

Jordaan, R. K., Oosthuizen, W. C., Reisinger, R. R. and de Bruyn, P. J. N. 2020. Abundance, survival and population growth of killer whales *Orcinus orca* at subantarctic Marion Island. – Wildlife Biology 2020: wlb.00732

Appendix 1

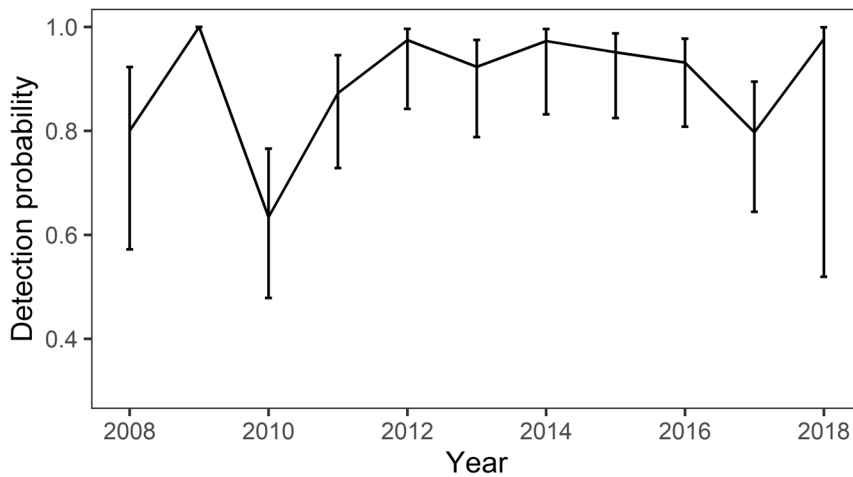


Figure A1. The annual probability of detection of killer whales at Marion Island for the period 2006 to 2018. Error bars depicting lower- and upper confidence limits of the 95% confidence interval are included.

Table A1. Full model selection results for survival (Φ), capture probability (p) and the probability of moving between states (Ψ) obtained from multistate analysis of killer whale sighting histories at Marion Island between 2006-2018. The number of parameters (K), model deviance, ΔQAICc (the difference in QAICc between the model with the lowest QAICc value and the relevant model) and QAICc weight (w_i) (the relative support by the data of a model, in relation to the other models) are presented. ~1 = constant, ~time = time variable and ~state= class variable. Nested models used for ANODEV test are presented in bold.

| Survival | Model | | K | Deviance | ΔQAICc | w_i |
|----------|-----------------------|--|----|----------|----------------------|-------|
| | Detection probability | Probability of moving between age-class states | | | | |
| ~1 | ~time | ~state | 15 | 350.38 | 0.00 | 0.64 |
| ~state | ~time | ~state | 17 | 349.36 | 3.35 | 0.12 |
| ~1 | ~time | ~state + time | 25 | 331.91 | 3.82 | 0.09 |
| ~sex | ~time | ~state | 17 | 350.35 | 4.33 | 0.07 |
| ~1 | ~time | ~1 | 13 | 360.66 | 5.97 | 0.03 |
| ~state | ~time | ~state + time | 27 | 330.85 | 7.37 | 0.02 |
| ~sex | ~time | ~state + time | 27 | 331.88 | 8.40 | 0.01 |
| ~state | ~time | ~1 | 15 | 359.61 | 9.23 | 0.01 |
| ~1 | ~time | ~sex | 15 | 360.40 | 10.02 | 0.00 |
| ~sex | ~time | ~1 | 15 | 360.64 | 10.26 | 0.00 |
| ~1 | ~time | ~time | 23 | 345.38 | 12.74 | 0.00 |
| ~state | ~time | ~sex | 17 | 359.34 | 13.33 | 0.00 |
| ~time | ~time | ~state | 25 | 341.78 | 13.69 | 0.00 |
| ~sex | ~time | ~sex | 17 | 360.37 | 14.35 | 0.00 |
| ~1 | ~covar.photos | ~state | 6 | 384.44 | 15.00 | 0.00 |
| ~state | ~time | ~time | 25 | 344.28 | 16.19 | 0.00 |
| ~sex | ~time | ~time | 25 | 345.35 | 17.26 | 0.00 |
| ~1 | ~covar.photos | ~state + time | 16 | 365.97 | 17.77 | 0.00 |
| ~state | ~covar.photos | ~state | 8 | 383.68 | 18.40 | 0.00 |
| ~time | ~time | ~state + time | 35 | 323.31 | 18.77 | 0.00 |
| ~sex | ~covar.photos | ~state | 8 | 384.41 | 19.13 | 0.00 |
| ~time | ~time | ~1 | 23 | 352.06 | 19.42 | 0.00 |
| ~1 | ~covar.photos | ~1 | 4 | 394.73 | 21.17 | 0.00 |
| ~state | ~covar.photos | ~state + time | 18 | 365.16 | 21.35 | 0.00 |
| ~sex | ~covar.photos | ~state + time | 18 | 365.94 | 22.12 | 0.00 |

| | | | | | | |
|--------|---------------|---------------|----|--------|-------|------|
| ~1 | ~state | ~state | 7 | 389.67 | 22.31 | 0.00 |
| ~1 | ~covar.hours | ~state | 6 | 392.09 | 22.64 | 0.00 |
| ~1 | ~covar.obs | ~state | 6 | 392.44 | 23.00 | 0.00 |
| ~1 | ~1 | ~state | 5 | 394.91 | 23.41 | 0.00 |
| ~time | ~time | ~sex | 25 | 351.80 | 23.71 | 0.00 |
| ~1 | ~sex | ~state | 7 | 391.55 | 24.18 | 0.00 |
| ~1 | ~state | ~state + time | 17 | 370.47 | 24.46 | 0.00 |
| ~state | ~covar.photos | ~1 | 6 | 393.93 | 24.49 | 0.00 |
| ~1 | ~covar.photos | ~sex | 6 | 394.46 | 25.02 | 0.00 |
| ~state | ~state | ~state | 9 | 388.31 | 25.13 | 0.00 |
| ~state | ~covar.hours | ~state | 8 | 390.52 | 25.24 | 0.00 |
| ~sex | ~covar.photos | ~1 | 6 | 394.70 | 25.26 | 0.00 |
| ~1 | ~covar.hours | ~state + time | 16 | 373.62 | 25.42 | 0.00 |
| ~state | ~covar.obs | ~state | 8 | 390.86 | 25.58 | 0.00 |
| ~1 | ~covar.obs | ~state + time | 16 | 373.97 | 25.77 | 0.00 |
| ~state | ~1 | ~state | 7 | 393.35 | 25.98 | 0.00 |
| ~1 | ~1 | ~state + time | 15 | 376.44 | 26.07 | 0.00 |
| ~sex | ~state | ~state | 9 | 389.56 | 26.37 | 0.00 |
| ~state | ~sex | ~state | 9 | 389.88 | 26.69 | 0.00 |
| ~sex | ~covar.hours | ~state | 8 | 392.03 | 26.75 | 0.00 |
| ~1 | ~covar.photos | ~time | 14 | 379.44 | 26.90 | 0.00 |
| ~1 | ~sex | ~state + time | 17 | 373.08 | 27.07 | 0.00 |
| ~sex | ~covar.obs | ~state | 8 | 392.38 | 27.10 | 0.00 |
| ~time | ~covar.photos | ~state | 16 | 375.38 | 27.18 | 0.00 |
| ~state | ~state | ~state + time | 19 | 368.87 | 27.26 | 0.00 |
| ~time | ~time | ~time | 33 | 336.78 | 27.42 | 0.00 |
| ~sex | ~1 | ~state | 7 | 394.86 | 27.49 | 0.00 |
| ~state | ~covar.hours | ~state + time | 18 | 372.01 | 28.19 | 0.00 |
| ~sex | ~sex | ~state | 9 | 391.43 | 28.25 | 0.00 |
| ~state | ~covar.photos | ~sex | 8 | 393.66 | 28.38 | 0.00 |
| ~state | ~covar.obs | ~state + time | 18 | 372.35 | 28.53 | 0.00 |
| ~sex | ~state | ~state + time | 19 | 370.31 | 28.70 | 0.00 |
| ~1 | ~covar.hours | ~1 | 4 | 402.37 | 28.82 | 0.00 |
| ~state | ~1 | ~state + time | 17 | 374.84 | 28.82 | 0.00 |
| ~sex | ~covar.photos | ~sex | 8 | 394.43 | 29.15 | 0.00 |

| | | | | | | |
|--------|---------------|---------------|----|--------|-------|------|
| ~1 | ~covar.obs | ~1 | 4 | 402.72 | 29.17 | 0.00 |
| ~1 | ~1 | ~1 | 3 | 405.20 | 29.60 | 0.00 |
| ~sex | ~covar.hours | ~state + time | 18 | 373.56 | 29.75 | 0.00 |
| ~state | ~sex | ~state + time | 19 | 371.36 | 29.76 | 0.00 |
| ~sex | ~covar.obs | ~state + time | 18 | 373.91 | 30.10 | 0.00 |
| ~1 | ~sex | ~1 | 5 | 401.84 | 30.33 | 0.00 |
| ~sex | ~1 | ~state + time | 17 | 376.39 | 30.37 | 0.00 |
| ~state | ~covar.photos | ~time | 16 | 378.60 | 30.39 | 0.00 |
| ~time | ~covar.photos | ~state + time | 26 | 356.91 | 31.12 | 0.00 |
| ~1 | ~state | ~1 | 5 | 402.69 | 31.19 | 0.00 |
| ~sex | ~covar.photos | ~time | 16 | 379.41 | 31.21 | 0.00 |
| ~state | ~covar.hours | ~1 | 6 | 400.77 | 31.33 | 0.00 |
| ~sex | ~sex | ~state + time | 19 | 372.97 | 31.36 | 0.00 |
| ~state | ~covar.obs | ~1 | 6 | 401.11 | 31.67 | 0.00 |
| ~state | ~1 | ~1 | 5 | 403.60 | 32.10 | 0.00 |
| ~1 | ~covar.hours | ~sex | 6 | 402.11 | 32.66 | 0.00 |
| ~state | ~sex | ~1 | 7 | 400.13 | 32.76 | 0.00 |
| ~sex | ~covar.hours | ~1 | 6 | 402.32 | 32.88 | 0.00 |
| ~1 | ~covar.obs | ~sex | 6 | 402.46 | 33.02 | 0.00 |
| ~time | ~covar.photos | ~1 | 14 | 385.65 | 33.11 | 0.00 |
| ~sex | ~covar.obs | ~1 | 6 | 402.67 | 33.23 | 0.00 |
| ~state | ~state | ~1 | 7 | 400.79 | 33.42 | 0.00 |
| ~1 | ~1 | ~sex | 5 | 404.93 | 33.43 | 0.00 |
| ~sex | ~1 | ~1 | 5 | 405.14 | 33.64 | 0.00 |
| ~time | ~state | ~state | 17 | 379.89 | 33.88 | 0.00 |
| ~1 | ~sex | ~sex | 7 | 401.57 | 34.20 | 0.00 |
| ~sex | ~sex | ~1 | 7 | 401.72 | 34.36 | 0.00 |
| ~1 | ~covar.hours | ~time | 14 | 387.09 | 34.55 | 0.00 |
| ~1 | ~covar.obs | ~time | 14 | 387.44 | 34.90 | 0.00 |
| ~time | ~covar.hours | ~state | 16 | 383.11 | 34.91 | 0.00 |
| ~1 | ~state | ~sex | 7 | 402.40 | 35.03 | 0.00 |
| ~1 | ~state | ~time | 15 | 385.47 | 35.10 | 0.00 |
| ~time | ~covar.obs | ~state | 16 | 383.35 | 35.15 | 0.00 |
| ~state | ~covar.hours | ~sex | 8 | 400.50 | 35.22 | 0.00 |
| ~1 | ~1 | ~time | 13 | 389.91 | 35.22 | 0.00 |

| | | | | | | |
|--------|---------------|---------------|----|--------|-------|------|
| ~sex | ~state | ~1 | 7 | 402.60 | 35.23 | 0.00 |
| ~time | ~1 | ~state | 15 | 385.83 | 35.45 | 0.00 |
| ~state | ~covar.obs | ~sex | 8 | 400.84 | 35.56 | 0.00 |
| ~time | ~sex | ~state | 17 | 381.72 | 35.71 | 0.00 |
| ~state | ~1 | ~sex | 7 | 403.33 | 35.97 | 0.00 |
| ~1 | ~sex | ~time | 15 | 386.55 | 36.18 | 0.00 |
| ~state | ~sex | ~sex | 9 | 399.86 | 36.67 | 0.00 |
| ~sex | ~covar.hours | ~sex | 8 | 402.05 | 36.77 | 0.00 |
| ~time | ~state | ~state + time | 27 | 360.27 | 36.78 | 0.00 |
| ~sex | ~covar.obs | ~sex | 8 | 402.40 | 37.12 | 0.00 |
| ~time | ~covar.photos | ~sex | 16 | 385.39 | 37.18 | 0.00 |
| ~state | ~covar.hours | ~time | 16 | 385.44 | 37.24 | 0.00 |
| ~state | ~state | ~sex | 9 | 400.50 | 37.31 | 0.00 |
| ~state | ~state | ~time | 17 | 383.50 | 37.48 | 0.00 |
| ~sex | ~1 | ~sex | 7 | 404.88 | 37.51 | 0.00 |
| ~state | ~covar.obs | ~time | 16 | 385.79 | 37.58 | 0.00 |
| ~state | ~1 | ~time | 15 | 388.27 | 37.90 | 0.00 |
| ~sex | ~sex | ~sex | 9 | 401.45 | 38.27 | 0.00 |
| ~state | ~sex | ~time | 17 | 384.80 | 38.78 | 0.00 |
| ~sex | ~covar.hours | ~time | 16 | 387.04 | 38.83 | 0.00 |
| ~time | ~covar.hours | ~state + time | 26 | 364.65 | 38.85 | 0.00 |
| ~time | ~covar.obs | ~state + time | 26 | 364.88 | 39.09 | 0.00 |
| ~sex | ~state | ~sex | 9 | 402.31 | 39.12 | 0.00 |
| ~sex | ~covar.obs | ~time | 16 | 387.38 | 39.18 | 0.00 |
| ~time | ~1 | ~state + time | 25 | 367.36 | 39.27 | 0.00 |
| ~sex | ~state | ~time | 17 | 385.38 | 39.37 | 0.00 |
| ~sex | ~1 | ~time | 15 | 389.86 | 39.48 | 0.00 |
| ~time | ~sex | ~state + time | 27 | 363.26 | 39.77 | 0.00 |
| ~time | ~covar.photos | ~time | 24 | 370.37 | 40.00 | 0.00 |
| ~sex | ~sex | ~time | 17 | 386.44 | 40.42 | 0.00 |
| ~time | ~covar.hours | ~1 | 14 | 393.40 | 40.86 | 0.00 |
| ~time | ~covar.obs | ~1 | 14 | 393.64 | 41.10 | 0.00 |
| ~time | ~1 | ~1 | 13 | 396.12 | 41.42 | 0.00 |
| ~time | ~sex | ~1 | 15 | 392.01 | 41.64 | 0.00 |
| ~time | ~state | ~1 | 15 | 394.26 | 43.88 | 0.00 |

| | | | | | | |
|-------|--------------|-------|----|--------|-------|------|
| ~time | ~covar.hours | ~sex | 16 | 393.13 | 44.93 | 0.00 |
| ~time | ~covar.obs | ~sex | 16 | 393.37 | 45.17 | 0.00 |
| ~time | ~sex | ~sex | 17 | 391.74 | 45.73 | 0.00 |
| ~time | ~state | ~sex | 17 | 392.58 | 46.56 | 0.00 |
| ~time | ~state | ~time | 25 | 375.55 | 47.46 | 0.00 |
| ~time | ~covar.hours | ~time | 24 | 378.12 | 47.75 | 0.00 |
| ~time | ~covar.obs | ~time | 24 | 378.36 | 47.98 | 0.00 |
| ~time | ~1 | ~time | 23 | 380.83 | 48.19 | 0.00 |
| ~time | ~sex | ~time | 25 | 376.73 | 48.64 | 0.00 |
| ~time | ~1 | ~sex | 15 | 401.71 | 51.34 | 0.00 |

Table A2. Full model selection results list for POPAN analysis of survival (Φ), capture probability (p), probability of entry ($pent$) and population size (n) of killer whales at Marion Island between 2006-2018. The number of parameters (K), model deviance, $\Delta QAICc$ (the difference in QAICc between the model with the lowest QAICc value and the relevant model) and QAICc weight (w_i) (the relative support by the data of a model, in relation to the other models) are presented. ~1 = constant, ~time = time variable and ~state= class variable.

| Survival | Model | | | K | $\Delta QAICc$ | w_i |
|----------|-----------------------|----------------------|----------|----|----------------|-------|
| | Detection probability | Probability of entry | Survival | | | |
| ~1 | ~time | ~1 | ~1 | 15 | 0.00 | 0.99 |
| ~time | ~time | ~1 | ~1 | 25 | 9.13 | 0.01 |
| ~1 | ~time | ~time | ~1 | 25 | 23.59 | 0.00 |
| ~time | ~time | ~time | ~1 | 35 | 28.72 | 0.00 |
| ~1 | ~1 | ~time | ~1 | 14 | 36.15 | 0.00 |
| ~time | ~1 | ~time | ~1 | 24 | 45.42 | 0.00 |
| ~1 | ~1 | ~1 | ~1 | 4 | 53.51 | 0.00 |
| ~time | ~1 | ~1 | ~1 | 14 | 61.83 | 0.00 |