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Estimated capture of seabirds in New Zealand trawl and longline fisheries, to 2016–17

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E. R. Abraham and Y. Richard

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EXECUTIVE SUMMARY

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A wide range of seabird species are caught in New Zealand commercial fisheries. Managing the impacts of fisheries on seabird populations requires understanding what species are being caught and in which fisheries the captures are occurring. When government fisheries observers are onboard commercial fishing vessels, they record the seabird captures that occur, and these records may be used to estimate total seabird captures.

This study presents the most recent annual assessment of seabird captures, including the 2016–17 fishing year. The assessment used statistical models to obtain estimates of total seabird captures across all commercial trawl and longline fisheries. The time periods covered in this estimation were the 2002–03 to 2016–17 fishing years for trawl fisheries, and the 1998–99 to 2016–17 fishing years for longline fisheries.

The present assessment used a unified modelling framework to estimate incidental captures of seabirds for 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*), and flesh-footed shearwater (*Puffinus carneipes*). Estimates were also derived for seabirds grouped as either "other albatrosses" or "other birds".

There were a total of 4210 (95% c.i.: 3508–5296) estimated seabird captures in trawl and longline fisheries (c.i., credible interval, the 95th quantile range of the posterior distribution) in 2016–17. The total estimate included 1767 (95% c.i.: 1493–2145) seabird captures in trawl fisheries, 1869 (95% c.i.: 1286–2909) captures in bottom-longline fisheries, and 573 (95% c.i.: 426–789) captures in surface-longline fisheries.

White-chinned petrel had the highest number of total estimated captures in 2016–17, with 995 (95% c.i.: 557–1882) captures of this species. The second highest estimate was 448 (95% c.i.: 349–574) captures of New Zealand white-capped albatross, followed by 435 (95% c.i.: 293–670) captures of flesh-footed shearwater. Capture estimates for other species included 451 (95% c.i.: 272–810) captures of Salvin's albatross, 286 (95% c.i.: 189–442) captures of black petrel, 226 (95% c.i.: 157–326) captures of Buller's albatrosses, 398 (95% c.i.: 276–615) captures of sooty shearwater and 176 (95% c.i.: 67–465) captures of grey petrel. In addition to estimates for individual species, there were 563 (95% c.i.: 376–859) captures of other birds and 228 (95% c.i.: 148–362) captures of other albatrosses.

Considering capture estimates over time, there was a decrease in the total number of estimated captures for seven of the ten modelled species groups between 2002–03 and 2016–17. This decrease largely corresponded with decreases in fishing effort over this period. For three species, Salvin's albatross, white-chinned petrel and grey petrel, there was no distinct decrease in total captures over the assessment period; only white-chinned petrel had higher mean estimated captures in 2016–17 than in 2002–03.

Among different fisheries, large-vessel fisheries had sufficient number of captures to examine temporal trends. In large-vessel squid trawl fisheries, there was an initial decrease in albatross captures after the introduction of mandatory warp mitigation in January 2006, but capture rates of albatrosses have not clearly decreased since the 2006–07 fishing year. Capture rates of petrels in large-vessel squid trawl fisheries showed a distinct pattern of higher captures in alternate years. The reasons for this distinct fluctuation are unknown.

When the model was updated, captures were estimated for all previous years. Comparison of estimates between the current and previous models for the 2015–16 fishing year showed some changes, including a decrease in the mean estimated captures of black petrel in small-vessel longline fisheries. Overall, however, there was agreement between the estimates from the two models.

The estimation of seabird bycatch relies on observer data. Between 2002–03 and 2016–17, around 50%, 60%, and 40% of small bottom-longline, surface-longline and trawl vessels, respectively, had no observers placed on them for any fishing during the 14 years. The observer coverage across these fisheries was also low (at around 2%, 6% and 2%, respectively). With a core of vessels that had no observer coverage, and with low observer coverage overall, bycatch in the small-vessel fleet may not be adequately represented in the observer data. Increasing observer coverage in small-vessel fisheries, and ensuring that observers are placed across the fleet so that all vessels have at least some observer coverage, would help to ensure that estimates based on observer data reliably reflect protected species bycatch across New Zealand's trawl and longline fisheries.

1. INTRODUCTION

Interactions with commercial fisheries can lead to the incidental capture of protected species, including seabirds. In New Zealand waters, fisheries observers on-board commercial fishing vessels document the incidental captures of seabirds (and other non-target species), including their number and identification. These observer data provide an independent and systematic record, which can be used in bycatch assessments that estimate the total number of incidental seabird captures in commercial fisheries within New Zealand's Exclusive Economic Zone.

These bycatch assessments are regularly carried out for fisheries with sufficient observer coverage, including trawl, surface-longline and bottom-longline fisheries. The most recent analysis of incidental seabird captures included data up to the 2015–16 fishing year (Abraham & Richard 2019). The current assessment provides an update of this analysis by including observer records of seabird captures from the 2016–17 fishing year. The time periods covered in the present estimation were from 2002–03 to 2016–17 for trawl fisheries, and from 1998–99 to 2016–17 for longline fisheries.

The present assessment followed the same approach as recent bycatch assessments, using a unified modelling framework, allowing more direct comparisons across species (Abraham & Richard 2017, 2018, 2019). This modelling is based on a hierarchical mixed-effects generalised linear model (GLM) that is fitted using Bayesian methods.

Specifically, the current study assessed how many seabirds would be reported caught if every trawl and longline vessel had an observer onboard. The impact of these captures on seabird populations was not considered. Furthermore, seabird mortalities that would not be reported by observers were also excluded from the assessment. For example, birds may get hooked but fall off the line before they are brought onboard the vessel, and seabird captures may occur while the observer is not on duty. These additional fatalities were not considered in the present study.

2. METHODS

The current estimation of seabird captures in New Zealand fisheries followed methods used in previous bycatch assessments, based on a unified modelling framework (Abraham & Richard 2017, 2018, 2019). The current assessment extended the range of data included in the modelling to the 2016–17 fishing year, with the data preparation and statistical modelling following the previous estimation methods.

2.1 Data preparation

The estimation of seabird captures uses observed seabird captures and effort data from the Centralised Observer Database (COD; Sanders & Fisher 2010), which is maintained by the National Institute of Water and Atmospheric Research (NIWA) on behalf of Fisheries New Zealand (FNZ; previously Ministry for Primary Industries). Fisher-reported information on fishing effort is also used (in order to estimate captures on unobserved fishing). These data were obtained from the Warehou database maintained by FNZ. These datasets are prepared for the purpose of protected species information. They are stored in the Protected Species Capture (PSC) database, with summaries available through the PSC website (https://psc.dragonfly.co.nz).

The preparation of the protected species capture data is described by Thompson et al. (2017), with changes and updates in preparation of the PSC data for the 2016–17 fishing year detailed by Abraham & Berkenbusch (2019). Several key discrepancies that potentially impact on the seabird bycatch estimation were addressed in this most recent data preparation (see Abraham & Berkenbusch 2019). First, observer data from handheld electronic (Nomad) devices were included directly in COD, whereas they were not previously. During the development of the use of these devices by observers, Nomad data were not included in COD, so that observer effort data were generated using fisher effort data for this period. The effort was generated on the assumption that all fishing effort between the start and finish of an observer trip was observed. However, in small fisheries, it was found that observers sometimes leave the vessel and return later, without the trip number being updated. Because of this, the direct inclusion of the data from Nomad devices in COD resulted in a decrease in the recorded observed effort in small inshore fisheries where these devices were used.

Second, the updated data preparation detected discrepancies in a small number of vessel identifiers (vessel keys) in COD, which in turn meant that some observed captures had incorrect vessel and area data associated. Third, all captures that had been added to COD during the data preparation were reviewed by FNZ staff (for example, seabird captures reported in observer photographs, but without a corresponding record in COD). In addition to these changes, some of the linking and data preparation methods were updated.

2.1.1 Observed trips

The reconciliation of observer trips between the final PSC dataset and the administrative record of observer trips maintained by FNZ is part of ensuring the integrity of the final dataset (Abraham & Berkenbusch 2019). There was a total of 302 observed fishing trips that started during the 2016–17 fishing year. Of this total, 276 trips were included in the reporting of protected species captures. Trips that were excluded were mostly extra-territorial trips, i.e., they were entirely outside New Zealand's Exclusive Economic Zone. Captures from these trips are reported through the relevant Regional Fisheries Management Organisations (RFMOs). Of the remaining trips that were excluded, two trips were cancelled, one trip had no fishing activity, and four trips were included in the trip register, but had no records in COD (this lack of records may occur if, for example, paperwork from the trip is incomplete or missing).

The observed trips were mainly trawl trips. Of the trips in the PSC database that started during 2016–17, there were 203 trawl trips, 26 bottom-longline trips, 22 surface-longline trips, 15 set-net trips, three purse-seine trips, one Danish seine trip and six trips that used multiple methods (including trolling and dahn line). Of the observed trips, 50 trips were on vessels that were less than 17 m in length, 76 trips were on vessels between 17 and 28 m in length and 150 trips were on vessels that were over 28 m long.

2.1.2 Seabird captures and the PSC dataset

During 2016–17, a total of 736 seabird captures were recorded by observers across all fishing methods.

Of the observed captures, 205 captures were regarded as not fishing captures, and were excluded from the dataset used for estimation (Table 1). The excluded captures were mainly deck captures or landings (190 deck captures or landings during 2016–17), where the birds landed on the vessel or struck the vessel, but the incident was not associated with fishing. Of the deck captures that were excluded from the estimation dataset, 186 were of live birds, and four birds were killed. The species that was most commonly reported from deck landings were New Zealand white-faced storm petrel (*Pelagodroma marina maoriana*; 36 incidents) and common diving petrel (*Pelecanoides urinatrix*; 27 incidents). There were four incidents where more than ten deck captures were reported on the same vessel and date: 30 deck captures on a vessel targeting snapper while bottom longlining on the west coast of North Island; 23 deck captures on a vessel trawl fishing for trevally on the west coast of North Island; 20 captures on the same trawl vessel

Table 1: Records of observed seabird captures in New Zealand commercial fisheries that were excluded from the final dataset during data preparation, by fishing year for the period between 2002–03 and 2016–17. Exclusions included records of seabirds landing on the deck or colliding with vessel structures ("Deck"), captures recorded during mitigation research trips ("Research"), animals in a decomposed state at the time of capture ("Decomposed"), seabirds caught on trawl warps but not brought onboard the vessel ("Warp lost"), records that were determined from observer remarks to not be bycatch events ("Not bycatch"), records that could not be linked to fishing effort ("No station"), records of land birds ("Land birds"), and captures in extra-territorial waters ("ET"). For each fishing year, the table also indicates the number of seabird captures remaining in the database.

Fishing year	Exclusions								Final
	Deck	Research	Decomposed	Warp lost	Not bycatch	No station	Land birds	ET	
2002–03	176	0	1	5	37	0	0	1	633
2003–04	58	58	3	8	1	0	1	0	379
2004–05	106	61	6	31	1	0	0	1	505
2005–06	63	73	1	6	3	0	0	0	427
2006–07	41	0	3	3	0	0	0	0	467
2007–08	77	4	8	4	0	0	0	0	317
2008–09	67	0	4	9	4	0	0	0	577
2009–10	229	0	1	1	1	0	0	0	475
2010–11	92	0	12	1	0	1	0	1	431
2011–12	84	0	0	0	2	0	2	0	321
2012–13	119	0	4	0	2	0	1	0	739
2013–14	120	0	1	8	1	2	0	0	631
2014–15	82	0	2	2	1	0	0	1	686
2015–16	402	0	4	0	6	0	0	0	712
2016–17	190	0	7	3	5	0	0	0	531
All years	1 906	196	57	81	64	3	4	4	7 831

fishing for tarakihi in the Northland-Hauraki area; and 11 captures on a vessel bottom longlining for ling in Stewart-Snares shelf area. The captures by the same trawl vessel are likely to have happened during the same night (with some birds being found the following day). These captures were also reported by the fisher, and they reported the captures as a single event.

Of the 15 other seabird captures during 2016–17 that were excluded from the dataset used for estimation, there were seven captures that were reported as decomposing. For this reason, the mortality of the birds was assumed to not have been associated with fishing by that vessel. There were five records that were treated as not bycatch (one record where the bird was found after the set, but the observer considered that it was not associated with fishing, and four birds that struck the warps, but flew away, with the observer noting that they "appeared uninjured"). There were also three birds that were recorded as captures, but were lost before being brought onboard the vessel. These records included a cape pigeon that was caught on paravane and became dislodged as the paravane was raised, a white-capped albatross that fell off the hook while being hauled on a snood line, and an albatross that was caught in the winch chain and then fell into the water. Birds that are not retrieved on the vessel are not included in the estimation, as the observation of these incidents is not systematic.

Following these exclusions, there remained 531 observed seabird captures during 2016–17. Of these, three captures (Stewart Island shag *Leucocarbo chalconotus*; sooty shearwater, *Puffinus griseus*; cape pigeon, *Daption* spp.) were in South Island set-net fisheries, and were not included in the estimation. When restricted to trawl and longline fisheries, there were 528 observed seabird captures during 2016–17 that were included in the model dataset.

2.1.3 Seabird identification

Information provided by Wildlife Management International (WMIL), from necropsies and from photographs, was used to identify the species captured (to the species or sub-species level, where possible). During preparation of the data used in this analysis, records from COD were merged with seabird necropsy and photo-identification records provided by WMIL (Abraham & Berkenbusch 2019). For the

2016–17 fishing year, WMIL provided expert identification for 427 seabird captures (from 186 necropsies and 242 photographic identifications, with one capture having both a necropsy and a photograph identification). At the time of the data extract from COD in April 2018, only 141 captures had the associated expert identification recorded in COD.

For all seabird captures that had not been identified by WMIL, an imputation process was used to infer the identification (Thompson et al. 2017). After the imputation was applied, there were only four remaining seabird captures in 2016–17 that could only be identified to a generic level.

2.1.4 Seabird bycatch estimation dataset

During the 2016–17 fishing year, there were 528 observed seabird captures in trawl and longline fisheries that were included in the model dataset (Table 2). Observed captures in these fisheries were of a wide range of seabird taxa, with 19 different species (or sub-species) being reported. Of all the seabird captures, 393 captures were seabirds that were dead when they were brought onboard the vessel (or that died before being released). The other captured birds were released alive, but their post-capture survival was unknown. About three-quarters (73.5%) of the captured birds had their identity confirmed, either from necropsy or from a photograph.

The species that was most frequently observed caught was white-chinned petrel with 173 recorded captures, 32.8% of all observed seabird captures. Of all observed captures of this species, 93 captures were in squid trawl fisheries, and 30 captures were in ling bottom-longline fisheries. Other species with more than ten observed captures were sooty shearwater, New Zealand white-capped albatross, Southern Buller’s albatross, black petrel, Salvin’s albatross, and Westland petrel (Table 2).

2.1.5 Distribution of observed captures during 2016–17

During 2016–17, seabird captures in trawl and longline fisheries occurred throughout the New Zealand region, with clear patterns in the distribution of species (Figure 1). Among the albatrosses, white-capped albatross and Buller’s albatross were mainly observed caught in the west and to the south of South Island, whereas Salvin’s albatross was mainly observed caught on Chatham Rise, to the east of South Island. There was also a capture of white-capped albatross reported from the north of New Zealand in bigeye surface longline; however, the identity of this capture was not confirmed. Among the shearwaters, there were captures of sooty shearwater in the western Chatham Rise area and to the south of South Island. The capture of *Procellaria* petrels reflected their breeding locations, with capture records of white-chinned petrel largely to the south and east of South Island, of black petrel on the north-eastern coast of North Island, and observed captures of Westland petrel from the west of South Island. There were few seabird captures during observed fishing on the west coast of North Island.

The distribution of observed captures reflected both seabird distributions and the distribution of observer coverage. In general, observer coverage was concentrated on offshore fisheries, with little observer coverage in trawl or longline fisheries around the coast of South Island or lower North Island (Figure 1).

2.2 Estimating seabird captures

The methods used for the estimation of total captures followed methods used by Abraham & Richard (2019), with the exception that the date range was extended to cover the periods 1998–99 to 2016–17 for longline fisheries and 2002–03 to 2016–17 for trawl fisheries. Earlier observer records of seabird captures in trawl fisheries were not included in the estimation as they were considered incomplete, due to observers on trawl vessels not focusing on seabird captures during that period.

Generalised linear models (GLMs) were fitted to the observed fishing effort and capture data, and then used to estimate the observable captures on unobserved fishing effort. The model structure was the same as used previously (Abraham & Richard 2019), and is only briefly outlined here. Models were fitted

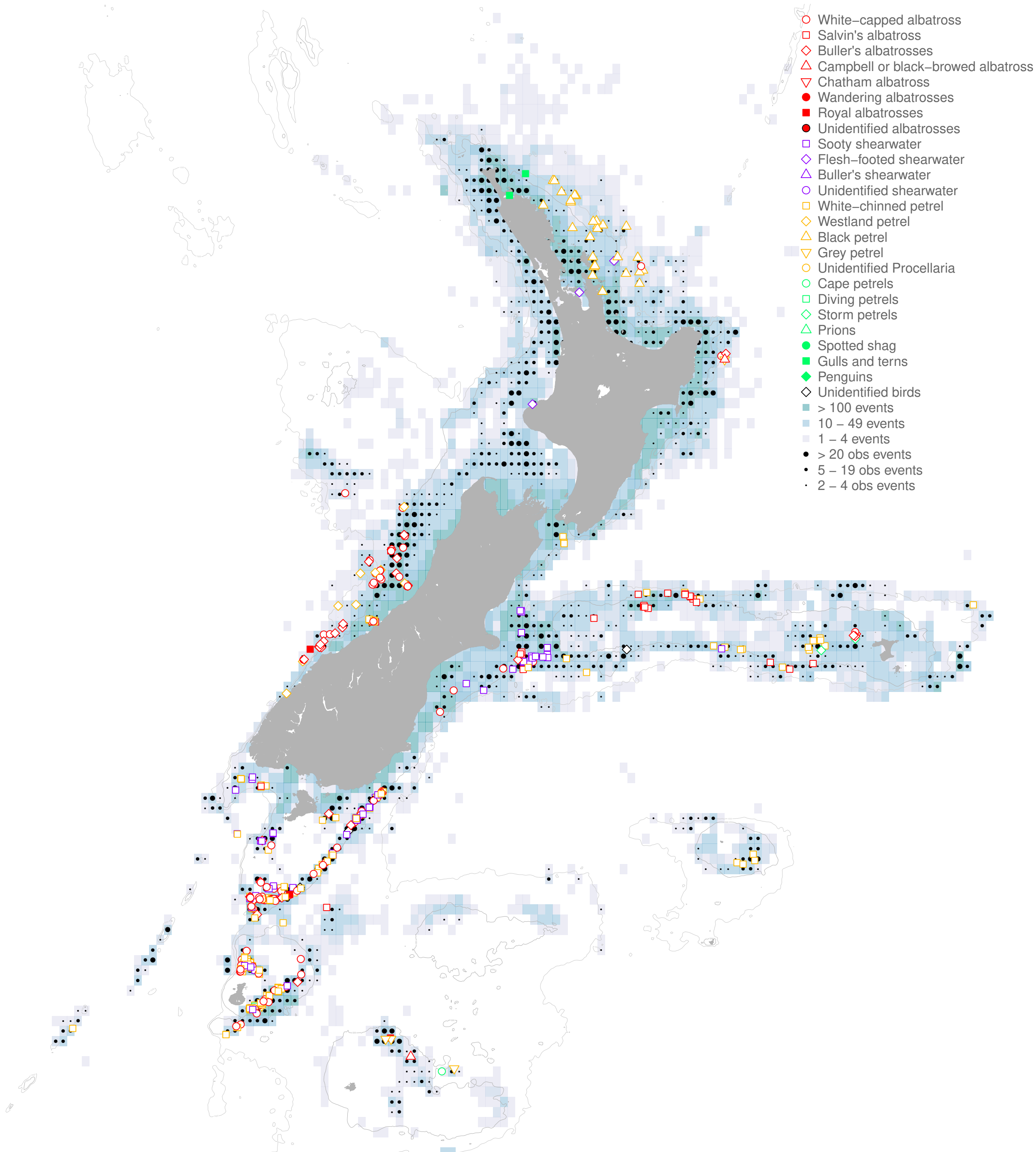

Figure 1: Captures of seabirds recorded during the 2016–17 fishing year in trawl, surface-longline, and bottom-longline fisheries in New Zealand's Exclusive Economic Zone. Shown are also total fishing effort and the amount of effort observed (as number of fishing events).

Table 2: Number of observed seabird captures during the 2016–17 fishing year, in trawl and longline fisheries, that were included in the model dataset to estimate the capture of seabirds in New Zealand fisheries. Shown for each species group are the total number of captures, the number of captures with a confirmed identification by experts (either through necropsy or photograph), and the numbers of captures that were dead when brought onboard the vessel.

Common name	Scientific name	Captures	Confirmed	Dead
White-chinned petrel	*Procellaria aequinoctialis*	173	133	136
Sooty shearwater	*Puffinus griseus*	133	115	115
New Zealand white-capped albatross	*Thalassarche cauta steadi*	98	64	63
Southern Buller's albatross	*Thalassarche bulleri bulleri*	36	22	23
Black petrel	*Procellaria parkinsoni*	27	11	12
Salvin's albatross	*Thalassarche salvini*	26	18	19
Westland petrel	*Procellaria westlandica*	10	8	10
Grey petrel	*Procellaria cinerea*	5	5	5
Southern royal albatross	*Diomedea epomophora*	4	4	3
Flesh-footed shearwater	*Puffinus carneipes*	3	2	2
Royal albatrosses	*Diomedea sanfordi, and D. epomophora*	2	0	0
Campbell black-browed albatross	*Thalassarche impavida*	2	2	2
Southern black-backed gull	*Larus dominicanus dominicanus*	2	0	0
Common diving petrel	*Pelecanoides urinatrix*	1	1	1
Northern giant petrel	*Macronectes halli*	1	0	0
Fulmars, petrels, prions and shearwaters	*Procellariidae*	1	0	0
Snares Cape petrel	*Daption capense australe*	1	0	0
New Zealand white-faced storm petrel	*Pelagodroma marina maoriana*	1	1	0
Gibson's albatross	*Diomedea antipodensis gibsoni*	1	1	1
Grey-backed storm petrel	*Garrodia nereis*	1	1	1
Total		528	388	393

for 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*), and flesh-footed shearwater (*Puffinus carneipes*). Estimates were also derived for seabirds grouped as either "other albatrosses" or "other birds".

For each model, data were grouped 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 property 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).

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,
- 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; (see Figure 2),
- 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.)

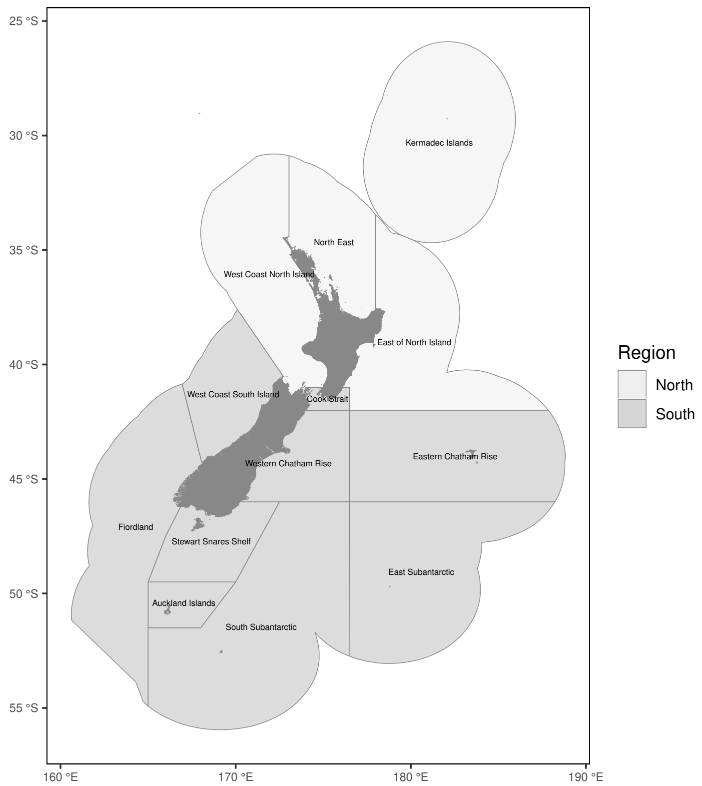

Figure 2: Areas used for the estimation of the number of incidental captures of seabirds in commercial fisheries in New Zealand’s Exclusive Economic Zone (EEZ). The shading shows the division of the EEZ in to north and south regions.

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 temporal effects are primarily determined by the ecology of the species, not 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 3 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 random effects, with the prior being a gamma distribution. 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 5. The random effects were truncated to 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.

Target fisheries were the same as those used previously (Abraham & Richard 2017, 2018, 2019) (see Table 4). They included the split of bottom-longline fisheries targeting ling into three different target fisheries, including small vessels, large vessels using integrated weight lines, and large vessels not using integrated weight lines. 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. This weighting of lines has been shown to be effective in minimising the time that baited hooks are available to seabirds, and was previously found to significantly reduce capture rates in models used for estimating seabird captures (Abraham et al. 2016).

Each model was fitted with the software package Stan (Carpenter et al. 2015), using Markov chain Monte Carlo (MCMC) methods. The model code is presented by Abraham & Richard (2019). 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 2 000 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).

Traces from the posterior chains for the model parameters provide a visual assessment of the performance of the Bayesian model, and 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) and their convergence (Geweke 1992). 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.

Table 3: 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 for the large-vessel size class 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

Table 4: 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 2014–15 for trawl, and between 1998–99 and 2014–15 for bottom-longline (BLL) and surface-longline (SLL) fisheries. 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. 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	2003	2017	180 624	38 025	21.1
		Deepwater	2003	2017	79 941	21 297	26.6
		Squid	2003	2017	68 814	24 675	35.9
		Middle depths	2003	2017	45 435	11 566	25.5
		Inshore	2003	2017	33 879	983	2.9
		Mackerel	2003	2017	33 879	15 123	44.6
		Hake	2003	2017	15 516	5 199	33.5
		S. blue whiting	2003	2017	11 996	6 652	55.5
		Ling	2003	2017	11 370	2 045	18.0
		Scampi	2003	2017	9 690	973	10.0
	Small vessels	Inshore	2003	2017	479 047	10 699	2.2
		Flatfish	2003	2017	292 640	1 674	0.6
		Middle depths	2003	2017	67 317	798	1.2
		Scampi	2003	2017	59 156	4 506	7.6
		Hoki	2003	2017	18 836	1 005	5.3
		Ling	2003	2017	6 449	170	2.6
		Deepwater	2003	2017	6 157	263	4.3
		Squid	2003	2017	4 642	8	0.2
SLL	Large vessels	Bluefin	1999	2015	4 357	3 828	87.9
	Small vessels	Bigeye	1999	2017	44 161	1 018	2.3
		Bluefin	1999	2017	19 692	1 440	7.3
		Albacore	1999	2017	4 044	32	0.8
		Swordfish	1999	2017	3 358	244	7.3
		Minor species	1999	2017	1 606	42	2.6
BLL	Large vessels	Ling, no IWL	1999	2017	34 423	5 147	15.0
		Ling, with IWL	2003	2017	11 072	2 824	25.5
	Small vessels	Snapper	1999	2017	153 920	1 822	1.2
		Ling	1999	2017	55 843	1 078	1.9
		Bluenose	1999	2017	51 934	385	0.7
		Hāpuku	1999	2017	36 516	224	0.6
		Minor species	1999	2017	31 804	528	1.7

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 twelve cases where one of the three chains failed the convergence test). There were no chains where autocorrelation led to a reduction in the effective length of the chains to below 10% 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 model was an update of the same model framework applied previously to the data to the 2015–16 fishing year (Abraham & Richard 2019). When the model parameters were compared between the two years, for all 115 parameters and for all 10 species or species groups, the mean value of the parameters from this model remained within within the 95% c.i. of the parameters from the 2015–16 model. The single exception was the standard deviation of the overdispersion in surface-longline fisheries for black petrel, which decreased from 6.876 (95% c.i.: 4.641–9.707) in the model to 2015–16 to 4.172 (95% c.i.: 1.626–6.798) in the model to 2016–17. One of the changes between the two years was correcting a discrepancy with vessel keys that had resulted in observer effort being allocated to the incorrect fishing vessel (Abraham & Berkenbusch 2019). For black petrel, this correction changed the location of 27 captures from the eastern North Island area to the Northland-Hauraki area. There was a corresponding shift in the model covariates. The area effect for the eastern North Island area decreased from 0.97 (95% c.i.: 0.14–2.71) to 0.15 (95% c.i.: 0.01–0.53) between the two models, whereas the area effect for Northland-Hauraki increased from 2.48 (95% c.i.: 0.41–6.64) to 3.29 (95% c.i.: 0.3–8.33). Because of the wide uncertainty in these parameters, the mean estimates did not change to values outside the ranges from the 2015–16 model, but the changes were in the direction expected from this change in the data.

As a test of the model fit, the models were used to estimate captures on the observed fishing, and the comparison of these estimates with the observed captures provided a model diagnostic. For example, in the model of white-capped albatross, the ten strata (where the strata were defined by region, fishery, vessel size, area and season) with the highest estimated captures on observed fishing all included the observed captures within the 95% credible interval (see Appendix A, Figure A-1). Overall, for white-capped albatross, there were six strata where the observed captures were outside the 95% credible interval of the estimates, but these strata all had relatively low numbers of captures (Appendix A, Table A-3).

Nevertheless, not all models performed well. For example, the model of other albatrosses indicated there were an estimated 22 (95% c.i.: 0–40) 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). These captures occurred during only 22 observed fishing events, and were outside of the credible interval predicted by the model when all data were taken into account. Across all the models, white-chinned petrel had the highest number of strata (twelve) 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 was a total of 428 observed captures by vessels over 28 m in length in the period from 2002–03 to 2016–17 (Appendix A, Table A-1). These captures were based on observer coverage of 37.7% (10 155 observed tows). The ratio estimate of the observed captures (obtained by dividing the number of observed captures by the observer coverage) was 1136 seabird captures. This estimate was within the range estimated by the model of 1277 (95% c.i.: 1029–1573) captures (over the entire 15-year period).

Discrepancies between the ratio estimate and the model estimate are often associated with low observer coverage. For example, there have been no observed captures of Buller's albatross in small-vessel bigeye surface-longline fisheries in the North Island east coast area in the summer quarter; however, the model estimated that there were 747 (95% c.i.: 268 to 1667) captures over the 19-year period covered by the

Table 5: 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 2016–17 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	308	234–404	106	58–185	32	11–67	448	349–574
Salvin's albatross	284	184–432	3	0–9	162	40–513	451	272–810
Buller's albatrosses	84	54–127	112	61–200	29	10–65	226	157–326
Other albatrosses	33	18–57	97	56–164	97	36–212	228	148–362
White-chinned petrel	284	219–384	25	4–86	686	261–1 578	995	557–1 882
Black petrel	36	22–54	63	30–136	186	104–326	286	189–442
Grey petrel	9	4–21	23	8–54	144	39–432	176	67–465
Sooty shearwater	378	260–588	0	0–4	18	2–52	398	276–615
Flesh-footed shearwater	85	39–182	104	27–269	244	154–396	435	293–670
Other birds	261	131–510	36	22–58	265	158–439	563	376–859
All birds	1 767	1 493–2 145	573	426–789	1 869	1 286–2 909	4 210	3 508–5 296

longline models (Appendix A, Table A-9). The observer coverage in this stratum was only 2.1%. Another example of this kind of mismatch was the model estimate for grey petrel (also highlighted previously by Abraham & Richard 2019). For this species, the model estimated that over the 19-year period, there was a total of 1085 (95% c.i.: 304–2760) captures by snapper bottom-longline vessels less than 34 m long, in the North East area during winter (Appendix A, Table A-21). As there have been no observations of snapper bottom-longline fishing during winter, there have been no observed captures (during the 2016 calendar year there were 48 seabird captures reported by fishers in this fishery, with 12 of those captures being reported during July, August, and September).

3.2 Estimated seabird captures

There was an estimated total of 4210 (95% c.i.: 3508–5296) seabirds captured during the 2016–17 fishing year, including 1767 (95% c.i.: 1493–2145) seabirds in trawl fisheries, 1869 (95% c.i.: 1286–2909) seabirds in bottom-longline fisheries, and 573 (95% c.i.: 426–789) seabirds in surface-longline fisheries (Table 5, 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 2016–17). Detailed data on fisheries captures, including the location and identification of each observed capture, and estimates by fishery, area and year are available from the protected species capture website (https://data.dragonfly.co.nz/psc/).

White-chinned petrel had 995 (95% c.i.: 557–1882) estimated captures during the 2016–17 fishing year, the highest estimate of any of the modelled species groups. These captures were estimated to have mainly occurred in trawl and bottom-longline fisheries (Table 5). Other species groups with mean estimated captures of over 400 birds during the 2016–17 fishing year were white-capped albatross, flesh-footed shearwater, Salvin's albatross, and the other birds group.

During the 2016–17 fishing year, seabird captures occurred in a wide range of fisheries—there was a mean of over 100 seabird captures for 14 different seabird group and fishing method combinations (Table 5). When grouped by target fishery, there was an estimated mean of more than 100 seabird captures in 13 of the 20 defined target fisheries (Table 6). The target fisheries within each method that had the highest estimated mean seabird captures during the 2016–17 fishing year were trawl fisheries targeting inshore species, with 362 (95% c.i.: 256–496) estimated seabird captures, ling target bottom-longline fisheries, with 873 (95% c.i.: 471–1688) estimated seabird captures, and southern bluefin tuna surface-longline fisheries, with 275 (95% c.i.: 198–382) estimated seabird captures.

For seven of the ten modelled species groups, the total number of estimated captures decreased between 2002–03 and 2016–17 (where the decrease was sufficient for the upper credible interval in 2016–17 to be lower than the mean in 2002–03) (Figure 3). Only Salvin's albatross, white-chinned petrel and grey petrel

Table 6: Number of estimated seabird captures in different trawl, bottom-longline (BLL), and surface-longline (SLL) target fisheries for the 2016–17 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	362	256–496
	Squid	353	302–439
	Hoki	279	215–372
	Flatfish	259	128–509
	Middle depths	259	167–438
	Scampi	168	110–256
	Ling	59	33–111
	Deepwater	10	5–19
	Mackerel	6	4–12
	S. blue whiting	6	6–7
	Hake	1	1–5
BLL	Ling	873	471–1688
	Snapper	399	288–549
	Minor species	281	122–656
	Hāpuku	168	50–515
	Bluenose	146	65–309
SLL	Bluefin	275	198–382
	Bigeye	192	104–367
	Swordfish	96	41–197
	Minor species	6	0–30
	Albacore	2	0–16

did not show a clear decrease in total captures over this time period, and only white-chinned petrel had higher mean estimated captures in 2016–17 than in 2002–03. When captures in 2016–17 were compared with captures in 2006–07, the changes were considerably less clear, with many species showing similar total numbers of captures during 2016–17 than in 2006–07. 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 2016–17 being the lowest of any of the 15 years, at about half the number of estimated seabird captures in 2002–03.

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, excepting large-vessel surface-longline fisheries data which are restricted by confidentiality requirements). The number of tows in trawl fisheries in 2016–17 was 69% 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. The number of hooks set in small-vessel surface-longline fisheries in 2016–17 was 24% of the number of hooks set in 2002–03. Across all surface-longline fishing, the number of hooks set in 2016–17 was 19% of the number of hooks set during 2002–03. In bottom-longline fisheries, the number of hooks set during 2016–17 was 123% and 124% of the number of hooks set during 2002–03, for small- and large-vessel fisheries, respectively.

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 4). 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 decreased

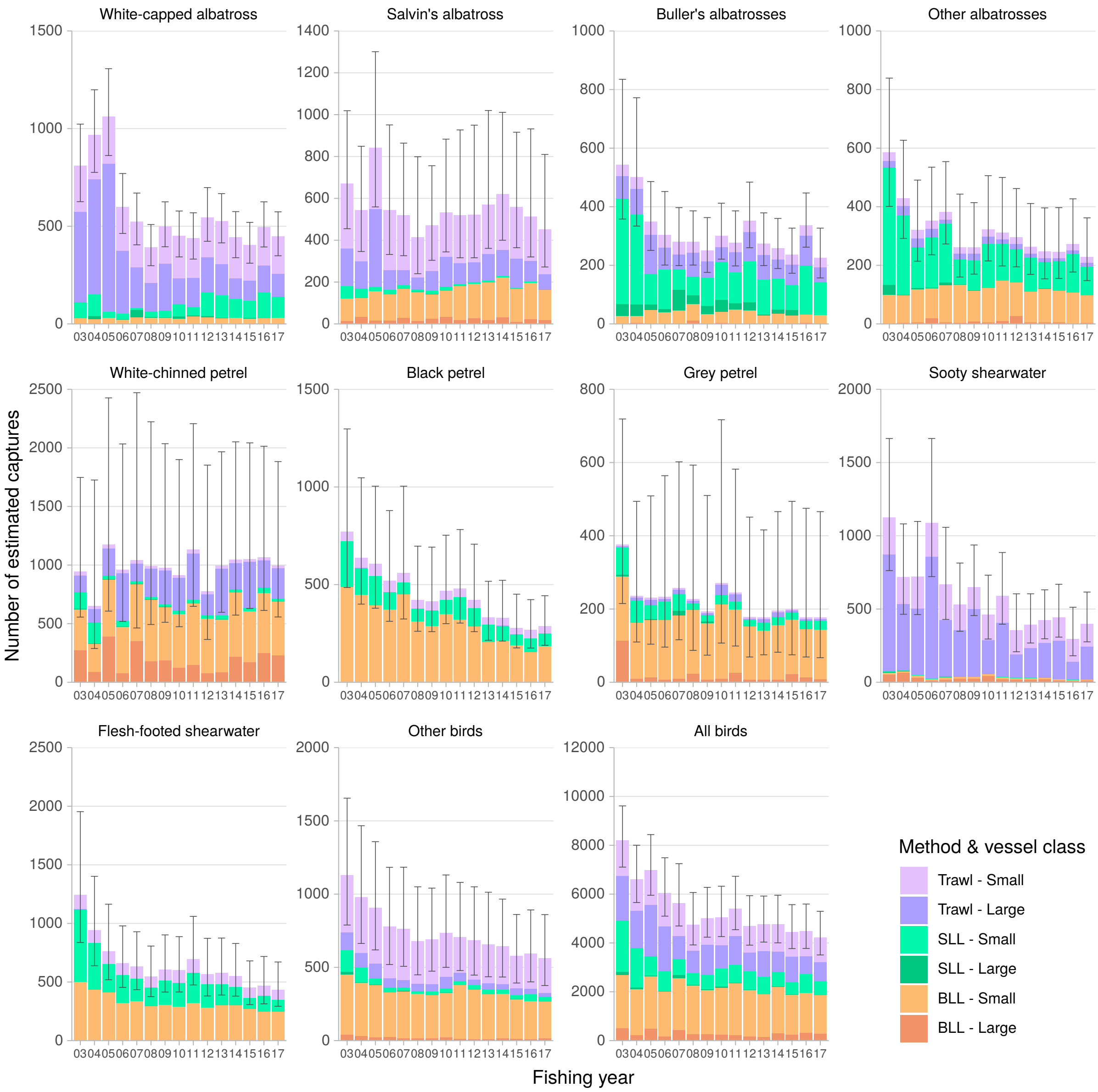

Figure 3: Time series of the number of estimated captures for the seabird species groups and for all birds for the 2002–03 to 2016–17 fishing years. Estimates are shown by fishing method and vessel size class. Cut-off lengths for small and large vessel size classes were 45 m, 34 m, and 28 m, for surface-longline (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.)

in 2016–17, relative to 2015–16, but there has been no clear trend in capture rates over the 10-year period 2007–08 to 2016–17. 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 higher capture rate during 2016–17 than in 2015–16. This fluctuation is related to inter-annual variation in the behaviour or distribution of white-chinned petrel and sooty shearwater, which both show this variation (Appendix B, Figure B-27, Figure B-30).

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. Nevertheless, the capture rates of both petrels and albatrosses decreased over the four-year period from 2013–14 to 2016–17.

In large-vessel ling bottom-longline fisheries, capture rates peaked in 1999–2000 for albatrosses and in 2000–01 for 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. The observed capture rate of petrels and other birds in large-vessel ling bottom-longline fisheries decreased in 2016–17, when all observations of large-vessel bottom-longliners were on vessels with integrated weight line.

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 were no large vessels in this fishery during 2015–16 or 2016–17, and so the time series does not continue.

Capture rates in trawl fisheries targeting middle-depth species were lower during 2016–17 than in the previous five years, although there have not been consistent changes in capture rates over a longer time period.

Many fisheries caught a range of seabird species or species groups in 2016–17 (Figure 5). As in 2015–16, white-chinned petrel was the species with the highest mean estimated captures in ling bottom-longline, squid trawl, minor-species bottom-longline and hāpuka bottom-longline fisheries in 2016–17. In snapper bottom-longline fisheries, the highest estimated captures were of flesh-footed shearwater and other birds, followed by black petrel 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 6, 7). Patterns of captures reflect both the distribution of fishing and the distribution of seabirds. Black petrel mainly breed on Great Barrier Island, in the Hauraki Gulf region. Estimated captures of black petrel are 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 on the North Island west coast. White-chinned petrel and sooty shearwater are both caught in the south of New Zealand, in the subantarctic area and on 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 on 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 on the South Island west coast, and to the south of New Zealand; estimated mean captures of Salvin's albatross were higher on the South Island east coast and on Chatham Rise; and Buller's albatrosses were caught in surface longline fisheries on both the South Island west coast, and the North Island east coast

Figure 4: Capture rates (captures per 100 fishing events) of two seabird groupings in selected large-vessel target fisheries, for fishing years between 2002–03 and 2016–17 for trawling, and between 1998–99 and 2016–17 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.)

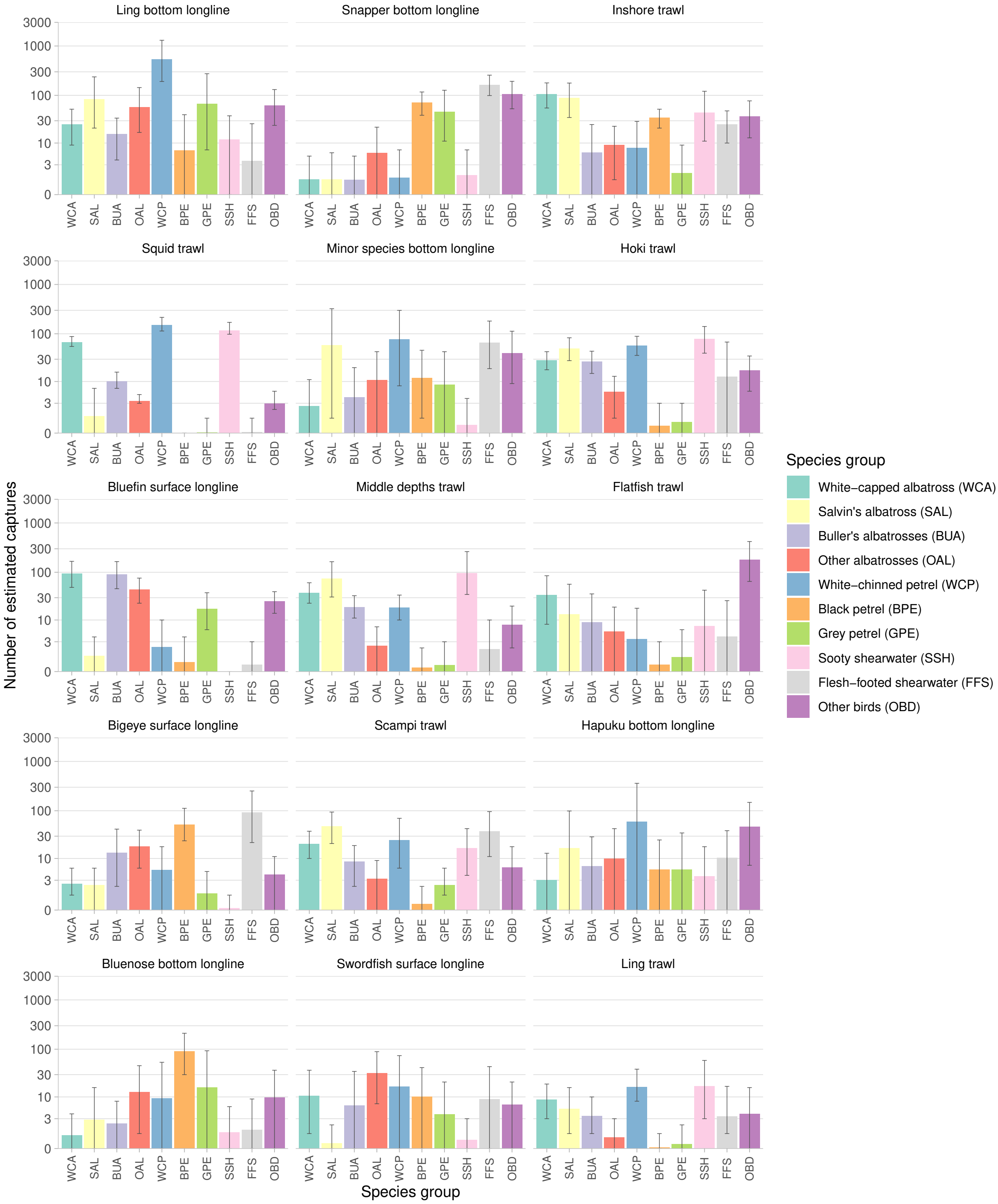

Figure 5: Number of estimated captures for the modelled seabird species groups for the 2016–17 fishing year. For each species group and target fishery, the bars show mean captures and the 95% credible interval. The y-axis is on the log plus one scale. Shown are only fisheries that were estimated to have caught a mean of more than 50 birds.

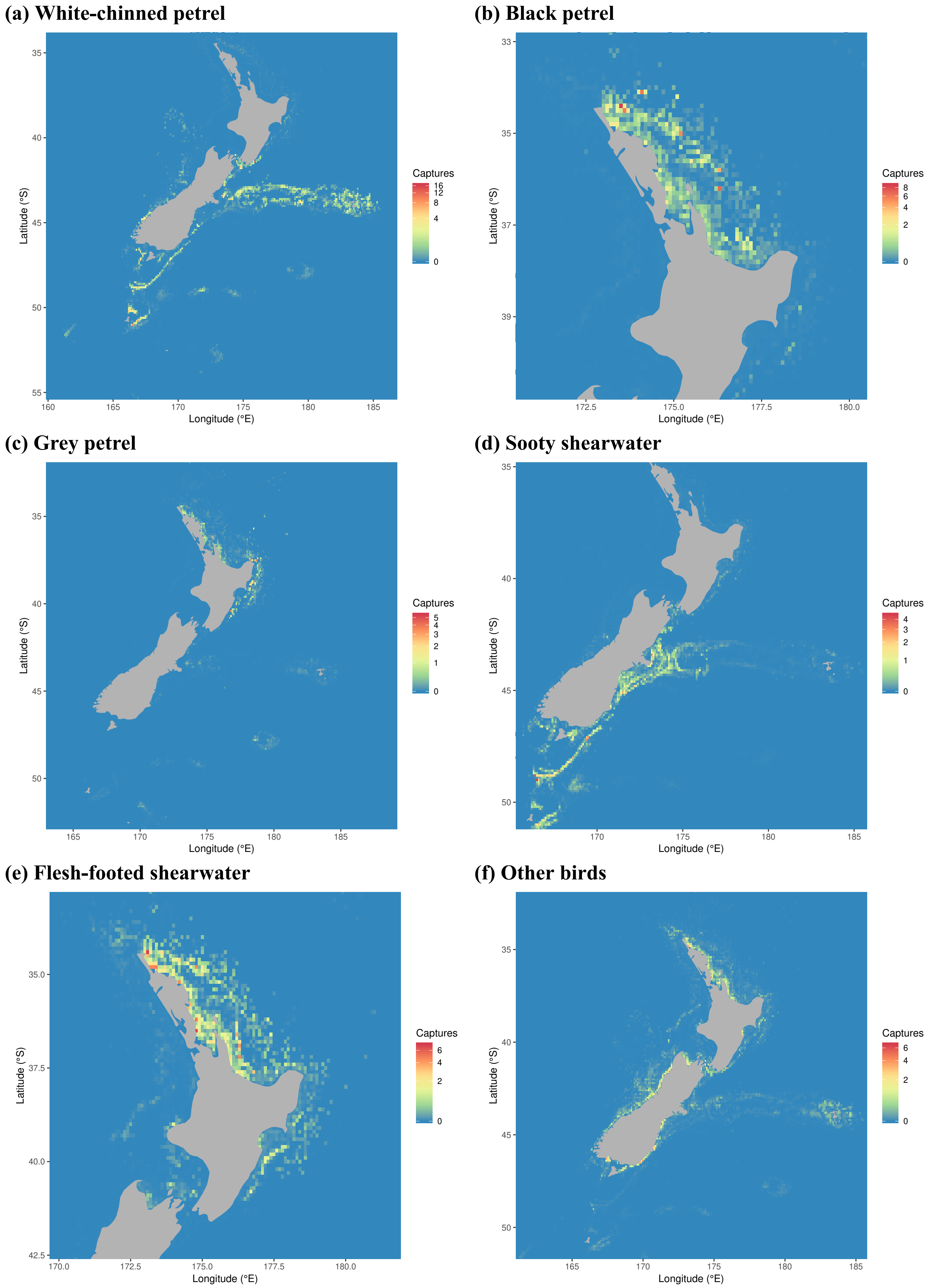

Figure 6: Estimated captures of petrels and other birds in New Zealand's Exclusive Economic Zone in the 2016–17 fishing year. For each of the modelled species groups, colour indicates the number of model-estimated captures in 0.1 degree cells. Shown is the mean value from the model applied to all fishing effort (observed captures not included).

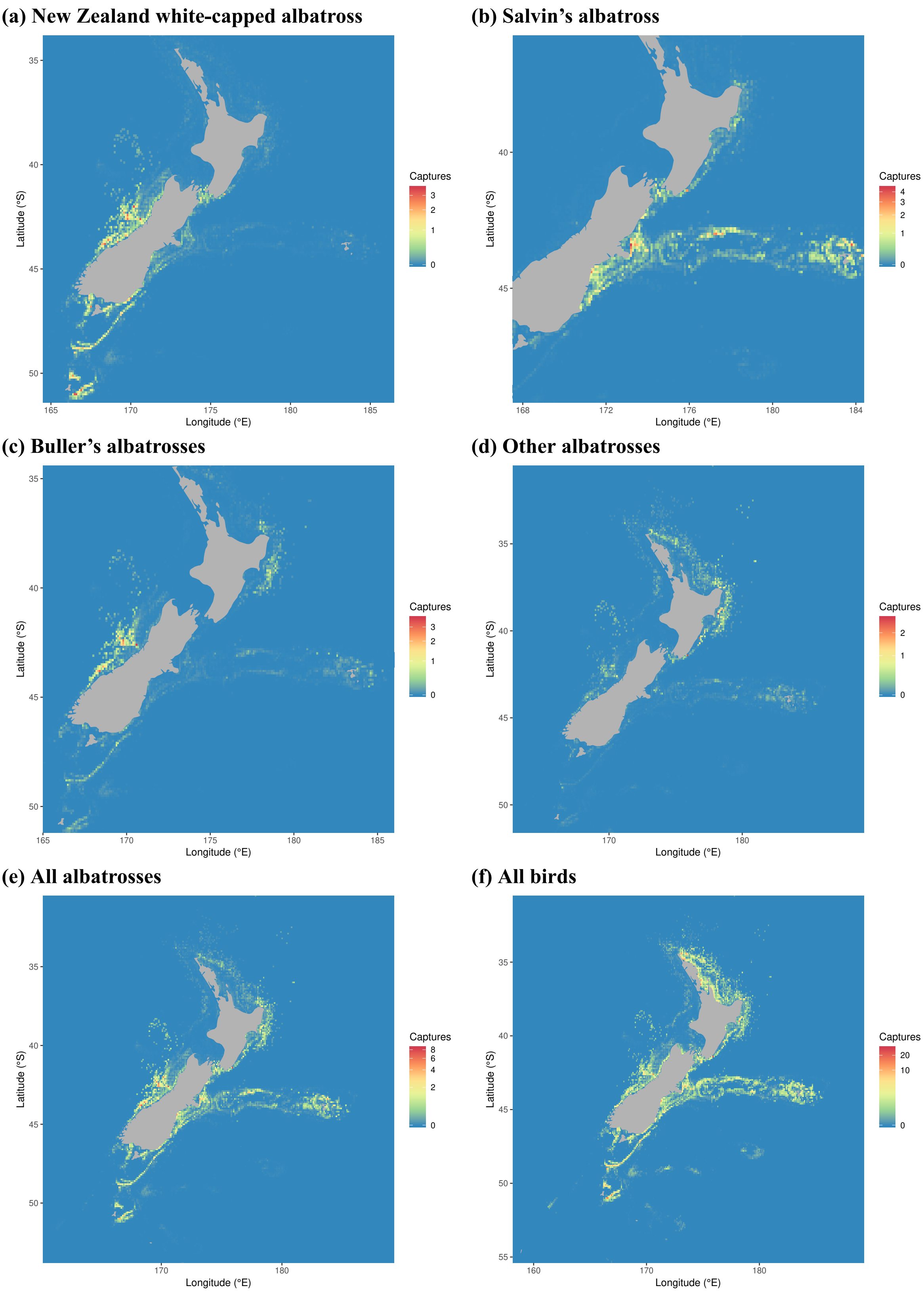

Figure 7: Estimated captures of albatrosses and of all birds in New Zealand's Exclusive Economic Zone in the 2016–17 fishing year. For each of the modelled species groups, colour indicates the number of model-estimated captures in 0.1 degree cells. Shown is the mean value from the model applied to all fishing effort (observed captures not included). The map of all birds is the total of the estimated captures of all species and species groups.

(Figure 7). 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 7). Estimated captures of seabirds were highest in the North-East, and Chatham Rise areas (Table 7). Captures in the north-eastern area were primarily in bottom-longline fisheries, while captures in the eastern and western Chatham Rise areas were primarily in bottom-longline and trawl fisheries, respectively.

Table 7: Number of estimated seabird captures by model area and fishing method in the 2016–17 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	103	65–175	212	121–393	585	429–799	901	699–1 184
Eastern Chatham Rise	155	112–218	0	0	537	236–1 183	692	381–1 341
Western Chatham Rise	451	315–660	0	0	224	83–572	676	452–1 063
Stewart-Snares Shelf	499	408–629	0	0	41	7–187	540	431–730
West Coast South Island	182	117–292	228	150–349	72	41–132	483	365–660
East of North Island	75	41–132	107	61–176	155	65–385	338	211–587
Auckland Islands	192	146–265	0	0	0	0	192	146–265
Cook Strait	53	28–93	0	0	114	40–307	167	82–360
West Coast North Island	31	13–67	18	5–44	51	25–93	101	59–164
Fiordland	13	7–28	6	3–25	45	11–170	65	26–196
South Subantarctic	8	8–12	0	0	24	3–103	33	11–112
East Subantarctic	0	0–0	0	0	16	4–59	16	4–59
Kermadec Islands	0	0	1	0–8	0	0	1	0–8

4. DISCUSSION

Seabird bycatch is a persistent issue that occurs in a range of commercial fisheries throughout the New Zealand region. In this assessment, estimates of total seabird bycatch in commercial trawl and longline fisheries were updated to include data from the 2016–17 fishing year. In addition, the current estimation incorporated recent changes and updates in the preparation of the source data (Abraham & Berkenbusch 2019).

4.1 Comparison with the previous estimation model

When the model was updated, the estimates were recalculated for all previous years, which allowed a comparison between the models fitted to the different data (Figures 8, 9). Overall, the comparison between the current model and the model to the 2015–16 fishing year found that capture estimates were similar. Mean values estimated for 2015–16 in one model were within the corresponding credible intervals of estimates derived with the other model for this fishing year.

The general outcome of the comparison between the models fitted to the different data sets gives confidence that the overall results from these models are robust. Nevertheless, there were some marked changes in the estimates at a finer scale.

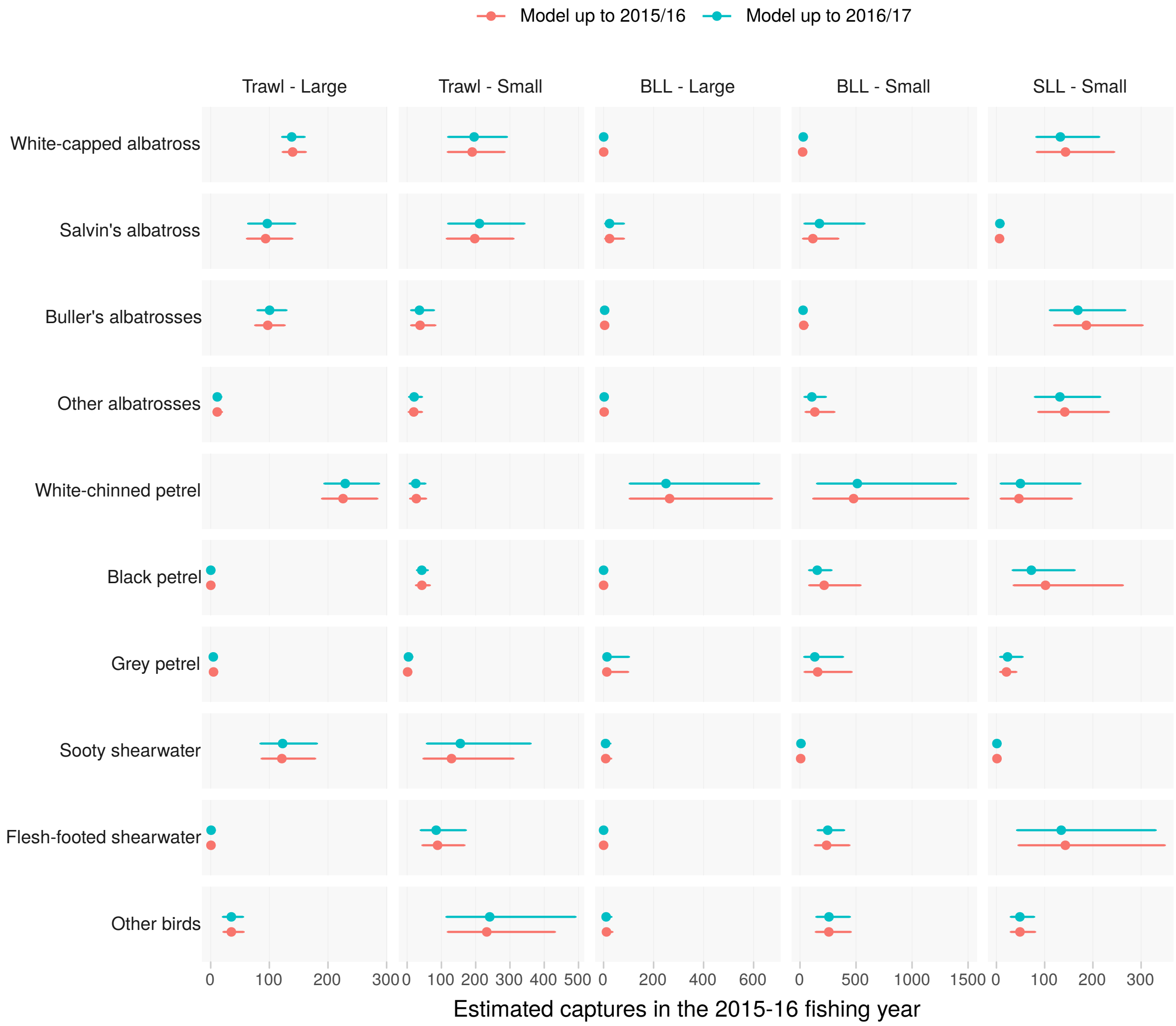

Figure 8: Comparison of the number of estimated seabird captures in 2015–16 derived from the current model (data to 2016-17) and the previous model (data to 2015–16) (Abraham & Richard 2019). Shown are for each species or species group, fishing method (trawl, SLL: surface longline, BLL: bottom longline) and vessel size class, the mean and 95% credible interval of the estimated captures during 2015–16. 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. Lines and symbols indicate mean captures, error bars are the 95% credible interval for the total number of estimated captures. (Note different x-axis scales.)

Correcting a vessel key during data preparation moved the location of 27 observed captures from the East Cape to the Hauraki Gulf area. This correction also resulted in a change in fishing method associated with the captures from a mix of bottom-longline and surface-longline fisheries to bottom-longline fisheries only. The number of observed black petrel captures in east coast North Island fisheries decreased from 13 to no observed captures. Correspondingly, the number of estimated captures of black petrel in east coast North Island bottom-longline fisheries during the 2015–16 fishing year decreased between the two versions of the models, from 60 (95% c.i.: 9–201) to 5 (95% c.i.: 0–18) estimated captures. Similarly, the number of observed captures of black petrel in surface-longline fisheries in the east coast North Island area decreased from 11 to one observed capture; the corresponding capture estimates decreased from 24 (95% c.i.: 3 – 88) to 1 (95% c.i.: 0–5) estimated capture of this species. In New Zealand seabird risk assessments, black petrel has been identified as the species at highest risk from fisheries mortality (e.g., see Richard et al. 2017). It will be necessary to update the seabird risk assessment with the most recent data to assess the impact of these changes on the risk of this species.

4.2 Model structure and future developments

The current model used the same code used previously (Abraham & Berkenbusch 2019), but was built with updated data. One limitation of this model structure was that the frequency distribution of estimated captures was broader than the distribution of observed captures (i.e., the model predicted capture events with a higher number of captured animals than were observed) (Figure 9). When grouped by fishing method and fishery, the 90th percentile of the number of birds caught, given that a capture event occurred, was less than eight for all species and methods. In the model estimates, however, there were many cases where the 90th percentile of the number of seabirds caught was over ten; and for many species and fisheries, the observed 90th percentile was below the range predicted from the model. Within the models, the shape of the distribution of the number of animals caught per capture event was determined by an overdispersion parameter. It seems that this parameter is insufficient for covering the wide range of capture rates that were encountered in the data. The same limitation was recently found in a model with a similar structure used to estimate the bycatch of New Zealand fur seal (Abraham et al. 2019). When this limitation was addressed in the fur seal model, the credible interval in the estimated captures decreased.

For this reason, it is recommended that the parameterisation of the capture distribution is further explored in future developments of the seabird estimation model to ensure that the distribution of captures agrees between the model and the observations. It is anticipated that addressing this aspect will reduce the uncertainty in the estimates, especially in bottom-longline fisheries, where the model predicted capture events with a high number of captures.

In the models to date, a simple approach to spatial modelling was used, dividing the New Zealand region into areas and allowing the model to separately estimate captures rates within each area. For the different species and species groups, there has been sufficient captures to allow the fitting of spatial models, where the capture rate varied at scales chosen within the model. We anticipate that a more advanced spatial model (such as a conditional autoregressive model (Gelfand & Vounatsou 2003, Jin et al. 2005)) would allow for variation of capture rates near breeding colonies. For example, black petrel breed on Great Barrier and Little Barrier Islands, but the locations of the breeding colonies are not represented in the current model, which treats the Northland-Hauraki area as having the same base capture rate.

4.3 Observer coverage

The estimation of seabird captures depends on data from observers. An implicit assumption in the modelling is that the observed fishing effort is representative of the unobserved fishing effort. Most large vessels that were active for three or more years (and that reported at least 100 fishing events) have been observed (Table 8). In longline fisheries, the number of active vessels during the period 2002–03 to 2015–16 was small, and there was only one large bottom longline vessel that was not observed during this period. Over 90% of active trawl vessels over 28 m were observed at least once during the 14-year

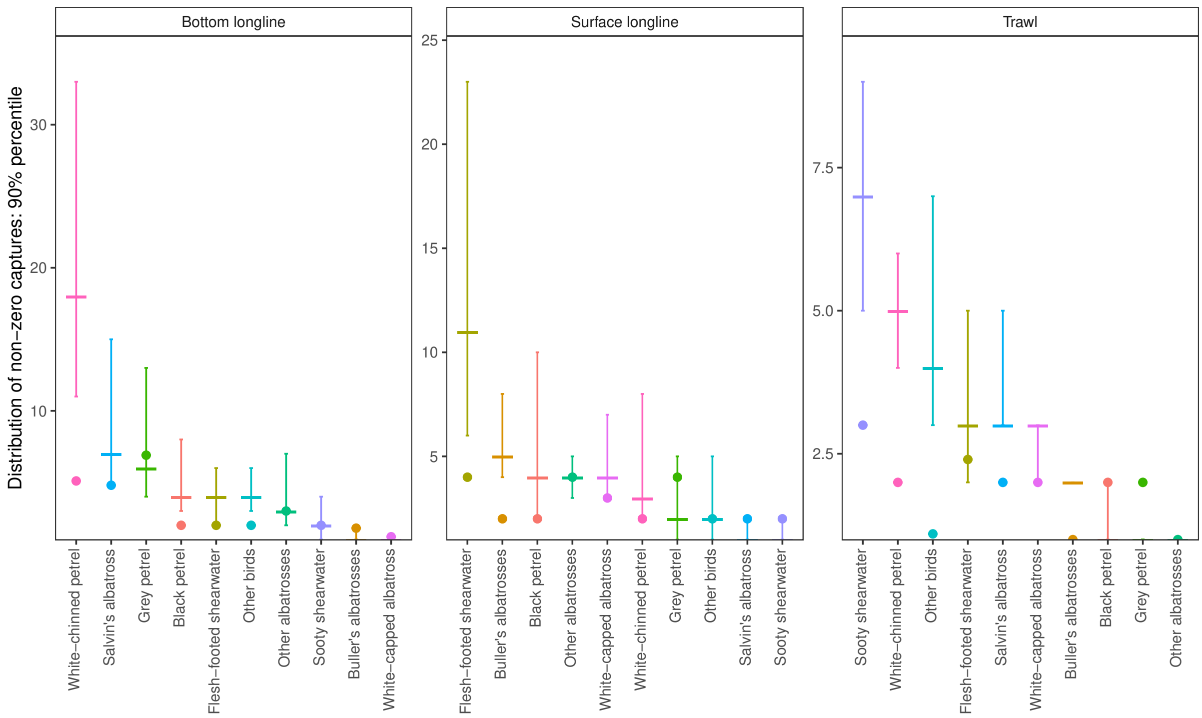

Figure 9: Comparison of the 90th percentile between the observed and estimated non-zero captures of seabirds. Shown are for each species or species group and fishing method (trawl, SLL: surface longline, BLL: bottom longline), the mean and 95% credible interval of the 90th percentile of estimated non-zero captures (horizontal line and vertical bars) and the 90th percentile of observed non-zero captures (filled circle).

Table 8: Observed fishing effort between 2002–03 and 2016–17. 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	14.1
	Small	214	47.2	1.8
Surface longline	Large	5	100.0	89.3
	Small	73	58.9	6.0
Trawl	Large	61	91.8	27.5
	Small	262	41.2	2.1

period.

In contrast, there were many small vessels fishing during the 2002–03 to 2016–17 period. Around 50%, 60%, and 40% of small bottom-longline, surface-longline and trawl vessels, respectively, had no observers placed on them for any fishing during the 14-year period. The observer coverage across these fisheries was also low (at around 2%, 6%, and 2% respectively; Table 8). With a core of vessels that had no observer coverage, and with low observer coverage overall, seabird bycatch in the small-vessel fleet may not represented in the observer data. For example, if vessels with observers placed on them are also more compliant with the use of seabird bycatch mitigation, then seabird capture rates may be higher in the unobserved component of the fleet.

Increasing observer coverage in small-vessel fisheries, and ensuring that observers are placed across the fleet so that all vessels have at least some observer coverage, would help to ensure that estimates based on observer data reliably reflect protected species bycatch across New Zealand's trawl and longline fisheries.

5. ACKNOWLEDGMENTS

Data for this project were collected by government fisheries observers. We are grateful for their ongoing work to collect the independent information that enhances our understanding of interactions between New Zealand fisheries and protected species.

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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 2016–17 for bottom- and surface-longline fisheries, and between 2002–03 and 2016–17 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.

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Trawl									
Squid trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Summer	428	10155	0.377	1136	1277	1029–1573
Squid trawl	Vessels ≥ 28 m	Auckland Islands	Summer	329	7259	0.488	673	604	471–759
Squid trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Autumn	109	2918	0.324	336	402	287–547
Squid trawl	Vessels ≥ 28 m	Auckland Islands	Autumn	91	2969	0.379	240	295	205–404
Inshore trawl	Vessels < 28 m	Stewart Snares Shelf	Summer	2	155	0.019	105	254	127–453
Flatfish trawl	Vessels < 28 m	Stewart Snares Shelf	Summer	0	527	0.020	0	196	52–466
Inshore trawl	Vessels < 28 m	West Coast South Island	Summer	12	439	0.038	317	187	95–319
Inshore trawl	Vessels < 28 m	Stewart Snares Shelf	Autumn	0	0	0.000		161	75–297
Inshore trawl	Vessels < 28 m	West Coast South Island	Autumn	2	30	0.003	636	145	73–250
Flatfish trawl	Vessels < 28 m	Stewart Snares Shelf	Autumn	3	51	0.003	1016	124	32–297
Inshore trawl	Vessels < 28 m	Western Chatham Rise	Summer	0	438	0.018	0	123	57–224
Inshore trawl	Vessels < 28 m	Western Chatham Rise	Autumn	0	77	0.004	0	105	46–194
Inshore trawl	Vessels < 28 m	Stewart Snares Shelf	Spring	0	22	0.003	0	101	44–192
Inshore trawl	Vessels < 28 m	West Coast South Island	Spring	1	94	0.008	129	98	44–181
Scampi trawl	Vessels < 28 m	Auckland Islands	Autumn	9	603	0.112	80	97	47–173
Surface longline									
Southern bluefin SLL	Vessels < 43 m	West Coast South Island	Autumn	80	326	0.118	679	647	365–1076
Southern bluefin SLL	Vessels < 43 m	East of North Island	Autumn	4	372	0.045	89	108	41–211
Southern bluefin SLL	Vessels ≥ 43 m	Fiordland	Autumn	81	3057	0.900	89	103	64–150
Southern bluefin SLL	Vessels < 43 m	West Coast South Island	Summer	0	0	0.000		96	39–188
Southern bluefin SLL	Vessels < 43 m	Fiordland	Autumn	10	12	0.032	310	87	31–185
Southern bluefin SLL	Vessels < 43 m	West Coast South Island	Winter	0	46	0.057	0	57	25–111
Swordfish SLL	Vessels < 43 m	West Coast South Island	Summer	1	20	0.044	22	47	8–144
Swordfish SLL	Vessels < 43 m	West Coast South Island	Autumn	2	37	0.136	14	27	4–83
Bigeye SLL	Vessels < 43 m	East of North Island	Summer	0	161	0.026	0	25	3–73
Bigeye SLL	Vessels < 43 m	East of North Island	Autumn	0	96	0.021	0	18	2–50
Bigeye SLL	Vessels < 43 m	North East	Summer	0	160	0.029	0	16	2–46
Bigeye SLL	Vessels < 43 m	West Coast North Island	Summer	0	60	0.023	0	14	1–42
Bigeye SLL	Vessels < 43 m	North East	Autumn	0	56	0.012	0	13	1–37
Southern bluefin SLL	Vessels ≥ 43 m	West Coast South Island	Autumn	4	333	0.915	4	11	3–24
Albacore SLL	Vessels < 43 m	East of North Island	Autumn	0	23	0.015	0	10	0–44
Bottom longline									
Ling BLL – vessels < 34 m	Vessels < 34 m	West Coast South Island	Autumn	4	35	0.014	279	62	18–136
Ling BLL – vessels < 34 m	Vessels < 34 m	West Coast South Island	Summer	2	23	0.010	199	62	18–138
Ling BLL – vessels < 34 m	Vessels < 34 m	West Coast South Island	Spring	0	2	0.001	0	38	10–86
Ling BLL – vessels < 34 m	Vessels < 34 m	West Coast South Island	Winter	0	6	0.002	0	24	6–54
Ling BLL – vessels < 34 m	Vessels < 34 m	Cook Strait	Autumn	0	4	0.003	0	17	3–45
Ling BLL – vessels < 34 m	Vessels < 34 m	Western Chatham Rise	Autumn	0	55	0.031	0	14	3–33
Ling BLL – vessels < 34 m	Vessels < 34 m	Cook Strait	Spring	0	0	0.000		13	2–36
Ling BLL – vessels < 34 m	Vessels < 34 m	Western Chatham Rise	Spring	0	66	0.022	0	13	3–30
Ling BLL – vessels < 34 m	Vessels < 34 m	Cook Strait	Summer	0	11	0.014	0	12	2–34
Snapper BLL	Vessels < 34 m	North East	Summer	0	743	0.020	0	12	0–47
Ling BLL – vessels < 34 m	Vessels < 34 m	Fiordland	Winter	0	3	0.002	0	11	2–29
Snapper BLL	Vessels < 34 m	North East	Autumn	0	508	0.014	0	11	0–42
Hāpuku BLL	Vessels < 34 m	West Coast South Island	Summer	0	0	0.000		10	0–41
Ling BLL – vessels < 34 m	Vessels < 34 m	Western Chatham Rise	Summer	0	2	0.002	0	10	2–23
Minor targets BLL	Vessels < 34 m	Cook Strait	Summer	0	0	0.000		9	0–42

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 areas, 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
S.d.(Year)							
BLL	1.145	1.091	0.218 – 2.305			2791	
SLL	0.739	0.729	0.363 – 1.171			4002	
Trawl	0.357	0.346	0.211 – 0.565			4002	
S.d.(Area)	0.975	0.942	0.594 – 1.513			3750	
S.d.(Fishery)	0.909	0.881	0.562 – 1.388			3879	
Overdispersion							
BLL	1.256	1.082	0.369 – 3.085			3816	
SLL	5.070	4.984	3.637 – 6.962			4002	
Trawl	7.942	7.919	6.468 – 9.588			3945	
Intercept	0.009	0.008	0.003 – 0.022			4008	
Method / Vessel class							
BLL / vessels $\geq$ 34 m	0.401	0.252	0.044 – 1.708			4002	
SLL / vessels $\geq$ 43 m	2.483	1.899	0.495 – 8.111			4022	
Trawl / vessels $\geq$ 28 m	1.000	1.000	1.000 – 1.000	3			
BLL / vessels $<$ 34 m	1.818	1.436	0.318 – 5.531			3865	
SLL / vessels $<$ 43 m	18.029	14.271	3.889 – 53.307			3963	
Trawl / vessels $<$ 28 m	1.252	1.188	0.631 – 2.248			4100	
Region							
North	0.106	0.074	0.019 – 0.375			3841	
South	1.000	1.000	1.000 – 1.000	3			
Season							
Autumn (Apr-Jun)	0.951	0.944	0.756 – 1.187			4002	
Spring (Oct-Dec)	0.505	0.497	0.345 – 0.712			3882	
Summer (Jan-Mar)	1.000	1.000	1.000 – 1.000	3			
Winter (Jul-Sep)	0.290	0.284	0.190 – 0.429			4214	
Fishery							
Albacore SLL	0.837	0.635	0.018 – 2.851			3808	
Bigeye SLL	0.599	0.496	0.083 – 1.739			4115	
Bluenose BLL	0.713	0.551	0.020 – 2.371			3879	
Deepwater trawl	0.157	0.139	0.039 – 0.388			3813	
Flatfish trawl	0.370	0.314	0.081 – 0.992			4002	
Hake trawl	0.664	0.623	0.251 – 1.296			4002	
Hāpuku BLL	0.819	0.615	0.021 – 2.696			4370	
Hoki trawl	0.629	0.603	0.291 – 1.122			4002	
Inshore trawl	1.497	1.393	0.567 – 3.023			4002	
Ling (no IWL) BLL – vessels $\geq$ 34 m	1.583	1.319	0.276 – 4.286			4154	
Ling (IWL) BLL – vessels $\geq$ 34 m	0.492	0.333	0.008 – 1.848			4002	
Ling BLL – vessels $<$ 34 m	2.128	1.828	0.544 – 5.324			3814	
Ling trawl	1.284	1.192	0.493 – 2.608			4167	
Mackerel trawl	0.661	0.623	0.253 – 1.291			3650	
Middle depths trawl	1.691	1.635	0.812 – 2.905			4002	
Minor targets BLL	0.601	0.457	0.011 – 2.009			3806	
Minor surface longline	0.849	0.641	0.022 – 2.891			3894	
Southern blue whiting trawl	0.388	0.264	0.006 – 1.499			4002	
Scampi trawl	1.037	0.974	0.425 – 2.004			3743	
Snapper BLL	0.601	0.447	0.011 – 2.110			4002	
Squid trawl	2.445	2.356	1.186 – 4.258			4002	
Southern bluefin SLL	2.026	1.811	0.545 – 4.805			3629	
Swordfish SLL	0.792	0.653	0.132 – 2.270			4002	
Area							
Auckland Islands	2.198	2.074	0.948 – 4.099			4002	
Cook Strait	0.741	0.665	0.216 – 1.714			4734	
East of North Island	1.046	0.897	0.182 – 2.772			3761	
Eastern Chatham Rise	0.189	0.171	0.057 – 0.415			3874	
East Subantarctic	0.258	0.164	0.001 – 1.036			4002	
Fiordland	1.274	1.193	0.521 – 2.477			4002	
Kermadec Islands	0.782	0.558	0.008 – 2.745			4257	
North East	0.742	0.634	0.119 – 2.016			3966	
South Subantarctic	0.193	0.147	0.014 – 0.627			4002	
Stewart Snares Shelf	2.489	2.365	1.075 – 4.544			4002	
Western Chatham Rise	0.417	0.395	0.162 – 0.814			4002	
West Coast North Island	1.313	1.155	0.240 – 3.282			3810	
West Coast South Island	1.301	1.234	0.537 – 2.465			4137	

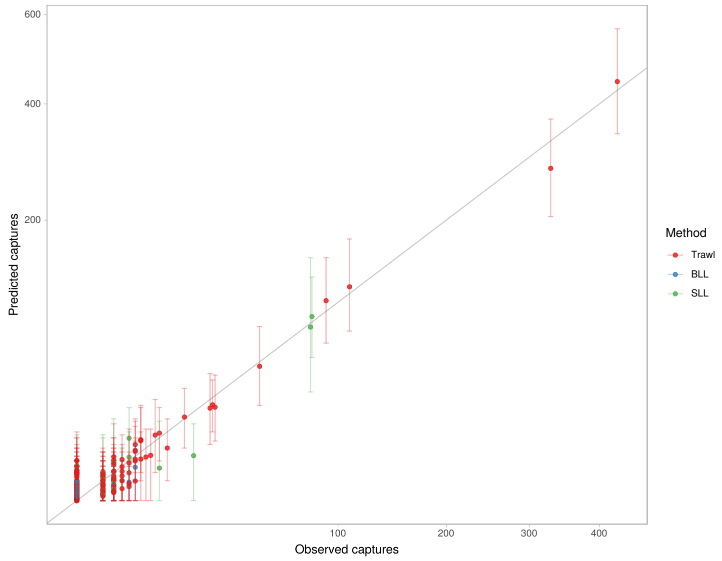


Figure A-1: Comparison between the observed and the predicted number of captures of white-capped albatross (represented by their mean and 95% credible interval), for each combination of region, fishery, vessel size, area, and season. The points were coloured according to the fishing method (BLL, bottom 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 six of these strata, representing 1.0% of all 620 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	5.14	0–15
Trawl	Squid trawl	Large	South	Stewart Snares Shelf	Winter (Jul-Sep)	93	5	0.97	0–4
BLL	Ling BLL – vessels < 34 m	Small	South	West Coast South Island	Autumn (Apr-Jun)	35	4	0.86	0–3
Trawl	Ling trawl	Small	South	West Coast South Island	Autumn (Apr-Jun)	37	4	0.50	0–3
Trawl	Inshore trawl	Small	North	West Coast North Island	Winter (Jul-Sep)	613	2	0.20	0–1
Trawl	Scampi trawl	Small	North	North East	Autumn (Apr-Jun)	379	2	0.16	0–1

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 2016–17 for bottom- and surface-longline fisheries, and between 2002–03 and 2016–17 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.

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Trawl									
Inshore trawl	Vessels < 28 m	Western Chatham Rise	Spring	4	155	0.008	472	630	263–1286
Middle depths trawl	Vessels < 28 m	Western Chatham Rise	Spring	0	63	0.010	0	430	160–993
Hoki trawl	Vessels ≥ 28 m	Eastern Chatham Rise	Spring	75	2456	0.236	317	303	193–460
Scampi trawl	Vessels < 28 m	Eastern Chatham Rise	Spring	11	541	0.092	120	299	149–546
Inshore trawl	Vessels < 28 m	Western Chatham Rise	Summer	13	438	0.018	705	284	123–558
Hoki trawl	Vessels ≥ 28 m	Western Chatham Rise	Spring	33	2444	0.187	176	269	172–402
Inshore trawl	Vessels < 28 m	Western Chatham Rise	Winter	0	142	0.011	0	214	81–454
Middle depths trawl	Vessels < 28 m	Western Chatham Rise	Summer	4	191	0.026	154	179	65–398
Inshore trawl	Vessels < 28 m	East of North Island	Spring	0	193	0.006	0	128	36–307
Middle depths trawl	Vessels < 28 m	Western Chatham Rise	Winter	0	29	0.008	0	118	40–281
Hoki trawl	Vessels ≥ 28 m	Eastern Chatham Rise	Summer	23	1663	0.137	167	116	69–179
Flatfish trawl	Vessels < 28 m	Western Chatham Rise	Spring	0	54	0.003	0	113	0–472
Hoki trawl	Vessels ≥ 28 m	Western Chatham Rise	Summer	10	1890	0.138	72	98	56–156
Scampi trawl	Vessels < 28 m	Eastern Chatham Rise	Summer	11	279	0.052	213	97	46–177
Middle depths trawl	Vessels ≥ 28 m	Eastern Chatham Rise	Spring	9	291	0.109	82	96	43–173
Surface longline									
Bigeye SLL	Vessels < 43 m	East of North Island	Summer	7	161	0.026	266	162	65–309
Bigeye SLL	Vessels < 43 m	East of North Island	Spring	0	13	0.015	0	66	24–132
Bigeye SLL	Vessels < 43 m	North East	Spring	2	233	0.034	59	45	10–111
Bigeye SLL	Vessels < 43 m	East of North Island	Autumn	1	96	0.021	46	32	10–69
Bigeye SLL	Vessels < 43 m	North East	Winter	0	102	0.013	0	24	4–63
Albacore SLL	Vessels < 43 m	East of North Island	Summer	0	7	0.011	0	14	0–52
Bigeye SLL	Vessels < 43 m	North East	Summer	0	160	0.029	0	13	2–33
Southern bluefin SLL	Vessels < 43 m	East of North Island	Winter	0	212	0.116	0	13	2–34
Southern bluefin SLL	Vessels < 43 m	East of North Island	Autumn	0	372	0.045	0	11	1–31
Albacore SLL	Vessels < 43 m	East of North Island	Autumn	1	23	0.015	68	9	0–38
Minor surface longline	Vessels < 43 m	East of North Island	Summer	0	9	0.017	0	8	0–37
Bigeye SLL	Vessels < 43 m	East of North Island	Winter	0	1	0.007	0	5	1–13
Bigeye SLL	Vessels < 43 m	Eastern Chatham Rise	Summer	0	1	0.067	0	5	0–18
Bigeye SLL	Vessels < 43 m	West Coast North Island	Winter	0	69	0.026	0	5	0–20
Albacore SLL	Vessels < 43 m	East of North Island	Spring	0	0	0.000		4	0–16
Bottom longline									
Ling BLL – vessels < 34 m	Vessels < 34 m	Western Chatham Rise	Spring	1	66	0.022	46	266	75–728
Ling BLL – vessels < 34 m	Vessels < 34 m	Eastern Chatham Rise	Spring	6	132	0.058	104	263	70–717
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Eastern Chatham Rise	Winter	2	1018	0.142	14	231	80–572
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Eastern Chatham Rise	Spring	18	460	0.135	133	228	69–579
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	East Subantarctic	Spring	100	557	0.424	235	221	43–694
Ling BLL – vessels < 34 m	Vessels < 34 m	Eastern Chatham Rise	Winter	22	174	0.047	469	205	64–503
Minor targets BLL	Vessels < 34 m	Eastern Chatham Rise	Spring	2	8	0.012	172	170	8–834
Hāpuku BLL	Vessels < 34 m	Eastern Chatham Rise	Spring	0	24	0.015	0	151	0–822
Ling BLL – vessels < 34 m	Vessels < 34 m	Western Chatham Rise	Winter	0	109	0.035	0	131	37–344
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Western Chatham Rise	Spring	0	58	0.024	0	121	31–328
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	East Subantarctic	Summer	22	522	0.366	60	116	22–332
Minor targets BLL	Vessels < 34 m	Western Chatham Rise	Spring	0	2	0.003	0	111	4–593
Minor targets BLL	Vessels < 34 m	Eastern Chatham Rise	Winter	0	0	0.000		78	3–370
Hāpuku BLL	Vessels < 34 m	Eastern Chatham Rise	Summer	0	0	0.000		76	0–408
Bluenose BLL	Vessels < 34 m	Eastern Chatham Rise	Spring	0	0	0.000		72	0–397

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 areas, 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
S.d.(Year)							
BLL	1.219	1.191	0.608 – 1.997			4002	
SLL	1.045	0.960	0.183 – 2.313			2650	
Trawl	0.519	0.505	0.284 – 0.831			4002	
S.d.(Area)	1.627	1.587	1.128 – 2.310			4002	
S.d.(Fishery)	1.054	1.028	0.662 – 1.586	1		4002	
Overdispersion							
BLL	12.173	11.992	8.652 – 16.603			4028	
SLL	1.384	1.184	0.413 – 3.478			3865	
Trawl	10.164	10.147	8.388 – 12.073			4392	
Intercept	0.024	0.017	0.005 – 0.085	1		4080	
Method / Vessel class							
BLL / vessels $\geq$ 34 m	2.246	1.179	0.211 – 11.031			4002	
SLL / vessels $\geq$ 43 m	53.558	25.540	2.923 – 261.529			4002	
Trawl / vessels $\geq$ 28 m	1.000	1.000	1.000 – 1.000	3			
BLL / vessels $<$ 34 m	6.144	3.565	0.619 – 26.505			4134	
SLL / vessels $<$ 43 m	27.194	18.047	3.194 – 103.802			3893	
Trawl / vessels $<$ 28 m	2.281	2.056	0.914 – 4.954			4241	
Region							
North	0.203	0.061	0.008 – 0.999			4002	
South	1.000	1.000	1.000 – 1.000	3			
Season							
Autumn (Apr-Jun)	0.095	0.092	0.052 – 0.152			4069	
Spring (Oct-Dec)	1.000	1.000	1.000 – 1.000	3			
Summer (Jan-Mar)	0.357	0.351	0.243 – 0.504			3874	
Winter (Jul-Sep)	0.501	0.489	0.321 – 0.743			3852	
Fishery							
Albacore SLL	1.353	1.072	0.122 – 4.430			3788	
Bigeye SLL	1.981	1.695	0.392 – 5.193			3538	
Bluenose BLL	0.568	0.351	0.002 – 2.375			4002	
Deepwater trawl	0.136	0.126	0.046 – 0.286	1		3897	
Flatfish trawl	0.149	0.081	0.001 – 0.661			4132	
Hake trawl	1.613	1.460	0.500 – 3.631			4002	
Hāpuku BLL	0.730	0.464	0.004 – 2.946			4201	
Hoki trawl	1.069	1.015	0.418 – 2.077			3847	
Inshore trawl	0.853	0.745	0.215 – 2.084			3738	
Ling (no IWL) BLL – vessels $\geq$ 34 m	2.042	1.714	0.243 – 5.824			4164	
Ling (IWL) BLL – vessels $\geq$ 34 m	0.120	0.053	0.000 – 0.627			4002	
Ling BLL – vessels $<$ 34 m	1.286	1.021	0.146 – 3.865	1		4002	
Ling trawl	1.757	1.578	0.552 – 3.947			3647	
Mackerel trawl	0.479	0.398	0.096 – 1.307			4002	
Middle depths trawl	1.564	1.485	0.613 – 3.021			3998	
Minor targets BLL	1.705	1.388	0.232 – 5.206			4162	
Minor surface longline	0.815	0.553	0.008 – 3.146			4115	
Southern blue whiting trawl	0.453	0.385	0.101 – 1.191			3912	
Scampi trawl	0.955	0.858	0.277 – 2.181			4002	
Snapper BLL	0.617	0.404	0.004 – 2.419			3999	
Squid trawl	1.608	1.491	0.585 – 3.290			4002	
Southern bluefin SLL	0.379	0.294	0.040 – 1.246			4002	
Swordfish SLL	0.736	0.500	0.006 – 2.802			4002	
Area							
Auckland Islands	0.037	0.028	0.004 – 0.123			4167	
Cook Strait	0.416	0.341	0.065 – 1.194			4254	
East of North Island	2.783	2.331	0.164 – 8.080			3870	
Eastern Chatham Rise	1.814	1.661	0.379 – 4.170			4124	
East Subantarctic	4.426	4.183	1.031 – 9.058			4002	
Fiordland	0.034	0.023	0.002 – 0.134			4002	
Kermadec Islands	0.223	0.053	0.000 – 1.529			3750	
North East	0.259	0.179	0.010 – 0.965			3731	
South Subantarctic	0.159	0.130	0.025 – 0.469			4034	
Stewart Snares Shelf	0.193	0.172	0.039 – 0.479			3895	
Western Chatham Rise	1.377	1.240	0.283 – 3.307			4002	
West Coast North Island	0.136	0.071	0.002 – 0.645			4392	
West Coast South Island	0.013	0.009	0.001 – 0.044			4002	

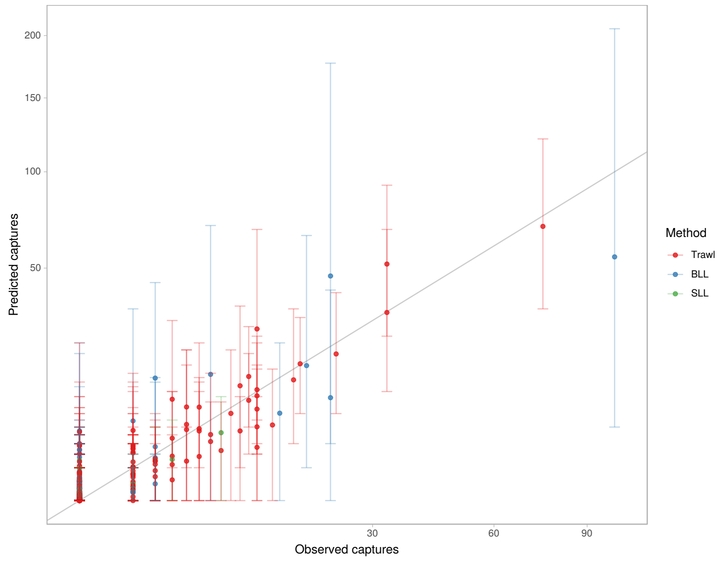


Figure A-2: Comparison between the observed and the predicted number of captures of Salvin's albatross (represented by their mean and 95% credible interval), for each combination of region, fishery, vessel size, area, and season. The points were coloured according to the fishing method (BLL, bottom longline; 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 620 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	Middle depths trawl	Large	South	Western Chatham Rise	Winter (Jul-Sep)	223	11	2.62	0–10
Trawl	Middle depths trawl	Small	South	West Coast South Island	Summer (Jan-Mar)	79	1	0.01	0–0
Trawl	Middle depths trawl	Small	South	West Coast South Island	Autumn (Apr-Jun)	6	1	0.00	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 2016–17 for bottom- and surface-longline fisheries, and between 2002–03 and 2016–17 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.

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Trawl									
Squid trawl	Vessels $\geq$ 28 m	Stewart Snares Shelf	Autumn	76	2918	0.324	234	183	119–266
Hoki trawl	Vessels $\geq$ 28 m	West Coast South Island	Winter	41	14364	0.332	123	105	70–147
Hoki trawl	Vessels $\geq$ 28 m	Stewart Snares Shelf	Autumn	18	1782	0.250	72	74	42–118
Squid trawl	Vessels $\geq$ 28 m	Stewart Snares Shelf	Summer	25	10155	0.377	66	74	48–108
Squid trawl	Vessels $\geq$ 28 m	Auckland Islands	Autumn	36	2969	0.379	95	72	41–113
Flatfish trawl	Vessels $<$ 28 m	Stewart Snares Shelf	Autumn	0	51	0.003	0	56	0–222
Hoki trawl	Vessels $\geq$ 28 m	Eastern Chatham Rise	Autumn	1	864	0.143	7	56	28–98
Hoki trawl	Vessels $\geq$ 28 m	West Coast South Island	Autumn	28	2444	0.360	77	56	32–88
Middle depths trawl	Vessels $\geq$ 28 m	Eastern Chatham Rise	Autumn	9	276	0.118	76	47	20–90
Middle depths trawl	Vessels $\geq$ 28 m	Stewart Snares Shelf	Autumn	23	868	0.409	56	46	22–81
Hoki trawl	Vessels $\geq$ 28 m	Western Chatham Rise	Autumn	9	2470	0.163	55	44	21–74
Squid trawl	Vessels $\geq$ 28 m	Fiordland	Autumn	8	296	0.216	37	43	16–87
Flatfish trawl	Vessels $<$ 28 m	West Coast South Island	Autumn	0	13	0.001	0	33	0–127
Middle depths trawl	Vessels $<$ 28 m	West Coast South Island	Autumn	0	6	0.003	0	30	6–88
Scampi trawl	Vessels $<$ 28 m	Auckland Islands	Autumn	1	603	0.112	8	28	8–62
Surface longline									
Bigeye SLL	Vessels $<$ 43 m	East of North Island	Autumn	0	96	0.021	0	747	268–1667
Southern bluefin SLL	Vessels $<$ 43 m	West Coast South Island	Autumn	81	326	0.118	688	636	334–1141
Southern bluefin SLL	Vessels $\geq$ 43 m	Fiordland	Autumn	422	3057	0.900	468	489	348–671
Southern bluefin SLL	Vessels $<$ 43 m	East of North Island	Autumn	18	372	0.045	401	462	241–814
Albacore SLL	Vessels $<$ 43 m	East of North Island	Autumn	0	23	0.015	0	275	64–805
Southern bluefin SLL	Vessels $<$ 43 m	Fiordland	Autumn	19	12	0.032	589	198	69–440
Bigeye SLL	Vessels $<$ 43 m	North East	Autumn	2	56	0.012	166	149	45–332
Bigeye SLL	Vessels $<$ 43 m	East of North Island	Summer	7	161	0.026	266	133	48–295
Bigeye SLL	Vessels $<$ 43 m	North East	Winter	2	102	0.013	148	80	25–186
Southern bluefin SLL	Vessels $<$ 43 m	West Coast South Island	Winter	2	46	0.057	35	62	25–122
Swordfish SLL	Vessels $<$ 43 m	West Coast South Island	Autumn	0	37	0.136	0	37	1–171
Southern bluefin SLL	Vessels $<$ 43 m	East of North Island	Winter	3	212	0.116	25	34	13–66
Southern bluefin SLL	Vessels $\geq$ 43 m	West Coast South Island	Autumn	16	333	0.915	17	24	7–51
Bigeye SLL	Vessels $<$ 43 m	North East	Summer	0	160	0.029	0	23	6–55
Albacore SLL	Vessels $<$ 43 m	West Coast South Island	Autumn	0	0	0.000		21	0–109
Bottom longline									
Bluenose BLL	Vessels $<$ 34 m	Eastern Chatham Rise	Autumn	2	29	0.018	112	76	15–209
Hāpuku BLL	Vessels $<$ 34 m	Eastern Chatham Rise	Autumn	0	0	0.000		54	0–249
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	West Coast South Island	Autumn	4	35	0.014	279	48	14–109
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	Eastern Chatham Rise	Winter	0	174	0.047	0	31	9–69
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	Eastern Chatham Rise	Autumn	1	43	0.043	23	25	7–54
Bluenose BLL	Vessels $<$ 34 m	East of North Island	Autumn	0	17	0.006	0	24	3–69
Ling (no IWL) BLL – vessels $\geq$ 34 m	Vessels $\geq$ 34 m	Eastern Chatham Rise	Autumn	0	157	0.066	0	23	6–51
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	Fiordland	Winter	0	3	0.002	0	22	5–54
Snapper BLL	Vessels $<$ 34 m	North East	Autumn	0	508	0.014	0	22	0–95
Ling (no IWL) BLL – vessels $\geq$ 34 m	Vessels $\geq$ 34 m	Eastern Chatham Rise	Winter	0	1018	0.142	0	20	5–47
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	West Coast South Island	Winter	0	6	0.002	0	20	5–46
Minor targets BLL	Vessels $<$ 34 m	Eastern Chatham Rise	Autumn	0	0	0.000		15	0–71
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	Western Chatham Rise	Autumn	0	55	0.031	0	14	3–34
Bluenose BLL	Vessels $<$ 34 m	Eastern Chatham Rise	Winter	0	2	0.002	0	13	1–37
Bluenose BLL	Vessels $<$ 34 m	Fiordland	Autumn	0	0	0.000		12	1–37

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 areas, 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
S.d.(Year)							
BLL	1.063	1.005	0.183 – 2.282			2895	
SLL	0.334	0.319	0.083 – 0.685			3859	
Trawl	0.408	0.397	0.201 – 0.681			4002	
S.d.(Area)	1.454	1.406	0.872 – 2.310			3217	
S.d.(Fishery)	1.025	0.996	0.639 – 1.587			3973	
Overdispersion							
BLL	1.452	1.234	0.411 – 3.795			4002	
SLL	5.946	5.921	4.481 – 7.531			4080	
Trawl	8.344	8.316	6.058 – 10.817			3885	
Intercept	0.145	0.097	0.024 – 0.555			4071	
Method / Vessel class							
BLL / vessels $\geq$ 34 m	0.087	0.040	0.005 – 0.406			3745	
SLL / vessels $\geq$ 43 m	1.000	1.000	1.000 – 1.000	3			
Trawl / vessels $\geq$ 28 m	0.101	0.078	0.017 – 0.326			4683	
BLL / vessels $<$ 34 m	0.292	0.181	0.030 – 1.236			4350	
SLL / vessels $<$ 43 m	3.743	3.512	1.740 – 6.953			4002	
Trawl / vessels $<$ 28 m	0.076	0.053	0.011 – 0.285			4002	
Region							
North	0.299	0.124	0.021 – 1.481			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)	0.086	0.084	0.046 – 0.144			3897	
Summer (Jan-Mar)	0.133	0.131	0.094 – 0.184			3891	
Winter (Jul-Sep)	0.334	0.329	0.232 – 0.460			3740	
Fishery							
Albacore SLL	1.794	1.547	0.380 – 4.725			4002	
Bigeye SLL	1.827	1.596	0.457 – 4.645			3891	
Bluenose BLL	1.705	1.413	0.307 – 4.767			4002	
Deepwater trawl	0.096	0.082	0.021 – 0.256			4012	
Flatfish trawl	0.406	0.259	0.003 – 1.596			3694	
Hake trawl	0.424	0.374	0.110 – 1.006			4113	
Hāpuku BLL	0.760	0.514	0.008 – 2.861			3888	
Hoki trawl	0.952	0.897	0.380 – 1.850			3940	
Inshore trawl	0.315	0.200	0.002 – 1.236			3867	
Ling (no IWL) BLL – vessels $\geq$ 34 m	1.781	1.491	0.248 – 5.059			4002	
Ling (IWL) BLL – vessels $\geq$ 34 m	0.306	0.174	0.001 – 1.361			4002	
Ling BLL – vessels $<$ 34 m	1.053	0.856	0.181 – 3.008			4113	
Ling trawl	1.458	1.310	0.434 – 3.403			4002	
Mackerel trawl	0.524	0.465	0.134 – 1.257			3864	
Middle depths trawl	1.990	1.883	0.817 – 3.836			4047	
Minor targets BLL	0.597	0.400	0.005 – 2.341	1		4201	
Minor surface longline	0.832	0.574	0.007 – 3.077			4002	
Southern blue whiting trawl	0.894	0.656	0.057 – 3.063	1		4099	
Scampi trawl	1.662	1.480	0.444 – 3.948			4002	
Snapper BLL	0.605	0.405	0.004 – 2.350			4002	
Squid trawl	1.978	1.862	0.812 – 3.764			4502	
Southern bluefin SLL	0.657	0.566	0.146 – 1.688			4195	
Swordfish SLL	0.333	0.212	0.015 – 1.338			4176	
Area							
Auckland Islands	0.735	0.668	0.189 – 1.659			3817	
Cook Strait	0.056	0.021	0.000 – 0.320			3872	
East of North Island	2.735	2.330	0.237 – 7.748			4002	
Eastern Chatham Rise	1.715	1.559	0.423 – 3.944			3826	
East Subantarctic	0.190	0.066	0.000 – 1.116			4382	
Fiordland	2.927	2.666	0.777 – 6.636			3816	
Kermadec Islands	0.294	0.100	0.000 – 1.765			3868	
North East	0.572	0.433	0.037 – 1.915			4433	
South Subantarctic	0.108	0.065	0.003 – 0.470			4002	
Stewart Snares Shelf	1.773	1.614	0.481 – 3.870			3978	
Western Chatham Rise	0.516	0.465	0.126 – 1.212			4004	
West Coast North Island	0.083	0.026	0.000 – 0.493			4002	
West Coast South Island	1.295	1.186	0.341 – 2.860			3899	

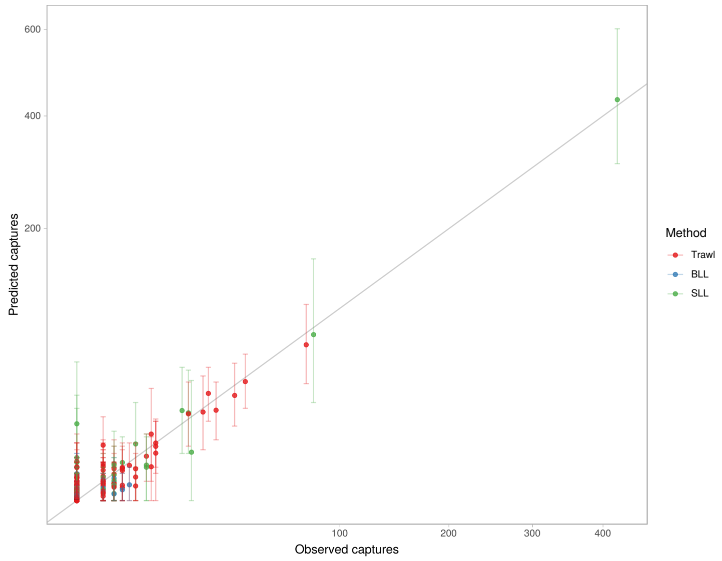


Figure A-3: Comparison between the observed and the predicted number of captures of Buller's albatrosses (represented by their mean and 95% credible interval), for each combination of region, fishery, vessel size, area, and season. The points were coloured according to the fishing method (BLL, bottom 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 eight of these strata, representing 1.3% of all 620 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	Autumn (Apr-Jun)	96	0	15.95	1–52
Trawl	Hoki trawl	Large	South	Eastern Chatham Rise	Autumn (Apr-Jun)	864	1	8.29	2–19
BLL	Ling BLL – vessels $<$ 34 m	Small	South	West Coast South Island	Autumn (Apr-Jun)	35	4	0.67	0–3
Trawl	Middle depths trawl	Large	South	Eastern Chatham Rise	Spring (Oct-Dec)	291	5	0.57	0–3
Trawl	Scampi trawl	Small	South	Eastern Chatham Rise	Summer (Jan-Mar)	279	3	0.45	0–2
BLL	Ling (no IWL) BLL – vessels $\geq$ 34 m	Large	South	Eastern Chatham Rise	Spring (Oct-Dec)	460	3	0.32	0–2
SLL	Southern bluefin SLL	Large	North	East of North Island	Autumn (Apr-Jun)	9	2	0.13	0–1
BLL	Ling (no IWL) BLL – vessels $\geq$ 34 m	Large	South	Western Chatham Rise	Winter (Jul-Sep)	47	2	0.12	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 2016–17 for bottom- and surface-longline fisheries, and between 2002–03 and 2016–17 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.

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Trawl									
Inshore trawl	Vessels $<$ 28 m	East of North Island	Spring	0	193	0.006	0	33	6–85
Flatfish trawl	Vessels $<$ 28 m	Stewart Snares Shelf	Spring	0	7	0.000	0	20	1–70
Hoki trawl	Vessels $\geq$ 28 m	Eastern Chatham Rise	Spring	2	2456	0.236	8	18	7–34
Hoki trawl	Vessels $\geq$ 28 m	West Coast South Island	Winter	8	14364	0.332	24	18	7–34
Squid trawl	Vessels $\geq$ 28 m	Stewart Snares Shelf	Summer	7	10155	0.377	18	17	6–32
Inshore trawl	Vessels $<$ 28 m	East of North Island	Winter	0	187	0.007	0	15	2–41
Deepwater trawl	Vessels $\geq$ 28 m	Eastern Chatham Rise	Spring	6	2781	0.271	22	13	4–26
Inshore trawl	Vessels $<$ 28 m	North East	Spring	0	1119	0.036	0	13	2–35
Flatfish trawl	Vessels $<$ 28 m	Western Chatham Rise	Spring	0	54	0.003	0	12	0–42
Hoki trawl	Vessels $\geq$ 28 m	Western Chatham Rise	Spring	2	2444	0.187	10	12	3–24
Inshore trawl	Vessels $<$ 28 m	East of North Island	Autumn	0	170	0.007	0	11	1–31
Inshore trawl	Vessels $<$ 28 m	Western Chatham Rise	Spring	0	155	0.008	0	11	1–31
Southern blue whiting trawl	Vessels $\geq$ 28 m	South Subantarctic	Winter	7	5503	0.570	12	11	3–22
Scampi trawl	Vessels $<$ 28 m	Eastern Chatham Rise	Spring	2	541	0.092	21	10	2–25
Inshore trawl	Vessels $<$ 28 m	East of North Island	Summer	0	265	0.010	0	9	1–25
Surface longline									
Southern bluefin SLL	Vessels $<$ 43 m	East of North Island	Autumn	15	372	0.045	334	484	264–832
Bigeye SLL	Vessels $<$ 43 m	North East	Spring	23	233	0.034	684	441	231–756
Bigeye SLL	Vessels $<$ 43 m	East of North Island	Autumn	0	96	0.021	0	331	134–663
Bigeye SLL	Vessels $<$ 43 m	East of North Island	Summer	6	161	0.026	228	319	136–651
Bigeye SLL	Vessels $<$ 43 m	North East	Winter	2	102	0.013	148	252	118–471
Albacore SLL	Vessels $<$ 43 m	East of North Island	Autumn	0	23	0.015	0	218	64–533
Bigeye SLL	Vessels $<$ 43 m	East of North Island	Spring	1	13	0.015	67	142	53–297
Bigeye SLL	Vessels $<$ 43 m	North East	Autumn	1	56	0.012	83	138	62–259
Southern bluefin SLL	Vessels $<$ 43 m	East of North Island	Winter	14	212	0.116	120	121	59–221
Bigeye SLL	Vessels $<$ 43 m	North East	Summer	3	160	0.029	103	114	52–217
Southern bluefin SLL	Vessels $<$ 43 m	North East	Winter	6	400	0.109	55	101	46–189
Southern bluefin SLL	Vessels $<$ 43 m	West Coast South Island	Autumn	12	326	0.118	101	80	36–148
Albacore SLL	Vessels $<$ 43 m	East of North Island	Summer	0	7	0.011	0	62	14–169
Swordfish SLL	Vessels $<$ 43 m	East of North Island	Autumn	0	12	0.055	0	61	12–174
Swordfish SLL	Vessels $<$ 43 m	West Coast South Island	Summer	1	20	0.044	22	45	10–125
Bottom longline									
Bluenose BLL	Vessels $<$ 34 m	East of North Island	Spring	0	0	0.000		152	24–517
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	East of North Island	Spring	0	36	0.011	0	119	29–334
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	East of North Island	Winter	2	93	0.015	130	112	31–274
Snapper BLL	Vessels $<$ 34 m	North East	Spring	0	535	0.013	0	97	3–346
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	Eastern Chatham Rise	Spring	3	132	0.058	52	85	23–215
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	Eastern Chatham Rise	Winter	13	174	0.047	277	70	21–164
Bluenose BLL	Vessels $<$ 34 m	North East	Spring	0	27	0.005	0	61	10–193
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	Western Chatham Rise	Spring	0	66	0.022	0	59	13–164
Ling (no IWL) BLL – vessels $\geq$ 34 m	Vessels $\geq$ 34 m	Eastern Chatham Rise	Spring	4	460	0.135	29	53	14–133
Ling (no IWL) BLL – vessels $\geq$ 34 m	Vessels $\geq$ 34 m	Eastern Chatham Rise	Winter	8	1018	0.142	56	52	16–123
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	West Coast South Island	Spring	0	2	0.001	0	50	11–144
Bluenose BLL	Vessels $<$ 34 m	East of North Island	Winter	0	14	0.005	0	46	7–145
Hāpuku BLL	Vessels $<$ 34 m	Eastern Chatham Rise	Spring	0	24	0.015	0	43	3–164
Ling BLL – vessels $<$ 34 m	Vessels $<$ 34 m	Cook Strait	Spring	0	0	0.000		40	5–138
Snapper BLL	Vessels $<$ 34 m	North East	Winter	0	0	0.000		40	1–144

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 areas, 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
S.d.(Year)							
BLL	1.368	1.344	0.545 – 2.304			4002	
SLL	0.417	0.381	0.090 – 0.962			3823	
Trawl	0.314	0.296	0.080 – 0.662			4002	
S.d.(Area)	0.743	0.722	0.446 – 1.191			4127	
S.d.(Fishery)	0.714	0.697	0.345 – 1.178			4002	
Overdispersion							
BLL	12.457	12.208	8.035 – 17.994			3393	
SLL	5.989	5.946	4.700 – 7.466			4002	
Trawl	1.161	1.024	0.389 – 2.858			4127	
Intercept	0.185	0.149	0.049 – 0.529			4112	
Method / Vessel class							
BLL / vessels $\geq$ 34 m	0.136	0.052	0.010 – 0.421			4002	
SLL / vessels $\geq$ 43 m	0.842	0.791	0.382 – 1.624			4263	
Trawl / vessels $\geq$ 28 m	0.008	0.007	0.002 – 0.023			3822	
BLL / vessels $<$ 34 m	0.108	0.083	0.021 – 0.342			3556	
SLL / vessels $<$ 43 m	1.000	1.000	1.000 – 1.000	3			
Trawl / vessels $<$ 28 m	0.007	0.005	0.001 – 0.021			4002	
Region							
North	1.000	1.000	1.000 – 1.000	3			
South	1.275	1.083	0.341 – 3.322			4115	
Season							
Autumn (Apr-Jun)	0.469	0.453	0.265 – 0.749			4002	
Spring (Oct-Dec)	1.000	1.000	1.000 – 1.000	3			
Summer (Jan-Mar)	0.333	0.319	0.182 – 0.557			4002	
Winter (Jul-Sep)	0.532	0.515	0.310 – 0.860			4002	
Fishery							
Albacore SLL	1.165	1.056	0.344 – 2.613			4140	
Bigeye SLL	0.649	0.602	0.194 – 1.370			4002	
Bluenose BLL	1.246	1.107	0.308 – 2.938			4155	
Deepwater trawl	0.728	0.684	0.279 – 1.422			4139	
Flatfish trawl	0.771	0.680	0.051 – 2.159			4215	
Hake trawl	0.810	0.741	0.205 – 1.797			4131	
Hāpuku BLL	1.052	0.913	0.156 – 2.767			4002	
Hoki trawl	1.004	0.956	0.454 – 1.853			3917	
Inshore trawl	0.784	0.704	0.153 – 1.916			4140	
Ling (no IWL) BLL – vessels $\geq$ 34 m	1.021	0.904	0.185 – 2.541			4002	
Ling (IWL) BLL – vessels $\geq$ 34 m	0.736	0.648	0.104 – 1.907			4230	
Ling BLL – vessels $<$ 34 m	1.655	1.486	0.506 – 3.870			4002	
Ling trawl	1.005	0.917	0.254 – 2.276			3937	
Mackerel trawl	0.430	0.351	0.017 – 1.241			4323	
Middle depths trawl	0.938	0.883	0.353 – 1.837			4002	
Minor targets BLL	0.885	0.774	0.124 – 2.332			4158	
Minor surface longline	0.711	0.594	0.029 – 2.110			4002	
Southern blue whiting trawl	1.653	1.506	0.622 – 3.563			3983	
Scampi trawl	1.151	1.050	0.344 – 2.456			4002	
Snapper BLL	0.288	0.203	0.006 – 0.998			4013	
Squid trawl	1.600	1.501	0.686 – 3.086			4182	
Southern bluefin SLL	0.531	0.492	0.168 – 1.130			3630	
Swordfish SLL	2.301	2.093	0.908 – 5.087			4177	
Area							
Auckland Islands	1.204	1.127	0.504 – 2.305			4205	
Cook Strait	1.010	0.925	0.270 – 2.289			3119	
East of North Island	1.867	1.733	0.666 – 3.775			4247	
Eastern Chatham Rise	1.742	1.665	0.860 – 3.112			4002	
East Subantarctic	0.526	0.453	0.069 – 1.454			3880	
Fiordland	0.248	0.225	0.080 – 0.541			4002	
Kermadec Islands	1.189	1.070	0.335 – 2.749			3622	
North East	0.765	0.711	0.253 – 1.599			4112	
South Subantarctic	1.317	1.228	0.532 – 2.525			4002	
Stewart Snares Shelf	1.218	1.153	0.569 – 2.202			3825	
Western Chatham Rise	0.883	0.828	0.348 – 1.730			4002	
West Coast North Island	0.224	0.188	0.040 – 0.599			4358	
West Coast South Island	0.823	0.776	0.345 – 1.526			4745	

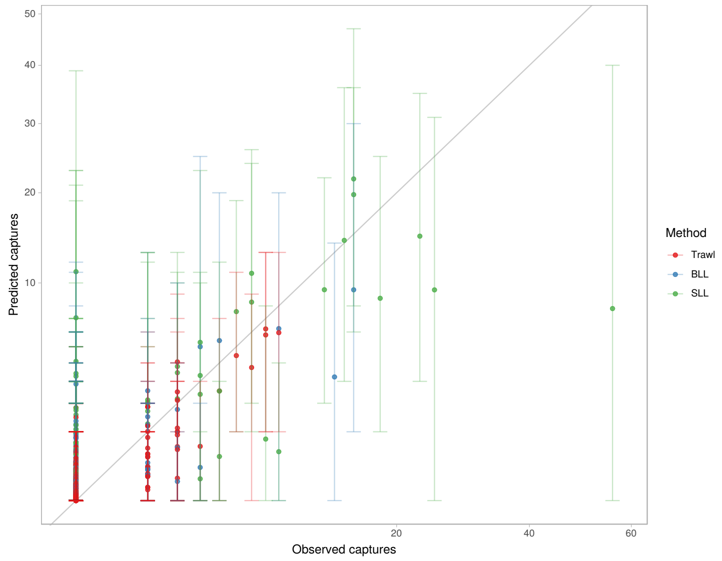


Figure A-4: Comparison between the observed and the predicted number of captures of other albatrosses (represented by their mean and 95% credible interval), for each combination of region, fishery, vessel size, area, and season. The points were coloured according to the fishing method (BLL, bottom longline; 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 eight of these strata, representing 1.3% of all 620 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	7.78	0–40
SLL	Southern bluefin SLL	Large	North	East of North Island	Autumn (Apr-Jun)	9	8	0.50	0–4
SLL	Bigeye SLL	Small	North	West Coast North Island	Spring (Oct-Dec)	23	4	0.41	0–3
BLL	Bluenose BLL	Small	North	North East	Autumn (Apr-Jun)	46	3	0.23	0–2
Trawl	Scampi trawl	Small	North	North East	Autumn (Apr-Jun)	379	2	0.11	0–1
SLL	Southern bluefin SLL	Small	South	Fiordland	Autumn (Apr-Jun)	12	3	0.10	0–1
BLL	Ling (no IWL) BLL – vessels $\geq$ 34 m	Large	South	Auckland Islands	Autumn (Apr-Jun)	20	2	0.08	0–1
Trawl	Hoki trawl	Large	South	South Subantarctic	Summer (Jan-Mar)	57	1	0.02	0–0

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 2016–17 for bottom- and surface-longline fisheries, and between 2002–03 and 2016–17 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.

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Trawl									
Squid trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Summer	516	10155	0.377	1370	1210	880–1626
Squid trawl	Vessels ≥ 28 m	Auckland Islands	Summer	460	7259	0.488	941	877	595–1229
Squid trawl	Vessels ≥ 28 m	Auckland Islands	Autumn	96	2969	0.379	253	214	128–327
Squid trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Autumn	153	2918	0.324	472	181	111–275
Ling trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Spring	12	918	0.189	63	105	38–234
Middle depths trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Spring	29	1698	0.304	95	96	48–166
Scampi trawl	Vessels ≥ 28 m	Auckland Islands	Spring	1	412	0.174	5	92	25–231
Hoki trawl	Vessels ≥ 28 m	Eastern Chatham Rise	Summer	5	1663	0.137	36	87	47–146
Middle depths trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Summer	78	1725	0.587	132	76	37–136
Hoki trawl	Vessels ≥ 28 m	Western Chatham Rise	Summer	10	1890	0.138	72	75	41–126
Hoki trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Spring	5	1529	0.239	20	62	30–111
Hoki trawl	Vessels ≥ 28 m	Eastern Chatham Rise	Spring	24	2456	0.236	101	59	30–99
Hoki trawl	Vessels ≥ 28 m	Western Chatham Rise	Spring	16	2444	0.187	85	51	27–87
Squid trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Spring	0	139	0.096	0	49	17–107
Hoki trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Autumn	9	1782	0.250	36	46	23–80
Surface longline									
Bigeye SLL	Vessels < 43 m	East of North Island	Summer	3	161	0.026	114	156	38–440
Swordfish SLL	Vessels < 43 m	West Coast South Island	Summer	3	20	0.044	67	93	9–404
Albacore SLL	Vessels < 43 m	Eastern Chatham Rise	Summer	0	0	0.000		92	0–669
Bigeye SLL	Vessels < 43 m	North East	Summer	0	160	0.029	0	80	17–231
Bigeye SLL	Vessels < 43 m	North East	Spring	1	233	0.034	29	79	17–226
Albacore SLL	Vessels < 43 m	East of North Island	Autumn	0	23	0.015	0	60	4–255
Albacore SLL	Vessels < 43 m	East of North Island	Summer	0	7	0.011	0	55	4–242
Bigeye SLL	Vessels < 43 m	East of North Island	Autumn	0	96	0.021	0	50	10–144
Albacore SLL	Vessels < 43 m	Western Chatham Rise	Summer	0	0	0.000		40	0–277
Southern bluefin SLL	Vessels ≥ 43 m	Fiordland	Autumn	21	3057	0.900	23	35	16–65
Bigeye SLL	Vessels < 43 m	West Coast North Island	Summer	0	60	0.023	0	33	5–103
Bigeye SLL	Vessels < 43 m	North East	Autumn	1	56	0.012	83	30	5–88
Bigeye SLL	Vessels < 43 m	Eastern Chatham Rise	Summer	0	1	0.067	0	25	0–161
Swordfish SLL	Vessels < 43 m	West Coast South Island	Autumn	2	37	0.136	14	25	1–107
Albacore SLL	Vessels < 43 m	Cook Strait	Summer	0	0	0.000		23	0–153
Bottom longline									
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Stewart Snares Shelf	Spring	143	936	0.480	298	964	351–2155
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Eastern Chatham Rise	Spring	366	460	0.135	2716	846	365–1764
Ling BLL – vessels < 34 m	Vessels < 34 m	Eastern Chatham Rise	Spring	24	132	0.058	417	819	219–2268
Ling BLL – vessels < 34 m	Vessels < 34 m	Western Chatham Rise	Spring	3	66	0.022	139	806	219–2337
Ling BLL – vessels < 34 m	Vessels < 34 m	Eastern Chatham Rise	Summer	0	8	0.005	0	652	161–1864
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Eastern Chatham Rise	Summer	40	285	0.149	269	627	197–1558
Bluenose BLL	Vessels < 34 m	Eastern Chatham Rise	Summer	0	32	0.018	0	510	23–2466
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	East Subantarctic	Summer	82	522	0.366	224	478	129–1329
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Western Chatham Rise	Spring	5	58	0.024	207	409	141–976
Hāpuku BLL	Vessels < 34 m	Eastern Chatham Rise	Summer	0	0	0.000		398	0–2604
Ling BLL – vessels < 34 m	Vessels < 34 m	Western Chatham Rise	Summer	0	2	0.002	0	377	81–1133
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Eastern Chatham Rise	Autumn	30	157	0.066	456	376	138–867
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	South Subantarctic	Summer	13	12	0.007	1785	337	79–962
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Western Chatham Rise	Summer	6	65	0.044	136	333	96–875
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	East Subantarctic	Spring	68	557	0.424	160	320	84–880

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 areas, 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
S.d.(Year)							
BLL	0.829	0.824	0.335 – 1.331			4287	
SLL	0.529	0.483	0.115 – 1.197			3578	
Trawl	0.644	0.628	0.429 – 0.951			3857	
S.d.(Area)	0.807	0.780	0.490 – 1.265			4002	
S.d.(Fishery)	1.230	1.208	0.848 – 1.748	1		4154	
Overdispersion							
BLL	11.668	11.602	9.487 – 14.384			3565	
SLL	7.951	7.772	4.285 – 12.679			3873	
Trawl	12.213	12.185	10.568 – 14.088			4002	
Intercept	0.017	0.014	0.005 – 0.048			3856	
Method / Vessel class							
BLL / vessels $\geq$ 34 m	15.540	9.671	1.827 – 64.184			4002	
SLL / vessels $\geq$ 43 m	115.389	53.272	6.487 – 597.984			4002	
Trawl / vessels $\geq$ 28 m	1.000	1.000	1.000 – 1.000	3			
BLL / vessels $<$ 34 m	35.278	20.985	3.795 – 150.800			4002	
SLL / vessels $<$ 43 m	230.741	107.714	14.116 – 1173.551			3646	
Trawl / vessels $<$ 28 m	0.178	0.158	0.055 – 0.427			4002	
Region							
North	0.024	0.016	0.003 – 0.089			4002	
South	1.000	1.000	1.000 – 1.000	3			
Season							
Autumn (Apr-Jun)	0.441	0.436	0.327 – 0.586			4002	
Spring (Oct-Dec)	0.806	0.793	0.544 – 1.145			3226	
Summer (Jan-Mar)	1.000	1.000	1.000 – 1.000	3			
Winter (Jul-Sep)	0.013	0.012	0.004 – 0.028			4002	
Fishery							
Albacore SLL	2.579	2.136	0.378 – 7.319			3868	
Bigeye SLL	1.053	0.811	0.116 – 3.357			3683	
Bluenose BLL	0.861	0.587	0.040 – 3.298			3950	
Deepwater trawl	0.033	0.027	0.005 – 0.097			4002	
Flatfish trawl	0.254	0.120	0.000 – 1.252			4598	
Hake trawl	0.214	0.178	0.043 – 0.586			4002	
Hāpuku BLL	0.503	0.215	0.000 – 2.585			3634	
Hoki trawl	0.601	0.561	0.194 – 1.228			3576	
Inshore trawl	0.686	0.500	0.043 – 2.429			4002	
Ling (no IWL) BLL – vessels $\geq$ 34 m	2.771	2.361	0.493 – 7.348			4002	
Ling (IWL) BLL – vessels $\geq$ 34 m	0.553	0.439	0.072 – 1.664			3873	
Ling BLL – vessels $<$ 34 m	1.672	1.352	0.241 – 4.953			3798	
Ling trawl	1.027	0.891	0.258 – 2.544			4002	
Mackerel trawl	0.900	0.804	0.262 – 2.088			3915	
Middle depths trawl	0.978	0.911	0.335 – 1.993			3551	
Minor targets BLL	0.665	0.504	0.075 – 2.235			3872	
Minor surface longline	0.717	0.364	0.001 – 3.547			4002	
Southern blue whiting trawl	0.295	0.150	0.000 – 1.432			3756	
Scampi trawl	2.694	2.448	0.845 – 5.908			3942	
Snapper BLL	0.198	0.076	0.000 – 1.088			3455	
Squid trawl	2.399	2.217	0.824 – 4.904			3935	
Southern bluefin SLL	0.075	0.047	0.004 – 0.318			3810	
Swordfish SLL	1.145	0.874	0.107 – 3.816			3835	
Area							
Auckland Islands	2.357	2.255	1.172 – 4.120			4701	
Cook Strait	0.399	0.343	0.085 – 1.035			4115	
East of North Island	1.251	1.121	0.262 – 2.922			4280	
Eastern Chatham Rise	1.019	0.975	0.466 – 1.815			4002	
East Subantarctic	0.997	0.903	0.331 – 2.250			3841	
Fiordland	0.721	0.671	0.272 – 1.490			4166	
Kermadec Islands	1.271	1.097	0.210 – 3.464			4002	
North East	0.732	0.632	0.127 – 1.903			4002	
South Subantarctic	0.799	0.729	0.287 – 1.710			4002	
Stewart Snares Shelf	1.947	1.859	0.982 – 3.347			4405	
Western Chatham Rise	0.745	0.710	0.346 – 1.346			4702	
West Coast North Island	0.612	0.511	0.091 – 1.704			4450	
West Coast South Island	0.126	0.110	0.031 – 0.313			4002	

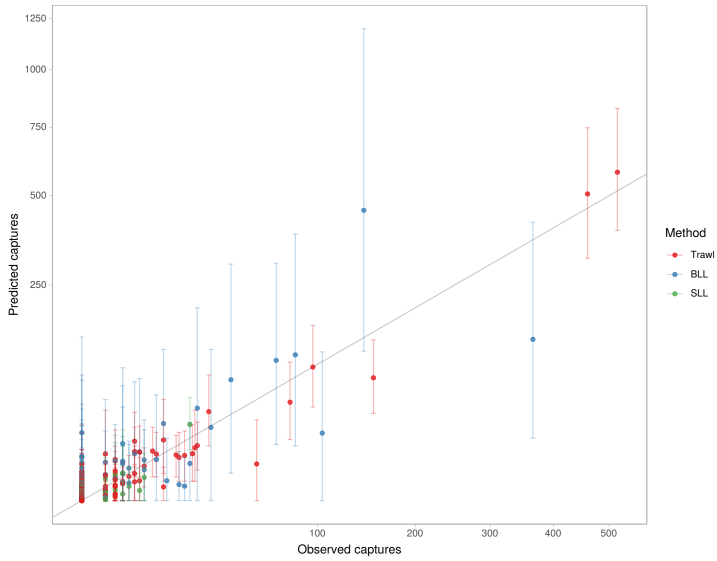


Figure A-5: Comparison between the observed and the predicted number of captures of white-chinned petrel (represented by their mean and 95% credible interval), for each combination of region, fishery, vessel size, area, and season. The points were coloured according to the fishing method (BLL, bottom 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 620 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)	2918	153	81.16	41–139
Trawl	Hoki trawl	Large	South	Stewart Snares Shelf	Spring (Oct-Dec)	1529	5	18.96	6–42
Trawl	Scampi trawl	Large	South	Auckland Islands	Summer (Jan-Mar)	111	55	7.22	0–35
BLL	Minor targets BLL	Small	South	Eastern Chatham Rise	Spring (Oct-Dec)	8	17	1.38	0–13
BLL	Ling BLL – vessels $<$ 34 m	Small	South	West Coast South Island	Summer (Jan-Mar)	23	19	1.13	0–10
Trawl	Scampi trawl	Small	South	Auckland Islands	Summer (Jan-Mar)	81	12	1.00	0–6
SLL	Southern bluefin SLL	Large	South	South Subantarctic	Autumn (Apr-Jun)	55	6	0.55	0–4
SLL	Bigeye SLL	Small	North	West Coast North Island	Spring (Oct-Dec)	23	3	0.23	0–2
Trawl	Hoki trawl	Large	South	Fiordland	Spring (Oct-Dec)	33	2	0.07	0–1
BLL	Ling (no IWL) BLL – vessels $\geq$ 34 m	Large	South	Stewart Snares Shelf	Winter (Jul-Sep)	4	1	0.03	0–0
SLL	Bigeye SLL	Small	North	North East	Winter (Jul-Sep)	102	1	0.02	0–0
SLL	Southern bluefin SLL	Small	North	North East	Winter (Jul-Sep)	400	1	0.00	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 2016–17 for bottom- and surface-longline fisheries, and between 2002–03 and 2016–17 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.

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Trawl									
Inshore trawl	Vessels < 28 m	North East	Autumn	20	1540	0.051	395	280	162–432
Inshore trawl	Vessels < 28 m	North East	Summer	8	1261	0.036	222	234	126–377
Inshore trawl	Vessels < 28 m	North East	Spring	0	1119	0.036	0	93	34–181
Inshore trawl	Vessels < 28 m	East of North Island	Autumn	0	170	0.007	0	10	1–30
Inshore trawl	Vessels < 28 m	East of North Island	Summer	0	265	0.010	0	8	0–25
Inshore trawl	Vessels < 28 m	North East	Winter	0	894	0.032	0	7	0–31
Inshore trawl	Vessels < 28 m	East of North Island	Spring	0	193	0.006	0	4	0–17
Inshore trawl	Vessels < 28 m	West Coast North Island	Autumn	0	912	0.057	0	4	0–14
Middle depths trawl	Vessels < 28 m	North East	Autumn	0	44	0.040	0	4	0–19
Flatfish trawl	Vessels < 28 m	West Coast North Island	Autumn	0	1	0.000	0	3	0–19
Inshore trawl	Vessels < 28 m	West Coast North Island	Summer	0	1231	0.058	0	3	0–14
Hoki trawl	Vessels < 28 m	North East	Autumn	0	32	0.055	0	2	0–13
Inshore trawl	Vessels < 28 m	West Coast North Island	Spring	0	704	0.029	0	2	0–8
Scampi trawl	Vessels < 28 m	North East	Autumn	0	379	0.179	0	2	0–9
Scampi trawl	Vessels < 28 m	North East	Summer	0	172	0.051	0	2	0–11
Surface longline									
Bigeye SLL	Vessels < 43 m	North East	Autumn	0	56	0.012	0	895	353–2116
Bigeye SLL	Vessels < 43 m	North East	Summer	10	160	0.029	345	746	341–1686
Bigeye SLL	Vessels < 43 m	North East	Spring	21	233	0.034	624	385	206–667
Albacore SLL	Vessels < 43 m	North East	Autumn	0	1	0.002	0	234	21–1058
Minor surface longline	Vessels < 43 m	North East	Summer	3	23	0.059	50	109	15–425
Albacore SLL	Vessels < 43 m	North East	Summer	0	0	0.000		46	2–215
Albacore SLL	Vessels < 43 m	North East	Spring	2	1	0.004	566	44	3–182
Swordfish SLL	Vessels < 43 m	North East	Summer	2	31	0.063	31	43	5–167
Bigeye SLL	Vessels < 43 m	North East	Winter	0	102	0.013	0	37	1–151
Bigeye SLL	Vessels < 43 m	East of North Island	Autumn	0	96	0.021	0	35	5–97
Swordfish SLL	Vessels < 43 m	North East	Autumn	0	16	0.058	0	34	3–136
Bigeye SLL	Vessels < 43 m	East of North Island	Summer	3	161	0.026	114	33	5–93
Albacore SLL	Vessels < 43 m	East of North Island	Autumn	0	23	0.015	0	32	1–145
Minor surface longline	Vessels < 43 m	North East	Autumn	0	0	0.000		20	1–99
Albacore SLL	Vessels < 43 m	East of North Island	Summer	0	7	0.011	0	9	0–40
Bottom longline									
Bluenose BLL	Vessels < 34 m	North East	Autumn	0	46	0.010	0	1564	492–3798
Bluenose BLL	Vessels < 34 m	North East	Summer	43	85	0.013	3243	1482	566–3300
Snapper BLL	Vessels < 34 m	North East	Autumn	21	508	0.014	1486	1098	612–1847
Snapper BLL	Vessels < 34 m	North East	Summer	14	743	0.020	714	833	473–1376
Bluenose BLL	Vessels < 34 m	North East	Spring	4	27	0.005	754	527	164–1303
Snapper BLL	Vessels < 34 m	North East	Spring	2	535	0.013	157	417	163–830
Hāpuku BLL	Vessels < 34 m	North East	Autumn	3	26	0.017	178	168	18–611
Hāpuku BLL	Vessels < 34 m	North East	Summer	0	5	0.003	0	153	15–571
Minor targets BLL	Vessels < 34 m	North East	Autumn	0	26	0.018	0	77	6–294
Hāpuku BLL	Vessels < 34 m	North East	Spring	0	3	0.002	0	63	5–252
Minor targets BLL	Vessels < 34 m	North East	Summer	2	37	0.025	81	56	5–218
Bluenose BLL	Vessels < 34 m	East of North Island	Summer	0	50	0.012	0	40	5–127
Bluenose BLL	Vessels < 34 m	North East	Winter	0	15	0.003	0	39	1–170
Bluenose BLL	Vessels < 34 m	East of North Island	Autumn	0	17	0.006	0	37	4–120
Ling BLL – vessels < 34 m	Vessels < 34 m	North East	Autumn	0	0	0.000		34	0–192

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 areas, 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
S.d.(Year)							
BLL	0.940	0.810	0.140 – 2.344			1926	
SLL	0.833	0.713	0.130 – 2.131			2073	
Trawl	0.929	0.794	0.142 – 2.354			1896	
S.d.(Area)	1.520	1.461	0.845 – 2.471			4002	
S.d.(Fishery)	1.337	1.298	0.758 – 2.133			3652	
Overdispersion							
BLL	6.302	6.177	3.970 – 9.265			4002	
SLL	4.172	4.138	1.626 – 6.798			3867	
Trawl	2.141	1.322	0.407 – 10.039			4226	
Intercept	0.081	0.027	0.005 – 0.331			4002	
Method / Vessel class							
BLL / vessels $\geq$ 34 m	1.348	0.036	0.000 – 6.641			4010	
SLL / vessels $\geq$ 43 m	1.659	0.344	0.017 – 9.364			4002	
Trawl / vessels $\geq$ 28 m	0.007	0.001	0.000 – 0.055	1		4082	
BLL / vessels $<$ 34 m	1.000	1.000	1.000 – 1.000	3			
SLL / vessels $<$ 43 m	5.608	2.187	0.328 – 20.114			4002	
Trawl / vessels $<$ 28 m	0.076	0.045	0.006 – 0.325			4002	
Region							
North	1.000	1.000	1.000 – 1.000	3			
South	0.019	0.002	0.000 – 0.113			4002	
Season							
Autumn (Apr-Jun)	1.449	1.391	0.781 – 2.459			4026	
Spring (Oct-Dec)	0.464	0.437	0.182 – 0.876			4106	
Summer (Jan-Mar)	1.000	1.000	1.000 – 1.000	3			
Winter (Jul-Sep)	0.040	0.026	0.002 – 0.157			3886	
Fishery							
Albacore SLL	1.862	1.449	0.211 – 5.940			4002	
Bigeye SLL	0.964	0.756	0.105 – 3.017	1		4002	
Bluenose BLL	3.263	2.873	0.636 – 8.105			4002	
Deepwater trawl	0.636	0.318	0.000 – 3.063			3936	
Flatfish trawl	0.892	0.475	0.000 – 4.246			4002	
Hake trawl	0.986	0.516	0.001 – 4.548			4002	
Hāpuku BLL	1.021	0.739	0.085 – 3.595			3895	
Hoki trawl	0.673	0.353	0.000 – 3.269			4002	
Inshore trawl	2.438	1.988	0.343 – 7.115			4002	
Ling (no IWL) BLL – vessels $\geq$ 34 m	0.908	0.476	0.001 – 4.301			4002	
Ling (IWL) BLL – vessels $\geq$ 34 m	0.878	0.471	0.001 – 4.216			3767	
Ling BLL – vessels $<$ 34 m	0.493	0.233	0.000 – 2.433			3594	
Ling trawl	0.788	0.416	0.000 – 3.878			4202	
Mackerel trawl	0.895	0.469	0.000 – 4.161			4002	
Middle depths trawl	0.623	0.327	0.000 – 2.875			3560	
Minor targets BLL	0.536	0.355	0.038 – 2.098			4012	
Minor surface longline	1.579	1.213	0.160 – 5.093			3874	
Southern blue whiting trawl	0.967	0.523	0.001 – 4.663			4002	
Scampi trawl	0.201	0.084	0.000 – 1.077			3874	
Snapper BLL	0.344	0.290	0.059 – 0.944			4002	
Squid trawl	0.904	0.483	0.001 – 4.346			4128	
Southern bluefin SLL	0.058	0.018	0.000 – 0.363			3319	
Swordfish SLL	0.574	0.390	0.031 – 2.169			3781	
Area							
Auckland Islands	0.941	0.437	0.000 – 4.785			3841	
Cook Strait	0.922	0.414	0.000 – 4.879			3761	
East of North Island	0.145	0.102	0.009 – 0.532			3919	
Eastern Chatham Rise	0.858	0.348	0.000 – 4.643			4002	
East Subantarctic	0.928	0.409	0.000 – 4.981			4002	
Fiordland	0.882	0.408	0.000 – 4.570			4002	
Kermadec Islands	0.748	0.461	0.022 – 3.028			4183	
North East	3.289	2.873	0.377 – 8.329			4002	
South Subantarctic	0.896	0.385	0.000 – 4.549			3883	
Stewart Snares Shelf	0.864	0.383	0.000 – 4.541			3809	
Western Chatham Rise	0.861	0.390	0.000 – 4.605			4002	
West Coast North Island	0.080	0.049	0.002 – 0.348			4157	
West Coast South Island	0.873	0.383	0.000 – 4.847			4011	

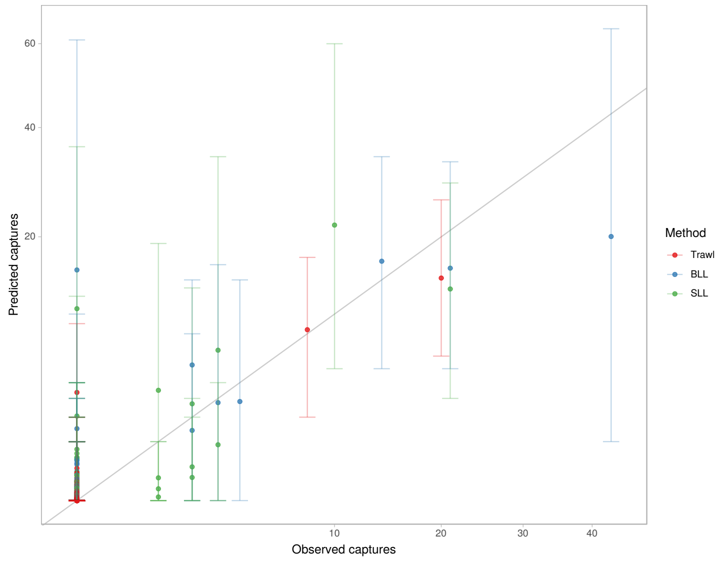


Figure A-6: Comparison between the observed and the predicted number of captures of black petrel (represented by their mean and 95% credible interval), for each combination of region, fishery, vessel size, area, and season. The points were coloured according to the fishing method (BLL, bottom longline; 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 were two of these strata, representing 0.3% of all 620 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	North East	Autumn (Apr-Jun)	56	0	10.58	1–36
SLL	Albacore SLL	Large	North	North East	Winter (Jul-Sep)	2	1	0.00	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 2016–17 for bottom- and surface-longline fisheries, and between 2002–03 and 2016–17 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.

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Trawl									
Southern blue whiting trawl	Vessels ≥ 28 m	South Subantarctic	Winter	38	5503	0.570	66	69	44–98
Southern blue whiting trawl	Vessels ≥ 28 m	East Subantarctic	Winter	14	983	0.491	28	19	6–36
Inshore trawl	Vessels < 28 m	East of North Island	Winter	0	187	0.007	0	17	0–85
Flatfish trawl	Vessels < 28 m	Western Chatham Rise	Winter	0	63	0.004	0	6	0–39
Hoki trawl	Vessels ≥ 28 m	Western Chatham Rise	Autumn	1	2470	0.163	6	6	0–17
Hoki trawl	Vessels ≥ 28 m	Western Chatham Rise	Winter	0	1100	0.154	0	6	0–16
Inshore trawl	Vessels < 28 m	East of North Island	Autumn	0	170	0.007	0	6	0–31
Flatfish trawl	Vessels < 28 m	East of North Island	Winter	0	0	0.000		4	0–27
Flatfish trawl	Vessels < 28 m	Western Chatham Rise	Autumn	0	94	0.005	0	4	0–22
Inshore trawl	Vessels ≥ 28 m	East of North Island	Winter	0	0	0.000		4	0–22
Scampi trawl	Vessels ≥ 28 m	Auckland Islands	Winter	0	48	0.036	0	4	0–14
Squid trawl	Vessels ≥ 28 m	Auckland Islands	Autumn	0	2969	0.379	0	4	0–13
Deepwater trawl	Vessels ≥ 28 m	East of North Island	Autumn	0	416	0.112	0	3	0–10
Deepwater trawl	Vessels ≥ 28 m	South Subantarctic	Winter	0	603	0.251	0	3	0–9
Inshore trawl	Vessels < 28 m	North East	Winter	0	894	0.032	0	3	0–17
Surface longline									
Southern bluefin SLL	Vessels < 43 m	East of North Island	Autumn	13	372	0.045	290	235	111–447
Southern bluefin SLL	Vessels < 43 m	East of North Island	Winter	7	212	0.116	60	125	51–272
Albacore SLL	Vessels < 43 m	East of North Island	Autumn	0	23	0.015	0	51	5–204
Bigeye SLL	Vessels < 43 m	East of North Island	Autumn	0	96	0.021	0	51	3–192
Southern bluefin SLL	Vessels < 43 m	North East	Winter	3	400	0.109	27	51	16–118
Bigeye SLL	Vessels < 43 m	North East	Winter	0	102	0.013	0	41	2–157
Southern bluefin SLL	Vessels ≥ 43 m	East of North Island	Winter	25	146	0.764	32	25	3–71
Swordfish SLL	Vessels < 43 m	East of North Island	Autumn	0	12	0.055	0	25	1–126
Bigeye SLL	Vessels < 43 m	North East	Autumn	0	56	0.012	0	10	0–40
Minor surface longline	Vessels < 43 m	East of North Island	Autumn	0	2	0.011	0	10	0–60
Swordfish SLL	Vessels < 43 m	Kermadec Islands	Winter	0	0	0.000		8	0–45
Albacore SLL	Vessels ≥ 43 m	Kermadec Islands	Winter	0	106	1.000	0	7	0–35
Albacore SLL	Vessels < 43 m	North East	Winter	0	0	0.000		6	0–27
Bigeye SLL	Vessels < 43 m	Kermadec Islands	Winter	0	17	0.057	0	6	0–35
Swordfish SLL	Vessels < 43 m	North East	Autumn	0	16	0.058	0	6	0–27
Bottom longline									
Snapper BLL	Vessels < 34 m	North East	Winter	0	0	0.000		1085	304–2760
Ling BLL – vessels < 34 m	Vessels < 34 m	East of North Island	Winter	0	93	0.015	0	513	60–1872
Snapper BLL	Vessels < 34 m	North East	Autumn	11	508	0.014	778	476	157–1171
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	South Subantarctic	Autumn	105	424	0.242	433	330	85–865
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Eastern Chatham Rise	Winter	9	1018	0.142	63	247	62–664
Bluenose BLL	Vessels < 34 m	East of North Island	Winter	0	14	0.005	0	228	3–1168
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Auckland Islands	Winter	98	165	0.358	273	221	17–765
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Western Chatham Rise	Winter	10	47	0.026	382	199	28–689
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	East Subantarctic	Autumn	0	8	0.013	0	136	16–467
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	South Subantarctic	Winter	103	55	0.186	554	134	6–533
Hāpuku BLL	Vessels < 34 m	East of North Island	Winter	0	1	0.001	0	89	0–518
Bluenose BLL	Vessels < 34 m	East of North Island	Autumn	0	17	0.006	0	80	1–393
Snapper BLL	Vessels < 34 m	North East	Spring	0	535	0.013	0	77	12–262
Ling BLL – vessels < 34 m	Vessels < 34 m	Western Chatham Rise	Winter	3	109	0.035	86	73	10–264
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	East Subantarctic	Winter	0	21	0.135	0	69	0–339

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 areas, 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
S.d.(Year)							
BLL	1.800	1.789	0.953 – 2.717			4002	
SLL	0.510	0.439	0.095 – 1.322			2994	
Trawl	0.601	0.584	0.211 – 1.082			4002	
S.d.(Area)	1.828	1.790	1.205 – 2.701			4109	
S.d.(Fishery)	0.950	0.929	0.479 – 1.527			3443	
Overdispersion							
BLL	12.425	12.240	7.411 – 18.194			4141	
SLL	5.510	5.475	1.755 – 9.183			4213	
Trawl	1.326	1.097	0.395 – 3.692			4002	
Intercept	0.147	0.074	0.012 – 0.669			4569	
Method / Vessel class							
BLL / vessels $\geq$ 34 m	1.000	1.000	1.000 – 1.000	3			
SLL / vessels $\geq$ 43 m	2.186	0.812	0.079 – 10.836			3489	
Trawl / vessels $\geq$ 28 m	0.029	0.020	0.003 – 0.110			4002	
BLL / vessels $<$ 34 m	0.908	0.476	0.051 – 4.199			3670	
SLL / vessels $<$ 43 m	1.406	0.478	0.043 – 5.872			4000	
Trawl / vessels $<$ 28 m	0.010	0.004	0.000 – 0.054			4002	
Region							
North	5.510	1.579	0.135 – 32.405			3869	
South	1.000	1.000	1.000 – 1.000	3			
Season							
Autumn (Apr-Jun)	0.445	0.424	0.211 – 0.821			4002	
Spring (Oct-Dec)	0.064	0.050	0.011 – 0.205			4162	
Summer (Jan-Mar)	0.008	0.005	0.000 – 0.035			3775	
Winter (Jul-Sep)	1.000	1.000	1.000 – 1.000	3			
Fishery							
Albacore SLL	0.772	0.626	0.064 – 2.406			4002	
Bigeye SLL	0.314	0.223	0.013 – 1.130			3991	
Bluenose BLL	0.594	0.411	0.014 – 2.146			4002	
Deepwater trawl	0.395	0.327	0.052 – 1.082			4002	
Flatfish trawl	0.920	0.674	0.011 – 3.231			4002	
Hake trawl	0.934	0.710	0.014 – 3.332			3640	
Hāpuku BLL	0.756	0.538	0.009 – 2.778			4002	
Hoki trawl	0.860	0.734	0.149 – 2.348			3721	
Inshore trawl	0.612	0.445	0.005 – 2.182			4235	
Ling (no IWL) BLL – vessels $\geq$ 34 m	1.262	1.072	0.229 – 3.374			3945	
Ling (IWL) BLL – vessels $\geq$ 34 m	1.106	0.909	0.173 – 3.292			4002	
Ling BLL – vessels $<$ 34 m	0.865	0.676	0.109 – 2.767			4002	
Ling trawl	1.482	1.216	0.196 – 4.459			3875	
Mackerel trawl	0.731	0.546	0.007 – 2.528			3660	
Middle depths trawl	0.482	0.352	0.004 – 1.697			3747	
Minor targets BLL	0.857	0.652	0.054 – 2.913			3865	
Minor surface longline	0.949	0.690	0.016 – 3.410			3669	
Southern blue whiting trawl	2.865	2.551	0.922 – 6.672			4133	
Scampi trawl	0.932	0.764	0.075 – 2.854			3656	
Snapper BLL	1.915	1.607	0.362 – 5.291			4127	
Squid trawl	0.476	0.360	0.038 – 1.581			4002	
Southern bluefin SLL	0.873	0.725	0.102 – 2.454			4002	
Swordfish SLL	2.095	1.783	0.436 – 5.733			3858	
Area							
Auckland Islands	2.416	2.015	0.373 – 7.070			4004	
Cook Strait	0.064	0.009	0.000 – 0.461			4002	
East of North Island	2.259	1.729	0.095 – 7.473			4030	
Eastern Chatham Rise	0.391	0.299	0.046 – 1.244			4002	
East Subantarctic	2.612	2.222	0.431 – 7.024			4002	
Fiordland	0.035	0.016	0.001 – 0.188			4002	
Kermadec Islands	1.144	0.724	0.032 – 4.860			3736	
North East	0.481	0.335	0.015 – 1.780			3794	
South Subantarctic	2.193	1.887	0.385 – 5.595			4002	
Stewart Snares Shelf	0.031	0.006	0.000 – 0.206			4002	
Western Chatham Rise	1.013	0.775	0.118 – 3.412			3925	
West Coast North Island	0.034	0.005	0.000 – 0.257			4115	
West Coast South Island	0.011	0.002	0.000 – 0.073			3721	

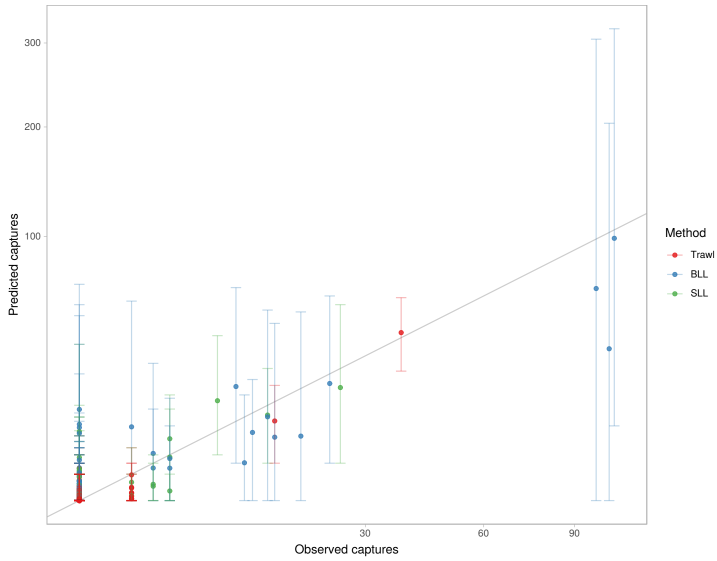


Figure A-7: Comparison between the observed and the predicted number of captures of grey petrel (represented by their mean and 95% credible interval), for each combination of region, fishery, vessel size, area, and season. The points were coloured according to the fishing method (BLL, bottom longline; 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 620 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	3	0.13	0–1
Trawl	Ling trawl	Large	South	South Subantarctic	Spring (Oct-Dec)	90	1	0.02	0–0
Trawl	Hoki trawl	Large	South	Fiordland	Winter (Jul-Sep)	149	1	0.01	0–0
Trawl	Squid trawl	Large	South	Western Chatham Rise	Winter (Jul-Sep)	5	1	0.00	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 2016–17 for bottom- and surface-longline fisheries, and between 2002–03 and 2016–17 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.

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Trawl									
Squid trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Summer	351	10155	0.377	932	1109	771–1565
Squid trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Autumn	375	2918	0.324	1157	781	464–1237
Hoki trawl	Vessels ≥ 28 m	Western Chatham Rise	Autumn	117	2470	0.163	715	476	282–746
Middle depths trawl	Vessels < 28 m	Western Chatham Rise	Autumn	0	6	0.001	0	334	86–967
Hoki trawl	Vessels ≥ 28 m	Western Chatham Rise	Spring	54	2444	0.187	288	300	174–489
Middle depths trawl	Vessels < 28 m	Western Chatham Rise	Spring	0	63	0.010	0	294	76–846
Hoki trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Autumn	28	1782	0.250	112	283	146–497
Squid trawl	Vessels ≥ 28 m	Auckland Islands	Autumn	69	2969	0.379	182	231	127–382
Middle depths trawl	Vessels < 28 m	Western Chatham Rise	Summer	11	191	0.026	424	222	64–617
Squid trawl	Vessels ≥ 28 m	Auckland Islands	Summer	102	7259	0.488	208	214	129–333
Squid trawl	Vessels ≥ 28 m	Western Chatham Rise	Autumn	18	412	0.145	124	208	82–430
Squid trawl	Vessels < 28 m	Western Chatham Rise	Autumn	0	0	0.000		207	39–683
Inshore trawl	Vessels < 28 m	Western Chatham Rise	Autumn	3	77	0.004	837	205	44–581
Hoki trawl	Vessels ≥ 28 m	Western Chatham Rise	Summer	39	1890	0.138	281	201	116–323
Middle depths trawl	Vessels ≥ 28 m	Stewart Snares Shelf	Spring	32	1698	0.304	105	201	97–367
Surface longline									
Albacore SLL	Vessels < 43 m	East of North Island	Autumn	0	23	0.015	0	11	0–61
Albacore SLL	Vessels ≥ 43 m	East of North Island	Autumn	7	67	0.971	7	5	0–12
Southern bluefin SLL	Vessels ≥ 43 m	Fiordland	Autumn	0	3057	0.900	0	4	0–12
Bigeye SLL	Vessels < 43 m	East of North Island	Autumn	0	96	0.021	0	3	0–20
Albacore SLL	Vessels < 43 m	East of North Island	Summer	0	7	0.011	0	2	0–13
Bigeye SLL	Vessels < 43 m	East of North Island	Summer	0	161	0.026	0	2	0–13
Albacore SLL	Vessels ≥ 43 m	North East	Autumn	0	44	1.000	0	1	0–4
Albacore SLL	Vessels < 43 m	North East	Autumn	0	1	0.002	0	1	0–7
Albacore SLL	Vessels < 43 m	North East	Spring	0	1	0.004	0	1	0–4
Albacore SLL	Vessels < 43 m	Western Chatham Rise	Autumn	0	0	0.000		1	0–4
Bigeye SLL	Vessels < 43 m	North East	Autumn	0	56	0.012	0	1	0–7
Bigeye SLL	Vessels < 43 m	North East	Spring	0	233	0.034	0	1	0–8
Bigeye SLL	Vessels < 43 m	North East	Summer	0	160	0.029	0	1	0–5
Minor surface longline	Vessels < 43 m	East of North Island	Autumn	0	2	0.011	0	1	0–5
Minor surface longline	Vessels < 43 m	East of North Island	Summer	0	9	0.017	0	1	0–7
Bottom longline									
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Stewart Snares Shelf	Spring	70	936	0.480	145	119	70–183
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Western Chatham Rise	Spring	0	58	0.024	0	102	51–191
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Western Chatham Rise	Autumn	0	61	0.033	0	97	38–218
Ling (IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Stewart Snares Shelf	Spring	12	118	0.082	146	75	27–161
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Western Chatham Rise	Summer	1	65	0.044	22	42	16–88
Snapper BLL	Vessels < 34 m	North East	Autumn	0	508	0.014	0	21	0–79
Snapper BLL	Vessels < 34 m	North East	Spring	0	535	0.013	0	18	0–71
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Eastern Chatham Rise	Autumn	0	157	0.066	0	14	4–34
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Eastern Chatham Rise	Spring	1	460	0.135	7	14	4–29
Ling (IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Fiordland	Spring	3	154	0.217	13	14	3–34
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Fiordland	Spring	4	98	0.173	23	11	3–25
Snapper BLL	Vessels < 34 m	North East	Summer	1	743	0.020	51	11	0–41
Hāpuku BLL	Vessels < 34 m	Western Chatham Rise	Summer	0	6	0.011	0	10	0–49
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Auckland Islands	Autumn	0	20	0.061	0	10	2–26
Bluenose BLL	Vessels < 34 m	Western Chatham Rise	Autumn	0	10	0.023	0	9	0–42

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 areas, 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
S.d.(Year)							
BLL	0.769	0.740	0.220 – 1.465			4138	
SLL	0.710	0.607	0.120 – 1.871			2598	
Trawl	0.363	0.354	0.156 – 0.621			4002	
S.d.(Area)	1.265	1.234	0.865 – 1.825			4002	
S.d.(Fishery)	1.371	1.346	0.940 – 1.936			4002	
Overdispersion							
BLL	3.420	3.035	0.571 – 8.159	1		4016	
SLL	1.319	1.129	0.399 – 3.292			4002	
Trawl	15.344	15.333	13.623 – 17.236			4002	
Intercept	0.016	0.012	0.004 – 0.049			3647	
Method / Vessel class							
BLL / vessels $\geq$ 34 m	9.101	3.251	0.497 – 52.162			3726	
SLL / vessels $\geq$ 43 m	64.084	15.151	1.251 – 341.826			4226	
Trawl / vessels $\geq$ 28 m	1.000	1.000	1.000 – 1.000	3			
BLL / vessels $<$ 34 m	0.962	0.492	0.040 – 4.930			3866	
SLL / vessels $<$ 43 m	2.273	0.828	0.028 – 13.674			4002	
Trawl / vessels $<$ 28 m	1.754	1.459	0.538 – 4.666			4197	
Region							
North	0.420	0.190	0.028 – 2.371			4084	
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)	0.753	0.734	0.471 – 1.155			4002	
Summer (Jan-Mar)	0.480	0.473	0.341 – 0.651			4002	
Winter (Jul-Sep)	0.012	0.010	0.002 – 0.034			4600	
Fishery							
Albacore SLL	2.069	1.657	0.131 – 6.511			4002	
Bigeye SLL	0.299	0.110	0.000 – 1.677			4116	
Bluenose BLL	1.215	0.869	0.060 – 4.639	1		4115	
Deepwater trawl	0.058	0.046	0.008 – 0.170			4234	
Flatfish trawl	0.040	0.012	0.000 – 0.244			3897	
Hake trawl	1.621	1.401	0.404 – 4.221			4275	
Hāpuku BLL	1.999	1.531	0.117 – 6.649			3801	
Hoki trawl	1.175	1.075	0.362 – 2.537			3871	
Inshore trawl	0.261	0.190	0.029 – 0.927			4226	
Ling (no IWL) BLL – vessels $\geq$ 34 m	0.846	0.601	0.043 – 3.029			3820	
Ling (IWL) BLL – vessels $\geq$ 34 m	0.918	0.655	0.046 – 3.331			4121	
Ling BLL – vessels $<$ 34 m	0.287	0.106	0.000 – 1.732			3829	
Ling trawl	1.354	1.144	0.327 – 3.539			4002	
Mackerel trawl	0.330	0.270	0.066 – 0.930			4171	
Middle depths trawl	1.427	1.308	0.441 – 3.095			3993	
Minor targets BLL	0.207	0.071	0.000 – 1.176			3888	
Minor surface longline	0.899	0.444	0.000 – 4.338			4002	
Southern blue whiting trawl	0.645	0.293	0.000 – 3.284			4002	
Scampi trawl	1.090	0.918	0.212 – 2.977			4002	
Snapper BLL	1.500	1.065	0.075 – 5.563	1		3982	
Squid trawl	2.576	2.370	0.811 – 5.474			4008	
Southern bluefin SLL	0.015	0.007	0.000 – 0.079			3897	
Swordfish SLL	1.831	1.326	0.098 – 6.264			4192	
Area							
Auckland Islands	1.154	1.076	0.363 – 2.457			3920	
Cook Strait	0.251	0.188	0.025 – 0.858			3888	
East of North Island	1.544	1.213	0.152 – 4.636			3835	
Eastern Chatham Rise	0.267	0.240	0.076 – 0.613			4117	
East Subantarctic	0.090	0.068	0.010 – 0.292			4115	
Fiordland	1.088	0.981	0.295 – 2.501			3944	
Kermadec Islands	1.619	1.259	0.101 – 5.194			4212	
North East	0.506	0.355	0.031 – 1.884			4002	
South Subantarctic	0.108	0.083	0.012 – 0.341			3867	
Stewart Snares Shelf	3.331	3.117	1.092 – 6.687			3962	
Western Chatham Rise	2.619	2.422	0.855 – 5.482			4002	
West Coast North Island	0.215	0.118	0.005 – 1.040			3755	
West Coast South Island	0.106	0.087	0.017 – 0.305			4002	

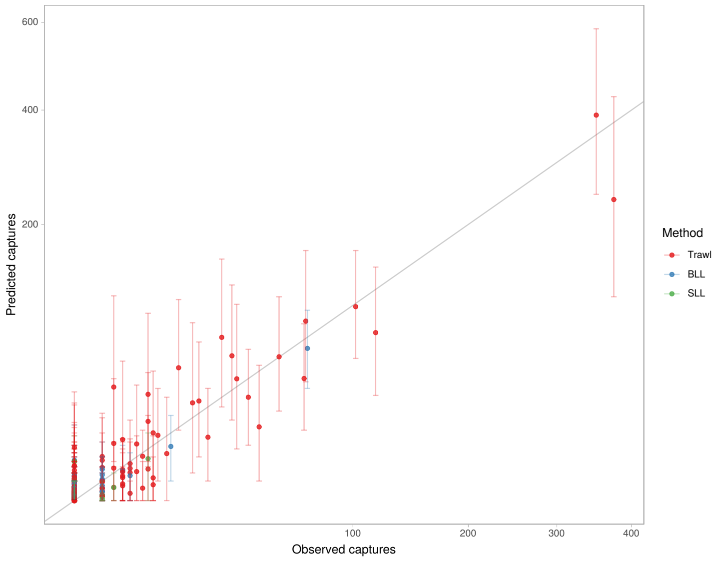


Figure A-8: Comparison between the observed and the predicted number of captures of sooty shearwater (represented by their mean and 95% credible interval), for each combination of region, fishery, vessel size, area, and season. The points were coloured according to the fishing method (BLL, bottom longline; 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 five of these strata, representing 0.8% of all 620 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	Hake trawl	Large	South	Stewart Snares Shelf	Spring (Oct-Dec)	812	2	33.81	4–110
Trawl	Scampi trawl	Small	South	Auckland Islands	Summer (Jan-Mar)	81	8	0.66	0–5
Trawl	Hoki trawl	Large	South	Fiordland	Spring (Oct-Dec)	33	6	0.40	0–4
Trawl	Hake trawl	Large	South	Eastern Chatham Rise	Summer (Jan-Mar)	69	4	0.14	0–1
SLL	Southern bluefin SLL	Large	South	South Subantarctic	Autumn (Apr-Jun)	55	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 2016–17 for bottom- and surface-longline fisheries, and between 2002–03 and 2016–17 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.

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Trawl									
Scampi trawl	Vessels < 28 m	North East	Summer	4	172	0.051	78	206	77–471
Inshore trawl	Vessels < 28 m	North East	Summer	6	1261	0.036	167	162	76–291
Scampi trawl	Vessels < 28 m	East of North Island	Summer	0	11	0.003	0	154	39–427
Scampi trawl	Vessels < 28 m	North East	Spring	31	447	0.100	310	105	45–204
Inshore trawl	Vessels < 28 m	North East	Autumn	8	1540	0.051	158	104	47–191
Scampi trawl	Vessels < 28 m	North East	Autumn	2	379	0.179	11	98	31–246
Inshore trawl	Vessels < 28 m	East of North Island	Summer	1	265	0.010	101	79	22–184
Inshore trawl	Vessels < 28 m	North East	Spring	2	1119	0.036	55	59	21–120
Inshore trawl	Vessels < 28 m	East of North Island	Autumn	0	170	0.007	0	52	13–125
Scampi trawl	Vessels < 28 m	East of North Island	Spring	0	259	0.085	0	46	12–119
Hoki trawl	Vessels < 28 m	North East	Summer	0	13	0.030	0	38	2–200
Inshore trawl	Vessels < 28 m	East of North Island	Spring	0	193	0.006	0	38	8–99
Hoki trawl	Vessels < 28 m	North East	Autumn	2	32	0.055	36	37	2–174
Inshore trawl	Vessels < 28 m	West Coast North Island	Summer	0	1231	0.058	0	24	6–58
Scampi trawl	Vessels < 28 m	East of North Island	Autumn	0	84	0.110	0	23	3–76
Surface longline									
Bigeye SLL	Vessels < 43 m	North East	Summer	17	160	0.029	587	1616	653–3698
Bigeye SLL	Vessels < 43 m	East of North Island	Summer	87	161	0.026	3315	1036	462–2023
Bigeye SLL	Vessels < 43 m	North East	Autumn	9	56	0.012	750	1031	357–2485
Bigeye SLL	Vessels < 43 m	North East	Spring	14	233	0.034	416	817	291–2005
Bigeye SLL	Vessels < 43 m	East of North Island	Autumn	0	96	0.021	0	583	212–1290
Bigeye SLL	Vessels < 43 m	West Coast North Island	Summer	0	60	0.023	0	189	46–506
Albacore SLL	Vessels < 43 m	East of North Island	Autumn	0	23	0.015	0	186	13–828
Albacore SLL	Vessels < 43 m	East of North Island	Summer	5	7	0.011	439	98	7–456
Albacore SLL	Vessels < 43 m	North East	Autumn	0	1	0.002	0	92	5–441
Minor surface longline	Vessels < 43 m	North East	Summer	3	23	0.059	50	73	2–389
Bigeye SLL	Vessels < 43 m	West Coast North Island	Autumn	0	16	0.012	0	71	13–221
Bigeye SLL	Vessels < 43 m	North East	Winter	0	102	0.013	0	62	1–272
Bigeye SLL	Vessels < 43 m	East of North Island	Spring	1	13	0.015	67	60	16–149
Minor surface longline	Vessels < 43 m	East of North Island	Summer	0	9	0.017	0	59	2–302
Albacore SLL	Vessels < 43 m	North East	Summer	0	0	0.000		33	0–188
Bottom longline									
Snapper BLL	Vessels < 34 m	North East	Summer	44	743	0.020	2245	2459	1520–3888
Snapper BLL	Vessels < 34 m	North East	Autumn	33	508	0.014	2335	1746	1004–2802
Snapper BLL	Vessels < 34 m	North East	Spring	7	535	0.013	552	1113	549–2041
Minor targets BLL	Vessels < 34 m	North East	Summer	5	37	0.025	202	335	93–958
Minor targets BLL	Vessels < 34 m	West Coast North Island	Summer	11	229	0.042	261	254	100–544
Minor targets BLL	Vessels < 34 m	North East	Autumn	3	26	0.018	168	242	63–696
Hāpuku BLL	Vessels < 34 m	North East	Summer	0	5	0.003	0	177	19–701
Minor targets BLL	Vessels < 34 m	North East	Spring	0	24	0.019	0	116	24–358
Hāpuku BLL	Vessels < 34 m	North East	Autumn	1	26	0.017	59	101	12–371
Minor targets BLL	Vessels < 34 m	West Coast North Island	Spring	2	46	0.011	182	80	25–191
Minor targets BLL	Vessels < 34 m	West Coast North Island	Autumn	0	44	0.021	0	76	24–174
Minor targets BLL	Vessels < 34 m	East of North Island	Summer	0	0	0.000		72	12–234
Hāpuku BLL	Vessels < 34 m	North East	Spring	0	3	0.002	0	67	6–281
Snapper BLL	Vessels < 34 m	North East	Winter	0	0	0.000		64	2–263
Hāpuku BLL	Vessels < 34 m	West Coast North Island	Summer	0	35	0.011	0	62	8–217

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 areas, 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
S.d.(Year)							
BLL	0.914	0.774	0.143 – 2.306			2057	
SLL	0.963	0.832	0.145 – 2.403			1818	
Trawl	0.942	0.810	0.142 – 2.347			2072	
S.d.(Area)	0.919	0.830	0.317 – 2.046			3762	
S.d.(Fishery)	1.592	1.571	1.016 – 2.295			3862	
Overdispersion							
BLL	6.120	6.036	3.993 – 8.733			4002	
SLL	8.828	8.725	6.587 – 11.681			3817	
Trawl	10.176	10.039	6.286 – 14.913			4002	
Intercept	0.160	0.081	0.015 – 0.693			3805	
Method / Vessel class							
BLL / vessels $\geq$ 34 m	2.573	0.018	0.000 – 3.175			4424	
SLL / vessels $\geq$ 43 m	0.195	0.007	0.000 – 0.862			3883	
Trawl / vessels $\geq$ 28 m	0.038	0.009	0.000 – 0.267	1		4159	
BLL / vessels $<$ 34 m	1.681	0.686	0.074 – 8.740			4002	
SLL / vessels $<$ 43 m	1.000	1.000	1.000 – 1.000	3			
Trawl / vessels $<$ 28 m	0.560	0.233	0.025 – 2.304			3873	
Region							
North	1.000	1.000	1.000 – 1.000	3			
South	0.015	0.007	0.000 – 0.081			3614	
Season							
Autumn (Apr-Jun)	0.777	0.745	0.408 – 1.316			4290	
Spring (Oct-Dec)	0.418	0.396	0.202 – 0.771			4293	
Summer (Jan-Mar)	1.000	1.000	1.000 – 1.000	3			
Winter (Jul-Sep)	0.030	0.019	0.001 – 0.121			4002	
Fishery							
Albacore SLL	1.695	1.225	0.133 – 5.986			3734	
Bigeye SLL	2.504	2.089	0.313 – 7.089			4002	
Bluenose BLL	0.044	0.009	0.000 – 0.303			4002	
Deepwater trawl	0.152	0.036	0.000 – 0.998			4053	
Flatfish trawl	0.200	0.049	0.000 – 1.378			4134	
Hake trawl	0.941	0.390	0.000 – 5.185			4002	
Hāpuku BLL	1.026	0.697	0.056 – 4.000			3356	
Hoki trawl	2.220	1.723	0.224 – 7.255			3869	
Inshore trawl	0.189	0.149	0.021 – 0.595			3920	
Ling (no IWL) BLL – vessels $\geq$ 34 m	0.860	0.309	0.000 – 4.872			3995	
Ling (IWL) BLL – vessels $\geq$ 34 m	0.757	0.261	0.000 – 4.354			3872	
Ling BLL – vessels $<$ 34 m	0.133	0.028	0.000 – 0.920			3726	
Ling trawl	1.569	1.090	0.081 – 5.993			4125	
Mackerel trawl	0.276	0.060	0.000 – 1.914			3829	
Middle depths trawl	0.470	0.269	0.011 – 2.101			3846	
Minor targets BLL	2.585	2.145	0.266 – 7.395			3606	
Minor surface longline	1.158	0.712	0.051 – 5.028			4002	
Southern blue whiting trawl	0.924	0.358	0.000 – 5.182			3894	
Scampi trawl	2.281	1.889	0.288 – 6.626			4090	
Snapper BLL	0.936	0.714	0.074 – 3.098			4002	
Squid trawl	0.700	0.260	0.000 – 3.998			3830	
Southern bluefin SLL	0.024	0.005	0.000 – 0.169			4002	
Swordfish SLL	0.487	0.274	0.019 – 2.362			3897	
Area							
Auckland Islands	0.821	0.660	0.003 – 2.763			4002	
Cook Strait	0.947	0.754	0.005 – 3.213			4147	
East of North Island	1.149	1.002	0.240 – 2.950			4002	
Eastern Chatham Rise	0.788	0.649	0.004 – 2.568			4131	
East Subantarctic	0.971	0.760	0.006 – 3.366			4002	
Fiordland	0.980	0.772	0.005 – 3.379			3759	
Kermadec Islands	0.718	0.571	0.002 – 2.442			3864	
North East	1.877	1.640	0.445 – 4.854			4191	
South Subantarctic	0.972	0.773	0.003 – 3.338			3866	
Stewart Snares Shelf	0.863	0.700	0.002 – 2.859			4002	
Western Chatham Rise	1.515	1.201	0.192 – 4.990			4002	
West Coast North Island	0.454	0.397	0.074 – 1.150			4443	
West Coast South Island	0.878	0.716	0.004 – 2.891			3951	

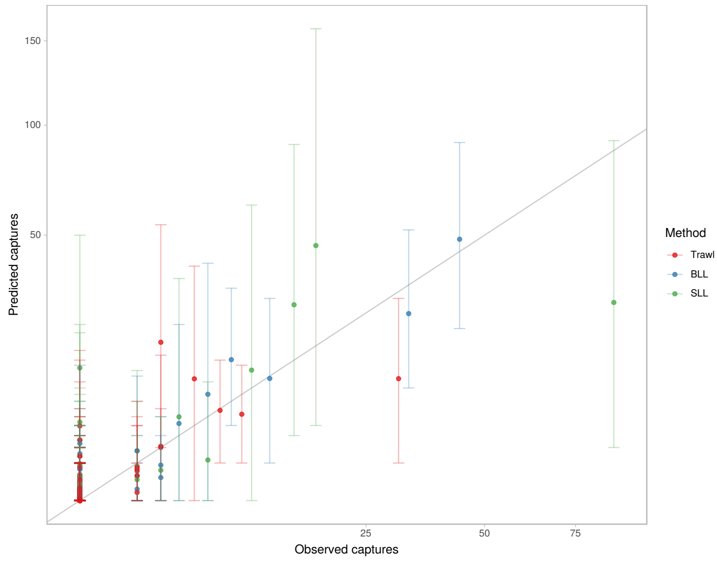


Figure A-9: Comparison between the observed and the predicted number of captures of flesh-footed shearwater (represented by their mean and 95% credible interval), for each combination of region, fishery, vessel size, area, and season. The points were coloured according to the fishing method (BLL, bottom 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 one of these strata, representing 0.2% of all 620 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	Scampi trawl	Small	North	North East	Spring (Oct-Dec)	447	31	10.55	1–29

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 2016–17 for bottom- and surface-longline fisheries, and between 2002–03 and 2016–17 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.

Fishery	Vessel size	Area	Season	Observations				Estimated captures	
				Captures	Events	Coverage	Ratio est.	Mean	95% c.i.
Trawl									
Flatfish trawl	Vessels < 28 m	Stewart Snares Shelf	Spring	0	7	0.000	0	342	113–867
Flatfish trawl	Vessels < 28 m	Stewart Snares Shelf	Summer	0	527	0.020	0	313	113–734
Flatfish trawl	Vessels < 28 m	West Coast South Island	Autumn	0	13	0.001	0	300	91–754
Flatfish trawl	Vessels < 28 m	Western Chatham Rise	Autumn	0	94	0.005	0	252	95–585
Flatfish trawl	Vessels < 28 m	Western Chatham Rise	Spring	0	54	0.003	0	247	90–587
Flatfish trawl	Vessels < 28 m	Western Chatham Rise	Summer	32	241	0.011	3020	245	102–527
Flatfish trawl	Vessels < 28 m	West Coast South Island	Spring	0	103	0.010	0	243	72–647
Flatfish trawl	Vessels < 28 m	Stewart Snares Shelf	Autumn	0	51	0.003	0	238	75–607
Flatfish trawl	Vessels < 28 m	West Coast South Island	Winter	0	22	0.002	0	228	69–588
Flatfish trawl	Vessels < 28 m	Stewart Snares Shelf	Winter	0	22	0.001	0	226	70–571
Flatfish trawl	Vessels < 28 m	Western Chatham Rise	Winter	0	63	0.004	0	176	61–418
Flatfish trawl	Vessels < 28 m	West Coast South Island	Summer	0	128	0.015	0	166	50–428
Flatfish trawl	Vessels < 28 m	West Coast North Island	Autumn	0	1	0.000	0	133	39–342
Hoki trawl	Vessels ≥ 28 m	West Coast South Island	Winter	34	14364	0.332	102	120	72–183
Flatfish trawl	Vessels < 28 m	West Coast North Island	Winter	0	0	0.000		106	30–275
Surface longline									
Albacore SLL	Vessels < 43 m	East of North Island	Autumn	0	23	0.015	0	170	31–548
Southern bluefin SLL	Vessels < 43 m	West Coast South Island	Autumn	22	326	0.118	186	82	37–144
Southern bluefin SLL	Vessels < 43 m	East of North Island	Autumn	1	372	0.045	22	70	29–132
Bigeye SLL	Vessels < 43 m	North East	Spring	5	233	0.034	148	64	23–132
Albacore SLL	Vessels < 43 m	East of North Island	Summer	0	7	0.011	0	60	10–194
Albacore SLL	Vessels < 43 m	North East	Autumn	0	1	0.002	0	60	10–197
Bigeye SLL	Vessels < 43 m	North East	Winter	0	102	0.013	0	59	20–127
Albacore SLL	Vessels < 43 m	North East	Winter	0	0	0.000		47	7–156
Bigeye SLL	Vessels < 43 m	North East	Summer	1	160	0.029	34	44	14–96
Bigeye SLL	Vessels < 43 m	North East	Autumn	0	56	0.012	0	42	14–89
Albacore SLL	Vessels < 43 m	North East	Spring	0	1	0.004	0	41	5–135
Bigeye SLL	Vessels < 43 m	East of North Island	Summer	0	161	0.026	0	40	12–92
Southern bluefin SLL	Vessels < 43 m	North East	Winter	1	400	0.109	9	35	13–70
Bigeye SLL	Vessels < 43 m	East of North Island	Autumn	0	96	0.021	0	32	9–74
Albacore SLL	Vessels < 43 m	West Coast North Island	Summer	0	0	0.000		27	3–97
Bottom longline									
Snapper BLL	Vessels < 34 m	North East	Spring	11	535	0.013	867	1085	560–1933
Snapper BLL	Vessels < 34 m	North East	Autumn	8	508	0.014	566	880	451–1592
Snapper BLL	Vessels < 34 m	North East	Summer	22	743	0.020	1122	829	436–1448
Snapper BLL	Vessels < 34 m	North East	Winter	0	0	0.000		715	341–1348
Hāpuku BLL	Vessels < 34 m	Eastern Chatham Rise	Autumn	0	0	0.000		107	18–361
Hāpuku BLL	Vessels < 34 m	Eastern Chatham Rise	Summer	0	0	0.000		96	16–321
Ling (no IWL) BLL – vessels ≥ 34 m	Vessels ≥ 34 m	Eastern Chatham Rise	Winter	15	1018	0.142	105	86	41–158
Hāpuku BLL	Vessels < 34 m	Eastern Chatham Rise	Spring	0	24	0.015	0	76	12–257
Hāpuku BLL	Vessels < 34 m	North East	Winter	0	20	0.006	0	73	15–217
Ling BLL – vessels < 34 m	Vessels < 34 m	West Coast South Island	Spring	0	2	0.001	0	71	18–189
Minor targets BLL	Vessels < 34 m	West Coast North Island	Summer	2	229	0.042	47	69	19–173
Ling BLL – vessels < 34 m	Vessels < 34 m	West Coast South Island	Winter	0	6	0.002	0	64	18–163
Hāpuku BLL	Vessels < 34 m	West Coast North Island	Spring	0	20	0.007	0	63	12–199
Minor targets BLL	Vessels < 34 m	West Coast North Island	Spring	3	46	0.011	274	63	17–160
Minor targets BLL	Vessels < 34 m	Cook Strait	Summer	0	0	0.000		62	12–188

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 areas, 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
S.d.(Year)							
BLL	0.588	0.560	0.127 – 1.224			3660	
SLL	0.790	0.738	0.154 – 1.717			3707	
Trawl	0.336	0.325	0.114 – 0.615			3899	
S.d.(Area)	0.360	0.339	0.106 – 0.732			4002	
S.d.(Fishery)	0.895	0.879	0.555 – 1.327			4002	
Overdispersion							
BLL	10.511	10.436	7.854 – 13.599			4002	
SLL	4.530	4.491	0.739 – 9.153			4002	
Trawl	19.120	19.295	17.305 – 19.974			4462	
Intercept	0.004	0.004	0.002 – 0.011			3622	
Method / Vessel class							
BLL / vessels $\geq$ 34 m	5.023	3.707	0.789 – 16.579			4109	
SLL / vessels $\geq$ 43 m	5.741	4.190	0.893 – 19.799			4353	
Trawl / vessels $\geq$ 28 m	1.000	1.000	1.000 – 1.000	3			
BLL / vessels $<$ 34 m	11.778	9.585	2.494 – 34.581			3924	
SLL / vessels $<$ 43 m	26.598	18.807	4.304 – 93.197			3631	
Trawl / vessels $<$ 28 m	1.209	1.073	0.400 – 2.884			3589	
Region							
North	0.576	0.516	0.255 – 1.260			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)	1.069	1.043	0.693 – 1.592			4002	
Summer (Jan-Mar)	0.915	0.896	0.593 – 1.355			3845	
Winter (Jul-Sep)	0.886	0.868	0.568 – 1.300			4002	
Fishery							
Albacore SLL	3.407	3.141	1.203 – 7.109			4292	
Bigeye SLL	0.302	0.250	0.043 – 0.874			3858	
Bluenose BLL	0.486	0.375	0.041 – 1.541			4002	
Deepwater trawl	0.316	0.289	0.093 – 0.714			3642	
Flatfish trawl	3.753	3.431	1.489 – 7.744			3584	
Hake trawl	0.452	0.393	0.103 – 1.108			3845	
Hāpuku BLL	1.435	1.241	0.332 – 3.705			3805	
Hoki trawl	0.671	0.633	0.236 – 1.310			3972	
Inshore trawl	0.584	0.518	0.167 – 1.366			3914	
Ling (no IWL) BLL – vessels $\geq$ 34 m	1.245	1.084	0.263 – 3.170			4002	
Ling (IWL) BLL – vessels $\geq$ 34 m	0.871	0.735	0.174 – 2.320			4002	
Ling BLL – vessels $<$ 34 m	0.534	0.456	0.103 – 1.439			4002	
Ling trawl	1.303	1.189	0.373 – 2.924			4002	
Mackerel trawl	1.124	1.034	0.373 – 2.412			4002	
Middle depths trawl	0.512	0.478	0.162 – 1.097			4002	
Minor targets BLL	1.023	0.904	0.264 – 2.533			4002	
Minor surface longline	0.614	0.444	0.012 – 2.180			4028	
Southern blue whiting trawl	0.844	0.749	0.219 – 1.995			4066	
Scampi trawl	0.502	0.441	0.121 – 1.234			3890	
Snapper BLL	1.537	1.401	0.436 – 3.564			3875	
Squid trawl	0.553	0.516	0.185 – 1.139			3893	
Southern bluefin SLL	0.356	0.308	0.066 – 0.928			3793	
Swordfish SLL	0.425	0.331	0.047 – 1.384			4002	
Area							
Auckland Islands	1.270	1.210	0.777 – 2.095			4126	
Cook Strait	1.068	1.025	0.576 – 1.814			4002	
East of North Island	0.775	0.777	0.301 – 1.289	1		3466	
Eastern Chatham Rise	0.868	0.862	0.501 – 1.298			4179	
East Subantarctic	0.789	0.793	0.323 – 1.287			4002	
Fiordland	1.080	1.045	0.624 – 1.699			3907	
Kermadec Islands	1.446	1.322	0.779 – 2.743			3884	
North East	0.964	0.954	0.449 – 1.528			3701	
South Subantarctic	0.793	0.790	0.361 – 1.258			3885	
Stewart Snares Shelf	0.903	0.893	0.560 – 1.329			4002	
Western Chatham Rise	0.836	0.833	0.448 – 1.283			3900	
West Coast North Island	0.802	0.808	0.326 – 1.321			4002	
West Coast South Island	1.390	1.333	0.889 – 2.197			4136	

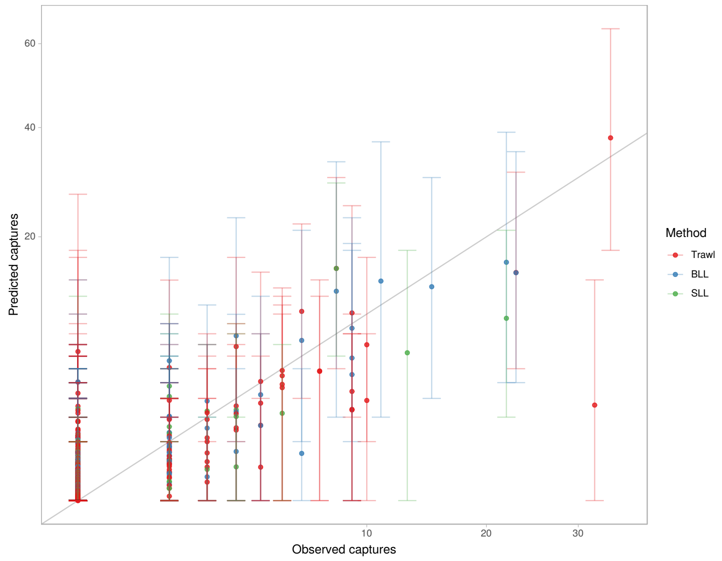


Figure A-10: Comparison between the observed and the predicted number of captures of other birds (represented by their mean and 95% credible interval), for each combination of region, fishery, vessel size, area, and season. The points were coloured according to the fishing method (BLL, bottom longline; 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 ten of these strata, representing 1.6% of all 620 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	Small	South	West Coast South Island	Autumn (Apr-Jun)	326	22	9.55	2–21
Trawl	Deepwater trawl	Large	South	Eastern Chatham Rise	Autumn (Apr-Jun)	2997	10	2.88	0–8
Trawl	Flatfish trawl	Small	South	Western Chatham Rise	Summer (Jan-Mar)	241	32	2.62	0–14
Trawl	Mackerel trawl	Large	North	West Coast North Island	Summer (Jan-Mar)	1982	9	2.39	0–8
Trawl	Hoki trawl	Large	South	Cook Strait	Winter (Jul-Sep)	1074	9	2.36	0–8
BLL	Hāpuku BLL	Small	North	North East	Autumn (Apr-Jun)	26	6	0.64	0–5
SLL	Southern bluefin SLL	Large	North	East of North Island	Winter (Jul-Sep)	146	3	0.33	0–2
Trawl	Hoki trawl	Large	South	Fiordland	Autumn (Apr-Jun)	137	4	0.32	0–3
Trawl	Hoki trawl	Large	South	Fiordland	Spring (Oct-Dec)	33	2	0.10	0–1
Trawl	Ling trawl	Large	South	South Subantarctic	Summer (Jan-Mar)	1	1	0.01	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), 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	1 807.2126	1 435–2 294	3.33	2.65–4.23
2003–04	47 339	13.4	248	3.90	1 515.4348	1 221–1 877	3.20	2.58–3.97
2004–05	44 156	17.2	428	5.64	2 098.8146	1 749–2 508	4.75	3.96–5.68
2005–06	39 121	15.8	333	5.39	1 825.0397	1 431–2 356	4.67	3.66–6.02
2006–07	35 193	20.6	176	2.43	946.3743	739–1 236	2.69	2.10–3.51
2007–08	32 767	25.3	221	2.66	930.1157	743–1 175	2.84	2.27–3.59
2008–09	29 976	24.7	373	5.03	1 225.5492	1 010–1 525	4.09	3.37–5.09
2009–10	29 505	26.0	241	3.14	961.7836	773–1 196	3.26	2.62–4.05
2010–11	27 397	22.7	311	5.00	1 169.4785	947–1 464	4.27	3.46–5.34
2011–12	25 593	32.7	225	2.68	773.4495	638–944	3.02	2.49–3.69
2012–13	23 980	49.3	693	5.86	1 041.2991	943–1 169	4.34	3.93–4.87
2013–14	25 657	43.7	462	4.12	819.6757	722–937	3.19	2.81–3.65
2014–15	25 648	43.9	597	5.30	1 027.0590	916–1 172	4.00	3.57–4.57
2015–16	25 008	43.0	435	4.04	738.3916	660–835	2.95	2.64–3.34
2016–17	25 750	38.4	399	4.03	769.7299	666–903	2.99	2.59–3.51

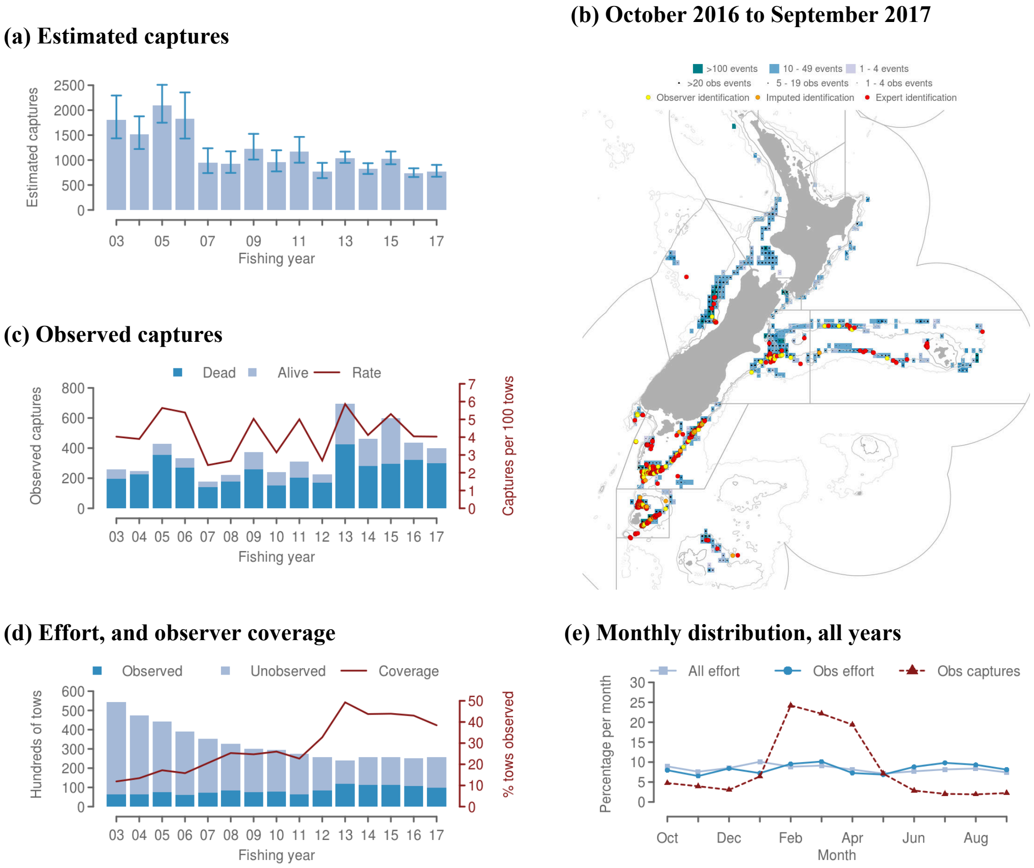


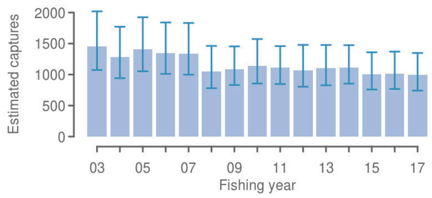
Figure B-11: All birds captures in large-vessel (≥ 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 97.8% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, 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

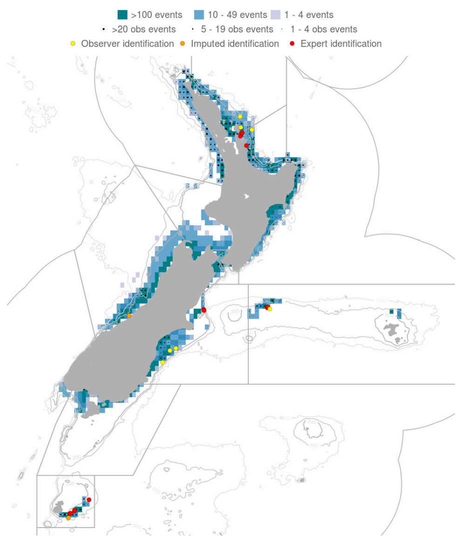
Table B-32: Annual fishing effort and number of tows observed in small-vessel (< 28 m length) trawl fisheries, number of observed captures of all birds and observed capture rate (captures per hundred tows), estimated captures and capture rate of all birds (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	75 965	0.5	1	0.26	1 455.9198	1 073–2 019	1.92	1.41–2.66
2003–04	73 470	0.2	3	1.64	1 280.6399	942–1 771	1.74	1.28–2.41
2004–05	76 309	0.2	6	4.76	1 406.0465	1 054–1 924	1.84	1.38–2.52
2005–06	70 822	0.6	12	2.75	1 348.2019	1 011–1 840	1.90	1.43–2.60
2006–07	68 115	1.0	32	4.66	1 335.2491	998–1 832	1.96	1.47–2.69
2007–08	56 770	1.3	11	1.46	1 049.5842	780–1 462	1.85	1.37–2.58
2008–09	57 574	4.1	87	3.69	1 083.6317	831–1 454	1.88	1.44–2.53
2009–10	63 384	2.1	23	1.71	1 140.6209	855–1 573	1.80	1.35–2.48
2010–11	58 692	2.1	53	4.29	1 108.4345	847–1 459	1.89	1.44–2.49
2011–12	58 827	1.7	22	2.24	1 071.2946	804–1 479	1.82	1.37–2.51
2012–13	59 857	1.0	8	1.38	1 099.3761	827–1 477	1.84	1.38–2.47
2013–14	59 452	3.3	25	1.27	1 116.4790	854–1 474	1.88	1.44–2.48
2014–15	53 118	4.3	21	0.91	1 005.5090	759–1 359	1.89	1.43–2.56
2015–16	53 024	4.2	25	1.12	1 013.7754	768–1 370	1.91	1.45–2.58
2016–17	52 420	7.3	25	0.65	991.7031	742–1 348	1.89	1.42–2.57

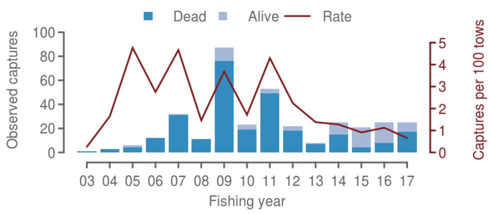
(a) Estimated captures



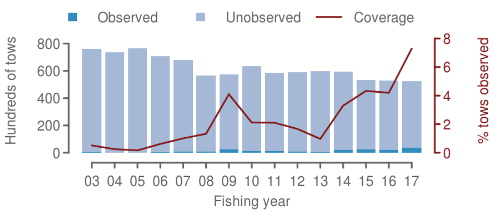
(b) October 2016 to September 2017



(c) Observed captures



(d) Effort, and observer coverage



(e) Monthly distribution, all years

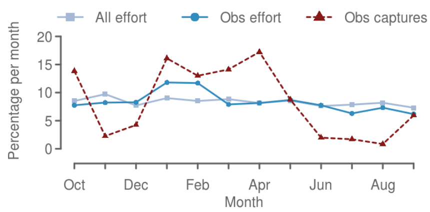


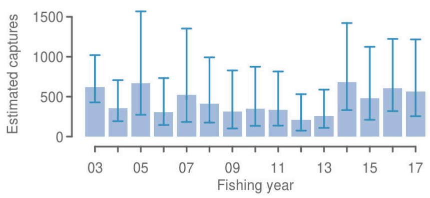
Figure B-12: All birds captures in small-vessel (< 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 , (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.1.3 All birds captures in large-vessel (≥ 28 m length) bottom-longline fisheries

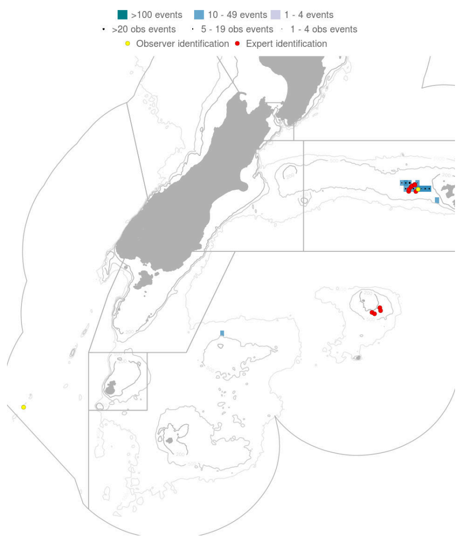
Table B-33: Annual fishing effort and number of hooks observed in large-vessel (≥ 28 m length) bottom-longline fisheries, number of observed captures of all birds and observed capture rate (captures per thousand hooks), estimated captures and capture rate of all birds (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	17 928 519	61.5	254	0.230	619.8106	428–1 020	0.346	0.239–0.569
2003–04	23 339 252	20.9	46	0.094	355.6357	193–707	0.152	0.083–0.303
2004–05	18 932 296	13.7	17	0.066	668.5972	273–1 568	0.353	0.144–0.828
2005–06	14 888 023	24.4	29	0.080	309.2389	145–733	0.208	0.097–0.492
2006–07	12 759 288	14.2	15	0.083	521.6844	183–1 353	0.409	0.143–1.060
2007–08	14 127 896	21.8	22	0.071	409.9673	175–992	0.290	0.124–0.702
2008–09	12 861 501	24.9	5	0.016	312.0522	101–828	0.243	0.079–0.644
2009–10	13 602 940	12.6	10	0.058	348.4640	134–874	0.256	0.099–0.643
2010–11	12 919 517	11.8	18	0.118	332.1027	137–815	0.257	0.106–0.631
2011–12	11 571 447	17.5	4	0.020	207.6829	74–531	0.179	0.064–0.459
2012–13	8 234 145	3.3	0	0.000	259.1379	109–588	0.315	0.132–0.714
2013–14	16 459 721	11.7	47	0.244	682.0625	332–1 422	0.414	0.202–0.864
2014–15	14 060 072	2.5	11	0.308	481.5335	210–1 124	0.342	0.149–0.799
2015–16	18 604 396	10.8	80	0.398	606.8813	319–1 223	0.326	0.171–0.657
2016–17	22 157 051	17.6	13	0.033	567.1779	255–1 217	0.256	0.115–0.549

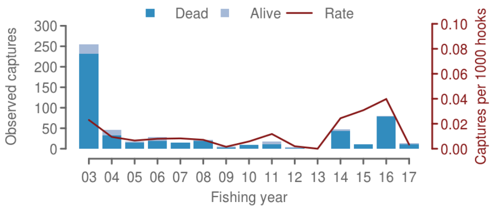
(a) Estimated captures



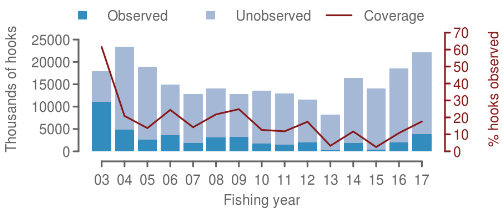
(b) October 2016 to September 2017



(c) Observed captures



(d) Effort, and observer coverage



(e) Monthly distribution, all years

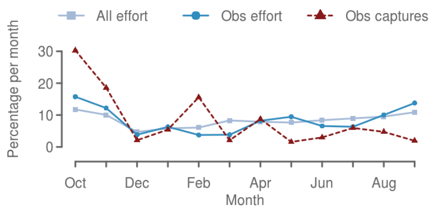


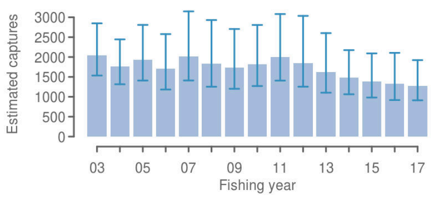
Figure B-13: All birds captures in large-vessel (≥ 28 m length) bottom-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 79.5% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.1.4 All birds captures in small-vessel (< 28 m length) bottom-longline fisheries

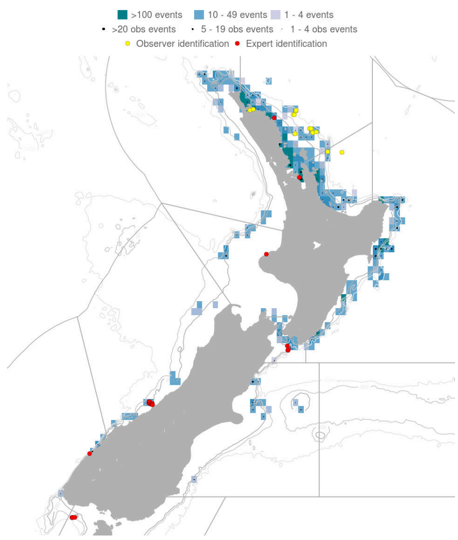
Table B-34: Annual fishing effort and number of hooks observed in small-vessel (< 28 m length) bottom-longline fisheries, number of observed captures of all birds and observed capture rate (captures per thousand hooks), estimated captures and capture rate of all birds (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	19 869 259	0.0	3	5.46	2 044.935	1 535–2 848	1.03	0.77–1.43
2003–04	19 910 503	1.1	11	0.49	1 758.624	1 316–2 444	0.88	0.66–1.23
2004–05	22 930 292	1.3	13	0.45	1 936.519	1 409–2 808	0.84	0.61–1.22
2005–06	22 260 510	0.7	12	0.76	1 700.249	1 183–2 577	0.76	0.53–1.16
2006–07	25 371 652	2.0	44	0.89	2 014.890	1 411–3 148	0.79	0.56–1.24
2007–08	27 376 411	1.8	18	0.37	1 837.148	1 253–2 930	0.67	0.46–1.07
2008–09	24 573 964	3.6	34	0.38	1 729.595	1 202–2 705	0.70	0.49–1.10
2009–10	26 845 521	2.7	58	0.80	1 812.609	1 271–2 806	0.68	0.47–1.05
2010–11	27 981 339	1.0	2	0.07	1 996.964	1 407–3 081	0.71	0.50–1.10
2011–12	26 312 456	0.3	6	0.72	1 853.290	1 254–3 035	0.70	0.48–1.15
2012–13	24 271 654	1.9	7	0.15	1 618.712	1 104–2 602	0.67	0.45–1.07
2013–14	24 419 994	4.1	57	0.57	1 480.920	1 064–2 174	0.61	0.44–0.89
2014–15	25 289 849	2.1	16	0.30	1 383.364	982–2 092	0.55	0.39–0.83
2015–16	24 887 264	2.5	24	0.38	1 327.626	918–2 105	0.53	0.37–0.85
2016–17	24 396 916	4.5	40	0.36	1 278.703	912–1 922	0.52	0.37–0.79

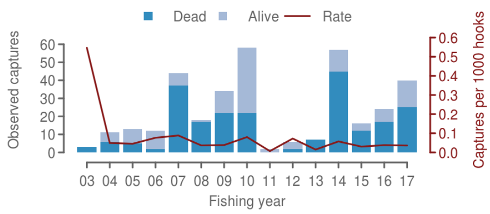
(a) Estimated captures



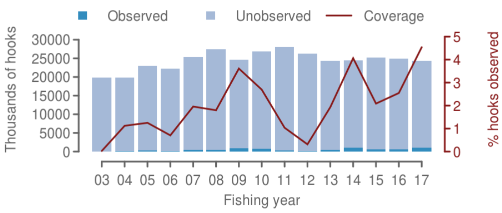
(b) October 2016 to September 2017



(c) Observed captures



(d) Effort, and observer coverage



(e) Monthly distribution, all years

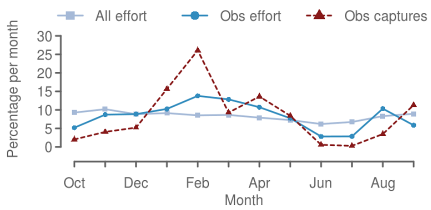


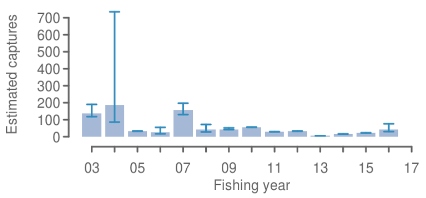
Figure B-14: All birds captures in small-vessel (< 28 m length) bottom-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 97.0% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.1.5 All birds captures in large-vessel ($\geq$ 28 m length) surface-longline fisheries

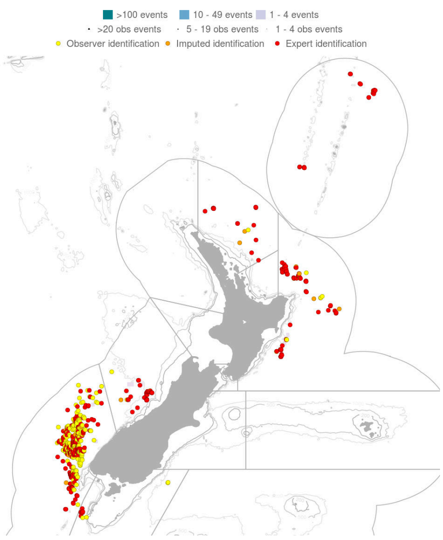
Table B-35: Annual fishing effort and number of hooks observed in large-vessel ($\geq$ 28 m length) surface-longline fisheries, number of observed captures of all birds and observed capture rate (captures per thousand hooks), estimated captures and capture rate of all birds (mean and 95% credible interval). Following Fisheries New Zealand data anonymity rules, effort and rate data are not shown where there were fewer than three vessels fishing.

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	2 197 522	99.9	115	0.52	138.51374	118–190	0.63	0.54–0.86
2003–04	1 655 920	88.9	64	0.43	185.60770	86–735	1.12	0.52–4.44
2004–05	.	.	33	0.51	33.00000	33–33	.	.–.
2005–06	.	.	15	0.25	27.72764	17–55	.	.–.
2006–07	1 407 149	60.7	111	1.30	156.43253	130–197	1.11	0.92–1.40
2007–08	.	.	24	0.84	42.46952	28–72	.	.–.
2008–09	.	.	42	0.53	43.52549	42–52	.	.–.
2009–10	.	.	56	1.17	56.00000	56–56	.	.–.
2010–11	.	.	29	0.58	29.00000	29–29	.	.–.
2011–12	.	.	33	0.59	33.00000	33–33	.	.–.
2012–13	.	.	5	0.10	5.00000	5–5	.	.–.
2013–14	.	.	16	0.24	16.00000	16–16	.	.–.
2014–15	.	.	22	0.36	22.10070	22–23	.	.–.
2015–16	.	.	27	11.37	43.61619	30–76	.	.–.
2016–17	0	.	0	.	.	.–.	.	.–.

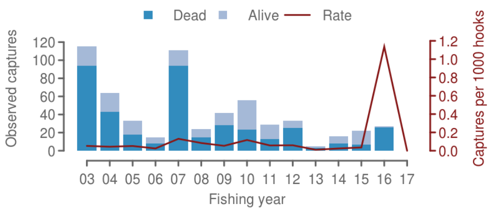
(a) Estimated captures



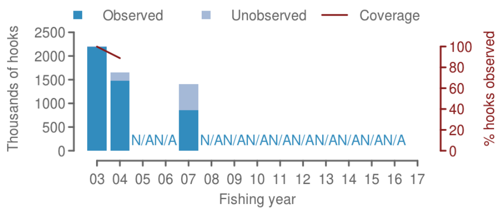
(b) October 2002 to September 2017



(c) Observed captures



(d) Effort, and observer coverage



(e) Monthly distribution, all years

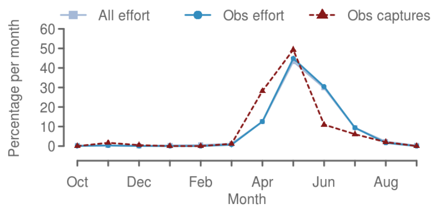


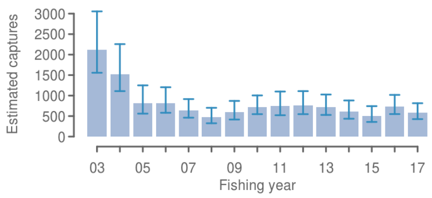
Figure B-15: All birds captures in large-vessel ($\geq$ 28 m length) surface-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures from 2002–03 to 2016–17 (Following confidentiality rules, 1.3% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.1.6 All birds captures in small-vessel (< 28 m length) surface-longline fisheries

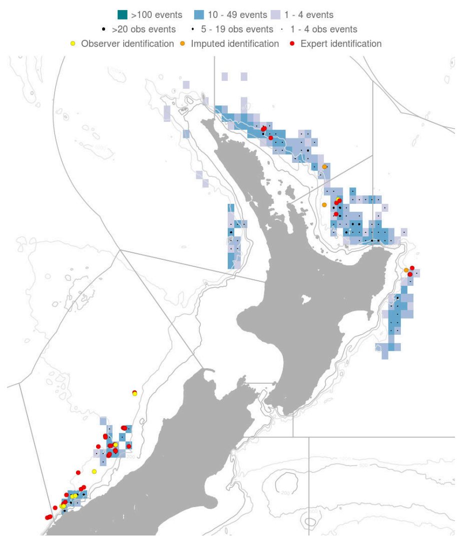
Table B-36: Annual fishing effort and number of hooks observed in small-vessel (< 28 m length) surface-longline fisheries, number of observed captures of all birds and observed capture rate (captures per thousand hooks), estimated captures and capture rate of all birds (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	8 572 516	0.0	0	.	2 122.3486	1 557–3 055	2.48	1.82–3.56
2003–04	5 730 829	2.4	7	0.52	1 522.1669	1 109–2 256	2.66	1.94–3.94
2004–05	3 044 211	4.7	8	0.56	811.8593	560–1 250	2.67	1.84–4.11
2005–06	3 028 099	3.2	22	2.26	815.1164	581–1 204	2.69	1.92–3.98
2006–07	2 332 763	8.0	76	4.06	639.6829	461–915	2.74	1.98–3.92
2007–08	1 678 054	8.1	13	0.95	471.9848	325–702	2.81	1.94–4.18
2008–09	2 306 403	6.5	15	0.99	599.3968	416–870	2.60	1.80–3.77
2009–10	2 516 706	7.3	79	4.29	724.9835	547–1 004	2.88	2.17–3.99
2010–11	2 684 809	6.4	18	1.05	740.7799	521–1 099	2.76	1.94–4.09
2011–12	2 548 687	6.8	31	1.79	758.4025	547–1 109	2.98	2.15–4.35
2012–13	2 389 412	3.1	22	3.02	722.9360	528–1 026	3.03	2.21–4.29
2013–14	1 896 434	6.8	20	1.55	608.0330	435–881	3.21	2.29–4.65
2014–15	1 790 036	6.0	16	1.50	507.6937	357–743	2.84	1.99–4.15
2015–16	2 302 691	13.0	104	3.48	729.6132	549–1 017	3.17	2.38–4.42
2016–17	2 092 486	16.5	51	1.48	579.0960	426–814	2.77	2.04–3.89

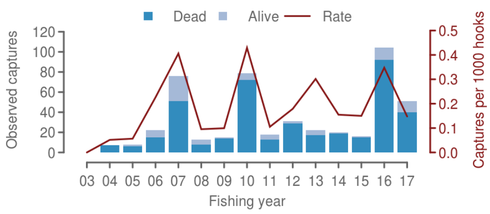
(a) Estimated captures



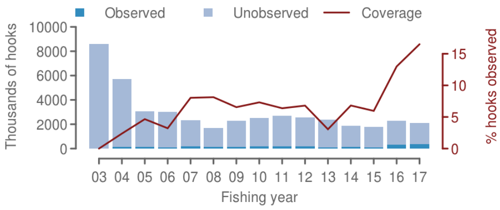
(b) October 2016 to September 2017



(c) Observed captures



(d) Effort, and observer coverage



(e) Monthly distribution, all years

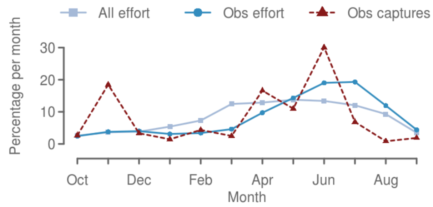


Figure B-16: All birds captures in small-vessel (< 28 m length) surface-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 95.4% of total effort is shown), (c) Observed captures, (d) Effort and 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-37: 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), 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	81	1.26	463.3581	337–631	0.85	0.62–1.16
2003–04	47 339	13.4	139	2.18	587.0977	440–768	1.24	0.93–1.62
2004–05	44 156	17.2	212	2.79	758.4465	598–967	1.72	1.35–2.19
2005–06	39 121	15.8	63	1.02	321.8331	228–445	0.82	0.58–1.14
2006–07	35 193	20.6	48	0.66	210.6107	147–294	0.60	0.42–0.84
2007–08	32 767	25.3	42	0.51	144.1027	101–204	0.44	0.31–0.62
2008–09	29 976	24.7	78	1.05	239.4198	178–316	0.80	0.59–1.05
2009–10	29 505	26.0	33	0.43	131.1674	86–194	0.44	0.29–0.66
2010–11	27 397	22.7	40	0.64	146.8491	101–209	0.54	0.37–0.76
2011–12	25 593	32.7	60	0.72	176.9460	131–242	0.69	0.51–0.95
2012–13	23 980	49.3	121	1.02	158.0790	140–182	0.66	0.58–0.76
2013–14	25 657	43.7	70	0.62	104.1697	88–126	0.41	0.34–0.49
2014–15	25 648	43.9	75	0.67	105.0840	91–124	0.41	0.35–0.48
2015–16	25 008	43.0	103	0.96	138.2261	122–160	0.55	0.49–0.64
2016–17	25 750	38.4	73	0.74	118.1407	98–146	0.46	0.38–0.57

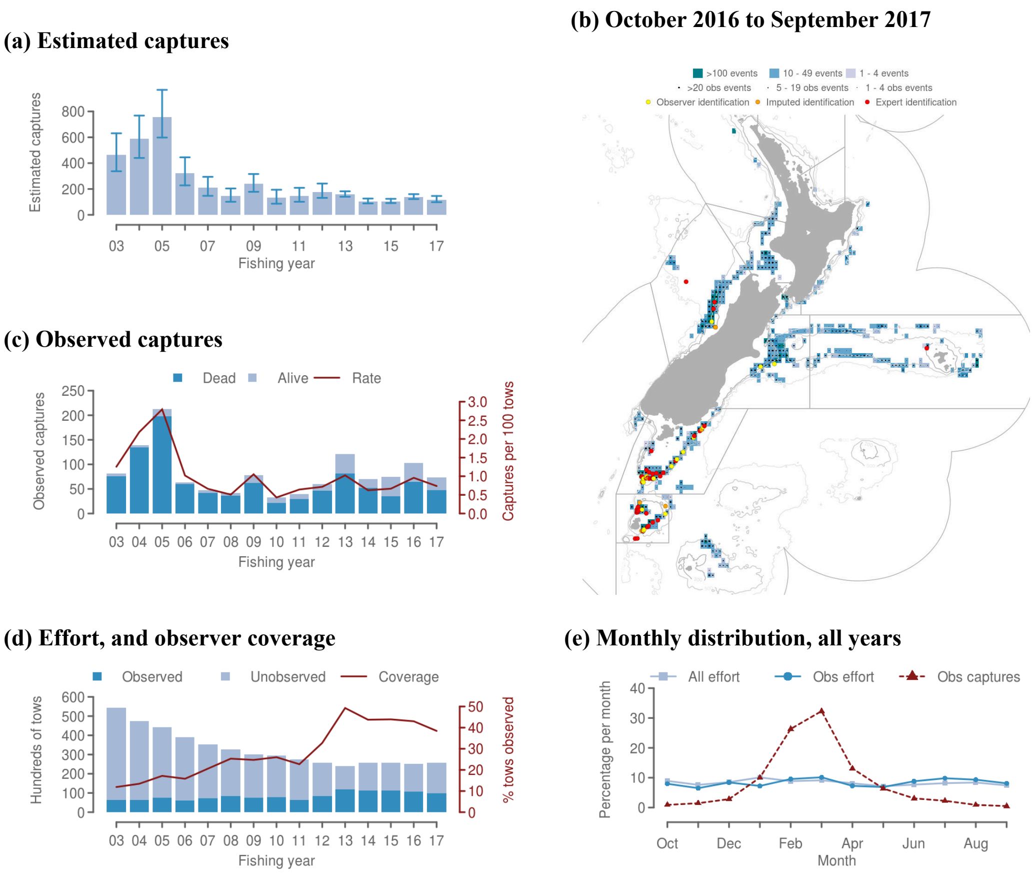


Figure B-17: White-capped albatross captures in large-vessel (≥ 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 97.8% of total effort is shown), (c) Observed captures, (d) Effort and 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-38: 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), 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	75 965	0.5	0	0.00	235.5700	146–356	0.31	0.19–0.47
2003–04	73 470	0.2	0	0.00	225.5037	138–341	0.31	0.19–0.46
2004–05	76 309	0.2	0	0.00	238.9653	148–360	0.31	0.19–0.47
2005–06	70 822	0.6	0	0.00	223.1804	138–337	0.32	0.19–0.48
2006–07	68 115	1.0	6	0.87	232.4830	146–345	0.34	0.21–0.51
2007–08	56 770	1.3	0	0.00	182.7849	111–278	0.32	0.20–0.49
2008–09	57 574	4.1	11	0.47	190.7926	122–278	0.33	0.21–0.48
2009–10	63 384	2.1	9	0.67	216.6619	136–319	0.34	0.21–0.50
2010–11	58 692	2.1	2	0.16	203.2661	128–304	0.35	0.22–0.52
2011–12	58 827	1.7	10	1.02	203.8811	130–302	0.35	0.22–0.51
2012–13	59 857	1.0	5	0.86	219.3518	138–328	0.37	0.23–0.55
2013–14	59 452	3.3	4	0.20	211.3301	132–314	0.36	0.22–0.53
2014–15	53 118	4.3	0	0.00	181.0152	114–277	0.34	0.21–0.52
2015–16	53 024	4.2	4	0.18	195.0182	123–289	0.37	0.23–0.55
2016–17	52 420	7.3	6	0.16	190.5850	121–283	0.36	0.23–0.54

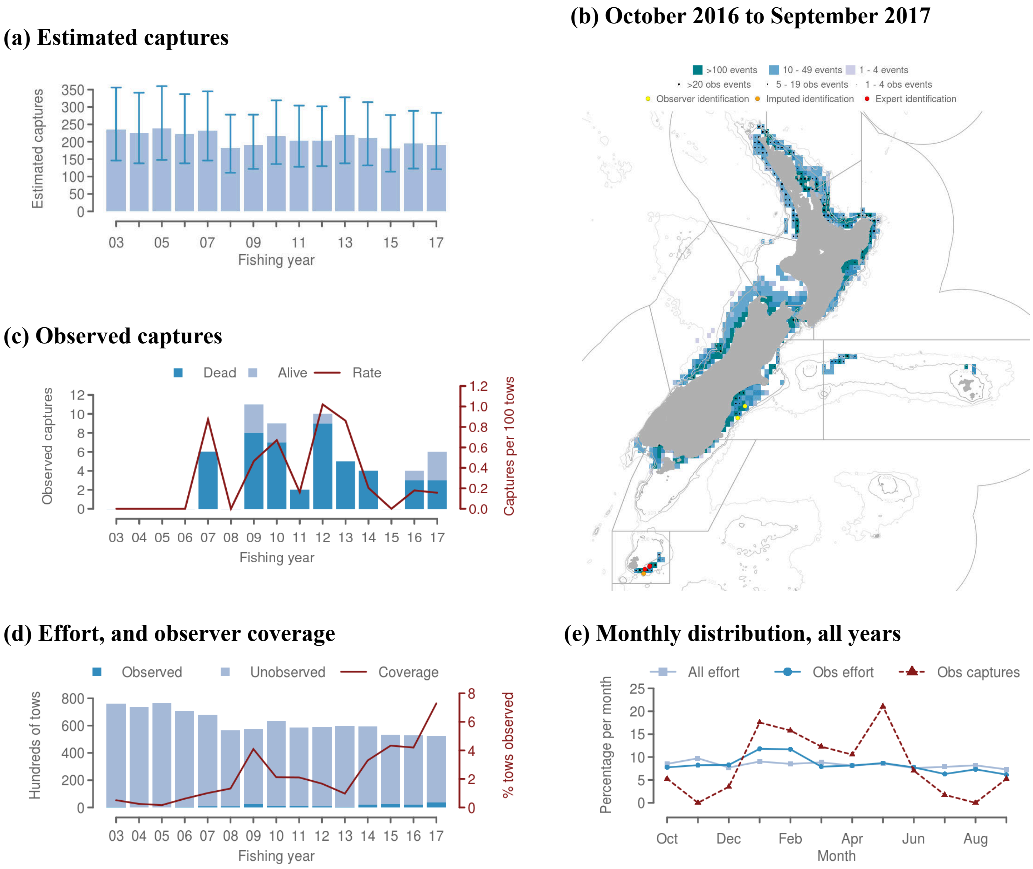


Figure B-18: White-capped albatross captures in small-vessel (< 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 , (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.2.3 White-capped albatross captures in small-vessel (< 28 m length) surface-longline fisheries

Table B-39: Annual fishing effort and number of hooks observed in small-vessel (< 28 m length) surface-longline fisheries, number of observed captures of white-capped albatross and observed capture rate (captures per thousand hooks), 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	8 572 516	0.0	0	.	72.654923	34–134	0.08	0.04–0.16
2003–04	5 730 829	2.4	1	0.07	103.606197	50–184	0.18	0.09–0.32
2004–05	3 044 211	4.7	0	0.00	28.354823	10–59	0.09	0.03–0.19
2005–06	3 028 099	3.2	1	0.10	28.467016	10–60	0.09	0.03–0.20
2006–07	2 332 763	8.0	1	0.05	9.697901	3–21	0.04	0.01–0.09
2007–08	1 678 054	8.1	1	0.07	28.615192	9–61	0.17	0.05–0.36
2008–09	2 306 403	6.5	1	0.07	35.651424	13–74	0.15	0.06–0.32
2009–10	2 516 706	7.3	19	1.03	62.982009	37–105	0.25	0.15–0.42
2010–11	2 684 809	6.4	0	0.00	42.777361	17–84	0.16	0.06–0.31
2011–12	2 548 687	6.8	2	0.12	120.684408	58–219	0.47	0.23–0.86
2012–13	2 389 412	3.1	10	1.37	115.837831	61–205	0.48	0.26–0.86
2013–14	1 896 434	6.8	7	0.54	94.540480	46–169	0.50	0.24–0.89
2014–15	1 790 036	6.0	4	0.37	85.504748	40–158	0.48	0.22–0.88
2015–16	2 302 691	13.0	28	0.94	117.605197	69–197	0.51	0.30–0.86
2016–17	2 092 486	16.5	17	0.49	105.058721	57–180	0.50	0.27–0.86

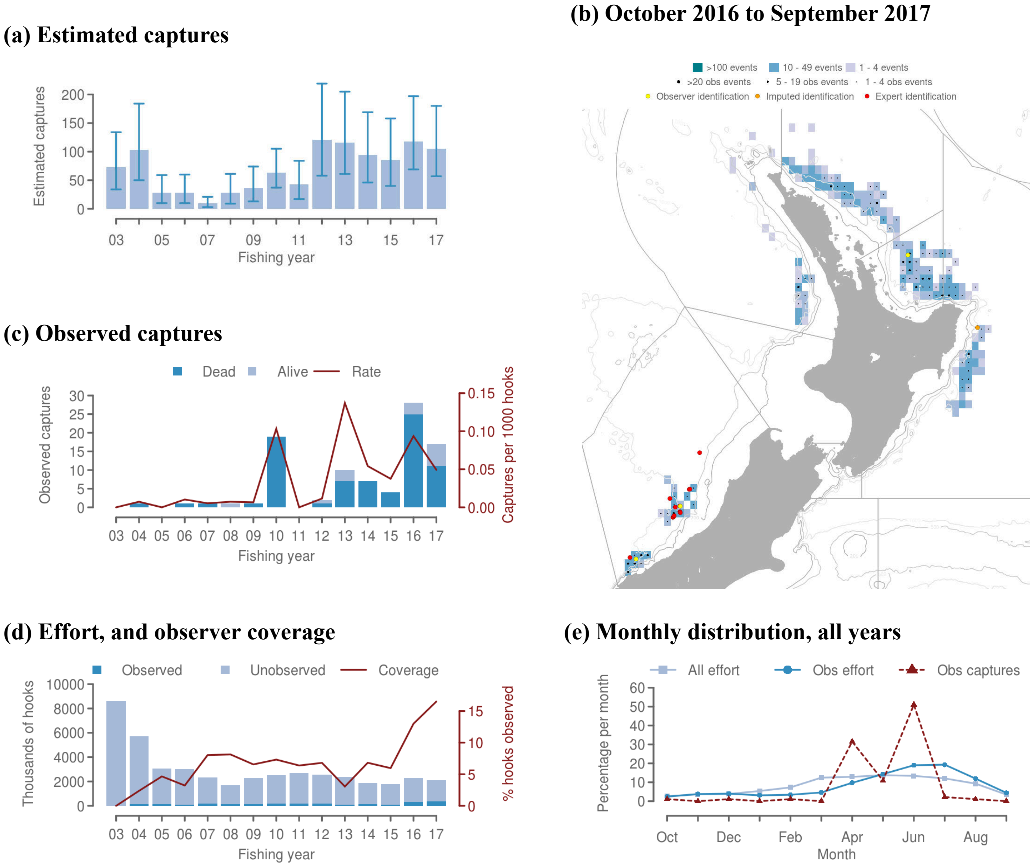


Figure B-19: White-capped albatross captures in small-vessel (< 28 m length) surface-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 95.4% of total effort is shown), (c) Observed captures, (d) 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-40: 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), 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	181.61744	100–299	0.335	0.185–0.552
2003–04	47 339	13.4	7	0.110	128.57171	52–255	0.272	0.110–0.539
2004–05	44 156	17.2	36	0.474	372.82484	216–616	0.844	0.489–1.395
2005–06	39 121	15.8	7	0.113	95.74663	40–181	0.245	0.102–0.463
2006–07	35 193	20.6	9	0.124	72.06922	32–136	0.205	0.091–0.386
2007–08	32 767	25.3	5	0.060	58.01674	21–116	0.177	0.064–0.354
2008–09	29 976	24.7	12	0.162	94.53198	48–168	0.315	0.160–0.560
2009–10	29 505	26.0	33	0.430	141.19440	89–216	0.479	0.302–0.732
2010–11	27 397	22.7	16	0.257	96.79210	51–167	0.353	0.186–0.610
2011–12	25 593	32.7	21	0.251	91.27186	53–150	0.357	0.207–0.586
2012–13	23 980	49.3	51	0.432	126.34333	89–182	0.527	0.371–0.759
2013–14	25 657	43.7	48	0.428	124.84208	87–178	0.487	0.339–0.694
2014–15	25 648	43.9	40	0.355	139.97476	91–211	0.546	0.355–0.823
2015–16	25 008	43.0	33	0.307	96.17191	64–145	0.385	0.256–0.580
2016–17	25 750	38.4	19	0.192	70.96952	42–115	0.276	0.163–0.447

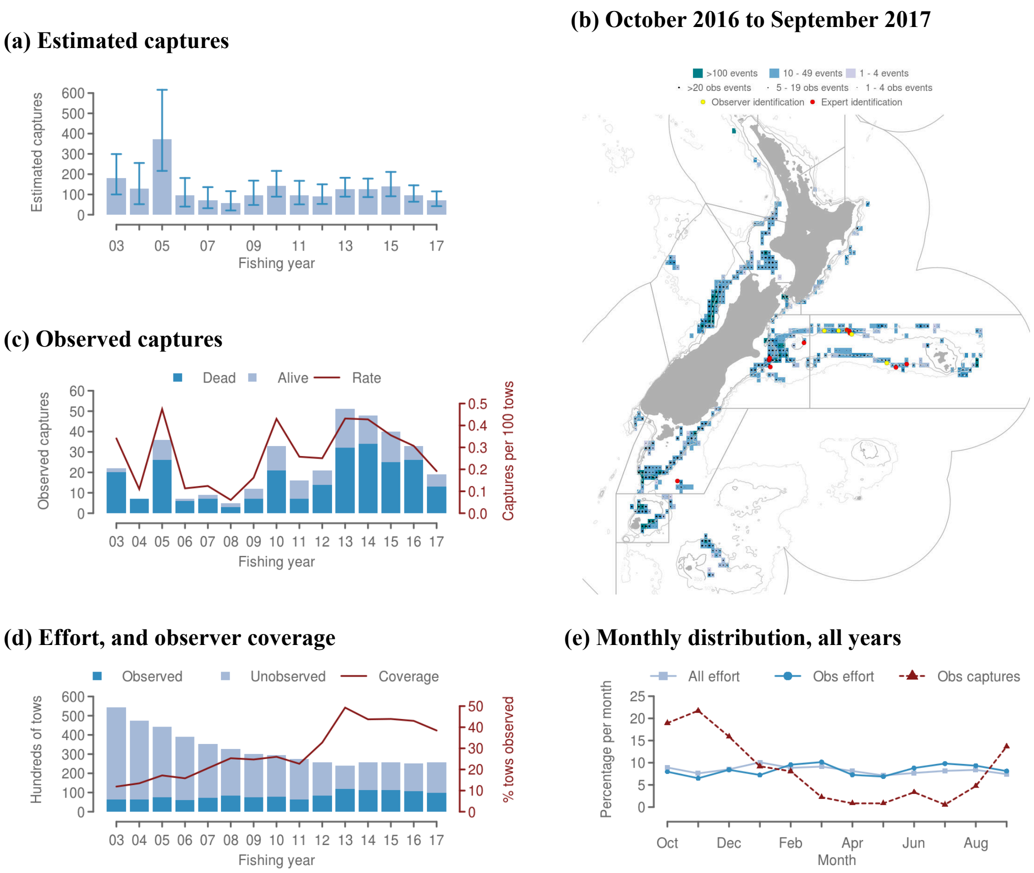


Figure B-20: Salvin's albatross captures in large-vessel (≥ 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 97.8% of total effort is shown), (c) Observed captures, (d) Effort and observed 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-41: 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), 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	75 995	0.5	1	0.26	315.5095	170–551	0.42	0.22–0.73
2003–04	73 511	0.3	3	1.62	245.5067	131–429	0.33	0.18–0.58
2004–05	76 312	0.2	2	1.59	295.6932	164–489	0.39	0.21–0.64
2005–06	70 812	0.6	1	0.23	290.3953	160–495	0.41	0.23–0.70
2006–07	68 135	1.0	1	0.15	263.8006	146–445	0.39	0.21–0.65
2007–08	56 767	1.3	4	0.53	193.5037	107–327	0.34	0.19–0.58
2008–09	57 574	4.1	24	1.02	219.3178	128–356	0.38	0.22–0.62
2009–10	63 386	2.1	10	0.75	214.5895	119–360	0.34	0.19–0.57
2010–11	58 692	2.1	4	0.32	231.5217	125–388	0.39	0.21–0.66
2011–12	58 825	1.7	5	0.51	229.3963	132–385	0.39	0.22–0.65
2012–13	59 856	1.0	2	0.34	239.0345	135–396	0.40	0.23–0.66
2013–14	59 453	3.3	3	0.15	268.2219	155–440	0.45	0.26–0.74
2014–15	53 119	4.3	6	0.26	251.0572	146–409	0.47	0.27–0.77
2015–16	53 022	4.2	2	0.09	211.8206	120–353	0.40	0.23–0.67
2016–17	52 422	7.3	6	0.16	215.6879	123–361	0.41	0.23–0.69

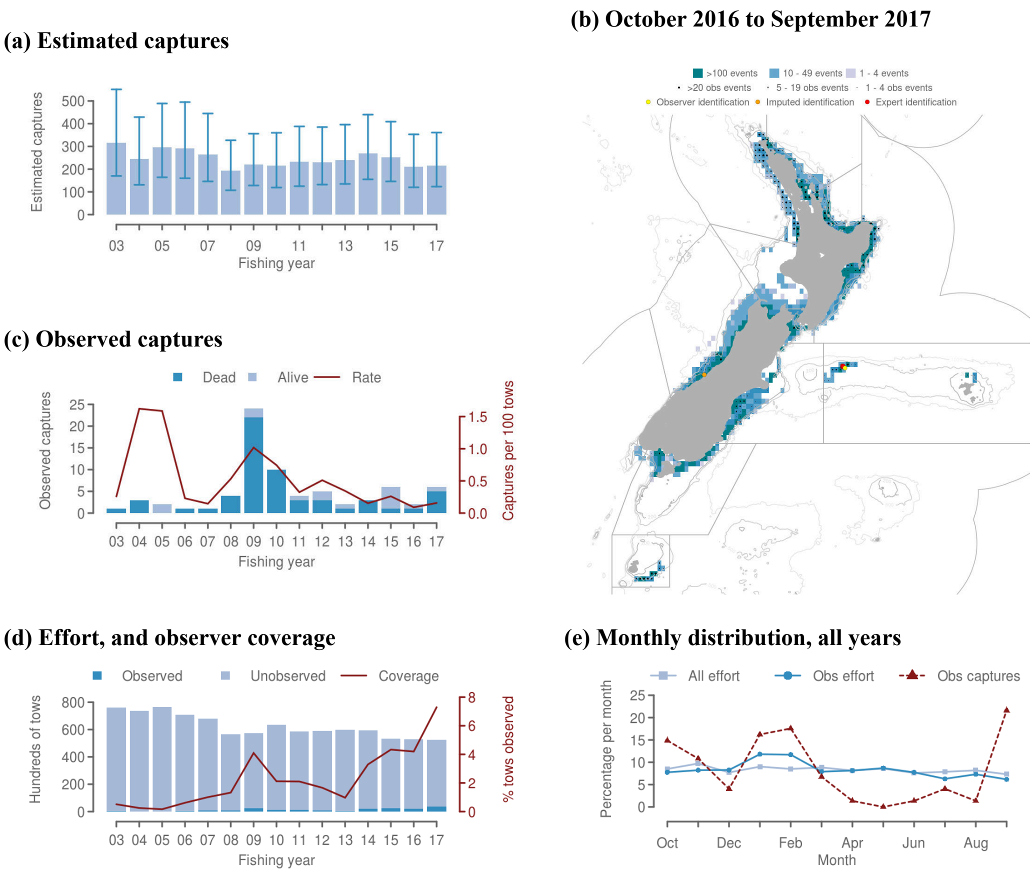


Figure B-21: Salvin’s albatross captures in small-vessel (< 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 , (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.3.3 Salvin's albatross captures in small-vessel (< 28 m length) bottom-longline fisheries

Table B-42: Annual fishing effort and number of hooks observed in small-vessel (< 28 m length) bottom-longline fisheries, number of observed captures of Salvin's albatross and observed capture rate (captures per thousand hooks), 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	19 869 259	0.0	0	0.000	69.15567	14–224	0.035	0.007–0.113
2003–04	19 910 503	1.1	0	0.000	66.14618	11–243	0.033	0.006–0.122
2004–05	22 930 292	1.3	0	0.000	104.15042	20–366	0.045	0.009–0.160
2005–06	22 260 510	0.7	0	0.000	97.63843	13–387	0.044	0.006–0.174
2006–07	25 371 652	2.0	22	0.443	121.70465	42–358	0.048	0.017–0.141
2007–08	27 376 411	1.8	0	0.000	112.68991	23–380	0.041	0.008–0.139
2008–09	24 573 964	3.6	0	0.000	107.23613	25–330	0.044	0.010–0.134
2009–10	26 845 521	2.7	0	0.000	112.87106	24–353	0.042	0.009–0.131
2010–11	27 981 339	1.0	0	0.000	145.30635	30–473	0.052	0.011–0.169
2011–12	26 312 456	0.3	0	0.000	157.24838	33–536	0.060	0.013–0.204
2012–13	24 271 654	1.9	1	0.021	143.51949	28–514	0.059	0.012–0.212
2013–14	24 419 994	4.1	1	0.010	113.68216	26–357	0.047	0.011–0.146
2014–15	25 289 849	2.1	0	0.000	109.15992	22–370	0.043	0.009–0.146
2015–16	24 887 264	2.5	0	0.000	106.43903	21–373	0.043	0.008–0.150
2016–17	24 396 916	4.5	1	0.009	74.57371	15–254	0.031	0.006–0.104

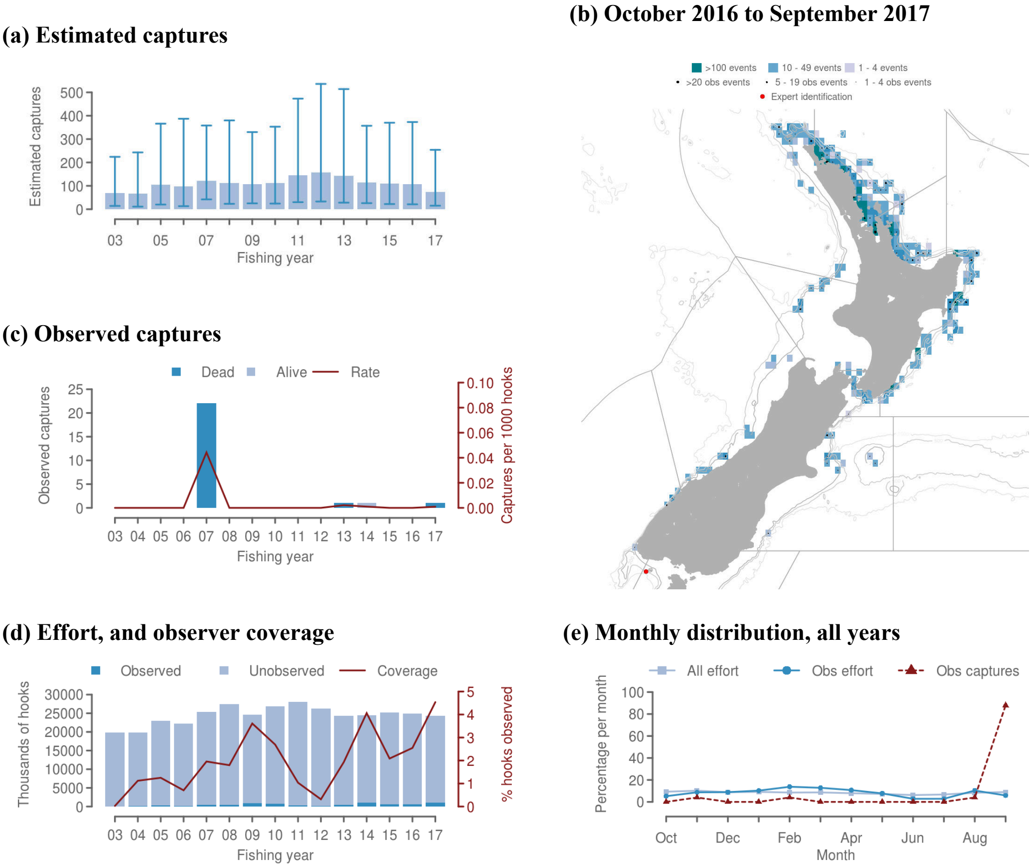


Figure B-22: Salvin's albatross captures in small-vessel (< 28 m length) bottom-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 97.0% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

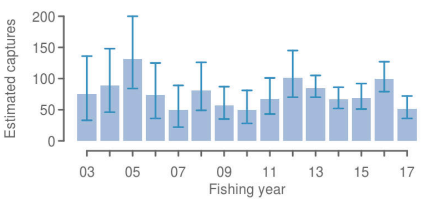
B.4 Buller's albatrosses captures

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

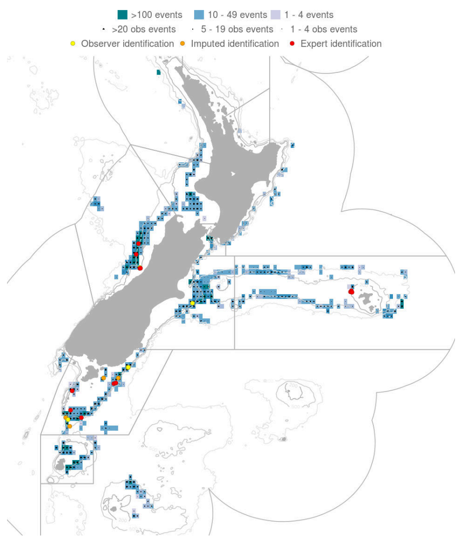
Table B-43: Annual fishing effort and number of tows observed in large-vessel (≥ 28 m length) trawl fisheries, number of observed captures of Buller's albatrosses and observed capture rate (captures per hundred tows), estimated captures and capture rate of Buller's albatrosses (mean and 95% credible 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	6	0.093	75.17366	33–136	0.139	0.061–0.251
2003–04	47 339	13.4	9	0.141	88.48776	46–148	0.187	0.097–0.313
2004–05	44 156	17.2	21	0.277	131.97176	84–200	0.299	0.190–0.453
2005–06	39 121	15.8	8	0.129	74.16717	36–125	0.190	0.092–0.320
2006–07	35 193	20.6	6	0.083	49.81509	22–89	0.142	0.063–0.253
2007–08	32 767	25.3	17	0.205	80.55947	49–126	0.246	0.150–0.385
2008–09	29 976	24.7	16	0.216	56.86107	35–87	0.190	0.117–0.290
2009–10	29 505	26.0	11	0.143	49.53473	28–81	0.168	0.095–0.275
2010–11	27 397	22.7	20	0.322	67.73038	43–101	0.247	0.157–0.369
2011–12	25 593	32.7	33	0.394	101.13193	70–145	0.395	0.274–0.567
2012–13	23 980	49.3	58	0.491	84.27561	70–105	0.351	0.292–0.438
2013–14	25 657	43.7	38	0.339	66.52799	52–86	0.259	0.203–0.335
2014–15	25 648	43.9	34	0.302	68.61494	51–92	0.268	0.199–0.359
2015–16	25 008	43.0	57	0.530	99.64793	79–127	0.398	0.316–0.508
2016–17	25 750	38.4	22	0.222	51.48726	36–72	0.200	0.140–0.280

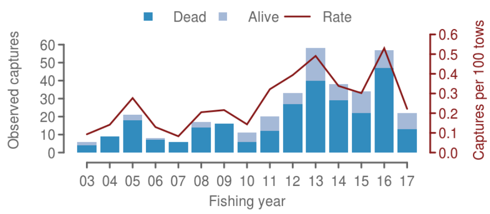
(a) Estimated captures



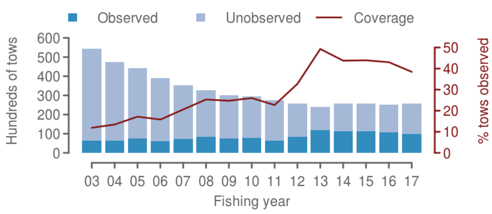
(b) October 2016 to September 2017



(c) Observed captures



(d) Effort, and observer coverage



(e) Monthly distribution, all years

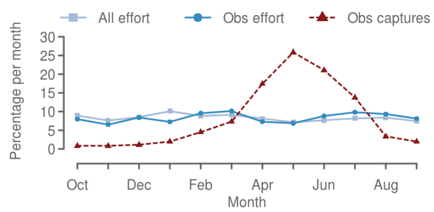


Figure B-23: Buller's albatrosses captures in large-vessel (≥ 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 97.8% of total effort is shown), (c) Observed captures, (d) Effort and 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) surface-longline fisheries

Table B-44: Annual fishing effort and number of hooks observed in small-vessel (< 28 m length) surface-longline fisheries, number of observed captures of Buller's albatrosses and observed capture rate (captures per thousand hooks), 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	8 572 816	0.0	0	.	348.16992	187–627	0.41	0.22–0.73
2003–04	5 730 459	2.4	0	0.00	295.62319	157–540	0.52	0.27–0.94
2004–05	3 044 411	4.7	1	0.07	106.67816	50–208	0.35	0.16–0.68
2005–06	3 028 699	3.2	5	0.51	132.14268	61–258	0.44	0.20–0.85
2006–07	2 332 813	8.0	1	0.05	72.41029	30–158	0.31	0.13–0.68
2007–08	1 678 754	8.1	3	0.22	65.16742	27–130	0.39	0.16–0.77
2008–09	2 305 503	6.5	2	0.13	94.35032	43–185	0.41	0.19–0.80
2009–10	2 517 986	7.3	28	1.52	129.87281	78–213	0.52	0.31–0.85
2010–11	2 683 529	6.4	4	0.23	105.45727	53–184	0.39	0.20–0.69
2011–12	2 548 787	6.8	4	0.23	138.25712	70–248	0.54	0.27–0.97
2012–13	2 389 462	3.1	8	1.10	118.08346	62–208	0.49	0.26–0.87
2013–14	1 896 434	6.8	8	0.62	104.80135	53–189	0.55	0.28–1.00
2014–15	1 790 036	6.0	3	0.28	85.21264	40–164	0.48	0.22–0.92
2015–16	2 303 441	13.0	43	1.44	150.81059	95–249	0.65	0.41–1.08
2016–17	2 092 486	16.5	13	0.38	114.02299	61–206	0.54	0.29–0.98

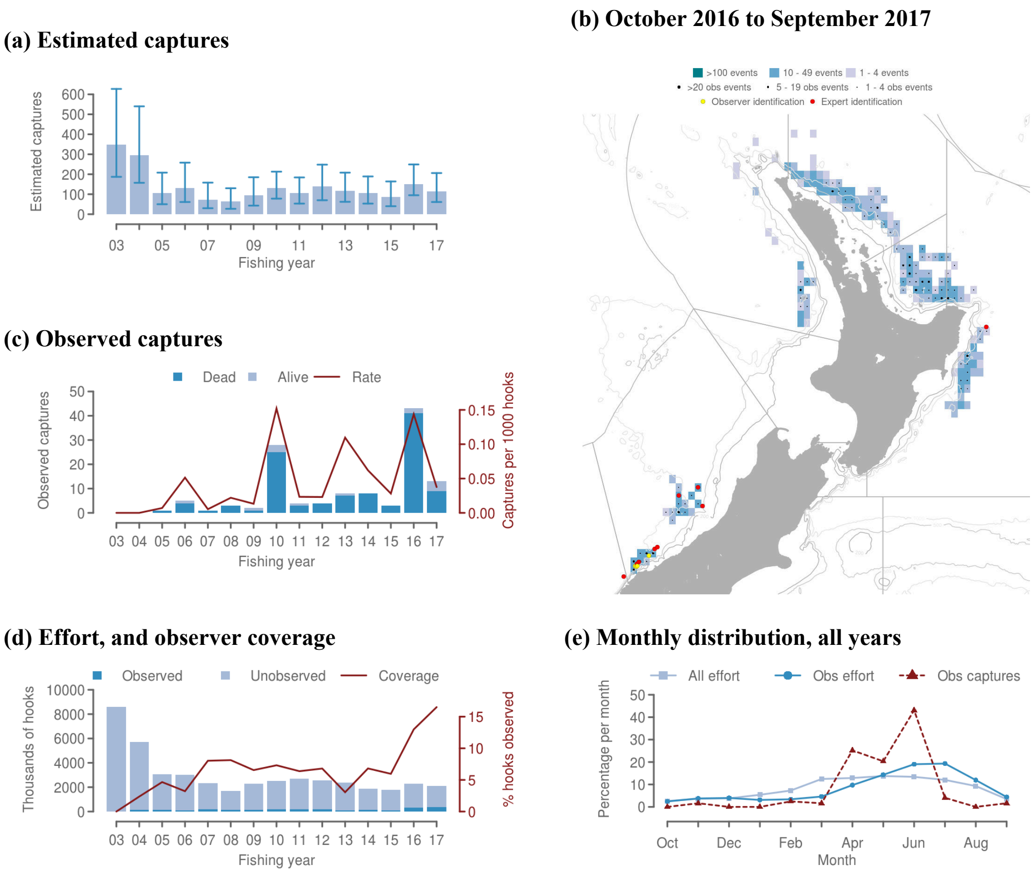


Figure B-24: Buller's albatrosses captures in small-vessel (< 28 m length) surface-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 95.4% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

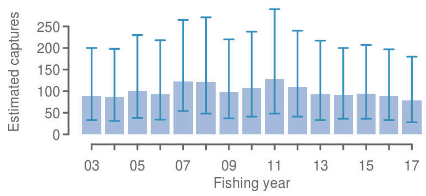
B.5 Other albatrosses captures

B.5.1 Other albatrosses captures in small-vessel (< 28 m length) bottom-longline fisheries

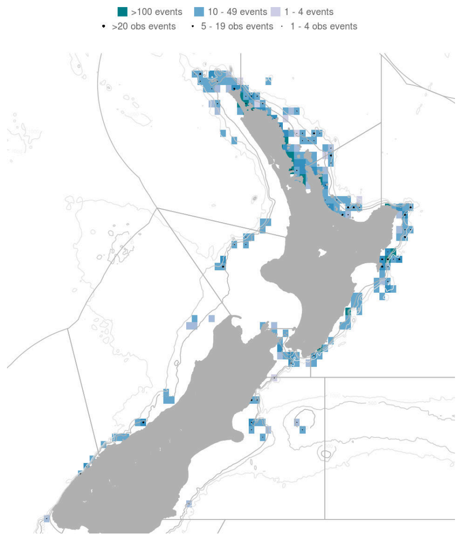
Table B-45: Annual fishing effort and number of hooks observed in small-vessel (< 28 m length) bottom-longline fisheries, number of observed captures of other albatrosses and observed capture rate (captures per thousand hooks), estimated captures and capture rate of other albatrosses (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	19 869 259	0.0	0	0.000	88.34708	33–200	0.044	0.017–0.101
2003–04	19 910 503	1.1	0	0.000	86.52049	31–198	0.043	0.016–0.099
2004–05	22 930 292	1.3	0	0.000	100.12869	38–230	0.044	0.017–0.100
2005–06	22 260 510	0.7	0	0.000	93.09370	34–218	0.042	0.015–0.098
2006–07	25 371 652	2.0	14	0.282	121.85682	54–265	0.048	0.021–0.104
2007–08	27 376 411	1.8	4	0.081	121.47901	48–271	0.044	0.018–0.099
2008–09	24 573 964	3.6	0	0.000	97.71589	37–220	0.040	0.015–0.090
2009–10	26 845 521	2.7	0	0.000	107.42029	41–238	0.040	0.015–0.089
2010–11	27 981 339	1.0	0	0.000	127.80035	48–290	0.046	0.017–0.104
2011–12	26 312 456	0.3	0	0.000	109.03423	41–240	0.041	0.016–0.091
2012–13	24 271 654	1.9	0	0.000	93.23638	33–217	0.038	0.014–0.089
2013–14	24 419 994	4.1	1	0.010	91.83433	36–200	0.038	0.015–0.082
2014–15	25 289 849	2.1	0	0.000	93.90355	36–207	0.037	0.014–0.082
2015–16	24 887 264	2.5	2	0.032	88.46852	33–197	0.036	0.013–0.079
2016–17	24 396 916	4.5	0	0.000	78.05497	28–180	0.032	0.011–0.074

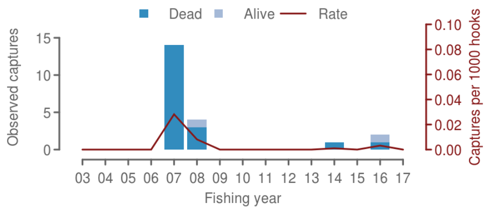
(a) Estimated captures



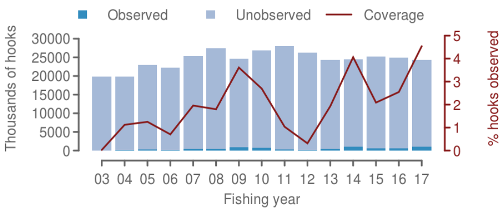
(b) October 2016 to September 2017



(c) Observed captures



(d) Effort, and observer coverage



(e) Monthly distribution, all years

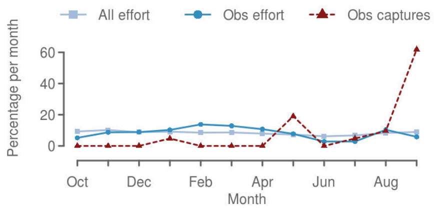


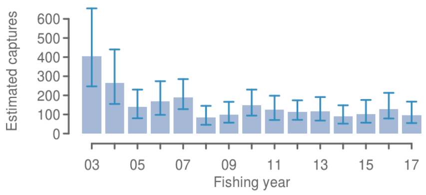
Figure B-25: Other albatrosses captures in small-vessel (< 28 m length) bottom-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 97.0% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.5.2 Other albatrosses captures in small-vessel (< 28 m length) surface-longline fisheries

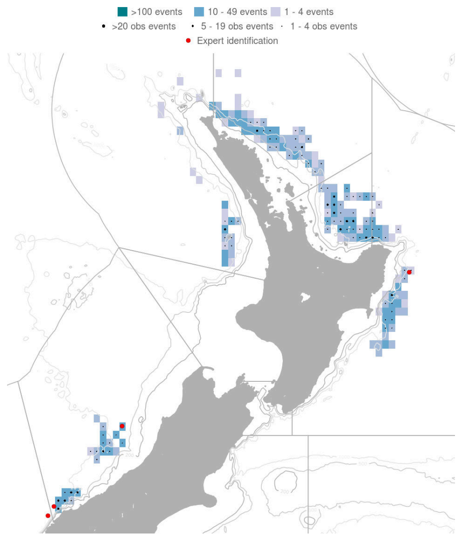
Table B-46: Annual fishing effort and number of hooks observed in small-vessel (< 28 m length) surface-longline fisheries, number of observed captures of other albatrosses and observed capture rate (captures per thousand hooks), estimated captures and capture rate of other albatrosses (mean and 95% credible interval).

		Observed			Est. captures		Est. capture rate	
Year	Effort	% obs.	Cap.	Rate	Mean	95% c.i.	Mean	95% c.i.
2002–03	8 572 516	0.0	0	.	405.63318	247–655	0.47	0.29–0.76
2003–04	5 730 829	2.4	1	0.07	265.55822	155–440	0.46	0.27–0.77
2004–05	3 044 211	4.7	3	0.21	140.57146	80–230	0.46	0.26–0.76
2005–06	3 028 099	3.2	5	0.51	168.04823	98–274	0.55	0.32–0.90
2006–07	2 332 763	8.0	56	2.99	187.82184	128–285	0.81	0.55–1.22
2007–08	1 678 054	8.1	4	0.29	85.65292	46–145	0.51	0.27–0.86
2008–09	2 306 403	6.5	5	0.33	99.87756	57–166	0.43	0.25–0.72
2009–10	2 516 706	7.3	20	1.09	148.14293	94–230	0.59	0.37–0.91
2010–11	2 684 809	6.4	4	0.23	123.95502	71–198	0.46	0.26–0.74
2011–12	2 548 687	6.8	16	0.92	113.14393	72–174	0.44	0.28–0.68
2012–13	2 389 412	3.1	4	0.55	116.53998	68–191	0.49	0.28–0.80
2013–14	1 896 434	6.8	3	0.23	90.82634	52–148	0.48	0.27–0.78
2014–15	1 790 036	6.0	6	0.56	102.09995	57–176	0.57	0.32–0.98
2015–16	2 302 691	13.0	15	0.50	129.39905	79–213	0.56	0.34–0.93
2016–17	2 092 486	16.5	4	0.12	97.30560	55–167	0.47	0.26–0.80

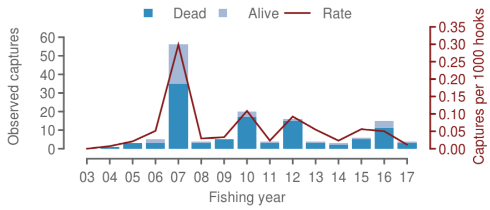
(a) Estimated captures



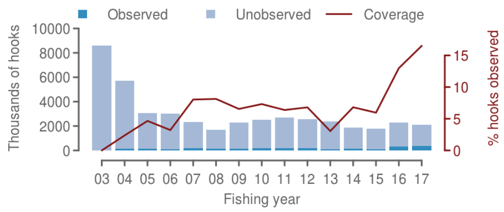
(b) October 2016 to September 2017



(c) Observed captures



(d) Effort, and observer coverage



(e) Monthly distribution, all years

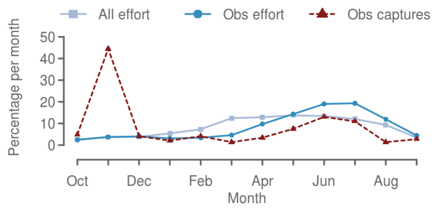


Figure B-26: Other albatrosses captures in small-vessel (< 28 m length) surface-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 95.4% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

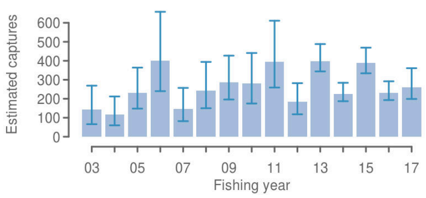
B.6 White-chinned petrel captures

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

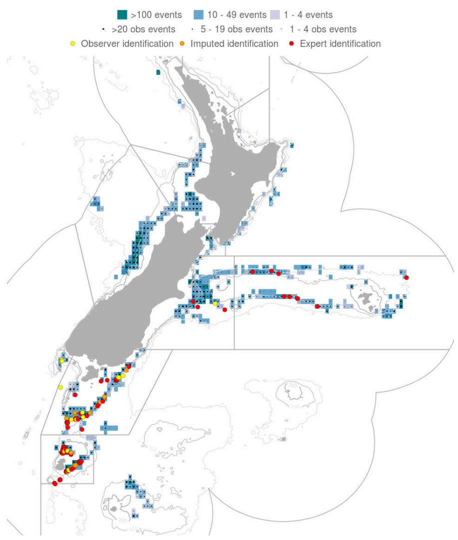
Table B-47: Annual fishing effort and number of tows observed in large-vessel (≥ 28 m length) trawl fisheries, number of observed captures of white-chinned petrel and observed capture rate (captures per hundred tows), estimated captures and capture rate of white-chinned petrel (mean and 95% credible 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	13	0.20	143.8096	66–269	0.27	0.12–0.50
2003–04	47 339	13.4	20	0.31	116.6087	60–212	0.25	0.13–0.45
2004–05	44 156	17.2	54	0.71	232.3831	148–364	0.53	0.34–0.82
2005–06	39 121	15.8	70	1.13	401.4360	240–658	1.03	0.61–1.68
2006–07	35 193	20.6	31	0.43	145.7926	82–257	0.41	0.23–0.73
2007–08	32 767	25.3	58	0.70	243.9200	150–394	0.74	0.46–1.20
2008–09	29 976	24.7	104	1.40	287.6167	196–427	0.96	0.65–1.42
2009–10	29 505	26.0	72	0.94	279.3798	175–441	0.95	0.59–1.49
2010–11	27 397	22.7	114	1.83	395.2449	259–611	1.44	0.95–2.23
2011–12	25 593	32.7	59	0.70	183.3328	118–282	0.72	0.46–1.10
2012–13	23 980	49.3	293	2.48	398.9668	344–488	1.66	1.43–2.04
2013–14	25 657	43.7	149	1.33	224.4385	187–284	0.87	0.73–1.11
2014–15	25 648	43.9	276	2.45	387.7079	334–469	1.51	1.30–1.83
2015–16	25 008	43.0	160	1.49	229.5775	193–292	0.92	0.77–1.17
2016–17	25 750	38.4	142	1.43	261.2041	199–361	1.01	0.77–1.40

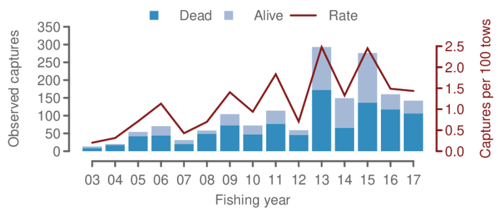
(a) Estimated captures



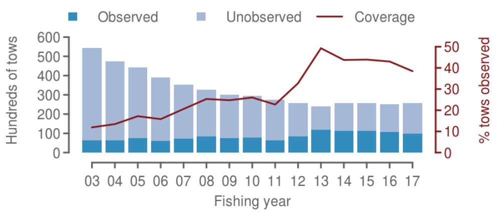
(b) October 2016 to September 2017



(c) Observed captures



(d) Effort, and observer coverage



(e) Monthly distribution, all years

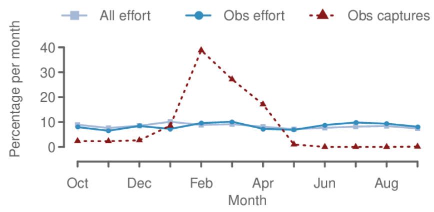


Figure B-27: White-chinned petrel captures in large-vessel (≥ 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 97.8% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.6.2 White-chinned petrel captures in large-vessel (≥ 28 m length) bottom-longline fisheries

Table B-48: Annual fishing effort and number of hooks observed in large-vessel (≥ 28 m length) bottom-longline fisheries, number of observed captures of white-chinned petrel and observed capture rate (captures per thousand hooks), 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	326.74213	182–671	0.182	0.102–0.374
2003–04	23 339 252	20.9	15	0.031	151.36832	36–465	0.065	0.015–0.199
2004–05	18 932 296	13.7	11	0.042	508.45052	139–1 395	0.269	0.073–0.737
2005–06	14 888 023	24.4	13	0.036	172.32359	40–572	0.116	0.027–0.384
2006–07	12 759 288	14.2	13	0.072	403.22839	102–1 218	0.316	0.080–0.955
2007–08	14 127 896	21.8	7	0.023	256.71364	55–810	0.182	0.039–0.573
2008–09	12 861 501	24.9	1	0.003	199.33208	21–704	0.155	0.016–0.547
2009–10	13 602 940	12.6	1	0.006	180.87281	18–662	0.133	0.013–0.487
2010–11	12 919 517	11.8	15	0.098	201.43853	47–637	0.156	0.036–0.493
2011–12	11 571 447	17.5	1	0.005	93.85732	6–381	0.081	0.005–0.329
2012–13	8 234 145	3.3	0	0.000	123.78536	13–420	0.150	0.016–0.510
2013–14	16 459 721	11.7	36	0.187	458.11169	144–1 163	0.278	0.087–0.707
2014–15	14 060 072	2.5	11	0.308	326.65792	88–937	0.232	0.063–0.666
2015–16	18 604 396	10.8	72	0.358	433.52574	179–1 020	0.233	0.096–0.548
2016–17	22 157 051	17.6	12	0.031	389.08046	120–990	0.176	0.054–0.447

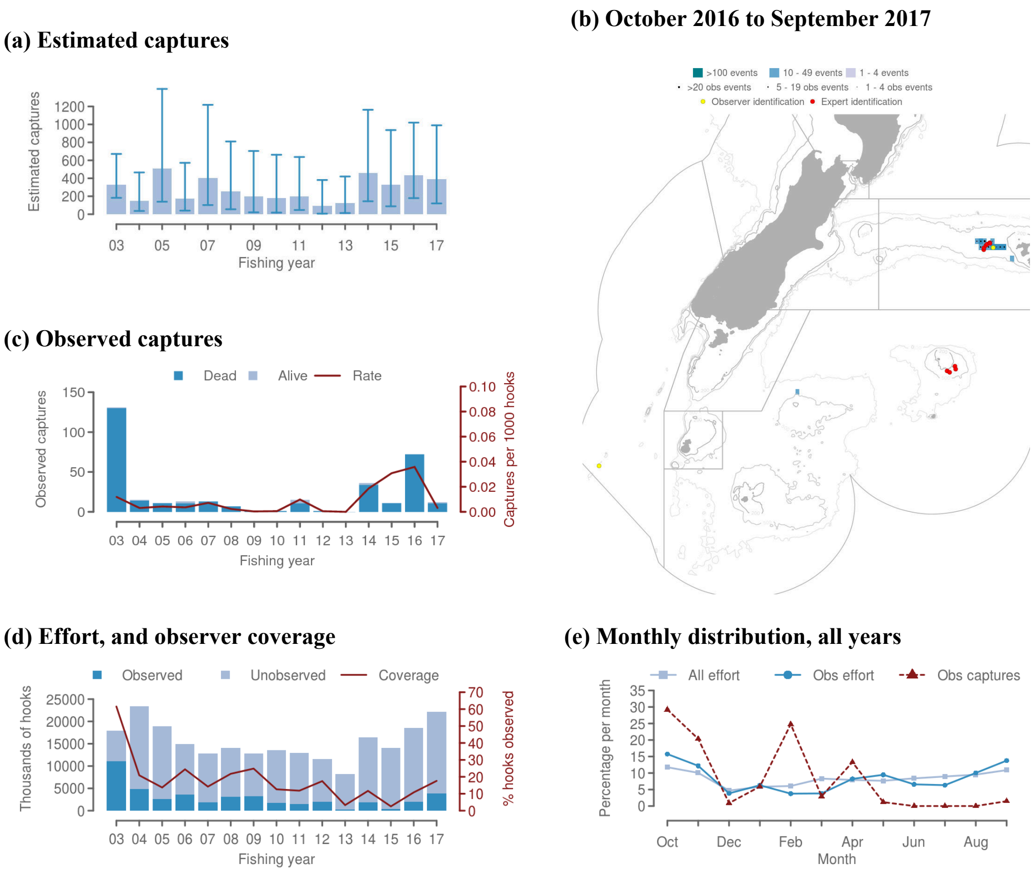


Figure B-28: White-chinned petrel captures in large-vessel (≥ 28 m length) bottom-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 79.5% of total effort is shown), (c) Observed captures, (d) 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 (< 28 m length) bottom-longline fisheries

Table B-49: Annual fishing effort and number of hooks observed in small-vessel (< 28 m length) bottom-longline fisheries, number of observed captures of white-chinned petrel and observed capture rate (captures per thousand hooks), 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	19 869 259	0.0	0	0.000	291.8868	75–847	0.147	0.038–0.426
2003–04	19 910 503	1.1	0	0.000	184.4225	41–593	0.093	0.021–0.298
2004–05	22 930 292	1.3	0	0.000	361.9275	92–1 034	0.158	0.040–0.451
2005–06	22 260 510	0.7	0	0.000	310.6309	66–1 064	0.140	0.030–0.478
2006–07	25 371 652	2.0	1	0.020	435.3013	98–1 415	0.172	0.039–0.558
2007–08	27 376 411	1.8	3	0.061	462.0015	115–1 446	0.169	0.042–0.528
2008–09	24 573 964	3.6	0	0.000	437.7446	117–1 324	0.178	0.048–0.539
2009–10	26 845 521	2.7	0	0.000	412.8458	106–1 201	0.154	0.039–0.447
2010–11	27 981 339	1.0	0	0.000	481.5467	125–1 441	0.172	0.045–0.515
2011–12	26 312 456	0.3	0	0.000	466.8686	107–1 479	0.177	0.041–0.562
2012–13	24 271 654	1.9	0	0.000	409.0070	96–1 265	0.169	0.040–0.521
2013–14	24 419 994	4.1	0	0.000	295.4345	81–837	0.121	0.033–0.343
2014–15	25 289 849	2.1	0	0.000	279.1107	67–849	0.110	0.026–0.336
2015–16	24 887 264	2.5	7	0.111	326.9893	86–936	0.131	0.035–0.376
2016–17	24 396 916	4.5	19	0.171	292.8936	85–821	0.120	0.035–0.337

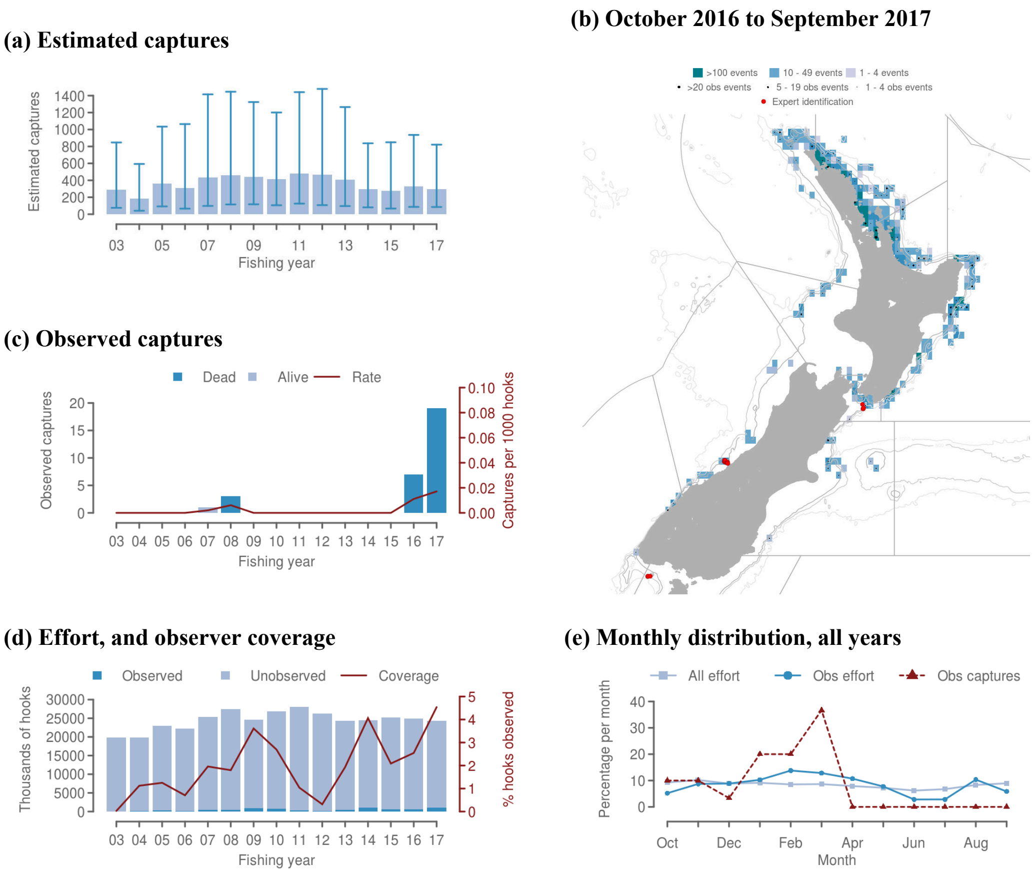


Figure B-29: White-chinned petrel captures in small-vessel (< 28 m length) bottom-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 97.0% of total effort is shown), (c) Observed captures, (d) 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 (≥ 28 m length) trawl fisheries

Table B-50: Annual fishing effort and number of tows observed in large-vessel (≥ 28 m length) trawl fisheries, number of observed captures of sooty shearwater and observed capture rate (captures per hundred tows), 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	119	1.84	791.1907	506–1 239	1.46	0.93–2.29
2003–04	47 339	13.4	51	0.80	451.9960	257–743	0.95	0.54–1.57
2004–05	44 156	17.2	75	0.99	455.2939	271–727	1.03	0.61–1.65
2005–06	39 121	15.8	170	2.75	830.8946	525–1 309	2.12	1.34–3.35
2006–07	35 193	20.6	70	0.97	390.5882	233–648	1.11	0.66–1.84
2007–08	32 767	25.3	80	0.96	320.7489	199–506	0.98	0.61–1.54
2008–09	29 976	24.7	143	1.93	465.3363	316–715	1.55	1.05–2.39
2009–10	29 505	26.0	50	0.65	230.5107	133–382	0.78	0.45–1.29
2010–11	27 397	22.7	97	1.56	370.8431	242–569	1.35	0.88–2.08
2011–12	25 593	32.7	34	0.41	162.1774	88–287	0.63	0.34–1.12
2012–13	23 980	49.3	132	1.12	205.6899	162–277	0.86	0.68–1.16
2013–14	25 657	43.7	127	1.13	239.1827	178–330	0.93	0.69–1.29
2014–15	25 648	43.9	144	1.28	261.4428	197–366	1.02	0.77–1.43
2015–16	25 008	43.0	62	0.58	122.8181	87–183	0.49	0.35–0.73
2016–17	25 750	38.4	129	1.30	223.0257	171–308	0.87	0.66–1.20

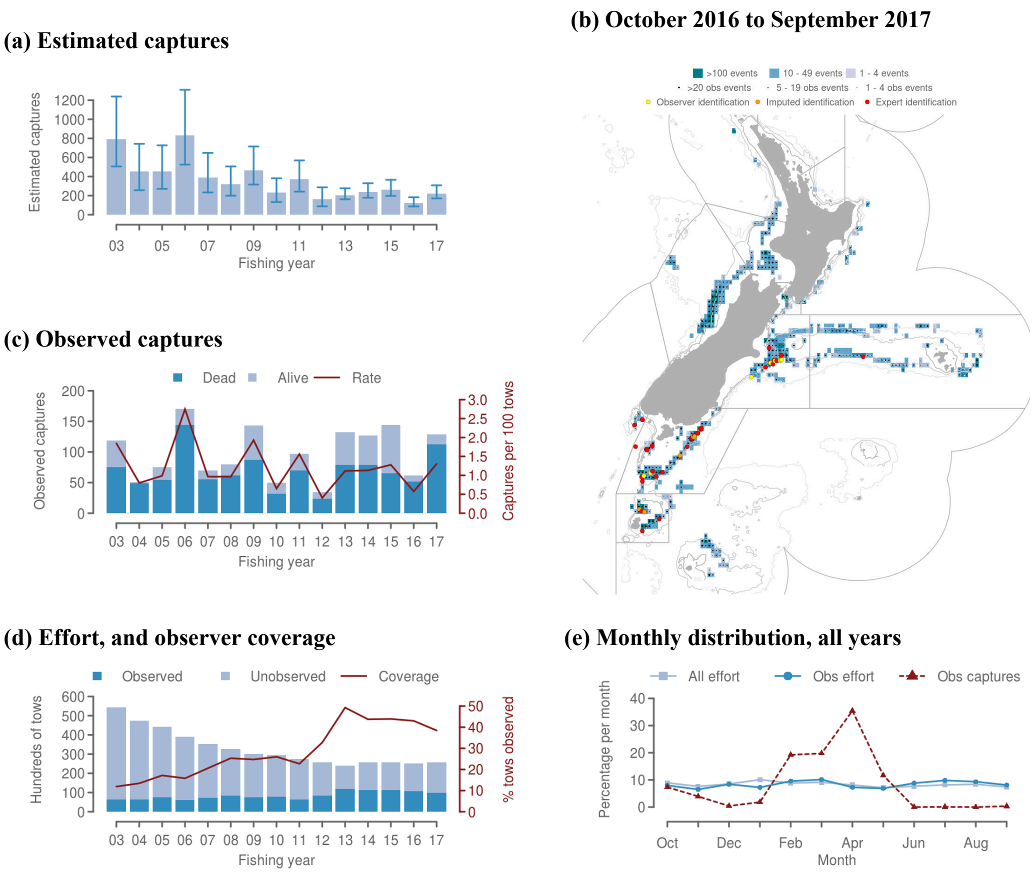


Figure B-30: Sooty shearwater captures in large-vessel (≥ 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 97.8% of total effort is shown), (c) Observed captures, (d) Effort and observed 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), 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	75 965	0.5	0	0.00	251.6672	96–582	0.33	0.13–0.77
2003–04	73 470	0.2	0	0.00	183.0520	68–405	0.25	0.09–0.55
2004–05	76 309	0.2	0	0.00	216.8398	86–493	0.28	0.11–0.65
2005–06	70 822	0.6	0	0.00	228.0887	89–517	0.32	0.13–0.73
2006–07	68 115	1.0	14	2.04	242.6482	104–552	0.36	0.15–0.81
2007–08	56 770	1.3	2	0.27	170.8633	66–392	0.30	0.12–0.69
2008–09	57 574	4.1	11	0.47	148.3283	65–318	0.26	0.11–0.55
2009–10	63 384	2.1	0	0.00	172.9940	65–409	0.27	0.10–0.65
2010–11	58 692	2.1	19	1.54	182.2981	81–403	0.31	0.14–0.69
2011–12	58 827	1.7	0	0.00	163.0185	60–387	0.28	0.10–0.66
2012–13	59 857	1.0	0	0.00	158.5990	61–374	0.26	0.10–0.62
2013–14	59 452	3.3	0	0.00	155.0727	60–351	0.26	0.10–0.59
2014–15	53 118	4.3	1	0.04	156.7306	59–363	0.30	0.11–0.68
2015–16	53 024	4.2	0	0.00	154.5387	58–354	0.29	0.11–0.67
2016–17	52 420	7.3	4	0.10	154.0865	60–357	0.29	0.11–0.68

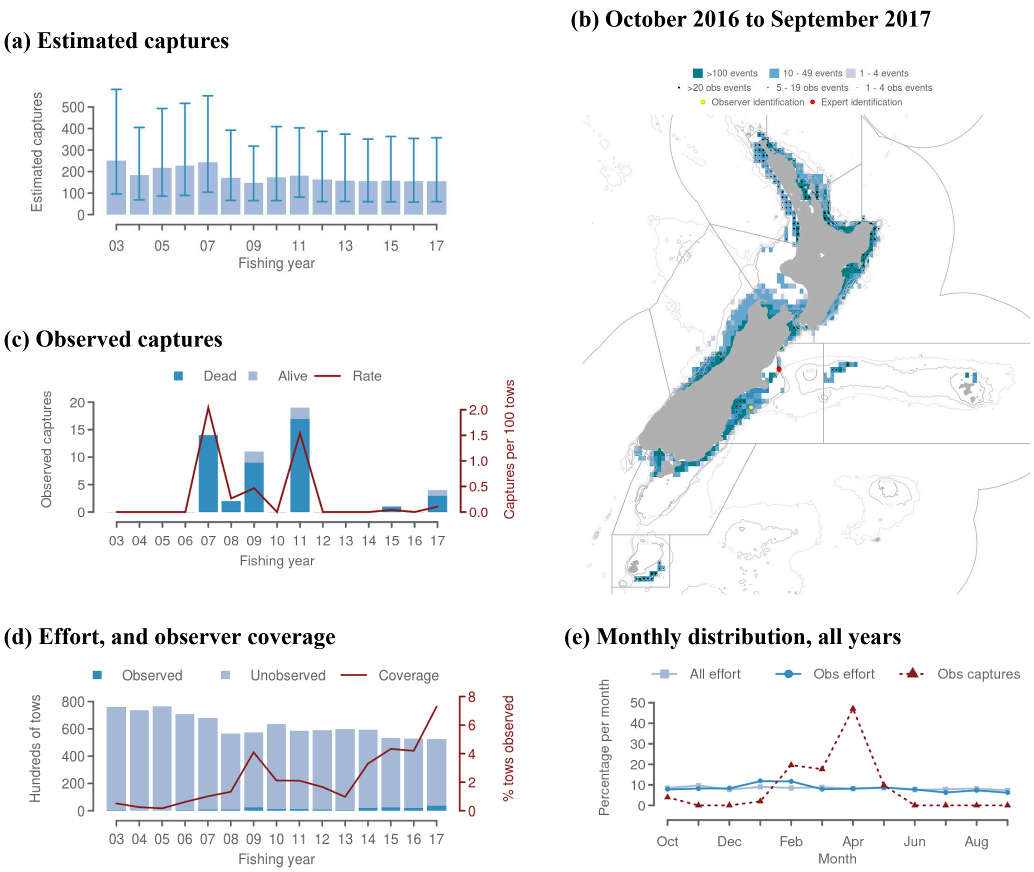


Figure B-31: Sooty shearwater captures in small-vessel (< 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 , (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.8 Black petrel captures

B.8.1 Black petrel captures in small-vessel (< 28 m length) bottom-longline fisheries

Table B-52: Annual fishing effort and number of hooks observed in small-vessel (< 28 m length) bottom-longline fisheries, number of observed captures of black petrel and observed capture rate (captures per thousand hooks), 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	19 873 309	0.0	0	0.000	486.5755	263–892	0.245	0.132–0.449
2003–04	19 908 473	1.1	2	0.090	445.5020	242–814	0.224	0.122–0.409
2004–05	22 927 582	1.3	1	0.035	395.7914	209–714	0.173	0.091–0.311
2005–06	22 255 410	0.7	2	0.127	374.3051	191–714	0.168	0.086–0.321
2006–07	25 369 522	2.0	4	0.081	446.2224	224–877	0.176	0.088–0.346
2007–08	27 384 307	1.8	3	0.061	313.0142	164–585	0.114	0.060–0.214
2008–09	24 569 215	3.6	8	0.090	289.6282	155–533	0.118	0.063–0.217
2009–10	26 848 346	2.7	43	0.594	351.9233	198–633	0.131	0.074–0.236
2010–11	27 975 994	1.0	2	0.069	323.3318	171–586	0.116	0.061–0.209
2011–12	26 319 876	0.3	0	0.000	287.7724	145–538	0.109	0.055–0.204
2012–13	24 275 944	1.9	2	0.043	207.5917	115–363	0.086	0.047–0.150
2013–14	24 411 354	4.1	7	0.071	213.6599	118–386	0.088	0.048–0.158
2014–15	25 287 149	2.1	2	0.038	192.5565	102–345	0.076	0.040–0.136
2015–16	24 898 664	2.5	0	0.000	153.8243	80–276	0.062	0.032–0.111
2016–17	24 385 436	4.5	13	0.117	188.2046	104–345	0.077	0.043–0.141

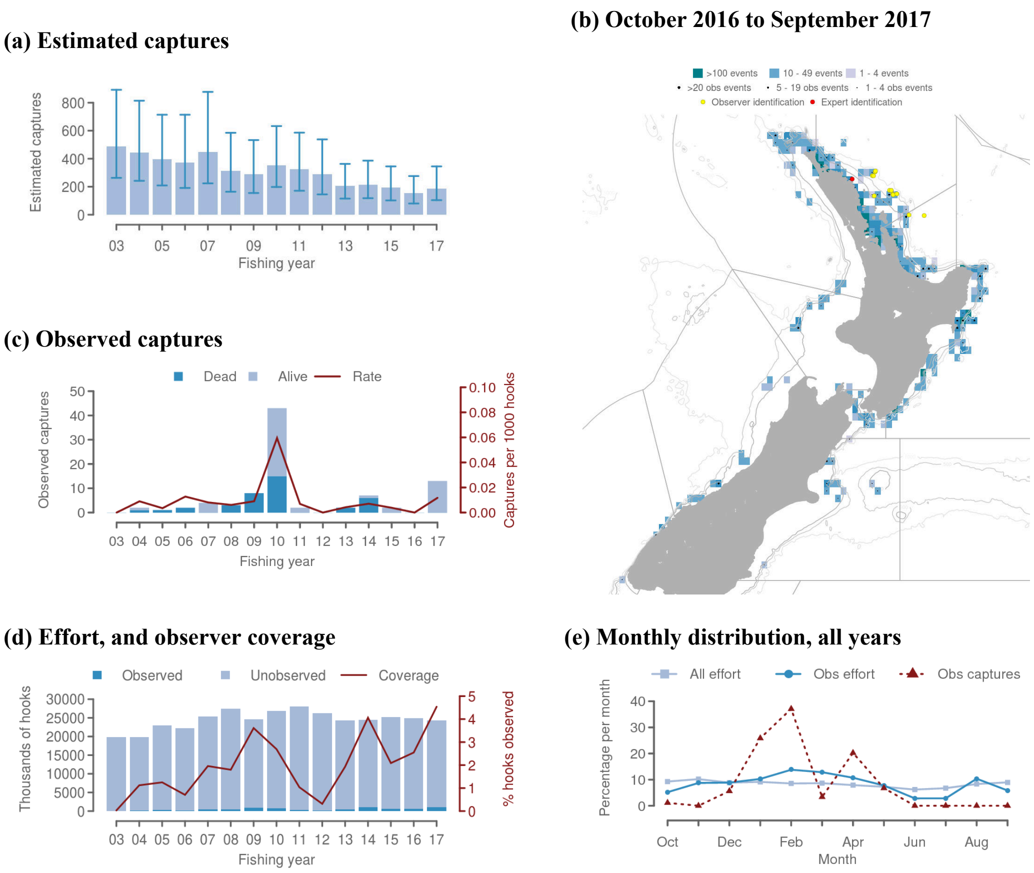


Figure B-32: Black petrel captures in small-vessel (< 28 m length) bottom-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 97.0% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.8.2 Black petrel captures in small-vessel (< 28 m length) surface-longline fisheries

Table B-53: Annual fishing effort and number of hooks observed in small-vessel (< 28 m length) surface-longline fisheries, number of observed captures of black petrel and observed capture rate (captures per thousand hooks), 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	8 572 816	0.0	0	.	236.85907	115–524	0.276	0.134–0.611
2003–04	5 730 459	2.4	1	0.074	139.23963	67–291	0.243	0.117–0.508
2004–05	3 044 411	4.7	0	0.000	148.59720	60–377	0.488	0.197–1.238
2005–06	3 028 699	3.2	0	0.000	89.36557	39–202	0.295	0.129–0.667
2006–07	2 332 813	8.0	0	0.000	63.80035	27–143	0.273	0.116–0.613
2007–08	1 678 754	8.1	1	0.073	66.00475	29–148	0.393	0.173–0.882
2008–09	2 305 503	6.5	2	0.132	80.28961	36–178	0.348	0.156–0.772
2009–10	2 517 986	7.3	6	0.326	71.65017	35–143	0.285	0.139–0.568
2010–11	2 683 529	6.4	1	0.058	116.67741	54–257	0.435	0.201–0.958
2011–12	2 548 787	6.8	1	0.058	93.37031	42–201	0.366	0.165–0.789
2012–13	2 389 462	3.1	0	0.000	89.85382	40–201	0.376	0.167–0.841
2013–14	1 896 434	6.8	0	0.000	76.07646	32–173	0.401	0.169–0.912
2014–15	1 790 036	6.0	0	0.000	54.68716	21–134	0.306	0.117–0.749
2015–16	2 303 441	13.0	7	0.234	73.47776	35–163	0.319	0.152–0.708
2016–17	2 092 486	16.5	8	0.232	64.45427	31–143	0.308	0.148–0.683

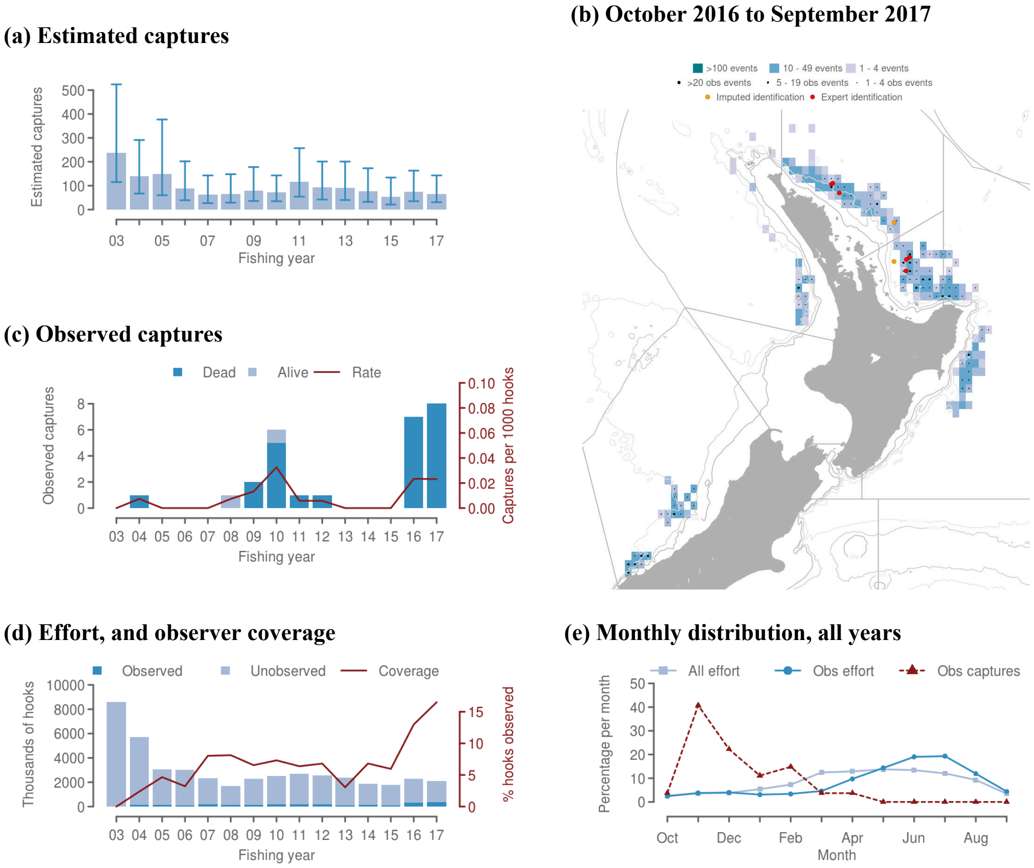


Figure B-33: Black petrel captures in small-vessel (< 28 m length) surface-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 95.4% of total effort is shown), (c) Observed captures, (d) Effort 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 (< 28 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), 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	19 873 309	0.0	0	0.000	170.2314	51–460	0.086	0.026–0.231
2003–04	19 908 473	1.1	0	0.000	150.3081	44–402	0.075	0.022–0.202
2004–05	22 927 582	1.3	0	0.000	153.2716	44–415	0.067	0.019–0.181
2005–06	22 255 410	0.7	0	0.000	157.0095	43–451	0.071	0.019–0.203
2006–07	25 369 522	2.0	0	0.000	165.5600	44–504	0.065	0.017–0.199
2007–08	27 384 307	1.8	0	0.000	160.2579	42–496	0.059	0.015–0.181
2008–09	24 569 215	3.6	2	0.023	138.7634	38–398	0.056	0.015–0.162
2009–10	26 848 346	2.7	0	0.000	180.7171	49–527	0.067	0.018–0.196
2010–11	27 975 994	1.0	0	0.000	160.3883	46–437	0.057	0.016–0.156
2011–12	26 319 876	0.3	0	0.000	140.0420	42–389	0.053	0.016–0.148
2012–13	24 275 944	1.9	0	0.000	126.5652	36–353	0.052	0.015–0.145
2013–14	24 411 354	4.1	1	0.010	142.0145	40–392	0.058	0.016–0.161
2014–15	25 287 149	2.1	3	0.057	143.7579	42–407	0.057	0.017–0.161
2015–16	24 898 664	2.5	0	0.000	124.3566	33–367	0.050	0.013–0.147
2016–17	24 385 436	4.5	0	0.000	128.5712	33–390	0.053	0.014–0.160

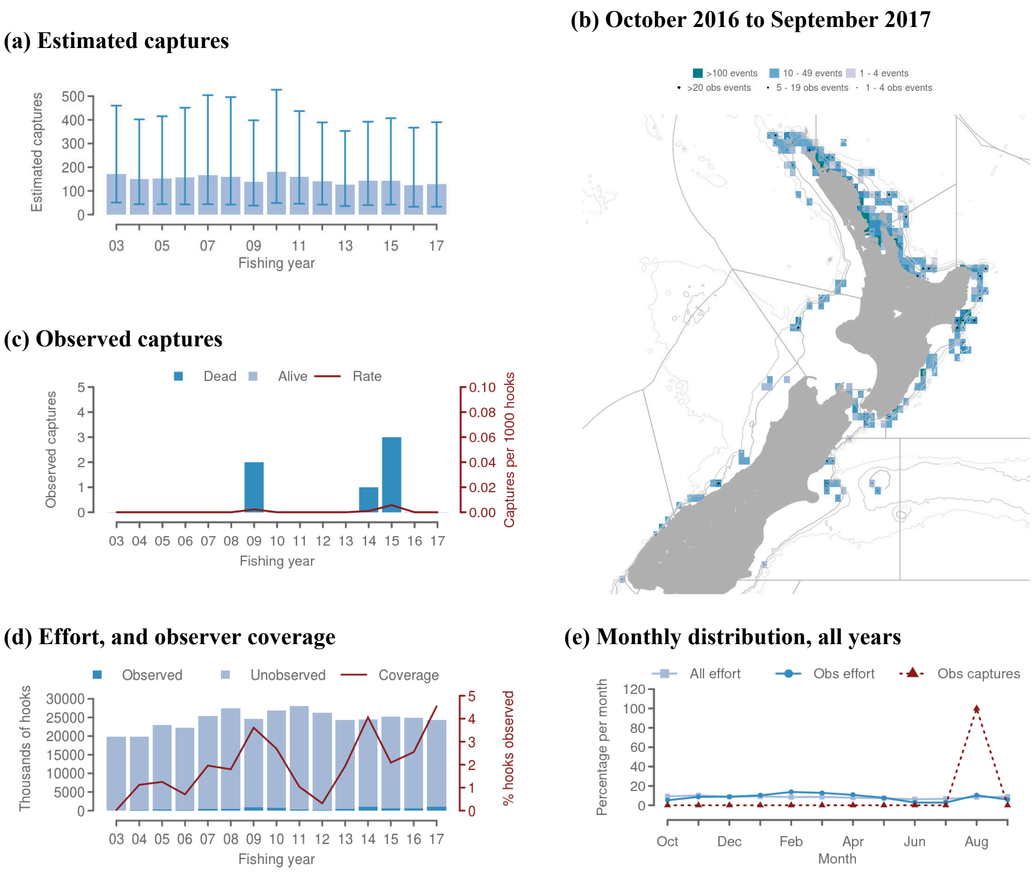


Figure B-34: Grey petrel captures in small-vessel (< 28 m length) bottom-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 97.0% of total effort is shown), (c) Observed captures, (d) Effort and 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), 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	75 995	0.5	0	0.00	119.64468	57–246	0.16	0.08–0.32
2003–04	73 511	0.3	0	0.00	106.52499	53–208	0.14	0.07–0.28
2004–05	76 312	0.2	0	0.00	108.51249	55–205	0.14	0.07–0.27
2005–06	70 812	0.6	8	1.83	99.13418	54–174	0.14	0.08–0.25
2006–07	68 135	1.0	6	0.87	104.76162	52–194	0.15	0.08–0.28
2007–08	56 767	1.3	5	0.66	90.87781	47–164	0.16	0.08–0.29
2008–09	57 574	4.1	3	0.13	92.57321	47–171	0.16	0.08–0.30
2009–10	63 386	2.1	2	0.15	108.54398	54–205	0.17	0.09–0.32
2010–11	58 692	2.1	15	1.22	113.85657	63–213	0.19	0.11–0.36
2011–12	58 825	1.7	0	0.00	82.11644	40–161	0.14	0.07–0.27
2012–13	59 856	1.0	0	0.00	96.81084	47–196	0.16	0.08–0.33
2013–14	59 453	3.3	9	0.46	92.05922	48–176	0.15	0.08–0.30
2014–15	53 119	4.3	8	0.35	88.04023	46–168	0.17	0.09–0.32
2015–16	53 022	4.2	2	0.09	86.25887	40–176	0.16	0.08–0.33
2016–17	52 422	7.3	1	0.03	85.71664	38–182	0.16	0.07–0.35

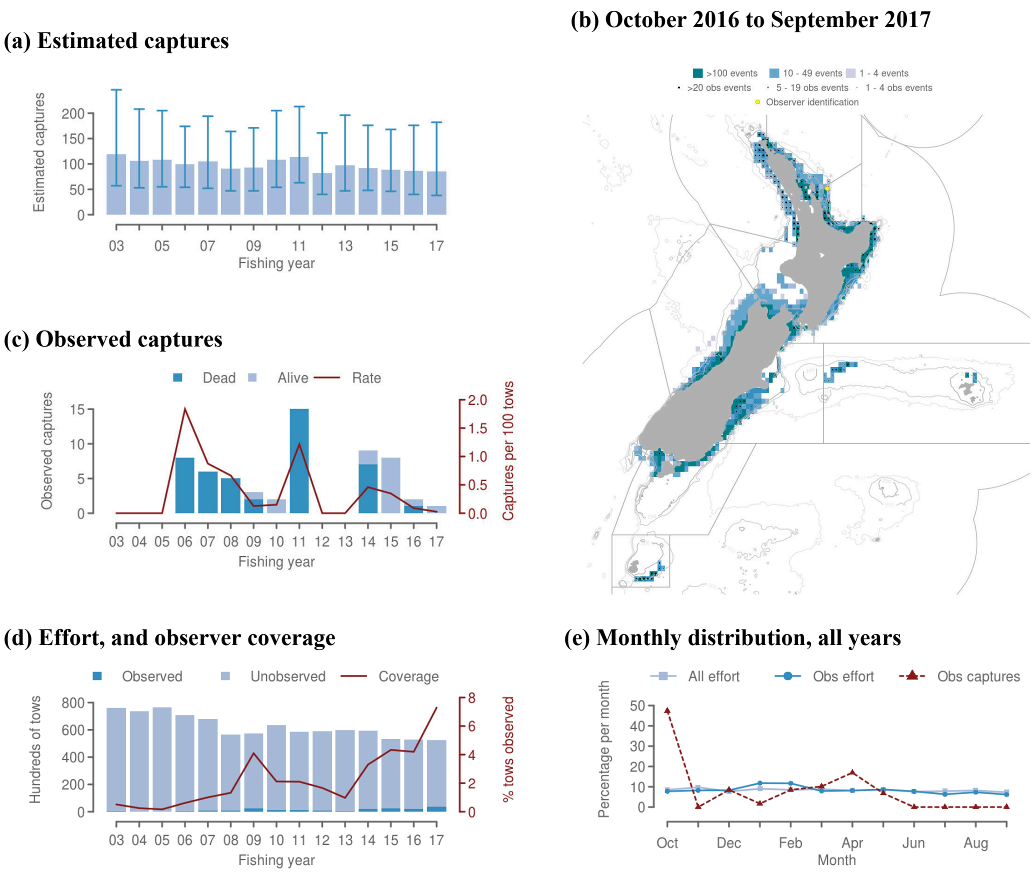


Figure B-35: Flesh-footed shearwater captures in small-vessel (< 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 , (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.10.2 Flesh-footed shearwater captures in small-vessel (< 28 m length) bottom-longline fisheries

Table B-56: Annual fishing effort and number of hooks observed in small-vessel (< 28 m length) bottom-longline fisheries, number of observed captures of flesh-footed shearwater and observed capture rate (captures per thousand hooks), 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	19 869 259	0.0	0	0.000	493.5915	325–751	0.248	0.164–0.378
2003–04	19 910 503	1.1	3	0.134	431.0197	284–665	0.216	0.143–0.334
2004–05	22 930 292	1.3	9	0.314	407.9685	269–634	0.178	0.117–0.276
2005–06	22 260 510	0.7	0	0.000	321.7114	205–510	0.145	0.092–0.229
2006–07	25 371 652	2.0	0	0.000	333.2816	214–521	0.131	0.084–0.205
2007–08	27 376 411	1.8	0	0.000	289.5352	186–453	0.106	0.068–0.165
2008–09	24 573 964	3.6	16	0.180	301.6632	198–456	0.123	0.081–0.186
2009–10	26 845 521	2.7	14	0.194	286.8011	188–427	0.107	0.070–0.159
2010–11	27 981 339	1.0	0	0.000	318.4498	207–480	0.114	0.074–0.172
2011–12	26 312 456	0.3	0	0.000	280.2106	185–422	0.106	0.070–0.160
2012–13	24 271 654	1.9	2	0.043	292.3798	187–453	0.120	0.077–0.187
2013–14	24 419 994	4.1	31	0.313	293.4230	197–456	0.120	0.081–0.187
2014–15	25 289 849	2.1	8	0.152	265.5795	170–423	0.105	0.067–0.167
2015–16	24 887 264	2.5	13	0.206	243.5847	157–384	0.098	0.063–0.154
2016–17	24 396 916	4.5	2	0.018	239.0755	150–385	0.098	0.061–0.158

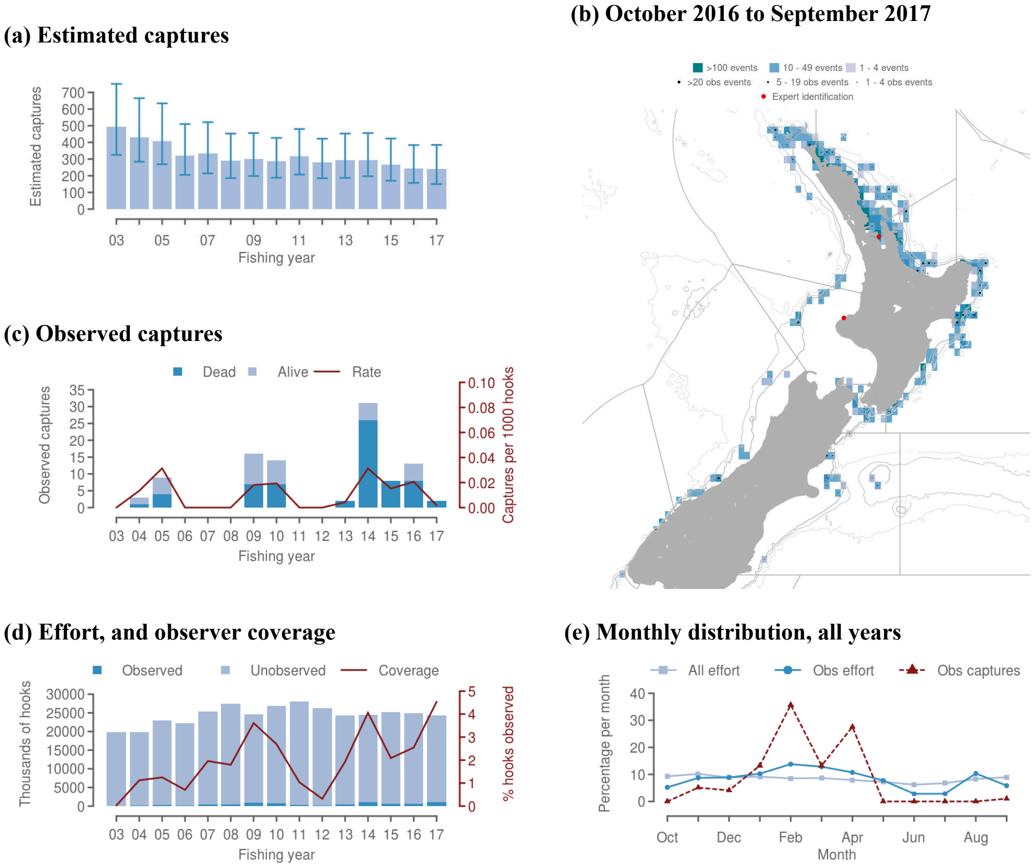


Figure B-36: Flesh-footed shearwater captures in small-vessel (< 28 m length) bottom-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 97.0% of total effort is shown), (c) Observed captures, (d) 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 (< 28 m length) surface-longline fisheries

Table B-57: Annual fishing effort and number of hooks observed in small-vessel (< 28 m length) surface-longline fisheries, number of observed captures of flesh-footed shearwater and observed capture rate (captures per thousand hooks), 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	8 572 816	0.0	0	.	629.50000	285–1 301	0.734	0.332–1.518
2003–04	5 730 459	2.4	0	0.000	401.07646	178–823	0.700	0.311–1.436
2004–05	3 044 411	4.7	1	0.071	247.00700	90–587	0.811	0.296–1.928
2005–06	3 028 699	3.2	4	0.411	240.53698	100–498	0.794	0.330–1.644
2006–07	2 332 813	8.0	3	0.160	193.52224	77–418	0.830	0.330–1.792
2007–08	1 678 754	8.1	2	0.147	161.98251	58–362	0.965	0.345–2.156
2008–09	2 305 503	6.5	0	0.000	208.81834	81–457	0.906	0.351–1.982
2009–10	2 517 986	7.3	0	0.000	205.32759	77–438	0.815	0.306–1.739
2010–11	2 683 529	6.4	2	0.117	259.42129	101–575	0.967	0.376–2.143
2011–12	2 548 787	6.8	0	0.000	204.84933	68–495	0.804	0.267–1.942
2012–13	2 389 462	3.1	0	0.000	183.78961	63–428	0.769	0.264–1.791
2013–14	1 896 434	6.8	0	0.000	160.38631	51–395	0.846	0.269–2.083
2014–15	1 790 036	6.0	1	0.094	93.07396	24–238	0.520	0.134–1.330
2015–16	2 303 441	13.0	0	0.000	134.61119	43–332	0.584	0.187–1.441
2016–17	2 092 486	16.5	0	0.000	107.85557	28–282	0.515	0.134–1.348

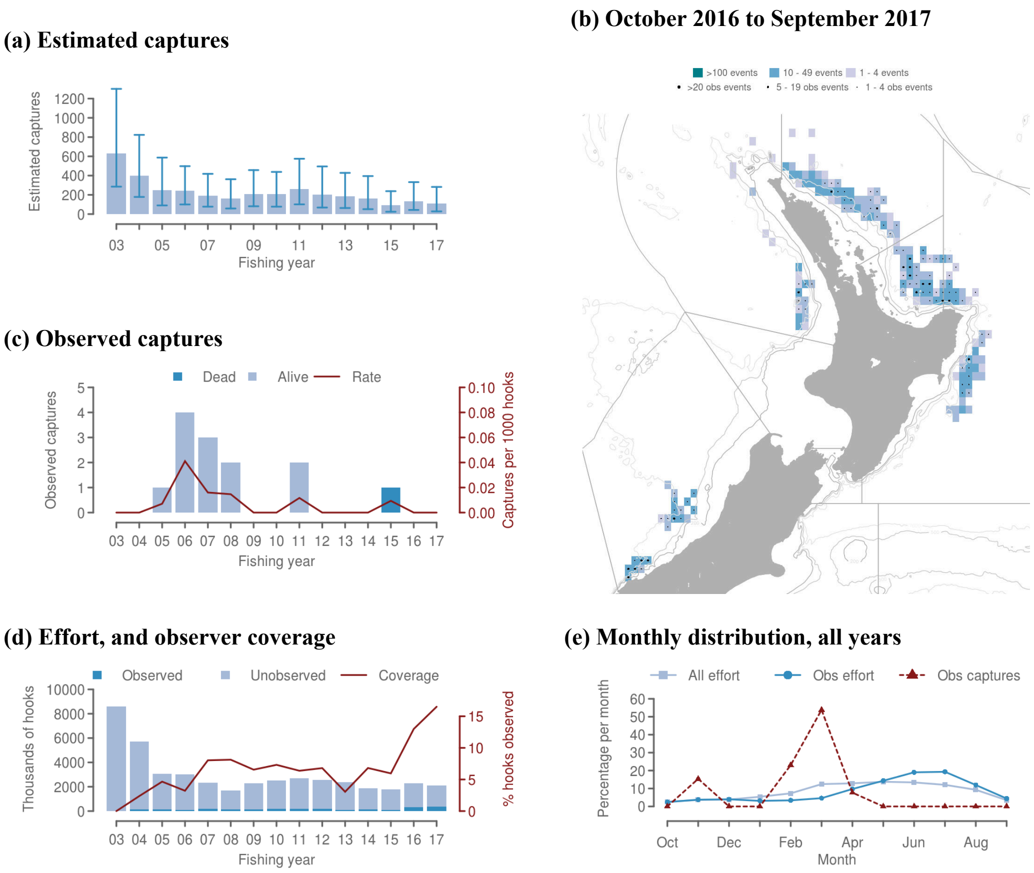


Figure B-37: Flesh-footed shearwater captures in small-vessel (< 28 m length) surface-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 95.4% of total effort is shown), (c) Observed captures, (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), 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	122.97276	74–196	0.227	0.137–0.362
2003–04	47 339	13.4	16	0.251	100.92929	61–165	0.213	0.129–0.349
2004–05	44 156	17.2	20	0.264	102.23663	63–167	0.232	0.143–0.378
2005–06	39 121	15.8	9	0.146	64.08921	35–107	0.164	0.089–0.274
2006–07	35 188	20.6	8	0.110	49.14668	25–85	0.140	0.071–0.242
2007–08	32 766	25.3	11	0.133	52.47701	29–88	0.160	0.089–0.269
2008–09	29 978	24.7	12	0.162	50.45427	29–83	0.168	0.097–0.277
2009–10	29 506	26.0	24	0.313	75.18216	48–119	0.255	0.163–0.403
2010–11	27 393	22.7	14	0.225	55.67341	33–91	0.203	0.120–0.332
2011–12	25 593	32.7	11	0.131	37.43228	21–61	0.146	0.082–0.238
2012–13	23 982	49.3	22	0.186	42.14443	30–61	0.176	0.125–0.254
2013–14	25 657	43.7	15	0.134	35.50375	23–55	0.138	0.090–0.214
2014–15	25 648	43.9	20	0.178	47.32634	32–70	0.185	0.125–0.273
2015–16	25 008	43.0	13	0.121	35.52899	22–56	0.142	0.088–0.224
2016–17	25 750	38.5	6	0.061	24.96302	12–45	0.097	0.047–0.175

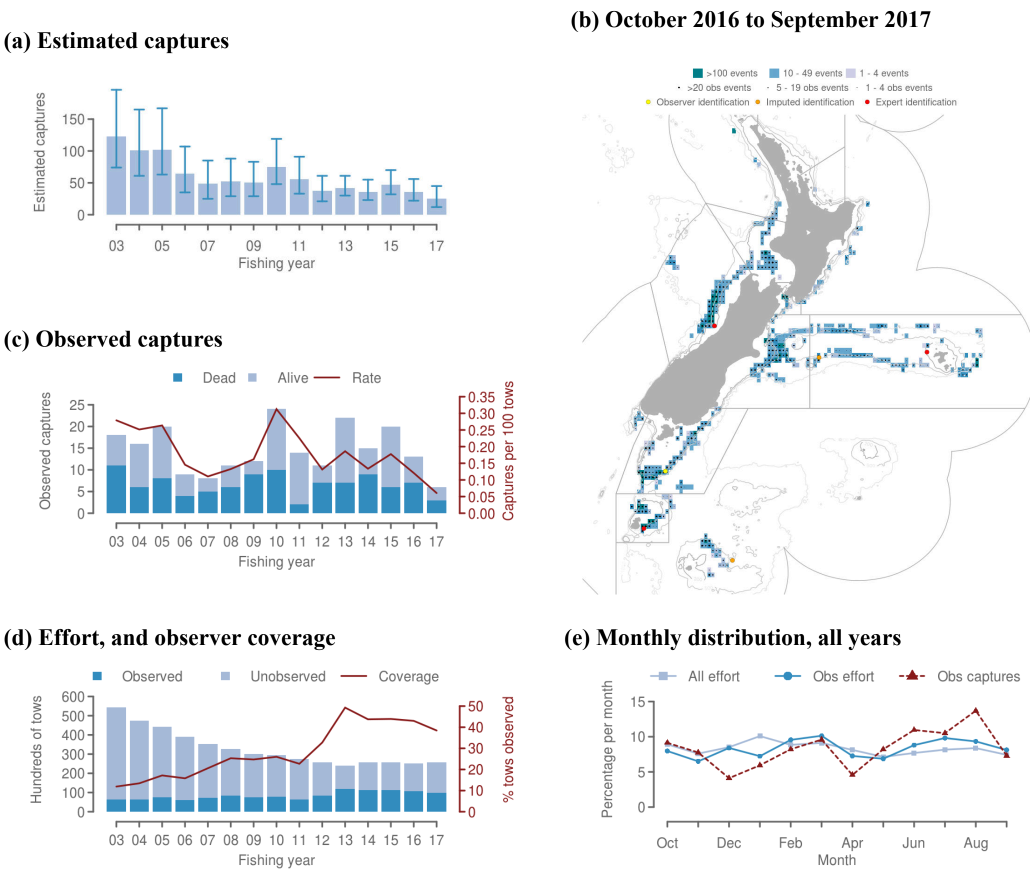


Figure B-38: Other birds captures in large-vessel (≥ 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 97.8% of total effort is shown), (c) Observed captures, (d) Effort and observed 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), 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	75 995	0.5	0	0.00	380.1287	174–780	0.50	0.23–1.03
2003–04	73 511	0.3	0	0.00	374.7151	171–778	0.51	0.23–1.06
2004–05	76 312	0.2	0	0.00	372.7661	172–775	0.49	0.23–1.02
2005–06	70 812	0.6	1	0.23	343.2554	157–710	0.48	0.22–1.00
2006–07	68 135	1.0	2	0.29	341.5012	156–711	0.50	0.23–1.04
2007–08	56 767	1.3	0	0.00	283.5705	125–588	0.50	0.22–1.04
2008–09	57 574	4.1	35	1.48	302.7239	156–584	0.53	0.27–1.01
2009–10	63 386	2.1	0	0.00	294.4995	135–607	0.46	0.21–0.96
2010–11	58 692	2.1	0	0.00	241.1227	112–500	0.41	0.19–0.85
2011–12	58 825	1.7	0	0.00	262.7216	118–538	0.45	0.20–0.91
2012–13	59 856	1.0	0	0.00	260.0560	122–533	0.43	0.20–0.89
2013–14	59 453	3.3	2	0.10	254.6189	119–511	0.43	0.20–0.86
2014–15	53 119	4.3	3	0.13	216.0362	104–429	0.41	0.20–0.81
2015–16	53 022	4.2	4	0.18	237.3901	111–480	0.45	0.21–0.91
2016–17	52 422	7.3	0	0.00	230.9425	105–473	0.44	0.20–0.90

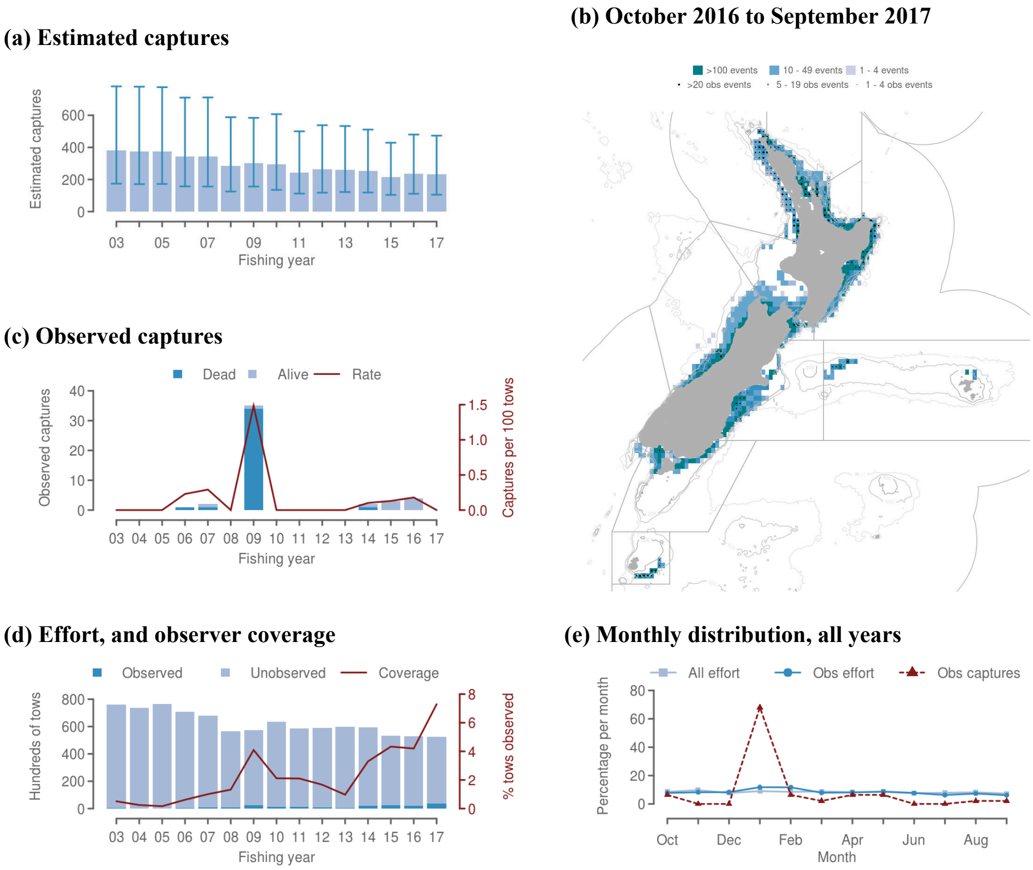


Figure B-39: Other birds captures in small-vessel (< 28 m length) trawl fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 , (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.

B.11.3 Other birds captures in small-vessel (< 28 m length) bottom-longline fisheries

Table B-60: Annual fishing effort and number of hooks observed in small-vessel (< 28 m length) bottom-longline fisheries, number of observed captures of other birds and observed capture rate (captures per thousand hooks), 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	19 869 259	0.0	2	3.64	388.5470	227–638	0.20	0.11–0.32
2003–04	19 910 503	1.1	5	0.22	347.6077	202–578	0.17	0.10–0.29
2004–05	22 930 292	1.3	3	0.10	337.4015	193–559	0.15	0.08–0.24
2005–06	22 260 510	0.7	10	0.64	289.1302	169–480	0.13	0.08–0.22
2006–07	25 371 652	2.0	3	0.06	304.7841	171–526	0.12	0.07–0.21
2007–08	27 376 411	1.8	6	0.12	287.0165	165–485	0.10	0.06–0.18
2008–09	24 573 964	3.6	8	0.09	285.5082	164–472	0.12	0.07–0.19
2009–10	26 845 521	2.7	1	0.01	289.0325	165–486	0.11	0.06–0.18
2010–11	27 981 339	1.0	0	0.00	349.6027	196–609	0.12	0.07–0.22
2011–12	26 312 456	0.3	1	0.12	326.5382	181–574	0.12	0.07–0.22
2012–13	24 271 654	1.9	2	0.04	286.7749	157–496	0.12	0.06–0.20
2013–14	24 419 994	4.1	15	0.15	270.8858	157–445	0.11	0.06–0.18
2014–15	25 289 849	2.1	2	0.04	248.0535	139–418	0.10	0.05–0.17
2015–16	24 887 264	2.5	2	0.03	231.4533	131–395	0.09	0.05–0.16
2016–17	24 396 916	4.5	3	0.03	221.7729	127–369	0.09	0.05–0.15

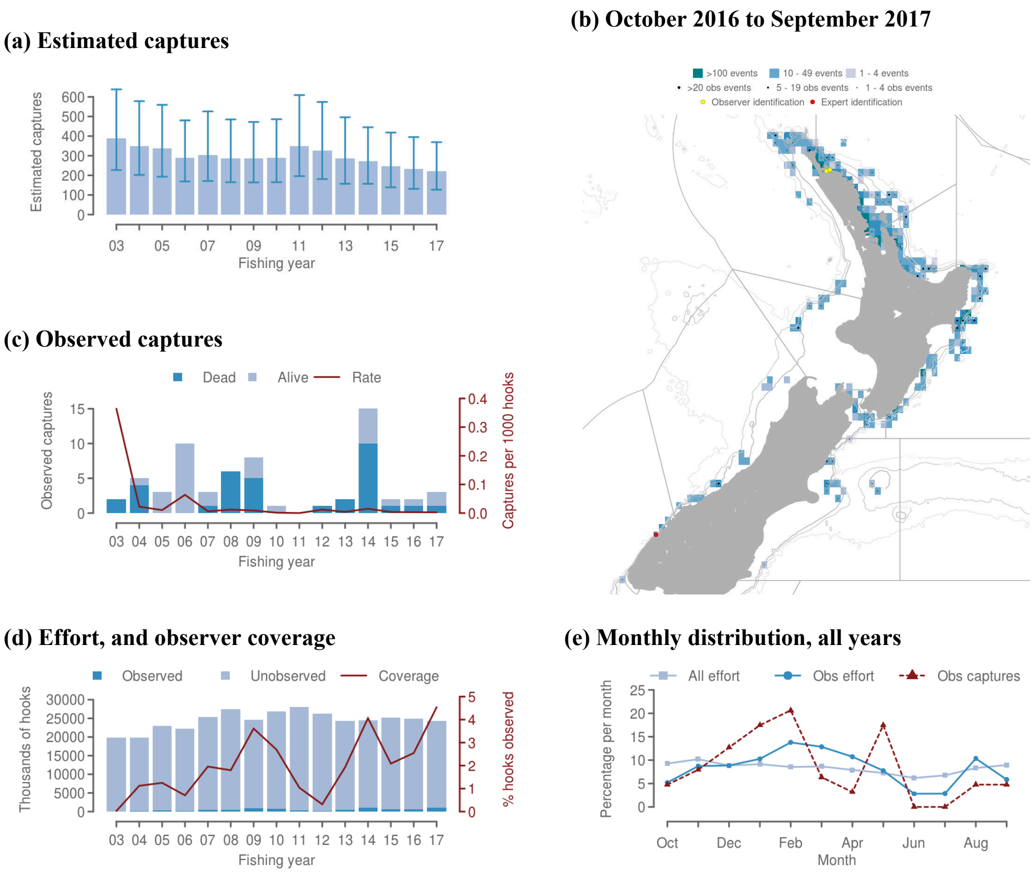


Figure B-40: Other birds captures in small-vessel (< 28 m length) bottom-longline fisheries. (a) Estimated captures, with 95% bootstrap credible intervals, (b) Mapped effort and captures in 2016–17 (Following confidentiality rules, 97.0% of total effort is shown), (c) Observed captures, (d) Effort and observed effort, and (e) Monthly distribution of fishing effort, observed effort, and observed captures.