**SUPPORTING INFORMATION**

**Appendix S2**

**A framework for mapping the distribution seabirds by integrating tracking, demography and phenology**

More details can be found at <https://github.com/anacarneiro/DensityMaps>

**TABLE S1** Population estimates (i.e. annual breeding pairs), % of all sites (i.e. percentage in relation to global estimates), demographic estimates of juvenile/immature (average annual survival from fledging to average age of 1st breeding) and adult annual survival, breeding frequency and success and age at first breeding for the populations from which tracking data were available for the analysis. Where no estimates were available for particular demographic parameters from a given population or age class, we used parameters from another location or another species with similar life-history attributes. For some species, no estimates of juvenile survival existed, and we estimated juvenile survival from adult survival, using age effect: juvenile survival = adult survival multiplied by the average ratio of juvenile to adult survival calculated from all available data for the relevant genus (*Procellaria*, *Thalassarche*, or both). Species in bold were representative of island or island group(s) holding >50% of the global population estimates.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Population (reference) | Annual pairs | % all sites | Juv/Imm survival | Adult  survival | Br frequency | Br success | Age 1st  br |
| **Wandering albatross** |  |  |  |  |  |  |  |
| Crozet (1, 2, 3, 4, 5, 6) | 1,815 | 23.1 | 0.889 | 0.945a | 0.566b | 0.730 | 10.0 |
| Kerguelen (1, 2, 3) | 1,184 | 14.7 | 0.889c | 0.945c | 0.566c | 0.730c | 10.0c |
| South Georgia (1, 7) | 1,858 | 17.6 | 0.819 | 0.879 | 0.365b | 0.808 | 9.8 |
| **Tristan albatross** |  |  |  |  |  |  |  |
| Gough (1, 8, 9) | 1,650 | 100.0 | 0.836 | 0.910 | 0.550 | 0.283 | 10.1 |
| **Antipodean albatross** |  |  |  |  |  |  |  |
| Antipodes Islands (1, 10, 11, 12) | 3,945 | 54.4 | 0.894 | 0.918 | 0.489 | 0.600 | 12.0 |
| Auckland Islands (1, 11, 13, 14) | 5,817 | 45.6 | 0.880 | 0.889 | 0.536 | 0.427 | 12.4 |
| **Amsterdam albatross** |  |  |  |  |  |  |  |
| Amsterdam (1, 15, 16, 17) | 51 | 100.0 | 0.936 | 0.971 | 0.600 | 0.677 | 9.4 |
| **Northern royal albatross** |  |  |  |  |  |  |  |
| Chatham Island (1, 11) | 5,800 | 99.5 | 0.876 | 0.960 | 0.581 | 0.427 | 9.0 |
| **White-capped albatross** |  |  |  |  |  |  |  |
| Auckland Islands (1, 11, 18) | 97,089 | 99.9 | 0.834 | 0.960 | 0.680 | 0.630 | 9.0 |
| Salvin's albatross |  |  |  |  |  |  |  |
| The Snares (1, 11, 19) | 1,195 | 3.7 | 0.837 | 0.967 | 0.859 | 0.467 | 9.0 |
| **Chatham albatross** |  |  |  |  |  |  |  |
| Chatham Island (1, 11, 20) | 5,245 | 100.0 | 0.828 | 0.887 | 0.773 | 0.463 | 8.0 |
| Buller's albatross |  |  |  |  |  |  |  |
| The Snares (1, 21, 22) | 8,704 | 28.6 | 0.910 | 0.950 | 0.800 | 0.727 | 12.0 |
| **Grey-headed albatross** |  |  |  |  |  |  |  |
| Prince Edward Islands (1, 11, 23) | 9,500 | 10.8 | 0.883d | 0.949d | 0.601d | 0.427d | 12.0d |
| South Georgia (1, 7) | 47,674 | 49.8 | 0.912 | 0.952 | 0.368b | 0.365 | 14.2 |
|  |  |  |  |  |  |  |  |
| Cont. |  |  |  |  |  |  |  |
| Population (reference) | Annual pairs | % all sites | Juv/Imm survival | Adult  survival | Br frequency | Br success | Age 1st  br |
| **Black-browed albatross** |  |  |  |  |  |  |  |
| Falkland Islands (1, 7, 24, 25, 26) | 399,416 | 66.6 | 0.862e | 0.942 | 0.787b,f | 0.620 | 7.5 |
| Islas Diego Ramirez (1, 7, 24, 25, 27) | 55,000 | 9.2 | 0.862g | 0.942g | 0.787g | 0.750 | 7.5g |
| Kerguelen (1, 5, 7, 28, 29) | 3,215 | 0.5 | 0.843 | 0.910 | 0.818b,h | 0.763 | 9.7 |
| South Georgia (1, 7) | 74,296 | 12.4 | 0.820 | 0.875 | 0.586b | 0.300 | 12.1 |
| Atlantic yellow-nosed albatross |  |  |  |  |  |  |  |
| Gough (1, 31, 33, 34) | 5,300 | 15.9 | 0.836 | 0.920 | 0.655 | 0.630 | 10.5 |
| **Indian yellow-nosed albatross** |  |  |  |  |  |  |  |
| Amsterdam and St Paul (1, 15, 17, 31, 32) | 22,000 | 65.0 | 0.794 | 0.902 | 0.655i | 0.159 | 9.0 |
| **Sooty albatross** |  |  |  |  |  |  |  |
| Prince Edward Islands (1, 34, 35, 36) | 2,493 | 18.8 | 0.842e | 0.920 | 0.600 | 0.560 | 11.8 |
| Tristan da Cunha (1, 33, 34, 35) | 8,188 | 61.7 | 0.842e | 0.920 | 0.600 | 0.480 | 11.8 |
| Light-mantled albatross |  |  |  |  |  |  |  |
| Prince Edward Islands (1, 11) | 657 | 3.2 | 0.876 | 0.959j | 0.597j | 0.352j | 11.0j |
| Southern giant petrel |  |  |  |  |  |  |  |
| Prince Edward Islands (1, 23, 35, 37, 38) | 2,800 | 4.7 | 0.795k | 0.890l | 0.730 | 0.550 | 8.0 |
| South Georgia (1, 35, 39, 40) | 5,500 | 11.0 | 0.821k | 0.920 | 0.730 | 0.449 | 8.0 |
| Northern giant petrel |  |  |  |  |  |  |  |
| Prince Edward Islands (1, 23, 32, 35, 37, 41) | 750 | 3.9 | 0.795k | 0.890 | 0.730m | 0.680 | 10.0 |
| South Georgia (1, 32, 35, 39, 40) | 4,310 | 36.5 | 0.813k | 0.910 | 0.730m | 0.573 | 10.0 |
| **White-chinned petrel** |  |  |  |  |  |  |  |
| Antipodes Islands (1, 7, 35, 37, 42, 43) | 40,000 | 3.0 | 0.819k | 0.940 | 0.750 | 0.300n | 6.5 |
| Prince Edward Islands (1, 35, 44, 45, 46, 47) | 36,000 | 2.7 | 0.700o | 0.895o | 0.750 | 0.590 | 6.1o |
| South Georgia (1, 7, 35, 43) | 773,150 | 58.8 | 0.820n | 0.875n | 0.750 | 0.444 | 6.0 |
| **Spectacled petrel** |  |  |  |  |  |  |  |
| Tristan da Cunha (1, 34, 35, 48, 49) | 30,000 | 100.0 | 0.840 | 0.970 | 0.790p | 0.600q | 5.0q |
| **Black petrel** |  |  |  |  |  |  |  |
| Great Barrier Island (1, 49, 50, 51, 52) | 2,427 | 94.3 | 0.792 | 0.903 | 0.800 | 0.735 | 6.6 |
| **Westland petrel** |  |  |  |  |  |  |  |
| New Zealand (1, 53) | 4,000 | 100.0 | 0.875r | 0.936 | 0.460 | 0.607 | 7.7s |
| Grey petrel |  |  |  |  |  |  |  |
| Antipodes Islands (1, 35, 52, 55) | 53,000 | NA | 0.819t | 0.940u | 0.810 | 0.735v | 7.0u |
| Prince Edward Islands (1, 35, 52, 55, 56) | 5,000 | NA | 0.819t | 0.940u | 0.810 | 0.735v | 7.0u |
| Gough (1, 35, 52, 55, 56) | 15,000 | NA | 0.819t | 0.940u | 0.810 | 0.735v | 7.0u |

a Average between males: 0.947 and females: 0.942; b Product of return and breeding probabilities; c Replaced from Crozet; d Replaced from grey-headed albatross at New Zealand, e AGE EFFECT - *Thalassarche*; f Breeding probability from Falkland Islands and return probability replaced from South Georgia; g Replaced from Falkland Islands; h Breeding probability from Kerguelen and return probability replaced from South Georgia; i Replaced from Atlantic yellow-nosed albatross at Gough; j Replaced from light-mantled albatross at New Zealand; k AGE EFFECT - *Procellaria* and *Thalassarche*; l Replaced from northern giant petrel at New Zealand; m Replaced from southern giant petrel; n Replaced from black-browed albatross at South Georgia; o Replaced from white-chinned petrel at Crozet; p Average of other *Procellaria* species; q Replaced from white-chinned petrel at Marion; r From fledging to first return; s Age of first return used as proxy for age of first breeding; t AGE EFFECT - *Procellaria*; u Replaced from grey petrel at Crozet; v Replaced from black petrel at New Zealand.

1 ACAP; 2 Delord et al., (2013); 3 Fayet et al., (2015); 4 Barbraud & Weimerskirch, (2012); 5 Pardo, Barbraud, Authier, & Weimerskirch, (2013); 6 Barbraud & Weimerskirch, (2012); 7 Pardo et al., (2017); 8 Davies, Dilley, Bond, Cuthbert, & Ryan, (2015); 9 Wanless et al., (2009); 10 Elliott & Walker, (2017); 11 Abraham, Yvan, & Clements, (2016); 12 Edwards, Robers, Walker, & Elliott, (2017); 13 Elliott, Walker, Parker, & Rexer-Huber, (2016); 14 Francis, Elliott, & Walker, (2015); 15 Heerah et al., (2019); 16 Rivalan, Barbraud, Inchausti, & Weimerskirch, (2010); 17 Jaeger et al., (2018); 18 Francis, (2012); 19 Sagar, (2011); 20 Fraser, Henderson, Robertson, & Scofield, (2011); 21 Sagar, (2014); 22 Francis & Sagar, (2012); 23 Ryan, Jones, Dyer, Upfold, & Crawford, (2009); 24 Catry, Forcada, & Almeida, (2011); 25 Campioni, Granadeiro, & Catry, (2017); 26 Catry unpub. data; 27 Robertson et al., (2014); 28 Nevoux, Weimerskirch, & Barbraud, (2010); 29 Pardo, Jenouvrier, Weimerskirch, & Barbraud, (2017); 30 Rolland, Barbraud, & Weimerskirch, (2009); 31 Cuthbert, Ryan, Cooper, & Hilton, (2003); 32 NZ birds online; 33 Cuthbert, Cooper, & Ryan, (2014)); 34 Ryan pers. comm; 35 Dobson & Jouventin, (2007); 36 Schoombie, Crawford, Makhado, Dyer, & Ryan, (2016), 37 Richard, Abraham, & Berkenbusch, (2017); 38 Ryan et al., (2003); 39 Gianuca et al., (n.d.); 40 Brown, Techow, Wood, & Phillips, (2015), 41 Jones, Risi, Cleeland, & Ryan, (2019), 42 Thompson pers. comm.; 43 Clay et al., (2019), 44 Ryan, Dilley, & Jones, (2012), 45 Rollinson, Dilley, Davies, & Ryan, (2018); 46 Barbraud, Marteau, Ridoux, Delord, & Weimerskirch, (2008); 47 Dilley et al., (2018); 48 Ryan, Dorse, & Hilton, (2006); 49 Francis & Bell, (2010); 50 Bell et al., (2018); 51 Bell, Sim, & Scofield, (2011); 52 Bell, Mischler, MacArthur, Sim, & Scofield, (2016); 53 Waugh et al., (2015); 54 Bell, (2013); 55 Barbraud, Delord, Marteau, & Weimerskirch, (2009); 56 Dilley pers. comm.

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