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Estimated capture of seabirds in New Zealand trawl and longline fisheries, to 2017–18

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New Zealand waters support a diverse range of seabird species, which frequently interact with fisheries throughout the region. Some of these interactions result in the incidental capture and mortality of seabirds in different commercial fisheries. Fisheries observers onboard commercial fishing vessels record this bycatch of seabirds, documenting the number and species that are getting caught. These observer records allow the estimation of total seabird captures, forming the basis of bycatch assessments in New Zealand's Exclusive Economic Zone.

The current analysis provides the most recent annual assessment of seabird captures in New Zealand waters, including data from the 2017–18 fishing year. The analysis used statistical models to derive estimates of total seabird captures across all commercial trawl and longline fisheries, applying a unified modelling framework to estimate incidental captures of seabirds. It followed the same approach as recent bycatch assessments, but an overdispersion scaling parameter was included in the current model update. This parameter took a value between zero and two: with a value of zero, the distribution of captures was assumed to follow a negative binomial distribution (as previously); with a value of two, the variance in the distribution of captures was proportional to the mean (similar to a Poisson distribution). The mean value of the posterior distribution of the overdispersion scaling parameters in the fitted models ranged from 0.54 to 1.27. This new parameter resulted in marked decreases in the uncertainty for a number of total seabird capture estimates.

Included in the modelling were ten species and species groups: New Zealand white-capped albatross (*Thalassarche steadi*), Salvin's albatross (*Thalassarche salvini*), Buller's albatross (*Thalassarche bulleri*, combining both southern *T. b. bulleri* and northern *T. b. platei* subspecies), white-chinned petrel (*Procellaria aequinoctialis*), black petrel (*Procellaria parkinsoni*), grey petrel (*Procellaria cinerea*), sooty shearwater (*Puffinus griseus*), flesh-footed shearwater (*Puffinus carneipes*), and "other albatrosses" and "other birds". The time periods of the current estimation were the fishing years from 2002–03 to 2017–18 for trawl fisheries, and from 1998–99 to 2017–18 for longline fisheries.

There was a total of 3328 (95% c.i.: 2971–3782) estimated seabird captures in trawl and longline fisheries (c.i., credible interval, the 95th quantile range of the posterior distribution) in 2017–18. The total estimate included 1506 (95% c.i.: 1344–1696) seabird captures in trawl fisheries, 1186 (95% c.i.: 913–1589) captures in bottom-longline fisheries, and 635 (95% c.i.: 536–758) captures in surface-longline fisheries. The highest number of total estimated captures in 2017–18 was of white-chinned petrel, with 681 (95% c.i.: 486–1040) estimated captures of this species. The second highest estimate was 462 (95% c.i.: 383–565) captures of New Zealand white-capped albatross, followed by 426 (95% c.i.: 321–554) captures of flesh-footed shearwater. Capture estimates for other species included 350 (95% c.i.: 256–474) captures of Salvin's albatross, 242 (95% c.i.: 159–369) captures of black petrel, 231 (95% c.i.: 181–295) captures of Buller's albatrosses, 213 (95% c.i.: 143–322) captures of sooty shearwater, and 139 (95% c.i.: 62–293) captures of grey petrel. In addition to estimates for individual species, there were 331 (95% c.i.: 255–431) captures of other birds and 249 (95% c.i.: 181–340) captures of other albatrosses.

For eight of the ten modelled species groups, the total number of estimated captures decreased between 2002–03 and 2017–18. The exceptions were white-chinned petrel and grey petrel, for which the total number of estimated captures did not show a clear decrease over this time period. When estimated captures in 2017–18 were compared with estimates in 2006–07, after mandatory mitigation measures were introduced in trawl fisheries in January 2006), the former estimates were similar to those in 2006–07 for many species. Capture estimates for all species groups combined showed a clear decrease over the assessment period, with the lowest mean number of seabird captures in the reporting period in 2017–18. These decreases were largely determined by marked decreases in fishing effort.

There were sufficient numbers of captures in large-vessel fisheries to examine temporal trends in capture rates (number of captures per unit fishing effort). Patterns over time varied, depending on the fishing method and target fishery, and between albatrosses and petrels. These patterns included a decrease in albatross capture rates (number of captures per unit fishing effort) in squid and in hoki trawl fisheries in 2006, immediately following the introduction of mandatory warp mitigation; however, capture rates subsequently increased or showed no clear trend in more recent years. For petrels in the squid trawl fishery, capture rates exhibited a distinct pattern of higher captures in alternate years, but the reason for these fluctuations is unknown.

The estimation of seabird captures relies on data collected by onboard fisheries observers, but observer coverage and effort varied considerably across fishing methods and vessel sizes over the reporting period. Increasing observer coverage in the small-vessel fleets, and ensuring that all vessels have at least some observer coverage, would help to ensure that estimates based on observer data reliably reflect seabird bycatch in New Zealand's commercial trawl and longline fisheries.

1. INTRODUCTION

New Zealand waters support a wide variety of seabirds, with over 80 species breeding on mainland and offshore islands (Taylor 2000b, Robertson et al. 2003). These species reflect about 25% of all seabird species worldwide, making New Zealand one of few seabird biodiversity hotspots on a global scale (Karpouzi et al. 2007).

In New Zealand and elsewhere, seabirds are exposed to a number of threats, including fishing-related mortality through incidental capture in fishing gear (Anderson et al. 2011, Lewison et al. 2014, Clay et al. 2019). Captures occur across a range of different fisheries; for example, seabirds become hooked or entangled in longline gear, get caught in trawl nets, or collide with warp cables on trawl vessels. For some species and populations, these incidental captures pose a serious threat (Sullivan et al. 2006, Jiménez et al. 2014). Of the twelve albatross taxa that are recognised by the Department of Conservation as breeding in New Zealand, five have a threatened status, and seven are considered at risk (Robertson et al. 2017).

Efforts to reduce seabird bycatch include assessments of the species and number of individuals caught, the identification of population and fishery characteristics that may contribute to captures, and modifications to fishing gear and practices to reduce the number of interactions (Pierre et al. 2014, Hedd et al. 2016, Jiménez et al. 2016). To monitor protected species captures in New Zealand waters, there have been regular bycatch assessments that combine data from the government fisheries observer programme with fisher-reported effort data to scale up capture rates from the observed fishing effort to the total fishing effort across different commercial fisheries (e.g., Abraham & Berkenbusch 2017, Abraham & Richard 2019a). Fisheries observers provide an independent record of incidental captures as they systematically document captures while they are onboard commercial fishing vessels, but observer coverage varies across fisheries. This variable observer coverage means that the estimation of incidental seabird captures is restricted to fisheries with sufficient observer data, which are trawling, bottom-longlining, and surface-longling. For these fisheries, the estimation derives the number of observable captures that would have been recorded if observers had been present during all fishing.

The most recent assessment of incidental seabird captures in trawl, bottom-longline, and surface-longline fisheries in New Zealand waters included data up to the 2016–17 fishing year (Abraham & Richard 2019b). The present update included an additional year of observer data from the 2017–18 fishing year. With this update, the time periods for the different fisheries were from 1998–99 to 2017–18 for longline fisheries, and from 2002–03 to 2017–18 for trawl fisheries. The aim of the assessment was to estimate how many seabird captures would be reported from trawl and longline fisheries, if all fishing was observed. A total mortality, including seabird mortalities that would not be recorded by observers (such as birds that are hooked and drowned, but fall off before the haul), was not estimated. The captures do not include seabird fatalities from deck strike (where birds are killed by collision with the vessel), but only account for fishing-related mortality.

The present assessment followed the same approach as recent bycatch assessments, applying a unified modelling framework to estimate incidental captures of seabirds for ten species and species groups. The ten species groups were: New Zealand white-capped albatross (*Thalassarche steadi*), Salvin's albatross (*Thalassarche salvini*), Buller's albatross (*Thalassarche bulleri*, combining both southern *T. b. bulleri* and northern *T. b. platei* subspecies), white-chinned petrel (*Procellaria aequinoctialis*), black petrel (*Procellaria parkinsoni*), grey petrel (*Procellaria cinerea*), sooty shearwater (*Puffinus griseus*), flesh-footed shearwater (*Puffinus carneipes*),"other albatrosses", and "other birds".

2. METHODS

2.1 Estimating seabird captures

The estimation of seabird bycatch followed methods used in recent seabird bycatch assessments, applying a unified modelling framework that allows direct comparisons across species (Abraham & Richard 2019a, 2019b). The modelling framework was based on a hierarchical generalised linear mixed-effects model (GLMM). The GLMMs were fitted to the observed fishing effort and capture data to estimate the observable captures on unobserved fishing effort, using Bayesian methods, and had the same structure as the previous models (e.g., Abraham & Richard 2019a, 2019b). The previous modelling (Abraham & Richard 2019b) found that the model occasionally estimated a higher number of captures on groups of fishing events than were observed. In the current assessment, this shortcoming was addressed by modifying the relationship between the mean number of captures and the variance (as described below).

Following on from previous assessments, the analysis was updated by including data from the 2017–18 fishing year. With this update, the time periods included in the estimation were from 1998–99 to 2017–18 for longline fisheries, and from 2002–03 to 2017–18 for trawl fisheries. The assessment period for trawl fisheries was shorter than for longline fisheries: earlier observer records of seabird captures in trawl fisheries were considered incomplete, because observers in these fisheries were not focused on recording seabird captures during this earlier period.

For the capture estimation, GLMMs were fitted to the observed fishing effort and capture data, and then used to estimate the observable captures on unobserved fishing effort. Models were fitted for the ten species and species groups, with data grouped for each model by fishing method, target fishery, vessel size class, spatial area, fishing year, and quarter of the year. Data on the use of integrated weight line (a mitigation measure used in bottom-longline (BLL) fisheries) were also included in the modelling. The capture rate (number of captures per unit fishing effort) was estimated within each of these strata from the observed captures. The capture rate was then applied to unobserved fishing effort to estimate the number of total captures.

To standardise the models, a single structure was used for all species and species groupings, combining all trawl, surface-longline, and bottom-longline fisheries. Observed captures were assumed to follow a negative binomial distribution. This distribution provides an adequate representation of capture data characterised by many zeros and occasional large values. The negative binomial distribution is parametrised by a mean, μ, and an overdispersion, ϕ. The variance is given by $\mu + \mu^2/\phi$. As the overdispersion increases to infinity, the variance nears the mean, and the negative binomial distribution converges to a Poisson distribution. As ϕ gets small relative to the mean, the negative binomial distribution becomes increasingly peaked at zero and becomes right-skewed (i.e., it develops a long right-hand tail). The negative binomial distribution has the convenient attribute that the sum of n samples drawn from a negative binomial distribution is also negative-binomially distributed, with mean $n\mu$ and overdispersion $n\phi$. This characteristic of the negative binomial distribution allowed the model to be applied to grouped event-level data (multiple fishing events reported as a single record).

In the previous estimation (Abraham & Richard 2019b), a shortcoming of the model was identified, with the model estimating occasional high numbers of captures that exceeded the number of observed captures. When there was a high mean catch rate, the variance in the distribution of estimated captures was higher than the variance in the observed captures. Across the three fishing methods, the species with highest ratio of the variance to the mean of the estimated captures were: sooty shearwater, white-chinned petrel (trawl); flesh-footed shearwater (surface longline); and white-chinned petrel, grey petrel, and Salvin's albatross (bottom longline). This shortcoming was addressed by introducing another parameter, ν, into the model, which controlled the relationship between the mean and the variance. The parameter ϕ was specified as $\phi\mu^{\nu}$. With this parameterisation, the variance of the negative binomial distribution became $\mu + \mu^{2-\nu}/\phi$. If $\nu = 0$, then the parameterisation is the same as above, but if $\nu = 2$, then the variance scales as the mean, μ (Figure 1). Apart from this change, and the extension of the date range to include the 2017–18 fishing year, the specification of the model was the same as used previously.

The mean catch rate for a single fishing event was assumed to vary with:

- $M_{m,v}$: combination of fishing method (m; either trawl, surface longline or bottom longline), and vessel class (v; "large" for vessels with a length over 45 m, 34 m, or 28 m, respectively for surface-longline, bottom-longline and trawl fishing, "small" otherwise),
- F: target fishery,

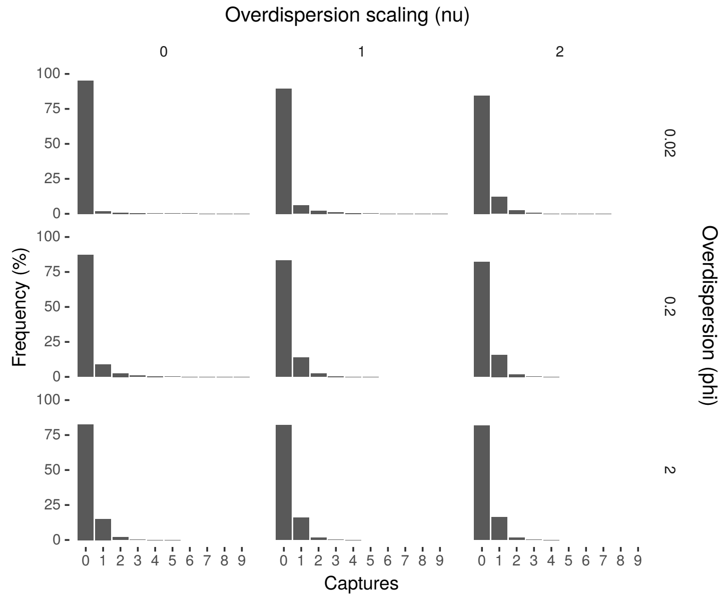

Figure 1: Example of the effect of the overdispersion scaling parameter on the distribution of the number of captures per fishing event. For a fixed value of the mean captures per event, μ=0.2, the distribution of samples from the negative binomial is shown for different values of the overdispersion, ϕ, and of the overdispersion scaling parameter, ν. Events of more than nine captures are not shown. As the overdispersion increases, relative to the mean, the distribution becomes narrower. As the overdispersion scaling increases, for fixed mean and overdispersion, the distribution also becomes narrower.

- A: area (see Figure 2),
- R: region ("north" or "south", with "north" being the region including Kermadec Islands, west coast North Island, east of North Island, and north-east areas),
- S: season (period of four months, starting with January–April considered to be summer),
- $Y_{m,v,y}$: year.

(Note that no event-level information was used, so that data could be aggregated by summing the number of fishing events and the number of observed captures by fishing method, target fishery, vessel class, region, area, fishing year, and season.)

The mean catch rate for a single fishing event in the group i of events was assumed to be the product of the effects:

$$\mu_i = \alpha M_{m,v,i} F_i A_i R_i S_i Y_{m,v,y,i}, \tag{1}$$

where α is the intercept, with a log-normal prior, defined with a mean of -3 and a standard deviation of 5 on the log scale.

The area, region, and season effects were assumed to apply to all fisheries, irrespective of the fishing method, fishery or vessel class. Under this assumption, spatial and seasonal effects are primarily determined by the ecology of the species, rather than by the fishing practices. In contrast, the year effect was estimated independently for each combination of method and vessel class, recognising that inter-annual variations may occur not only due to the ecology of species, but also due to changes in fishing practices.

The main effects of the combination of fishing method and vessel class, and the season and region effects, were modelled as fixed effects, relative to the base case, taken as the combination of method, vessel class, region and season with the highest number of observed captures, different for each species (see Table 1

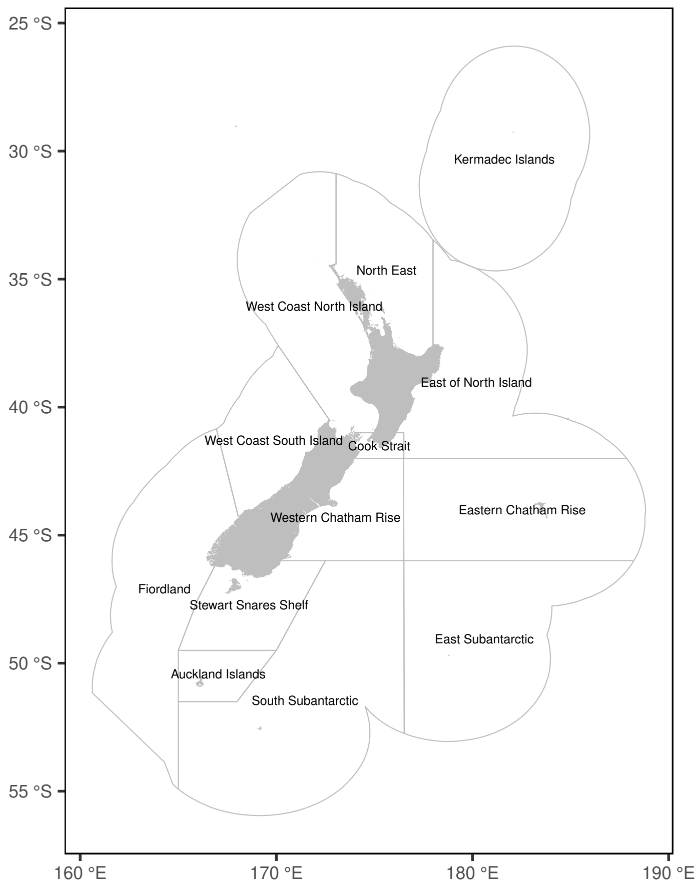

Figure 2: Areas used for the estimation of the number of incidental captures of seabirds in commercial fisheries in New Zealand's Exclusive Economic Zone.

for the base levels of these factors for each species). The prior of these fixed effects was a log-normal distribution, having a mean of 0 and a standard deviation of 5 on the log scale.

The effects of area, fishery and year were modelled as multiplicative random effects, drawn from a gamma distribution with mean 1. The year effect was only applied to large vessels, because the number of observations in the small-vessel fleet was insufficient to fit a random variable. For each random effect, the shape and rate of the gamma distribution were set to be the same, so that the mean was 1 for each random effect, and set so that the standard deviation of the random effect was drawn from a log-normal distribution (the standard deviation of a gamma-distributed random variable with mean 1 is the inverse of the square-root of the shape). The prior of the standard deviation was a log-normal distribution (with a mean of 0 and a standard deviation of 1, on the log scale), and was truncated to be between 10^{-8} and 10. This truncation assumed that large deviations from the mean (a multiplier over 10) would not be plausible, preventing limitations caused by occasional samples with exceedingly high values affecting the capture estimates; the quantiles of the posterior distributions were assessed to ensure they remained different from this limit.

The overdispersion parameter ϕ had a log-normal prior (with mean 0 and standard deviation 1 on the log scale), truncated to be within the range $1/400$ to 400. The prior of the additional parameter, ν, was a uniform distribution between 0 and 2.

Target fisheries were the same as those used previously (Abraham & Richard 2017, 2018, 2019a; see Table 2). They included the split of bottom-longline fisheries targeting ling into three different target fisheries, including small vessels, and large vessels with and without the use of integrated weight line.

Table 1: Base levels for fishing method, vessel class, region, and season, for which the number of observed seabirds captures was highest, for the ten models used to estimate the number of incidental captures of ten species groups in commercial trawl, bottom-longline (BLL), and surface-longline (SLL) fisheries. For each model, the effects were estimated relative to these base levels. Cut-off lengths between small- and large-vessel size classes were ≥45 m, ≥34 m, and ≥28 m, for surface-longline, bottom-longline, and trawl fishing, respectively.

Model	Method - vessel class	Region	Season
White-capped albatross	Trawl - Large vessels	South	Summer
Salvin's albatross	Trawl - Large vessels	South	Spring
Buller's albatrosses	SLL - Large vessels	South	Autumn
Other albatrosses	SLL - Small vessels	North	Spring
White-chinned petrel	Trawl - Large vessels	South	Summer
Black petrel	BLL - Small vessels	North	Summer
Grey petrel	BLL - Large vessels	South	Winter
Sooty shearwater	Trawl - Large vessels	South	Autumn
Flesh-footed shearwater	SLL - Small vessels	North	Summer
Other birds	Trawl - Large vessels	South	Autumn

This split was prompted by a proportion of large-vessel bottom-longline fisheries using integrated weight lines as a mitigation measure to reduce the capture rate of seabirds. The integrated weight lines have an added lead core so that they sink faster, reducing the amount of time baited hooks are available to seabirds. The weighting of lines has been previously found to significantly reduce capture rates in models used for estimating seabird captures (e.g., Abraham et al. 2016). Other mitigation measures were not represented in the models, because data on mitigation use were not routinely reported by fishers. As the primary purpose of these models was to extrapolate from observed fishing to all fishing, we were restricted to information available in the fisher reported data.

Each model was fitted with the software package Stan (Carpenter et al. 2017), using Markov chain Monte Carlo (MCMC) methods. The model code is presented by Abraham & Richard (2019a). Three chains were fitted to each model, with the output including samples of the posterior distribution from each chain. Model convergence was assessed with diagnostics provided by the CODA package for the R statistical system (Plummer et al. 2006), including the criteria of Heidelberger & Welch (1983) and Geweke (1992). The models were run for 2000 updates during burn-in, and then run for up to a further 40 000 updates, with every 30th sample retained for analysis (i.e., 1334 samples were retained from each chain, resulting in a total of 4000 samples).

Traces from the posterior chains for the model parameters provide a visual assessment of the performance of the Bayesian model, and would indicate parameters that had limited convergence, possibly resulting in unreliable estimates. For each parameter, diagnostics also included testing the number of chains that failed half-width (Heidelberger & Welch 1983), convergence (Geweke 1992), and $\hat{R}$. In addition, the sample size adjusted for autocorrelation was calculated, and the percentage of samples lost due to autocorrelation in the chains was included in the diagnostics.

2.2 Data used for seabird capture estimation

For the estimation, observer data of seabird captures, observed effort, and total fishing effort were obtained from the Protected Species Capture (PSC) database, updated to include data from the 2017–18 fishing year (see details of the preparation of this database, including changes and updates for the 2017–18 fishing year in Abraham & Berkenbusch 2019). Summaries of these data are available through the PSC website (https://psc.dragonfly.co.nz).

There was marked variation in fishing effort and observer coverage between methods, vessel size classes, and target fisheries (Table 2). In large-vessel surface-longline fisheries targeting southern bluefin tuna, observer coverage over the entire period was close to 90% (ranging between 50.2% and 100.0% annual observer coverage). This fishery was dominated by Japanese charter vessels, which stopped fishing in New Zealand in 2015–16 due to regulatory changes. In contrast, in the small-vessel bottom-longline fishery targeting snapper, the observer coverage was less than 2%, when averaged over the entire assessment period (ranging between 0.0% and 16.3% annual observer coverage).

When restricted to the fishing methods and years included in this analysis, there were 9977 observed seabird captures (Table 3). This total included 6249 seabird captures in trawl fisheries; 2183 seabird captures in bottom-longline fisheries; and 1545 seabird captures in surface-longline fisheries. The species with the highest number of observed captures was white-chinned petrel, with 2938 recorded captures. Some species, such as sooty shearwater, were predominantly caught in single fishing methods, whereas other species, such as flesh-footed shearwater, were caught across multiple fishing methods.

Over the period included in the models, there was a marked increase in the number of white-chinned petrel observed caught in trawl fisheries, and decreases in the number of white-chinned petrel and grey petrel observed caught in bottom longline fisheries (Figure 3). There have been shifts in observer coverage over the period covered by the models, however, and changes in the number of observed captures may have occurred both from changes in the number and distribution of observed fishing events, and any changes in the seabird capture rates.

Some seabird groups had particular years with high numbers of observed captures. For example, the high number of captures of other albatrosses during the 2006–07 fishing year was associated with a single surface longline trip targeting swordfish; the high number of black petrel captures during the 2009–10 fishing year was associated with a single bottom longline trip targeting bluenose in the vicinity of Great Barrier (Aotea) Island, where black petrel breed.

Table 2: Summary of total effort, observed effort, proportion of effort observed by modelled fishery, which consisted of a combination of fishing method, vessel class, and target fishery. Also shown are the fishing years during which the fisheries were active, between 2002–03 and 2017–18 for trawl, and between 1998–99 and 2017–18 for bottom-longline (BLL) and surface-longline (SLL) fisheries. Cut-off lengths between small- and large-vessel size classes were ≥45 m, ≥34 m, and ≥28 m, for surface-longline, bottom-longline, and trawl fishing, respectively. IWL: integrated weight line. Fisheries with fewer than 1000 events in the model dataset are not shown.

Method	Vessel class	Target fishery	Fishing years		Fishing events		
			First	Last	Total	Observed	Proportion (%)
Trawl	Large vessels	Hoki	2002–03	2017–18	192 642	42 565	22.1
		Deepwater	2002–03	2017–18	83 590	22 196	26.6
		Squid	2002–03	2017–18	71 511	27 191	38.0
		Middle depths	2002–03	2017–18	47 822	13 043	27.3
		Mackerel	2002–03	2017–18	35 572	16 607	46.7
		Inshore	2002–03	2017–18	35 533	1 802	5.1
		Hake	2002–03	2017–18	15 667	5 349	34.1
		S. blue whiting	2002–03	2017–18	12 457	7 110	57.1
		Ling	2002–03	2017–18	12 107	2 387	19.7
		Scampi	2002–03	2017–18	10 297	1 096	10.6
	Small vessels	Inshore	2002–03	2017–18	504 608	12 082	2.4
		Flatfish	2002–03	2017–18	305 014	1 721	0.6
		Middle depths	2002–03	2017–18	71 181	889	1.2
		Scampi	2002–03	2017–18	62 890	4 927	7.8
		Hoki	2002–03	2017–18	20 609	1 226	5.9
		Ling	2002–03	2017–18	6 881	170	2.5
		Deepwater	2002–03	2017–18	6 289	263	4.2
		Squid	2002–03	2017–18	4 778	8	0.2
SLL	Large vessels	Bluefin	1998–99	2014–15	4 339	3 828	88.2
	Small vessels	Bigeye	1998–99	2017–18	44 865	1 078	2.4
		Bluefin	1998–99	2017–18	21 095	1 661	7.9
		Albacore	1998–99	2016–17	4 043	32	0.8
		Swordfish	1998–99	2017–18	3 831	280	7.3
		Minor species	1998–99	2017–18	1 634	42	2.6
BLL	Large vessels	Ling, no IWL	1998–99	2017–18	35 223	5 430	15.4
		Ling, with IWL	2002–03	2017–18	11 914	3 085	25.9
	Small vessels	Snapper	1998–99	2017–18	158 371	1 992	1.3
		Ling	1998–99	2017–18	59 663	1 173	2.0
		Bluenose	1998–99	2017–18	52 757	410	0.8
		Hāpuku	1998–99	2017–18	38 029	264	0.7
		Minor species	1998–99	2017–18	33 425	614	1.8

Table 3: Number of observed seabird captures within each model group, by fishing method. The observed captures are the total over the period included in the data (2002–03 to 2017–18 for trawl fisheries, 1998–99 to 2017–18 for longline fisheries).

Species grouping	Trawl	Bottom longline	Surface longline	Total
White-chinned petrel	1 860	1 020	58	2 938
Sooty shearwater	1 577	98	14	1 689
White-capped albatross	1 403	10	264	1 677
Buller’s albatrosses	420	15	613	1 048
Salvin’s albatross	459	194	15	668
Grey petrel	65	416	58	539
Other birds	281	158	80	519
Other albatrosses	91	61	244	396
Flesh-footed shearwater	64	119	143	326
Black petrel	29	92	56	177
All	6 249	2 183	1 545	9 977

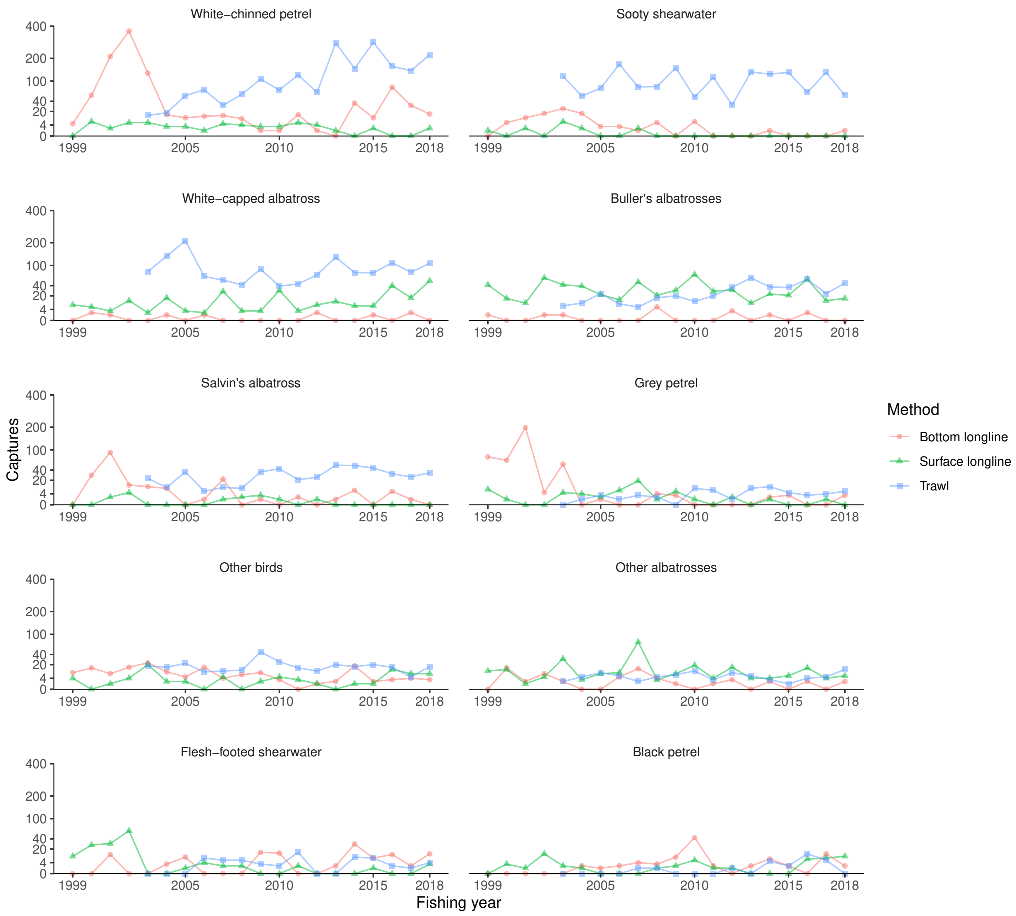

Figure 3: Observed captures of seabirds used in the estimation. For each of the ten species groups, the figure shows the number of observed captures per fishing year that were included in the estimation, for the three fishing methods. The charts are shown in order of decreasing total numbers of observed captures, and the y-axis is square root transformed.

3. RESULTS

3.1 Estimation model fitting

All model parameters, across all ten models, passed convergence and half-width tests for most chains (there were 15 cases where one of the three chains failed the convergence test). There were no cases where all the chains failed the convergence test. There were no chains where autocorrelation led to a reduction in the effective length of the chains to below 15% of the initial length (see Appendix A for diagnostics for each of the ten models, and details of each model by region, fishery, vessel size, area, and season strata).

The overdispersion scaling parameter, ν, was a new parameter that was included in the current model update. In all models, the 95% credible interval (c.i.) of the posterior distribution did not include zero (Figure 4), indicating that the variance of the distribution increased more slowly with the mean than would be expected from a standard negative binomial distribution. The parameter tended to be higher for species that had fewer observed captures overall, such as flesh-footed shearwater. Before the introduction of the overdispersion scaling, the model estimated a higher mean number of birds caught per capture event than were observed (Figure 5a; see also Abraham & Richard 2019b). The effect of the overdispersion scaling was to reduce the long tail of the distribution of the number of estimated captures per capture event (Figure 5b).

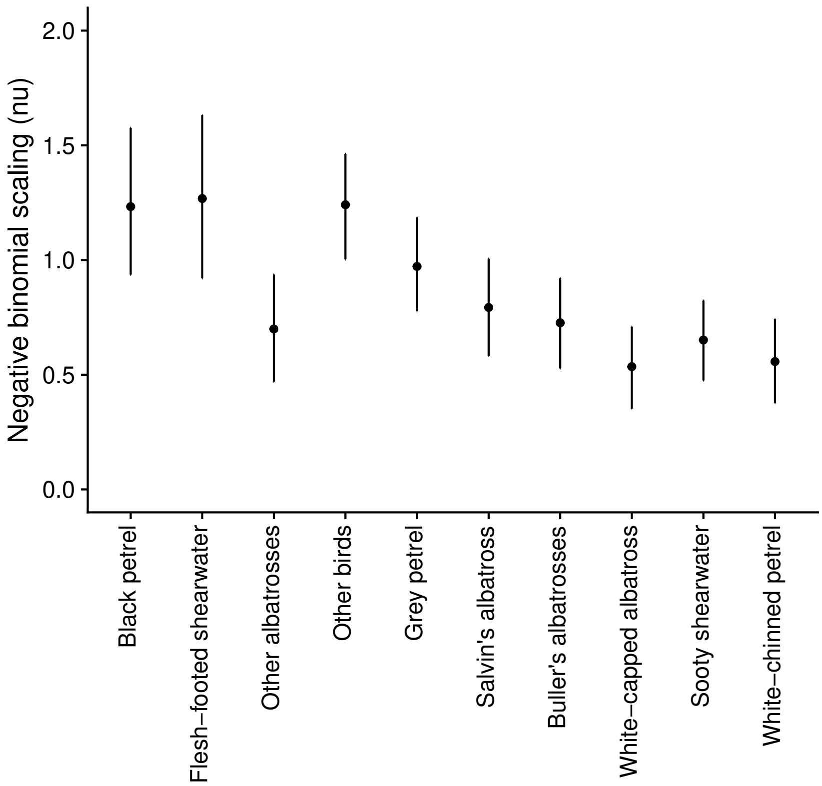

Figure 4: Estimates of the overdispersion scaling parameter. For the model of each species, the plot shows the mean and 95% credible interval of the posterior distribution of the overdispersion scaling parameter, ν. The prior was a uniform distribution between 0 and 2, with the parameterisation reducing to a standard negative binomial distribution for $\nu = 0$. The models are shown in order of the annual-mean observed captures.

Other than the introduction of the overdispersion scaling, the model was an update of the same model framework applied previously to the data to the 2016–17 fishing year (Abraham & Richard 2019b). When the model parameters were compared between the two years, for all 114 common parameters and for all ten species or species groups, the mean value of most parameters remained within the 95% c.i. of the parameters from the 2016–17 estimation. The main exceptions were the overdispersion parameters, with the standard deviation of the overdispersion (expressed at unit mean; $\sqrt{1/\phi}$) decreasing due to the re-parameterisation of the negative binomial. The only other parameters to change, resulting in a mean outside the range of the credible interval from the last estimation, were two parameters in the black petrel model: the log of the autumn (April to June) season effect decreased from 0.33 (95% c.i.: -0.25 to 0.90) to -0.78 (95% c.i.: -1.53 to -0.08) and the standard deviation of the fisheries random effect decreased from 1.34 (95% c.i.: 0.76 to 2.13) to 0.79 (95% c.i.: 0.32 to 1.48). The credible interval of the autumn season effect was entirely negative, with the model estimating that black petrel are less likely to be caught during autumn than during summer (January to March).

For example, in the model of white-capped albatross, the 12 strata (where the strata were defined by region, fishery, vessel size, area, and season) with the highest estimated captures all included the observed captures within the 95% credible interval (see Appendix A, Figure A-1). Overall, for white-capped albatross, there were only two strata where the observed captures were outside the 95% credible interval of the estimates (Appendix A, Table A-3). Nevertheless, there were only 23 observed captures in these two strata, compared with 1677 observed captures of white-capped albatross included in the model overall. In the previous model (Abraham & Richard 2019b), there were six strata that had observed captures of white-capped albatross outside the credible interval of the estimated captures.

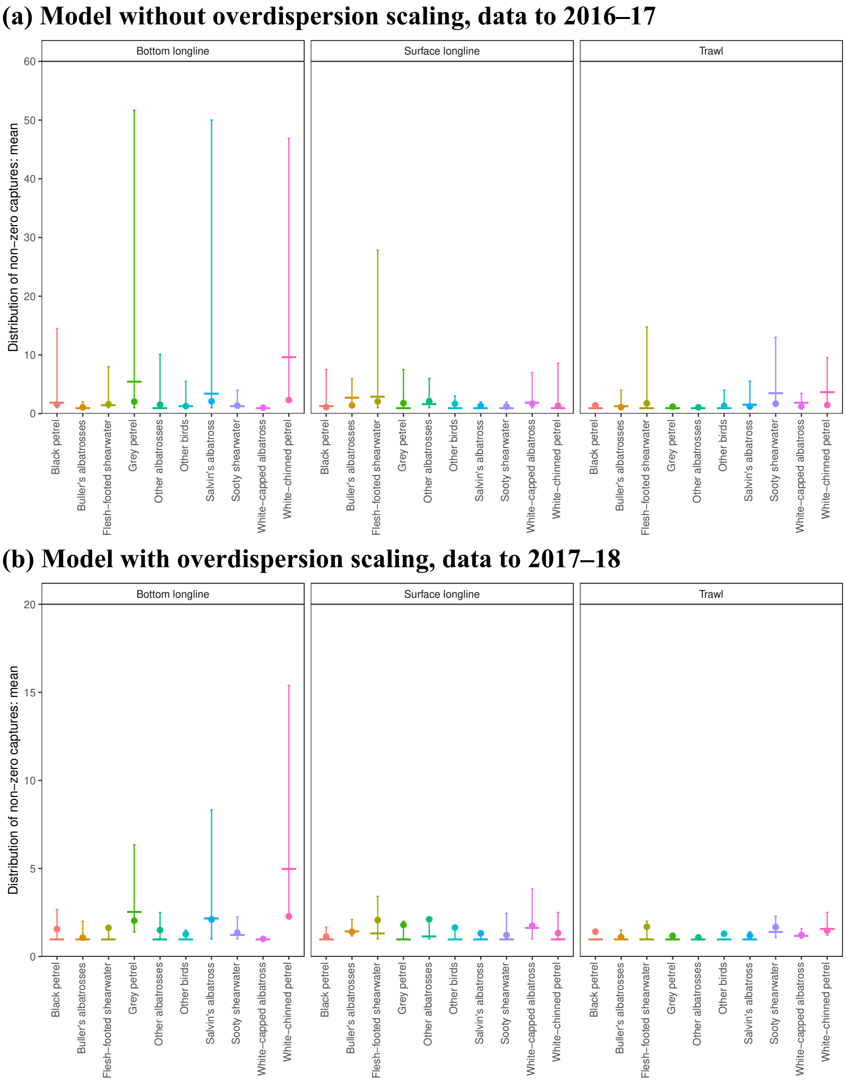

Figure 5: Mean number of each seabird species caught during fishing events with at least one capture. The dot marks the mean from the observed data; the lines mark mean and the 95% credible interval from the posterior distribution. (Note the different y-axis range in (a) and (b).)

Nevertheless, not all models performed well. For example, the model of other albatrosses indicated there were an estimated 6.97 (95% c.i.: 0–26) captures in observed fishing in the Kermadec Islands area (small-vessel surface longline, spring stratum), but a total of 56 captures were observed (Appendix A, Table A-12), during 22 observed fishing events. As in the previous year (Abraham & Richard 2019b), the model does not estimate the high number of captures that were observed in this stratum, with most (51) of these observed captures of other albatrosses being reported from a single trip.

Across all the models, white-chinned petrel had the highest number of strata (12) where the observed captures were outside the credible interval of the estimated captures on observed fishing (Appendix A, Table A-15).

Within fishery, vessel size, season, and area strata, the observer data can be used to define a ratio estimate of the number of seabird captures. As an assessment that the estimates from the models are reasonable, this ratio estimate was compared with the model estimate in the same strata. For example, in squid trawl fisheries on the Stewart-Snares shelf, there were 465 observed captures of white-capped albatross by vessels over 28 m in length in the period from 2002–03 to 2017–18 (Appendix A, Table A-1). These captures were based on observer coverage of 39.8% (11 121 observed tows). The ratio estimate of the

Table 4: Number of estimated captures (mean and 95% credible interval, c.i.) for each seabird species group in trawl, bottom-longline (BLL), and surface-longline (SLL) fisheries for the 2017–18 fishing year.

Species grouping	Trawl		SLL		BLL		Total	
	Mean	95% c.i.	Mean	95% c.i.	Mean	95% c.i.	Mean	95% c.i.
White-capped albatross	311	245–399	132	97–180	18	4–42	462	383–565
Salvin's albatross	287	204–395	8	2–20	54	19–119	350	256–474
Buller's albatrosses	115	85–160	95	66–135	19	4–49	231	181–295
Other albatrosses	43	27–67	132	88–191	72	31–143	249	181–340
White-chinned petrel	315	279–361	29	11–61	336	146–688	681	486–1 040
Black petrel	32	9–76	58	36–90	151	83–263	242	159–369
Grey petrel	13	6–30	18	8–35	106	32–262	139	62–293
Sooty shearwater	200	131–308	2	0–10	10	2–31	213	143–322
Flesh-footed shearwater	91	50–152	111	59–192	223	156–312	426	321–554
Other birds	95	64–139	45	28–68	190	127–275	331	255–431
All birds	1 506	1 344–1 696	635	536–758	1 186	913–1 589	3 328	2 971–3 782

observed captures (obtained by dividing the number of observed captures by the observer coverage) was 1169 seabird captures. This estimate was within the range estimated by the model of 1275 (95% c.i.: 1044–1524) captures (over the entire 16-year period).

Discrepancies between the ratio estimate and the model estimate are often associated with low observer coverage. As might be expected, ratio estimates are unreliable if the observer coverage is low and unrepresentative. For example, there has only been one observed capture of Buller's albatross in small-vessel bigeye surface-longline fisheries in the North Island east coast area in the summer quarter, from 100 observed fishing events, resulting in a ratio estimate of 45 captures; however, the model estimated that there were 467 (95% c.i.: 191 to 916) captures over the 20-year period covered by the longline models (Appendix A, Table A-9). The observer coverage in this stratum was only 2.2%. Another example of this kind of mismatch was the model estimate for grey petrel (also highlighted previously by Abraham & Richard 2019a). For this species, the model estimated that over the 19-year period, there was a total of 841 (95% c.i.: 118–2758) captures by snapper bottom-longline vessels less than 34 m long, in the North East area during winter (Appendix A, Table A-21). Because there have been no observations of snapper bottom-longline fishing during winter, there have been no observed captures.

3.2 Estimated seabird captures

During the 2017–18 fishing year, the total estimated number of captures was 3328 (95% c.i.: 2971–3782) seabirds (Table 4, and see Appendix B for detailed estimates for each modelled species group, for the fishing method and vessel classes that had a mean of over 50 estimated captures between 2002–03 and 2017–18). Included in this total estimate were 1506 (95% c.i.: 1344–1696) seabird captures in trawl fisheries, 1186 (95% c.i.: 913–1589) seabird captures in bottom-longline fisheries, and 635 (95% c.i.: 536–758) seabird captures in surface-longline fisheries.

The highest capture estimate of any modelled species or species group was for white-chinned petrel, with 681 (95% c.i.: 486–1040) estimated captures during the 2017–18 fishing year. Most of the estimated captures were associated with bottom-longline and trawl fisheries. Estimated captures were also high for white-capped albatross and flesh-footed shearwater, with over 400 captures of each of the two species in 2017–18. The majority of estimated captures of white-capped albatross were in trawl fisheries, compared with estimated captures of flesh-footed shearwater, which were primarily in bottom-longline fisheries.

Across the 20 different target fisheries included in the modelling, 12 fisheries had a mean of over 100 seabird captures in 2017–18 (Table 5). For several of these target fisheries, the estimated mean number of captures exceeded 300 seabirds, including trawl fisheries targeting inshore species and hoki, bottom-longline fisheries targeting ling and snapper, and surface-longline fisheries targeting bluefin tuna.

Table 5: Number of estimated seabird captures in different trawl, bottom-longline (BLL), and surface-longline (SLL) target fisheries for the 2017–18 fishing year. Mean and 95% credible interval (c.i.) of the posterior distribution of total seabird captures, summed over all modelled species groups.

Method	Target fishery	Mean	95% c.i.
Trawl	Inshore	368	263–493
	Hoki	334	293–381
	Squid	284	272–302
	Middle depths	214	157–294
	Scampi	130	99–165
	Flatfish	87	40–153
	Ling	51	35–72
	Deepwater	15	9–24
	Mackerel	11	10–14
	S. blue whiting	6	6–6
	Hake	2	1–5
BLL	Ling	495	315–785
	Snapper	349	253–471
	Minor species	170	102–286
	Hāpuku	109	48–245
	Bluenose	61	31–109
SLL	Bluefin	309	252–375
	Bigeye	190	139–259
	Swordfish	129	79–198
	Minor species	6	1–17

For eight of the ten modelled species groups, the total number of estimated captures decreased between 2002–03 and 2017–18 (where the decrease was sufficient for the upper credible interval in 2017–18 to be lower than the mean in 2002–03) (Figure 6). Only white-chinned petrel and grey petrel did not show a clear decrease in total captures over this time period, and no species had higher mean estimated captures in 2017–18 than in 2002–03. When all species were combined, the total estimated number of seabird captures showed a clear decrease over the assessment period, with the mean number of seabird captures in 2017–18 being the lowest of any of the 16 years, at under half the mean number of estimated seabird captures in 2002–03.

When estimated captures in 2017–18 were compared with captures in 2006–07 (immediately following the introduction of mandatory warp mitigation in January 2006), many species had similar total capture estimates during 2017–18 as in 2006–07. In large-vessel trawl fisheries, the upper credible interval of the estimated captures in 2017–18 was less than the mean estimate in 2006–07 for white-capped albatross, sooty shearwater, grey petrel, other birds groups, as well as for all birds combined. In the small-vessel fisheries, the models had no year effect, and so changes in the estimated number of captures in small-vessel fisheries corresponded with changes in fishing effort (either in the total fishing effort, or shifts by area or season, or between target species). In large-vessel fisheries, changes in the estimated number of seabird captures also corresponded with changes in fishing effort.

There were marked declines in fishing effort in New Zealand trawl and surface-longline fisheries over the reporting period, and the declines in estimated captures largely corresponded with changes in fishing effort (see Appendix B for time series of total seabird captures and of fishing effort in each of the six vessel-class fishing-method groups, except for large-vessel surface-longline fisheries data which are restricted by confidentiality requirements). The number of tows in trawl fisheries in 2017–18 was 63% and 48% of the effort in 2002–03 for small-vessel and large-vessel trawl fisheries, respectively.

Large surface-longline vessels stopped fishing in 2015–16, due to changes in the regulation of foreign vessels in New Zealand waters. In small-vessel surface-longline fisheries, the number of hooks set in 2017–18 was 27% of the number of hooks set in 2002–03. Across all surface-longline fishing, the number of hooks set in 2017–18 was 21% of the number of hooks set during 2002–03. In bottom-longline fisheries, the number of hooks set during 2017–18 was 119% and 90% of the number of hooks set during 2002–03, for small- and large-vessel fisheries, respectively.

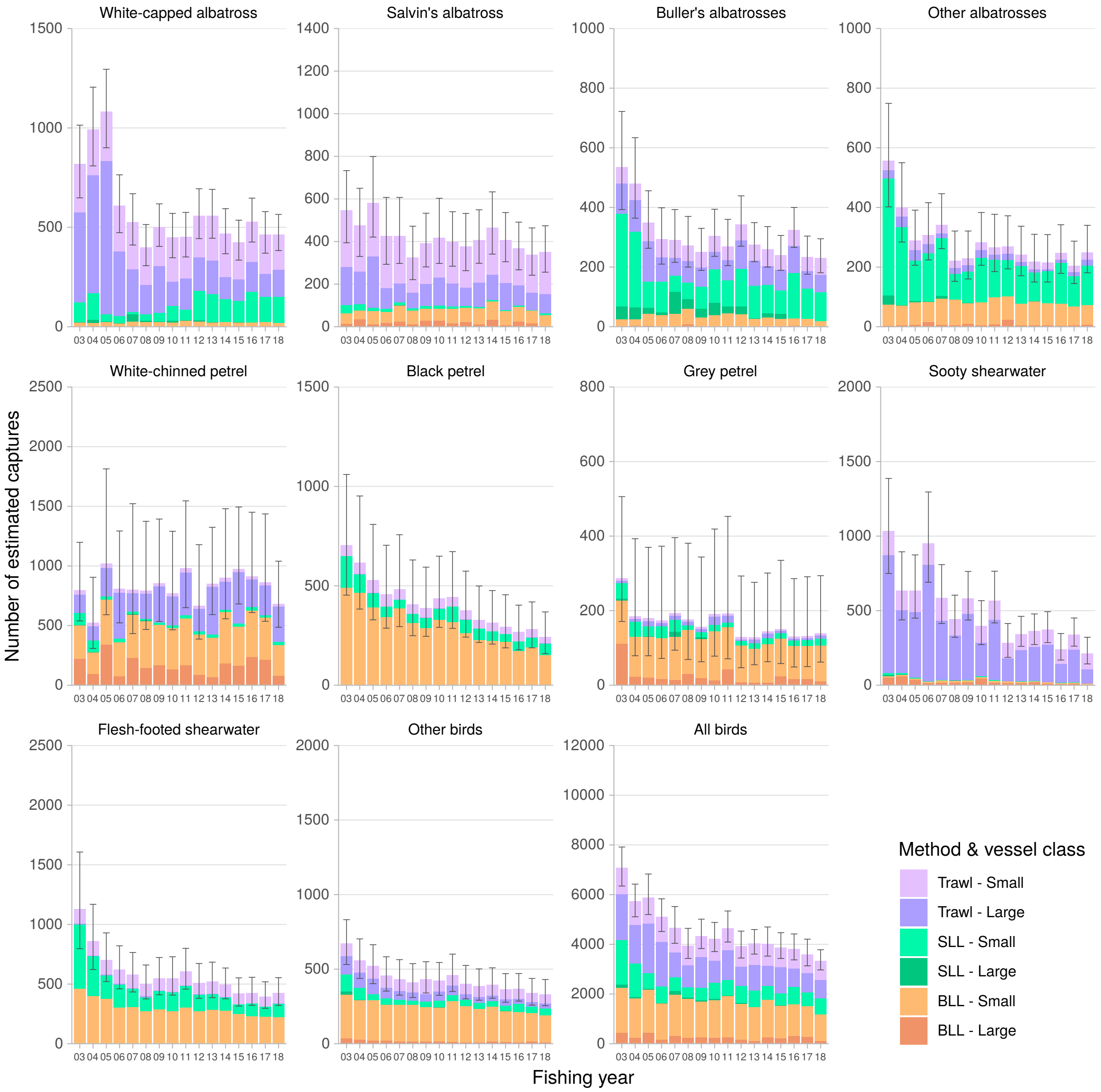

Figure 6: Time series of the number of estimated captures for the seabird species groups and for all birds for the 2002–03 to 2017–18 fishing years. Estimates are shown by fishing method and vessel size class. Cut-off lengths for small and large vessel size classes were 45 m, 34 m, and 28 m, for surface-longline (SLL), bottom-longline (BLL), and trawl fishing, respectively. Coloured bars indicate the mean number of captures, error bars are the 95% credible interval in the total number of estimated captures within each fishing year. (Note different y-axis scales.)

For the large-vessel fisheries that have had sufficient records of seabird captures, changes in capture rate (birds per unit fishing effort) showed different patterns over time (Figure 7). In large-vessel squid trawl fisheries, a decrease in albatross captures was evident following the introduction of mandatory warp mitigation in January 2006, before the 2005–06 fishing season. Albatross capture rates were similar in

2017–18, relative to 2015–16, and there has been no clear trend in capture rates over the 10-year period 2007–08 to 2017–18. Capture rates of petrels in the squid trawl fishery have shown a distinct pattern of higher captures in alternate years, with a lower capture rate in each of 2009–10, 2011–12, 2013–14, and 2015–16 than in the preceding year. This pattern was continued, with a lower capture rate during 2017–18 than in 2016–17.

In large-vessel hoki trawl fisheries, there was a marked decrease in albatross capture rates following the introduction of mandatory warp mitigation in January 2006. Capture rates of albatross then gradually increased between 2007–08 and 2011–12. There were no clear patterns in the capture rate of petrels in large-vessel hoki trawl fisheries, with large interannual variation in the capture rates.

In large-vessel ling bottom-longline fisheries, capture rates peaked in 2000–01 for both albatrosses and petrels. Integrated weight line was introduced to ling autoliners in 2002–03, and capture rates have remained relatively stable since then. In 2014–15, all observations were made on vessels without integrated weight line, and in 2015–16, 94% of observed sets were without integrated weight line. There was an increase in the observed capture rates of petrels and other birds in both of those fishing years. In 2016–17, all observations were on vessels with integrated weight lines, and the observed capture rate of petrels and other birds in large-vessel ling bottom-longline fisheries decreased. In 2017–18, around half of the observations (49%) were on vessels with integrated weight line. In 2014–15, there were five large bottom-longline vessels active, three of which used integrated weight line; in 2015–16 and 2016–17, there were four large bottom-longline vessels fishing, three of which used integrated weight line; in 2017–18, there were three large bottom-longline vessels fishing, two of which used integrated weight line.

In large-vessel ling trawl fisheries, capture rates of petrels and other birds were lower in 2017–18 than in the previous years, but had a similar range of capture rates over a longer time period. Capture rates in trawl fisheries targeting middle-depth species were lower during 2017–18 than in previous years, although there have not been consistent changes in capture rates over a longer time period.

In large-vessel surface-longline fisheries targeting bluefin tuna, the highest capture rates were of albatrosses. Capture rates varied widely. The capture rates often had no or low uncertainty, due to high observer coverage in these fisheries, which was frequently 100%. There have been no large vessels in this fishery from 2015–16 onwards.

Many fisheries caught a range of seabird species or species groups in 2017–18 (Figure 8). White-chinned petrel was the species with the highest mean estimated captures in ling bottom-longline, hoki trawl, squid trawl, and hāpuku bottom-longline fisheries in 2017–18. In snapper bottom-longline fisheries, the highest estimated captures were of flesh-footed shearwater and black petrel, followed by other birds and grey petrel. In inshore trawl fisheries, the highest estimated mean captures were of white-capped and Salvin's albatrosses.

Seabird captures showed clear spatial patterns (Figures 9, 10). Patterns of captures reflect both the distribution of fishing and the distribution of seabirds. Black petrel mainly breed on Great Barrier (Aotea) Island, in the Hauraki Gulf region. Estimated captures of black petrel were in the north-eastern region, close to this breeding site. Estimated captures of flesh-footed shearwater also primarily occurred in north and eastern areas, where this species breeds. Flesh-footed shearwater also breed in the Cook Strait area, and there were estimated captures of flesh-footed shearwater off the North Island west coast. White-chinned petrel and sooty shearwater were both caught to the south and east of New Zealand, in the subantarctic area and off the east coast of South Island, with white-chinned petrel captures extending further east along the Chatham Rise. Grey petrel breed on subantarctic islands, and there are some estimated captures in subantarctic waters; however, the highest estimated capture densities were off the east coast of North Island. The other birds group was caught in small-vessel inshore fisheries, and the estimated captures had a coastal distribution, with captures of a range of other bird species also occurring in all fisheries.

Among the three albatross species, estimated mean captures of white-capped albatrosses were highest off the South Island west coast, and to the south of New Zealand; estimated mean captures of Salvin's

Figure 7: Capture rates (captures per 100 fishing events) of two seabird groupings in selected large-vessel target fisheries, for fishing years between 2002–03 and 2017–18 for trawling, and between 1998–99 and 2017–18 for bottom and surface longlining. Cut-off lengths for the large vessel size class were 45 m, 34 m, and 28 m, for surface-longline, bottom-longline, and trawl fishing, respectively. Lines show the mean estimated capture rate per fishing year, error bars indicate the 95% credible interval of the estimates, and symbols mark observed capture rates. Observed captures are not shown in years with fewer than ten capture events. (Note different y-axis scales.)

albatross were higher off the South Island east coast and on Chatham Rise; and Buller's albatrosses were caught in surface-longline fisheries off both the South Island west coast and the North Island east coast (Figure 10). The two subspecies of Buller's albatross (southern Buller's albatross, *Thalassarche bulleri bulleri*, and northern Buller's albatross, *Thalassarche bulleri platei*) breed mainly on Snares Islands and Chatham Islands, respectively. The subspecies are difficult to distinguish, even during necropsy, and these two areas may reflect the different foraging distributions of the two subspecies. Captures of other albatrosses (which include all the great albatrosses, *Diomedea* spp.) primarily occurred in north-eastern surface-longline fisheries.

When grouped together, captures of all albatrosses and all seabirds occurred throughout the New Zealand region, where commercial trawl or longline fishing occurred (Figure 10). The total number of estimated captures of seabirds were highest in the North-East and the Chatham Rise areas (Table 6). Captures in the north-eastern area were primarily in bottom-longline fisheries, whereas captures in the eastern and western Chatham Rise areas were primarily in bottom-longline and trawl fisheries, respectively. For trawl fisheries, estimated captures were also high in the Stewart-Snares shelf area.

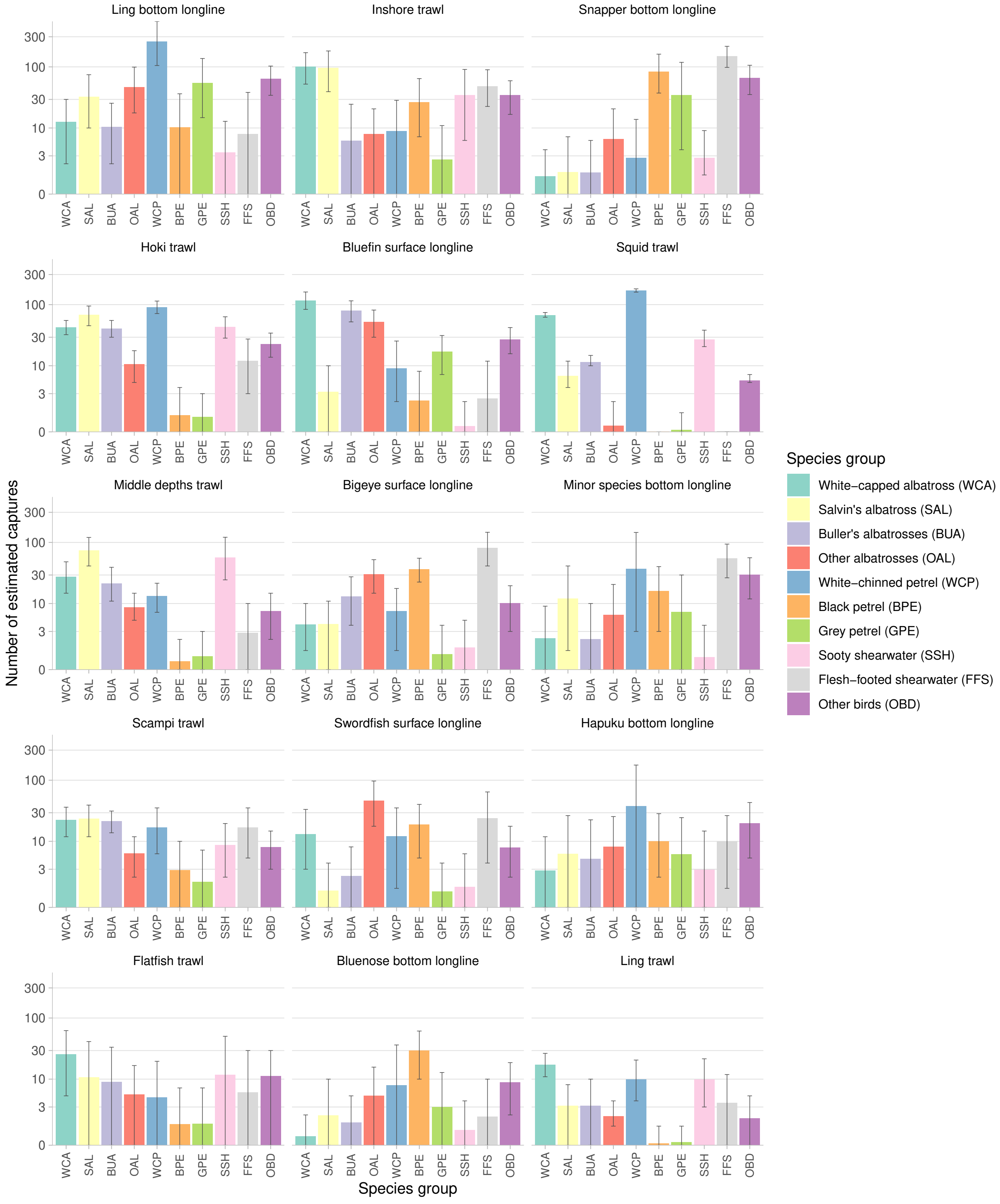

Figure 8: Number of estimated captures for the modelled seabird species groups for the 2017–18 fishing year. For each species group and target fishery, the bars show mean captures and the 95% credible interval. The y-axis is on the log plus one scale. Shown are only fisheries that were estimated to have caught a mean of more than 50 birds.

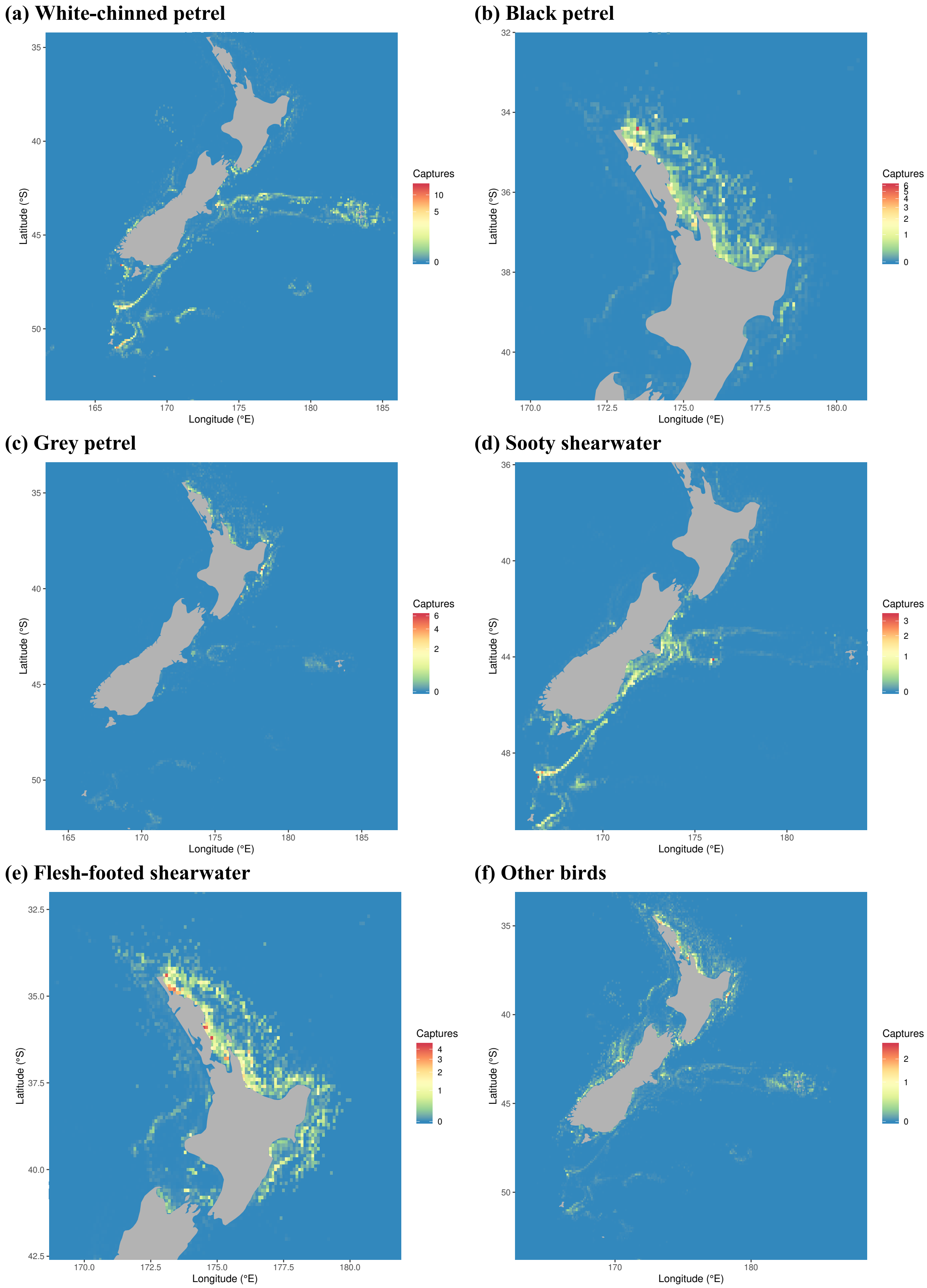

Figure 9: Number of estimated captures of petrels and other birds in commercial fisheries in New Zealand's Exclusive Economic Zone in the 2017–18 fishing year. For each of the modelled species groups, colour indicates the number of model-estimated captures in 0.1 degree cells. Shown is the mean value from the model applied to all fishing effort (observed captures not included).

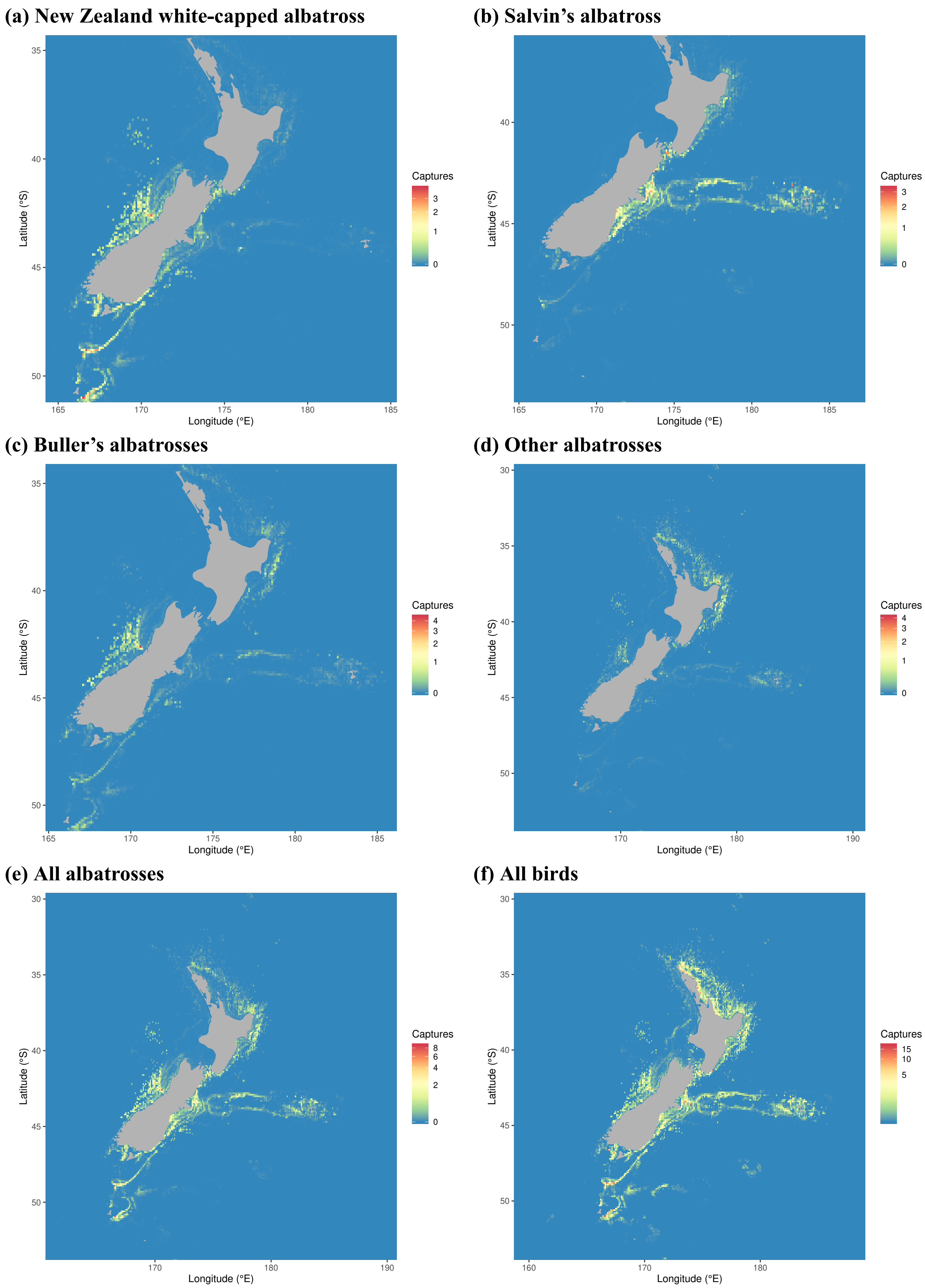

Figure 10: Number of estimated captures of albatrosses and of all birds in commercial fisheries in New Zealand's Exclusive Economic Zone in the 2017–18 fishing year. For each of the modelled species groups, colour indicates the number of model-estimated captures in 0.1 degree cells. Shown is the mean value from the model applied to all fishing effort (observed captures not included). The map of all birds is the total of the estimated captures of all species and species groups.

Table 6: Number of estimated seabird captures by model area and fishing method in the 2017–18 fishing year (SLL, surface longline; BLL, bottom longline). Mean and 95% credible interval (c.i.) of the posterior distribution of total estimated seabird captures, summed across all modelled species groups. Areas are sorted in decreasing order of the mean number of estimated captures.

Area	Trawl		SLL		BLL		Total	
	Mean	95% c.i.	Mean	95% c.i.	Mean	95% c.i.	Mean	95% c.i.
North East	87	55–135	224	168–294	446	336–588	758	621–921
Western Chatham Rise	375	283–494	17	7–35	133	73–252	527	407–692
Stewart-Snares Shelf	370	326–427	0	0	46	8–159	417	348–541
East of North Island	81	49–124	153	111–206	145	85–236	380	285–500
West Coast South Island	117	87–155	203	160–260	37	19–68	358	296–433
Eastern Chatham Rise	133	104–169	0	0	188	103–347	322	228–481
Auckland Islands	239	219–264	0	0	0	0–1	239	219–265
Cook Strait	55	33–86	0	0	57	24–138	112	63–203
West Coast North Island	28	15–48	14	6–26	62	39–91	105	73–145
Fiordland	5	2–11	19	13–34	27	8–74	52	29–101
South Subantarctic	10	9–13	0	0	29	5–98	39	15–108
East Subantarctic	0	0–0	0	0	10	1–33	10	1–33
Kermadec Islands	0	0	3	0–9	0	0	3	0–9

4. DISCUSSION

4.1 Estimated captures of seabirds

Incidental captures of seabirds occur across a range of commercial fisheries in New Zealand waters, with the current assessment providing an update of seabird bycatch estimates in trawl and longline fisheries. The update included fishery and observer data from the 2017–18 fishing year, with the estimation including the period from 1998–99 to 2017–18 for longline fisheries, and from 2002–03 to 2017–18 for trawl fisheries (see data preparation in Abraham & Berkenbusch 2019).

One of the main findings of the current assessment was the decrease in the estimated number of seabird captures in 2017–18: the mean total estimates were lower in this fishing year than in any year in the assessment period (from 2002–03); the estimated mean number of total captures in 2017–18 was less than half of the mean captures in 2002–03. The reasons for this decrease are mixed. For some species groups and fisheries, there have been decreases in the capture rates over the period of the data. Nevertheless, for many fishing methods, decreases in seabird captures corresponded with marked decreases in fishing effort, and capture rates remained similar over time.

In addition, the current analysis showed that capture rates of black petrel varied over time; the model estimated that the capture rate of this species was significantly lower in autumn (April to June) than in summer (January to March). Black petrel has been identified as the species most at risk of population decline resulting from incidental captures in commercial fisheries in New Zealand waters (Richard & Abraham 2020). Black petrel breed only in New Zealand, with colonies on Great Barrier (Aotea) Island and Hauturu-o-Toi/Little Barrier Island in Hauraki Gulf (Taylor 2000a). This species breeds over summer, before migrating to the eastern tropical Pacific Ocean during austral winter. The seasonal differences in capture rate determined here correspond with this breeding and migration pattern. This finding highlights the vulnerability of black petrel to New Zealand fisheries during the breeding season.

4.2 Comparison with previous estimation results

The introduction of the scaling parameter in the negative-binomial distribution resulted in a marked decrease in the uncertainty in the total estimated seabird captures for many method-size class groups (Figure 11). Across the three methods, the decrease in the uncertainty was greatest for fisheries in the small-vessel size class. For small-vessel trawl and bottom-longline fisheries, the change in parameterisation also resulted in a marked decrease in the mean captures. These changes were not the result of updating the models to include the 2017–18 data, but resulted from the change in the parameterisation of the negative binomial model.

Seabird captures have also been estimated on annual-average fishing effort from 2014–15 to 2016–17, as part of the seabird risk assessment (SRA; Richard & Abraham 2020). The method used for the seabird risk assessment relies on seabird distributions to obtain species-specific estimates of seabird bycatch. When aggregated to estimates of total seabird captures, the uncertainty was lower than from the estimation carried out in the current analysis. In most cases, the mean estimate of total seabird captures was within the range of the credible intervals from the seabird capture estimation. In large-vessel trawl fisheries, the estimates of total seabird captures from the seabird risk assessment were somewhat lower; for large-vessel surface-longline fisheries, the comparison was confounded because the annual average fishing effort in the seabird risk assessment includes two years (2015–16 and 2016–17) when the Japanese fleet had left New Zealand. In small-vessel trawl fisheries, the estimates from the seabird risk assessment were higher than the estimates from the current model; however, changes to the model parameterisation have brought the estimates from the generalised model into agreement with the estimates from the seabird risk assessment.

The impact of the changes in the model structure can be seen clearly in a comparison of estimates for 2017–18 between the previous and updated model (Figure 12). For many species and fisheries groups, there are reductions in the credible interval and the mean when the overdispersion scaling parameter was introduced. The reductions are seen in the small vessel fisheries that have lower observer coverage and that have no random year effect. In particular, there were reductions in the estimates for: black petrel in small-vessel surface longline fisheries; grey petrel in small-vessel bottom longline fisheries; and other birds and sooty shearwater in small-vessel trawl fisheries. There were no cases where the width of the credible interval markedly increased.

4.3 Observer coverage

The estimation of seabird captures integrates fisher-reported effort data with capture records collected by onboard fisheries observers. For this modelling, it is assumed that the observed fishing effort represents unobserved fishing effort. Nevertheless, observer coverage throughout the reporting period varied markedly across fisheries and vessel size classes (see Table 7 for vessels that were active for at least three years and reported at least 100 fishing events). There were relatively few large vessels in trawl and longline fisheries over the reporting period, ranging between 5 (surface longline) and 61 vessels (trawl). Most of these large vessels were observed at least once in the period between 2002–03 and 2017–18; the corresponding observed fishing effort varied between 28 (trawl) and 89% (surface longline). In contrast, there were comparatively large numbers of small fishing vessels participating in the different fisheries, ranging from 73 small vessels in surface longlining to 262 small vessels in trawl fisheries. At the same, only 41 to 59% of these small vessels had an onboard observer at least once in the 16-year period. The corresponding observer effort across the small-vessel size class was similarly low, at between 1.5% (bottom longline) to 6.0% (surface longline).

Low observer coverage and effort in the small-vessel fisheries mean that some of the patterns in seabird captures may not be determined in the bycatch assessment. For example, for fishing events without observers, there are no data on the use of mitigation measures. Increasing observer coverage in the small-vessel fleets and having observers across all fishing would help to ensure that estimates based on observer data reliably reflect seabird bycatch in New Zealand's commercial trawl and longline fisheries.

Figure 11: Comparison of the number of estimated seabird captures derived from the previous estimation (to 2016–17), from the previous model (with the current data, to 2017–18), and with the current estimation (to 2017–18). The lines show the estimated total seabird captures from each estimation, with their 95% credible intervals. The time series are for vessel-size and fishing method combinations, and are offset along the x axis to allow comparison of the credible intervals. For comparison, estimated seabird captures (without cryptic mortality) are shown from the seabird risk assessment (SRA; Richard & Abraham 2020). The time series are shown for vessel-size and fishing method combinations. Cut-off lengths for small and large vessel size classes were 45 m, 34 m, and 28 m for surface-longline, bottom-longline, and trawl fishing, respectively.

Table 7: Observed fishing effort between 2002–03 and 2017–18. For each method and vessel size class, the table shows the number of vessels, the percentage of vessels that had any observer effort within the period, and the percentage of the total effort that has been observed. Data are restricted to fishing by vessels that fished in three or more fishing years, for at least 100 fishing events. Cut-off lengths for the large-vessel size class were 45 m, 34 m, and 28 m, for surface-longline, bottom-longline, and trawl fishing, respectively.

Method	Vessel size	Number of vessels	Observed vessels (%)	Observed fishing effort (%)
Bottom longline	Large	8	87.5	13.8
	Small	214	47.2	1.5
Surface longline	Large	5	100.0	89.2
	Small	73	58.9	6.0
Trawl	Large	61	91.8	27.5
	Small	262	41.2	2.1

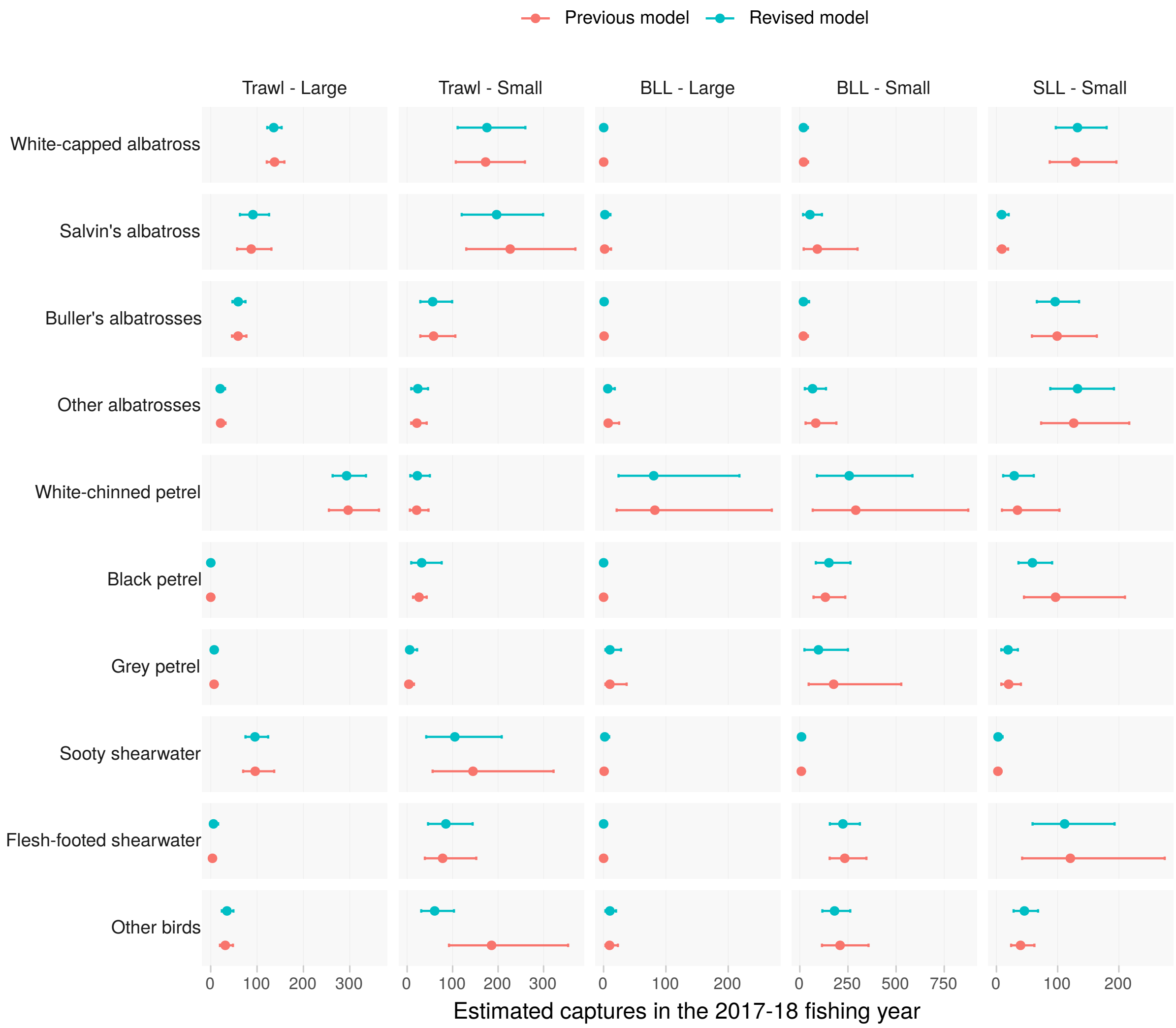

Figure 12: Comparison of the number of estimated seabird captures during 2017–18 by species and fishing-method and vessel-size group, derived from the previous model (with the current data, to 2017–18, red), and with the current estimation (to 2017–18, blue). The dots show the mean estimated seabird captures, with the lines indicating their 95% credible intervals.

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APPENDIX A: SUMMARIES OF MODELS USED FOR THE SEABIRD ESTIMATION

A.1 White-capped albatross

Table A-1: Model strata with the highest number of estimated captures of white-capped albatross in each of trawl, surface-longline (SLL), and bottom-longline (BLL) fisheries. Only the 15 strata with the most estimated captures are shown, sorted in decreasing order of mean estimated captures. The strata were defined as combinations of fishery, vessel size, area, and season. The number of observed captures between the fishing years 1998–99 and 2017–18 for bottom- and surface-longline fisheries, and between 2002–03 and 2017–18 for trawl fisheries, are shown, along with the number of fishing events observed, the proportion of fishing events observed (observer coverage), the associated ratio estimate of the total number of captures, and the mean and 95% credible interval of the total estimated number of captures.

(a) Trawl

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Squid trawl	Vessels $\geq$ 28 m	Stewart Snares Shelf	Summer	465	11121	0.398	1169	1275	1044–1524
Squid trawl	Vessels $\geq$ 28 m	Auckland Islands	Summer	341	8010	0.511	667	601	466–742
Squid trawl	Vessels $\geq$ 28 m	Stewart Snares Shelf	Autumn	116	3103	0.337	343	393	289–515
Squid trawl	Vessels $\geq$ 28 m	Auckland Islands	Autumn	89	3221	0.395	225	288	206–384
Inshore trawl	Vessels $<$ 28 m	Stewart Snares Shelf	Summer	2	155	0.018	111	281	138–487
Flatfish trawl	Vessels $<$ 28 m	Stewart Snares Shelf	Summer	0	526	0.020	0	200	45–472
Inshore trawl	Vessels $<$ 28 m	West Coast South Island	Summer	12	444	0.036	332	199	100–344
Inshore trawl	Vessels $<$ 28 m	Stewart Snares Shelf	Autumn	0	0	0.000		176	83–324
Inshore trawl	Vessels $<$ 28 m	Western Chatham Rise	Summer	0	443	0.018	0	153	70–278
Inshore trawl	Vessels $<$ 28 m	West Coast South Island	Autumn	2	30	0.003	672	153	73–269
Inshore trawl	Vessels $<$ 28 m	Western Chatham Rise	Autumn	0	77	0.003	0	131	57–246
Flatfish trawl	Vessels $<$ 28 m	Stewart Snares Shelf	Autumn	3	51	0.003	1058	126	27–301
Scampi trawl	Vessels $<$ 28 m	Auckland Islands	Autumn	13	757	0.128	101	121	60–207
Inshore trawl	Vessels $<$ 28 m	Stewart Snares Shelf	Spring	0	22	0.003	0	115	50–220
Inshore trawl	Vessels $<$ 28 m	West Coast South Island	Spring	1	95	0.007	138	109	48–205

(b) Surface longline

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Southern bluefin SLL	Vessels $<$ 43 m	West Coast South Island	Autumn	120	394	0.132	906	837	523–1261
Southern bluefin SLL	Vessels $<$ 43 m	West Coast South Island	Summer	0	0	0.000		119	55–209
Southern bluefin SLL	Vessels $<$ 43 m	Fiordland	Autumn	21	18	0.047	445	118	47–231
Southern bluefin SLL	Vessels $<$ 43 m	East of North Island	Autumn	3	406	0.047	63	107	35–232
Southern bluefin SLL	Vessels $\geq$ 43 m	Fiordland	Autumn	80	3057	0.901	88	104	61–161
Swordfish SLL	Vessels $<$ 43 m	West Coast South Island	Summer	1	19	0.038	26	73	17–185
Southern bluefin SLL	Vessels $<$ 43 m	West Coast South Island	Winter	0	46	0.050	0	71	30–132
Swordfish SLL	Vessels $<$ 43 m	West Coast South Island	Autumn	3	47	0.158	19	41	7–106
Bigeye SLL	Vessels $<$ 43 m	East of North Island	Summer	0	171	0.027	0	36	5–101
Bigeye SLL	Vessels $<$ 43 m	North East	Summer	0	168	0.030	0	29	5–78
Bigeye SLL	Vessels $<$ 43 m	West Coast North Island	Summer	0	62	0.023	0	25	3–70
Bigeye SLL	Vessels $<$ 43 m	East of North Island	Autumn	0	100	0.022	0	24	3–69
Bigeye SLL	Vessels $<$ 43 m	North East	Autumn	0	59	0.012	0	24	4–65
Bigeye SLL	Vessels $<$ 43 m	North East	Spring	3	256	0.036	82	18	3–50
Southern bluefin SLL	Vessels $<$ 43 m	North East	Winter	1	495	0.119	8	13	2–33

(c) Bottom longline

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	West Coast South Island	Autumn	4	56	0.022	182	43	9–99
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	West Coast South Island	Summer	2	23	0.009	210	43	9–102
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	West Coast South Island	Spring	0	16	0.006	0	26	5–64
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	West Coast South Island	Winter	0	6	0.002	0	15	2–36
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	Cook Strait	Autumn	0	4	0.003	0	12	1–35
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	Western Chatham Rise	Autumn	0	54	0.029	0	12	2–30
Snapper BLL	Vessels $<$ 34 m	North East	Summer	0	766	0.020	0	12	0–45
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	Western Chatham Rise	Spring	0	99	0.032	0	11	1–27
Snapper BLL	Vessels $<$ 34 m	North East	Autumn	0	528	0.014	0	11	0–40
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	Cook Strait	Spring	0	17	0.009	0	10	1–29
Hāpuku BLL	Vessels $<$ 34 m	West Coast South Island	Summer	0	0	0.000		9	0–38
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	Cook Strait	Summer	0	11	0.013	0	9	0–26
Minor targets BLL	Vessels $<$ 34 m	Cook Strait	Summer	0	0	0.000		9	0–38
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	Fiordland	Winter	0	3	0.002	0	8	1–21
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	Western Chatham Rise	Summer	0	2	0.002	0	8	1–21

Table A-2: Summary of model parameters, for white-capped albatross capture in New Zealand commercial trawl, bottom-, and surface-longline fisheries. For each parameter, the table gives summary statistics of the posterior distribution (mean, median, and 95% credible interval, based on the 2.5% and 97.5% quantiles), and diagnostics (the number of chains that fail convergence and half-width tests (Heidelberger & Welch 1983), and the effective length of the chains (without autocorrelation). Trace plots of the chains are also shown. Base levels of the factor covariates are: Large trawl for method, South for region, and Summer (Jan-Mar) for season. Model strata included different different regions, seasons, years, target fisheries, and areas for trawling, surface-longline (SLL), and bottom-longline (BLL) fisheries. IWL, integrated weight line.

Parameter	Statistic			Diagnostics			
	Mean	Median	95% c.i.	Conv.	H.W.	Effective length	Trace
Distribution parameterisation	0.535	0.538	0.352 – 0.710			3901	
S.d.(Year)							
BLL	0.773	0.648	0.127 – 2.028			2327	
SLL	0.654	0.643	0.229 – 1.154			3800	
Trawl	0.349	0.338	0.207 – 0.556			4671	
S.d.(Area)	0.928	0.895	0.575 – 1.462			4381	
S.d.(Fishery)	0.779	0.760	0.488 – 1.186			4122	
Overdispersion							
BLL	1.334	1.228	0.462 – 2.779			4002	
SLL	3.015	2.967	2.147 – 4.164			4002	
Trawl	3.121	3.045	2.034 – 4.655			4002	
Intercept	0.009	0.008	0.004 – 0.022			4151	
Method / Vessel class							
BLL / vessels $\geq$ 34 m	0.199	0.133	0.022 – 0.736	1		3772	
SLL / vessels $\geq$ 45 m	2.357	1.949	0.553 – 6.563			4002	
Trawl / vessels $\geq$ 28 m	1.000	1.000	1.000 – 1.000	3			
BLL / vessels $<$ 34 m	1.306	1.041	0.234 – 3.924			4002	
SLL / vessels $<$ 45 m	22.549	18.912	6.023 – 59.848			4002	
Trawl / vessels $<$ 28 m	1.261	1.203	0.653 – 2.203			4320	
Region							
North	0.087	0.063	0.017 – 0.270			4094	
South	1.000	1.000	1.000 – 1.000	3			
Season							
Autumn (Apr-Jun)	0.946	0.942	0.758 – 1.166			4025	
Spring (Oct-Dec)	0.515	0.508	0.355 – 0.712			4002	
Summer (Jan-Mar)	1.000	1.000	1.000 – 1.000	3			
Winter (Jul-Sep)	0.259	0.254	0.164 – 0.389			4063	
Fishery							
Albacore SLL	0.882	0.727	0.055 – 2.700			3890	
Bigeye SLL	0.738	0.641	0.143 – 1.856			3734	
Bluenose BLL	0.806	0.649	0.049 – 2.444			4037	
Deepwater trawl	0.205	0.187	0.065 – 0.449			4242	
Flatfish trawl	0.325	0.285	0.065 – 0.809			4002	
Hake trawl	0.657	0.620	0.281 – 1.248			4121	
Hāpuku BLL	0.880	0.720	0.055 – 2.647			3770	
Hoki trawl	0.648	0.630	0.328 – 1.050			4002	
Inshore trawl	1.419	1.342	0.582 – 2.685			4002	
Ling (no IWL) BLL – vessels $\geq$ 34 m	1.452	1.249	0.315 – 3.738			4085	
Ling (IWL) BLL – vessels $\geq$ 34 m	0.612	0.489	0.021 – 1.885			4002	
Ling BLL – vessels $<$ 34 m	1.773	1.556	0.509 – 4.361			4002	
Ling trawl	1.625	1.537	0.767 – 3.003			4002	
Mackerel trawl	0.649	0.618	0.269 – 1.228			4002	
Middle depths trawl	1.457	1.409	0.760 – 2.435			4002	
Minor targets BLL	0.707	0.575	0.038 – 2.131			4002	
Minor surface longline	0.892	0.727	0.053 – 2.657			4174	
Southern blue whiting trawl	0.647	0.523	0.064 – 1.891			4002	
Scampi trawl	1.093	1.036	0.484 – 1.966			4194	
Snapper BLL	0.736	0.599	0.041 – 2.237			4138	
Squid trawl	2.134	2.077	1.144 – 3.453			4002	
Southern bluefin SLL	1.764	1.598	0.595 – 3.837			4002	
Swordfish SLL	0.810	0.705	0.182 – 2.103			3621	
Area							
Auckland Islands	2.136	2.042	0.951 – 3.853			4125	
Cook Strait	0.716	0.643	0.192 – 1.629			4002	
East of North Island	0.887	0.756	0.166 – 2.271			4002	
Eastern Chatham Rise	0.206	0.189	0.064 – 0.439			3892	
East Subantarctic	0.311	0.212	0.003 – 1.166			4002	
Fiordland	1.329	1.249	0.546 – 2.574			4321	
Kermadec Islands	0.816	0.608	0.014 – 2.769			3843	
North East	0.827	0.716	0.154 – 2.146			3842	
South Subantarctic	0.222	0.175	0.026 – 0.677			4119	
Stewart Snares Shelf	2.468	2.349	1.109 – 4.476			4002	
Western Chatham Rise	0.467	0.442	0.189 – 0.899			4241	
West Coast North Island	1.418	1.251	0.322 – 3.625			4002	
West Coast South Island	1.236	1.174	0.534 – 2.318			4082	

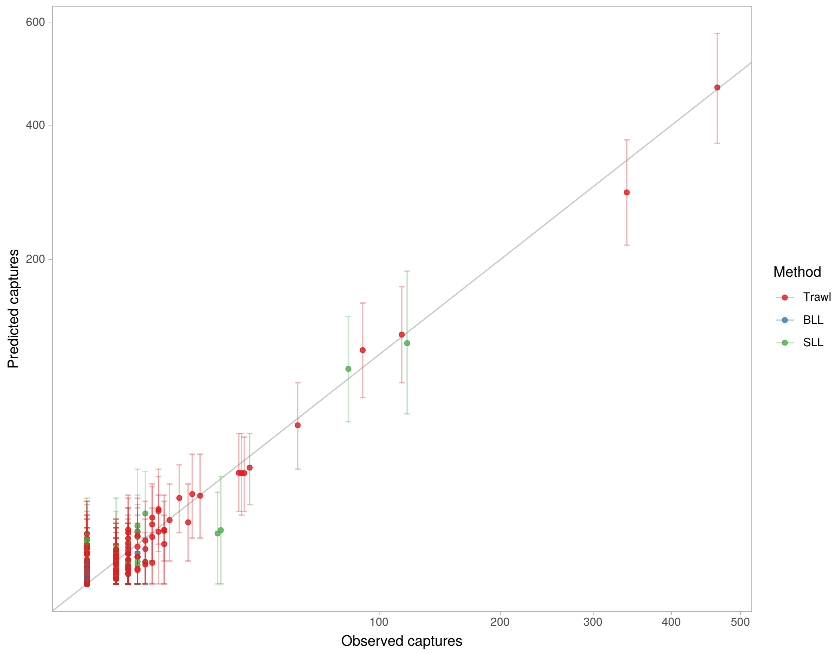


Figure A-1: Comparison between the observed and the predicted number of captures of white-capped albatross (represented by their mean and 95% credible interval), for each combination of region, fishery, vessel size, area, and season. The points were coloured according to the fishing method (BLL, bottom longline; SLL, surface longline).

Table A-3: List of strata, defined as combinations of region, fishery, vessel size, area, and season, for which the number of observed captures of white-capped albatross was outside the 95% credible interval (c.i.) of the estimated number of captures. There were two of these strata, representing 0.3% of all 629 strata. SLL, surface longline; BLL, bottom longline. Cut-off lengths between small and large vessels were 28 m for trawl, 34 m for BLL, and 45 m for SLL.

Method	Fishery	Vessel size	Region	Area	Season	Observations	Captures	Mean	95% c.i.
SLL	Southern bluefin SLL	Large	South	Stewart Snares Shelf	Autumn (Apr-Jun)	98	20	4.84	0–16
Trawl	Deepwater trawl	Large	South	Eastern Chatham Rise	Spring (Oct-Dec)	2781	3	0.44	0–2

A.2 Salvin's albatross

Table A-4: Model strata with the highest number of estimated captures of Salvin's albatross in each of trawl, surface-longline (SLL), and bottom-longline (BLL) fisheries. Only the 15 strata with the most estimated captures are shown, sorted in decreasing order of mean estimated captures. The strata were defined as combinations of fishery, vessel size, area, and season. The number of observed captures between the fishing years 1998–99 and 2017–18 for bottom- and surface-longline fisheries, and between 2002–03 and 2017–18 for trawl fisheries, are shown, along with the number of fishing events observed, the proportion of fishing events observed (observer coverage), the associated ratio estimate of the total number of captures, and the mean and 95% credible interval of the total estimated number of captures. IWL: Integrated weight line.

(a) Trawl

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Inshore trawl	Vessels < 28 m	Western Chatham Rise	Spring	4	163	0.008	482	560	219–1076
Middle depths trawl	Vessels < 28 m	Western Chatham Rise	Spring	0	63	0.009	0	310	142–574
Inshore trawl	Vessels < 28 m	Western Chatham Rise	Summer	13	443	0.018	732	274	104–528
Hoki trawl	Vessels ≥ 28 m	Western Chatham Rise	Spring	36	2573	0.187	192	272	186–374
Hoki trawl	Vessels ≥ 28 m	Eastern Chatham Rise	Spring	84	2705	0.240	349	268	180–375
Inshore trawl	Vessels < 28 m	Western Chatham Rise	Winter	1	142	0.011	95	216	79–420
Scampi trawl	Vessels < 28 m	Eastern Chatham Rise	Spring	12	649	0.101	118	203	115–322
Inshore trawl	Vessels < 28 m	East of North Island	Spring	0	204	0.006	0	145	37–351
Middle depths trawl	Vessels < 28 m	Western Chatham Rise	Summer	8	264	0.032	247	145	64–275
Flatfish trawl	Vessels < 28 m	Western Chatham Rise	Spring	0	84	0.004	0	114	0–444
Hoki trawl	Vessels ≥ 28 m	Eastern Chatham Rise	Summer	23	1665	0.131	175	114	66–173
Hoki trawl	Vessels ≥ 28 m	Western Chatham Rise	Summer	9	1919	0.134	67	111	65–170
Middle depths trawl	Vessels < 28 m	Western Chatham Rise	Winter	0	29	0.008	0	98	38–194
Middle depths trawl	Vessels ≥ 28 m	Eastern Chatham Rise	Spring	8	341	0.118	67	84	44–136
Hoki trawl	Vessels ≥ 28 m	Western Chatham Rise	Winter	14	1347	0.179	78	81	44–130

(b) Surface longline

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Bigeye SLL	Vessels < 43 m	East of North Island	Summer	7	171	0.027	257	112	30–259
Bigeye SLL	Vessels < 43 m	East of North Island	Spring	0	13	0.015	0	41	9–97
Bigeye SLL	Vessels < 43 m	North East	Spring	2	256	0.036	55	41	8–107
Bigeye SLL	Vessels < 43 m	North East	Winter	0	105	0.014	0	24	4–66
Bigeye SLL	Vessels < 43 m	East of North Island	Autumn	0	100	0.022	0	19	3–50
Southern bluefin SLL	Vessels < 43 m	East of North Island	Winter	0	225	0.115	0	18	2–49
Bigeye SLL	Vessels < 43 m	North East	Summer	0	168	0.030	0	13	1–35
Southern bluefin SLL	Vessels < 43 m	East of North Island	Autumn	1	406	0.047	21	13	1–36
Minor surface longline	Vessels < 43 m	East of North Island	Summer	0	9	0.017	0	6	0–28
Albacore SLL	Vessels < 43 m	East of North Island	Summer	0	7	0.011	0	5	0–27
Southern bluefin SLL	Vessels < 43 m	North East	Winter	1	495	0.119	8	5	0–18
Bigeye SLL	Vessels < 43 m	East of North Island	Winter	0	1	0.007	0	4	0–12
Bigeye SLL	Vessels < 43 m	West Coast North Island	Winter	0	69	0.026	0	4	0–17
Albacore SLL	Vessels < 43 m	East of North Island	Autumn	0	23	0.015	0	3	0–17
Bigeye SLL	Vessels < 43 m	West Coast North Island	Summer	0	62	0.023	0	3	0–12

(c) Bottom longline

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	East Subantarctic	Spring	100	562	0.428	233	218	81–408
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Eastern Chatham Rise	Winter	2	1148	0.154	12	205	75–428
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Eastern Chatham Rise	Spring	18	482	0.139	129	157	55–337
Ling BLL – vessels < 34 m	Vessels < 34 m	Western Chatham Rise	Spring	1	99	0.032	31	135	36–318
Ling BLL – vessels < 34 m	Vessels < 34 m	Eastern Chatham Rise	Spring	6	153	0.064	94	122	34–283
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	East Subantarctic	Summer	22	526	0.368	59	121	36–242
Ling BLL – vessels < 34 m	Vessels < 34 m	Eastern Chatham Rise	Winter	22	180	0.045	484	112	29–270
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Western Chatham Rise	Spring	0	194	0.076	0	104	32–241
Ling BLL – vessels < 34 m	Vessels < 34 m	Western Chatham Rise	Winter	0	116	0.035	0	80	19–197
Minor targets BLL	Vessels < 34 m	Eastern Chatham Rise	Spring	2	65	0.080	24	52	3–182
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Western Chatham Rise	Winter	0	47	0.026	0	49	11–118
Hāpuku BLL	Vessels < 34 m	Eastern Chatham Rise	Spring	0	54	0.032	0	42	0–194
Minor targets BLL	Vessels < 34 m	Western Chatham Rise	Spring	0	2	0.003	0	35	1–124
Bluenose BLL	Vessels < 34 m	Eastern Chatham Rise	Spring	0	0	0.000		33	0–156
Ling BLL – vessels < 34 m	Vessels < 34 m	Cook Strait	Spring	0	17	0.009	0	33	3–99

Table A-5: Summary of model parameters, for Salvin's albatross capture in New Zealand commercial trawl, bottom-, and surface-longline fisheries. For each parameter, the table gives summary statistics of the posterior distribution (mean, median, and 95% credible interval, based on the 2.5% and 97.5% quantiles), and diagnostics (the number of chains that fail convergence and half-width tests (Heidelberger & Welch 1983), and the effective length of the chains (without autocorrelation). Trace plots of the chains are also shown. Base levels of the factor covariates are: Large trawl for method, South for region, and Spring (Oct-Dec) for season. Model strata included different different regions, seasons, years, target fisheries, and areas for trawling, surface-longline (SLL), and bottom-longline (BLL) fisheries. IWL, integrated weight line.

Parameter	Statistic			Diagnostics			
	Mean	Median	95% c.i.	Conv.	H.W.	Effective length	Trace
Distribution parameterisation	0.793	0.793	0.583 – 1.006			4002	
S.d.(Year)							
BLL	1.190	1.156	0.610 – 1.984			4293	
SLL	0.840	0.710	0.136 – 2.122			2114	
Trawl	0.321	0.311	0.102 – 0.602			4002	
S.d.(Area)	1.585	1.547	1.102 – 2.263			4002	
S.d.(Fishery)	0.990	0.963	0.612 – 1.526			4002	
Overdispersion							
BLL	3.550	3.430	2.070 – 5.688			4002	
SLL	1.172	1.096	0.464 – 2.310			4297	
Trawl	1.923	1.867	1.122 – 3.066			4002	
Intercept	0.023	0.017	0.005 – 0.081			3901	
Method / Vessel class							
BLL / vessels $\geq$ 34 m	2.022	1.187	0.238 – 8.515			4002	
SLL / vessels $\geq$ 45 m	20.133	10.484	1.139 – 96.655			3890	
Trawl / vessels $\geq$ 28 m	1.000	1.000	1.000 – 1.000	3			
BLL / vessels $<$ 34 m	2.524	1.785	0.367 – 8.583			3453	
SLL / vessels $<$ 45 m	13.817	9.103	1.786 – 53.255			4594	
Trawl / vessels $<$ 28 m	1.764	1.662	0.894 – 3.133			3939	
Region							
North	0.234	0.076	0.009 – 1.044			3835	
South	1.000	1.000	1.000 – 1.000	3			
Season							
Autumn (Apr-Jun)	0.090	0.086	0.046 – 0.155			4002	
Spring (Oct-Dec)	1.000	1.000	1.000 – 1.000	3			
Summer (Jan-Mar)	0.390	0.384	0.276 – 0.535			3491	
Winter (Jul-Sep)	0.567	0.556	0.379 – 0.810			4121	
Fishery							
Albacore SLL	0.753	0.535	0.010 – 2.797			3970	
Bigeye SLL	1.960	1.682	0.414 – 5.130			4002	
Bluenose BLL	0.702	0.491	0.009 – 2.632			3795	
Deepwater trawl	0.133	0.122	0.046 – 0.290			4002	
Flatfish trawl	0.189	0.122	0.002 – 0.751			4002	
Hake trawl	1.943	1.787	0.713 – 3.978			4002	
Hāpuku BLL	0.582	0.401	0.007 – 2.115			4002	
Hoki trawl	1.120	1.071	0.484 – 2.032			4002	
Inshore trawl	0.948	0.867	0.276 – 2.094			4002	
Ling (no IWL) BLL – vessels $\geq$ 34 m	1.949	1.659	0.283 – 5.369			4003	
Ling (IWL) BLL – vessels $\geq$ 34 m	0.196	0.106	0.001 – 0.884			4002	
Ling BLL – vessels $<$ 34 m	1.390	1.169	0.267 – 3.799			4002	
Ling trawl	1.580	1.466	0.560 – 3.216			4002	
Mackerel trawl	0.481	0.416	0.095 – 1.228			4154	
Middle depths trawl	1.460	1.399	0.635 – 2.662			4002	
Minor targets BLL	1.491	1.251	0.238 – 4.289			3809	
Minor surface longline	0.906	0.622	0.012 – 3.372			4002	
Southern blue whiting trawl	0.314	0.268	0.069 – 0.803			3894	
Scampi trawl	0.910	0.845	0.328 – 1.865			4134	
Snapper BLL	0.768	0.540	0.008 – 2.832			3766	
Squid trawl	1.661	1.563	0.663 – 3.233			4118	
Southern bluefin SLL	0.737	0.578	0.105 – 2.177			3784	
Swordfish SLL	0.804	0.578	0.010 – 3.026			4002	
Area							
Auckland Islands	0.053	0.041	0.006 – 0.166			4002	
Cook Strait	0.514	0.434	0.086 – 1.427			3729	
East of North Island	2.710	2.200	0.180 – 7.906	1		3658	
Eastern Chatham Rise	1.486	1.359	0.299 – 3.458			3898	
East Subantarctic	4.610	4.343	1.099 – 9.272			4168	
Fiordland	0.056	0.037	0.003 – 0.218			4002	
Kermadec Islands	0.343	0.093	0.000 – 2.278			3822	
North East	0.371	0.257	0.017 – 1.369	1		3550	
South Subantarctic	0.169	0.138	0.022 – 0.495			4190	
Stewart Snares Shelf	0.198	0.178	0.039 – 0.476			3980	
Western Chatham Rise	1.271	1.154	0.266 – 2.959			3761	
West Coast North Island	0.157	0.078	0.002 – 0.771			3860	
West Coast South Island	0.007	0.005	0.000 – 0.031			3846	

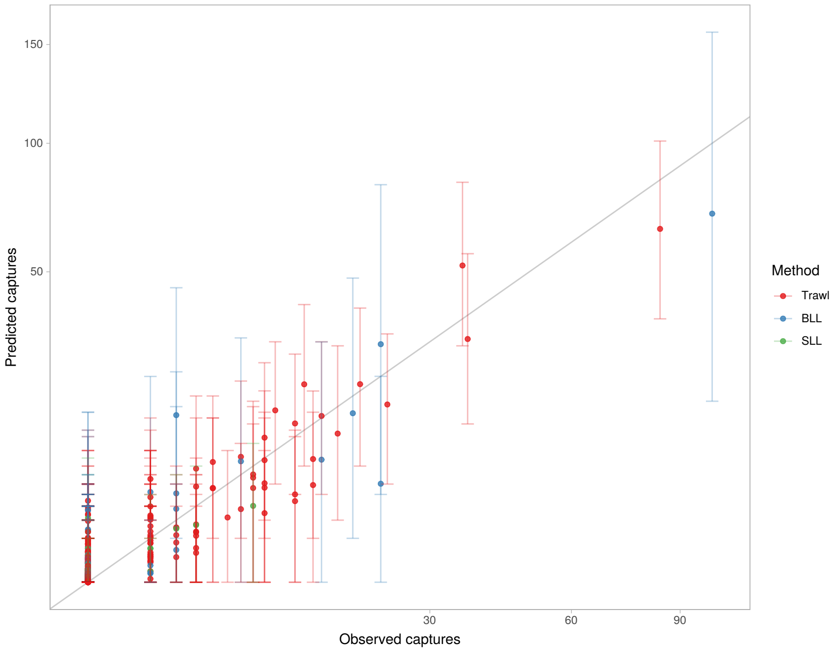


Figure A-2: Comparison between the observed and the predicted number of captures of Salvin's albatross (represented by their mean and 95% credible interval), for each combination of region, fishery, vessel size, area, and season. The points were coloured according to the fishing method (BLL, bottom longline; SLL, surface longline).

Table A-6: List of strata, defined as combinations of region, fishery, vessel size, area, and season, for which the number of observed captures of Salvin's albatross was outside the 95% credible interval (c.i.) of the estimated number of captures. There were three of these strata, representing 0.5% of all 629 strata. SLL, surface longline; BLL, bottom longline. Cut-off lengths between small and large vessels were 28 m for trawl, 34 m for BLL, and 45 m for SLL.

Method	Fishery	Vessel size	Region	Area	Season	Observations	Captures	Mean	95% c.i.
BLL	Ling BLL – vessels < 34 m	Small	South	Stewart Snares Shelf	Winter (Jul-Sep)	14	1	0.04	0–0
BLL	Minor targets BLL	Small	North	West Coast North Island	Summer (Jan-Mar)	230	1	0.04	0–0
Trawl	Middle depths trawl	Small	South	West Coast South Island	Summer (Jan-Mar)	79	1	0.01	0–0

A.3 Buller’s albatrosses

Table A-7: Model strata with the highest number of estimated captures of Buller’s albatrosses in each of trawl, surface-longline (SLL), and bottom-longline (BLL) fisheries. Only the 15 strata with the most estimated captures are shown, sorted in decreasing order of mean estimated captures. The strata were defined as combinations of fishery, vessel size, area, and season. The number of observed captures between the fishing years 1998–99 and 2017–18 for bottom- and surface-longline fisheries, and between 2002–03 and 2017–18 for trawl fisheries, are shown, along with the number of fishing events observed, the proportion of fishing events observed (observer coverage), the associated ratio estimate of the total number of captures, and the mean and 95% credible interval of the total estimated number of captures. IWL: Integrated weight line.

(a) Trawl

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Squid trawl	Vessels $\geq$ 28 m	Stewart Snares Shelf	Autumn	84	3103	0.337	249	198	134–274
Hoki trawl	Vessels $\geq$ 28 m	West Coast South Island	Winter	46	16382	0.350	131	108	67–158
Hoki trawl	Vessels $\geq$ 28 m	Stewart Snares Shelf	Autumn	26	2081	0.277	93	99	60–149
Flatfish trawl	Vessels $<$ 28 m	Stewart Snares Shelf	Autumn	0	51	0.003	0	84	0–316
Squid trawl	Vessels $\geq$ 28 m	Stewart Snares Shelf	Summer	26	11121	0.398	65	82	50–123
Squid trawl	Vessels $\geq$ 28 m	Auckland Islands	Autumn	42	3221	0.395	106	80	45–125
Hoki trawl	Vessels $\geq$ 28 m	Eastern Chatham Rise	Autumn	1	980	0.148	6	67	34–111
Hoki trawl	Vessels $\geq$ 28 m	West Coast South Island	Autumn	31	2706	0.354	87	58	32–89
Scampi trawl	Vessels $<$ 28 m	Auckland Islands	Autumn	7	757	0.128	54	58	23–110
Middle depths trawl	Vessels $\geq$ 28 m	Stewart Snares Shelf	Autumn	29	972	0.436	66	54	28–89
Hoki trawl	Vessels $\geq$ 28 m	Western Chatham Rise	Autumn	9	2666	0.171	52	49	23–85
Middle depths trawl	Vessels $<$ 28 m	Western Chatham Rise	Autumn	0	6	0.001	0	49	12–121
Middle depths trawl	Vessels $\geq$ 28 m	Eastern Chatham Rise	Autumn	9	276	0.117	77	45	19–83
Middle depths trawl	Vessels $<$ 28 m	West Coast South Island	Autumn	0	6	0.002	0	45	11–111
Squid trawl	Vessels $\geq$ 28 m	Fiordland	Autumn	8	309	0.224	35	43	19–77

(b) Surface longline

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Southern bluefin SLL	Vessels $<$ 43 m	West Coast South Island	Autumn	95	394	0.132	717	633	399–947
Southern bluefin SLL	Vessels $\geq$ 43 m	Fiordland	Autumn	421	3057	0.901	467	486	371–623
Southern bluefin SLL	Vessels $<$ 43 m	East of North Island	Autumn	18	406	0.047	382	480	251–801
Bigeye SLL	Vessels $<$ 43 m	East of North Island	Autumn	1	100	0.022	45	467	191–916
Southern bluefin SLL	Vessels $<$ 43 m	Fiordland	Autumn	19	18	0.047	403	233	113–413
Albacore SLL	Vessels $<$ 43 m	East of North Island	Autumn	1	23	0.015	68	209	44–553
Bigeye SLL	Vessels $<$ 43 m	North East	Autumn	2	59	0.012	164	135	36–316
Bigeye SLL	Vessels $<$ 43 m	East of North Island	Summer	6	171	0.027	221	88	32–183
Bigeye SLL	Vessels $<$ 43 m	North East	Winter	2	105	0.014	144	70	17–166
Southern bluefin SLL	Vessels $<$ 43 m	West Coast South Island	Winter	2	46	0.050	39	64	28–117
Southern bluefin SLL	Vessels $<$ 43 m	East of North Island	Winter	4	225	0.115	34	36	12–73
Bigeye SLL	Vessels $<$ 43 m	North East	Summer	0	168	0.030	0	21	3–55
Southern bluefin SLL	Vessels $<$ 43 m	North East	Winter	0	495	0.119	0	21	4–51
Southern bluefin SLL	Vessels $\geq$ 43 m	West Coast South Island	Autumn	16	333	0.917	17	20	5–42
Swordfish SLL	Vessels $<$ 43 m	West Coast South Island	Autumn	0	47	0.158	0	18	0–61

(c) Bottom longline

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Bluenose BLL	Vessels $<$ 34 m	Eastern Chatham Rise	Autumn	2	29	0.018	112	73	9–228
Hāpuku BLL	Vessels $<$ 34 m	Eastern Chatham Rise	Autumn	0	0	0.000		52	0–233
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	West Coast South Island	Autumn	4	56	0.022	182	37	7–97
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	Eastern Chatham Rise	Winter	0	180	0.045	0	27	5–74
Snapper BLL	Vessels $<$ 34 m	North East	Autumn	0	528	0.014	0	26	0–115
Bluenose BLL	Vessels $<$ 34 m	East of North Island	Autumn	0	17	0.006	0	22	1–70
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	Eastern Chatham Rise	Autumn	1	43	0.043	23	21	3–56
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	Fiordland	Winter	0	3	0.002	0	21	3–60
Ling (no IWL) BLL – vessels $\geq$ 34 m	Vessels $\geq$ 34 m	Eastern Chatham Rise	Autumn	0	162	0.065	0	19	3–48
Ling (no IWL) BLL – vessels $\geq$ 34 m	Vessels $\geq$ 34 m	Eastern Chatham Rise	Winter	0	1148	0.154	0	17	3–45
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	West Coast South Island	Winter	0	6	0.002	0	15	2–40
Bluenose BLL	Vessels $<$ 34 m	Fiordland	Autumn	0	0	0.000		14	0–46
Minor targets BLL	Vessels $<$ 34 m	Eastern Chatham Rise	Autumn	0	0	0.000		14	0–67
Bluenose BLL	Vessels $<$ 34 m	Eastern Chatham Rise	Winter	0	2	0.002	0	12	1–40
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	Western Chatham Rise	Autumn	0	54	0.029	0	12	1–35

Table A-8: Summary of model parameters, for Buller's albatrosses capture in New Zealand commercial trawl, bottom-, and surface-longline fisheries. For each parameter, the table gives summary statistics of the posterior distribution (mean, median, and 95% credible interval, based on the 2.5% and 97.5% quantiles), and diagnostics (the number of chains that fail convergence and half-width tests (Heidelberger & Welch 1983), and the effective length of the chains (without autocorrelation). Trace plots of the chains are also shown. Base levels of the factor covariates are: Large SLL for method, South for region, and Autumn (Apr-Jun) for season. Model strata included different different regions, seasons, years, target fisheries, and areas for trawling, surface-longline (SLL), and bottom-longline (BLL) fisheries. IWL, integrated weight line.

Parameter	Statistic			Diagnostics			
	Mean	Median	95% c.i.	Conv.	H.W.	Effective length	Trace
Distribution parameterisation	0.726	0.727	0.527 – 0.921			4192	
S.d.(Year)							
BLL	0.888	0.805	0.135 – 2.119			2454	
SLL	0.435	0.430	0.146 – 0.755			4353	
Trawl	0.284	0.275	0.100 – 0.515			4002	
S.d.(Area)	1.245	1.208	0.732 – 1.972			3926	
S.d.(Fishery)	1.029	1.003	0.634 – 1.543			3800	
Overdispersion							
BLL	1.573	1.475	0.664 – 2.999			4002	
SLL	2.252	2.205	1.535 – 3.235			4002	
Trawl	1.896	1.839	1.102 – 3.068			4336	
Intercept	0.096	0.069	0.018 – 0.327			3980	
Method / Vessel class							
BLL / vessels $\geq$ 34 m	0.104	0.051	0.006 – 0.501			3879	
SLL / vessels $\geq$ 45 m	1.000	1.000	1.000 – 1.000	3			
Trawl / vessels $\geq$ 28 m	0.130	0.103	0.024 – 0.406			4388	
BLL / vessels $<$ 34 m	0.401	0.249	0.040 – 1.659			3847	
SLL / vessels $<$ 45 m	4.337	4.135	2.266 – 7.519			4142	
Trawl / vessels $<$ 28 m	0.171	0.125	0.026 – 0.579			4002	
Region							
North	0.217	0.124	0.026 – 0.904			3812	
South	1.000	1.000	1.000 – 1.000	3			
Season							
Autumn (Apr-Jun)	1.000	1.000	1.000 – 1.000	3			
Spring (Oct-Dec)	0.083	0.080	0.043 – 0.138	1		3588	
Summer (Jan-Mar)	0.137	0.135	0.095 – 0.190			4192	
Winter (Jul-Sep)	0.331	0.327	0.227 – 0.460			4002	
Fishery							
Albacore SLL	1.856	1.584	0.407 – 4.845			4002	
Bigeye SLL	1.573	1.385	0.380 – 3.835			4233	
Bluenose BLL	1.753	1.475	0.296 – 4.865			3838	
Deepwater trawl	0.105	0.089	0.020 – 0.272			4075	
Flatfish trawl	0.319	0.203	0.002 – 1.232			4002	
Hake trawl	0.601	0.536	0.164 – 1.414			3982	
Hāpuku BLL	0.760	0.527	0.009 – 2.853			4063	
Hoki trawl	1.135	1.079	0.466 – 2.168			3855	
Inshore trawl	0.228	0.141	0.001 – 0.955			4773	
Ling (no IWL) BLL – vessels $\geq$ 34 m	1.718	1.423	0.215 – 5.060			3844	
Ling (IWL) BLL – vessels $\geq$ 34 m	0.318	0.182	0.001 – 1.378			4002	
Ling BLL – vessels $<$ 34 m	0.967	0.773	0.140 – 3.004			4131	
Ling trawl	1.453	1.320	0.443 – 3.252			3800	
Mackerel trawl	0.606	0.538	0.170 – 1.413			4002	
Middle depths trawl	2.114	1.988	0.858 – 4.028			4300	
Minor targets BLL	0.583	0.404	0.005 – 2.265			4283	
Minor surface longline	0.837	0.579	0.008 – 3.113			4002	
Southern blue whiting trawl	0.798	0.577	0.052 – 2.855	1		4002	
Scampi trawl	1.587	1.432	0.467 – 3.461			4002	
Snapper BLL	0.597	0.397	0.005 – 2.293			4235	
Squid trawl	1.909	1.803	0.775 – 3.681			3897	
Southern bluefin SLL	0.876	0.776	0.224 – 2.185			4002	
Swordfish SLL	0.236	0.171	0.012 – 0.832			4230	
Area							
Auckland Islands	0.834	0.766	0.273 – 1.795			4002	
Cook Strait	0.068	0.035	0.000 – 0.327			3906	
East of North Island	2.389	2.082	0.312 – 6.318			4002	
Eastern Chatham Rise	1.530	1.418	0.496 – 3.261			4002	
East Subantarctic	0.278	0.135	0.000 – 1.412			4002	
Fiordland	2.932	2.692	1.024 – 6.356			3837	
Kermadec Islands	0.481	0.248	0.000 – 2.251			4047	
North East	0.655	0.539	0.064 – 1.981			4002	
South Subantarctic	0.148	0.095	0.006 – 0.588			4550	
Stewart Snares Shelf	1.909	1.778	0.656 – 3.903			4002	
Western Chatham Rise	0.475	0.431	0.140 – 1.089			3868	
West Coast North Island	0.297	0.196	0.008 – 1.163			4127	
West Coast South Island	1.051	0.970	0.349 – 2.214			3829	

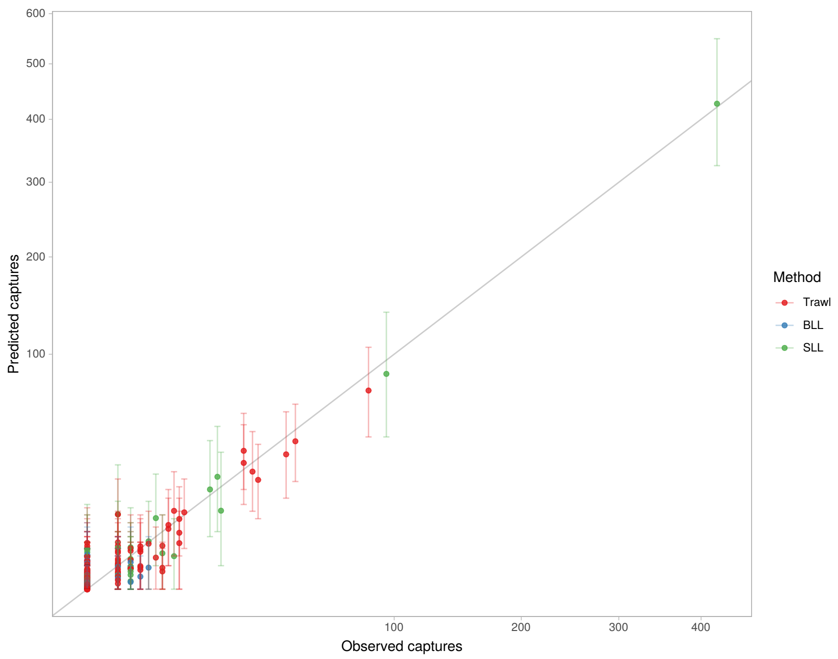


Figure A-3: Comparison between the observed and the predicted number of captures of Buller's albatrosses (represented by their mean and 95% credible interval), for each combination of region, fishery, vessel size, area, and season. The points were coloured according to the fishing method (BLL, bottom longline; SLL, surface longline).

Table A-9: List of strata, defined as combinations of region, fishery, vessel size, area, and season, for which the number of observed captures of Buller's albatrosses was outside the 95% credible interval (c.i.) of the estimated number of captures. There were six of these strata, representing 1.0% of all 629 strata. SLL, surface longline; BLL, bottom longline. Cut-off lengths between small and large vessels were 28 m for trawl, 34 m for BLL, and 45 m for SLL.

Method	Fishery	Vessel size	Region	Area	Season	Observations	Captures	Mean	95% c.i.
Trawl	Hoki trawl	Large	South	Eastern Chatham Rise	Autumn (Apr-Jun)	980	1	10.12	2–22
Trawl	Scampi trawl	Small	South	Eastern Chatham Rise	Summer (Jan-Mar)	327	6	0.83	0–4
Trawl	Middle depths trawl	Large	South	Eastern Chatham Rise	Spring (Oct-Dec)	341	6	0.57	0–3
BLL	Ling (no IWL) BLL – vessels $\geq$ 34 m	Large	South	Eastern Chatham Rise	Spring (Oct-Dec)	482	3	0.29	0–2
SLL	Southern bluefin SLL	Large	North	East of North Island	Autumn (Apr-Jun)	9	2	0.12	0–1
BLL	Ling (no IWL) BLL – vessels $\geq$ 34 m	Large	South	Western Chatham Rise	Winter (Jul-Sep)	47	2	0.09	0–1

A.4 Other albatrosses

Table A-10: Model strata with the highest number of estimated captures of other albatrosses in each of trawl, surface-longline (SLL), and bottom-longline (BLL) fisheries. Only the 15 strata with the most estimated captures are shown, sorted in decreasing order of mean estimated captures. The strata were defined as combinations of fishery, vessel size, area, and season. The number of observed captures between the fishing years 1998–99 and 2017–18 for bottom- and surface-longline fisheries, and between 2002–03 and 2017–18 for trawl fisheries, are shown, along with the number of fishing events observed, the proportion of fishing events observed (observer coverage), the associated ratio estimate of the total number of captures, and the mean and 95% credible interval of the total estimated number of captures. IWL: Integrated weight line.

(a) Trawl

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Inshore trawl	Vessels < 28 m	East of North Island	Spring	0	204	0.006	0	27	3–75
Flatfish trawl	Vessels < 28 m	Stewart Snares Shelf	Spring	0	18	0.001	0	24	1–75
Hoki trawl	Vessels ≥ 28 m	Eastern Chatham Rise	Spring	2	2705	0.240	8	21	8–39
Hoki trawl	Vessels ≥ 28 m	West Coast South Island	Winter	7	16382	0.350	19	19	7–35
Squid trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Summer	8	11121	0.398	20	19	7–37
Deepwater trawl	Vessels ≥ 28 m	Eastern Chatham Rise	Spring	6	2781	0.254	23	16	5–31
Flatfish trawl	Vessels < 28 m	Western Chatham Rise	Spring	0	84	0.004	0	15	0–50
Scampi trawl	Vessels < 28 m	Eastern Chatham Rise	Spring	3	649	0.101	29	15	4–36
Hoki trawl	Vessels ≥ 28 m	Western Chatham Rise	Spring	1	2573	0.187	5	13	3–26
Inshore trawl	Vessels < 28 m	North East	Spring	0	1188	0.037	0	13	1–35
Squid trawl	Vessels ≥ 28 m	Auckland Islands	Summer	5	8010	0.511	9	12	3–24
Flatfish trawl	Vessels < 28 m	Stewart Snares Shelf	Summer	0	526	0.020	0	11	0–37
Inshore trawl	Vessels < 28 m	East of North Island	Winter	0	192	0.007	0	11	1–32
Hoki trawl	Vessels ≥ 28 m	Eastern Chatham Rise	Summer	0	1665	0.131	0	10	3–22
Inshore trawl	Vessels < 28 m	East of North Island	Summer	0	265	0.009	0	10	1–29

(b) Surface longline

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Bigeye SLL	Vessels < 43 m	North East	Spring	24	256	0.036	660	491	251–844
Southern bluefin SLL	Vessels < 43 m	East of North Island	Autumn	15	406	0.047	318	491	274–793
Bigeye SLL	Vessels < 43 m	East of North Island	Summer	7	171	0.027	257	394	187–716
Bigeye SLL	Vessels < 43 m	East of North Island	Autumn	0	100	0.022	0	271	125–495
Bigeye SLL	Vessels < 43 m	North East	Winter	2	105	0.014	144	239	107–444
Bigeye SLL	Vessels < 43 m	North East	Summer	3	168	0.030	100	173	77–322
Albacore SLL	Vessels < 43 m	East of North Island	Autumn	0	23	0.015	0	155	45–363
Bigeye SLL	Vessels < 43 m	North East	Autumn	1	59	0.012	82	143	63–273
Bigeye SLL	Vessels < 43 m	East of North Island	Spring	1	13	0.015	68	127	53–243
Southern bluefin SLL	Vessels < 43 m	North East	Winter	6	495	0.119	50	126	57–230
Southern bluefin SLL	Vessels < 43 m	East of North Island	Winter	13	225	0.115	113	120	57–211
Southern bluefin SLL	Vessels < 43 m	West Coast South Island	Autumn	14	394	0.132	105	110	46–211
Albacore SLL	Vessels < 43 m	East of North Island	Summer	0	7	0.011	0	64	15–162
Swordfish SLL	Vessels < 43 m	West Coast South Island	Summer	1	19	0.038	26	63	18–145
Swordfish SLL	Vessels < 43 m	North East	Summer	4	39	0.061	65	62	18–141

(c) Bottom longline

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Snapper BLL	Vessels < 34 m	North East	Spring	0	619	0.014	0	111	5–336
Ling BLL – vessels < 34 m	Vessels < 34 m	East of North Island	Spring	0	36	0.010	0	84	18–221
Bluenose BLL	Vessels < 34 m	East of North Island	Spring	0	0	0.000		75	9–235
Ling BLL – vessels < 34 m	Vessels < 34 m	Eastern Chatham Rise	Spring	3	153	0.064	47	67	17–161
Ling BLL – vessels < 34 m	Vessels < 34 m	East of North Island	Winter	2	94	0.014	139	66	17–164
Ling BLL – vessels < 34 m	Vessels < 34 m	Eastern Chatham Rise	Winter	13	180	0.045	286	49	12–121
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Eastern Chatham Rise	Spring	4	482	0.139	28	46	11–111
Ling BLL – vessels < 34 m	Vessels < 34 m	Western Chatham Rise	Spring	0	99	0.032	0	44	8–113
Snapper BLL	Vessels < 34 m	North East	Summer	0	766	0.020	0	44	2–142
Ling BLL – vessels < 34 m	Vessels < 34 m	West Coast South Island	Spring	0	16	0.006	0	42	8–109
Snapper BLL	Vessels < 34 m	North East	Autumn	0	528	0.014	0	40	1–132
Snapper BLL	Vessels < 34 m	North East	Winter	0	0	0.000		40	1–132
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Eastern Chatham Rise	Winter	8	1148	0.154	51	39	10–90
Bluenose BLL	Vessels < 34 m	North East	Spring	0	37	0.007	0	36	4–112
Hāpuku BLL	Vessels < 34 m	Eastern Chatham Rise	Spring	0	54	0.032	0	31	2–103

Table A-11: Summary of model parameters, for other albatrosses capture in New Zealand commercial trawl, bottom-, and surface-longline fisheries. For each parameter, the table gives summary statistics of the posterior distribution (mean, median, and 95% credible interval, based on the 2.5% and 97.5% quantiles), and diagnostics (the number of chains that fail convergence and half-width tests (Heidelberger & Welch 1983), and the effective length of the chains (without autocorrelation). Trace plots of the chains are also shown. Base levels of the factor covariates are: Small SLL for method, North for region, and Spring (Oct-Dec) for season. Model strata included different different regions, seasons, years, target fisheries, and areas for trawling, surface-longline (SLL), and bottom-longline (BLL) fisheries. IWL, integrated weight line.

Parameter	Statistic			Diagnostics			
	Mean	Median	95% c.i.	Conv.	H.W.	Effective length	Trace
Distribution parameterisation	0.700	0.699	0.470 – 0.937	1		3905	
S.d.(Year)							
BLL	1.087	1.067	0.262 – 2.005			3335	
SLL	0.398	0.358	0.086 – 0.961			3299	
Trawl	0.341	0.326	0.086 – 0.711			3759	
S.d.(Area)	0.704	0.685	0.411 – 1.101			4002	
S.d.(Fishery)	0.628	0.613	0.251 – 1.101			4002	
Overdispersion							
BLL	3.265	3.113	1.617 – 5.872	1		3854	
SLL	2.487	2.450	1.714 – 3.473			4028	
Trawl	1.196	1.101	0.465 – 2.426			4002	
Intercept	0.154	0.125	0.044 – 0.408			3936	
Method / Vessel class							
BLL / vessels $\geq$ 34 m	0.076	0.050	0.012 – 0.304			4002	
SLL / vessels $\geq$ 45 m	0.753	0.710	0.323 – 1.427	1		3900	
Trawl / vessels $\geq$ 28 m	0.008	0.007	0.002 – 0.021			4002	
BLL / vessels $<$ 34 m	0.075	0.060	0.017 – 0.220			3815	
SLL / vessels $<$ 45 m	1.000	1.000	1.000 – 1.000	3			
Trawl / vessels $<$ 28 m	0.009	0.007	0.002 – 0.028			4002	
Region							
North	1.000	1.000	1.000 – 1.000	3			
South	1.478	1.267	0.406 – 3.795			3937	
Season							
Autumn (Apr-Jun)	0.431	0.415	0.253 – 0.697			4002	
Spring (Oct-Dec)	1.000	1.000	1.000 – 1.000	3			
Summer (Jan-Mar)	0.450	0.436	0.257 – 0.729			4134	
Winter (Jul-Sep)	0.460	0.444	0.267 – 0.740			4002	
Fishery							
Albacore SLL	1.110	1.024	0.357 – 2.359	1		3878	
Bigeye SLL	0.710	0.671	0.256 – 1.401			3899	
Bluenose BLL	1.023	0.938	0.212 – 2.428			3887	
Deepwater trawl	0.818	0.781	0.349 – 1.480			4002	
Flatfish trawl	0.743	0.688	0.060 – 1.840			4157	
Hake trawl	0.894	0.834	0.229 – 1.933	1		4570	
Hāpuku BLL	1.041	0.948	0.208 – 2.512			4261	
Hoki trawl	1.053	1.011	0.524 – 1.858			4002	
Inshore trawl	0.544	0.483	0.070 – 1.353			4205	
Ling (no IWL) BLL – vessels $\geq$ 34 m	0.911	0.844	0.199 – 2.068			4134	
Ling (IWL) BLL – vessels $\geq$ 34 m	0.880	0.809	0.168 – 2.060			4002	
Ling BLL – vessels $<$ 34 m	1.724	1.560	0.645 – 3.759			4002	
Ling trawl	1.196	1.092	0.402 – 2.590			4123	
Mackerel trawl	0.477	0.415	0.028 – 1.268			4002	
Middle depths trawl	1.079	1.027	0.459 – 1.973			4002	
Minor targets BLL	0.870	0.796	0.145 – 2.134			4142	
Minor surface longline	0.690	0.625	0.050 – 1.742			3633	
Southern blue whiting trawl	1.342	1.223	0.535 – 2.784			3963	
Scampi trawl	1.231	1.136	0.442 – 2.478			4002	
Snapper BLL	0.426	0.359	0.018 – 1.192			4210	
Squid trawl	1.447	1.352	0.685 – 2.700			3895	
Southern bluefin SLL	0.683	0.644	0.264 – 1.323			4160	
Swordfish SLL	2.130	1.958	0.918 – 4.353			4116	
Area							
Auckland Islands	1.150	1.083	0.475 – 2.188			3891	
Cook Strait	0.946	0.865	0.234 – 2.177			4002	
East of North Island	1.768	1.647	0.685 – 3.616			4078	
Eastern Chatham Rise	1.710	1.624	0.844 – 2.962			4050	
East Subantarctic	0.565	0.501	0.078 – 1.414			4002	
Fiordland	0.314	0.285	0.100 – 0.698			4002	
Kermadec Islands	1.180	1.083	0.334 – 2.607			4002	
North East	0.873	0.807	0.310 – 1.769			4002	
South Subantarctic	1.578	1.490	0.728 – 2.969			4002	
Stewart Snares Shelf	1.058	0.997	0.482 – 1.946			4002	
Western Chatham Rise	0.854	0.805	0.352 – 1.598			4173	
West Coast North Island	0.240	0.201	0.038 – 0.649			4002	
West Coast South Island	0.869	0.824	0.393 – 1.599			4002	

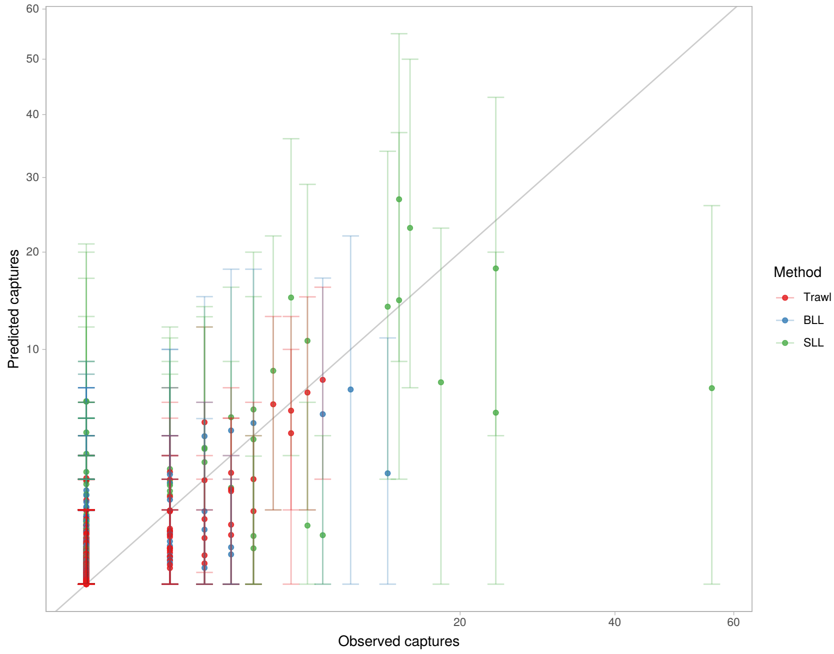


Figure A-4: Comparison between the observed and the predicted number of captures of other albatrosses (represented by their mean and 95% credible interval), for each combination of region, fishery, vessel size, area, and season. The points were coloured according to the fishing method (BLL, bottom longline; SLL, surface longline).

Table A-12: List of strata, defined as combinations of region, fishery, vessel size, area, and season, for which the number of observed captures of other albatrosses was outside the 95% credible interval (c.i.) of the estimated number of captures. There were eleven of these strata, representing 1.7% of all 629 strata. SLL, surface longline; BLL, bottom longline. Cut-off lengths between small and large vessels were 28 m for trawl, 34 m for BLL, and 45 m for SLL.

Method	Fishery	Vessel size	Region	Area	Season	Observations	Captures	Mean	95% c.i.
SLL	Swordfish SLL	Small	North	Kermadec Islands	Spring (Oct-Dec)	22	56	6.97	0–26
SLL	Albacore SLL	Large	North	East of North Island	Autumn (Apr-Jun)	67	24	5.34	0–20
BLL	Ling BLL – vessels $<$ 34 m	Small	South	Eastern Chatham Rise	Winter (Jul-Sep)	180	13	2.23	0–11
SLL	Swordfish SLL	Small	North	North East	Spring (Oct-Dec)	3	7	0.62	0–6
Trawl	Middle depths trawl	Large	South	Eastern Chatham Rise	Summer (Jan-Mar)	578	3	0.44	0–2
SLL	Southern bluefin SLL	Large	North	East of North Island	Autumn (Apr-Jun)	9	8	0.44	0–4
SLL	Southern bluefin SLL	Small	South	Fiordland	Autumn (Apr-Jun)	18	4	0.23	0–3
BLL	Bluenose BLL	Small	North	North East	Autumn (Apr-Jun)	53	3	0.16	0–2
Trawl	Scampi trawl	Small	North	North East	Autumn (Apr-Jun)	379	2	0.15	0–1
Trawl	Hoki trawl	Large	South	South Subantarctic	Summer (Jan-Mar)	102	2	0.08	0–1
BLL	Ling (no IWL) BLL – vessels $\geq$ 34 m	Large	South	Auckland Islands	Autumn (Apr-Jun)	20	2	0.05	0–1

A.5 White-chinned petrel

Table A-13: Model strata with the highest number of estimated captures of white-chinned petrel in each of trawl, surface-longline (SLL), and bottom-longline (BLL) fisheries. Only the 15 strata with the most estimated captures are shown, sorted in decreasing order of mean estimated captures. The strata were defined as combinations of fishery, vessel size, area, and season. The number of observed captures between the fishing years 1998–99 and 2017–18 for bottom- and surface-longline fisheries, and between 2002–03 and 2017–18 for trawl fisheries, are shown, along with the number of fishing events observed, the proportion of fishing events observed (observer coverage), the associated ratio estimate of the total number of captures, and the mean and 95% credible interval of the total estimated number of captures. IWL: Integrated weight line.

(a) Trawl

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Squid trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Summer	560	11121	0.398	1408	1170	913–1464
Squid trawl	Vessels ≥ 28 m	Auckland Islands	Summer	560	8010	0.511	1096	933	710–1192
Squid trawl	Vessels ≥ 28 m	Auckland Islands	Autumn	107	3221	0.395	270	233	149–343
Squid trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Autumn	161	3103	0.337	477	186	116–274
Hoki trawl	Vessels ≥ 28 m	Eastern Chatham Rise	Summer	5	1665	0.131	38	129	68–208
Ling trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Spring	14	1018	0.193	72	113	44–211
Hoki trawl	Vessels ≥ 28 m	Western Chatham Rise	Summer	10	1919	0.134	74	93	47–153
Middle depths trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Summer	78	1902	0.610	127	90	44–150
Middle depths trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Spring	30	1830	0.318	94	84	42–143
Hoki trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Autumn	27	2081	0.277	97	78	38–129
Hoki trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Spring	5	1776	0.261	19	76	39–128
Hoki trawl	Vessels ≥ 28 m	Eastern Chatham Rise	Spring	27	2705	0.240	112	70	34–122
Hoki trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Summer	34	797	0.249	136	67	31–117
Scampi trawl	Vessels ≥ 28 m	Auckland Islands	Spring	1	412	0.174	5	53	16–119
Hoki trawl	Vessels ≥ 28 m	Western Chatham Rise	Spring	16	2573	0.187	85	50	23–88

(b) Surface longline

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Bigeye SLL	Vessels < 43 m	East of North Island	Summer	3	171	0.027	110	129	28–333
Bigeye SLL	Vessels < 43 m	North East	Summer	0	168	0.030	0	77	16–195
Bigeye SLL	Vessels < 43 m	North East	Spring	1	256	0.036	27	58	12–148
Swordfish SLL	Vessels < 43 m	West Coast South Island	Summer	3	19	0.038	79	55	7–184
Bigeye SLL	Vessels < 43 m	East of North Island	Autumn	0	100	0.022	0	44	8–115
Albacore SLL	Vessels < 43 m	Eastern Chatham Rise	Summer	0	0	0.000		39	0–206
Albacore SLL	Vessels < 43 m	East of North Island	Autumn	0	23	0.015	0	36	2–144
Southern bluefin SLL	Vessels ≥ 43 m	Fiordland	Autumn	21	3057	0.901	23	35	14–66
Albacore SLL	Vessels < 43 m	East of North Island	Summer	0	7	0.011	0	31	2–123
Bigeye SLL	Vessels < 43 m	North East	Autumn	1	59	0.012	82	31	6–82
Bigeye SLL	Vessels < 43 m	West Coast North Island	Summer	0	62	0.023	0	23	1–79
Southern bluefin SLL	Vessels < 43 m	Fiordland	Autumn	0	18	0.047	0	22	1–82
Southern bluefin SLL	Vessels < 43 m	West Coast South Island	Autumn	2	394	0.132	15	22	2–67
Southern bluefin SLL	Vessels < 43 m	East of North Island	Autumn	1	406	0.047	21	17	1–62
Albacore SLL	Vessels < 43 m	Western Chatham Rise	Summer	0	0	0.000		16	0–91

(c) Bottom longline

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Stewart Snares Shelf	Spring	137	942	0.483	283	692	313–1278
Ling BLL – vessels < 34 m	Vessels < 34 m	Eastern Chatham Rise	Summer	0	8	0.005	0	631	179–1500
Ling BLL – vessels < 34 m	Vessels < 34 m	Eastern Chatham Rise	Spring	25	153	0.064	392	626	187–1417
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Eastern Chatham Rise	Spring	365	482	0.139	2621	622	268–1171
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Eastern Chatham Rise	Summer	42	285	0.144	290	604	225–1255
Ling BLL – vessels < 34 m	Vessels < 34 m	Western Chatham Rise	Spring	3	99	0.032	94	501	142–1177
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	East Subantarctic	Summer	82	526	0.368	222	441	139–976
Bluenose BLL	Vessels < 34 m	Eastern Chatham Rise	Summer	0	32	0.018	0	400	34–1408
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Eastern Chatham Rise	Autumn	30	162	0.065	460	389	143–815
Ling BLL – vessels < 34 m	Vessels < 34 m	Western Chatham Rise	Summer	0	2	0.002	0	330	80–829
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Western Chatham Rise	Summer	4	60	0.039	102	282	90–639
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	South Subantarctic	Summer	13	12	0.007	1903	274	67–653
Hāpuku BLL	Vessels < 34 m	Eastern Chatham Rise	Summer	0	0	0.000		272	1–1252
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Western Chatham Rise	Spring	20	194	0.076	262	261	91–551
Ling BLL – vessels < 34 m	Vessels < 34 m	Western Chatham Rise	Autumn	0	54	0.029	0	237	55–618

Table A-14: Summary of model parameters, for white-chinned petrel capture in New Zealand commercial trawl, bottom-, and surface-longline fisheries. For each parameter, the table gives summary statistics of the posterior distribution (mean, median, and 95% credible interval, based on the 2.5% and 97.5% quantiles), and diagnostics (the number of chains that fail convergence and half-width tests (Heidelberger & Welch 1983), and the effective length of the chains (without autocorrelation). Trace plots of the chains are also shown. Base levels of the factor covariates are: Large trawl for method, South for region, and Summer (Jan-Mar) for season. Model strata included different different regions, seasons, years, target fisheries, and areas for trawling, surface-longline (SLL), and bottom-longline (BLL) fisheries. IWL, integrated weight line.

Parameter	Statistic			Diagnostics			
	Mean	Median	95% c.i.	Conv.	H.W.	Effective length	Trace
Distribution parameterisation	0.557	0.557	0.377 – 0.742			3884	
S.d.(Year)							
BLL	0.710	0.703	0.328 – 1.152			3727	
SLL	0.440	0.396	0.087 – 1.063			3513	
Trawl	0.608	0.595	0.401 – 0.891			4002	
S.d.(Area)	0.881	0.858	0.556 – 1.348			4335	
S.d.(Fishery)	1.007	0.984	0.654 – 1.491			4002	
Overdispersion							
BLL	7.399	7.348	5.609 – 9.557			4002	
SLL	3.264	3.170	1.818 – 5.272			4002	
Trawl	4.420	4.338	2.996 – 6.250			3709	
Intercept	0.016	0.013	0.005 – 0.039	1		3940	
Method / Vessel class							
BLL / vessels $\geq$ 34 m	16.627	11.993	2.800 – 58.247			4029	
SLL / vessels $\geq$ 45 m	32.033	17.463	2.488 – 143.343			4002	
Trawl / vessels $\geq$ 28 m	1.000	1.000	1.000 – 1.000	3			
BLL / vessels $<$ 34 m	24.389	17.145	4.109 – 85.271			4002	
SLL / vessels $<$ 45 m	123.948	76.700	12.033 – 523.859			4002	
Trawl / vessels $<$ 28 m	0.211	0.188	0.061 – 0.505			3753	
Region							
North	0.032	0.020	0.004 – 0.134			4002	
South	1.000	1.000	1.000 – 1.000	3			
Season							
Autumn (Apr-Jun)	0.473	0.468	0.362 – 0.613			3755	
Spring (Oct-Dec)	0.616	0.607	0.436 – 0.839			4002	
Summer (Jan-Mar)	1.000	1.000	1.000 – 1.000	3			
Winter (Jul-Sep)	0.019	0.016	0.005 – 0.044			3900	
Fishery							
Albacore SLL	1.991	1.672	0.340 – 5.625			4164	
Bigeye SLL	1.030	0.849	0.173 – 2.888			4002	
Bluenose BLL	0.948	0.755	0.094 – 2.936			3814	
Deepwater trawl	0.067	0.056	0.013 – 0.179			4002	
Flatfish trawl	0.376	0.232	0.003 – 1.569			4002	
Hake trawl	0.433	0.381	0.104 – 1.046			4002	
Hāpuku BLL	0.482	0.296	0.003 – 1.938			4002	
Hoki trawl	0.875	0.831	0.365 – 1.632			4002	
Inshore trawl	0.772	0.608	0.066 – 2.398			3986	
Ling (no IWL) BLL – vessels $\geq$ 34 m	2.207	1.909	0.501 – 5.634			4002	
Ling (IWL) BLL – vessels $\geq$ 34 m	0.593	0.493	0.105 – 1.670			4002	
Ling BLL – vessels $<$ 34 m	2.008	1.762	0.443 – 5.072			4002	
Ling trawl	1.323	1.220	0.454 – 2.719			4002	
Mackerel trawl	1.008	0.932	0.349 – 2.094			3921	
Middle depths trawl	1.078	1.025	0.436 – 2.011			4002	
Minor targets BLL	0.592	0.479	0.073 – 1.759			4002	
Minor surface longline	0.763	0.551	0.010 – 2.741			3824	
Southern blue whiting trawl	0.428	0.278	0.004 – 1.730			4002	
Scampi trawl	1.945	1.776	0.694 – 4.099			3789	
Snapper BLL	0.392	0.230	0.003 – 1.666			4002	
Squid trawl	2.182	2.080	0.915 – 3.986			4002	
Southern bluefin SLL	0.213	0.155	0.021 – 0.766			3894	
Swordfish SLL	1.272	1.057	0.182 – 3.517			3962	
Area							
Auckland Islands	2.654	2.547	1.262 – 4.711			3895	
Cook Strait	0.360	0.308	0.069 – 0.979			4002	
East of North Island	1.194	1.055	0.216 – 2.991			3705	
Eastern Chatham Rise	1.013	0.972	0.456 – 1.814			3830	
East Subantarctic	1.027	0.947	0.359 – 2.190			4145	
Fiordland	0.666	0.620	0.228 – 1.390			3492	
Kermadec Islands	1.322	1.109	0.168 – 3.689			4002	
North East	0.828	0.707	0.132 – 2.252			4224	
South Subantarctic	0.632	0.571	0.213 – 1.405			4002	
Stewart Snares Shelf	2.030	1.954	0.972 – 3.505			3900	
Western Chatham Rise	0.626	0.596	0.273 – 1.145			3743	
West Coast North Island	0.501	0.399	0.045 – 1.512			4146	
West Coast South Island	0.098	0.084	0.022 – 0.254			4089	

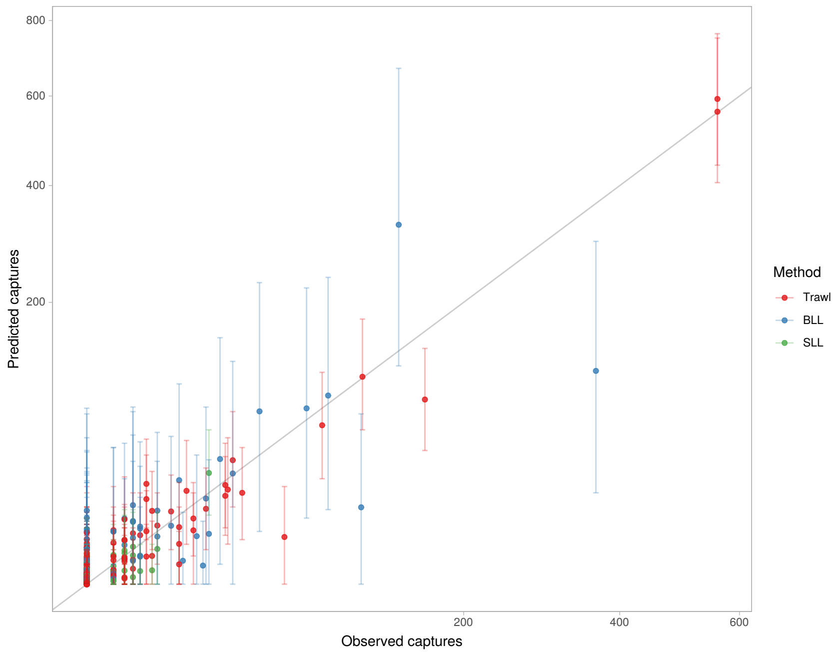


Figure A-5: Comparison between the observed and the predicted number of captures of white-chinned petrel (represented by their mean and 95% credible interval), for each combination of region, fishery, vessel size, area, and season. The points were coloured according to the fishing method (BLL, bottom longline; SLL, surface longline).

Table A-15: List of strata, defined as combinations of region, fishery, vessel size, area, and season, for which the number of observed captures of white-chinned petrel was outside the 95% credible interval (c.i.) of the estimated number of captures. There were twelve of these strata, representing 1.9% of all 629 strata. SLL, surface longline; BLL, bottom longline. Cut-off lengths between small and large vessels were 28 m for trawl, 34 m for BLL, and 45 m for SLL.

Method	Fishery	Vessel size	Region	Area	Season	Observations	Captures	Mean	95% c.i.
BLL	Ling (no IWL) BLL – vessels $\geq$ 34 m	Large	South	Eastern Chatham Rise	Spring (Oct-Dec)	482	365	114.53	21–296
Trawl	Squid trawl	Large	South	Stewart Snares Shelf	Autumn (Apr-Jun)	3103	161	85.85	45–140
Trawl	Hoki trawl	Large	South	Stewart Snares Shelf	Spring (Oct-Dec)	1776	5	25.33	8–53
BLL	Ling (no IWL) BLL – vessels $\geq$ 34 m	Large	South	Fiordland	Spring (Oct-Dec)	93	106	14.87	0–73
Trawl	Scampi trawl	Large	South	Auckland Islands	Summer (Jan-Mar)	111	55	5.60	0–24
Trawl	Scampi trawl	Small	South	Auckland Islands	Summer (Jan-Mar)	81	12	0.99	0–7
BLL	Ling BLL – vessels $<$ 34 m	Small	South	West Coast South Island	Summer (Jan-Mar)	23	19	0.87	0–10
SLL	Southern bluefin SLL	Large	South	South Subantarctic	Autumn (Apr-Jun)	55	6	0.49	0–4
SLL	Bigeye SLL	Small	North	West Coast North Island	Spring (Oct-Dec)	23	3	0.12	0–2
Trawl	Hoki trawl	Large	South	Fiordland	Spring (Oct-Dec)	33	2	0.08	0–1
SLL	Bigeye SLL	Small	North	North East	Winter (Jul-Sep)	105	1	0.03	0–0
SLL	Southern bluefin SLL	Small	North	North East	Winter (Jul-Sep)	495	1	0.03	0–0

A.6 Black petrel

Table A-16: Model strata with the highest number of estimated captures of black petrel in each of trawl, surface-longline (SLL), and bottom-longline (BLL) fisheries. Only the 15 strata with the most estimated captures are shown, sorted in decreasing order of mean estimated captures. The strata were defined as combinations of fishery, vessel size, area, and season. The number of observed captures between the fishing years 1998–99 and 2017–18 for bottom- and surface-longline fisheries, and between 2002–03 and 2017–18 for trawl fisheries, are shown, along with the number of fishing events observed, the proportion of fishing events observed (observer coverage), the associated ratio estimate of the total number of captures, and the mean and 95% credible interval of the total estimated number of captures.

(a) Trawl

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Inshore trawl	Vessels < 28 m	North East	Summer	8	1261	0.034	232	288	86–708
Inshore trawl	Vessels < 28 m	North East	Spring	0	1188	0.037	0	174	45–427
Inshore trawl	Vessels < 28 m	North East	Autumn	20	1780	0.056	357	119	25–321
Scampi trawl	Vessels < 28 m	North East	Summer	1	172	0.047	21	21	0–77
Inshore trawl	Vessels < 28 m	East of North Island	Summer	0	265	0.009	0	19	0–79
Scampi trawl	Vessels < 28 m	North East	Spring	0	523	0.111	0	19	0–72
Inshore trawl	Vessels < 28 m	East of North Island	Spring	0	204	0.006	0	16	0–76
Inshore trawl	Vessels < 28 m	North East	Winter	0	982	0.034	0	12	0–69
Inshore trawl	Vessels < 28 m	West Coast North Island	Summer	0	1565	0.070	0	12	0–62
Inshore trawl	Vessels < 28 m	West Coast North Island	Spring	0	1046	0.040	0	9	0–53
Inshore trawl	Vessels < 28 m	East of North Island	Autumn	0	203	0.008	0	8	0–48
Scampi trawl	Vessels < 28 m	North East	Autumn	0	379	0.168	0	6	0–32
Flatfish trawl	Vessels < 28 m	West Coast North Island	Autumn	0	1	0.000	0	5	0–37
Flatfish trawl	Vessels < 28 m	West Coast North Island	Spring	0	164	0.012	0	5	0–36
Flatfish trawl	Vessels < 28 m	West Coast North Island	Summer	0	68	0.008	0	4	0–35

(b) Surface longline

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Bigeye SLL	Vessels < 43 m	North East	Summer	10	168	0.030	335	590	338–934
Bigeye SLL	Vessels < 43 m	North East	Spring	28	256	0.036	770	502	270–823
Bigeye SLL	Vessels < 43 m	North East	Autumn	1	59	0.012	82	242	101–469
Swordfish SLL	Vessels < 43 m	North East	Summer	3	39	0.061	49	65	20–142
Bigeye SLL	Vessels < 43 m	East of North Island	Summer	3	171	0.027	110	56	6–158
Minor surface longline	Vessels < 43 m	North East	Summer	3	23	0.059	50	55	10–139
Albacore SLL	Vessels < 43 m	North East	Autumn	0	1	0.002	0	52	5–207
Albacore SLL	Vessels < 43 m	North East	Spring	2	1	0.004	564	49	5–199
Bigeye SLL	Vessels < 43 m	North East	Winter	0	105	0.014	0	40	0–142
Albacore SLL	Vessels < 43 m	North East	Summer	0	0	0.000		30	2–115
Bigeye SLL	Vessels < 43 m	East of North Island	Autumn	0	100	0.022	0	19	1–61
Bigeye SLL	Vessels < 43 m	West Coast North Island	Summer	0	62	0.023	0	18	0–61
Albacore SLL	Vessels < 43 m	East of North Island	Autumn	0	23	0.015	0	15	0–66
Swordfish SLL	Vessels < 43 m	North East	Autumn	0	16	0.050	0	15	2–41
Southern bluefin SLL	Vessels < 43 m	North East	Autumn	0	52	0.064	0	13	0–47

(c) Bottom longline

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Snapper BLL	Vessels < 34 m	North East	Summer	14	766	0.020	710	1422	641–2666
Bluenose BLL	Vessels < 34 m	North East	Summer	43	85	0.013	3250	1180	398–2406
Snapper BLL	Vessels < 34 m	North East	Spring	2	619	0.014	140	1099	451–2163
Bluenose BLL	Vessels < 34 m	North East	Spring	5	37	0.007	697	653	198–1414
Snapper BLL	Vessels < 34 m	North East	Autumn	22	528	0.014	1544	653	212–1429
Bluenose BLL	Vessels < 34 m	North East	Autumn	0	53	0.011	0	415	125–924
Hāpuku BLL	Vessels < 34 m	North East	Summer	0	5	0.003	0	304	56–810
Hāpuku BLL	Vessels < 34 m	North East	Spring	0	8	0.004	0	194	31–542
Minor targets BLL	Vessels < 34 m	North East	Summer	2	40	0.026	78	125	21–309
Hāpuku BLL	Vessels < 34 m	North East	Autumn	4	28	0.018	222	110	13–315
Minor targets BLL	Vessels < 34 m	North East	Spring	0	27	0.020	0	75	10–205
Snapper BLL	Vessels < 34 m	North East	Winter	0	0	0.000		67	0–283
Bluenose BLL	Vessels < 34 m	East of North Island	Summer	0	58	0.014	0	65	2–203
Minor targets BLL	Vessels < 34 m	North East	Autumn	0	32	0.020	0	59	6–164
Bluenose BLL	Vessels < 34 m	East of North Island	Spring	0	0	0.000		56	1–184

Table A-17: Summary of model parameters, for black petrel capture in New Zealand commercial trawl, bottom-, and surface-longline fisheries. For each parameter, the table gives summary statistics of the posterior distribution (mean, median, and 95% credible interval, based on the 2.5% and 97.5% quantiles), and diagnostics (the number of chains that fail convergence and half-width tests (Heidelberger & Welch 1983), and the effective length of the chains (without autocorrelation). Trace plots of the chains are also shown. Base levels of the factor covariates are: Small BLL for method, North for region, and Summer (Jan-Mar) for season. Model strata included different different regions, seasons, years, target fisheries, and areas for trawling, surface-longline (SLL), and bottom-longline (BLL) fisheries. IWL, integrated weight line.

Parameter	Statistic			Diagnostics			
	Mean	Median	95% c.i.	Conv.	H.W.	Effective length	Trace
Distribution parameterisation	1.233	1.228	0.936 – 1.576			3867	
S.d.(Year)							
BLL	0.904	0.766	0.130 – 2.357			1966	
SLL	0.795	0.658	0.127 – 2.097			2017	
Trawl	0.910	0.764	0.147 – 2.378			2160	
S.d.(Area)	1.303	1.243	0.663 – 2.335			3489	
S.d.(Fishery)	0.796	0.752	0.325 – 1.483			3402	
Overdispersion							
BLL	1.732	1.670	1.015 – 2.791			4002	
SLL	0.782	0.754	0.389 – 1.328			4149	
Trawl	1.444	1.328	0.586 – 3.032			3869	
Intercept	0.078	0.039	0.009 – 0.272			3621	
Method / Vessel class							
BLL / vessels $\geq$ 34 m	1.082	0.050	0.000 – 8.230			4115	
SLL / vessels $\geq$ 45 m	1.263	0.648	0.059 – 5.959			3474	
Trawl / vessels $\geq$ 28 m	0.011	0.002	0.000 – 0.074			3803	
BLL / vessels $<$ 34 m	1.000	1.000	1.000 – 1.000	3			
SLL / vessels $<$ 45 m	1.756	1.246	0.317 – 5.738			4166	
Trawl / vessels $<$ 28 m	0.091	0.063	0.012 – 0.337			3896	
Region							
North	1.000	1.000	1.000 – 1.000	3			
South	0.023	0.003	0.000 – 0.161			4008	
Season							
Autumn (Apr-Jun)	0.490	0.465	0.217 – 0.922			3817	
Spring (Oct-Dec)	0.708	0.678	0.383 – 1.204			3110	
Summer (Jan-Mar)	1.000	1.000	1.000 – 1.000	3			
Winter (Jul-Sep)	0.052	0.037	0.003 – 0.184			3817	
Fishery							
Albacore SLL	1.726	1.467	0.389 – 4.623			4002	
Bigeye SLL	0.945	0.886	0.211 – 2.105			3820	
Bluenose BLL	1.889	1.702	0.657 – 4.224			3773	
Deepwater trawl	0.909	0.779	0.026 – 2.763			4002	
Flatfish trawl	0.960	0.813	0.030 – 3.004			3848	
Hake trawl	0.998	0.826	0.034 – 3.079			4002	
Hāpuku BLL	1.485	1.299	0.368 – 3.656			4252	
Hoki trawl	0.889	0.743	0.032 – 2.592			3754	
Inshore trawl	1.343	1.157	0.308 – 3.669			3373	
Ling (no IWL) BLL – vessels $\geq$ 34 m	0.984	0.815	0.038 – 3.085			4002	
Ling (IWL) BLL – vessels $\geq$ 34 m	0.977	0.798	0.029 – 2.997			3982	
Ling BLL – vessels $<$ 34 m	0.699	0.606	0.012 – 2.002			3888	
Ling trawl	0.951	0.794	0.030 – 2.984			3966	
Mackerel trawl	0.938	0.777	0.029 – 2.888			3753	
Middle depths trawl	0.892	0.762	0.024 – 2.616			4002	
Minor targets BLL	0.828	0.750	0.165 – 2.003			3890	
Minor surface longline	1.172	1.037	0.224 – 2.934			3050	
Southern blue whiting trawl	0.996	0.823	0.025 – 3.201			4002	
Scampi trawl	0.907	0.782	0.126 – 2.508			3839	
Snapper BLL	0.403	0.362	0.110 – 0.937			4114	
Squid trawl	0.987	0.804	0.035 – 3.083			3949	
Southern bluefin SLL	0.312	0.228	0.003 – 1.059			3664	
Swordfish SLL	0.889	0.814	0.158 – 2.176			4223	
Area							
Auckland Islands	0.949	0.532	0.001 – 4.507			4002	
Cook Strait	0.943	0.547	0.000 – 4.523			4002	
East of North Island	0.248	0.191	0.017 – 0.802			3506	
Eastern Chatham Rise	0.871	0.514	0.000 – 3.758			3345	
East Subantarctic	0.940	0.538	0.000 – 4.175			4026	
Fiordland	0.821	0.469	0.000 – 3.712			3723	
Kermadec Islands	0.969	0.735	0.062 – 3.244			3888	
North East	2.934	2.551	0.497 – 7.593			3503	
South Subantarctic	0.959	0.537	0.000 – 4.458			4002	
Stewart Snares Shelf	0.924	0.519	0.000 – 4.377			4002	
Western Chatham Rise	0.903	0.506	0.000 – 4.161			3789	
West Coast North Island	0.186	0.126	0.008 – 0.693			3862	
West Coast South Island	0.905	0.513	0.000 – 4.153			3883	

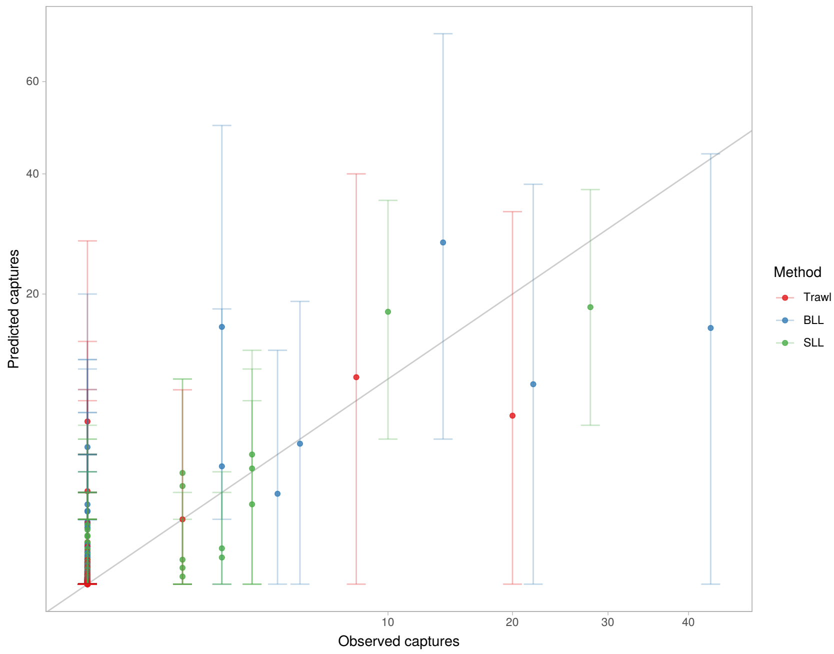


Figure A-6: Comparison between the observed and the predicted number of captures of black petrel (represented by their mean and 95% credible interval), for each combination of region, fishery, vessel size, area, and season. The points were coloured according to the fishing method (BLL, bottom longline; SLL, surface longline).

Table A-18: List of strata, defined as combinations of region, fishery, vessel size, area, and season, for which the number of observed captures of black petrel was outside the 95% credible interval (c.i.) of the estimated number of captures. There was one stratum, representing 0.2% of all 629 strata. SLL, surface longline; BLL, bottom longline. Cut-off lengths between small and large vessels were 28 m for trawl, 34 m for BLL, and 45 m for SLL.

Method	Fishery	Vessel size	Region	Area	Season	Observations	Captures	Mean	95% c.i.
SLL	Albacore SLL	Large	North	North East	Winter (Jul-Sep)	2	1	0.01	0–0

A.7 Grey petrel

Table A-19: Model strata with the highest number of estimated captures of grey petrel in each of trawl, surface-longline (SLL), and bottom-longline (BLL) fisheries. Only the 15 strata with the most estimated captures are shown, sorted in decreasing order of mean estimated captures. The strata were defined as combinations of fishery, vessel size, area, and season. The number of observed captures between the fishing years 1998–99 and 2017–18 for bottom- and surface-longline fisheries, and between 2002–03 and 2017–18 for trawl fisheries, are shown, along with the number of fishing events observed, the proportion of fishing events observed (observer coverage), the associated ratio estimate of the total number of captures, and the mean and 95% credible interval of the total estimated number of captures. IWL: Integrated weight line.

(a) Trawl

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Southern blue whiting trawl	Vessels $\geq$ 28 m	South Subantarctic	Winter	44	5923	0.588	74	79	43–125
Inshore trawl	Vessels $<$ 28 m	East of North Island	Winter	0	192	0.007	0	23	0–108
Flatfish trawl	Vessels $<$ 28 m	Western Chatham Rise	Winter	0	63	0.004	0	13	0–72
Hoki trawl	Vessels $\geq$ 28 m	Western Chatham Rise	Winter	0	1347	0.179	0	9	0–27
Southern blue whiting trawl	Vessels $\geq$ 28 m	East Subantarctic	Winter	14	1017	0.499	28	9	1–25
Inshore trawl	Vessels $<$ 28 m	Western Chatham Rise	Winter	0	142	0.011	0	7	0–33
Inshore trawl	Vessels $<$ 28 m	North East	Winter	0	982	0.034	0	6	0–31
Scampi trawl	Vessels $<$ 28 m	Auckland Islands	Winter	1	129	0.028	36	6	0–28
Deepwater trawl	Vessels $\geq$ 28 m	South Subantarctic	Winter	0	628	0.256	0	5	0–18
Flatfish trawl	Vessels $<$ 28 m	Western Chatham Rise	Autumn	0	103	0.005	0	5	0–26
Hoki trawl	Vessels $\geq$ 28 m	Western Chatham Rise	Autumn	0	2666	0.171	0	5	0–17
Inshore trawl	Vessels $<$ 28 m	East of North Island	Autumn	0	203	0.008	0	5	0–27
Scampi trawl	Vessels $\geq$ 28 m	Auckland Islands	Winter	0	102	0.072	0	5	0–19
Squid trawl	Vessels $\geq$ 28 m	Auckland Islands	Autumn	0	3221	0.395	0	5	0–17
Flatfish trawl	Vessels $<$ 28 m	East of North Island	Winter	0	0	0.000		4	0–26

(b) Surface longline

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Southern bluefin SLL	Vessels $<$ 43 m	East of North Island	Autumn	13	406	0.047	275	135	56–263
Southern bluefin SLL	Vessels $<$ 43 m	East of North Island	Winter	7	225	0.115	60	109	48–197
Southern bluefin SLL	Vessels $<$ 43 m	North East	Winter	3	495	0.119	25	64	20–139
Bigeye SLL	Vessels $<$ 43 m	North East	Winter	0	105	0.014	0	43	0–150
Albacore SLL	Vessels $<$ 43 m	East of North Island	Autumn	0	23	0.015	0	26	2–83
Bigeye SLL	Vessels $<$ 43 m	East of North Island	Autumn	0	100	0.022	0	26	0–91
Southern bluefin SLL	Vessels $\geq$ 43 m	East of North Island	Winter	25	146	0.768	32	25	6–52
Bigeye SLL	Vessels $<$ 43 m	North East	Autumn	0	59	0.012	0	7	0–30
Albacore SLL	Vessels $<$ 43 m	North East	Winter	0	0	0.000		6	0–25
Swordfish SLL	Vessels $<$ 43 m	East of North Island	Autumn	0	22	0.090	0	5	0–19
Southern bluefin SLL	Vessels $<$ 43 m	North East	Autumn	2	52	0.064	31	4	0–13
Bigeye SLL	Vessels $<$ 43 m	East of North Island	Winter	0	1	0.007	0	3	0–14
Minor surface longline	Vessels $<$ 43 m	East of North Island	Autumn	0	2	0.011	0	3	0–15
Southern bluefin SLL	Vessels $\geq$ 43 m	South Subantarctic	Autumn	0	55	0.743	0	3	0–13
Albacore SLL	Vessels $\geq$ 43 m	East of North Island	Autumn	3	67	0.971	3	2	0–11

(c) Bottom longline

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Snapper BLL	Vessels $<$ 34 m	North East	Winter	0	0	0.000		841	118–2758
Ling (no IWL) BLL – vessels $\geq$ 34 m	Vessels $\geq$ 34 m	Western Chatham Rise	Winter	10	47	0.026	383	422	99–1074
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	East of North Island	Winter	0	94	0.014	0	349	61–1001
Ling (no IWL) BLL – vessels $\geq$ 34 m	Vessels $\geq$ 34 m	South Subantarctic	Autumn	106	432	0.247	428	340	160–581
Ling (no IWL) BLL – vessels $\geq$ 34 m	Vessels $\geq$ 34 m	Auckland Islands	Winter	98	172	0.373	262	307	97–618
Ling (no IWL) BLL – vessels $\geq$ 34 m	Vessels $\geq$ 34 m	Eastern Chatham Rise	Winter	12	1148	0.154	77	270	78–624
Snapper BLL	Vessels $<$ 34 m	North East	Autumn	11	528	0.014	772	259	26–900
Ling (no IWL) BLL – vessels $\geq$ 34 m	Vessels $\geq$ 34 m	South Subantarctic	Winter	103	57	0.193	534	225	88–408
Bluenose BLL	Vessels $<$ 34 m	East of North Island	Winter	0	14	0.005	0	137	4–522
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	Western Chatham Rise	Winter	3	116	0.035	85	105	10–323
Ling (no IWL) BLL – vessels $\geq$ 34 m	Vessels $\geq$ 34 m	East Subantarctic	Autumn	0	6	0.010	0	70	12–187
Ling (no IWL) BLL – vessels $\geq$ 34 m	Vessels $\geq$ 34 m	Western Chatham Rise	Autumn	2	65	0.034	58	69	8–221
Ling (no IWL) BLL – vessels $\geq$ 34 m	Vessels $\geq$ 34 m	Auckland Islands	Autumn	17	20	0.060	281	62	11–146
Ling (no IWL) BLL – vessels $\geq$ 34 m	Vessels $\geq$ 34 m	East Subantarctic	Winter	0	21	0.135	0	59	9–153
Hāpuku BLL	Vessels $<$ 34 m	East of North Island	Winter	0	1	0.001	0	54	0–235

Table A-20: Summary of model parameters, for grey petrel capture in New Zealand commercial trawl, bottom-, and surface-longline fisheries. For each parameter, the table gives summary statistics of the posterior distribution (mean, median, and 95% credible interval, based on the 2.5% and 97.5% quantiles), and diagnostics (the number of chains that fail convergence and half-width tests (Heidelberger & Welch 1983), and the effective length of the chains (without autocorrelation). Trace plots of the chains are also shown. Base levels of the factor covariates are: Large BLL for method, South for region, and Winter (Jul-Sep) for season. Model strata included different different regions, seasons, years, target fisheries, and areas for trawling, surface-longline (SLL), and bottom-longline (BLL) fisheries. IWL, integrated weight line.

Parameter	Statistic			Diagnostics			
	Mean	Median	95% c.i.	Conv.	H.W.	Effective length	Trace
Distribution parameterisation	0.972	0.971	0.777 – 1.186			4002	
S.d.(Year)							
BLL	1.409	1.396	0.563 – 2.322			4053	
SLL	0.525	0.464	0.097 – 1.310			2941	
Trawl	0.397	0.368	0.089 – 0.865			3578	
S.d.(Area)	1.728	1.682	1.115 – 2.566			4002	
S.d.(Fishery)	0.753	0.729	0.307 – 1.343			4179	
Overdispersion							
BLL	2.997	2.904	1.727 – 4.822			3859	
SLL	1.269	1.223	0.669 – 2.146			4002	
Trawl	1.115	1.053	0.501 – 2.043			4002	
Intercept	0.153	0.095	0.022 – 0.617			4002	
Method / Vessel class							
BLL / vessels $\geq$ 34 m	1.000	1.000	1.000 – 1.000	3			
SLL / vessels $\geq$ 45 m	0.911	0.591	0.087 – 3.694			4332	
Trawl / vessels $\geq$ 28 m	0.020	0.016	0.004 – 0.059			4002	
BLL / vessels $<$ 34 m	0.443	0.303	0.044 – 1.628			4002	
SLL / vessels $<$ 45 m	0.425	0.269	0.039 – 1.719			4158	
Trawl / vessels $<$ 28 m	0.009	0.005	0.000 – 0.046			4002	
Region							
North	3.950	1.027	0.097 – 21.043			4320	
South	1.000	1.000	1.000 – 1.000	3			
Season							
Autumn (Apr-Jun)	0.289	0.275	0.155 – 0.493			4002	
Spring (Oct-Dec)	0.042	0.035	0.008 – 0.115			4075	
Summer (Jan-Mar)	0.016	0.012	0.001 – 0.063			3899	
Winter (Jul-Sep)	1.000	1.000	1.000 – 1.000	3			
Fishery							
Albacore SLL	1.113	0.988	0.193 – 2.866			4150	
Bigeye SLL	0.422	0.341	0.007 – 1.289			3842	
Bluenose BLL	0.676	0.592	0.068 – 1.790			4002	
Deepwater trawl	0.629	0.559	0.119 – 1.522			4146	
Flatfish trawl	0.952	0.814	0.045 – 2.850			4110	
Hake trawl	0.932	0.801	0.042 – 2.829			3982	
Hāpuku BLL	0.873	0.751	0.032 – 2.527			4034	
Hoki trawl	0.712	0.636	0.131 – 1.756			3810	
Inshore trawl	0.727	0.614	0.021 – 2.116			3819	
Ling (no IWL) BLL – vessels $\geq$ 34 m	1.376	1.219	0.429 – 3.181			4002	
Ling (IWL) BLL – vessels $\geq$ 34 m	0.848	0.742	0.158 – 2.214			4002	
Ling BLL – vessels $<$ 34 m	0.952	0.821	0.185 – 2.527			4002	
Ling trawl	1.231	1.068	0.213 – 3.257			4090	
Mackerel trawl	0.820	0.707	0.030 – 2.346			3991	
Middle depths trawl	0.630	0.544	0.018 – 1.765			4536	
Minor targets BLL	1.076	0.949	0.181 – 2.810			4002	
Minor surface longline	0.982	0.826	0.042 – 2.965			3780	
Southern blue whiting trawl	2.529	2.242	0.984 – 5.735			3861	
Scampi trawl	0.967	0.845	0.124 – 2.535			4002	
Snapper BLL	1.496	1.290	0.349 – 3.887			4002	
Squid trawl	0.640	0.565	0.078 – 1.629			4005	
Southern bluefin SLL	1.241	1.109	0.316 – 3.008			3891	
Swordfish SLL	1.237	1.079	0.224 – 3.198			4220	
Area							
Auckland Islands	2.827	2.488	0.507 – 7.105			3967	
Cook Strait	0.072	0.018	0.000 – 0.480			3873	
East of North Island	2.512	1.993	0.126 – 7.597	1		4002	
Eastern Chatham Rise	0.279	0.218	0.037 – 0.885			4002	
East Subantarctic	1.482	1.236	0.214 – 4.294			3788	
Fiordland	0.055	0.030	0.001 – 0.248			4002	
Kermadec Islands	0.442	0.228	0.006 – 2.129			3881	
North East	0.706	0.517	0.031 – 2.438	1		4002	
South Subantarctic	2.653	2.358	0.496 – 6.565			4002	
Stewart Snares Shelf	0.064	0.016	0.000 – 0.416			4002	
Western Chatham Rise	1.406	1.141	0.207 – 4.231			4002	
West Coast North Island	0.083	0.017	0.000 – 0.549			4002	
West Coast South Island	0.018	0.004	0.000 – 0.114			4002	

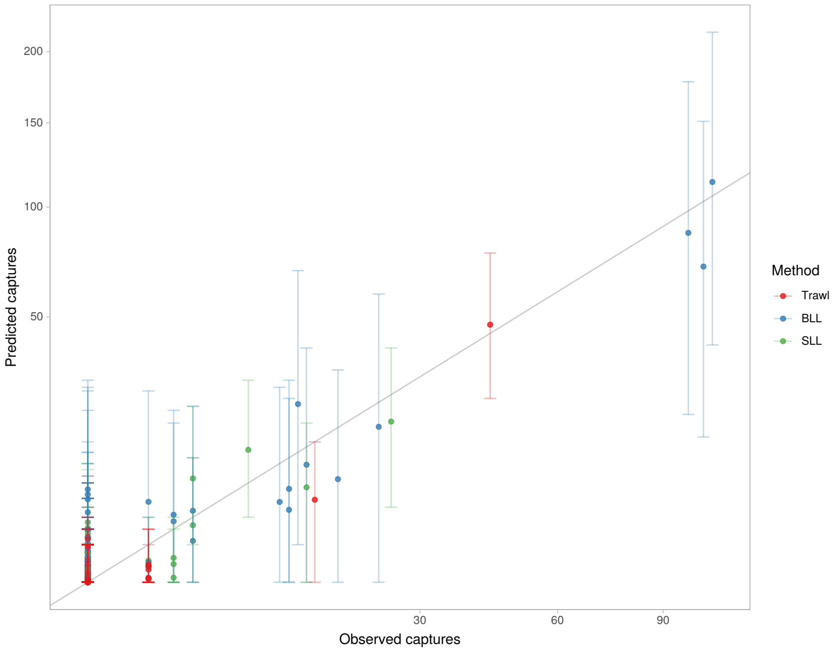


Figure A-7: Comparison between the observed and the predicted number of captures of grey petrel (represented by their mean and 95% credible interval), for each combination of region, fishery, vessel size, area, and season. The points were coloured according to the fishing method (BLL, bottom longline; SLL, surface longline).

Table A-21: List of strata, defined as combinations of region, fishery, vessel size, area, and season, for which the number of observed captures of grey petrel was outside the 95% credible interval (c.i.) of the estimated number of captures. There were four of these strata, representing 0.6% of all 629 strata. SLL, surface longline; BLL, bottom longline. Cut-off lengths between small and large vessels were 28 m for trawl, 34 m for BLL, and 45 m for SLL.

Method	Fishery	Vessel size	Region	Area	Season	Observations	Captures	Mean	95% c.i.
SLL	Swordfish SLL	Small	North	Kermadec Islands	Spring (Oct-Dec)	22	2	0.01	0–0
Trawl	Ling trawl	Large	South	South Subantarctic	Spring (Oct-Dec)	90	1	0.01	0–0
Trawl	Hoki trawl	Large	South	Fiordland	Winter (Jul-Sep)	169	1	0.01	0–0
Trawl	Squid trawl	Large	South	Western Chatham Rise	Winter (Jul-Sep)	5	1	0.01	0–0

A.8 Sooty shearwater

Table A-22: Model strata with the highest number of estimated captures of sooty shearwater in each of trawl, surface-longline (SLL), and bottom-longline (BLL) fisheries. Only the 15 strata with the most estimated captures are shown, sorted in decreasing order of mean estimated captures. The strata were defined as combinations of fishery, vessel size, area, and season. The number of observed captures between the fishing years 1998–99 and 2017–18 for bottom- and surface-longline fisheries, and between 2002–03 and 2017–18 for trawl fisheries, are shown, along with the number of fishing events observed, the proportion of fishing events observed (observer coverage), the associated ratio estimate of the total number of captures, and the mean and 95% credible interval of the total estimated number of captures. IWL: Integrated weight line.

(a) Trawl

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Squid trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Summer	356	11121	0.398	895	1094	806–1435
Squid trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Autumn	370	3103	0.337	1096	746	508–1047
Hoki trawl	Vessels ≥ 28 m	Western Chatham Rise	Autumn	124	2666	0.171	724	473	294–702
Hoki trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Autumn	32	2081	0.277	115	280	164–426
Hoki trawl	Vessels ≥ 28 m	Western Chatham Rise	Spring	56	2573	0.187	298	264	151–412
Squid trawl	Vessels ≥ 28 m	Auckland Islands	Autumn	71	3221	0.395	179	234	133–361
Squid trawl	Vessels ≥ 28 m	Auckland Islands	Summer	110	8010	0.511	215	222	132–338
Hoki trawl	Vessels ≥ 28 m	Western Chatham Rise	Summer	39	1919	0.134	290	209	118–331
Squid trawl	Vessels ≥ 28 m	Western Chatham Rise	Autumn	18	582	0.193	93	204	103–349
Middle depths trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Spring	32	1830	0.318	100	192	101–321
Inshore trawl	Vessels < 28 m	Western Chatham Rise	Autumn	3	77	0.003	882	178	32–472
Middle depths trawl	Vessels < 28 m	Western Chatham Rise	Autumn	0	6	0.001	0	177	44–466
Hoki trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Spring	15	1776	0.261	57	163	84–269
Ling trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Spring	10	1018	0.193	51	153	58–303
Middle depths trawl	Vessels < 28 m	Western Chatham Rise	Spring	0	63	0.009	0	133	30–354

(b) Surface longline

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Albacore SLL	Vessels < 43 m	East of North Island	Autumn	0	23	0.015	0	16	0–78
Bigeye SLL	Vessels < 43 m	East of North Island	Autumn	0	100	0.022	0	16	0–63
Bigeye SLL	Vessels < 43 m	North East	Autumn	0	59	0.012	0	13	0–53
Bigeye SLL	Vessels < 43 m	North East	Spring	2	256	0.036	55	12	0–49
Bigeye SLL	Vessels < 43 m	East of North Island	Summer	0	171	0.027	0	11	0–43
Bigeye SLL	Vessels < 43 m	North East	Summer	0	168	0.030	0	7	0–30
Southern bluefin SLL	Vessels ≥ 43 m	Fiordland	Autumn	0	3057	0.901	0	5	0–16
Albacore SLL	Vessels < 43 m	North East	Autumn	0	1	0.002	0	4	0–21
Albacore SLL	Vessels < 43 m	East of North Island	Summer	0	7	0.011	0	3	0–17
Southern bluefin SLL	Vessels < 43 m	East of North Island	Autumn	0	406	0.047	0	3	0–17
Albacore SLL	Vessels ≥ 43 m	East of North Island	Autumn	7	67	0.971	7	2	0–11
Albacore SLL	Vessels < 43 m	North East	Spring	0	1	0.004	0	2	0–9
Bigeye SLL	Vessels < 43 m	East of North Island	Spring	0	13	0.015	0	2	0–10
Swordfish SLL	Vessels < 43 m	East of North Island	Autumn	0	22	0.090	0	2	0–9
Albacore SLL	Vessels ≥ 43 m	North East	Autumn	0	43	0.977	0	1	0–7

(c) Bottom longline

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Stewart Snares Shelf	Spring	69	942	0.483	142	107	57–176
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Western Chatham Rise	Autumn	0	65	0.034	0	100	39–204
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Western Chatham Rise	Spring	0	194	0.076	0	92	42–171
Ling (IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Stewart Snares Shelf	Spring	12	118	0.082	146	56	17–128
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Western Chatham Rise	Summer	1	60	0.039	25	44	16–91
Snapper BLL	Vessels < 34 m	North East	Autumn	1	528	0.014	70	28	1–108
Snapper BLL	Vessels < 34 m	North East	Spring	0	619	0.014	0	21	0–83
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Eastern Chatham Rise	Autumn	0	162	0.065	0	18	4–44
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Eastern Chatham Rise	Spring	2	482	0.139	14	16	3–37
Snapper BLL	Vessels < 34 m	North East	Summer	0	766	0.020	0	14	0–56
Ling (IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Fiordland	Spring	3	154	0.214	14	11	1–33
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Auckland Islands	Autumn	0	20	0.060	0	10	1–28
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Fiordland	Spring	4	93	0.164	24	10	1–27
Ling BLL – vessels < 34 m	Vessels < 34 m	Western Chatham Rise	Spring	0	99	0.032	0	8	0–40
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Eastern Chatham Rise	Summer	0	285	0.144	0	7	0–19

Table A-23: Summary of model parameters, for sooty shearwater capture in New Zealand commercial trawl, bottom-, and surface-longline fisheries. For each parameter, the table gives summary statistics of the posterior distribution (mean, median, and 95% credible interval, based on the 2.5% and 97.5% quantiles), and diagnostics (the number of chains that fail convergence and half-width tests (Heidelberger & Welch 1983), and the effective length of the chains (without autocorrelation). Trace plots of the chains are also shown. Base levels of the factor covariates are: Large trawl for method, South for region, and Autumn (Apr-Jun) for season. Model strata included different different regions, seasons, years, target fisheries, and areas for trawling, surface-longline (SLL), and bottom-longline (BLL) fisheries. IWL, integrated weight line.

Parameter	Statistic			Diagnostics			
	Mean	Median	95% c.i.	Conv.	H.W.	Effective length	Trace
Distribution parameterisation	0.652	0.651	0.475 – 0.823			3734	
S.d.(Year)							
BLL	0.862	0.838	0.226 – 1.644			3806	
SLL	0.662	0.557	0.108 – 1.819			2367	
Trawl	0.383	0.371	0.206 – 0.622			4147	
S.d.(Area)	1.171	1.142	0.791 – 1.713			4138	
S.d.(Fishery)	1.063	1.048	0.651 – 1.567			4002	
Overdispersion							
BLL	2.258	2.175	0.936 – 3.952			4281	
SLL	2.421	2.258	0.911 – 4.936			4271	
Trawl	4.606	4.523	3.242 – 6.410			3875	
Intercept	0.014	0.011	0.004 – 0.037			4162	
Method / Vessel class							
BLL / vessels $\geq$ 34 m	4.544	2.666	0.545 – 20.055			4002	
SLL / vessels $\geq$ 45 m	12.869	4.612	0.291 – 76.156			4361	
Trawl / vessels $\geq$ 28 m	1.000	1.000	1.000 – 1.000	3			
BLL / vessels $<$ 34 m	0.513	0.293	0.027 – 2.257			4407	
SLL / vessels $<$ 45 m	2.738	1.326	0.113 – 14.474			4002	
Trawl / vessels $<$ 28 m	0.775	0.668	0.239 – 1.958			3658	
Region							
North	0.776	0.262	0.042 – 2.895			4002	
South	1.000	1.000	1.000 – 1.000	3			
Season							
Autumn (Apr-Jun)	1.000	1.000	1.000 – 1.000	3			
Spring (Oct-Dec)	0.646	0.633	0.442 – 0.910			4002	
Summer (Jan-Mar)	0.489	0.484	0.368 – 0.642			3541	
Winter (Jul-Sep)	0.014	0.011	0.002 – 0.044			4165	
Fishery							
Albacore SLL	1.896	1.572	0.241 – 5.429			4229	
Bigeye SLL	0.894	0.686	0.060 – 3.053			3960	
Bluenose BLL	1.298	1.005	0.096 – 4.161			3902	
Deepwater trawl	0.124	0.105	0.023 – 0.338			4115	
Flatfish trawl	0.181	0.094	0.001 – 0.841			3890	
Hake trawl	1.009	0.923	0.327 – 2.186			3890	
Hāpuku BLL	1.742	1.394	0.187 – 5.524			4002	
Hoki trawl	1.158	1.101	0.501 – 2.135			4002	
Inshore trawl	0.480	0.382	0.064 – 1.477			4110	
Ling (no IWL) BLL – vessels $\geq$ 34 m	0.971	0.784	0.116 – 2.895			4002	
Ling (IWL) BLL – vessels $\geq$ 34 m	0.934	0.737	0.098 – 2.936			4002	
Ling BLL – vessels $<$ 34 m	0.490	0.295	0.003 – 2.135			4114	
Ling trawl	1.451	1.331	0.503 – 3.046			4175	
Mackerel trawl	0.538	0.476	0.150 – 1.288			4002	
Middle depths trawl	1.592	1.513	0.686 – 2.973			4120	
Minor targets BLL	0.409	0.239	0.002 – 1.718			4701	
Minor surface longline	0.932	0.627	0.008 – 3.658			4167	
Southern blue whiting trawl	0.715	0.478	0.005 – 2.821			4002	
Scampi trawl	1.038	0.929	0.280 – 2.432			3708	
Snapper BLL	1.177	0.901	0.083 – 3.930			4112	
Squid trawl	2.491	2.359	1.075 – 4.586			4002	
Southern bluefin SLL	0.071	0.025	0.001 – 0.434			3760	
Swordfish SLL	1.293	1.007	0.114 – 4.170			4002	
Area							
Auckland Islands	1.151	1.062	0.398 – 2.391			4002	
Cook Strait	0.317	0.247	0.037 – 0.988			4140	
East of North Island	1.217	0.955	0.100 – 3.740			4114	
Eastern Chatham Rise	0.323	0.289	0.089 – 0.761			3994	
East Subantarctic	0.129	0.096	0.014 – 0.422			4002	
Fiordland	1.086	0.985	0.309 – 2.450			3811	
Kermadec Islands	1.565	1.185	0.105 – 5.290			3392	
North East	0.924	0.703	0.071 – 3.062			3715	
South Subantarctic	0.141	0.107	0.015 – 0.465			3759	
Stewart Snares Shelf	3.179	2.994	1.155 – 6.255			4090	
Western Chatham Rise	2.510	2.344	0.927 – 4.917			3883	
West Coast North Island	0.171	0.095	0.003 – 0.782			4002	
West Coast South Island	0.193	0.162	0.037 – 0.517			4002	

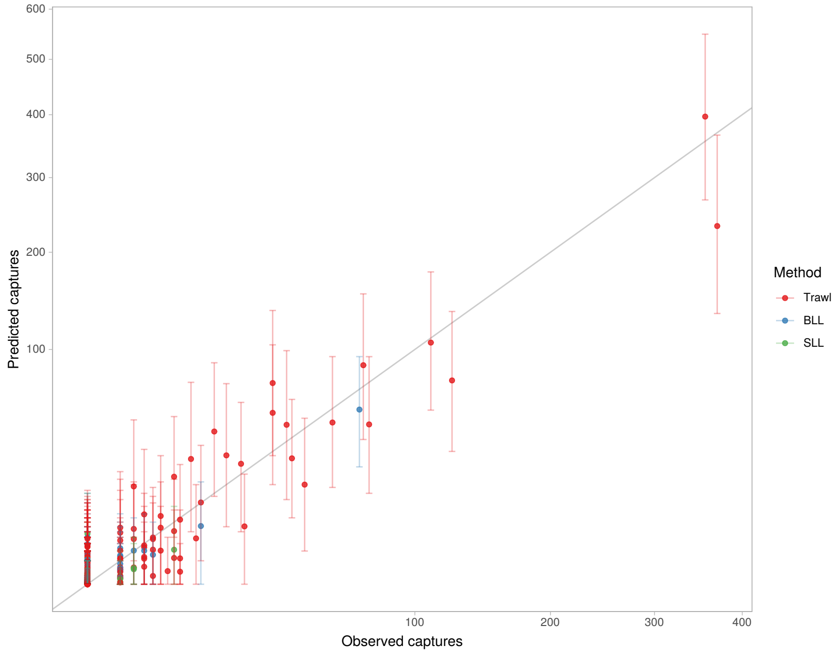


Figure A-8: Comparison between the observed and the predicted number of captures of sooty shearwater (represented by their mean and 95% credible interval), for each combination of region, fishery, vessel size, area, and season. The points were coloured according to the fishing method (BLL, bottom longline; SLL, surface longline).

Table A-24: List of strata, defined as combinations of region, fishery, vessel size, area, and season, for which the number of observed captures of sooty shearwater was outside the 95% credible interval (c.i.) of the estimated number of captures. There were seven of these strata, representing 1.1% of all 629 strata. SLL, surface longline; BLL, bottom longline. Cut-off lengths between small and large vessels were 28 m for trawl, 34 m for BLL, and 45 m for SLL.

Method	Fishery	Vessel size	Region	Area	Season	Observations	Captures	Mean	95% c.i.
Trawl	Squid trawl	Large	South	Stewart Snares Shelf	Autumn (Apr-Jun)	3103	370	232.80	133–366
Trawl	Scampi trawl	Small	South	Auckland Islands	Autumn (Apr-Jun)	757	23	6.07	0–22
Trawl	Hoki trawl	Large	South	Fiordland	Spring (Oct-Dec)	33	6	0.31	0–4
Trawl	Scampi trawl	Small	South	Auckland Islands	Summer (Jan-Mar)	81	8	0.28	0–3
Trawl	Hake trawl	Large	South	Eastern Chatham Rise	Summer (Jan-Mar)	69	4	0.12	0–2
SLL	Southern bluefin SLL	Large	South	South Subantarctic	Autumn (Apr-Jun)	55	1	0.01	0–0
Trawl	Deepwater trawl	Large	South	West Coast South Island	Spring (Oct-Dec)	68	1	0.01	0–0

A.9 Flesh-footed shearwater

Table A-25: Model strata with the highest number of estimated captures of flesh-footed shearwater in each of trawl, surface-longline (SLL), and bottom-longline (BLL) fisheries. Only the 15 strata with the most estimated captures are shown, sorted in decreasing order of mean estimated captures. The strata were defined as combinations of fishery, vessel size, area, and season. The number of observed captures between the fishing years 1998–99 and 2017–18 for bottom- and surface-longline fisheries, and between 2002–03 and 2017–18 for trawl fisheries, are shown, along with the number of fishing events observed, the proportion of fishing events observed (observer coverage), the associated ratio estimate of the total number of captures, and the mean and 95% credible interval of the total estimated number of captures.

(a) Trawl

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Inshore trawl	Vessels < 28 m	North East	Summer	6	1261	0.034	174	246	105–459
Inshore trawl	Vessels < 28 m	North East	Autumn	9	1780	0.056	160	186	75–368
Inshore trawl	Vessels < 28 m	East of North Island	Summer	1	265	0.009	106	149	49–317
Inshore trawl	Vessels < 28 m	East of North Island	Autumn	0	203	0.008	0	110	35–241
Inshore trawl	Vessels < 28 m	North East	Spring	2	1188	0.037	54	101	33–216
Inshore trawl	Vessels < 28 m	East of North Island	Spring	0	204	0.006	0	81	20–193
Scampi trawl	Vessels < 28 m	North East	Summer	4	172	0.047	84	78	24–166
Scampi trawl	Vessels < 28 m	East of North Island	Summer	0	11	0.003	0	68	16–161
Inshore trawl	Vessels < 28 m	West Coast North Island	Summer	0	1565	0.070	0	66	20–148
Scampi trawl	Vessels < 28 m	North East	Spring	31	523	0.111	279	46	11–104
Flatfish trawl	Vessels < 28 m	West Coast North Island	Autumn	0	1	0.000	0	44	0–221
Inshore trawl	Vessels < 28 m	West Coast North Island	Autumn	0	1035	0.061	0	44	10–105
Scampi trawl	Vessels < 28 m	North East	Autumn	2	379	0.168	11	41	11–90
Inshore trawl	Vessels < 28 m	West Coast North Island	Spring	0	1046	0.040	0	37	6–98
Hoki trawl	Vessels < 28 m	North East	Autumn	3	51	0.081	37	29	4–75

(b) Surface longline

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Bigeye SLL	Vessels < 43 m	North East	Summer	18	168	0.030	603	943	451–1796
Bigeye SLL	Vessels < 43 m	East of North Island	Summer	87	171	0.027	3205	821	326–1648
Bigeye SLL	Vessels < 43 m	North East	Autumn	11	59	0.012	905	702	312–1311
Bigeye SLL	Vessels < 43 m	North East	Spring	14	256	0.036	385	540	230–1020
Bigeye SLL	Vessels < 43 m	East of North Island	Autumn	0	100	0.022	0	510	189–1012
Albacore SLL	Vessels < 43 m	East of North Island	Autumn	0	23	0.015	0	290	35–810
Bigeye SLL	Vessels < 43 m	West Coast North Island	Summer	0	62	0.023	0	201	60–446
Albacore SLL	Vessels < 43 m	East of North Island	Summer	5	7	0.011	439	132	11–395
Albacore SLL	Vessels < 43 m	North East	Autumn	0	1	0.002	0	109	7–330
Bigeye SLL	Vessels < 43 m	North East	Winter	0	105	0.014	0	97	0–355
Bigeye SLL	Vessels < 43 m	West Coast North Island	Autumn	0	23	0.018	0	86	16–210
Minor surface longline	Vessels < 43 m	East of North Island	Summer	0	9	0.017	0	60	0–206
Swordfish SLL	Vessels < 43 m	North East	Summer	1	39	0.061	16	58	2–172
Minor surface longline	Vessels < 43 m	North East	Summer	3	23	0.059	50	55	0–185
Bigeye SLL	Vessels < 43 m	East of North Island	Spring	1	13	0.015	68	53	7–141

(c) Bottom longline

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Snapper BLL	Vessels < 34 m	North East	Summer	44	766	0.020	2232	2111	1321–3142
Snapper BLL	Vessels < 34 m	North East	Autumn	34	528	0.014	2386	1751	1045–2672
Snapper BLL	Vessels < 34 m	North East	Spring	9	619	0.014	631	1091	600–1773
Minor targets BLL	Vessels < 34 m	West Coast North Island	Summer	11	230	0.042	264	341	161–575
Minor targets BLL	Vessels < 34 m	North East	Summer	4	40	0.026	156	224	102–409
Minor targets BLL	Vessels < 34 m	North East	Autumn	3	32	0.020	146	194	83–360
Snapper BLL	Vessels < 34 m	North East	Winter	0	0	0.000		146	5–475
Minor targets BLL	Vessels < 34 m	West Coast North Island	Spring	2	53	0.012	165	127	47–251
Minor targets BLL	Vessels < 34 m	West Coast North Island	Autumn	1	47	0.021	47	120	51–224
Hāpuku BLL	Vessels < 34 m	North East	Summer	0	5	0.003	0	100	14–258
Minor targets BLL	Vessels < 34 m	North East	Spring	0	27	0.020	0	91	33–179
Hāpuku BLL	Vessels < 34 m	West Coast North Island	Summer	0	35	0.011	0	73	9–199
Hāpuku BLL	Vessels < 34 m	North East	Autumn	1	28	0.018	55	68	9–179
Minor targets BLL	Vessels < 34 m	East of North Island	Summer	0	0	0.000		60	19–128
Minor targets BLL	Vessels < 34 m	East of North Island	Spring	0	0	0.000		49	12–115

Table A-26: Summary of model parameters, for flesh-footed shearwater capture in New Zealand commercial trawl, bottom-, and surface-longline fisheries. For each parameter, the table gives summary statistics of the posterior distribution (mean, median, and 95% credible interval, based on the 2.5% and 97.5% quantiles), and diagnostics (the number of chains that fail convergence and half-width tests (Heidelberger & Welch 1983), and the effective length of the chains (without autocorrelation). Trace plots of the chains are also shown. Base levels of the factor covariates are: Small SLL for method, North for region, and Summer (Jan-Mar) for season. Model strata included different different regions, seasons, years, target fisheries, and areas for trawling, surface-longline (SLL), and bottom-longline (BLL) fisheries. IWL, integrated weight line.

Parameter	Statistic			Diagnostics			
	Mean	Median	95% c.i.	Conv.	H.W.	Effective length	Trace
Distribution parameterisation	1.268	1.269	0.920 – 1.632			4002	
S.d.(Year)							
BLL	0.878	0.737	0.128 – 2.227			1980	
SLL	0.937	0.811	0.143 – 2.309			1975	
Trawl	0.965	0.858	0.108 – 2.334			1707	
S.d.(Area)	0.661	0.568	0.190 – 1.701			3341	
S.d.(Fishery)	1.424	1.405	0.869 – 2.129			4002	
Overdispersion							
BLL	0.998	0.953	0.500 – 1.779			3864	
SLL	2.447	2.378	1.373 – 3.887			3748	
Trawl	0.970	0.893	0.408 – 1.947			3618	
Intercept	0.128	0.087	0.021 – 0.475			3006	
Method / Vessel class							
BLL / vessels $\geq$ 34 m	0.302	0.020	0.000 – 2.337			2789	
SLL / vessels $\geq$ 45 m	0.086	0.010	0.000 – 0.584			3688	
Trawl / vessels $\geq$ 28 m	0.112	0.049	0.005 – 0.567			4291	
BLL / vessels $<$ 34 m	1.053	0.518	0.073 – 4.034			3935	
SLL / vessels $<$ 45 m	1.000	1.000	1.000 – 1.000	3			
Trawl / vessels $<$ 28 m	0.271	0.162	0.027 – 1.082			3791	
Region							
North	1.000	1.000	1.000 – 1.000	3			
South	0.017	0.009	0.001 – 0.080			3883	
Season							
Autumn (Apr-Jun)	0.886	0.870	0.560 – 1.331			3031	
Spring (Oct-Dec)	0.472	0.458	0.272 – 0.741			3001	
Summer (Jan-Mar)	1.000	1.000	1.000 – 1.000	3			
Winter (Jul-Sep)	0.079	0.062	0.005 – 0.252	1		4002	
Fishery							
Albacore SLL	2.231	1.844	0.318 – 6.419			3964	
Bigeye SLL	1.546	1.288	0.286 – 4.388			3595	
Bluenose BLL	0.088	0.034	0.000 – 0.481			4002	
Deepwater trawl	0.118	0.039	0.000 – 0.675			3772	
Flatfish trawl	0.277	0.119	0.000 – 1.455			3995	
Hake trawl	0.965	0.494	0.000 – 4.481			4002	
Hāpuku BLL	0.887	0.678	0.076 – 2.872			4002	
Hoki trawl	2.710	2.352	0.585 – 6.780			4002	
Inshore trawl	0.373	0.316	0.071 – 1.004			3536	
Ling (no IWL) BLL – vessels $\geq$ 34 m	0.839	0.386	0.000 – 4.389			3898	
Ling (IWL) BLL – vessels $\geq$ 34 m	0.794	0.350	0.000 – 4.164			4200	
Ling BLL – vessels $<$ 34 m	0.182	0.074	0.000 – 0.973			4002	
Ling trawl	2.526	2.151	0.382 – 7.138			3620	
Mackerel trawl	0.103	0.034	0.000 – 0.633			4002	
Middle depths trawl	0.528	0.376	0.027 – 1.997			4195	
Minor targets BLL	2.571	2.229	0.398 – 6.957			3133	
Minor surface longline	1.172	0.903	0.084 – 3.907			3923	
Southern blue whiting trawl	0.954	0.463	0.000 – 4.753			3862	
Scampi trawl	1.152	0.960	0.212 – 3.136			3898	
Snapper BLL	1.033	0.861	0.146 – 2.925			3821	
Squid trawl	0.630	0.290	0.000 – 3.241			2697	
Southern bluefin SLL	0.073	0.027	0.000 – 0.400			3893	
Swordfish SLL	0.808	0.619	0.085 – 2.606			3542	
Area							
Auckland Islands	0.916	0.853	0.030 – 2.334			4119	
Cook Strait	0.949	0.856	0.039 – 2.543			4002	
East of North Island	1.189	1.083	0.443 – 2.591			4272	
Eastern Chatham Rise	0.888	0.833	0.027 – 2.267			2991	
East Subantarctic	0.990	0.901	0.032 – 2.762			4002	
Fiordland	0.995	0.912	0.039 – 2.652			4002	
Kermadec Islands	0.760	0.724	0.012 – 1.915			4126	
North East	1.547	1.409	0.606 – 3.370			4002	
South Subantarctic	0.958	0.857	0.041 – 2.576			4079	
Stewart Snares Shelf	0.880	0.827	0.020 – 2.241			4127	
Western Chatham Rise	1.393	1.144	0.325 – 4.061			3878	
West Coast North Island	0.682	0.629	0.232 – 1.435			3924	
West Coast South Island	0.922	0.838	0.023 – 2.510			4233	

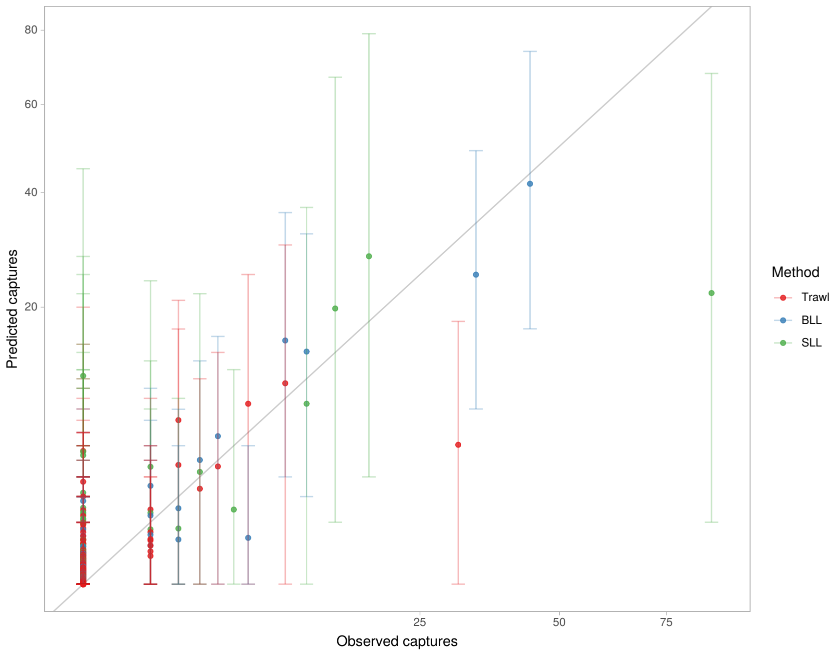


Figure A-9: Comparison between the observed and the predicted number of captures of flesh-footed shearwater (represented by their mean and 95% credible interval), for each combination of region, fishery, vessel size, area, and season. The points were coloured according to the fishing method (BLL, bottom longline; SLL, surface longline).

Table A-27: List of strata, defined as combinations of region, fishery, vessel size, area, and season, for which the number of observed captures of flesh-footed shearwater was outside the 95% credible interval (c.i.) of the estimated number of captures. There were three of these strata, representing 0.5% of all 629 strata. SLL, surface longline; BLL, bottom longline. Cut-off lengths between small and large vessels were 28 m for trawl, 34 m for BLL, and 45 m for SLL.

Method	Fishery	Vessel size	Region	Area	Season	Observations	Captures	Mean	95% c.i.
SLL	Bigeye SLL	Small	North	East of North Island	Summer (Jan-Mar)	171	87	22.10	1–68
Trawl	Scampi trawl	Small	North	North East	Spring (Oct-Dec)	523	31	5.06	0–18
BLL	Snapper BLL	Small	North	West Coast North Island	Spring (Oct-Dec)	49	6	0.56	0–5

A.10 Other birds

Table A-28: Model strata with the highest number of estimated captures of other birds in each of trawl, surface-longline (SLL), and bottom-longline (BLL) fisheries. Only the 15 strata with the most estimated captures are shown, sorted in decreasing order of mean estimated captures. The strata were defined as combinations of fishery, vessel size, area, and season. The number of observed captures between the fishing years 1998–99 and 2017–18 for bottom- and surface-longline fisheries, and between 2002–03 and 2017–18 for trawl fisheries, are shown, along with the number of fishing events observed, the proportion of fishing events observed (observer coverage), the associated ratio estimate of the total number of captures, and the mean and 95% credible interval of the total estimated number of captures. IWL: Integrated weight line.

(a) Trawl

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Hoki trawl	Vessels ≥ 28 m	West Coast South Island	Winter	37	16382	0.350	105	126	78–185
Squid trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Summer	11	11121	0.398	27	48	24–79
Inshore trawl	Vessels < 28 m	East of North Island	Spring	0	204	0.006	0	46	15–94
Inshore trawl	Vessels < 28 m	North East	Spring	0	1188	0.037	0	46	16–86
Inshore trawl	Vessels < 28 m	West Coast South Island	Spring	1	95	0.007	138	45	15–91
Flatfish trawl	Vessels < 28 m	Stewart Snares Shelf	Spring	0	18	0.001	0	34	1–92
Inshore trawl	Vessels < 28 m	Western Chatham Rise	Spring	0	163	0.008	0	34	11–71
Inshore trawl	Vessels < 28 m	North East	Summer	1	1261	0.034	29	33	10–66
Inshore trawl	Vessels < 28 m	North East	Autumn	4	1780	0.056	71	32	10–63
Inshore trawl	Vessels < 28 m	West Coast North Island	Spring	1	1046	0.040	24	32	11–64
Squid trawl	Vessels ≥ 28 m	Auckland Islands	Summer	25	8010	0.511	48	32	13–57
Hoki trawl	Vessels ≥ 28 m	Western Chatham Rise	Spring	1	2573	0.187	5	30	12–54
Hoki trawl	Vessels ≥ 28 m	Eastern Chatham Rise	Spring	6	2705	0.240	24	29	12–52
Inshore trawl	Vessels < 28 m	Western Chatham Rise	Autumn	0	77	0.003	0	28	7–59
Inshore trawl	Vessels < 28 m	East of North Island	Winter	0	192	0.007	0	27	7–58

(b) Surface longline

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Bigeye SLL	Vessels < 43 m	North East	Spring	5	256	0.036	137	138	58–254
Southern bluefin SLL	Vessels < 43 m	East of North Island	Autumn	1	406	0.047	21	114	49–212
Bigeye SLL	Vessels < 43 m	North East	Winter	0	105	0.014	0	98	39–189
Southern bluefin SLL	Vessels < 43 m	West Coast South Island	Autumn	30	394	0.132	226	97	37–179
Bigeye SLL	Vessels < 43 m	East of North Island	Summer	1	171	0.027	36	76	26–153
Bigeye SLL	Vessels < 43 m	North East	Summer	1	168	0.030	33	70	26–139
Bigeye SLL	Vessels < 43 m	North East	Autumn	0	59	0.012	0	68	26–134
Bigeye SLL	Vessels < 43 m	East of North Island	Autumn	0	100	0.022	0	62	22–124
Southern bluefin SLL	Vessels < 43 m	North East	Winter	1	495	0.119	8	53	19–105
Albacore SLL	Vessels < 43 m	East of North Island	Autumn	0	23	0.015	0	39	7–110
Bigeye SLL	Vessels < 43 m	West Coast North Island	Winter	0	69	0.026	0	31	8–69
Bigeye SLL	Vessels < 43 m	West Coast North Island	Summer	0	62	0.023	0	29	7–64
Southern bluefin SLL	Vessels < 43 m	West Coast South Island	Winter	0	46	0.050	0	27	8–58
Southern bluefin SLL	Vessels < 43 m	East of North Island	Winter	1	225	0.115	8	25	6–54
Southern bluefin SLL	Vessels ≥ 43 m	Fiordland	Autumn	9	3057	0.901	9	24	6–54

(c) Bottom longline

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Snapper BLL	Vessels < 34 m	North East	Spring	11	619	0.014	772	876	490–1385
Snapper BLL	Vessels < 34 m	North East	Autumn	8	528	0.014	561	531	279–865
Snapper BLL	Vessels < 34 m	North East	Summer	24	766	0.020	1217	495	263–815
Snapper BLL	Vessels < 34 m	North East	Winter	0	0	0.000		461	237–773
Ling BLL – vessels < 34 m	Vessels < 34 m	West Coast South Island	Spring	0	16	0.006	0	99	39–189
Minor targets BLL	Vessels < 34 m	West Coast North Island	Spring	3	53	0.012	248	81	31–160
Bluenose BLL	Vessels < 34 m	East of North Island	Spring	0	0	0.000		72	17–157
Bluenose BLL	Vessels < 34 m	North East	Spring	0	37	0.007	0	72	17–154
Ling BLL – vessels < 34 m	Vessels < 34 m	West Coast South Island	Winter	0	6	0.002	0	72	28–134
Minor targets BLL	Vessels < 34 m	West Coast North Island	Summer	2	230	0.042	48	64	23–130
Ling BLL – vessels < 34 m	Vessels < 34 m	West Coast South Island	Autumn	1	56	0.022	45	63	23–121
Ling BLL – vessels < 34 m	Vessels < 34 m	East of North Island	Winter	1	94	0.014	69	62	19–127
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Eastern Chatham Rise	Winter	15	1148	0.154	97	58	23–107
Bluenose BLL	Vessels < 34 m	North East	Summer	0	85	0.013	0	57	13–120
Ling BLL – vessels < 34 m	Vessels < 34 m	Eastern Chatham Rise	Winter	3	180	0.045	66	56	21–110

Table A-29: Summary of model parameters, for other birds capture in New Zealand commercial trawl, bottom-, and surface-longline fisheries. For each parameter, the table gives summary statistics of the posterior distribution (mean, median, and 95% credible interval, based on the 2.5% and 97.5% quantiles), and diagnostics (the number of chains that fail convergence and half-width tests (Heidelberger & Welch 1983), and the effective length of the chains (without autocorrelation). Trace plots of the chains are also shown. Base levels of the factor covariates are: Large trawl for method, South for region, and Autumn (Apr-Jun) for season. Model strata included different different regions, seasons, years, target fisheries, and areas for trawling, surface-longline (SLL), and bottom-longline (BLL) fisheries. IWL, integrated weight line.

Parameter	Statistic			Diagnostics			
	Mean	Median	95% c.i.	Conv.	H.W.	Effective length	Trace
Distribution parameterisation	1.241	1.245	1.003 – 1.462			4002	
S.d.(Year)							
BLL	0.388	0.359	0.085 – 0.845			3523	
SLL	0.584	0.522	0.121 – 1.390			3183	
Trawl	0.244	0.234	0.071 – 0.470			4002	
S.d.(Area)	0.306	0.291	0.121 – 0.575			3757	
S.d.(Fishery)	0.369	0.348	0.129 – 0.725			4002	
Overdispersion							
BLL	0.901	0.862	0.504 – 1.518			4002	
SLL	0.900	0.863	0.485 – 1.516			4002	
Trawl	0.562	0.515	0.243 – 1.146			4002	
Intercept	0.002	0.002	0.001 – 0.003			4713	
Method / Vessel class							
BLL / vessels $\geq$ 34 m	5.043	4.726	2.153 – 9.811			4149	
SLL / vessels $\geq$ 45 m	3.942	3.297	1.133 – 10.876			4468	
Trawl / vessels $\geq$ 28 m	1.000	1.000	1.000 – 1.000	3			
BLL / vessels $<$ 34 m	11.204	10.534	5.179 – 21.217			3876	
SLL / vessels $<$ 45 m	15.724	14.051	6.314 – 34.862			4268	
Trawl / vessels $<$ 28 m	0.720	0.680	0.333 – 1.288			4002	
Region							
North	0.613	0.577	0.322 – 1.129			4046	
South	1.000	1.000	1.000 – 1.000	3			
Season							
Autumn (Apr-Jun)	1.000	1.000	1.000 – 1.000	3			
Spring (Oct-Dec)	1.437	1.416	0.995 – 1.999			4140	
Summer (Jan-Mar)	0.904	0.891	0.618 – 1.277			4002	
Winter (Jul-Sep)	0.948	0.929	0.652 – 1.350			4108	
Fishery							
Albacore SLL	1.420	1.267	0.673 – 2.981			4426	
Bigeye SLL	0.846	0.839	0.346 – 1.429			3825	
Bluenose BLL	0.800	0.797	0.277 – 1.399			3795	
Deepwater trawl	0.543	0.528	0.238 – 0.913			4465	
Flatfish trawl	0.693	0.697	0.082 – 1.361			4002	
Hake trawl	0.875	0.868	0.425 – 1.408			3912	
Hāpuku BLL	0.852	0.850	0.277 – 1.516			4002	
Hoki trawl	1.071	1.055	0.697 – 1.541			4505	
Inshore trawl	1.268	1.190	0.732 – 2.228			4150	
Ling (no IWL) BLL – vessels $\geq$ 34 m	1.025	0.983	0.514 – 1.784			4339	
Ling (IWL) BLL – vessels $\geq$ 34 m	1.096	1.046	0.585 – 1.939			4002	
Ling BLL – vessels $<$ 34 m	0.846	0.838	0.403 – 1.374			4123	
Ling trawl	1.089	1.056	0.566 – 1.861			4125	
Mackerel trawl	1.057	1.028	0.615 – 1.655			4647	
Middle depths trawl	1.036	1.018	0.625 – 1.551			4002	
Minor targets BLL	1.214	1.158	0.690 – 2.067			4002	
Minor surface longline	0.929	0.918	0.258 – 1.684			4002	
Southern blue whiting trawl	1.155	1.111	0.646 – 1.892			4113	
Scampi trawl	1.174	1.121	0.657 – 1.993			3890	
Snapper BLL	1.186	1.132	0.653 – 1.975			3955	
Squid trawl	0.971	0.958	0.573 – 1.466			4196	
Southern bluefin SLL	0.840	0.835	0.350 – 1.405			4015	
Swordfish SLL	0.964	0.949	0.383 – 1.657			3928	
Area							
Auckland Islands	1.147	1.123	0.748 – 1.654			4129	
Cook Strait	0.924	0.911	0.503 – 1.445			4041	
East of North Island	0.967	0.954	0.521 – 1.527			3885	
Eastern Chatham Rise	0.842	0.836	0.545 – 1.174			3884	
East Subantarctic	0.878	0.869	0.470 – 1.345			4002	
Fiordland	1.261	1.218	0.813 – 1.941			4081	
Kermadec Islands	1.162	1.099	0.613 – 2.066			4003	
North East	0.995	0.984	0.556 – 1.496			4002	
South Subantarctic	0.939	0.933	0.560 – 1.376			4002	
Stewart Snares Shelf	0.949	0.938	0.640 – 1.328			3693	
Western Chatham Rise	0.695	0.691	0.400 – 1.007			4002	
West Coast North Island	0.871	0.866	0.453 – 1.319			4002	
West Coast South Island	1.352	1.318	0.929 – 1.963	1		4002	

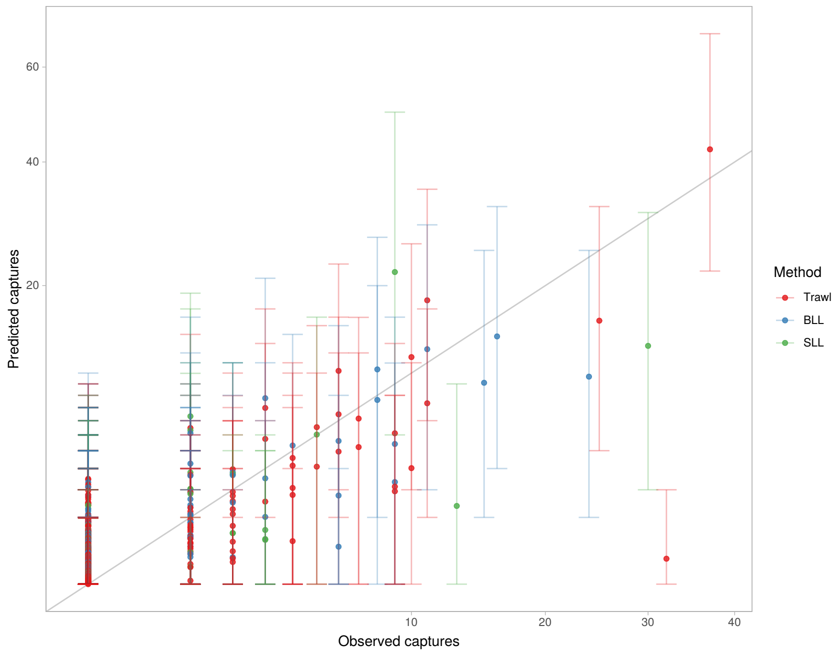


Figure A-10: Comparison between the observed and the predicted number of captures of other birds (represented by their mean and 95% credible interval), for each combination of region, fishery, vessel size, area, and season. The points were coloured according to the fishing method (BLL, bottom longline; SLL, surface longline).

Table A-30: List of strata, defined as combinations of region, fishery, vessel size, area, and season, for which the number of observed captures of other birds was outside the 95% credible interval (c.i.) of the estimated number of captures. There were eight of these strata, representing 1.3% of all 629 strata. SLL, surface longline; BLL, bottom longline. Cut-off lengths between small and large vessels were 28 m for trawl, 34 m for BLL, and 45 m for SLL.

Method	Fishery	Vessel size	Region	Area	Season	Observations	Captures	Mean	95% c.i.
Trawl	Hoki trawl	Large	South	Cook Strait	Winter (Jul-Sep)	1137	9	2.13	0–8
Trawl	Mackerel trawl	Large	North	West Coast North Island	Summer (Jan-Mar)	2198	9	1.94	0–8
SLL	Albacore SLL	Large	North	Kermadec Islands	Winter (Jul-Sep)	106	13	1.37	0–9
Trawl	Hoki trawl	Large	South	Fiordland	Autumn (Apr-Jun)	160	4	0.42	0–3
BLL	Hāpuku BLL	Small	North	North East	Autumn (Apr-Jun)	28	6	0.32	0–3
Trawl	Flatfish trawl	Small	South	Western Chatham Rise	Summer (Jan-Mar)	238	32	0.15	0–2
Trawl	Mackerel trawl	Large	South	Eastern Chatham Rise	Summer (Jan-Mar)	71	2	0.11	0–1
Trawl	Ling trawl	Large	South	South Subantarctic	Summer (Jan-Mar)	1	1	0.00	0–0

APPENDIX B: SUMMARIES OF CAPTURES BY SPECIES AND FISHERY

B.1 All birds captures

B.1.1 All birds captures in large-vessel (≥ 28 m length) trawl fisheries

Table B-31: Annual fishing effort and number of tows observed in large-vessel (≥ 28 m length) trawl fisheries, number of observed captures of all birds and observed capture rate (captures per hundred tows), and estimated captures and capture rate of all birds (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	54 200	11.9	260	4.03	1 839.3748	1 520–2 222	3.39	2.80–4.10
2003–04	47 339	13.4	248	3.90	1 546.1137	1 282–1 839	3.27	2.71–3.88
2004–05	44 156	17.2	428	5.64	1 984.5685	1 723–2 301	4.49	3.90–5.21
2005–06	39 121	15.8	333	5.39	1 779.6962	1 474–2 164	4.55	3.77–5.53
2006–07	35 188	20.6	176	2.43	999.9630	816–1 211	2.84	2.32–3.44
2007–08	32 767	25.3	221	2.66	902.7609	758–1 070	2.76	2.31–3.27
2008–09	29 978	24.7	373	5.03	1 238.8591	1 068–1 439	4.13	3.56–4.80
2009–10	29 506	26.0	241	3.14	893.4218	756–1 049	3.03	2.56–3.56
2010–11	27 393	22.7	311	5.01	1 196.5357	1 020–1 417	4.37	3.72–5.17
2011–12	25 593	32.7	225	2.68	762.9980	655–882	2.98	2.56–3.45
2012–13	23 982	49.3	694	5.87	1 041.5345	976–1 118	4.34	4.07–4.66
2013–14	25 657	43.7	462	4.12	819.3141	750–897	3.19	2.92–3.50
2014–15	25 648	43.9	597	5.30	1 049.3661	959–1 151	4.09	3.74–4.49
2015–16	25 008	43.0	435	4.04	744.0337	681–816	2.98	2.72–3.26
2016–17	25 750	38.4	399	4.03	774.0280	699–860	3.01	2.71–3.34
2017–18	26 077	49.2	519	4.04	744.0787	688–807	2.85	2.64–3.09

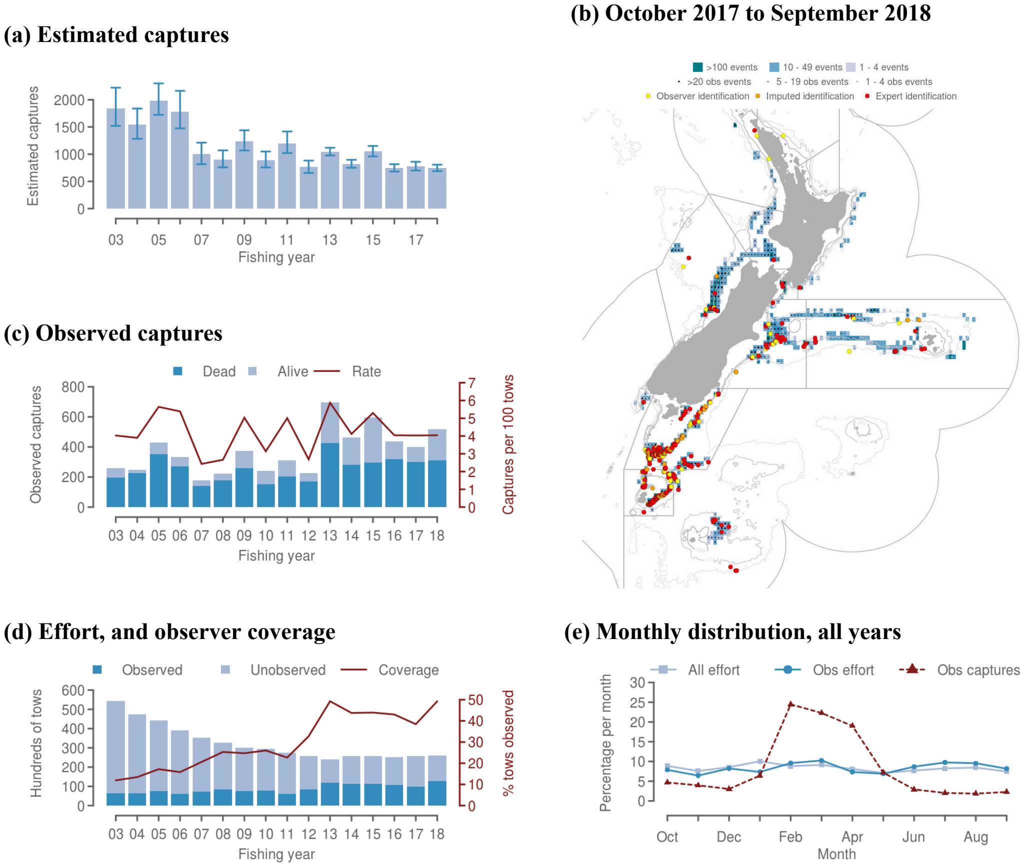


Figure B-11: All birds captures in large-vessel (≥ 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 97.8% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.1.2 All birds captures in small-vessel (< 28 m length) trawl fisheries

Table B-32: Annual fishing effort and number of tows observed in small-vessel (< 28 m length) trawl fisheries, number of observed captures of all birds and observed capture rate (captures per hundred tows), and estimated captures and capture rate of all birds (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	75 948	0.5	1	0.26	1 061.3926	836–1 329	1.40	1.10–1.75
2003–04	73 482	0.2	3	1.65	952.7874	744–1 200	1.30	1.01–1.63
2004–05	76 281	0.2	6	4.76	1 049.4140	832–1 308	1.38	1.09–1.71
2005–06	70 810	0.6	12	2.75	1 013.3481	801–1 261	1.43	1.13–1.78
2006–07	68 123	1.0	32	4.76	981.8696	785–1 208	1.44	1.15–1.77
2007–08	56 764	1.3	12	1.59	783.0302	621–977	1.38	1.09–1.72
2008–09	57 571	4.1	87	3.69	842.3436	680–1 032	1.46	1.18–1.79
2009–10	63 387	2.1	23	1.71	868.7634	691–1 082	1.37	1.09–1.71
2010–11	58 686	2.1	53	4.29	877.7961	707–1 076	1.50	1.20–1.83
2011–12	58 827	1.7	22	2.25	823.4565	656–1 018	1.40	1.12–1.73
2012–13	59 867	1.0	8	1.37	853.4945	675–1 059	1.43	1.13–1.77
2013–14	59 454	3.4	25	1.23	879.4050	705–1 085	1.48	1.19–1.82
2014–15	53 117	4.3	21	0.91	780.1322	628–958	1.47	1.18–1.80
2015–16	53 021	4.2	25	1.12	778.3736	629–950	1.47	1.19–1.79
2016–17	52 423	7.3	25	0.65	755.4415	604–928	1.44	1.15–1.77
2017–18	48 130	4.4	39	1.86	762.1084	612–941	1.58	1.27–1.96

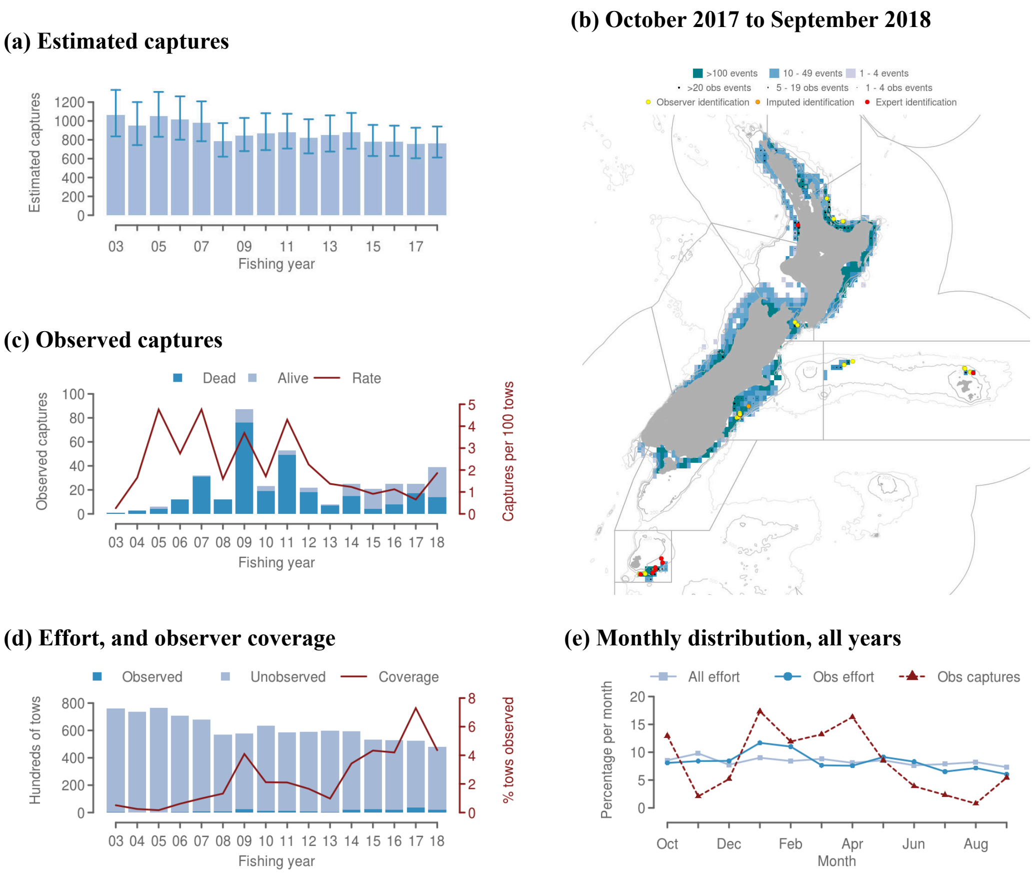


Figure B-12: All birds captures in small-vessel (< 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 , (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.1.3 All birds captures in large-vessel (≥ 34 m length) bottom-longline fisheries

Table B-33: Annual fishing effort and number of hooks observed in large-vessel (≥ 34 m length) bottom-longline fisheries, number of observed captures of all birds and observed capture rate (captures per thousand hooks), and estimated captures and capture rate of all birds (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	17 928 519	61.5	254	0.230	524.2246	417–684	0.292	0.233–0.382
2003–04	23 337 365	20.9	46	0.094	328.2629	204–528	0.141	0.087–0.226
2004–05	18 932 296	13.7	17	0.066	584.9600	281–1 277	0.309	0.148–0.675
2005–06	14 888 023	24.4	29	0.080	269.6814	152–478	0.181	0.102–0.321
2006–07	12 759 288	14.2	15	0.083	373.5455	158–858	0.293	0.124–0.672
2007–08	14 123 096	21.8	22	0.071	324.0860	172–614	0.229	0.122–0.435
2008–09	12 861 501	24.9	5	0.016	295.9733	117–672	0.230	0.091–0.522
2009–10	13 607 740	12.6	10	0.058	319.1562	149–647	0.235	0.109–0.475
2010–11	12 914 717	11.8	18	0.118	340.5990	166–663	0.264	0.129–0.513
2011–12	11 560 277	17.5	4	0.020	193.9013	81–404	0.168	0.070–0.349
2012–13	8 242 515	3.3	0	0.000	206.0217	108–394	0.250	0.131–0.478
2013–14	16 448 081	11.7	47	0.244	570.0292	325–1 003	0.347	0.198–0.610
2014–15	14 074 799	2.5	11	0.313	413.7321	216–827	0.294	0.153–0.588
2015–16	18 603 012	10.8	80	0.397	525.2896	325–865	0.282	0.175–0.465
2016–17	22 150 093	17.7	13	0.033	478.8786	248–908	0.216	0.112–0.410
2017–18	16 210 400	31.9	23	0.044	183.7976	99–343	0.113	0.061–0.212

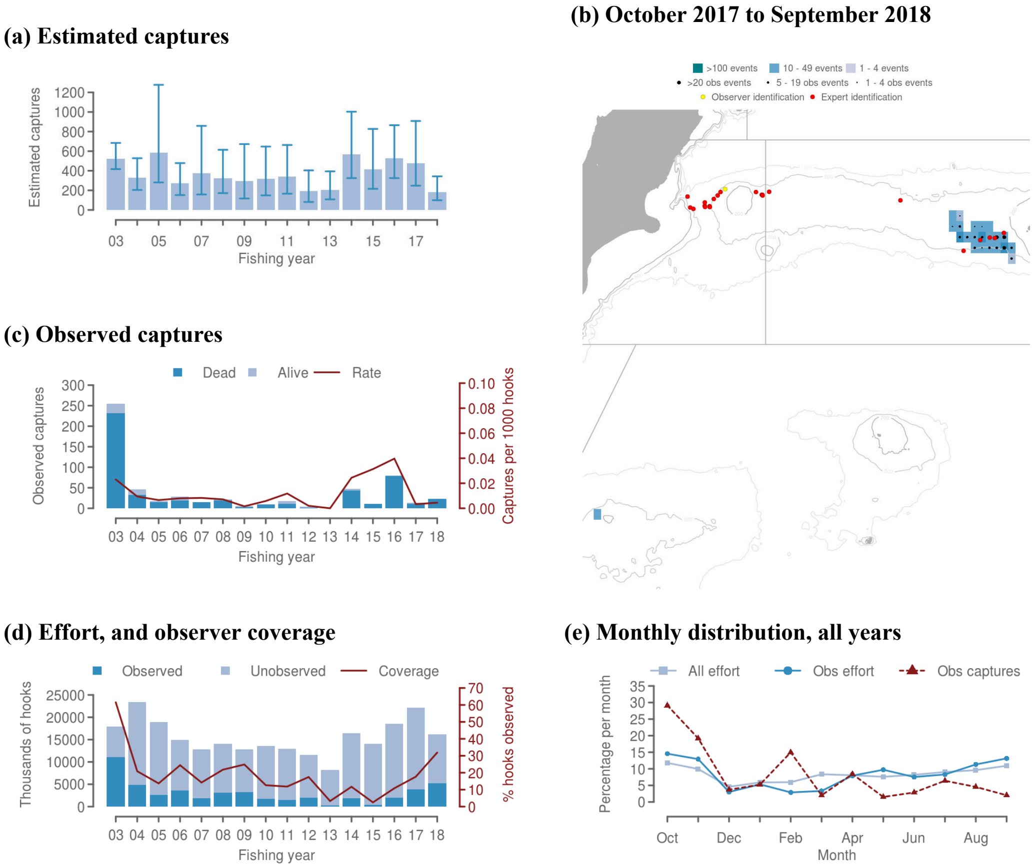


Figure B-13: All birds captures in large-vessel (≥ 34 m length) bottom-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 80.5% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.1.4 All birds captures in small-vessel (< 34 m length) bottom-longline fisheries

Table B-34: Annual fishing effort and number of hooks observed in small-vessel (< 34 m length) bottom-longline fisheries, number of observed captures of all birds and observed capture rate (captures per thousand hooks), estimated captures and capture rate of all birds (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	19 868 809	0.0	3	5.46	1 729.967	1 350–2 223	0.87	0.68–1.12
2003–04	19 908 903	1.1	11	0.49	1 496.021	1 157–1 919	0.75	0.58–0.96
2004–05	22 926 662	1.3	13	0.45	1 591.716	1 227–2 068	0.69	0.54–0.90
2005–06	22 254 310	0.7	12	0.76	1 356.951	1 031–1 798	0.61	0.46–0.81
2006–07	25 371 172	2.0	44	0.89	1 600.628	1 214–2 174	0.63	0.48–0.86
2007–08	27 369 981	1.8	18	0.37	1 493.430	1 131–2 021	0.55	0.41–0.74
2008–09	24 570 867	3.6	34	0.38	1 405.749	1 067–1 892	0.57	0.43–0.77
2009–10	26 846 311	2.7	58	0.80	1 435.869	1 095–1 911	0.53	0.41–0.71
2010–11	27 984 934	1.1	2	0.07	1 574.678	1 199–2 109	0.56	0.43–0.75
2011–12	26 317 076	0.3	6	0.72	1 411.534	1 062–1 920	0.54	0.40–0.73
2012–13	24 275 214	1.9	7	0.15	1 269.638	965–1 722	0.52	0.40–0.71
2013–14	24 416 824	4.1	56	0.56	1 194.159	938–1 532	0.49	0.38–0.63
2014–15	25 287 349	2.1	16	0.30	1 113.412	866–1 456	0.44	0.34–0.58
2015–16	24 891 714	2.5	24	0.38	1 054.096	809–1 410	0.42	0.33–0.57
2016–17	24 400 716	4.5	40	0.36	1 035.680	798–1 364	0.42	0.33–0.56
2017–18	23 691 912	3.0	17	0.24	1 002.239	761–1 341	0.42	0.32–0.57

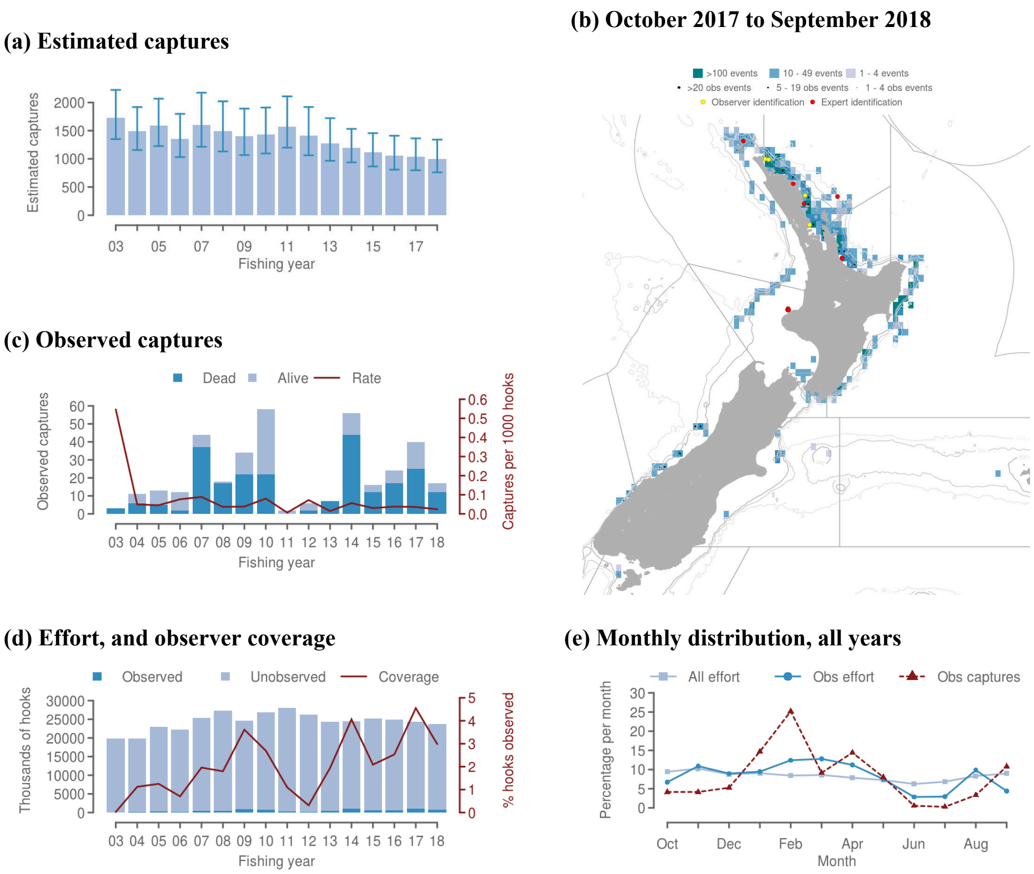


Figure B-14: All birds captures in small-vessel (< 34 m length) bottom-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 97.2% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.1.5 All birds captures in small-vessel (< 45 m length) surface-longline fisheries

Table B-35: Annual fishing effort and number of hooks observed in small-vessel (< 45 m length) surface-longline fisheries, number of observed captures of all birds and observed capture rate (captures per thousand hooks), and estimated captures and capture rate of all birds (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	8 572 416	0.0	0	.	1 780.6834	1 405–2 270	2.08	1.64–2.65
2003–04	5 730 839	2.4	7	0.52	1 269.7969	1 018–1 599	2.22	1.78–2.79
2004–05	3 044 211	4.7	8	0.56	642.5462	506–818	2.11	1.66–2.69
2005–06	3 028 469	3.2	22	2.26	662.6882	525–839	2.19	1.73–2.77
2006–07	2 332 863	8.0	76	4.06	544.5417	435–681	2.33	1.86–2.92
2007–08	1 678 054	8.1	13	0.95	402.9740	317–508	2.40	1.89–3.03
2008–09	2 306 403	6.5	15	0.99	510.9533	403–647	2.22	1.75–2.81
2009–10	2 516 706	7.3	79	4.29	647.9513	531–793	2.57	2.11–3.15
2010–11	2 684 809	6.4	18	1.05	619.5250	497–778	2.31	1.85–2.90
2011–12	2 548 687	6.8	31	1.79	691.2781	565–844	2.71	2.22–3.31
2012–13	2 389 212	3.1	22	3.02	660.6457	544–802	2.77	2.28–3.36
2013–14	1 896 434	6.8	20	1.55	543.5767	445–668	2.87	2.35–3.52
2014–15	1 790 036	6.0	16	1.50	487.8286	395–597	2.73	2.21–3.34
2015–16	2 304 091	13.0	104	3.48	672.0195	563–799	2.92	2.44–3.47
2016–17	2 094 236	16.5	51	1.48	545.7784	451–655	2.61	2.15–3.13
2017–18	2 288 801	12.9	98	3.31	635.8113	536–758	2.78	2.34–3.31

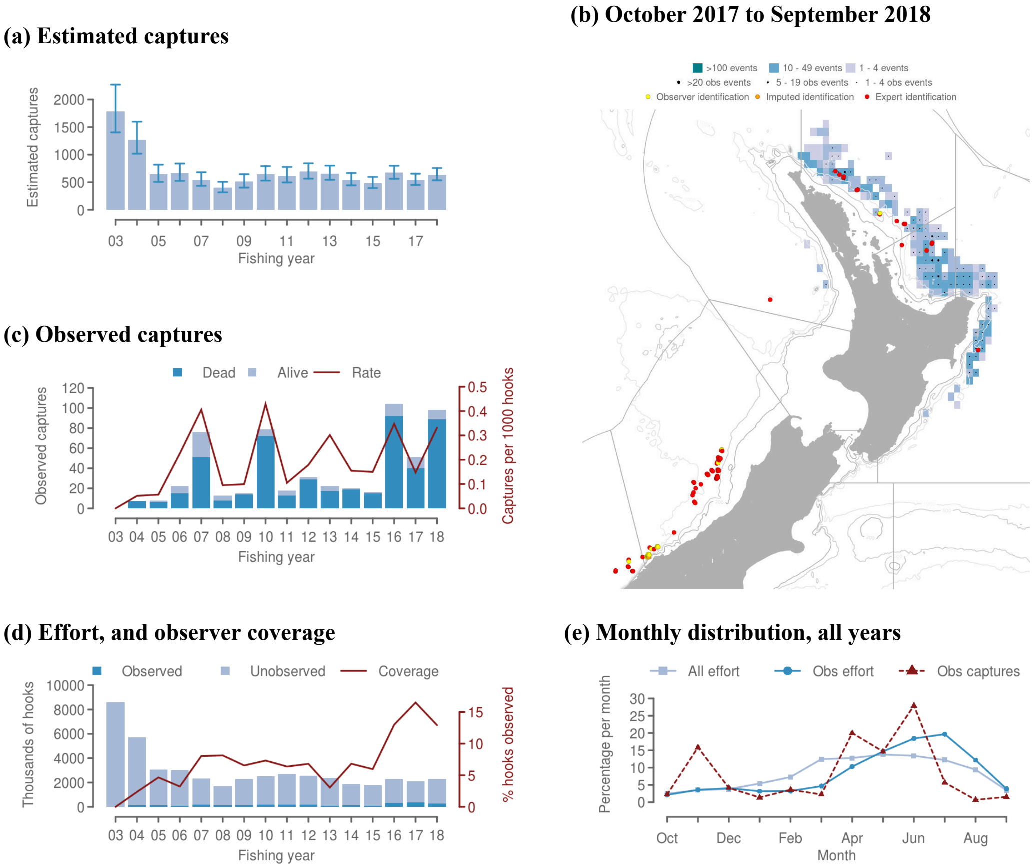


Figure B-15: All birds captures in small-vessel (< 45 m length) surface-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 95.4% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.2 White-capped albatross captures

B.2.1 White-capped albatross captures in large-vessel (≥ 28 m length) trawl fisheries

Table B-36: Annual fishing effort and number of tows observed in large-vessel (≥ 28 m length) trawl fisheries, number of observed captures of white-capped albatross and observed capture rate (captures per hundred tows), and estimated captures and capture rate of white-capped albatross (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	54 200	11.9	79	1.22	452.5720	334–600	0.84	0.62–1.11
2003–04	47 339	13.4	138	2.17	593.3728	460–755	1.25	0.97–1.59
2004–05	44 156	17.2	210	2.77	771.6202	626–943	1.75	1.42–2.14
2005–06	39 121	15.8	64	1.04	323.6227	233–430	0.83	0.60–1.10
2006–07	35 188	20.6	48	0.66	213.6632	151–292	0.61	0.43–0.83
2007–08	32 767	25.3	42	0.51	146.6392	104–200	0.45	0.32–0.61
2008–09	29 978	24.7	76	1.03	235.4350	182–303	0.79	0.61–1.01
2009–10	29 506	26.0	31	0.40	122.8066	84–170	0.42	0.28–0.58
2010–11	27 393	22.7	42	0.68	156.1097	112–210	0.57	0.41–0.77
2011–12	25 593	32.7	59	0.70	169.8088	131–217	0.66	0.51–0.85
2012–13	23 982	49.3	127	1.07	168.7004	153–189	0.70	0.64–0.79
2013–14	25 657	43.7	72	0.64	111.3753	95–131	0.43	0.37–0.51
2014–15	25 648	43.9	74	0.66	109.8981	94–129	0.43	0.37–0.50
2015–16	25 008	43.0	106	0.99	148.2034	131–168	0.59	0.52–0.67
2016–17	25 750	38.4	70	0.71	117.0640	98–141	0.45	0.38–0.55
2017–18	26 077	49.2	104	0.81	135.9408	122–153	0.52	0.47–0.59

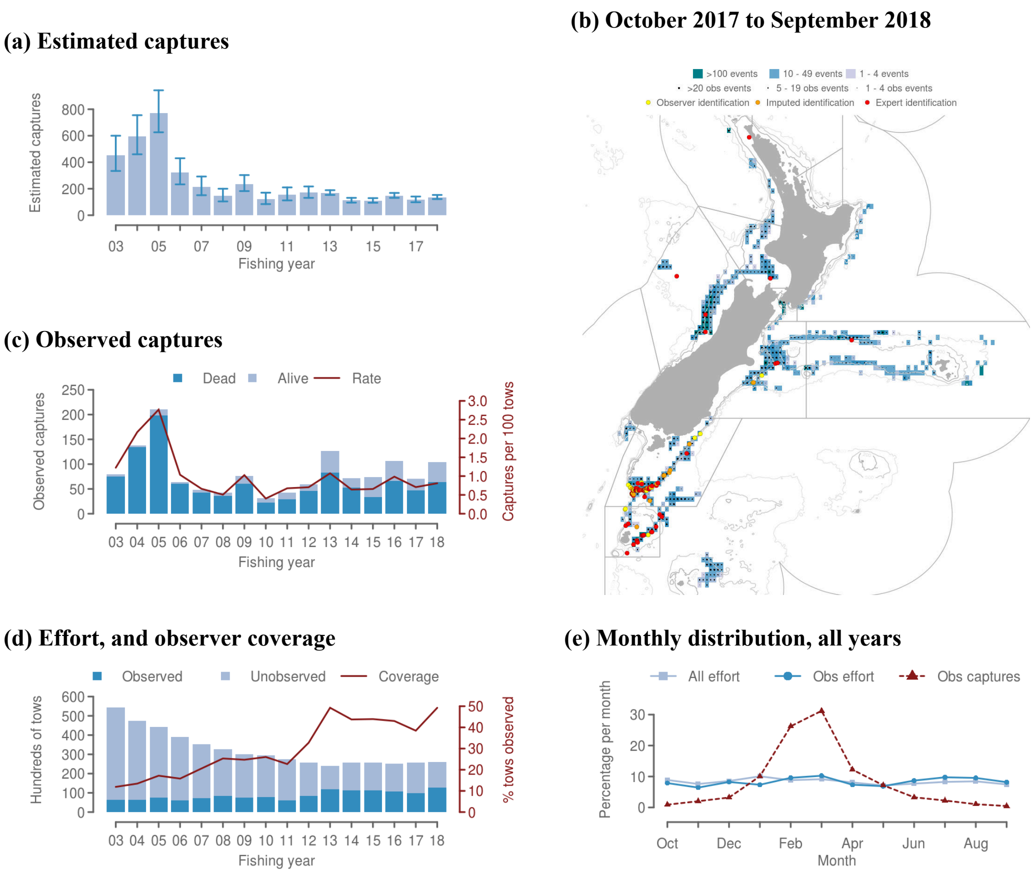


Figure B-16: White-capped albatross captures in large-vessel (≥ 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 97.8% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.2.2 White-capped albatross captures in small-vessel (< 28 m length) trawl fisheries

Table B-37: Annual fishing effort and number of tows observed in small-vessel (< 28 m length) trawl fisheries, number of observed captures of white-capped albatross and observed capture rate (captures per hundred tows), and estimated captures and capture rate of white-capped albatross (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	75 948	0.5	0	0.00	242.3658	150–368	0.32	0.20–0.48
2003–04	73 482	0.2	0	0.00	229.4638	141–346	0.31	0.19–0.47
2004–05	76 281	0.2	0	0.00	247.1144	154–374	0.32	0.20–0.49
2005–06	70 810	0.6	0	0.00	230.6787	142–347	0.33	0.20–0.49
2006–07	68 123	1.0	6	0.89	236.7734	149–356	0.35	0.22–0.52
2007–08	56 764	1.3	0	0.00	187.7304	117–284	0.33	0.21–0.50
2008–09	57 571	4.1	11	0.47	195.0352	125–285	0.34	0.22–0.50
2009–10	63 387	2.1	9	0.67	221.7454	140–330	0.35	0.22–0.52
2010–11	58 686	2.1	2	0.16	209.5982	131–313	0.36	0.22–0.53
2011–12	58 827	1.7	10	1.02	208.3273	133–311	0.35	0.23–0.53
2012–13	59 867	1.0	5	0.86	224.2386	142–334	0.37	0.24–0.56
2013–14	59 454	3.4	4	0.20	217.6174	139–324	0.37	0.23–0.54
2014–15	53 117	4.3	1	0.04	186.4140	118–281	0.35	0.22–0.53
2015–16	53 021	4.2	4	0.18	200.9760	127–297	0.38	0.24–0.56
2016–17	52 423	7.3	7	0.18	197.5902	127–292	0.38	0.24–0.56
2017–18	48 130	4.4	4	0.19	175.4320	111–260	0.36	0.23–0.54

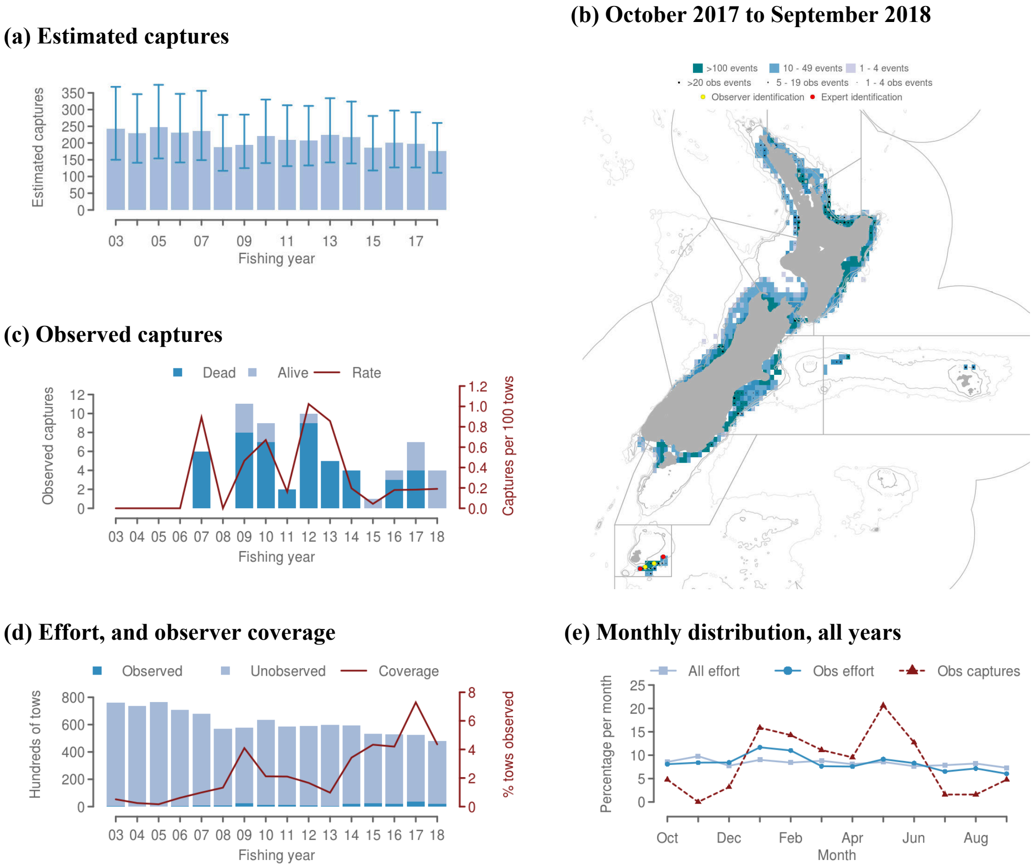


Figure B-17: White-capped albatross captures in small-vessel (< 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 , (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.2.3 White-capped albatross captures in small-vessel (< 45 m length) surface-longline fisheries

Table B-38: Annual fishing effort and number of hooks observed in small-vessel (< 45 m length) surface-longline fisheries, number of observed captures of white-capped albatross and observed capture rate (captures per thousand hooks), and estimated captures and capture rate of white-capped albatross (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	8 572 416	0.0	0	.	90.60245	47–155	0.11	0.05–0.18
2003–04	5 730 839	2.4	1	0.07	127.84233	74–198	0.22	0.13–0.35
2004–05	3 044 211	4.7	0	0.00	36.44328	17–63	0.12	0.06–0.21
2005–06	3 028 469	3.2	1	0.10	36.02424	17–64	0.12	0.06–0.21
2006–07	2 332 863	8.0	1	0.05	12.03223	4–25	0.05	0.02–0.11
2007–08	1 678 054	8.1	0	0.00	34.48276	15–63	0.21	0.09–0.38
2008–09	2 306 403	6.5	1	0.07	44.25437	22–76	0.19	0.10–0.33
2009–10	2 516 706	7.3	19	1.03	72.00325	48–106	0.29	0.19–0.42
2010–11	2 684 809	6.4	0	0.00	52.78261	27–89	0.20	0.10–0.33
2011–12	2 548 687	6.8	2	0.12	147.70465	86–229	0.58	0.34–0.90
2012–13	2 389 212	3.1	10	1.37	140.25562	86–216	0.59	0.36–0.90
2013–14	1 896 434	6.8	7	0.54	114.61644	69–179	0.60	0.36–0.94
2014–15	1 790 036	6.0	4	0.37	105.08371	62–164	0.59	0.35–0.92
2015–16	2 304 091	13.0	29	0.97	140.35757	93–207	0.61	0.40–0.90
2016–17	2 094 236	16.5	17	0.49	125.33633	80–190	0.60	0.38–0.91
2017–18	2 288 801	12.9	52	1.76	132.37931	97–180	0.58	0.42–0.79

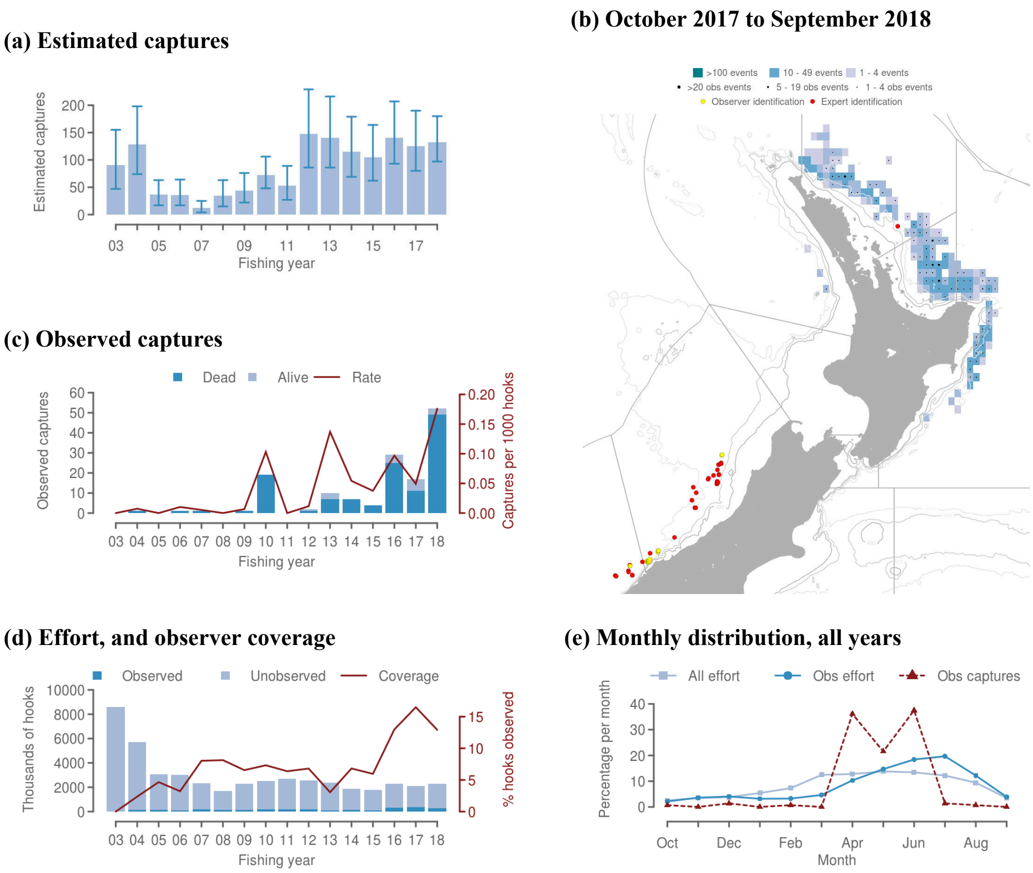


Figure B-18: White-capped albatross captures in small-vessel (< 45 m length) surface-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 95.4% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.3 Salvin’s albatross captures

B.3.1 Salvin’s albatross captures in large-vessel (≥ 28 m length) trawl fisheries

Table B-39: Annual fishing effort and number of tows observed in large-vessel (≥ 28 m length) trawl fisheries, number of observed captures of Salvin’s albatross and observed capture rate (captures per hundred tows), and estimated captures and capture rate of Salvin’s albatross (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	54 200	11.9	22	0.341	178.83208	102–267	0.330	0.188–0.493
2003–04	47 339	13.4	7	0.110	154.97451	78–251	0.327	0.165–0.530
2004–05	44 156	17.2	34	0.448	242.64968	152–380	0.550	0.344–0.861
2005–06	39 121	15.8	5	0.081	95.99125	45–157	0.245	0.115–0.401
2006–07	35 188	20.6	9	0.124	88.32859	43–140	0.251	0.122–0.398
2007–08	32 767	25.3	5	0.060	73.85357	32–122	0.225	0.098–0.372
2008–09	29 978	24.7	12	0.162	103.43578	61–157	0.345	0.203–0.524
2009–10	29 506	26.0	34	0.443	131.05847	92–184	0.444	0.312–0.624
2010–11	27 393	22.7	17	0.274	109.00125	68–162	0.398	0.248–0.591
2011–12	25 593	32.7	20	0.239	87.40630	57–123	0.342	0.223–0.481
2012–13	23 982	49.3	50	0.423	113.15317	87–147	0.472	0.363–0.613
2013–14	25 657	43.7	48	0.428	118.92704	91–154	0.464	0.355–0.600
2014–15	25 648	43.9	40	0.355	127.70115	92–177	0.498	0.359–0.690
2015–16	25 008	43.0	30	0.279	94.15817	67–127	0.377	0.268–0.508
2016–17	25 750	38.4	21	0.212	82.36582	53–118	0.320	0.206–0.458
2017–18	26 077	49.2	28	0.218	91.06872	63–126	0.349	0.242–0.483

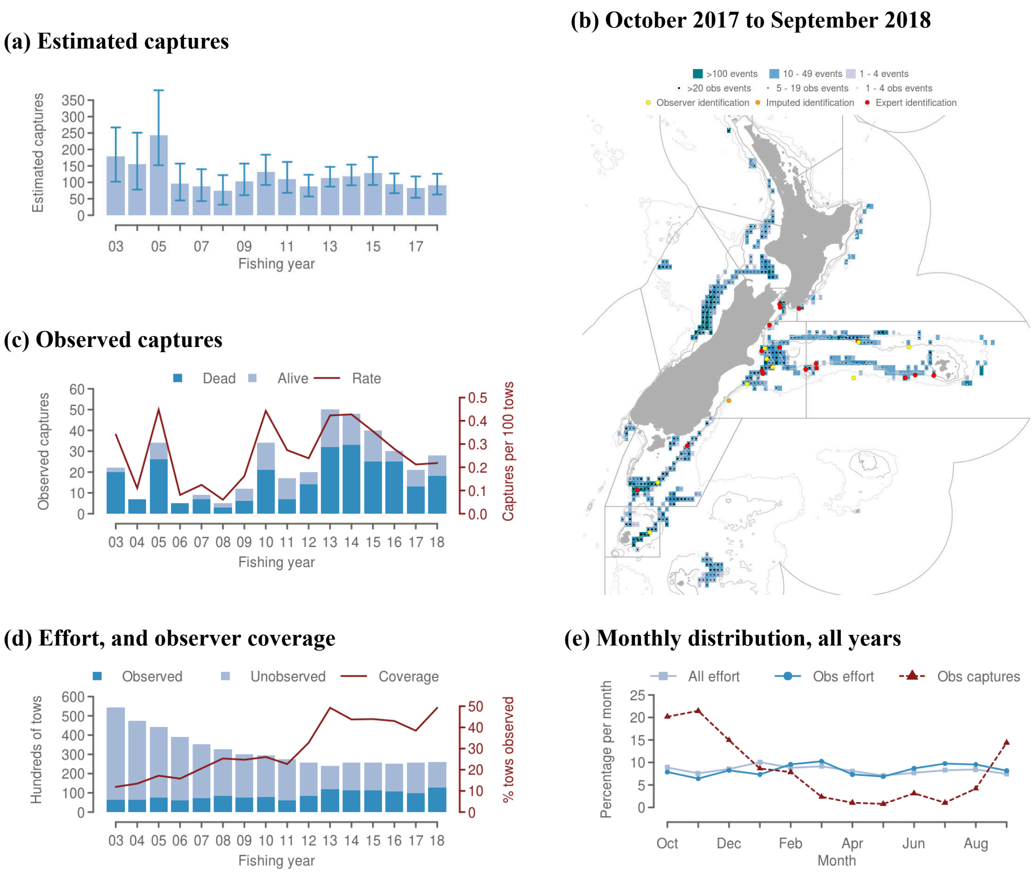


Figure B-19: Salvin’s albatross captures in large-vessel (≥ 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 97.8% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.3.2 Salvin’s albatross captures in small-vessel (< 28 m length) trawl fisheries

Table B-40: Annual fishing effort and number of tows observed in small-vessel (< 28 m length) trawl fisheries, number of observed captures of Salvin’s albatross and observed capture rate (captures per hundred tows), and estimated captures and capture rate of Salvin’s albatross (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	75 948	0.5	1	0.26	267.0550	156–420	0.35	0.21–0.55
2003–04	73 482	0.2	3	1.65	216.4188	122–350	0.29	0.17–0.48
2004–05	76 281	0.2	2	1.59	251.4365	149–390	0.33	0.20–0.51
2005–06	70 810	0.6	1	0.23	243.8888	145–376	0.34	0.20–0.53
2006–07	68 123	1.0	2	0.30	222.5352	136–341	0.33	0.20–0.50
2007–08	56 764	1.3	4	0.53	165.1212	99–256	0.29	0.17–0.45
2008–09	57 571	4.1	24	1.02	191.1077	121–285	0.33	0.21–0.50
2009–10	63 387	2.1	10	0.75	187.1329	112–290	0.30	0.18–0.46
2010–11	58 686	2.1	4	0.32	194.2034	117–297	0.33	0.20–0.51
2011–12	58 827	1.7	5	0.51	191.9910	120–293	0.33	0.20–0.50
2012–13	59 867	1.0	2	0.34	198.9208	120–306	0.33	0.20–0.51
2013–14	59 454	3.4	3	0.15	220.1482	135–334	0.37	0.23–0.56
2014–15	53 117	4.3	5	0.22	200.9328	126–300	0.38	0.24–0.56
2015–16	53 021	4.2	2	0.09	172.8943	109–260	0.33	0.21–0.49
2016–17	52 423	7.3	5	0.13	176.6309	109–268	0.34	0.21–0.51
2017–18	48 130	4.4	7	0.33	196.6709	120–299	0.41	0.25–0.62

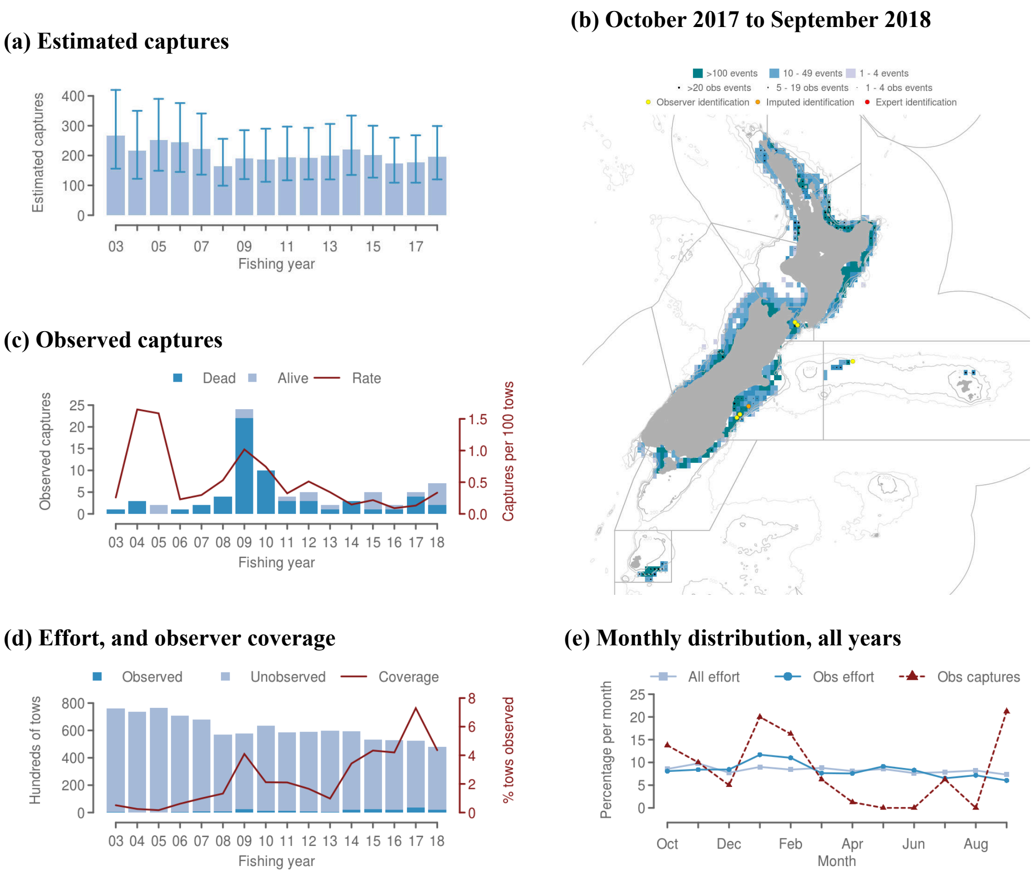


Figure B-20: Salvin’s albatross captures in small-vessel (< 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 , (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.3.3 Salvin's albatross captures in small-vessel (< 34 m length) bottom-longline fisheries

Table B-41: Annual fishing effort and number of hooks observed in small-vessel (< 34 m length) bottom-longline fisheries, number of observed captures of Salvin's albatross and observed capture rate (captures per thousand hooks), and estimated captures and capture rate of Salvin's albatross (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	19 868 809	0.0	0	0.000	34.83283	11–78	0.018	0.006–0.039
2003–04	19 908 903	1.1	0	0.000	31.21264	9–74	0.016	0.005–0.037
2004–05	22 926 662	1.3	0	0.000	49.44703	15–120	0.022	0.007–0.052
2005–06	22 254 310	0.7	0	0.000	42.85257	10–111	0.019	0.004–0.050
2006–07	25 371 172	2.0	22	0.443	70.85982	36–144	0.028	0.014–0.057
2007–08	27 369 981	1.8	0	0.000	54.96577	16–139	0.020	0.006–0.051
2008–09	24 570 867	3.6	0	0.000	54.06547	17–121	0.022	0.007–0.049
2009–10	26 846 311	2.7	0	0.000	54.04773	18–123	0.020	0.007–0.046
2010–11	27 984 934	1.1	0	0.000	65.43753	22–147	0.023	0.008–0.053
2011–12	26 317 076	0.3	0	0.000	65.86382	21–150	0.025	0.008–0.057
2012–13	24 275 214	1.9	1	0.021	59.28461	20–135	0.024	0.008–0.056
2013–14	24 416 824	4.1	1	0.010	54.02674	18–117	0.022	0.007–0.048
2014–15	25 287 349	2.1	0	0.000	48.72689	16–109	0.019	0.006–0.043
2015–16	24 891 714	2.5	0	0.000	46.11544	14–100	0.019	0.006–0.040
2016–17	24 400 716	4.5	1	0.009	35.90680	12–77	0.015	0.005–0.032
2017–18	23 691 912	3.0	0	0.000	44.59645	14–101	0.019	0.006–0.043

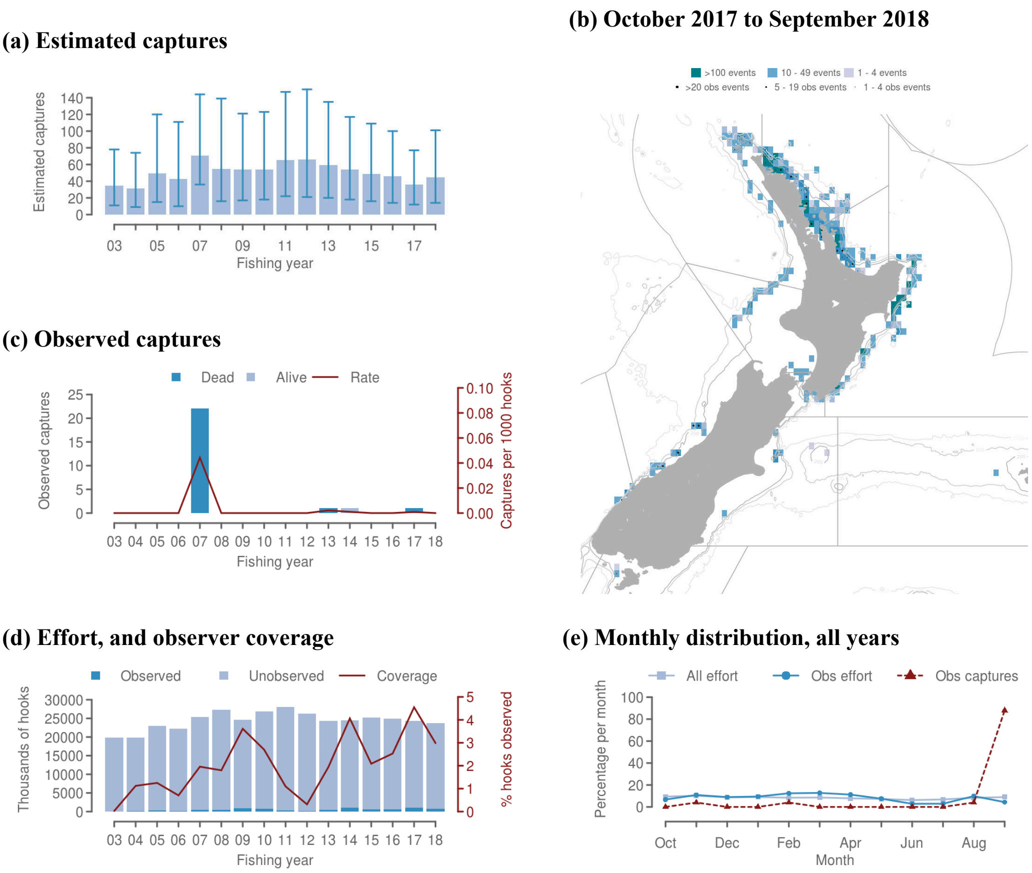


Figure B-21: Salvin's albatross captures in small-vessel (< 34 m length) bottom-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 97.2% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.4 Buller's albatrosses captures

B.4.1 Buller's albatrosses captures in large-vessel ($\geq$ 28 m length) trawl fisheries

Table B-42: Annual fishing effort and number of tows observed in large-vessel ($\geq$ 28 m length) trawl fisheries, number of observed captures of Buller's albatrosses and observed capture rate (captures per hundred tows), and estimated captures and capture rate of Buller's albatrosses (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	54 200	11.9	7	0.108	100.32634	52–158	0.185	0.096–0.292
2003–04	47 339	13.4	10	0.157	105.25887	59–159	0.222	0.125–0.336
2004–05	44 156	17.2	22	0.290	135.72564	92–193	0.307	0.208–0.437
2005–06	39 121	15.8	8	0.129	80.84983	44–123	0.207	0.112–0.314
2006–07	35 188	20.6	6	0.083	59.93553	31–93	0.170	0.088–0.264
2007–08	32 767	25.3	17	0.205	72.52749	47–106	0.221	0.143–0.323
2008–09	29 978	24.7	18	0.243	63.77586	42–90	0.213	0.140–0.300
2009–10	29 506	26.0	12	0.156	57.28036	35–83	0.194	0.119–0.281
2010–11	27 393	22.7	20	0.322	67.10145	45–94	0.245	0.164–0.343
2011–12	25 593	32.7	33	0.394	96.12744	71–130	0.376	0.277–0.508
2012–13	23 982	49.3	59	0.499	84.51874	72–100	0.352	0.300–0.417
2013–14	25 657	43.7	37	0.330	64.40955	51–82	0.251	0.199–0.320
2014–15	25 648	43.9	35	0.311	70.04173	54–90	0.273	0.211–0.351
2015–16	25 008	43.0	56	0.521	91.32734	76–112	0.365	0.304–0.448
2016–17	25 750	38.4	23	0.232	57.09745	41–77	0.222	0.159–0.299
2017–18	26 077	49.2	35	0.273	59.28111	47–75	0.227	0.180–0.288

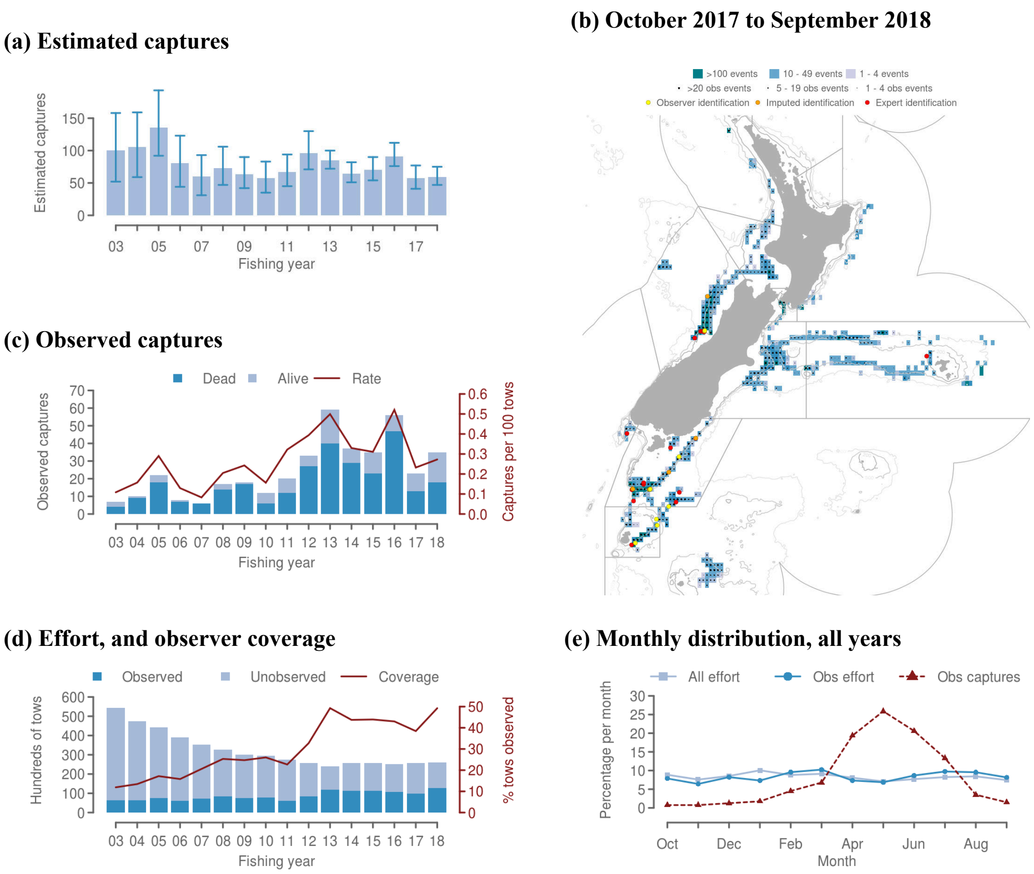


Figure B-22: Buller's albatrosses captures in large-vessel ($\geq$ 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 97.8% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.4.2 Buller's albatrosses captures in small-vessel (< 28 m length) trawl fisheries

Table B-43: Annual fishing effort and number of tows observed in small-vessel (< 28 m length) trawl fisheries, number of observed captures of Buller's albatrosses and observed capture rate (captures per hundred tows), and estimated captures and capture rate of Buller's albatrosses (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	75 948	0.5	0	0.00	55.11969	18–118	0.07	0.02–0.16
2003–04	73 482	0.2	0	0.00	55.26562	17–122	0.08	0.02–0.17
2004–05	76 281	0.2	2	1.59	62.31359	24–125	0.08	0.03–0.16
2005–06	70 810	0.6	1	0.23	61.22239	24–120	0.09	0.03–0.17
2006–07	68 123	1.0	0	0.00	60.00150	23–123	0.09	0.03–0.18
2007–08	56 764	1.3	0	0.00	51.08571	19–105	0.09	0.03–0.18
2008–09	57 571	4.1	2	0.08	51.67316	19–105	0.09	0.03–0.18
2009–10	63 387	2.1	0	0.00	53.54098	19–110	0.08	0.03–0.17
2010–11	58 686	2.1	0	0.00	46.00400	17–95	0.08	0.03–0.16
2011–12	58 827	1.7	3	0.31	52.76287	21–103	0.09	0.04–0.18
2012–13	59 867	1.0	1	0.17	53.65617	20–106	0.09	0.03–0.18
2013–14	59 454	3.4	0	0.00	55.83858	23–108	0.09	0.04–0.18
2014–15	53 117	4.3	1	0.04	48.82759	20–93	0.09	0.04–0.18
2015–16	53 021	4.2	0	0.00	52.49475	21–99	0.10	0.04–0.19
2016–17	52 423	7.3	1	0.03	46.44328	18–91	0.09	0.03–0.17
2017–18	48 130	4.4	11	0.52	56.17916	29–99	0.12	0.06–0.21

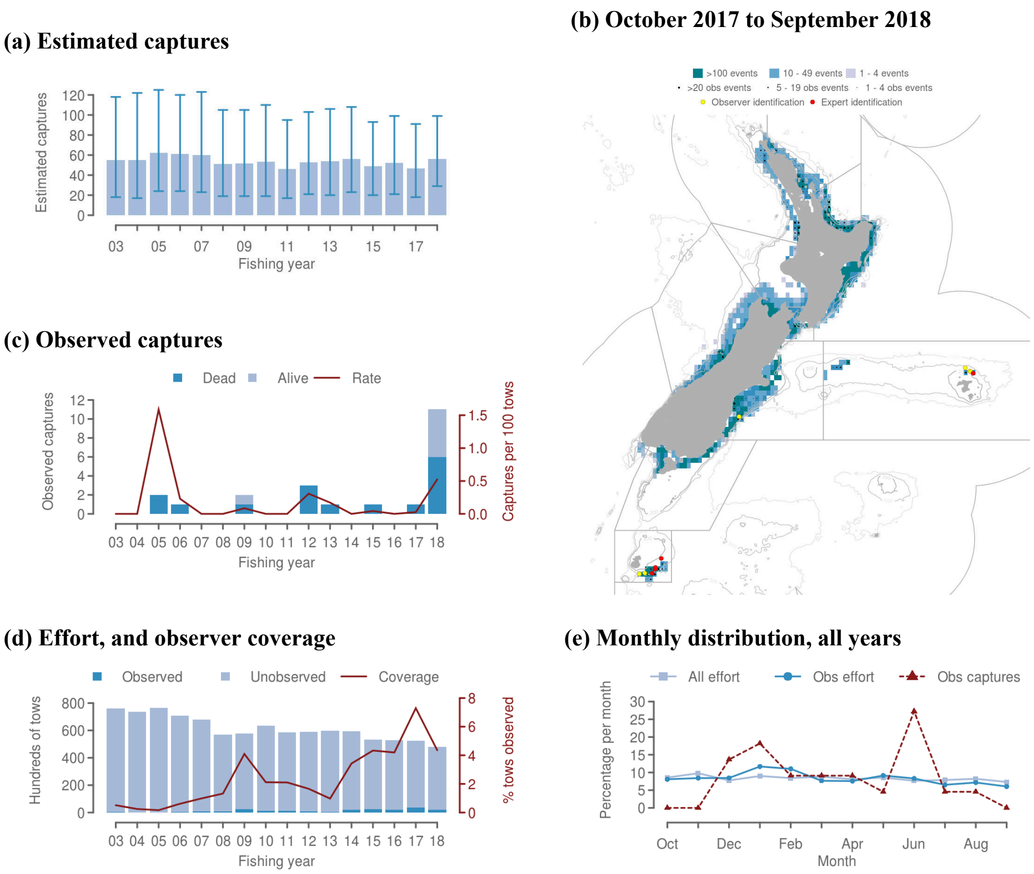


Figure B-23: Buller's albatrosses captures in small-vessel (< 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 , (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.4.3 Buller's albatrosses captures in small-vessel (< 45 m length) surface-longline fisheries

Table B-44: Annual fishing effort and number of hooks observed in small-vessel (< 45 m length) surface-longline fisheries, number of observed captures of Buller's albatrosses and observed capture rate (captures per thousand hooks), and estimated captures and capture rate of Buller's albatrosses (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	8 572 416	0.0	0	.	297.99275	184–463	0.35	0.21–0.54
2003–04	5 730 839	2.4	0	0.00	245.98076	159–371	0.43	0.28–0.65
2004–05	3 044 211	4.7	3	0.21	88.29210	54–138	0.29	0.18–0.45
2005–06	3 028 469	3.2	4	0.41	100.24038	58–162	0.33	0.19–0.53
2006–07	2 332 863	8.0	1	0.05	52.49125	26–92	0.23	0.11–0.39
2007–08	1 678 054	8.1	4	0.29	56.03423	33–86	0.33	0.20–0.51
2008–09	2 306 403	6.5	2	0.13	74.91204	44–120	0.32	0.19–0.52
2009–10	2 516 706	7.3	28	1.52	112.54873	80–154	0.45	0.32–0.61
2010–11	2 684 809	6.4	4	0.23	87.81934	55–131	0.33	0.20–0.49
2011–12	2 548 687	6.8	4	0.23	125.50975	82–183	0.49	0.32–0.72
2012–13	2 389 212	3.1	8	1.10	108.08471	73–153	0.45	0.31–0.64
2013–14	1 896 434	6.8	8	0.62	93.87581	62–135	0.50	0.33–0.71
2014–15	1 790 036	6.0	3	0.28	77.51599	49–116	0.43	0.27–0.65
2015–16	2 304 091	13.0	42	1.40	135.41304	101–179	0.59	0.44–0.78
2016–17	2 094 236	16.5	13	0.38	102.77261	70–149	0.49	0.33–0.71
2017–18	2 288 801	12.9	17	0.57	95.90705	66–135	0.42	0.29–0.59

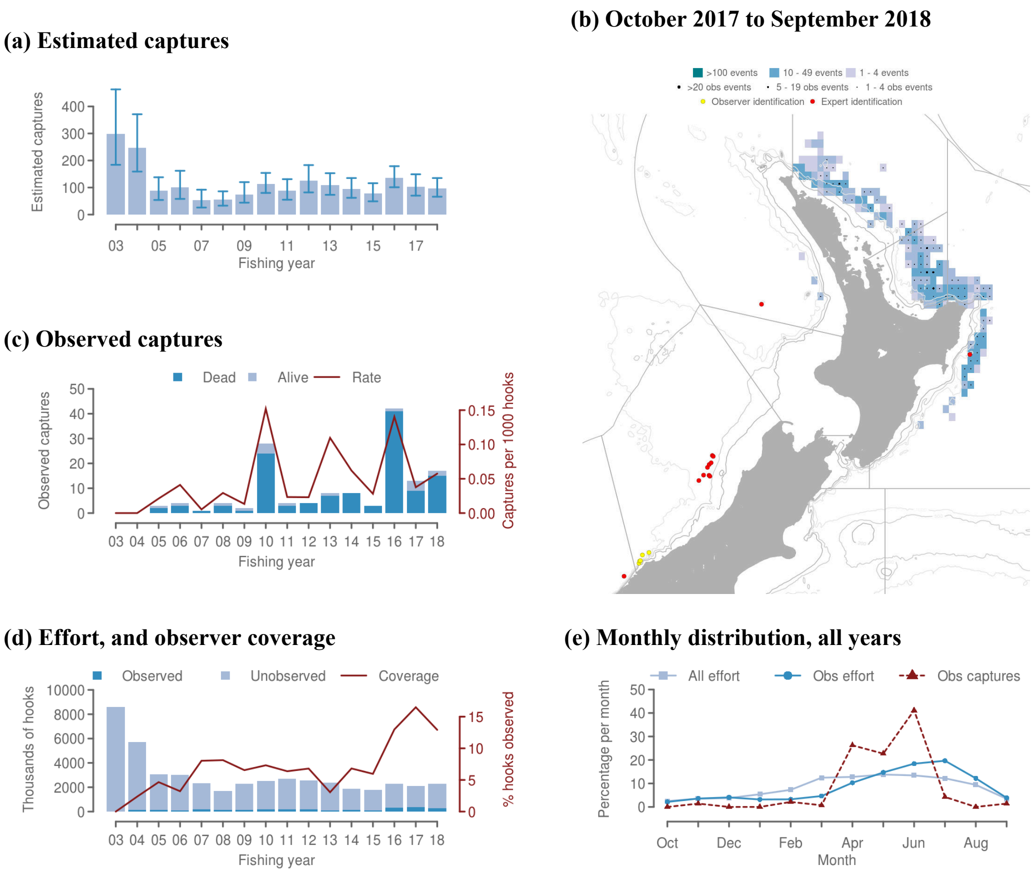


Figure B-24: Buller's albatrosses captures in small-vessel (< 45 m length) surface-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 95.4% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

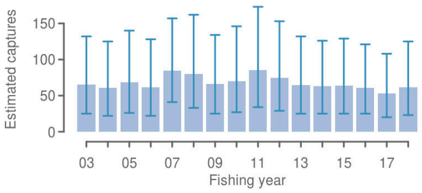
B.5 Other albatrosses captures

B.5.1 Other albatrosses captures in small-vessel (< 34 m length) bottom-longline fisheries

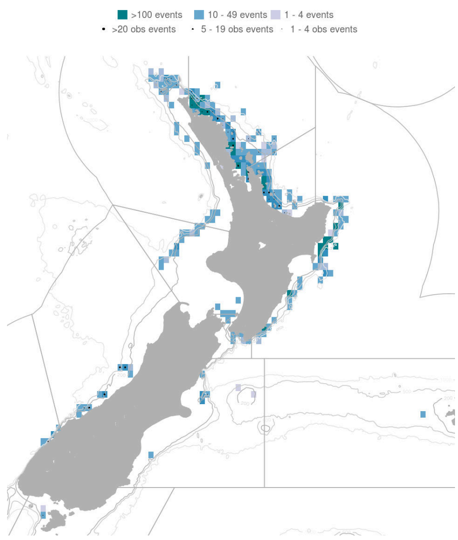
Table B-45: Annual fishing effort and number of hooks observed in small-vessel (< 34 m length) bottom-longline fisheries, number of observed captures of other albatrosses and observed capture rate (captures per thousand hooks), and estimated captures and capture rate of other albatrosses (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	19 868 809	0.0	0	0.000	65.03448	25–132	0.033	0.013–0.066
2003–04	19 908 903	1.1	0	0.000	60.63218	22–125	0.030	0.011–0.063
2004–05	22 926 662	1.3	0	0.000	68.24263	26–140	0.030	0.011–0.061
2005–06	22 254 310	0.7	0	0.000	61.78661	22–128	0.028	0.010–0.058
2006–07	25 371 172	2.0	14	0.282	84.61994	41–157	0.033	0.016–0.062
2007–08	27 369 981	1.8	4	0.081	80.13718	33–162	0.029	0.012–0.059
2008–09	24 570 867	3.6	0	0.000	66.01624	25–134	0.027	0.010–0.055
2009–10	26 846 311	2.7	0	0.000	70.04498	27–146	0.026	0.010–0.054
2010–11	27 984 934	1.1	0	0.000	85.25962	34–173	0.030	0.012–0.062
2011–12	26 317 076	0.3	0	0.000	74.46527	29–153	0.028	0.011–0.058
2012–13	24 275 214	1.9	0	0.000	64.94478	25–132	0.027	0.010–0.054
2013–14	24 416 824	4.1	1	0.010	63.10920	25–126	0.026	0.010–0.052
2014–15	25 287 349	2.1	0	0.000	63.63818	25–129	0.025	0.010–0.051
2015–16	24 891 714	2.5	2	0.032	60.61494	25–121	0.024	0.010–0.049
2016–17	24 400 716	4.5	0	0.000	52.89705	20–108	0.022	0.008–0.044
2017–18	23 691 912	3.0	0	0.000	61.16492	23–125	0.026	0.010–0.053

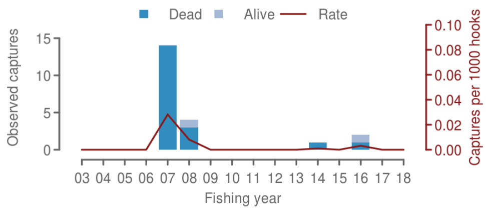
(a) Estimated captures



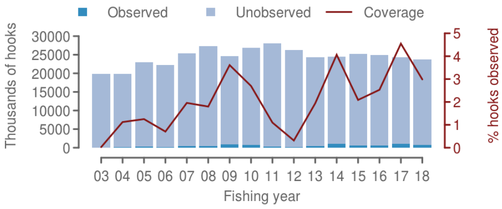
(b) October 2017 to September 2018



(c) Observed captures



(d) Effort, and observer coverage



(e) Monthly distribution, all years

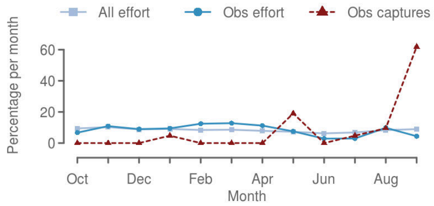


Figure B-25: Other albatrosses captures in small-vessel (< 34 m length) bottom-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 97.2% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.5.2 Other albatrosses captures in small-vessel (< 45 m length) surface-longline fisheries

Table B-46: Annual fishing effort and number of hooks observed in small-vessel (< 45 m length) surface-longline fisheries, number of observed captures of other albatrosses and observed capture rate (captures per thousand hooks), and estimated captures and capture rate of other albatrosses (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	8 572 416	0.0	0	.	390.65392	253–571	0.46	0.30–0.67
2003–04	5 730 839	2.4	1	0.07	253.69440	163–378	0.44	0.28–0.66
2004–05	3 044 211	4.7	3	0.21	134.36582	86–198	0.44	0.28–0.65
2005–06	3 028 469	3.2	6	0.62	158.46227	106–227	0.52	0.35–0.75
2006–07	2 332 863	8.0	56	2.99	180.09645	135–240	0.77	0.58–1.03
2007–08	1 678 054	8.1	3	0.22	85.77161	55–125	0.51	0.33–0.74
2008–09	2 306 403	6.5	5	0.33	103.85932	66–154	0.45	0.29–0.67
2009–10	2 516 706	7.3	19	1.03	150.66442	106–210	0.60	0.42–0.83
2010–11	2 684 809	6.4	4	0.23	126.63618	84–184	0.47	0.31–0.69
2011–12	2 548 687	6.8	16	0.92	121.48176	84–173	0.48	0.33–0.68
2012–13	2 389 212	3.1	4	0.55	125.43753	84–180	0.53	0.35–0.75
2013–14	1 896 434	6.8	3	0.23	96.18216	63–137	0.51	0.33–0.72
2014–15	1 790 036	6.0	6	0.56	106.96227	69–159	0.60	0.39–0.89
2015–16	2 304 091	13.0	15	0.50	133.97601	90–193	0.58	0.39–0.84
2016–17	2 094 236	16.5	4	0.12	100.30535	65–146	0.48	0.31–0.70
2017–18	2 288 801	12.9	6	0.20	132.47251	88–192	0.58	0.38–0.84

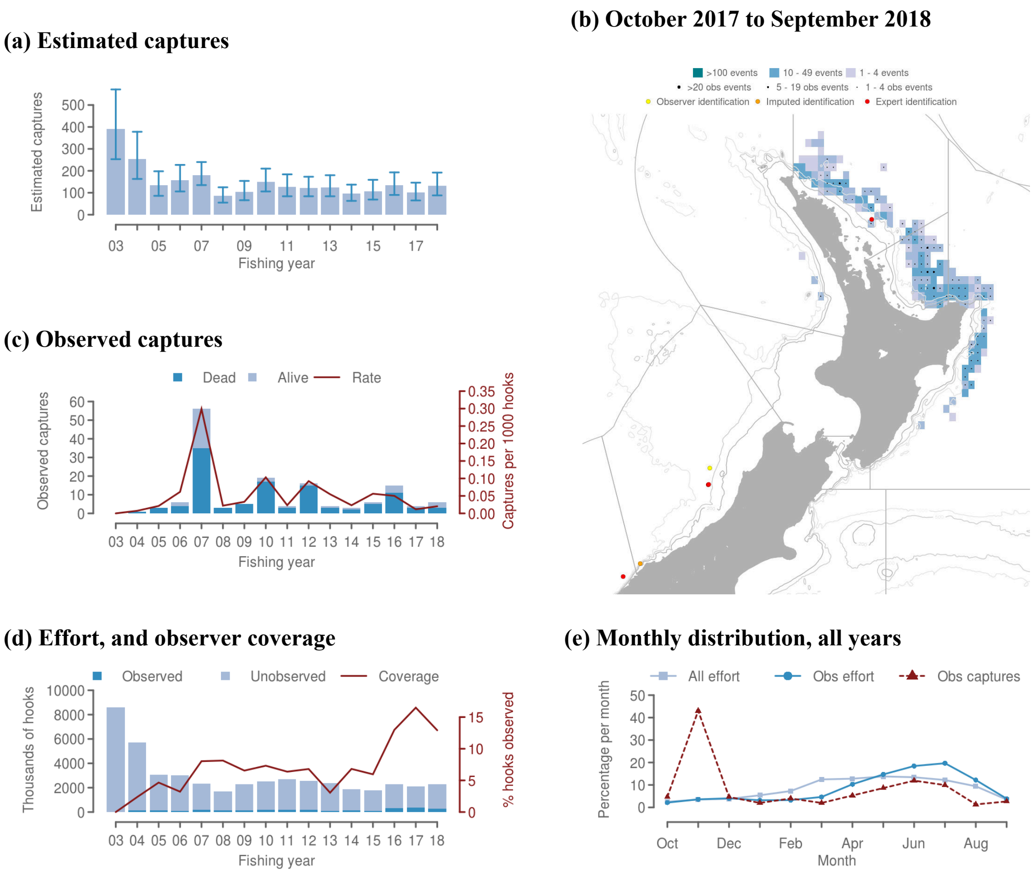


Figure B-26: Other albatrosses captures in small-vessel (< 45 m length) surface-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 95.4% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.6 White-chinned petrel captures

B.6.1 White-chinned petrel captures in large-vessel (≥ 28 m length) trawl fisheries

Table B-47: Annual fishing effort and number of tows observed in large-vessel (≥ 28 m length) trawl fisheries, number of observed captures of white-chinned petrel and observed capture rate (captures per hundred tows), and estimated captures and capture rate of white-chinned petrel (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	54 200	11.9	14	0.22	152.7741	73–274	0.28	0.13–0.51
2003–04	47 339	13.4	18	0.28	118.3246	58–207	0.25	0.12–0.44
2004–05	44 156	17.2	53	0.70	236.6832	153–348	0.54	0.35–0.79
2005–06	39 121	15.8	71	1.15	382.4210	249–551	0.98	0.64–1.41
2006–07	35 188	20.6	31	0.43	152.8851	90–242	0.43	0.26–0.69
2007–08	32 767	25.3	58	0.70	210.1572	143–306	0.64	0.44–0.93
2008–09	29 978	24.7	106	1.43	305.9675	225–412	1.02	0.75–1.37
2009–10	29 506	26.0	71	0.92	242.4340	168–340	0.82	0.57–1.15
2010–11	27 393	22.7	112	1.80	358.9673	267–485	1.31	0.97–1.77
2011–12	25 593	32.7	61	0.73	191.8166	135–266	0.75	0.53–1.04
2012–13	23 982	49.3	287	2.43	397.8413	356–448	1.66	1.48–1.87
2013–14	25 657	43.7	149	1.33	233.3131	200–277	0.91	0.78–1.08
2014–15	25 648	43.9	292	2.59	431.3888	380–494	1.68	1.48–1.93
2015–16	25 008	43.0	161	1.50	230.5785	202–268	0.92	0.81–1.07
2016–17	25 750	38.4	142	1.43	247.5515	205–302	0.96	0.80–1.17
2017–18	26 077	49.2	217	1.69	293.1309	263–335	1.12	1.01–1.28

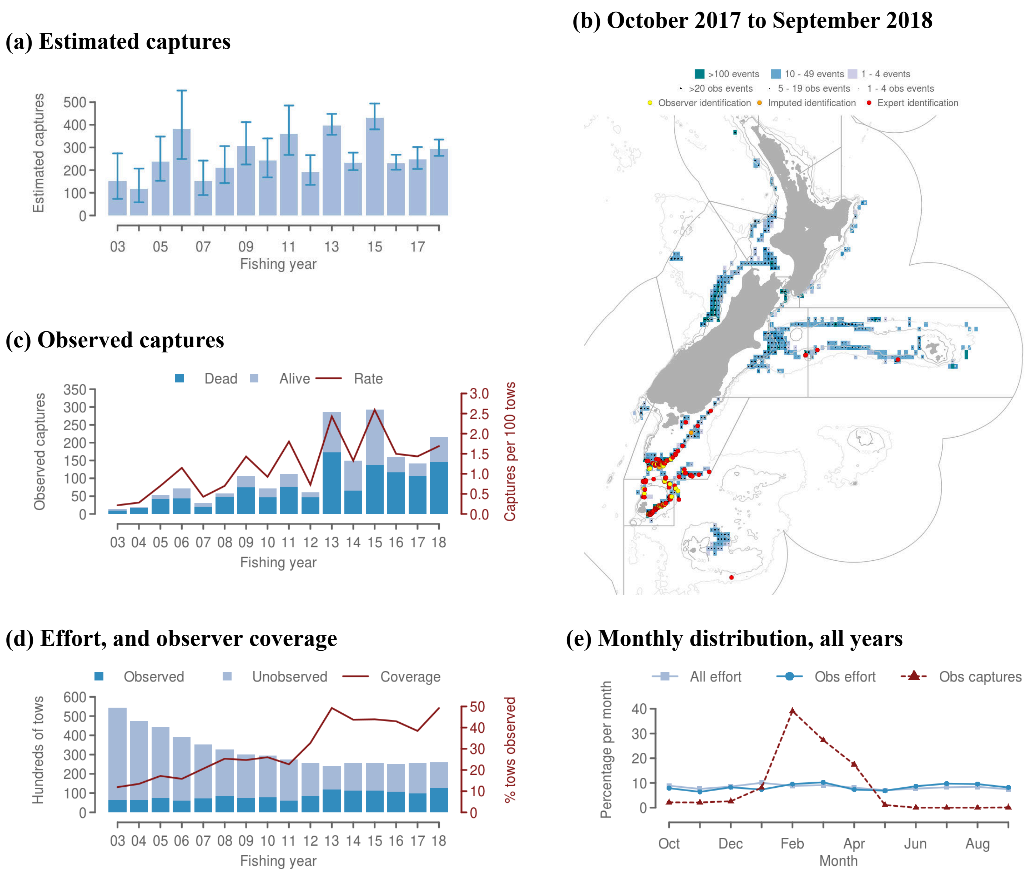


Figure B-27: White-chinned petrel captures in large-vessel (≥ 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 97.8% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.6.2 White-chinned petrel captures in large-vessel (≥ 34 m length) bottom-longline fisheries

Table B-48: Annual fishing effort and number of hooks observed in large-vessel (≥ 34 m length) bottom-longline fisheries, number of observed captures of white-chinned petrel and observed capture rate (captures per thousand hooks), and estimated captures and capture rate of white-chinned petrel (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	17 928 519	61.5	131	0.119	266.62044	183–423	0.149	0.102–0.236
2003–04	23 337 365	20.9	15	0.031	138.63143	49–313	0.059	0.021–0.134
2004–05	18 932 296	13.7	11	0.042	441.53023	155–1 127	0.233	0.082–0.595
2005–06	14 888 023	24.4	13	0.036	141.67441	47–340	0.095	0.032–0.228
2006–07	12 759 288	14.2	13	0.072	268.33058	76–747	0.210	0.060–0.585
2007–08	14 123 096	21.8	7	0.023	194.41179	60–474	0.138	0.042–0.336
2008–09	12 861 501	24.9	1	0.003	179.71514	27–533	0.140	0.021–0.414
2009–10	13 607 740	12.6	1	0.006	170.60620	32–475	0.125	0.024–0.349
2010–11	12 914 717	11.8	15	0.098	208.45802	70–488	0.161	0.054–0.378
2011–12	11 560 277	17.5	1	0.005	94.57071	12–285	0.082	0.010–0.247
2012–13	8 242 515	3.3	0	0.000	99.97776	20–283	0.121	0.024–0.343
2013–14	16 448 081	11.7	36	0.187	391.22464	165–816	0.238	0.100–0.496
2014–15	14 074 799	2.5	11	0.313	291.12094	104–680	0.207	0.074–0.483
2015–16	18 603 012	10.8	72	0.357	384.91279	202–718	0.207	0.109–0.386
2016–17	22 150 093	17.7	12	0.031	342.99225	129–766	0.155	0.058–0.346
2017–18	16 210 400	31.9	16	0.031	124.85057	48–279	0.077	0.030–0.172

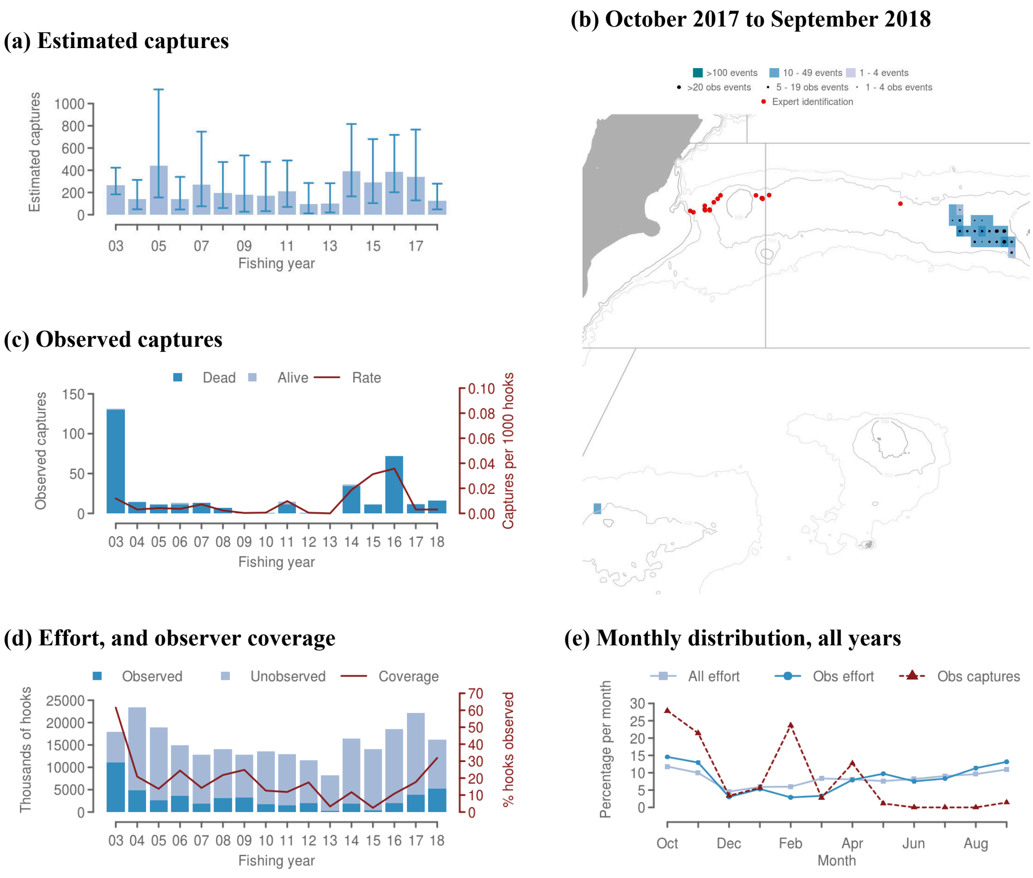


Figure B-28: White-chinned petrel captures in large-vessel (≥ 34 m length) bottom-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 80.5% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.6.3 White-chinned petrel captures in small-vessel (< 34 m length) bottom-longline fisheries

Table B-49: Annual fishing effort and number of hooks observed in small-vessel (< 34 m length) bottom-longline fisheries, number of observed captures of white-chinned petrel and observed capture rate (captures per thousand hooks), and estimated captures and capture rate of white-chinned petrel (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	19 868 809	0.0	0	0.000	236.1022	80–528	0.119	0.040–0.266
2003–04	19 908 903	1.1	0	0.000	137.5782	43–334	0.069	0.022–0.168
2004–05	22 926 662	1.3	0	0.000	275.0367	96–612	0.120	0.042–0.267
2005–06	22 254 310	0.7	0	0.000	217.9973	65–529	0.098	0.029–0.238
2006–07	25 371 172	2.0	1	0.020	324.8438	105–795	0.128	0.041–0.313
2007–08	27 369 981	1.8	3	0.061	343.7186	121–772	0.126	0.044–0.282
2008–09	24 570 867	3.6	0	0.000	325.2259	113–727	0.132	0.046–0.296
2009–10	26 846 311	2.7	0	0.000	307.5985	109–691	0.115	0.041–0.257
2010–11	27 984 934	1.1	0	0.000	351.6502	125–800	0.126	0.045–0.286
2011–12	26 317 076	0.3	0	0.000	331.5987	108–814	0.126	0.041–0.309
2012–13	24 275 214	1.9	0	0.000	297.7501	99–702	0.123	0.041–0.289
2013–14	24 416 824	4.1	0	0.000	223.3888	81–499	0.091	0.033–0.204
2014–15	25 287 349	2.1	0	0.000	201.6319	68–470	0.080	0.027–0.186
2015–16	24 891 714	2.5	7	0.111	239.7039	85–546	0.096	0.034–0.219
2016–17	24 400 716	4.5	19	0.171	226.2989	89–495	0.093	0.036–0.203
2017–18	23 691 912	3.0	0	0.000	212.0970	69–495	0.090	0.029–0.209

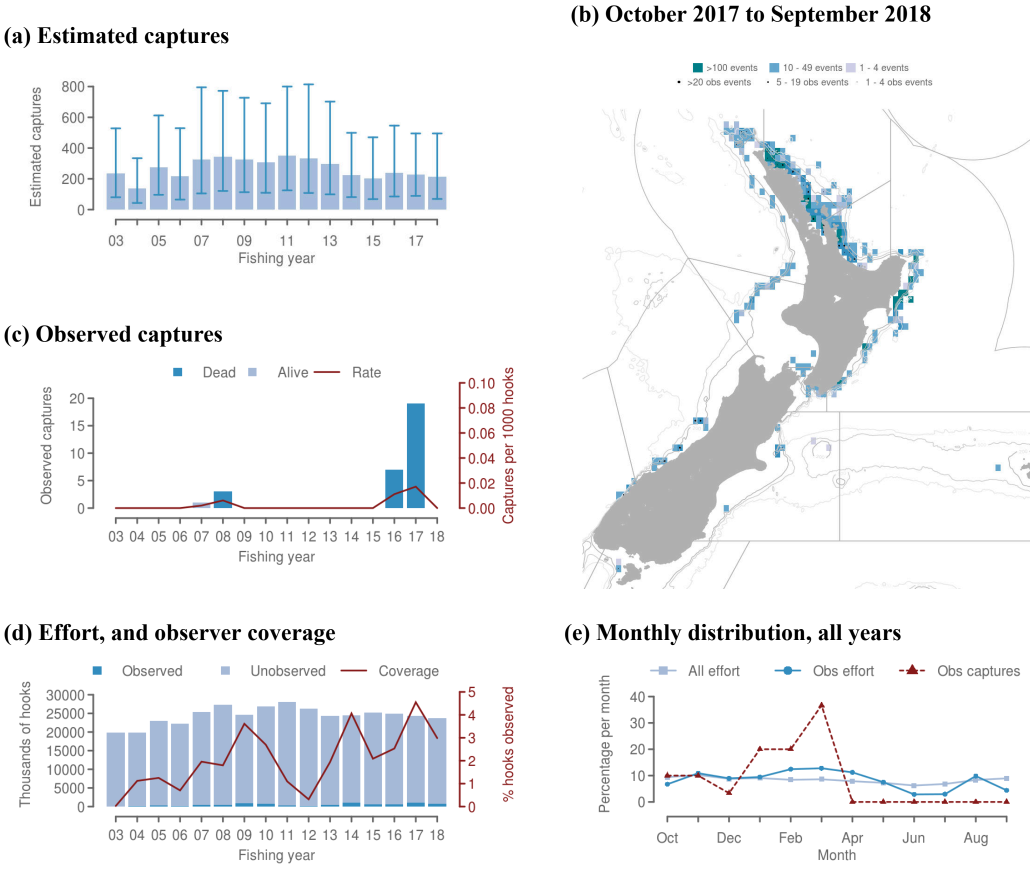


Figure B-29: White-chinned petrel captures in small-vessel (< 34 m length) bottom-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 97.2% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.7 Sooty shearwater captures

B.7.1 Sooty shearwater captures in large-vessel ($\geq$ 28 m length) trawl fisheries

Table B-50: Annual fishing effort and number of tows observed in large-vessel ($\geq$ 28 m length) trawl fisheries, number of observed captures of sooty shearwater and observed capture rate (captures per hundred tows), and estimated captures and capture rate of sooty shearwater (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	54 200	11.9	118	1.83	790.90605	538–1 116	1.46	0.99–2.06
2003–04	47 339	13.4	53	0.83	424.25937	255–635	0.90	0.54–1.34
2004–05	44 156	17.2	76	1.00	441.35132	293–635	1.00	0.66–1.44
2005–06	39 121	15.8	170	2.75	781.49975	547–1 105	2.00	1.40–2.82
2006–07	35 188	20.6	69	0.95	395.03348	260–570	1.12	0.74–1.62
2007–08	32 767	25.3	79	0.95	300.90105	209–420	0.92	0.64–1.28
2008–09	29 978	24.7	143	1.93	443.08646	326–595	1.48	1.09–1.98
2009–10	29 506	26.0	50	0.65	225.27836	148–326	0.76	0.50–1.10
2010–11	27 393	22.7	95	1.53	405.94528	291–568	1.48	1.06–2.07
2011–12	25 593	32.7	32	0.38	150.97001	92–224	0.59	0.36–0.88
2012–13	23 982	49.3	136	1.15	208.85257	178–248	0.87	0.74–1.03
2013–14	25 657	43.7	127	1.13	227.19865	186–281	0.89	0.72–1.10
2014–15	25 648	43.9	133	1.18	252.25987	201–321	0.98	0.78–1.25
2015–16	25 008	43.0	63	0.59	125.57246	96–164	0.50	0.38–0.66
2016–17	25 750	38.4	130	1.31	219.47676	180–272	0.85	0.70–1.06
2017–18	26 077	49.2	55	0.43	95.43578	75–124	0.37	0.29–0.48

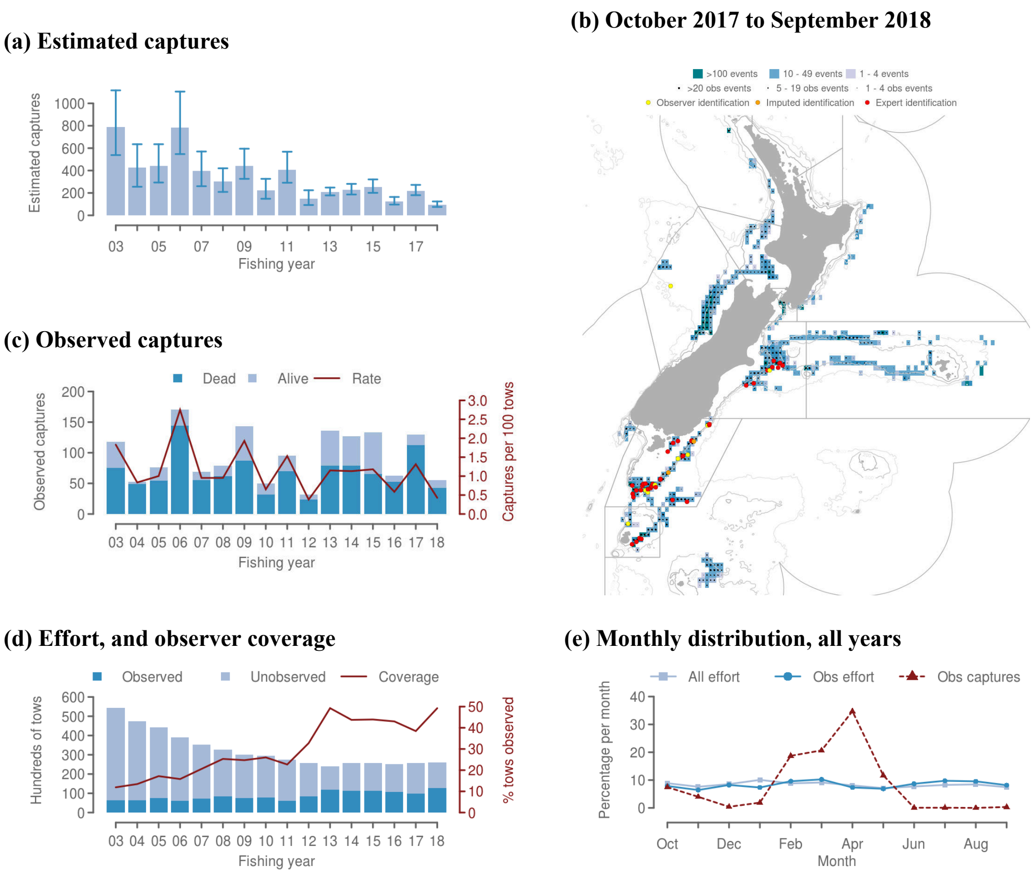


Figure B-30: Sooty shearwater captures in large-vessel ($\geq$ 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 97.8% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.7.2 Sooty shearwater captures in small-vessel (< 28 m length) trawl fisheries

Table B-51: Annual fishing effort and number of tows observed in small-vessel (< 28 m length) trawl fisheries, number of observed captures of sooty shearwater and observed capture rate (captures per hundred tows), and estimated captures and capture rate of sooty shearwater (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	75 948	0.5	0	0.00	160.54748	64–322	0.21	0.08–0.42
2003–04	73 482	0.2	0	0.00	129.64368	48–265	0.18	0.07–0.36
2004–05	76 281	0.2	0	0.00	144.03273	59–285	0.19	0.08–0.37
2005–06	70 810	0.6	0	0.00	143.90630	59–283	0.20	0.08–0.40
2006–07	68 123	1.0	14	2.08	152.07096	72–291	0.22	0.11–0.43
2007–08	56 764	1.3	2	0.27	109.36682	45–213	0.19	0.08–0.38
2008–09	57 571	4.1	11	0.47	103.70715	48–193	0.18	0.08–0.34
2009–10	63 387	2.1	0	0.00	112.92779	45–223	0.18	0.07–0.35
2010–11	58 686	2.1	19	1.54	126.35032	61–232	0.22	0.10–0.40
2011–12	58 827	1.7	0	0.00	104.53023	42–211	0.18	0.07–0.36
2012–13	59 867	1.0	0	0.00	106.14068	42–211	0.18	0.07–0.35
2013–14	59 454	3.4	0	0.00	105.49200	41–209	0.18	0.07–0.35
2014–15	53 117	4.3	1	0.04	99.48026	41–197	0.19	0.08–0.37
2015–16	53 021	4.2	0	0.00	97.66467	39–194	0.18	0.07–0.37
2016–17	52 423	7.3	4	0.10	100.53348	42–194	0.19	0.08–0.37
2017–18	48 130	4.4	0	0.00	104.81534	42–208	0.22	0.09–0.43

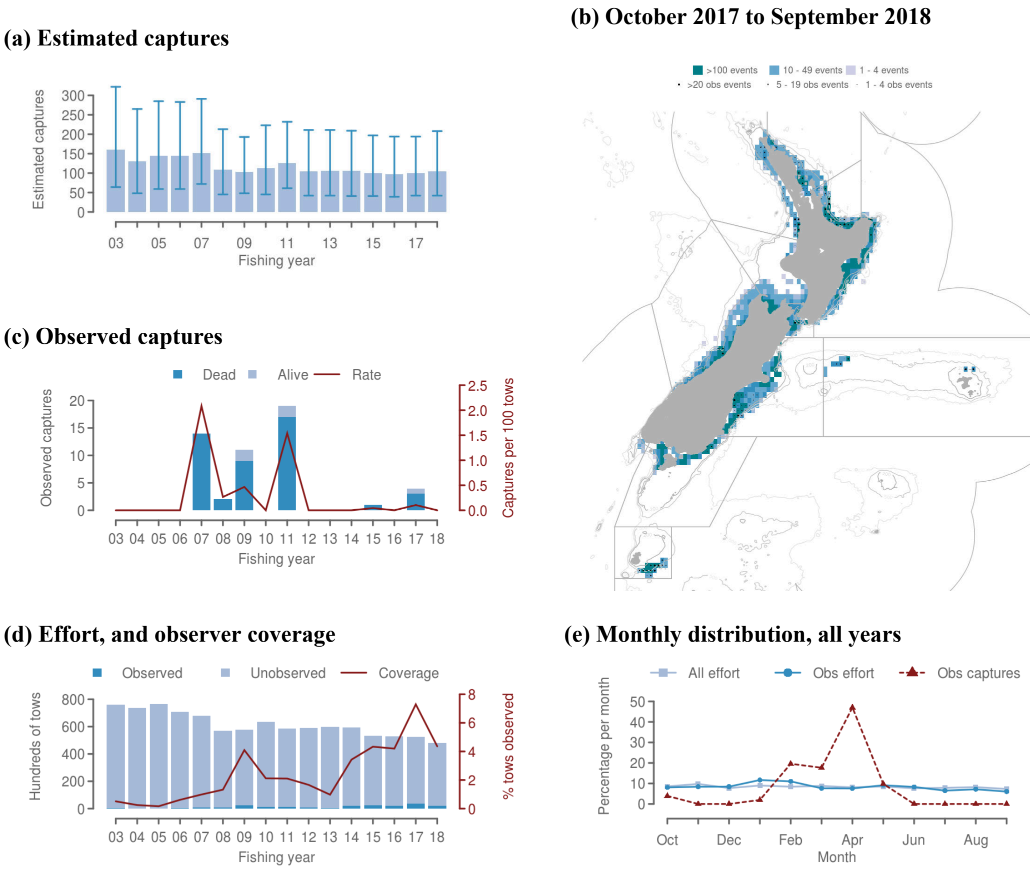


Figure B-31: Sooty shearwater captures in small-vessel (< 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 , (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.8 Black petrel captures

B.8.1 Black petrel captures in small-vessel (< 34 m length) bottom-longline fisheries

Table B-52: Annual fishing effort and number of hooks observed in small-vessel (< 34 m length) bottom-longline fisheries, number of observed captures of black petrel and observed capture rate (captures per thousand hooks), and estimated captures and capture rate of black petrel (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	19 868 809	0.0	0	0.000	487.2834	264–811	0.245	0.133–0.408
2003–04	19 908 903	1.1	2	0.090	465.0490	251–785	0.234	0.126–0.394
2004–05	22 926 662	1.3	1	0.035	389.9430	214–647	0.170	0.093–0.282
2005–06	22 254 310	0.7	2	0.127	342.4878	189–573	0.154	0.085–0.257
2006–07	25 371 172	2.0	4	0.081	387.3493	209–645	0.153	0.082–0.254
2007–08	27 369 981	1.8	3	0.061	313.7101	170–526	0.115	0.062–0.192
2008–09	24 570 867	3.6	9	0.101	286.3936	160–476	0.117	0.065–0.194
2009–10	26 846 311	2.7	43	0.594	328.3991	196–522	0.122	0.073–0.194
2010–11	27 984 934	1.1	2	0.065	314.8328	173–531	0.113	0.062–0.190
2011–12	26 317 076	0.3	0	0.000	258.5922	143–440	0.098	0.054–0.167
2012–13	24 275 214	1.9	2	0.042	226.2809	126–375	0.093	0.052–0.154
2013–14	24 416 824	4.1	7	0.071	221.9453	125–366	0.091	0.051–0.150
2014–15	25 287 349	2.1	2	0.038	216.4153	117–362	0.086	0.046–0.143
2015–16	24 891 714	2.5	0	0.000	170.3253	93–291	0.068	0.037–0.117
2016–17	24 400 716	4.5	13	0.117	190.4733	110–310	0.078	0.045–0.127
2017–18	23 691 912	3.0	2	0.028	150.8893	83–262	0.064	0.035–0.111

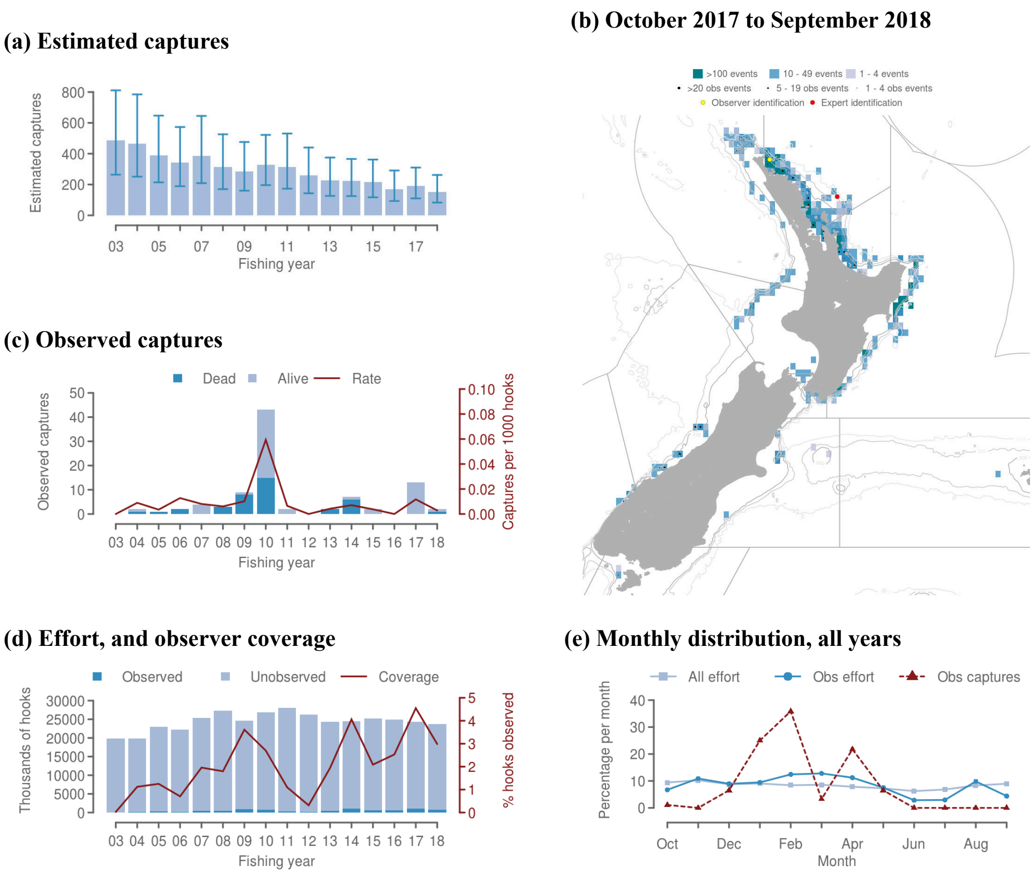


Figure B-32: Black petrel captures in small-vessel (< 34 m length) bottom-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 97.2% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.8.2 Black petrel captures in small-vessel (< 45 m length) surface-longline fisheries

Table B-53: Annual fishing effort and number of hooks observed in small-vessel (< 45 m length) surface-longline fisheries, number of observed captures of black petrel and observed capture rate (captures per thousand hooks), and estimated captures and capture rate of black petrel (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	8 572 416	0.0	0	.	157.15617	93–251	0.183	0.108–0.293
2003–04	5 730 839	2.4	1	0.074	92.47601	55–143	0.161	0.096–0.250
2004–05	3 044 211	4.7	0	0.000	73.06147	40–125	0.240	0.131–0.411
2005–06	3 028 469	3.2	0	0.000	53.07421	31–85	0.175	0.102–0.281
2006–07	2 332 863	8.0	0	0.000	43.09870	24–68	0.185	0.103–0.291
2007–08	1 678 054	8.1	1	0.073	44.21139	26–69	0.263	0.155–0.411
2008–09	2 306 403	6.5	2	0.132	51.64843	30–80	0.224	0.130–0.347
2009–10	2 516 706	7.3	6	0.326	55.45927	34–84	0.220	0.135–0.334
2010–11	2 684 809	6.4	1	0.058	79.67341	48–120	0.297	0.179–0.447
2011–12	2 548 687	6.8	1	0.058	68.67591	40–105	0.269	0.157–0.412
2012–13	2 389 212	3.1	0	0.000	59.54548	35–91	0.249	0.146–0.381
2013–14	1 896 434	6.8	0	0.000	49.06822	28–77	0.259	0.148–0.406
2014–15	1 790 036	6.0	0	0.000	41.20265	22–69	0.230	0.123–0.385
2015–16	2 304 091	13.0	7	0.234	50.00025	31–76	0.217	0.135–0.330
2016–17	2 094 236	16.5	8	0.232	49.58696	31–73	0.237	0.148–0.349
2017–18	2 288 801	12.9	10	0.338	58.77061	36–91	0.257	0.157–0.398

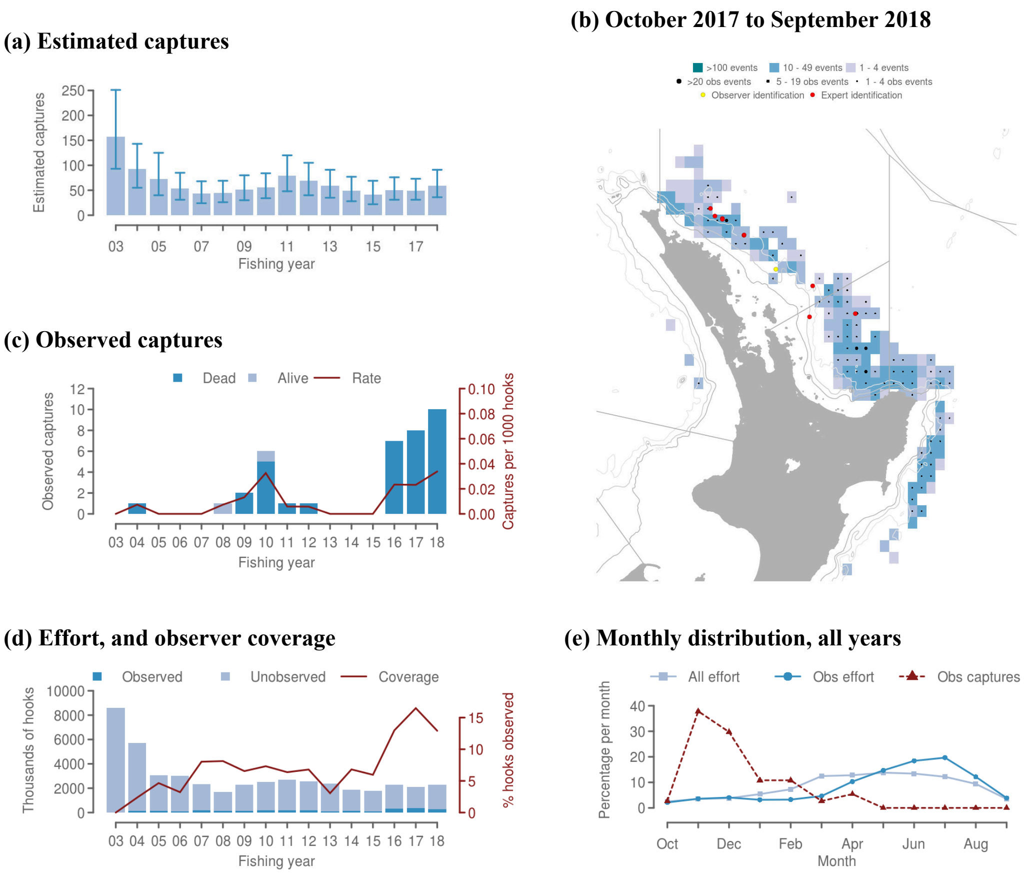


Figure B-33: Black petrel captures in small-vessel (< 45 m length) surface-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 95.4% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.9 Grey petrel captures

B.9.1 Grey petrel captures in small-vessel (< 34 m length) bottom-longline fisheries

Table B-54: Annual fishing effort and number of hooks observed in small-vessel (< 28 m length) bottom-longline fisheries, number of observed captures of grey petrel and observed capture rate (captures per thousand hooks), and estimated captures and capture rate of grey petrel (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	19 868 809	0.0	0	0.000	114.65892	24–316	0.058	0.012–0.159
2003–04	19 908 903	1.1	0	0.000	104.43653	23–287	0.052	0.012–0.144
2004–05	22 926 662	1.3	0	0.000	108.25562	23–289	0.047	0.010–0.126
2005–06	22 254 310	0.7	0	0.000	106.49925	24–288	0.048	0.011–0.129
2006–07	25 371 172	2.0	0	0.000	111.39305	27–289	0.044	0.011–0.114
2007–08	27 369 981	1.8	0	0.000	112.05347	28–286	0.041	0.010–0.104
2008–09	24 570 867	3.6	2	0.023	97.13518	24–255	0.040	0.010–0.104
2009–10	26 846 311	2.7	0	0.000	121.50525	29–321	0.045	0.011–0.120
2010–11	27 984 934	1.1	0	0.000	108.74913	26–284	0.039	0.009–0.101
2011–12	26 317 076	0.3	0	0.000	96.94753	24–251	0.037	0.009–0.095
2012–13	24 275 214	1.9	0	0.000	86.08246	20–224	0.035	0.008–0.092
2013–14	24 416 824	4.1	2	0.020	98.20565	25–246	0.040	0.010–0.101
2014–15	25 287 349	2.1	3	0.057	99.30110	28–248	0.039	0.011–0.098
2015–16	24 891 714	2.5	0	0.000	84.68191	20–211	0.034	0.008–0.085
2016–17	24 400 716	4.5	0	0.000	86.45377	21–221	0.035	0.009–0.091
2017–18	23 691 912	3.0	0	0.000	94.97676	24–247	0.040	0.010–0.104

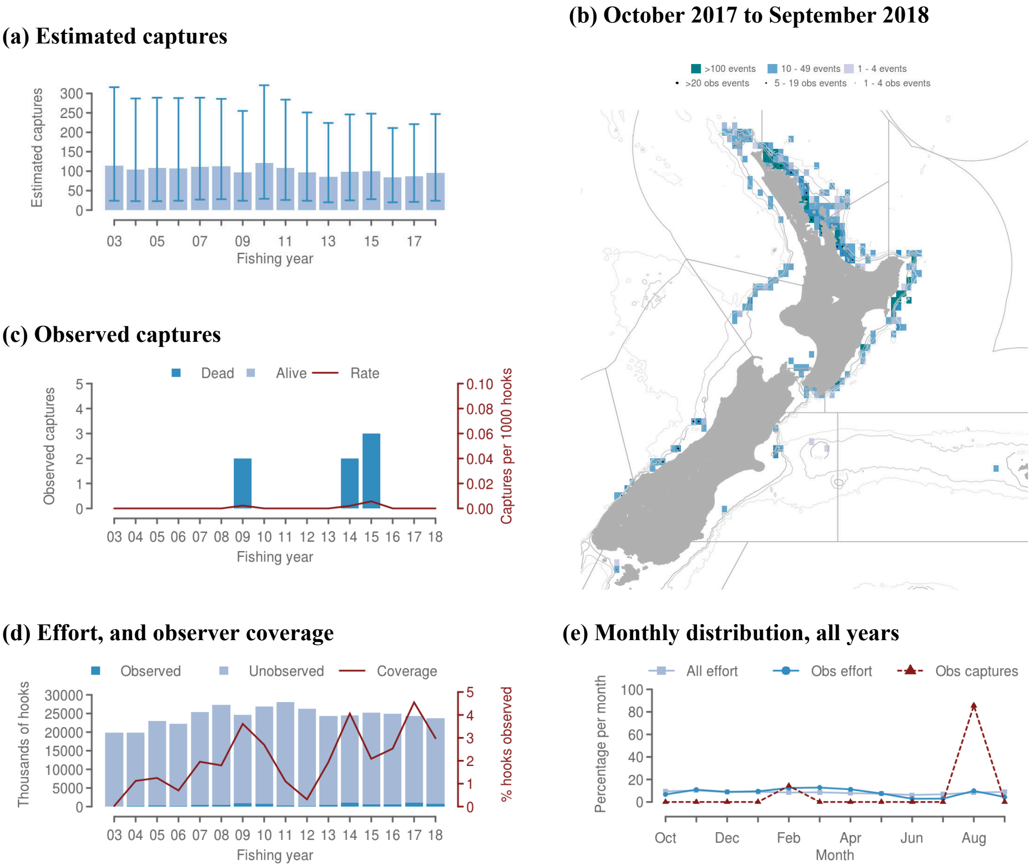


Figure B-34: Grey petrel captures in small-vessel (< 34 m length) bottom-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 97.2% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.10 Flesh-footed shearwater captures

B.10.1 Flesh-footed shearwater captures in small-vessel (< 28 m length) trawl fisheries

Table B-55: Annual fishing effort and number of tows observed in small-vessel (< 28 m length) trawl fisheries, number of observed captures of flesh-footed shearwater and observed capture rate (captures per hundred tows), and estimated captures and capture rate of flesh-footed shearwater (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	75 948	0.5	0	0.00	122.28711	64–211	0.16	0.08–0.28
2003–04	73 482	0.2	0	0.00	119.29435	60–209	0.16	0.08–0.28
2004–05	76 281	0.2	0	0.00	121.46027	62–212	0.16	0.08–0.28
2005–06	70 810	0.6	8	1.83	118.82034	63–207	0.17	0.09–0.29
2006–07	68 123	1.0	6	0.89	113.45427	61–192	0.17	0.09–0.28
2007–08	56 764	1.3	5	0.66	101.22089	53–176	0.18	0.09–0.31
2008–09	57 571	4.1	3	0.13	101.21164	53–175	0.18	0.09–0.30
2009–10	63 387	2.1	2	0.15	114.86782	61–196	0.18	0.10–0.31
2010–11	58 686	2.1	15	1.22	118.50700	69–194	0.20	0.12–0.33
2011–12	58 827	1.7	0	0.00	95.39530	49–167	0.16	0.08–0.28
2012–13	59 867	1.0	0	0.00	100.96002	53–174	0.17	0.09–0.29
2013–14	59 454	3.4	9	0.44	102.84058	57–172	0.17	0.10–0.29
2014–15	53 117	4.3	8	0.35	91.28211	50–152	0.17	0.09–0.29
2015–16	53 021	4.2	2	0.09	85.04498	45–147	0.16	0.08–0.28
2016–17	52 423	7.3	1	0.03	82.29660	43–142	0.16	0.08–0.27
2017–18	48 130	4.4	2	0.10	85.13518	46–144	0.18	0.10–0.30

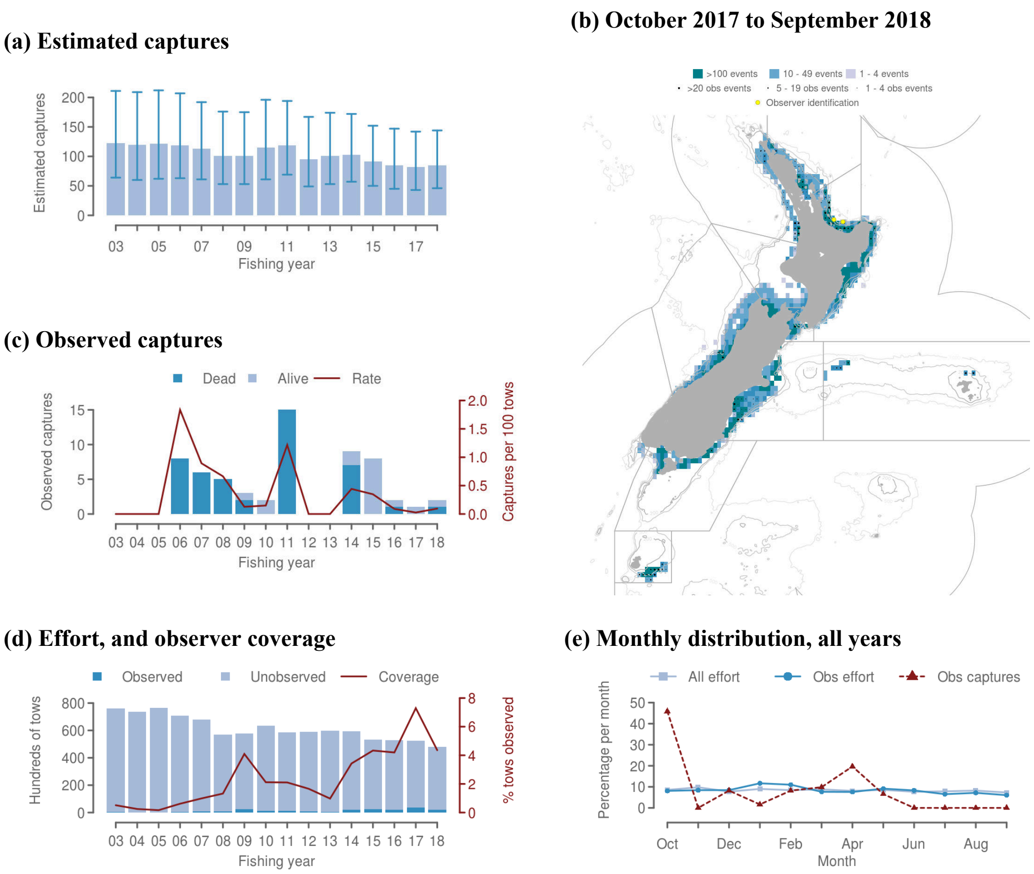


Figure B-35: Flesh-footed shearwater captures in small-vessel (< 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 , (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.10.2 Flesh-footed shearwater captures in small-vessel (< 34 m length) bottom-longline fisheries

Table B-56: Annual fishing effort and number of hooks observed in small-vessel (< 34 m length) bottom-longline fisheries, number of observed captures of flesh-footed shearwater and observed capture rate (captures per thousand hooks), and estimated captures and capture rate of flesh-footed shearwater (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	19 868 809	0.0	0	0.000	457.8953	314–635	0.230	0.158–0.320
2003–04	19 908 903	1.1	3	0.134	398.3303	275–551	0.200	0.138–0.277
2004–05	22 926 662	1.3	9	0.314	375.7604	262–515	0.164	0.114–0.225
2005–06	22 254 310	0.7	0	0.000	303.0765	208–423	0.136	0.093–0.190
2006–07	25 371 172	2.0	0	0.000	307.3838	209–425	0.121	0.082–0.168
2007–08	27 369 981	1.8	0	0.000	271.0590	187–376	0.099	0.068–0.137
2008–09	24 570 867	3.6	15	0.169	286.7659	203–393	0.117	0.083–0.160
2009–10	26 846 311	2.7	14	0.193	272.7439	190–374	0.102	0.071–0.139
2010–11	27 984 934	1.1	0	0.000	304.3271	210–426	0.109	0.075–0.152
2011–12	26 317 076	0.3	0	0.000	272.2506	187–380	0.103	0.071–0.144
2012–13	24 275 214	1.9	2	0.042	276.0937	191–384	0.114	0.079–0.158
2013–14	24 416 824	4.1	29	0.292	272.1014	193–367	0.111	0.079–0.150
2014–15	25 287 349	2.1	8	0.152	247.7329	173–341	0.098	0.068–0.135
2015–16	24 891 714	2.5	12	0.190	228.7614	159–315	0.092	0.064–0.127
2016–17	24 400 716	4.5	2	0.018	223.5335	154–314	0.092	0.063–0.129
2017–18	23 691 912	3.0	13	0.184	223.3301	156–311	0.094	0.066–0.131

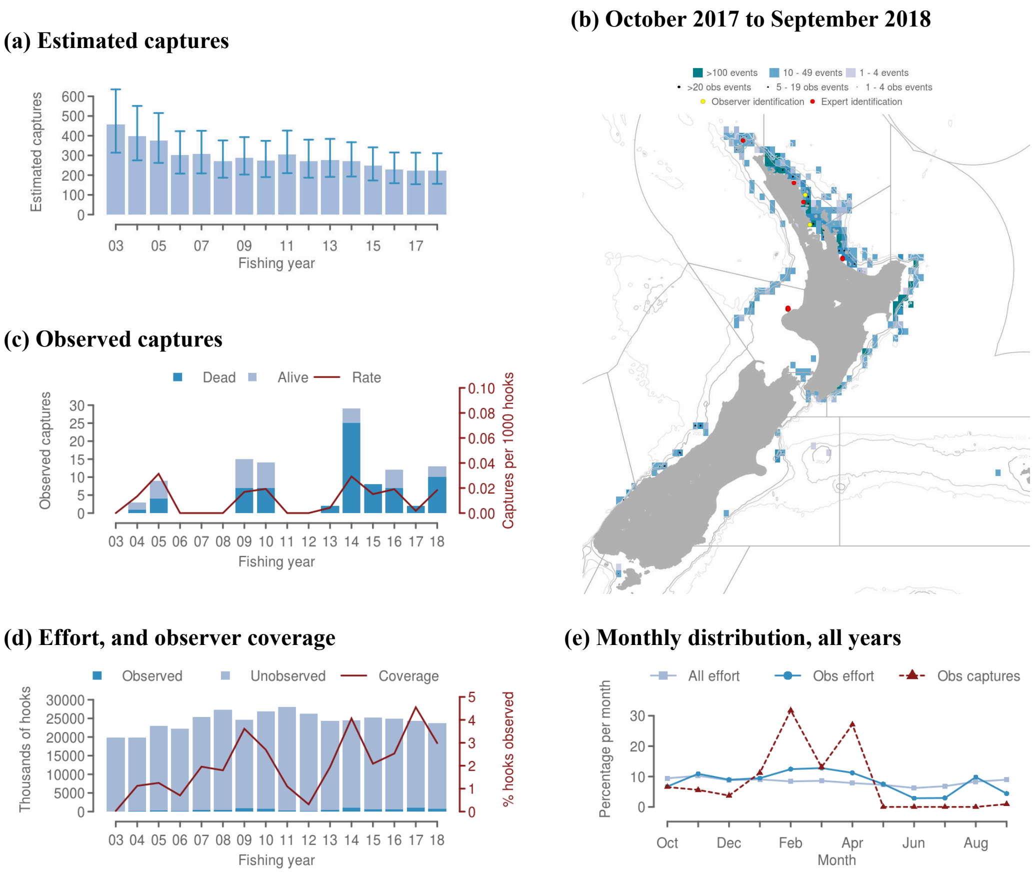


Figure B-36: Flesh-footed shearwater captures in small-vessel (< 34 m length) bottom-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 97.2% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.10.3 Flesh-footed shearwater captures in small-vessel (< 45 m length) surface-longline fisheries

Table B-57: Annual fishing effort and number of hooks observed in small-vessel (< 45 m length) surface-longline fisheries, number of observed captures of flesh-footed shearwater and observed capture rate (captures per thousand hooks), and estimated captures and capture rate of flesh-footed shearwater (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	8 572 416	0.0	0	.	539.87106	273–984	0.630	0.318–1.148
2003–04	5 730 839	2.4	0	0.000	326.88781	171–577	0.570	0.298–1.007
2004–05	3 044 211	4.7	1	0.071	196.78461	102–352	0.646	0.335–1.156
2005–06	3 028 469	3.2	4	0.411	190.82559	101–333	0.630	0.334–1.100
2006–07	2 332 863	8.0	3	0.160	152.55372	79–269	0.654	0.339–1.153
2007–08	1 678 054	8.1	2	0.147	118.06997	60–205	0.704	0.358–1.222
2008–09	2 306 403	6.5	0	0.000	155.13943	79–274	0.673	0.343–1.188
2009–10	2 516 706	7.3	0	0.000	156.16217	80–277	0.621	0.318–1.101
2010–11	2 684 809	6.4	2	0.117	181.11219	96–318	0.675	0.358–1.184
2011–12	2 548 687	6.8	0	0.000	137.95352	69–246	0.541	0.271–0.965
2012–13	2 389 212	3.1	0	0.000	133.60120	71–233	0.559	0.297–0.975
2013–14	1 896 434	6.8	0	0.000	111.83383	58–200	0.590	0.306–1.055
2014–15	1 790 036	6.0	1	0.094	77.35357	39–141	0.432	0.218–0.788
2015–16	2 304 091	13.0	0	0.000	103.53848	54–182	0.449	0.234–0.790
2016–17	2 094 236	16.5	0	0.000	82.48501	41–147	0.394	0.196–0.702
2017–18	2 288 801	12.9	3	0.101	111.38281	59–193	0.487	0.258–0.843

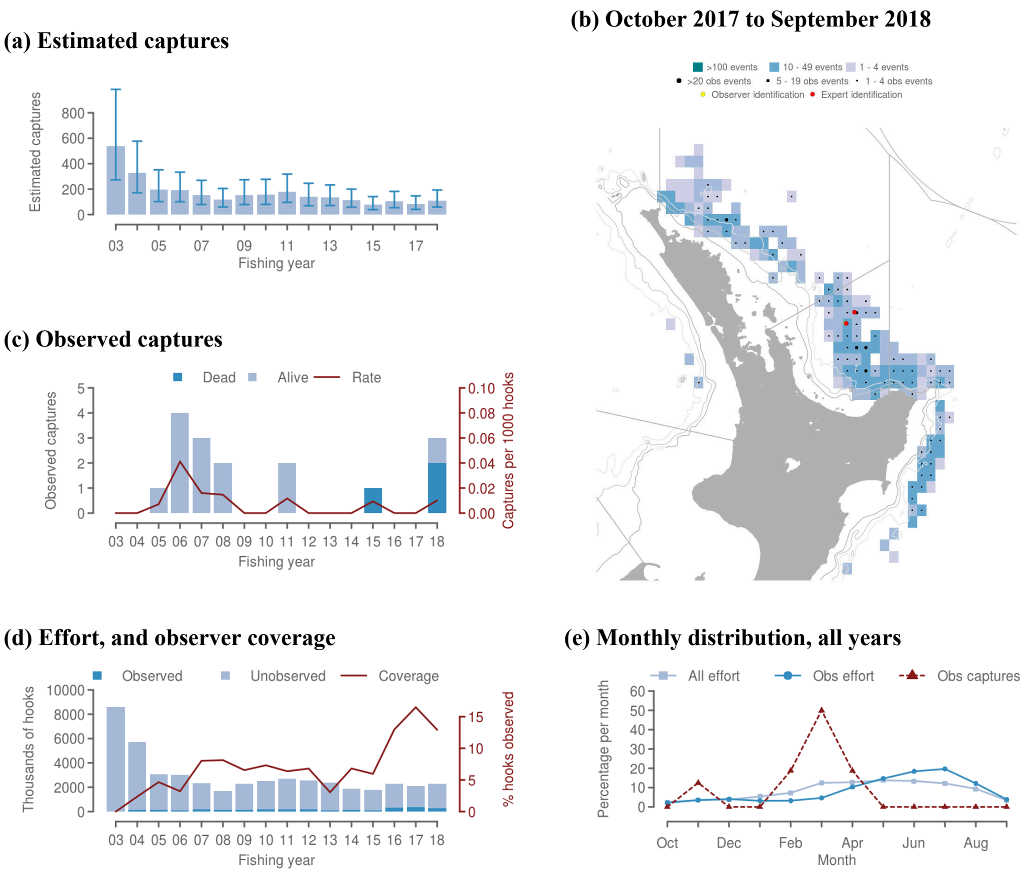


Figure B-37: Flesh-footed shearwater captures in small-vessel (< 45 m length) surface-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 95.4% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.11 Other birds captures

B.11.1 Other birds captures in large-vessel (≥ 28 m length) trawl fisheries

Table B-58: Annual fishing effort and number of tows observed in large-vessel (≥ 28 m length) trawl fisheries, number of observed captures of other birds and observed capture rate (captures per hundred tows), and estimated captures and capture rate of other birds (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	54 200	11.9	18	0.279	122.85132	82–182	0.227	0.151–0.336
2003–04	47 339	13.4	16	0.251	100.17666	67–148	0.212	0.142–0.313
2004–05	44 156	17.2	22	0.290	101.86882	69–149	0.231	0.156–0.337
2005–06	39 121	15.8	9	0.146	71.08596	45–106	0.182	0.115–0.271
2006–07	35 188	20.6	9	0.124	57.81509	35–86	0.164	0.099–0.244
2007–08	32 767	25.3	12	0.145	58.21889	37–86	0.178	0.113–0.262
2008–09	29 978	24.7	11	0.148	51.45327	33–75	0.172	0.110–0.250
2009–10	29 506	26.0	25	0.326	64.05822	46–88	0.217	0.156–0.298
2010–11	27 393	22.7	15	0.241	62.50700	42–92	0.228	0.153–0.336
2011–12	25 593	32.7	11	0.131	37.80210	23–54	0.148	0.090–0.211
2012–13	23 982	49.3	20	0.169	41.44553	30–56	0.173	0.125–0.234
2013–14	25 657	43.7	15	0.134	38.43353	26–54	0.150	0.101–0.210
2014–15	25 648	43.9	17	0.151	42.69590	30–58	0.166	0.117–0.226
2015–16	25 008	43.0	12	0.112	34.79035	23–50	0.139	0.092–0.200
2016–17	25 750	38.4	5	0.051	28.06897	14–45	0.109	0.054–0.175
2017–18	26 077	49.2	15	0.117	35.09795	24–49	0.135	0.092–0.188

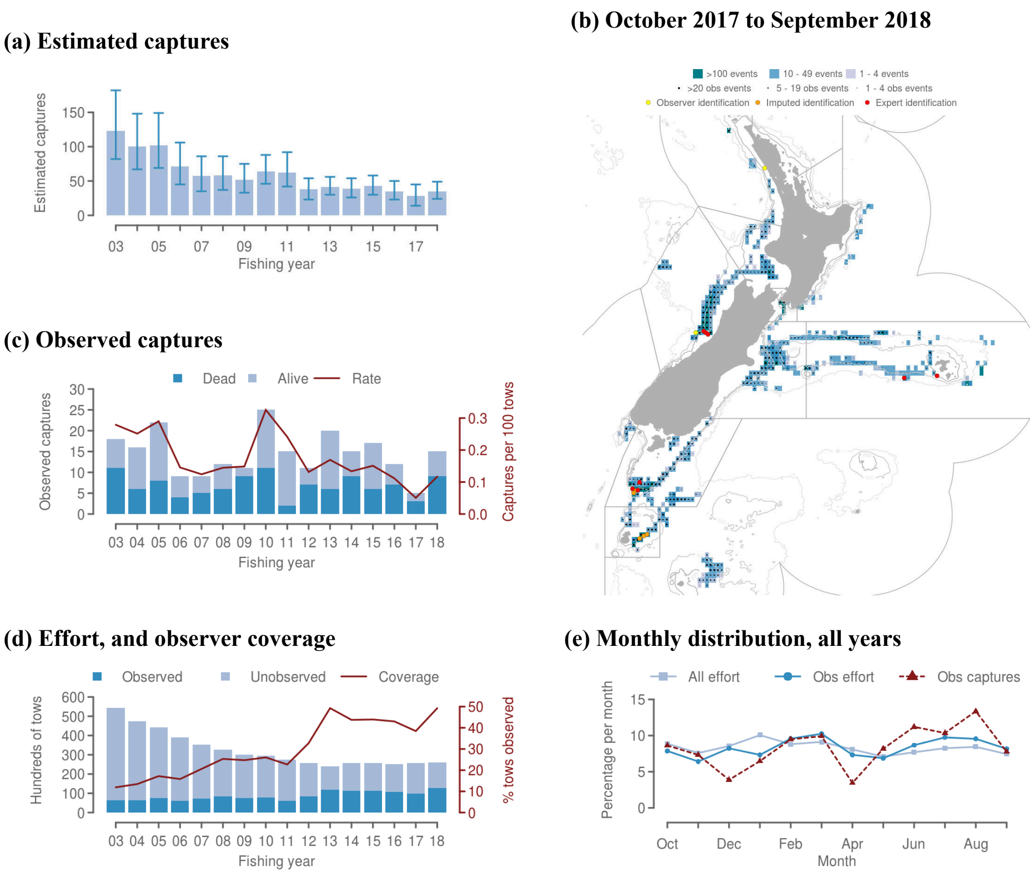


Figure B-38: Other birds captures in large-vessel (≥ 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 97.8% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.11.2 Other birds captures in small-vessel (< 28 m length) trawl fisheries

Table B-59: Annual fishing effort and number of tows observed in small-vessel (< 28 m length) trawl fisheries, number of observed captures of other birds and observed capture rate (captures per hundred tows), and estimated captures and capture rate of other birds (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	75 948	0.5	0	0.00	85.40905	43–147	0.11	0.06–0.19
2003–04	73 482	0.2	0	0.00	82.69565	41–144	0.11	0.06–0.20
2004–05	76 281	0.2	0	0.00	85.24788	43–146	0.11	0.06–0.19
2005–06	70 810	0.6	1	0.23	82.81934	41–142	0.12	0.06–0.20
2006–07	68 123	1.0	2	0.30	79.30260	39–135	0.12	0.06–0.20
2007–08	56 764	1.3	0	0.00	66.13968	32–114	0.12	0.06–0.20
2008–09	57 571	4.1	35	1.48	99.40605	66–146	0.17	0.11–0.25
2009–10	63 387	2.1	0	0.00	72.19490	35–123	0.11	0.06–0.19
2010–11	58 686	2.1	0	0.00	70.07871	35–120	0.12	0.06–0.20
2011–12	58 827	1.7	0	0.00	69.14093	34–118	0.12	0.06–0.20
2012–13	59 867	1.0	0	0.00	70.81834	36–120	0.12	0.06–0.20
2013–14	59 454	3.4	2	0.10	72.49900	38–122	0.12	0.06–0.21
2014–15	53 117	4.3	3	0.13	65.52299	35–108	0.12	0.07–0.20
2015–16	53 021	4.2	4	0.18	67.15692	35–113	0.13	0.07–0.21
2016–17	52 423	7.3	0	0.00	60.30885	30–104	0.12	0.06–0.20
2017–18	48 130	4.4	3	0.14	60.50800	31–103	0.13	0.06–0.21

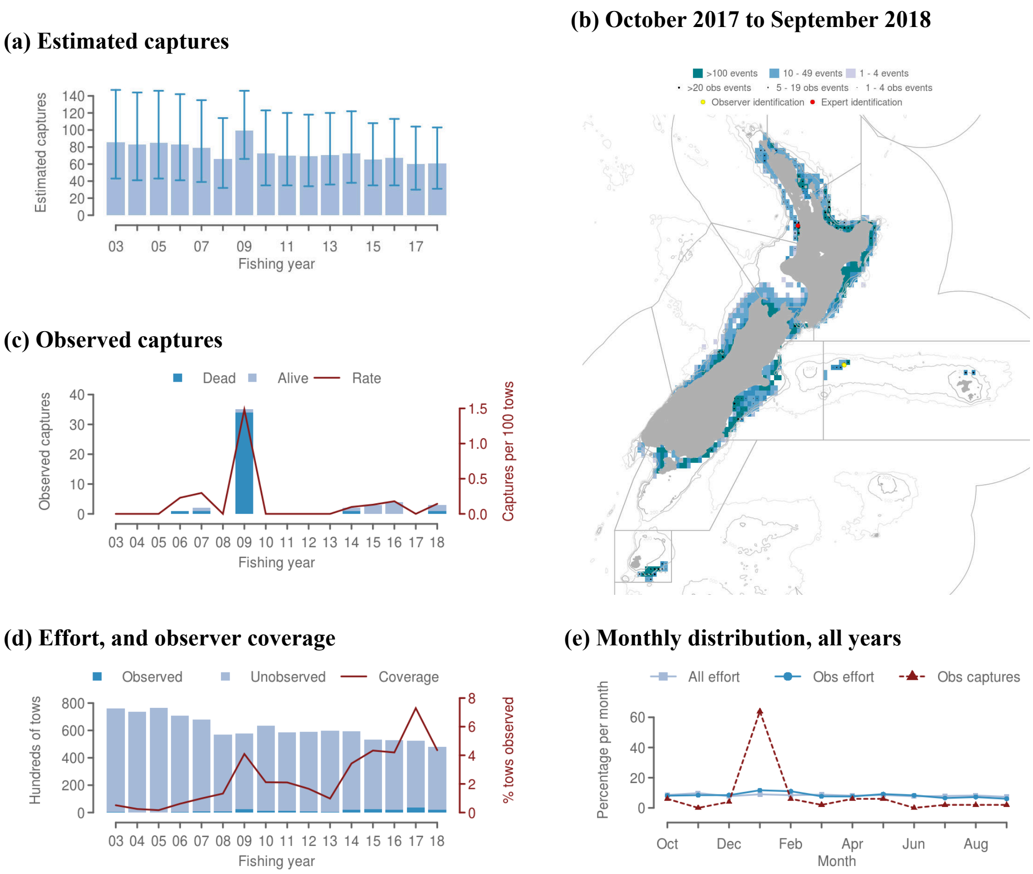


Figure B-39: Other birds captures in small-vessel (< 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 , (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.11.3 Other birds captures in small-vessel (< 34 m length) bottom-longline fisheries

Table B-60: Annual fishing effort and number of hooks observed in small-vessel (< 34 m length) bottom-longline fisheries, number of observed captures of other birds and observed capture rate (captures per thousand hooks), and estimated captures and capture rate of other birds (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	19 868 809	0.0	2	3.64	284.3148	184–412	0.14	0.09–0.21
2003–04	19 908 903	1.1	5	0.22	256.7929	166–370	0.13	0.08–0.19
2004–05	22 926 662	1.3	3	0.10	258.4090	167–372	0.11	0.07–0.16
2005–06	22 254 310	0.7	10	0.64	231.4290	153–329	0.10	0.07–0.15
2006–07	25 371 172	2.0	3	0.06	238.4353	154–345	0.09	0.06–0.14
2007–08	27 369 981	1.8	6	0.12	237.7006	153–345	0.09	0.06–0.13
2008–09	24 570 867	3.6	8	0.09	229.5162	152–327	0.09	0.06–0.13
2009–10	26 846 311	2.7	1	0.01	220.1624	142–318	0.08	0.05–0.12
2010–11	27 984 934	1.1	0	0.00	266.8986	173–387	0.10	0.06–0.14
2011–12	26 317 076	0.3	1	0.12	237.3581	152–342	0.09	0.06–0.13
2012–13	24 275 214	1.9	2	0.04	208.7036	136–302	0.09	0.06–0.12
2013–14	24 416 824	4.1	16	0.16	212.0777	142–299	0.09	0.06–0.12
2014–15	25 287 349	2.1	2	0.04	192.5092	126–275	0.08	0.05–0.11
2015–16	24 891 714	2.5	3	0.05	180.5460	118–260	0.07	0.05–0.10
2016–17	24 400 716	4.5	3	0.03	173.7306	112–250	0.07	0.05–0.10
2017–18	23 691 912	3.0	1	0.01	173.4950	113–253	0.07	0.05–0.11

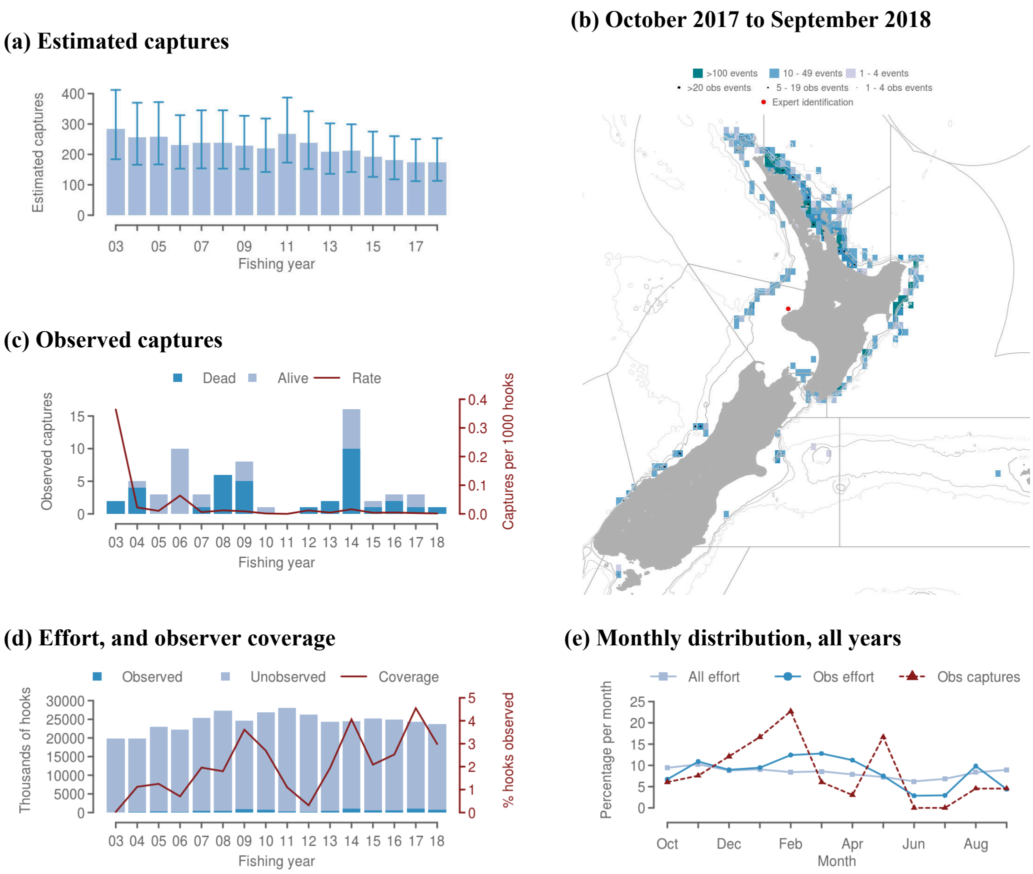


Figure B-40: Other birds captures in small-vessel (< 34 m length) bottom-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2017–18 (Following confidentiality rules, 97.2% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.