Seasonality and temporal trends in counts of seabirds from pelagic tours off Kaikoura, New Zealand

Report prepared for Encounter Foundation, Kaikoura

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EXECUTIVE SUMMARY

Seabird populations frequently breed at remote locations, making it difficult to assess and monitor their populations. While the remoteness of seabird colonies may prevent regular ground counts of breeding pairs, consistently collected at-sea abundance data presents an alternative way of obtaining information on trends in seabird populations. Regular pelagic seabird trips carried out by ecotourism operators provide an opportunity to collect these at-sea data on seabird abundance.

In Kaikoura, New Zealand, the ecotourism operator Albatross Encounter conducts daily at-sea excursions for tourists. Albatross Encounter staff have systematically recorded seabirds encountered on each trip for over a decade. From their data collected over seven years between 2006 and 2012 off the coast of Kaikoura (2987 tours), we analysed the seasonality and temporal trend in the count data for each of 32 seabird species that were recorded on at least 10% of occasions. The pattern of seasonality was clear and consistent for all species, except for great albatrosses and coastal species. There was a significant decline in counts over time for five species, including little shag, wandering albatross, white-fronted tern, black-browed albatross, and Westland petrel. At the same time, there was an increase in counts of four species, including Buller's shearwater, northern and southern royal albatrosses, and northern giant petrel. There was an overall mean of 16.7 species recorded per trip. The mean number of species recorded per trip declined over the study period, however, with one fewer species in 2012 than in 2006.

The observed changes in counts of seabirds may reflect either a real trend in population sizes, or a gradual change in at-sea distributions. As the count data were recorded at a single location, it was not possible to distinguish these causes. Conducting similar counts in other regions would allow a better understanding of the observed trends. Nevertheless, the present study highlights the value of seabird count data collected during seabird-watching trips, as they provide a unique opportunity to assess the temporal variation in the number of seabirds at sea.

1. INTRODUCTION

The use of "citizen science", which involves the collection of research information by non-professionals without significant scientific training (e.g., Jordan et al. 2012), is widespread in biodiversity monitoring (Dickinson et al. 2010). Most commonly, monitoring of this kind focuses on species presence and abundance, sometimes over significant geographic areas and periods of time. For example, uses of citizen science have included species groups such as anurans (Solla et al. 2005), terrestrial and aquatic birds (Hoyer et al. 2001, Bonney et al. 2009), terrestrial and aquatic mammals (Black 2009, Belt & Krausman 2012), and reef fish (Pattengill-Semmens & Semmens 2003). In New Zealand, one of the longest operating citizen science project is the beach patrol scheme, coordinated by Birds New Zealand, which has been recording dead birds on New Zealand beaches since 1951 (e.g., Scofield & Christie 2002). While many citizen science-based projects rely on the contributions of volunteers resident in an area, ecotourism operators may also be well-placed to provide valuable information from less accessible locations. For example, ecotourism operations have enabled the collection of significant bodies of information on marine species, such as data identifying declines in a regional population of whale shark (Theberge & Dearden 2006).

For seabirds, particularly Procellariiformes, obtaining population status and trend estimates is time-consuming and necessitates intensive effort over time to generate quality data (e.g., Ryan 2005). Challenges amongst this group include the remoteness of breeding locations (e.g., subantarctic islands), many species that nest in burrows, intermittent returns to breeding sites (e.g., once every two years at most for biennial breeders), long periods of absence from nests on foraging trips, and considerable ocean ranges outside the breeding season (e.g., circumpolar distributions).

To find alternatives to land-based estimates of seabird abundance, scientists have developed methods to derive abundance estimates from at-sea counts. For some species (e.g., wandering albatross *Diomedea exulans* and giant petrel *Macronectes* spp.), this approach has been considered effective (e.g., Clarke et al. 2003), and allowed the detection of longer-term trends (e.g., Peron et al. 2010). Nevertheless, the effort involved in these data collections means that they are often opportunistic in nature, so that the frequency and intensity of at-sea counts are typically limited in space and time. In coastal areas where seabird watching is common, these limitations may be overcome by ecotourism operators, who conduct regular at-sea bird-watching trips and collect information on seabirds encountered during these trips. Tour operators often promulgate lists of seabird sightings over time (e.g., http://www.sossa-international.org, http://www.albatrossencounter.co.nz/albatross/sightings/), and may also include counts of the various species encountered.

In New Zealand's South Island, Albatross Encounter has undertaken seabird-watching trips in the vicinity of the town of Kaikoura since 1998. Records of seabird species seen and their abundances during trips have been collected since 2003, sometimes from multiple trips per day.

Using this citizen-science based dataset, we aimed to:

- investigate any detectable trends in seabird abundance, species richness, and diversity, within and between years;
- compare any trends in species abundance emerging from this dataset with other datasets (e.g., collected at breeding sites);
- test for relationships between observed seabird abundances and selected environmental variables of demonstrated importance in other areas, and;
- develop recommendations for improvements to the data collection methodology used during seabird-watching trips.

2. METHODS

2.1 Study location and data collection

Seabird tours were conducted by Albatross Encounter from Kaikoura, New Zealand (42.4167°S, 173.6833°E). This area is known for its particularly high marine biodiversity, including areas close to shore, due to the existence of ocean upwelling and the productive Kaikoura canyon (Leo et al. 2010).

Dependent on tourist demand, trips were conducted up to four times each day, generally leaving at 06:00, 09:00, 13:00, and 16:00 New Zealand Standard Time (daylight-savings adjusted in season). Vessels used during the data collection were 9.7 m in length, and powered by jet engines. Trips involved up to 14 passengers with highly variable seabird knowledge, ranging from minimal to expert, and a skipper experienced in seabird identification.

Tour vessels leave port at South Bay near Kaikoura, and stop at different locations approximately 10 kilometres from shore to make seabird observations. Tours are approximately three hours in maximum duration, depending on weather conditions, the seabird sightings made, and the interest level of the group. Seabirds are attracted to the tour vessel using a ball of frozen fish waste, which thaws gradually, so that seabirds can only feed on small quantities at a time. Skippers complete a sightings form on each trip, recording the number and identification of species seen by different tour members, including themselves.

2.2 Data processing

In this report, species names follow the taxonomy adopted in the checklist of the Ornithological Society of New Zealand Checklist Committee (Ornithological Society of New Zealand checklist committee 2010). Counts of seabirds by species for each tour were available from 30 July 2003 to 31 December 2012 (summarised in Table 1). These data, provided in spreadsheet format, were first groomed to confirm the accuracy of data entry e.g., aligning counts with species names. Subspecies of Cape petrel were merged by summing their counts for each tour as they are difficult to distinguish at sea. Similarly, northern and southern Buller's albatross were combined and treated as a single species.

Data preparation also involved the omission of count data prior to January 2006, as these counts tended to be significantly higher than those in the subsequent period. This pattern did not seem related to actual seabird abundance, although the reason of such change is unclear, as the skippers' behaviour, the way of attracting birds, and the visited locations are thought to have been consistent since 2003 (D. Buurman, pers. comm.).

Sightings were recorded on a form with a pre-defined list of species. However, rare species were not represented in this list, and their sightings were recorded as additional comments. These comments were missing for some years, suggesting that this information was not recorded systematically. These sightings were therefore removed from the dataset, as trends in counts cannot be obtained without consistent records over years. These sightings were of 34 species, including reef heron (78 birds recorded since January 2006), Caspian tern (31), variable oystercatcher (18), white-faced storm petrel (15), welcome swallow (14), yellow-eyed penguin (14), king shag (11), ruddy turnstone (11), Cook's petrel (10), Wilson's storm petrel (9), white-faced heron (8), grey-backed storm petrel (7), subantarctic skua (5), black swan (4), royal spoonbill (3), black petrel (2), Indian Ocean yellow-nosed albatross (2), and Subantarctic skua (2), with a single sighting of bar-tailed godwit, black-winged petrel, broad-billed prion, Chatham Island albatross, great shearwater, grey-headed albatross, grey teal, Long-tailed skua, mottled petrel, New Zealand kingfisher, pink-footed shearwater, pomarine skua, south polar skua, spur-winged plover, white-bellied storm petrel and white-flippered blue penguin.

The final dataset for the present analyses included counts made on 2987 trips between 1 January 2006 and 31 December 2012, encompassing 1774 days.

Seabird count data were analysed using Generalized Linear Models (GLMs), including environmental variables that may influence seabird abundance. The environmental variables used related to climate and oceanographic conditions, and included the monthly Southern Oscillation Index anomaly, sea surface temperature anomaly, wind speed, air pressure, and air temperature. Data for the monthly Southern Oscillation Index anomaly, calculated from the departure from the monthly averages of the 1981–2010 period, was obtained from the Climate Prediction Center of the National Weather Service (available at http://www.cpc.ncep.noaa.gov/data/indices/soi). Sea surface temperature anomaly data were obtained from the National Oceanic and Atmospheric Administration CoastWatch Program (http://coastwatch.pfeg.noaa.gov), averaged over an area of 100 km centred on Kaikoura. Three-hourly values of wind speed, air pressure, and air temperature were obtained from the automatic weather station located in Kaikoura using New Zealand's National Climate Database (http://cliflo.niwa.co.nz). The respective anomalies of the latter variables were calculated as their deviation from the monthly averages since 1992.

Table 1: Summary of seabird species regularly identified and counted during pelagic trips by ecotourism operator Albatross Encounter off the coast of Kaikoura between January 2006 and December 2012. Data include the number (No. counts) and percentage (Perc.) of trips of a total 2987 trips during which each seabird species was counted. Also included are the mean and maximum number of individuals counted during trips. Asterisks indicate species endemic to New Zealand. Other species were recorded infrequently but are not included here (see text for these species).

Species	Scientific name	No. counts	Perc.	Mean	Max
Gibson's albatross*	*Diomedea antipodensis gibsoni*	2937	98.3	8.95	46
Northern giant petrel	*Macronectes halli*	2909	97.4	10.23	72
Cape petrel	*Daption capense capense*	2876	96.3	53.34	400
Southern black-backed gull	*Larus dominicanus dominicanus*	2844	95.2	28.74	950
Red-billed gull*	*Larus novaehollandiae*	2818	94.3	127.03	10000
NZ white-capped albatross*	*Thalassarche cauta steadi*	2756	92.3	4.80	360
White-fronted tern	*Sterna striata*	2576	86.2	19.44	1600
Salvin's albatross*	*Thalassarche salvini*	2575	86.2	6.95	300
Westland petrel*	*Procellaria westlandica*	2574	86.2	8.98	200
Hutton's shearwater*	*Puffinus huttoni*	2348	78.6	423.91	50000
White-chinned petrel	*Procellaria aequinoctialis*	1830	61.3	3.41	70
Southern royal albatross*	*Diomedea epomophora*	1738	58.2	1.16	25
Pied shag	*Phalacrocorax varius varius*	1591	53.3	2.61	150
Spotted shag*	*Phalacrocorax punctatus*	1502	50.3	76.88	3000
Buller's shearwater*	*Puffinus bulleri*	1456	48.7	3.61	400
Northern royal albatross*	*Diomedea sanfordi*	1450	48.5	0.89	15
Black-browed albatross	*Thalassarche melanophris*	1379	46.2	1.78	70
Sooty shearwater	*Puffinus griseus*	1288	43.1	5.46	10000
Antipodean albatross*	*Diomedea antipodensis antipodensis*	1119	37.5	0.55	23
Little shag*	*Phalacrocorax melanoleucos*	1089	36.5	0.91	16
Black-fronted tern*	*Chlidonias albostriatus*	946	31.7	1.21	51
Australasian gannet	*Morus serrator*	945	31.6	0.63	12
Buller's albatross*	*Thalassarche bulleri* spp	917	30.7	1.03	45
Southern giant petrel	*Macronectes giganteus*	796	26.6	0.48	26
Black-billed gull*	*Larus bulleri*	697	23.3	1.40	120
Flesh-footed shearwater	*Puffinus carneipes*	658	22.0	0.51	20
Little penguin	*Eudyptula minor*	595	19.9	0.40	16
Arctic skua	*Stercorarius parasiticus*	401	13.4	0.21	15
Short-tailed shearwater	*Puffinus tenuirostris*	399	13.4	0.34	30
Fairy prion	*Pachyptila turtur*	389	13.0	7.45	2000
Grey-faced petrel*	*Pterodroma macroptera gouldi*	370	12.4	0.51	200
Wandering albatross	*Diomedea exulans*	326	10.9	0.17	17
Campbell albatross*	*Thalassarche impavida*	242	8.1	0.11	25
Unknown	-	189	6.3	0.20	220
Common diving petrel	*Pelecanoides urinatrix*	188	6.3	0.33	120
Fluttering shearwater*	*Puffinus gavia*	180	6.0	0.97	1000
Antarctic fulmar	*Fulmarus glacialoides*	80	2.7	0.03	3
Black shag	*Phalacrocorax carbo*	21	0.7	0.01	6
Grey petrel	*Procellaria cinerea*	10	0.3	0.01	4

2.3 Statistical modelling

Seabird count data were analysed using GLMs to detect potential interannual trends and to determined seasonality in bird abundance. Data were analysed separately for each of the species recorded on over 10% of trips, resulting in the inclusion of 32 species in the analysis. For modelling purposes, years were defined for each bird species as the 12-month period centred around the month of highest mean abundance. Counts were highly variable among trips, with occasional large counts, including species that were on average encountered at low densities. Because of this overdispersion, the counts were assumed to follow a negative-binomial distribution, which is more suitable than a Poisson distribution for overdispersed data (Gardner et al. 1995).

Two models were fitted for each species: a base model with only time-related variables, and a more complex model (hereafter referred to as the "full model") that included all environmental variables. Seasonality in bird distributions and in environmental factors are often confounded, and the full model was used to assess the robustness of seasonality and inter-annual trend determined in the time-only base model.

The base model included the number of days since the first day (t) in the dataset (1 January 2006) to analyse the trend over time; the day of year (d) using a Fourier series of order 3, e.g., $\sum_{i=1}^{3}\left(a_i \cos(2\pi i \frac{d}{366}) + b_i \sin(2\pi i \frac{d}{366})\right)$, to analyse seasonality (with the coefficients a_i and b_i being estimated by the GLM); and time of day (a factor indicating whether the sighting was before or after 12:00) to analyse variation in bird abundance within a day. A fixed year effect was also included to investigate changes in bird abundance between years, but only for the period between the first and last years, to avoid a confounding effect with trend over time.

The full model was the same as the base model, but included the environmental variables monthly Southern Oscillation Index anomaly, monthly sea surface temperature anomaly; and three-hourly wind speed, air temperature, and air pressure anomalies. These environmental variables were standardised by their means and standard deviations.

Preliminary analyses showed that years with particularly high or low bird counts could greatly influence the estimation of trend over time due to the low number of years overall. To minimise this influence and obtain a robust estimate of the trend over time, the models were each run multiple times, successively excluding each year from the dataset. Model coefficients and count predictions were then obtained for each model by merging the posterior distributions of model estimates for each year removed.

Models were fitted for each species using Integrated Nested Laplace Approximations (INLA; Rue et al. 2009), using the INLA library (http://www.r-inla.org) in statistical package R (R Development Core Team 2008). This method was chosen after some preliminary analyses showed that model fitting under this approach was considerably faster than Markov Chain Monte-Carlo (MCMC) methods, and provided similar results.

Additionally, to assess a potential change in the number of species recorded across years, the number of species recorded per trip over time was analysed using a statistical model similar to the base model, but only including as covariates the day since start (1 January 2006) and seasonality (as described previously). The number of species recorded per trip was assumed to follow a Poisson distribution as these data were not overdispersed. Diversity was also calculated using Shannon's index H, which increases with the number of species but also with the evenness of counts across species. It is calculated using the formula $H = -\sum_{i=1}^{N} p_i \ln(p_i)$, with p_i being the proportion of species i among all N species.

3. RESULTS

3.1 Data summary - observations

The final dataset included counts of seabirds made on 2987 pelagic trips between 1 January 2006 and 31 December 2012, encompassing 1774 days. The number of trips each year varied between 346 in 2012, and 507 in 2007 (Table 2). There was a maximum of four trips a day, with most trips departing at 09:00, and this pattern was consistent across years.

A total of 73 seabird species (and subspecies) was identified during these trips, including 39 species for which records were consistent over years (Table 1). In addition, on 6.3% of trips, unidentified birds were observed. Six species were observed on over 90% of the trips: Gibson's albatross, northern giant petrel, Cape petrel, southern black-backed gull, red-billed gull, and New Zealand white-capped albatross.

Among the 32 species that were observed on at least 10% of the trips, there were five great albatrosses, four lesser albatrosses, five shearwaters, seven

Table 2: Number of pelagic trips by ecotourism operator Albatross Encounter off Kaikoura, New Zealand, by year and time of day, between 1 January 2006 and 31 December 2012.

Time	2006	2007	2008	2009	2010	2011	2012	Total
06:00	83	83	78	58	69	58	44	473
07:00	3	0	0	0	0	0	0	3
08:30	1	0	0	0	0	0	0	1
09:00	185	210	200	180	206	169	173	1323
10:00	14	0	0	0	0	0	0	14
11:00	0	0	0	0	0	1	0	1
13:00	160	201	183	160	152	139	122	1117
13:30	0	0	0	0	0	0	1	1
14:00	11	0	0	0	0	0	0	11
14:30	1	0	0	0	0	0	0	1
16:00	3	13	3	2	2	11	3	37
16:30	0	0	0	0	0	1	2	3
17:00	0	0	0	0	0	1	1	2
Total	461	507	464	400	429	380	346	2987

petrels, three shags, one penguin, three gulls, two terns, one gannet, and one skua (Table 1). Nineteen of these species are endemic to New Zealand.

Between 5 and 31 different species were observed during any one trip, with a mean of 16.7 and a median of 17 species. Over time, there was a significant decline in the mean number of species observed per trip, with an average of one fewer species in 2012 than in 2006 (Figure 1). This decline was not related to a single species, but to multiple species being more rare in observations at the end of the study period. Throughout the year, the mean number of species observed per trip was highest in March, at 18.6 species, and lowest in August, at 14.5 species (Figure 2). When diversity was measured using Shannon's index, seabird diversity was highest during the period from December to March, and lowest in September and October. The drop in diversity during September and October was due to a large number of Hutton's shearwater off Kaikoura, which dominated the seabird counts during this period.

Within the year, the pattern of dominance varied slightly (Figure 3). Red-billed gull, Cape petrel, and southern black-backed gull were the most abundant species from January to August, whereas Hutton's shearwater dominated seabird counts between September and December. The mean number of birds recorded on a trip was 805 individuals, with a median of 336 individuals. The lowest number of birds recorded between 2006 and 2012 was 14 individuals on 18 July 2009, and the maximum was 50 295 individuals on 1 October 2012, due to the presence of 50 000 Hutton's shearwater during that trip.

Figure 1: Diversity of seabird species off Kaikoura, New Zealand, observed during pelagic trips by ecotourism operator Albatross Encounter between 2006 and 2012. (a) Monthly averages of the number of species detected per trip, including observed (blue) and modelled (red) data, and modelled trend (mean and 95% confidence interval; green). (b) Monthly averages of the Shannon's index of species observed per trip (mean and 95% confidence interval obtained from 5000 bootstraps).

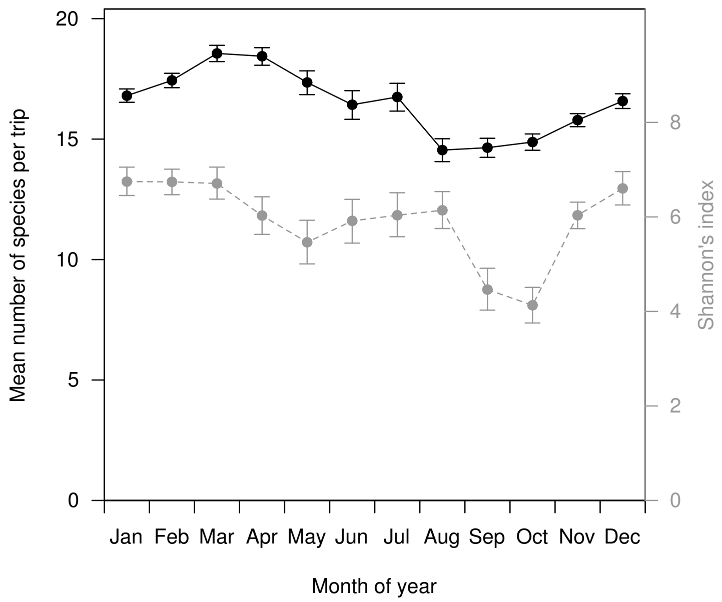


Figure 2: Within - year variation in the diversity of seabird species off Kaikoura, New Zealand, observed during pelagic trips by ecotourism operator Albatross Encounter between 2006 and 2012. Diversity is presented as the mean number of species observed (black, solid line) and as Shannon's index (grey, dashed line) per trip (error bars represent the 95% confidence interval of the mean, obtained from 5000 bootstraps).

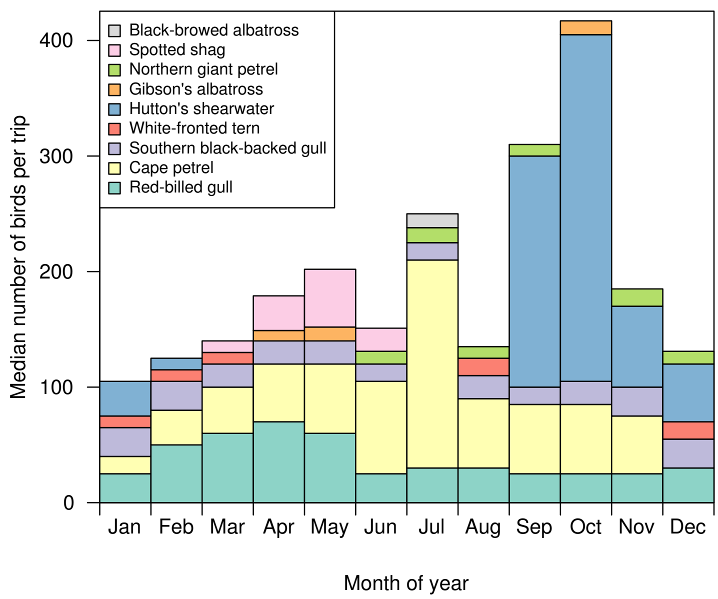


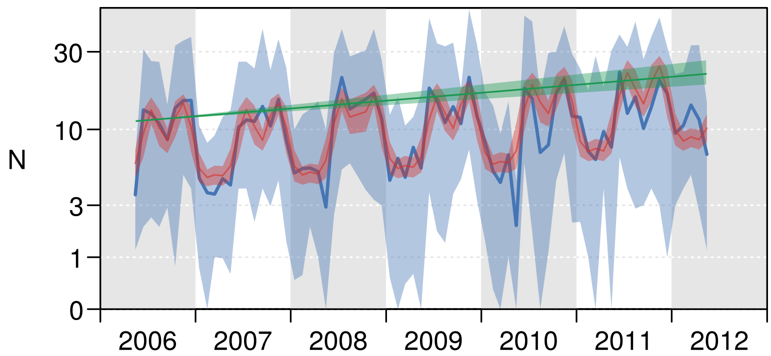
Figure 3: Within year variation in the most abundant of seabird species off Kaikoura, New Zealand, observed during pelagic trips by ecotourism operator Albatross Encounter between 2006 and 2012. Bars indicate the median number of the five most abundant species observed per trip for each month of the year.

3.2 Model results

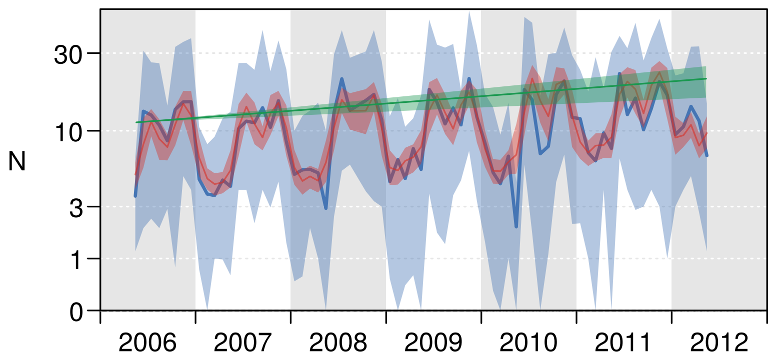
For all species, the base model, which only included a trend over time, a seasonal effect, a random inter-annual variability, and a difference between morning and afternoon, was sufficient to explain most of the variation over time in the number of birds observed during each trip. The fit of the base model to the observed data was similar to that of the full model, as evident in the differences in monthly averages between the observed number of birds per trip and model predictions, which were similar for both models (see Appendix A, Table A-1). For most species, adding environmental variables did not improve the fit of the model to the data (e.g., see a model comparison for northern giant petrel in Figure 4). Despite the large variability in the number of birds observed across trips, the base model effectively described the trend over time and the pattern of seasonality for each species (see Appendix A, Figure A-1).

Figure 4: Number of northern giant petrel off Kaikoura, New Zealand, observed during pelagic trips by ecotourism operator Albatross Encounter between 2006 and 2012. Monthly averages (mean; solid line) and 95% confidence intervals (shading) of observed numbers (in blue) and model outputs (in red) from (a) a base model that only included time-related variables, and (b) a full model that also included environmental variables. Also presented is the linear trend over time (green). (Outputs from the two models were also similar for most other species in the dataset.)

(a) Base model



(b) Full model



3.2.1 Seasonality

The majority of species showed some degree of seasonality (see Appendix A, Figure A-1), and most of these seasonal species were most abundant during late austral spring and summer, i.e., between November and March. Four species were most abundant in winter—black-browed albatross, Buller's albatross, Cape petrel, and fairy prion. The largest intra-annual variation in abundance was in Hutton's shearwater, with a predicted mean varying from 13 birds per trip in July to 3300 in October. Three of the nine coastal species included in this analysis did not show seasonal variation in numbers, including pied shag, southern black-backed gull and white-fronted tern. The degree of seasonality was also relatively small for large albatross species (Antipodean and Gibson's albatrosses). In contrast, other species were not detected on trips during part of the year, including Arctic skua, black-fronted tern, Buller's albatross, Buller's shearwater, fairy prion, flesh-footed shearwater, grey-faced petrel, short-tailed shearwater, sooty shearwater, and white-chinned petrel.

The variation in abundance around a seasonal peak was not symmetrical for some species, such as Arctic skua, fairy prion, Hutton's shearwater, little penguin, little shag, New Zealand white-capped albatross, southern giant petrel, and Westland petrel. Instead, their abundances showed a sharp increase, followed by a more gradual decrease. The opposite pattern was evident for Australasian gannet, Buller's albatross, Buller's shearwater, spotted shag, and white-chinned petrel. For Gibson's albatross, northern giant petrel, sooty shearwater, and short-tailed shearwater, the intra-annual variation in abundance was bimodal.

3.2.2 Interannual trends

The overall trend in the number of individuals recorded for each species between 2006 and 2012 was assessed in the models using the annual trends calculated from the coefficients associated with the number of days since 1 January 2006 (Table 3). Ten of the 32 species included in this assessment showed negative trends in the number of individuals recorded per year; for five of these species, the decrease was significant under both models. They included (from the largest to the smallest decrease) little shag, wandering albatross, white-fronted tern, black-browed albatross, and Westland petrel. Depending on the model, decreases occurred at average rates of -30.9% (little shag; full model) to -9.1% (Westland petrel; full model) per year. There were another five species that showed a decrease in abundance, and this decrease was significant under either model. Under the base model, abundances of fairy prion, southern giant petrel and Cape petrel decreased significantly, while the negative trend in abundance for Australasian gannet and Antipodean albatross was significant under the full model (Table 3). For wandering and Antipodean albatrosses, mean abundances were very low throughout the dataset, at less than one bird per trip.

There were eight species that showed positive annual trends in the number of individuals recorded per year (Table 3). This increase was significant under both models for four species, including Buller's shearwater, northern and southern royal albatrosses, and northern giant petrel. The corresponding annual rates of increase in abundance ranged from 39.6% (Buller's shearwater; base model) to 10.9% (northern giant petrel; full model). For four other species, the increase in abundance was significant under either model, and grey-faced petrel showed a significant annual increase only under the full model (75.7%). For Buller's albatross, southern black-backed gull and New Zealand white-capped albatross, the increase in abundance was significant under the base model only. For all species except northern royal albatross and grey-faced petrel, positive trends were relatively consistent over time. Low numbers of northern royal albatross were reported prior to 2009. The trend in number of grey-faced petrel reported was dominated by particularly high numbers in 2010 and 2011.

Salvin's albatross had a decreasing trend in abundance over time, but this trend was not significant in either model.

Table 3: Annual rate of change (%) in the number of birds off Kaikoura, New Zealand recorded during pelagic trips by ecotourism operator Albatross Encounter between 2006 and 2012. Rates (mean and 95% confidence interval (c.i.)) were estimated under a base model including time - related variables only, and under a full model that also included environmental variables. Presented are all species with a significant rate of change (i.e., the 95% c.i. did not encompass 0; indicated in bold), ordered by the mean rate estimated from the base model.

	Base model		Full model	
Species	Mean	95% c.i.	Mean	95% c.i.
Little shag	**-29.1**	**-39.3 – -23.3**	**-30.9**	**-40.5 – -22.5**
Wandering albatross	**-19.4**	**-29.4 – -6.4**	**-26.9**	**-36.7 – -15.0**
Fairy prion	**-17.7**	**-33.2 – -1.1**	-7.5	-27.7 – 16.3
White-fronted tern	**-16.3**	**-22.7 – -7.9**	**-16.1**	**-21.3 – -9.9**
Black-browed albatross	**-11.7**	**-21.3 – -6.6**	**-13.6**	**-22.5 – -8.5**
Southern giant petrel	**-11.5**	**-19.8 – -3.9**	-4.2	-12.5 – 4.0
Westland petrel	**-10.7**	**-14.7 – -7.7**	**-9.1**	**-12.8 – -5.4**
Australasian gannet	-6.3	-13.5 – 3.0	**-7.6**	**-14.9 – -0.2**
Antipodean albatross	-4.6	-10.9 – 0.8	**-7.6**	**-16.1 – -1.2**
Cape petrel	**-4.5**	**-6.9 – -2.1**	-2.2	-8.0 – 1.5
New Zealand white-capped albatross	**4.4**	**0.7 – 7.3**	4.3	-1.0 – 8.8
Southern black-backed gull	**5.5**	**1.3 – 12.1**	4.9	-0.5 – 13.3
Buller's albatross	**9.7**	**2.2 – 23.7**	7.4	-0.7 – 19.3
Northern giant petrel	**11.8**	**9.1 – 15.5**	**10.9**	**6.1 – 14.2**
Southern royal albatross	**19.6**	**9.2 – 26.8**	**19.9**	**8.9 – 27.7**
Northern royal albatross	**24.9**	**18.9 – 35.2**	**36.5**	**22.2 – 77.7**
Grey-faced petrel	33.5	-3.0 – 105.6	**75.7**	**1.4 – 160.9**
Buller's shearwater	**39.6**	**29.0 – 61.4**	**31.0**	**3.3 – 71.2**

3.2.3 Model covariates

The significance and direction of the effect of covariates varied greatly between species (see Table 4 for a summary of the parameters, and Appendix A, Table A-2 for parameter values for each species). Environmental covariates were only significant for a third or fewer of the species. Wind speed was the most important environmental parameter among species, and was significant in 11 of 32 models. The number of birds observed was negatively correlated with wind speed for ten species, with no apparent association with a particular seabird group (three albatrosses, three petrels, two gulls, one shag, and one penguin). It was positively correlated with wind speed for grey-faced petrel only. Similarly, air temperature was significant for ten species, and the effect was negative in eight of them, without any apparent relation to the species group. The Southern Oscillation Index anomaly had a positive effect on the number of birds recorded for five species (all albatrosses), and a negative effect for three species (two petrels and one albatross). The sea surface temperature anomaly had a negative effect for three species (all petrels), and a positive effect for two species (both albatrosses). Air pressure anomaly only had a significant effect for four species; it was negative for two species of albatross, and positive for a petrel and an albatross species. In addition, the time of the day was important in explaining the variations in the counts of seabirds for 14 species under the base model (and for 13 species under the full model), with no relation to a particular group of species. In all cases, more birds were recorded in the morning than in the afternoon. Interannual variations were inconsistent across species, except during the year 2008–09, when almost half the species, of various types, had considerably higher counts than in any of the other years.

Table 4: Summary of parameters included in statistical models to explain variation in the number of seabirds off Kaikoura, New Zealand, recorded during pelagic trips by ecotourism operator Albatross Encounter between 2006 and 2012. For counts of each of 32 seabird species (recorded on over 10% of trips), modelling involved a base model including time-related variables only, and a full model that also included environmental variables. For each parameter, the number (No. signif.) and percentage (Perc.) of significant models (of a total of 32 models each) are indicated, including significant negative (Neg.) and significant positive (Pos.) correlations. A parameter was considered significant if its 95% confidence interval did not encompass zero. (SOI, Southern Oscillation Index.)

	Base model				Full model			
Parameter	No. signif.	Perc.	Neg.	Pos.	No. signif.	Perc.	Neg.	Pos.
Intercept	28	87.5	14	14	29	90.6	15	14
Days since start	15	46.9	8	7	12	37.5	7	5
cos(Day of year) - 1^{st} order	31	96.9	15	16	29	90.6	14	15
cos(Day of year) - 2^{nd} order	13	40.6	8	5	13	40.6	8	5
cos(Day of year) - 3^{rd} order	14	43.8	7	7	12	37.5	6	6
sin(Day of year) - 1^{st} order	24	75.0	8	16	23	71.9	8	15
sin(Day of year) - 2^{nd} order	23	71.9	16	7	23	71.9	16	7
sin(Day of year) - 3^{rd} order	15	46.9	9	6	16	50.0	10	6
Afternoon	14	43.8	14	0	13	40.6	13	0
Year 2007–08	17	53.1	8	9	15	46.9	6	9
Year 2008–09	15	46.9	1	14	13	40.6	1	12
Year 2009–10	12	37.5	6	6	8	25.0	4	4
Year 2010–11	13	40.6	6	7	11	34.4	6	5
Wind speed	-	-	-	-	11	34.4	10	1
Air temperature	-	-	-	-	10	31.2	8	2
SOI anomaly	-	-	-	-	8	25.0	3	5
Sea surface temperature anomaly	-	-	-	-	5	15.6	3	2
Air pressure anomaly	-	-	-	-	4	12.5	2	2

4. DISCUSSION

4.1 Seasonality

The analysis of count data collected during seabird-watching trips off Kaikoura revealed clear seasonal patterns in the number of birds detected of the different species recorded. This seasonality was broadly reflective of the species' life history strategies, specifically the breeding frequency, with differences evident between annual and biennial breeders in pelagic species. In general, records of biennial breeders showed less seasonal variation than those of annual breeders. For example, at-sea count data of biennially-breeding species such as Antipodean, Gibson's and southern royal albatrosses varied little across seasons within a year, whereas there was a strong seasonal pattern in the counts of annually-breeding species such as Salvin's and Buller's albatrosses, white-chinned petrel, and flesh-footed shearwater. For biennial species, a proportion of the population is not breeding in a given year, so that individuals continue to forage over a wide range. In addition to a portion of the population being continuously present in non-breeding habitat throughout the year (ACAP 2009a, 2009b), breeding cycles of great albatrosses are longer and, therefore, less pronounced than those of annual breeders (June to May for Antipodean albatross compared with September to May for white-chinned petrel). The latter group also included migratory species that leave New Zealand waters after the breeding season. This departure of migratory species, such as sooty and flesh-footed shearwaters, from New Zealand waters is well documented (Taylor 2000a, Shaffer et al. 2006).

For coastal species (all breeding annually), at-sea count data generally showed less seasonal variation than those for both annually- and biennially-breeding pelagic species. Exceptions to this lack of a strong seasonal pattern were coastal species that move to other habitats to breed. For example, counts of the coastal species white-fronted tern, black-backed gull, and pied shag were not strongly seasonal, whereas count data of black-fronted tern showed a distinct seasonal pattern. Black-fronted tern breeds inland on braided riverbeds (Taylor 2000b), so that breeding individuals are less likely to be observed at sea. For shags, there was stronger seasonality in the count data of spotted and little shags than of pied shag, which may be related to the greater seasonality of colonial breeding in the former two species compared with the year-round breeding exhibited by pied shag (Biswell 2010).

4.2 Interannual trends

Counts of ten species declined off Kaikoura between 2006 and 2012. For five of these species, the decline in counts over time was significant under both models, and included little shag, wandering albatross, white-fronted tern, black-browed albatross, and Westland petrel. For another five species, fairy prion, southern giant petrel, Cape petrel, Australasian gannet and Antipodean albatross, the significance of this decrease depended on the model. Further to these ten species, data suggested a decline in the counts of Salvin's albatross, although this decrease was not significant. Additional years of data collection will clarify these interannual trends.

For eight species, at-sea count data indicated an increase off Kaikoura between 2006 and 2012. This increase in counts was significant under both models for four species, including Buller's shearwater, northern and southern royal albatrosses, and northern giant petrel. An additional four species showed increases in at-sea counts that were significant under either model; the species included grey-faced petrel, Buller's albatross, southern black-backed gull, and New Zealand white-capped albatross.

To examine the efficacy of at-sea counts in detecting real changes in population trends, it is informative to compare trends in the Albatross Encounter data with other data sources (Table 5). The latter included threat status assessments developed from data and expert advice, and ground counts from breeding sites where these data are available.

There were six species with a declining trend in the Albatross Encounter sightings data: little shag, wandering albatross, white-fronted tern, black-browed albatross, Westland petrel, and Salvin's albatross. There were four species that showed interannual increases in abundance: Buller's shearwater, northern and southern royal albatrosses, and northern giant petrel.

Of the species with a declining trend, little shag showed the greatest decrease in the number of birds observed off Kaikoura. This species is common throughout New Zealand, where it is reported to be increasing in the southern part of North Island (Powlesland & Luke 2000). Nevertheless, it has significantly decreased in the Auckland region (Taylor 2013). This species is regularly encountered in the South Bay Harbour from which the vessel departs. It is possible that the skippers' focus is on operating the vessel in the harbour instead of recording counts of this bird, which is widespread and not the main interest of the tours (D. Buurman, Encounter Kaikoura, pers. comm.).

Wandering albatross does not breed in New Zealand, but is a regular visitor in this region. This species is considered to have undergone a decline over the last three generations (70 years), and is classified as "Vulnerable" (IUCN 2012).

White-fronted tern is considered to be in decline nationally in New Zealand (Taylor 2000a, Robertson et al. 2013), although no recent survey data are available. For this species, the global population is considered stable, with an international threat status of "Least Concern" (IUCN 2012). One possible reason of this decline around Kaikoura may be the increase in the population of fur seals, displacing white-fronted tern from their breeding ground (D. Buurman, Encounter Kaikoura, pers. comm.).

Black-browed albatross is considered to have been declining at a rapid rate at a global level, and this species is classified as "Endangered" (IUCN 2012). In New Zealand, this species occurs at naturally very low numbers (ACAP 2010a), and is classified as "Coloniser" (Robertson et al. 2013). There are no recent census data on breeding pairs in New Zealand.

Westland petrel breeds only on the west coast of South Island. Because of this restricted breeding range, this species has been classified as "Vulnerable" (IUCN 2012). The population is considered to be stable.

At-sea count data from Kaikoura also suggested a slight decline in Salvin's albatross between 2006 and 2012, although this trend was not significant. The lack of detailed information from the main breeding population at Bounty Islands prevents identification of an overall, temporal trend for this species. Recent surveys of Salvin's albatross on The Snares revealed an apparent decline of almost 8% over the three years between 2008 and 2010 (Sagar et al. 2011). The conservation status of this species changed in 2013 from Naturally Vulnerable to Nationally Critical, according to the New Zealand Threat Classification System (Robertson et al. 2013).

In addition to the population-level information available from ground counts, a recent assessment of the risk of commercial fisheries to seabirds in New Zealand waters examined the potential effect of incidental captures on different seabird populations (Richard & Abraham 2013). The risk assessment suggests that the level of fisheries bycatch experienced by Westland petrel and Salvin's albatross in New Zealand waters may impact the populations of these species.

Of the species that showed a positive trend in the observed number of birds over time, Buller's shearwater showed the greatest increase over the study period. The population status of this species is considered to be stable, although its population size is not well known and past population estimates have been revised downward based on recent research (IUCN 2012). Buller's shearwater is restricted to two breeding sites in northern New Zealand. Its at-sea distribution is considerably larger, encompassing the Pacific Ocean, including areas off the coasts of Japan, and North and South Americas (IUCN 2012). Based on tracking of breeding birds, the increase may be due to Buller's shearwater foraging further away from its breeding sites (Graeme Taylor, Department of Conservation, pers. comm).

Northern royal albatross breed mainly at the Chatham Islands, with 99.5% of the breeding population at this location (ACAP 2009a). The current trend of the population is unknown. A small colony that established itself at Taiaroa Head on Otago Peninsula has doubled in size in the last 20 years Richard et al. (2013).

Southern royal albatross breeds mainly on Campbell Island, and populations at breeding colonies appear to have been stable in recent years (ACAP 2009b).

Northern giant petrel also showed an increasing trend in at-sea count data from Kaikoura. There are also ground count data available from New Zealand breeding sites of this species, but these data are insufficient to establish a trend. The number of birds present at the largest breeding sites (at Chatham Islands) was last reported in 1993. At breeding sites in other regions, such as Macquarie Island (Australia) and Marion Island (South Africa), surveys indicate increases in populations in recent years (ACAP

Table 5: Comparison of population trends determined from seabird sightings recorded off Kaikoura during seabird-watching trips between 2006 and 2012 (present study) and from ground-based count data (various sources, see text). Double-headed arrow indicates a stable population, whereas dash indicates an unknown population trajectory. Also shown are the population status from the New Zealand Threat Classification System (NZTCS) (Robertson et al. 2013) and from the International Union for Conservation of Nature (IUCN) Red List (IUCN 2012).

Seabird species	Trend in Kaikoura sightings	Trend in ground counts	NZTCS	IUCN
Little shag	↓	↓ / ↑	Not Threatened	Least Concern
Wandering albatross	↓	↓	Migrant	Vulnerable
White-fronted tern	↓	↓	Declining	Least Concern
Black-browed albatross	↓	↓	Coloniser	Near Threatened
Westland petrel	↓	↔	Naturally Uncommon	Vulnerable
Salvin's albatross	↓?	↓	Nationally Critical	Vulnerable
Buller's shearwater	↑	↔	Naturally Uncommon	Vulnerable
Northern royal albatross	↑	-	Naturally Uncommon	Endangered
Southern royal albatross	↑	↔	Naturally Uncommon	Vulnerable
Northern giant petrel	↑	-	Naturally Uncommon	Least Concern

2010b).

Overall, seabird sightings off Kaikoura reflected the same trends as ground-based data for four species. For an additional three species, counts of seabirds off Kaikoura revealed a change over time whereas ground counts suggest stable populations. Ground-based data reflecting the population trajectories of three species were unavailable or trends were unclear. Lack of concordance between the at-sea and ground-based counts may be accounted for by methodological or environmental factors, or a combination of both. For example, the location of the pelagic tours has varied slightly in recent years, favouring places where unusual species may be encountered (D. Buurman, Encounter Kaikoura, pers. comm.). Also, although most of the tours were operated by a single skipper, new skippers joined the Albatross Encounter team in 2005 and 2010, which may have introduced some variations in the way birds were detected.

Variations in at-sea counts from a single area may also reflect a change in seabird distributions, which may not be related to changes in the total population size. Random inter-annual changes in seabird distributions may occur due to short-term variations in environmental factors (Oedekoven et al. 2001). Additionally, long-term variations such as climate change may lead to shifts in seabird distributions (Weimerskirch et al. 2012) and, therefore, to shifts in observed trends in the seabird counts, especially for species that are at the edge of their distributions.

For Procellariiformes (albatrosses and petrels), strong winds facilitate long-distance flights, as birds require less energy to fly (Weimerskirch et al. 2000). This effect was not reflected in the full model, as counts were positively correlated to wind speed for grey-faced petrel only, with a negative correlation between the two variables for ten species, including albatrosses and other petrels. This negative effect of wind on Procellariiformes may be confounded by conditions at sea being different to those recorded on-land, as wind data used here were from the weather station at Kaikoura. Another confounding factor could be a lower at-sea detection probability of birds in strong winds (e.g., caused by a moving boat, and by waves obstructing vision).

Habitat characteristics have been shown in other studies to influence seabird distributions at sea, including the climate and oceanographic descriptors used here (e.g., Ballance 2007). Nevertheless, for the 7-year period in the present study, species abundances were not significantly influenced by environmental variables such as sea surface temperature and wind patterns. The base model only included time-related variables, but was sufficient to explain the variations within and across years, and adding environmental variables to the base model did not greatly alter trends and seasonality patterns. This robustness of the model findings in the base model could be related to the seasonality component of the model, which accounts for environmental variability and thereby limits any additional explanatory power of specific environmental variables *per se*. Analysing the influence of environmental variables on individual seabird species in detail may help clarify potential relationships. Also, repeating the analysis with additional data in the future may be informative, as additional variation in environmental variables may emerge over time.

4.3 Recommendations

This study highlights some of the possible improvements for the data collection process used on seabird-watching tours. As with all opportunistically-collected datasets, establishing a data collection framework under a strict scientific protocol would be inappropriate here; data collections in these touristic situations are inevitably somewhat *ad hoc*. Tours may for example vary in duration, as they may be shortened due to sea-sickness of passengers or unsuitable sea conditions. To some extent, the volume of data collected over time ameliorates inconsistencies within the data collection framework. Nevertheless, the robustness of the dataset could be improved by:

- standardising the seabird identification expertise of skippers as much as possible, and recording when identifications were made by skippers versus others (e.g., guests who happen to be seabird experts);
- recording information that describes the data collection effort in more detail, e.g., start and end times, the routes followed by trips, and locations of key sightings or points where the vessel stopped to observe birds;
- recording weather conditions and visibility;
- recording seabird sightings in distance categories from the vessel (e.g., 0–20 m, 20–50 m, 50–100 m, and >100 m).

4.4 Conclusions

Studying trends in seabird populations is generally a difficult task, requiring repeated ground-based surveys of breeding pairs, in situations that can be challenging due to the remoteness of breeding grounds and the difficulties in accessing them (e.g., Woehler & Croxall 1997, Ryan 2005). Furthermore, life history strategies of many seabird species, such as their longevity and biennial breeding cycles, often require long-term data, involving considerable survey effort.

Counts of seabirds carried out by tour operators can complement knowledge on the trends and seasonality of seabird abundance data obtained from ground-based surveys (Clarke et al. 2003). Coastal Kaikoura supports a high diversity of seabird species, including a variety of endemic species, at frequently high abundances in close proximity to the coast (Karpouzi et al. 2007). For this reason, the Kaikoura region is a valuable location to carry out seabird counts at sea.

The present study showed that data collected by Albatross Encounter allowed the identification of distinct trends in seasonality in the occurrence and abundance of seabirds. The present findings highlight the value of this dataset, collected through seabird ecotourism. Nevertheless, citizen science is most effective in monitoring biodiversity when implemented over large spatial and temporal scales (Bonney et al. 2009). The value of the dataset collected off Kaikoura could be increased further by combining its analysis with that of similar datasets from other areas. For example, evaluating results across larger spatial scales would facilitate the disentanglement of population trends from changes in bird distribution over time. Seabird-watching tours also operate in Hauraki Gulf and other locations around New Zealand. We strongly recommend that other tour operators make their at-sea sightings of seabirds publicly available, strengthening this citizen-science initiative nationwide.

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A. APPENDIX

Table A-1: Fit of models used to predict monthly average seabird abundance based on the observed number of seabirds per trip by ecotourism operator Albatross Encounter off Kaikoura, New Zealand, between 2006 and 2012. The fit was measured as the difference between the observed monthly average in counts and the monthly average count predicted by the model, relative to the mean observed count. For each species, two models were run, including a base model that only included time-related variables, and a full model that also including environmental variables. Presented are the mean and 95% confidence interval of the fit for each model.

	Base model		Full model	
Species	Mean	95% c.i.	Mean	95% c.i.
Antipodean albatross	0.00	-0.78 – 0.87	-0.00	-0.85 – 0.83
Arctic skua	-0.00	-1.24 – 1.86	-0.00	-1.24 – 1.65
Australasian gannet	0.00	-0.99 – 1.51	0.00	-0.97 – 1.43
Black-billed gull	-0.06	-2.01 – 2.12	-0.02	-1.96 – 2.04
Black-browed albatross	0.00	-1.49 – 1.17	0.00	-1.60 – 1.02
Black-fronted tern	-0.00	-1.17 – 1.36	-0.02	-1.22 – 1.32
Buller's albatross	-0.02	-1.42 – 1.16	-0.03	-1.00 – 1.09
Buller's shearwater	-0.07	-2.86 – 3.93	-0.06	-2.70 – 3.57
Cape petrel	-0.03	-0.66 – 0.70	-0.04	-0.70 – 0.47
Fairy prion	-0.28	-7.64 – 6.01	-0.28	-7.02 – 5.33
Flesh-footed shearwater	0.00	-1.31 – 1.56	-0.00	-1.33 – 1.22
Gibson's albatross	0.00	-0.35 – 0.50	0.00	-0.34 – 0.49
Grey-faced petrel	-0.01	-4.75 – 4.95	0.07	-4.15 – 4.15
Hutton's shearwater	0.02	-2.23 – 1.31	0.02	-1.95 – 1.48
Little penguin	-0.03	-1.03 – 1.50	-0.06	-1.03 – 1.50
Little shag	-0.00	-0.86 – 1.24	-0.01	-0.79 – 1.45
New Zealand white-capped albatross	-0.02	-0.64 – 0.83	-0.02	-0.58 – 0.89
Northern giant petrel	-0.01	-0.58 – 0.52	-0.01	-0.55 – 0.48
Northern royal albatross	-0.01	-1.14 – 1.38	-0.00	-0.94 – 0.99
Pied shag	0.03	-0.76 – 2.34	0.04	-0.69 – 2.30
Red-billed gull	0.01	-0.82 – 1.54	0.01	-0.83 – 1.49
Salvin's albatross	0.00	-0.60 – 0.68	0.00	-0.60 – 0.69
Short-tailed shearwater	-0.00	-4.53 – 6.97	0.03	-4.12 – 6.30
Sooty shearwater	0.37	-2.27 – 2.53	0.49	-1.62 – 2.33
Southern black-backed gull	-0.02	-0.48 – 0.67	-0.02	-0.48 – 0.61
Southern giant petrel	-0.04	-1.10 – 1.60	-0.04	-1.06 – 1.41
Southern royal albatross	0.02	-0.88 – 0.89	0.02	-0.80 – 0.82
Spotted shag	-0.15	-2.88 – 2.09	-0.21	-2.88 – 2.39
Wandering albatross	0.05	-1.47 – 4.00	0.00	-1.79 – 3.82
Westland petrel	0.01	-0.59 – 0.90	0.00	-0.53 – 0.90
White-chinned petrel	-0.02	-1.02 – 1.28	-0.02	-1.06 – 1.06
White-fronted tern	0.01	-0.62 – 1.52	0.00	-0.67 – 1.45

Table A-2: Coefficients of the variables included in statistical models used to analyse seabird count data collected during pelagic trips by ecotourism operator Albatross Encounter off Kaikoura, New Zealand, between 2006 and 2012. The base model only included time-related variables, whereas the full model also included environmental variables. Each seabird species was modelled independently. Significant coefficients (i.e., the 95% confidence interval did not encompass zero) are shown in bold.

Species	Variables	Base model Mean	Base model 95% c.i.	Full model Mean	Full model 95% c.i.
Antipodean albatross	Intercept	**-0.58**	**-0.79 – -0.29**	**-0.48**	**-0.73 – -0.07**
	Days since start (×366)	-0.05	-0.12 – 0.01	**-0.08**	**-0.18 – -0.01**
	Afternoon	**-0.22**	**-0.38 – -0.07**	**-0.2**	**-0.36 – -0.04**
	Year 2007/08	0.16	-0.03 – 0.34	0.08	-0.19 – 0.33
	Year 2008/09	**0.36**	**0.14 – 0.56**	**0.35**	**0.09 – 0.59**
	Year 2009/10	**0.28**	**0.08 – 0.48**	**0.34**	**0.05 – 0.64**
	Year 2010/11	-0.01	-0.24 – 0.23	-0.18	-0.45 – 0.09
	sin(Day of year) - 1st order	-0.01	-0.13 – 0.11	0.01	-0.11 – 0.14
	sin(Day of year) - 2nd order	**-0.2**	**-0.34 – -0.07**	**-0.21**	**-0.36 – -0.08**
	sin(Day of year) - 3rd order	0.05	-0.06 – 0.18	0.07	-0.05 – 0.2
	cos(Day of year) - 1st order	**-0.17**	**-0.34 – -0.01**	**-0.22**	**-0.39 – -0.04**
	cos(Day of year) - 2nd order	-0.04	-0.17 – 0.08	-0.04	-0.17 – 0.09
	cos(Day of year) - 3rd order	-0.03	-0.17 – 0.12	-0.03	-0.17 – 0.11
	Wind speed		–	-0.07	-0.15 – 0.02
	Air pressure anomaly		–	0.02	-0.07 – 0.11
	SOI anomaly		–	**0.15**	**0.04 – 0.27**
	Air temperature		–	0.05	-0.03 – 0.12
	Sea surface temperature anomaly		–	-0.1	-0.26 – 0.05
Arctic skua	Intercept	**-3.42**	**-4.77 – -2.49**	**-3.4**	**-4.83 – -2.23**
	Days since start (×366)	-0.11	-0.25 – 0.05	-0.1	-0.26 – 0.12
	Afternoon	-0.04	-0.31 – 0.23	-0.04	-0.32 – 0.25
	Year 2007/08	**-0.38**	**-0.74 – -0.02**	-0.52	-1.23 – 0.37
	Year 2008/09	-0.15	-0.58 – 0.29	-0.23	-0.75 – 0.42
	Year 2009/10	0.23	-0.17 – 0.66	0.08	-0.9 – 0.78
	Year 2010/11	-0.35	-0.79 – 0.08	-0.49	-1.24 – 0.11
	sin(Day of year) - 1st order	**2.43**	**1.26 – 4.05**	**2.4**	**1.21 – 4.01**
	sin(Day of year) - 2nd order	-0.87	-2.17 – 0.08	-0.88	-2.17 – 0.08
	sin(Day of year) - 3rd order	**-0.57**	**-0.99 – -0.09**	**-0.54**	**-0.97 – -0.04**
	cos(Day of year) - 1st order	**2.61**	**1.56 – 4.18**	**2.68**	**1.55 – 4.32**
	cos(Day of year) - 2nd order	0.51	-0.48 – 1.42	0.49	-0.59 – 1.4
	cos(Day of year) - 3rd order	-0.22	-0.78 – 0.31	-0.19	-0.78 – 0.38
	Wind speed		–	-0.01	-0.16 – 0.13
	Air pressure anomaly		–	-0.02	-0.3 – 0.24
	SOI anomaly		–	0	-0.57 – 0.52
	Air temperature		–	-0.04	-0.19 – 0.11
	Sea surface temperature anomaly		–	0.06	-0.24 – 0.33

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Table A-2: (*continued*) Coefficients of the variables included in statistical models used to analyse seabird count data collected during pelagic trips by ecotourism operator Albatross Encounter off Kaikoura, New Zealand, between 2006 and 2012. The base model only included time-related variables, whereas the full model also included environmental variables. Each seabird species was modelled independently. Significant coefficients (i.e., the 95% confidence interval did not encompass zero) are shown in bold.

Species	Variables	Base model Mean	Base model 95% c.i.	Full model Mean	Full model 95% c.i.
Australasian gannet	Intercept	**-0.83**	**-1.08 – -0.52**	**-0.79**	**-1.1 – -0.45**
	Days since start (×366)	-0.07	-0.14 – 0.03	-0.08	-0.16 – 0
	Afternoon	0.02	-0.16 – 0.21	0.03	-0.16 – 0.21
	Year 2007/08	0.1	-0.14 – 0.33	-0.03	-0.41 – 0.35
	Year 2008/09	**0.64**	**0.37 – 0.9**	**0.65**	**0.35 – 0.93**
	Year 2009/10	0	-0.31 – 0.29	0.05	-0.28 – 0.38
	Year 2010/11	**0.28**	**0.01 – 0.56**	0.24	-0.14 – 0.62
	sin(Day of year) - 1^{st} order	**0.73**	**0.51 – 0.98**	**0.72**	**0.5 – 0.97**
	sin(Day of year) - 2^{nd} order	**-0.22**	**-0.41 – -0.04**	**-0.21**	**-0.41 – -0.01**
	sin(Day of year) - 3^{rd} order	0.04	-0.18 – 0.24	0.05	-0.16 – 0.25
	cos(Day of year) - 1^{st} order	**0.51**	**0.29 – 0.75**	**0.5**	**0.24 – 0.77**
	cos(Day of year) - 2^{nd} order	-0.15	-0.4 – 0.11	-0.13	-0.39 – 0.14
	cos(Day of year) - 3^{rd} order	-0.03	-0.2 – 0.14	-0.03	-0.19 – 0.14
	Wind speed		–	-0.02	-0.11 – 0.08
	Air pressure anomaly		–	0.09	-0.04 – 0.21
	SOI anomaly		–	0	-0.18 – 0.21
	Air temperature		–	0.07	-0.02 – 0.16
	Sea surface temperature anomaly		–	0.04	-0.1 – 0.17
Black-billed gull	Intercept	-0.06	-0.52 – 0.68	-0.07	-0.63 – 0.87
	Days since start (×366)	0.04	-0.11 – 0.2	0.05	-0.16 – 0.23
	Afternoon	**-0.4**	**-0.69 – -0.11**	**-0.43**	**-0.73 – -0.13**
	Year 2007/08	**0.46**	**0.06 – 0.9**	0.45	-0.02 – 0.98
	Year 2008/09	**0.65**	**0.18 – 1.11**	**0.71**	**0.16 – 1.29**
	Year 2009/10	0.15	-0.32 – 0.62	-0.1	-0.68 – 0.48
	Year 2010/11	0.39	-0.01 – 0.8	0.28	-0.12 – 0.69
	sin(Day of year) - 1^{st} order	**0.77**	**0.44 – 1.15**	**0.83**	**0.49 – 1.24**
	sin(Day of year) - 2^{nd} order	**0.5**	**0.13 – 0.77**	**0.47**	**0.13 – 0.75**
	sin(Day of year) - 3^{rd} order	-0.03	-0.26 – 0.21	-0.03	-0.29 – 0.21
	cos(Day of year) - 1^{st} order	**-0.92**	**-1.25 – -0.61**	**-0.87**	**-1.24 – -0.51**
	cos(Day of year) - 2^{nd} order	0.02	-0.23 – 0.28	-0.06	-0.31 – 0.19
	cos(Day of year) - 3^{rd} order	-0.17	-0.4 – 0.07	-0.12	-0.38 – 0.15
	Wind speed		–	0.04	-0.1 – 0.19
	Air pressure anomaly		–	0.15	-0.05 – 0.33
	SOI anomaly		–	-0.17	-0.39 – 0.07
	Air temperature		–	0.13	-0.01 – 0.28
	Sea surface temperature anomaly		–	0.01	-0.28 – 0.28

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Table A-2: (*continued*) Coefficients of the variables included in statistical models used to analyse seabird count data collected during pelagic trips by ecotourism operator Albatross Encounter off Kaikoura, New Zealand, between 2006 and 2012. The base model only included time-related variables, whereas the full model also included environmental variables. Each seabird species was modelled independently. Significant coefficients (i.e., the 95% confidence interval did not encompass zero) are shown in bold.

Species	Variables	Base model Mean	Base model 95% c.i.	Full model Mean	Full model 95% c.i.
Black-browed albatross	Intercept	**0.61**	**0.37 – 1.22**	**0.66**	**0.4 – 1.26**
	Days since start (×366)	**-0.13**	**-0.24 – -0.07**	**-0.15**	**-0.25 – -0.09**
	Afternoon	-0.09	-0.22 – 0.03	-0.06	-0.19 – 0.07
	Year 2007/08	**0.43**	**0.29 – 0.57**	**0.4**	**0.26 – 0.55**
	Year 2008/09	**0.34**	**0.02 – 0.53**	0.3	0 – 0.5
	Year 2009/10	-0.1	-0.36 – 0.11	-0.03	-0.31 – 0.19
	Year 2010/11	0.03	-0.17 – 0.22	0.01	-0.19 – 0.21
	sin(Day of year) - 1st order	**0.23**	**0.1 – 0.38**	**0.21**	**0.09 – 0.36**
	sin(Day of year) - 2nd order	**-0.37**	**-0.47 – -0.22**	**-0.37**	**-0.47 – -0.22**
	sin(Day of year) - 3rd order	**-0.4**	**-0.52 – -0.29**	**-0.39**	**-0.52 – -0.28**
	cos(Day of year) - 1st order	**-1.77**	**-1.92 – -1.66**	**-1.8**	**-1.93 – -1.69**
	cos(Day of year) - 2nd order	**0.48**	**0.38 – 0.6**	**0.49**	**0.38 – 0.6**
	cos(Day of year) - 3rd order	**-0.14**	**-0.22 – -0.07**	**-0.14**	**-0.22 – -0.06**
	Wind speed		–	**-0.09**	**-0.15 – -0.03**
	Air pressure anomaly		–	0.02	-0.05 – 0.08
	SOI anomaly		–	**0.1**	**0.01 – 0.2**
	Air temperature		–	-0.03	-0.09 – 0.02
	Sea surface temperature anomaly		–	0	-0.09 – 0.09
Black-fronted tern	Intercept	**-0.75**	**-1.06 – -0.45**	**-0.83**	**-1.2 – -0.4**
	Days since start (×366)	-0.03	-0.15 – 0.04	-0.01	-0.11 – 0.07
	Afternoon	-0.11	-0.31 – 0.08	-0.12	-0.32 – 0.07
	Year 2007/08	0.06	-0.18 – 0.31	-0.12	-0.46 – 0.2
	Year 2008/09	-0.12	-0.41 – 0.19	-0.09	-0.38 – 0.2
	Year 2009/10	0.26	-0.02 – 0.63	0.14	-0.13 – 0.42
	Year 2010/11	**-0.39**	**-0.67 – -0.09**	-0.16	-0.62 – 0.24
	sin(Day of year) - 1st order	**1.92**	**1.64 – 2.24**	**1.9**	**1.62 – 2.2**
	sin(Day of year) - 2nd order	**0.85**	**0.61 – 1.15**	**0.84**	**0.6 – 1.15**
	sin(Day of year) - 3rd order	-0.02	-0.25 – 0.2	-0.05	-0.27 – 0.16
	cos(Day of year) - 1st order	**-1.77**	**-2.07 – -1.52**	**-1.69**	**-1.95 – -1.46**
	cos(Day of year) - 2nd order	0.09	-0.16 – 0.32	0.13	-0.13 – 0.37
	cos(Day of year) - 3rd order	-0.02	-0.19 – 0.17	0	-0.19 – 0.18
	Wind speed		–	0.03	-0.08 – 0.14
	Air pressure anomaly		–	0.08	-0.05 – 0.23
	SOI anomaly		–	-0.14	-0.34 – 0.09
	Air temperature		–	-0.08	-0.2 – 0.03
	Sea surface temperature anomaly		–	0.21	-0.01 – 0.4

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Table A-2: (*continued*) Coefficients of the variables included in statistical models used to analyse seabird count data collected during pelagic trips by ecotourism operator Albatross Encounter off Kaikoura, New Zealand, between 2006 and 2012. The base model only included time-related variables, whereas the full model also included environmental variables. Each seabird species was modelled independently. Significant coefficients (i.e., the 95% confidence interval did not encompass zero) are shown in bold.

		Base model		Full model	
Species	Variables	Mean	95% c.i.	Mean	95% c.i.
Buller's albatross	Intercept	**-0.74**	**-1.14 – -0.5**	**-0.64**	**-1.22 – -0.29**
	Days since start (×366)	**0.09**	**0.02 – 0.21**	0.07	-0.01 – 0.18
	Afternoon	-0.14	-0.3 – 0.03	-0.11	-0.28 – 0.05
	Year 2007/08	-0.16	-0.38 – 0.06	**-0.38**	**-0.7 – -0.05**
	Year 2008/09	**0.36**	**0.03 – 0.64**	**0.37**	**0.11 – 0.68**
	Year 2009/10	0.24	-0.15 – 0.49	0.26	-0.02 – 0.52
	Year 2010/11	**0.45**	**0.23 – 0.68**	0.14	-0.22 – 0.47
	sin(Day of year) - 1st order	**0.95**	**0.78 – 1.13**	**0.95**	**0.69 – 1.14**
	sin(Day of year) - 2nd order	0.06	-0.13 – 0.22	0.06	-0.12 – 0.26
	sin(Day of year) - 3rd order	**-0.23**	**-0.37 – -0.05**	**-0.22**	**-0.36 – -0.05**
	cos(Day of year) - 1st order	**-2.08**	**-2.33 – -1.92**	**-2.2**	**-2.43 – -2.01**
	cos(Day of year) - 2nd order	0.09	-0.11 – 0.26	0.08	-0.12 – 0.26
	cos(Day of year) - 3rd order	-0.05	-0.2 – 0.1	-0.04	-0.19 – 0.12
	Wind speed		–	-0.01	-0.09 – 0.08
	Air pressure anomaly		–	0.1	-0.03 – 0.24
	SOI anomaly		–	**0.29**	**0.13 – 0.51**
	Air temperature		–	**-0.16**	**-0.25 – -0.07**
	Sea surface temperature anomaly		–	0.01	-0.19 – 0.21
Buller's shearwater	Intercept	**-1.54**	**-3.19 – -0.89**	**-1.28**	**-2.67 – -0.43**
	Days since start (×366)	**0.33**	**0.25 – 0.48**	**0.26**	**0.03 – 0.54**
	Afternoon	-0.2	-0.4 – 0	**-0.26**	**-0.46 – -0.06**
	Year 2007/08	**-0.58**	**-0.8 – -0.35**	**-1.08**	**-1.47 – -0.71**
	Year 2008/09	**0.36**	**0.05 – 0.83**	0.34	-0.12 – 1.07
	Year 2009/10	**-0.58**	**-0.89 – -0.2**	-0.16	-0.63 – 0.46
	Year 2010/11	0.07	-0.21 – 0.36	**-0.46**	**-0.92 – -0.04**
	sin(Day of year) - 1st order	**2.56**	**2.06 – 4.35**	**2.54**	**2.05 – 4.24**
	sin(Day of year) - 2nd order	**-0.87**	**-2.61 – -0.29**	**-0.86**	**-2.47 – -0.36**
	sin(Day of year) - 3rd order	**0.45**	**0.04 – 1.23**	**0.47**	**0.09 – 1.18**
	cos(Day of year) - 1st order	**2.16**	**1.47 – 4.64**	**2.1**	**1.41 – 4.44**
	cos(Day of year) - 2nd order	**-0.77**	**-1.47 – -0.38**	**-0.82**	**-1.53 – -0.43**
	cos(Day of year) - 3rd order	**0.29**	**0.07 – 0.53**	**0.3**	**0.09 – 0.53**
	Wind speed		–	0.03	-0.06 – 0.12
	Air pressure anomaly		–	0.11	-0.02 – 0.24
	SOI anomaly		–	**0.32**	**0.11 – 0.53**
	Air temperature		–	0.08	-0.04 – 0.2
	Sea surface temperature anomaly		–	-0.01	-0.15 – 0.12

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Table A-2: (*continued*) Coefficients of the variables included in statistical models used to analyse seabird count data collected during pelagic trips by ecotourism operator Albatross Encounter off Kaikoura, New Zealand, between 2006 and 2012. The base model only included time-related variables, whereas the full model also included environmental variables. Each seabird species was modelled independently. Significant coefficients (i.e., the 95% confidence interval did not encompass zero) are shown in bold.

Species	Variables	Base model Mean	Base model 95% c.i.	Full model Mean	Full model 95% c.i.
Cape petrel	Intercept	**4.26**	**4.16 – 4.37**	**4.13**	**3.99 – 4.37**
	Days since start (×366)	**-0.05**	**-0.07 – -0.02**	-0.02	-0.08 – 0.02
	Afternoon	**-0.15**	**-0.23 – -0.07**	**-0.13**	**-0.2 – -0.05**
	Year 2007/08	0	-0.1 – 0.09	**0.12**	**0.03 – 0.23**
	Year 2008/09	-0.05	-0.15 – 0.04	**0.19**	**0.02 – 0.34**
	Year 2009/10	**0.23**	**0.13 – 0.33**	**0.14**	**0.04 – 0.25**
	Year 2010/11	-0.01	-0.12 – 0.09	0	-0.11 – 0.11
	sin(Day of year) - 1st order	**-0.13**	**-0.19 – -0.06**	**-0.08**	**-0.14 – -0.02**
	sin(Day of year) - 2nd order	**-0.15**	**-0.24 – -0.08**	**-0.14**	**-0.22 – -0.06**
	sin(Day of year) - 3rd order	0.02	-0.06 – 0.1	0.03	-0.05 – 0.1
	cos(Day of year) - 1st order	**-0.82**	**-0.91 – -0.74**	**-0.85**	**-0.95 – -0.75**
	cos(Day of year) - 2nd order	**-0.17**	**-0.27 – -0.09**	**-0.21**	**-0.3 – -0.13**
	cos(Day of year) - 3rd order	**-0.36**	**-0.43 – -0.3**	**-0.39**	**-0.46 – -0.32**
	Wind speed		–	**-0.06**	**-0.1 – -0.02**
	Air pressure anomaly		–	-0.04	-0.11 – 0.01
	SOI anomaly		–	-0.05	-0.11 – 0.03
	Air temperature		–	**-0.05**	**-0.09 – -0.02**
	Sea surface temperature anomaly		–	**-0.16**	**-0.23 – -0.08**
Fairy prion	Intercept	**1.57**	**0.82 – 2.23**	**1.22**	**0.38 – 2.13**
	Days since start (×366)	**-0.2**	**-0.4 – -0.01**	-0.09	-0.32 – 0.15
	Afternoon	-0.47	-0.98 – 0.05	-0.52	-1.1 – 0.05
	Year 2007/08	-0.05	-0.7 – 0.6	-0.07	-0.84 – 0.72
	Year 2008/09	-0.41	-1.16 – 0.35	-0.42	-1.26 – 0.49
	Year 2009/10	**-1**	**-1.77 – -0.21**	**-1.2**	**-2.21 – -0.05**
	Year 2010/11	-0.26	-1.1 – 0.6	-0.36	-1.21 – 0.48
	sin(Day of year) - 1st order	**-1.74**	**-2.26 – -1.3**	**-1.74**	**-2.3 – -1.25**
	sin(Day of year) - 2nd order	**-0.93**	**-1.42 – -0.42**	**-1.02**	**-1.47 – -0.53**
	sin(Day of year) - 3rd order	**0.46**	**0.03 – 0.88**	**0.56**	**0.07 – 1.04**
	cos(Day of year) - 1st order	**-2.67**	**-3.18 – -2.02**	**-2.41**	**-3.03 – -1.87**
	cos(Day of year) - 2nd order	**1.84**	**1.29 – 2.46**	**1.8**	**1.24 – 2.48**
	cos(Day of year) - 3rd order	**0.79**	**0.12 – 1.43**	**0.89**	**0.24 – 1.55**
	Wind speed		–	0.07	-0.23 – 0.31
	Air pressure anomaly		–	-0.04	-0.35 – 0.35
	SOI anomaly		–	-0.37	-0.93 – 0.19
	Air temperature		–	-0.02	-0.3 – 0.27
	Sea surface temperature anomaly		–	0.4	-0.08 – 0.89
Flesh-footed shearwater	Intercept	**-5.98**	**-12.7 – -3.13**	**-6.64**	**-15.19 – -2.95**
	Days since start (×366)	0.05	-0.06 – 0.25	0.04	-0.09 – 0.21
	sin(Day of year) - 1st order	**3.84**	**1.12 – 9.57**	**4.52**	**1.13 – 12.25**
	sin(Day of year) - 2nd order	-1.23	-6.46 – 1.23	-1.91	-8.48 – 1.1
	sin(Day of year) - 3rd order	-0.3	-1.19 – 1.35	0.01	-1.02 – 1.87
	cos(Day of year) - 1st order	**5.99**	**1.9 – 15.49**	**7.04**	**1.82 – 18.35**
	cos(Day of year) - 2nd order	-0.17	-3.25 – 1.69	-0.39	-3.68 – 1.65
	cos(Day of year) - 3rd order	-0.43	-1.21 – 0.35	-0.46	-1.49 – 0.37
	Wind speed		–	0.05	-0.06 – 0.16
	Air pressure anomaly		–	0.03	-0.25 – 0.24
	SOI anomaly		–	-0.05	-0.48 – 0.32
	Air temperature		–	**0.43**	**0.31 – 0.56**
	Sea surface temperature anomaly		–	0.13	-0.2 – 0.36

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Table A-2: (*continued*) Coefficients of the variables included in statistical models used to analyse seabird count data collected during pelagic trips by ecotourism operator Albatross Encounter off Kaikoura, New Zealand, between 2006 and 2012. The base model only included time-related variables, whereas the full model also included environmental variables. Each seabird species was modelled independently. Significant coefficients (i.e., the 95% confidence interval did not encompass zero) are shown in bold.

Species	Variables	Base model Mean	Base model 95% c.i.	Full model Mean	Full model 95% c.i.
Gibson's albatross	Intercept	**2.23**	**2.13 – 2.46**	**2.2**	**2.04 – 2.56**
	Days since start (×366)	-0.01	-0.06 – 0.04	0	-0.09 – 0.04
	Afternoon	**-0.13**	**-0.19 – -0.08**	**-0.1**	**-0.16 – -0.04**
	Year 2007/08	**0.16**	**0.09 – 0.24**	**0.19**	**0.05 – 0.32**
	Year 2008/09	0.02	-0.12 – 0.12	0.01	-0.15 – 0.14
	Year 2009/10	-0.04	-0.16 – 0.06	-0.09	-0.25 – 0.03
	Year 2010/11	**0.13**	**0.04 – 0.21**	**0.18**	**0.03 – 0.33**
	sin(Day of year) - 1st order	-0.04	-0.12 – 0.03	-0.05	-0.13 – 0.05
	sin(Day of year) - 2nd order	**-0.24**	**-0.29 – -0.19**	**-0.23**	**-0.29 – -0.18**
	sin(Day of year) - 3rd order	**0.08**	**0.04 – 0.12**	**0.08**	**0.03 – 0.13**
	cos(Day of year) - 1st order	**-0.17**	**-0.22 – -0.09**	**-0.14**	**-0.22 – -0.06**
	cos(Day of year) - 2nd order	**-0.23**	**-0.28 – -0.18**	**-0.22**	**-0.27 – -0.18**
	cos(Day of year) - 3rd order	**-0.11**	**-0.16 – -0.06**	**-0.11**	**-0.16 – -0.06**
	Wind speed		–	**-0.08**	**-0.11 – -0.06**
	Air pressure anomaly		–	**-0.05**	**-0.11 – -0.01**
	SOI anomaly		–	-0.02	-0.1 – 0.06
	Air temperature		–	-0.02	-0.05 – 0.01
	Sea surface temperature anomaly		–	-0.01	-0.1 – 0.05
Grey-faced petrel	Intercept	**-3.24**	**-4.24 – -1.87**	**-4.46**	**-6 – -2.17**
	Days since start (×366)	0.27	-0.03 – 0.72	**0.53**	**0.01 – 0.96**
	Afternoon	0.16	-0.41 – 0.68	0.2	-0.31 – 0.72
	Year 2007/08	0.58	-0.19 – 1.24	**1.17**	**0.26 – 2.07**
	Year 2008/09	0.18	-0.83 – 0.97	**1.59**	**0.3 – 2.75**
	Year 2009/10	-0.49	-1.78 – 0.33	**-1.53**	**-2.68 – -0.38**
	Year 2010/11	**1.85**	**1.19 – 2.64**	**1.75**	**1.09 – 2.54**
	sin(Day of year) - 1st order	**-2.1**	**-2.66 – -1.58**	**-2**	**-2.5 – -1.51**
	sin(Day of year) - 2nd order	**1.25**	**0.66 – 1.9**	**0.84**	**0.25 – 1.48**
	sin(Day of year) - 3rd order	**-1.15**	**-1.85 – -0.59**	**-1.15**	**-1.83 – -0.6**
	cos(Day of year) - 1st order	**1.13**	**0.46 – 2.55**	**0.93**	**0.19 – 2.11**
	cos(Day of year) - 2nd order	0.45	-0.67 – 1.02	0.16	-0.52 – 0.63
	cos(Day of year) - 3rd order	-0.14	-0.78 – 0.52	0.2	-0.28 – 0.62
	Wind speed		–	**0.35**	**0.05 – 0.67**
	Air pressure anomaly		–	**0.38**	**0.07 – 0.74**
	SOI anomaly		–	**-0.65**	**-1.29 – -0.22**
	Air temperature		–	0.17	-0.02 – 0.37
	Sea surface temperature anomaly		–	**-0.55**	**-0.99 – -0.17**

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Table A-2: (*continued*) Coefficients of the variables included in statistical models used to analyse seabird count data collected during pelagic trips by ecotourism operator Albatross Encounter off Kaikoura, New Zealand, between 2006 and 2012. The base model only included time-related variables, whereas the full model also included environmental variables. Each seabird species was modelled independently. Significant coefficients (i.e., the 95% confidence interval did not encompass zero) are shown in bold.

		Base model		Full model	
Species	Variables	Mean	95% c.i.	Mean	95% c.i.
Hutton's shearwater	Intercept	**5.05**	**4.74 – 5.62**	**5.17**	**4.77 – 5.66**
	Days since start (×366)	-0.01	-0.12 – 0.08	-0.04	-0.15 – 0.07
	Afternoon	-0.15	-0.38 – 0.07	-0.15	-0.38 – 0.06
	Year 2007/08	**0.39**	**0.13 – 0.66**	0.21	-0.26 – 0.7
	Year 2008/09	**0.51**	**0.13 – 0.85**	**0.49**	**0.08 – 0.89**
	Year 2009/10	**-0.75**	**-1.11 – -0.29**	**-0.64**	**-1.27 – -0.06**
	Year 2010/11	**-0.38**	**-0.68 – -0.09**	**-0.54**	**-1.05 – -0.07**
	sin(Day of year) - 1st order	**-1.63**	**-2.01 – -1.31**	**-1.64**	**-2.05 – -1.24**
	sin(Day of year) - 2nd order	-0.33	-0.55 – 0.04	-0.33	-0.58 – 0.08
	sin(Day of year) - 3rd order	**0.67**	**0.31 – 0.88**	**0.68**	**0.3 – 0.91**
	cos(Day of year) - 1st order	**1.07**	**0.85 – 1.27**	**1.05**	**0.72 – 1.32**
	cos(Day of year) - 2nd order	**-0.39**	**-0.56 – -0.23**	**-0.38**	**-0.58 – -0.2**
	cos(Day of year) - 3rd order	**0.24**	**0.01 – 0.47**	0.23	-0.01 – 0.43
	Wind speed		–	0.02	-0.1 – 0.13
	Air pressure anomaly		–	0.04	-0.09 – 0.16
	SOI anomaly		–	0.1	-0.24 – 0.44
	Air temperature		–	-0.01	-0.13 – 0.11
	Sea surface temperature anomaly		–	0.03	-0.17 – 0.23
Little penguin	Intercept	**-1.44**	**-2.03 – -1.04**	**-1.8**	**-2.44 – -1.33**
	Days since start (×366)	-0.04	-0.16 – 0.16	0.02	-0.14 – 0.35
	Afternoon	-0.22	-0.45 – 0	-0.09	-0.32 – 0.14
	Year 2007/08	**-0.49**	**-0.87 – -0.12**	-0.22	-0.71 – 0.28
	Year 2008/09	0.25	-0.33 – 0.82	0.37	-0.3 – 0.93
	Year 2009/10	0.34	-0.4 – 0.84	0.21	-0.97 – 0.87
	Year 2010/11	**0.93**	**0.59 – 1.26**	**1.08**	**0.59 – 1.57**
	sin(Day of year) - 1st order	**0.73**	**0.5 – 0.96**	**0.72**	**0.47 – 0.98**
	sin(Day of year) - 2nd order	**0.34**	**0.11 – 0.57**	**0.36**	**0.13 – 0.6**
	sin(Day of year) - 3rd order	0.13	-0.11 – 0.35	0.12	-0.13 – 0.34
	cos(Day of year) - 1st order	**0.59**	**0.28 – 1.17**	**0.63**	**0.29 – 1.17**
	cos(Day of year) - 2nd order	0.2	-0.3 – 0.59	0.19	-0.28 – 0.59
	cos(Day of year) - 3rd order	0.24	0 – 0.51	0.25	0 – 0.52
	Wind speed		–	**-0.4**	**-0.53 – -0.26**
	Air pressure anomaly		–	0.01	-0.13 – 0.15
	SOI anomaly		–	-0.12	-0.37 – 0.15
	Air temperature		–	0.03	-0.09 – 0.14
	Sea surface temperature anomaly		–	-0.01	-0.24 – 0.21

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Table A-2: (*continued*) Coefficients of the variables included in statistical models used to analyse seabird count data collected during pelagic trips by ecotourism operator Albatross Encounter off Kaikoura, New Zealand, between 2006 and 2012. The base model only included time-related variables, whereas the full model also included environmental variables. Each seabird species was modelled independently. Significant coefficients (i.e., the 95% confidence interval did not encompass zero) are shown in bold.

Species	Variables	Base model Mean	Base model 95% c.i.	Full model Mean	Full model 95% c.i.
Little shag	Intercept	0.23	-0.1 – 1.06	0.3	-0.26 – 1.08
	Days since start (×366)	**-0.35**	**-0.5 – -0.26**	**-0.37**	**-0.52 – -0.26**
	Afternoon	0	-0.18 – 0.18	-0.01	-0.19 – 0.17
	Year 2007/08	**0.59**	**0.4 – 0.78**	**0.57**	**0.25 – 0.94**
	Year 2008/09	**0.61**	**0.17 – 0.88**	**0.57**	**0.1 – 0.93**
	Year 2009/10	-0.17	-0.57 – 0.14	0.03	-0.38 – 0.53
	Year 2010/11	-0.07	-0.42 – 0.26	-0.13	-0.61 – 0.38
	sin(Day of year) - 1^{st} order	**-0.49**	**-0.68 – -0.31**	**-0.48**	**-0.69 – -0.3**
	sin(Day of year) - 2^{nd} order	**-0.22**	**-0.41 – -0.02**	**-0.23**	**-0.42 – -0.03**
	sin(Day of year) - 3^{rd} order	0.08	-0.06 – 0.22	0.08	-0.05 – 0.23
	cos(Day of year) - 1^{st} order	**0.46**	**0.27 – 0.63**	**0.39**	**0.15 – 0.67**
	cos(Day of year) - 2^{nd} order	-0.15	-0.3 – 0.03	-0.16	-0.32 – 0.03
	cos(Day of year) - 3^{rd} order	-0.09	-0.25 – 0.09	-0.08	-0.23 – 0.08
	Wind speed		–	0.03	-0.07 – 0.12
	Air pressure anomaly		–	-0.08	-0.22 – 0.03
	SOI anomaly		–	0.15	-0.13 – 0.38
	Air temperature		–	0.06	-0.03 – 0.16
	Sea surface temperature anomaly		–	-0.08	-0.23 – 0.09
White-capped albatross	Intercept	**1.56**	**1.46 – 1.68**	**1.54**	**1.37 – 1.7**
	Days since start (×366)	**0.04**	**0.01 – 0.07**	0.04	-0.01 – 0.08
	Afternoon	-0.07	-0.18 – 0.02	-0.04	-0.16 – 0.05
	Year 2007/08	0.07	-0.02 – 0.17	-0.01	-0.13 – 0.11
	Year 2008/09	0.05	-0.06 – 0.16	0.05	-0.07 – 0.17
	Year 2009/10	0.02	-0.09 – 0.14	0.07	-0.05 – 0.2
	Year 2010/11	-0.11	-0.22 – 0	-0.11	-0.24 – 0.02
	sin(Day of year) - 1^{st} order	**0.21**	**0.14 – 0.28**	**0.19**	**0.12 – 0.26**
	sin(Day of year) - 2^{nd} order	**-0.25**	**-0.33 – -0.16**	**-0.24**	**-0.32 – -0.15**
	sin(Day of year) - 3^{rd} order	**-0.16**	**-0.23 – -0.09**	**-0.16**	**-0.24 – -0.09**
	cos(Day of year) - 1^{st} order	**-0.52**	**-0.61 – -0.42**	**-0.49**	**-0.6 – -0.38**
	cos(Day of year) - 2^{nd} order	**-0.11**	**-0.18 – -0.04**	**-0.11**	**-0.17 – -0.04**
	cos(Day of year) - 3^{rd} order	0.02	-0.04 – 0.09	0.02	-0.04 – 0.09
	Wind speed		–	**-0.06**	**-0.1 – -0.02**
	Air pressure anomaly		–	-0.02	-0.06 – 0.02
	SOI anomaly		–	0.02	-0.05 – 0.08
	Air temperature		–	**-0.1**	**-0.14 – -0.05**
	Sea surface temperature anomaly		–	**0.08**	**0.02 – 0.15**

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Table A-2: (*continued*) Coefficients of the variables included in statistical models used to analyse seabird count data collected during pelagic trips by ecotourism operator Albatross Encounter off Kaikoura, New Zealand, between 2006 and 2012. The base model only included time-related variables, whereas the full model also included environmental variables. Each seabird species was modelled independently. Significant coefficients (i.e., the 95% confidence interval did not encompass zero) are shown in bold.

Species	Variables	Base model Mean	Base model 95% c.i.	Full model Mean	Full model 95% c.i.
Northern giant petrel	Intercept	**2.05**	**1.89 – 2.14**	**2.05**	**1.93 – 2.17**
	Days since start (×366)	**0.11**	**0.09 – 0.14**	**0.1**	**0.06 – 0.13**
	Afternoon	**-0.1**	**-0.16 – -0.04**	**-0.09**	**-0.15 – -0.03**
	Year 2007/08	**-0.09**	**-0.17 – -0.01**	0.03	-0.09 – 0.15
	Year 2008/09	-0.07	-0.16 – 0.03	0.01	-0.09 – 0.11
	Year 2009/10	**-0.11**	**-0.2 – -0.03**	-0.11	-0.23 – 0.04
	Year 2010/11	-0.04	-0.13 – 0.04	-0.04	-0.16 – 0.08
	sin(Day of year) - 1st order	**-0.48**	**-0.56 – -0.41**	**-0.45**	**-0.54 – -0.38**
	sin(Day of year) - 2nd order	**-0.14**	**-0.2 – -0.08**	**-0.14**	**-0.2 – -0.09**
	sin(Day of year) - 3rd order	**-0.14**	**-0.2 – -0.09**	**-0.14**	**-0.19 – -0.09**
	cos(Day of year) - 1st order	**-0.13**	**-0.19 – -0.08**	**-0.18**	**-0.24 – -0.11**
	cos(Day of year) - 2nd order	**0.18**	**0.12 – 0.25**	**0.17**	**0.11 – 0.24**
	cos(Day of year) - 3rd order	**-0.18**	**-0.23 – -0.13**	**-0.17**	**-0.22 – -0.13**
	Wind speed		–	-0.03	-0.06 – 0
	Air pressure anomaly		–	0.02	-0.02 – 0.06
	SOI anomaly		–	0.03	-0.04 – 0.1
	Air temperature		–	**-0.04**	**-0.07 – -0.01**
	Sea surface temperature anomaly		–	**-0.12**	**-0.17 – -0.06**
Northern royal albatross	Intercept	**-1.28**	**-1.49 – -1.08**	**-1.54**	**-2.03 – -1.21**
	Days since start (×366)	**0.22**	**0.17 – 0.3**	**0.3**	**0.2 – 0.57**
	Afternoon	**-0.24**	**-0.35 – -0.13**	**-0.24**	**-0.36 – -0.13**
	Year 2007/08	-0.03	-0.22 – 0.17	0.17	-0.13 – 0.45
	Year 2008/09	**1.29**	**1.1 – 1.44**	**1.25**	**0.97 – 1.53**
	Year 2009/10	**0.57**	**0.34 – 0.74**	0.11	-0.7 – 0.45
	Year 2010/11	**0.25**	**0.11 – 0.4**	**0.57**	**0.23 – 0.82**
	sin(Day of year) - 1st order	0.1	-0.06 – 0.25	0.05	-0.1 – 0.21
	sin(Day of year) - 2nd order	**-0.17**	**-0.27 – -0.06**	**-0.14**	**-0.26 – -0.02**
	sin(Day of year) - 3rd order	**-0.35**	**-0.43 – -0.26**	**-0.4**	**-0.49 – -0.3**
	cos(Day of year) - 1st order	**0.33**	**0.11 – 0.51**	**0.44**	**0.21 – 0.65**
	cos(Day of year) - 2nd order	0.05	-0.1 – 0.17	0.04	-0.12 – 0.18
	cos(Day of year) - 3rd order	**0.18**	**0.02 – 0.35**	**0.18**	**0.04 – 0.33**
	Wind speed		–	0.01	-0.06 – 0.06
	Air pressure anomaly		–	**-0.13**	**-0.21 – -0.04**
	SOI anomaly		–	**-0.32**	**-0.58 – -0.03**
	Air temperature		–	0.04	-0.04 – 0.1
	Sea surface temperature anomaly		–	0.11	0 – 0.27

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Table A-2: (*continued*) Coefficients of the variables included in statistical models used to analyse seabird count data collected during pelagic trips by ecotourism operator Albatross Encounter off Kaikoura, New Zealand, between 2006 and 2012. The base model only included time-related variables, whereas the full model also included environmental variables. Each seabird species was modelled independently. Significant coefficients (i.e., the 95% confidence interval did not encompass zero) are shown in bold.

Species	Variables	Base model Mean	Base model 95% c.i.	Full model Mean	Full model 95% c.i.
Pied shag	Intercept	**1.02**	**0.5 – 1.31**	**0.96**	**0.46 – 1.29**
	Days since start (×366)	-0.06	-0.17 – 0.06	-0.06	-0.24 – 0.07
	Afternoon	-0.04	-0.21 – 0.12	0.02	-0.15 – 0.18
	Year 2007/08	**-0.35**	**-0.56 – -0.15**	-0.22	-0.55 – 0.08
	Year 2008/09	**-0.4**	**-0.68 – -0.05**	**-0.44**	**-0.76 – -0.1**
	Year 2009/10	-0.02	-0.28 – 0.28	-0.01	-0.33 – 0.51
	Year 2010/11	**-0.26**	**-0.51 – -0.01**	**-0.39**	**-0.71 – -0.07**
	sin(Day of year) - 1st order	-0.15	-0.34 – 0.1	-0.09	-0.3 – 0.11
	sin(Day of year) - 2nd order	-0.06	-0.34 – 0.14	-0.1	-0.31 – 0.09
	sin(Day of year) - 3rd order	-0.1	-0.25 – 0.07	-0.04	-0.19 – 0.11
	cos(Day of year) - 1st order	**0.31**	**0.11 – 0.65**	**0.31**	**0.09 – 0.62**
	cos(Day of year) - 2nd order	**0.34**	**0.17 – 0.52**	**0.33**	**0.16 – 0.5**
	cos(Day of year) - 3rd order	0.03	-0.12 – 0.16	0	-0.13 – 0.13
	Wind speed		–	**-0.16**	**-0.25 – -0.07**
	Air pressure anomaly		–	-0.05	-0.15 – 0.05
	SOI anomaly		–	0.07	-0.11 – 0.24
	Air temperature		–	**0.24**	**0.15 – 0.34**
	Sea surface temperature anomaly		–	-0.11	-0.27 – 0.06
Red-billed gull	Intercept	**4.46**	**4.21 – 4.66**	**4.54**	**4.27 – 4.79**
	Days since start (×366)	0.05	-0.02 – 0.1	0.02	-0.07 – 0.09
	Afternoon	**-0.15**	**-0.3 – -0.01**	-0.1	-0.24 – 0.04
	Year 2007/08	-0.12	-0.29 – 0.06	-0.2	-0.51 – 0.17
	Year 2008/09	0.01	-0.18 – 0.21	-0.03	-0.29 – 0.22
	Year 2009/10	**-0.26**	**-0.45 – -0.05**	-0.19	-0.48 – 0.17
	Year 2010/11	-0.2	-0.41 – 0.01	**-0.37**	**-0.7 – -0.06**
	sin(Day of year) - 1st order	**0.82**	**0.67 – 1**	**0.8**	**0.63 – 0.98**
	sin(Day of year) - 2nd order	0	-0.17 – 0.16	0	-0.18 – 0.19
	sin(Day of year) - 3rd order	-0.05	-0.2 – 0.08	-0.04	-0.17 – 0.1
	cos(Day of year) - 1st order	0.11	-0.06 – 0.44	0.05	-0.21 – 0.4
	cos(Day of year) - 2nd order	0.03	-0.17 – 0.2	0.04	-0.15 – 0.22
	cos(Day of year) - 3rd order	-0.13	-0.25 – 0	-0.13	-0.26 – 0.01
	Wind speed		–	**-0.14**	**-0.21 – -0.06**
	Air pressure anomaly		–	0.06	-0.06 – 0.16
	SOI anomaly		–	0.12	-0.03 – 0.34
	Air temperature		–	0.01	-0.09 – 0.1
	Sea surface temperature anomaly		–	-0.05	-0.24 – 0.12

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Table A-2: (*continued*) Coefficients of the variables included in statistical models used to analyse seabird count data collected during pelagic trips by ecotourism operator Albatross Encounter off Kaikoura, New Zealand, between 2006 and 2012. The base model only included time-related variables, whereas the full model also included environmental variables. Each seabird species was modelled independently. Significant coefficients (i.e., the 95% confidence interval did not encompass zero) are shown in bold.

Species	Variables	Base model Mean	Base model 95% c.i.	Full model Mean	Full model 95% c.i.
Salvin's albatross	Intercept	**1.34**	**1.16 – 1.79**	**1.27**	**0.97 – 1.7**
	Days since start (×366)	-0.06	-0.15 – 0	-0.05	-0.14 – 0.09
	Afternoon	**-0.15**	**-0.23 – -0.08**	**-0.13**	**-0.2 – -0.05**
	Year 2007/08	**0.34**	**0.25 – 0.43**	**0.34**	**0.19 – 0.49**
	Year 2008/09	**0.36**	**0.1 – 0.52**	**0.33**	**0.1 – 0.52**
	Year 2009/10	0.17	-0.01 – 0.32	0.08	-0.33 – 0.31
	Year 2010/11	0.14	0 – 0.27	**0.24**	**0.09 – 0.39**
	sin(Day of year) - 1st order	**-0.89**	**-0.99 – -0.78**	**-0.9**	**-0.99 – -0.8**
	sin(Day of year) - 2nd order	**0.45**	**0.36 – 0.53**	**0.45**	**0.36 – 0.54**
	sin(Day of year) - 3rd order	-0.03	-0.11 – 0.05	-0.03	-0.12 – 0.04
	cos(Day of year) - 1st order	**1.12**	**1.02 – 1.23**	**1.17**	**1.04 – 1.3**
	cos(Day of year) - 2nd order	-0.01	-0.1 – 0.09	-0.01	-0.1 – 0.09
	cos(Day of year) - 3rd order	**-0.39**	**-0.48 – -0.33**	**-0.39**	**-0.48 – -0.31**
	Wind speed		–	-0.04	-0.08 – 0
	Air pressure anomaly		–	-0.04	-0.08 – 0.01
	SOI anomaly		–	-0.06	-0.19 – 0.04
	Air temperature		–	**-0.11**	**-0.15 – -0.07**
	Sea surface temperature anomaly		–	0.06	-0.02 – 0.13
Short-tailed shearwater	Intercept	**-1.24**	**-3.22 – -0.44**	**-1.45**	**-4.23 – -0.05**
	Days since start (×366)	-0.27	-0.45 – 0.15	-0.27	-0.69 – 0.36
	Afternoon	**-0.54**	**-0.9 – -0.16**	**-0.54**	**-0.9 – -0.15**
	Year 2007/08	**-1.41**	**-1.9 – -0.91**	**-1.3**	**-2.32 – -0.09**
	Year 2008/09	0.12	-0.53 – 1.24	0.44	-0.37 – 1.9
	Year 2009/10	0.58	-0.02 – 1.32	0.79	0 – 2.02
	Year 2010/11	0.01	-0.68 – 0.71	-0.16	-1.06 – 1.15
	sin(Day of year) - 1st order	0.26	-0.2 – 0.69	0.36	-0.12 – 0.86
	sin(Day of year) - 2nd order	**-1.43**	**-2.21 – -0.84**	**-1.45**	**-2.37 – -0.8**
	sin(Day of year) - 3rd order	0.18	-0.33 – 0.82	0.16	-0.48 – 0.94
	cos(Day of year) - 1st order	**0.62**	**0.03 – 1.31**	0.59	-0.12 – 1.45
	cos(Day of year) - 2nd order	**-0.84**	**-1.33 – -0.27**	-0.82	-1.35 – 0.02
	cos(Day of year) - 3rd order	**0.64**	**0.19 – 0.99**	0.51	0 – 0.9
	Wind speed		–	-0.04	-0.24 – 0.16
	Air pressure anomaly		–	0.19	-0.15 – 0.44
	SOI anomaly		–	0.22	-0.95 – 0.68
	Air temperature		–	-0.03	-0.2 – 0.19
	Sea surface temperature anomaly		–	-0.08	-0.59 – 0.58

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Table A-2: (*continued*) Coefficients of the variables included in statistical models used to analyse seabird count data collected during pelagic trips by ecotourism operator Albatross Encounter off Kaikoura, New Zealand, between 2006 and 2012. The base model only included time-related variables, whereas the full model also included environmental variables. Each seabird species was modelled independently. Significant coefficients (i.e., the 95% confidence interval did not encompass zero) are shown in bold.

Species	Variables	Base model Mean	Base model 95% c.i.	Full model Mean	Full model 95% c.i.
Sooty shearwater	Intercept	-0.39	-0.92 – 0.07	-0.43	-0.95 – 0.07
	Days since start (×366)	-0.06	-0.16 – 0.04	-0.05	-0.18 – 0.18
	Afternoon	**-0.34**	**-0.57 – -0.05**	**-0.29**	**-0.52 – -0.01**
	Year 2007/08	0.18	-0.07 – 0.43	0.05	-0.28 – 0.41
	Year 2008/09	0.02	-0.26 – 0.3	-0.02	-0.34 – 0.33
	Year 2009/10	**0.99**	**0.65 – 1.34**	0.54	-0.14 – 1.08
	Year 2010/11	0.22	-0.07 – 0.53	0.11	-0.6 – 0.67
	sin(Day of year) - 1st order	**0.6**	**0.18 – 1.44**	**0.8**	**0.42 – 1.48**
	sin(Day of year) - 2nd order	**-1.74**	**-2.08 – -1.43**	**-1.72**	**-2.1 – -1.37**
	sin(Day of year) - 3rd order	**1.16**	**0.68 – 1.44**	**0.95**	**0.67 – 1.2**
	cos(Day of year) - 1st order	**1.71**	**1.23 – 2.25**	**1.63**	**1.15 – 2.14**
	cos(Day of year) - 2nd order	**-2.46**	**-2.97 – -1.64**	**-2.22**	**-2.66 – -1.66**
	cos(Day of year) - 3rd order	**0.96**	**0.51 – 1.33**	**0.82**	**0.51 – 1.13**
	Wind speed		–	0.04	-0.07 – 0.16
	Air pressure anomaly		–	0.02	-0.21 – 0.18
	SOI anomaly		–	0.01	-0.33 – 0.47
	Air temperature		–	**-0.51**	**-0.65 – -0.22**
	Sea surface temperature anomaly		–	0.05	-0.22 – 0.34
Southern black-backed gull	Intercept	**3.15**	**2.83 – 3.3**	**3.18**	**2.77 – 3.45**
	Days since start (×366)	**0.05**	**0.01 – 0.11**	0.05	-0.01 – 0.12
	Afternoon	-0.05	-0.14 – 0.04	-0.03	-0.12 – 0.06
	Year 2007/08	**-0.21**	**-0.31 – -0.12**	**-0.32**	**-0.51 – -0.17**
	Year 2008/09	**0.15**	**0.02 – 0.32**	0.1	-0.07 – 0.36
	Year 2009/10	-0.07	-0.19 – 0.07	-0.06	-0.21 – 0.12
	Year 2010/11	-0.06	-0.18 – 0.06	-0.13	-0.35 – 0.06
	sin(Day of year) - 1st order	0.01	-0.08 – 0.09	-0.01	-0.09 – 0.07
	sin(Day of year) - 2nd order	-0.03	-0.12 – 0.04	-0.03	-0.12 – 0.04
	sin(Day of year) - 3rd order	0.03	-0.05 – 0.1	0.04	-0.05 – 0.11
	cos(Day of year) - 1st order	**0.18**	**0.08 – 0.33**	**0.19**	**0.03 – 0.33**
	cos(Day of year) - 2nd order	-0.04	-0.11 – 0.04	-0.02	-0.1 – 0.08
	cos(Day of year) - 3rd order	-0.06	-0.12 – 0.01	-0.06	-0.12 – 0.01
	Wind speed		–	**-0.06**	**-0.1 – -0.02**
	Air pressure anomaly		–	0.02	-0.06 – 0.08
	SOI anomaly		–	0.01	-0.08 – 0.14
	Air temperature		–	0.03	-0.02 – 0.08
	Sea surface temperature anomaly		–	0.05	-0.02 – 0.14

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Table A-2: (*continued*) Coefficients of the variables included in statistical models used to analyse seabird count data collected during pelagic trips by ecotourism operator Albatross Encounter off Kaikoura, New Zealand, between 2006 and 2012. The base model only included time-related variables, whereas the full model also included environmental variables. Each seabird species was modelled independently. Significant coefficients (i.e., the 95% confidence interval did not encompass zero) are shown in bold.

Species	Variables	Base model Mean	Base model 95% c.i.	Full model Mean	Full model 95% c.i.
Southern giant petrel	Intercept	**-0.29**	**-0.65 – -0.03**	**-0.58**	**-0.87 – -0.3**
	Days since start ($\times$366)	**-0.12**	**-0.22 – -0.04**	-0.04	-0.13 – 0.04
	Afternoon	-0.16	-0.41 – 0.05	-0.14	-0.41 – 0.08
	Year 2007/08	-0.14	-0.36 – 0.09	0	-0.28 – 0.26
	Year 2008/09	-0.21	-0.5 – 0.08	-0.1	-0.44 – 0.23
	Year 2009/10	0.06	-0.23 – 0.37	-0.21	-0.51 – 0.1
	Year 2010/11	-0.23	-0.53 – 0.08	-0.24	-0.56 – 0.08
	sin(Day of year) - 1st order	**-0.59**	**-0.8 – -0.36**	**-0.55**	**-0.76 – -0.31**
	sin(Day of year) - 2nd order	**-0.36**	**-0.52 – -0.19**	**-0.35**	**-0.51 – -0.18**
	sin(Day of year) - 3rd order	-0.15	-0.31 – 0.04	-0.19	-0.37 – 0
	cos(Day of year) - 1st order	**-0.49**	**-0.66 – -0.32**	**-0.41**	**-0.6 – -0.22**
	cos(Day of year) - 2nd order	**0.37**	**0.19 – 0.54**	**0.37**	**0.18 – 0.54**
	cos(Day of year) - 3rd order	-0.01	-0.18 – 0.16	0	-0.17 – 0.19
	Wind speed		–	-0.06	-0.17 – 0.06
	Air pressure anomaly		–	-0.05	-0.18 – 0.07
	SOI anomaly		–	**-0.28**	**-0.44 – -0.09**
	Air temperature		–	-0.04	-0.14 – 0.08
	Sea surface temperature anomaly		–	0.02	-0.13 – 0.18
Southern royal albatross	Intercept	-0.44	-0.68 – 0.07	**-0.45**	**-0.69 – -0.04**
	Days since start ($\times$366)	**0.18**	**0.09 – 0.24**	**0.18**	**0.09 – 0.24**
	Afternoon	**-0.23**	**-0.33 – -0.12**	**-0.21**	**-0.31 – -0.11**
	Year 2007/08	**0.43**	**0.27 – 0.58**	**0.3**	**0.14 – 0.47**
	Year 2008/09	**0.44**	**0.1 – 0.69**	**0.35**	**0.05 – 0.58**
	Year 2009/10	0.17	-0.11 – 0.45	0.17	-0.08 – 0.5
	Year 2010/11	**-0.32**	**-0.49 – -0.17**	**-0.4**	**-0.56 – -0.25**
	sin(Day of year) - 1st order	0.09	0 – 0.18	0.08	-0.04 – 0.18
	sin(Day of year) - 2nd order	**0.18**	**0.08 – 0.3**	**0.19**	**0.09 – 0.31**
	sin(Day of year) - 3rd order	-0.09	-0.19 – 0.02	**-0.1**	**-0.2 – -0.01**
	cos(Day of year) - 1st order	**-0.19**	**-0.29 – -0.09**	**-0.16**	**-0.27 – -0.06**
	cos(Day of year) - 2nd order	0	-0.11 – 0.1	0.02	-0.08 – 0.12
	cos(Day of year) - 3rd order	-0.09	-0.2 – 0.01	-0.08	-0.18 – 0.01
	Wind speed		–	-0.01	-0.07 – 0.05
	Air pressure anomaly		–	**0.08**	**0.01 – 0.14**
	SOI anomaly		–	-0.04	-0.1 – 0.03
	Air temperature		–	**-0.18**	**-0.23 – -0.13**
	Sea surface temperature anomaly		–	**0.12**	**0.04 – 0.21**

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Table A-2: (*continued*) Coefficients of the variables included in statistical models used to analyse seabird count data collected during pelagic trips by ecotourism operator Albatross Encounter off Kaikoura, New Zealand, between 2006 and 2012. The base model only included time-related variables, whereas the full model also included environmental variables. Each seabird species was modelled independently. Significant coefficients (i.e., the 95% confidence interval did not encompass zero) are shown in bold.

Species	Variables	Base model Mean	Base model 95% c.i.	Full model Mean	Full model 95% c.i.
Spotted shag	Intercept	**3.03**	**2.65 – 3.72**	**2.99**	**2.5 – 4.1**
	Days since start (×366)	0.08	-0.06 – 0.17	0.07	-0.16 – 0.19
	Afternoon	**-0.53**	**-0.85 – -0.25**	**-0.51**	**-0.8 – -0.22**
	Year 2007/08	**0.37**	**0.06 – 0.68**	**0.72**	**0.27 – 1.18**
	Year 2008/09	**0.49**	**0.05 – 0.85**	0.54	-0.15 – 1.02
	Year 2009/10	**0.39**	**0.06 – 0.72**	0.36	-0.15 – 0.76
	Year 2010/11	-0.11	-0.45 – 0.25	0.1	-0.4 – 0.59
	sin(Day of year) - 1^{st} order	**1.97**	**1.76 – 2.19**	**1.96**	**1.74 – 2.17**
	sin(Day of year) - 2^{nd} order	**0.5**	**0.24 – 0.75**	**0.51**	**0.25 – 0.78**
	sin(Day of year) - 3^{rd} order	0.15	-0.04 – 0.33	0.18	-0.01 – 0.37
	cos(Day of year) - 1^{st} order	**-2.12**	**-2.36 – -1.87**	**-2.2**	**-2.53 – -1.87**
	cos(Day of year) - 2^{nd} order	-0.23	-0.47 – 0.02	**-0.29**	**-0.53 – -0.05**
	cos(Day of year) - 3^{rd} order	-0.05	-0.29 – 0.2	-0.02	-0.26 – 0.21
	Wind speed		–	-0.14	-0.31 – 0.01
	Air pressure anomaly		–	-0.02	-0.21 – 0.15
	SOI anomaly		–	-0.04	-0.23 – 0.21
	Air temperature		–	0	-0.13 – 0.12
	Sea surface temperature anomaly		–	-0.17	-0.36 – 0.01
Wandering albatross	Intercept	**-1.06**	**-1.44 – -0.67**	**-0.78**	**-1.29 – -0.28**
	Days since start (×366)	**-0.22**	**-0.35 – -0.07**	**-0.32**	**-0.46 – -0.16**
	Afternoon	-0.26	-0.6 – 0.09	-0.27	-0.6 – 0.07
	Year 2007/08	-0.06	-0.46 – 0.33	-0.21	-0.65 – 0.23
	Year 2008/09	-0.13	-0.58 – 0.34	-0.39	-0.94 – 0.17
	Year 2009/10	0.18	-0.37 – 0.71	**0.63**	**0.09 – 1.19**
	Year 2010/11	**0.52**	**0.02 – 1.04**	0.36	-0.16 – 0.88
	sin(Day of year) - 1^{st} order	-0.21	-0.58 – 0.11	-0.31	-0.64 – 0.01
	sin(Day of year) - 2^{nd} order	0.22	-0.02 – 0.47	0.19	-0.05 – 0.44
	sin(Day of year) - 3^{rd} order	-0.04	-0.33 – 0.22	0.01	-0.27 – 0.28
	cos(Day of year) - 1^{st} order	**-0.56**	**-0.88 – -0.21**	**-0.64**	**-1 – -0.26**
	cos(Day of year) - 2^{nd} order	-0.18	-0.51 – 0.13	-0.11	-0.43 – 0.2
	cos(Day of year) - 3^{rd} order	-0.13	-0.4 – 0.13	-0.19	-0.47 – 0.07
	Wind speed		–	0.02	-0.17 – 0.19
	Air pressure anomaly		–	-0.07	-0.25 – 0.11
	SOI anomaly		–	**0.39**	**0.14 – 0.64**
	Air temperature		–	0.1	-0.07 – 0.3
	Sea surface temperature anomaly		–	0.03	-0.22 – 0.29

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Table A-2: (*continued*) Coefficients of the variables included in statistical models used to analyse seabird count data collected during pelagic trips by ecotourism operator Albatross Encounter off Kaikoura, New Zealand, between 2006 and 2012. The base model only included time-related variables, whereas the full model also included environmental variables. Each seabird species was modelled independently. Significant coefficients (i.e., the 95% confidence interval did not encompass zero) are shown in bold.

Species	Variables	Base model Mean	Base model 95% c.i.	Full model Mean	Full model 95% c.i.
Westland petrel	Intercept	**1.85**	**1.68 – 2.1**	**1.74**	**1.55 – 1.95**
	Days since start (×366)	**-0.11**	**-0.16 – -0.08**	**-0.1**	**-0.14 – -0.06**
	Afternoon	**-0.33**	**-0.42 – -0.24**	**-0.28**	**-0.37 – -0.19**
	Year 2007/08	**0.16**	**0.05 – 0.27**	**0.25**	**0.09 – 0.41**
	Year 2008/09	**0.27**	**0.13 – 0.4**	**0.3**	**0.1 – 0.47**
	Year 2009/10	0	-0.13 – 0.13	-0.02	-0.19 – 0.17
	Year 2010/11	-0.01	-0.15 – 0.12	0.04	-0.14 – 0.22
	sin(Day of year) - 1^{st} order	0.07	-0.03 – 0.16	0.05	-0.07 – 0.16
	sin(Day of year) - 2^{nd} order	**-0.74**	**-0.87 – -0.62**	**-0.74**	**-0.88 – -0.62**
	sin(Day of year) - 3^{rd} order	**0.19**	**0.06 – 0.32**	**0.2**	**0.07 – 0.32**
	cos(Day of year) - 1^{st} order	**1.23**	**1.08 – 1.42**	**1.23**	**1.07 – 1.44**
	cos(Day of year) - 2^{nd} order	**-0.62**	**-0.78 – -0.41**	**-0.61**	**-0.76 – -0.4**
	cos(Day of year) - 3^{rd} order	**-0.15**	**-0.25 – -0.05**	**-0.15**	**-0.26 – -0.05**
	Wind speed		–	**-0.12**	**-0.17 – -0.07**
	Air pressure anomaly		–	-0.04	-0.1 – 0.03
	SOI anomaly		–	-0.03	-0.13 – 0.06
	Air temperature		–	0.04	-0.01 – 0.09
	Sea surface temperature anomaly		–	0	-0.09 – 0.13
White-chinned petrel	Intercept	**-0.55**	**-1.18 – -0.13**	**-0.45**	**-0.96 – -0.14**
	Days since start (×366)	0	-0.06 – 0.06	-0.04	-0.1 – 0.02
	Afternoon	0	-0.16 – 0.13	0.03	-0.12 – 0.17
	Year 2007/08	0.09	-0.06 – 0.24	**-0.31**	**-0.58 – -0.05**
	Year 2008/09	0.14	-0.04 – 0.31	0.02	-0.2 – 0.24
	Year 2009/10	**0.35**	**0.17 – 0.52**	**0.57**	**0.33 – 0.85**
	Year 2010/11	0.14	-0.03 – 0.3	-0.05	-0.31 – 0.2
	sin(Day of year) - 1^{st} order	**1.72**	**1.38 – 2.07**	**1.65**	**1.34 – 2**
	sin(Day of year) - 2^{nd} order	**-0.66**	**-0.96 – -0.26**	**-0.65**	**-0.96 – -0.3**
	sin(Day of year) - 3^{rd} order	**-0.34**	**-0.56 – -0.18**	**-0.31**	**-0.5 – -0.15**
	cos(Day of year) - 1^{st} order	**2.22**	**1.8 – 3.44**	**2.28**	**1.83 – 3.51**
	cos(Day of year) - 2^{nd} order	-0.26	-1.22 – 0.09	-0.32	-1.32 – 0.05
	cos(Day of year) - 3^{rd} order	-0.37	-0.61 – 0.12	-0.32	-0.55 – 0.16
	Wind speed		–	**-0.07**	**-0.14 – -0.01**
	Air pressure anomaly		–	0.05	-0.03 – 0.13
	SOI anomaly		–	0.13	-0.01 – 0.27
	Air temperature		–	**-0.11**	**-0.18 – -0.04**
	Sea surface temperature anomaly		–	0.12	-0.02 – 0.27

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Table A-2: (*continued*) Coefficients of the variables included in statistical models used to analyse seabird count data collected during pelagic trips by ecotourism operator Albatross Encounter off Kaikoura, New Zealand, between 2006 and 2012. The base model only included time-related variables, whereas the full model also included environmental variables. Each seabird species was modelled independently. Significant coefficients (i.e., the 95% confidence interval did not encompass zero) are shown in bold.

Species	Variables	Mean	Base model 95% c.i.	Mean	Full model 95% c.i.
White-fronted tern	Intercept	**3.54**	**3.1 – 3.76**	**3.55**	**3.19 – 3.94**
	Days since start (×366)	**-0.18**	**-0.26 – -0.08**	**-0.18**	**-0.24 – -0.1**
	Afternoon	-0.04	-0.16 – 0.07	-0.01	-0.13 – 0.1
	Year 2007/08	**-0.32**	**-0.47 – -0.17**	**-0.34**	**-0.63 – -0.09**
	Year 2008/09	-0.14	-0.35 – 0.12	-0.14	-0.37 – 0.1
	Year 2009/10	**-0.35**	**-0.55 – -0.13**	**-0.42**	**-0.63 – -0.2**
	Year 2010/11	**-0.2**	**-0.39 – -0.02**	**-0.27**	**-0.61 – -0.01**
	sin(Day of year) - 1st order	**0.25**	**0.1 – 0.39**	**0.23**	**0.11 – 0.36**
	sin(Day of year) - 2nd order	-0.02	-0.12 – 0.08	-0.01	-0.12 – 0.09
	sin(Day of year) - 3rd order	**-0.13**	**-0.25 – -0.02**	**-0.13**	**-0.26 – -0.02**
	cos(Day of year) - 1st order	**-0.15**	**-0.28 – -0.01**	-0.15	-0.36 – 0.01
	cos(Day of year) - 2nd order	-0.03	-0.19 – 0.12	-0.03	-0.19 – 0.15
	cos(Day of year) - 3rd order	-0.05	-0.16 – 0.06	-0.05	-0.16 – 0.07
	Wind speed		–	-0.05	-0.12 – 0.01
	Air pressure anomaly		–	0.04	-0.02 – 0.11
	SOI anomaly		–	-0.01	-0.18 – 0.22
	Air temperature		–	0.01	-0.06 – 0.07
	Sea surface temperature anomaly		–	0	-0.12 – 0.12

Figure A-1: Number of seabirds recorded during pelagic tours by ecotourism operator Albatross Encounter off the coast of Kaikoura, New Zealand, between 2006 and 2012 (time series, log scale) and within years (seasonality), for each species. The mean (solid line) and 95% confidence interval (shading) of the number of birds observed per trip (in blue) and model outputs (in red) from a base model that only included time-related variables are shown. The time series is aggregated by month, while the seasonality is aggregated by week (model) and month (observations). The time series also shows the mean and 95% confidence interval of the linear trend over time (in green) from the model.

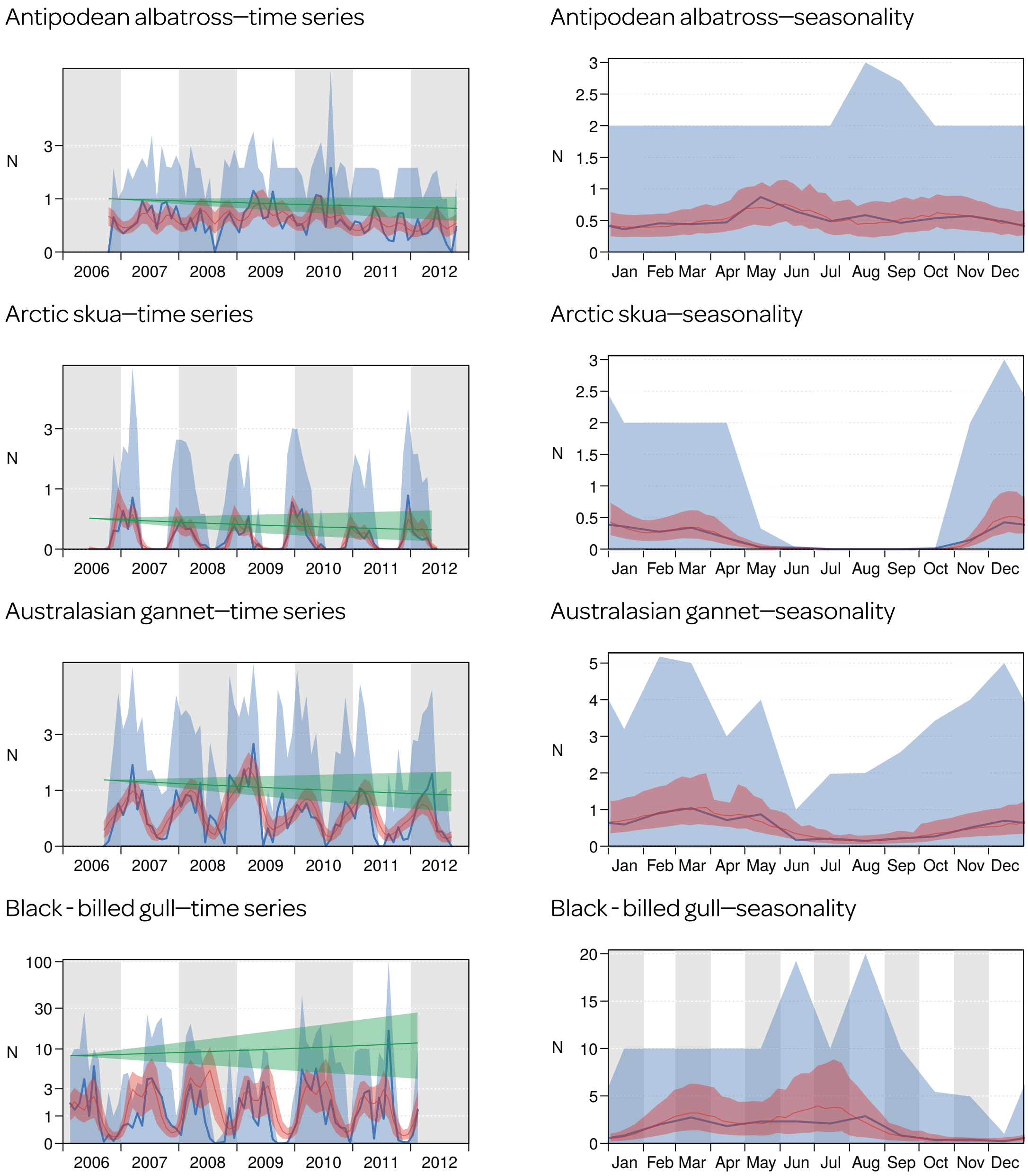
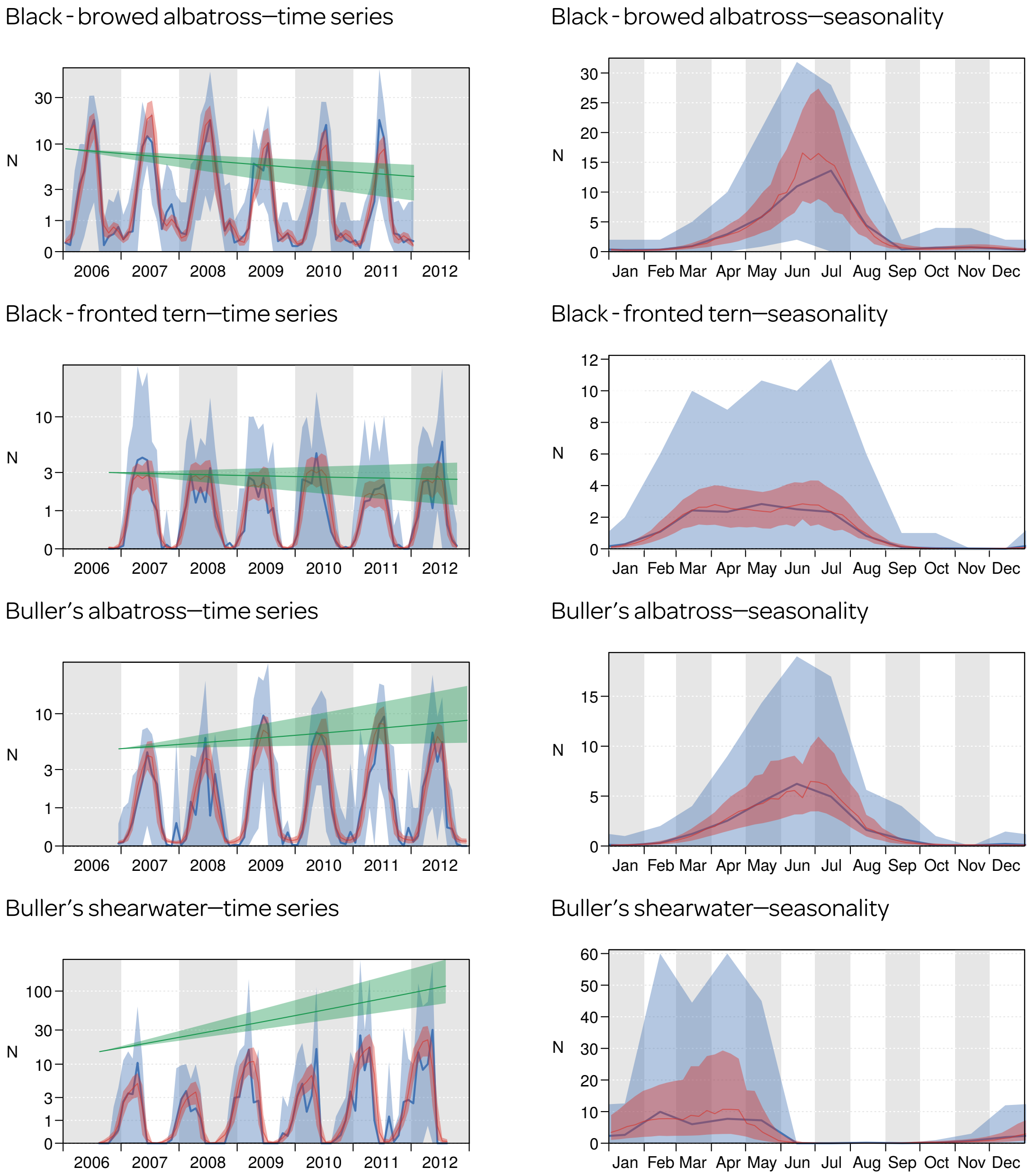


Figure A-1: (*continued*) Number of seabirds recorded during pelagic tours by ecotourism operator Albatross Encounter off the coast of Kaikoura, New Zealand, between 2006 and 2012 (time series, log scale) and within years (seasonality), for each species. The mean (solid line) and 95% confidence interval (shading) of the number of birds observed per trip (in blue) and model outputs (in red) from a base model that only included time-related variables are shown. The time series is aggregated by month, while the seasonality is aggregated by week (model) and month (observations). The time series also shows the mean and 95% confidence interval of the linear trend over time (in green) from the model.



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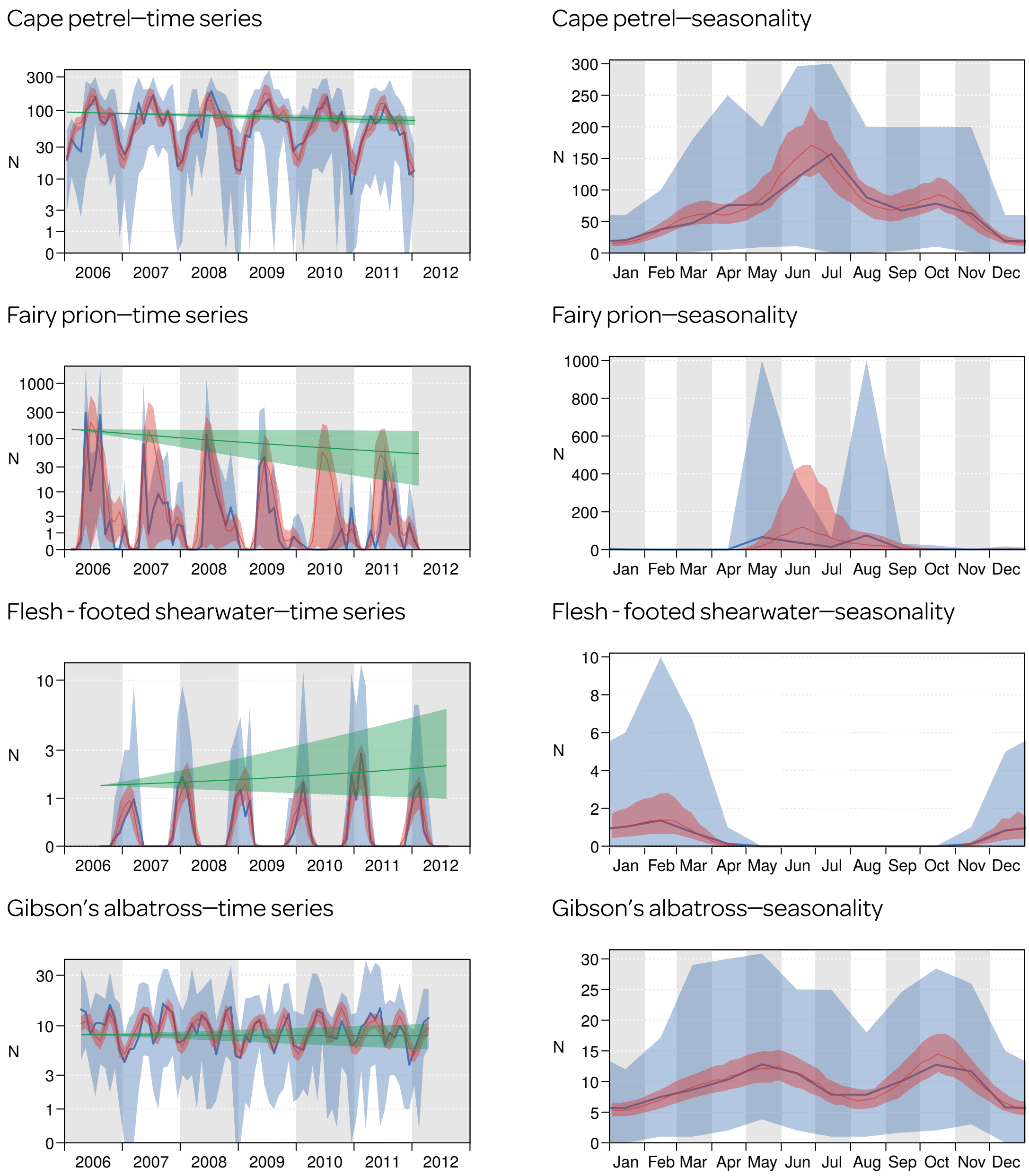

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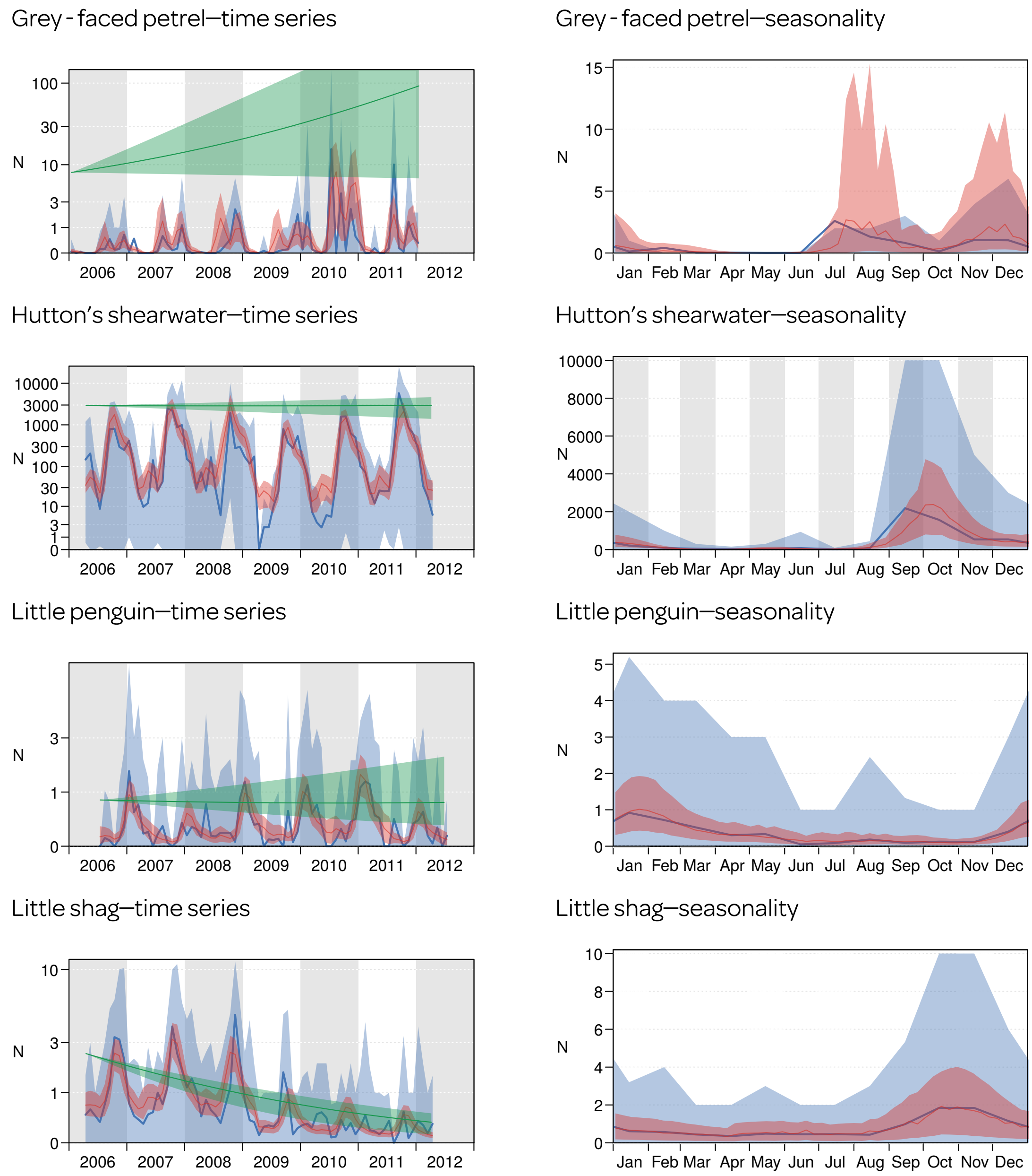

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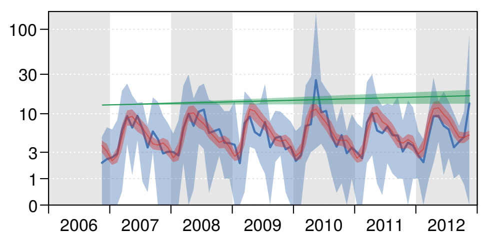
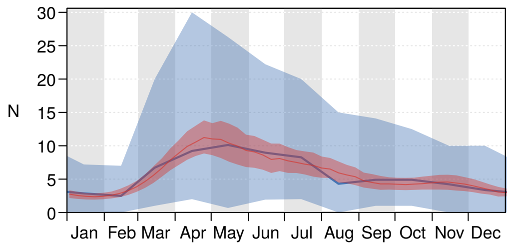
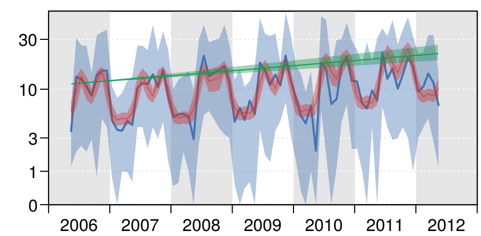
New Zealand white-capped albatross—time series



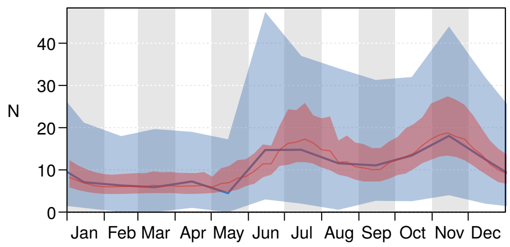
New Zealand white-capped albatross—seasonality



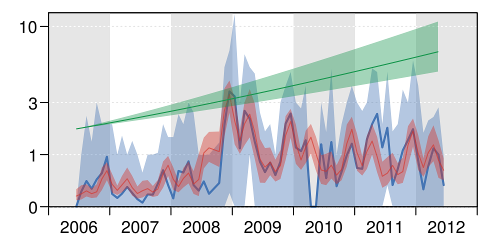
Northern giant petrel—time series



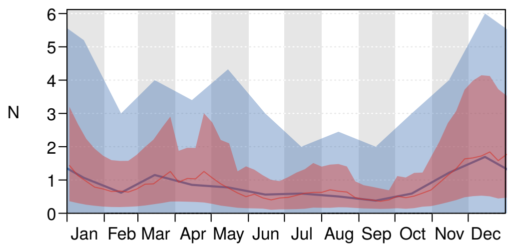
Northern giant petrel—seasonality



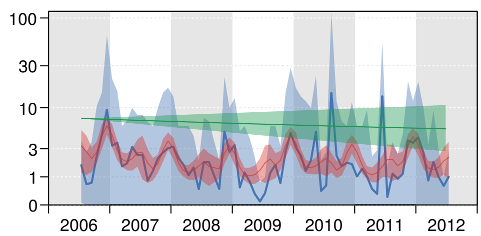
Northern royal albatross—time series



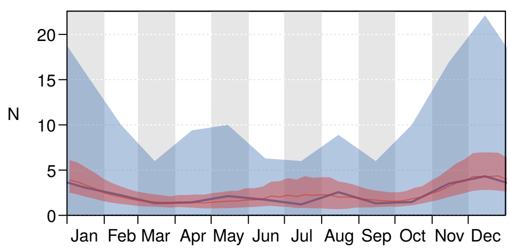
Northern royal albatross—seasonality



Pied shag—time series



Pied shag—seasonality



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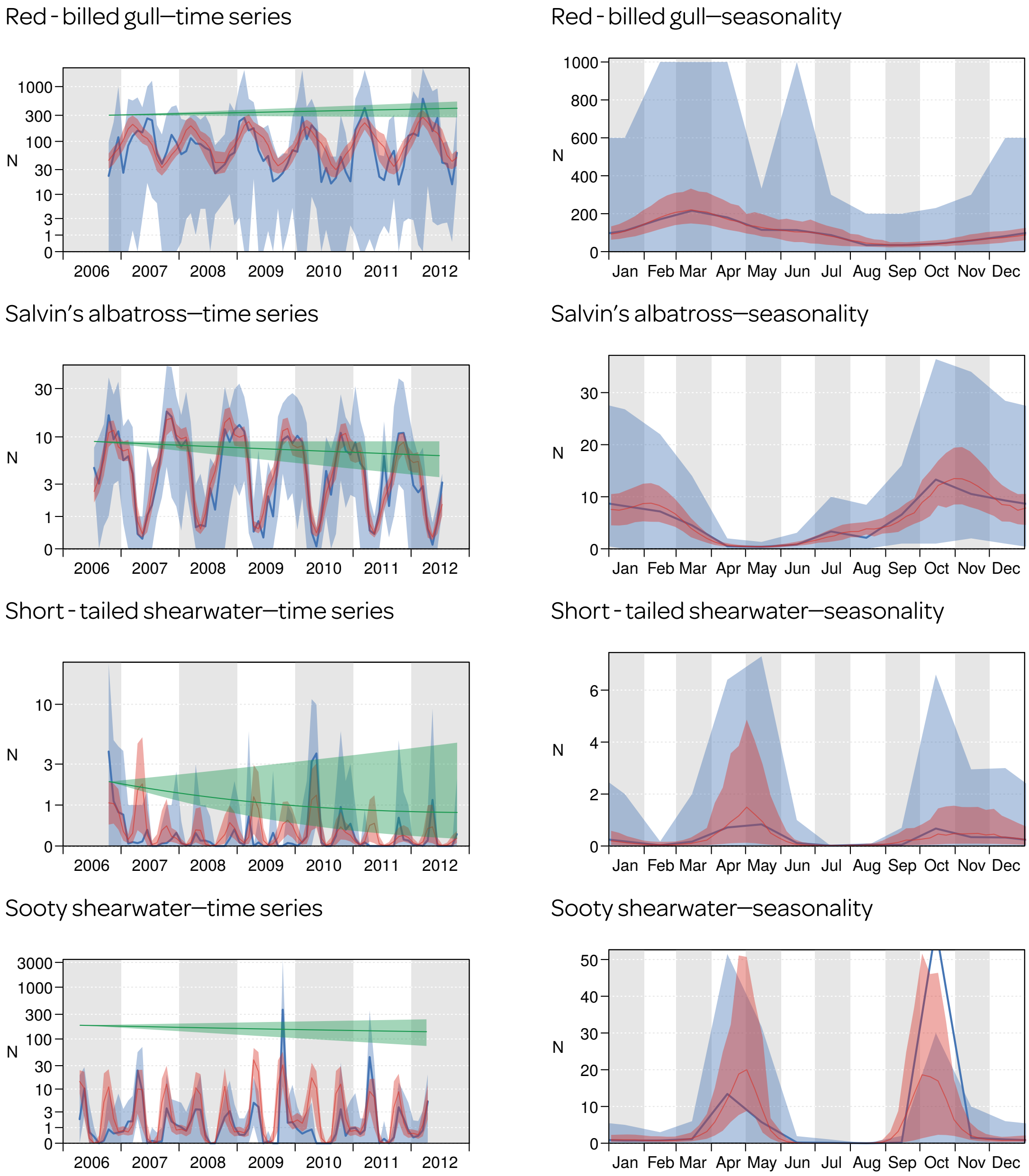

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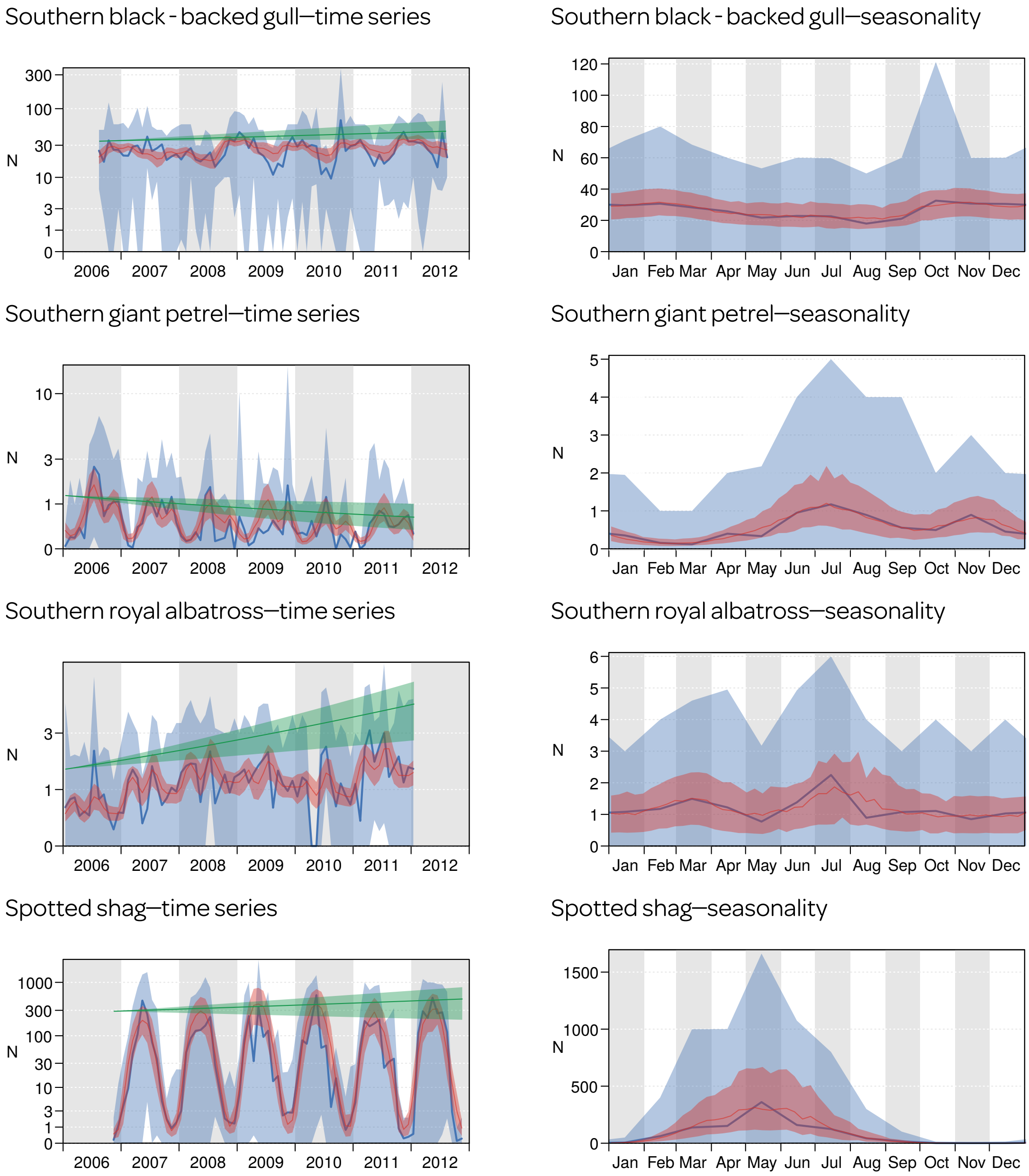

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