

Conservation Services Programme

Seabird medium term research plan 2017

February 2017

Conservation Services Programme

Department of Conservation

1. Purpose

The Conservation Services Programme (CSP) undertakes research to understand and address the effects of commercial fishing on protected species in New Zealand fisheries waters (for further details see the [CSP Strategic Statement 2015](#)).

This CSP seabird medium term research plan 2017 (CSP seabird plan 2017) outlines a five year research programme to deliver on the seabird population research component of CSP as well as providing guidance on priority fisheries for seabird-focussed observer coverage and mitigation development.

It has been developed as part of the work of the CSP Research Advisory Group ([CSP RAG](#)), and will be used by the Group as tool to develop and prioritise seabird-focussed research proposals. These proposals will subsequently be used in the development of CSP Annual Plans and any other relevant delivery mechanisms.

Seabird population research that falls outside the scope and mandate of CSP is not included in this plan.

2. Guiding objectives and risk framework

This plan is guided by the relevant objectives of CSP and the National Plan of Action – 2013 to reduce the incidental catch of seabirds in New Zealand Fisheries ([NPOA-Seabirds](#)). These are summarised in Table 1.

The risk referred to in the guiding objectives is the risk of commercial fisheries to New Zealand seabird populations. For the purposes of the implementation of the NPOA-Seabirds, and of this plan, risk estimation will primarily be based on the findings of [\[2017 Risk Assessment\]](#) and any future updates of that approach. [\[2017 Risk Assessment\]](#) compare estimated bycatch in New Zealand commercial trawl, longline and setnet fisheries to a Population Sustainability Threshold (PST) for the majority of seabird taxa breeding in New Zealand.

As the CSP mandate covers all commercial fishing methods, this plan will also consider species for which risk from any other commercial fisheries has been identified. For the purposes of this plan the expert-opinion based qualitative risk assessment by Rowe (2013) will be the primary assessment for fisheries not included by [\[2017 Risk Assessment\]](#).

Whilst consideration of the indirect effect of fishing on seabirds (and other protected species) falls within the scope of CSP, for simplicity this plan is restricted to consideration on direct effects.

3. Data requirements

Addressing the relevant CSP and NPOA-Seabirds five-year objectives summarised in Table 1 requires the availability of certain seabird population information. In order to accurately estimate fisheries risk to seabirds using the approach of [2017 Risk Assessment], and measure change in risk in response to fisheries management, the following seabird population inputs are required:

- number of annual breeding pairs (N_{BP});
- proportion of adults breeding in a given year (P_B);
- age at first reproduction (A);
- annual adult survival rate (S_A); and
- spatial distribution.

A summary of existing relevant literature has been produced for the [CSP RAG](#). This plan describes a research programme to fill knowledge gaps and obtain updated estimates for the seabird population inputs listed above for higher risk seabird taxa and/or where current estimates are most uncertain.

The guiding objectives from both the NPOA-Seabirds and CSP relate to populations. The taxonomy of some seabirds remains uncertain, even at the species level. In order to understand population level risk, it is important to understand which breeding sites represent distinct populations, whether at a formal subspecies level (e.g. Gibson's and Antipodean albatross) or not. Where taxonomic experts are uncertain, or in disagreement, conducting further taxonomic work is required to meet the guiding objectives.

Other sources of information, particularly around estimation of capture rates in fisheries, is also of great importance in accurately estimating risk. This information is generally best obtained via vessel observation programmes. This plan provides guidance on which fisheries contribute most uncertainty in estimates of risk to seabirds. Obtaining additional information on capture rates in these fisheries is thus of greatest importance in developing robust risk estimates.

This plan also summarises which fisheries contribute most risk to seabirds, and are thus of greatest priority in ensuring effective mitigation strategies are available.

4. Current risk and uncertainty

Table 2 lists all 17 seabird taxa that found to have a risk ratio with the upper 95% confidence interval exceeding 0.1 (see [2017 Risk Assessment] for full details). These taxa have relative risk scores categorised as low to very high. There have been a number of notable changes in risk scores reported by [2017 Risk Assessment] compared to those reported by Richard & Abraham

(2015), on which the CSP seabird plan 2016 was based. To maintain consistency with the CSP seabird plan 2016, species categorised at low or high risk by Richard & Abraham (2015), but now categorised as at negligible risk by [2017 Risk Assessment] have also been included in Table 2. Thirteen taxa have been included on this basis. This ensures a precautionary approach is taken in identifying population research responses for taxa based on risk category.

Table 2 also identifies risk from commercial fisheries other than those considered by [2017 Risk Assessment], where the risk for any seabird taxon was found to be moderate or higher by Rowe (2013). This results in five additional seabird taxa being listed.

In addition to summarising the risk from commercial fisheries for each seabird taxon, Table 2 also provides both the International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species classification and the New Zealand Conservation Status (NZCS; Robertson et al 2013) for each taxon. It should be noted that for several taxa the IUCN classification is for a higher taxonomic level (all are at global species level), and for yellow-eyed penguin (mainland) the NZCS is also at species level.

A summary of the key sources of uncertainty in the risk estimates of [2017 Risk Assessment] for the 35 seabird taxa considered in this plan is provided in Table 3. The coefficient of variation (CV) is also provided for each taxon as a measure of the overall uncertainty of each species' risk estimate.

The uncertainty in risk arises from uncertainty in a range of parameters. Of relevance to planning seabird population research is the uncertainty around parameters A , S_A , N_{BP} and P_B (see Section 3 above). The population research component of this plan is focussed on obtaining better estimates of those parameters, which contribute most uncertainty in risk estimates. It also provides a plan to conduct baseline population monitoring for at risk taxa to allow measurement of risk over time in response to fisheries management actions, spatial tracking to identify areas of fisheries overlap for potential management, and taxonomic determination.

Whilst this plan is centred on the outputs of [2017 Risk Assessment], more detailed quantitative modelling to assess fisheries risk has been completed for some taxa. These assessments are listed in Table 4. This plan does not attempt to summarise the findings and recommendations from these assessments, but the findings should be taken into consideration by the CSP RAG in prioritising research proposals for these taxa.

The relative contribution of risk from each of the fishery groupings considered by [2017 Risk Assessment] is of relevance to prioritising where observer coverage is placed (to obtain more certain interaction data) and where mitigation strategies are developed (to focus mitigation effort on fisheries posing most risk). Fishery breakdowns have been tabulated and colour coded in this plan to assist in prioritisation of observer coverage and mitigation projects.

5. Population research plan

As well as providing information on sources of uncertainties in current risk estimates Table 3 also provides the CSP seabird population research response to obtain better information

required to meet the relevant NPOA-Seabirds and CSP objectives. The CSP research response has been developed to achieve the following outputs:

- total population estimates for seabird taxa which have both considerable uncertainty in their risk ratio, as measured by the CV, and considerable uncertainty arising from current N_{BP} estimate, or where initial work has indicated a potential decline;
- annual mark-recapture studies to estimate population parameters, including S_A , for those seabird taxa which have both considerable uncertainty in their risk ratio, as measured by the CV, and considerable uncertainty arising from the current S_A estimate, where there are existing studies in place, or where new studies are logistically easy and relatively low cost;
- investigation of feasibility for establishing annual mark-recapture studies to estimate population parameters, including S_A , for those seabird taxa which have both considerable uncertainty in their risk ratio, as measured by the CV, and considerable uncertainty arising from the current S_A estimate, where there are no existing studies in place, or where breeding sites are logistically difficult to access with associated higher cost;
- tracking studies for seabird taxa where little or no information exists and/or those taxa at particularly high risk where more detailed tracking information can inform spatial fisheries management responses;
- taxonomic investigation to clarify species taxonomy and understand which breeding sites represent distinct populations;
- routine population monitoring for all seabird taxa at medium or higher relative risk from Richard & Abraham (2015), or for species where the risk assessment may be underestimated; and
- routine population monitoring for all seabird taxa at moderate or higher relative risk from fisheries other than those assessed by Richard & Abraham (2015) (Rowe, 2013) and with a New Zealand Conservation Status of Threatened.

In order to plan a five-year research programme to deliver the CSP research response described in Table 3, some operational principles were used:

- studies on highest risk species prioritised for earlier years;
- annual grouping of projects by location, in order to maximise cost effectiveness, for example, a focus in the Chatham Islands in 2016/17 and Campbell & Antipodes Islands in 2017/18;
- conduct mark-recapture and tracking studies together, and time total population estimates to coincide with these where appropriate;
- routine monitoring (of whole population or a sample, as appropriate and feasible for the taxon) at 3 year intervals, or annually for species demonstrating a decline in population;

- aim to leverage from existing studies;
- prioritise taxonomic and review projects in early year as these are relatively low cost and may result in finding current risk estimates are under-estimated for potential new taxa; and
- conduct periodic review of annualised studies or review CSP research response when it is envisaged that substantial new information will be available.

These principles were used to develop a five-year research plan, summarised in Table 5.

6. Observer programme priorities

Tables 6a-d highlight the fisheries by target species that contribute most risk to seabird taxa categorised as at low or higher risk (in either L2 iteration; Table 2) and where that risk has substantial levels of uncertainty.

The following principles were used in developing Tables 6a-d:

- for each seabird taxon listed in Table 2, any fishing methods of trawl (TWL), bottom longline (BLL), surface longline (SLL) or setnet (SN) were included if their level-2 risk uncertainty contribution was $\geq 10\%$ (Table 3); and
- target fisheries within each of TWL, BLL, SLL, and SN were ranked by colour within each fishery method.

In Tables 6a-d, seabird taxa are listed in priority of risk category and the CV is also provided for each taxon as a measure of the overall uncertainty of each species' risk estimate. Red coloured fisheries represent the highest relative priority for observer coverage to better estimate risk to a seabird taxon, green the lowest relative priority for that taxon.

Tables 6a-d only include fisheries assessed by [2017 Risk Assessment]. All fisheries from Rowe (2013) listed in Table 2, which were too information poor to be assessed by [2017 Risk Assessment], pose moderate or higher risk to seabirds and should also be considered high priority for observer programme coverage.

7. Mitigation priorities

Table 7 summarises the risk posed to seabirds listed in Table 2 by the fisheries assessed in [2017 Risk Assessment]. Seabird taxa are listed in priority of risk category, and fisheries are ranked for each species by colour according to their contribution to risk. Those fisheries contributing considerable levels of risk to the highest risk taxa should be considered highest priority for ensuring mitigation strategies are developed.

8. References

[2017 Risk Assessment]

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*

Robertson, H.A.; Dowding, J.E.; Elliott, G.P.; Hitchmough, R.A.; Miskelly, C.M.; O'Donnell, C.J.F.; Powlesland, R.G.; Sagar, P.M.; Scofield, R.P.; Taylor, G.A. 2013. Conservation status of New Zealand birds, 2012. [New Zealand Threat Classification Series 4](#). Department of Conservation, Wellington. 22 p.

Rowe, S. 2013: Level 1 risk assessment for incidental seabird mortality associated with fisheries in New Zealand's Exclusive Economic Zone. [DOC Marine Conservation Services Series 10](#). Department of Conservation, Wellington. 58 p.

DRAFT

Tables

Table 1. Guiding objectives.

Objective type	Objective		
NPOA-Seabirds Long term	“New Zealand seabirds thrive without pressure from fishing related mortalities, New Zealand fishers avoid or mitigate against seabird captures and New Zealand fisheries are globally recognised as seabird friendly”		
	Practical	Biological Risk	Research & Development
NPOA-Seabirds High level subsidiary	“All New Zealand fishers implement current best practice mitigation measures relevant to their fishery and aim through continuous improvement to reduce and where practicable eliminate the incidental mortality of seabirds”	“Incidental mortality of seabirds in New Zealand fisheries is at or below a level that allows for the maintenance at a favourable conservation status or recovery to a more favourable conservation status for all New Zealand seabird populations”	“the testing and refinement of existing mitigation measures and the development of new mitigation measures results in more practical and effective mitigation options that fishers readily employ” “research and development of new observation and monitoring methods results in improved cost effective assurance that mitigation methods are being deployed effectively” “Research outputs relating to seabird biology, demography and ecology provide a robust basis for understanding and mitigating seabird incidental mortality”
NPOA-Seabirds Five year	“all New Zealand commercial fishing vessels are shown to be implementing current best practice mitigation measures relevant to their area and fishery” “capture rates are reducing in all New Zealand fisheries in accordance with reduction targets in the relevant planning documents for those fisheries”	“The level of mortality of New Zealand seabirds in New Zealand commercial fisheries are reduced so that species currently categorised as at very high or high risk from fishing move to a lower category of risk”	“where existing mitigation measures are impractical or of limited effectiveness in reducing the mortality of New Zealand seabirds, new or improved mitigation measures have been sought and where identified are under development for all priority fisheries or fishing methods” “new observation and monitoring methods, especially in relation to poorly observed fisheries, are researched, developed and implemented” “programmes of research to improve our understanding of and ability to mitigate seabird incidental mortality for at risk species are underway and key projects for very high risk species have been completed”
CSP Objectives			
A	Proven mitigation strategies are in place to avoid or minimise the adverse effects of commercial fishing on protected species across the range of fisheries with known interactions		
B	The nature of direct adverse effects of commercial fishing on protected species is described		
C	The extent of known adverse direct effects of commercial fishing on protected species is adequately understood.		
E	Adequate information on population level and susceptibility to fisheries effects exists for protected species populations identified as at medium or higher risk from fisheries		

Table 2. Seabird taxa at risk from commercial fishing. L2 risk – relative risk score based on [2017 Risk Assessment] for 2017 and Richard & Abraham (2015) for 2015: VH = very high, H = high, M = medium, L= low; other fishery – fisheries other than those considered by [2017 Risk Assessment] which pose moderate or higher risk; L1 risk – Rowe (2013); IUCN Threat – [IUCN Red List 2016](#); NZ Threat – T = Threatened, AR = At Risk, NT = Not Threatened [Robertson et al \(2013\)](#). * = assessed at species level. Taxa in bold have been assessed by quantitative modelling (Table 4).

Common name	Scientific name	L2 risk 2017	L2 risk 2016	Other fishery	L1 risk	IUCN Threat status	NZ Threat status
Black petrel	<i>Procellaria parkinsoni</i>	VH	VH	Hand line Purse seine light Troll	Moderate Moderate Moderate	Vulnerable	T Vulnerable
Salvin's albatross	<i>Thalassarche salvini</i>	H	VH			Vulnerable	T Critical
Flesh-footed shearwater	<i>Puffinus carneipes</i>	H	VH	Hand line Purse seine light	Moderate Moderate	Near threatened	T Vulnerable
Westland petrel	<i>Procellaria westlandica</i>	H	H			Vulnerable	AR Uncommon
Southern Buller's albatross	<i>Thalassarche bulleri bulleri</i>	H	VH			Near threatened *	AR Uncommon
Chatham Island albatross	<i>Thalassarche eremite</i>	H	H			Near threatened	AR Uncommon
New Zealand white-capped albatross	<i>Thalassarche steadi</i>	H	VH			Near threatened	AR Declining
Gibson's albatross	<i>Diomedea antipodensis gibsoni</i>	H	VH			Vulnerable *	T Critical
Northern Buller's albatross	<i>Thalassarche bulleri platei</i>	M	VH			Near threatened *	AR Uncommon
Antipodean albatross	<i>Diomedea antipodensis antipodensis</i>	M	H			Vulnerable *	T Critical
Yellow-eyed penguin (mainland)	<i>Megadyptes antipodes</i>	M	M			Endangered	T Vulnerable*
Otago shag	<i>Leucocarbo chalconotus,</i>	M	M			Vulnerable *	T Vulnerable
Northern giant petrel	<i>Macronectes halli</i>	M	M			Least concern	AR Uncommon
Spotted shag	<i>Stictocarbo punctatus</i>	L	M			Least concern	NT
Yellow-eyed penguin	<i>Megadyptes antipodes</i>	L	L			Endangered	T Vulnerable*
Campbell black-browed albatross	<i>Thalassarche impavida</i>	L	H			Vulnerable *	AR Uncommon
Northern royal albatross	<i>Diomedea sanfordi</i>	L	M			Endangered	AR Uncommon
White-chinned petrel	<i>Procellaria aequinoctialis</i>	N	M			Vulnerable	AR Declining
Foveaux shag	<i>Leucocarbo stewarti</i>	N	M			Vulnerable *	T Vulnerable
Chatham petrel	<i>Pterodroma axillaris</i>	N	M			Vulnerable	T Vulnerable
Chatham Island taiko	<i>Pterodroma magentae</i>	N	M			Critically endangered	T Critical
Grey petrel	<i>Procellaria cinerea</i>	N	L			Near threatened	AR Uncommon
Southern royal albatross	<i>Diomedea epomophora epomophora</i>	N	L			Vulnerable	AR Uncommon
Snares Cape petrel	<i>Daption capense austral</i>	N	L			Least concern *	AR Uncommon
Little black shag	<i>Phalacrocorax sulcirostris</i>	N	L			Least concern	AR Uncommon
Fiordland crested penguin	<i>Eudyptes pachyrhynchus</i>	N	L			Vulnerable	T Endangered
Grey-headed albatross	<i>Thalassarche chrysostoma</i>	N	L			Endangered	T Vulnerable
Light-mantled sooty albatross	<i>Pheobertia palpebrata</i>	N	L			Near threatened	AR Declining
New Zealand white-faced storm petrel	<i>Pelagodroma marina maoriana</i>	N	N	Purse seine light	Moderate	Least concern	AR Relict
North Island little shearwater	<i>Puffinus assimilis haurakiensis</i>	N	N	Purse seine light	Moderate	Least concern*	AR Recovering
Chatham Island shag	<i>Leucocarbo onslowi</i>	N	N	Trap & Pot	Moderate	Critically endangered	T Critical
New Zealand king shag	<i>Leucocarbo carunculatus</i>	N	L	Trap & Pot	Moderate	Vulnerable	T Endangered
New Zealand storm petrel	<i>Pealeornis maoriana</i>	N	L	Purse seine light	Extreme	Critically endangered	T Endangered
Pitt Island shag	<i>Stictocarbo featherstoni</i>	N	N	Trap & Pot	High	Endangered	T Critical
Pycroft's petrel	<i>Pterodroma pycrofti</i>	N	N	Purse seine light	Moderate	Vulnerable	AR Recovering

Table 3. Risk uncertainty due to underlying parameters and CSP research response. Values are the percentage reduction in the 95% confidence interval of the risk ratio that occurs when the parameter is set to its arithmetic mean. See Richard & Abraham (2015) for full details. The parameters are: annual potential fatalities in trawl, bottom longline, surface longline and set-net fisheries (TWL, BLL, SLL, SN, respectively); age at first reproduction (A); adult survival (S_A); the number of annual breeding pairs (N_{BP}); and the proportion of adults breeding (P_B). CSP research response: M-R = Mark-recapture study to estimate demographic parameters including S_A; Pop Est = total population estimate; Monitor = routine monitoring of population trend; Track = collecting spatial tracking information; Taxonomy = requires taxonomic investigation. Y = yes (required). I = investigate feasibility. P = pending completion of current research projects. Taxa in bold have been assessed by quantitative modelling (Table 4). * Uncertainty around risk ratio parameters is assessed at species level

Common name	RiskC V	Risk parameter								CSP research response				
		TW L	BLL	SLL	SN	A	S _A	N _{BP}	P _B	M-R	Pop Est	Monitor	Track	Taxonom y
Black petrel	0.36	0	0	0	0	0	0	33	0		Y	Y		
Salvin's albatross	0.19	26	5	4	4	10	14	0	0	Y		Y	Y	
Flesh-footed shearwater	0.29	36	2	2	2	6	0	0	1			Y	P	
Westland petrel	0.50	52	4	1	0	1	0	1	0			Y		
Southern Buller's albatross	0.29	24	1	1	0	3	15	7	2	Y		Y		
Chatham Island albatross	0.33	12	28	3	1	2	0	9	2			Y		
New Zealand white-capped albatross	0.27	33	3	2	3	4	15	3	4	Y		Y	P	
Gibson's albatross	0.30	5	5	28	4	1	10	4	7	Y		Y		
Northern Buller's albatross	0.28	7	3	4	0	2	19	8	2	P		Y		P
Antipodean albatross	0.31	11	4	29	1	1	1	9	4			Y		
Yellow-eyed penguin (mainland)	0.50	15	9	3	28	2	1	1	3			Y		
Otago shag	0.37	50	11	8	11	5	7	4	4			Y	Y	
Northern giant petrel	0.79	24	17	1	3	3	18	5	2	I		Y	Y	
Spotted shag	0.45	19	4	5	6	1	0	31	0		Y			Y
Yellow-eyed penguin	0.49	14	11	2	29	2	0	4	2					
Campbell black-browed albatross	0.49	19	5	5	0	0	0	27	0		Y			
Northern royal albatross	0.82	39	13	3	3	1	9	17	2		Y			
White-chinned petrel	0.27	9	6	2	2	9	11	19	6	Y	Y			P
Foveaux shag	0.50	58	4	6	7	2	1	6	0				Y	
Chatham petrel	0.00													
Chatham Island taiko	0.00													
Grey petrel	0.40	17	9	4	0	0	0	21	0		Y			
Southern royal albatross	0.54	41	11	11	3	1	7	3	5				P	
Snares Cape petrel	1.32	54	2	1	0	2	15	25	10	I	Y		Y	
Little black shag	1.12	12	11	0	29	0	1	12	5		Y			
Fiordland crested penguin	1.74	2	66	2	0	4	0	25	21	I	Y		Y	
Grey-headed albatross	1.73	54	16	9	3	0	4	14	1		Y			
Light-mantled sooty albatross	1.41	61	12	2	0	2	0	0	0				Y	
New Zealand white-faced storm petrel	0.93	22	21	0	0	0	0	24	2		Y			
North Island Little shearwater	0.63	13	42	3	2	0	2	11	0		Y			
Chatham Island shag	2.10	4	90	2	0	0	5	0	0			Y	Y	
New Zealand king shag	1.70	20	26	0	3	0	0	0	0			Y	Y	
New Zealand storm petrel	7.46	75	5	12	0	0	0	54	0		Y	Y	Y	
Pitt Island shag	2.34	0	91	0	0	0	0	0	8			Y	Y	
Pycroft's petrel	3.69	94	2	2	1	0	8	9	4					

DRAFT

Table 4. Level 3 Risk Assessments

Species	Citation and Link
Black petrel	<p data-bbox="553 217 2007 284">Bell, E.A., Sim, J.L., Scofield, P., Francis, C. 2011b: Population parameters of the black petrels (<i>Procellaria parkinsoni</i>) on Great Barrier Island (Aotea Island), 2009/10. Research report for Department of Conservation, Wellington</p> <p data-bbox="553 306 2033 373">Francis, R.I.C.C.; Bell, E.A. 2010: Fisheries risks to the population viability of black petrel (<i>Procellaria parkinsoni</i>). New Zealand Aquatic Environment and Biodiversity Report No. 51. Ministry of Agriculture and Forestry, Wellington.</p>
Southern Buller's albatross	<p data-bbox="553 392 1957 459">Francis, R.I.C.C. & Sagar, P.M. 2011: Modelling the effect of fishing on southern Buller's albatross using a 60-year dataset. New Zealand Journal of Zoology, DOI:10.1080/03014223.2011.600766</p> <p data-bbox="553 472 1951 539">Fu, D.; Sagar, P. (2016). The 2014 demographic assessment of the Snares Islands population of Southern Buller's albatross (<i>Diomedea bulleri bulleri</i>). New Zealand Aquatic Environment and Biodiversity Report No. 165. 40 p.</p>
Gibson's albatross	<p data-bbox="553 560 1995 627">Francis, R.I.C.C., Elliot, G., Walker, K. 2013: Fisheries risk to the viability of Gibson's wandering albatross <i>Diomedea gibsoni</i>. New Zealand Aquatic Environment and Biodiversity Report. No 152. 48p.</p>
White-capped albatross	<p data-bbox="553 647 2029 715">Francis, R.I.C.C. 2012: Fisheries Risks to the Population Viability of White-capped Albatross <i>Thalassarche steadi</i>. New Zealand Aquatic Environment and Biodiversity Report. No. 104. 24 p.</p>
Antipodean albatross	<p data-bbox="553 735 1167 767">[Edwards et al Antipodean albatross assessment]</p>

Table 5. Five year CSP seabird research plan. M-R study = Mark-recapture study to estimate demographic parameters including S_A ; Pop est = population estimate; Track = spatial tracking project; Taxonomy = requires taxonomic investigation; Antip = Antipodes Island; Auck Is = Auckland Islands; Bounty = Bounty Islands; Campbell = Campbell Island; Chat = Chatham Islands; GBI = Great Barrier Island; LBI = Little Barrier Island; Snares = The Snares. * = dependent upon findings of modelling underway as of Feb 2016.

Common name	2017/18	2018/19	2019/20	2020/21	2021/22
Black petrel	Review M-R response	Pop est GBI, LBI			
Salvin's albatross	Pop est & Track Bounty	Pop est & Track Bounty Pop est Snares			Pop est Snares
Flesh-footed shearwater	M-R study	Review M-R response			Pop est various
Westland petrel		Pop est mainland			
Southern Buller's albatross	M-R study Snares	Review M-R response Pop est Snares			Pop est Snares
Chatham Island albatross			Pop est Chat		
New Zealand white-capped albatross	M-R study Auk Is	Review M-R study	Pop est Auck Is		
Gibson's albatross	M-R study Auck Is	Review M-R study	Pop est Auck Is	Pop est Auck Is	
Northern Buller's albatross			Pop est Chat		
Antipodean albatross	M-R study*	Review M-R study* Track and pop est Antip			Pop est Antip
Yellow-eyed penguin (mainland)		Pop est mainland			
Otago shag		Pop est & Track mainland		Pop est mainland	
Northern giant petrel	Pop est Campbell	Pop est Auck Is Pop est Antip	Pop est Chat	Pop est Campbell	Pop est Antip
Spotted shag		Pop est & taxonomy review year 1	Pop est & taxonomy review year 2		
Campbell black-browed albatross	Pop est Campbell			Pop est Campbell	
Northern royal albatross			Pop est Chat		
White-chinned petrel	M-R study Auck Is Pop est Campbell	M-R study Auck Is Pop est Auck Is Pop est Antip		Pop est Campbell	Pop est Antip
Foveaux shag		Track mainland			
Grey petrel					Pop est Antip
Snares Cape petrel		Pop est & Track Snares Investigate M-R study	Pop est & Track Snares		
Little black shag				Pop est mainland	
Fiordland crested penguin				Pop est & Track mainland Investigate M-R study	
Grey-headed albatross	Pop est Campbell				
Light-mantled sooty albatross	Trial tracking Campbell				
New Zealand white-faced storm petrel			Pop est Chat	Pop est mainland	
North Island little shearwater				Pop est mainland	
Chatham Island shag			Pop est & Track Chat		
New Zealand king shag			Pop est & Track mainland		
New Zealand storm petrel				Pop est & Track LBI	
Pitt Island shag			Pop est & Track Chat		

Tables 6a - 6d. Breakdown of risk ratio by fishery targets for (a) trawl, (b) bottom long line, (c) surface long line, and (d) set net fisheries. Coefficient of variation (CV) of risk ratio is included. For each species, the overall ranking of impact by fishery target is indicated by colour (red = highest, green = lowest). For species where no information is collected for that fishing method, all cells are orange.

Table 6a. Observer priorities in trawl fisheries

Common name	Risk CV	Deepwater trawl	Flatfish trawl	Hake trawl	Hoki trawl	Inshore trawl	Jack mackerel trawl	Ling trawl	Middle depth trawl	SBW trawl	Scampi trawl	Squid trawl
Salvin's albatross	0.19	0.0220	0.0280	0.0040	0.1200	0.2980	0.0000	0.0110	0.0850	0.0090	0.0770	0.0020
Flesh-footed shearwater	0.29	0.0010	0.0080	0.0000	0.0080	0.2860	0.0000	0.0020	0.0090	0.0000	0.0320	0.0000
Westland petrel	0.50	0.0000	0.0470	0.0080	0.0680	0.1465	0.0000	0.0040	0.0310	0.0000	0.0000	0.0000
Southern Buller's albatross	0.29	0.0010	0.0120	0.0060	0.1440	0.0260	0.0020	0.0050	0.0440	0.0000	0.0070	0.0480
Chatham Island albatross	0.33	0.0600	0.0000	0.0000	0.0150	0.0050	0.0000	0.0000	0.0050	0.0000	0.0020	0.0000
NZ white-capped albatross	0.27	0.0000	0.0530	0.0040	0.0420	0.1530	0.0010	0.0060	0.0320	0.0000	0.0080	0.0280
Antipodean albatross	0.31	0.0020	0.0000	0.0000	0.0000	0.0030	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Yellow-eyed penguin (mainland)	0.50	0.0000	0.0030	0.0000	0.0000	0.0030	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Otago shag	0.37	0.0000	0.1310	0.0000	0.0000	0.0110	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Northern giant petrel	0.79	0.0050	0.0000	0.0000	0.0300	0.0040	0.0000	0.0000	0.0080	0.0000	0.0080	0.0000
Spotted shag	0.45	0.0000	0.0630	0.0000	0.0000	0.0190	0.0000	0.0000	0.0020	0.0000	0.0000	0.0000
Yellow-eyed penguin	0.49	0.0000	0.0030	0.0000	0.0000	0.0030	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Campbell black-browed albatross	0.49	0.0000	0.0020	0.0000	0.0100	0.0030	0.0000	0.0010	0.0030	0.0020	0.0030	0.0000
Northern royal albatross	0.82	0.0010	0.0020	0.0000	0.0020	0.0040	0.0000	0.0000	0.0010	0.0000	0.0000	0.0010
Foveaux shag	0.50	0.0000	0.0320	0.0000	0.0000	0.0030	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Grey petrel	0.40	0.0000	0.0010	0.0000	0.0010	0.0020	0.0000	0.0000	0.0000	0.0060	0.0000	0.0000
Southern royal albatross	0.54	0.0000	0.0000	0.0000	0.0010	0.0010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010
Snares Cape petrel	1.32	0.0000	0.0000	0.0010	0.0020	0.0000	0.0000	0.0010	0.0010	0.0000	0.0000	0.0000

Table 6b. Observer priorities in bottom long line (BLL) fisheries.

Common name	CV	Bluenose BLL	Hapuka BLL	Large ling BLL	Minor BLL	Small ling BLL	Snapper BLL
Chatham Island albatross	0.33	0.0000	0.0060	0.0090	0.0080	0.2025	0.0000
Otago shag	0.37	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Northern giant petrel	0.79	0.0000	0.0160	0.0000	0.0070	0.0000	0.0050
Yellow-eyed penguin	0.49	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Northern royal albatross	0.82	0.0000	0.0000	0.0010	0.0000	0.0060	0.0000
Southern royal albatross	0.54	0.0000	0.0000	0.0010	0.0000	0.0010	0.0000

Table 6c. Observer priorities in surface long line (SLL) fisheries.

Common name	CV	Albacore SLL	Bigeye SLL	Large STN SLL	Minor surface SLL	Small STN SLL	Swordfish SLL
Gibson's albatross	0.30	0.0000	0.0360	0.0000	0.0000	0.0730	0.1930
Antipodean albatross	0.31	0.0000	0.0240	0.0000	0.0000	0.0470	0.0980
Southern royal albatross	0.54	0.0000	0.0020	0.0000	0.0000	0.0030	0.0000

Table 6d. Observer priorities in set net (SN) fisheries.

Common name	CV	Flatfish SN	Grey mullet SN	Minor SN	Shark SN
Otago shag	0.37	0.0000	0.0000	0.0000	0.0000
Yellow-eyed penguin	0.49	0.0060	0.0000	0.0100	0.0410

Table 7. Risk ratio broken down by fishery for species identified with low through very high L2 risk for aid in prioritisation of mitigation efforts.

Common Name	Deepwater trawl	Flatfish trawl	Hake trawl	Hoki trawl	Inshore trawl	Jack mackerel trawl	Ling trawl	Middle depth trawl	SBW trawl	Scampi trawl	Squid trawl
Black petrel	0.0020	0.0000	0.0000	0.0090	0.2020	0.0000	0.0000	0.0070	0.0000	0.0110	0.0000
Salvin's albatross	0.0220	0.0280	0.0040	0.1200	0.2980	0.0000	0.0110	0.0850	0.0090	0.0770	0.0020
Flesh-footed shearwater	0.0010	0.0080	0.0000	0.0080	0.2860	0.0000	0.0020	0.0090	0.0000	0.0320	0.0000
Westland petrel	0.0000	0.0470	0.0080	0.0680	0.1465	0.0000	0.0040	0.0310	0.0000	0.0000	0.0000
Southern Buller's albatross	0.0010	0.0120	0.0060	0.1440	0.0260	0.0020	0.0050	0.0440	0.0000	0.0070	0.0480
Chatham Island albatross	0.0600	0.0000	0.0000	0.0150	0.0050	0.0000	0.0000	0.0050	0.0000	0.0020	0.0000
New Zealand white-capped albatross	0.0000	0.0530	0.0040	0.0420	0.1530	0.0010	0.0060	0.0320	0.0000	0.0080	0.0280
Gibson's albatross	0.0020	0.0000	0.0000	0.0000	0.0040	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Northern Buller's albatross	0.0020	0.0000	0.0000	0.0330	0.0120	0.0000	0.0000	0.0150	0.0000	0.0300	0.0000
Antipodean albatross	0.0020	0.0000	0.0000	0.0000	0.0030	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Yellow-eyed penguin (mainland)	0.0000	0.0030	0.0000	0.0000	0.0030	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Otago shag	0.0000	0.1310	0.0000	0.0000	0.0110	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Foveaux shag	0.0000	0.0320	0.0000	0.0000	0.0030	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Northern giant petrel	0.0050	0.0000	0.0000	0.0300	0.0040	0.0000	0.0000	0.0080	0.0000	0.0080	0.0000
Spotted shag	0.0000	0.0630	0.0000	0.0000	0.0190	0.0000	0.0000	0.0020	0.0000	0.0000	0.0000
Yellow-eyed penguin	0.0000	0.0030	0.0000	0.0000	0.0030	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Campbell black-browed albatross	0.0000	0.0020	0.0000	0.0100	0.0030	0.0000	0.0010	0.0030	0.0020	0.0030	0.0000
Northern royal albatross	0.0010	0.0020	0.0000	0.0020	0.0040	0.0000	0.0000	0.0010	0.0000	0.0000	0.0010
White-chinned petrel	0.0000	0.0010	0.0000	0.0060	0.0010	0.0000	0.0000	0.0010	0.0000	0.0060	0.0090
Northern royal albatross	0.0010	0.0020	0.0000	0.0020	0.0040	0.0000	0.0000	0.0010	0.0000	0.0000	0.0010
Foveaux shag	0.0000	0.0320	0.0000	0.0000	0.0030	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Grey petrel	0.0000	0.0010	0.0000	0.0010	0.0020	0.0000	0.0000	0.0000	0.0060	0.0000	0.0000
Southern royal albatross	0.0000	0.0000	0.0000	0.0010	0.0010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010
Snares Cape petrel	0.0000	0.0000	0.0010	0.0020	0.0000	0.0000	0.0010	0.0010	0.0000	0.0000	0.0000

Table 7 (continued)

Common Name	Bluenose BLL	Hapuka BLL	Large ling BLL	Minor BLL	Small ling BLL	Snapper BLL	Large SLL	Small SLL	Swordfish SLL	Setnet
Black petrel	0.1840	0.0620	0.0000	0.0350	0.0000	0.2180	0.0000	0.2890	0.0260	0.0000
Salvin's albatross	0.0000	0.0020	0.0020	0.0050	0.0880	0.0000	0.0000	0.0040	0.0000	0.0000
Flesh-footed shearwater	0.0010	0.0380	0.0000	0.0410	0.0010	0.1850	0.0000	0.0180	0.0050	0.0075
Westland petrel	0.0000	0.0090	0.0000	0.0100	0.0220	0.0000	0.0000	0.0470	0.0030	0.0150
Southern Buller's albatross	0.0010	0.0010	0.0030	0.0010	0.0170	0.0000	0.0140	0.0400	0.0000	0.0000
Chatham Island albatross	0.0000	0.0060	0.0090	0.0080	0.2025	0.0000	0.0000	0.0000	0.0000	0.0000
NZ white-capped albatross	0.0000	0.0000	0.0000	0.0000	0.0030	0.0000	0.0010	0.0150	0.0010	0.0000
Gibson's albatross	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1090	0.1930	0.0000
Northern Buller's albatross	0.0030	0.0040	0.0030	0.0030	0.0210	0.0010	0.0000	0.1030	0.0010	0.0000
Antipodean albatross	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0710	0.0980	0.0000
Yellow-eyed penguin (mainland)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0570
Otago shag	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Northern giant petrel	0.0000	0.0160	0.0000	0.0070	0.0000	0.0050	0.0000	0.0000	0.0000	0.0000
Spotted shag	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0050
Yellow-eyed penguin	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0250	0.0040	0.0000
Campbell black-browed albatross	0.0030	0.0020	0.0010	0.0020	0.0010	0.0000	0.0000	0.0010	0.0020	0.0000
Northern royal albatross	0.0000	0.0000	0.0010	0.0000	0.0060	0.0000	0.0000	0.0000	0.0000	0.0000
White-chinned petrel	0.0000	0.0000	0.0050	0.0010	0.0180	0.0000	0.0000	0.0060	0.0000	0.0000
Foveaux shag	0.0000	0.0160	0.0000	0.0070	0.0000	0.0050	0.0000	0.0000	0.0000	0.0000
Grey petrel	0.0000	0.0000	0.0020	0.0000	0.0100	0.0000	0.0000	0.0080	0.0020	0.0000
Southern royal albatross	0.0000	0.0000	0.0010	0.0000	0.0010	0.0000	0.0000	0.0050	0.0000	0.0000