Agreement on the Conservation of Albatrosses and Petrels

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Updating New Zealand's bycatch estimations and risk assessment

Nathan Walker and Edward Abraham

SUMMARY

This paper summarises the updates to the time series of New Zealand's estimates of total seabird bycatch. The paper also summarises changes to the quantitative risk assessment and its underlying methods.

Bycatch estimations have been continued and now extend to include the 2015–16 fishing year. The most recent set of extrapolations have utilised a simplified extrapolation (strata-based ratio) method that is consistent across all seabird species. This approach is stratified by areas and allows for a random year effect for larger vessels (as these have been observed at a higher rate). These in general compared reasonably well with previous estimates and the quantitative seabird risk assessment.

New Zealand's quantitative risk assessment which underpins New Zealand's NPOA-Seabirds was rerun in 2016. This paper describes the changes in the methodology applied and the resulting risk scores.

1. NEW ZEALAND'S SEABIRD BYCATCH ESTIMATIONS

1.1. Methods

As previously (SBWG7 Inf21, Abraham & Richard 2017), a single model was used for each species, including all trawl and longline fisheries; all covariates were based on a set of strata (fishing year, area, fishery, season), so that the data could be aggregated before the modelling; and covariates that reflected the distribution of seabirds (e.g., area and season) were shared across different fisheries. The identical model structure and parameters for each species then allowed direct comparisons.

Consistent with preceding bycatch assessments, total capture estimates were focused on seabird species with the largest number of observed captures. In addition to the five species (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*), sooty shearwater (*Puffinus griseus*), and two species groupings (other albatross and other birds) used previously, the updated modelling allowed separate capture estimates for another three seabird species (black petrel (*Procellaria parkinsoni*), grey petrel (*Procellaria cinerea*), flesh-footed shearwater (*Puffinus carneipes*)).

As data were updated and all statistical models were re-developed, previous estimates are superseded, and any comparison across fishing years should be made using the results from this modelling.

The most recent set of extrapolations were undertaken by developing a simplified extrapolation (strata-based ratio) method that is consistent across all seabird species. This approach is stratified by areas and allows for a random year effect for larger vessels (28 m or more, as these have been observed at a higher rate). These in general compared reasonably well with previous estimates and the quantitative seabird risk assessment.

1.2. Updates to time series

Total seabird bycatch estimations have been continued to include data up to the 2015/16 fishing year. These estimations are available in more detail on the publically available website https://data.dragonfly.co.nz/psc/ , this website allows users to investigate trends in seabird bycatch in various target fisheries and by area.

1.1.1. *Trawl fisheries*

In general, trawl fisheries are showing a decline in total estimated captures however this tracks with declining levels of fishing effort (Figure 1). Over the period 2002-03 to 2015-16 there has been increasing levels of observer coverage, mainly on the large offshore vessels.

From 2012-13 there have been increased percentages of seabirds released alive (light blue portions of the bottom graph in Figure 1).

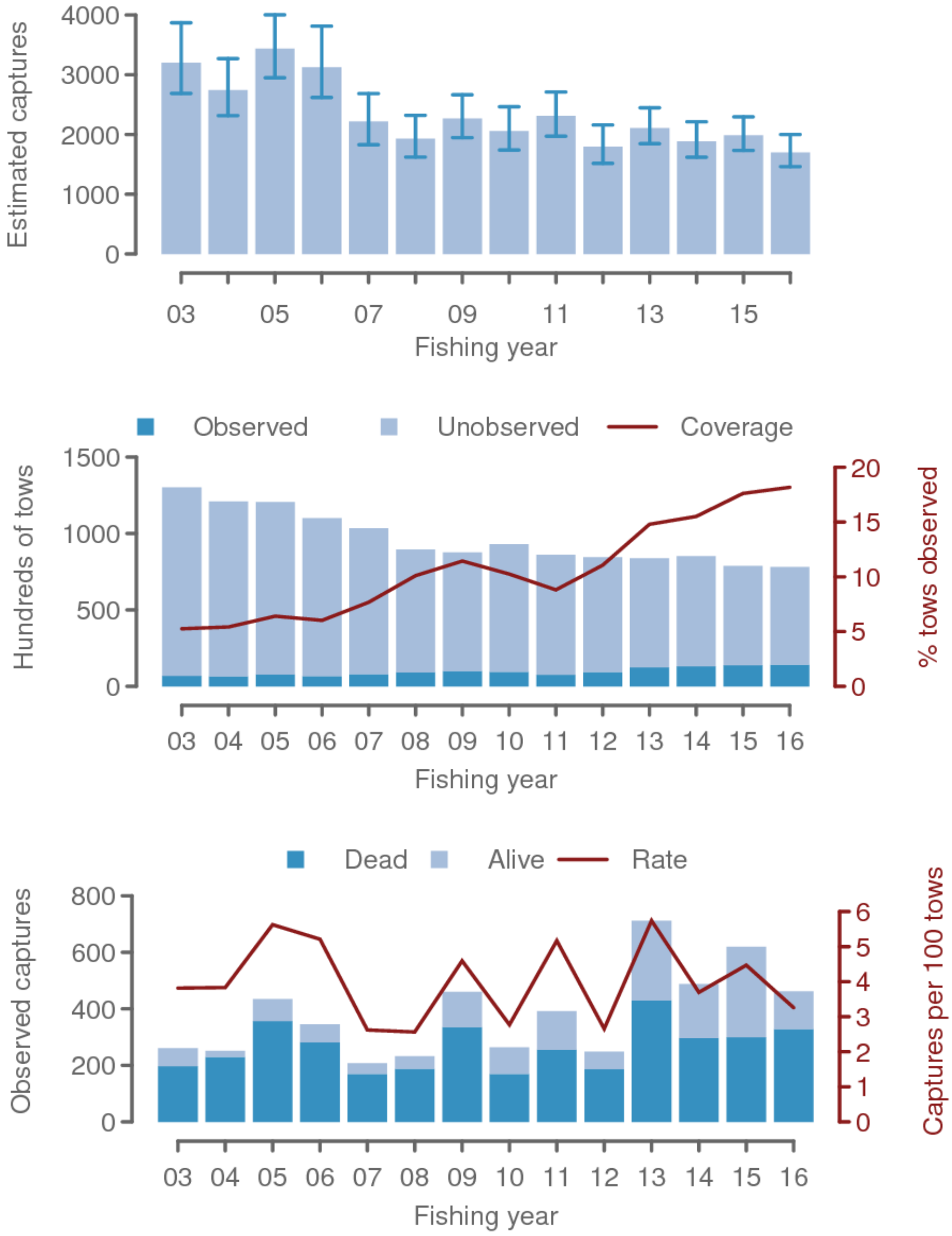

Figure 1. Estimated captures, fishing effort, and observed captures for all trawl fisheries in New Zealand from 2002-03 to 2013-14.

1.1.2. ***Surface longline fisheries***

In general, the total estimates of seabird bycatch from New Zealand surface longline fisheries has remained relatively constant from 2004-05 to 2014-15 with an increase in observed and estimated captures in 2015-16 (Figure 2).

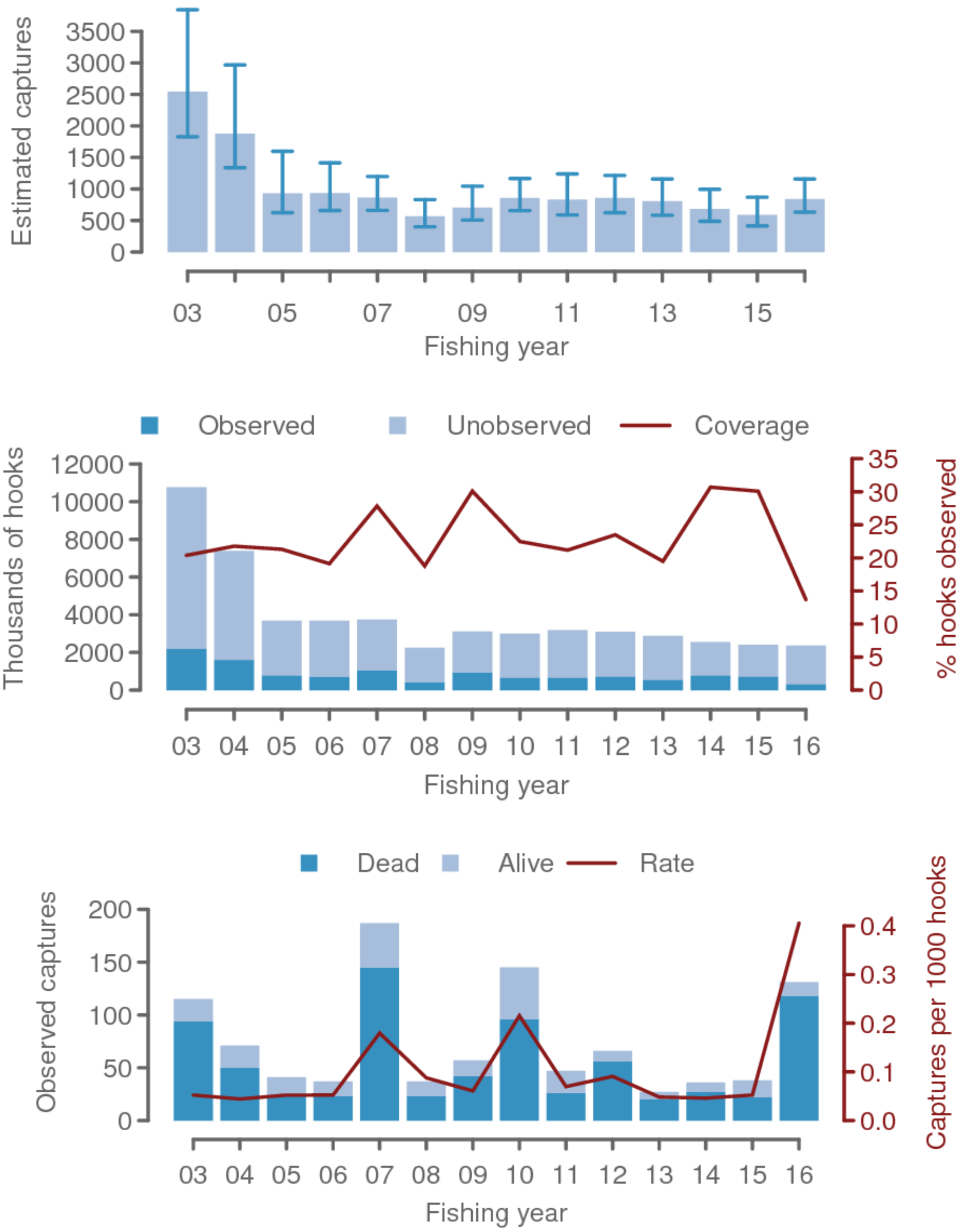

Figure 2. Estimated captures, fishing effort, and observed captures for all surface longline fisheries in New Zealand from 2002-03 to 2015-16.

1.1.3. ***Bottom longline fisheries***

New Zealand bottom longline fisheries are typically observed at lower rates, leading to less precise total estimates (see the wide uncertainties associated with estimates in the top graph of Figure 3). In these fisheries, the proportion of seabirds released alive can be high as well (see the light blue portions of the bars in the top graph of Figure 3).

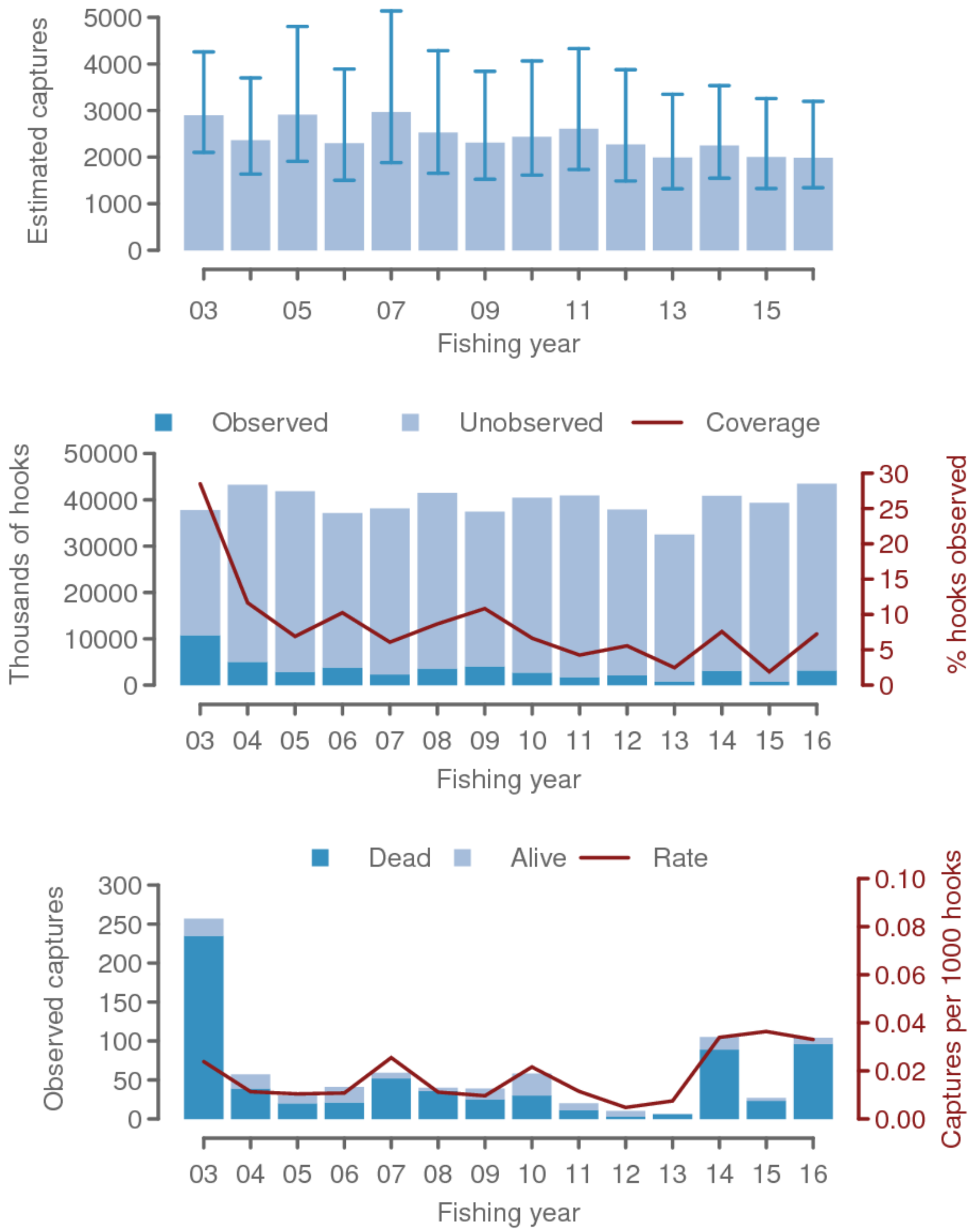

Figure 3. Estimated captures, fishing effort, and observed captures for all surface longline fisheries in New Zealand from 2002-03 to 2015-16.

1.1.4. *Time series of estimated captures of seabirds by fishing method*

The time series of estimated captures can be portrayed to demonstrate the trends by the individual species included in the modelling (see Figure 4). One example of the utility of this plot is the recent fluctuations, since 2012-13, of captures of white capped petrels (middle left plot in Figure 4) by large vessels in trawl fisheries (dark purple), this graph shows that the small vessel bottom longline (light brown) has demonstrated opposite fluctuations resulting in a relatively constant level of total captures.

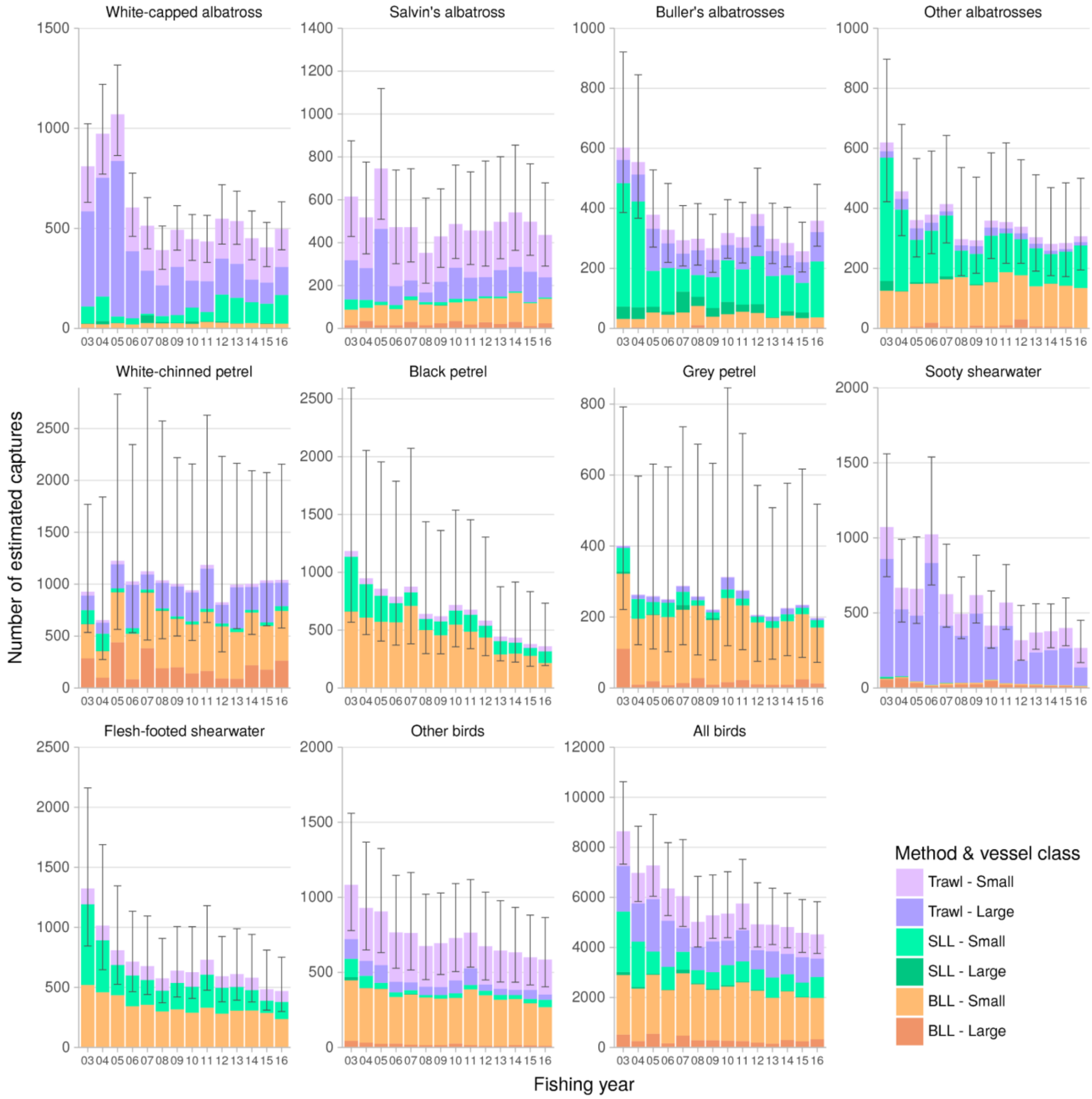

Figure 4. Time series of the number of estimated captures for the seabird species groups and for all birds for the 2002–03 to 2015–16 fishing years. Estimates are shown by fishing method and vessel size class. Cut-off lengths for small and large vessel size classes were 45 m, 34 m, and 28 m, for surface-longline (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.)

1.1.5. *Time series of capture method in trawl fisheries*

As warp mitigation has been required on large trawl vessels (28m +) since 2006, the rate of warp captures have reduced. This trend is most notable for albatrosses in the squid fishery, however the rates of net captures have fluctuated (see top left plot in Figure 5). Petrels and other birds tend to be caught in the net (see right hand plots in Figure 5).

Figure 5. Observed capture methods from selected trawl fisheries in New Zealand from 2002-03 to 2015-16.

2. NEW ZEALAND'S SEABIRD RISK ASSESSMENT

2.1. Updated methodology

The risk assessment followed the Spatially Explicit Framework for Risk Assessment (SEFRA, Ministry for Primary Industries 2016). The risk of fisheries to seabirds is expressed as the ratio of annual potential fatalities (APF) to the Population Sustainability Threshold (PST), an index of population productivity.

The risk assessment was applied to 71 seabird species that breed in New Zealand waters. The annual potential fatalities are estimated using spatial overlap, and include all fatalities from the fisheries with sufficient observations: trawl, bottom-longline, surface-longline, and set-net fisheries within New Zealand's Exclusive Economic Zone (EEZ). The estimate of annual potential fatalities includes cryptic mortalities, i.e., birds that are killed by the fishing activity but not brought on-board the fishing vessel and not included in captures reported by fisheries observers. The term "potential fatalities" is used to indicate the inherent uncertainty associated with estimating these cryptic fatalities, and the other uncertainties associated with estimating fatalities from observed captures.

The PST is adapted from the Potential Biological Removal index (PBR; Wade 1998), which was developed under the United States Marine Mammal Protection Act to assess the maximum level of human-induced mortality that a population can incur, while being able to stay above half its carrying capacity in the long term. The PST is expressed as

$$\mathrm{PST} = 0.5\ \varphi\ r_{\mathrm{max}} N\ ,$$

where φ is a calibration factor, r_{max} is the maximum population growth rate (in the absence of human-caused mortality), and N is the population size. The PST differs from the PBR in that distributions of parameters are used (rather than point estimates); the PST uses the full distribution of the population size estimate (rather than an estimated minimum); and the PST does not include a recovery factor, f. For seabirds, the maximum growth rate r_{max} and the population size N are estimated from available demographic parameters (the age at first breeding A, adult survival $S_{A,}$, and in the case of the population size, from the number of annual breeding pairs).

In accordance with the New Zealand National Plan of Action for reducing seabird bycatch, the risk of fisheries to seabirds was categorised according to the median and the upper limit of the 95% credible interval of the risk ratio:

- Very high risk: median risk ratio above 1 or an upper 95 credible limit above 2,
- High risk: median above 0.3 or an upper 95% credible limit above 1,
- Medium risk: median above 0.1 or an upper 95% credible limit above 0.3,
- Low risk: upper 95% credible limit above 0.1,
- Negligible risk: upper 95% credible limit less than 0.1.

The current risk assessment includes a number of updates to the analysis by Richard & Abraham (2015), resulting from consultation with New Zealand's Ministry for Primary Industries (MPI), MPI's Aquatic Environment Working Group (AEWG), and seabird and fishery experts. These updates include changes to the methodology and to the input data.

Full details of the method are detailed by Richard et al (2017), and are summarised in a schematic form in Figure 6. The main updates to the method were:

- Data on fishing effort and observed captures included two more fishing years, and vulnerability to capture was estimated using data for the period between 2006–07 and 2014–15.
- Annual potential fatalities were estimated based on spatial overlap using data between the 2012–13 and 2014–15 fishing years to reflect the current level and spatial distribution of fishing effort.
- The total population size rather than the lower quartile was used in calculating the PST.
- Allometric modelling was used to reduce variability in the estimates of age at first reproduction and of adult survival, which are used in calculating the population growth rate in optimal conditions.
- An overall correction factor, φ, of 0.5 for all species was used in the PST formulation, so that seabird populations meet the long-term goal of remaining above half their carrying capacity, in the presence of environmental variability, confirmed by simulations.
- An integrated model for estimating fisheries mortalities was developed, so that the fishing-related mortality is constrained to be less than the total annual mortality of the adult population (which was estimated from adult survival). This update ensured that estimated mortalities, population size, and adult survival were mutually consistent.
- The proportion of captures released alive was estimated from the data, and half of the live releases were assumed to survive on average.
- Fishery groups were amended and the species demographic parameters updated, following consultation with experts, as directed by MPI.
- The cryptic multiplier, used to estimate the total number of fatalities from the number of observable captures, was disaggregated between fishery groups in trawl fisheries based on observer data.
- The total number of fatalities instead of the number of observable captures was assumed to be related to vulnerability.
- Vulnerability to capture was allowed to vary between the pre- and post-2010 period in fisheries with a sufficient number of observations.
- Vulnerability was estimated in a single integrated model, instead of modelling each fishing method separately.
- Stewart Island shag (*Leucocarbo chalconotus*) was split into two separate species, the Otago shag (*L. chalconotus*) and Foveaux shag (*L. stewarti*), following a recent study.
- An updated, seasonally-disaggregated at-sea distribution map for black petrel (*Procellaria parkinsoni*) was used, derived from Global Positioning System (GPS) tracking data.

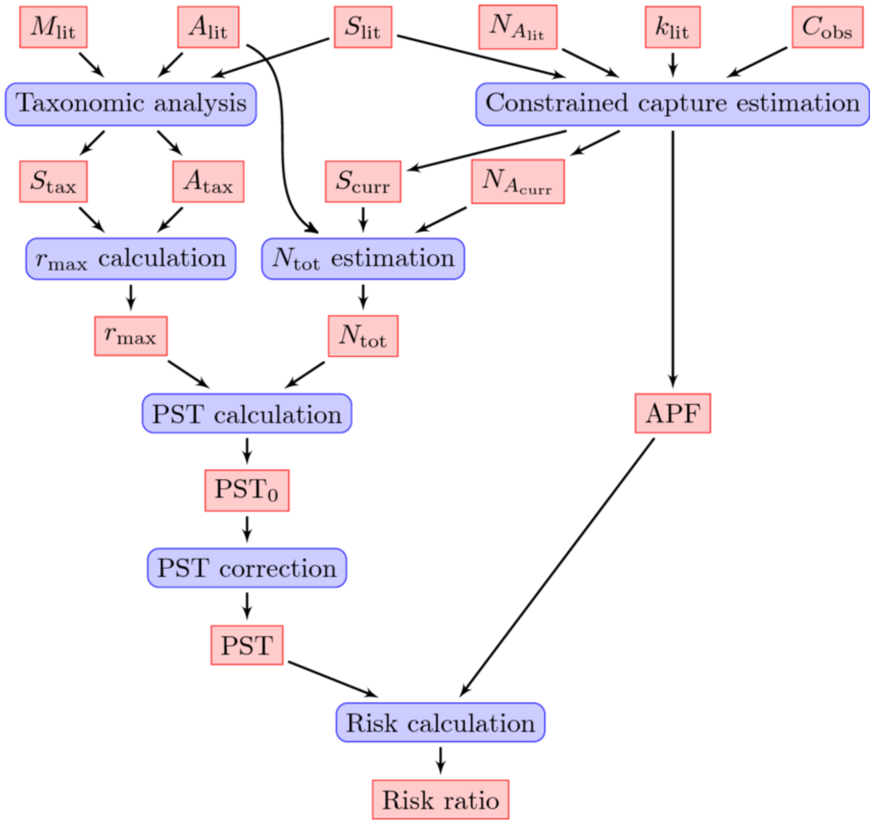

Figure 6: Schematic process of the estimation of risk in the current seabird risk assessment, showing the input parameters and how they are combined to derive a risk score. Full details of the method are described by Richard et al (2017). M: body mass, A: age at first reproduction; S: adult survival rate; N_A : adult population size; k: cryptic mortality multiplier; C: seabird captures; r_{max}: maximum net productivity rate; N_{tot}: total population size; PST: Population Sustainability Threshold; APF: annual potential fatalities. For the indices: lit: from the literature or expert-based; obs: recorded by observers; tax: from the taxonomic analysis; curr: representing current conditions, corrected by the model; tot: total; 0: prior to correction.

2.2. Revised risk results

The risk assessment results are shown in Figure 7. Black petrel was the species the most at risk from commercial fisheries in New Zealand, with a median risk ratio of 1.15 (95% c.i.: 0.51–2.03), based on an estimated mean PST of 437 (95% c.i.: 220–834) individuals and mean annual potential fatalities of 468 (95% c.i.: 316–666) black petrel. The estimated annual potential fatalities of this species were mostly in the surface-longline fishery targeting bigeye tuna, inshore trawl fisheries, and bottom-longline fisheries targeting snapper and bluenose. These fisheries all have relatively low observer coverage, and so estimates of observable captures of black petrel are inherently uncertain (of all observed captures of black petrel, around one-third occurred during a single trip).

If the risk ratio is larger than one, fisheries-related fatalities may be sufficiently high to prevent the population from remaining (or increasing to) above half its carrying capacity. While the risk ranking of black petrel was estimated as "very high risk", the population trend of this species is unclear. For example, demographic modelling indicated an estimated population growth rate between -2.3% and 2.5% per year, depending on the estimated annual survival rate of juveniles. Assuming a juvenile survival rate of 88%, the population growth rate was estimated at -1.1% per year (Bell et al 2013).

Furthermore, the population size of black petrel in New Zealand is not well known. The current study used the population size estimate of black petrel of 2750 (95% c.i.: 1600–5120) annual breeding pairs that was also used in the preceding risk assessment by Richard et al (2015). Data from regular field surveys of breeding black petrel within a 35 ha area on Great Barrier Island (Bell et al 2013, Bell et al 2016b), and from a recent survey of Little Barrier Island (Bell et al 2016a), show that the number of breeding pairs varies widely between years. This variation reflects both the number of birds choosing to breed each year, changes in the population size, and uncertainty from the sampling process. Obtaining a population estimate from these survey data requires a demographic model. Ideally, this model would also include an estimate of black petrel that breed on Great Barrier Island outside the surveyed colony. At-sea counts of black petrel off the coast of South America outside the breeding season such as in Spear (2005) and additional recoveries of tagged individuals caught in fisheries would also improve estimates of the black petrel population.

The species with the second highest risk ranking was Salvin's albatross, with a median risk ratio of 0.78 (95% c.i.: 0.51–1.09). In this assessment, the mean PST was estimated at 3598 (95% c.i.: 2709–4941) individuals, while the mean number of annual potential fatalities was 2778 (95% c.i.: 2028–3764), estimated from 328 observed captures, mainly in trawl fisheries. Of the estimated total annual potential fatalities of this species, 40% were in inshore trawl fisheries, but other fisheries with high estimated annual potential fatalities of Salvin's albatross included trawl fisheries targeting hoki, the fleet of small (less than 34-m length) bottom-longline vessels targeting ling, and trawl fisheries targeting middle-depth species and scampi.

Survey data of Salvin's albatross populations indicate different potential trends at different colonies. At Bounty Islands, where most of the population breeds, survey data indicate decreases in the annual number of breeding pairs, including a 30% decrease between 1997 and 2011 at Proclamation Island, and a 13% decrease between 2004 and 2011 at Depot Island (Sagar et al 2015a). In contrast, recent aerial surveys across the Bounty Islands group indicated an increase from 31786 to 39995 annual breeding pairs between 2010 and 2013, including a doubling of the number of annual breeding pairs at Proclamation Island since the earlier survey (Baker et al 2014). At Snares Islands (the Western Chain), ground counts indicated a stable population of Salvin's albatross between 2008 and 2014 (Sagar et al 2015b). Inter-annual variability in the number of annual breeding pairs make it difficult to ascertain changes in population size based on discrete surveys, suggesting that regular surveys are required to determine the status of the Salvin's albatross population. Providing an accurate population estimate of Salvin's albatross is also relevant in view of the conservation status of this species, which changed in 2013 from “nationally vulnerable” to “nationally critical'”, according to the New Zealand Threat Classification System (Robertson et al 2017).

Another species with the upper bound of the estimated number of annual fatalities exceeding the PST was flesh-footed shearwater, which had the third highest risk ranking in the current assessment. The risk ratio for this species had an estimated median of 0.67 (95% c.i.: 0.39–1.15), while the mean PST was estimated at 1451 (95% c.i.: 1033–1998) individuals, and the mean number of annual potential fatalities was 987 (95% c.i.: 623–1561) flesh-footed shearwater, estimated from 125 observed captures. Observed captures of this species included 68 and 49 captures in bottom-longline and trawl fisheries, respectively.

Flesh-footed shearwater populations in New Zealand are considered to be declining, and this is supported by recent population estimates from survey data (Baker et al 2010, Waugh 2013). For example, the New Zealand population size is currently estimated at between 10000 and 15000 breeding pairs (Waugh 2013), compared with an earlier estimate of 25000 to 50000 pairs (Taylor 2000). Owing to the population decline, this species was included in the threatened categories of the New Zealand Threat Classification System in 2012, and flesh-footed shearwater are currently classified as "nationally vulnerable" (Robertson et al 2017).

Westland petrel was the only other species with a 95% credible interval that exceeded one. The risk to Westland petrel was highly uncertain, with the median risk ratio being less than 0.5. For all other species, the risk ratio was entirely below one.

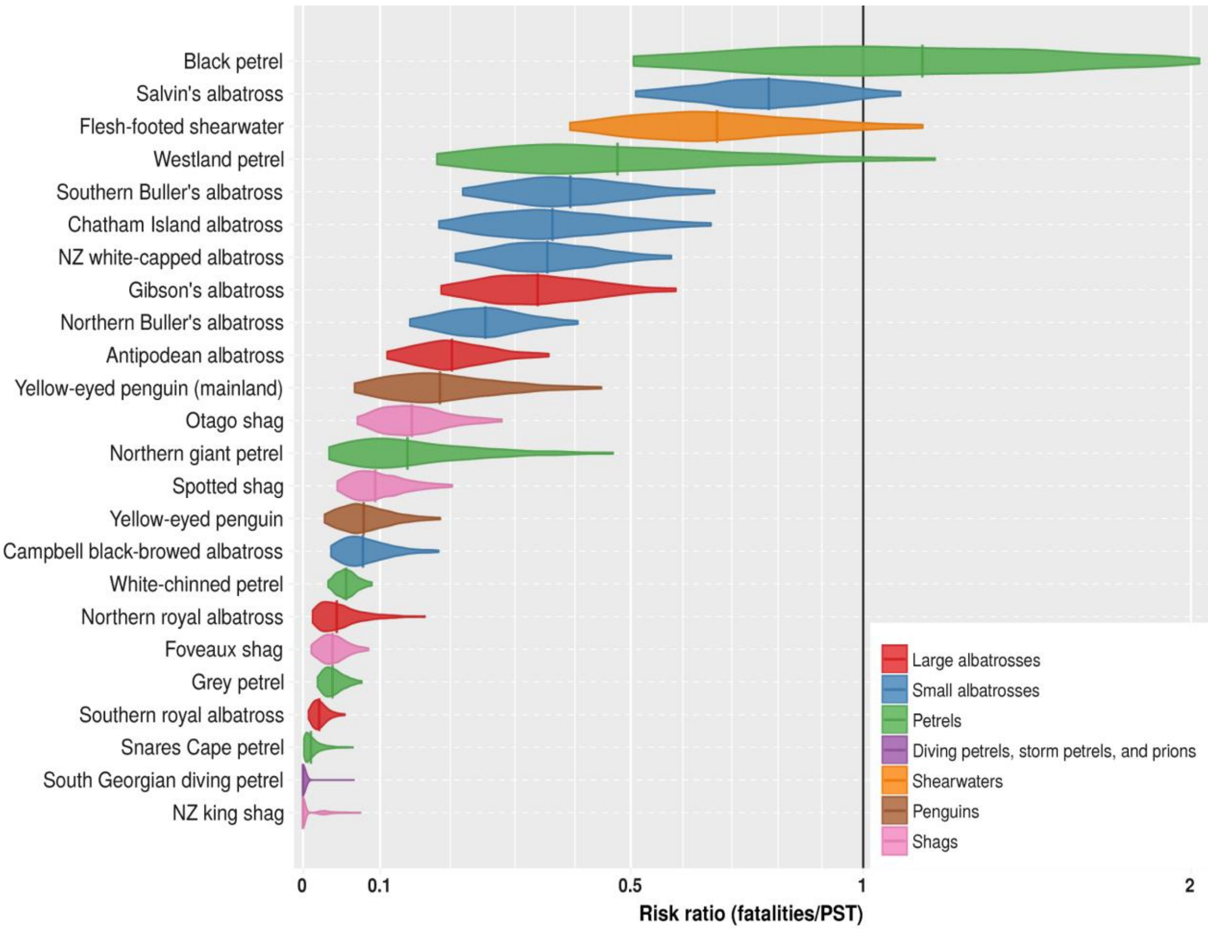

Figure 7. Risk ratio for different seabird taxa, based on data between 2006–07 and 2014–15. The risk ratio is displayed on a logarithmic scale, with the threshold of the number of potential bird fatalities equalling the Population Sustainability Threshold (PST) represented by the black vertical line, and the distribution of the risk ratios within their 95% credible interval indicated by the coloured shapes, including the median risk ratio (vertical line). Seabird taxa are listed in decreasing order of the median risk ratio. Taxa with a risk ratio of almost zero were not included (95% upper limit less than 0.05). The risk ratio of yellow-eyed penguin refers to the mainland population only, based on the assumption that all estimated fatalities were of the mainland population, and the number of annual breeding pairs was between 600 and 800.

The risk assessment allows sources of uncertainty in the risk ratio to be identified (Figure 8). For black petrel there would be over a 30% reduction in the uncertainty in the risk score, if the number of breeding pairs were known precisely, while for a species such as Westland petrel the largest reduction in uncertainty would coming from knowing the number of birds killed in trawl fisheries. This analysis allows for different responses to the uncertainty in the risk score: suggesting either improved observer coverage in the relevant fisheries, or improved knowledge of the seabird populations.

Figure 8. Sources of the uncertainty in the risk ratio for the 16 most-at-risk seabird taxa. Values are percentage decrease in the 95% credible interval of the risk ratio for each parameter, when fixed to the mean independently of each other. Parameters include age at first reproduction A and adult survival rate S (from the literature or from taxonomic analysis), the number of annual breeding pairs N_{BP}, the proportion of adults breeding in a year, P_B, and annual potential fatalities (APF) in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

2.3 Limitations of the risk assessment

In the current risk assessment framework, cryptic mortality had a considerable influence on the estimated risk ratio. When cryptic mortality was not considered in the estimation, and the number of observable captures was used, the risk category decreased for 13 of the 16 seabird taxa that had non-negligible risk rankings; there were no populations in the “very high risk'” category, and only one population in the ``high risk" category. Data on cryptic mortality are limited, and most of the information is from fisheries operating elsewhere. It is difficult to determine how adequate these data are to inform the current risk assessment of New Zealand fisheries; however, the occurrence of cryptic mortalities is well-recognised, necessitating their inclusion in risk assessment frameworks. Further research on cryptic mortalities of seabirds and other protected species is needed to provide a better understanding of this type of fisheries interaction.

Estimation of seabird captures relies on observer data, and in many fisheries, particularly small-vessel inshore fisheries, observer coverage has consistently been low. If fisheries are poorly observed, it is possible that rare multiple-capture events have not been recorded, and this lack of records may downwardly bias the estimation of observable captures. An example is set-net fisheries, where the largest number of seabirds observed caught in a capture event is two individuals, but multiple captures are likely to occur. Similar to set-net fisheries, small-vessel longline and trawl fisheries have not been well observed. Increasing observer coverage in these fisheries would allow seabird captures to be more accurately estimated, and it is possible that quantitatively different interactions with seabirds are occurring in the unobserved parts of these fisheries.

The risk assessment only considered the risk to seabird populations from commercial fisheries in New Zealand waters. Nevertheless, seabirds are exposed to a broad range of anthropogenic impacts, and some species might be in decline even when the mortality from New Zealand commercial fisheries is below the PST. Other fisheries impacts include mortalities in non-commercial fishing activities (Abraham et al 2010, Miskelly et al 2012). The only available estimate of incidental captures in recreational fisheries in New Zealand was over 11000 birds annually in northeastern New Zealand, with potentially 40000 incidental captures throughout the entire country (Abraham et al 2010). Noting that many recreational fishing seabirds are subsequently released alive although with unknown likelihood of survival. The latter estimate is higher than the number of annual potential fatalities in commercial trawl and longline fisheries estimated in the present study. Anthropogenic sources of mortality that pose a significant threat to seabird populations also include the introduction of exotic predators, light and chemical pollution, or climate change (Grémillet & Boulinier 2009, Croxall et al 2012, Wilcox et al 2015). These impacts were not considered here.

Another important issue for the current risk assessment is that the distribution of seabird species breeding in New Zealand is frequently not restricted to this region. Many seabirds migrate after breeding in New Zealand, such as species that forage off the coast of Chile and Peru during the non-breeding season (e.g., Buller's albatross, Chatham Island albatross, Westland petrel), in eastern tropical Pacific Ocean waters (e.g., black petrel), or around South Africa (e.g., New Zealand white-capped albatross). At these locations, they will interact with different fisheries, but these interactions and the associated risk have not been assessed. A Southern Hemisphere seabird risk assessment is currently under way (see **SBWG8 Doc 07**).

REFERENCES:

Abraham, E.R., ; Berkenbusch, K.N., ; Richard, Y., (2010). The capture of seabirds and marine mammals in New Zealand non-commercial fisheries. New Zealand Aquatic Environment and Biodiversity Report No. 64. 52 p.

Abraham, E.R.; Richard, Y. (2017). Summary of the capture of seabirds in New Zealand commercial fisheries, 2002–03 to 2013–14. *New Zealand Aquatic Environment and Biodiversity Report No. 184*. 88 p. Available at http://www.mpi.govt.nz/news-and-resources/publications

Baker, B., ; Hedley, G., ; Cunningham, R., (2010). Data collection of demographic, distributional, and trophic information on the flesh-footed shearwater to allow estimation of effects of fishing on population viability: 2009–10 field season. Final Research Report for Ministry for Primary Industries Research Project PRO2006/01 (Unpublished report held by the Ministry for Primary Industries, Wellington).

Baker, G.B.; Jensz, K.; Sagar, P. (2014). 2013 Aerial survey of Salvin's albatross at the Bounty Islands. Unpublished report prepared for the Department of Conservation, Wellington, New Zealand. Retrieved from http://www.doc.govt.nz/Documents/conservation/marine- and- coastal/marine-conservation-services/reports/pop2012-06-salvins-aerial-population-estimate.pdf

Bell, E.A., ; Mischler, C., ; Sim, J.L., ; Scofield, P., ; Francis, C., ; Abraham, E., ; Landers, T., (2013). At-sea distribution and population parameters of the black petrels (*Procellaria parkinsoni*) on Great Barrier Island (Aotea Island), 2013–14. Unpublished report prepared for the Department of Conservation, Wellington, New Zealand. Retrieved 28 July 2015, from http://bit.ly/1rz0HN4

Bell, E.A., ; Mischler, C.P., ; MacArthur, N., ; Sim, J.L., (2016a). Black petrels (*Procellaria parkinsoni*) population study on Hauturu-o-Toi/Little Barrier Island, 2015/16. Unpublished report prepared for the Department of Conservation. Retrieved 24 November 2016, from http://www.doc.govt.nz/Documents/conservation/marine-and-coastal/marine-conservation-services/reports/pop2015-01-black-petrel-lbi-final.pdf

Bell, E.A., ; Mischler, C.P., ; MacArthur, N., ; Sim, J.L., (2016b). Population parameters of the black petrels (Procellaria parkinsoni) on Great Barrier Island (Aotea Island), 2015/16. Unpublished report prepared for the Department of Conservation. Retrieved 24 November 2016, from http://www.doc.govt.nz/Documents/conservation/marine-and-coastal/marine-conservation-services/reports/pop2015-01-black-petrel-gbi-final.pdf

Croxall, J.P.; Butchart, S.H.; Lascelles, B.; Stattersfield, A.J.; Sullivan, B.; Symes, A.; Taylor, P. (2012). Seabird conservation status, threats and priority actions: a global assessment. Bird Conservation International 22: 1–34.

Grémillet, D.; Boulinier, T. (2009). Spatial ecology and conservation of seabirds facing global climate change: a review. Marine Ecology Progress Series 391: 121–137.

Ministry for Primary Industries (2016). Aquatic Environment and Biodiversity Annual Review 2016. Compiled by the Fisheries Management Science Team, Ministry for Primary Industries, Wellington, New Zealand. 790 p. Available at https://www.mpi.govt.nz/news-and-resources/open-data-and-forecasting/fisheries/

Miskelly, C.; Baylis, S.; Tennyson, A.; Waugh, S.; Bartle, S.; Hunter, S.; Gartrell, B.; Morgan, K. (2012). Impacts of the Rena oil spill on New Zealand seabirds. Unpublished poster held by Te Papa, Wellington. Retrieved 29 September 2014, from http://collections.tepapa.govt.nz/publication/3818

Richard, Y. ; Abraham, E.R. (2015). Assessment of the risk of commercial fisheries to New Zealand seabirds, 2006–07 to 2012–13. New Zealand Aquatic Environment and Biodiversity Report No. 162. 89 p. Retrieved 18 March 2016, from https://www.mpi.govt.nz/document-vault/10523

Richard, Y.; Abraham, E. R., Berkenbusch, K. (2017) Assessment of the risk of commercial fisheries to New Zealand seabirds, 2006–07 to 2014–15. Draft Aquatic Environment and Biodiversity Report, Ministry for Primary Industries, Wellington, New Zealand.

Robertson, H.; Baird, K.; Dowding, J.; Elliott, G. P.; Hitchmough, R. A.; Miskelly, C.M.; McArthur N.; O'Donnell, C.F.J.; Sagar P.M.; Scofield R.P.; Taylor, G.A. (2017). Conservation status of New Zealand birds, 2016. In, New Zealand Threat Classification Series 19, Department of Conservation, Wellington, New Zealand, p. 23.

Sagar, P.M., ; Amey, J., ; Scofield, R.P., ; Robertson, C.J.R., (2015). Population trends, timing of breeding and survival of Salvin's albatrosses (*Thalassarche salvini*) at Proclamation Island, Bounty Islands, New Zealand. Notornis 62(1): 21–29.

Sagar, P.M., ; Charteris, M., ; Scofield, P., (2015b). Salvin's albatross population size and survival at the Snares Western Chain - Salvin's albatross, The Snares 2014. Final Research Report (Unpublished report held by the Ministry for Primary Industries, Wellington.)

Spear, L.B., ; Ainley, D.G., ; Webb, S.W., (2005). Distribution, abundance, habitat use and behaviour of three Procellaria petrels off South America. Notornis 52(2): 88–105.

Taylor, G.A., (2000). Action plan for seabird conservation in New Zealand. Part B: Non-threatened seabirds. Threatened Species Occasional Publication No. 17, 201 p.

Wade, P. (1998). Calculating limits to the allowable human-caused mortality of cetaceans and pinnipeds. Marine Mammal Science 14(1): 1–37.

Waugh, S.M., ; Tennyson, A.J.D., ; Taylor, G.A., ; Wilson, K.-J., (2013a). Population sizes of shearwaters (*Puffinus* spp.) breeding in New Zealand, with recommendations for monitoring. Tuhinga 24: 159–204.

Wilcox, C.; Sebille, E.V.; Hardesty, B.D. (2015). Threat of plastic pollution to seabirds is global, pervasive, and increasing. Proceedings of the National Academy of Sciences 112(38): 11899–11904.