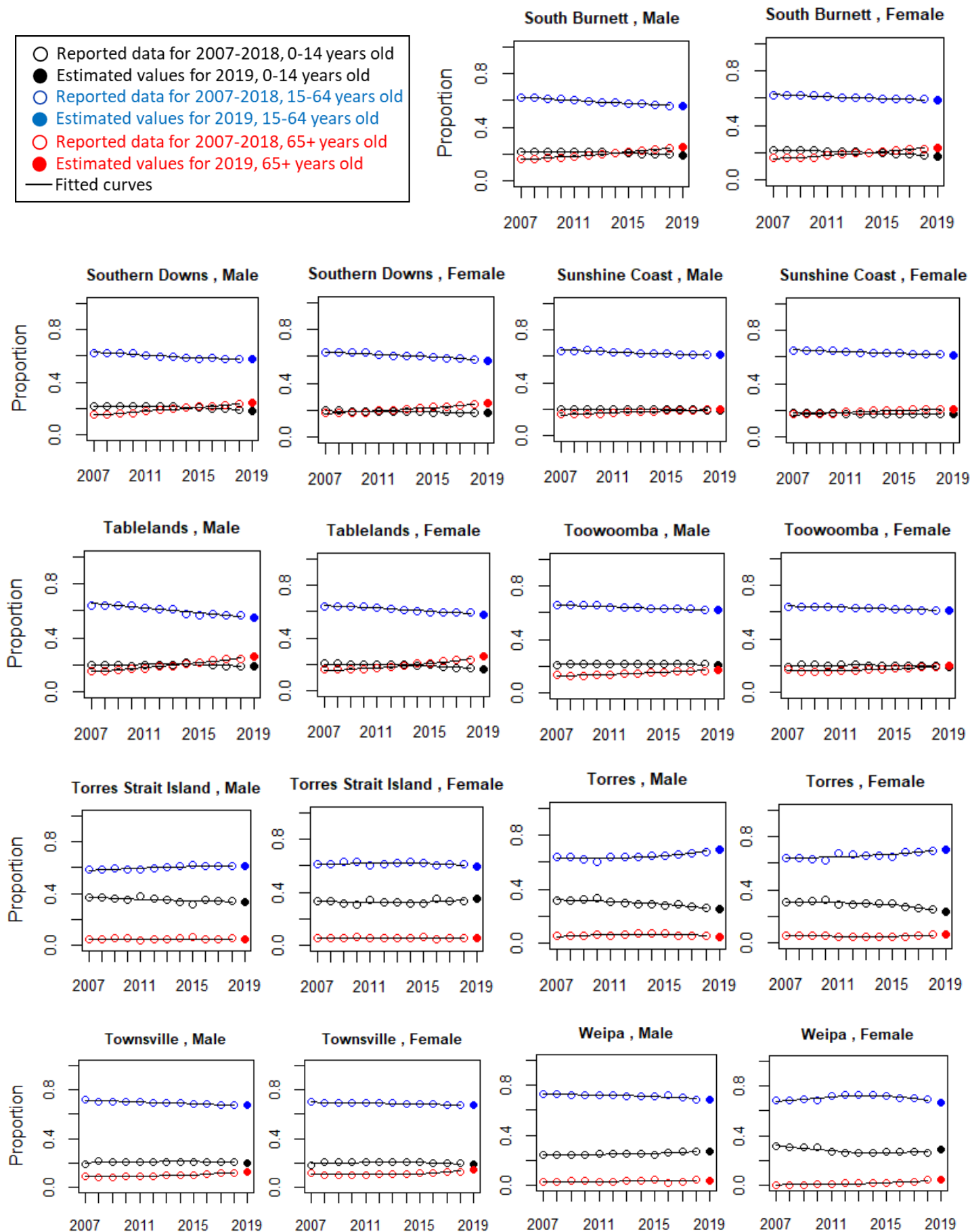


Fig. S4 (continued) - Nonlinear least-squares (NLS) fitting to LASN-specific demographic data from 2007 to 2018, and estimated values for 2019 from the NLS models.

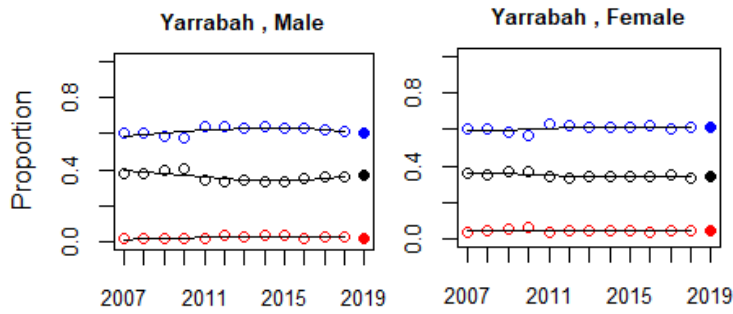
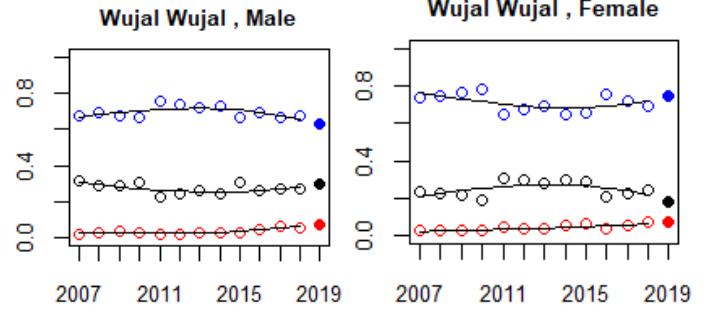
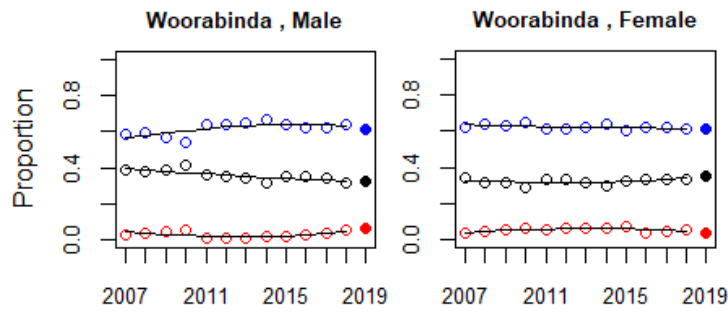
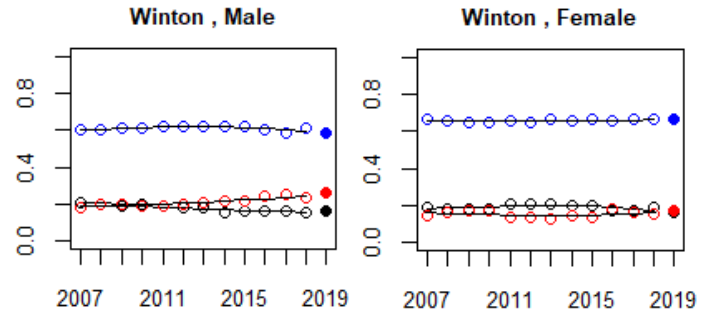
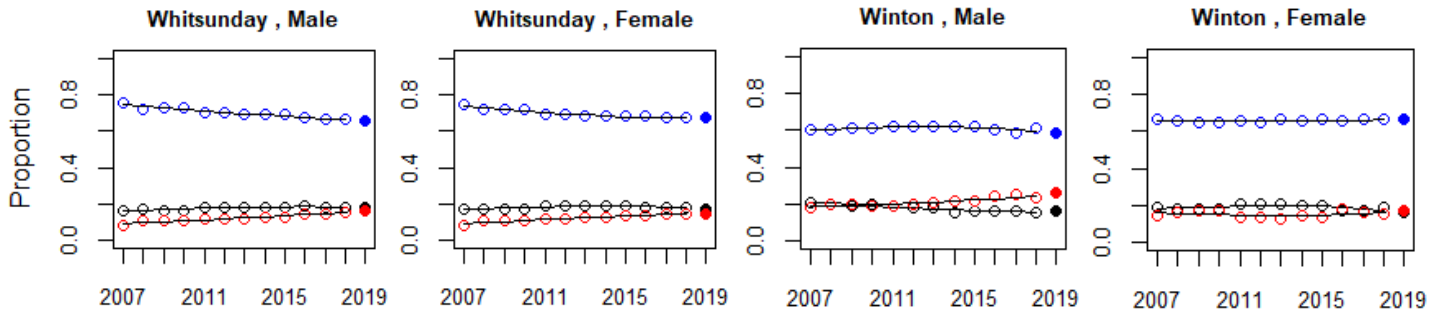
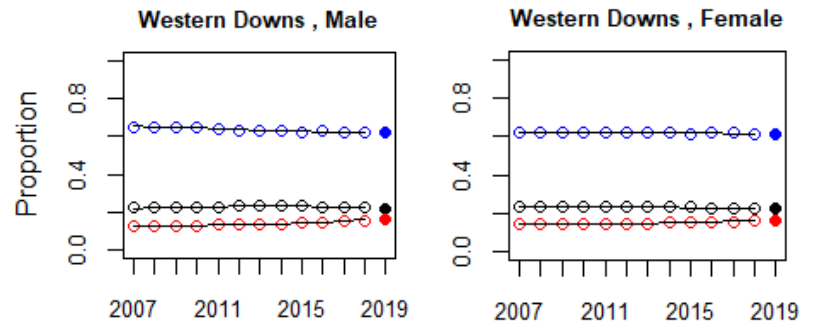
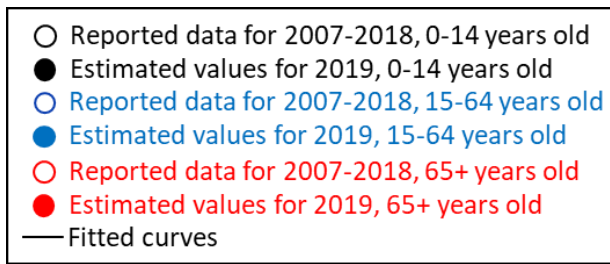


Fig. S4 (continued) - Nonlinear least-squares (NLS) fitting to LASN-specific demographic data from 2007 to 2018, and estimated values for 2019 from the NLS models.

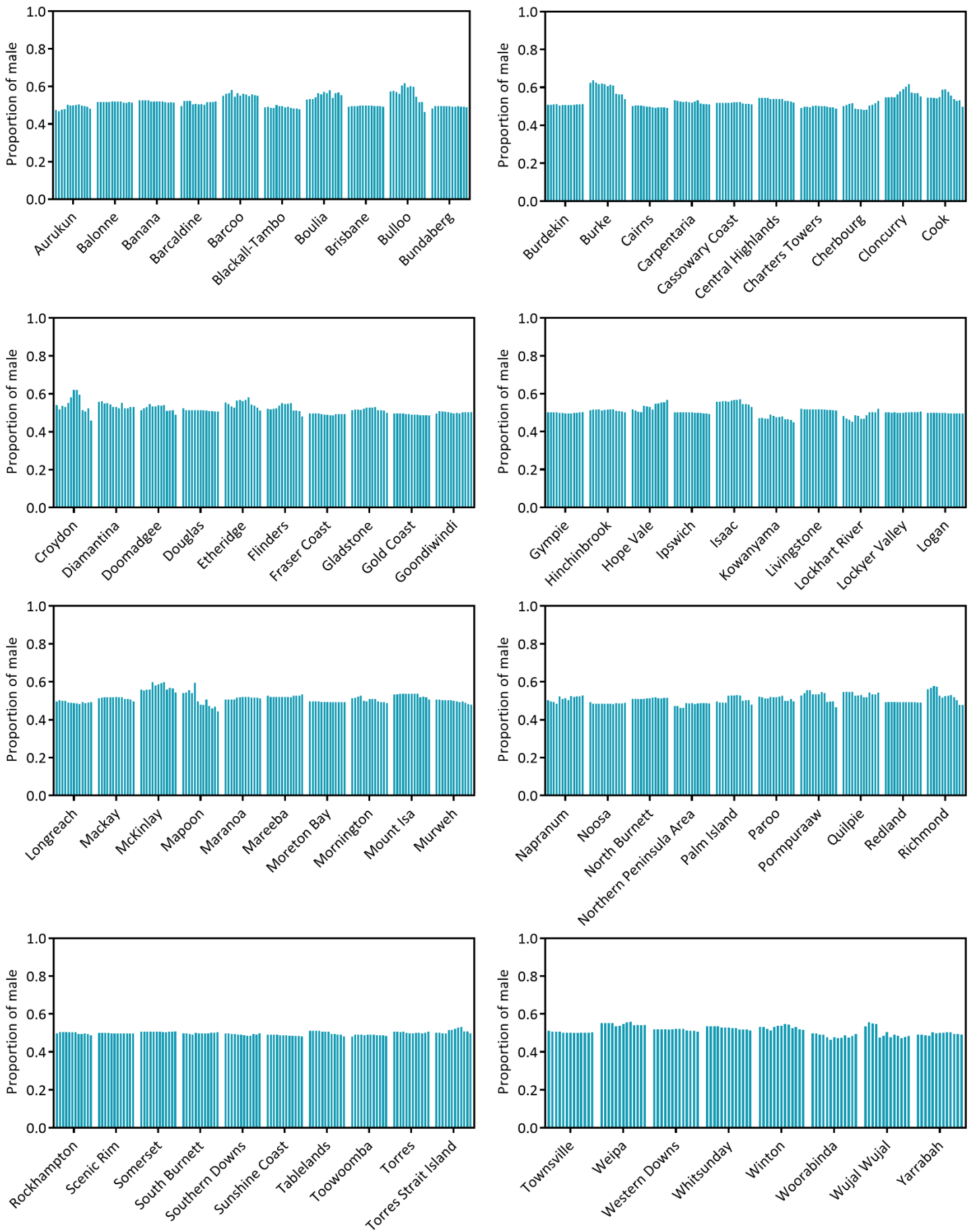


Fig. S5 - Proportion of male population of each local government area (LGA) by year. Each panel represents a group of 10 LGAs in alphabetical order, except for the last (bottom right) panel which has 8 LGAs. For each LGA, there are 13 bars, representing years 2007 to 2019 from left to right in chronological order.

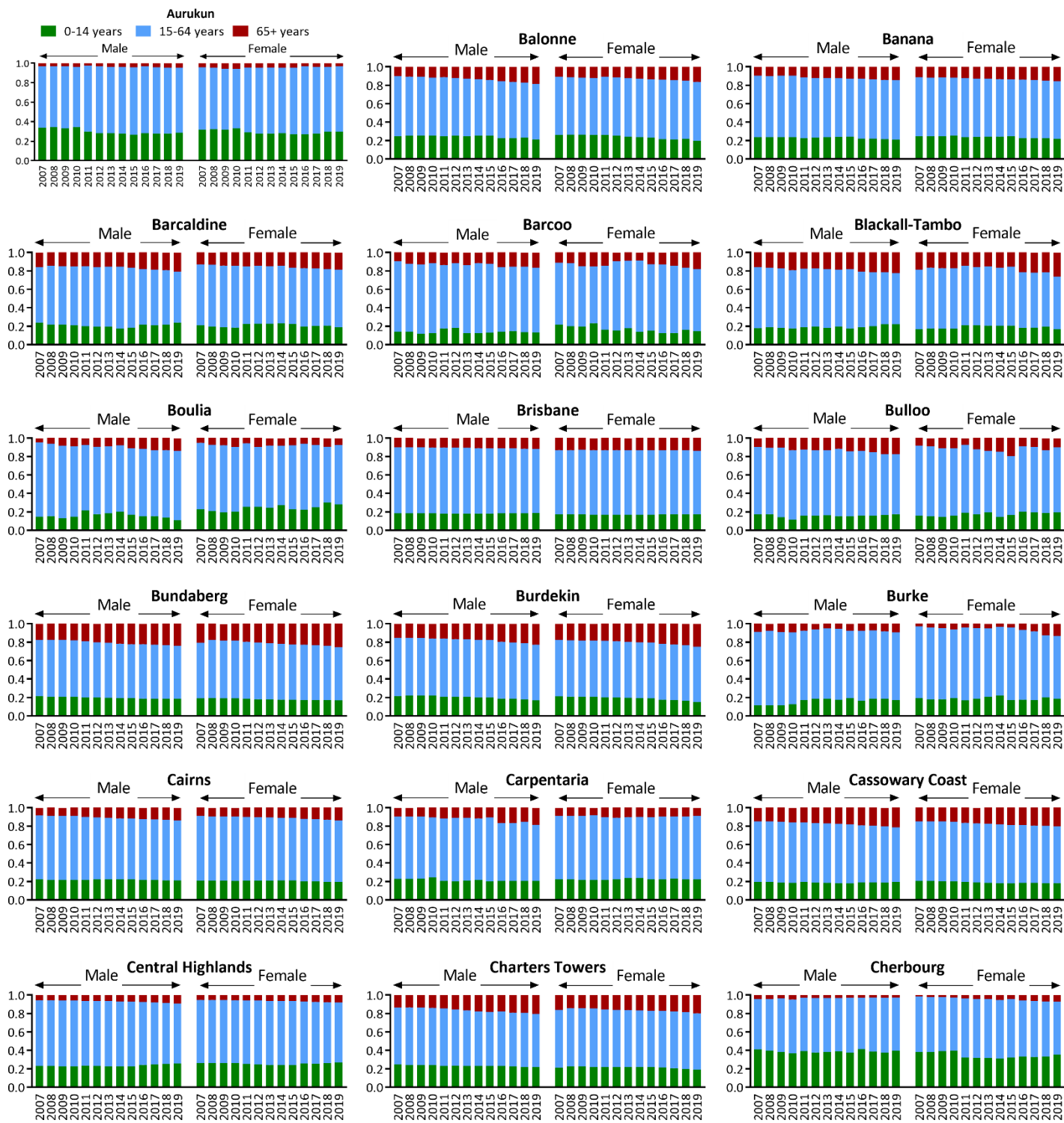


Fig. S6 - Age composition by sex for the 78 local government areas, presented in alphabetical order. The figure continues into the next 3 pages.

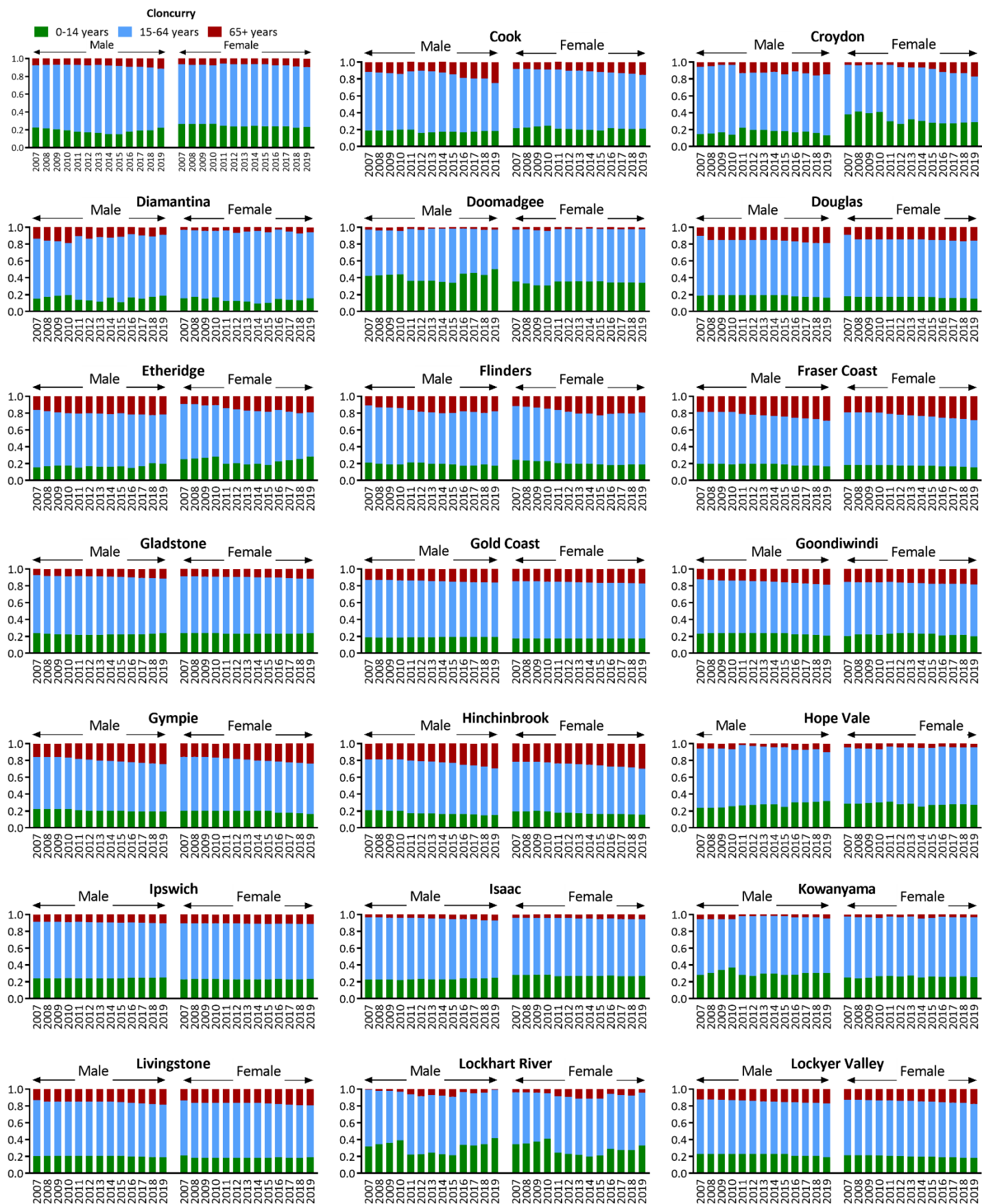


Fig. S6 (continued) - Age composition by sex for the 78 local government areas, presented in alphabetical order.

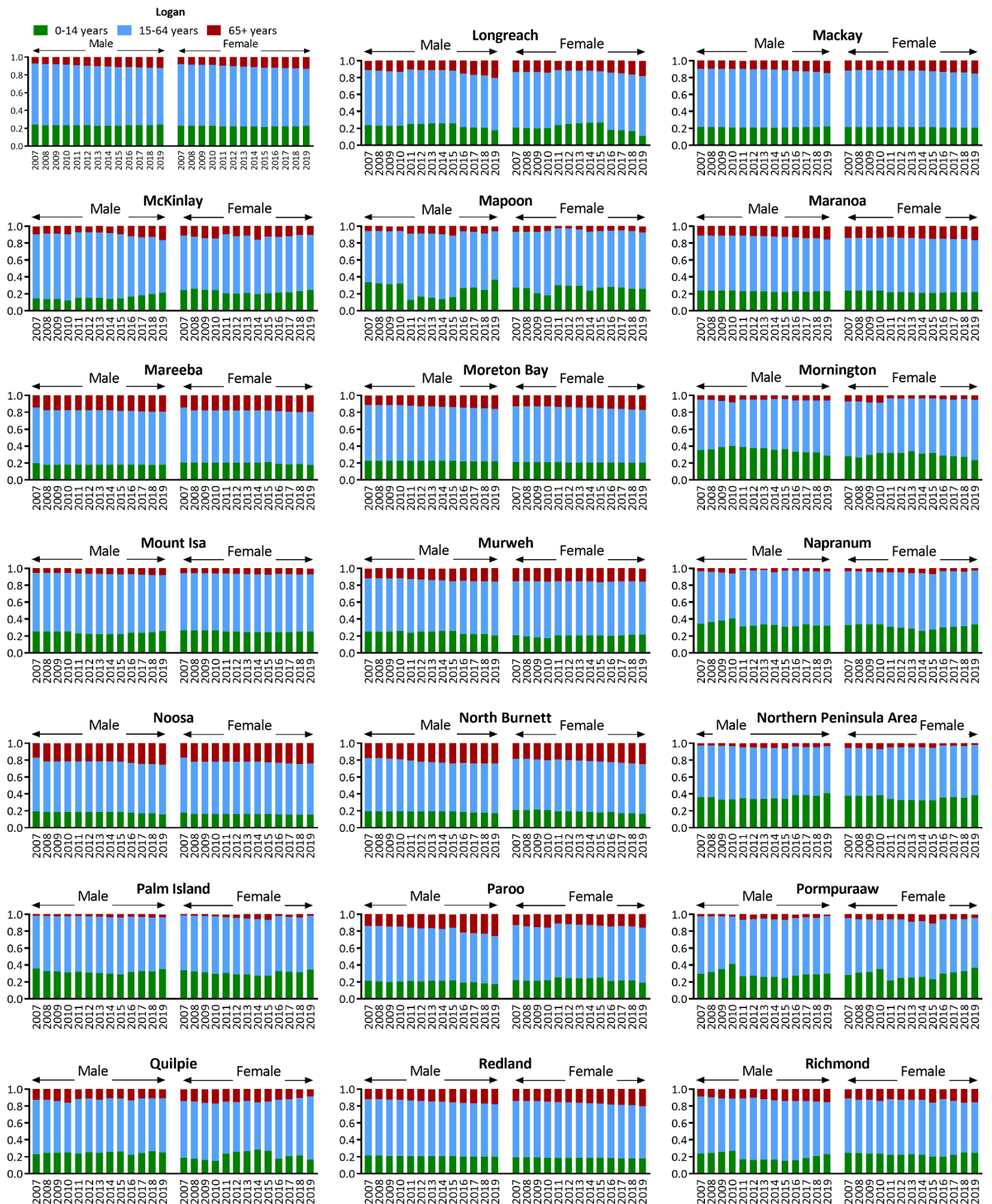


Fig. S6 (continued) - Age composition by sex for the 78 local government areas, presented in alphabetical order.



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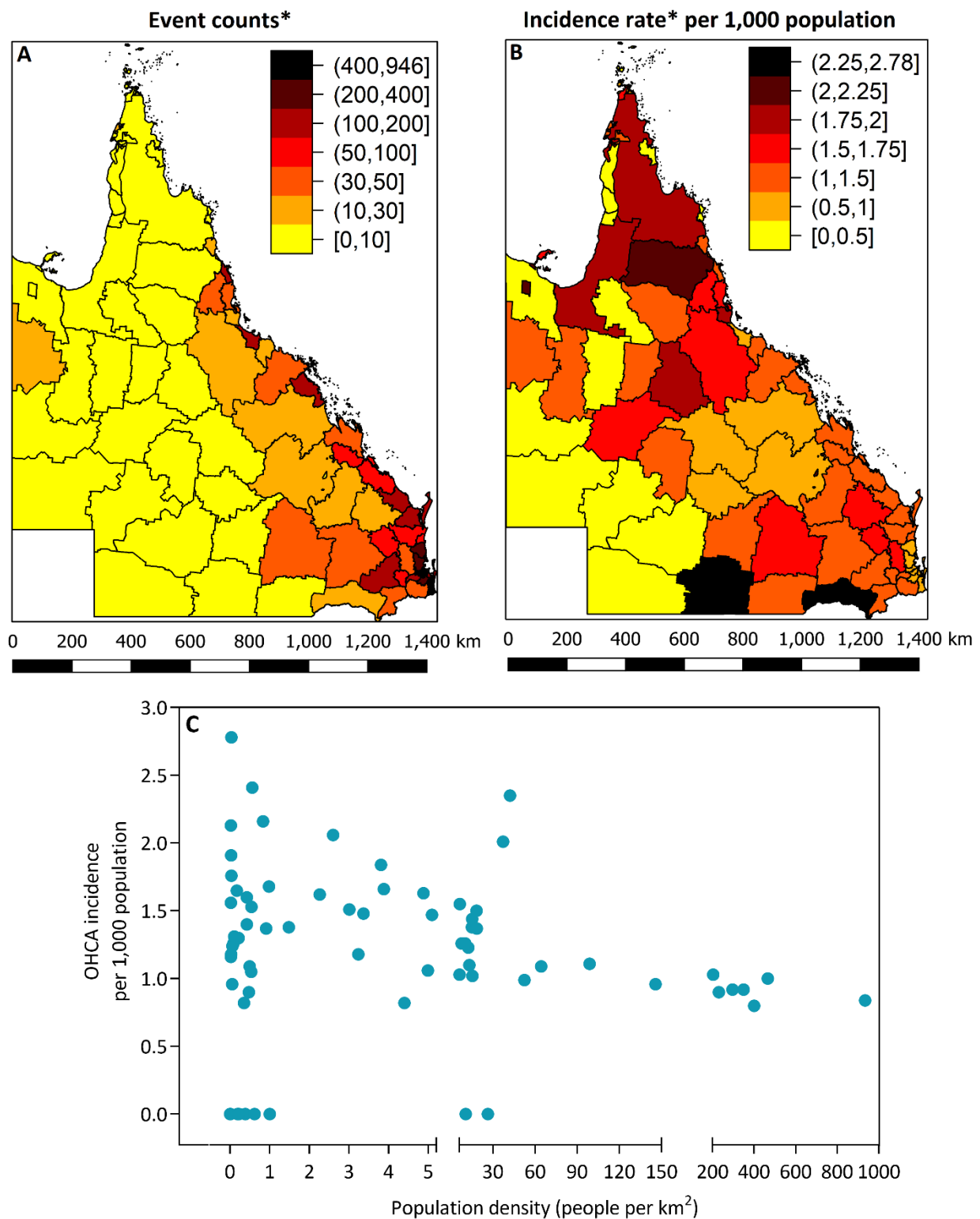


Fig. S7 - Crude event counts (panel A), crude incidence rate per 1,000 population (panel B), and incidence versus population density (panel C), of the 78 local government areas (LGAs). *For event counts, the map shows average number of cases per year across the study period, calculated as total number of cases for all years in each LGA divided by the number of years; For incidence rates, the map shows average incidence rates per 1,000 population per year across the study period, calculated as total number of cases across all years in each LGA divided by the number of years and over the average annual population of that LGA. Refer to Supplementary Tables S2 and S3 for LGA-specific event counts and incidence rates for individual years.

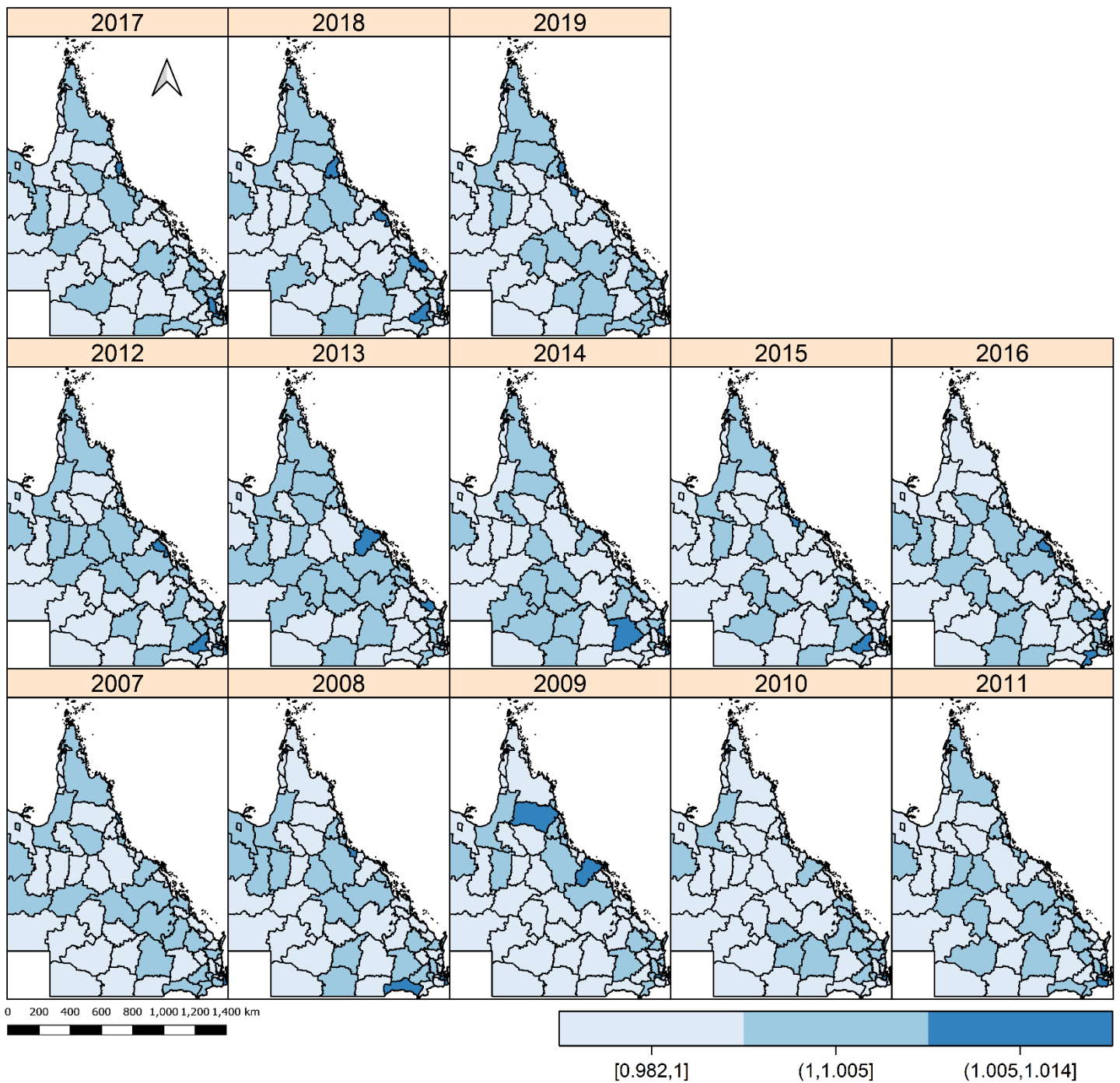


Fig. S8 - Posterior mean of the space-time interactions for the risk of out-of-hospital cardiac arrest in Queensland.

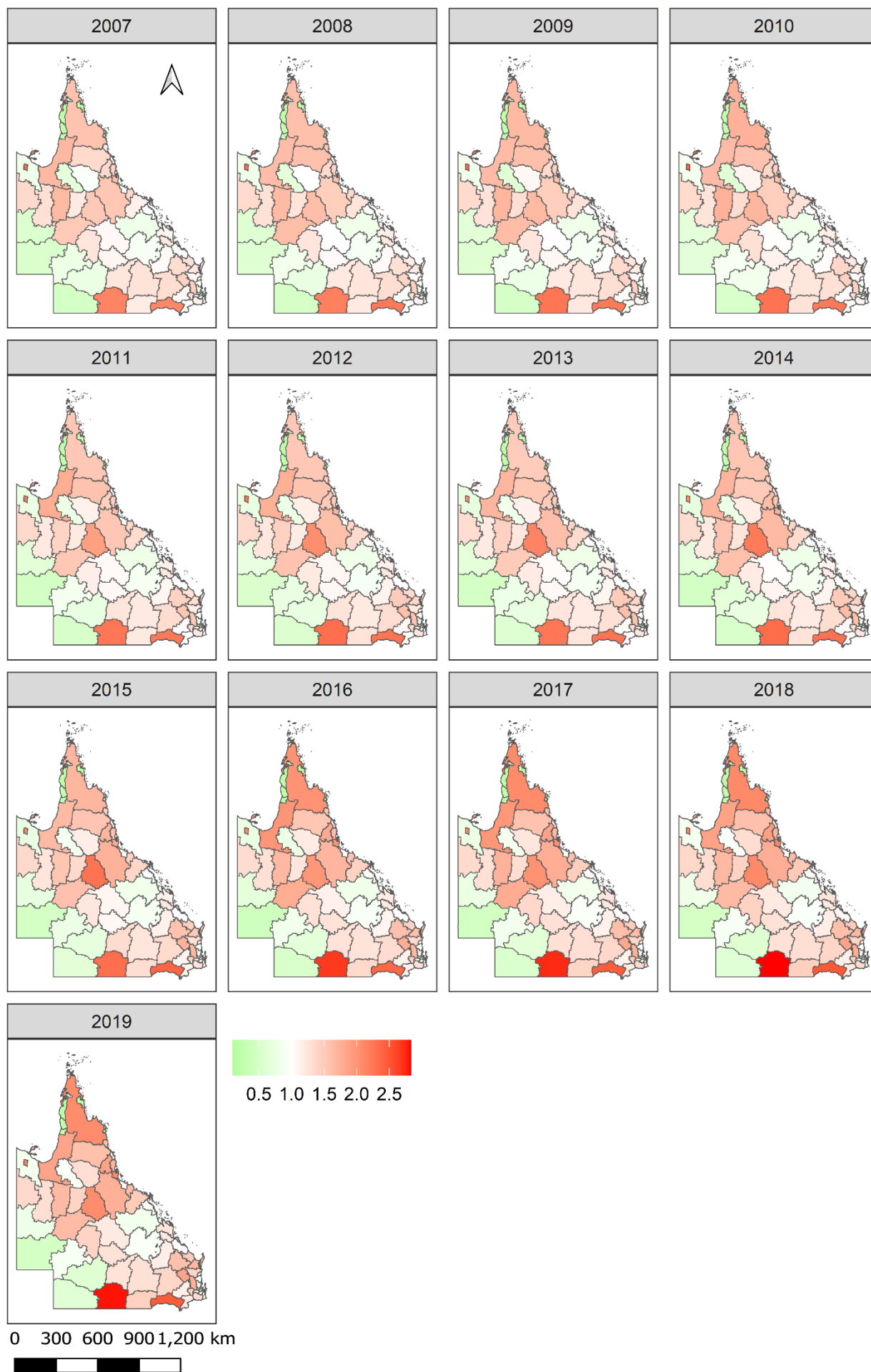


Fig. S9 - Posterior mean of the relative risk of out-of-hospital cardiac arrest for each of the 78 local government areas over time.

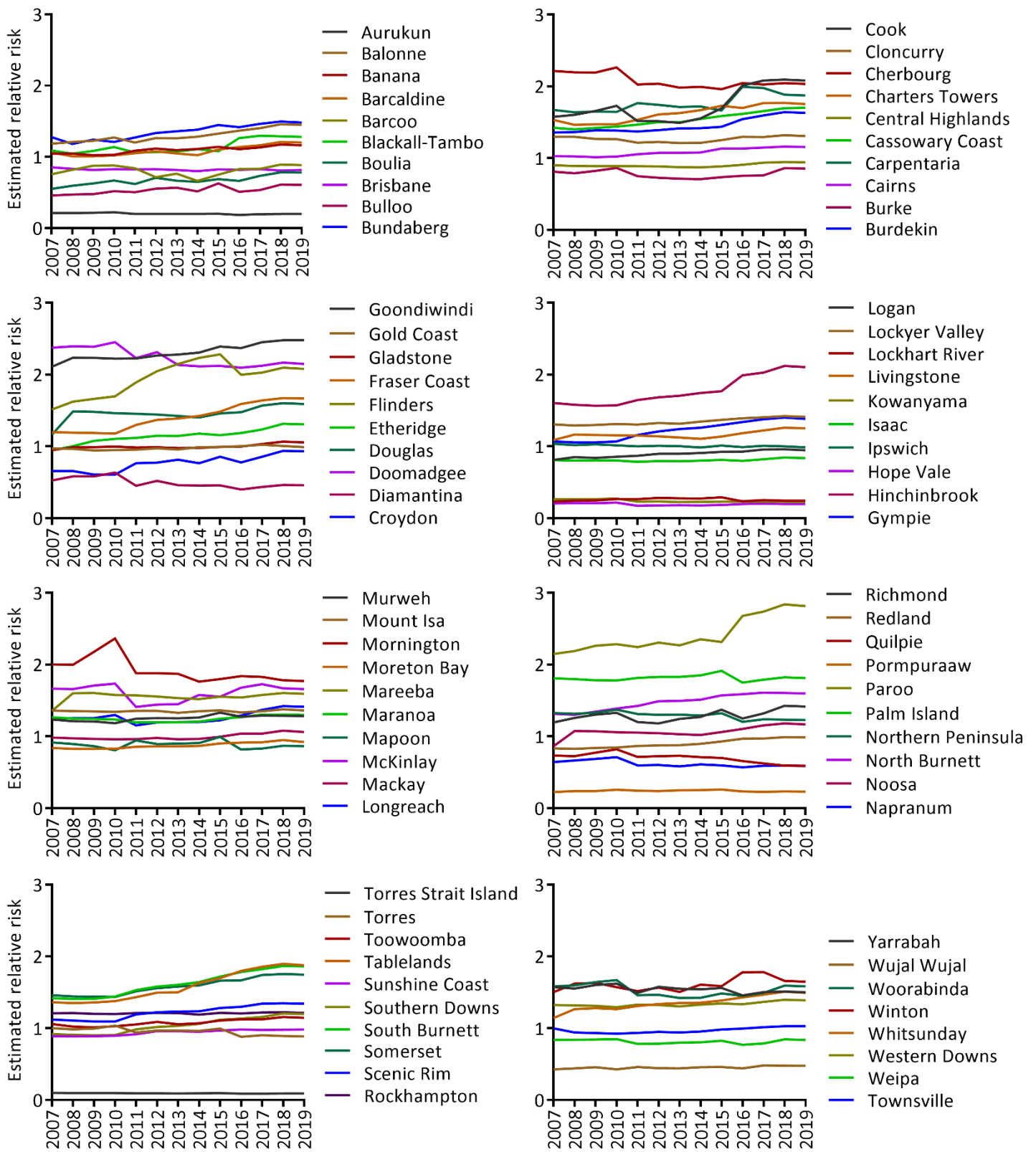


Fig. S10 - Trend lines of posterior mean of the relative risk of out-of-hospital cardiac arrest for each of the 78 local government areas over time.

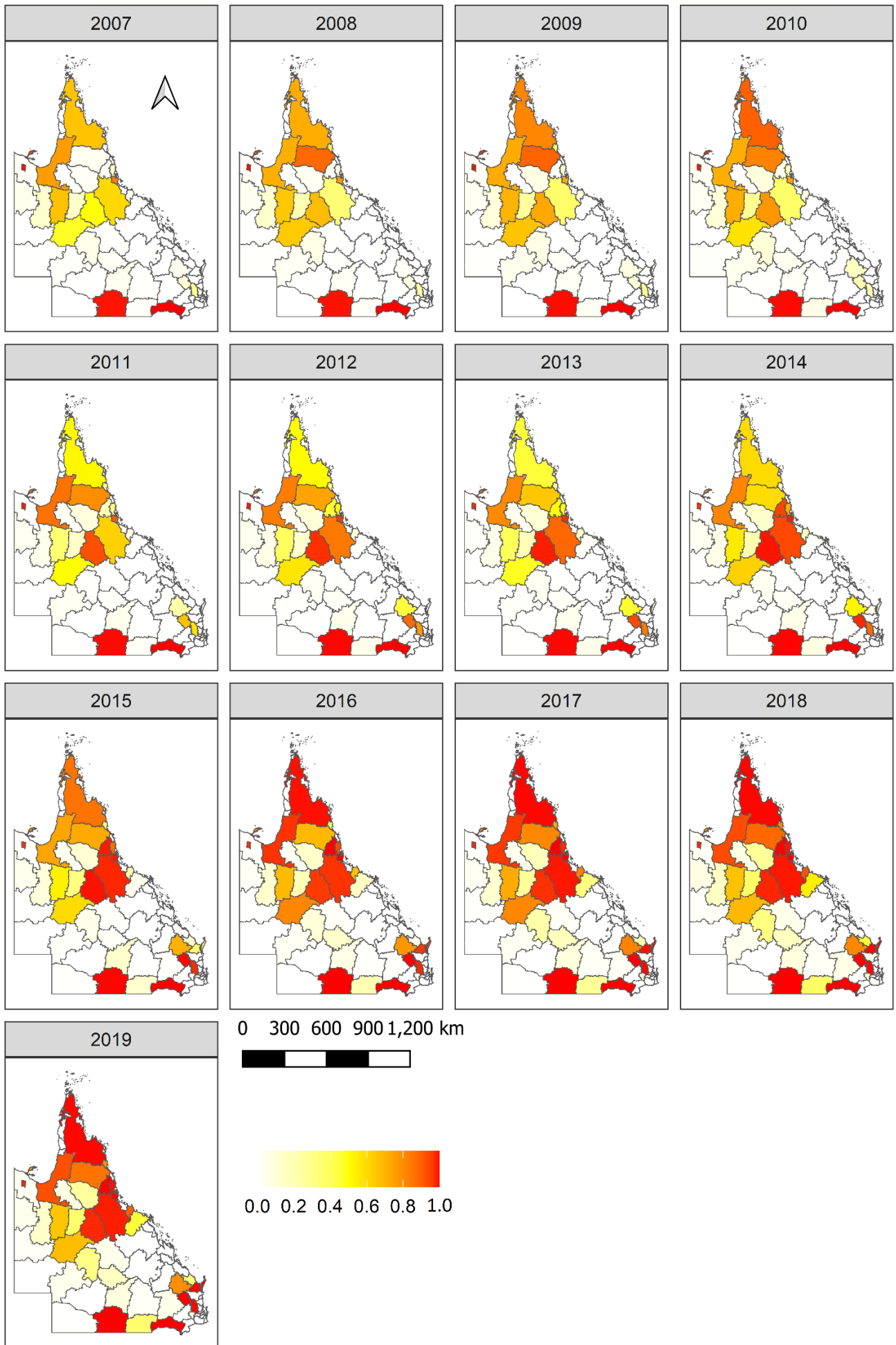


Fig. S11 - Map of exceedance probabilities (threshold = 1.5).

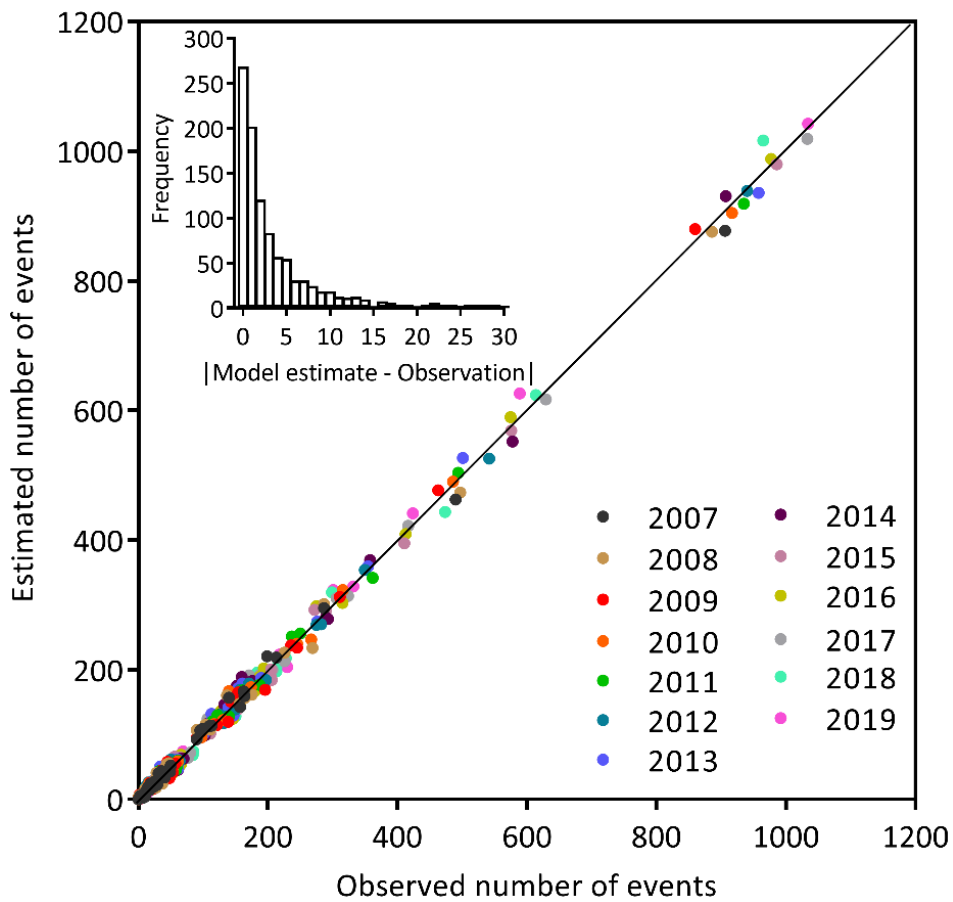


Fig. S12 - Comparison of model estimated and observed numbers of events. The majority of the dots fall onto the line of equality, indicating an excellent agreement between model estimates and observations. This is further supported by the inset histogram of the absolute differences between model estimates and observations (aggregating across years), showing the majority of the differences are zero or only a few cases.

Table S1. Total annual population of each local government area (LGA) by year

LGA	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Aurukun	1164	1252	1315	1365	1398	1372	1350	1332	1321	1323	1343	1381	1418
Balonne	4760	4786	4813	4833	4862	4787	4776	4726	4610	4461	4373	4333	4360
Banana	14883	14880	14941	14855	14812	14852	14948	14860	14707	14570	14485	14287	14156
Barcaldine	3338	3322	3303	3295	3292	3249	3232	3166	3082	2909	2868	2851	2849
Barcoo	364	371	360	360	363	348	333	317	296	272	267	267	266
Blackall-Tambo	2076	2124	2171	2216	2257	2236	2214	2152	2035	1925	1876	1863	1868
Boulia	428	443	456	485	493	486	481	473	459	436	424	425	423
Brisbane	1010222	1033472	1057692	1073144	1089879	1111798	1131996	1149107	1165437	1184752	1208663	1230938	1253982
Bulloo	369	379	390	405	418	410	396	388	372	356	343	330	325
Bundaberg	86486	88599	90335	91400	92063	93293	93850	94025	94028	94256	94697	95280	95856
Burdekin	17568	17653	17776	17786	17775	17862	17754	17695	17566	17326	17232	17073	16971
Burke	532	542	543	549	557	551	506	450	396	342	345	352	354
Cairns	136251	141403	145962	148943	150992	154041	156764	158574	159944	161573	163762	165462	166862
Carpentaria	2087	2124	2136	2182	2197	2170	2146	2112	2092	2051	1994	1974	1977
Cassowary Coast	28706	28739	28761	28718	28636	28880	28950	29038	29098	29287	29578	29679	29794
Central Highlands	27596	28090	28714	29082	29541	29741	29782	29598	29143	28690	28604	28636	28701
Charters Towers	11915	12096	12239	12316	12434	12403	12391	12367	12235	12087	11967	11849	11739
Cherbourg	1190	1206	1222	1245	1264	1283	1292	1300	1304	1293	1312	1315	1331
Cloncurry	3250	3308	3304	3301	3342	3359	3327	3270	3179	3125	3132	3090	3047
Cook	3650	3787	3988	4135	4409	4215	4231	4073	4225	4310	4352	4452	4557
Croydon	271	297	307	319	327	317	308	303	297	296	292	288	284
Diamantina	290	295	296	293	292	295	299	303	301	296	287	292	291
Doomadgee	1194	1235	1273	1327	1374	1368	1400	1422	1454	1475	1494	1506	1526
Douglas	10768	10995	11116	11146	11186	11380	11585	11757	11877	12070	12261	12252	12367
Etheridge	902	915	927	923	929	897	864	840	818	807	807	804	793
Flinders	1842	1837	1834	1834	1840	1795	1754	1710	1643	1582	1519	1498	1505
Fraser Coast	89109	92018	94813	96618	97661	99021	100290	101332	102129	102962	104042	105448	106712
Gladstone	53587	55425	57046	57697	59461	60521	62158	63367	63697	63017	62800	62961	63412
Gold Coast	466940	481569	495835	506135	515202	528342	540687	550718	561629	575303	591141	606528	620518

Goondiwindi	10468	10605	10722	10823	10900	10944	10952	10902	10835	10813	10770	10725	10799
Gympie	43634	44700	45774	46366	46837	47786	48491	49089	49540	50327	51049	51578	52446
Hinchinbrook	11822	11826	11829	11808	11817	11763	11613	11412	11181	10968	10878	10803	10687
Hope Vale	850	897	955	1011	1052	1059	1043	1030	1009	1014	1046	1081	1117
Ipswich	148133	154428	161664	167134	172200	178215	183688	189195	194274	200103	206500	213568	222307
Isaac	21018	21632	22237	22658	23188	23344	23284	22786	22173	21543	21182	20930	20886
Kowanyama	1075	1079	1088	1103	1112	1078	1042	1014	996	983	972	977	990
Livingstone	30629	31407	32474	32906	33394	34381	35279	36063	36579	36950	37286	37629	38078
Lockhart River	573	555	554	552	520	569	617	663	689	738	752	774	792
Lockyer Valley	32050	32974	34333	35110	35880	36547	37682	38363	38861	39499	40219	40996	41731
Logan	264410	270628	277372	282189	287474	293974	300545	305147	309342	314511	320487	326494	334358
Longreach	4174	4193	4219	4250	4296	4217	4104	4027	3812	3727	3598	3529	3470
Mackay	106026	108644	111455	113669	115960	117495	118878	118916	118292	117218	116601	116514	116763
McKinlay	963	994	1011	1044	1085	1041	992	943	876	816	810	814	818
Mapoon	254	262	271	276	281	290	293	302	304	318	322	325	333
Maranoa	12770	12952	13113	13286	13437	13424	13515	13434	13292	12926	12847	12788	12665
Mareeba	19195	19737	20177	20495	20745	20953	21379	21542	21812	22038	22203	22511	22730
Moreton Bay	344545	357499	370447	381357	390051	401188	410687	419764	428994	439292	449213	459456	469465
Mornington	1119	1120	1158	1184	1220	1218	1206	1202	1202	1197	1205	1218	1230
Mount Isa	20711	21381	21607	21830	22079	21958	21822	21261	20586	19606	19187	18870	18595
Murweh	4665	4668	4699	4714	4731	4737	4685	4639	4527	4386	4305	4317	4295
Napranum	881	890	901	910	908	919	922	939	959	989	1018	1047	1077
Noosa	48595	49600	50315	50770	51038	51678	52360	52988	53497	53922	54642	55355	55873
North Burnett	10322	10335	10377	10358	10374	10408	10487	10547	10607	10646	10663	10624	10599
Northern Peninsula Area	2168	2234	2273	2391	2463	2547	2620	2741	2836	2945	3001	3068	3163
Palm Island	2162	2265	2333	2430	2538	2539	2529	2527	2550	2581	2613	2637	2671
Paroo	1946	1921	1909	1924	1937	1903	1849	1807	1734	1668	1649	1586	1562
Porpuraaw	647	662	673	691	715	730	737	747	764	785	819	833	845
Quilpie	994	992	996	1003	1007	983	944	915	868	825	819	790	778
Redland	133596	136771	139859	141552	143711	145719	147328	148833	150107	152216	154590	156825	158815
Richmond	908	895	898	873	847	841	839	838	820	806	802	806	810

Rockhampton	75195	76272	77448	78193	78939	80555	81745	82136	82026	81322	81193	81051	81512
Scenic Rim	34983	35578	36525	37167	37437	37966	38732	39882	40307	40984	41749	42576	43123
Somerset	19919	20366	21071	21717	22200	22761	23619	24459	24681	25153	25529	25881	26219
South Burnett	30114	30583	31173	31518	31803	32340	32647	32606	32589	32625	32574	32549	32521
Southern Downs	32933	33451	33976	34313	34649	35013	35501	35580	35566	35638	35566	35593	35452
Sunshine Coast	243309	250800	258047	263053	267241	274828	281969	288652	295317	302841	311142	319837	328428
Tablelands	23553	23885	24103	24230	24372	24603	24827	25060	25111	25217	25335	25535	25575
Toowoomba	147927	150140	152525	154222	155473	157884	159916	161523	162775	164168	166013	167611	169008
Torres	3418	3457	3481	3485	3477	3567	3647	3717	3753	3799	3809	3847	3887
Torres Strait Island	4577	4606	4609	4600	4578	4599	4614	4690	4731	4775	4860	4993	5104
Townsville	163509	168503	173067	176528	180114	183612	186519	188777	190011	191348	192944	194019	195032
Weipa	3133	3246	3303	3337	3423	3684	3811	3863	3964	4040	4156	4239	4333
Western Downs	29520	30235	30893	31466	32365	32899	33415	33744	33867	34049	34434	34459	34585
Whitsunday	30759	31337	31838	32140	32416	33397	34113	34362	34509	34538	34774	35037	35357
Winton	1403	1372	1371	1359	1380	1345	1312	1276	1222	1154	1148	1157	1153
Woorabinda	902	916	934	957	976	984	986	990	989	999	998	1005	1016
Wujal Wujal	325	319	311	297	287	287	289	291	287	292	298	306	312
Yarrabah	2498	2531	2535	2588	2595	2643	2686	2694	2695	2702	2799	2847	2901

Table S2. Out-of-hospital cardiac arrest (OHCA) event counts for each local government area (LGA) by year

LGA	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Aurukun	0	0	0	0	0	0	0	0	0	0	0	0	0
Balonne	5	2	4	6	4	11	6	5	7	9	7	6	7
Banana	16	11	13	21	13	18	15	17	25	15	13	20	16
Barcaldine	5	4	3	1	1	5	6	6	2	1	2	2	5
Barcoo	0	0	0	0	0	0	1	1	0	0	0	1	0
Blackall-Tambo	1	1	1	4	2	1	3	3	3	6	1	2	2
Boulia	1	0	0	0	0	0	1	0	0	0	0	0	0
Brisbane	906	886	860	917	935	940	958	907	986	977	1033	965	1034
Bulloo	0	0	0	0	0	0	0	0	0	0	0	0	0
Bundaberg	110	90	117	108	114	136	147	127	153	128	133	152	145
Burdekin	19	23	25	17	26	28	30	34	28	25	30	27	25
Burke	0	1	0	0	0	0	0	0	0	0	1	0	0
Cairns	157	156	143	156	166	157	166	164	206	189	188	184	192
Carpentaria	4	4	7	4	3	5	5	2	5	1	2	5	6
Cassowary Coast	40	28	53	42	37	45	36	43	50	49	63	41	64
Central Highlands	27	24	19	23	27	22	27	24	22	25	39	27	38
Charters Towers	15	27	21	13	18	27	20	17	18	22	24	22	18
Cherbourg	1	2	0	1	3	4	1	1	4	4	6	2	7
Cloncurry	4	5	3	2	2	3	9	0	4	8	9	4	2
Cook	8	4	2	7	7	7	7	8	11	8	10	11	14
Croydon	0	0	0	0	0	0	0	1	0	0	0	0	0
Diamantina	0	0	0	0	0	0	0	0	0	0	0	0	0
Doomadgee	4	4	3	2	0	5	4	2	2	1	3	8	4
Douglas	12	16	24	12	13	16	23	13	20	11	22	22	22
Etheridge	1	0	0	1	1	0	2	0	0	1	2	1	1
Flinders	1	5	3	1	7	6	3	5	5	3	2	4	0
Fraser Coast	100	112	121	117	122	150	139	133	154	180	177	174	185
Gladstone	50	47	45	61	61	50	53	70	65	64	74	84	77
Gold Coast	490	497	463	486	494	542	501	578	576	575	629	614	589
Goondiwindi	29	37	22	20	30	16	22	24	25	23	34	18	33

Gympie	49	44	44	52	51	64	61	66	56	66	80	85	69
Hinchinbrook	24	20	22	25	25	12	27	23	14	17	19	21	18
Hope Vale	0	0	0	0	0	0	0	0	0	0	0	0	0
Ipswich	140	137	196	174	187	197	190	160	205	194	226	228	218
Isaac	19	19	24	17	22	22	19	16	16	24	11	15	12
Kowanyama	0	0	0	0	0	0	0	0	0	0	0	0	0
Livingstone	41	29	34	42	47	43	51	38	40	37	44	45	47
Lockhart River	0	0	0	0	0	0	0	0	0	0	0	0	0
Lockyer Valley	48	45	46	53	44	46	34	59	51	62	51	65	63
Logan	213	269	236	267	250	275	276	290	272	275	324	314	301
Longreach	3	4	5	3	7	5	7	7	7	6	3	4	7
Mackay	96	111	105	110	107	132	108	106	116	146	107	150	127
McKinlay	0	2	5	1	1	2	1	0	3	1	1	1	4
Mapoon	0	0	0	0	0	0	1	1	0	0	0	1	0
Maranoa	18	11	13	17	23	14	17	16	12	16	16	20	24
Mareeba	24	29	48	30	31	29	34	39	28	31	34	39	40
Moreton Bay	287	287	311	316	362	350	355	358	411	413	417	474	424
Mornington	7	0	2	3	6	1	3	1	0	2	2	2	3
Mount Isa	29	33	33	30	32	31	24	39	24	32	16	30	20
Murweh	3	7	5	8	5	7	5	7	6	7	2	5	9
Napranum	0	0	0	2	0	4	1	0	0	1	0	0	0
Noosa	49	44	57	47	46	50	54	57	63	65	77	70	63
North Burnett	17	14	15	16	17	13	11	11	14	20	20	15	22
Northern Peninsula Area	1	2	4	7	2	3	1	5	3	2	7	1	8
Palm Island	4	3	4	10	7	6	3	1	5	4	7	2	6
Paroo	4	5	0	3	2	3	9	8	4	8	4	7	3
Pormpuraaw	0	0	0	0	0	0	0	0	0	0	0	0	0
Quilpie	0	0	0	0	1	0	0	3	1	0	1	0	0
Redland	113	104	139	131	140	126	113	138	145	157	138	151	164
Richmond	1	1	0	1	3	1	5	0	1	2	0	0	0
Rockhampton	90	91	90	98	96	98	101	103	111	105	100	96	99
Scenic Rim	41	32	32	35	58	52	55	40	46	66	63	56	59

Somerset	29	30	35	30	45	29	40	37	40	43	59	38	40
South Burnett	36	42	37	52	59	53	47	55	56	57	61	63	70
Southern Downs	31	26	35	28	41	34	44	30	37	54	32	44	44
Sunshine Coast	199	226	245	245	237	282	276	293	290	315	306	299	332
Tablelands	31	36	38	34	38	35	39	38	41	35	40	62	54
Toowoomba	164	164	142	167	161	194	154	152	203	187	171	213	209
Torres	7	0	0	5	6	1	3	2	5	2	8	1	5
Torres Strait Island	0	0	0	0	0	0	0	0	0	0	0	0	0
Townsville	163	175	154	140	174	171	161	176	204	194	207	213	230
Weipa	6	7	5	0	0	3	3	1	3	1	5	4	2
Western Downs	31	43	47	35	40	55	41	61	48	41	43	47	48
Whitsunday	41	37	54	44	32	41	61	50	39	57	48	53	45
Winton	3	2	2	1	3	4	2	2	1	3	4	0	1
Woorabinda	1	0	2	1	3	2	1	3	1	2	1	1	3
Wujal Wujal	0	0	0	0	0	0	0	0	0	0	0	0	0
Yarrabah	10	5	3	4	5	2	2	1	3	4	5	5	6

Table S3. Out-of-hospital cardiac arrest (OHCA) incidence rate per 1,000 population for each local government area (LGA) by year

LGA	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Aurukun	0	0	0	0	0	0	0	0	0	0	0	0	0
Balonne	1.05	0.42	0.83	1.24	0.82	2.3	1.26	1.06	1.52	2.02	1.6	1.38	1.61
Banana	1.08	0.74	0.87	1.41	0.88	1.21	1	1.14	1.7	1.03	0.9	1.4	1.13
Barcardine	1.5	1.2	0.91	0.3	0.3	1.54	1.86	1.9	0.65	0.34	0.7	0.7	1.76
Barcoo	0	0	0	0	0	0	3	3.15	0	0	0	3.75	0
Blackall-Tambo	0.48	0.47	0.46	1.81	0.89	0.45	1.36	1.39	1.47	3.12	0.53	1.07	1.07
Boulia	2.34	0	0	0	0	0	2.08	0	0	0	0	0	0
Brisbane	0.9	0.86	0.81	0.85	0.86	0.85	0.85	0.79	0.85	0.82	0.85	0.78	0.82
Bulloo	0	0	0	0	0	0	0	0	0	0	0	0	0
Bundaberg	1.27	1.02	1.3	1.18	1.24	1.46	1.57	1.35	1.63	1.36	1.4	1.6	1.51
Burdekin	1.08	1.3	1.41	0.96	1.46	1.57	1.69	1.92	1.59	1.44	1.74	1.58	1.47
Burke	0	1.85	0	0	0	0	0	0	0	0	2.9	0	0
Cairns	1.15	1.1	0.98	1.05	1.1	1.02	1.06	1.03	1.29	1.17	1.15	1.11	1.15
Carpentaria	1.92	1.88	3.28	1.83	1.37	2.3	2.33	0.95	2.39	0.49	1	2.53	3.03
Cassowary Coast	1.39	0.97	1.84	1.46	1.29	1.56	1.24	1.48	1.72	1.67	2.13	1.38	2.15
Central Highlands	0.98	0.85	0.66	0.79	0.91	0.74	0.91	0.81	0.75	0.87	1.36	0.94	1.32
Charters Towers	1.26	2.23	1.72	1.06	1.45	2.18	1.61	1.37	1.47	1.82	2.01	1.86	1.53
Cherbourg	0.84	1.66	0	0.8	2.37	3.12	0.77	0.77	3.07	3.09	4.57	1.52	5.26
Cloncurry	1.23	1.51	0.91	0.61	0.6	0.89	2.71	0	1.26	2.56	2.87	1.29	0.66
Cook	2.19	1.06	0.5	1.69	1.59	1.66	1.65	1.96	2.6	1.86	2.3	2.47	3.07
Croydon	0	0	0	0	0	0	0	3.3	0	0	0	0	0
Diamantina	0	0	0	0	0	0	0	0	0	0	0	0	0
Doomadgee	3.35	3.24	2.36	1.51	0	3.65	2.86	1.41	1.38	0.68	2.01	5.31	2.62
Douglas	1.11	1.46	2.16	1.08	1.16	1.41	1.99	1.11	1.68	0.91	1.79	1.8	1.78
Etheridge	1.11	0	0	1.08	1.08	0	2.31	0	0	1.24	2.48	1.24	1.26
Flinders	0.54	2.72	1.64	0.55	3.8	3.34	1.71	2.92	3.04	1.9	1.32	2.67	0
Fraser Coast	1.12	1.22	1.28	1.21	1.25	1.51	1.39	1.31	1.51	1.75	1.7	1.65	1.73
Gladstone	0.93	0.85	0.79	1.06	1.03	0.83	0.85	1.1	1.02	1.02	1.18	1.33	1.21

Gold Coast	1.05	1.03	0.93	0.96	0.96	1.03	0.93	1.05	1.03	1	1.06	1.01	0.95
Goondiwindi	2.77	3.49	2.05	1.85	2.75	1.46	2.01	2.2	2.31	2.13	3.16	1.68	3.06
Gympie	1.12	0.98	0.96	1.12	1.09	1.34	1.26	1.34	1.13	1.31	1.57	1.65	1.32
Hinchinbrook	2.03	1.69	1.86	2.12	2.12	1.02	2.32	2.02	1.25	1.55	1.75	1.94	1.68
Hope Vale	0	0	0	0	0	0	0	0	0	0	0	0	0
Ipswich	0.95	0.89	1.21	1.04	1.09	1.11	1.03	0.85	1.06	0.97	1.09	1.07	0.98
Isaac	0.9	0.88	1.08	0.75	0.95	0.94	0.82	0.7	0.72	1.11	0.52	0.72	0.57
Kowanyama	0	0	0	0	0	0	0	0	0	0	0	0	0
Livingstone	1.34	0.92	1.05	1.28	1.41	1.25	1.45	1.05	1.09	1	1.18	1.2	1.23
Lockhart River	0	0	0	0	0	0	0	0	0	0	0	0	0
Lockyer Valley	1.5	1.36	1.34	1.51	1.23	1.26	0.9	1.54	1.31	1.57	1.27	1.59	1.51
Logan	0.81	0.99	0.85	0.95	0.87	0.94	0.92	0.95	0.88	0.87	1.01	0.96	0.9
Longreach	0.72	0.95	1.19	0.71	1.63	1.19	1.71	1.74	1.84	1.61	0.83	1.13	2.02
Mackay	0.91	1.02	0.94	0.97	0.92	1.12	0.91	0.89	0.98	1.25	0.92	1.29	1.09
McKinlay	0	2.01	4.95	0.96	0.92	1.92	1.01	0	3.42	1.23	1.23	1.23	4.89
Mapoon	0	0	0	0	0	0	3.41	3.31	0	0	0	3.08	0
Maranoa	1.41	0.85	0.99	1.28	1.71	1.04	1.26	1.19	0.9	1.24	1.25	1.56	1.89
Mareeba	1.25	1.47	2.38	1.46	1.49	1.38	1.59	1.81	1.28	1.41	1.53	1.73	1.76
Moreton Bay	0.83	0.8	0.84	0.83	0.93	0.87	0.86	0.85	0.96	0.94	0.93	1.03	0.9
Mornington	6.26	0	1.73	2.53	4.92	0.82	2.49	0.83	0	1.67	1.66	1.64	2.44
Mount Isa	1.4	1.54	1.53	1.37	1.45	1.41	1.1	1.83	1.17	1.63	0.83	1.59	1.08
Murweh	0.64	1.5	1.06	1.7	1.06	1.48	1.07	1.51	1.33	1.6	0.46	1.16	2.1
Napranum	0	0	0	2.2	0	4.35	1.08	0	0	1.01	0	0	0
Noosa	1.01	0.89	1.13	0.93	0.9	0.97	1.03	1.08	1.18	1.21	1.41	1.26	1.13
North Burnett	1.65	1.35	1.45	1.54	1.64	1.25	1.05	1.04	1.32	1.88	1.88	1.41	2.08
Northern Peninsula Area	0.46	0.9	1.76	2.93	0.81	1.18	0.38	1.82	1.06	0.68	2.33	0.33	2.53
Palm Island	1.85	1.32	1.71	4.12	2.76	2.36	1.19	0.4	1.96	1.55	2.68	0.76	2.25
Paroo	2.06	2.6	0	1.56	1.03	1.58	4.87	4.43	2.31	4.8	2.43	4.41	1.92
Pormpuraaw	0	0	0	0	0	0	0	0	0	0	0	0	0
Quilpie	0	0	0	0	0.99	0	0	3.28	1.15	0	1.22	0	0
Redland	0.85	0.76	0.99	0.93	0.97	0.86	0.77	0.93	0.97	1.03	0.89	0.96	1.03
Richmond	1.1	1.12	0	1.15	3.54	1.19	5.96	0	1.22	2.48	0	0	0

Rockhampton	1.2	1.19	1.16	1.25	1.22	1.22	1.24	1.25	1.35	1.29	1.23	1.18	1.21
Scenic Rim	1.17	0.9	0.88	0.94	1.55	1.37	1.42	1	1.14	1.61	1.51	1.32	1.37
Somerset	1.46	1.47	1.66	1.38	2.03	1.27	1.69	1.51	1.62	1.71	2.31	1.47	1.53
South Burnett	1.2	1.37	1.19	1.65	1.86	1.64	1.44	1.69	1.72	1.75	1.87	1.94	2.15
Southern Downs	0.94	0.78	1.03	0.82	1.18	0.97	1.24	0.84	1.04	1.52	0.9	1.24	1.24
Sunshine Coast	0.82	0.9	0.95	0.93	0.89	1.03	0.98	1.02	0.98	1.04	0.98	0.93	1.01
Tablelands	1.32	1.51	1.58	1.4	1.56	1.42	1.57	1.52	1.63	1.39	1.58	2.43	2.11
Toowoomba	1.11	1.09	0.93	1.08	1.04	1.23	0.96	0.94	1.25	1.14	1.03	1.27	1.24
Torres	2.05	0	0	1.43	1.73	0.28	0.82	0.54	1.33	0.53	2.1	0.26	1.29
Torres Strait Island	0	0	0	0	0	0	0	0	0	0	0	0	0
Townsville	1	1.04	0.89	0.79	0.97	0.93	0.86	0.93	1.07	1.01	1.07	1.1	1.18
Weipa	1.92	2.16	1.51	0	0	0.81	0.79	0.26	0.76	0.25	1.2	0.94	0.46
Western Downs	1.05	1.42	1.52	1.11	1.24	1.67	1.23	1.81	1.42	1.2	1.25	1.36	1.39
Whitsunday	1.33	1.18	1.7	1.37	0.99	1.23	1.79	1.46	1.13	1.65	1.38	1.51	1.27
Winton	2.14	1.46	1.46	0.74	2.17	2.97	1.52	1.57	0.82	2.6	3.48	0	0.87
Woorabinda	1.11	0	2.14	1.04	3.07	2.03	1.01	3.03	1.01	2	1	1	2.95
Wujal Wujal	0	0	0	0	0	0	0	0	0	0	0	0	0
Yarrabah	4	1.98	1.18	1.55	1.93	0.76	0.74	0.37	1.11	1.48	1.79	1.76	2.07

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