Conservation Services Programme

DRAFT

Seabird Medium-Term Research Plan

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).

This CSP seabird medium term research plan (CSP seabird plan) 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 – 2020 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 Richard et al (2020) and any future updates of that approach. Richard et al (2020) 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 Richard et al (2020).

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 Richard et al (2020), 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 seabird taxa that have a mean risk ratio exceeding 0.01 (see Richard et al 2020). Table 2 also identifies risk from commercial fisheries other than those considered by Richard et al (2020), where the risk for any seabird taxon was found to be moderate or higher by Rowe (2013).

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 2016) 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 Richard et al (2020) for the seabird taxa with low or high risk scores 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 Richard et al (2020), 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 Richard et al (2020) 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 according the methods of Richard et al (2020), or for species where the risk assessment may be under-estimated; and

- routine population monitoring for all seabird taxa at moderate or higher relative risk from fisheries other than those assessed by Richard et al (2020) (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;

- 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 three to five-year intervals, or annually for species demonstrating a decline in population or of particular concern;

- 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 (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 ≥ 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 Richard et al (2020). All fisheries from Rowe (2013) listed in Table 2, which were too information poor to be assessed by Richard et al (2020), 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 Richard et al (2020). 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

Fisheries New Zealand. 2020. *Aquatic Environment and Biodiversity Annual Review 2019–20*. Compiled by the Aquatic Environment Team, Fisheries Science and Information, Fisheries New Zealand, Wellington New Zealand. 765 p.

Richard, Y.; Abraham, E.R.; Berkenbusch, K. 2020. Assessment of the risk of commercial fisheries to New Zealand seabirds, 2006-07 to 2016-17. *New Zealand Aquatic Environment and Biodiversity Report 237*. 57 p.

Robertson, H.A.; Baird, K.; Dowding, J.E.; Elliott, G.P.; Hitchmough, R.A.; Miskelly, C.M.; McArthur, N.; O'Donnell, C.J.F.; Sagar, P.M.; Scofield, R.P.; Taylor, G.A. 2013. Conservation status of New Zealand birds, 2016. New Zealand Threat Classification Series 19. Department of Conservation, Wellington. 27 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.

Tables

Table 1. Guiding objectives (relevant to this plan).

Objective type	Objective		
NPOA-Seabirds Vision	New Zealanders work towards zero		
NPOA-Seabirds Goals	Avoiding Bycatch Effective bycatch mitigation practices are implemented in New Zealand fisheries	Healthy Seabird Populations Direct effects of New Zealand fishing do not threaten seabird populations or their recovery	Research and Information Information to effectively manage direct fisheries effects on seabirds is continuously improved
NPOA-Seabirds Objective	1. Ensure all New Zealand commercial fishers are using practices that best avoid the risk of seabird bycatch, enabled by appropriate regulations"	3. Research, monitoring and management actions are prioritised for seabird populations of particular concern10 and their risk11 ratios reduce 4. The number of fishing-related mortalities is decreasing towards zero	5. Research is undertaken to improve bycatch mitigation across sectors, especially where there are high bycatch rates and no known effective mitigation (note: mitigation may include spatial and temporal closures) 6. Monitoring programmes for New Zealand commercial fisheries are designed and implemented to provide statistically robust information to assess progress towards the NPOA Seabirds 2020's objectives 7. Observation and monitoring methods are researched, developed and implemented across all sectors 8. A research programme provides information to reduce uncertainty in estimates of risk to seabirds from fishing across all sectors
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– mean risk ratio (and risk category) based on Fisheries New Zealand (2020), risk value: VH = very high, H = high, M = medium, L = low, N = negligible; other fishery – fisheries other than those considered by Richard et al (2020) which pose moderate or higher risk; L1 risk – Rowe (2013); IUCN Threat – IUCN Red List 2020; NZ Threat – T = Threatened, AR = At Risk, NT = Not Threatened Robertson et al (2016). * = assessed at species level. Taxa in bold have been assessed by quantitative modelling (Table 4).

Common name	Scientific name	L2 risk	Other fishery	L1 risk	IUCN Threat status	NZ Threat status
Black petrel	*Procellaria parkinsoni*	1.23 (VH)	Hand line Purse seine light Troll	Moderate Moderate Moderate	Vulnerable	T Vulnerable
Salvin's albatross	*Thalassarche salvini*	0.65 (H)			Vulnerable	T Critical
Westland petrel	*Procellaria westlandica*	0.54 (H)			Endangered	AR Uncommon
Flesh-footed shearwater	*Puffinus carneipes*	0.49 (H)	Hand line Purse seine light	Moderate Moderate	Near threatened	T Vulnerable
Southern Buller's albatross	*Thalassarche bulleri bulleri*	0.37 (H)			Near threatened*	AR Uncommon
Gibson's albatross	*Diomedea antipodensis gibsoni*	0.31 (H)			Endangered *	T Critical
New Zealand white-capped albatross	*Thalassarche steadi*	0.29 (M)			Near threatened	AR Declining
Chatham Island albatross	*Thalassarche eremite*	0.28 (M)			Vulnerable	AR Uncommon
Northern Buller's albatross	*Thalassarche bulleri platei*	0.27 (M)			Near threatened*	AR Uncommon
Yellow-eyed penguin (mainland)	*Megadyptes antipodes*	0.17 (M)			Endangered	T Endangered*
Antipodean albatross	*Diomedea antipodensis antipodensis*	0.17 (M)			Endangered *	T Critical
Northern giant petrel	*Macronectes halli*	0.15 (M)			Least concern	AR Recovering
Otago shag	*Leucocarbo chalconotus,*	0.13 (M)			Vulnerable *	AR Recovering
Spotted shag	*Stictocarbo punctatus*	0.09 (L)			Least concern	NT
Yellow-eyed penguin	*Megadyptes antipodes*	0.07 (L)			Endangered	T Endangered
White-chinned petrel	*Procellaria aequinoctialis*	0.07 (L)			Vulnerable	NT
Campbell black-browed albatross	*Thalassarche impavida*	0.06 (L)			Vulnerable	T Vulnerable
Northern royal albatross	*Diomedea sanfordi*	0.05 (L)			Endangered	AR Uncommon
Foveaux shag	*Leucocarbo stewarti*	0.03 (N)			Vulnerable *	T Vulnerable
Grey petrel	*Procellaria cinerea*	0.02 (N)			Near threatened	AR Uncommon
Southern royal albatross	*Diomedea epomophora epomophora*	0.02 (N)			Vulnerable	AR Uncommon
Snares Cape petrel	*Daption capense austral*	0.01 (N)			Least concern *	AR Uncommon
Fluttering shearwater	*Puffinus gavia*	0.01 (N)			Least concern	AR Relict
Northern little penguin	*Eudyptula minor iredalei*	0.01 (N)			Least concern *	AR Declining
White-flippered little penguin	*Eudyptula minor albosignata*	0.01 (N)			Least concern *	AR Declining
Little black shag	*Phalacrocorax sulcirostris*	0.01 (N)			Least concern	AR Uncommon
Pied shag	*Phalacrocorax varius varius*	0.01 (N)			Least concern	AR Recovering
Grey-headed albatross	*Thalassarche chrysostoma*	0.01 (N)			Endangered	T Vulnerable
New Zealand white-faced storm petrel	*Pelagodroma marina maoriana*	<0.01 (N)	Purse seine light	Moderate	Least concern *	AR Relict
North Island little shearwater	*Puffinus assimilis haurakiensis*	<0.01 (N)	Purse seine light	Moderate	Least concern*	AR Recovering
Chatham Island shag	*Leucocarbo onslowi*	<0.01 (N)	Trap & Pot	Moderate	Critically endangered	T Critical
New Zealand king shag	*Leucocarbo carunculatus*	<0.01 (N)	Trap & Pot	Moderate	Vulnerable	T Endangered
New Zealand storm petrel	*Pealeornis maoriana*	<0.01 (N)	Purse seine light	Extreme	Critically endangered	T Vulnerable
Pitt Island shag	*Stictocarbo featherstoni*	<0.01 (N)	Trap & Pot	High	Endangered	T Critical
Pycroft's petrel	*Pterodroma pycrofti*	<0.01 (N)	Purse seine light	Moderate	Vulnerable	AR Recovering

Table 3. Risk uncertainty due to underlying parameters and CSP research response for species at low or higher risk according to Fisheries New Zealand (2020). 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 et al (2020) 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 SA; 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	RiskCV	Risk parameter								CSP research response				
		TWL	BLL	SLL	SN	A	S_A	N_{BP}	P_B	M-R	Pop Est	Monitor	Track	Taxonomy
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	
Westland petrel	0.50	52	4	1	0	1	0	1	0			Y		
Flesh-footed shearwater	0.29	36	2	2	2	6	0	0	1			Y	P	
Southern Buller's albatross	0.29	24	1	1	0	3	15	7	2	Y		Y		
Gibson's albatross	0.30	5	5	28	4	1	10	4	7	Y		Y		
New Zealand white-capped albatross	0.27	33	3	2	3	4	15	3	4	Y		Y	P	
Chatham Island albatross	0.33	12	28	3	1	2	0	9	2			Y		
Northern Buller's albatross	0.28	7	3	4	0	2	19	8	2	P		Y		P
Yellow-eyed penguin (mainland)	0.50	15	9	3	28	2	1	1	3			Y		
Antipodean albatross	0.31	11	4	29	1	1	1	9	4			Y		
Northern giant petrel	0.79	24	17	1	3	3	18	5	2	I		Y	Y	
Otago shag	0.37	50	11	8	11	5	7	4	4			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					
White-chinned petrel	0.27	9	6	2	2	9	11	19	6	Y	Y			P
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		

Table 4. Level 3 Risk Assessments

Species	Citation and Link
Black petrel	Bell, E.A., Sim, J.L., Scofield, P., Francis, C. 2011b: Population parameters of the black petrels (Procellaria parkinsoni) on Great Barrier Island (Aotea Island), 2009/10. Research report for Department of Conservation, Wellington
	Francis, R.I.C.C.; Bell, E.A. 2010: Fisheries risks to the population viability of black petrel (Procellaria parkinsoni). New Zealand Aquatic Environment and Biodiversity Report No. 51. Ministry of Agriculture and Forestry, Wellington.
Southern Buller's albatross	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 Fu, D.; Sagar, P. (2016). The 2014 demographic assessment of the Snares Islands population of Southern Buller's albatross (*Diomedea bulleri bulleri*). New Zealand Aquatic Environment and Biodiversity Report No. 165. 40 p.
Gibson's albatross	Francis, R.I.C.C., Elliot, G., Walker, K. 2013: Fisheries risk to the viability of Gibson's wandering albatross *Diomedea gibsoni*. New Zealand Aquatic Environment and Biodiversity Report. No 152. 48p.
White-capped albatross	Francis, R.I.C.C. 2012: Fisheries Risks to the Population Viability of White-capped Albatross *Thalassarche steadi*. New Zealand Aquatic Environment and Biodiversity Report. No. 104. 24 p.
Antipodean albatross	Edwards, C.T.T.; Roberts, J.O.;Walker, K.; Elliott, G. 2017. Quantitative modelling of Antipodean wandering albatross. New Zealand Aquatic Environment and Biodiversity Report No. 180. 32 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.

Common name	2021/22	2022/23	2023/24	2024/25	2025/26	notes
Black petrel	At sea capture to supplement land-based M-R (pop est & juv survival)	Assess progress		Pop est LBI		M-R GBI under contract to FNZ
Salvin's albatross			Pop est Snares Track juveniles Est breeding success	Pop est Bounties		
Westland petrel	M-R at two sites Assess occupancy rate Track juv & adults	M-R at two sites Assess occupancy rate Track juv & adults	M-R at two sites	Review M-R		
Flesh-footed shearwater	M-R at two sites	M-R at two sites	M-R at two sites	Review M-R	Pop est at key sites	
Southern Buller's albatross	M-R and breeding success Analyse spatial data and breeding success	M-R Potential sat tracking	M-R Pop est Snares	Review M-R		GLS tracking underway and camera deployment planned Snares
Gibson's albatross	Pop est Adams Is M-R Sat tracking	Pop est Adams Is M-R	Pop est Disappointment M-R	Review M-R		
New Zealand white-capped albatross	M-R Pop est Auck Is	M-R data analysis review	Pop est Disappointment			
Chatham Island albatross				Pop est Chat		
Northern Buller's albatross	GLS retrieval and analysis Pop est Assess M-R options	Review dependent on 20/21				Monitoring and GLS tracking planned for 20/21
Yellow-eyed penguin (mainland)		Pop est mainland				
Antipodean albatross	Pop est Antip	Pop est Antip				
Northern giant petrel	Pop est Antip Tracking analysis Chat		Pop est Campbell			Pop est and sat tracking Chat planned for 20/21
Otago shag	Pop est mainland					Monitoring feasibility planned for 20/21
Spotted shag	Assess options for tracking northern pop		Pop est northern pop			Taxonomic work underway
White-chinned petrel	Pop est Antip	Comparative analysis of historic data	Pop est Campbell			
Campbell black-browed albatross			Pop est Campbell			

Table 5 (continued)

Common name	2021/22	2022/23	2023/24	2024/25	2025/26	notes
Northern royal albatross	Assess options for M-R Chat					Pop est and sat tracking Chat planned for 20/21
Foveaux shag	Pop est mainland					Monitoring feasibility planned for 20/21
Grey petrel		Pop est Antip				
Southern royal albatross	Pop est Campbell Sat track Campbell	Pop est Campbell				
New Zealand white-faced storm petrel			Spatial assessment of vessel impact risks	Pop est Chat		
North Island little shearwater					Pop est mainland	
Chatham Island shag				Pop est Chat		Pop est Chat underway
New Zealand king shag					Pop est mainland	Tracking and population studies underway
New Zealand storm petrel				Pop est and track LBI		
Pitt Island shag				Pop est Chat		Pop est Chat underway
Pycroft's petrel					Pop est key sites	

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 longline (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 longline (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 setnet (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	0.0000	0.0000	0.0570
Campbell black-browed albatross	0.0030	0.0020	0.0010	0.0020	0.0010	0.0000	0.0000	0.0250	0.0040	0.0000
Northern royal albatross	0.0000	0.0000	0.0010	0.0000	0.0060	0.0000	0.0000	0.0060	0.0000	0.0000
White-chinned petrel	0.0000	0.0000	0.0050	0.0010	0.0180	0.0000	0.0000	0.0010	0.0020	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	0.0000	0.0000	0.0000
Southern royal albatross	0.0000	0.0000	0.0010	0.0000	0.0010	0.0000	0.0000	0.0080	0.0020	0.0000