Ministry for Primary Industries
Manatū Ahu Matua

Assessment of the risk of commercial fisheries to New Zealand seabirds, 2006–07 to 2014–15: Supplementary information

New Zealand Aquatic Environment and Biodiversity Report 191S

Y. Richard
E.R. Abraham
K. Berkenbusch

ISSN 1179-6480 (online)
ISBN 978-1-77665-111-5 (online)

December 2017

New Zealand Government

Growing and Protecting New Zealand

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OVERVIEW

This supplementary information presents a summary of population and distributional data for the 71 taxa included in the risk assessment of the impact of fishing-related mortalities on seabirds breeding in the New Zealand region.

For each seabird taxon included in the risk assessment, the demographic parameters used were the New Zealand population size, the age at first reproduction, and the survival rate. These data are included here with an assigned index of quality (poor, medium, high). For species for which no demographic estimates were available, values from proxy species were used, as indicated with a reference to the data source. Distributional data are presented as maps of the at-sea distribution of each species, with separate maps for the non-breeding and breeding distributions. The distribution of non-breeders was derived from existing maps published by NABIS (National Aquatic Biodiversity Information System) and BirdLife International. A single distribution map was generated when the breeding season extended throughout the year. Included in the distributional maps are data of any incidental captures in commercial trawl, longline and set-net fisheries between the 2006–07 and 2014–15 fishing years, recorded by fisheries observers.

The derived parameters as used in the calculations for the risk assessment are also included. Included with each derived parameter is the density distribution, with the red line indicating the mean, and blue lines indicating the 2.5 and 97.5 percentiles. A detailed description of the methods used to derive the data presented here is provided in the main document.

1. SPECIES DATA

1.1 Gibson's albatross (*Diomedea antipodensis gibsoni*)

Table 1: Raw input data of population parameters of Gibson's albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment.

Parameter	Data	Reference	Quality
Population (NZ)	4 792 pairs [2014]	Elliott & Walker (2014), Baker & Jensz (2014)	High
Age at first reproduction	10 to 12 years	de L. Brooke (2004)	
Current survival rate	96 to 98 % [1997] 93.8 to 98.5 % [1996] 95.9 ± 0.6 % [2004]	Walker & Elliott (1999) Croxall & Gales (1998) Agreement on the Conservation of Albatrosses and Petrels (2010)	Medium
Optimal survival rate	96 to 98 % [1997] 93.8 to 98.5 % [1996] 95.9 ± 0.6 % [2004]	Walker & Elliott (1999) Croxall & Gales (1998) Agreement on the Conservation of Albatrosses and Petrels (2010)	Medium
Body mass	8 017 g	Myhrvold et al. (2015)	
Breeding period	All year	G. Taylor (pers. comm.)	

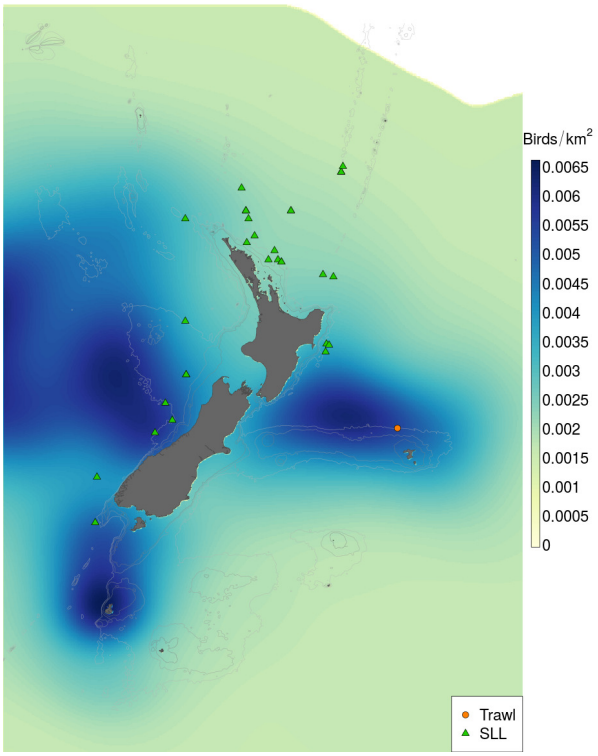
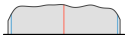
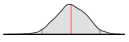
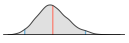


Figure 1: Relative density of Gibson's albatross (*Diomedea antipodensis gibsoni*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl and surface-longline (SLL) fisheries.

Table 2: Derived values of population parameters of Gibson's albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	11.0	10.1–12.0	Years	
Age at first reproduction (from allometric model)	11.1	9.2–13.2	Years	
Current adult annual survival rate (from raw input parameters)	96.2	93.9–98.4	%	
Optimal adult annual survival rate (from raw input parameters)	96.1	93.9–98.4	%	
Optimal adult annual survival rate (from allometric model)	95.9	94.6–97.0	%	
Proportion of adults breeding (from raw input parameters)	59.9	50.2–69.4	%	
Annual breeding pairs (from raw input parameters)	4 810	3 940–5 820	Pairs	
Total population size (from raw input parameters)	42 900	29 600–62 800	Individuals	
Maximum net productivity rate r_{max}	0.046	0.039–0.054		

1.2 Antipodean albatross (*Diomedea antipodensis antipodensis*)

Table 3: Raw input data of population parameters of Antipodean albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment.

Parameter	Data	Reference	Quality
Population (NZ)	3 320 pairs [2014]	G. Elliot (pers. comm.)	High
Age at first reproduction	10 to 13 years [1997]	Walker & Elliott (2002)	
Current survival rate	95.7 ± 0.7 % [2004]	Walker & Elliott (1999)	High
Optimal survival rate	95.7 ± 0.7 % [2004]	Walker & Elliott (1999)	High
Body mass	8 017 g	Myhrvold et al. (2015)	
Breeding period	All year	G. Taylor (pers. comm.)	

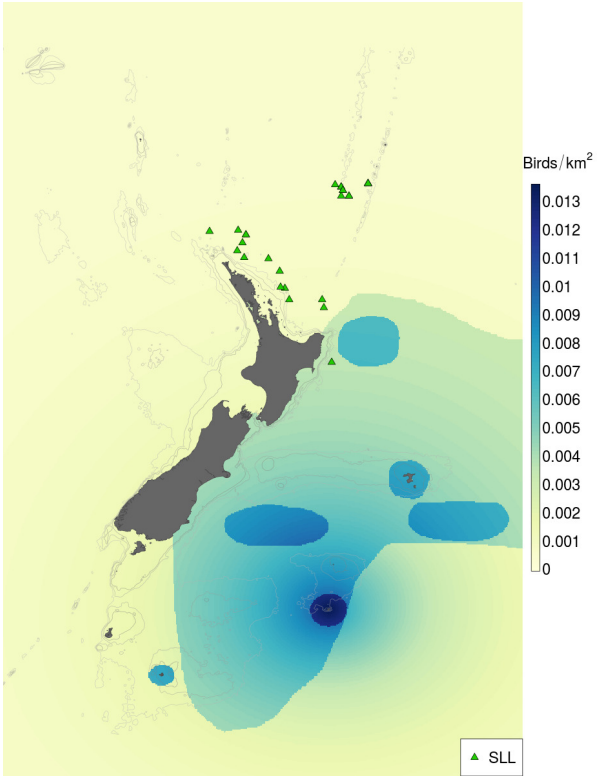
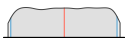
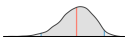
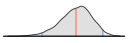
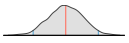
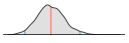
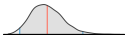


Figure 2: Relative density of Antipodean albatross (*Diomedea antipodensis antipodensis*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in surface-longline (SLL) fisheries.

Table 4: Derived values of population parameters of Antipodean albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	11.5	10.1–12.9	Years	
Age at first reproduction (from allometric model)	11.1	9.2–13.4	Years	
Current adult annual survival rate (from raw input parameters)	95.6	94.1–96.8	%	
Optimal adult annual survival rate (from raw input parameters)	95.6	94.1–96.9	%	
Optimal adult annual survival rate (from allometric model)	96.0	94.6–97.1	%	
Proportion of adults breeding (from raw input parameters)	59.9	50.4–69.4	%	
Annual breeding pairs (from raw input parameters)	3 330	2 690–4 040	Pairs	
Total population size (from raw input parameters)	31 500	22 900–42 600	Individuals	
Maximum net productivity rate r_{max}	0.046	0.039–0.055		

1.3 Southern royal albatross (*Diomedea epomophora*)

Table 5: Raw input data of population parameters of southern royal albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment.

Parameter	Data	Reference	Quality
Population (NZ)	7 886 pairs [2008]	Agreement on the Conservation of Albatrosses and Petrels (2010)	High
Age at first reproduction	8.5 to 10.6 years	Robertson (1993)	
Current survival rate	94.9 ± 0.8 % [2001]	Agreement on the Conservation of Albatrosses and Petrels (2010)	High
Optimal survival rate	94.9 ± 0.8 % [2001]	Agreement on the Conservation of Albatrosses and Petrels (2010)	High
Body mass	8 218 g	Myhrvold et al. (2015)	
Breeding period	All year	G. Taylor (pers. comm.)	

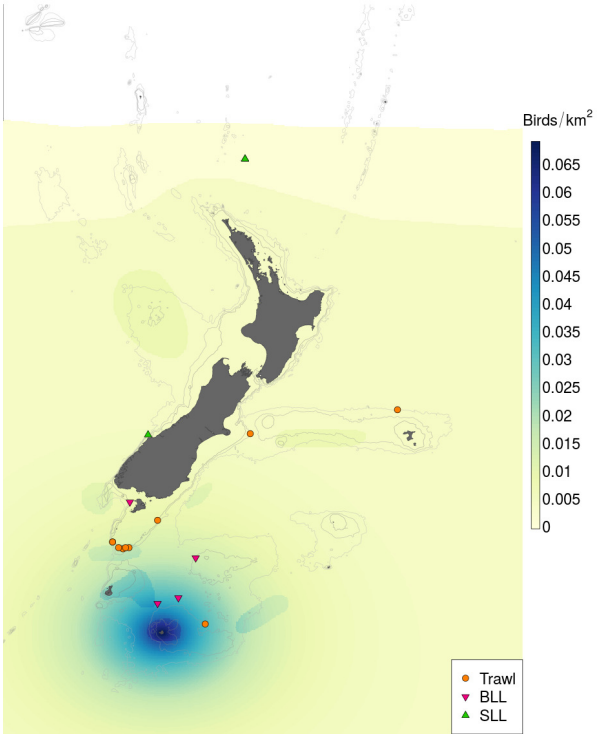
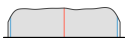
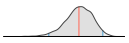
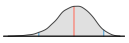
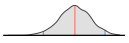
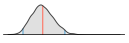
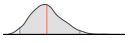


Figure 3: Relative density of southern royal albatross (*Diomedea epomophora*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), and bottom-longline (BLL) fisheries.

Table 6: Derived values of population parameters of southern royal albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	9.6	8.5–10.5	Years	
Age at first reproduction (from allometric model)	11.2	9.3–13.4	Years	
Current adult annual survival rate (from raw input parameters)	94.9	93.1–96.3	%	
Optimal adult annual survival rate (from raw input parameters)	94.9	93.2–96.3	%	
Optimal adult annual survival rate (from allometric model)	96.0	94.6–97.1	%	
Proportion of adults breeding (from raw input parameters)	60.0	50.2–69.5	%	
Annual breeding pairs (from raw input parameters)	7 930	6 540–9 490	Pairs	
Total population size (from raw input parameters)	73 800	54 100–98 000	Individuals	
Maximum net productivity rate r_{max}	0.046	0.039–0.054		

1.4 Northern royal albatross (*Diomedea sanfordi*)

Table 7: Raw input data of population parameters of northern royal albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment.

Parameter	Data	Reference	Quality
Population (NZ)	5 832 pairs [2003]	Agreement on the Conservation of Albatrosses and Petrels (2010)	
Age at first reproduction	8.5 to 10.6 years	Robertson (1993)	
Current survival rate	94.6 ± 1.5 % [1993]	Agreement on the Conservation of Albatrosses and Petrels (2010)	High
	95.2 % [1993]	Agreement on the Conservation of Albatrosses and Petrels (2010)	High
Optimal survival rate	94.6 ± 1.5 % [1993]	Agreement on the Conservation of Albatrosses and Petrels (2010)	High
	95.2 % [1993]	Agreement on the Conservation of Albatrosses and Petrels (2010)	High
Body mass	7 943 g	Myhrvold et al. (2015)	
Breeding period	All year	G. Taylor (pers. comm.)	

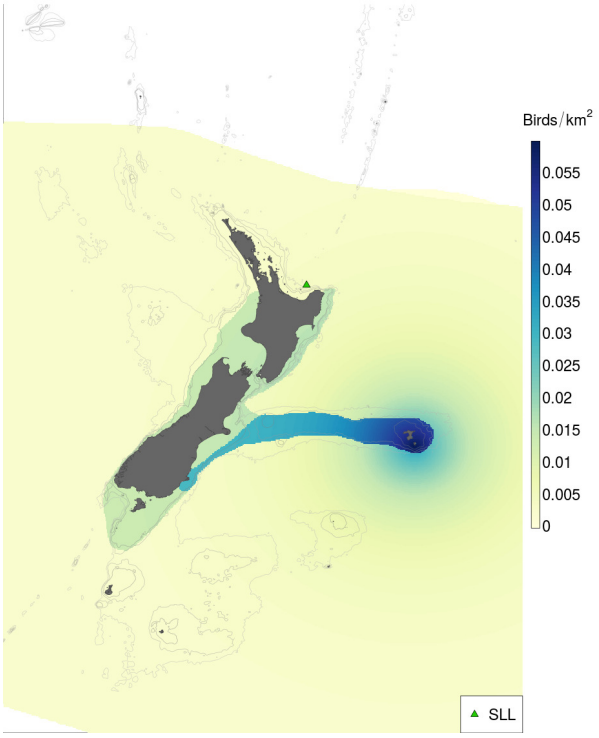
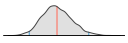
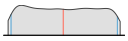
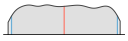
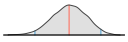
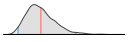
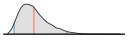


Figure 4: Relative density of northern royal albatross (*Diomedea sanfordi*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in surface-longline (SLL) fisheries.

Table 8: Derived values of population parameters of northern royal albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

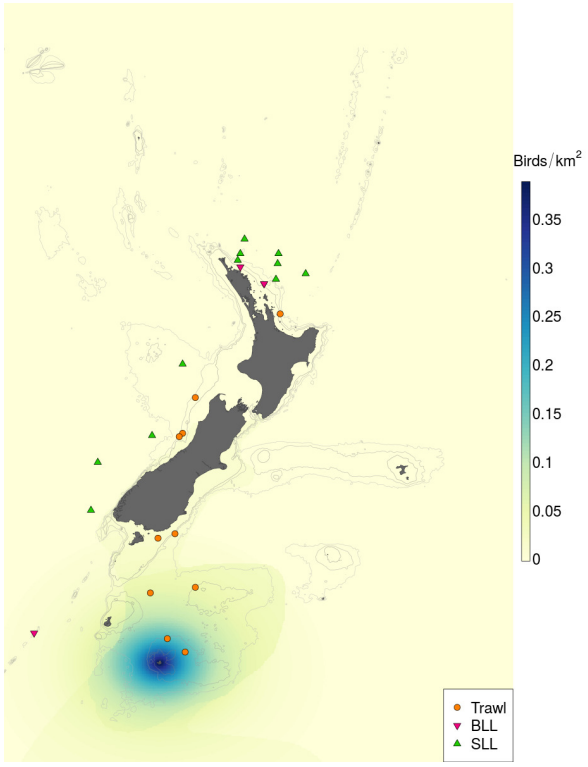
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	9.6	8.5–10.5	Years	
Age at first reproduction (from allometric model)	11.1	9.1–13.3	Years	
Current adult annual survival rate (from raw input parameters)	93.8	91.0–96.7	%	
Optimal adult annual survival rate (from raw input parameters)	93.8	91.0–96.7	%	
Optimal adult annual survival rate (from allometric model)	95.9	94.6–97.0	%	
Proportion of adults breeding (from raw input parameters)	60.9	51.0–70.0	%	
Annual breeding pairs (from raw input parameters)	6 050	3 190–10 500	Pairs	
Total population size (from raw input parameters)	61 800	30 400–114 000	Individuals	
Maximum net productivity rate r_{max}	0.046	0.039–0.055		

1.5 Campbell black-browed albatross (*Thalassarche impavida*)

Table 9: Raw input data of population parameters of Campbell black-browed albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	21 000 pairs [1998]	Agreement on the Conservation of Albatrosses and Petrels (2010)	
Age at first reproduction	10 (6–13) years [1995]	Waugh et al. (1999)	High
Current survival rate	94.5 ± 0.7 % [1996]	Agreement on the Conservation of Albatrosses and Petrels (2010)	
Optimal survival rate	94.5 ± 0.7 % [1996]	Agreement on the Conservation of Albatrosses and Petrels (2010)	
Body mass	3 479 g	Myhrvold et al. (2015)	
Breeding period	August–May	G. Taylor (pers. comm.)	
Relative non-breeding pop.	50%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

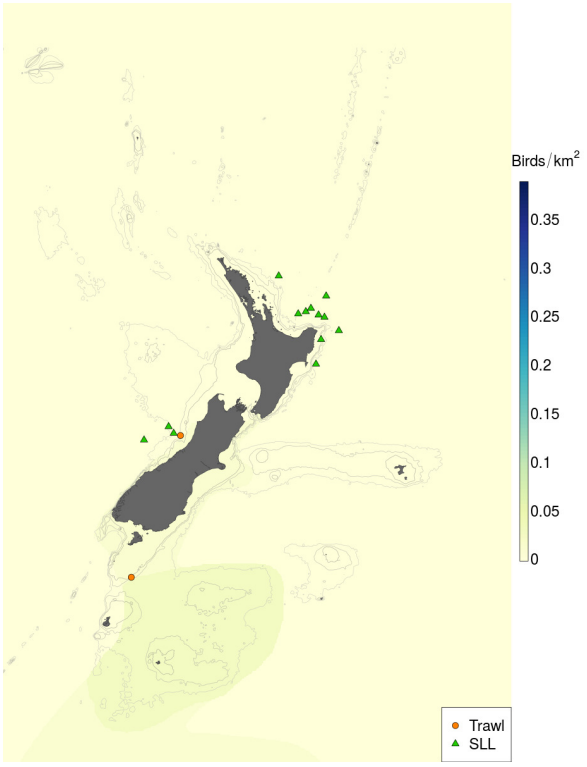
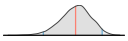
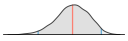
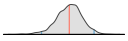
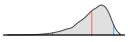
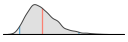
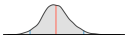


Figure 5: Relative density of Campbell black-browed albatross (*Thalassarche impavida*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), and bottom-longline (BLL) fisheries.

Table 10: Derived values of population parameters of Campbell black-browed albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	9.5	6.2–12.8	Years	
Age at first reproduction (from allometric model)	9.0	7.8–10.3	Years	
Current adult annual survival rate (from raw input parameters)	94.5	93.0–95.7	%	
Optimal adult annual survival rate (from raw input parameters)	94.4	92.9–95.7	%	
Optimal adult annual survival rate (from allometric model)	95.0	93.8–96.1	%	
Proportion of adults breeding (from raw input parameters)	88.9	75.3–96.4	%	
Annual breeding pairs (from raw input parameters)	22 000	11 800–38 300	Pairs	
Total population size (from raw input parameters)	136 000	70 700–246 000	Individuals	
Maximum net productivity rate r_{max}	0.058	0.051–0.066		

1.6 New Zealand white-capped albatross (*Thalassarche cauta steadi*)

Table 11: Raw input data of population parameters of New Zealand white-capped albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	95 701 (95% c.i.: 85 350 – 106 338) pairs	Richard et al. (2015)	High
Age at first reproduction	12 years [2011]	Southern Buller's albatross as proxy; Francis & Sagar (2012)	
Current survival rate	96 % [2011]	Francis (2012)	High
Optimal survival rate	96 % [2011]	Francis (2012)	High
Body mass	3 900 (3 400–4 400) g	Sagar (2013)	
Breeding period	November–August	G. Taylor (pers. comm.)	
Relative non-breeding pop.	50%	G. Taylor (pers. comm.)	

(a) Breeding season distribution **(b) Non-breeding season distribution**

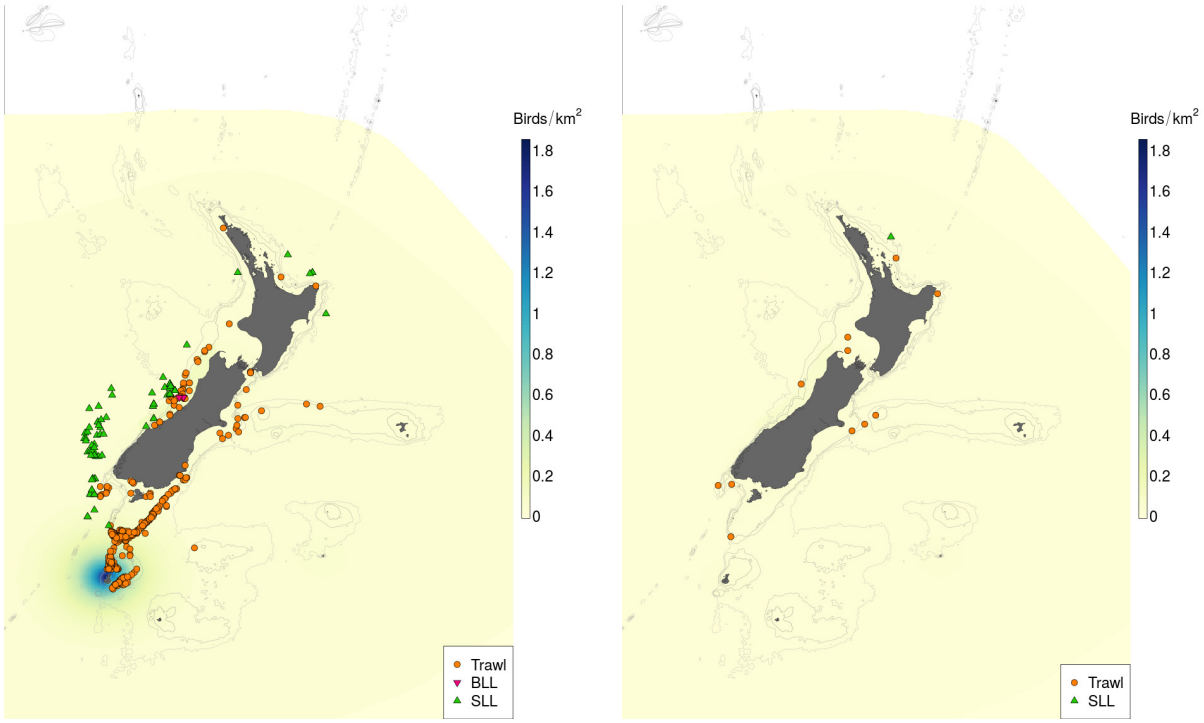
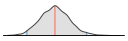
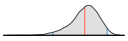
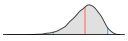
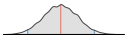
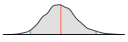


Figure 6: Relative density of New Zealand white-capped albatross (*Thalassarche cauta steadi*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), and bottom-longline (BLL) fisheries.

Table 12: Derived values of population parameters of New Zealand white-capped albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

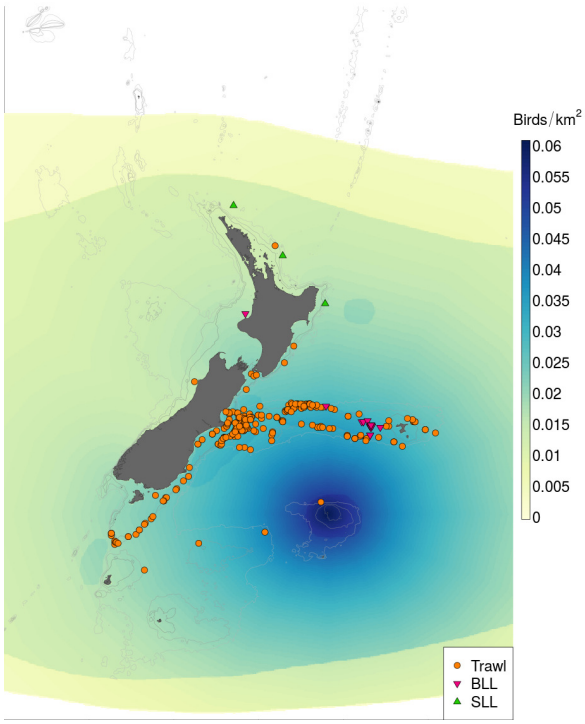
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	12.1	9.2–14.9	Years	
Age at first reproduction (from allometric model)	9.2	7.9–10.7	Years	
Current adult annual survival rate (from raw input parameters)	95.9	93.5–97.5	%	
Optimal adult annual survival rate (from raw input parameters)	95.9	93.6–97.5	%	
Optimal adult annual survival rate (from allometric model)	95.1	93.9–96.2	%	
Proportion of adults breeding (from raw input parameters)	67.7	57.5–76.8	%	
Annual breeding pairs (from raw input parameters)	95 700	85 400–106 000	Pairs	
Total population size (from raw input parameters)	775 000	563 000–1 080 000	Individuals	
Maximum net productivity rate r_{max}	0.056	0.049–0.065		

1.7 Salvin's albatross (*Thalassarche salvini*)

Table 13: Raw input data of population parameters of Salvin's albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population ()	41 004 to 41 958 pairs [2014]	Baker et al. (2014, 2015)	High
Age at first reproduction	12 years [2011]	Southern Buller's albatross as proxy; Francis & Sagar (2012)	
Current survival rate	96.7 % [2011]	Sagar et al. (2011)	High
Optimal survival rate	96.7 % [2011]	Sagar et al. (2011)	High
Body mass	3 874 g	Myhrvold et al. (2015)	
Breeding period	September–April	G. Taylor (pers. comm.)	
Relative non-breeding pop.	10%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

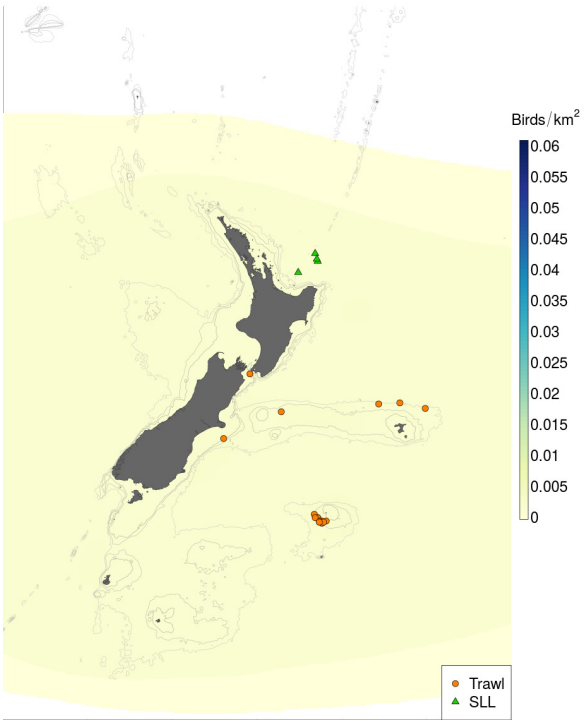
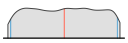
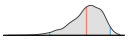
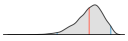
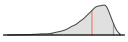
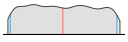
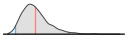


Figure 7: Relative density of Salvin's albatross (*Thalassarche salvini*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), and bottom-longline (BLL) fisheries.

Table 14: Derived values of population parameters of Salvin's albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	12.0	9.1–14.9	Years	
Age at first reproduction (from allometric model)	9.2	8.0–10.6	Years	
Current adult annual survival rate (from raw input parameters)	96.6	94.1–98.2	%	
Optimal adult annual survival rate (from raw input parameters)	96.6	94.1–98.2	%	
Optimal adult annual survival rate (from allometric model)	95.1	93.9–96.2	%	
Proportion of adults breeding (from raw input parameters)	89.0	75.2–96.4	%	
Annual breeding pairs (from raw input parameters)	41 500	41 000–41 900	Pairs	
Total population size (from raw input parameters)	255 000	202 000–344 000	Individuals	
Maximum net productivity rate r_{max}	0.056	0.049–0.065		

1.8 Chatham Island albatross (*Thalassarche eremita*)

Table 15: Raw input data of population parameters of Chatham Island albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population ()	5 245 pairs [2011]	Fraser et al. (2011)	High
Age at first reproduction	12 years [2011]	Southern Buller's albatross as proxy; Francis & Sagar (2012)	
Current survival rate	96.7 % [2011]	Salvin's albatross as proxy; Sagar et al. (2011)	
Optimal survival rate	96.7 % [2011]	Salvin's albatross as proxy; Sagar et al. (2011)	
Body mass	3 874 g	Myhrvold et al. (2015)	
Breeding period	August–May	G. Taylor (pers. comm.)	
Relative non-breeding pop.	2.5%	G. Taylor (pers. comm.)	

(a) Breeding season distribution **(b) Non-breeding season distribution**

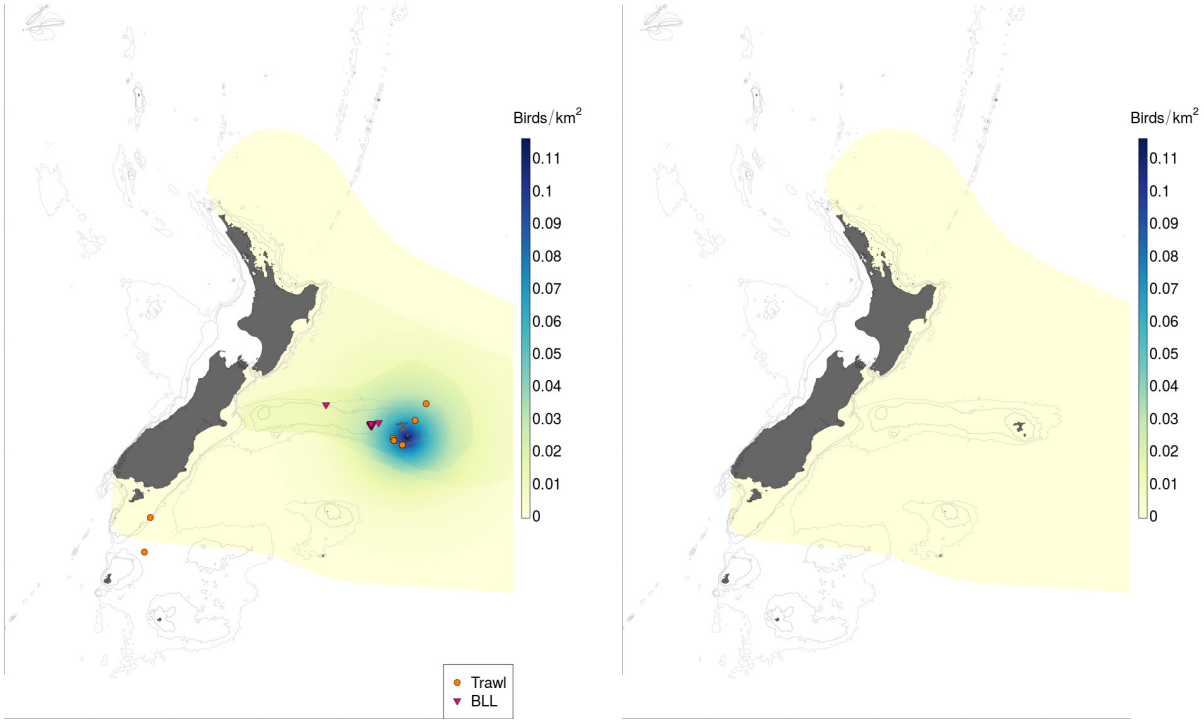
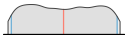
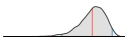
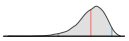
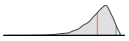
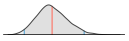
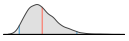


Figure 8: Relative density of Chatham Island albatross (*Thalassarche eremita*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl and bottom-longline (BLL) fisheries.

Table 16: Derived values of population parameters of Chatham Island albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	12.0	9.2–14.8	Years	
Age at first reproduction (from allometric model)	9.2	7.9–10.6	Years	
Current adult annual survival rate (from raw input parameters)	96.6	94.0–98.2	%	
Optimal adult annual survival rate (from raw input parameters)	96.6	94.1–98.2	%	
Optimal adult annual survival rate (from allometric model)	95.1	93.9–96.2	%	
Proportion of adults breeding (from raw input parameters)	88.8	74.7–96.5	%	
Annual breeding pairs (from raw input parameters)	5 280	4 300–6 400	Pairs	
Total population size (from raw input parameters)	30 100	21 600–43 000	Individuals	
Maximum net productivity rate r_{max}	0.056	0.049–0.064		

1.9 Grey-headed albatross (*Thalassarche chrysostoma*)

Table 17: Raw input data of population parameters of grey-headed albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	6 600 pairs [1997]	Agreement on the Conservation of Albatrosses and Petrels (2010)	
Age at first reproduction	7 to 13 years	Schreiber & Burger (2001)	
Current survival rate	95.3 ± 0.9 % ($N = 225$) [1996]	Waugh et al. (1999)	High
Optimal survival rate	95.3 ± 0.9 % ($N = 225$) [1996]	Waugh et al. (1999)	High
Body mass	3 792 g	Myhrvold et al. (2015)	
Breeding period	September–May	G. Taylor (pers. comm.)	
Relative non-breeding pop.	20%	G. Taylor (pers. comm.)	

(a) Breeding season distribution **(b) Non-breeding season distribution**

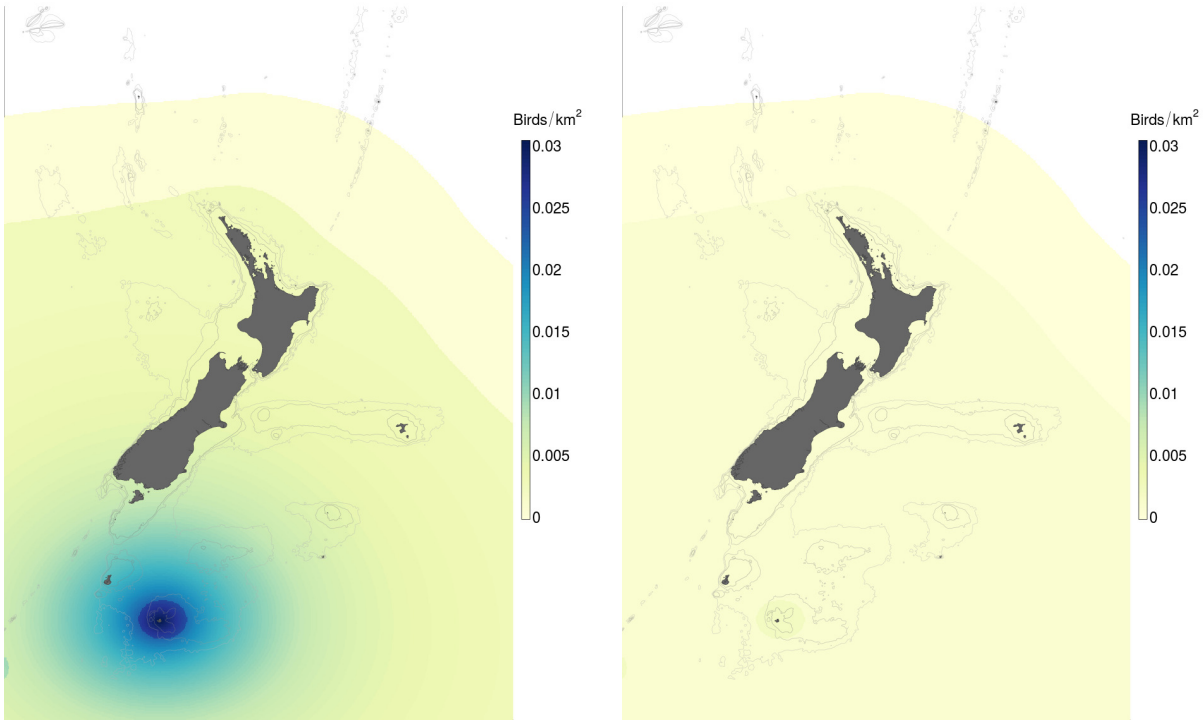
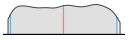
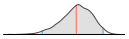
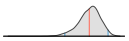
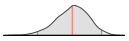
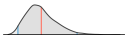


Figure 9: Relative density of grey-headed albatross (*Thalassarche chrysostoma*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 18: Derived values of population parameters of grey-headed albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

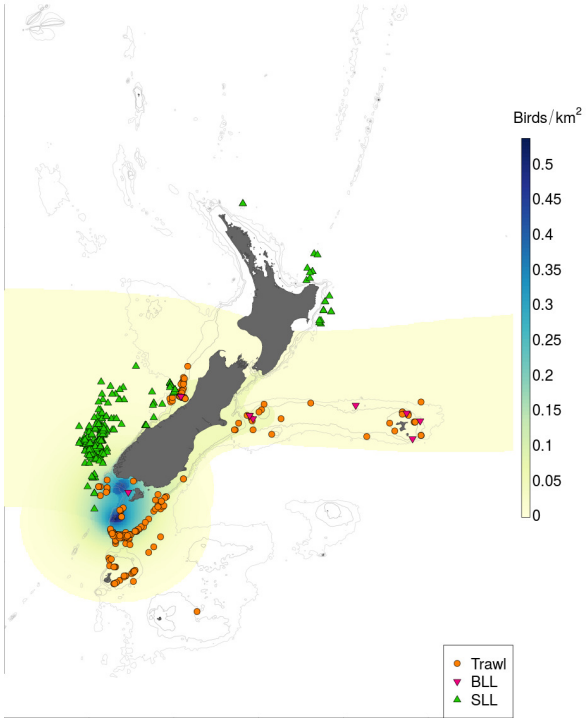
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	10.0	7.1–12.8	Years	
Age at first reproduction (from allometric model)	9.2	7.9–10.5	Years	
Current adult annual survival rate (from raw input parameters)	95.2	93.2–96.8	%	
Optimal adult annual survival rate (from raw input parameters)	95.2	93.1–96.8	%	
Optimal adult annual survival rate (from allometric model)	95.1	93.9–96.2	%	
Proportion of adults breeding (from raw input parameters)	74.8	64.0–83.8	%	
Annual breeding pairs (from raw input parameters)	6 900	3 710–11 800	Pairs	
Total population size (from raw input parameters)	49 000	25 400–86 700	Individuals	
Maximum net productivity rate r_{max}	0.057	0.050–0.065		

1.10 Southern Buller's albatross (*Thalassarche bulleri bulleri*)

Table 19: Raw input data of population parameters of southern Buller's albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	13 625 pairs [2002]	Sagar & Stahl (2005)	High
Age at first reproduction	12 years [2011]	Francis & Sagar (2012)	High
Current survival rate	93 to 98 % [2011]	Francis & Sagar (2012)	High
Optimal survival rate	93 to 98 % [2011]	Francis & Sagar (2012)	High
Body mass	2 837 g	Myhrvold et al. (2015)	
Breeding period	December–August	G. Taylor (pers. comm.)	
Relative non-breeding pop.	2.5%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

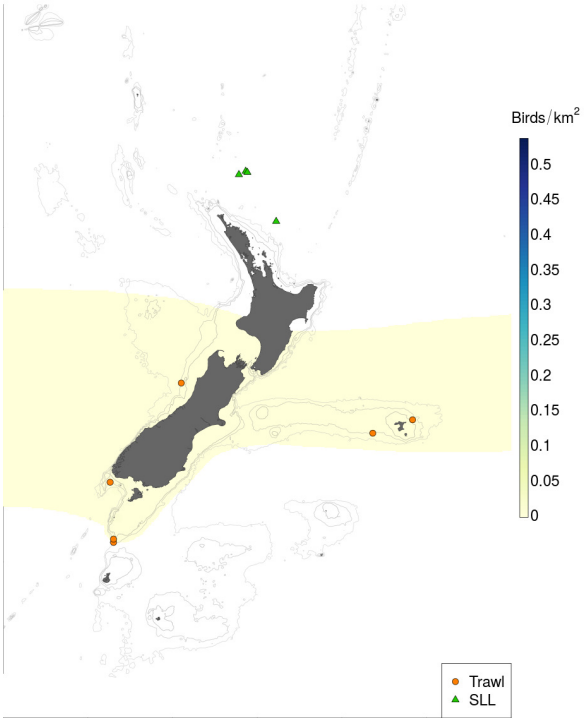
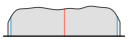
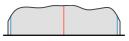
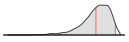
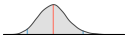


Figure 10: Relative density of southern Buller's albatross (*Thalassarche bulleri bulleri*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), and bottom-longline (BLL) fisheries.

Table 20: Derived values of population parameters of southern Buller's albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	12.0	9.2–14.8	Years	
Age at first reproduction (from allometric model)	8.5	7.5–9.6	Years	
Current adult annual survival rate (from raw input parameters)	95.5	93.1–97.9	%	
Optimal adult annual survival rate (from raw input parameters)	95.5	93.1–97.9	%	
Optimal adult annual survival rate (from allometric model)	94.7	93.4–95.8	%	
Proportion of adults breeding (from raw input parameters)	88.8	74.8–96.4	%	
Annual breeding pairs (from raw input parameters)	13 700	11 100–16 600	Pairs	
Total population size (from raw input parameters)	89 100	60 100–140 000	Individuals	
Maximum net productivity rate r_{max}	0.061	0.055–0.069		

1.11 Northern Buller's albatross (*Thalassarche bulleri platei*)

Table 21: Raw input data of population parameters of northern Buller's albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	16 346 pairs [2008]	Agreement on the Conservation of Albatrosses and Petrels (2010)	High
Age at first reproduction	12 years [2011]	Southern Buller's albatross as proxy; Francis & Sagar (2012)	
Current survival rate	93.5 (93–98) % [2011]	Southern Buller's albatross as proxy; Francis & Sagar (2012)	
Optimal survival rate	93.5 (93–98) % [2011]	Southern Buller's albatross as proxy; Francis & Sagar (2012)	
Body mass	2 837 g	Myhrvold et al. (2015)	
Breeding period	October–June	G. Taylor (pers. comm.)	
Relative non-breeding pop.	2.5%	G. Taylor (pers. comm.)	

(a) Breeding season distribution

(b) Non-breeding season distribution

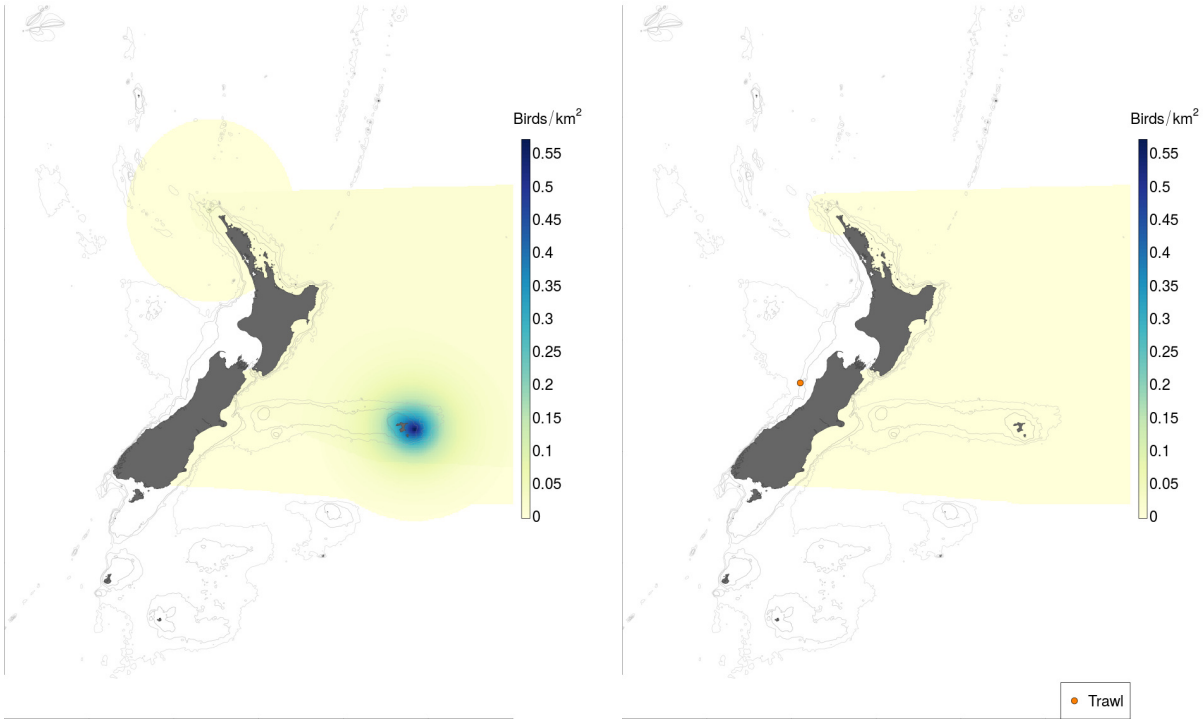
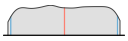
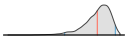
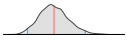
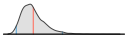


Figure 11: Relative density of northern Buller's albatross (*Thalassarche bulleri platei*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl fisheries.

Table 22: Derived values of population parameters of northern Buller's albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

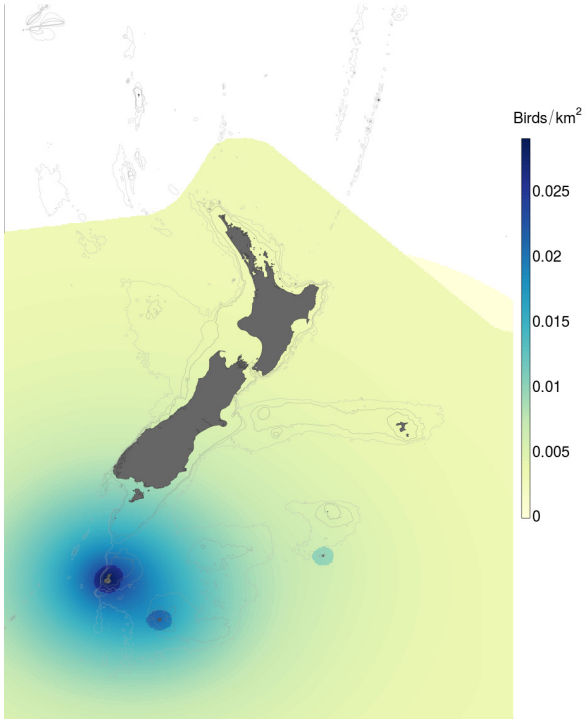
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	12.0	9.1–14.8	Years	
Age at first reproduction (from allometric model)	8.5	7.5–9.7	Years	
Current adult annual survival rate (from raw input parameters)	95.5	93.1–97.9	%	
Optimal adult annual survival rate (from raw input parameters)	95.5	93.1–97.9	%	
Optimal adult annual survival rate (from allometric model)	94.7	93.5–95.8	%	
Proportion of adults breeding (from raw input parameters)	88.8	74.8–96.5	%	
Annual breeding pairs (from raw input parameters)	16 400	13 300–20 000	Pairs	
Total population size (from raw input parameters)	106 000	70 500–167 000	Individuals	
Maximum net productivity rate r_{max}	0.061	0.054–0.069		

1.12 Light-mantled sooty albatross (*Phoebetria palpebrata*)

Table 23: Raw input data of population parameters of light-mantled sooty albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	6 770 to 6 900 pairs	Taylor (2000a)	Poor
Age at first reproduction	12 years	de L. Brooke (2004)	Poor
Current survival rate	96 to 98 % [1997]	Gibson's albatross as proxy; Walker & Elliott (1999)	
Optimal survival rate	96 to 98 % [1997]	Gibson's albatross as proxy; Walker & Elliott (1999)	
Body mass	2 892 g	Myhrvold et al. (2015)	
Breeding period	September–June	G. Taylor (pers. comm.)	
Relative non-breeding pop.	20%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

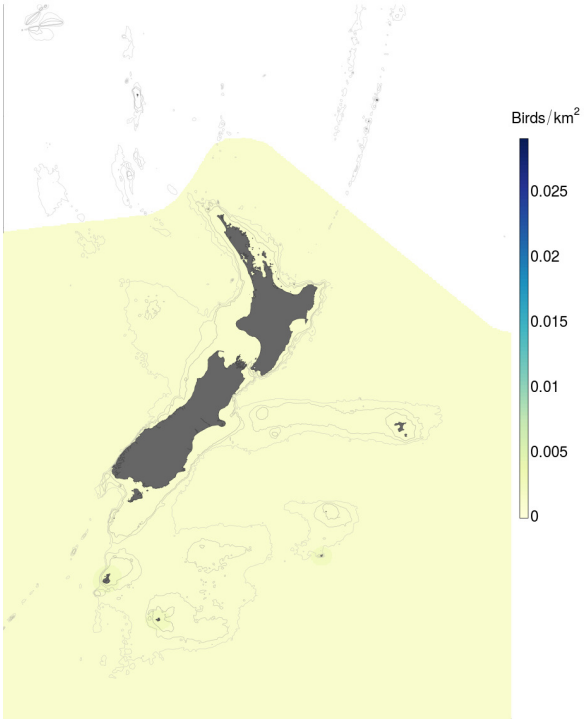
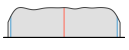
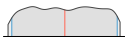
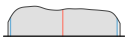
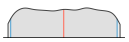
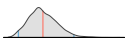


Figure 12: Relative density of light-mantled sooty albatross (*Phoebetria palpebrata*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 24: Derived values of population parameters of light-mantled sooty albatross for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

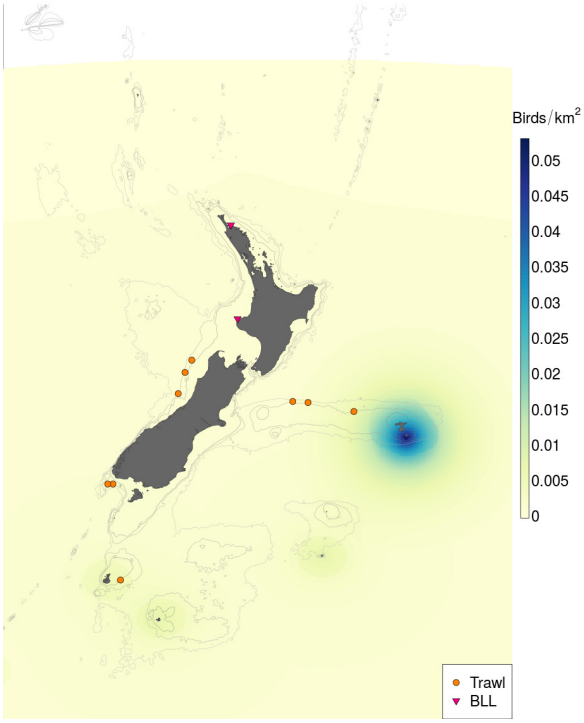
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	12.0	9.1–14.9	Years	
Age at first reproduction (from allometric model)	8.5	7.5–9.7	Years	
Current adult annual survival rate (from raw input parameters)	97.0	96.1–98.0	%	
Optimal adult annual survival rate (from raw input parameters)	97.0	96.0–97.9	%	
Optimal adult annual survival rate (from allometric model)	94.7	93.5–95.8	%	
Proportion of adults breeding (from raw input parameters)	59.9	50.0–69.4	%	
Annual breeding pairs (from raw input parameters)	6 840	6 770–6 900	Pairs	
Total population size (from raw input parameters)	56 800	44 700–72 000	Individuals	
Maximum net productivity rate r_{max}	0.061	0.054–0.069		

1.13 Northern giant petrel (*Macronectes halli*)

Table 25: Raw input data of population parameters of northern giant petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	2 140 to 3 140 pairs [2015]	I. Debski (pers. comm.)	
Age at first reproduction	6 to 10 years	Trivelpiece & Trivelpiece (1998)	
Current survival rate	92.3 % 88 % [2003] 88 to 93 % [1981]	de L. Brooke (2004) Agreement on the Conservation of Albatrosses and Petrels (2010) Agreement on the Conservation of Albatrosses and Petrels (2010)	
Optimal survival rate	92.3 % 88 % [2003] 88 to 93 % [1981]	de L. Brooke (2004) Agreement on the Conservation of Albatrosses and Petrels (2010) Agreement on the Conservation of Albatrosses and Petrels (2010)	
Body mass	4 315 g	Myhrvold et al. (2015)	
Breeding period	August–February	G. Taylor (pers. comm.)	
Relative non-breeding pop.	75%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

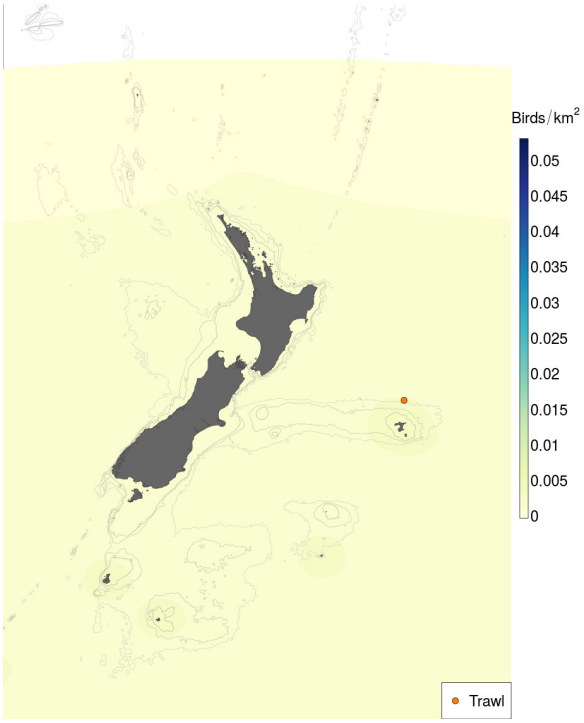
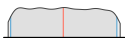
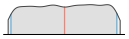
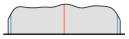
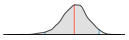
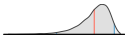
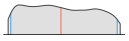


Figure 13: Relative density of northern giant petrel (*Macronectes halli*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl and bottom-longline (BLL) fisheries.

Table 26: Derived values of population parameters of northern giant petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

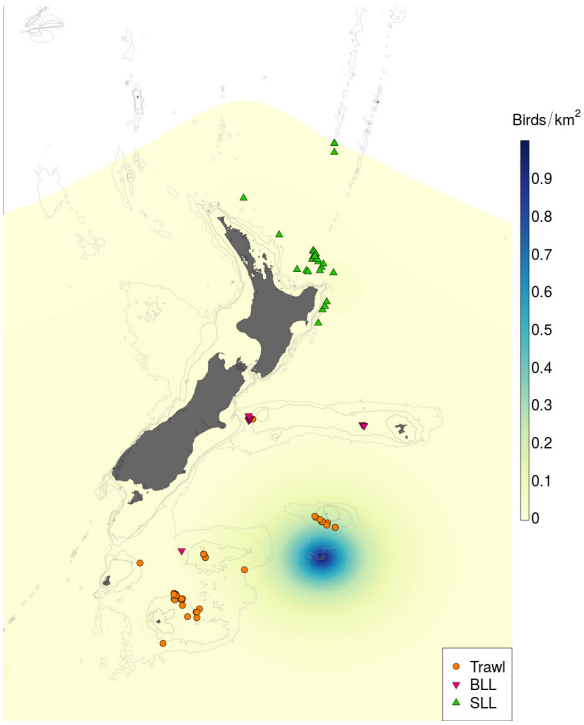
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	8.0	6.1–9.9	Years	
Age at first reproduction (from allometric model)	9.5	8.2–10.9	Years	
Current adult annual survival rate (from raw input parameters)	88.7	81.2–96.0	%	
Optimal adult annual survival rate (from raw input parameters)	88.6	81.2–96.1	%	
Optimal adult annual survival rate (from allometric model)	95.2	94.0–96.3	%	
Proportion of adults breeding (from raw input parameters)	88.9	74.5–96.5	%	
Annual breeding pairs (from raw input parameters)	2 610	2 160–3 110	Pairs	
Total population size (from raw input parameters)	24 500	11 700–58 400	Individuals	
Maximum net productivity rate r_{max}	0.055	0.048–0.063		

1.14 Grey petrel (*Procellaria cinerea*)

Table 27: Raw input data of population parameters of grey petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	32 000 to 73 000 pairs [2012]	Bell et al. (2013)	
Age at first reproduction	7 years	Barbraud et al. (2009)	
Current survival rate	90 to 97 %	White-chinned petrel as proxy; Dillingham & Fletcher (2008)	
Optimal survival rate	90 to 97 %	White-chinned petrel as proxy; Dillingham & Fletcher (2008)	
Body mass	1 131 g	Myhrvold et al. (2015)	
Breeding period	February–November	G. Taylor (pers. comm.)	
Relative non-breeding pop.	2.5%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

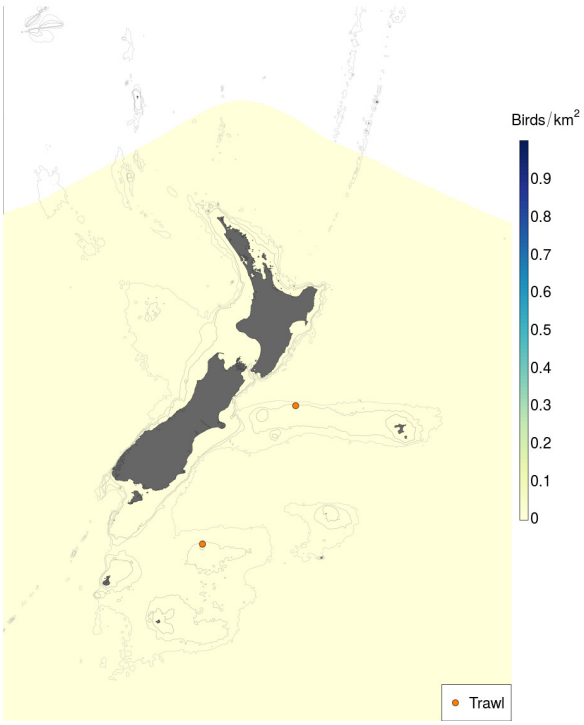
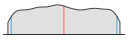
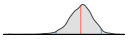
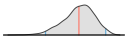
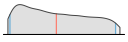
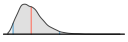
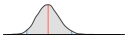


Figure 14: Relative density of grey petrel (*Procellaria cinerea*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), and bottom-longline (BLL) fisheries.

Table 28: Derived values of population parameters of grey petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

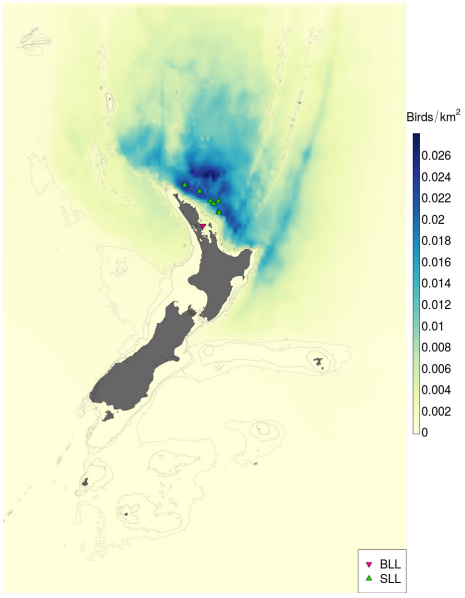
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	7.0	5.1–8.9	Years	
Age at first reproduction (from allometric model)	6.7	6.0–7.5	Years	
Current adult annual survival rate (from raw input parameters)	93.5	90.2–96.8	%	
Optimal adult annual survival rate (from raw input parameters)	93.5	90.2–96.8	%	
Optimal adult annual survival rate (from allometric model)	93.2	91.6–94.6	%	
Proportion of adults breeding (from raw input parameters)	79.4	68.6–88.1	%	
Annual breeding pairs (from raw input parameters)	49 700	32 700–71 400	Pairs	
Total population size (from raw input parameters)	278 000	163 000–455 000	Individuals	
Maximum net productivity rate r_{max}	0.080	0.071–0.089		

1.15 Black petrel (*Procellaria parkinsoni*)

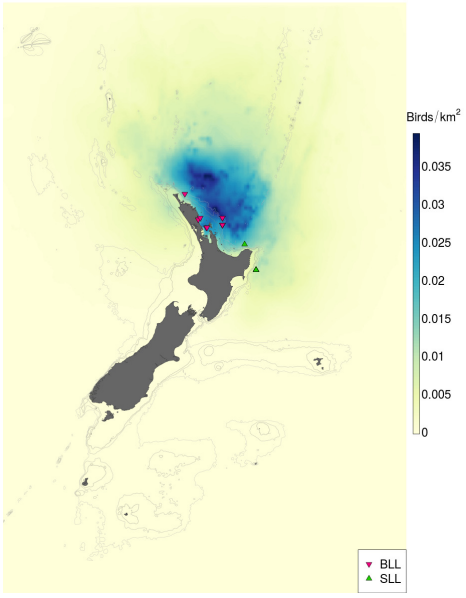
Table 29: Raw input data of population parameters of black petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	4627 (95% c.i.: 1972 – 9777) pairs	Richard & Abraham (2015)	High
Age at first reproduction	6.6 ± 0.2 years [2010]	Bell et al. (2011)	High
Current survival rate	92.7 ± 1.2 % [2016]	Bell et al. (2016)	High
Optimal survival rate	95 %	Walker et al. (2015)	High
Body mass	702 g	Myhrvold et al. (2015)	
Breeding period	October–July	G. Taylor (pers. comm.)	
Relative non-breeding pop.	0.5%	G. Taylor (pers. comm.)	

(a) Pre-egg laying (Oct–Nov)



(b) Incubation (Dec–Jan)



(c) Chick rearing (Feb–May)

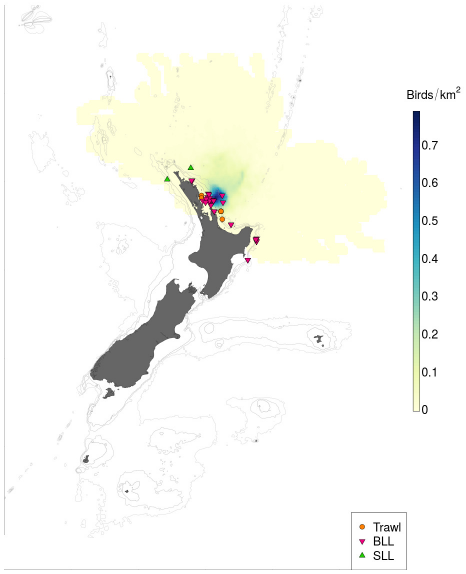
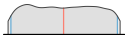
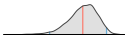
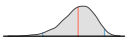
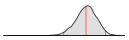
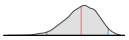
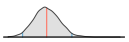


Figure 15: Relative density of black petrel (*Procellaria parkinsoni*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), and bottom-longline (BLL) fisheries.

Table 30: Derived values of population parameters of black petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	6.6	6.2–7.0	Years	
Age at first reproduction (from allometric model)	6.0	5.3–6.6	Years	
Current adult annual survival rate (from raw input parameters)	92.7	89.9–94.7	%	
Optimal adult annual survival rate (from raw input parameters)	94.9	92.6–96.6	%	
Optimal adult annual survival rate (from allometric model)	92.3	90.3–94.1	%	
Proportion of adults breeding (from raw input parameters)	79.5	68.6–88.0	%	
Annual breeding pairs (from raw input parameters)	4 630	1 970–9 780	Pairs	
Total population size (from raw input parameters)	19 200	9 630–36 700	Individuals	
Maximum net productivity rate r_{max}	0.091	0.080–0.103		

1.16 Westland petrel (*Procellaria westlandica*)

Table 31: Raw input data of population parameters of Westland petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	2 954 to 5 137 pairs [2013]	Wood & Otley (2013)	High
Age at first reproduction	6.5 years [2002]	Waugh et al. (2006)	
Current survival rate	91.8 to 97.5 %	Waugh et al. (2015)	
Optimal survival rate	91.8 to 97.5	Waugh et al. (2015)	
Body mass	1 204 g	Myhrvold et al. (2015)	
Breeding period	March–December	G. Taylor (pers. comm.)	
Relative non-breeding pop.	2.5%	G. Taylor (pers. comm.)	

(a) Breeding season distribution **(b) Non-breeding season distribution**

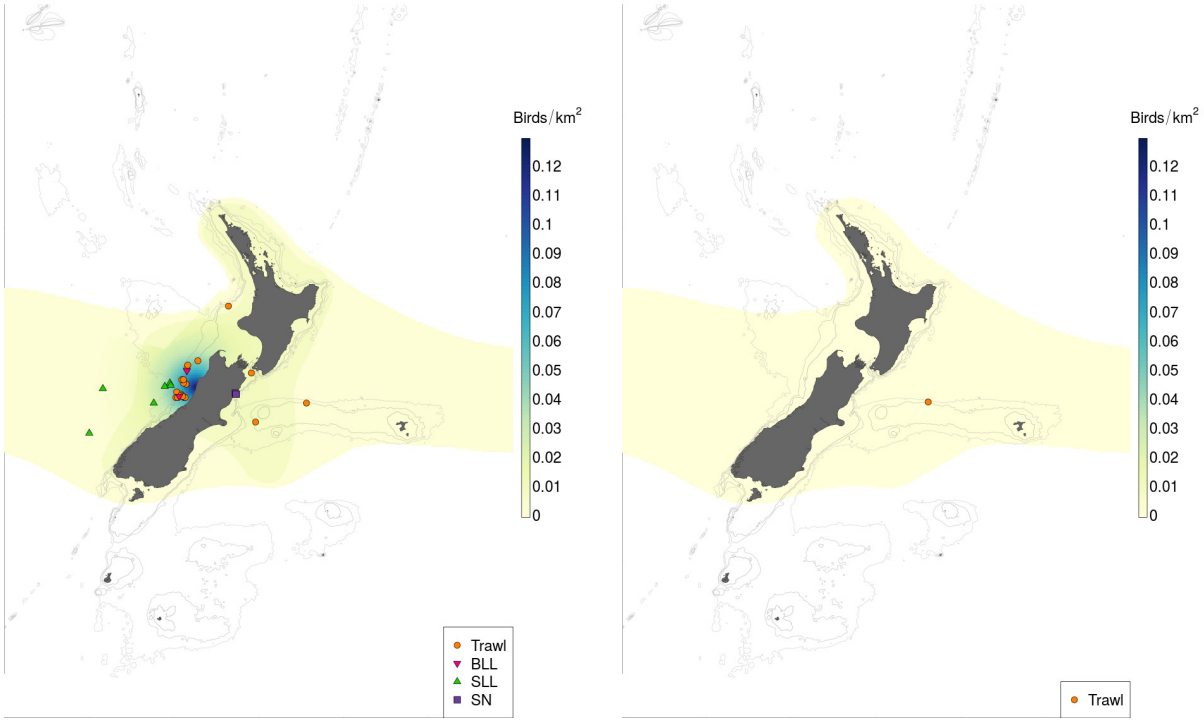
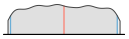
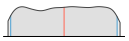
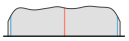
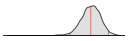
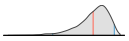
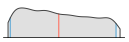
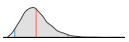


Figure 16: Relative density of Westland petrel (*Procellaria westlandica*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 32: Derived values of population parameters of Westland petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	6.5	4.1–8.9	Years	
Age at first reproduction (from allometric model)	6.8	6.1–7.6	Years	
Current adult annual survival rate (from raw input parameters)	94.7	91.9–97.4	%	
Optimal adult annual survival rate (from raw input parameters)	94.7	91.9–97.4	%	
Optimal adult annual survival rate (from allometric model)	93.3	91.8–94.7	%	
Proportion of adults breeding (from raw input parameters)	89.0	74.8–96.4	%	
Annual breeding pairs (from raw input parameters)	3 940	3 000–5 060	Pairs	
Total population size (from raw input parameters)	17 900	12 200–26 300	Individuals	
Maximum net productivity rate r_{max}	0.078	0.070–0.087		

1.17 White-chinned petrel (*Procellaria aequinoctialis*)

Table 33: Raw input data of population parameters of white-chinned petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	204 725 to 368 125 pairs	Rexer-Huber et al. (2016), Sommer et al. (2010), Sommer et al. (2011)	High
Age at first reproduction	6.5 years	Schreiber & Burger (2001)	
Current survival rate	90 to 97 %	Dillingham & Fletcher (2008)	
Optimal survival rate	90 to 97 %	Dillingham & Fletcher (2008)	
Body mass	1 318 g	Myhrvold et al. (2015)	
Breeding period	November–May	G. Taylor (pers. comm.)	
Relative non-breeding pop.	20%	G. Taylor (pers. comm.)	

(a) Breeding season distribution **(b) Non-breeding season distribution**

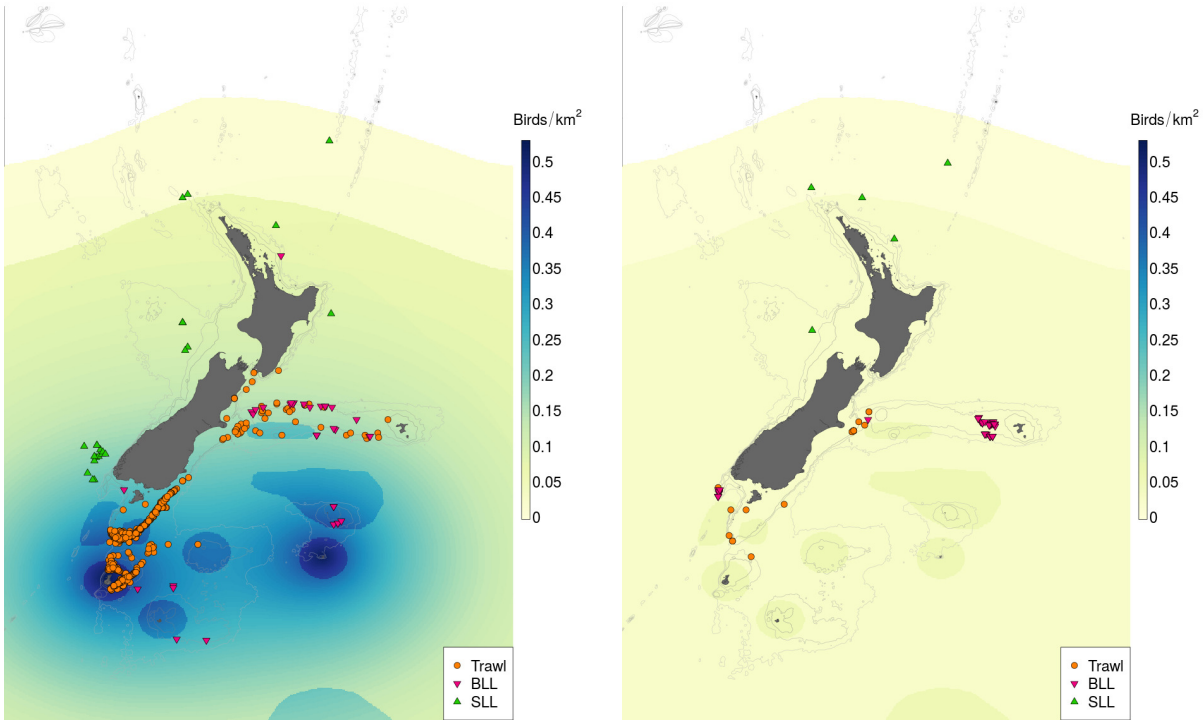
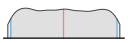
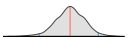
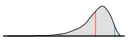
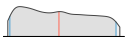
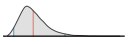
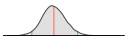


Figure 17: Relative density of white-chinned petrel (*Procellaria aequinoctialis*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), and bottom-longline (BLL) fisheries.

Table 34: Derived values of population parameters of white-chinned petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

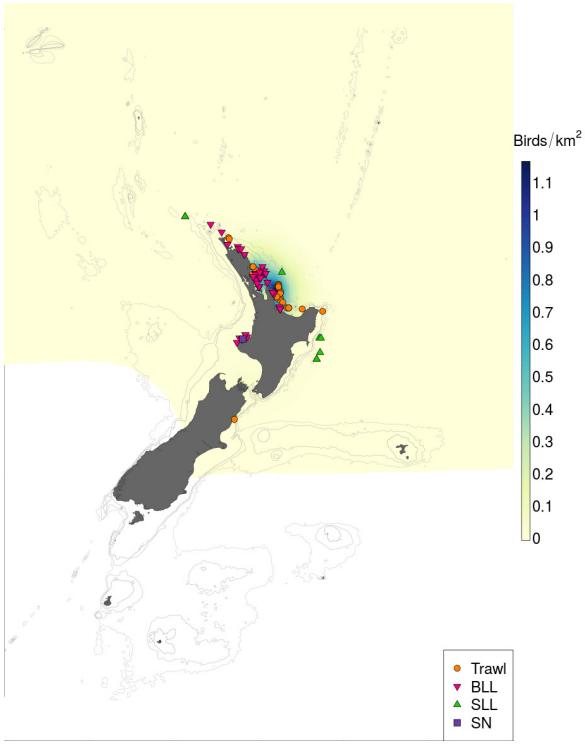
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	6.5	4.1–8.9	Years	
Age at first reproduction (from allometric model)	7.0	6.3–7.8	Years	
Current adult annual survival rate (from raw input parameters)	93.5	90.2–96.8	%	
Optimal adult annual survival rate (from raw input parameters)	93.5	90.2–96.8	%	
Optimal adult annual survival rate (from allometric model)	93.5	92.0–94.9	%	
Proportion of adults breeding (from raw input parameters)	89.1	75.8–96.4	%	
Annual breeding pairs (from raw input parameters)	279 000	208 000–362 000	Pairs	
Total population size (from raw input parameters)	1 340 000	865 000–2 130 000	Individuals	
Maximum net productivity rate r_{max}	0.076	0.068–0.085		

1.18 Flesh-footed shearwater (*Puffinus carneipes*)

Table 35: Raw input data of population parameters of flesh-footed shearwater for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	10 000 to 15 000 pairs [2013]	Waugh et al. (2013)	
Age at first reproduction	4 to 9 years [1973]	Bradley et al. (1999)	
Current survival rate	93.1 to 94 % [2014]	Barbraud et al. (2014)	High
Optimal survival rate	94 %	Walker et al. (2015)	
Body mass	614 g	Myhrvold et al. (2015)	
Breeding period	September–May	G. Taylor (pers. comm.)	
Relative non-breeding pop.	0.5%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

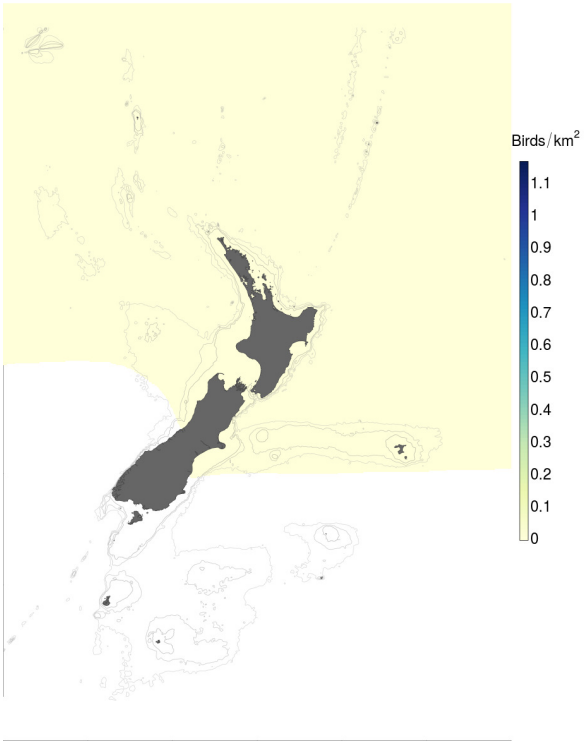
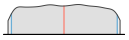
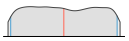
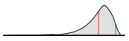
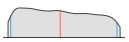
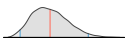
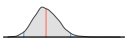


Figure 18: Relative density of flesh-footed shearwater (*Puffinus carneipes*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 36: Derived values of population parameters of flesh-footed shearwater for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

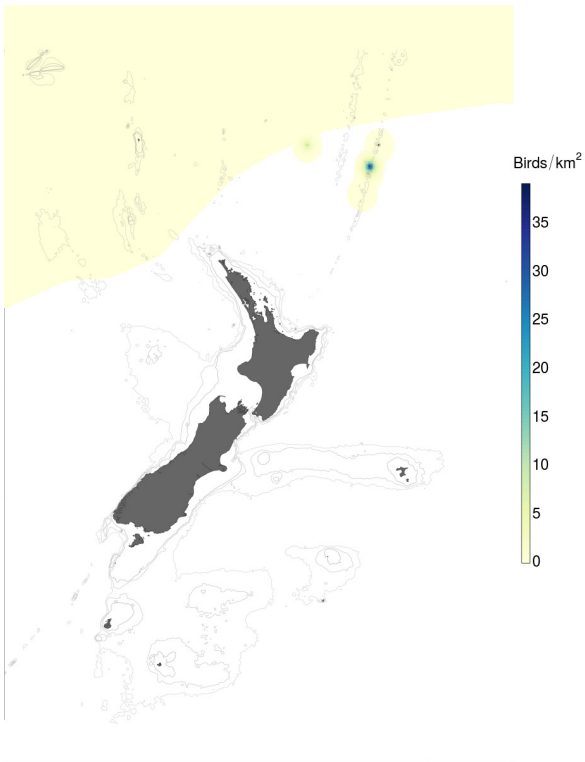
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	6.5	4.2–8.9	Years	
Age at first reproduction (from allometric model)	5.8	5.2–6.4	Years	
Current adult annual survival rate (from raw input parameters)	93.5	93.1–94.0	%	
Optimal adult annual survival rate (from raw input parameters)	93.2	84.4–97.8	%	
Optimal adult annual survival rate (from allometric model)	92.1	89.9–94.0	%	
Proportion of adults breeding (from raw input parameters)	88.9	74.9–96.5	%	
Annual breeding pairs (from raw input parameters)	12 300	10 100–14 900	Pairs	
Total population size (from raw input parameters)	61 500	44 900–82 700	Individuals	
Maximum net productivity rate r_{max}	0.094	0.083–0.107		

1.19 Wedge-tailed shearwater (*Puffinus pacificus*)

Table 37: Raw input data of population parameters of wedge-tailed shearwater for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	50 000 pairs	Waugh et al. (2013)	Poor
Age at first reproduction	4 years	Schreiber & Burger (2001)	
Current survival rate	93.1 (88.9–95.8) % [1999]	Hutton's shearwater as proxy; Cuthbert & Davis (2002)	
Optimal survival rate	93.1 (88.9–95.8) % [1999]	Hutton's shearwater as proxy; Cuthbert & Davis (2002)	
Body mass	429 g	Myhrvold et al. (2015)	
Breeding period	October–May	G. Taylor (pers. comm.)	
Relative non-breeding pop.	0.5%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

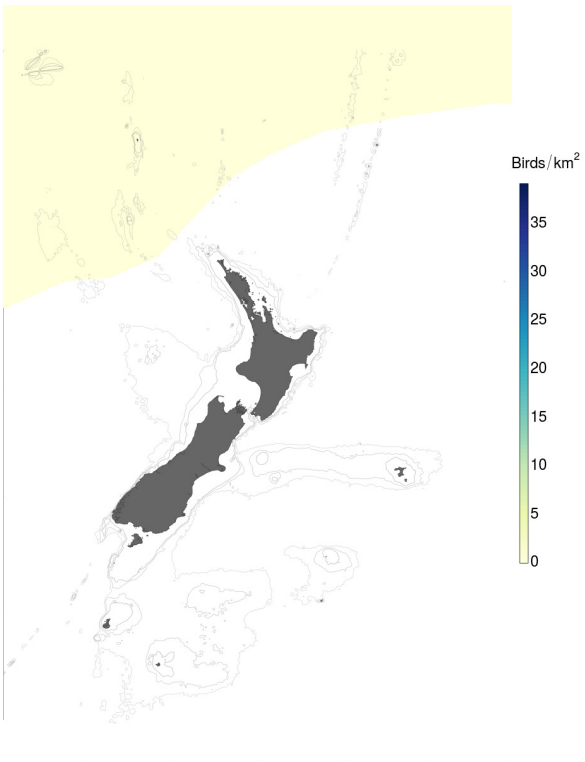
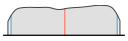
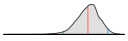
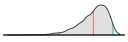
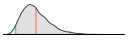
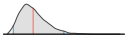


Figure 19: Relative density of wedge-tailed shearwater (*Puffinus pacificus*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 38: Derived values of population parameters of wedge-tailed shearwater for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	4.0	3.1–5.0	Years	
Age at first reproduction (from allometric model)	5.3	4.6–6.0	Years	
Current adult annual survival rate (from raw input parameters)	92.4	89.1–95.6	%	
Optimal adult annual survival rate (from raw input parameters)	92.3	89.1–95.6	%	
Optimal adult annual survival rate (from allometric model)	91.3	88.3–93.6	%	
Proportion of adults breeding (from raw input parameters)	89.0	76.0–96.4	%	
Annual breeding pairs (from raw input parameters)	52 100	28 200–92 000	Pairs	
Total population size (from raw input parameters)	226 000	120 000–391 000	Individuals	
Maximum net productivity rate r_{max}	0.105	0.090–0.121		

1.20 Buller's shearwater (*Puffinus bulleri*)

Table 39: Raw input data of population parameters of Buller's shearwater for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	300 000 to 400 000 pairs	Waugh et al. (2013)	Poor
Age at first reproduction	4 to 9 years [1973]	Bradley et al. (1999)	
Current survival rate	92 %	Short-tailed shearwater as proxy; de L. Brooke (2004)	
Optimal survival rate	92 %	Short-tailed shearwater as proxy; de L. Brooke (2004)	
Body mass	355 g	Myhrvold et al. (2015)	
Breeding period	September–May	G. Taylor (pers. comm.)	
Relative non-breeding pop.	0.5%	G. Taylor (pers. comm.)	

(a) Breeding season distribution **(b) Non-breeding season distribution**

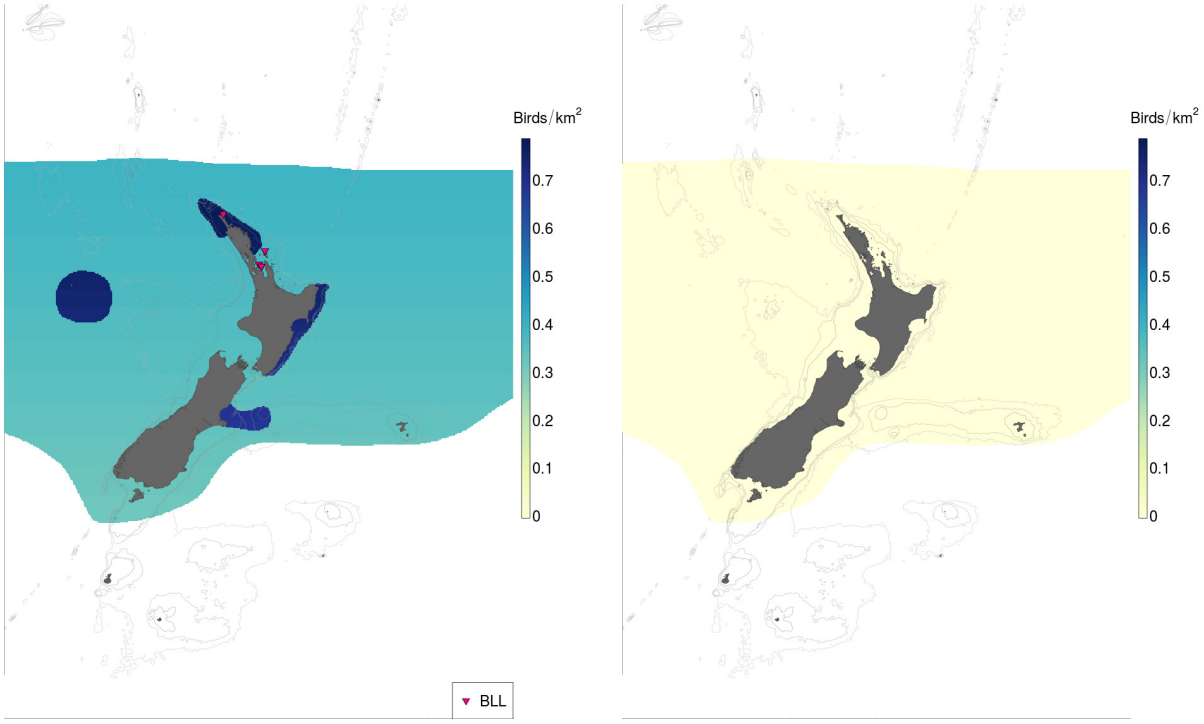
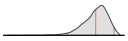
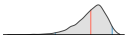
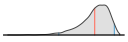
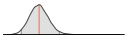


Figure 20: Relative density of Buller's shearwater (*Puffinus bulleri*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in bottom-longline (BLL) fisheries.

Table 40: Derived values of population parameters of Buller's shearwater for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

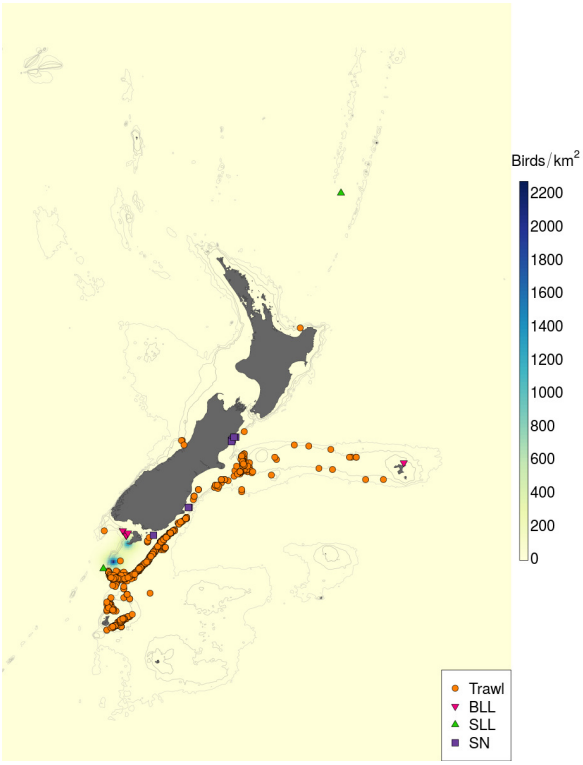
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	6.5	4.1–8.9	Years	
Age at first reproduction (from allometric model)	5.0	4.4–5.7	Years	
Current adult annual survival rate (from raw input parameters)	91.5	84.1–96.3	%	
Optimal adult annual survival rate (from raw input parameters)	91.5	83.6–96.3	%	
Optimal adult annual survival rate (from allometric model)	90.8	87.5–93.4	%	
Proportion of adults breeding (from raw input parameters)	88.9	75.0–96.5	%	
Annual breeding pairs (from raw input parameters)	347 000	302 000–397 000	Pairs	
Total population size (from raw input parameters)	2 020 000	1 280 000–3 630 000	Individuals	
Maximum net productivity rate r_{max}	0.111	0.095–0.130		

1.21 Sooty shearwater (*Puffinus griseus*)

Table 41: Raw input data of population parameters of sooty shearwater for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	5 000 000 pairs	Waugh et al. (2013)	Poor
Age at first reproduction	5 to 7 years	de L. Brooke (2004)	
Current survival rate	86 to 97.9 % [2005]	Clucas et al. (2008)	
Optimal survival rate	86 to 97.9 % [2005]	Clucas et al. (2008)	
Body mass	787 g	Myhrvold et al. (2015)	
Breeding period	November–May	G. Taylor (pers. comm.)	
Relative non-breeding pop.	0.5%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

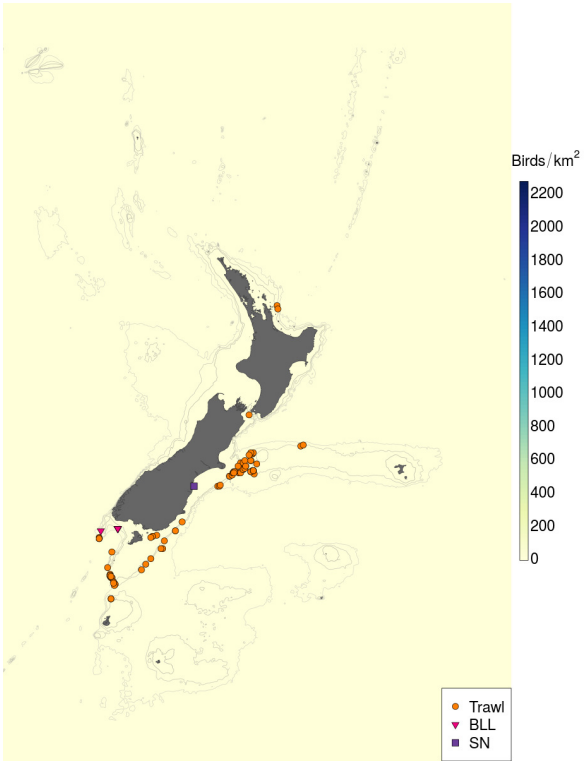
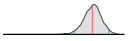
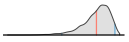
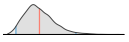
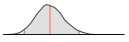


Figure 21: Relative density of sooty shearwater (*Puffinus griseus*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 42: Derived values of population parameters of sooty shearwater for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

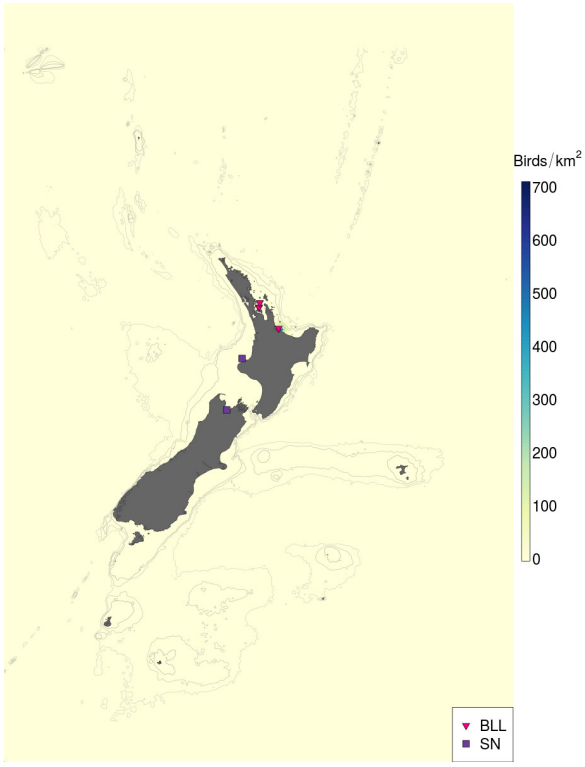
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	6.0	5.1–6.9	Years	
Age at first reproduction (from allometric model)	6.1	5.5–6.8	Years	
Current adult annual survival rate (from raw input parameters)	91.8	86.3–97.6	%	
Optimal adult annual survival rate (from raw input parameters)	92.0	86.3–97.6	%	
Optimal adult annual survival rate (from allometric model)	92.5	90.6–94.2	%	
Proportion of adults breeding (from raw input parameters)	88.8	74.5–96.4	%	
Annual breeding pairs (from raw input parameters)	5 230 000	2 740 000–9 070 000	Pairs	
Total population size (from raw input parameters)	27 900 000	13 300 000–55 500 000	Individuals	
Maximum net productivity rate r_{max}	0.088	0.078–0.100		

1.22 Fluttering shearwater (*Puffinus gavia*)

Table 43: Raw input data of population parameters of fluttering shearwater for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	100 000 to 500 000 pairs	Waugh et al. (2013)	Poor
Age at first reproduction	4 to 6 years	Hutton's shearwater as proxy; Waugh et al. (1999)	
Current survival rate	93.1 (88.9–95.8) % [1999]	Hutton's shearwater as proxy; Cuthbert & Davis (2002)	
Optimal survival rate	93.1 (88.9–95.8) % [1999]	Hutton's shearwater as proxy; Cuthbert & Davis (2002)	
Body mass	232 g	Myhrvold et al. (2015)	
Breeding period	July–February	G. Taylor (pers. comm.)	
Relative non-breeding pop.	80%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

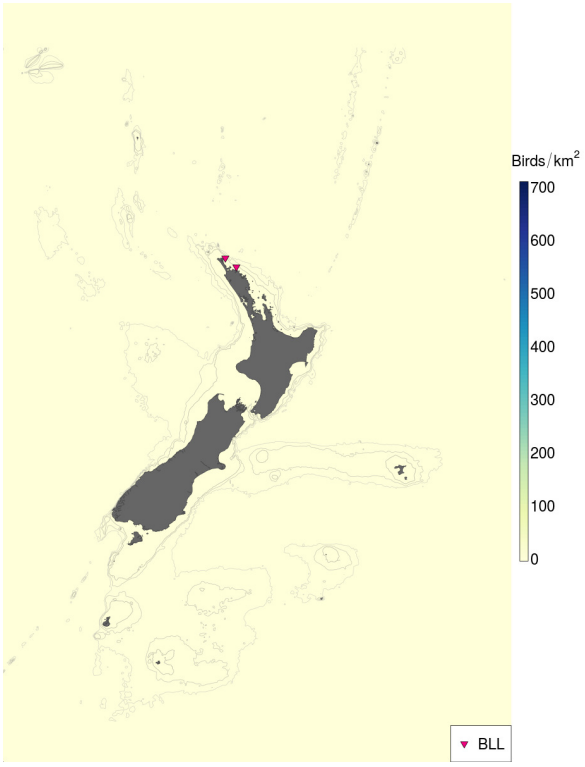
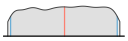
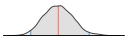
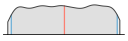
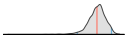
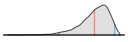
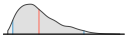
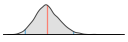


Figure 22: Relative density of fluttering shearwater (*Puffinus gavia*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in bottom-longline (BLL) and set-net (SN) fisheries.

Table 44: Derived values of population parameters of fluttering shearwater for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

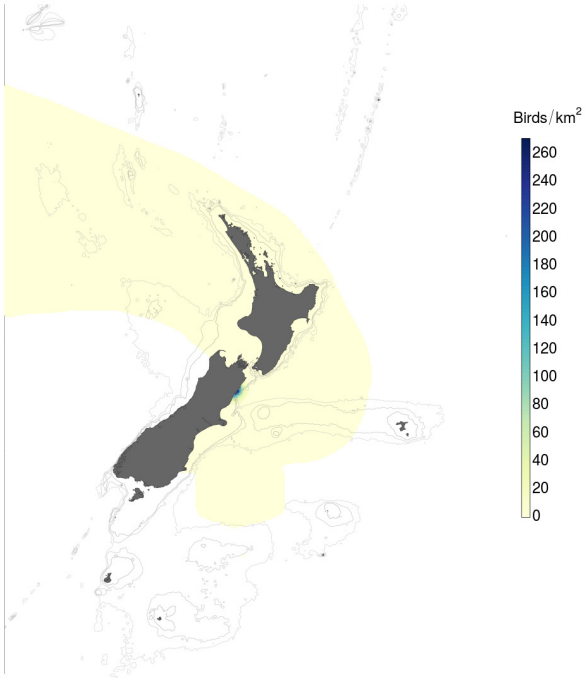
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	5.0	4.1–6.0	Years	
Age at first reproduction (from allometric model)	4.5	3.8–5.3	Years	
Current adult annual survival rate (from raw input parameters)	92.3	89.1–95.6	%	
Optimal adult annual survival rate (from raw input parameters)	92.4	89.1–95.6	%	
Optimal adult annual survival rate (from allometric model)	89.7	85.1–93.0	%	
Proportion of adults breeding (from raw input parameters)	89.0	75.8–96.4	%	
Annual breeding pairs (from raw input parameters)	250 000	104 000–483 000	Pairs	
Total population size (from raw input parameters)	1 150 000	496 000–2 260 000	Individuals	
Maximum net productivity rate r_{max}	0.126	0.104–0.152		

1.23 Hutton's shearwater (*Puffinus huttoni*)

Table 45: Raw input data of population parameters of Hutton's shearwater for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population ()	114 000 pairs	Waugh et al. (2013)	Medium
Age at first reproduction	4 to 6 years	Waugh et al. (1999)	
Current survival rate	93.1 (88.9–95.8) % [1999]	Cuthbert & Davis (2002)	High
Optimal survival rate	93.1 (88.9–95.8) % [1999]	Cuthbert & Davis (2002)	High
Body mass	364 g	Myhrvold et al. (2015)	
Breeding period	September–April	G. Taylor (pers. comm.)	
Relative non-breeding pop.	2.5%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

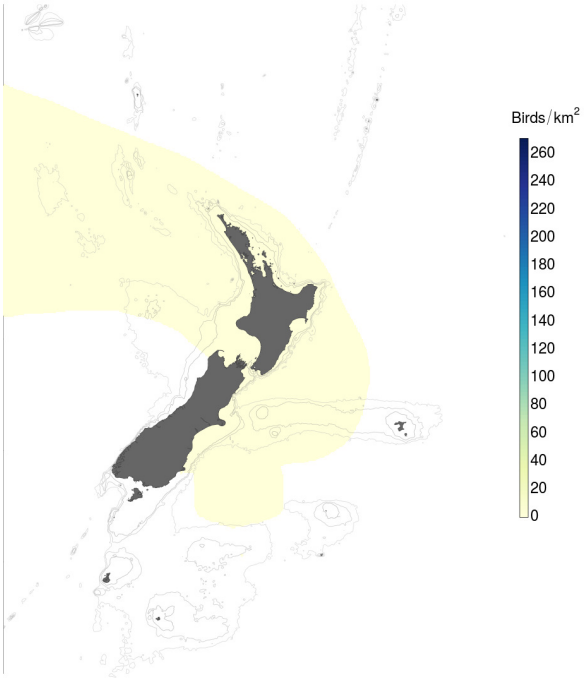
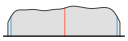
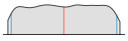
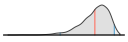
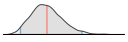
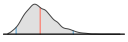
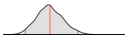


Figure 23: Relative density of Hutton's shearwater (*Puffinus huttoni*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 46: Derived values of population parameters of Hutton's shearwater for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	5.0	4.1–6.0	Years	
Age at first reproduction (from allometric model)	5.1	4.4–5.8	Years	
Current adult annual survival rate (from raw input parameters)	92.3	89.1–95.6	%	
Optimal adult annual survival rate (from raw input parameters)	92.3	89.1–95.6	%	
Optimal adult annual survival rate (from allometric model)	90.9	87.7–93.4	%	
Proportion of adults breeding (from raw input parameters)	88.9	75.5–96.5	%	
Annual breeding pairs (from raw input parameters)	116 000	77 300–167 000	Pairs	
Total population size (from raw input parameters)	547 000	344 000–824 000	Individuals	
Maximum net productivity rate r_{max}	0.110	0.094–0.128		

1.24 Little shearwater (*Puffinus assimilis*)

Table 47: Raw input data of population parameters of little shearwater for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	115 000 to 210 000 pairs	Waugh et al. (2013)	
Age at first reproduction	4 to 6 years	Hutton's shearwater as proxy; Waugh et al. (1999)	
Current survival rate	93.1 (88.9–95.8) % [1999]	Hutton's shearwater as proxy; Cuthbert & Davis (2002)	
Optimal survival rate	93.1 (88.9–95.8) % [1999]	Hutton's shearwater as proxy; Cuthbert & Davis (2002)	
Body mass	225 g	Myhrvold et al. (2015)	
Breeding period	April–November	G. Taylor (pers. comm.)	
Relative non-breeding pop.	5%	G. Taylor (pers. comm.)	

(a) Breeding season distribution **(b) Non-breeding season distribution**

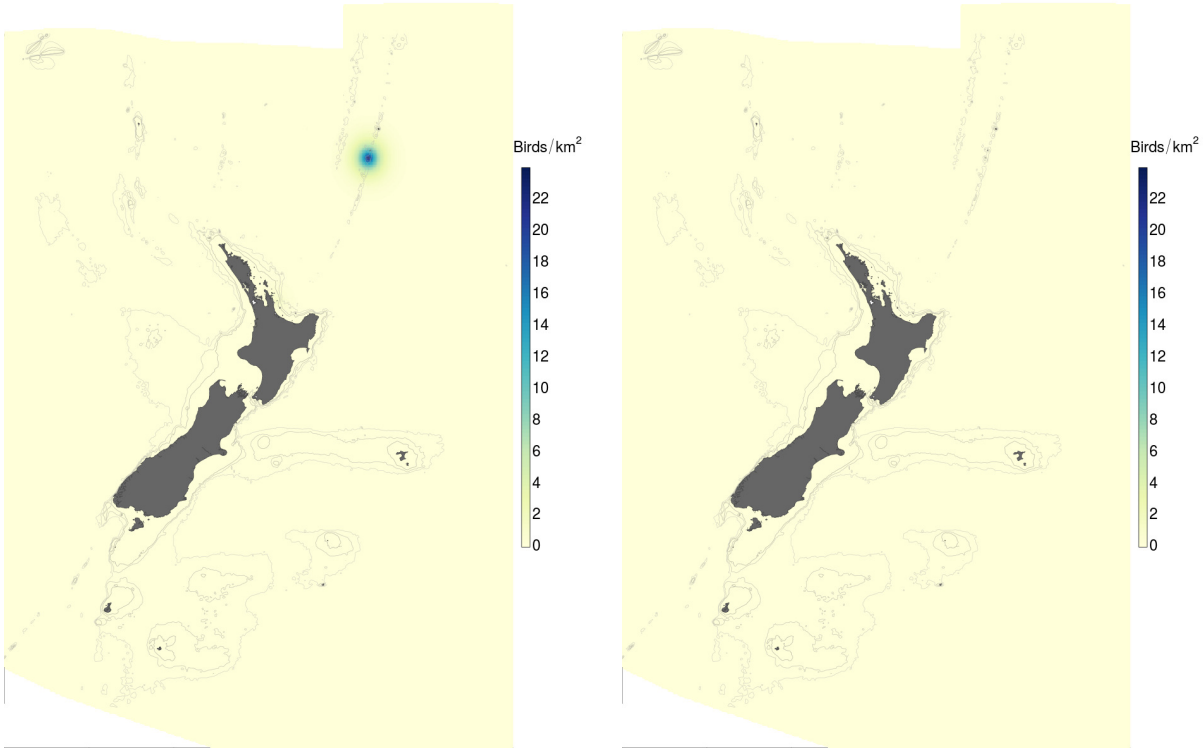
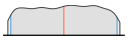
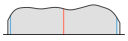
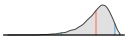
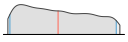
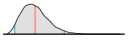
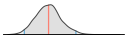


Figure 24: Relative density of little shearwater (*Puffinus assimilis*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 48: Derived values of population parameters of little shearwater for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	5.0	4.0–5.9	Years	
Age at first reproduction (from allometric model)	4.5	3.8–5.3	Years	
Current adult annual survival rate (from raw input parameters)	92.3	89.1–95.6	%	
Optimal adult annual survival rate (from raw input parameters)	92.3	89.1–95.6	%	
Optimal adult annual survival rate (from allometric model)	89.6	85.4–92.9	%	
Proportion of adults breeding (from raw input parameters)	88.8	74.8–96.5	%	
Annual breeding pairs (from raw input parameters)	158 000	117 000–207 000	Pairs	
Total population size (from raw input parameters)	688 000	466 000–1 010 000	Individuals	
Maximum net productivity rate r_{max}	0.127	0.104–0.152		

1.25 Snares Cape petrel (*Daption capense australe*)

Table 49: Raw input data of population parameters of Snares Cape petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	8 420 pairs	de L. Brooke (2004)	
Age at first reproduction	3 to 5 years [1968] 6 years	Beck (1969) Schreiber & Burger (2001)	Medium
Current survival rate	77.1 to 93.9 % [1987]	Sagar et al. (1996)	Poor
Optimal survival rate	77.1 to 93.9 % [1987]	Sagar et al. (1996)	Poor
Body mass	431 g	Myhrvold et al. (2015)	
Breeding period	November–February	G. Taylor (pers. comm.)	
Relative non-breeding pop.	90%	G. Taylor (pers. comm.)	

(a) Breeding season distribution

(b) Non-breeding season distribution

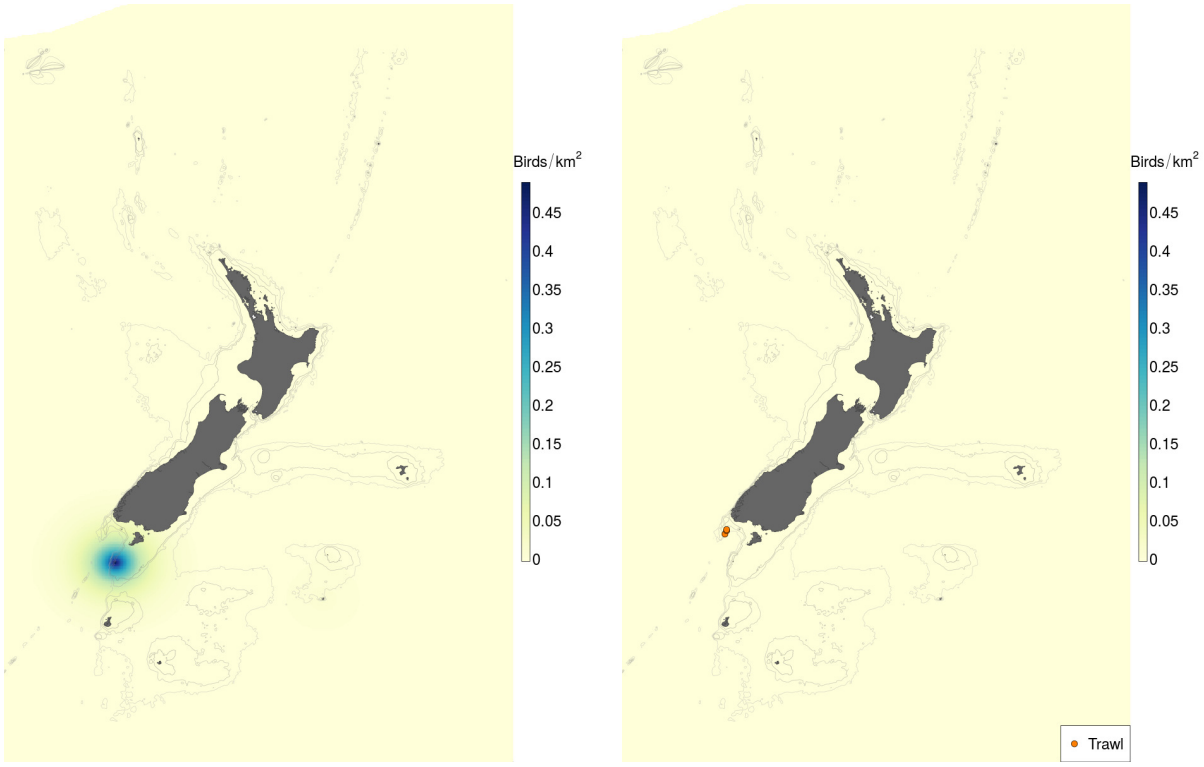
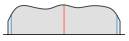
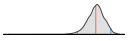
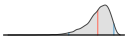
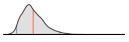
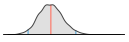


Figure 25: Relative density of Snares Cape petrel (*Daption capense australe*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl fisheries.

Table 50: Derived values of population parameters of Snares Cape petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

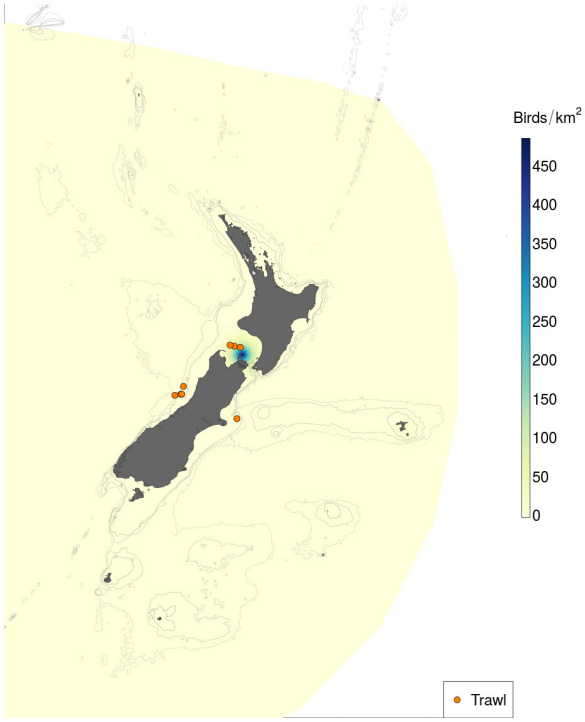
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	5.5	3.2–7.9	Years	
Age at first reproduction (from allometric model)	5.3	4.7–6.0	Years	
Current adult annual survival rate (from raw input parameters)	85.5	77.6–93.5	%	
Optimal adult annual survival rate (from raw input parameters)	85.5	77.6–93.4	%	
Optimal adult annual survival rate (from allometric model)	91.2	88.3–93.6	%	
Proportion of adults breeding (from raw input parameters)	88.8	75.4–96.3	%	
Annual breeding pairs (from raw input parameters)	8 850	4 850–15 300	Pairs	
Total population size (from raw input parameters)	61 000	23 100–151 000	Individuals	
Maximum net productivity rate r_{max}	0.105	0.090–0.121		

1.26 Fairy prion (*Pachyptila turtur*)

Table 51: Raw input data of population parameters of fairy prion for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	1 500 000 pairs	Jamieson et al. (2016)	High
Age at first reproduction	4 to 5 years	Schreiber & Burger (2001)	
Current survival rate	84 %	de L. Brooke (2004)	
Optimal survival rate	84 %	de L. Brooke (2004)	
Body mass	139 g	Myhrvold et al. (2015)	
Breeding period	March–January	G. Taylor (pers. comm.)	
Relative non-breeding pop.	15%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

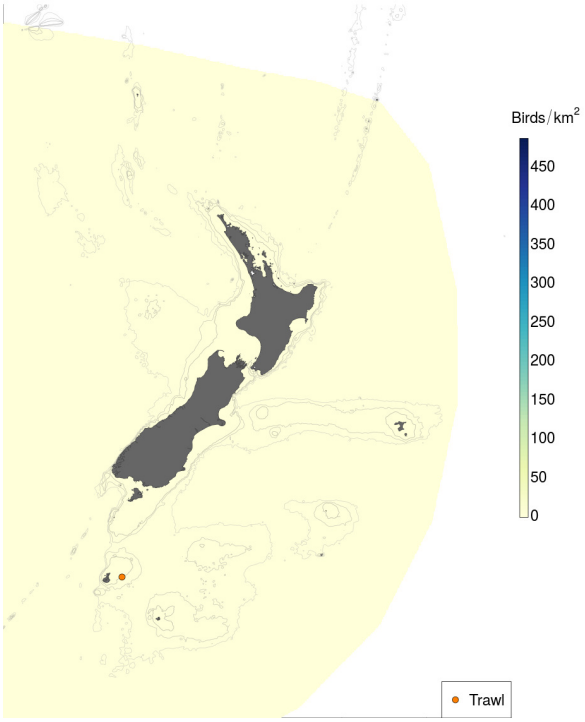
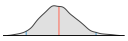
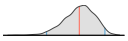
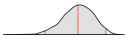
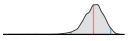
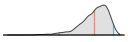
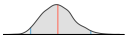
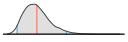
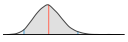


Figure 26: Relative density of fairy prion (*Pachyptila turtur*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl fisheries.

Table 52: Derived values of population parameters of fairy prion for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	4.5	4.0–5.0	Years	
Age at first reproduction (from allometric model)	4.0	3.3–4.8	Years	
Current adult annual survival rate (from raw input parameters)	83.7	77.1–88.9	%	
Optimal adult annual survival rate (from raw input parameters)	83.9	77.6–89.2	%	
Optimal adult annual survival rate (from allometric model)	88.1	82.5–92.4	%	
Proportion of adults breeding (from raw input parameters)	88.8	74.9–96.3	%	
Annual breeding pairs (from raw input parameters)	1 510 000	1 240 000–1 830 000	Pairs	
Total population size (from raw input parameters)	8 940 000	6 260 000–13 000 000	Individuals	
Maximum net productivity rate r_{max}	0.147	0.117–0.183		

1.27 Antarctic prion (*Pachyptila desolata*)

Table 53: Raw input data of population parameters of Antarctic prion for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	350 000 to 1 000 000 pairs	Jamieson et al. (2016)	High
Age at first reproduction	5 to 6 years	de L. Brooke (2004)	
Current survival rate	84 %	Fairy prion as proxy; de L. Brooke (2004)	
Optimal survival rate	84 %	Fairy prion as proxy; de L. Brooke (2004)	
Body mass	154 g	Myhrvold et al. (2015)	
Breeding period	November–March	G. Taylor (pers. comm.)	
Relative non-breeding pop.	15%	G. Taylor (pers. comm.)	

(a) Breeding season distribution **(b) Non-breeding season distribution**

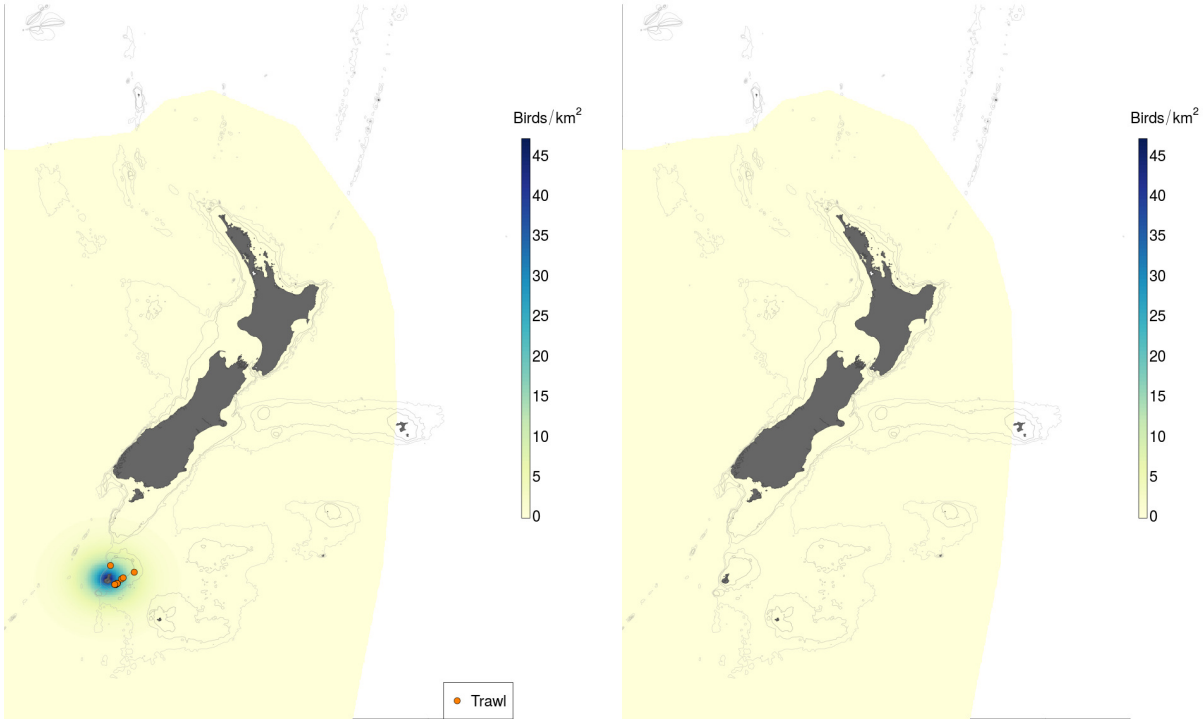
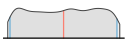
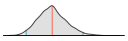
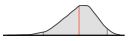
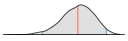
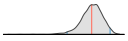
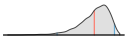
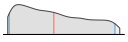
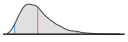
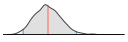


Figure 27: Relative density of Antarctic prion (*Pachyptila desolata*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl fisheries.

Table 54: Derived values of population parameters of Antarctic prion for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

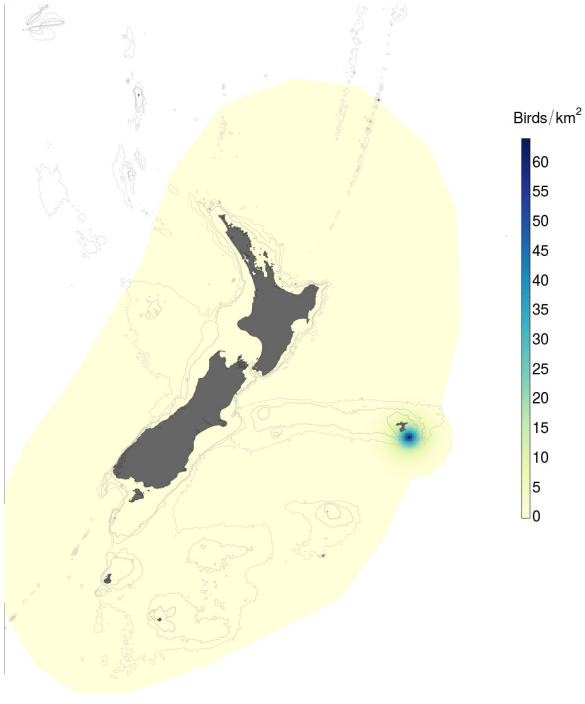
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	5.5	5.0–6.0	Years	
Age at first reproduction (from allometric model)	4.1	3.4–4.9	Years	
Current adult annual survival rate (from raw input parameters)	83.7	76.9–89.1	%	
Optimal adult annual survival rate (from raw input parameters)	83.8	77.1–89.2	%	
Optimal adult annual survival rate (from allometric model)	88.4	82.8–92.6	%	
Proportion of adults breeding (from raw input parameters)	88.9	74.9–96.4	%	
Annual breeding pairs (from raw input parameters)	618 000	358 000–972 000	Pairs	
Total population size (from raw input parameters)	4 320 000	2 270 000–7 810 000	Individuals	
Maximum net productivity rate r_{max}	0.142	0.115–0.175		

1.28 Broad-billed prion (*Pachyptila vittata*)

Table 55: Raw input data of population parameters of broad-billed prion for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	350 000 pairs	Jamieson et al. (2016)	High
Age at first reproduction	4 to 5 years	Fairy prion as proxy; Schreiber & Burger (2001)	
Current survival rate	84 %	Fairy prion as proxy; de L. Brooke (2004)	
Optimal survival rate	84 %	Fairy prion as proxy; de L. Brooke (2004)	
Body mass	193 g	Myhrvold et al. (2015)	
Breeding period	February–January	G. Taylor (pers. comm.)	
Relative non-breeding pop.	5%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

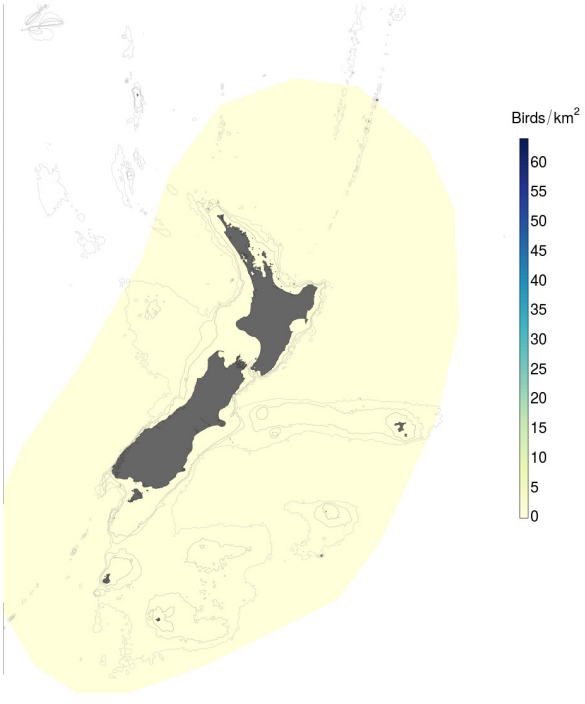
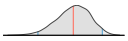
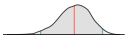
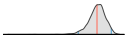
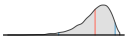
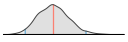
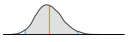


Figure 28: Relative density of broad-billed prion (*Pachyptila vittata*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 56: Derived values of population parameters of broad-billed prion for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

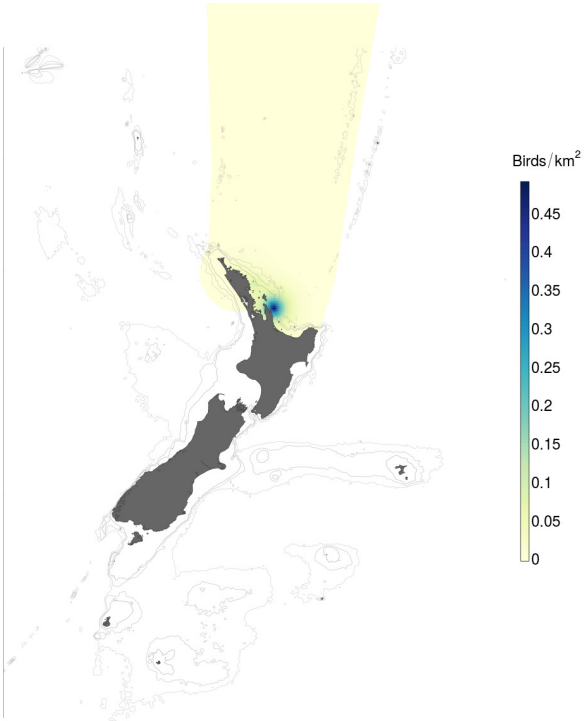
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	4.5	4.0–5.0	Years	
Age at first reproduction (from allometric model)	4.3	3.6–5.1	Years	
Current adult annual survival rate (from raw input parameters)	83.8	77.3–89.1	%	
Optimal adult annual survival rate (from raw input parameters)	83.7	77.3–89.0	%	
Optimal adult annual survival rate (from allometric model)	89.1	84.4–92.8	%	
Proportion of adults breeding (from raw input parameters)	88.9	75.4–96.3	%	
Annual breeding pairs (from raw input parameters)	352 000	285 000–429 000	Pairs	
Total population size (from raw input parameters)	2 080 000	1 430 000–3 010 000	Individuals	
Maximum net productivity rate r_{max}	0.133	0.109–0.162		

1.29 Pycroft's petrel (*Pterodroma pycrofti*)

Table 57: Raw input data of population parameters of Pycroft's petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	2 000 to 3 000 pairs [1998]	Taylor (2000a)	High
Age at first reproduction	6 to 7 years	Grey-faced petrel as proxy; Schreiber & Burger (2001)	
Current survival rate	94 %	Grey-faced petrel as proxy; Marchant & Higgins (1990)	
Optimal survival rate	94 %	Grey-faced petrel as proxy; Marchant & Higgins (1990)	
Body mass	159 g	Myhrvold et al. (2015)	
Breeding period	October–April	G. Taylor (pers. comm.)	
Relative non-breeding pop.	0%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

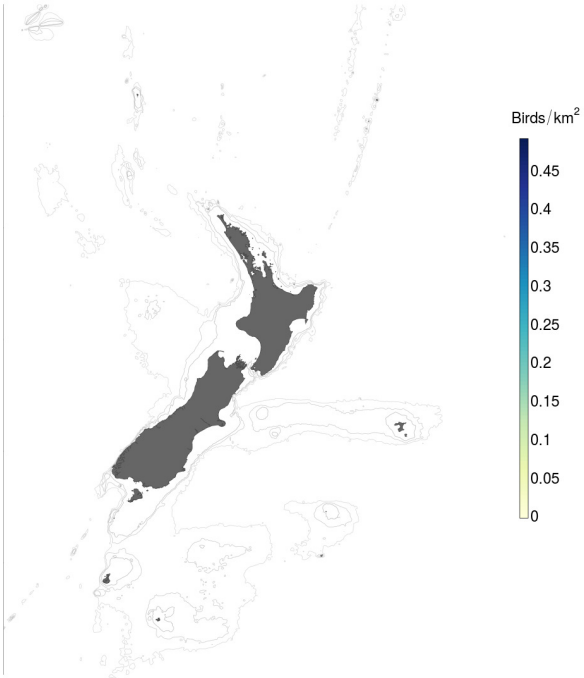
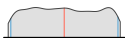
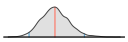
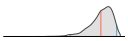
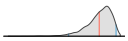
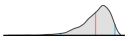
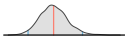


Figure 29: Relative density of Pycroft's petrel (*Pterodroma pycrofti*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 58: Derived values of population parameters of Pycroft's petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

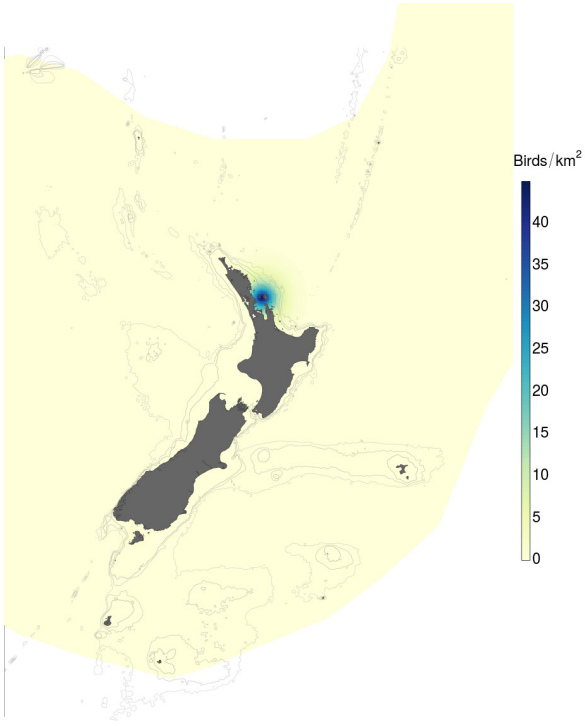
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	6.5	6.0–7.0	Years	
Age at first reproduction (from allometric model)	4.1	3.4–4.9	Years	
Current adult annual survival rate (from raw input parameters)	93.3	84.6–97.8	%	
Optimal adult annual survival rate (from raw input parameters)	93.2	85.0–97.7	%	
Optimal adult annual survival rate (from allometric model)	88.5	83.2–92.6	%	
Proportion of adults breeding (from raw input parameters)	88.8	74.9–96.4	%	
Annual breeding pairs (from raw input parameters)	2 460	2 020–2 970	Pairs	
Total population size (from raw input parameters)	11 700	7 480–19 900	Individuals	
Maximum net productivity rate r_{max}	0.141	0.113–0.173		

1.30 Cook's petrel (*Pterodroma cookii*)

Table 59: Raw input data of population parameters of Cook's petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	216 000 to 419 000 pairs	Rayner et al. (2007), Rayner et al. (2008)	High
Age at first reproduction	6 to 7 years	Grey-faced petrel as proxy; Schreiber & Burger (2001)	
Current survival rate	94 %	Grey-faced petrel as proxy; Marchant & Higgins (1990)	
Optimal survival rate	94 %	Grey-faced petrel as proxy; Marchant & Higgins (1990)	
Body mass	187 g	Myhrvold et al. (2015)	
Breeding period	September–April	G. Taylor (pers. comm.)	
Relative non-breeding pop.	0.5%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

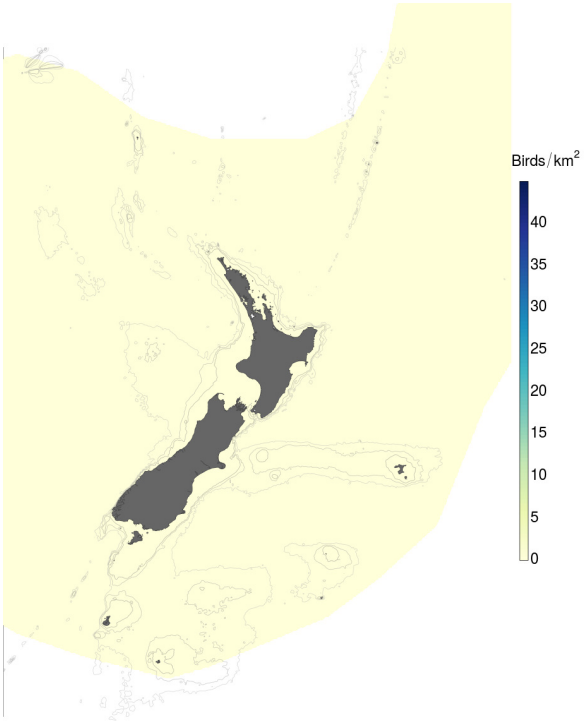
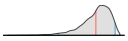
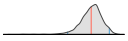
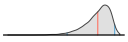
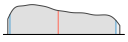
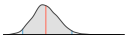


Figure 30: Relative density of Cook's petrel (*Pterodroma cookii*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 60: Derived values of population parameters of Cook's petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

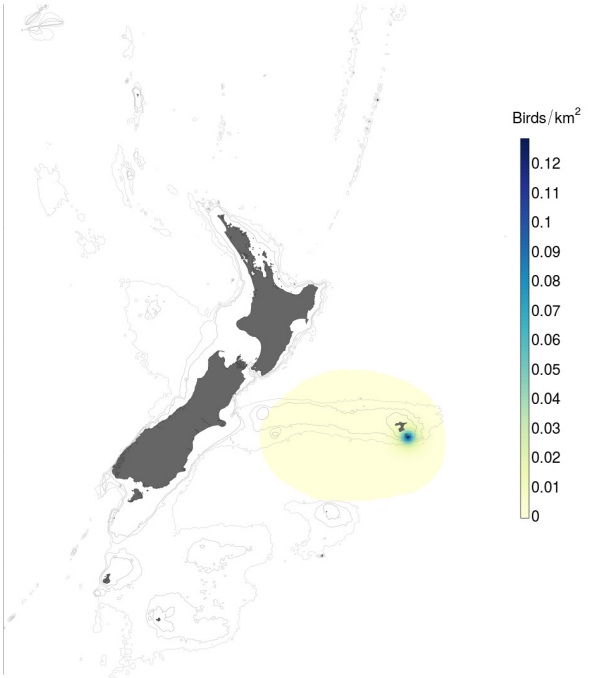
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	6.5	6.0–7.0	Years	
Age at first reproduction (from allometric model)	4.3	3.6–5.0	Years	
Current adult annual survival rate (from raw input parameters)	93.2	84.3–97.8	%	
Optimal adult annual survival rate (from raw input parameters)	93.2	84.4–97.7	%	
Optimal adult annual survival rate (from allometric model)	89.0	84.1–92.7	%	
Proportion of adults breeding (from raw input parameters)	88.9	75.7–96.3	%	
Annual breeding pairs (from raw input parameters)	307 000	220 000–412 000	Pairs	
Total population size (from raw input parameters)	1 470 000	859 000–2 610 000	Individuals	
Maximum net productivity rate r_{max}	0.135	0.110–0.163		

1.31 Chatham petrel (*Pterodroma axillaris*)

Table 61: Raw input data of population parameters of Chatham petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	250 pairs [2009]	BirdLife International (2012)	Medium
Age at first reproduction	6 to 7 years	Grey-faced petrel as proxy; Schreiber & Burger (2001)	
Current survival rate	94 %	Grey-faced petrel as proxy; Marchant & Higgins (1990)	
Optimal survival rate	94 %	Grey-faced petrel as proxy; Marchant & Higgins (1990)	
Body mass	165 g	Myhrvold et al. (2015)	
Breeding period	November–June	G. Taylor (pers. comm.)	
Relative non-breeding pop.	0%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

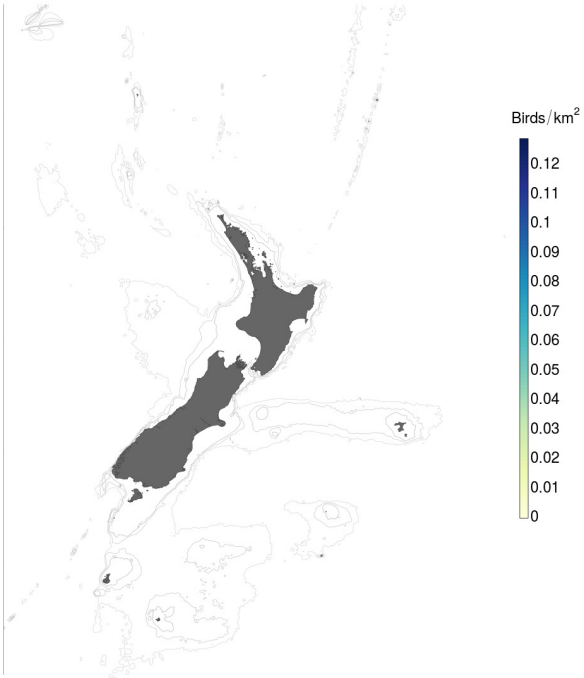
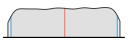
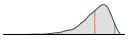
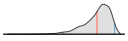
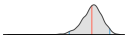
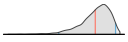
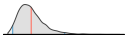


Figure 31: Relative density of Chatham petrel (*Pterodroma axillaris*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 62: Derived values of population parameters of Chatham petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	6.5	6.0–7.0	Years	
Age at first reproduction (from allometric model)	4.1	3.5–4.9	Years	
Current adult annual survival rate (from raw input parameters)	93.3	84.9–97.9	%	
Optimal adult annual survival rate (from raw input parameters)	93.2	84.5–97.7	%	
Optimal adult annual survival rate (from allometric model)	88.6	83.8–92.5	%	
Proportion of adults breeding (from raw input parameters)	89.0	75.7–96.4	%	
Annual breeding pairs (from raw input parameters)	255	170–367	Pairs	
Total population size (from raw input parameters)	1 190	674–2 120	Individuals	
Maximum net productivity rate r_{max}	0.140	0.113–0.171		

1.32 Mottled petrel (*Pterodroma inexpectata*)

Table 63: Raw input data of population parameters of mottled petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	300 000 to 400 000 pairs [1999]	Taylor (2000b)	
Age at first reproduction	6 to 7 years	Grey-faced petrel as proxy; Schreiber & Burger (2001)	
Current survival rate	94 %	Grey-faced petrel as proxy; Marchant & Higgins (1990)	
Optimal survival rate	94 %	Grey-faced petrel as proxy; Marchant & Higgins (1990)	
Body mass	304 g	Myhrvold et al. (2015)	
Breeding period	October–May	G. Taylor (pers. comm.)	
Relative non-breeding pop.	0%	G. Taylor (pers. comm.)	

(a) Breeding season distribution

(b) Non-breeding season distribution

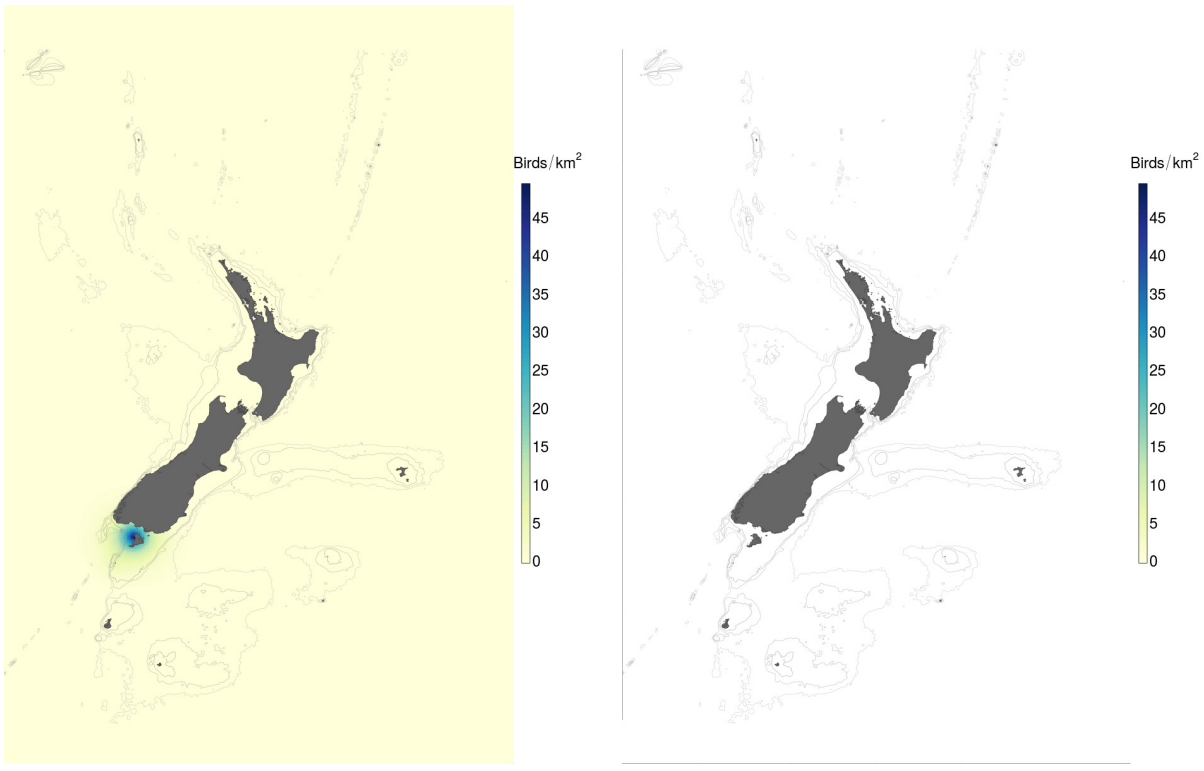
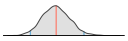
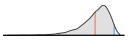
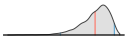
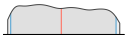
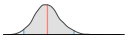


Figure 32: Relative density of mottled petrel (*Pterodroma inexpectata*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 64: Derived values of population parameters of mottled petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

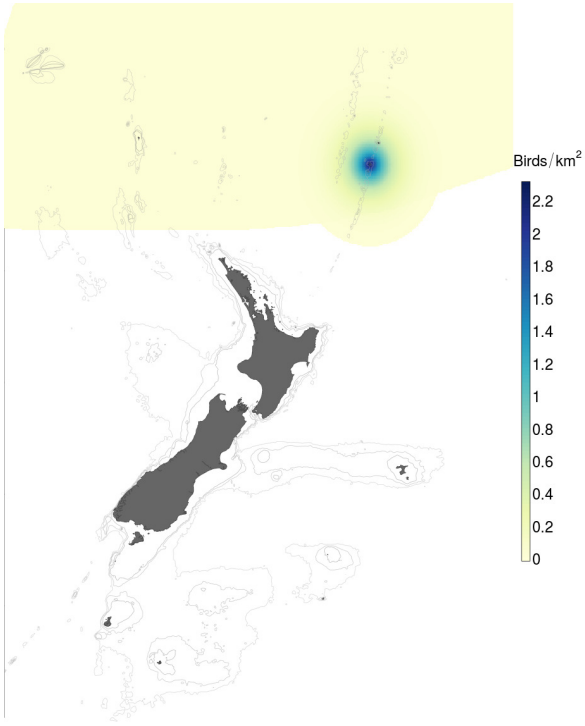
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	6.5	6.0–7.0	Years	
Age at first reproduction (from allometric model)	4.8	4.2–5.5	Years	
Current adult annual survival rate (from raw input parameters)	93.3	84.8–97.8	%	
Optimal adult annual survival rate (from raw input parameters)	93.4	85.0–97.8	%	
Optimal adult annual survival rate (from allometric model)	90.4	86.7–93.2	%	
Proportion of adults breeding (from raw input parameters)	89.0	75.8–96.4	%	
Annual breeding pairs (from raw input parameters)	348 000	303 000–397 000	Pairs	
Total population size (from raw input parameters)	1 640 000	1 100 000–2 620 000	Individuals	
Maximum net productivity rate r_{max}	0.116	0.098–0.137		

1.33 White-naped petrel (*Pterodroma cervicalis*)

Table 65: Raw input data of population parameters of white-naped petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	50 000 pairs [1988]	Taylor (2000a)	
Age at first reproduction	6 to 7 years	Grey-faced petrel as proxy; Schreiber & Burger (2001)	
Current survival rate	94 %	Grey-faced petrel as proxy; Marchant & Higgins (1990)	
Optimal survival rate	94 %	Grey-faced petrel as proxy; Marchant & Higgins (1990)	
Body mass	438 g	Myhrvold et al. (2015)	
Breeding period	October–May	G. Taylor (pers. comm.)	
Relative non-breeding pop.	0%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

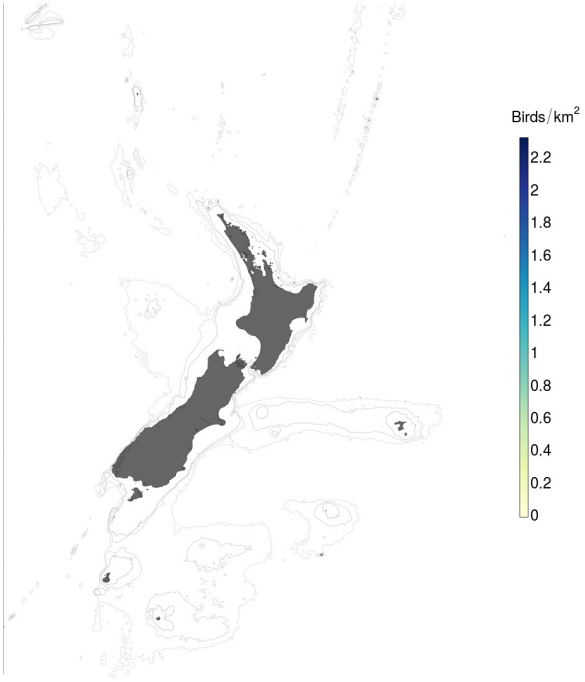
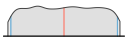
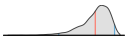
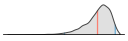
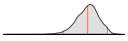
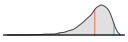
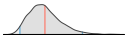


Figure 33: Relative density of white-naped petrel (*Pterodroma cervicalis*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 66: Derived values of population parameters of white-naped petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	6.5	6.0–7.0	Years	
Age at first reproduction (from allometric model)	5.3	4.7–6.0	Years	
Current adult annual survival rate (from raw input parameters)	93.3	84.7–97.8	%	
Optimal adult annual survival rate (from raw input parameters)	93.3	84.9–97.9	%	
Optimal adult annual survival rate (from allometric model)	91.3	88.4–93.6	%	
Proportion of adults breeding (from raw input parameters)	89.0	75.3–96.4	%	
Annual breeding pairs (from raw input parameters)	52 400	28 100–88 900	Pairs	
Total population size (from raw input parameters)	268 000	129 000–519 000	Individuals	
Maximum net productivity rate r_{max}	0.104	0.090–0.121		

1.34 Kermadec petrel (*Pterodroma neglecta*)

Table 67: Raw input data of population parameters of Kermadec petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment.

Parameter	Data	Reference	Quality
Population (NZ)	5 000 to 7 000 pairs	Taylor (2000b)	Poor
Age at first reproduction	6 to 7 years	Grey-faced petrel as proxy; Schreiber & Burger (2001)	
Current survival rate	94 %	Grey-faced petrel as proxy; Marchant & Higgins (1990)	
Optimal survival rate	94 %	Grey-faced petrel as proxy; Marchant & Higgins (1990)	
Body mass	485 g	Myhrvold et al. (2015)	
Breeding period	All year	G. Taylor (pers. comm.)	

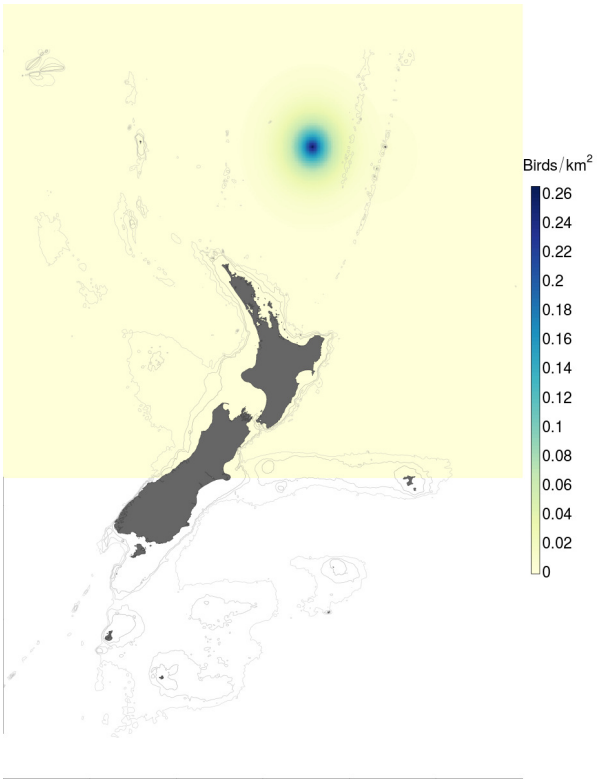
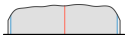
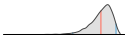
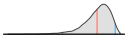
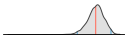
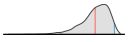
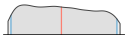
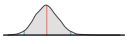


Figure 34: Relative density of Kermadec petrel (*Pterodroma neglecta*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 68: Derived values of population parameters of Kermadec petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

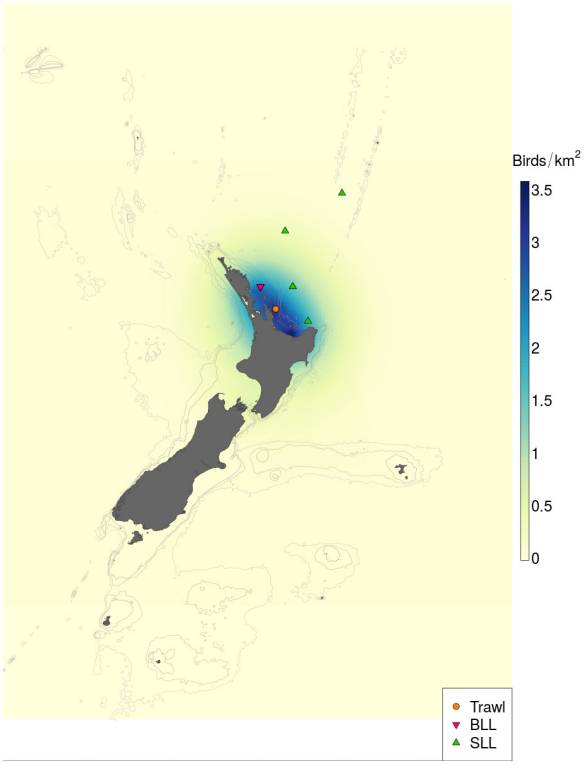
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	6.5	6.0–7.0	Years	
Age at first reproduction (from allometric model)	5.4	4.8–6.1	Years	
Current adult annual survival rate (from raw input parameters)	93.3	85.0–97.8	%	
Optimal adult annual survival rate (from raw input parameters)	93.3	84.8–97.8	%	
Optimal adult annual survival rate (from allometric model)	91.5	88.8–93.7	%	
Proportion of adults breeding (from raw input parameters)	89.0	75.5–96.5	%	
Annual breeding pairs (from raw input parameters)	5 950	5 050–6 940	Pairs	
Total population size (from raw input parameters)	30 800	20 700–51 300	Individuals	
Maximum net productivity rate r_{max}	0.101	0.087–0.116		

1.35 Grey-faced petrel (*Pterodroma macroptera gouldi*)

Table 69: Raw input data of population parameters of grey-faced petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	200 000 to 300 000 pairs	Taylor (2000b)	Medium
Age at first reproduction	6 to 7 years	Schreiber & Burger (2001)	
Current survival rate	94 %	Marchant & Higgins (1990)	
Optimal survival rate	94 %	Marchant & Higgins (1990)	
Body mass	624 g	Myhrvold et al. (2015)	
Breeding period	March–January	G. Taylor (pers. comm.)	
Relative non-breeding pop.	10%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

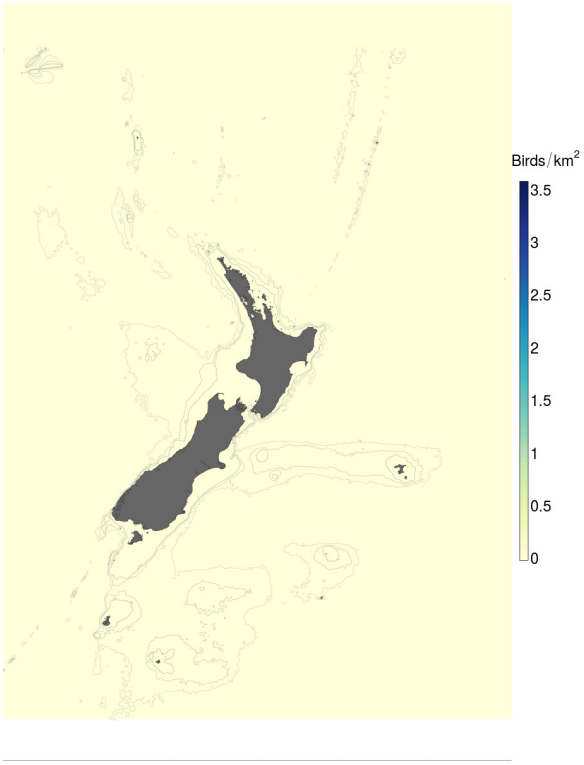
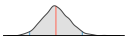
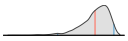
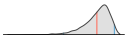
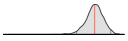
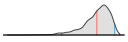
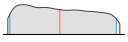


Figure 35: Relative density of grey-faced petrel (*Pterodroma macroptera gouldi*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), and bottom-longline (BLL) fisheries.

Table 70: Derived values of population parameters of grey-faced petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

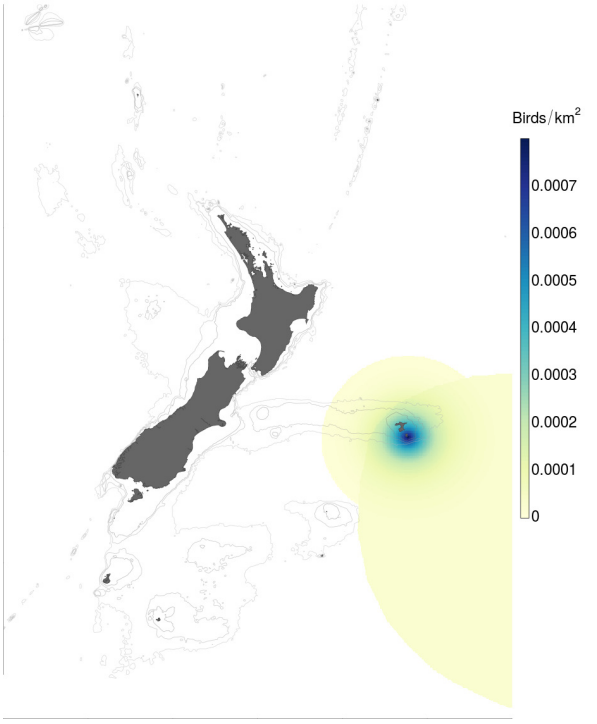
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	6.5	6.0–7.0	Years	
Age at first reproduction (from allometric model)	5.8	5.1–6.5	Years	
Current adult annual survival rate (from raw input parameters)	93.3	84.4–97.8	%	
Optimal adult annual survival rate (from raw input parameters)	93.3	84.8–97.8	%	
Optimal adult annual survival rate (from allometric model)	92.1	89.9–94.0	%	
Proportion of adults breeding (from raw input parameters)	88.8	74.0–96.3	%	
Annual breeding pairs (from raw input parameters)	246 000	202 000–297 000	Pairs	
Total population size (from raw input parameters)	1 270 000	834 000–2 070 000	Individuals	
Maximum net productivity rate r_{max}	0.094	0.082–0.107		

1.36 Chatham Island taiko (*Pterodroma magentae*)

Table 71: Raw input data of population parameters of Chatham Island taiko for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	17 pairs [2010]	BirdLife International (2012)	High
Age at first reproduction	6 to 7 years	Grey-faced petrel as proxy; Schreiber & Burger (2001)	
Current survival rate	94 %	Grey-faced petrel as proxy; Marchant & Higgins (1990)	
Optimal survival rate	94 %	Grey-faced petrel as proxy; Marchant & Higgins (1990)	
Body mass	465 g	Myhrvold et al. (2015)	
Breeding period	September–May	G. Taylor (pers. comm.)	
Relative non-breeding pop.	20%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

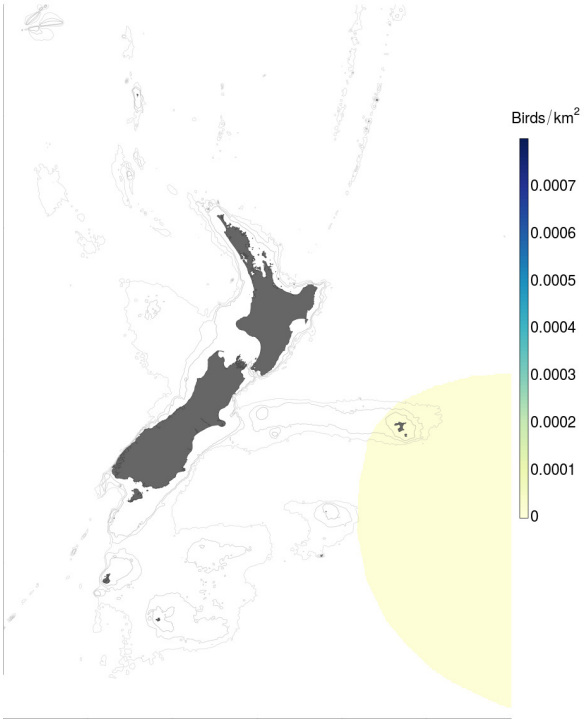
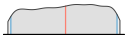
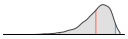
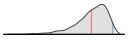
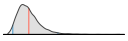
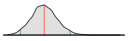


Figure 36: Relative density of Chatham Island taiko (*Pterodroma magentae*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 72: Derived values of population parameters of Chatham Island taiko for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

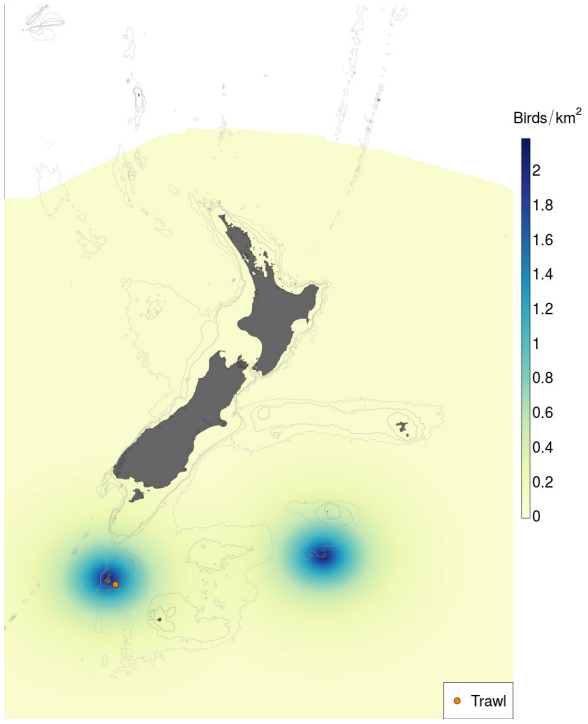
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	6.5	6.0–7.0	Years	
Age at first reproduction (from allometric model)	5.4	4.7–6.1	Years	
Current adult annual survival rate (from raw input parameters)	93.2	84.8–97.8	%	
Optimal adult annual survival rate (from raw input parameters)	93.2	84.7–97.8	%	
Optimal adult annual survival rate (from allometric model)	91.4	88.8–93.7	%	
Proportion of adults breeding (from raw input parameters)	88.9	75.0–96.2	%	
Annual breeding pairs (from raw input parameters)	17	14–21	Pairs	
Total population size (from raw input parameters)	88	58–142	Individuals	
Maximum net productivity rate r_{max}	0.103	0.088–0.118		

1.37 White-headed petrel (*Pterodroma lessonii*)

Table 73: Raw input data of population parameters of white-headed petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	200 000 pairs	de L. Brooke (2004)	
Age at first reproduction	5.5 years	Schreiber & Burger (2001)	
Current survival rate	94 %	Grey-faced petrel as proxy; Marchant & Higgins (1990)	
Optimal survival rate	94 %	Grey-faced petrel as proxy; Marchant & Higgins (1990)	
Body mass	667 g	Myhrvold et al. (2015)	
Breeding period	August–May	G. Taylor (pers. comm.)	
Relative non-breeding pop.	10%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

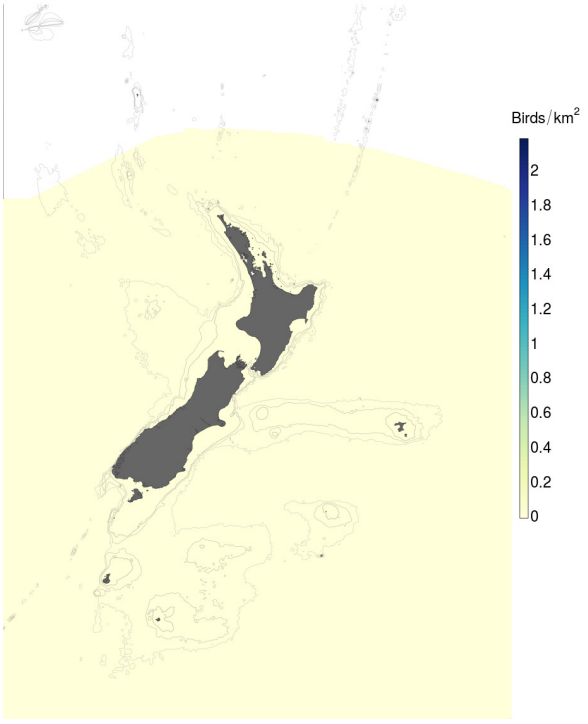
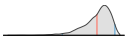
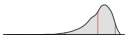
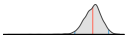
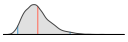
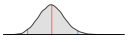


Figure 37: Relative density of white-headed petrel (*Pterodroma lessonii*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl fisheries.

Table 74: Derived values of population parameters of white-headed petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

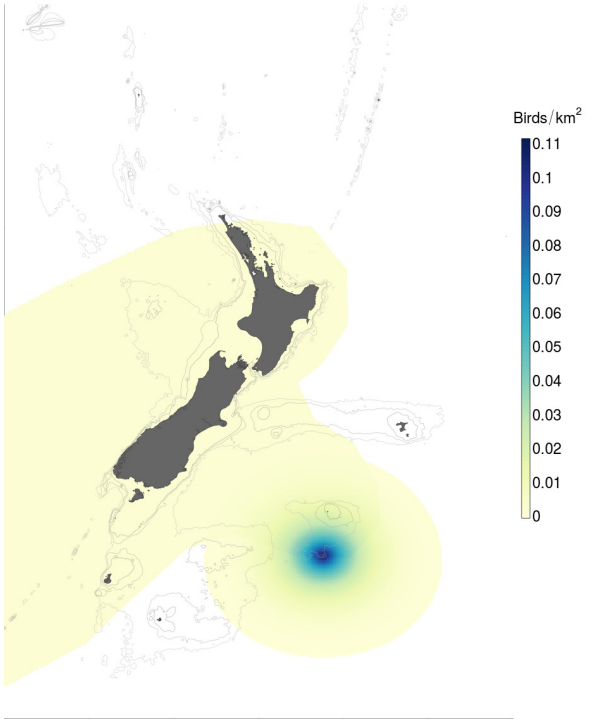
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	5.5	4.1–6.9	Years	
Age at first reproduction (from allometric model)	5.9	5.2–6.6	Years	
Current adult annual survival rate (from raw input parameters)	93.3	84.6–97.8	%	
Optimal adult annual survival rate (from raw input parameters)	93.3	84.9–97.8	%	
Optimal adult annual survival rate (from allometric model)	92.2	90.1–94.1	%	
Proportion of adults breeding (from raw input parameters)	60.0	49.9–69.4	%	
Annual breeding pairs (from raw input parameters)	210 000	112 000–371 000	Pairs	
Total population size (from raw input parameters)	1 480 000	727 000–2 840 000	Individuals	
Maximum net productivity rate r_{max}	0.093	0.081–0.105		

1.38 Soft-plumaged petrel (*Pterodroma mollis*)

Table 75: Raw input data of population parameters of soft-plumaged petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	1 000 to 9 999 pairs	Taylor (2000b)	Poor
Age at first reproduction	6 to 7 years	Grey-faced petrel as proxy; Schreiber & Burger (2001)	
Current survival rate	94 %	Grey-faced petrel as proxy; Marchant & Higgins (1990)	
Optimal survival rate	94 %	Grey-faced petrel as proxy; Marchant & Higgins (1990)	
Body mass	312 g	Myhrvold et al. (2015)	
Breeding period	September–May	G. Taylor (pers. comm.)	
Relative non-breeding pop.	0.5%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

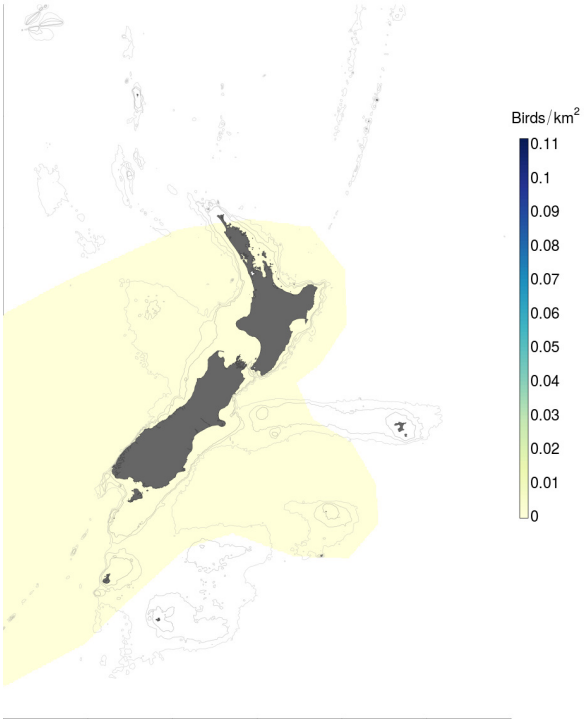
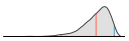
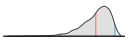
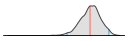
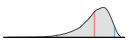
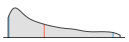
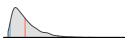


Figure 38: Relative density of soft-plumaged petrel (*Pterodroma mollis*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 76: Derived values of population parameters of soft-plumaged petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	6.5	6.0–7.0	Years	
Age at first reproduction (from allometric model)	4.9	4.2–5.5	Years	
Current adult annual survival rate (from raw input parameters)	93.3	84.5–97.8	%	
Optimal adult annual survival rate (from raw input parameters)	93.4	85.1–97.8	%	
Optimal adult annual survival rate (from allometric model)	90.4	87.0–93.2	%	
Proportion of adults breeding (from raw input parameters)	88.9	75.0–96.4	%	
Annual breeding pairs (from raw input parameters)	3 910	1 070–9 440	Pairs	
Total population size (from raw input parameters)	17 300	4 790–44 600	Individuals	
Maximum net productivity rate r_{max}	0.116	0.098–0.136		

1.39 Common diving petrel (*Pelecanoides urinatrix*)

Table 77: Raw input data of population parameters of common diving petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	300 000 to 2 150 000 pairs	Taylor (2000b)	Poor
Age at first reproduction	2 to 3 years	de L. Brooke (2004)	
Current survival rate	75 to 87 %	Schreiber & Burger (2001)	
Optimal survival rate	75 to 87 %	Schreiber & Burger (2001)	
Body mass	120 g	Myhrvold et al. (2015)	
Breeding period	March–January	G. Taylor (pers. comm.)	
Relative non-breeding pop.	20%	G. Taylor (pers. comm.)	

(a) Breeding season distribution **(b) Non-breeding season distribution**

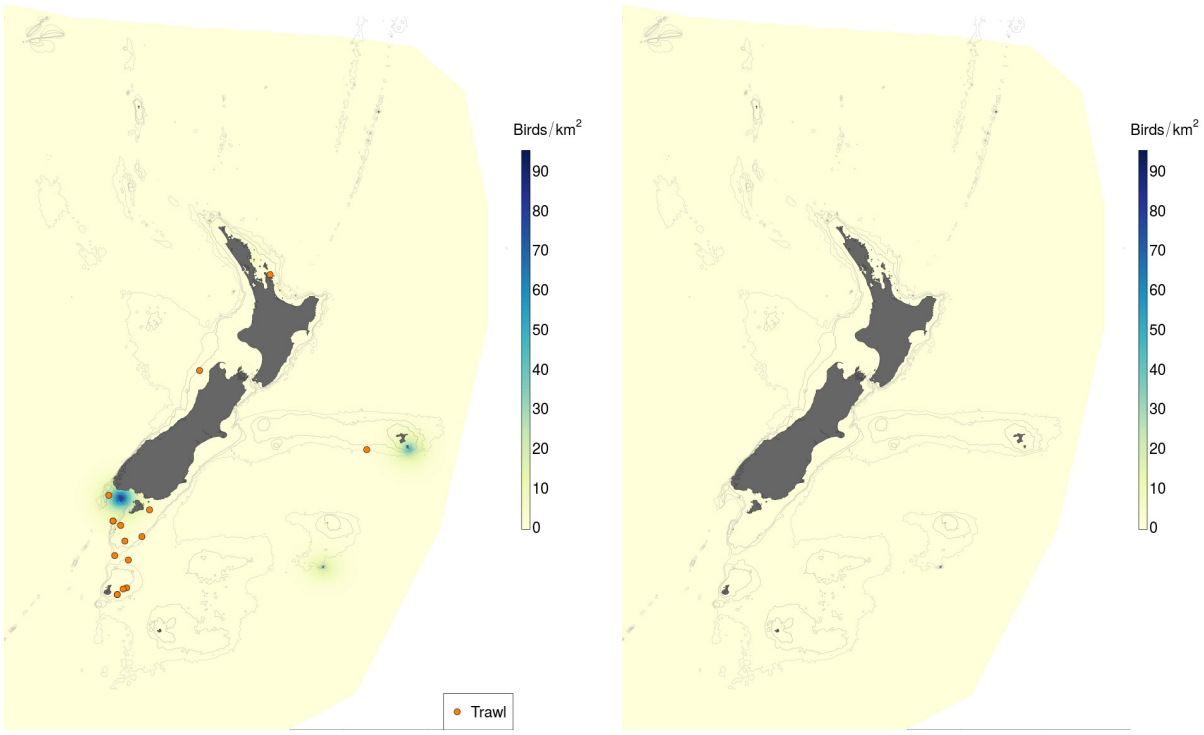
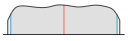
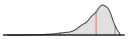
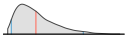
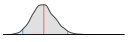


Figure 39: Relative density of common diving petrel (*Pelecanoides urinatrix*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl fisheries.

Table 78: Derived values of population parameters of common diving petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	2.5	2.0–3.0	Years	
Age at first reproduction (from allometric model)	3.8	3.2–4.6	Years	
Current adult annual survival rate (from raw input parameters)	81.1	75.3–86.7	%	
Optimal adult annual survival rate (from raw input parameters)	81.0	75.3–86.7	%	
Optimal adult annual survival rate (from allometric model)	87.7	81.4–92.4	%	
Proportion of adults breeding (from raw input parameters)	88.7	74.1–96.4	%	
Annual breeding pairs (from raw input parameters)	939 000	314 000–2 060 000	Pairs	
Total population size (from raw input parameters)	3 520 000	1 290 000–7 840 000	Individuals	
Maximum net productivity rate r_{max}	0.154	0.121–0.191		

1.40 South Georgian diving petrel (*Pelecanoides georgicus*)

Table 79: Raw input data of population parameters of South Georgian diving petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	64 pairs [1998]	Taylor (2000b)	
Age at first reproduction	2 to 3 years	Common diving petrel as proxy; de L. Brooke (2004)	
Current survival rate	75 to 87 %	Common diving petrel as proxy; Schreiber & Burger (2001)	
Optimal survival rate	75 to 87 %	Common diving petrel as proxy; Schreiber & Burger (2001)	
Body mass	120 g	Myhrvold et al. (2015)	
Breeding period	September–February	G. Taylor (pers. comm.)	
Relative non-breeding pop.	0%	G. Taylor (pers. comm.)	

(a) Breeding season distribution **(b) Non-breeding season distribution**

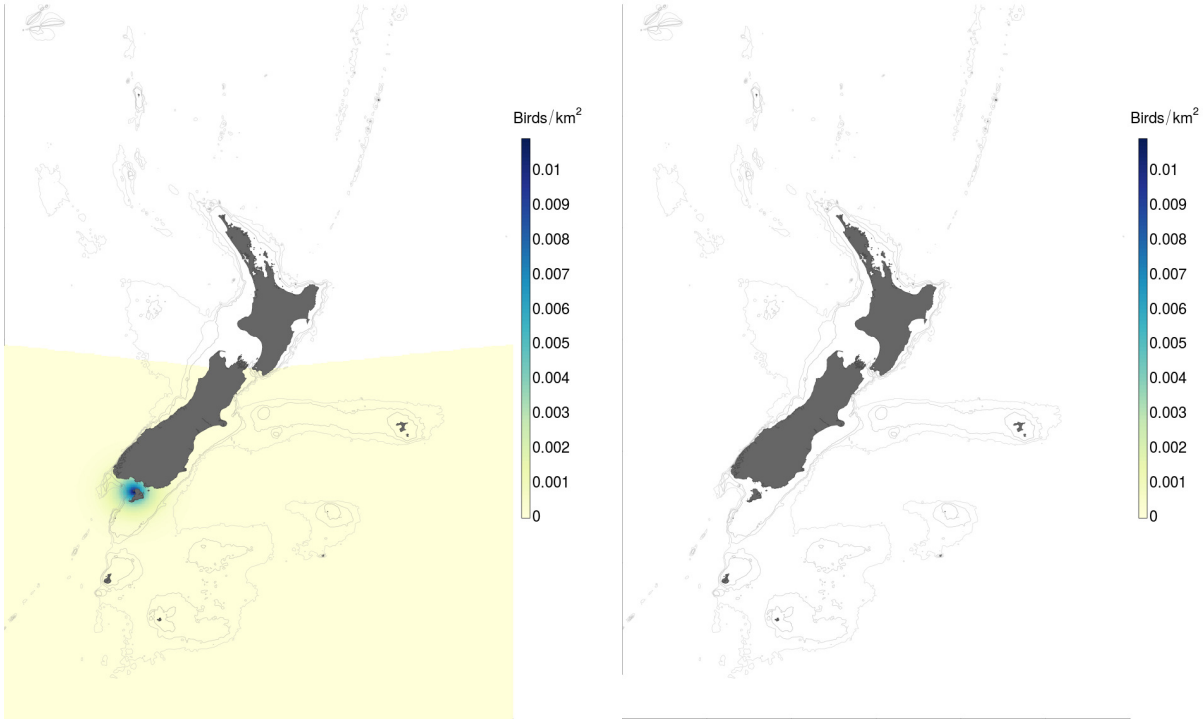
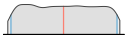
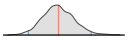
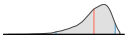
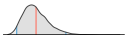
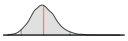


Figure 40: Relative density of South Georgian diving petrel (*Pelecanoides georgicus*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 80: Derived values of population parameters of South Georgian diving petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

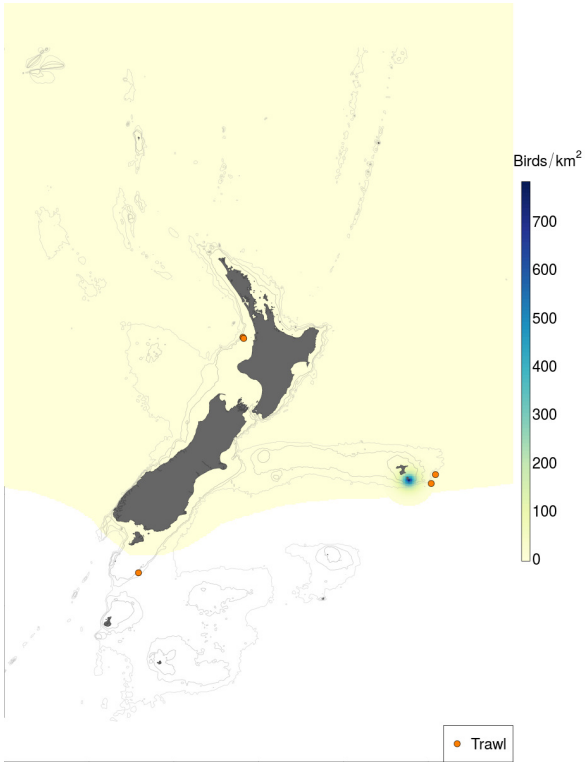
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	2.5	2.0–3.0	Years	
Age at first reproduction (from allometric model)	3.8	3.1–4.6	Years	
Current adult annual survival rate (from raw input parameters)	81.0	75.3–86.7	%	
Optimal adult annual survival rate (from raw input parameters)	80.9	75.3–86.7	%	
Optimal adult annual survival rate (from allometric model)	87.6	81.4–92.4	%	
Proportion of adults breeding (from raw input parameters)	88.9	75.5–96.4	%	
Annual breeding pairs (from raw input parameters)	67	36–114	Pairs	
Total population size (from raw input parameters)	263	135–470	Individuals	
Maximum net productivity rate r_{max}	0.154	0.121–0.193		

1.41 New Zealand white-faced storm petrel (*Pelagodroma marina maoriana*)

Table 81: Raw input data of population parameters of New Zealand white-faced storm petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	More than 1 000 000 pairs	Taylor (2000b)	Medium
Age at first reproduction	4 to 5 years	Several species as proxy; Croxall (1987)	
	More than 3 years	de L. Brooke (2004)	
Current survival rate	90 %	Several species as proxy; Croxall (1987)	
Optimal survival rate	90 %	Several species as proxy; Croxall (1987)	
Body mass	44 g	Myhrvold et al. (2015)	
Breeding period	September–April	G. Taylor (pers. comm.)	
Relative non-breeding pop.	0.5%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

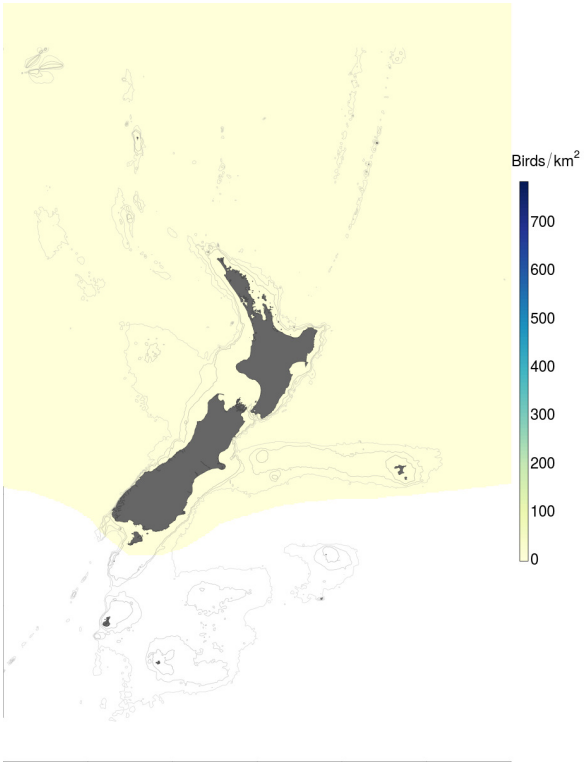
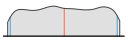
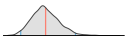
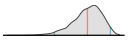
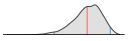
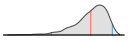
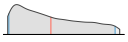
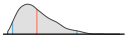
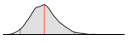


Figure 41: Relative density of New Zealand white-faced storm petrel (*Pelagodroma marina maoriana*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl fisheries.

Table 82: Derived values of population parameters of New Zealand white-faced storm petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

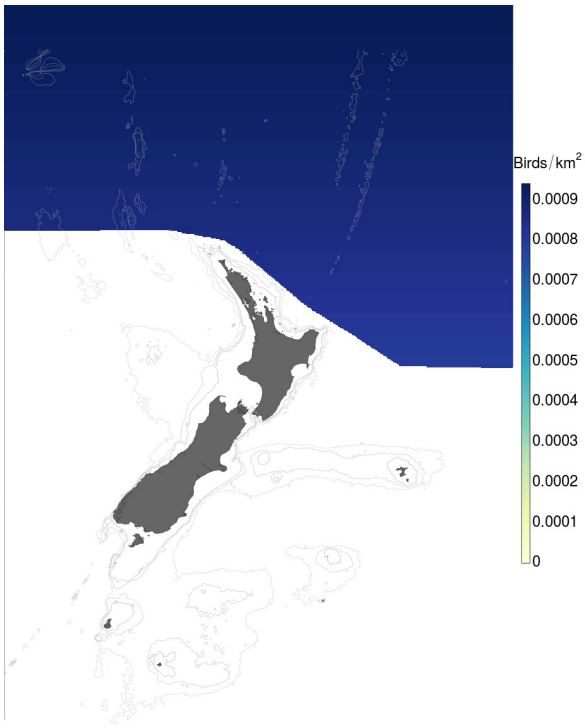
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	4.0	3.0–5.0	Years	
Age at first reproduction (from allometric model)	3.0	2.3–3.8	Years	
Current adult annual survival rate (from raw input parameters)	89.6	82.6–94.5	%	
Optimal adult annual survival rate (from raw input parameters)	89.6	82.4–94.6	%	
Optimal adult annual survival rate (from allometric model)	84.1	73.6–91.6	%	
Proportion of adults breeding (from raw input parameters)	88.9	75.5–96.3	%	
Annual breeding pairs (from raw input parameters)	1 590 000	725 000–2 910 000	Pairs	
Total population size (from raw input parameters)	6 300 000	2 790 000–12 100 000	Individuals	
Maximum net productivity rate r_{max}	0.210	0.150–0.286		

1.42 White-bellied storm petrel (*Fregetta grallaria grallaria*)

Table 83: Raw input data of population parameters of white-bellied storm petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	1 000 pairs	Taylor (2000a)	Poor
Age at first reproduction	4 to 5 years	Several species as proxy; Croxall (1987)	
Current survival rate	90 %	Several species as proxy; Croxall (1987)	
Optimal survival rate	90 %	Several species as proxy; Croxall (1987)	
Body mass	50 g	Myhrvold et al. (2015)	
Breeding period	April–August	G. Taylor (pers. comm.)	
Relative non-breeding pop.	100%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

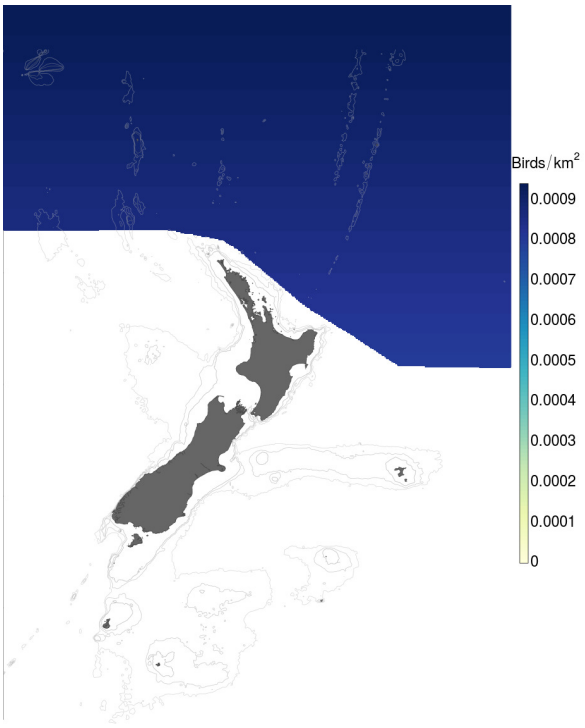
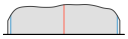
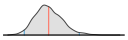
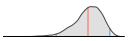
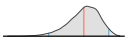
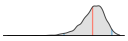
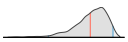
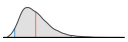
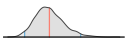


Figure 42: Relative density of white-bellied storm petrel (*Fregetta grallaria grallaria*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 84: Derived values of population parameters of white-bellied storm petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

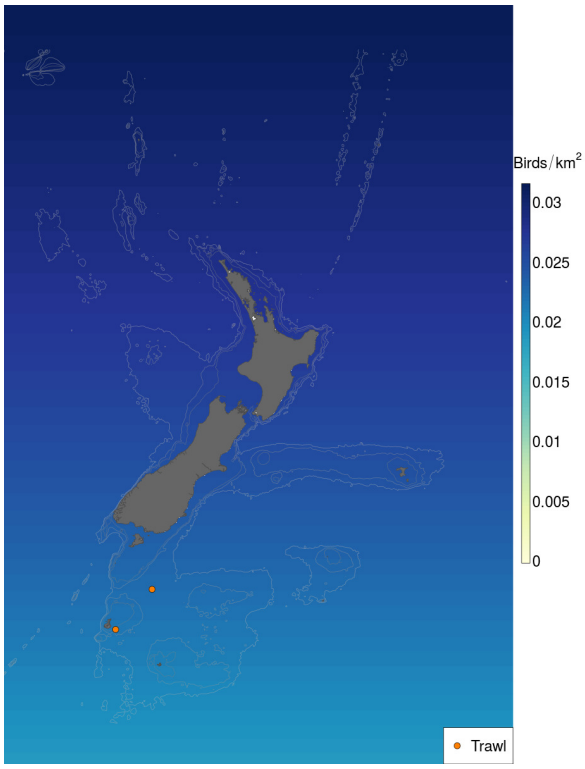
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	4.5	4.0–5.0	Years	
Age at first reproduction (from allometric model)	3.1	2.4–4.0	Years	
Current adult annual survival rate (from raw input parameters)	89.6	82.3–94.6	%	
Optimal adult annual survival rate (from raw input parameters)	89.6	82.4–94.6	%	
Optimal adult annual survival rate (from allometric model)	84.4	73.9–91.5	%	
Proportion of adults breeding (from raw input parameters)	88.7	74.6–96.3	%	
Annual breeding pairs (from raw input parameters)	1 050	555–1 820	Pairs	
Total population size (from raw input parameters)	4 580	2 240–8 560	Individuals	
Maximum net productivity rate r_{max}	0.202	0.147–0.272		

1.43 Black-bellied storm petrel (*Fregetta tropica*)

Table 85: Raw input data of population parameters of black-bellied storm petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	50 000 to 100 000 pairs	Taylor (2000b)	Poor
Age at first reproduction	4 to 5 years	Several species as proxy; Croxall (1987)	
Current survival rate	90 %	Several species as proxy; Croxall (1987)	
Optimal survival rate	90 %	Several species as proxy; Croxall (1987)	
Body mass	53 g	Myhrvold et al. (2015)	
Breeding period	October–May	G. Taylor (pers. comm.)	
Relative non-breeding pop.	50%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

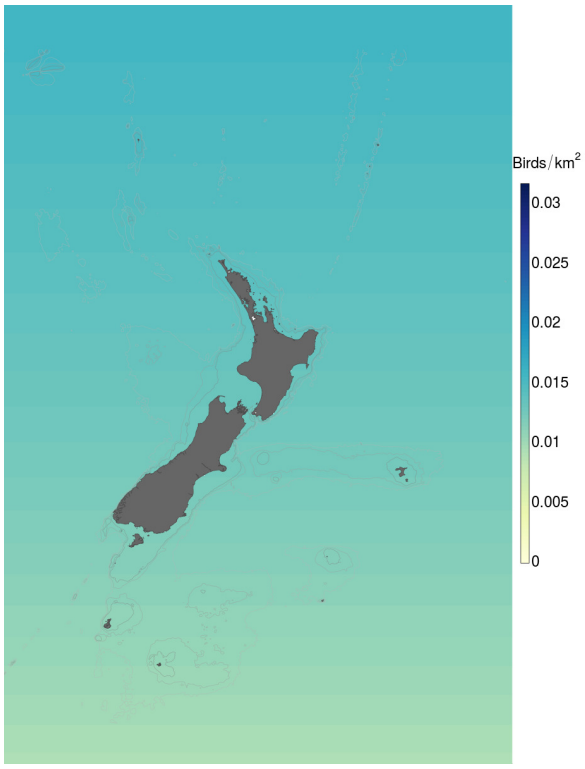
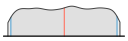
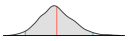
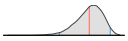
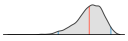
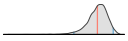
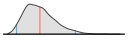
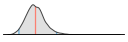


Figure 43: Relative density of black-bellied storm petrel (*Fregetta tropica*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl fisheries.

Table 86: Derived values of population parameters of black-bellied storm petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

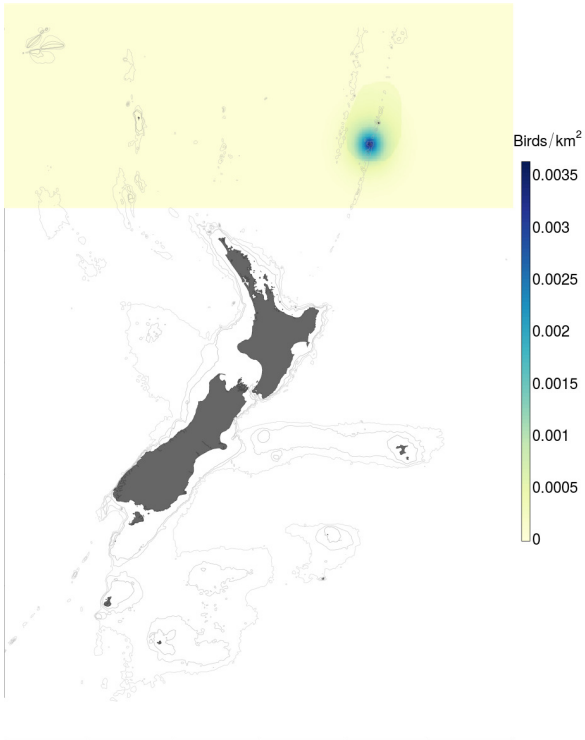
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	4.5	4.0–5.0	Years	
Age at first reproduction (from allometric model)	3.1	2.4–3.9	Years	
Current adult annual survival rate (from raw input parameters)	89.6	82.5–94.6	%	
Optimal adult annual survival rate (from raw input parameters)	89.6	82.3–94.6	%	
Optimal adult annual survival rate (from allometric model)	84.5	74.4–91.4	%	
Proportion of adults breeding (from raw input parameters)	88.9	75.2–96.2	%	
Annual breeding pairs (from raw input parameters)	72 300	50 900–98 200	Pairs	
Total population size (from raw input parameters)	314 000	198 000–489 000	Individuals	
Maximum net productivity rate r_{max}	0.199	0.146–0.266		

1.44 Kermadec storm petrel (*Pelagodroma albiclunis*)

Table 87: Raw input data of population parameters of Kermadec storm petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	Less than 100 pairs	Taylor (2000a)	
Age at first reproduction	4 to 5 years	Several species as proxy; Croxall (1987)	
	More than 3 years	de L. Brooke (2004)	
Current survival rate	90 %	Several species as proxy; Croxall (1987)	
Optimal survival rate	90 %	Several species as proxy; Croxall (1987)	
Body mass	44 g	Myhrvold et al. (2015)	
Breeding period	June–December	G. Taylor (pers. comm.)	
Relative non-breeding pop.	50%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

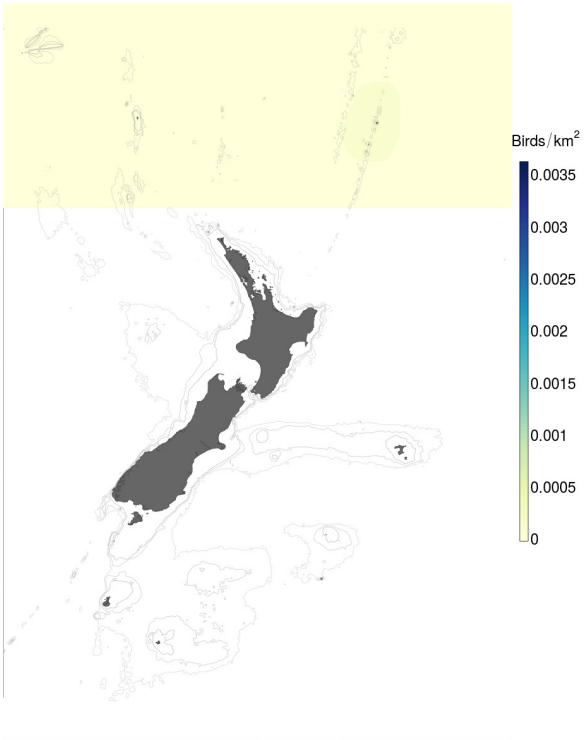
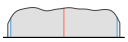
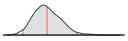
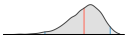
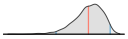
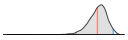
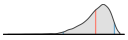
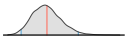


Figure 44: Relative density of Kermadec storm petrel (*Pelagodroma albiclunis*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 88: Derived values of population parameters of Kermadec storm petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	4.0	3.1–5.0	Years	
Age at first reproduction (from allometric model)	3.0	2.3–3.8	Years	
Current adult annual survival rate (from raw input parameters)	89.6	82.1–94.6	%	
Optimal adult annual survival rate (from raw input parameters)	89.6	82.3–94.5	%	
Optimal adult annual survival rate (from allometric model)	84.0	73.7–91.5	%	
Proportion of adults breeding (from raw input parameters)	88.9	76.4–96.2	%	
Annual breeding pairs (from raw input parameters)	55	21–115	Pairs	
Total population size (from raw input parameters)	216	85–470	Individuals	
Maximum net productivity rate r_{max}	0.210	0.151–0.281		

1.45 New Zealand storm petrel (*Pealeornis maoriana*)

Table 89: Raw input data of population parameters of New Zealand storm petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment.

Parameter	Data	Reference	Quality
Population (NZ)	20 to 1 000 pairs	NA	Poor
Age at first reproduction	4 to 5 years	Several species as proxy; Croxall (1987)	
Current survival rate	90 %	Several species as proxy; Croxall (1987)	
Optimal survival rate	90 %	Several species as proxy; Croxall (1987)	
Body mass	35 g	Gaskin (2013)	High
Breeding period	All year	G. Taylor (pers. comm.)	

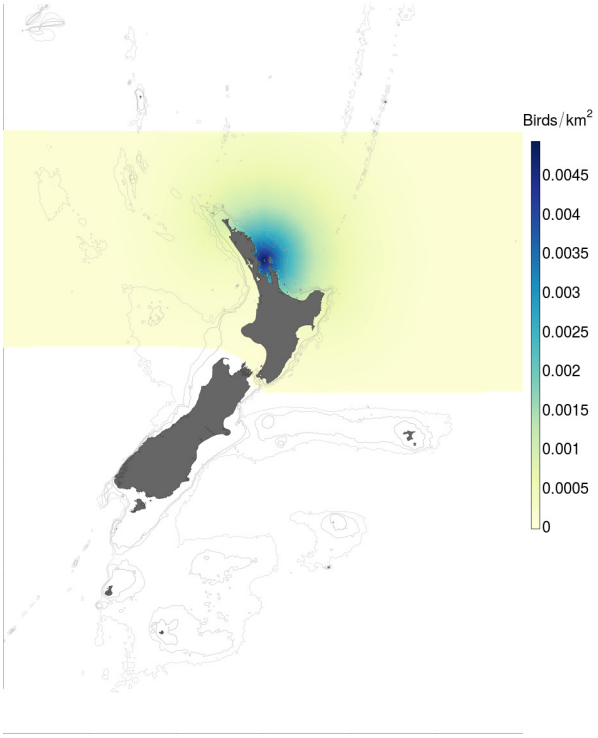
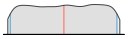
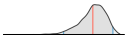
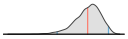
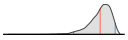


Figure 45: Relative density of New Zealand storm petrel (*Pealeornis maoriana*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 90: Derived values of population parameters of New Zealand storm petrel for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	4.5	4.0–5.0	Years	
Age at first reproduction (from allometric model)	2.8	2.1–3.7	Years	
Current adult annual survival rate (from raw input parameters)	89.5	82.2–94.5	%	
Optimal adult annual survival rate (from raw input parameters)	89.7	82.6–94.6	%	
Optimal adult annual survival rate (from allometric model)	83.0	70.9–90.6	%	
Proportion of adults breeding (from raw input parameters)	88.8	75.4–96.4	%	
Annual breeding pairs (from raw input parameters)	247	22–898	Pairs	
Total population size (from raw input parameters)	896	107–3 290	Individuals	
Maximum net productivity rate r_{max}	0.227	0.162–0.314		

1.46 Yellow-eyed penguin (*Megadyptes antipodes*)

Table 91: Raw input data of population parameters of yellow-eyed penguin for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	1 450 to 1 890 pairs	Ellenberg & Mattern (2012)	Medium
Age at first reproduction	2 to 4 years	Ellenberg & Mattern (2012)	
Current survival rate	87 %	Schreiber & Burger (2001)	
Optimal survival rate	87 %	Schreiber & Burger (2001)	
Body mass	5 328 g	Myhrvold et al. (2015)	
Breeding period	August–April	G. Taylor (pers. comm.)	
Relative non-breeding pop.	100%	G. Taylor (pers. comm.)	

(a) Breeding season distribution **(b) Non-breeding season distribution**

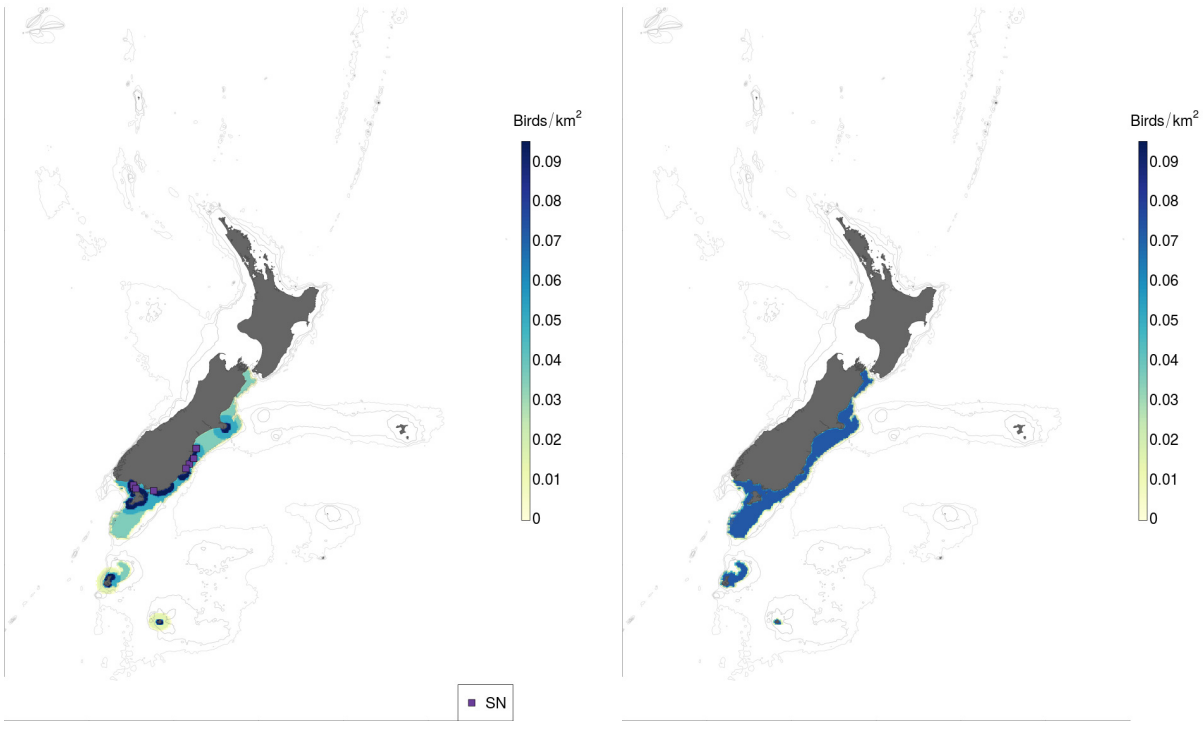
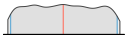
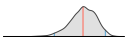
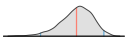
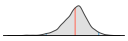
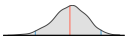
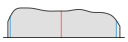
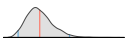
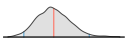


Figure 46: Relative density of yellow-eyed penguin (*Megadyptes antipodes*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in set-net (SN) fisheries.

Table 92: Derived values of population parameters of yellow-eyed penguin for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

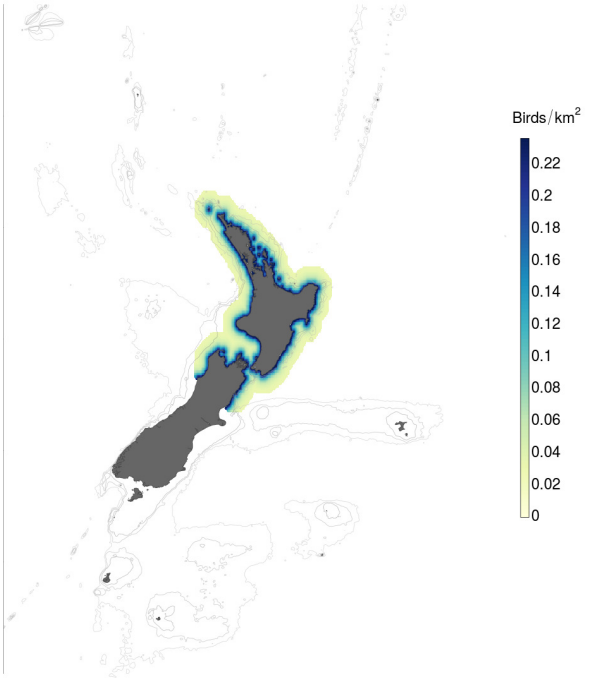
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	3.0	2.0–4.0	Years	
Age at first reproduction (from allometric model)	4.4	3.4–5.7	Years	
Current adult annual survival rate (from raw input parameters)	86.6	79.9–91.9	%	
Optimal adult annual survival rate (from raw input parameters)	86.7	79.9–91.9	%	
Optimal adult annual survival rate (from allometric model)	88.2	83.2–92.2	%	
Proportion of adults breeding (from raw input parameters)	68.4	58.1–77.6	%	
Annual breeding pairs (from raw input parameters)	1 660	1 460–1 880	Pairs	
Total population size (from raw input parameters)	8 510	6 160–11 700	Individuals	
Maximum net productivity rate r_{max}	0.135	0.105–0.171		

1.47 Northern little penguin (*Eudyptula minor f. iredalei*)

Table 93: Raw input data of population parameters of northern little penguin for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	5 000 to 10 000 pairs [1984]	Taylor (2000b)	Poor
Age at first reproduction	2 to 3 years	Schreiber & Burger (2001)	
Current survival rate	83 %	Sidhu et al. (2007)	Medium
Optimal survival rate	83 %	Sidhu et al. (2007)	Medium
Body mass	1 146 g	Myhrvold et al. (2015)	
Breeding period	July–February	G. Taylor (pers. comm.)	
Relative non-breeding pop.	100%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

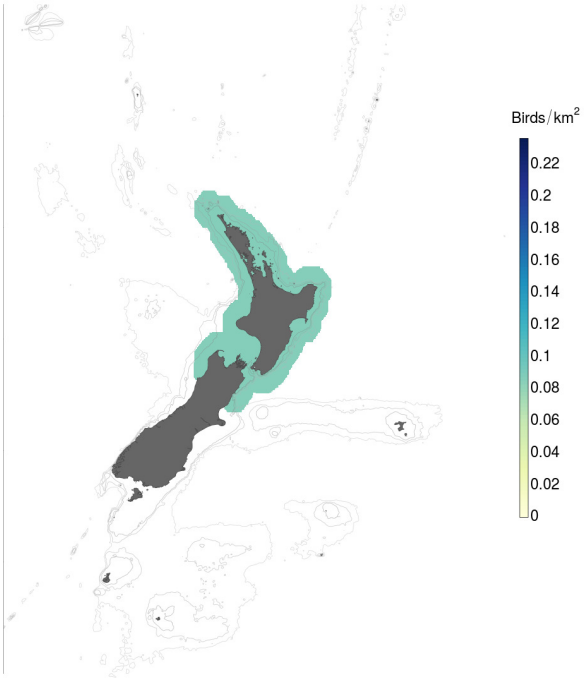
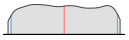
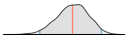
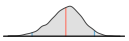
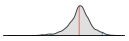
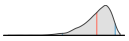
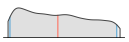
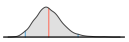


Figure 47: Relative density of northern little penguin (*Eudyptula minor f. iredalei*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 94: Derived values of population parameters of northern little penguin for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

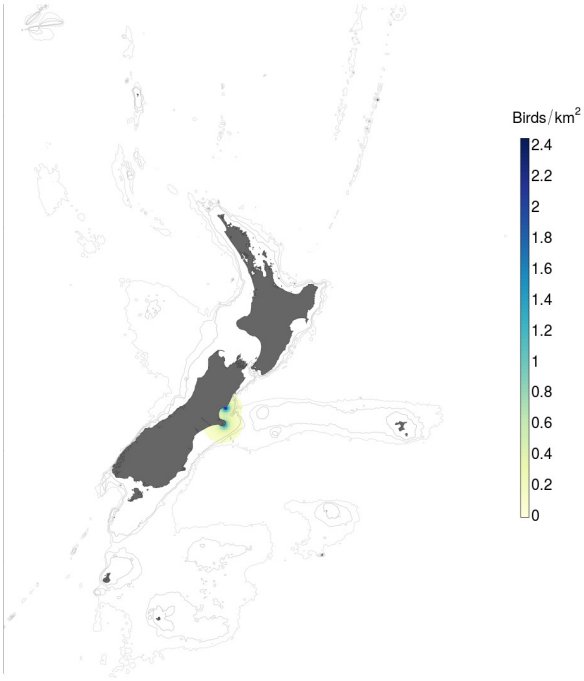
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	2.5	2.0–3.0	Years	
Age at first reproduction (from allometric model)	3.0	2.3–3.9	Years	
Current adult annual survival rate (from raw input parameters)	82.9	78.8–86.5	%	
Optimal adult annual survival rate (from raw input parameters)	82.9	78.6–86.6	%	
Optimal adult annual survival rate (from allometric model)	82.7	75.6–88.4	%	
Proportion of adults breeding (from raw input parameters)	88.9	75.1–96.4	%	
Annual breeding pairs (from raw input parameters)	7 220	5 080–9 850	Pairs	
Total population size (from raw input parameters)	28 000	18 900–40 400	Individuals	
Maximum net productivity rate r_{max}	0.216	0.165–0.280		

1.48 White-flippered little penguin (*Eudyptula minor f. albosignata*)

Table 95: Raw input data of population parameters of white-flippered little penguin for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	2 200 pairs [1998]	Taylor (2000a)	Medium
Age at first reproduction	2 to 3 years	Schreiber & Burger (2001)	
Current survival rate	83 %	Sidhu et al. (2007)	Medium
Optimal survival rate	83 %	Sidhu et al. (2007)	Medium
Body mass	1 146 g	Myhrvold et al. (2015)	
Breeding period	July–February	G. Taylor (pers. comm.)	
Relative non-breeding pop.	100%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

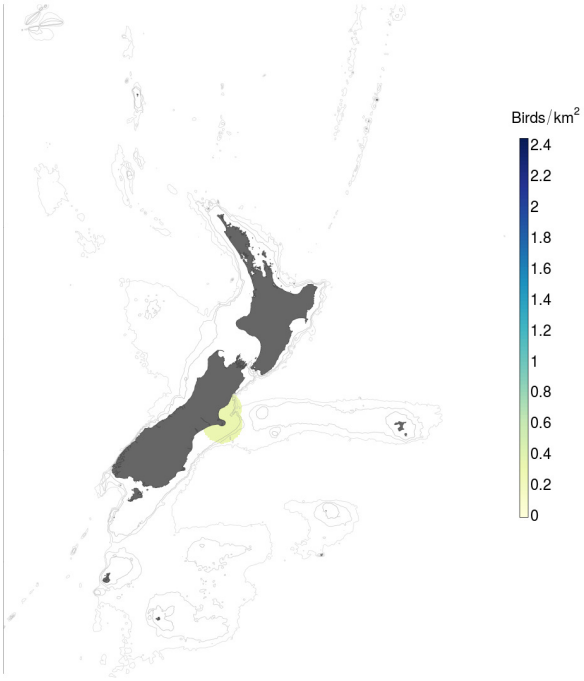
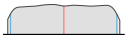
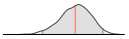
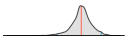
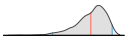
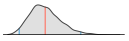
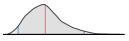
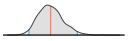


Figure 48: Relative density of white-flippered little penguin (*Eudyptula minor f. albosignata*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 96: Derived values of population parameters of white-flippered little penguin for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

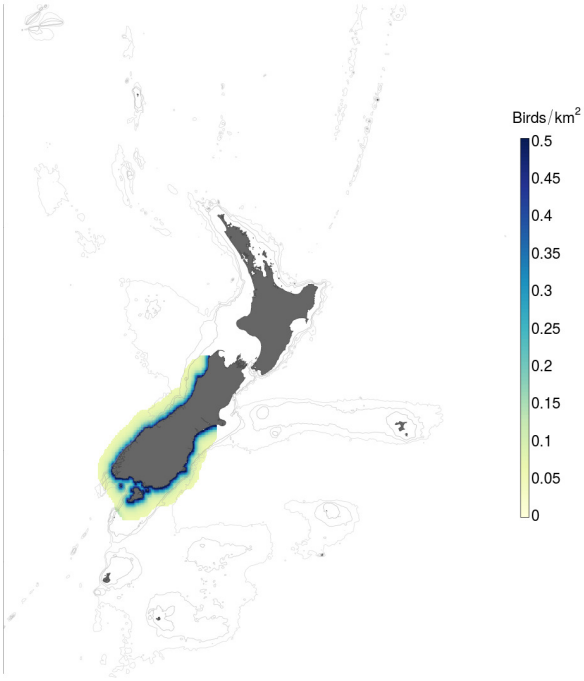
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	2.5	2.0–3.0	Years	
Age at first reproduction (from allometric model)	3.0	2.3–3.8	Years	
Current adult annual survival rate (from raw input parameters)	82.9	78.6–86.5	%	
Optimal adult annual survival rate (from raw input parameters)	83.0	78.7–86.5	%	
Optimal adult annual survival rate (from allometric model)	82.7	76.0–88.3	%	
Proportion of adults breeding (from raw input parameters)	88.8	75.4–96.3	%	
Annual breeding pairs (from raw input parameters)	2 240	1 470–3 290	Pairs	
Total population size (from raw input parameters)	8 630	5 520–13 100	Individuals	
Maximum net productivity rate r_{max}	0.216	0.167–0.276		

1.49 Southern little penguin (*Eudyptula minor f. minor*)

Table 97: Raw input data of population parameters of southern little penguin for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	5 000 to 10 000 pairs [1984]	Taylor (2000b)	Poor
Age at first reproduction	2 to 3 years	Schreiber & Burger (2001)	
Current survival rate	83 %	Sidhu et al. (2007)	Medium
Optimal survival rate	83 %	Sidhu et al. (2007)	Medium
Body mass	1 146 g	NA	
Breeding period	July–February	G. Taylor (pers. comm.)	
Relative non-breeding pop.	100%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

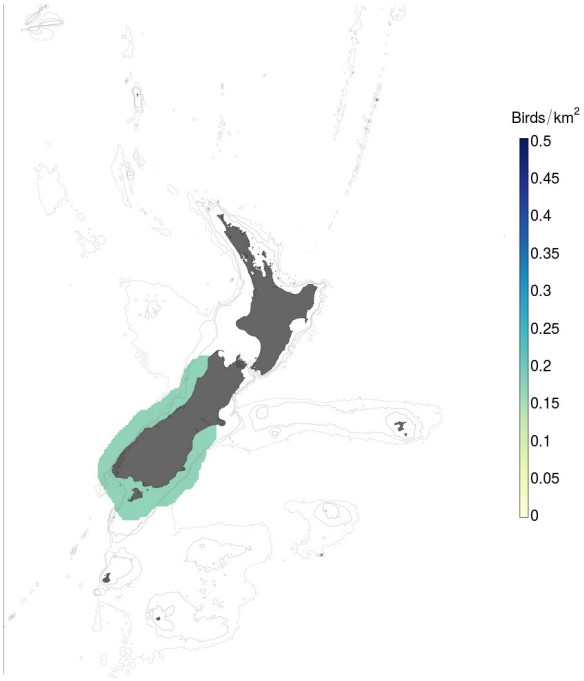
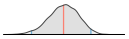
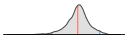
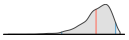
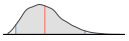
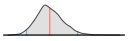


Figure 49: Relative density of southern little penguin (*Eudyptula minor f. minor*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 98: Derived values of population parameters of southern little penguin for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

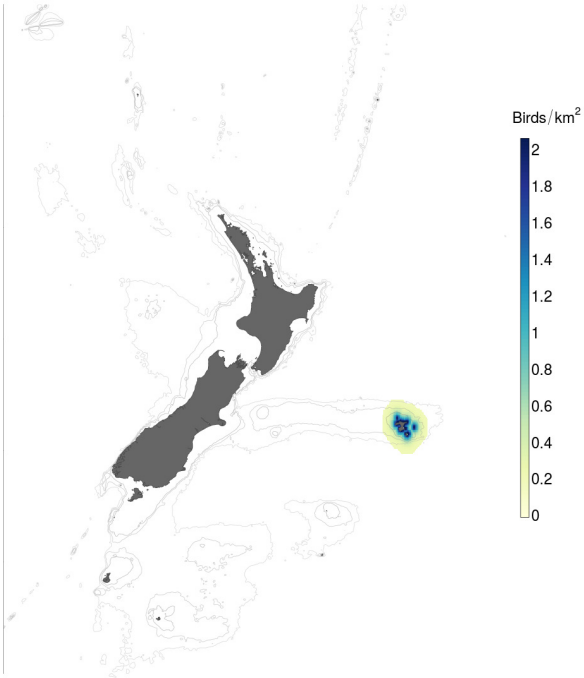
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	2.5	2.0–3.0	Years	
Age at first reproduction (from allometric model)	3.0	2.3–3.8	Years	
Current adult annual survival rate (from raw input parameters)	82.9	78.7–86.5	%	
Optimal adult annual survival rate (from raw input parameters)	82.9	78.7–86.5	%	
Optimal adult annual survival rate (from allometric model)	82.7	76.1–88.3	%	
Proportion of adults breeding (from raw input parameters)	88.9	75.7–96.4	%	
Annual breeding pairs (from raw input parameters)	7 220	5 100–9 840	Pairs	
Total population size (from raw input parameters)	28 200	18 600–41 400	Individuals	
Maximum net productivity rate r_{max}	0.216	0.165–0.277		

1.50 Chatham Island little penguin (*Eudyptula minor f. chathamensis*)

Table 99: Raw input data of population parameters of Chatham Island little penguin for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	5 000 to 10 000 pairs [1984]	Taylor (2000b)	Poor
Age at first reproduction	2 to 3 years	Schreiber & Burger (2001)	
Current survival rate	83 %	Sidhu et al. (2007)	Medium
Optimal survival rate	83 %	Sidhu et al. (2007)	Medium
Body mass	1 146 g	Myhrvold et al. (2015)	
Breeding period	July–February	G. Taylor (pers. comm.)	
Relative non-breeding pop.	100%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

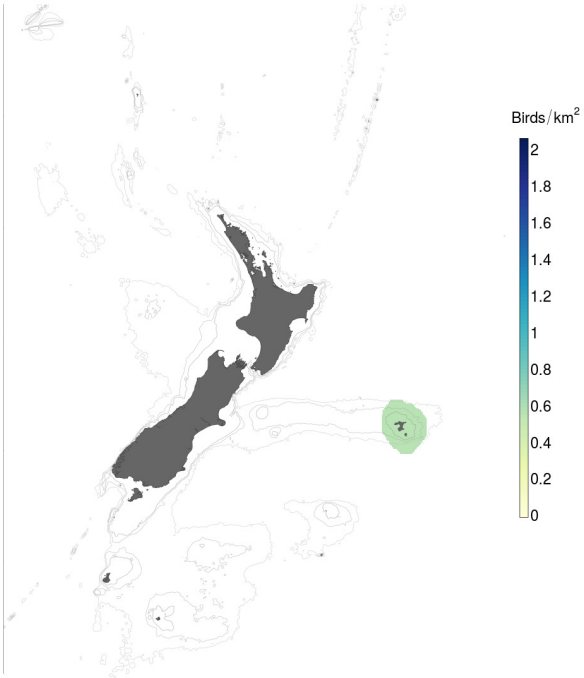
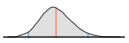
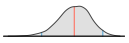
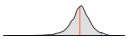
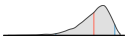
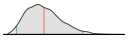
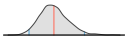


Figure 50: Relative density of Chatham Island little penguin (*Eudyptula minor f. chathamensis*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 100: Derived values of population parameters of Chatham Island little penguin for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	2.5	2.0–3.0	Years	
Age at first reproduction (from allometric model)	3.0	2.3–3.9	Years	
Current adult annual survival rate (from raw input parameters)	82.9	78.6–86.7	%	
Optimal adult annual survival rate (from raw input parameters)	82.9	78.6–86.6	%	
Optimal adult annual survival rate (from allometric model)	82.7	76.2–88.2	%	
Proportion of adults breeding (from raw input parameters)	88.8	75.0–96.5	%	
Annual breeding pairs (from raw input parameters)	7 230	5 080–9 830	Pairs	
Total population size (from raw input parameters)	28 000	18 600–41 400	Individuals	
Maximum net productivity rate r_{max}	0.216	0.165–0.279		

1.51 Eastern rockhopper penguin (*Eudyptes chrysocome filholi*)

Table 101: Raw input data of population parameters of eastern rockhopper penguin for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	38 961 to 58 500 pairs	Taylor (2000a)	
Age at first reproduction	4.7 years	Moseley's rockhopper penguin as proxy; Guinard et al. (1998)	
Current survival rate	84 ± 1.1 % [1995]	Northern rockhopper penguin as proxy; Guinard et al. (1998)	
Optimal survival rate	84 ± 1.1 % [1995]	Northern rockhopper penguin as proxy; Guinard et al. (1998)	
Body mass	2 480 g	Myhrvold et al. (2015)	
Breeding period	October–May	G. Taylor (pers. comm.)	
Relative non-breeding pop.	5%	G. Taylor (pers. comm.)	

(a) Breeding season distribution

(b) Non-breeding season distribution

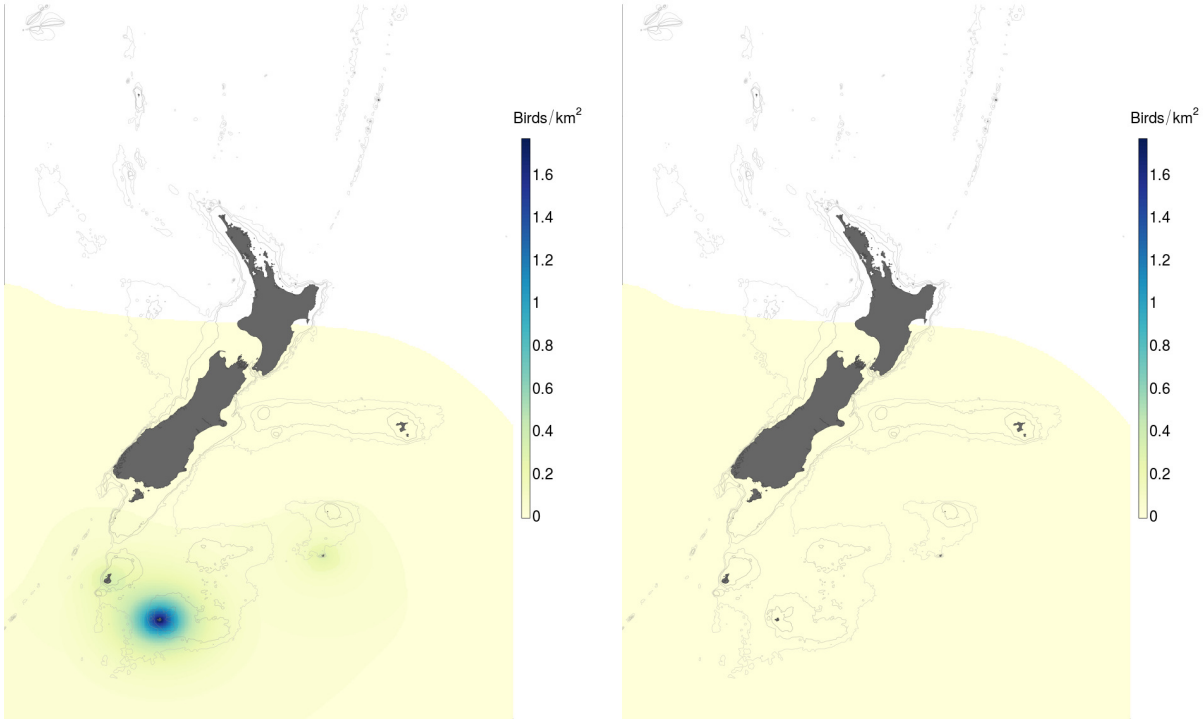
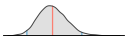
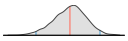
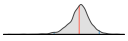
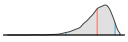
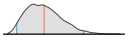


Figure 51: Relative density of eastern rockhopper penguin (*Eudyptes chrysocome filholi*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 102: Derived values of population parameters of eastern rockhopper penguin for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	4.5	3.1–5.9	Years	
Age at first reproduction (from allometric model)	3.7	2.8–4.7	Years	
Current adult annual survival rate (from raw input parameters)	84.0	81.6–86.0	%	
Optimal adult annual survival rate (from raw input parameters)	84.0	81.8–86.1	%	
Optimal adult annual survival rate (from allometric model)	85.7	80.2–90.1	%	
Proportion of adults breeding (from raw input parameters)	89.0	76.1–96.3	%	
Annual breeding pairs (from raw input parameters)	48 200	39 400–58 000	Pairs	
Total population size (from raw input parameters)	262 000	175 000–387 000	Individuals	
Maximum net productivity rate r_{max}	0.170	0.132–0.217		

1.52 Fiordland crested penguin (*Eudyptes pachyrhynchus*)

Table 103: Raw input data of population parameters of Fiordland crested penguin for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	3 000 pairs	Roots (2006)	
Age at first reproduction	5 to 6 years 3 to 4 years	Marchant & Higgins (1990) Schreiber & Burger (2001)	Poor
Current survival rate	84 ± 1.1 % [1995]	Northern rockhopper penguin as proxy; Guinard et al. (1998)	
Optimal survival rate	84 ± 1.1 % [1995]	Northern rockhopper penguin as proxy; Guinard et al. (1998)	
Body mass	3 775 g	Myhrvold et al. (2015)	
Breeding period	July–March	G. Taylor (pers. comm.)	
Relative non-breeding pop.	50%	G. Taylor (pers. comm.)	

(a) Breeding season distribution

(b) Non-breeding season distribution

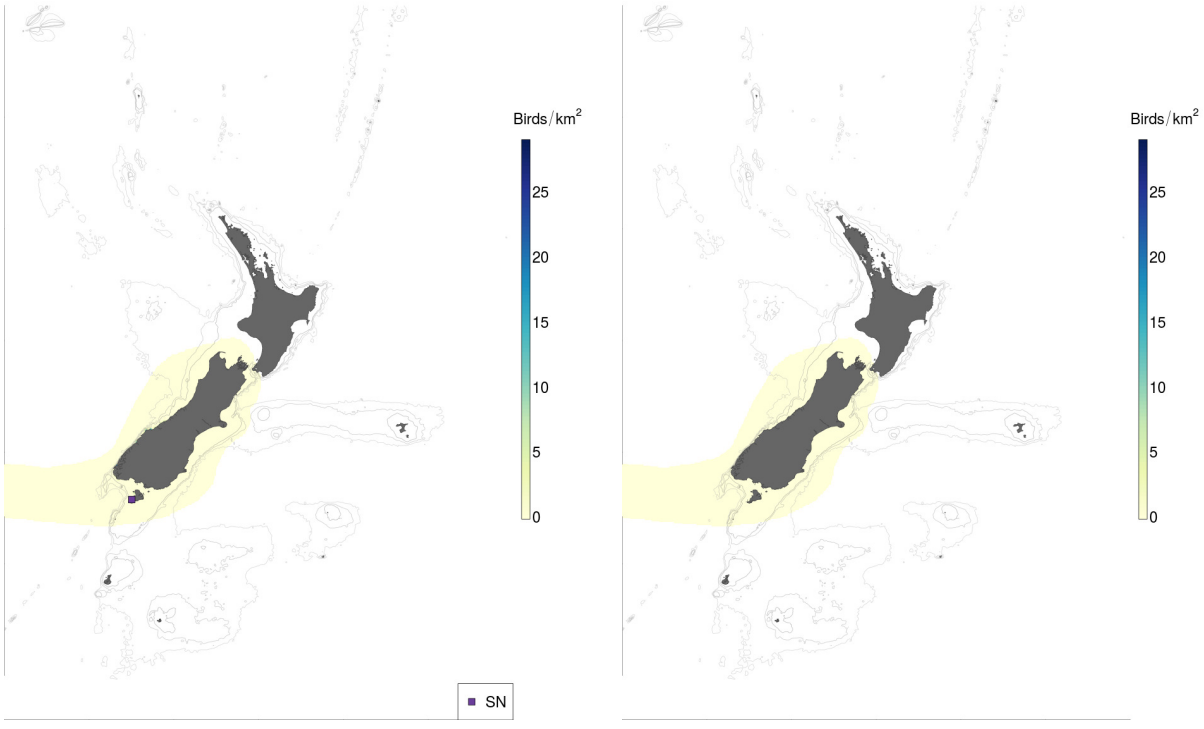
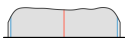
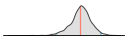
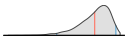
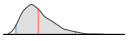
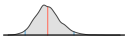


Figure 52: Relative density of Fiordland crested penguin (*Eudyptes pachyrhynchus*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in set-net (SN) fisheries.

Table 104: Derived values of population parameters of Fiordland crested penguin for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

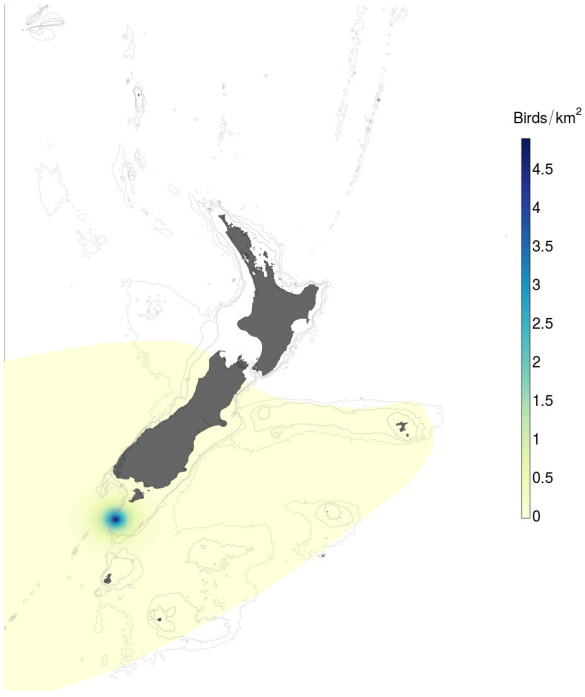
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	4.5	3.1–5.9	Years	
Age at first reproduction (from allometric model)	4.1	3.2–5.2	Years	
Current adult annual survival rate (from raw input parameters)	84.0	81.8–86.1	%	
Optimal adult annual survival rate (from raw input parameters)	84.0	81.8–86.1	%	
Optimal adult annual survival rate (from allometric model)	87.1	82.2–91.2	%	
Proportion of adults breeding (from raw input parameters)	88.9	75.3–96.5	%	
Annual breeding pairs (from raw input parameters)	3 160	1 660–5 440	Pairs	
Total population size (from raw input parameters)	17 000	8 470–31 300	Individuals	
Maximum net productivity rate r_{max}	0.149	0.116–0.187		

1.53 Snares crested penguin (*Eudyptes robustus*)

Table 105: Raw input data of population parameters of Snares crested penguin for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population ()	24 666 to 30 672 pairs	Hiscock & Chilvers (2016)	High
Age at first reproduction	5 to 6 years	Roots (2006)	
Current survival rate	84 ± 1.1 % [1995]	Northern rockhopper penguin as proxy; Guinard et al. (1998)	
Optimal survival rate	84 ± 1.1 % [1995]	Northern rockhopper penguin as proxy; Guinard et al. (1998)	
Body mass	3 336 g	Myhrvold et al. (2015)	
Breeding period	September–February	G. Taylor (pers. comm.)	
Relative non-breeding pop.	5%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

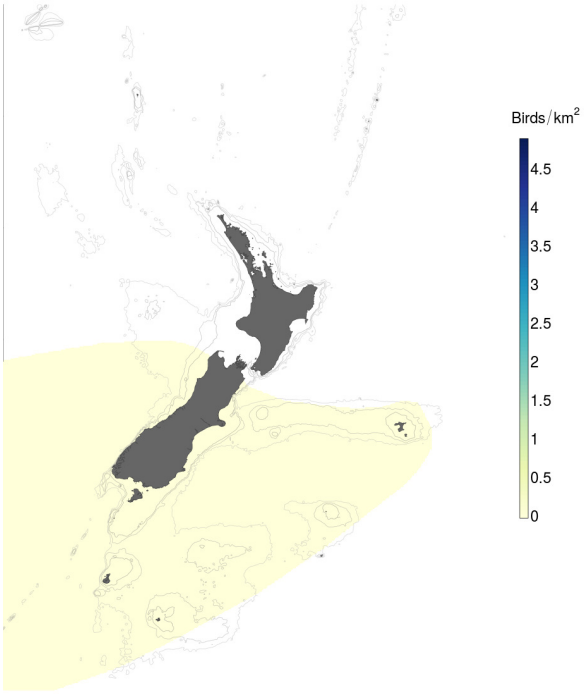
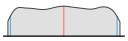
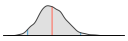
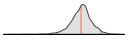
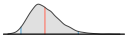


Figure 53: Relative density of Snares crested penguin (*Eudyptes robustus*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 106: Derived values of population parameters of Snares crested penguin for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

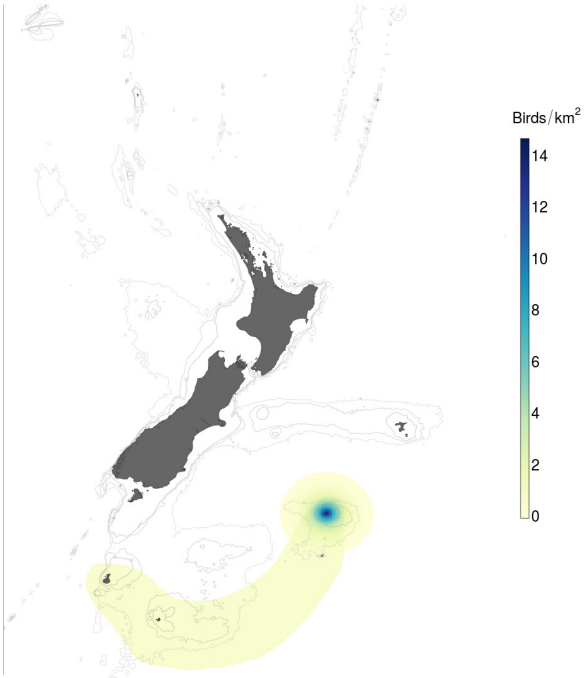
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	5.5	5.0–6.0	Years	
Age at first reproduction (from allometric model)	4.0	3.1–5.0	Years	
Current adult annual survival rate (from raw input parameters)	84.0	81.8–86.0	%	
Optimal adult annual survival rate (from raw input parameters)	84.0	81.8–86.1	%	
Optimal adult annual survival rate (from allometric model)	86.8	81.8–91.0	%	
Proportion of adults breeding (from raw input parameters)	89.1	75.6–96.3	%	
Annual breeding pairs (from raw input parameters)	27 500	24 800–30 500	Pairs	
Total population size (from raw input parameters)	177 000	138 000–231 000	Individuals	
Maximum net productivity rate r_{max}	0.155	0.121–0.197		

1.54 Erect-crested penguin (*Eudyptes sclateri*)

Table 107: Raw input data of population parameters of erect-crested penguin for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	81 000 (77 000–85 000) pairs	Taylor (2000a)	
Age at first reproduction	5 to 6 years	Fiordland crested penguin as proxy; Roots (2006)	
Current survival rate	84 ± 1.1 % [1995]	Northern rockhopper penguin as proxy; Guinard et al. (1998)	
Optimal survival rate	84 ± 1.1 % [1995]	Northern rockhopper penguin as proxy; Guinard et al. (1998)	
Body mass	5 212 g	Myhrvold et al. (2015)	
Breeding period	September–March	G. Taylor (pers. comm.)	
Relative non-breeding pop.	50%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

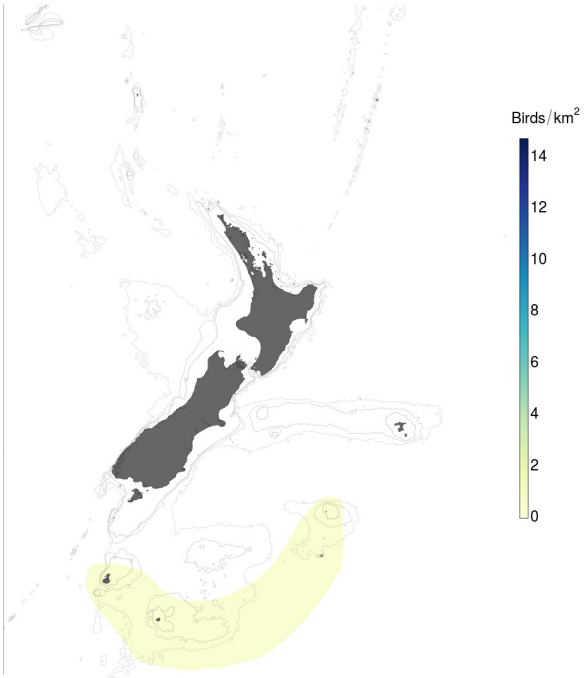
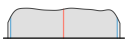
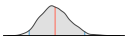
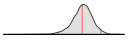
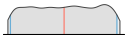
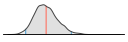


Figure 54: Relative density of erect-crested penguin (*Eudyptes sclateri*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 108: Derived values of population parameters of erect-crested penguin for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

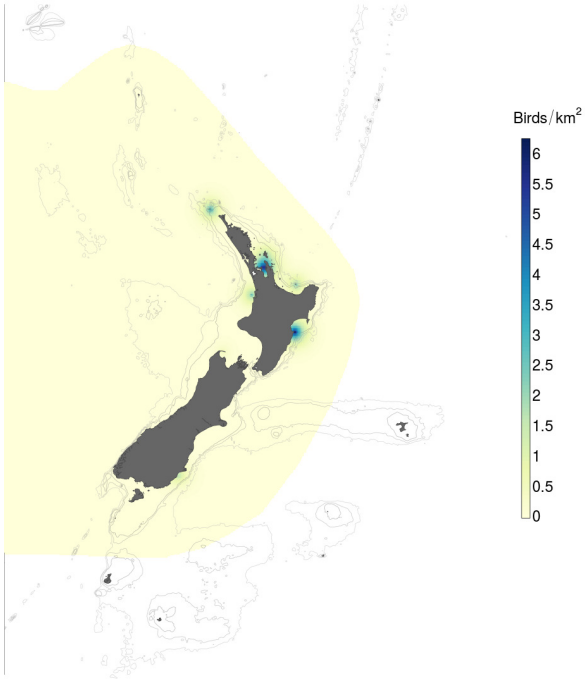
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	5.5	5.0–6.0	Years	
Age at first reproduction (from allometric model)	4.4	3.4–5.6	Years	
Current adult annual survival rate (from raw input parameters)	84.0	81.6–86.0	%	
Optimal adult annual survival rate (from raw input parameters)	84.0	81.7–86.0	%	
Optimal adult annual survival rate (from allometric model)	88.2	83.4–92.0	%	
Proportion of adults breeding (from raw input parameters)	89.0	75.2–96.4	%	
Annual breeding pairs (from raw input parameters)	81 000	77 200–84 800	Pairs	
Total population size (from raw input parameters)	525 000	419 000–667 000	Individuals	
Maximum net productivity rate r_{max}	0.135	0.107–0.171		

1.55 Australasian gannet (*Morus serrator*)

Table 109: Raw input data of population parameters of Australasian gannet for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	46 004 pairs [1981]	Wodzicki et al. (1984)	
Age at first reproduction	3 to 7 years	Schreiber & Burger (2001)	
Current survival rate	94 %	Northern gannet as proxy; Schreiber & Burger (2001)	
Optimal survival rate	94 %	Northern gannet as proxy; Schreiber & Burger (2001)	
Body mass	2 274 g	Myhrvold et al. (2015)	
Breeding period	August–March	G. Taylor (pers. comm.)	
Relative non-breeding pop.	20%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

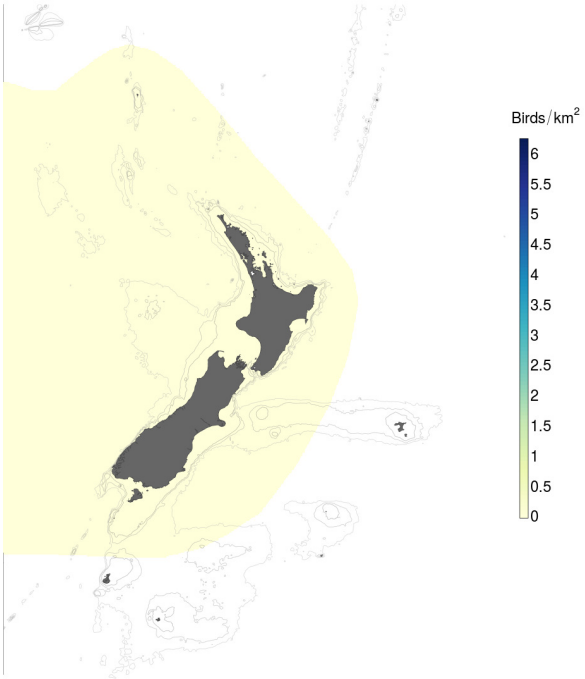
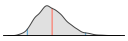
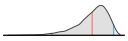
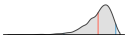
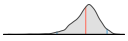
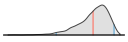
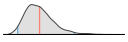
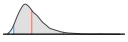
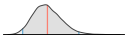


Figure 55: Relative density of Australasian gannet (*Morus serrator*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 110: Derived values of population parameters of Australasian gannet for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	5.0	3.1–6.9	Years	
Age at first reproduction (from allometric model)	3.2	2.4–4.4	Years	
Current adult annual survival rate (from raw input parameters)	93.4	85.0–97.8	%	
Optimal adult annual survival rate (from raw input parameters)	93.3	84.5–97.8	%	
Optimal adult annual survival rate (from allometric model)	85.8	77.1–92.4	%	
Proportion of adults breeding (from raw input parameters)	88.9	75.6–96.4	%	
Annual breeding pairs (from raw input parameters)	48 500	26 000–84 100	Pairs	
Total population size (from raw input parameters)	200 000	97 600–380 000	Individuals	
Maximum net productivity rate r_{max}	0.189	0.133–0.260		

1.56 Masked booby (*Sula dactylatra*)

Table 111: Raw input data of population parameters of masked booby for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment.

Parameter	Data	Reference	Quality
Population (NZ)	240 pairs	Veitch et al. (2004)	Medium
Age at first reproduction	2 to 4 years	Schreiber & Burger (2001)	
Current survival rate	85 % [1979]	Harris (1979)	Poor
Optimal survival rate	85 % [1979]	Harris (1979)	Poor
Body mass	1 971 g	Myhrvold et al. (2015)	
Breeding period	All year	G. Taylor (pers. comm.)	

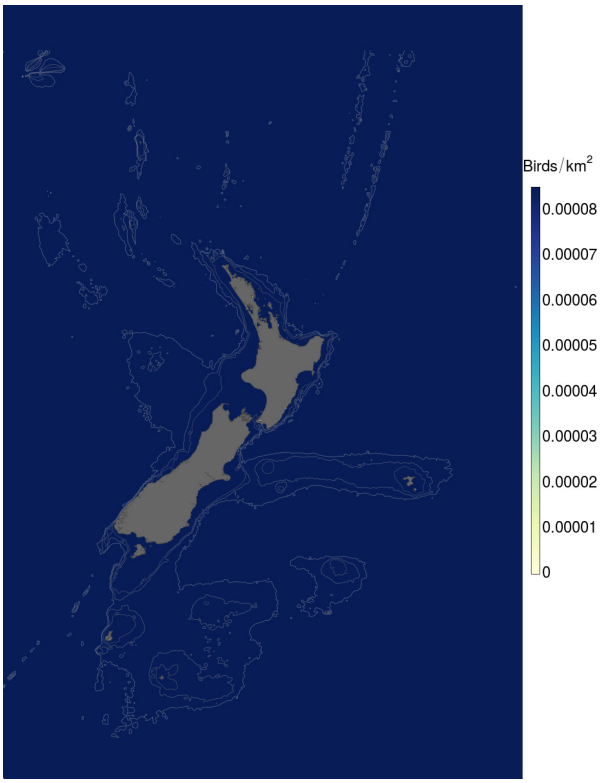
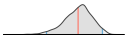
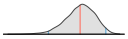
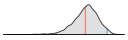
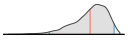
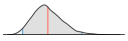
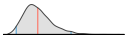
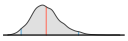


Figure 56: Relative density of masked booby (*Sula dactylatra*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 112: Derived values of population parameters of masked booby for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	3.0	2.0–3.9	Years	
Age at first reproduction (from allometric model)	3.1	2.3–4.2	Years	
Current adult annual survival rate (from raw input parameters)	84.8	78.1–90.0	%	
Optimal adult annual survival rate (from raw input parameters)	84.7	78.1–90.1	%	
Optimal adult annual survival rate (from allometric model)	85.3	76.1–92.1	%	
Proportion of adults breeding (from raw input parameters)	88.9	76.0–96.5	%	
Annual breeding pairs (from raw input parameters)	245	162–358	Pairs	
Total population size (from raw input parameters)	1 060	645–1 690	Individuals	
Maximum net productivity rate r_{max}	0.196	0.138–0.271		

1.57 Pied shag (*Phalacrocorax varius varius*)

Table 113: Raw input data of population parameters of pied shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	6 400 pairs [2013]	Bell (2013)	High
Age at first reproduction	More than 2 years	Schreiber & Burger (2001)	
Current survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Optimal survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Body mass	1 750 g	Myhrvold et al. (2015)	
Breeding period	All year	G. Taylor (pers. comm.)	
Relative non-breeding pop.	100%	G. Taylor (pers. comm.)	

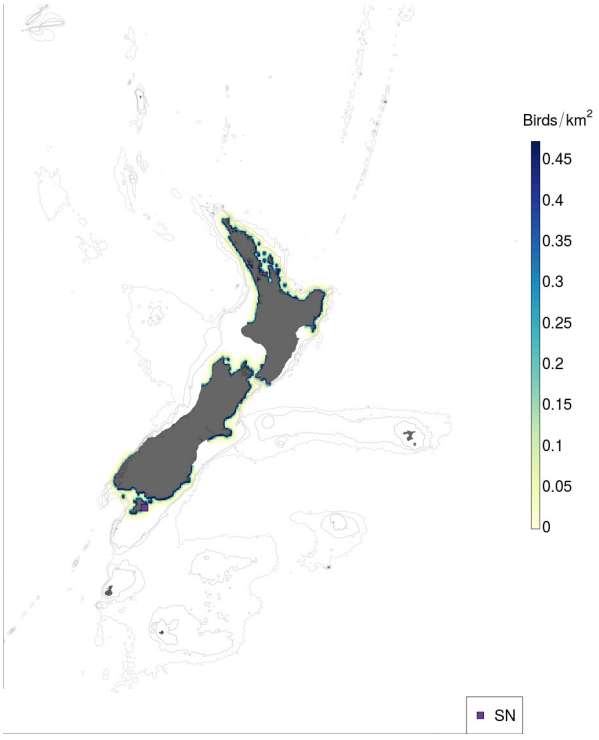
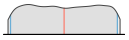
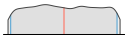
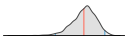
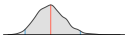
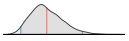
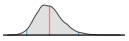


Figure 57: Relative density of pied shag (*Phalacrocorax varius varius*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in set-net (SN) fisheries.

Table 114: Derived values of population parameters of pied shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

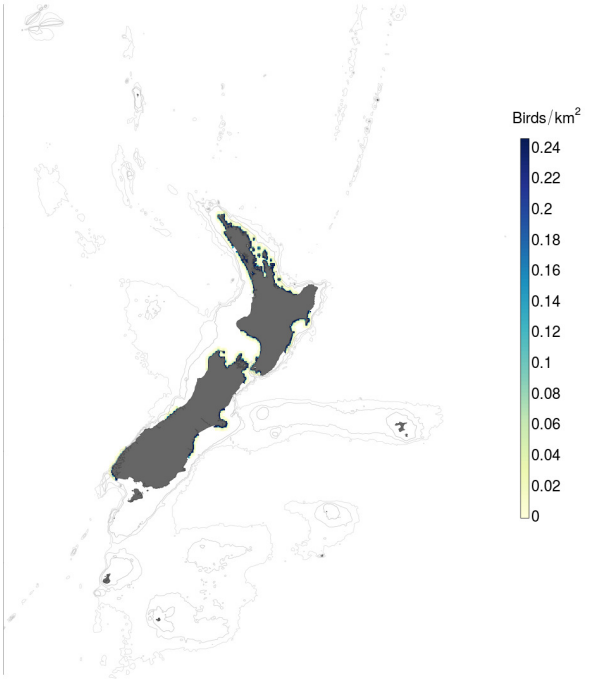
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	2.7	2.0–3.3	Years	
Age at first reproduction (from allometric model)	3.0	2.2–4.1	Years	
Current adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from allometric model)	84.9	75.5–91.7	%	
Proportion of adults breeding (from raw input parameters)	100.0	100.0–100.0	%	
Annual breeding pairs (from raw input parameters)	6 430	5 280–7 760	Pairs	
Total population size (from raw input parameters)	21 800	17 000–28 500	Individuals	
Maximum net productivity rate r_{max}	0.205	0.142–0.286		

1.58 Little black shag (*Phalacrocorax sulcirostris*)

Table 115: Raw input data of population parameters of little black shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	1 500 pairs	Walker et al. (2015)	Poor
Age at first reproduction	2 years	NA	
Current survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Optimal survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Body mass	1 000 g	Myhrvold et al. (2015)	
Breeding period	October–December	G. Taylor (pers. comm.)	
Relative non-breeding pop.	100%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

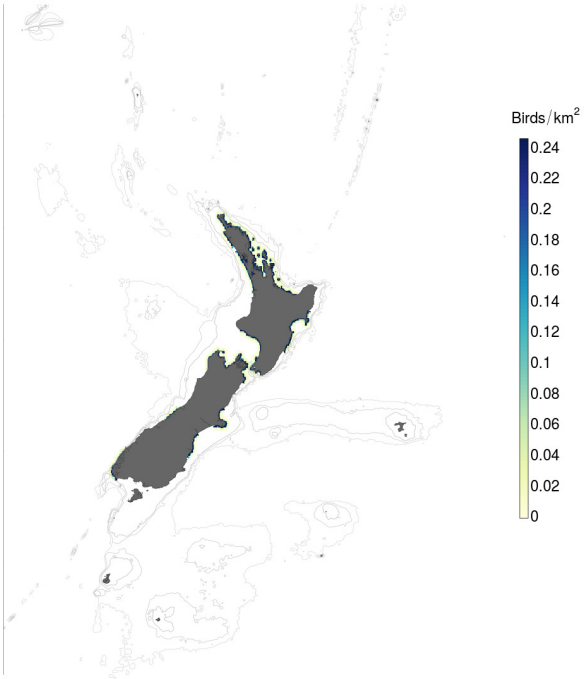
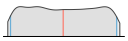
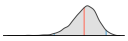
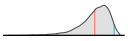
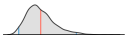
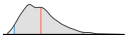


Figure 58: Relative density of little black shag (*Phalacrocorax sulcirostris*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 116: Derived values of population parameters of little black shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

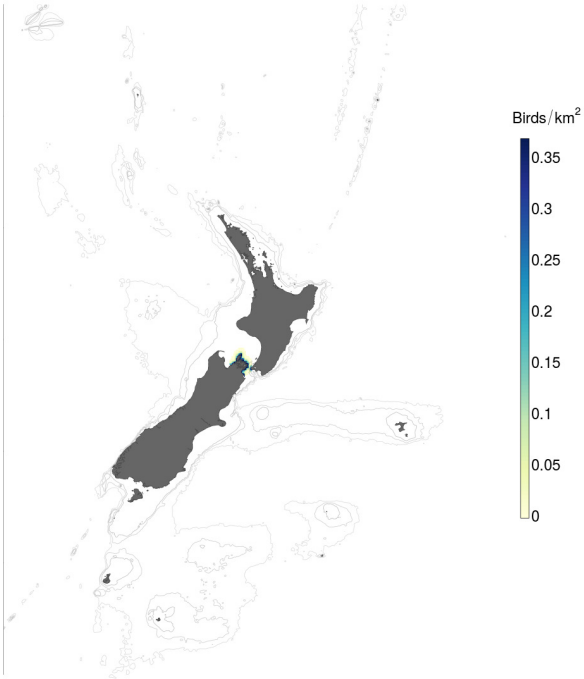
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	2.0	1.1–2.9	Years	
Age at first reproduction (from allometric model)	2.6	1.9–3.6	Years	
Current adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from allometric model)	82.7	72.0–90.5	%	
Proportion of adults breeding (from raw input parameters)	89.0	75.1–96.3	%	
Annual breeding pairs (from raw input parameters)	1 570	835–2 770	Pairs	
Total population size (from raw input parameters)	5 510	2 800–9 820	Individuals	
Maximum net productivity rate r_{max}	0.245	0.169–0.349		

1.59 New Zealand king shag (*Leucocarbo carunculatus*)

Table 117: Raw input data of population parameters of New Zealand king shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	187 pairs [2015]	Schuckard et al. (2015)	High
Age at first reproduction	More than 3 years	R. Powlesland (pers. comm.)	
Current survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Optimal survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Body mass	2 578 g	Myhrvold et al. (2015)	
Breeding period	March–October	G. Taylor (pers. comm.)	
Relative non-breeding pop.	100%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

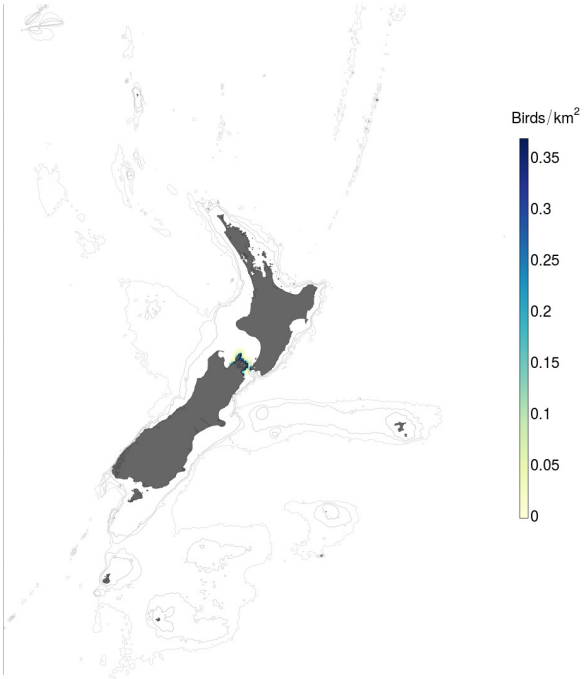
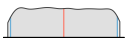
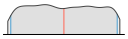
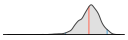
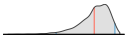
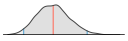
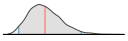
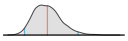


Figure 59: Relative density of New Zealand king shag (*Leucocarbo carunculatus*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 118: Derived values of population parameters of New Zealand king shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	4.0	3.0–5.0	Years	
Age at first reproduction (from allometric model)	3.3	2.4–4.6	Years	
Current adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from allometric model)	86.3	78.1–92.7	%	
Proportion of adults breeding (from raw input parameters)	88.9	74.7–96.6	%	
Annual breeding pairs (from raw input parameters)	188	153–227	Pairs	
Total population size (from raw input parameters)	861	621–1 190	Individuals	
Maximum net productivity rate r_{max}	0.182	0.129–0.253		

1.60 Otago shag (*Leucocarbo chalconotus*)

Table 119: Raw input data of population parameters of Otago shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	1 230 to 1 400 pairs [2016]	C. Lalas (pers. comm.)	High
Age at first reproduction	More than 3 years	R. Powlesland (pers. comm.)	
Current survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Optimal survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Body mass	2 295 g	Myhrvold et al. (2015)	
Breeding period	August–March	G. Taylor (pers. comm.)	
Relative non-breeding pop.	100%	G. Taylor (pers. comm.)	

(a) Breeding season distribution

(b) Non-breeding season distribution

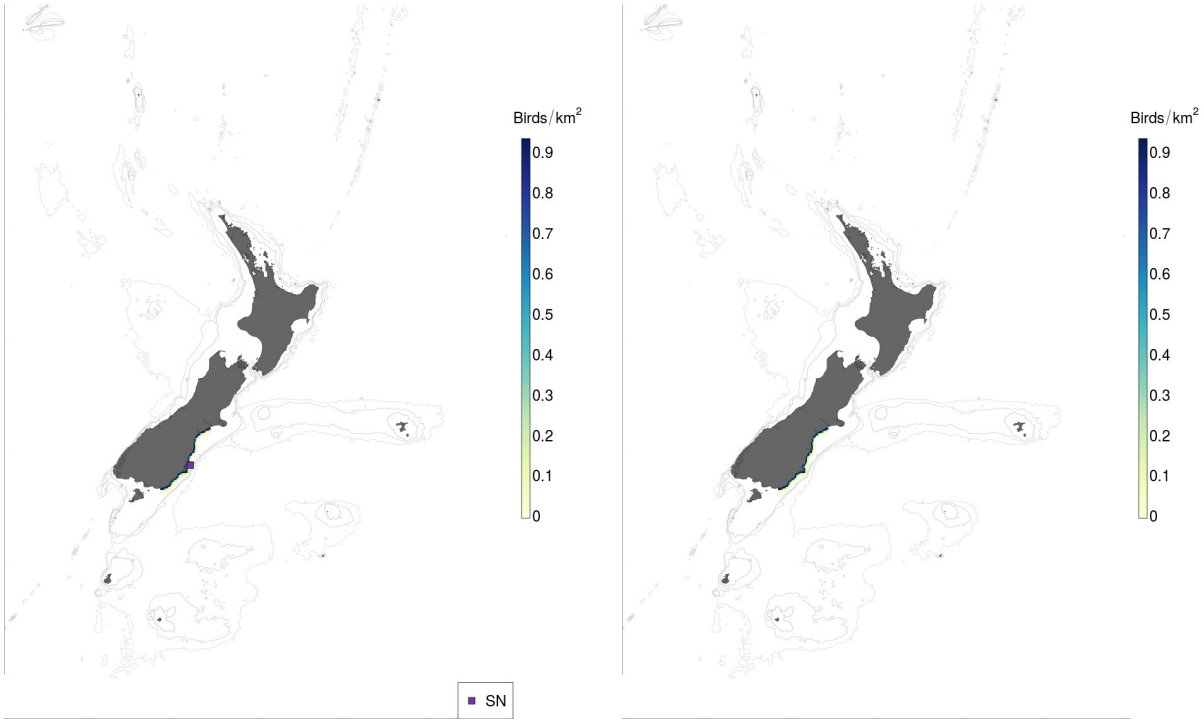
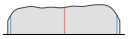
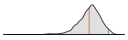
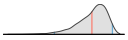
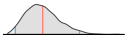
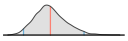


Figure 60: Relative density of Otago shag (*Leucocarbo chalconotus*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in set-net (SN) fisheries.

Table 120: Derived values of population parameters of Otago shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

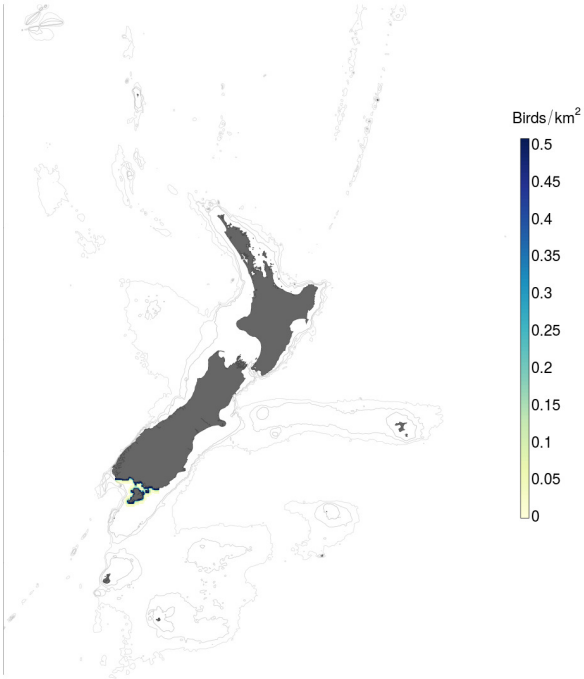
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	4.0	3.0–4.9	Years	
Age at first reproduction (from allometric model)	3.2	2.3–4.4	Years	
Current adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from allometric model)	85.8	76.2–92.4	%	
Proportion of adults breeding (from raw input parameters)	89.0	75.5–96.4	%	
Annual breeding pairs (from raw input parameters)	1 310	1 230–1 400	Pairs	
Total population size (from raw input parameters)	6 020	4 690–7 830	Individuals	
Maximum net productivity rate r_{max}	0.189	0.133–0.259		

1.61 Foveaux shag (*Leucocarbo stewarti*)

Table 121: Raw input data of population parameters of Foveaux shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	840 to 1 080 pairs [2016]	C. Lalas (pers. comm.)	High
Age at first reproduction	More than 3 years	R. Powlesland (pers. comm.)	
Current survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Optimal survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Body mass	2 295 g	Myhrvold et al. (2015)	
Breeding period	August–March	G. Taylor (pers. comm.)	
Relative non-breeding pop.	100%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

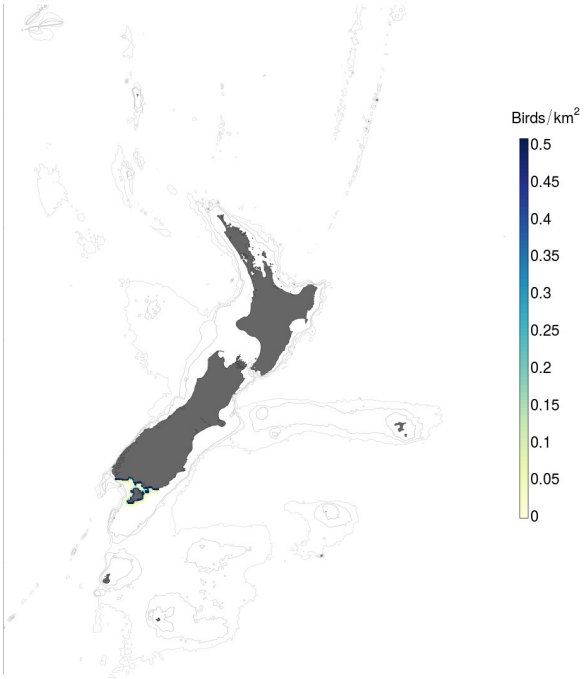
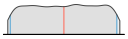
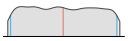
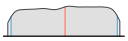
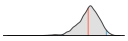
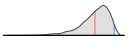
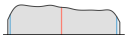
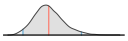


Figure 61: Relative density of Foveaux shag (*Leucocarbo stewarti*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 122: Derived values of population parameters of Foveaux shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

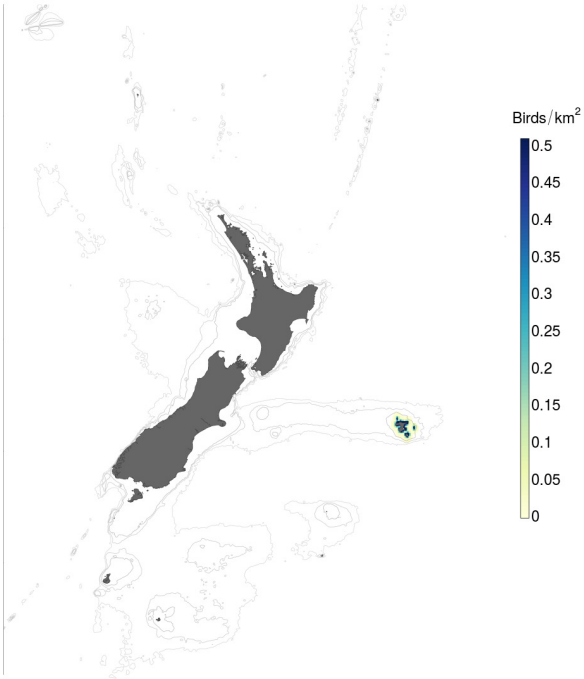
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	4.0	3.0–4.9	Years	
Age at first reproduction (from allometric model)	3.2	2.4–4.4	Years	
Current adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from allometric model)	85.9	77.2–92.3	%	
Proportion of adults breeding (from raw input parameters)	88.8	74.1–96.5	%	
Annual breeding pairs (from raw input parameters)	955	845–1 070	Pairs	
Total population size (from raw input parameters)	4 420	3 330–5 900	Individuals	
Maximum net productivity rate r_{max}	0.187	0.130–0.259		

1.62 Chatham Island shag (*Leucocarbo onslowi*)

Table 123: Raw input data of population parameters of Chatham Island shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population ()	355 pairs [2011]	Debski et al. (2012)	High
Age at first reproduction	More than 3 years	R. Powlesland (pers. comm.)	
Current survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Optimal survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Body mass	2 374 g	Myhrvold et al. (2015)	
Breeding period	September–February	G. Taylor (pers. comm.)	
Relative non-breeding pop.	100%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

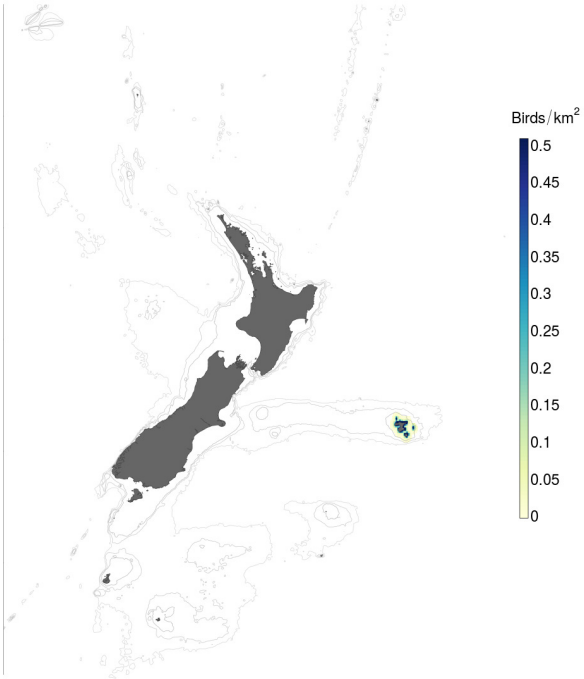
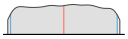
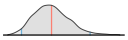
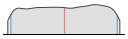
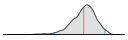
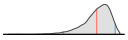
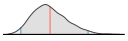


Figure 62: Relative density of Chatham Island shag (*Leucocarbo onslowi*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 124: Derived values of population parameters of Chatham Island shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

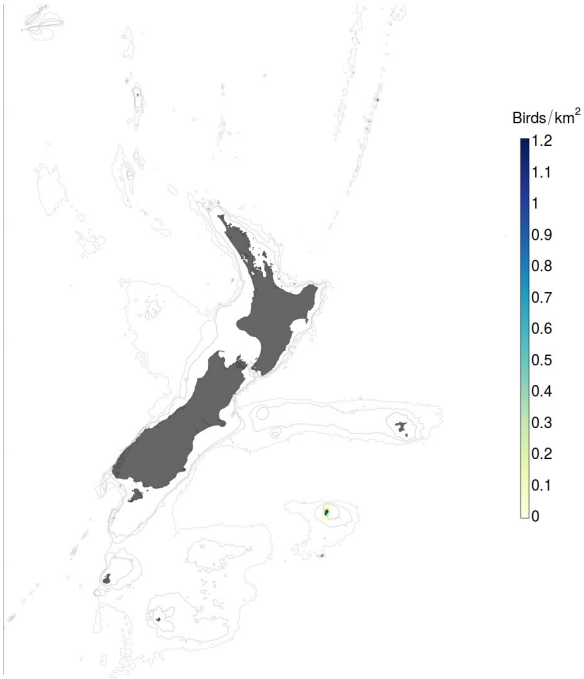
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	4.0	3.0–5.0	Years	
Age at first reproduction (from allometric model)	3.3	2.4–4.4	Years	
Current adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from allometric model)	85.9	76.9–92.4	%	
Proportion of adults breeding (from raw input parameters)	89.1	75.7–96.5	%	
Annual breeding pairs (from raw input parameters)	357	292–433	Pairs	
Total population size (from raw input parameters)	1 620	1 180–2 200	Individuals	
Maximum net productivity rate r_{max}	0.186	0.132–0.259		

1.63 Bounty Island shag (*Leucocarbo ranfurlyi*)

Table 125: Raw input data of population parameters of Bounty Island shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	120 pairs [2005]	BirdLife International (2012)	Medium
Age at first reproduction	More than 3 years	R. Powlesland (pers. comm.)	
Current survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Optimal survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Body mass	2 425 g	Myhrvold et al. (2015)	
Breeding period	October–December	G. Taylor (pers. comm.)	
Relative non-breeding pop.	100%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

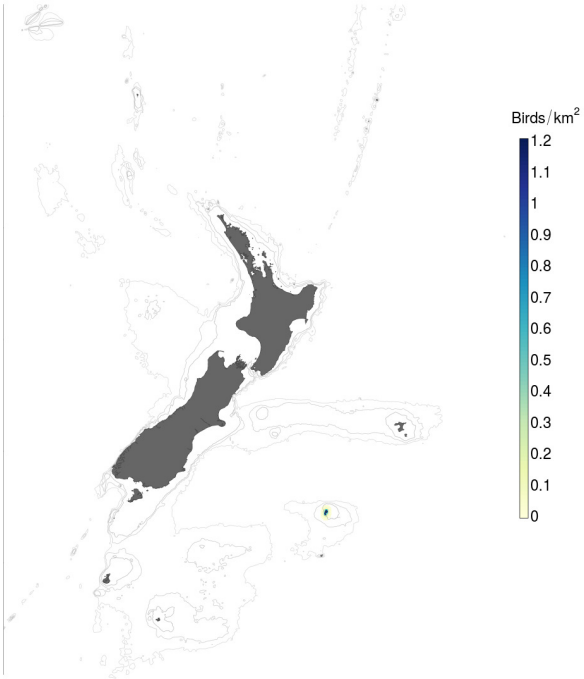
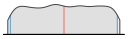
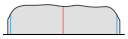
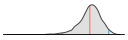
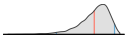
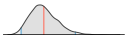
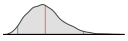
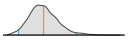


Figure 63: Relative density of Bounty Island shag (*Leucocarbo ranfurlyi*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 126: Derived values of population parameters of Bounty Island shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	4.0	3.0–5.0	Years	
Age at first reproduction (from allometric model)	3.3	2.4–4.4	Years	
Current adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from allometric model)	86.0	76.5–92.5	%	
Proportion of adults breeding (from raw input parameters)	88.8	74.7–96.4	%	
Annual breeding pairs (from raw input parameters)	123	81–180	Pairs	
Total population size (from raw input parameters)	562	350–856	Individuals	
Maximum net productivity rate r_{max}	0.185	0.128–0.259		

1.64 Auckland Island shag (*Leucocarbo colensoi*)

Table 127: Raw input data of population parameters of Auckland Island shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	More than 1 366 pairs [2011]	BirdLife International (2012)	Poor
Age at first reproduction	More than 3 years	R. Powlesland (pers. comm.)	
Current survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Optimal survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Body mass	1 919 g	Myhrvold et al. (2015)	
Breeding period	November–March	G. Taylor (pers. comm.)	
Relative non-breeding pop.	100%	G. Taylor (pers. comm.)	

(a) Breeding season distribution **(b) Non-breeding season distribution**

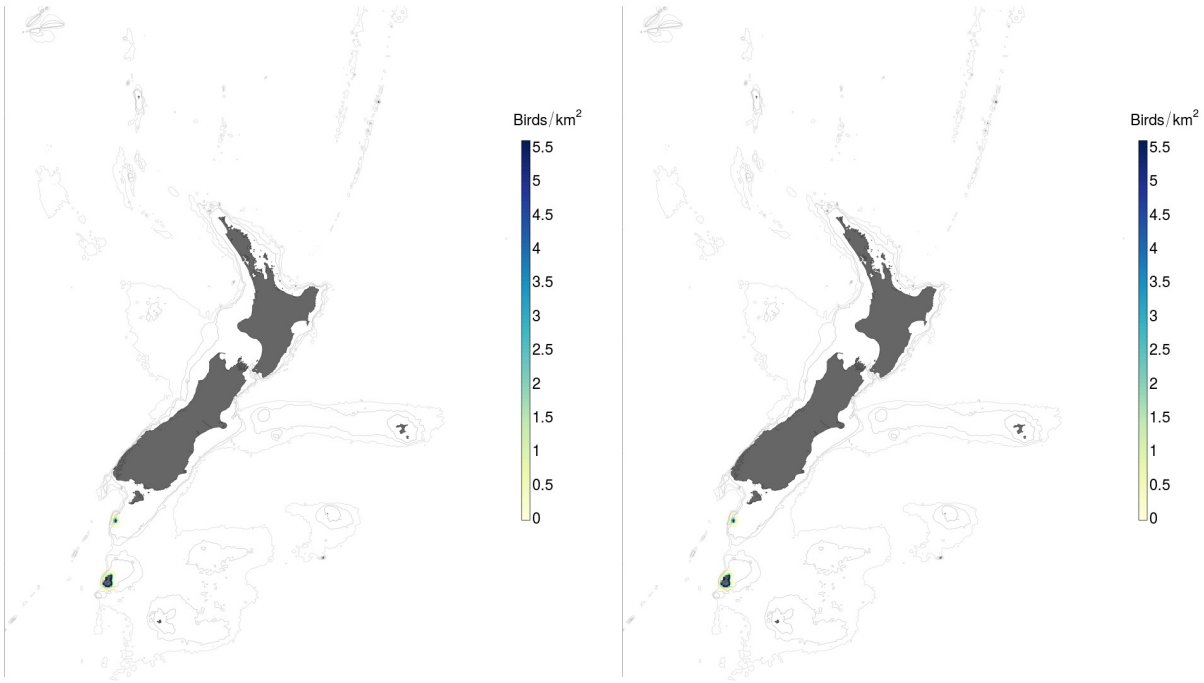
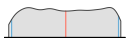
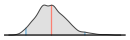
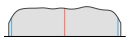
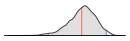
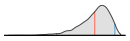
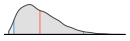
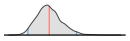


Figure 64: Relative density of Auckland Island shag (*Leucocarbo colensoi*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 128: Derived values of population parameters of Auckland Island shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

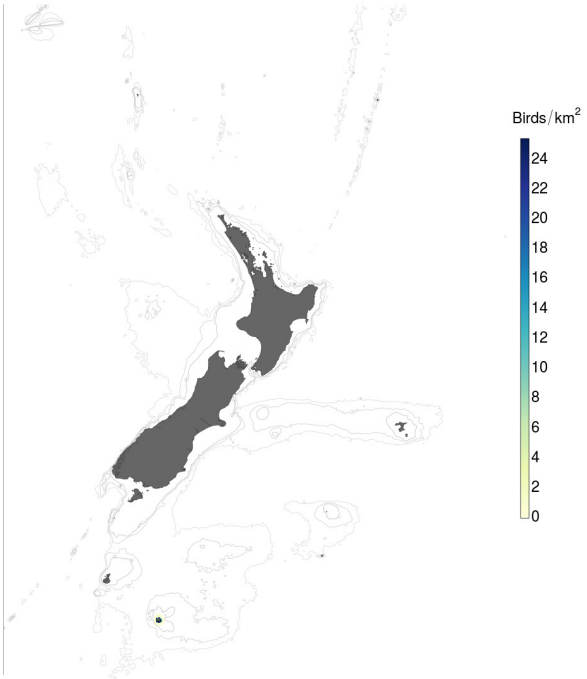
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	4.0	3.0–5.0	Years	
Age at first reproduction (from allometric model)	3.1	2.3–4.2	Years	
Current adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from allometric model)	85.3	75.9–92.1	%	
Proportion of adults breeding (from raw input parameters)	89.1	75.3–96.4	%	
Annual breeding pairs (from raw input parameters)	2 150	990–3 950	Pairs	
Total population size (from raw input parameters)	9 530	4 450–18 000	Individuals	
Maximum net productivity rate r_{max}	0.199	0.140–0.274		

1.65 Campbell Island shag (*Leucocarbo campbelli*)

Table 129: Raw input data of population parameters of Campbell Island shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	2 000 pairs [1975]	BirdLife International (2012)	Poor
Age at first reproduction	More than 3 years	R. Powlesland (pers. comm.)	
Current survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Optimal survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Body mass	1 858 g	Myhrvold et al. (2015)	
Breeding period	November–February	G. Taylor (pers. comm.)	
Relative non-breeding pop.	100%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

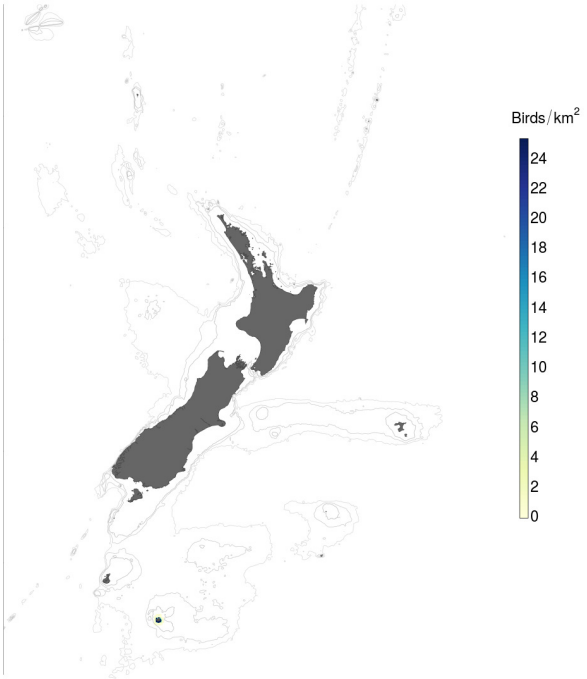
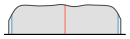
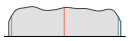
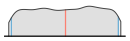
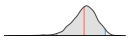
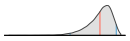
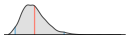
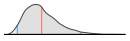
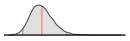


Figure 65: Relative density of Campbell Island shag (*Leucocarbo campbelli*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 130: Derived values of population parameters of Campbell Island shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	4.0	3.1–5.0	Years	
Age at first reproduction (from allometric model)	3.1	2.3–4.1	Years	
Current adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from allometric model)	85.1	76.3–91.8	%	
Proportion of adults breeding (from raw input parameters)	89.0	75.3–96.4	%	
Annual breeding pairs (from raw input parameters)	2 110	1 100–3 660	Pairs	
Total population size (from raw input parameters)	9 770	4 980–17 500	Individuals	
Maximum net productivity rate r_{max}	0.201	0.143–0.277		

1.66 Spotted shag (*Stictocarbo punctatus*)

Table 131: Raw input data of population parameters of spotted shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment.

Parameter	Data	Reference	Quality
Population (NZ)	10 000 to 30 000 pairs	Taylor (2000b)	Poor
Age at first reproduction	2 years	Schreiber & Burger (2001)	
Current survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Optimal survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Body mass	1 186 g	Myhrvold et al. (2015)	
Breeding period	All year	G. Taylor (pers. comm.)	

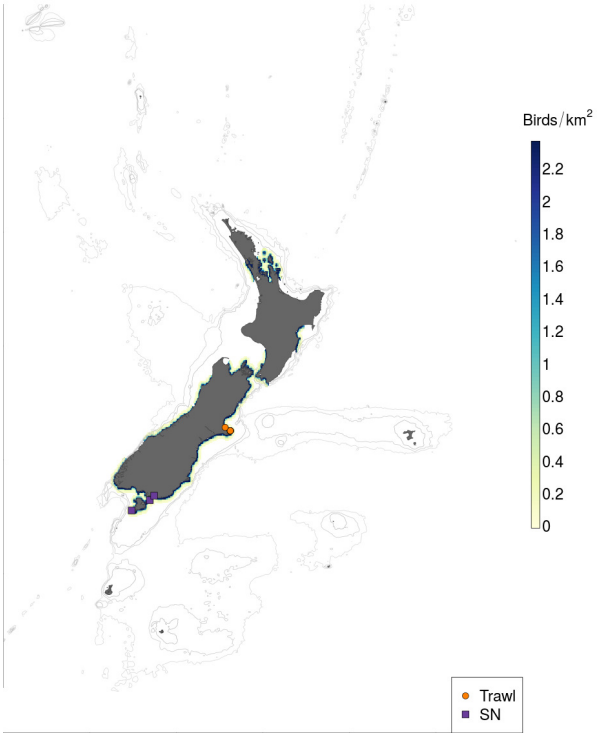
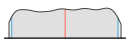
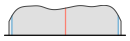
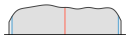
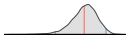
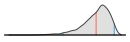
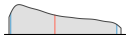
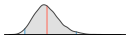


Figure 66: Relative density of spotted shag (*Stictocarbo punctatus*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in trawl and set-net (SN) fisheries.

Table 132: Derived values of population parameters of spotted shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

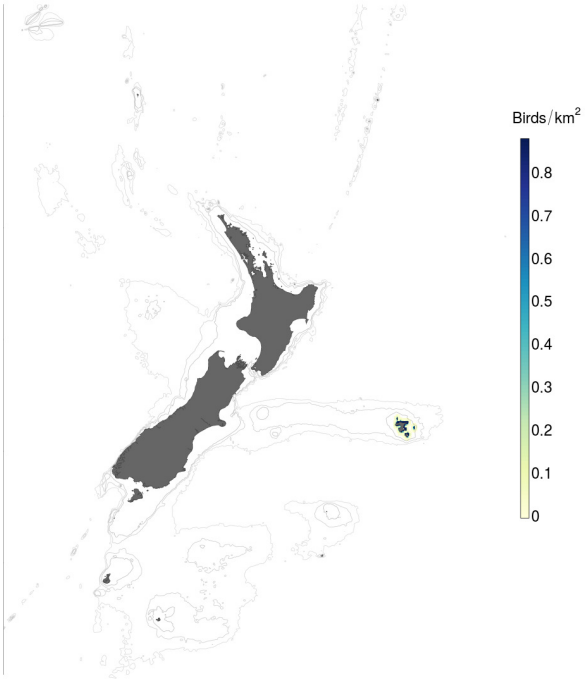
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	2.0	1.0–2.9	Years	
Age at first reproduction (from allometric model)	2.7	2.0–3.7	Years	
Current adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from allometric model)	83.3	73.1–91.0	%	
Proportion of adults breeding (from raw input parameters)	88.9	75.3–96.3	%	
Annual breeding pairs (from raw input parameters)	18 200	10 300–29 200	Pairs	
Total population size (from raw input parameters)	63 600	34 900–108 000	Individuals	
Maximum net productivity rate r_{max}	0.233	0.160–0.330		

1.67 Pitt Island shag (*Stictocarbo featherstoni*)

Table 133: Raw input data of population parameters of Pitt Island shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population ()	388 pairs [2011]	Debski et al. (2012)	High
Age at first reproduction	More than 3 years	R. Powlesland (pers. comm.)	
Current survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Optimal survival rate	87.8 (85.9–89.7) %	European shag as proxy; Harris et al. (1994)	
Body mass	1 185 g	Myhrvold et al. (2015)	
Breeding period	September–February	G. Taylor (pers. comm.)	
Relative non-breeding pop.	100%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

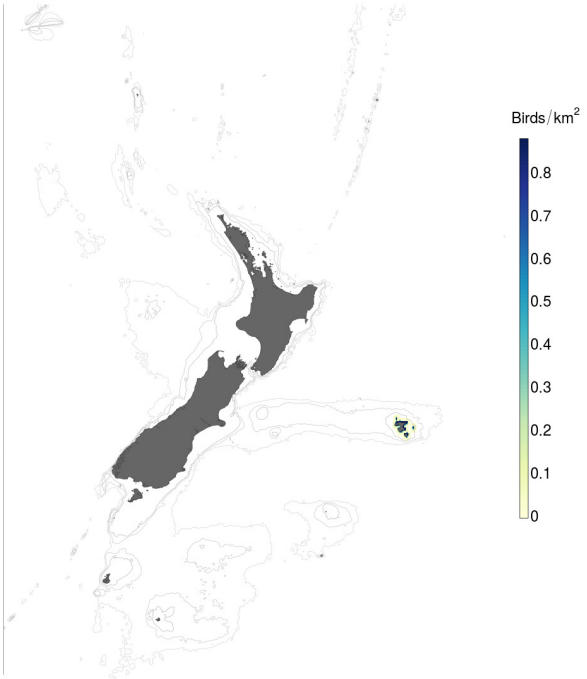
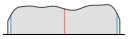
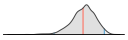
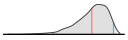
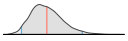


Figure 67: Relative density of Pitt Island shag (*Stictocarbo featherstoni*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 134: Derived values of population parameters of Pitt Island shag for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

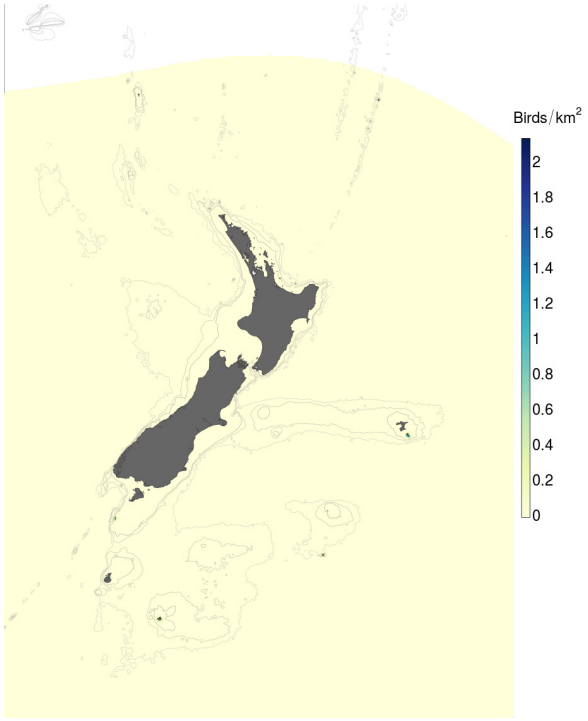
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	4.0	3.1–4.9	Years	
Age at first reproduction (from allometric model)	2.7	2.0–3.7	Years	
Current adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from raw input parameters)	87.8	86.0–89.6	%	
Optimal adult annual survival rate (from allometric model)	83.4	73.2–90.8	%	
Proportion of adults breeding (from raw input parameters)	88.8	75.5–96.3	%	
Annual breeding pairs (from raw input parameters)	391	319–475	Pairs	
Total population size (from raw input parameters)	1 790	1 310–2 460	Individuals	
Maximum net productivity rate r_{max}	0.233	0.159–0.326		

1.68 Subantarctic skua (*Catharacta antarctica lonnbergi*)

Table 135: Raw input data of population parameters of subantarctic skua for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	450 to 470 pairs	Wilson (2006)	
Age at first reproduction	8.03 $\pm$ 0.21 years ($N = 96$) [1996]	Young (1998)	High
Current survival rate	93.8 (91–97) % [1965]	Wood (1971)	Medium
Optimal survival rate	93.8 (91–97) % [1965]	Wood (1971)	Medium
Body mass	1 725 g	Myhrvold et al. (2015)	
Breeding period	September–February	G. Taylor (pers. comm.)	
Relative non-breeding pop.	50%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

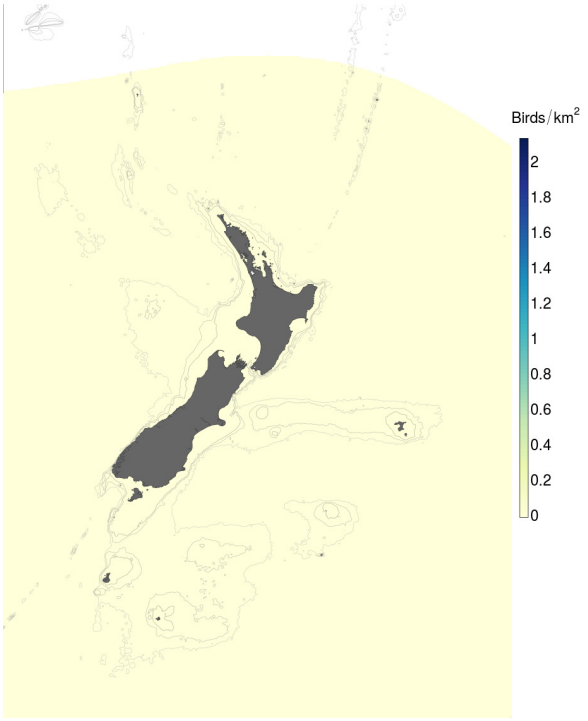
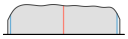
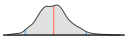
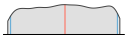
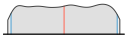
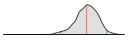
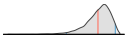
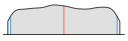
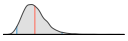


Figure 68: Relative density of subantarctic skua (*Catharacta antarctica lonnbergi*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 136: Derived values of population parameters of subantarctic skua for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

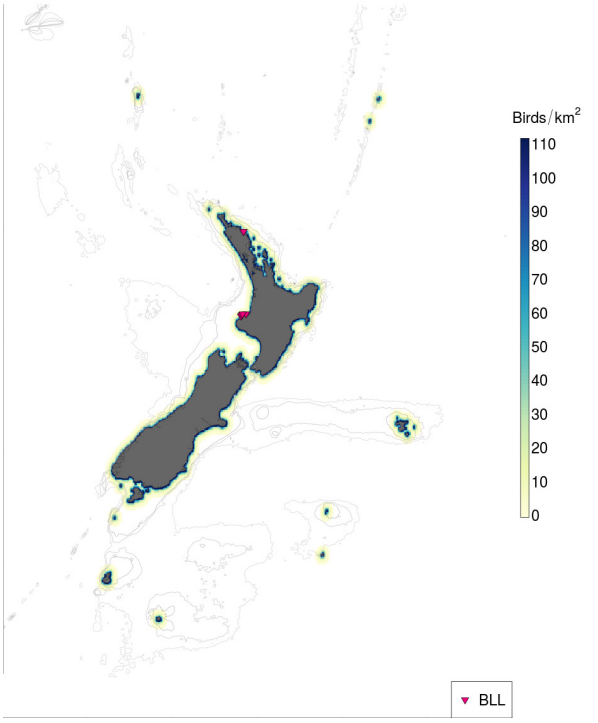
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	8.0	7.6–8.4	Years	
Age at first reproduction (from allometric model)	5.8	4.4–7.4	Years	
Current adult annual survival rate (from raw input parameters)	94.1	91.1–96.9	%	
Optimal adult annual survival rate (from raw input parameters)	94.0	91.2–96.9	%	
Optimal adult annual survival rate (from allometric model)	84.3	75.7–91.0	%	
Proportion of adults breeding (from raw input parameters)	88.9	75.0–96.5	%	
Annual breeding pairs (from raw input parameters)	460	451–470	Pairs	
Total population size (from raw input parameters)	2 220	1 640–3 120	Individuals	
Maximum net productivity rate r_{max}	0.120	0.092–0.156		

1.69 Southern black-backed gull (*Larus dominicanus dominicanus*)

Table 137: Raw input data of population parameters of southern black-backed gull for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	More than 1 000 000 pairs	Taylor (2000b)	
Age at first reproduction	4 years	Schreiber & Burger (2001)	
Current survival rate	81 %	Schreiber & Burger (2001)	
Optimal survival rate	81 %	Schreiber & Burger (2001)	
Body mass	966 g	Myhrvold et al. (2015)	
Breeding period	September–March	G. Taylor (pers. comm.)	
Relative non-breeding pop.	100%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

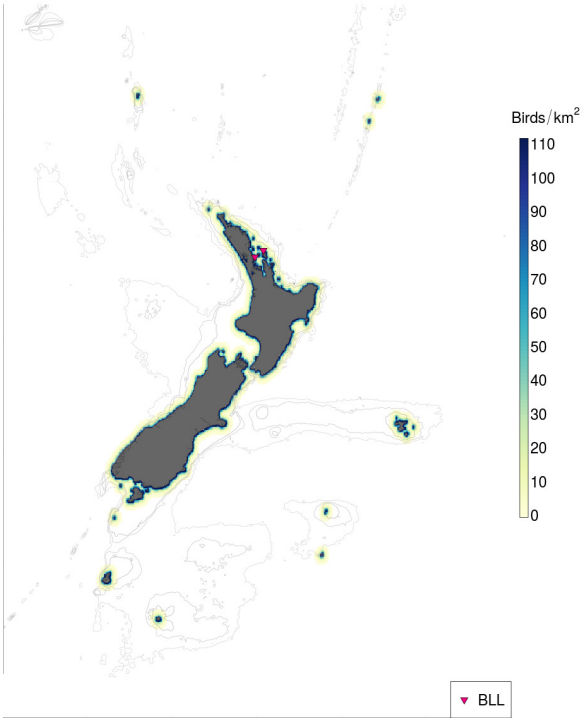
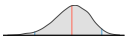
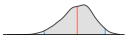
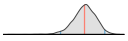
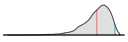
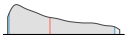
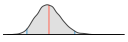


Figure 69: Relative density of southern black-backed gull (*Larus dominicanus dominicanus*). Also shown are incidental captures recorded by observers between the 2006–07 and 2014–15 fishing years in bottom-longline (BLL) fisheries.

Table 138: Derived values of population parameters of southern black-backed gull for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

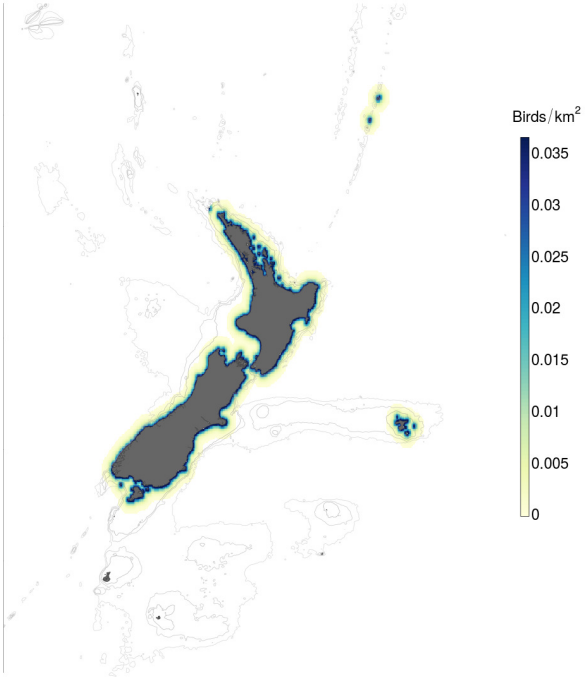
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	4.0	3.1–5.0	Years	
Age at first reproduction (from allometric model)	5.0	3.8–6.3	Years	
Current adult annual survival rate (from raw input parameters)	80.8	74.3–86.1	%	
Optimal adult annual survival rate (from raw input parameters)	80.8	74.5–86.2	%	
Optimal adult annual survival rate (from allometric model)	82.0	73.1–89.6	%	
Proportion of adults breeding (from raw input parameters)	88.8	75.0–96.5	%	
Annual breeding pairs (from raw input parameters)	1 570 000	728 000–2 900 000	Pairs	
Total population size (from raw input parameters)	9 400 000	4 030 000–19 200 000	Individuals	
Maximum net productivity rate r_{max}	0.142	0.108–0.181		

1.70 Caspian tern (*Hydroprogne caspia*)

Table 139: Raw input data of population parameters of Caspian tern for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	1 000 pairs [1992]	Taylor (2000b)	Medium
Age at first reproduction	2 to 4 years	Schreiber & Burger (2001)	
Current survival rate	87 to 91 % 89 % [1980]	Schreiber & Burger (2001) Gill & Mewaldt (1983)	
Optimal survival rate	87 to 91 % 89 % [1980]	Schreiber & Burger (2001) Gill & Mewaldt (1983)	
Body mass	648 g	Myhrvold et al. (2015)	
Breeding period	September–January	G. Taylor (pers. comm.)	
Relative non-breeding pop.	100%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

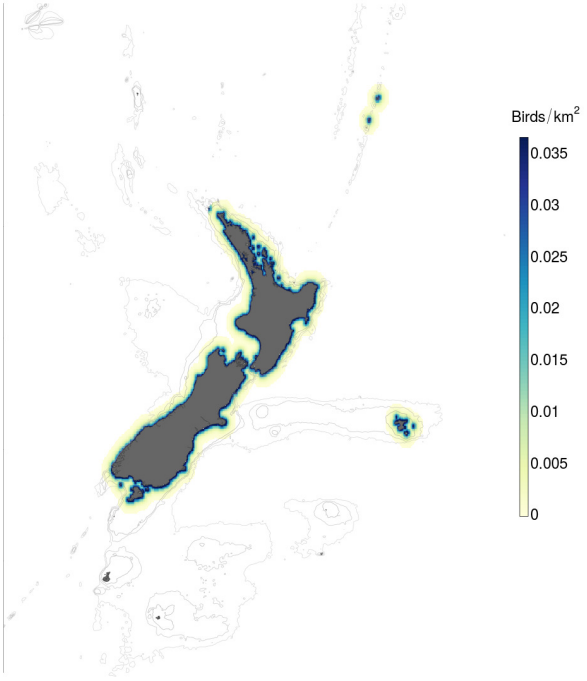
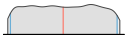
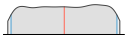
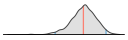
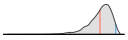
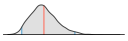
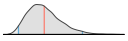
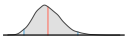


Figure 70: Relative density of Caspian tern (*Hydroprogne caspia*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 140: Derived values of population parameters of Caspian tern for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

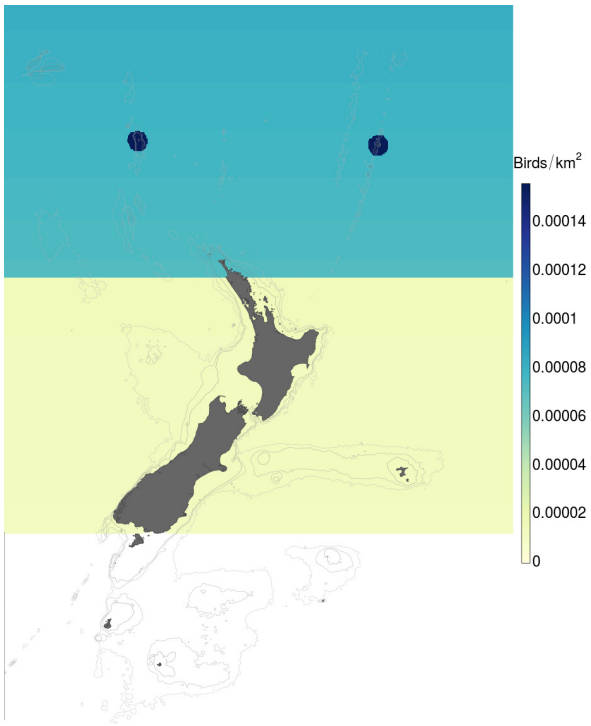
Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	3.0	2.0–4.0	Years	
Age at first reproduction (from allometric model)	4.5	3.4–5.7	Years	
Current adult annual survival rate (from raw input parameters)	87.7	82.0–93.3	%	
Optimal adult annual survival rate (from raw input parameters)	87.6	81.9–93.3	%	
Optimal adult annual survival rate (from allometric model)	80.1	69.6–88.4	%	
Proportion of adults breeding (from raw input parameters)	89.0	74.6–96.5	%	
Annual breeding pairs (from raw input parameters)	1 020	692–1 480	Pairs	
Total population size (from raw input parameters)	4 220	2 570–6 670	Individuals	
Maximum net productivity rate r_{max}	0.161	0.120–0.211		

1.71 White tern (*Gygis alba candida*)

Table 141: Raw input data of population parameters of white tern for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters, including the data source and an assigned quality ranking. Years in square parentheses indicate time of population assessment. "Relative non-breeding pop." refers to the population in New Zealand outside the breeding season relative to the population during the breeding season.

Parameter	Data	Reference	Quality
Population (NZ)	60 to 100 pairs	Taylor (2000b)	Poor
Age at first reproduction	3 to 5 years	Schreiber & Burger (2001)	
Current survival rate	78 to 83 %	Bridled tern as proxy; Schreiber & Burger (2001)	
Optimal survival rate	78 to 83 %	Bridled tern as proxy; Schreiber & Burger (2001)	
Body mass	232 g	Myhrvold et al. (2015)	
Breeding period	September–April	G. Taylor (pers. comm.)	
Relative non-breeding pop.	100%	G. Taylor (pers. comm.)	

(a) Breeding season distribution



(b) Non-breeding season distribution

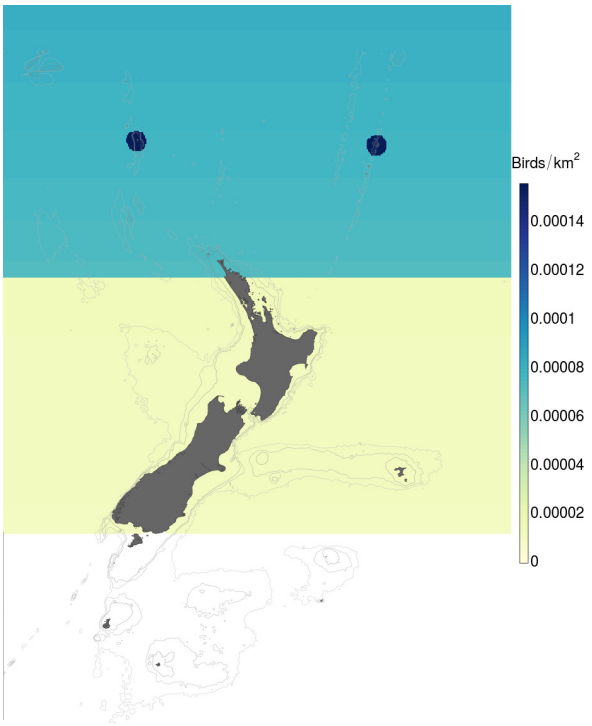
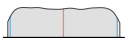
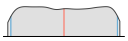
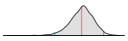
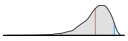
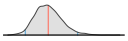


Figure 71: Relative density of white tern (*Gygis alba candida*). No incidental capture was recorded by observers between the 2006–07 and 2014–15 fishing years in trawl, surface-longline (SLL), bottom-longline (BLL), and set-net (SN) fisheries.

Table 142: Derived values of population parameters of white tern for the assessment of the risk of commercial fisheries to seabirds in New Zealand waters. For the density distribution of each parameter, the central red line indicates the mean, outer blue lines indicate the 2.5 and 97.5 percentiles.

Parameter	Mean	95% c.i.	Unit	Distribution
Age at first reproduction (from raw input parameters)	4.0	3.0–5.0	Years	
Age at first reproduction (from allometric model)	3.5	2.6–4.5	Years	
Current adult annual survival rate (from raw input parameters)	80.5	78.1–82.9	%	
Optimal adult annual survival rate (from raw input parameters)	80.5	78.1–82.9	%	
Optimal adult annual survival rate (from allometric model)	74.5	60.6–85.8	%	
Proportion of adults breeding (from raw input parameters)	89.0	75.7–96.3	%	
Annual breeding pairs (from raw input parameters)	78	61–99	Pairs	
Total population size (from raw input parameters)	480	311–717	Individuals	
Maximum net productivity rate r_{max}	0.221	0.161–0.297		

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