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Incidental capture of seabird species in commercial fisheries in New Zealand waters, 2000–01

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Amendments re squid fishery seabird capture estimates to:

Baird, S. J. (2004). Incidental capture of seabird species in commercial fisheries in New Zealand waters, 2000–01. ***New Zealand Fisheries Assessment Report 2004/58.*** **63 p.**

EXECUTIVE SUMMARY

[para 4]

Limitations in the data restrict the reliability of the results. Total estimates are provided for the main fisheries: 16 seabirds (c.v. = 6%) were caught during chartered tuna longline sets, primarily off the southern west coast of the South Island; 757 seabirds (c.v. = 11%) were estimated caught by four autoline vessels when stratified by area and season compared with an estimated 2367 seabirds (c.v. = 12%) for the six autoline vessels by area; 1065 seabirds (c.v. = 9%) were estimated caught during hoki targeted trawls; **and 433 seabirds (c.v. = 4%)** were estimated caught during squid trawls. Numbers are given for seabirds in total, rather than individual taxa, because of problems in extrapolating by seabird species over a fishery.

3.4.2.2 Squid trawl fishery at the Stewart-Snares shelf

3.4.2.2.2 Seabird incidental captures and estimates

[para 3]

When the data for January–April 2001 are combined, 75% of the 3112 tows were observed, and from a mean bycatch rate of 0.130 seabirds per tow (s.e. = 0.012), an estimated 403 seabirds were caught (c.v. = 5%). If the three observed Polish vessels, which accounted for 12% of all the effort, 14% of the observed effort, and 37% of all observed seabird captures are excluded from this dataset, **74% of the 2716 tows** were observed and a mean bycatch rate of 0.095 seabirds per tow (s.e. = 0.009) and a **total estimate of 257 seabirds (c.v. = 5%).** Another 134 seabirds (c.v. = 7%) were estimated caught from the Polish outlier vessels.

SEE ATTACHED TABLES WHERE CHANGES ARE HIGHLIGHTED [7 JUNE 2005]

APPENDIX A — *continued*

Table A2: Summary seabird statistics for hoki and squid trawl fisheries, 2000–01*. No estimates were provided for trawl fisheries targeting other species. Numbers of seabird captures in these fisheries are given in Table A4.

Target species/ Area†	Total no. tows/ hooks	% observed	No. observed seabirds	Incident rate (%)	Mean bycatch rate	Standard error	Estimated no. seabirds caught	*c.v.* (%)
Hoki target: total estimate of 1 065 seabirds (c.v. = 9%)								
CHAT	8 133	11	21	2	0.023	0.006	187	20
CHAT outlier	671	37	197	–	0.785	0.105	527	11
COOK	3 091	9	2	<1	0.008	0.008	–	–
PUYS	919	12	4	2	0.037	0.030	34	76
SUBA	6 088	11	19	4	0.028	0.010	211	28
WCSI	7 549	14	15	1	0.014	0.004	106	26
Squid target: total estimate of 433 seabirds (c.v. = 4%)								
CHAT	546	2	0	0	0.000	–	–	–
ECSI	2 003	4	6	6	0.071	0.032	–	–
SQU 6T	580	99	42	6	0.073	–	42	0
STEW	2 716	74	189	9	0.095	0.009	257	5
STEW outlier	396	84	113	–	0.339	0.059	134	7

* Estimates were provided for those fisheries where at least 10% of the fishing effort was observed, and the observed effort was representative of the fishing effort.

† CHAT hoki data are for October-April. The SUBA hoki total estimate includes 39 seabirds (caught by an outlier vessel, the effort of which was 100% observed). STEW squid data are for January-April.

APPENDIX A — *continued*

Table A3: Summary of observed seabird captures or total estimates for the main longline and trawl fisheries, 1998–99 to 2000–01. Fishery areas and codes are shown in Appendix D and the relevant fishery appendices. Data for 1998–99 and 1999–2000 are from Baird (2001, 2004).

Fishing year	Chartered tuna longline fleet			
	Area 1	Area 2	Area 3	Area 4
1998–99	18*	2*	54*	0
1999–00	11*	11*	18*	0
2000–01	–	1*	15 (c.v.=7)	–

	Domestic tuna longline fleet			
	Area 1	Area 2	Area 3	Area 4
1998–99	10†	–	–	–
1999–00	34†	–	–	–
2000–01	38†	–	0†	0†

	Ling autoline fleet					
	LIN 2	LIN 3	LIN 4	LIN5	LIN 6	LIN 7
1998–99	–	–	6‡	–	85‡	–
1999–00	–	4‡	12‡	90‡	97‡	–
2000–01	9 (c.v.=98%)	–	2‡	523 (c.v.=17%)	1838 (c.v.= 14)‡	–

	Hoki				
	CHAT	COOK	PUYS	SUBA	WCSI
1998–99	53†	1†	3†	94 (c.v. = 23%)	215 (c.v. = 18%)
1999–00	46†	0	1†	209 (c.v.=19)	69 (c.v.=41)
2000–01	187 (c.v.=20)§	2†	4†	211 (c.v.=28)	106 (c.v. = 26)

	Squid				
	CHAT	ECSI	PUYS	SQU 6T	STEW
1998–99	0†	21†	0†	1†	268 (c.v.= 20%)
1999–00	4†	1†	–	82 (c.v. = 19%)	93 (c.v. = 34%)
2000–01	0†	6†	0†	42*	257 (c.v.= 5%)§

* These numbers are numbers of observed seabirds for fishery areas where the observed effort represents 100% of the fishery effort.

† These numbers are observed seabird captures for fishery areas where the observer coverage was too low.

‡ These numbers are observed seabird captures for fishery areas where the actual numbers of seabirds reported includes both observed and unobserved seabirds, or where the numbers of hooks observed is unknown (as in ling longline fisheries in 1998–99 and 1999–00). The estimate given for LIN 6 in 2000–01 includes an unknown number of unobserved seabirds and therefore may be an overestimate.

§ Outlier vessels are excluded from the totals for CHAT hoki and STEW squid in 2000–01 (see Table A2 for the outlier vessel data).

APPENDIX F— *continued*

Table F4: Fishing effort, observed effort, seabird captures, and mean seabird catch rates (numbers of seabirds per tow) for the STEW squid fishery, 2000–01.

Month*	Total no. tows	No. observed tows	% tows observed	No. seabirds observed caught	Mean bycatch rate	Standard error	Estimated number caught	c.v. (%)
January	604	311	51	41	0.132	0.048	80	25
February	1 110	1 053	95	139	0.132	0.016	147	3
March	866	713	82	109	0.153	0.02	132	6
April	532	254	48	13	0.051	0.016	27	23
Jan-Apr	3 112	2 331	75	302	0.130	0.012	403	5
Jan-Apr†	2 716	1 998	74	189	0.095	0.009	257	5
Jan-Apr‡	396	333	84	113	0.339	0.059	134	7

* Effort in other months: 40 tows in December, 113 in May, and 44 in June.

† Data are for all vessels but the three observed Polish vessels.

‡ Data are for Polish vessels only.

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EXECUTIVE SUMMARY

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Ministry of Fisheries observers reported 1236 seabird captures from fishing operations in 2000–01: 701 from observed trawl fishing operations (87% landed dead); 53 from tuna (*Thunnus* spp.) longlining operations (87% landed dead); 452 from ling (*Genypterus blacodes*) longline operations (99% dead); 26 from snapper (*Pagrus auratus*) longlines (100% dead); and 4 from bluenose (*Hyperoglyphe antarctica*) longlines (75% landed dead). Observed squid (*Nototodarus* spp.) and hoki (*Macruronus novaezelandiae*) trawl fisheries accounted for 94% of the 701 seabird captures in observed trawl fisheries.

Observed incident rates in longline fisheries were highest in the ling longline fishery: 24% of observed ling autoline sets caught seabirds, compared with 6% of observed chartered tuna longline sets, 15% of domestic tuna longlines, and 16% of snapper longlines. Lower incident rates were observed in the trawl fisheries: 8% of observed tows in the squid fishery, 4% in hoki, barracouta (*Thyrsites atun*), and scampi (*Metanephrops challengeri*) fisheries, and less than 2% in jack mackerel (*Trachurus* spp.), southern blue whiting (*Micromesistius australis*), and orange roughy (*Hoplostethus atlanticus*) fisheries.

Mean seabird catch rates were estimated for the main fisheries with observed seabird captures: for ling longline fisheries, mean catch rates varied from 0.218 seabirds per 1000 hooks (s.e. = 0.033) in LIN 6 to 0.004 (s.e. = 0.004) in LIN 2; for the chartered tuna fishery off the southern west coast of the South Island, 0.026 seabirds per 1000 hooks (s.e. = 0.008); for hoki fisheries, between 0.014 seabirds per tow (s.e. = 0.004) in the west coast South Island fishery and 0.037 (s.e. = 0.030) in the Puysegur fishery; and for squid trawl fisheries, 0.095 seabirds per tow (s.e. = 0.009) at the Stewart-Snares shelf fishery and 0.073 seabirds per tow in SQU 6T.

Limitations in the data restrict the reliability of the results. Total estimates are provided for the main fisheries: 16 seabirds (c.v. = 6%) were caught during chartered tuna longline sets, primarily off the southern west coast of the South Island; 757 seabirds (c.v. = 11%) were estimated caught by four autoline vessels when stratified by area and season compared with an estimated 2367 seabirds (c.v. = 12%) for the six autoline vessels by area; 1065 seabirds (c.v. = 9%) were estimated caught during hoki targeted trawls; and 586 seabirds (c.v. = 11%) were estimated caught during squid trawls. Numbers are given for seabirds in total, rather than individual taxa, because of problems in extrapolating by seabird species over a fishery.

In fisheries for which the observer coverage was under 10% of the total effort in a season or fishing year, the number of observed seabirds are reported: 68 seabirds from domestic tuna, bluenose, and snapper longline sets and 44 seabirds from trawls targeting at least 10 species other than hoki and squid.

Apart from one black-backed gull (*Larus dominicanus*), the remaining 1045 seabirds observed caught and returned for identification represented 9 albatross and 13 petrel taxa. These taxa included three previously unrecorded as caught during observed fishing operations: Buller's shearwater (*Puffinus bulleri*), fluttering shearwater (*Puffinus gavia*), and short-tailed shearwater (*Puffinus tenuirostris*). White-chinned petrels (*Procellaria aequinoctialis*), sooty shearwaters (*Puffinus griseus*), grey petrels (*Procellaria cinerea*), white-capped albatrosses (*Thalassarche steadi*), and Salvin's albatrosses (*T. salvini*) accounted for 92% of the seabirds landed dead and returned for autopsy.

1. INTRODUCTION

Statutory obligations under the 1996 Fisheries Act require the Ministry of Fisheries (MFish) to monitor the bycatch of associated or dependent species during commercial fishing operations in New Zealand waters. The Ministry of Fisheries Observer Programme collects data on the incidental catch of albatross and petrel taxa as part of its monitoring programme.

In New Zealand waters, seabird captures have been reported from observed longline fishing activities, particularly those that target tuna species (*Thunnus* spp.) and ling (*Genypterus blacodes*) (Baird 2004, Baird & Bradford 2000, Murray et al. 1993) and trawl operations, especially for hoki (*Macruronus novaezealandiae*) and squid (*Nototodarus* spp.) (Baird 2004, Bartle 1991). Estimation of the numbers of seabirds captured (dead and alive seabirds) is limited by the proportion of the fleet's effort that is observed and the number of seabird captures actually observed (Baird 2004, Bradford 2002). Estimates of total captures are most reliable from those fisheries where the observer coverage (percent of total hooks or tows observed) is representative of the fishing effort in time and space, is greater than 10%, and where a reasonable number of seabirds have been observed caught. In recent years, seasonal estimates have been provided for the southern bluefin tuna longline fishery in waters south of 42° S; the hoki fisheries on the Chatham Rise, off the west coast South Island, and off the Stewart-Snares shelf; the squid trawl fisheries off the Stewart-Snares shelf and the Auckland Islands Shelf; and for some ling longline effort (for example, Baird 2004). Generally, where seabirds have been observed caught in other fisheries, mean catch rates and catch estimates have not been calculated because catches have been few and separated in time and space.

This report addresses Specific Objective 1 of ENV2001/01 "to estimate and report the total numbers of captures, releases, and deaths of seabirds — where possible by species, fishery and fishing method — caught in fishing operations during the 2000/2001 fishing year".

2. METHODS

2.1 Data sources and treatment

Data used for the analyses undertaken to estimate the total numbers caught included observed seabird capture data, observed fishing effort data, and total fishing effort data. These data were extracted from MFish observer databases based on observer logbooks and commercial databases based on Trawl Catch Effort Processing Return forms (TCEPR), Catch Effort Landing Return forms (CELR), and Tuna Longline Catch Effort Returns (TLCER).

Data were extracted for the target trawl and longline fisheries in which incidental captures of nonfish species were recorded by MFish scientific observers during the fishing year (1 October–30 September) 2000–01. The following observer data were extracted by target species for each fishing operation: trip, tow (or set and associated number of hooks), gear type, latitude and longitude, date and time, vessel identifier and nation, number of seabirds, seabird species, life status (alive or dead), handling code (released, discarded, or retained), and sex, as recorded by MFish observers. The following total fishing effort data for each fishing operation were extracted: target species, gear type, latitude and longitude, date and time, and vessel characteristics and nation. Where seabirds were landed dead, observers returned the seabirds to the Department of Conservation (DoC) for autopsy (carried out under a Conservation Services Programme (CSP) project (Robertson et al. 2003)), and the resulting information was used to update the species identification and sex fields in the *l_line* and *obs_lfs* databases at NIWA. The identifications are based on Robertson & Nunn (1998).

All data were error checked and erroneous data were amended where possible; for example, where position data of some fishing operations were identified as obvious outliers, the

latitudes and longitudes were amended with reference to fishing operations before and after the incorrect data. Other problems encountered related to the numbers of hooks, dates of fishing operations, and gear codes.

In this report, "captures" refer to all observed seabird captures, whether the seabird was landed dead or captured alive and released, as reported by MFish observers.

2.1.1 Tuna longline fisheries

Tuna species targeted by surface longlines in New Zealand waters in 2000–01 included southern bluefin (*Thunnus maccoyii*), bigeye (*T. obesus*), albacore (*T. alalunga*), yellowfin (*T. albacares*), and Pacific (previously "northern") bluefin (*T. orientalis*). All data were extracted by position (latitude and longitude) at the start of each longline set for the 1 October 2000 to 30 September 2001 fishing year. Each set was then allocated to the following areas, defined by the Ministry of Fisheries:

- Area 1 — east of the QMA 1/QMA 9 boundary at 173°02.8' E south to the intersection of the QMA 2/QMA 3/QMA 4 boundary at latitude 42°10.0' S;
- Area 2 — south of the QMA 2/QMA 3/QMA 4 boundary at latitude 42°10.0' S to a line at longitude 167° E;
- Area 3 — west of longitude 167° E north to latitude 38° S; and
- Area 4 — north of latitude 38° S to the QMA 1/QMA 9 boundary at 173°02.8' E.

Data were then stratified by fleet (chartered Japanese vessels or domestic owned and operated vessels) because different fishing practices are used by the two fleets (Murray et al. 1999). The chartered Japanese vessels complete TLCERs, whereas domestic owned and operated vessels complete TLCERs or CELRs (though the latter records represent less than 1.5% of the hooks set by domestic vessels). Data were groomed according to routine procedures (Wei 2003). Where no latitude and longitude data were reported on CELR records (41% of the 116 records), the given statistical area was used to determine the area location.

In the chartered data, five bigeye tuna sets reported for Area 3 were allocated to Area 4 because their locations were just south of the Area 4 southern boundary, well north of the earlier southern bluefin tuna effort to the south of Area 3. Comparison of the hook data from the commercial records and from the observed records for the same trip sometimes yielded discrepancies in the numbers of hooks per set. All chartered sets were observed and the total hook data recorded by observers represented 99.6% of the total hook data reported on TLCERs for this fleet. The total hook number reported from observers is used to determine the total hook number set for a stratum; all these data are well groomed as part of the database administration (Mackay & Griggs 2001).

The number of hooks observed in each set is estimated from the proportion of the haul observed (based on the haul duration and the time recorded as unobserved in the observer events logs) multiplied by the number of hooks set.

2.1.2 Bottom longline fisheries

Bottom longline fisheries for bluenose, ling, and snapper were observed in 2000–01. Commercial data for these fisheries are recorded on CELRs. All bottom longline data were extracted and stratified by the given statistical area into the target species Quota Management Areas (QMAs). Where the statistical area boundaries were inconsistent with the QMAs, the effort was assigned to the closest QMA. Some CELR fishing effort data were difficult to interpret, especially the relative columns of the number of sets and the number of hooks.

These data were groomed where possible, but doubts about the accuracy of the number of hooks set remain because of these inconsistencies. The total effort hook data collection on CELRs requires the number of hooks hauled on a daily basis. Some vessels complete a form for a set and others complete a form for a day's fishing effort.

Where hook data were missing for a vessel, equivalent data from the observer records were used if the dates matched. In records where the number of sets per day was included, an equivalent number of hooks reported in other daily effort by that vessel was used. Changes to hook data were made to 2% of the CELR ling records. To determine the actual number of hooks observed during the ling sets, data recorded by observers on new ling "setting observation" and "hauling observation" forms were used. These forms record the number of hooks observed set in each line and the number of hooks observed during the haul of each line.

Some ling longline haul observation forms and nonfish bycatch forms indicated that some seabirds reported by the observers were not actually observed caught during the observers' hours of duty. These seabirds are reported in the Results, but are not included in the estimates.

Discrepancies were also found in the CELR data for longlines where snapper was the target. For example, some data showed large differences between numbers of lines and numbers of hooks, and other snapper effort records reported 9 lines and 900 hooks as the effort for one day. These data were from an extract that specified "BLL" (bottom longlining) as the fishing method, and it was difficult to distinguish whether errors were reporting or punching errors. Thus, the "number of lines" column was considered unreliable, and just the hook numbers reported per record were used. Where it was obvious or suspected that hook numbers were incorrect due to a punching error, records were amended to be consistent with the vessel's related effort (less than 0.2% of records).

2.1.3 Trawl fisheries

Seabird data from trawl fisheries were investigated by target fishery QMAs as defined in Annala et al. (2001). Position data (latitude and longitude) at the start of the fishing operation were used to determine the key areas for each interaction. Where appropriate, data were collated into individual species QMAs. However, for some target fisheries, such as those for hoki where there is one QMA (HOK 1) and effort is concentrated within certain localised areas, for example, the west coast South Island fishery (see Annala et al. 2001 for area), finer-scale strata were used. The hoki trawl data were therefore stratified into the main hoki fishery areas: west coast South Island (WCSI), east coast South Island-Chatham Rise (CHAT), Cook Strait (COOK), sub-Antarctic (SUBA), and Puysegur (PUYS). The areas used for the analyses of seabird captures in the southern squid trawl fisheries were the Auckland Islands part of SQU 6T and the Stewart-Snares shelf.

For some fisheries (for example, hoki fisheries at the Chatham Rise and in sub-Antarctic waters), initial data exploration indicated that certain vessels were responsible for a disproportionate number of seabird captures in a fishery stratum. These vessels are treated as "outliers" and separate estimates are provided under the relevant fisheries in the Results.

General descriptions of the characteristics of the fisheries, such as main season, vessel nationality, and gear type used are provided for each fishery area. The presence of meal plants on vessels is also noted, given the strong evidence of the presence of offal, discards, and/or bait as the main attractants to seabirds (Robertson & Bell 2002).

2.2 Data analysis

The extracted observer data were stratified by target fishery, gear type (where appropriate), area, and month. Data were pooled across months to provide mean catch rates and estimates for the season or fishing year.

Seabird catch rates are expressed as the number of seabirds observed caught per 1000 hooks for longline fisheries and the number of seabirds observed caught per tow for trawl fisheries. Mean catch rates for defined strata were calculated by use of the ratio-of-means estimator:

$$\bar{y} = \frac{\sum c_i}{\sum n_i}$$

where n_i is the observed effort (tows, 1000 hooks), and c_i is the number of observed incidental captures of seabirds. The total catch of seabirds, $\hat{T}$, is estimated by

$$\hat{T} = N\bar{y} \qquad \text{with estimated variance} \qquad Var(\hat{T}) = N^2 s_b^2 (1 - n/N)$$

where N is the total fishing effort (tows, 1000 hooks) and s_b^2 is the sample variance of the bycatch rate. These are standard results from finite sampling theory (Cochran 1977, Manly 1992). The variance of the observed bycatch rate was estimated by bootstrapping (randomly resampling the observed data 1000 times, after Efron & Tibshirani (1993)), and thus this estimate of variance takes into account the sample size.

The coefficient of variation (*c.v.*) is given by: $$c.v. = \frac{\sqrt{Var(\hat{T})}}{\hat{T}}$$

For the total number of seabirds caught (B_{Tot}) when different fishery-areas contribute to the numbers estimated caught for a given target species

$$B_{Tot} = \sum B_{ij}$$

where B_{ij} is the total estimated captures in each fishery-area strata, with the variance given by

$$V(B_{Tot}) = \sum s_{B_{ij}}{}^2 \qquad \text{and the c.v. equal to} \qquad c.v. = \frac{\sqrt{V(B_{Tot})}}{B_{Tot}} \times 100$$

If the sampling fraction (of observed effort over total effort) is low (for example, under 10%), then extrapolation from the observed effort to that of the whole fleet in that stratum may be unwise, in that errors in the sample estimators will have a high leverage on the final total estimate for that stratum. Furthermore, if vessels show different seabird bycatch rates (and in some fisheries, some vessels have high bycatch rates relative to others) then, where there are many vessels operating, the observer coverage (percent of all fishing operations that is observed) needs to include several vessels — ideally in a representative way. A stratum may be a month, a season (for example, February to June for the SQU 6T squid fishery), or a fishing year. The incident rate is the percent of observed fishing operations (tows or longlines) with observed seabird captures.

For each target fishery, the spread of observer effort data (number of fishing operations and number of vessels, by area and time period, and, where appropriate, by gear type and vessel nationality) was compared with that for the commercial data to determine whether the observed data were representative of the commercial data. Further, given the random nature of

observed seabird captures, mean catch rates and estimates (where appropriate) for a stratum are provided only for those fisheries in which at least 10% of all fishing operations or at least 100 sets/tows within a stratum are observed. Total estimates and c.v.s were calculated only where there was confidence in the representativeness of the data. Therefore, for some interactions, it was not appropriate to estimate the total numbers of seabirds caught, or to define the total numbers of seabirds landed dead or alive. The percent of observed longline sets or tows with observed seabird incidental captures is defined as the incident rate.

The total estimates are provided for all seabird species combined, other than in those fisheries where the observer coverage is close to or at 100% for a given stratum. This is because only those seabirds landed dead and returned to shore are formally identified from the DoC CSP autopsy programme. Further, in some fisheries (for example, the west coast South Island hoki fishery) few seabirds are observed caught and returned and the species composition in the catch is diverse. From one year of data for this kind of fishery-seabird species interaction, there can be little confidence in the likelihood that the observed species composition would be achieved if there were close to 100% observer coverage. Even for fisheries where there are few species represented in the returned catch (with many captured individuals), as seen in the ling longline fishery, the random nature of capture creates difficulties in confidence when extrapolating the data over relative effort.

The above methods assume that the observed sample is collected randomly and thus is representative of the fishery.

3. RESULTS

Summary statistics for the main target fisheries by method and area are given in Tables A1 and A2 in Appendix A. Total estimates (or reported seabird captures) for these main fisheries are given by fishing year for 1998–99 to 2000–01 in Table A3. The data used to generate these results are summarised generally below and then discussed with relevance to the fishing effort (both total and observed) and the observed captures for each fishing method by target fishery. Relevant tables and figures are presented in the accompanying appendices.

Ministry of Fisheries scientific observers reported 53 seabird captures (32% landed dead) during tuna longline fisheries in 2000–01, 452 captures (99% landed dead) during ling longline operations, 26 captures (100% landed dead) in snapper longline operations, and 4 captures (75% landed dead) in bluenose longline operations. A further 701 seabirds were observed caught (87% landed dead) during trawl fishery operations (Table A4 in Appendix A).

Seabirds observed caught during trawling operations were reported from the main fishery areas within the New Zealand 200 n. mile Exclusive Economic Zone (EEZ), such as the Chatham Rise, west coast of the South Island, Stewart-Snares shelf, Auckland Islands Shelf, and Campbell Plateau (Figures A1 and A2 in Appendix A). Those observed caught in the tuna longline fishery were primarily off the west coast of the South Island south of 43° S and the east coast of the North Island between 34° and 40° S. Those caught during observed ling longline fishing were mainly from the Bounty Platform, on the Campbell Plateau, and south of Puysegur Point. Demersal longline sets targeting bluenose caught seabirds just south of Gisborne and those targeting snapper were set north and east of Hauraki Gulf.

The seabirds observed caught and returned for identification represented 9 albatross taxa and 13 petrel taxa (Table A5). The inclusion of observer data from the snapper fishery for the first time has resulted in the presence of two shearwater species previously unrecorded as caught during observed fishing operations: Buller's shearwater (*Puffinus bulleri*) and fluttering

shearwater (*Puffinus gavia*). Short-tailed shearwaters (*Puffinus tenuirostris*), returned from hoki trawls, were also recorded for the first time.

Petrels dominated the catch of seabirds returned for identification: 27% were white-chinned petrels (*Procellaria aequinoctialis*), 21% were sooty shearwaters (*Puffinus griseus*), and 19% were grey petrels (*Procellaria cinerea*). Another 15% were white-capped albatrosses (*Thalassarche steadi*), and 10% were Salvin's albatrosses (*T. salvini*).

White-chinned petrels and grey petrels accounted for 41% and 37% respectively of the seabirds returned from ling longlines, with Salvin's albatrosses accounting for another 18%. Most white-capped albatross and sooty shearwater returns were from hoki and squid trawl fisheries.

The distribution of the seabird captures is related to the location of the observed fishing activity and the return of dead seabirds for identification. Seabird captures observed in waters north of 40° S were predominantly from pelagic longlining for tuna species, and many of these seabirds were released alive and therefore there is limited species identification for these seabirds. Fewer captures from demersal longlining for snapper and bluenose and some inshore trawl activity provide further information on the species caught in northern waters. Salvin's albatross was the only albatross taxon identified from here, with most of the smaller petrel species being represented in the catch (Figure A3). Some of these species were recorded in northern waters only: black petrel (*Procellaria parkinsoni*), Buller's shearwater, flesh-footed shearwater (*Puffinus carneipes*), and fluttering shearwater.

Captures of white-capped albatrosses and white-chinned petrels were returned from the Auckland Islands Shelf, and, with sooty shearwaters, these species dominated the species composition from around the Stewart-Snares shelf. White-chinned petrels were also reported from the Chatham Rise (west of 180°), Campbell Plateau, and Bounty Platform, and large numbers of sooty shearwaters were caught on the Chatham Rise. Salvin's albatrosses were caught mainly on the Chatham Rise and the Bounty Platform. Most of the observed captures of Buller's albatrosses were recorded from off the southwestern coast of the South Island, the southern edge of the Stewart-Snares shelf, and the Chatham Rise. As in previous years (see Baird 2001, 2004), the species diversity reported in the captures from the east coast of the South Island was greater than from the west coast.

3.1 Seabirds in the tuna longline fisheries

All vessels targeting tuna species by pelagic longlines have been required by law to use a tori line since 1992 as the primary mitigation measure against seabird incidental capture, though some fishers of smaller vessels may not always use a tori line on each set because of problems of tangling of the mainline and the tori line. Fishers also voluntarily set their lines in the hours of darkness (Baird & Bradford 2000). One large domestic vessel and the chartered Japanese vessels work under a strict code of practice aimed at minimising seabird captures, with added mitigation measures such as the use of more than one tori line and a bird-scaring gun during the set and pendulums and water hoses during the haul. Commercial and observed fishery data for the tuna longline effort are presented in Appendix B.

3.1.1 Chartered Japanese vessels

3.1.1.1 Description of the fishery

Four chartered Japanese vessels targeted southern bluefin tuna in southern waters in Areas 2 and 3 during April–June 2001 (Table A1, Figure B1). These vessels set an average of 3120

hooks per set, with the average per vessel ranging from 3025 to 3352. A Ministry of Fisheries observer was placed on each vessel and all 199 longline hauls were observed. Of the 621 000 hooks, about 96% were observed.

3.1.1.2 Seabird incidental captures and estimates

Seabirds were observed caught on about 6% of all observed sets, with nine sets reporting one capture and three sets reporting two seabirds, to give a total of 15 seabirds for the season. Two vessels caught five birds, one vessel caught three, and the remaining vessel caught two birds. Mean catch rates calculated for Area 2 (0.019 seabirds per 1000 hooks) and for Area 3 (0.026 seabirds per 1000 hooks) (see Table A1) gave a total estimate of 16 seabird captures (c.v. = 6%) for the chartered vessels.

3.1.1.3 Seabird taxa

Twelve (80%) of the observed seabirds were landed dead and returned for formal identification (Table B1). Buller's albatrosses accounted for over 60% of the dead seabirds, and although the identification of three seabirds released alive is not verified, the observers (all very experienced) reported these seabirds as Buller's albatrosses. Of the dead birds, nine swallowed the hook, two were tangled in the line, and one was hooked in the bill. Those birds released alive were hooked in the bill or tangled.

3.1.2 Domestic owned and operated vessels

3.1.2.1 Description of the fishery

About 128 domestic owned and operated tuna longline vessels fished in 2000–01. Of these, 124 fished in Area 1, 4 in Area 2, 8 in Area 3, and 83 in Area 4. Over 9.1 million hooks were set, 77% of which were in Area 1 and 20% in Area 4 (Figure B1). Vessels in Area 1 and Area 4 fished throughout the year, with over a million hooks set in June (Table B2) when there was a large increase in effort targeting southern bluefin tuna at the end of the season. Effort in Area 1 was directed primarily at bigeye (78%), southern bluefin (13%), albacore (6%), and yellowfin tunas (2%), and in Area 4 at bigeye (88%), albacore (6%), and yellowfin tunas (4%) in Area 4. Effort in Area 2 and Area 3 targeted southern bluefin tuna, mainly during March–June. Smaller vessels averaged about 1100 hooks per set, whereas one larger vessel averaged about 3000 hooks. The median number of sets made in 2000–01 was 62 per vessel (range 1–208).

Despite an increase in the number of observed sets in 2000–01 (275 sets (469 118 hooks) compared with less than 40 sets or 40 000 hooks in the previous two seasons), only about 3.5% of sets (5% of hooks) were observed (Table B2). This represents 12% of vessels in Area 1, none in Area 2, 12.5% in Area 3, and 5% in Area 4. The observer coverage in Area 3 was on one large vessel (86% of the hooks were observed) that accounted for 40% of the total effort here. The fishing strategy used by this vessel is substantially different from the other smaller vessels fishing in the same area, as is its rigorous adherence to a code of practice that includes many different mitigation measures. Thus the data are not comparable. There were no incidental captures of seabirds reported from this vessel, though one seabird which hit the tori line and landed on the deck was released alive.

3.1.2.2 Seabird incidental captures

All 38 of the reported seabird incidental captures were from Area 1 (see Table A1), during December–February inclusive. Seabirds were caught in 15% of observed domestic sets in this area: of the 38 seabirds observed caught, 21 observed sets caught one seabird, two caught four, and three caught three. No catch rates or estimates are provided because of the inadequacy of the observer data.

3.1.2.3 Seabird taxa

Five seabirds (13% of all captures) were landed dead: two had swallowed the hook, two were hooked in the bill, and one hooked in the wing. These seabirds were identified as one male Salvin's albatross and one male white-chinned petrel from off the east coast at around 39° S, and two female black petrels and one male grey-faced petrel from off the east coast at around 35° S. Most of the seabirds released alive had been tangled ($n = 21$), with a few hooked in the wing, throat, bill, or foot. All but one of the latter seabirds were released without a hook.

3.3 Seabird bycatch in demersal longline fisheries

Seabirds were observed caught in demersal longline operations for bluenose, ling, and snapper. Commercial and observed fishery data for demersal longline effort are presented in Appendix C.

3.3.1 Ling longline

3.3.1.1 Description of the fishery

Forty-one vessels reported bottom longline effort for ling in 2000–01 on CELRs, with about 28.6 million hooks set (about 5200 sets) (Table C1). About 32% of hooks were set in LIN 4 and another 30% in LIN 6 (see Figure C1 for areas). Six large autoline vessels, fishing mainly in LIN 2–6, set at least 530 sets during the fishing year (range 537–746 sets) and accounted for about 93% of all the ling longline hook effort. These vessels set 5000–11 250 hooks per line (up to 32 000 hooks per day), compared with smaller vessels, which set 300–5000 hooks per day.

Of the larger vessels, two fished throughout the year, whereas the other four vessels targeted other species during some of the summer months. There was some overlap of effort in some areas, but often this effort was spatially and temporally isolated, especially in LIN 6.

Four large autoline vessels were observed, and the distribution of the observed effort and seabird incidental captures is shown in Figure C1. One vessel was observed fishing in LIN 2 (May–June) and LIN 5 (October–December), another in LIN 4 and LIN 6 (June–July), one in LIN 5 (October–December) and LIN 6 (April–May), and one just in LIN6 (November–December). Thus, only the observed effort shown in LIN 5 includes more than one vessel, and about 29% of the hooks set here were observed (Table C1). In LIN 6, 11% of hooks set were observed, but the distribution of the effort is spatially and temporally disparate.

Overall, the total effort of these four vessels represented about 60% of all reported ling longline effort for 2000–01, with at least 70% of all hooks in LIN 4, LIN 5, and LIN 6 set by these vessels. These vessels accounted for less than 10% of LIN 3 effort where 11% of all

hooks were set, and none of this effort was observed. Observer coverage by individual vessel for the time in which there was an observer on board ranged from 29% to 60% of hooks set.

3.3.1.2 Seabird incidental captures

Of the 743 longlines set when observers were on board, almost 83% of the hauls were observed; however, because only sections of each corresponding haul were observed, the observer coverage equated to 12% of all the hooks hauled by these vessels (and 8% of all ling hooks) in the 2000–01 fishery.

Seabirds were observed caught on 24% of the 613 observed hauls, but there were large differences in the frequency of captures by vessel (and area and time) (Table C2). Seabirds were observed caught in all areas where there was observer coverage, with 371 seabird captures actually observed by observers and at least another 81 seabirds that were landed when the observers were not present, but were passed on to the observers by the crew. A further 53 seabirds were handed to observers from longlines that were not observed (see Table C2). The crew reported seabird captures from about 20% of unobserved hauls.

Seabirds were caught throughout the 24 h period of fishing, with captures of five or more seabirds per set being greatest on sets starting between 0330 and 0800 h. Set start times were throughout the 24 h on all observed vessels but one, which generally started sets between 2000 and 0230 h.

All but three seabirds observed caught were from LIN 5 and LIN 6 where multiple captures (up to 21 seabirds per set) occurred. The percent of sets with observed seabirds varied from 11% to 60% for vessels where at least 75 sets were observed.

Mean seabird capture rates, based on the 371 captures actually seen by observers, are given by area, vessel, and time in Table C3. It must be noted that for one vessel fishing in LIN 4 and in LIN 6, these "observed" captures may include seabirds that were caught on partially observed hauls, but the captures were made outside the period of observation; these seabirds were passed to the observer when he/she returned from a break or the factory. It was not possible to discern these "unobserved" seabirds from those reported as "observed" for one trip. Thus the mean bycatch rates may slightly overestimate the observed catch rate, and no extrapolation to the vessel's total effort is provided here.

Mean seabird bycatch rates of the two vessels observed in LIN 5 in October–December were substantially different (Figure C2). One of these vessels accounted for 61% of all observed effort (vessel D in LIN 5 and LIN 6) and achieved a lower mean catch rate when fishing in LIN 6 (in April–May) than the other two vessels observed in this area. Substantial differences are evident also between the observed mean catch rates of vessels fishing in LIN 6, where the observed vessels fished in different waters at different times of the year. Apart from the effort in June–July, when two vessels were fishing in the same waters, each observed vessel fished on its own during the observed period.

3.3.1.3 Seabird taxa

About 63% of the 505 seabirds (including 53 seabirds returned from unobserved sets) were caught in LIN 6 and another 36% were from LIN 5. All but three seabirds were landed dead, and of these 97% (488) were returned for autopsy. Three albatross and four petrel taxa were represented in the seabirds that were returned (Table C4). Of the albatross taxa caught, Salvin's were the most numerous and all but one were caught in LIN 6 on the Bounty Platform during November and December on a vessel that set the observed lines mainly

during hours of darkness, with set start times ranging between 2000 and 0230 h. About 77% of the Salvin's albatrosses were females.

Of the petrel taxa, grey (183 birds) and white-chinned (200 birds) petrels were the main taxa caught, with grey petrel captures mainly from one vessel operating on the Campbell Plateau northeast of the Auckland Islands and north of Campbell Rise in June–July. Although less than 20% of these birds could be sexed, all but one were males (see Table C4). Males also dominated the returned white-chinned petrels, accounting for 75% of the 194 returned birds. About 93% of the white-chinned petrels came from south of Puysegur Point in LIN 5 during October–December.

Further data were available for seabirds (predominantly white-chinned petrels) returned from LIN 5; 41% of 184 seabirds were hooked in the wing, 30% in the bill, and 10% in other body parts (neck, foot) or had swallowed the hook (one specimen). The method of capture was unknown for the remainder.

3.3.1.4 Estimated captures

Estimates for total captures are restricted to the months observed, by vessel and area. Based on the individual vessel mean catch rates, an estimated 376 seabirds (c.v. = 15%) were caught in October–December in LIN 5 and about 90% were white-chinned petrels. Another 334 seabirds (c.v. = 18%) were estimated caught in LIN 6 off the Bounty Platform in November–December 2000, and 77% of captures returned from here were Salvin's albatrosses and 22% were white-chinned petrels. During April–May in LIN 6 across the Pukaki Rise, 53 seabirds (c.v. = 17%) were estimated caught. Of the captures returned, 54% were white-chinned petrels and 38% grey petrels.

A total estimate for these four vessels only for the time periods and areas given in Table C3 is 757 seabirds (c.v. = 11%), with another 137 seabirds for the stratum where estimation of total captures was not possible. This contrasts markedly with a total estimate of 2367 seabirds (c.v. = 12%) for LIN 2, LIN 5, and LIN 6 (Table A1). The latter estimates are based on all observed seabirds and effort by autoline vessels in that area during the fishing year; thus, the data include the observed trip where the number of actually observed seabirds is not known (see above) and the total effort of six autoline vessels.

3.3.2 Bluenose longline

3.3.2.1 Description of the fishery

About 56 vessels targeted bluenose by demersal longline during 2000–01, with most effort in BNS 1 (Table C5). A total of 30 sets (about 120 057 observed hooks) was observed on a large ling autoliner that briefly targeted bluenose off the east coast of the North Island at around 40° S during June 2001. Of the 200 000 hooks hauled by this vessel, about 60% were observed. The observers on this vessel reported a mean setting time of 50 min, soak time of 6–20 h, mean haul time of 4.5 h, mean length of line of 9 km, and mean number of hooks per line of 7100 hooks. Tori lines were used during setting. Sets were started throughout the 24 h period.

3.3.2.2 Seabird incidental captures

Four birds were observed caught in three sets: one sooty shearwater (as identified by the observer) was released alive, and one male sooty shearwater, one female grey petrel, and one female cape pigeon were landed dead. This effort is not representative of the total bluenose longline effort and no further investigation of the data was undertaken.

3.3.3 Snapper longline

3.3.3.1 Description of the fishery

Five snapper longline vessels were observed during mid-April to mid-May 2001 in the Hauraki Gulf in SNA 1 (equivalent to Fishery Management Area 1 in Figure A2 in Appendix A). These vessels either set two shorter lines (mean hooks per set range of 416–505), or one longer line (mean hooks per set range of 1011–1075) per day, in daylight hours. Longlines ranged from 2.4 to 5.4 km long. Mean setting and hauling times were about 13 minutes and 63 minutes, respectively, for the shorter lines, and 34–49 minutes and 107–155 minutes for the longer lines. All snoods were 50 cm long and lines were set with three surface buoys: one at each end and one in the centre. One vessel also used floats on the backbone when fishing rough ground. Pilchards, squid, barracouta, kahawai, and octopus were used as bait.

Overall, about 124 vessels targeted snapper by longline throughout the year in 2000–01, and 116 of these fished in SNA 1 where about 94% of the 17.4 million hooks were set (as reported on CELRs). All observed fishing was in Statistical Areas 005, 008, and the southern parts of 003 and 004 (Figure C3). These areas represented about 45% of the total hooks set in SNA 1. During the months of the observed fishing activity (April and May) in 2001, about 50 vessels targeted snapper in these statistical areas and set nearly 1.2 million hooks. The CELR data show that about 75% of vessels fishing in SNA 1 set one line a day (range of 90–6000 hooks per line), 18% set two lines (range 100–3000 hooks per line), and the remainder set three to ten lines per day (range 100–1000 hooks per line). These hook numbers may include some extreme values; it was difficult to determine from some data whether the number of hooks reported per record matched the number of lines reported for that record. The median number of hooks set per day was 1300 (range 90–8000 hooks). The observed activity represents about 4% of the hooks set in the relevant statistical areas and is too low to be analysed any further.

3.3.3.2 Seabird incidental captures

Of the 63 sets (44 050 hooks) observed, 16% caught birds, and all 26 captures were reported from two vessels only: one accounted for 15 birds (caught on 4 sets, with 10 birds on one set), and another for 11 birds (caught on 4 sets). This gave a mean bycatch rate of 0.59 seabirds per 1000 hooks (s.e. = 0.025). All birds were landed dead, with most captures being flesh-footed shearwaters or grey petrels, and the remainder were Buller's and fluttering shearwaters (Table C6). One vessel operating west of Great Barrier Island caught all but one of the flesh-footed shearwaters, and most of the other birds were caught at about 176° E off the Coromandel Peninsula, with the one set of 10 birds including grey petrels and Buller's and fluttering shearwaters. Buller's shearwaters have not been previously reported as fisheries bycatch. Although 11 is not a large sample size, there appears to be a sex bias in the captures of grey petrels.

3.4 Seabird bycatch in trawl fisheries

The incidental capture of seabirds in trawl fisheries was recorded from observed tows that targeted at least 12 different species (Table D1 in Appendix D). Most observed effort was in target fisheries for hoki and squid, where at least 3000 tows were observed throughout 2000–01. Seabirds were observed caught in about 8% of observed squid trawls, 4% of observed hoki, barracouta, and scampi tows, and less than 2% of observed jack mackerel, southern blue whiting, and orange roughy tows. Multiple captures of seabirds (more than one seabird per tow) occurred in the hoki and squid trawl fisheries. Given the low levels of observed seabird incidental captures in most of the fisheries, data analysis will be presented for the hoki and squid trawl fisheries only. Incidental capture information from observed tows targeting other fish species are reported at the end of this section. Codes and scientific names for target species and seabird species are given in Tables D2–D4 in Appendix D. Summary seabird capture statistics for the hoki and squid target trawl fisheries are given in Table A2. Associated tables and figures are given in Appendix E for the hoki fisheries, Appendix F for the squid fisheries, and Appendix G for other trawl fisheries.

3.4.1 Seabird bycatch in hoki trawl fisheries

During 2000–01, about 60% of the 70 vessels that reported target fishing for hoki on TCEPRs were observed at some stage in the fishing year, representing about 12% of the 29 300 tows made. Vessels had different fishing distribution patterns, with 11% targeting hoki in one area (see Section 2.3 and Figure E1 in Appendix E for areas), 21% in two areas, 19% in three areas, 47% in four areas, and 1% in five areas. Over half of the observed vessels (54%) were observed in one area, 23% in two areas, 19% in three areas, 2% in four areas, and 2% in five areas. Those observed in one area included 13 New Zealand vessels, 4 Korean, 3 Ukrainian, and 2 Japanese; in two areas, 4 Korean, 3 New Zealand, and 2 Ukrainian vessels were observed; in three areas, 3 Polish, 2 New Zealand, 2 Ukrainian, and 2 Korean vessels were observed; one Japanese vessel was observed in four areas; and one New Zealand vessel was observed in five areas.

The incidental capture of seabirds in hoki fisheries was recorded for about 4% of observed tows in 2000–01 (range 7% at the Chatham Rise to under 1% at Cook Strait) (Table E1). These tows accounted for 307 observed captures (44% of seabirds reported from observed trawls in 2000–01). About 75% of the seabirds were reported from the Chatham Rise (CHAT) and another 19% from the Sub-Antarctic (SUBA) fishery off the Stewart-Snares shelf. Of the 307 seabirds observed caught, 223 of the 250 seabirds landed dead were returned for identification. Six albatross and eight petrel taxa were represented in those seabirds returned from hoki fisheries, and 92% of the returned seabirds were petrels and shearwaters, about 65% of which were sooty shearwaters, primarily from the CHAT fishery (Table E2). Another 15% were short-tailed shearwaters from the SUBA fishery: this is the first year this species has been identified as a species caught in New Zealand fisheries.

About 40% of all hoki tows (as recorded on TCEPRs) used midwater trawl nets. However, the dominant gear used in the fishery areas differed: midwater nets were used in about 10% of observed tows in CHAT and SUBA, and at least 71% of observed tows in the main hoki spawning fisheries off the west coast South Island (WCSI) and Cook Strait (COOK). A comparison with the observed data shows that a higher proportion of observed tows (51%) used midwater nets; midwater nets were used in about 26% of observed hoki tows in CHAT and SUBA fisheries and about 87% in WCSI and COOK. About 86% of all observed seabirds were caught in observed tows with midwater nets.

Where it was possible to determine the sex, the data show 74% of all seabirds returned were males. For the seabird taxa for which there were most returns, males accounted for 86% of

sooty shearwaters, about 50% of short-tailed shearwaters, and 40% of white-chinned petrels (Robertson et al. 2003).

3.4.1.1 Chatham Rise (CHAT) hoki fishery

3.4.1.1.1 Description of the fishery

Fishing on the Chatham Rise is carried out in all months other than July–August when the main spawning fisheries at WCSI and COOK occur. At least 1000 tows were made in the CHAT hoki fishery between October 2000 and April 2001, with effort peaking in March and gradually dropping off after April (Figure E2). During the main months of the fishery, observer coverage was at least 11% except in February (Table E3). The number of TCEPR vessels operating in the fishery during these months ranged between 15 and 32 each month, and generally at least 15% of vessels were observed each month. A total of 228 seabirds was observed caught in 2000–01, with captures reported from all months except August (when there was minimal effort and no observer coverage) and May. Seabird captures peaked in April, when 67% of all observed captures from this area were reported, with smaller peaks in October and March.

At least 50 vessels targeted hoki in this area in 2000–01 (as reported on TCEPRs), and of the 11 vessels that completed at least 500 tows, 6 were observed at some time. Twenty vessels were observed (range 1–229 observed hoki tows per vessel), with about 70% observed tows on seven vessels. Nearly 60% of observed effort was on eight New Zealand vessels, 18% on three Polish vessels, 17% on one Japanese vessel, 5% on three Ukrainian vessels, and 1% on five Korean vessels. Bottom trawl nets were used on 74% of observed tows, and of the remaining tows (with midwater nets), about 70% were on Polish vessels.

3.4.1.1.2 Seabird incidental captures and estimates

Seabirds were observed caught in 7% of tows and most captures were during tows west of 178° 30' E, where most of the observed effort took place (see Figure E1). Overall, 96% of seabirds were caught in midwater gear and this gear type was used on 26% of observed tows (and 9% of all tows). All vessels had meal plants on board except the Korean and several New Zealand vessels.

Fourteen observed vessels had reported seabird incidental captures, but one vessel accounted for 53% of all captures, and two vessels caught another 33% of observed seabirds. These three Polish vessels accounted for 25% and 69% of the observed effort in March and April, respectively, and for 95% of the seabird incidental captures in March and 97% in April. During October, the other month of peak captures, these vessels accounted for 19% of the observed effort and 77% of the seabird captures, with seabird incidental captures reported from 29% of observed tows. Multiple captures were reported from these vessels, with up to 28 seabirds reported from one tow. The mean bycatch rate for Polish vessels was substantially higher than for the other nations (Figure E3), and these vessels were considered to be outliers in the analysis and have been reported on separately in the data presented in Table E3. Overall these Polish vessels accounted for 16% of all hoki trawlers at the Chatham Rise in 2000–01, 6% of all hoki effort, 18% of all observed hoki effort, and 86% of all observed seabird captures. The total estimate for these vessels, based on a mean catch rate of 0.785 (s.e. = 0.105), is 527 seabirds (c.v. = 11%).

Observed seabird captures were reported from 2% of tows on the remaining vessels. There was little difference in the mean bycatch rates for those months for which there was more than 10% coverage. A total of 31 seabirds was observed caught for 2000–01. During the main

months of the fishery (October–April), observers recorded 21 seabirds, which gave a mean bycatch rate of 0.023 seabirds per tow (s.e. = 0.006) and a total estimate of 187 seabirds (c.v. = 20%).

3.4.1.1.3 Seabird taxa

Seabirds landed dead made up 82% of captures and 90% (168) of these were returned for identification. Three albatross and 4 petrel taxa were represented in the 168 seabirds returned from CHAT, and 81% were sooty shearwaters (87% males) (see Table E2). Of the 156 seabirds returned from the Polish outlier vessels, 83% were sooty shearwaters and 15% were white-chinned petrels. This species information cannot be used to provide any estimates by species for the remainder of the vessels because of the small numbers of each species represented.

3.4.1.2 Cook Strait (COOK) and Puysegur (PUYS) hoki fisheries

About 3100 tows were made in the COOK hoki fishery throughout 2000–01, but tows were observed during July–September, when 25 vessels completed 55% of the fishing year effort in this spawning hoki fishery, primarily with midwater gear. At least 5 New Zealand vessels were observed here in August and September when 16% of 540 tows and 24% of about 700 tows were observed. Two southern cape pigeons (*Daption capense capense*) were the only seabirds observed caught here, in one of the 88 tows observed during August.

Most of the effort at PUYS is concentrated in the months following the spawning fisheries in the WCSI and COOK fisheries. Thirty-seven vessels reported hoki target fishing in the PUYS fishery in 2000–01, completing 919 tows, with 41% effort in September 2001 and another 27% in October–November 2000. About 56% were bottom trawls.

Observers were placed on 8 vessels representing Japan, Poland, New Zealand, and Ukraine, with observed effort concentrated in September when 3 of the 24 vessels fishing in PUYS were observed, representing 15% of the tows. In October, 3 of 13 vessels were observed (18% of all tows). This observed effort represented 56 tows in September and 26 in October and was too low for any analysis. Four seabirds were observed caught in two tows, three of which were landed dead: one Buller's albatross in September and one male white-chinned petrel and a male short-tailed shearwater in a tow in October.

3.4.1.3 Sub-Antarctic (SUBA) hoki fishery

3.4.1.3.1 Description of the fishery

Vessels targeted hoki in SUBA in all months except August, with about 40% effort in April–June and another 34% in October–December. Of the 39 vessels, 20 were observed, with almost 12% of the 6118 tows observed. Observers were placed on two Japanese, seven Korean, five New Zealand, three Polish, and three Ukrainian vessels. Overall, 50% of the observed effort was on New Zealand vessels, 17% on Ukrainian, 13% on Japanese, 12% on Polish, and 8% on Korean vessels. For some vessels the observed effort was equal to their total effort in the fishery for that year, whereas for others it represented as little as 2%. About 89% of the total effort and 73% of observed tows, used bottom trawls. Representation of the observer effort throughout the fishing year is shown in Figure E5.

3.4.1.3.2 Seabird incidental captures and estimates

Seabirds were reported from 4% of observed tows on six vessels and the observed effort of these vessels accounted for 38% of observed tows. From the total of 58 seabirds, 39 were from one vessel in October. Five other vessels were observed here at that time and one other caught two seabirds. Midwater tows accounted for 72% of seabird captures, primarily from one Polish vessel. Seabirds were reported from two Korean vessels (11 seabirds), two Polish vessels (41 seabirds), and two New Zealand vessels (6 seabirds).

The mean seabird bycatch rates by month are given in Table E4. However, these data do not include the data for the one vessel which was responsible for 39 seabird captures (67% of the total). This vessel completed less than 0.5% of all tows in SUBA in 2000–01 and accounted for about 4% of the observed tows. Thus, it heavily skewed the analysis of bycatch rates. Further, all 30 tows completed by this vessel were observed. For the SUBA area, less the effort of this one vessel, 11% of the 6088 tows were observed, and 19 seabirds were reported gave a mean bycatch rate of 0.028 (s.e. = 0.010) and a total estimate of 172 seabirds (c.v. = 34%). When the seabirds from the outlier vessels are added, the total for SUBA is 211 seabirds (c.v. = 28%).

3.4.1.3.3 Seabird taxa

Of the 58 seabirds, 9 were released alive and 43 of the 49 seabirds landed dead were returned for autopsy. About 74% were short-tailed shearwaters, 12% sooty shearwaters, 7% white-capped albatrosses, 5% white-chinned petrels, and 2% southern cape pigeon. The vessel that was removed from the estimation of total bycatch accounted for 35 of the 43 seabirds returned — the short-tailed shearwaters, white-chinned petrels, and the southern cape pigeon. The multiple captures per tow were of short-tailed shearwaters in October.

3.4.1.4 West coast South Island (WCSI) hoki fishery

3.4.1.4.1 Description of the fishery

The fishing effort in the WCSI hoki fishery is concentrated during July and August (Figure E6), when about 58 vessels completed a total of about 7000 tows. Ten percent of vessels were observed in July and 18% in August, and at least 13% of the tows were observed in these months (Table E5). There were 13 observed tows on one vessel during the last week of May and first week of June. No seabirds were observed caught during these tows and this effort is not included in the seasonal analysis.

About 70% of the 1066 observed tows (July–September) were on five New Zealand vessels (29% observed tows), five Ukrainian vessels (28%), and seven Korean vessels (25%), with another 10% on one Polish vessel and 8% on two Japanese vessels.

3.4.1.4.2 Seabird incidental captures and estimates

Fifteen seabirds were observed caught during the June to September WCSI hoki fishery, all north of 43° S (see Figure E1). Seabird incidental captures were observed on 7 of the 19 observed vessels. About 87% of observed tows used midwater nets, and 13 of the 15 seabirds observed caught were from midwater tows on New Zealand, Korean, and Polish vessels, with the remaining two seabirds reported from Japanese and New Zealand bottom trawls. No seabirds were reported from the Ukrainian vessels. There were no differences between the bycatch rates by nation, given the large variances from the small numbers of seabirds

reported. Seabirds were caught on 1% of observed tows in this area, with most incidents capturing one seabird.

For the WCSI fishery in July–September 2000–01, 14% of the 7549 tows were observed and the mean bycatch rate of 0.014 seabirds per tow (s.e. = 0.004) gave an estimated seabird capture total of 106 seabirds (c.v. = 26%).

3.4.1.4.3 Seabird taxa

Ten seabirds were landed dead and the 8 returned for identification represented 5 species (including the black-backed gull which is not a protected species, but is included here as one of the July seabirds) (see Table E2). The nature of the capture of these seabirds and the small number observed caught does not allow for any species breakdown of the total estimate.

3.4.2 Seabird bycatch in squid trawl fisheries

Squid trawls were observed off the east coast of the South Island between 42° and 45° S and west of 174° 30' E (ECSI), on the Chatham Rise east of 174° 30' E (CHAT), off Stewart-Snares shelf (STEW), and in the Auckland Islands part of SQU 6T (SQU 6T). This coverage accounted for 2% of all tows on the CHAT, 4% in ECSI, 99% in SQU 6T, and 70% in STEW. Due to the low coverage of the ECSI and CHAT areas, no analysis was undertaken and the seabird incidental captures from these areas are reported on at the end of this section. Associated tables and figures for squid fishery-seabird interactions are given in Appendix F.

3.4.2.1 Squid trawl fishery in SQU 6T

3.4.2.1.1 Description of the fishery

Twenty-three vessels participated in the southern squid trawl fishery in SQU 6T, with 580 tows reported from this area between 15 January and 30 April 2001. Most vessels targeting squid shifted from the fishery at the Stewart-Snares shelf in the first week of February to the Auckland Islands Shelf (Figures F1, F2, and F3). Fishing here was mainly off the southeastern edge until mid February, when most vessels shifted to the fishing grounds just north of the Auckland Islands. While MFish observers were placed on vessels (15 January to 24 April), 576 of the 580 tows were observed (99%).

Vessels from five nations fished in the 2001 season, with Ukrainian and Polish vessels using midwater nets. They accounted for 70% of all tows in SQU 6T. About 60% of this midwater effort was in waters off the southeastern edge. Twelve vessels (50–93 m overall length) from Japan, Korea, and New Zealand used bottom trawls, with about 67% of their effort conducted off the northern edge of the Auckland Islands Shelf.

3.4.2.1.2 Seabird incidental captures and estimates

Seabirds were observed caught on 6% of observed tows (Table F1), with 42 seabirds observed caught from this almost 100% observed fishery (Table F2). The rate for March (0.157 seabirds per tow with s.e. = 0.039) was substantially higher than that for February (0.039 seabirds per tow) due to the capture of 22 seabirds in midwater tows by Ukrainian vessels. The mean seabird bycatch rate for Ukrainian vessels was substantially higher than that for midwater tows made by the Polish vessels. No seabirds were observed caught on the Japanese

or New Zealand vessels, and the mean bycatch rate for the Korean vessels was similar to that of the Polish vessels.

3.4.2.1.3 Seabird taxa

Of the 42 seabirds observed caught, one was released alive. Thirty-seven of the seabirds landed dead were returned for autopsy and 32 were identified as white-capped albatrosses, with the reminder white-chinned petrels (Table F3).

3.4.2.2 Squid trawl fishery at the Stewart-Snares shelf

3.4.2.2.1 Description of the fishery

Twenty-six vessels targeted squid in the southern squid trawl fishery in 2000–01. These vessels completed 3309 tows on the Stewart-Snares shelf, with effort concentrated during January–April. These months accounted for 94% of the effort and vessels used midwater tows for 62% of these tows.

Observers were present on 26 vessels during January to April and covered 70% of the effort. The eight Ukrainian vessels accounted for 54% of observer coverage, and another 26% was on 12 Korean vessels, 14% on 3 Polish vessels, and the remaining 6% was on 2 Japanese and 3 New Zealand vessels. Japanese, New Zealand, and Korean vessels used bottom trawls, whereas the Polish and Ukrainian vessels used midwater trawls (67% of all observed trawls).

3.4.2.2.2 Seabird incidental captures and estimates

Seabirds were observed caught in about 9% of observed tows, with more multiple captures per tow than reported from other squid trawl fisheries (see Table F1). Of the 302 seabirds observed caught, 248 were caught during February and March when the fishery was at its peak (Table F4). Midwater tows on Polish and Ukrainian vessels resulted in 78% of all reported captures. The mean seabird catch rate was substantially higher for all observed effort on Polish vessels at 0.34 seabirds per tow (s.e. = 0.06) than that for the other nations. There was no difference in the bycatch rates for the other nations. There was no difference between the mean bycatch rates by month for January–March, but the bycatch rate for April was substantially lower than for February and March. The observed effort in April was almost entirely on Ukrainian vessels.

With the distinction by nation as to the gear type used, it is not surprising that the seabird bycatch rate for midwater trawls is substantially higher than that for bottom trawls: 0.087 seabirds per tow (s.e. = 0.014) compared with 0.150 (s.e. = 0.015).

When the data for January–April 2001 are combined, 75% of the 3112 tows were observed, and from a mean bycatch rate of 0.130 seabirds per tow (s.e. = 0.012), an estimated 403 seabirds were caught (c.v. = 5%). If the three observed Polish vessels, which accounted for 12% of all the effort, 14% of the observed effort, and 37% of all observed seabird captures are excluded from this dataset, 69% of the 2913 tows were observed and a mean bycatch rate of 0.095 seabirds per tow (s.e. = 0.009) and a total estimate of 276 seabirds (c.v. = 5%). Another 134 seabirds (c.v. = 7%) were estimated caught from the Polish outlier vessels.

3.4.2.2.3 Seabird taxa

Of the 281 seabirds were landed dead, 219 were returned for autopsy. All observed vessels returned similar species. Nearly 46% of these seabirds were white-capped albatrosses, 30% sooty shearwaters, and 21% white-chinned petrels, with the remainder Buller's, southern royal, and Salvin's albatrosses (Table F3).

3.4.2.3 Squid trawl fishery off the east coast South Island and Chatham Rise

Vessels targeted squid in these areas throughout the year, except July and August. About 2% of the 546 tows and 4% of the 2003 tows in the CHAT and ECSI areas, respectively, were observed. No seabirds were reported from the CHAT observed tows, but six were observed caught in ECSI. About 6% of observed tows in this area caught seabirds, but this is based on few tows (see Table F1). Two seabirds were released alive, and three were returned for autopsy and identified as two Salvin's albatrosses and one sooty shearwater.

3.4.3 Summary of other trawl fishery-seabird interactions

Seabirds were observed caught in 10 other target species tows (see Table D1). Of the 44 seabirds caught in these tows, 30 were returned for identification (Tables G1 and G2 in Appendix G). A brief summary of these reported captures is given below.

Barracouta (*Thyrsites atun*) target fishing operations
Of the six seabirds observed caught in barracouta tows, four were landed dead and returned for autopsy. Returned birds were from tows off the east coast South Island (two white-capped albatrosses and one sooty shearwater) and east of the Chatham Islands (one northern royal albatross).

Hake (*Merluccius australis*) target fishing operations
Three albatrosses (Pacific, Chatham, and Salvin's) and one northern giant petrel were landed dead during hake tows around 180° on the Chatham Rise.

Jack mackerel (*Trachurus* spp.) target fishing operations
Of the nine seabirds caught in jack mackerel tows, eight were landed dead and returned from tows off the southern edge of the Stewart-Snares shelf (five white-capped albatrosses, one white-chinned petrel, and one sooty shearwater). One seabird was released alive off the northern west coast of the South Island.

Oreo species target fishing operations
One seabird was released alive from a black oreo (*Allocyttus niger*) tow southwest of the Mernoo Bank. Another seabird was released alive from a smooth oreo (*Pseudocyttus maculatus*) tow on the southern Chatham Rise.

Orange roughy (*Hoplostethus atlanticus*) target fishing operations
Two Chatham albatrosses and one Pacific albatross were landed dead in orange roughy tows east of the Chatham Islands.

Red cod (*Pseudophycis bachus*) target fishing operations
One Salvin's albatross was reported from a tow southwest of the Mernoo Bank.

Southern blue whiting (*Micromesistius australis*) target fishing operations

One Salvin's albatross was observed caught off the Bounty Platform and a grey petrel and southern cape pigeon were caught north of the Campbell Rise.

Scampi (*Metanephrops challengeri*) target fishing operations

Three seabirds were released alive from tows on the northern Chatham Rise and the southeastern edge of the Auckland Islands Shelf. Of the eight seabirds landed dead, one white-capped and three Salvin's albatrosses were returned.

Silver warehou (*Seriolella punctata*) target fishing operations

One seabird was released alive from near the Mernoo Bank, and three white-capped albatrosses were landed dead from the northern edge of the Stewart-Snares Shelf.

4. DISCUSSION

The analysis of the occurrences of seabird bycatch in New Zealand fisheries is very dependent on the spatial and temporal distribution of observer coverage. The incidental capture of seabird species is often a rare event and therefore the stratification of data into time periods for fishery areas can pose problems and result in small sample sizes and high variance. Some fisheries in New Zealand waters have 15–20% of the fishing operations observed, and for these fisheries annual estimates of the incidental capture of seabirds can be made and compared (Table A3), but there are difficulties in estimating the relative species capture numbers, especially where few birds of each species are caught or only a portion of the seabirds caught are returned for autopsy.

4.1 Tuna longline fleet

The most comprehensive data collection on the incidental capture of seabirds is from the chartered Japanese tuna longline fleet where in recent years observer coverage has been close to or at 100%. These vessels operate under a voluntary code of practice (including the use of different mitigation methods) that results in most of their fishing occurring off the southern and western coasts of the South Island where seabird bycatch rates are lower (Baird & Bradford 2000). These areas do not appear to be frequented by many of the seabird species that are classed as "threatened" (Hitchmough 2002). Bycatch rates here (Area 3) in 2000–01 continued to follow the decreasing trend seen over the three previous years (0.026 seabirds per 1000 hooks compared with 0.06 for 1998–99); the number of seabirds observed caught in 2000–01 was the lowest ever reported for these vessels. The rate for Area 2, where less than 10% of the effort was made, was lower at 0.019 seabirds per 1000 hooks than the previous year (0.162 seabirds per 1000 hooks).

In comparison, observer coverage of the domestic fleet continued to be low, though at 3.7% coverage of about 7 million hooks in the main fishing area, this was a substantial increase over that for the previous four years (when less than 1% of total effort was observed). The ongoing difficulties in placing observers on these vessels and the huge increase in effort during the last four years continue to hamper efforts to increase this coverage. Most of these domestic vessels fish in the northern waters and the few data that are available suggest that seabird bycatch rates from some of these vessels are high (Baird 2004). It also appears that seabird species reported caught by these vessels in Area 1 are different from those reported in earlier years from the larger chartered Japanese vessels fishing in the same area. The seabirds caught on domestic longlines in northern waters also are more likely to be released alive than are those caught on chartered Japanese longlines. The survival of the seabirds that are released alive is unknown.

4.2 Demersal longline fisheries

Estimation of seabird captures from the ling longline fishery continues to be problematic due to the data collection. Most of the large autoline vessels were observed at some time during the fishing year, but the percent of hooks actually observed (12%) is not adequate given the variation in the temporal and spatial distribution of the effort of these vessels and the differences in their observed mean bycatch rates. Mean bycatch rates are high for some vessels in certain area-month strata, with an average of 24% of observed sets with incidental seabird captures, though this varies greatly between vessels. As in previous years, the seabird species caught on these longlines and returned for autopsy are mainly grey petrels, white-chinned petrels, sooty shearwaters, and Salvin's albatrosses. Captures of these seabirds are vessel and area-season dependent, and estimated totals given in Tables A1 and A3 should be treated with caution.

Observer coverage on the bluenose and snapper longline effort in 2000–01 gives no more than a snapshot of the fisheries. As with the ling longline seabird captures, the smaller deeper diving seabirds seem to be more vulnerable to these longlines. Buller's shearwaters and fluttering shearwaters, not previously reported from observed fishing operations, have been reported from these fisheries.

4.3 Trawl fisheries

The fluctuations seen in the total seabird captures estimated for main trawl fishery areas in recent years (see Table A3) reflect the number of seabirds observed caught. In 2000–01, 701 seabirds were observed caught, almost four times that reported from 1999–2000 (n = 181) and more than twice that in 1998–99 (n = 322) (Baird 2001, 2004), despite similar numbers of observed tows in each year for the main fisheries. The observed squid and hoki effort accounted for 94% of all observed captures, and the increases in incidence rates in these fisheries results from the activity of a few vessels with very high catch rates. These vessels were responsible for the high incidence rates in the hoki fishery at the Chatham Rise (7% of observed tows) and the squid fisheries at SQU 6T (6%) and at the Stewart-Snares shelf (9%).

In the observed hoki fisheries, CHAT and SUBA had the highest catch rates, and the diversity in the seabird species caught in these areas was greater than elsewhere. As in previous years the mean catch rate observed in the west coast South Island fishery was low relative to the above areas (as reflected in the estimated numbers caught) (Table E5 in Appendix E). Of the 22 vessels that had over 50 observed hoki tows in the year (range of 64–253 tows), 12 had observed seabird captures and all but 3 of these vessels reported 10 or fewer seabirds per vessel. A comparison of the mean catch rates for these vessels is shown by area in Figure H1 in Appendix H. When the three vessels with high seabird catch rates are excluded from these analyses, there is little difference in the mean catch rates between other vessels (Figure H2). All of these vessels fished in CHAT and SUBA and one fished in WCSI; however, their observed mean catch rates in CHAT and SUBA, though substantially higher than for most other vessels, were different in each area they were observed. These vessels operate very large midwater nets that appear to be hauled at a slower rate than other nets and one in particular experienced problems with the net needing repairs on several occasions (MFish observer reports).

The multiple captures from these vessels accounted for most of the sooty shearwaters and white-chinned petrels reported from CHAT and all the short-tailed shearwaters from SUBA (Stewart-Snares shelf area). The mean catch rate for one of these vessels may be slightly overestimated due to confusion in the reporting of unobserved and observed seabirds on one trip. These vessels also accounted for 50% of the sooty shearwaters, 70% of the white-

chinned petrels, and 56% of the white-capped albatrosses reported from observed squid tows at Stewart-Snares shelf.

When all the observed effort for hoki and squid is combined, there are substantial differences in vessel mean catch rates (Figure H3). Mean catch rates by nation for the combined data show that Japanese and New Zealand vessels' seabird catch rates are substantially lower than those for Korean and Ukrainian vessels, which in turn are substantially lower than the mean seabird catch rates for Polish vessels. Polish and Ukrainian vessels use midwater trawls and hence the substantial difference between mean catch rates by gear (Figure H3).

Robertson et al. (2003) noted the high proportion of offal in the stomach contents of returned seabirds. There are some observed data on the release of offal during shooting or hauling, but these only relate to when a seabird is observed caught and there is no equivalent information in the commercial database. Observer data show that about 60% of observed New Zealand vessels and all the observed Japanese, Polish, and Ukrainian vessels have meal plants. None of the observed Korean vessels had meal plants on board. Comments below show that different vessels may experience problems with bycatch or may discharge discards and offal during the fishing operation.

4.3.1 Observer comments on captures during trawling

Observers report that the petrels and shearwaters tend to be caught in the net meshes from near the headline back to the cod-end, often when the net is being hauled. This may be exacerbated in areas where there are fewer albatrosses around, because the latter tend to displace the smaller seabirds. Other seabirds are brought on board on the trawl warps, and some of these drop off when they reach the rollers at the stern and therefore are not able to be retrieved. Similarly, other observed seabirds are discarded overboard by crewmembers before the observer can retrieve the seabird. It is thought that once there are several seabirds caught on the warp, that subsequent seabirds may be knocked off the warp when they hit those caught earlier. Thus the seabirds that are retrieved from the warps are a subset of those actually caught, and it is likely that these seabirds are the larger ones, such as the albatrosses. Some were retrieved from ragged wire near trawl doors.

Sometimes seabirds are released alive from the wings of the net, especially the smaller seabirds. In tows where there were multiple captures of seabirds, observers noted that the seabirds were very waterlogged suggesting they were caught when the net was shot. There was no discarding at the time of shooting and observers have suggested that the net may not have been entirely cleaned of fish from the previous tow.

Observers also reported seabird captures from isolated squid tows at SQU 6T during the shooting of which there was discarding of bycatch (such as crabs) from the previous tow and the numbers of seabirds, especially white-capped albatrosses, around the vessel were particularly high. Other vessel related factors thought to contribute to some of the captures include slow hauling, slow net deployment due to net repairs, and turns made when the net was at the surface. These events were few but generally accounted for the multiple captures. Weather conditions such as light winds, which restricted the seabirds' (generally albatrosses) mobility, were also considered to increase the potential for some captures when the net was at the surface. Similarly, snow and strong winds, which seemed to disorientate the seabirds, resulted in warp strikes.

When the seabird captures were high, observers sometimes ran out of the official "bird bags" in which to package the seabirds for return for autopsy. Some seabirds were discarded for this reason, though observers generally took photos of these seabirds. One albatross that was released alive from being tangled in the net had a ling longline hook in the wing.

4.4 Seabird species

Of the 22 albatross and petrel taxa reported caught in 2000–01, 14 are considered "threatened" under the DoC Threatened Species Classification system (see Table D4). The vulnerability of the different seabird species to capture will relate to many factors, including the spatial and temporal overlap of the fishing activity with seabird activity, especially in relation to breeding colonies and seasons; type of fishing gear used; specific seabird feeding behaviours; and composition of seabird species around the vessels. Some seabird taxa have one or few breeding locations within the New Zealand EEZ, whereas others breed throughout the zone (Figure I1). Most taxa breed primarily during the summer months (Figures I2 and I3), some into autumn and winter months, such as the larger albatrosses that breed biennially (Antipodean, Gibson's, and royal albatrosses), Buller's and white-capped albatrosses, grey petrels, and Westland petrels. Thus these seabirds are generally feeding over shelf waters (close to their breeding grounds) that are being fished during the main summer fishing seasons for hoki and squid in southern waters, tuna longline fishing in northern waters, and the ling longline fishery.

Five taxa accounted for 92% of the seabirds returned from observed commercial fishing operations in 2000–01. Of the albatross taxa, Salvin's were caught during their breeding season close to the main breeding locations at Bounty and Antipodes Islands, during summer longline effort for ling (Figures I1 and I2), and white-capped albatrosses were caught at the height of their breeding season, predominantly in waters close to the main colony at the Auckland Islands.

The other main taxa caught were white-chinned petrels, grey petrels, and sooty shearwaters. These taxa tend to flock in large numbers and this behaviour probably contributes to the statistics; they accounted for 67% of all returned captures, though many of these captures were a result of fishing practices by a few vessels. Sooty shearwaters tended to be caught at the extremes of their breeding season during the overlap of trawl fishing activity on the Chatham Rise and off the Stewart-Snares shelf when the birds are beginning or ending their winter migration from the main breeding colonies (Figures I1 and I3). White-chinned petrels were caught during the overlap of their breeding season and trawl and ling longline activity, and the captures of grey petrels were mainly from the winter ling longline activity on the Campbell Plateau.

At present knowledge of the at-sea distribution of many of the seabird species that interact with fishing operations is insufficient. There is some *ad hoc* data collection that relates to the distribution of seabirds around vessels at sea, but this would be more valuable if there was a standardised approach to the collection of these data. Although the seabird identification data from those landed dead and returned give a limited picture, they show differences in the distribution of captures. Some species are caught in certain fisheries in certain areas, whereas others have a less localised distribution. Antipodean albatrosses have been reported only from eastern waters north of 45° S (Fisheries Management Areas (FMA) 2 & 3) predominantly in tuna longline sets before 2000 (Table I1). Buller's, Campbell, Salvin's, black-browed, and white-capped albatross captures have been more widespread and have occurred in observed tuna and ling longline fisheries as well as trawl fisheries.

Similar distribution differences are seen with petrel taxa. Black petrels have been reported only from FMA 1 on tuna longlines, and flesh-footed shearwaters have been reported from FMA 1 and FMA 2 during both tuna longline and trawl activity. Captures of other species such as grey petrels, white-chinned petrels, and sooty shearwaters have been more widespread around New Zealand and have been represented in the different fisheries. Coverage of the snapper and bluenose longline effort in 2000–01 resulted in the first reports of grey petrel captures in FMA 1 as well as of Buller's shearwaters and fluttering shearwaters. Grey petrels were also reported from FMA 4 for the first time for the years 1997–2001.

These distributions are obviously very dependent on the spatial and temporal distribution of observer coverage, and a shift in fishing effort, as occurred in the tuna longline fishing by the chartered Japanese vessels after the 1996–97 fishing year, will impact on the seabird species captured. These vessels used to expend more fishing effort in FMA 1 and FMA 2 than they do now and therefore they report fewer captures of the seabird species generally caught there, many of which are "threatened" species (Hitchmough 2002). These vessels now fish primarily in FMA 5 and the seabird species reported from these vessels, especially Buller's and white-capped albatrosses, are also reported from trawl fisheries in the same area.

4.5 Data collection

Data collection remains a problem with the collation and estimation of the incidental captures of seabirds in New Zealand fisheries. Both observed data and total effort data pose difficulties in the design of forms as well as the way the forms are completed. In recent years, as the fishers have become more aware of the problem of incidental captures, some may keep seabirds for observers when the observers are not on duty. If these seabirds cannot be easily distinguished in the data from those actually "observed" by the observer, then any calculation of mean catch rates or estimation of total numbers becomes problematic.

Further, the coverage of many of the fisheries may not represent the actual temporal and spatial distribution of the total fishing effort. This is compounded when there are large differences between vessels and their seabird bycatch rates, as seen in the ling longline fishery and the hoki and squid trawl fisheries. Robertson et al. (2003) stated that many of the returned seabirds come from a few vessels. Although there may be various return rates for different vessels, the three trawlers treated as outliers in the hoki and squid analyses are examples of such vessels. The fishing practices of these large vessels that use large midwater nets appear to make them more susceptible to multiple catches of smaller diving seabirds. Observers noted slow hauling procedures and problems with the gear on some occasions. All three vessels caught more seabirds than other vessels in the CHAT hoki and STEW squid observed fisheries, but only one had observed high catches in the SUBA hoki fishery when it was fishing in the same area and time as one of the other outlier vessels and caught short-tailed shearwaters.

The nature of seabird captures during trawling operations further exacerbates the collection of data. Seabirds may be "caught" on warps and then pulled under the water and drown, but may then be knocked off the warp and not be returned to the vessel (MFish observer reports). Thus, the number of seabirds caught will be underestimated and any comparison of the numbers of different taxa that are landed may then by weighted towards those taxa which get caught in other ways, such as diving into the net. In fisheries where there are few taxa in certain areas and seasons, it is possible to provide estimates of actual species caught, as could be possible in the ling longline fishery areas (when the data are verified). But for the trawl fisheries, the seabird data for the vessels other than the outliers, are spread across a number of different taxa, which represent moments of time and space that may not be applicable to the rest of the effort data because of many factors, such as the vulnerability of different taxa to capture (including their presence/absence in time and space and behaviour around the vessels) and differences in fishing strategies and gear used.

Mitigation methods and associated strategies (such as area fished) have been very effective in the southern bluefin tuna fishery in southern waters. Many of these methods have been taken up and adapted by the ling autoline vessels; however, there still appears to be a vessel difference as noted in LIN 5 when two vessels fished together and had different seabird bycatch rates. Development of mitigation methods for trawlers is underway, but it appears that there may be changes to fishing practices (especially the deployment of gear) that could

reduce captures. A suite of mitigation measures may be necessary to mitigate against the various behaviours of seabirds and thus their vulnerability to capture.

5. CONCLUSION

The highest incident rates (numbers of seabirds observed caught per observed fishing operation) were from the longline fisheries: 24% of observed ling sets, 15% of observed domestic tuna sets, and 6% of observed chartered Japanese longlines had seabird bycatch. The incidence rates in the trawl fisheries showed an increase over those reported for 1999–2000 (see Baird 2004), especially in the hoki fishery at the Chatham Rise (7% of observed tows) and the squid fisheries at SQU 6T (6%) and at the Stewart-Snares shelf (9%).

These increased rates are reflected in the annual fluctuations in total estimates (see Table A3) and are largely driven by the choice of vessel for observer coverage in any one year or area. The highest seabird bycatch rates were reported from ling longlines, though these are vessel and area specific. When the outlier vessels are excluded, bycatch rates are higher for squid trawls compared with hoki trawls in the summer months. There are many target fishery areas for which there are not enough data to adequately estimate incidental captures; these include not only those shown in Tables A1 and A2 for the main fisheries, but also trawl fisheries that target species other than hoki and squid. This may be a result of inadequate observer coverage or too few observed seabird captures. The fisheries of most concern here are the domestic longline fisheries for tuna species, snapper, and bluenose, which operate in waters known to be frequented by many seabird species.

Seabirds observed caught during ling longline and trawl fisheries are more likely to be landed dead. These fisheries operate day and night and therefore potentially offer more instances for interactions between fishing operations and seabirds to occur. The observation of seabirds caught during trawl operations is problematic, given the difficulty in actually observing instances of "capture" and the probability that some of the seabirds may not be retrieved easily.

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7. REFERENCES

Annala, J.H.; Sullivan, K.J.; O'Brien, C.J.; Smith, N.W. McL. (comps.) (2001). Report from the Fishery Assessment Plenary, May 2001: stock assessments and yield estimates. (Unpublished report held in NIWA library, Wellington.) 515 p.

Baird, S.J. (2001). Estimation of the incidental capture of seabird and marine mammal species in commercial fisheries in New Zealand waters, 1998–99. *New Zealand Fisheries Assessment Report 2001/14.* 43 p.

Baird, S.J. (2003). New Zealand breeding seabirds: human-induced mortality — a review. Draft report prepared for the Ministry of Fisheries Project ENV2000/09. 74 p. (Unpublished report held by MFish, Wellington.)

Baird, S.J. (2004). Estimation of the incidental capture of seabird and marine mammal species in commercial fisheries in New Zealand waters, 1999–00. *New Zealand Fisheries Assessment Report 2004/41.* 56 p.

Baird, S.J.; Bradford, E. (2000). Factors that may have influenced the capture of seabirds in New Zealand tuna longline fisheries. *NIWA Technical Report 93.* 61 p.

Bartle, J. A. (1991). Incidental capture of seabirds in the New Zealand subantarctic squid trawl fishery, 1990. *Bird Conservation International 1*: 351–359.

Bradford, E. (2002). Estimation of the variance of mean catch rates and total catches of non-target species in New Zealand fisheries. *New Zealand Fisheries Assessment Report 2002/54.* 60 p.

Cochran, W.G. 1997: Sampling techniques. Third edition. John Wiley & Sons, New York. 428 p.

Efron, B.; Tibshirani, R.J. (1993). "An introduction to the bootstrap". Chapman & Hall, New York. 436 p.

Hitchmough, R.A. (comp.)(2002). New Zealand threat classification system lists, 2002. *Threatened Species Occasional Publication 23.* Department of Conservation. 210 p.

IUCN (2003). 2003 IUCN Red List of Threatened Species. www.iucnredlist.org

Mackay, K.A.: Griggs, L. (2001). Database documentation: l_line. (Unpublished report held in NIWA Greta Point library, Wellington.) 38 p.

Manly, B.F.J. 1992: The design and analysis of research studies. Cambridge University Press, Cambridge. 353 p.

Murray, T.E.; Bartle, J.A.; Kalish, S.R.; Taylor, P.R. (1993). Incidental capture of seabirds by Japanese southern bluefin tuna longline vessels in New Zealand waters, 1988–1992. *Bird Conservation International 3*: 181–210.

Murray, T.E.; Richardson, K.; Dean, H.; Griggs, L. (1999). New Zealand tuna fisheries with reference to stock status and swordfish bycatch. (Unpublished report prepared for the Ministry of Fisheries as part of TUN9701.) 126 p.

Robertson, C.J.R.; Bell, E. (2002). Autopsy report for seabirds killed and returned from New Zealand fisheries, 1 October 1999 to 30 September 2000. *DOC Science Internal Series 29.* 41 p.

Robertson, C.J.R.; Bell, E.; Scofield, P. (2003). Autopsy report for seabirds killed and returned from New Zealand fisheries, 1 October 2000 to 30 September 2001. *DOC Science Internal Series 96.* 75 p.

Robertson, C. J. R.; Nunn, G. B. (1998). Towards a new taxonomy for albatrosses. *In* Robertson, G.; Gales, R. (eds.), Albatross biology and conservation, pp. 13–19, Surrey Beatty & Sons, Chipping Norton.

Wei, F. (2003). Database documentation: tuna. (Unpublished report held in NIWA Greta Point library, Wellington.) 23 p.

APPENDIX A: 2000–01 FISHERY-SEABIRD CAPTURE INFORMATION DATA

Table A1: Summary seabird statistics for longline fisheries, 2000–01*.

Area/ Month	Total no. hooks	% observed	No. observed seabirds	Incident rate (%)	Mean bycatch rate	Standard error	Estimated no. seabirds caught	*c.v.* (%)
Surface longline								
Chartered Tuna longline fishery: total estimate of 16 seabirds (c.v. = 6%)								
Area 1	0	–	–	–	–	–	–	–
Area 2	53 010	100	1	6	0.019	0.017	1	0
Area 3	567 998	95	14	6	0.026	0.008	15	7
Area 4	0	–	–	–	–	–	–	–
Domestic Tuna longline fishery: total observed captures of 38 seabirds								
Area 1	7 058 957	4	38	15	0.144	0.029	–	–
Area 2	99 675	0	–	–	–	–	–	–
Area 3	229 515	63	0	–	0.0	–	–	–
Area 4	1 797 792	3	0	–	0.0	–	–	–
Bottom longline								
Autoline ling longline fisheries: total estimate of 2 367 seabirds (c.v. = 12%)								
LIN 1	252 000	0	0	–	–	–	–	–
LIN 2	2 057 425	12	1	2	0.004	0.004	9	98
LIN 3	3 201 913	0	0	0	–	–	–	–
LIN 4	8 594 571	< 1	2	50	0.563	0.354	–	–
LIN 5	3 279 670	29	153	24	0.160	0.033	523	17
LIN 6	8 414 303	12	215	27	0.218	0.033	1 838	14
LIN 7	28 440	0	0	–	–	–	–	–
Small vessel ling longline fisheries: no observer coverage								
LIN 1	221 900	0	–	–	–	–	–	–
LIN 2	555 280	0	–	–	–	–	–	–
LIN 3	106 300	0	–	–	–	–	–	–
LIN 4	179 200	0	–	–	–	–	–	–
LIN 5	0	–	–	–	–	–	–	–
LIN 6	0	–	–	–	–	–	–	–
LIN 7	1 022 405	0	–	–	–	–	–	–
Autoline bluenose longline fishery: total estimate of 7 seabirds (c.v. = 37%)								
BNS 2	200 456	60	4	10	0.033	0.019	7	37
Small vessel bluenose longline fishery: no observer coverage								
BNS 1	1 318 000	0	–	–	–	–	–	–
BNS 2	452 580	0	–	–	–	–	–	–
BNS 3	32 900	0	–	–	–	–	–	–
BNS 7	130 100	0	–	–	–	–	–	–
BNS 8	6 600	0	–	–	–	–	–	–
Snapper longline fishery: total observed captures of 26 seabirds								
SNA 1	16 212 218	< 1	26	16	0.590	0.250	–	–
SNA 2	15 800	0	–	–	–	–	–	–
SNA 3	3 400	0	–	–	–	–	–	–
SNA 7	22 450	0	–	–	–	–	–	–
SNA 8	29 100	0	–	–	–	–	–	–
SNA 9	1 034 710	0	–	–	–	–	–	–

* Total estimates are provided for those fisheries where at least 10% of the hooks were observed. Note that these statistics are summary statistics for target fisheries by area for the fishing year, as requested by the Ministry of Fisheries. The data provided for LIN 6 are based on the assumption that all the seabirds reported by the observers were actually observed.

APPENDIX A — *continued*

Table A2: Summary seabird statistics for hoki and squid trawl fisheries, 2000–01*. No estimates were provided for trawl fisheries targeting other species. Numbers of seabird captures in these fisheries are given in Table A4.

Target species/ Area†	Total no. tows/ hooks	% observed	No. observed seabirds	Incident rate (%)	Mean bycatch rate	Standard error	Estimated no. seabirds caught	*c.v.* (%)
Hoki target: total estimate of 1 065 seabirds (c.v. = 9%)								
CHAT	8 133	11	21	2	0.023	0.006	187	20
CHAT outlier	671	37	197	–	0.785	0.105	527	11
COOK	3 091	9	2	<1	0.008	0.008	–	–
PUYS	919	12	4	2	0.037	0.030	34	76
SUBA	6 088	11	19	4	0.028	0.010	211	28
WCSI	7 549	14	15	1	0.014	0.004	106	26
Squid target: total estimate of 586 seabirds (c.v. = 11%)								
CHAT	546	2	0	0	0.000	–	–	–
ECSI	2 003	4	6	6	0.071	0.032	–	–
SQU 6T	580	99	42	6	0.073	–	42	0
STEW	2 913	69	189	9	0.095	0.009	276	5
STEW outlier	396	84	113	–	0.339	0.059	134	7

* Estimates were provided for those fisheries where at least 10% of the fishing effort was observed, and the observed effort was representative of the fishing effort.

† CHAT hoki data are for October-April. The SUBA hoki total estimate includes 39 seabirds (caught by an outlier vessel, the effort of which was 100% observed). STEW squid data are for January-April.

APPENDIX A — *continued*

Table A3: Summary of observed seabird captures or total estimates for the main longline and trawl fisheries, 1998–99 to 2000–01. Fishery areas and codes are shown in Appendix D and the relevant fishery appendices. Data for 1998–99 and 1999–2000 are from Baird (2001, 2004).

Fishing year	Chartered tuna longline fleet			
	Area 1	Area 2	Area 3	Area 4
1998–99	18*	2*	54*	0
1999–00	11*	11*	18*	0
2000–01	–	1*	15 (c.v.=7)	–

	Domestic tuna longline fleet			
	Area 1	Area 2	Area 3	Area 4
1998–99	10†	–	–	–
1999–00	34†	–	–	–
2000–01	38†	–	0†	0†

	Ling autoline fleet					
	LIN 2	LIN 3	LIN 4	LIN5	LIN 6	LIN 7
1998–99	–	–	6‡	–	85‡	–
1999–00	–	4‡	12‡	90‡	97‡	–
2000–01	9 (c.v.=98%)	–	2‡	523 (c.v.=17%)	1838 (c.v.= 14)‡	–

	Hoki				
	CHAT	COOK	PUYS	SUBA	WCSI
1998–99	53†	1†	3†	94 (c.v. = 23%)	215 (c.v. = 18%)
1999–00	46†	0	1†	209 (c.v.=19)	69 (c.v.=41)
2000–01	187 (c.v.=20)§	2†	4†	211 (c.v.=28)	106 (c.v. = 26)

	Squid				
	CHAT	ECSI	PUYS	SQU 6T	STEW
1998–99	0†	21†	0†	1†	268 (c.v.= 20%)
1999–00	4†	1†	–	82 (c.v. = 19%)	93 (c.v. = 34%)
2000–01	0†	6†	0†	42*	276 (c.v. = 5%)§

* These numbers are numbers of observed seabirds for fishery areas where the observed effort represents 100% of the fishery effort.

† These numbers are observed seabird captures for fishery areas where the observer coverage was too low.

‡ These numbers are observed seabird captures for fishery areas where the actual numbers of seabirds reported includes both observed and unobserved seabirds, or where the numbers of hooks observed is unknown (as in ling longline fisheries in 1998–99 and 1999–00). The estimate given for LIN 6 in 2000–01 includes an unknown number of unobserved seabirds and therefore may be an overestimate.

§ Outlier vessels are excluded from the totals for CHAT hoki and STEW squid in 2000–01 (see Table A2 for the outlier vessel data).

APPENDIX A — *continued*

Table A4: Numbers of seabirds observed caught in New Zealand trawl fisheries, 2000–01.

Target fishery		No. seabirds Total	% dead
Barracouta	*Thyrsites atun*	6	67
Black oreo	*Allocytus niger*	1	0
Hake	*Merluccius australis*	4	100
Hoki	*Macruronus novaezelandiae*	307	81
Jack mackerels	*Trachurus* spp.	9	89
Orange roughy	*Hoplostethus atlanticus*	3	100
Red cod	*Pseudophycis bacchus*	2	100
Scampi	*Metanephrops challengeri*	11	73
Silver warehou	*Seriolella punctata*	4	100
Smooth oreo	*Pseudocyttus maculatus*	1	0
Southern blue whiting	*Micromesistius australis*	3	100
Squid	*Nototodarus* spp.	350	93
Total		701	87

APPENDIX A — *continued*

Table A5: Numbers of seabird taxa identified from seabirds landed dead and returned for autopsy, from observed commercial fisheries, 2000–01.

Seabird code*	Trawl fisheries*										Longline fisheries*				Total	% Total
	BAR	HAK	HOK	JMA	ORH	RCO	SBW	SCI	SQU	SWA	BNS	LIN	SNA	Tuna†		
Albatross taxa																
Northern royal	1														1	< 1
Southern royal			1						1						2	< 1
Black-browed			1									2			3	< 1
Buller's			3						5					7	15	2
Campbell			1											1	2	< 1
Chatham		1			2										3	< 1
Pacific		1			1										2	< 1
Salvin's		1	4			1	1	3	3			90		1	104	10
White-capped	2		6	6				1	133	3		1		3	155	15
Petrel taxa																
Northern giant		1	1									1			3	< 1
Black														2	2	< 1
Grey			2				1				1	183	11		198	19
White-chinned			25	1					51			200		2	279	27
Grey-faced														1	1	< 1
Buller's shearwater													2		2	< 1
Flesh-footed shearwater													12		12	1
Fluttering shearwater													1		1	< 1
Sooty shearwater	1		141	1					66		1	11			221	21
Short-tailed shearwater			32												32	3
Cape pigeon											1				1	< 1
Southern cape pigeon			3				1								4	< 1
Fairy prion			2												2	< 1
Black-backed gull			1												1	< 1
Total	4	4	223	8	3	1	3	4	259	3	3	488	26	17	1046	

* Seabird identification data are from Robertson et al. (2003). Seabird species and target fishery codes are given in Appendix D.

† Tuna species include southern bluefin tuna (*Thunnus thunnus*) and bigeye tuna (*T. obesus*).

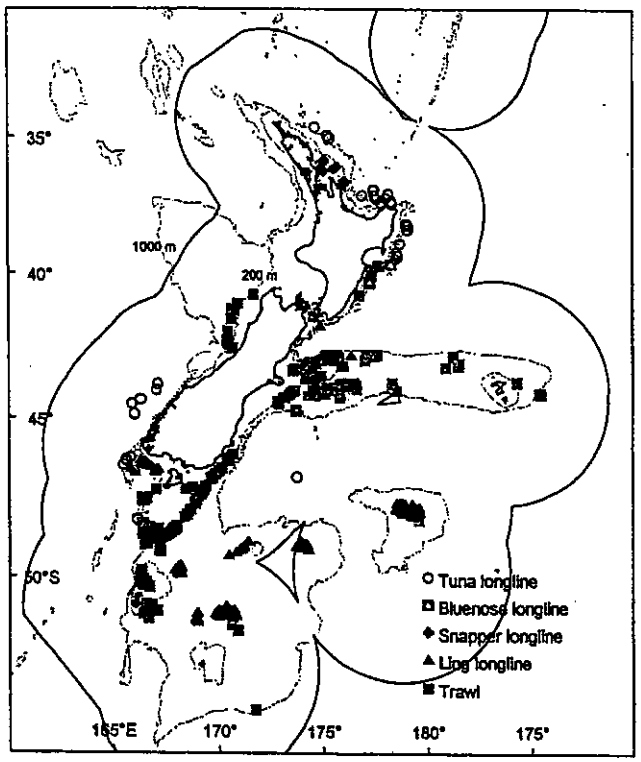
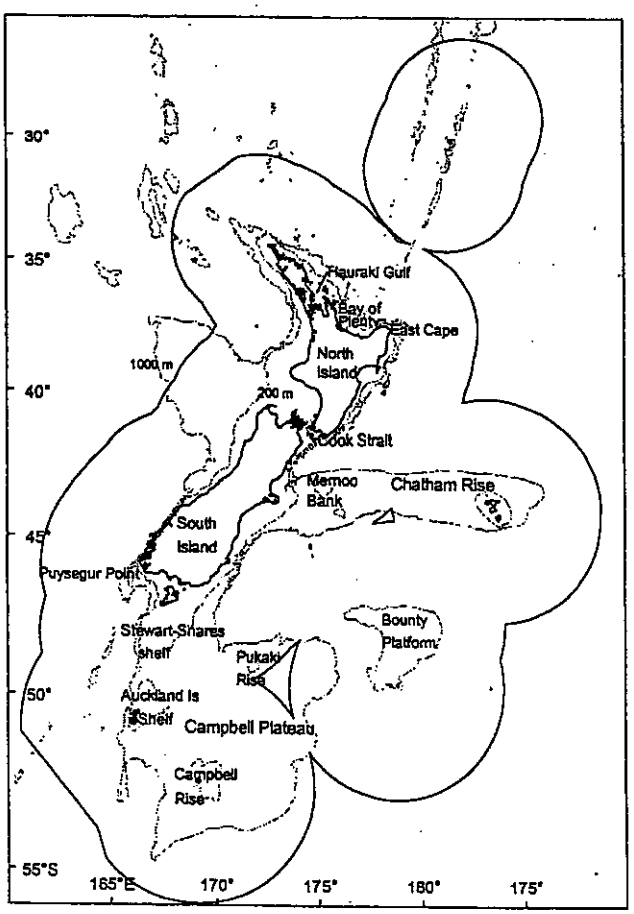


Figure A1: Start positions of longline and trawl fishing operations during which seabirds were observed caught, 2000–01.



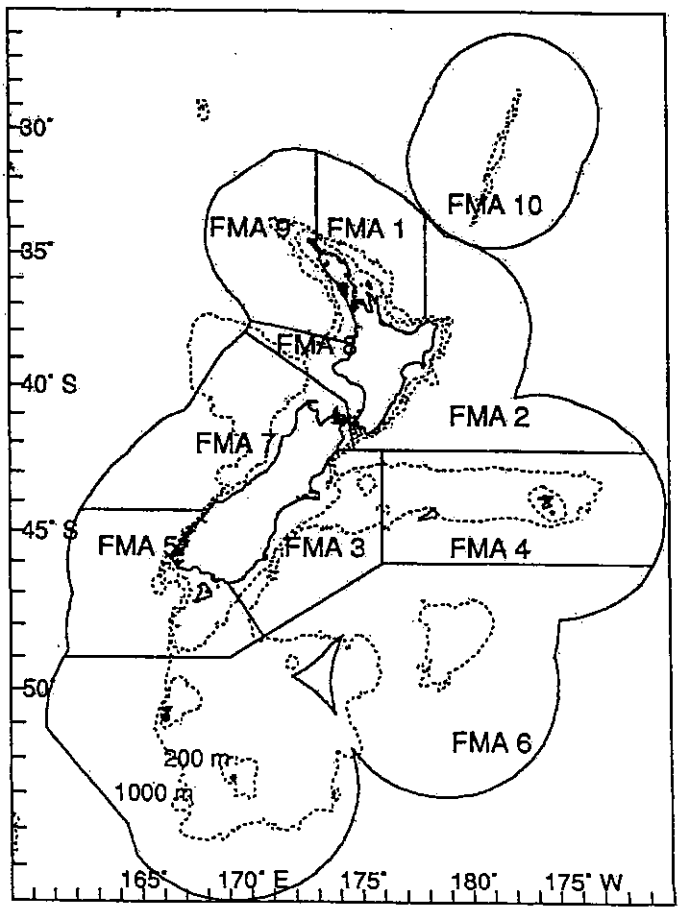


Figure A2: Places mentioned in the text (left) and Fishery Management Areas (FMAs) 1–10 (right).

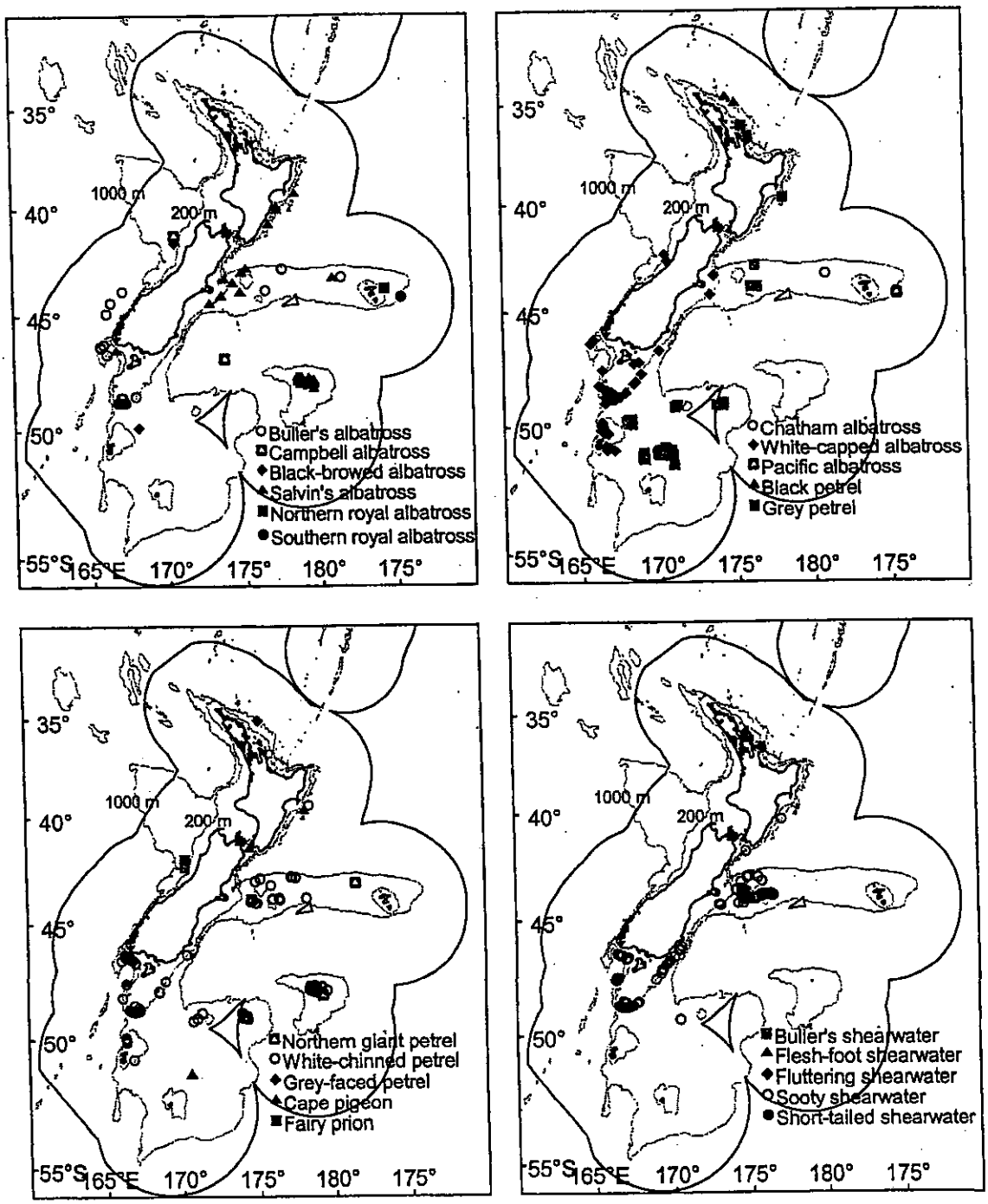


Figure A3: Start positions of observed fishing operations from which seabird taxa were returned for autopsy, 2000–01.

APPENDIX B: TUNA LONGLINE FISHERY DATA, 2000–01

Table B1: Seabird species observed caught on chartered tuna longlines during 2000–01*.

Common name	Scientific name	Area†	No. males	No. females	Total
Albatross species					
Campbell	*Thalassarche impavida*	2	–	1	1
Buller's	*Thalassarche bulleri*	3	1	6	7
White-capped	*Thalassarche steadi*	3	1	2	3
Petrel species					
White-chinned	*Procellaria aequinoctialis*	3	1	–	1

* Species identification data are from Robertson et al. (2003). Of the 15 seabirds caught, 12 were returned.

† See Figure B1 for areas.

APPENDIX B — *continued*

Table B3: Domestic TLCER & CELR effort, 2000–01.

	Area 1		Area 2		Area 3		Area 4		Total	
Month	No. sets	No. hooks	No. sets	No. hooks	No.sets	No. hooks	No. sets	No. hooks	No. sets	No.hooks
October	532	606 110	–	–	–	–	10	13 750	542	619 860
November	341	391 955	–	–	–	–	34	39 600	375	431 555
December	360	401 200	–	–	–	–	29	32 800	389	434 000
January	394	439 305	1	1 300	–	–	159	176 520	554	617 125
February	456	505 583	–	–	–	–	207	248 530	663	754 113
March	565	637 465	11	33 225	–	–	184	213 390	760	884 080
April	631	702 762	21	64 100	10	23 300	121	144 590	783	934 752
May	477	553 534	1	1 050	61	117 055	41	51 000	580	722 639
June	882	1 007 205	–	–	55	89 160	53	59 740	990	1 156 105
July	543	649 484	–	–	–	–	222	253 225	765	902 709
August	480	549 804	–	–	–	–	263	329 967	743	879 771
September	536	614 550	–	–	–	–	193	234 680	729	849 230
Total	6 197	7 058 957	34	99 675	126	229 515	1 516	1 797 792	7 873	9 185 939

Table B4: Percent sets and hooks observed, based on Domestic TLCER & CELR effort, 2000–01.

	Area 1		Area 2		Area 3		Area 4		Total	
Month	% sets	% hooks	% sets	% hooks	% sets	% hooks	% sets	% hooks	% sets	% hooks
October	0.0	0.0	–	–	–	–	0.0	0.0	0.0	0.0
November	0.0	0.0	–	–	–	–	0.0	0.0	0.0	0.0
December	2.5	2.3	–	–	–	–	0.0	0.0	2.3	2.1
January	10.7	11.1	0.0	0.0	–	–	9.4	9.7	10.3	10.6
February	7.9	8.1			–	–	9.7	10.7	8.4	9.0
March	5.5	6.0	0.0	0.0	–	–	0.0	0.0	4.1	4.3
April	3.6	3.1	0.0	0.0	0.0	0.0	0.0	0.0	2.9	2.4
May	3.1	4.0	0.0	0.0	44.3	77.3	0.0	0.0	7.2	15.6
June	0.9	2.1	–	–	27.3	59.4	3.8	9.2	2.5	6.8
July	3.5	7.2	–	–	–	–	1.4	2.5	2.9	5.9
August	0.0	0.0	–	–	–	–	0.0	0.0	0.0	0.0
September	1.9	2.4	–	–	–	–	0.0	0.0	1.4	1.8
Total	3.1	3.7	0.0	0.0	33.3	62.5	2.6	3.1	3.5	5.0

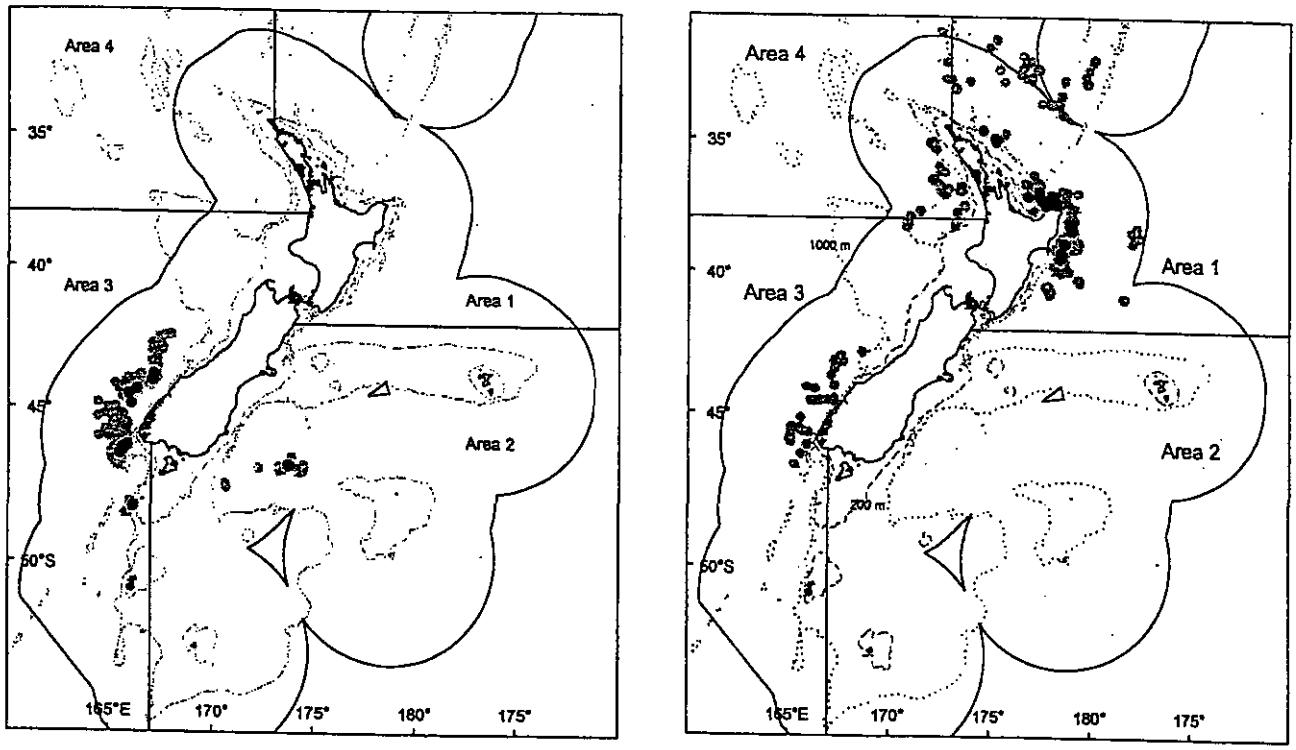


Figure B1: Start positions of observed sets (•), including those with seabird bycatch (•), for chartered Japanese vessels (left) and domestic owned and operated vessels (right), 2000–01.

APPENDIX C: LING LONGLINE DATA, 2000–01

Table C1: Comparison of number of vessels and number of total hooks set with number of observed vessels and number of observed hooks for the ling longline fishery (all vessels), by areas* shown in Figure C1, for 2000–01.

Number	LIN 1	LIN 2	LIN 3	LIN 4	LIN 5	LIN 6	LIN 7†	Total
Vessels	10	18	7	7	4	5	17	41
Observed vessels	0	1	0	1	2	3	0	4
% vessels observed	0	6	0	14	50	60	0	10
Autoline vessels	1	2	6	6	4	5	2	6
% autoline vessels observed	0	50	0	16	50	60	0	67
Total hooks x 10^3 set by all vessels	473.9	2 691.7	3 288.2	9 183.2	3 279.7	8 666.3	1 050.9	28 634.0
Observed hooks x 10^3	0	236.9	0	3.6	959.1	984.2	–	2 183.8
% total hooks observed	0	9	0	< 1	29	11	–	8
Total hooks for autoline vessels	252.0	2 057.4	3 201.9	8 594.6	3 279.7	8 414.3	28.4	25 828.3
% hooks observed for autoline vessels	0	12	0	< 1	29	12	–	8

* There was no reported effort in LIN 10.

† Effort data are from CELRs. No set number data are given here because of the inconsistent way in which these records are reported. Total hook data for LIN 7 are incomplete because there were 47 records by one vessel with no hook data.

APPENDIX C— *continued*

Table C2: Frequency of seabird incidental captures in ling longline sets, by observed vessel (A–D) and area*, 2000–01.

No. sets	A		B		C		D	Total
with birds	LIN6	LIN4	LIN6	LIN2	LIN5	LIN5	LIN6	
Observed sets								
0	72	1	30	45	77	105	137	467
1	13		19	1	5	23	9	70
2	9	1	7		3	8	4	32
3	3		9			7	1	20
4	3		2			2		7
5			2			2		4
6	1							1
7						2		2
8			4			1		5
10						1		1
11						1		1
12			1					1
15			1					1
21						1		1
Observed sets	101	2	75	46	85	153	151	613
Observed birds	58	2	137	1	11	142	20	371
% observed sets with birds	29	50	60	2	9	31	9	24
No. unobserved birds	52	0	0	0	11	12	6	81
Unobserved sets								
0		2	20	3	75	0	0	104
1			9		6			15
2			5		1			6
3			2					2
4			1					1
5	1							1
11			1					1
Observed sets	1	2	38	3	82			130
Observed birds	5	0	40	0	8			53

* Note there are two parts to this table: the "observed sets" section gives data from the longlines that were observed by a Ministry of Fisheries observer (but includes some seabirds not actually observed — see sections 2.1.2 and 3.3.1.2); and the "unobserved sets" gives data from sets that were made when the observer was on board, but the haul was not observed — the seabirds were kept for the observers who then recorded the information.

APPENDIX C— *continued*

Table C3: Fishing effort (1000 hooks), percent observed effort, observed seabird catch and seabird catch rate (mean number per 1000 hooks) for 4 ling autoline vessels in LIN 2, LIN 5, and LIN 6* (see Figure C1), 2000–01.

Area, vessel, month	Total hooks	% hooks observed	Observed no. seabirds	Mean seabird catch rate	Standard error	Total seabird estimate	c.v.
LIN2 C May-Jun	345.943	68	1	0.004	0.004	1	58
LIN5 C Oct-Dec	1 413.220	21	11	0.037	0.014	52	33
LIN5 D Oct-Dec	1 555.450	43	142	0.214	0.045	333	16
LIN6 D Apr-May	1 111.030	60	20	0.030	0.008	33	17
LIN6 A Nov-Dec	1 147.506	17	58	0.294	0.058	338	18
LIN6 B Jun-Jul†	600.000	21	137	1.112	0.197	–	–

* Two observed seabird captures were reported for one vessel in June in LIN 4 when 37% of 9600 hooks (1 set) were observed.

† Seabird data here include some seabirds caught outside the observer's hours of duty and thus may overestimate the number observed caught. Hence, no estimate is provided.

Table C4: Seabird species* landed dead and returned from ling longlines, by area, 2000–01.

Common name	Scientific name	Area†	No. males	No. females	Total‡
Albatross species					
Black-browed	*Thalassarche melanophrys*	LIN 6	–	–	2
White-capped	*Thalassarche steadi*	LIN 6	–	1	1
Salvin's	*Thalassarche salvini*	LIN 5	1	–	1
		LIN 6	20	69	89
Petrel species					
Northern giant	*Macronectes halli*	LIN 6	1	–	1
Grey	*Procellaria cinerea*	LIN 4	2	–	2
		LIN 6	38	1	181
White-chinned	*Procellaria aequinoctialis*	LIN 5	124	37	161
		LIN 6	21	12	39
Sooty shearwaters	*Puffinus griseus*	LIN 2	–	–	1
		LIN 5	8	1	9
		LIN 6	1	–	1

* Species identification data are from Robertson et al. (2003). Note that 488 of the 505 seabirds reported caught were returned for identification.

† See Figure C1.

‡ Total includes those seabirds identified but not able to be sexed. Many of the grey petrels had been eaten by lice and were unable to be sexed (Robertson et al. 2003).

APPENDIX C— *continued*

Table C5: Bluenose longline commercial and observed effort as recorded on CELRs for all vessels, by quota management area*, 2000–01.

	BNS 1	BNS 2	BNS 3	BNS 7	BNS 8	Total
No. vessels	36	18	6	11	4	56
No. vessels observed	0	1	0	0	0	1
% vessels observed	0	6	0	0	0	2
No. hooks set x 10^3	1 318.0	651.7	32.9	130.1	6.6	2 139.4
No. hooks observed x 10^3	0	120.1	0	0	0	120.1
% hooks observed	0	18	0	0	0	6

* Bluenose (BNS) areas are shown in Annala et al. (2001).

Table C6: Seabird species observed caught on snapper longlines in FMA 1 during 2000–01* .

Common name	Scientific name	No. males	No. females	Total
Grey petrel	*Procellaria cinerea*	10	1	11
Buller's shearwater	*Puffinus bulleri*	1	1	2
Flesh-footed shearwater	*Puffinus carneipes*	7	5	12
Fluttering shearwater	*Puffinus gavia*	1	0	1

* Species identification data are from Robertson et al. (2003). All observed seabirds were returned.

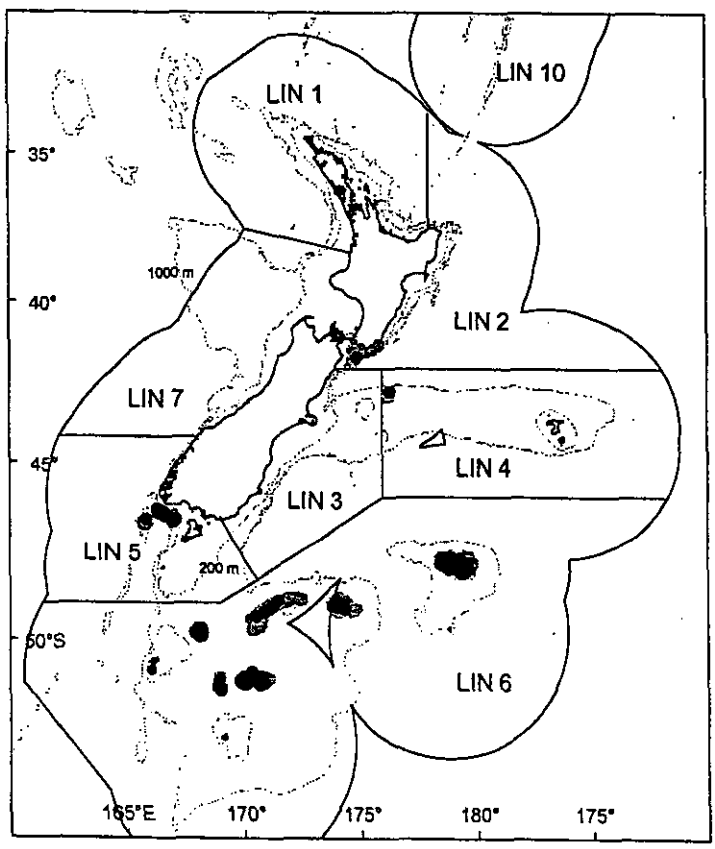


Figure C1: start positions of observed ling longline sets (•), including those with seabird incidental captures (•), 2000–01.

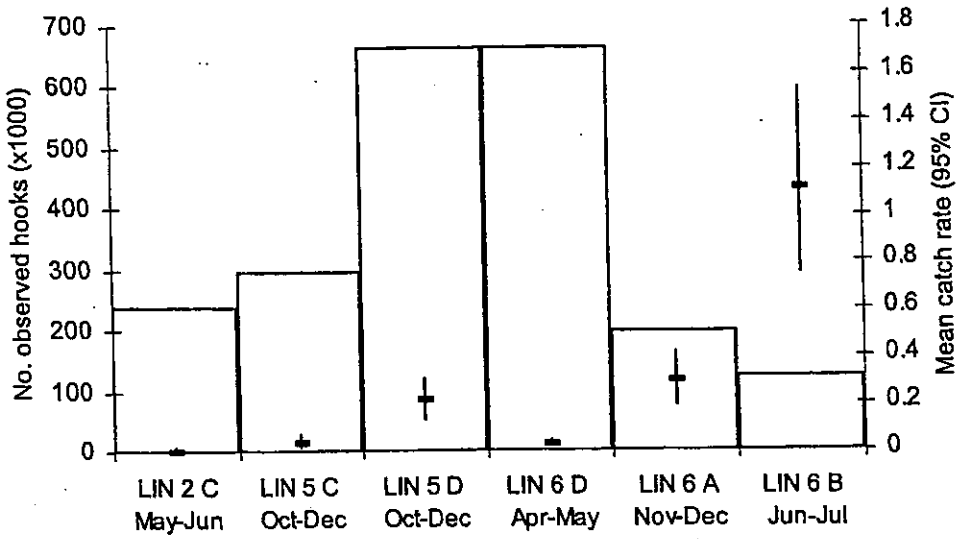


Figure C2: Observed effort (histogram) and mean number of seabird captures per 1000 hooks (and 95% confidence intervals) for four observed autoline ling longliners in LIN 2, LIN 5, and LIN 6, 2000–01.

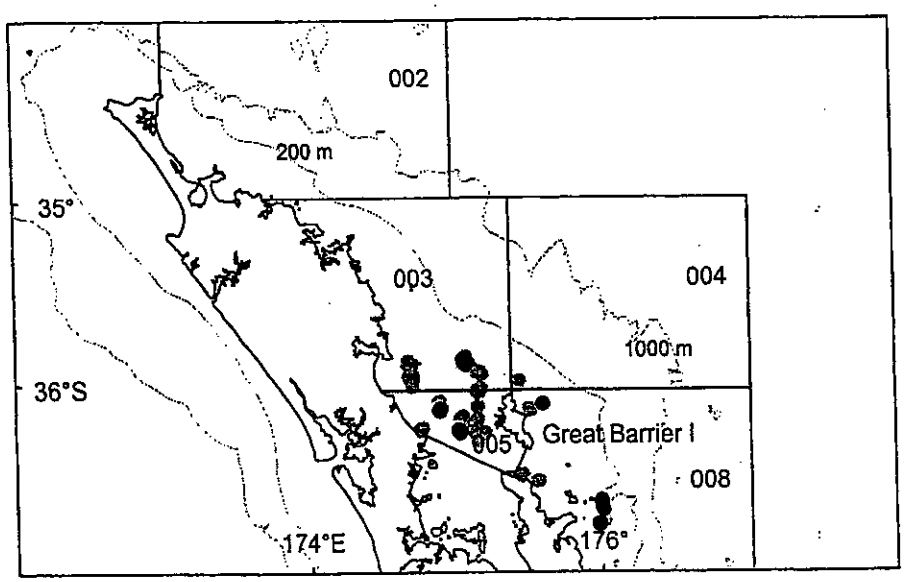


Figure C3: Start positions of observed sets targeting snapper (⊕), including those with incidental captures of seabirds (●), in Statistical Areas 002, 003, 004, 005, and 008.

APPENDIX D: SEABIRD CAPTURES IN TRAWL FISHERIES

Table D1: Frequency of seabird bycatch for observed trawl fishing operations, 2000–01.

No. birds per tow	Target trawl fishery*											
	BAR	BOE	HAK	HOK	JMA	ORH	RCO	SBW	SCI	SQU	SSO	SWA
0	134	399	50	3 392	389	851	4	385	255	2 757	173	26
1	4	1	2	84	9	1	2	3	11	186	1	1
2	1		1	16		1				32		
3				12						14		1
4				11						3		
5				8						4		
6				4								
7										2		
8				2								
9				1								
10												
11				2								
12										1		
Observed tows	139	400	53	3 532	398	853	6	388	266	2 999	174	28
Observed birds	6	1	4	307	9	3	2	3	11	350	1	4
% observed tows with birds	4	< 1	6	4	2	< 1	33	1	4	8	1	7

* Target species for which there was reported seabird bycatch. Fishery areas and species codes are given in Table D2 and D3.

Table D2: Target fishery species codes.

Common name	Scientific name	Species code
Barracouta	*Thyrsites atun*	BAR
Hake	*Merluccius australis*	HAK
Hoki	*Macruronus novaezelandiae*	HOK
Jack mackerels	*Trachurus* spp.	JMA
Ling	*Genypterus blacodes*	LIN
Orange roughy	*Hoplostethus atlanticus*	ORH
Red cod	*Pseudophycis bachus*	RCO
Scampi	*Metanephrops challengeri*	SCI
Silver warehou	*Seriolella punctata*	SWA
Southern blue whiting	*Micromesistius australis*	SBW
Squid	*Nototodarus* spp.	SQU

Table D3: Fishery area codes.

Fishery area	Code	Fishery area	Code
Chatham Rise	CHAT	East coast South Island	ECSI
Cook Strait	COOK	Stewart-Snares shelf	STEW
Puysegur	PUYS		
Sub-Antarctic	SUBA		
West coast South Island	WCSI		

APPENDIX D— *continued*

Table D4: Seabird species codes.

Common name	Scientific name	Code	Threatened status IUCN*	Threatened status DoC†
Albatross taxa				
Northern royal	*Diomedea sanfordi*	XNR	E	NV
Southern royal	*Diomedea epomophora*	XRA	V	RR
Black-browed	*Thalassarche melanophrys*	XSM	LRNT	C
Buller's	*Thalassarche bulleri*	XBM	V	RR
Campbell	*Thalassarche impavida*	XCM	V	NV
Chatham	*Thalassarche eremita*	XCI	CE	SD
Pacific	*Thalassarche platei* nov. sp	XNB	V	RR
Salvin's	*Thalassarche salvini*	XSA	V	RR
White-capped	*Thalassarche steadi*	XWM	V	RR
Petrel taxa				
Northern giant	*Macronectes halli*	XNP	LRNT	–
Black	*Procellaria parkinsoni*	XBP	V	GD
Grey	*Procellaria cinerea*	XGP	LRNT	GD
White-chinned	*Procellaria aequinoctialis*	XWC	V	RR
Grey-faced	*Pterodroma macroptera*	XGF	LRLC	–
Buller's shearwater	*Puffinus bulleri*	XBS	V	RR
Flesh-footed shearwater	*Puffinus carneipes*	XFS	LRNT	GD
Fluttering shearwater	*Puffinus gavia*	XFL	–	–
Sooty shearwater	*Puffinus griseus*	XSH	LRLC	GD
Short-tailed shearwater	*Puffinus tenuirostris*	XST	–	M
Cape pigeon	*Daption capense*	XCP	–	–
Southern cape pigeon	*Daption capense capense*	XCC	LRLC	–
Fairy prion	*Pachyptila turtur*	XFP	–	–

* From IUCN (2003) and Taylor (2000), where CE is Critically Endangered, E is endangered, V is Vulnerable, LRNT is Lower Risk-Near Threatened, LRLC is Lower Risk-Least Concern. Dashes indicate the species is not listed or not threatened.

† From Hitchmough (2002), where NV is Nationally Vulnerable, SD is Serious Decline, GD is Gradual Decline, RR is range restricted, C is Coloniser, M is Migrant.

APPENDIX E: HOKI DATA, 2000–01

Table E1: Frequency of seabird bycatch for observed hoki trawl operations, by area, 2000–01.

No. birds per tow	CHAT	COOK	PUYS	SUBA	WCSI	Total
0	1277	264	106	679	1066	3 392
1	55		1	16	12	84
2	12	1		3		16
3	9		1	1	1	12
4	11					11
5	6			2		8
6	2			2		4
7						
8	2					2
9	1					1
10						
11	1			1		2
Observed tows	1 376	265	108	704	1 079	3 532
Observed birds	228	2	4	58	15	307
% observed tows with birds	7	< 1	2	4	1	4

* Fishery area code definitions are given in Appendix D and shown in Figure E1.

Table E2: Total numbers of seabird taxa* (males, females) observed caught during hoki trawl operations, by hoki fishery area, 2000–01.

Seabird taxa	CHAT	COOK	PUYS	SUBA	WCSI	Total
Southern royal albatross	1 (1,0)	–	–	–	–	1
Buller's albatross	2 (1,1)	–	1 (1,0)	–	–	3
Campbell albatross	–	–	–	–	1 (0,1)	1
Black-browed albatross	–	–	–	–	1	1
Salvin's albatross	4 (3,1)	–	–	–	–	4
White-capped albatross	–	–	–	3 (2,1)	3 (3,0)	6
Northern giant petrel	1 (1,0)	–	–	–	–	1
Grey petrel	2 (1,1)	–	–	–	–	2
White-chinned petrel	22 (8,14)	–	1 (1,0)	2 (1,1)	–	25
Short-tailed shearwater	–	–	1 (1,0)	32 (15,17)	–	33
Sooty shearwater	136 (118,18)	–	–	5 (4,1)	–	141
Southern cape pigeon	–	2 (1,1)	–	1 (1,0)	–	3
Fairy prion	–	–	–	–	2 (1,1)	2
Black-backed gull	–	–	–	–	1 (1,0)	1
Unidentified	60	0	1	15	7	83
Total	228	2	4	58	15	307

* Seabird scientific names and fishery area code definitions are given in Appendix D. Species identification data are from Robertson et al. (2003).

APPENDIX E— *continued*

Table E3: Fishing effort, observed effort, seabird captures, and mean seabird catch rates (numbers of seabirds per tow) for the CHAT hoki fishery*, 2000–01. Data for the three outlier vessels (see section 3.4.1.1.2) are given in bold.

Month	Total no. tows	No. observed tows	% tows observed	No. seabirds observed caught	Mean bycatch rate	Standard error	Estimated number caught	c.v. (%)
October	1 130	133	12	9	0.068	0.026	76	36
November	1 024	155	15	1	0.006	0.007	7	90
December	896	160	18	5	0.031	0.013	28	38
January	1 217	175	14	3	0.017	0.010	20	55
February	1 033	84	8	3	–	–	–	–
March	1 794	145	8	1	–	–	–	–
April	1 039	77	7	4	–	–	–	–
May	785	28	4	0	–	–	–	–
June	437	151	35	2	0.013	0.009	6	57
July	190	13	7	2	–	–	–	–
August	5		0	–	–	–	–	–
September	739	4	1	1	–	–	–	–
Oct-Apr	8 133	929	11	21	0.023	0.006	187	20
2000–01	**671**	**251**	**37**	**197**	**0.785**	**0.105**	**527**	**11**

* Note that these data do not include the 671 tows of three Polish vessels.

† Data for three Polish vessels that fished mainly in October-January 2000 and March-June 2001. Observed seabird captures from these vessels totalled 30 in October, 18 in March, and 152 in April.

Table E4: Fishing effort, observed effort, seabird captures, and mean seabird catch rates (numbers of seabirds per tow) for the SUBA hoki fishery, 2000–01*.

Month	Total no. tows	No. observed tows	% tows observed	No. seabirds observed caught	Mean bycatch rate	Standard error	Estimated number caught	c.v. (%)
October	791	150	19	2	0.013	0.009	10	64
November	546	18	3	0	–	–	–	–
December	748	0	0	–	–	–	–	–
January	498	128	26	2	0.016	0.011	8	60
February	280	86	31	0	–	–	–	–
March	345	8	2	9	–	–	–	–
April	635	15	2	0	–	–	–	–
May	949	115	12	4	0.035	0.018	33	46
June	824	42	5	0	–	–	–	–
July	151	0	0	–	–	–	–	–
August	0	–	–	–	–	–	–	–
September	321	112	35	2	0.018	0.013	6	57
2000–01	6 088	674	11	19	0.028	0.010	172	34

* Note that these data do not include the 30 tows (all observed) of one vessel that fished mainly in October and accounted for 39 of the 41 birds caught in that month and of the 58 birds reported for 2000–01 in SUBA.

APPENDIX E— *continued*

Table E5: Fishing effort, observed effort, seabird captures, and mean seabird catch rates (numbers of seabirds per tow) for the WCSI hoki fishery, 2000–01.

Month	Total no. tows	No. observed tows	% tows observed	No. seabirds observed caught	Mean catch rate	Standard error	Estimated number caught	c.v. (%)
June	661	5	< 1	0	–	–	–	–
July	3 448	518	15	10	0.019	0.008	67	39
August	3 692	473	13	4	0.008	0.004	31	47
September	409	75	18	1	0.013	0.013	5	84
Jul-Sep	7 549	1 066	14	15	0.014	0.004	106	26

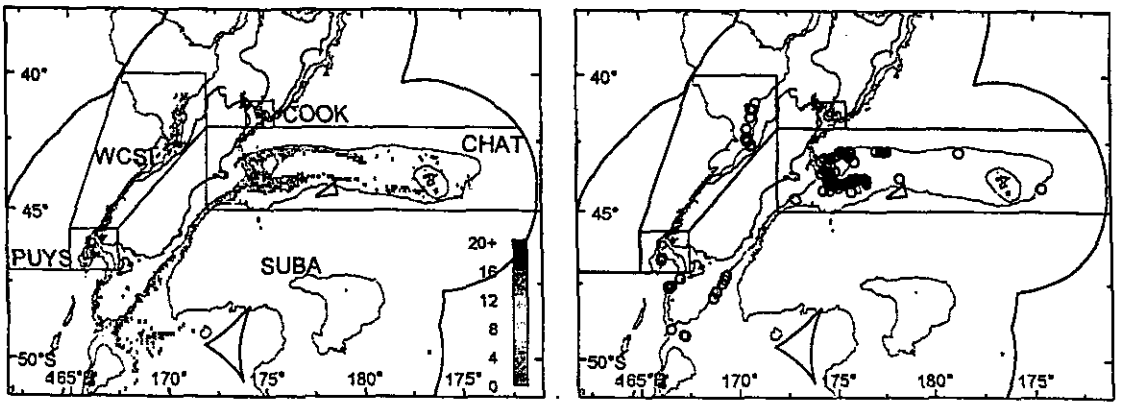


Figure E1: Distribution and density of observed hoki trawl effort (number of tows in 0.1 degree cells), based on start of tow positions (left), and start positions of observed tows with seabird incidental captures (o) (right), for hoki fishery areas, 2000–01.

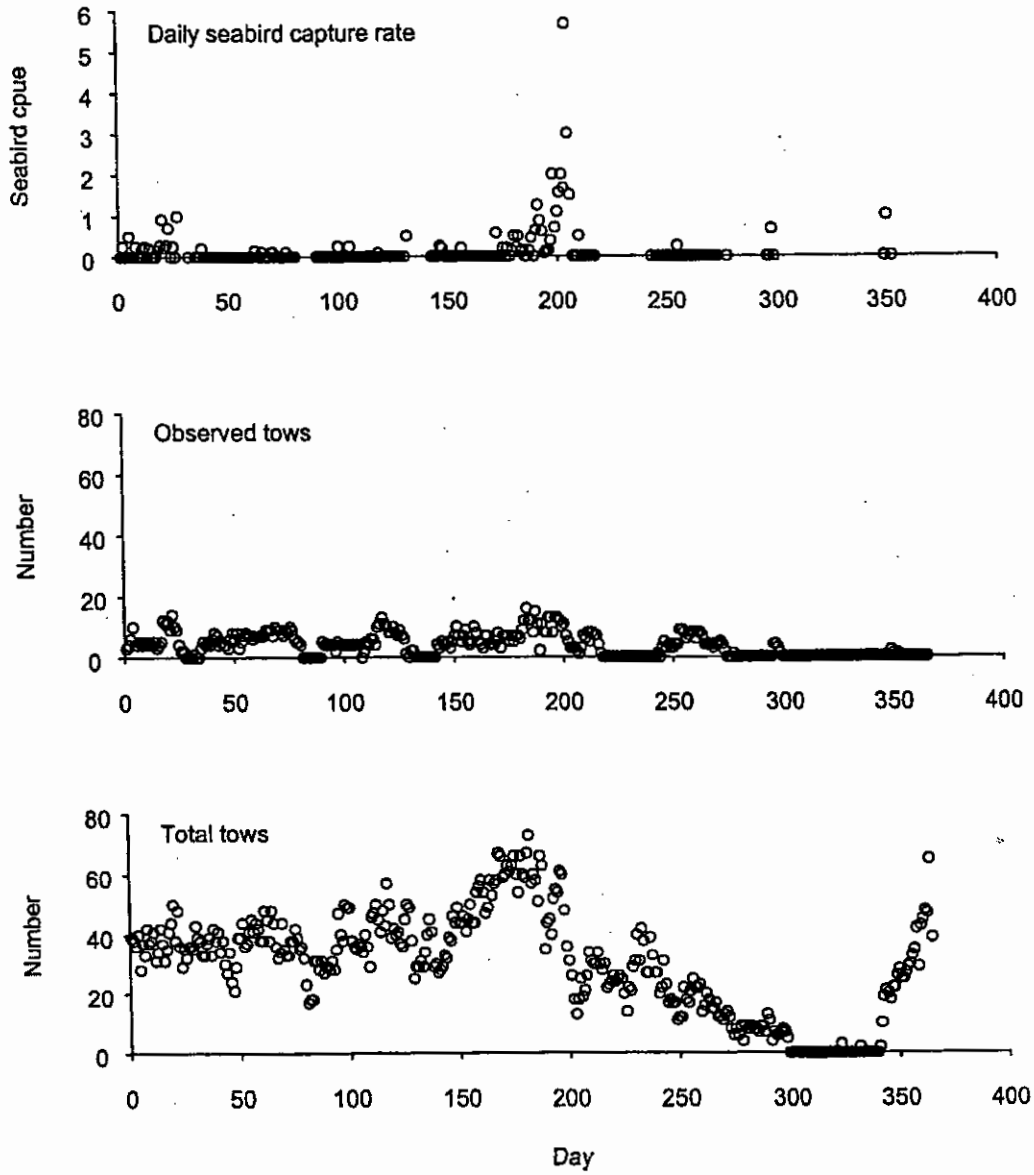


Figure E2: Total tows, observed tows, and observed seabird capture rates in the Chatham Rise (CHAT) hoki fishery for each day of 2000–01 fishing year, where Day 1 is 1 October 2000.

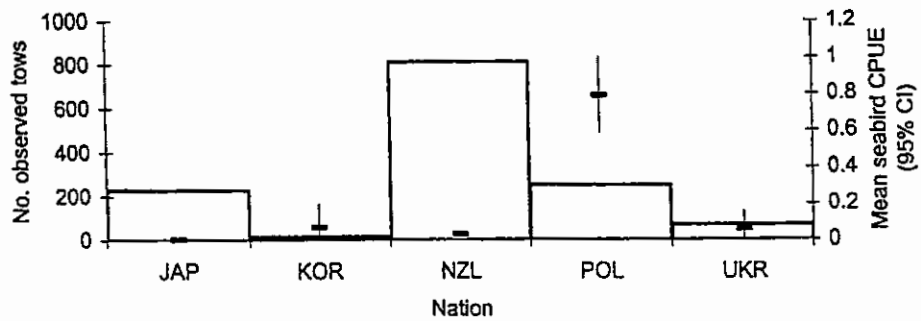


Figure E3: Observed effort (histogram) and mean seabird bycatch rates for observed hoki tows on the Chatham Rise in 2000–01, by nation (where JAP is Japan, KOR is Korea, NZL is New Zealand, POL is Poland, and UKR is Ukraine).

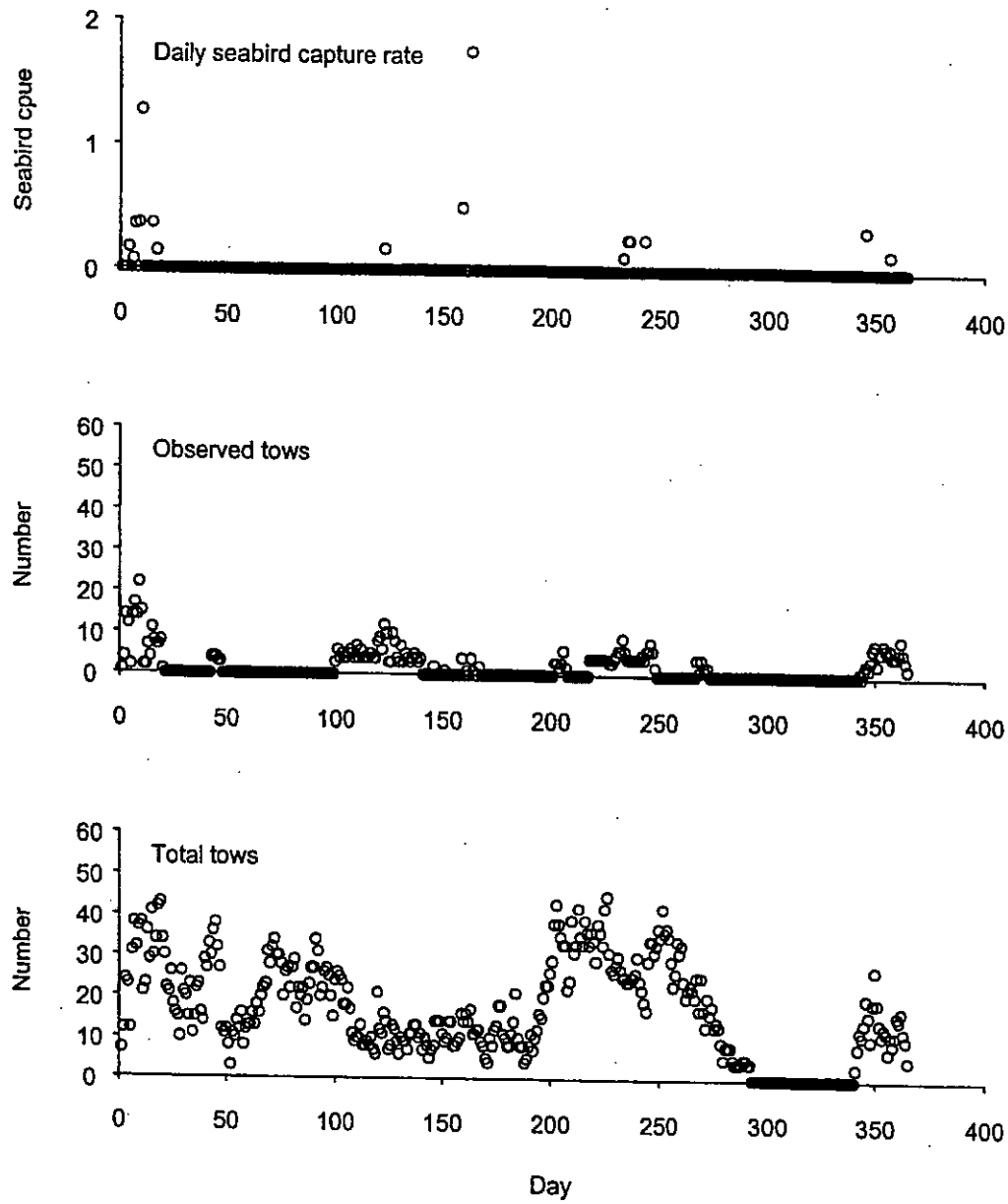


Figure E5: Total tows, observed tows, and observed seabird capture rates in the sub-Antarctic (SUBA) hoki fishery for each day of 2000–01 fishing year, where Day 1 is 1 October 2000.

APPENDIX E— *continued*

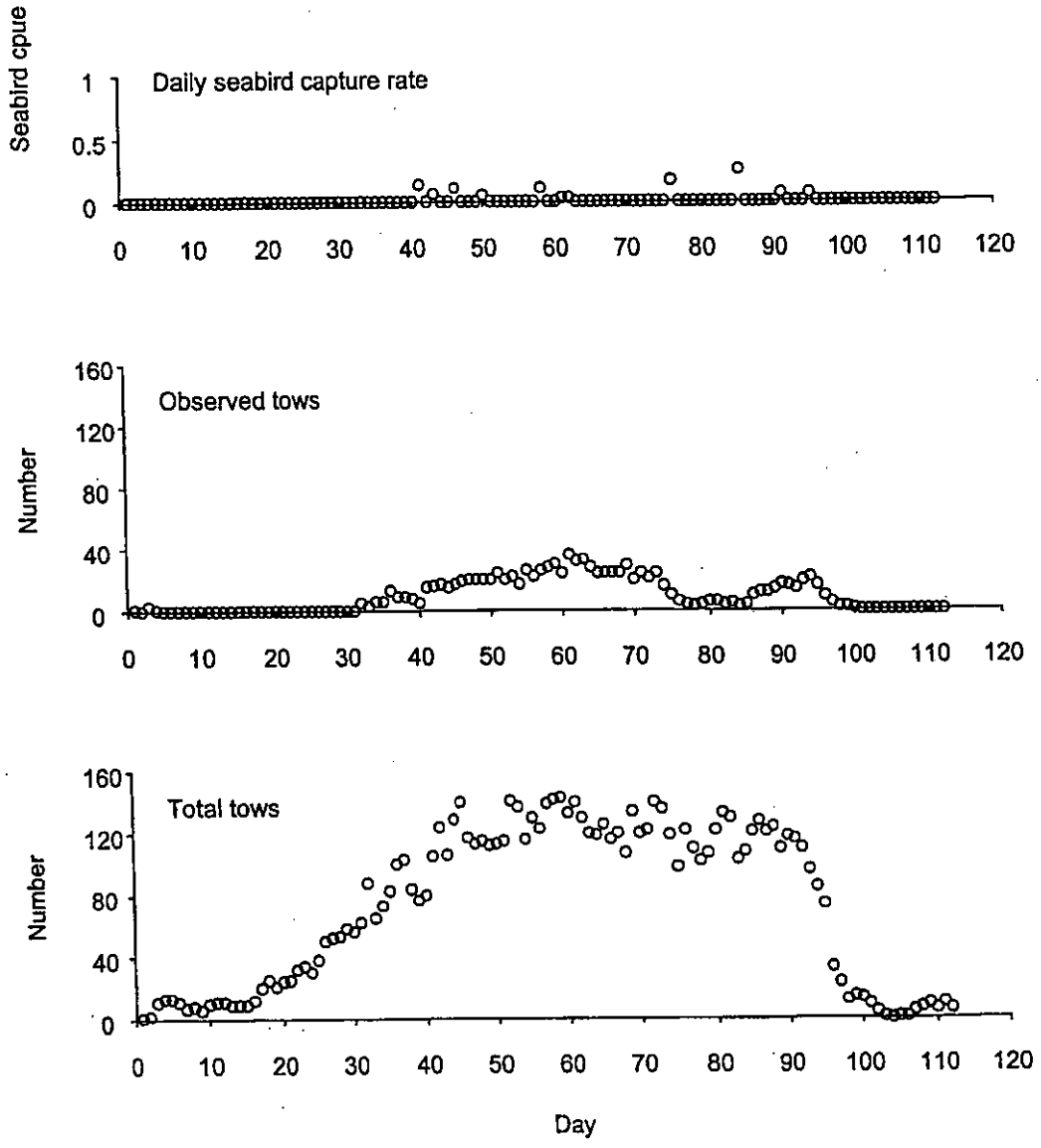


Figure E6: Total tows, observed tows, and observed seabird capture rates in the west coast South Island (WCSI) hoki fishery for each day of 2000–01 fishing year, where Day 1 is 1 June 2001.

APPENDIX F: SQUID DATA, 2000–01

Table F1: Frequency of seabird captures in observed squid trawl fisheries, 2000–01.

No. seabirds per tow	Squid trawl fishery areas*				All areas
	CHAT	ECSI	SQU 6T	STEW	
0	9	79	541	2 128	2 757
1		4	29	153	186
2		1	5	26	32
3			1	13	14
4				3	3
5				4	4
6					
7				2	2
12				1	1
Observed tows	9	84	576	2 330	2 999
Observed birds	0	6	42	302	350
% observed tows with birds	0	6	6	9	9

* See Appendix D and Figure F1 for area definition.

Table F2: Fishing effort, observed effort, seabird captures, and mean seabird catch rates (numbers of seabirds per tow) for the SQU6T squid fishery, 2000–01.

Month*	Total no. tows	No. observed tows	% tows observed	No. seabirds observed caught	Mean catch rate	Standard error
January	21	21	100	3	0.143	–
February	389	389	100	15	0.039	–
March	143	140	98	22	0.157	0.039
April	27	26	96	2	0.077	0.051
Jan-Apr	580	576	99	42	0.077	0.013

* Effort in other months: 5 tows in late May.

Table F3: Numbers of seabird taxa* (males, females) observed caught during squid trawl operations, by squid fishery area, 2000–01.

Seabird taxa	ECSI	SQU6T	STEW	Total
Albatrosses				
Southern royal albatross	–	–	1 (1,0)	1
Buller's albatross	–	–	5 (4,1)	5
Salvin's albatross	2 (1,1)	–	1 (1,0)	3
White-capped albatross	–	32 (21,11)	101 (59,37)	133
Petrels				
White-chinned petrel	–	5 (3,2)	46 (26,20)	51
Sooty shearwater	1 (1,0)	–	65 (59,6)	66
Unidentified	3	5	83	91
Total seabirds	6	42	302	350

* Seabird scientific names and fishery code definitions are given in Appendix D. Species identification data are from Robertson et al. (2003). Totals included those seabirds that could not be sexed.

APPENDIX F— *continued*

Table F4: Fishing effort, observed effort, seabird captures, and mean seabird catch rates (numbers of seabirds per tow) for the STEW squid fishery, 2000–01.

Month*	Total no. tows	No. observed tows	% tows observed	No. seabirds observed caught	Mean bycatch rate	Standard error	Estimated number caught	c.v. (%)
January	604	311	51	41	0.132	0.048	80	25
February	1 110	1 053	95	139	0.132	0.016	147	3
March	866	713	82	109	0.153	0.02	132	6
April	532	254	48	13	0.051	0.016	27	23
Jan-Apr	3 112	2 331	75	302	0.130	0.012	403	5
Jan-Apr†	2 913	1 997	69	189	0.095	0.009	276	5
Jan-Apr‡	396	333	84	113	0.339	0.059	134	7

* Effort in other months: 40 tows in December, 113 in May, and 44 in June.
† Data are for all vessels but the three observed Polish vessels.
‡ Data are for Polish vessels only.

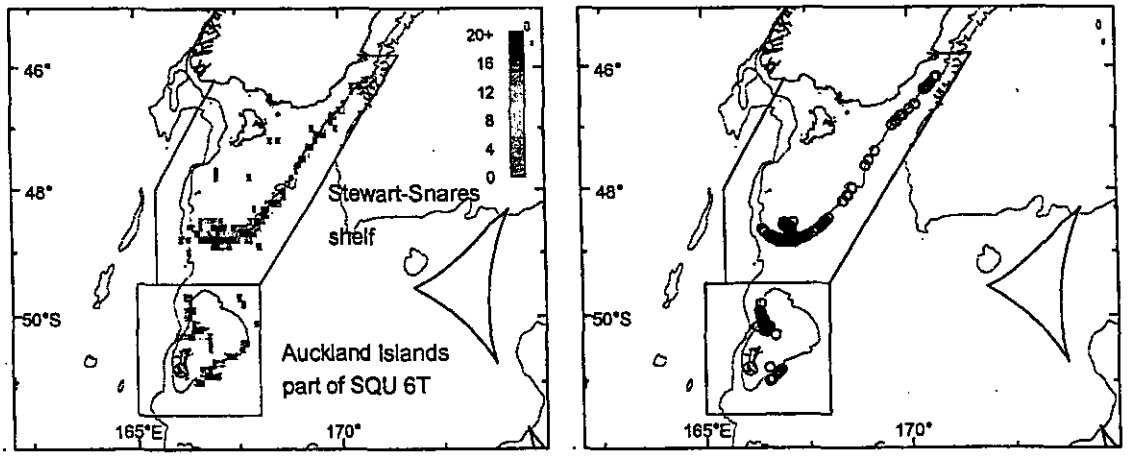


Figure F1: Distribution and density of observed squid trawl effort (number of tows in 0.1 degree cells), based on start of tow positions (left), and start positions of observed tows with seabird incidental captures (○) (right), for defined fishery areas of Stewart-Snares shelf and Auckland Islands part of SQU 6T, 2000–01.

APPENDIX F— *continued*

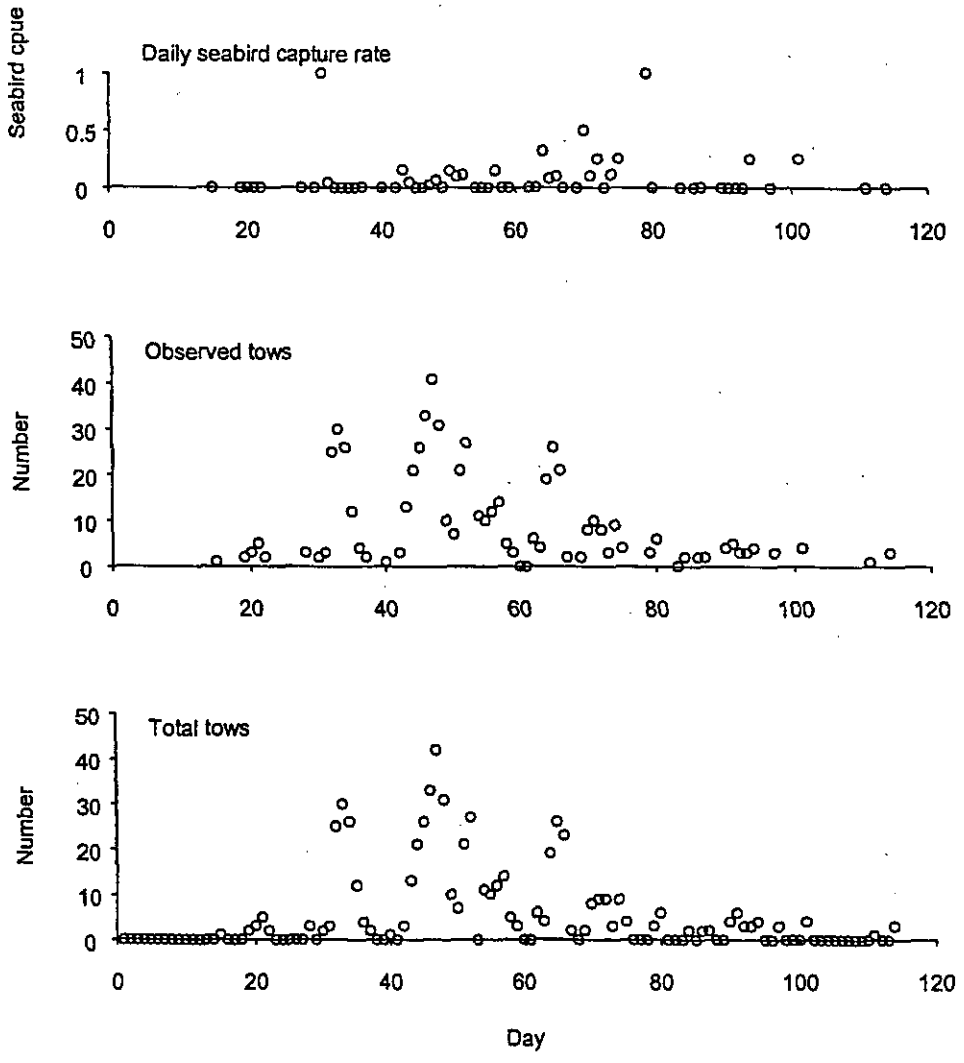


Figure F2: Daily number of vessels, total tows, observed tows, and observed seabird captures in the 2001 SQU 6T squid fishery, where fishing began on 15 January 2001 (Day 15) and finished on 24 April 2001 (Day 114).

APPENDIX F— *continued*

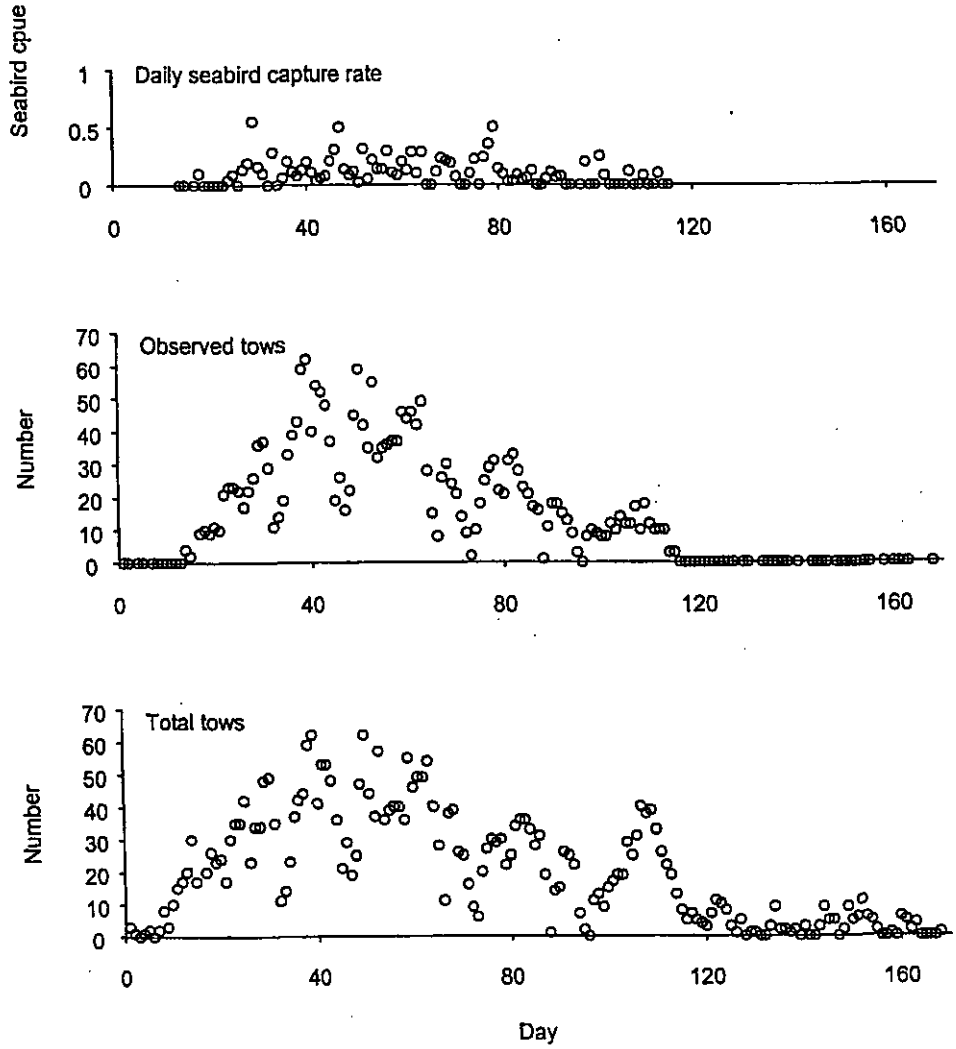


Figure F3: Daily number of total tows, observed tows, and observed seabird captures in the 2001 squid fishery on the Stewart-Snares shelf, where 1 January 2001 is Day 1 and 17 June 2001 is Day 168, when fishing ceased.

APPENDIX G: OTHER TRAWL TARGET FISHERIES SUMMARY, 2000–01

Table G1: Seabirds returned from Chatham Rise*, by target species for 2000–01.

Seabird taxa	BAR		HAK		ORH		RCO	
	♂	♀	♂	♀	♂	♀	♂	♀
Albatrosses								
Northern royal	1	–	–	–	–	–	–	–
Buller's	–	–	1	–	–	–	–	–
Chatham	–	–	–	1	–	2	–	–
Pacific	–	–	–	–	1	–	–	–
Salvin's	–	–	1	–	–	–	–	1
White-capped	1	1	–	–	–	–	–	–
Petrels								
Northern giant	–	–	1	–	–	–	–	–
Sooty shearwater	–	1					–	–

* See Appendix D for fish species codes. Birds were caught west of 175° E in BAR, RCO, and SWA tows, except for the northern royal albatross (east of Chatham Islands). All birds from these target fisheries were from east of 175° E. Species identification data are from Robertson et al. (2003).

Table G2: Seabirds returned from Stewart-Snares shelf, Campbell Plateau, west coast South Island, east coast North Island*, by target species for 2000–01.

Seabird taxa	JMA		SBW		SCI		SWA	
	♂	♀	♂	♀	♂	♀	♂	♀
Albatrosses								
Salvin's	–	–	1	–	2	1	1	2
White-capped	5	1	–	–	–	1	–	–
Petrels								
Grey	–	–	–	1	–	–	–	–
White-chinned	1	–	–	–	–	–	–	–
Sooty shearwater	1	–	–	–	–	–	–	–
Southern cape pigeon	–	–	1	–	–	–	–	–

* See Appendix D for fish species codes. JMA birds were from Stewart-Snares Shelf, SBW from Bounty Platform (Salvin's albatross) and near Campbell Rise, SCI from Auckland Islands Shelf (white-capped albatross) and east coast North Island, SWA from Stewart-Snares Shelf. Species identification data are from Robertson et al. (2003).

APPENDIX H: TRAWL FISHERY DATA

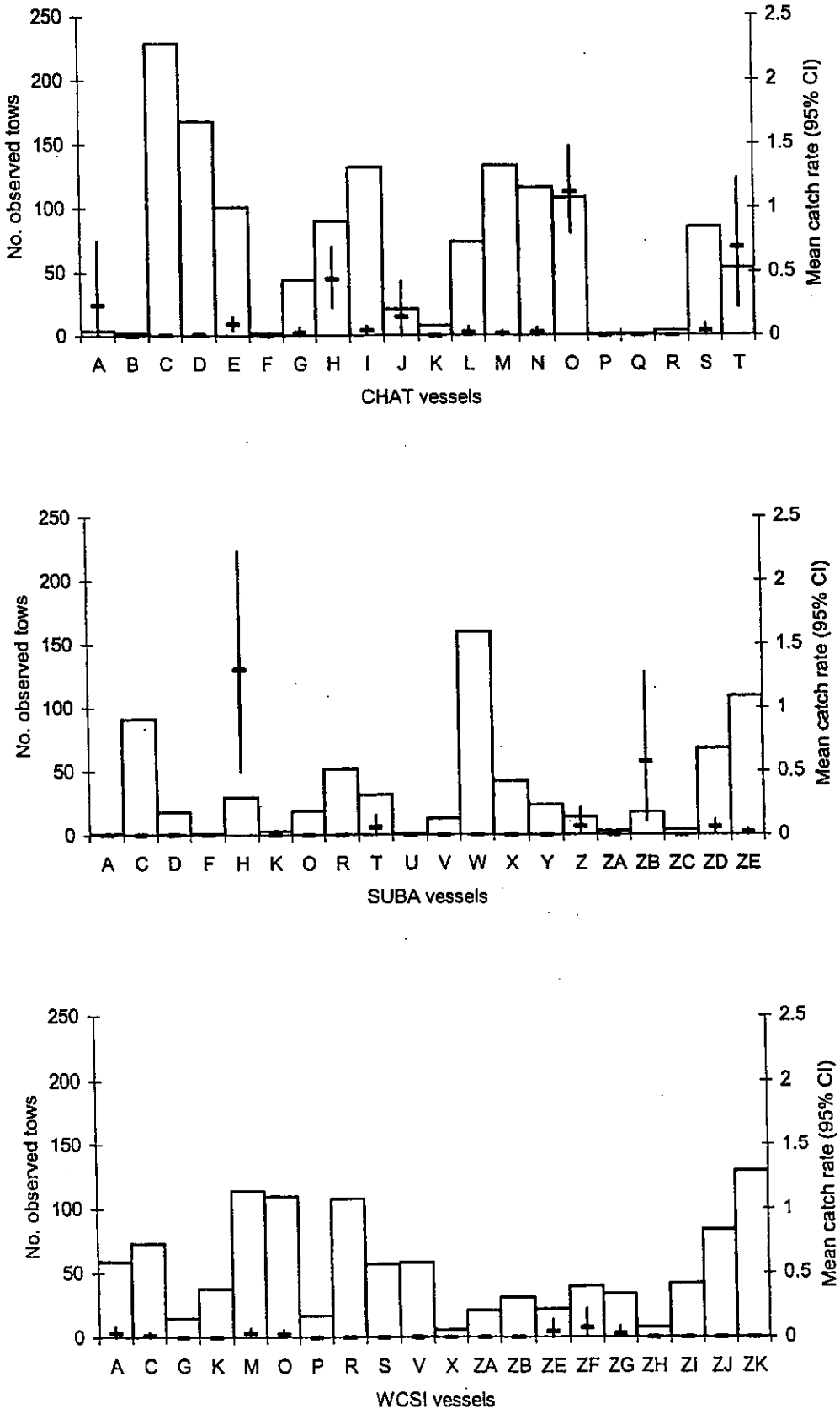


Figure H1: Observed effort (histogram) and mean seabird catch rates (± 95% confidence intervals) for all observed hoki target trawlers, by fishery area, 2000–01.

APPENDIX H— *continued*

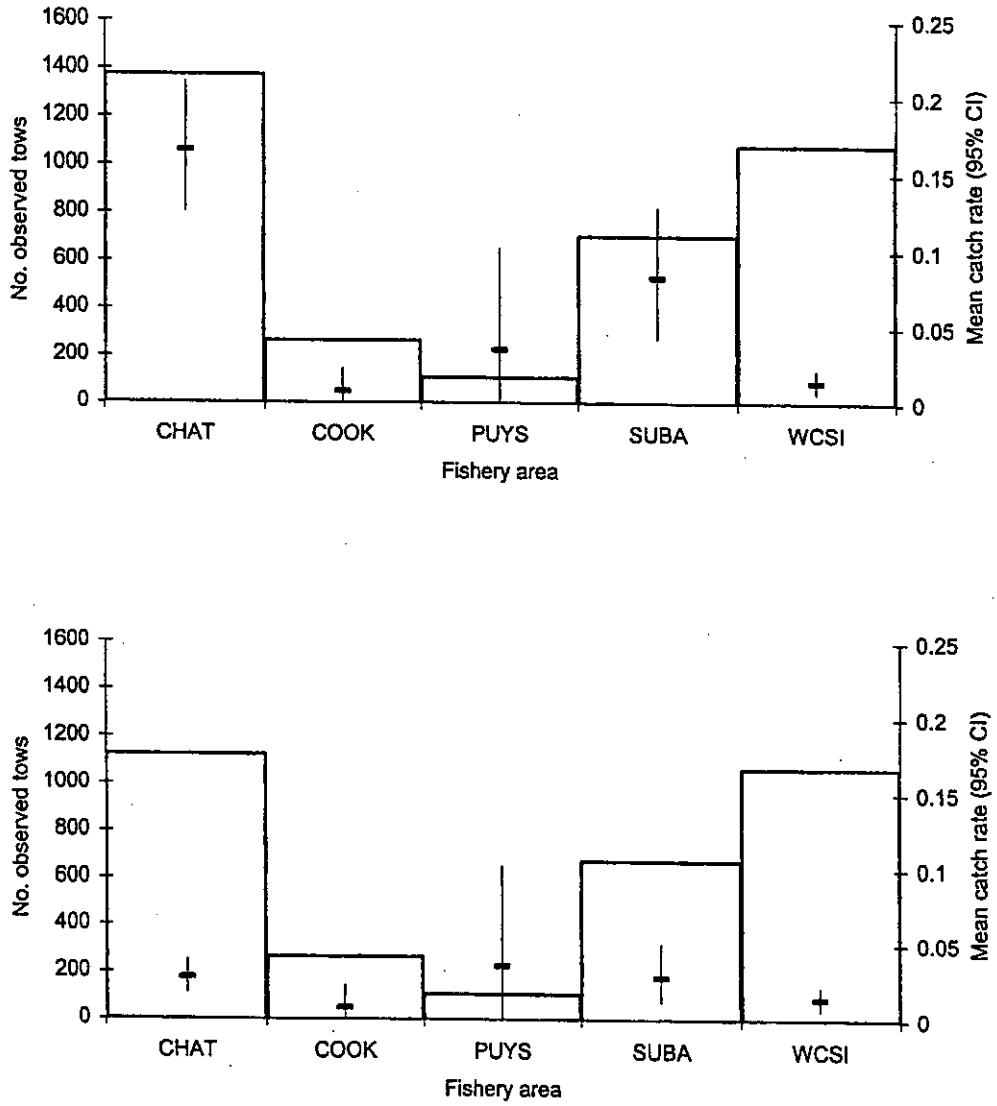


Figure H2: Comparison of observed effort (histogram) and mean seabird catch rates (± 95% confidence intervals) for all observed hoki vessels (top) and for all vessels except three Polish vessels (bottom).

APPENDIX H— *continued*

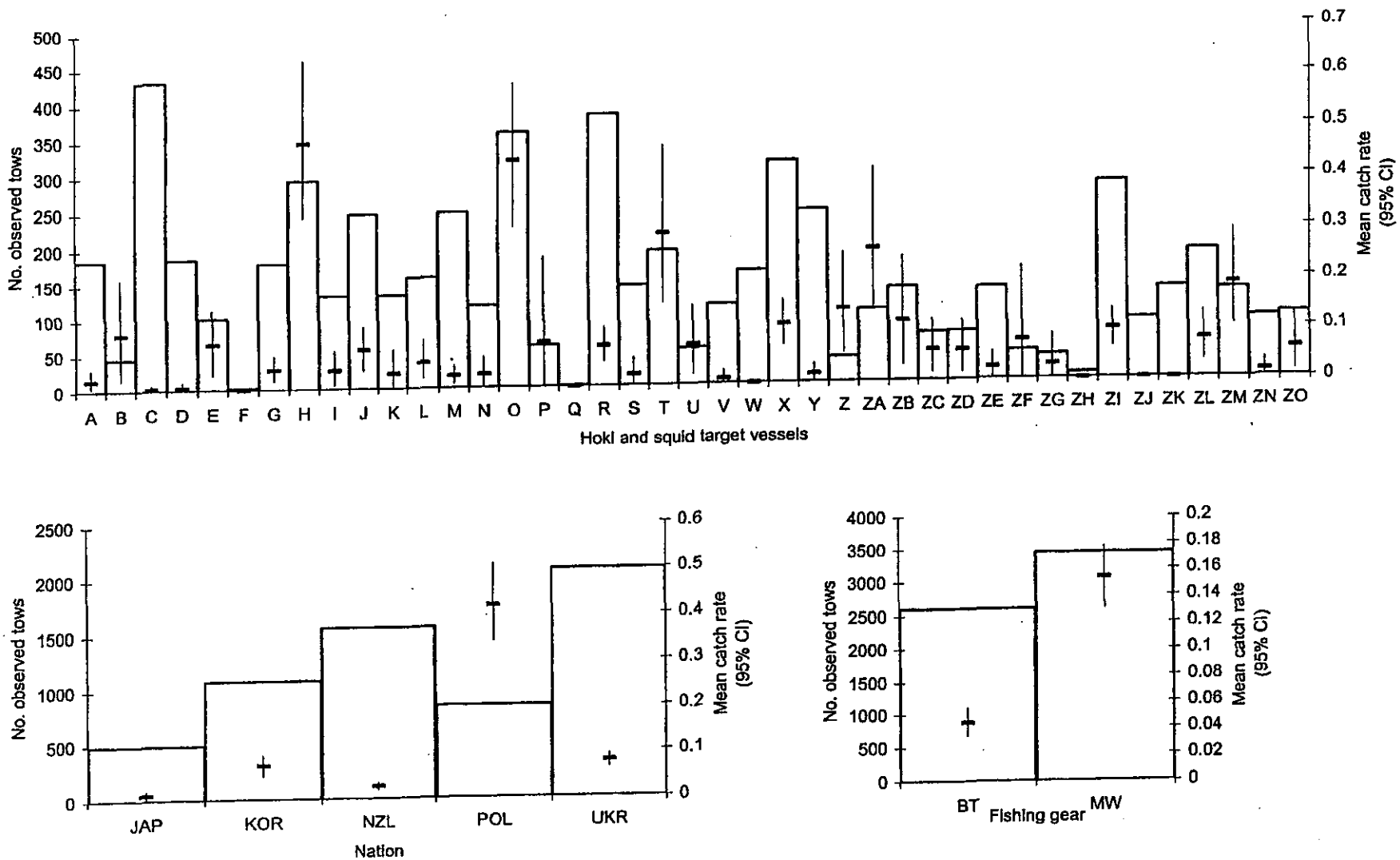


Figure H3: Observed effort (histogram) and mean seabird catch rates (± 95% confidence intervals) for all observed hoki and squid target trawlers (top), by nation (bottom left), and by fishing gear (bottom right).

APPENDIX I: SEABIRD SUMMARY INFORMATION

Table I1: Seabird taxa recorded for those seabirds returned from observed longline and trawl fishing operations, 1996–97 to 2000–01, by Fisheries Management Area (FMA)*.

FMA	Tuna longline fisheries	Demersal longline fisheries†	Trawl fisheries
Albatross taxa			
FMA 1	XCM		
FMA 2	XAN, XAU, XBM, XCI, XCM, XNR, XSA, XSM, XWA, XWM		XNB, XSA, XWM
FMA 3	XAN, XAU, XBM, XCM, XLM, XNR, XWA, XWM	XSA	XAN, XBM, XSA, XRA, XWM
FMA 4		XBM	XSM, XBM, XCM, XSA, XWM
FMA 5	XAU, XBM, XCM, XLM, XRA, XWM		XBM, XCM, XSA, XRA, XWM
FMA 6		XSA	XBM, XCM, XWM
FMA 7	XAU, XBM, XCM, XLM, XSM, XWM		XSM, XBM, XCM, XWM
Petrel taxa			
FMA 1	XBP, XFS, **XGF**	**XGP, XBS, XFS, XFL**	XFS, XSH
FMA 2	XNP, XBP, XGP, XWC, XFS	**XGP, XSH, XCP**	XFS, XSH
FMA 3	XGP, XWC	XWC	XGP, XSH, **XWC, XNP**
FMA 4		XWC	XNP, XGF, XWC, XSH, XPR, XCC, **XGP**
FMA 5	XGP, XWC	XWC	XWC, XFT, XSH, **XCC, XST**
FMA 6	XWC	XNP, XSP, XGP, XWC, XCC, XCP, XCA	XGP, XWC, XSH, XCP, XDP, **XCC**
FMA 7			XCP, XFP, **XCC**

* There were no seabirds returned from FMA 8, FMA 9 or FMA 10 (Figure A2). Species codes are given in Appendix D. Species in bold were first reported for that area and method in 2000–01.

† All petrels and shearwaters in FMA 1 were on snapper longlines and all those in FMA 2 were on bluenose longlines.

APPENDIX I— continued

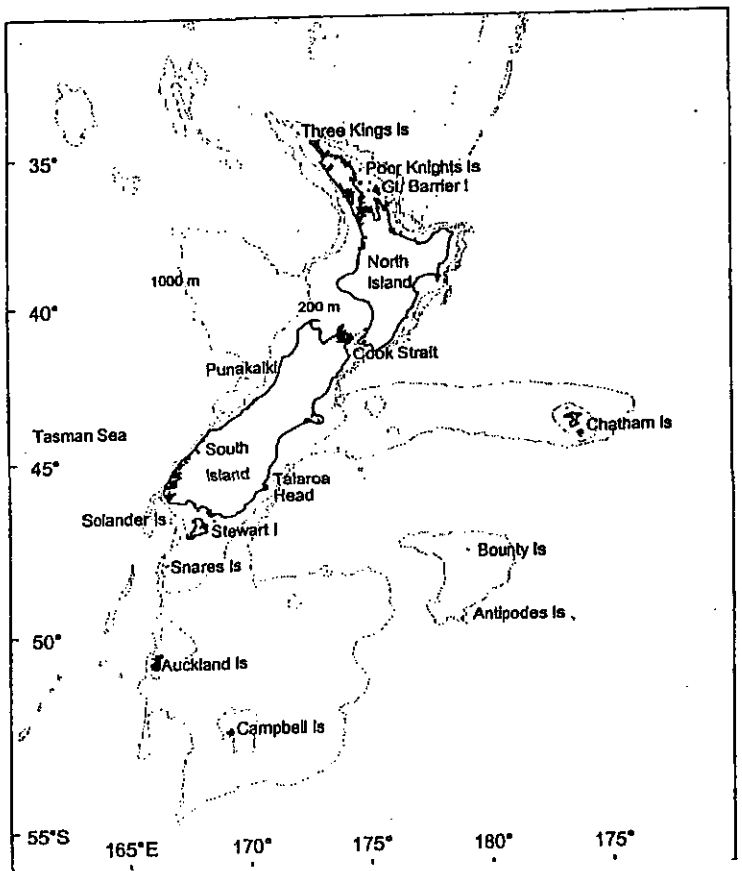


Figure I1: Breeding locations for seabird species that have been reported from observed commercial fishing operations, as presented in the associated table. [Adapted from Baird (2003)].

Breeding location	Seabird taxa
Three Kings Islands:	·Pacific albatross
	·grey-faced petrel, sooty shearwater
Poor Knights Islands	·Buller's shearwater
Little & Great Barrier Islands:	·Black petrel
North Island offshore (including Cook Strait):	·Fairy prions, flesh-footed shearwater, grey-faced petrel (north of 39° S), fluttering shearwater, sooty shearwater
Chathams Islands:	·Chatham, northern royal, Pacific, Salvin's?, and white-capped albatrosses
	·northern giant petrel, Snares cape pigeon, sooty shearwater
Bounty Islands:	·Salvin's albatross
Antipodes Islands:	·Antipodean, black-browed, light-mantled sooty, Salvin's, and white-capped albatrosses
	·black-bellied storm petrel, grey petrel, northern giant petrel, Snares cape pigeon, sooty shearwaters, white-chinned petrels
Campbell Island:	·Antipodean, black-browed, light-mantled sooty, and southern royal albatrosses
	·grey petrel, northern giant petrel, Snares cape pigeon, sooty shearwaters
Auckland Islands:	·Campbell, Gibson's, grey-headed, light-mantled sooty, northern royal, southern royal, and white-capped albatrosses
	·black-bellied storm petrel, northern giant petrel, Snares cape pigeon, sooty shearwaters, white-chinned petrels
Snares Islands:	·black-browed, Buller's, and Salvin's albatrosses
	·Snares cape pigeon
Solander Islands:	·Buller's albatross
South Island:	·northern royal and southern royal albatrosses (Taiaroa Head)
	·sooty shearwater (Stewart I.), Westland petrel (Punakaiki)

APPENDIX I— *continued*

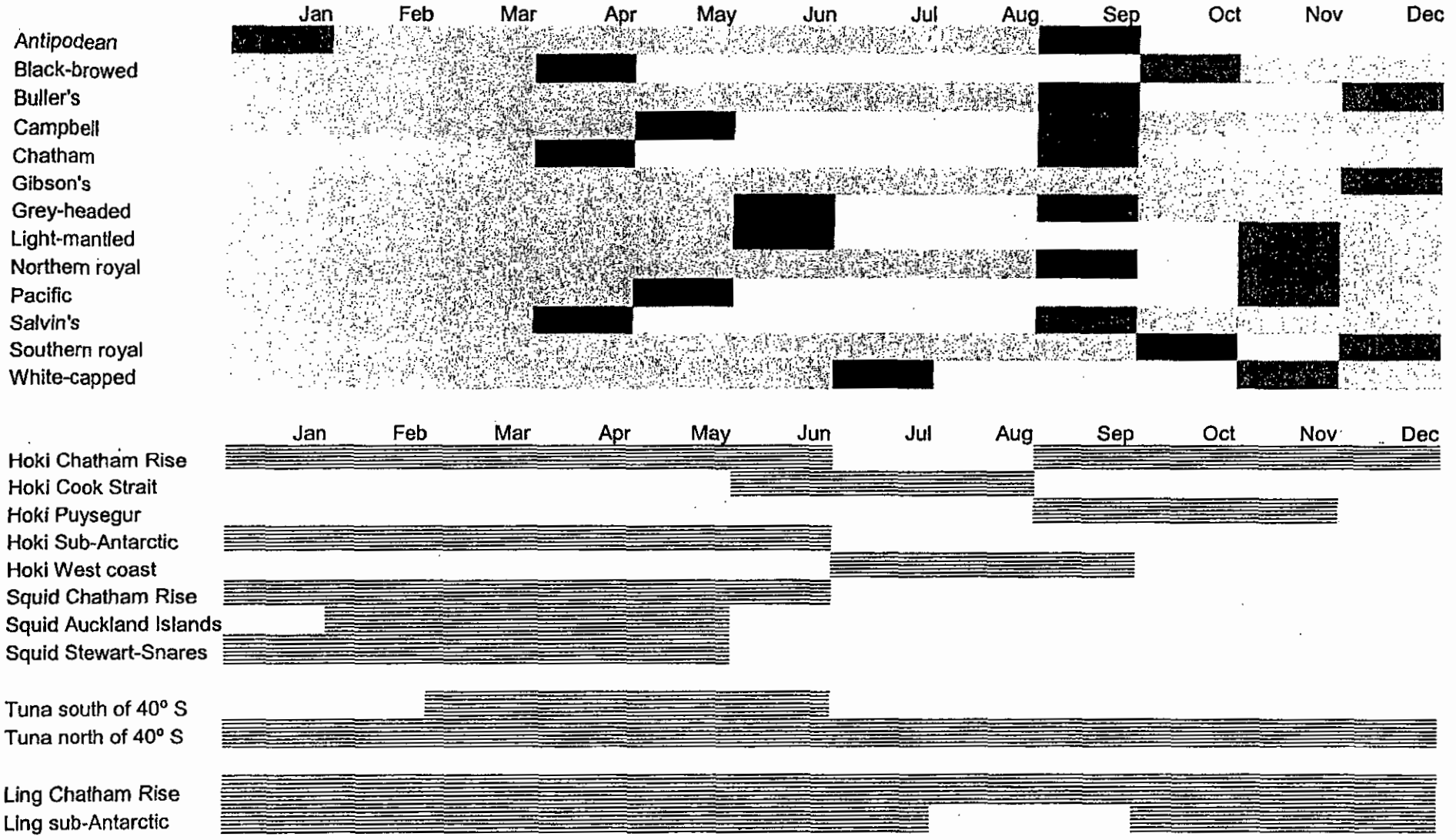


Figure I2: Temporal overlap of albatross breeding seasons and major commercial fisheries (hoki trawl, squid trawl, ling longline, and tuna longline) [from Baird (2003)].

APPENDIX I— *continued*

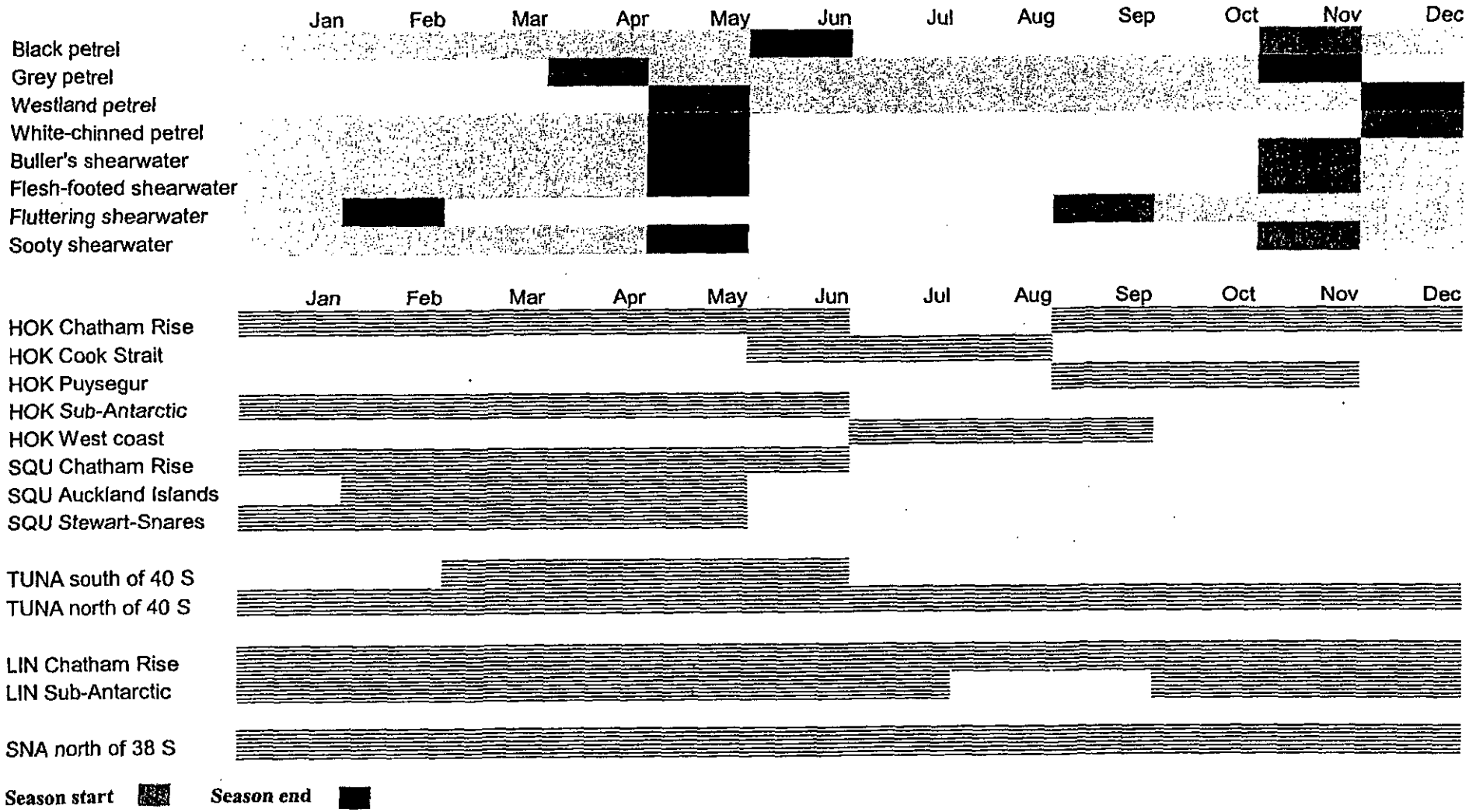


Figure I3: Temporal overlap of petrel and shearwater taxa breeding seasons and *major commercial* fisheries (hoki trawl, squid trawl, ling longline, snapper longline, and tuna *longline*) [adapted from Baird (2003)].