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Estimation of the incidental capture of seabird and marine mammal species in commercial fisheries in New Zealand waters, 1999–2000

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EXECUTIVE SUMMARY

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Mean catch rates and standard errors for observed captures of nonfish species in target fisheries during 1999–2000 were produced from Ministry of Fisheries scientific observer data. Total estimates and coefficients of variation were calculated only where there was confidence in the adequacy of the data.

Seabirds

Seabirds were observed caught in both trawl and longline operations in New Zealand waters in 1999–2000. The highest incident rates (numbers of seabirds per observed fishing operation) were from the longline fisheries: 44% of observed domestic tuna sets, 19% of observed ling sets in LIN6, and 10% of observed chartered Japanese longlines had seabird bycatch. In comparison, about 2–3% of observed hoki and squid trawls at Stewart-Snares shelf and about 5% of observed squid tows at SQU 6T had seabird bycatch.

A total of 181 seabird captures was observed during trawl fishing operations, and 84% of these seabirds were landed dead. A further 74 seabirds were observed caught in tuna (*Thunnus* spp.) longlining operations (42% landed dead), and 203 seabirds (94% dead) in ling (*Genypterus blacodes*) longline operations. The 235 seabirds observed caught and returned for identification represented 8 albatross and 10 petrel taxa. Two petrel species previously unrecorded as caught during observed fishing operations were represented in the catch during 1999–2000: diving petrel (*Pelecanoides urinatrix*) and fairy prion (*Pachyptila turtur*). About 25% of the seabirds returned for identification were grey petrels (*Procellaria cinerea*), 22% were white-capped albatrosses (*Thalassarche steadi*), 15% were white-chinned petrels (*Procellaria aequinoctialis*), 9% were Salvin's albatrosses (*T. salvini*), and 9% were sooty shearwaters (*Puffinus griseus*).

The distributions of some of the seabird taxa were delineated by the area fished, season fished, and/or type of gear used for each target fishery. Seabirds returned from the Chatham Rise showed the greatest species diversity. About 60% of seabirds returned from ling longlines in sub-Antarctic waters were grey petrels (*Procellaria cinerea*), 21% were white-chinned petrels (which were also caught on tuna longlines and during hoki (*Macruronus novaezelandiae*) trawls in the same area), and 14% were Salvin's albatrosses (also caught on hoki trawls). Most white-capped albatross and sooty shearwater returns were from hoki and squid trawl fisheries. Buller's albatrosses (*T. bulleri*) were mainly from the hoki trawl and tuna longline fisheries. All but one Antipodean albatross (*Diomedea antipodensis*) and all Gibson's albatrosses (*D. gibsoni*) were reported caught from tuna longline sets.

The number of hooks observed on domestic tuna vessels was low and the spatial and temporal coverage of vessels was unrepresentative of the fleet. Less than 1% of the 7.2 million hooks were observed. Mean seabird bycatch rates for ling longline fisheries are based on the assumption that all the hooks recorded by the observers were observed. The results suggest that ling longline fisheries have higher seabird bycatch rates than trawl fisheries in similar areas.

Mean seabird bycatch rates for fisheries with adequate data were highest in the chartered Japanese tuna fishery off the eastern coasts of New Zealand, but the effort here represented about 14% of the total effort by these vessels. A mean of 0.033 seabirds per 1000 hooks (s.e. = 0.003) was calculated for the area off the west coast of the South Island where 84% of the chartered Japanese fishing effort took place. A total of 45 seabirds was observed and estimated caught by these vessels; 65% of the seabirds were landed dead.

Highest mean seabird bycatch rates during observed trawl fishing operations were from the squid fishery around the Auckland Islands (0.068 seabirds per tow, s.e. = 0.016). Seabird bycatch rates for the hoki fishery off the Stewart-Snares shelf (0.033 seabirds per tow, s.e. = 0.006) were lower than in 1998–99, but were similar to those for the observed squid vessels in the same area in 1999–2000 (0.057 seabirds per tow, s.e. = 0.020). A substantially lower rate was observed for the west coast South Island hoki fishery (0.009 seabirds per tow, s.e. = 0.004).

Summaries of seabird bycatch data from trawl fisheries are given by target fishery. An estimated 69 seabirds (c.v. = 41%) were caught during west coast South Island hoki trawls, 209 seabirds (c.v. = 19%) during sub-Antarctic hoki tows, 82 seabirds (c.v. = 19%) during SQU 6T squid (*Nototodarus* spp.) tows, and 93 seabirds (c.v. = 34%) during squid trawls at the Stewart-Snares shelf. Of the seabirds returned from these southern areas, most were white-capped albatrosses, Buller's albatrosses, and sooty shearwaters.

Hooker's (New Zealand) sea lions

An estimated 70 Hooker's sea lions (*Phocarctos hookeri*) (c.v. = 17%) were caught during the January to March 2000 squid fishery around the Auckland Islands in SQU 6T. Thirty-six percent of the 1206 tows were observed and the observed capture of 25 sea lions resulted in a mean bycatch rate of 0.059 sea lions per tow (s.e. = 0.01). All observed sea lions were landed dead.

Three Hooker's sea lions were also observed caught during hoki (one released alive) and jack mackerel tows (two landed dead) and one was released alive from a tuna longline.

New Zealand fur seals

Observers recorded 203 New Zealand fur seal (*Arctocephalus forsteri*) captures during trawl fishing operations in 1999–2000. About 50% of fur seal captures were in hoki trawls, and 42% were from southern blue whiting (*Micromesistius australis*) tows. These fisheries accounted for most of the multiple captures per tow. About 6% of observed trawls in the west coast South Island hoki fishery had fur seal bycatch, and 75% of observed southern blue whiting tows at Bounty Platform had fur seal bycatch. Best estimates for the hoki fisheries are for the west coast South Island and the sub-Antarctic fisheries. The total estimate for the west coast South Island hoki fishery was 561 New Zealand fur seals (c.v. = 13%), based on a mean bycatch rate of 0.073 fur seals per tow (s.e. = 0.009). This mean bycatch rate was substantially higher than that recorded for the sub-Antarctic fishery (0.011 fur seals per tow, s.e. = 0.003) which gave a total estimate of 70 fur seals (c.v. = 25%). About 90% of the fur seals observed caught in these fisheries were landed dead.

The total estimate of fur seals caught (and landed dead) during the August to September 2000 southern blue whiting fishery was 277 (c.v. = 24%), with 89% of these from around the Bounty Platform. Mean bycatch rates at the Bounty Platform were substantially higher than in any other observed fishery at 2.5 fur seals per tow (s.e. = 0.658). About 50% of the observed tows here caught more than one fur seal.
An estimated 46 New Zealand fur seals (c.v. = 28%) were caught during the 1999–2000 squid trawl fishery at the Stewart-Snares shelf. About 90% of fur seals observed caught in this fishery were landed dead. Lesser captures were observed in jack mackerel (*Trachurus* spp.) tows. Of the 49 fur seals observed caught on tuna longlines, 46 were released alive. One fur seal was caught and released alive from a ling longline.

Other species

Two separate incidents during observed jack mackerel tows in October 1999 resulted in the observed captures of one bottlenose dolphin and three pilot whales in October 1999 in JMA 7 at 40° S off the west coast of the North Island. All animals were landed dead.

1. INTRODUCTION

Statutory obligations require the Ministry of Fisheries (MFish) to monitor the bycatch of associated or dependent species during commercial fishing operations in New Zealand waters (Anon. 2000a). The Ministry of Fisheries Scientific Observer Programme collects data on the incidental catch of the nonfish species as part of its monitoring programme. To date, these nonfish species have included albatross and petrel taxa, marine mammals, including New Zealand fur seals (*Arctocephalus forsteri*), Hooker's (New Zealand) sea lions (*Phocarctos hookeri*), and cetaceans, and marine reptiles.

Seabird captures have been reported from observed longline fishing activities, particularly those that target tuna species (*Thunnus* spp.) and ling (*Genypterus blacodes*) (Baird & Bradford 2000a, Baird 2001a). Most seabirds are caught during longline setting in the brief time before the baited hook sinks beyond the birds' reach. Once a hook has been swallowed or the bird has been entangled, it is pulled under water by the sinking longline and drowned. Seabirds captured on the haul are usually released alive, though the survival rate of these seabirds is unknown. Declines in populations of some seabirds, especially albatross species, have been shown to be directly attributable to some fisheries that use surface or bottom longlines (Weimerskirch & Jouventin 1987, Weimerskirch et al. 1997). In New Zealand waters, the interaction between tuna longlines and seabirds has been measured each year since the introduction of the Ministry of Fisheries Scientific Observer Programme in 1986 (Murray et al. 1993, Baird 1994).

Concern about the continued bycatch of seabird species, especially those considered vulnerable or endangered, on tuna longlines has resulted in the introduction of various measures in an attempt to mitigate the bird bycatch during tuna longline fishing operations in New Zealand waters. These include the use of tori lines and nightsetting (Murray et al. 1993). Some fishers use other methods, such as bait casting machines and weighted hooks and lines, to increase the sinking rate of the line. Various other measures such as deck hoses, painted balloons, and tori poles with streamers are used during the haul to scare away the birds. The chartered Japanese vessels follow a voluntary code of practice based on a limit on the capture of "at risk" seabirds (Anon. 2000a). Other mitigation methods under investigation include underwater setting devices and the use of dyed bait (Baird 2001b). Variables such as the area fished, moon phase, and sea surface temperature were found to influence the catch rates of seabirds on tuna longlines (Baird & Bradford 2000a). Further regulatory measures are being evaluated for use under the draft National Plan of Action (Anon. 2000a), and these measures will be extended to suit other longline fisheries, as well as trawl fisheries.

In recent years, more effort has been put into attempting to quantify the catch of seabirds during trawling operations. It is likely that the estimates of seabird bycatch in trawl fisheries are underestimates, because of the way the birds are caught. Anecdotal evidence suggests seabirds may hit the trawl warps, for example, and be pulled under the water out of sight. Seabirds have been observed caught in many target trawl fisheries, especially the hoki (*Macruronus novaezealandiae*) fishery on the Chatham Rise and the hoki and squid (*Nototodarus* spp.) fisheries off the Stewart-Snares shelf (Baird 2001a).

Proximity of the southern squid trawl fishery to the breeding grounds of the Hooker's sea lion has resulted in the incidental catch of these marine mammals. A 12 n. mile exclusion zone is defined around the Auckland Islands, and, because of the vulnerable nature of the sea lion population (Gales & Fletcher 1999), the in-season capture of sea lions during the February to June fishery is monitored (Doonan 2000). The squid fishery is closed if the total number of sea lion captures in squid trawls exceeds the level of allowable take set before each squid season. In recent squid fishing seasons, sea lion exclusion devices have been used in the trawl nets as part of at-sea trials to test the effectiveness of the device in ejecting live sea lions without compromising the squid catch.

New Zealand fur seals are distributed around the New Zealand coastline, on offshore islands, and on sub-Antarctic islands. Recent fur seal population estimates are available only for a few discrete populations. Fur seals have been reported caught from trawl operations primarily off the west coast of the South Island, the Stewart-Snares shelf, and at the Bounty Platform (Baird 2001a). A code of practice was developed by the fishing industry in 1990. The most recent code used by hoki and southern blue whiting (*Micromesistius australis*) vessels aims to minimise marine mammal captures, collect data as a basis for further research on potential mitigation measures, ensure all vessels follow agreed practices, and maximise compliance with New Zealand laws in relation to captures of marine mammals (R. Cade, Hoki Fishery Management Company, pers. comm.). In some fisheries, marine mammal exclusion devices are under evaluation as a tool to mitigate against fur seal bycatch.

The origin of fur seals caught incidentally by trawlers is not known, and neither is the impact on the fur seal populations. Data suggest most fur seal breeding populations are either increasing or remaining stable (Baird & Bradford 2000b). However, the estimated numbers of fur seal pups at the main rookeries on the west coast of the South Island in late January-early February 1999 and 2000 showed an average decline of more than 50% when compared with the average estimate of pup numbers for 1992–98 (H. Best, Department of Conservation, unpublished data). Best (pers. comm.) noted that these low numbers coincided with a period of strong La Niña conditions when fur seals may have had difficulty in obtaining their preferred fish species. Best considers that this climatic effect also impacted on the pup numbers estimated for late January-early February 2001; these numbers were higher than in the previous two years, but were still lower than the 1992–98 average. Overall, Best (pers. comm.) concluded that the main rookeries off the west coast of the South Island are either stable, with periodic fluctuations, or declining. Fur seal numbers at other rookeries have been increasing, for example, in the Nelson-Marlborough area (Taylor et al. 1995), in Otago (Lalas & Harcourt 1995, Lalas & Murphy 1998), and at the Bounty Islands (Taylor 1996).

This report addresses Specific Objective 1 of ENV2000/01 "to estimate the total numbers of captures, releases, and deaths of seabirds and marine mammals — by species — caught in fishing operations during the 1999/2000 fishing year".

2. METHODS

2.1 Data sources and treatment

Data used for the analyses undertaken to estimate the total numbers caught included: observed nonfish species 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 Return forms (TLCER).

Data were extracted for the target fisheries in which incidental captures of nonfish species were recorded by MFish scientific observers during the fishing year (1 October–30 September) 1999–2000:

- Seabirds in trawl fisheries and longline fisheries for tuna and ling
- Hooker's sea lions in the southern squid trawl fishery in SQU 6T and in trawl and tuna longline fisheries at the Stewart-Snares shelf
- New Zealand fur seals in trawl fisheries and longline fisheries for tuna and ling
- Cetaceans in jack mackerel fisheries off the west coast of New Zealand and in longline fisheries for tuna off the Stewart-Snares shelf

The following observer data were extracted by target species for each fishing operation: gear type, latitude and longitude, date, nonfish species, life status (alive or dead), handling code (released, discarded, or retained), and sex, as recorded by MFish scientific observers. The following total fishing effort data for each fishing operation were extracted: target species, gear type, latitude and longitude, and date.

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.

2.2 Seabird-fishery interactions data

Where seabirds were landed dead, observers returned the seabirds to the Department of Conservation (DoC) for autopsy. The species identification of these seabirds was carried out under a Conservation Services Levy project, and the resulting data (as described in Robertson & Bell 2002) were used to update the MFish observer databases.

2.2.1 Tuna longline fisheries

Tuna species targeted by use of surface longlines in New Zealand waters in 1999–2000 included southern bluefin (*Thunnus maccoyii*), bigeye (*T. obesus*), albacore (*T. alalunga*), yellowfin (*T. albacares*), and Pacific (previously "northern") bluefin (*T. orientalis*) tunas. All data were extracted by position (latitude and longitude) at the start of each longline set for the 1 October 1999 to 30 September 2000 fishing year. Each set was then allocated to one of 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 further stratified by fleet (chartered Japanese vessels or domestic owned and operated vessels) because of the different fishing practices used by the two fleets (Murray et al. 1999).

For the tuna longline interaction analyses, total effort data were extracted from the Tuna Longline Catch Effort Returns (TLCER) in April 2000. The chartered Japanese vessels complete these TLCER forms, whereas domestic owned and operated vessels complete TLCERs or Catch Effort Landing Returns (CELR). The quality and completeness of the CELR data had yet to be determined and so the data presented here are limited to that from TLCERs. This is not considered a problem because preliminary extracts from the 1999–2000 CELR data suggest that CELR data represented about 3% of the total hook data from domestic owned and operated vessels. Data were groomed according to routine procedures and the following amendments were made.

- For the commercial data, where latitude and longitude values were invalid, data from sets made before and after those without position data were used to assign appropriate latitude and longitude values.
- Where records for some attributes within a set were missing from the commercial dataset, such as number of hooks set or position data, and the fishing operation was observed, the observed records were used to complete the commercial data.

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. This resulted in slightly higher numbers of hooks observed than recorded as set in some strata. This suggests that the total number of hooks set (derived from the commercial data) may underestimate the total effort because fishers may fail to fill in the appropriate catch forms.

2.2.2 Bottom longline fisheries

Bottom longline fisheries for ling operated in 1999–2000 and resulted in the observed incidental capture of seabirds. All ling data were extracted and stratified by the given statistical area into the ling Quota Management Areas (QMAs). The CELR fishing effort data were full of errors and inconsistencies and were groomed where possible. There are some doubts about the accuracy of the number of hooks set because of inconsistencies in the number of sets recorded and the number of hooks for each record. Where the statistical area boundaries were inconsistent with the ling QMAs, the effort was assigned to the closest QMA.

2.2.3 Trawl fisheries

Seabird data from trawl fisheries were investigated by target fishery QMAs as defined by Annala et al. (2001), or as in the hoki-marine mammal interaction, by the specific hoki fishery areas within HOK 1 (see 2.3 below). Data for the squid fishery at SQU 6T were also analysed by sub-areas separated at 50° 20' S.

2.3 Marine mammal interactions with trawl fisheries

Data for the marine mammal-fishery interactions were stratified by QMA. Position data (latitude and longitude) at the start of the fishing operation were used to determine the key areas for each nonfish species 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 marine mammal (or seabird) captures in the southern squid trawl fisheries were the Auckland Islands part of SQU 6T and the Stewart-Snares shelf. Data for SQU 6T were also analysed by sub-areas separated at 50° 20' S.

2.4 Data analysis

The extracted observer data were stratified by target fishery, gear type (where appropriate), area, and month for each nonfish species. Data were pooled across months in some nonfish species-fishery interactions to provide a total estimate for the 1999–2000 fishing year. Bycatch rates (the number of seabirds or marine mammals observed caught per tow or 1000 hooks) were calculated for each fishing operation. The mean bycatch rate was calculated for each stratum and the standard error of the mean was estimated by a bootstrap procedure that resampled the bycatch rates for each fishing operation 1000 times (Efron & Tibshirani 1993).

The mean bycatch rate for each fishery-area or fleet-area stratum was then scaled by the total commercial fishing effort in that stratum to provide a total estimate (B_T) of the nonfish species caught, where enough fishing operations were observed to obtain a meaningful result. Therefore,

$$B_T = \bar{x} H_T$$

where H_T is the total number of hooks set (or tows made) in any month (or the fishing year) in each fishery-area or fleet-area stratum and $\bar{x}$ is the mean bycatch rate, with the variance given by

$$s^2 = (S.E.\sqrt{1-\frac{n}{N}})^2 H_T^2$$

where n is the observed number of sets (or tows) and N is the total number of sets (or tows) for a fishery or fleet and *S.E.* is the standard error derived from the bootstrap procedure.

The standard deviation (s) is then used to calculate the coefficient of variation (*c.v.*) of the total estimate:

$$c.v. = \frac{s}{B_T} \text{ x } 100$$

For the total number of bycatch species 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

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

If the sampling fraction (of observed effort over total effort) is low (for example, less than 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. If the number of observed fishing operations is low, the bootstrap method used may be unreliable. Furthermore, if vessels show different marine mammal or seabird bycatch rates (and in some fisheries, some vessels have very high bycatch rates relative to others) then, where there are many vessels operating, the observer coverage needs to include several vessels — ideally, in a representative way.

The spread of observer and total effort data, by area, number of fishing operations, and number of vessels was investigated. Total estimates and c.v.s were calculated only where there was confidence in the use of the bootstrap method. Therefore, for some nonfish species-fishery interactions, it was not appropriate to estimate the total numbers of animals caught, or to define the total numbers of marine mammals or seabirds landed dead or alive.

Total estimates are given for those fisheries for which at least 10% of all fishing operations within a stratum are observed. Where at least 10 animals are reported caught in any one fishery-area stratum in a fishing year, the percentages of observed animals in those categories are applied to the annual estimates to give an approximation of the numbers landed dead or released alive.

3. SEABIRD BYCATCH

Ministry of Fisheries scientific observers reported 74 seabird captures (42% dead) during tuna longline fisheries in 1999–2000 and 203 seabird captures (94% dead) during ling longline operations. A further 181 seabirds were observed caught (84% dead) during trawl fishery operations (Table 1).

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 (Figure 1, see Appendix A for place names). Those observed caught in the tuna longline fishery were primarily off the west and east coasts of the South Island, off the Stewart-Snares shelf, the Bay of Plenty, and south of East Cape. Those caught during observed ling longline fishing were from the Chatham Rise, northeast of Auckland Islands Shelf, and off the southern coast of the South Island.

The seabirds observed caught and returned for identification represented 8 albatross taxa and 10 petrel taxa (Table 2). Two petrel species previously unrecorded as caught during observed fishing operations were represented in the catch during 1999–2000: diving petrel (*Pelecanoides urinatrix*) (XDP) and fairy prion (*Pachyptila turtur*) (XFP). About 25% of the 235 seabirds returned for identification were grey petrels (*Procellaria cinerea*) (XGP), 22% were white-capped albatrosses (*Thalassarche steadi*) (XWM), 15% were white-chinned petrels (*Procellaria aequinoctialis*) (XWC), 9% were Salvin's albatrosses (*T. salvini*) (XSA), and 9% were sooty shearwaters (*Puffinus griseus*) (XSH).

Different seabird species dominated the returned seabird catch from different fisheries. Four petrel species and one albatross species were represented in the observed seabirds returned from ling longline sets (Table 2). About 60% of these seabirds were grey petrels, 21% were white-chinned petrels (which were also caught on tuna longlines and during hoki trawls), and 14% were Salvin's albatrosses (also caught on hoki trawls). Most white-capped albatross and sooty shearwater returns were from trawl fisheries (especially hoki and squid). Buller's albatrosses (*T. bulleri*) were mainly from the hoki trawl and tuna longline fisheries. All but one Antipodean albatross (*Diomedea antipodensis*) and all Gibson's albatrosses (*D. gibsoni*) were reported caught from tuna longline sets.

Table 1: Numbers of seabirds observed caught in New Zealand trawl fisheries, 1999–2000.

		No. seabirds	
Target fishery		Total	% dead
Barracouta	*Thyrsites atun*	4	50
Black oreo	*Allocytus niger*	1	0
Common warehou	*Seriolella brama*	1	0
Hake	*Merluccius australis*	2	50
Hoki	*Macruronus novaezelandiae*	94	88
Jack mackerels	*Trachurus* spp.	7	57
Oreo	species unspecified	1	100
Orange roughy	*Hoplostethus atlanticus*	5	60
Scampi	*Metanephrops challengeri*	8	100
Silver warehou	*Seriolella punctata*	1	100
Smooth oreo	*Pseudocyttus maculatus*	1	100
Southern blue whiting	*Micromesistius australis*	2	100
Squid	*Nototodarus* spp.	53	87
White warehou	*Seriolella caerulea*	1	100
Total		181	84

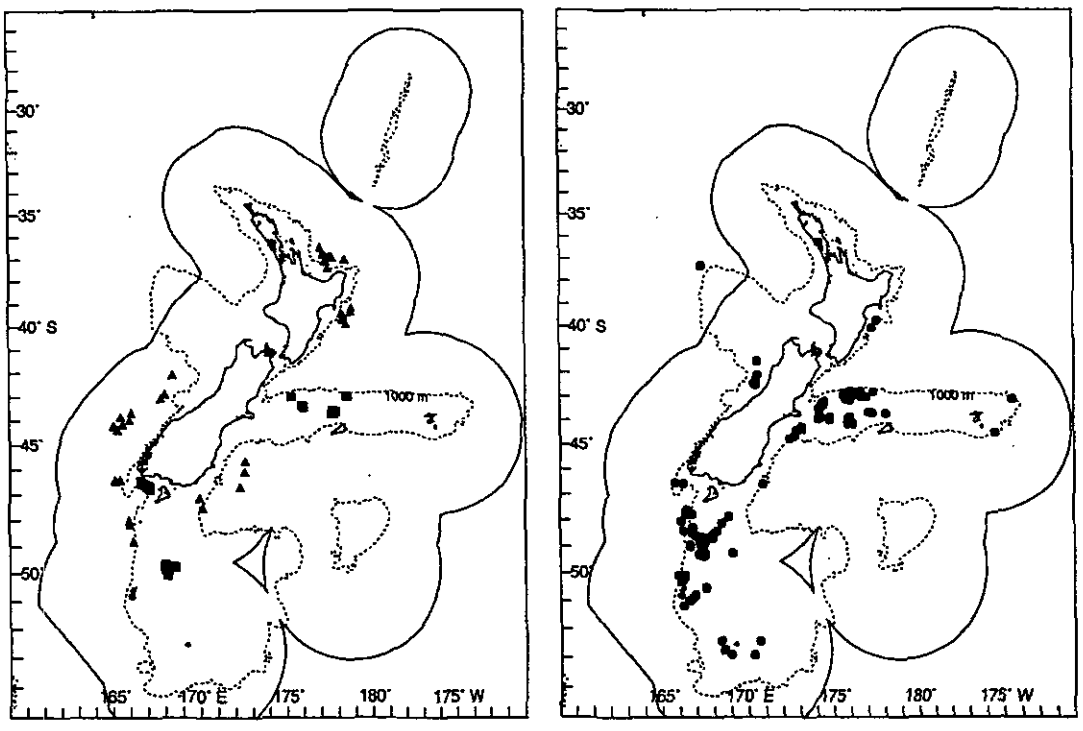

Figure 1: Start positions of tuna longline sets (▲), and ling longline sets (■), and trawl operations (●) during which seabirds were observed caught, 1999–2000.

The distribution of the seabird captures is related to where the observed fishing activity was and the return of dead seabirds for identification. Seabird captures observed in waters north of 40° S were all from tuna longline fishing operations, and some of these seabirds represented species that were recorded in northern waters only: Gibson's albatross, black petrel (*Procellaria parkinsoni*), and flesh-footed shearwaters (*Puffinus carneipes*). Captures of white-capped albatrosses were all south of 42° S and were mainly observed at the Stewart-Snares shelf and Auckland Islands Shelf. Most of the observed captures of Buller's and Salvin's albatrosses were recorded from waters south of 42° S, with most from around the Bounty Platform (Appendix C). Albatross taxa reported from both northern and southern waters include Antipodean, Buller's, Campbell (*Thalassarche impavida*), and black-browed albatrosses (*T. melanophrys*). Southern royal albatrosses (*D. epomophora*) were observed caught in waters south of 42° S only.

Observed captures of most petrel species were generally distributed in waters south of 42° S, though there were localised distributions for some species. Most grey petrels were observed caught northeast of the Auckland Islands Shelf, and sooty shearwaters were caught mainly on the Stewart-Snares shelf and the Auckland Islands Shelf. Overall, the greatest diversity of seabird species was found off the east coast of New Zealand. The species represented by the bycatch off the west coast of New Zealand comprised white-capped and Buller's albatrosses and fairy prions.

Table 2: Numbers of seabird taxa* identified from seabirds landed dead and returned for identification, in New Zealand commercial fisheries, 1999–2000.

Seabird code*	Trawl fisheries*										Longline fisheries*		Total	% Total
	BAR	HAK	HOK	JMA	SBW	SCI	SQU	SSO	SWA	WWA	LIN	Tuna†		
XAN							1					3	4	2
XAU												4	4	2
XRA			1									1	2	1
XBM			13									4	17	7
XCM			1									1	2	1
XSM			1									1	2	1
XKM			1										1	< 1
XSA			6	1		1			1		13		22	9
XWM	1	1	14	1		1	26	1		1		5	51	22
XNP			2										2	1
XSP											4		4	2
XGP			1		2						55	1	59	25
XWC			2				7				19	7	35	15
XBP												1	1	<1
XFS						1						1	2	1
XSH			16	1			5						22	9
XDP							1						1	<1
XCC			1								1		2	1
XFP			2										2	1
Total	1	1	61	3	2	3	40	1	1	1	92	29	235	

* Seabird identification data are from Robertson & Bell (2002). Seabird and fishery codes are defined in Appendix B.
† Tuna species include southern bluefin tuna (*Thunnus thunnus*) and bigeye tuna (*T. obesus*).

3.1 Seabirds in the tuna longline fisheries

The tuna longline fishery in New Zealand waters in 1999–2000 comprised domestic owned and operated New Zealand vessels and chartered Japanese vessels. Because of the differences in the fishing strategies of these vessels (Murray et al. 1999), the data for these two vessel types will be treated separately.

3.1.1 Japanese vessels

Four chartered Japanese tuna longline vessels fished in New Zealand waters in the 1999–2000 fishing year. These vessels set a total of 269 longlines (0.8 million hooks), primarily off the west coast of the South Island, with the remainder of the effort south and east of the South Island and off East Cape and in waters north of 35° S (Figure 2). Vessels fishing south of 40° S targeted southern bluefin tuna during April-July and those fishing further north targeted bigeye tuna during late June-July. The average Japanese longline comprised 3250 hooks.

A Ministry of Fisheries observer was placed on each vessel. On one vessel the observer was charged primarily with carrying out an experiment to test the sink rate of the hooks. This trial was undertaken in Area 3 and involved 30 sets, and therefore there are no seabird bycatch data for these sets. All but one of the remaining 26 sets were observed, though intermittently (with between 26 and 90% of hooks observed in each set (median of 55%)), resulting in 24% of hooks for the trip being observed. The data for the remaining 25 sets are included in the analysis. Observer coverage of the hooks on the other vessels ranged from 98.6% to 100%. All hooks set in Areas 1, 2, and 4 were observed (Table 3), and 99.4% of those in Area 3 excluding the one vessel mentioned above were observed.

Forty seabirds were reported caught from these four vessels (Table 3). The vessel which set the most hooks (29% of the total hooks set) caught 58% of the reported seabird bycatch, with about 50% of these seabirds caught when the vessel was fishing in Area 2 during April and 50% in Area 1 during June. The remaining 18 seabirds were reported caught from Area 3 during April-June, and one vessel caught 14 of them. If the unobserved hooks in Area 3 are included, the mean seabird bycatch rate for this area is 0.033 (s.e. = 0.003), which gives an estimate of 23 birds (c.v. = 9%) for Area 3.

Seabirds were observed caught on about 10% of all observed sets (Table 4). Sixty-five percent of the observed seabirds were landed dead, and these included all those reported from Areas 1 and 2, and 4 of those reported from Area 3. The remaining 14 were released alive. The identification of those seabirds released alive is not known.

Table 3: Fishing effort, observed effort, and seabird bycatch for chartered Japanese tuna longline vessels in Areas 1–4, 1999–2000.

Area	Total no. vessels	% vessels observed	Total no. hooks (10^3)	% hooks observed	No. birds observed caught	Mean bycatch rate (per 10^3 hooks)
Area 1	2	100	47.00	100	11	0.203
Area 2	2	100	64.85	100	11	0.162
Area 3	4	100	690.04	80	18	0.033
Area 4	1	100	22.5	100	0	0.000
All	4	100	824.39	83	40	0.056

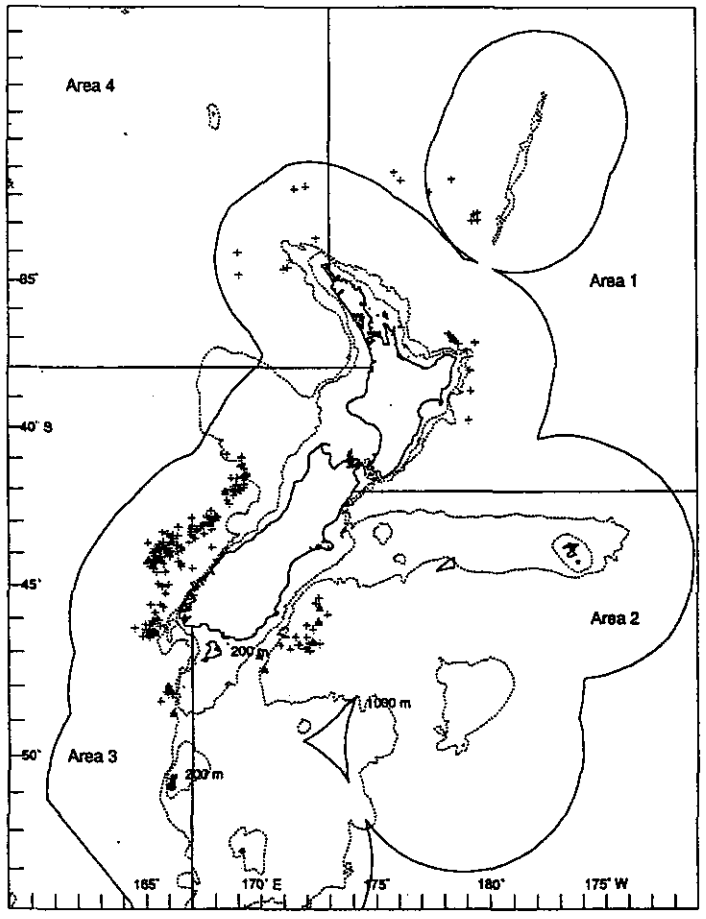

Figure 2: Start positions of all sets (+), including those with seabird bycatch (▲), for chartered Japanese vessels, 1999–2000.

Of the 26 seabirds landed dead from chartered Japanese longlines in 1999–2000, 11 swallowed the hooks, 6 were caught in the bill/mouth, 6 were tangled, and the method of capture for the remainder was unknown. The 14 seabirds that were released alive were generally either hooked in the bill or tangled.

Those landed dead were returned for autopsy and comprised 6 albatross species and 2 petrel species (Table 5). Area 1 accounted for the greatest number of species: Antipodean albatross, Gibson's albatross, black-browed albatross, Buller's albatross, and grey petrel. The seabird species represented in the Area 2 bycatch included southern royal albatross, Buller's albatross, white-capped albatross, and white-chinned petrel. Further Buller's and white-capped albatrosses were reported caught in Area 3. Both sexes of most species were reported caught, though more female Antipodean and Gibson's albatrosses were caught than male and there were more male than female white-chinned petrels (Robertson & Bell 2002). Buller's albatrosses were caught in three areas, and, as in previous years (Baird 2001a), there were no reported seabird captures from Area 4.

The weekly fishing effort is shown in Figure D1 in Appendix D. During the first 3 weeks of the fishery, where Week 1 starts on 1 April 2000, the effort is in Areas 2 and 3 and 11 of the 12 seabird captures during this time were from Area 2. All the effort in Weeks 4–9 inclusive is in Area 3 and 13 seabirds were reported during these weeks (22 April to 2 June). Observed effort during Weeks 10–14 (early June to early July) was mainly in Area 3, but also occurred in Areas 1 and 4. Most seabird captures at this time were from Area 1.

Table 4: Frequency of observed seabird captures per observed chartered Japanese longline set, by Areas 1–4, 1999–2000.

No. birds per set	Area 1	Area 2	Area 3	Area 4	Total
0	15	16	176	8	215
1	0	2	14	0	16
2	0	1	2	0	3
3	0	1	0	0	1
4	1	1	0	0	2
7	1	0	0	0	1
Observed birds	11	11	18	0	40
Observed sets	17	21	192	8	238

Table 5: Seabird species observed caught on chartered tuna longlines during 1999–2000*.

Common name	Scientific name	Area†	No. males	No. females	Total
Albatross species					
Antipodean	*Diomedea antipodensis*	1	1	2	3
Gibson's	*Diomedea gibsoni*	1	1	3	4
Southern royal	*Diomedea epomophora*	2	1	0	1
Black-browed	*Thalassarche melanophrys*	1	0	1	1
Buller's	*Thalassarche bulleri*	1	1	1	2
		2	1	0	1
		3	0	1	1
White-capped	*Thalassarche steadi*	2	1	1	2
		3	0	3	3
Petrel species					
Grey petrel	*Procellaria cinerea*	1	0	1	1
White-chinned	*Procellaria aequinoctialis*	2	5	2	7

* Species identification data are from Robertson & Bell (2002).
† See Figure 2 for areas.

3.1.2 Domestic-owned and operated vessels

About 100 domestic-owned and operated tuna longline vessels fished in 1999–2000 (TLCER data). Of these, 99 fished in Area 1, 2 in Area 2, 13 in Area 3, and 61 in Area 4. Over 7.2 million hooks were set, 81% of which were in Area 1 and 15% in Area 4 (Figure 3). Vessels in Area 1 and Area 4 fished throughout the year (Figure D2 in Appendix D) for albacore, bigeye, southern bluefin, and yellowfin tunas, and those in Area 2 and Area 3 fished mainly during March-May for southern bluefin tuna. Vessels that fished in the two northern areas averaged about 1100 hooks per set, whereas those in the southern areas averaged about 2050 hooks. The median number of sets made in 1999–2000 was 67 per vessel (range 1–160).

Observer coverage was very low in 1999–2000, and only Area 1 vessels were observed (Figure 3). About 9% of the vessels fishing here were observed, each for one trip. This equated to less than 0.5% of all hooks set by domestic-owned and operated vessels being observed, and 0.8% of those set in the main months of observer coverage (December to April inclusive and June). The weekly coverage where

Week 1 starts on 1 December 1999 is shown in Figure D3 in Appendix D, and the highest numbers of seabird captures were observed during early December 1999 and early February 2000.

Seabirds were caught in 44% of observed domestic sets in Area 1 (Table 6). Sixteen of the 36 sets observed were in the Bay of Plenty during December-February and these sets accounted for 25 of the 34 seabirds observed caught. Of the 29 seabirds that were released alive, 10 were caught in the wing, 8 were tangled, and the remainder were hooked in the bill/mouth. Those landed dead were tangled, or hooked in the wing or had swallowed the hook. Five seabirds were landed dead (which represents about 15% of those observed caught) and three were formally identified: one male black petrel from the Bay of Plenty and one female Campbell albatross and one female flesh-footed shearwater, both from southeast of East Cape.

A mean seabird bycatch rate of 0.86 seabirds per 1000 hooks (s.e. = 0.22) was calculated for Area 1, but the lack of observer data precluded any further analysis.

Table 6: Frequency of seabird bycatch for observed tuna longlines set by domestic-owned and operated vessels, 1999–2000.

No. birds per set	0	1	2	3	4	5	7
No. sets	20	9	3	1	1	1	1

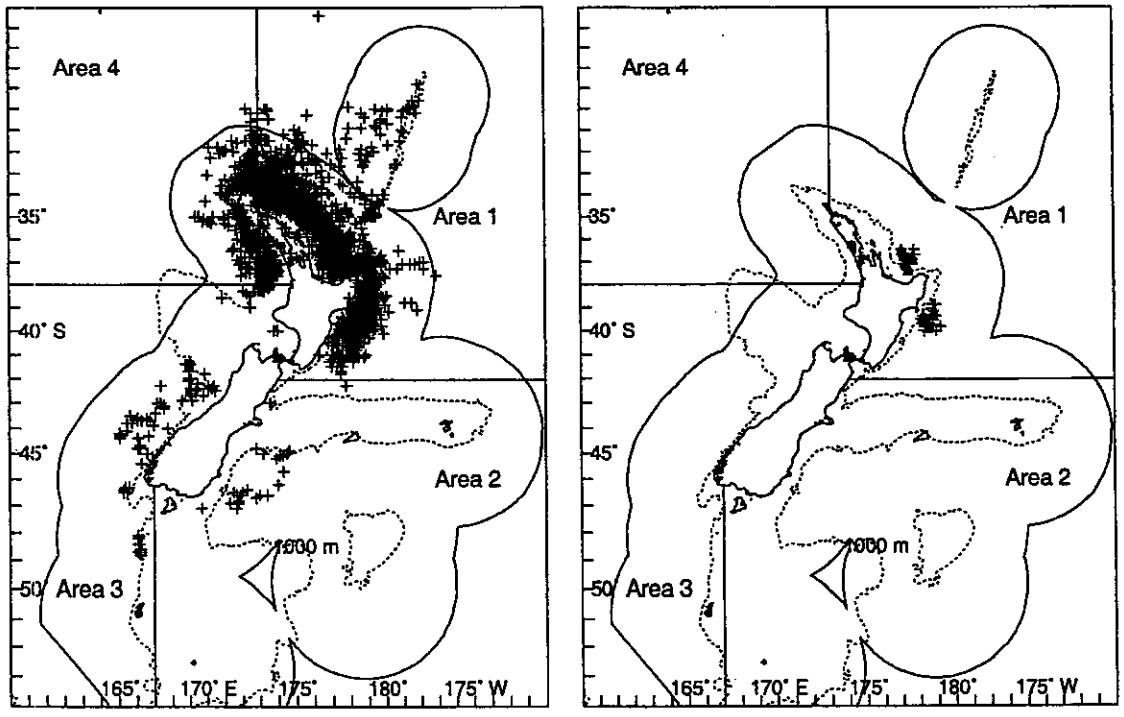

Figure 3: Start positions of all sets (left) and observed sets (+), including those with seabird bycatch (▲) (right), for domestic-owned and operated vessels, 1999–2000.

3.2 Seabirds in ling longline fisheries

Of the nearly 30 million hooks set for ling in 1999–2000 (CELR data), 36% were in LIN 6, 31% in LIN 4, 17% in LIN 3, and 10% in LIN 5 (see Figure 4 for areas). Most of the effort in LIN 3 was during October-November and June-August. In LIN 4, most fishing was during October 1999 and August-September 2000, and for LIN 5 there was very little fishing outside October-December. In LIN 6 monthly fishing effort was similar throughout December-July, with a peak in April.

Four ling longline vessels were observed in 1999–2000, all at different times in different areas. One was observed in LIN 3 and LIN 4 in November-December 1999 when 10 other vessels were in the same areas. A second was observed in LIN 5 during November and December and was one of five vessels targeting ling there. Two vessels were observed in LIN 6 — one during January-February 2000 at the Bounty Platform (one of two vessels fishing there) and one in August-September northeast of the Auckland Islands Shelf (the only vessel there) (Figure 4). The number of hooks recorded by observers on an average longline for each observed vessel ranged from 5200 to 11 250 hooks per set. With 3 or 4 sets a day, these vessels set up to 43 000 hooks per day.

The pattern of the fishing effort and observer coverage is shown in Figures D4 and D5 of Appendix D, where Week 1 of Figure D4 begins on 1 November 1999. Effort in the weeks before Week 9 is for all four areas, but observer coverage in LIN 3 and LIN 4 occurred in Weeks 4 and 5 only, with the main coverage in LIN 5. Effort for Weeks 10–18 is from LIN 3, LIN 4, and LIN 6, with more than 90% from LIN 6 in Weeks 12–16 inclusive. Observer coverage in this period was only from LIN 6. Figure D5 gives the effort during August-September, when there was only coverage of LIN 6. Although almost all the effort here was observed, LIN 6 represented about 14% total ling longline effort during these months (65% was in LIN 4 and 19% in LIN 3).

Seabirds were observed caught on 19% of 508 observed sets (Table 7), though this number varied from 5% for LIN 6 in November-December to 38% for LIN 5, and sets with more than one seabird per set were more likely to be in LIN 5 and LIN 6. Of the 203 seabirds observed caught during ling longline fishing in these areas and time periods, 44% were from LIN 5 in November-December and 40% from LIN 6 in August-September (Table 8). The mean bycatch rates given in Table 8 should be treated with caution because they represent the numbers of seabirds observed per 1000 hooks, where it is assumed that the numbers of hooks recorded by the observers were all observed. The observers record the number of hooks set, but not the number they actually observe. One observer noted in a trip report that 25–50% of the hooks on each set were observed. Therefore, the bycatch rates may be biased, and no total estimates are given.

Ninety-four percent (191) of the seabirds were landed dead, and of these only 48% were returned for identification. None of the 87 seabirds landed dead during the trip in LIN 5 in November-December were returned for identification; however, about 50% of these birds were identified from photographs as white-chinned petrels (Robertson & Bell 2002).

Species recorded from those seabirds observed caught and returned for identification are given in Table 2. Those from LIN 3 included one Salvin's albatross and three white-chinned petrels in November-December. Eleven white-chinned petrels were returned from LIN 4. The bycatch from LIN 6 included 12 Salvin's albatrosses and 1 white-chinned petrel in January-February, and 55 grey petrels, 4 southern giant petrels (*Macronectes giganteus*), 4 white-chinned petrels, and 1 southern cape pigeon (*Daption capense capense*) during August-September. Where it was possible to determine the sex of the seabirds, the data show that males represented 66% of white-chinned petrels returned (n = 18), 75% of southern giant petrels (n = 4), 91% of Salvin's albatrosses (n = 11), and 95% of grey petrels (n = 38) (Robertson & Bell 2002).

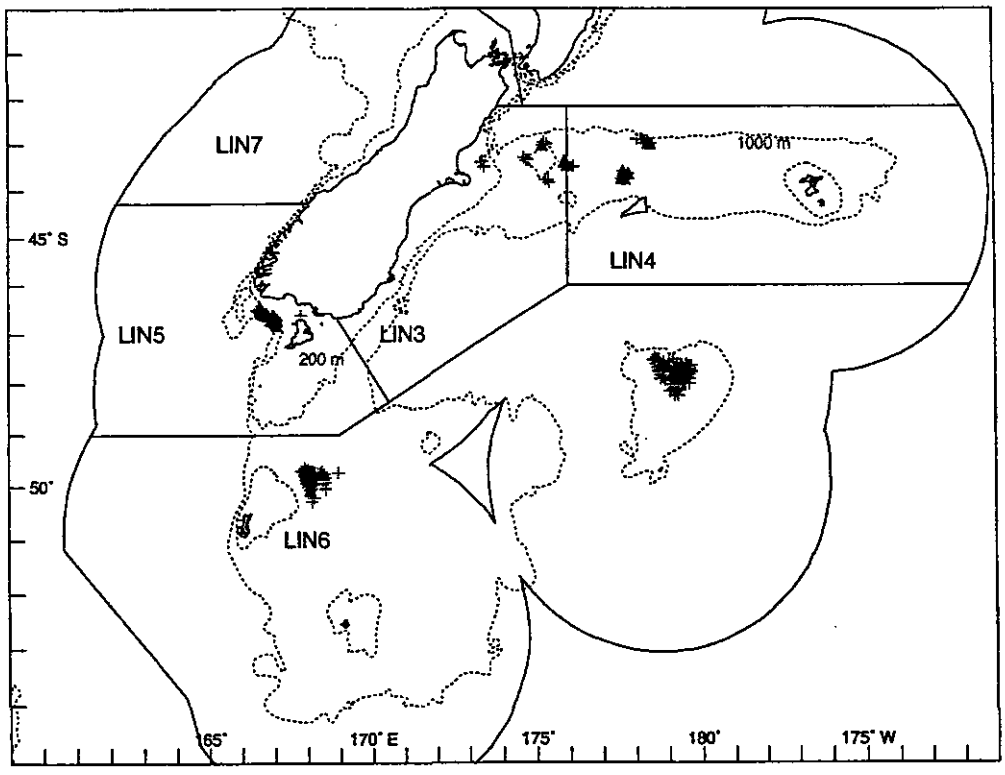

Figure 4: Start positions of observed ling longline sets (+), including those with seabird bycatch (▲), 1999–2000.

Table 7: Frequency of seabird bycatch for observed ling longline sets, 1999–2000.

No. birds per set	LIN 3	LIN 4	LIN 5	LIN 6	Total
0	15	16	72	307	410
1	2	1	23	23	49
2	1	4	10	11	26
3		1	4	3	8
4			3	3	6
5			3	2	5
6				1	1
7				1	1
8			1	1	2
Observed birds	4	12	90	97	203
Observed sets	18	22	116	352	508
% observed sets with birds	17	27	38	13	19

Table 8: Mean bycatch rate* (seabirds per 1000 hooks) for ling longline fisheries for which there was observer coverage in 1999–2000.

Area and month	Total hooks ($x10^3$)	% hooks observed	No. birds observed caught	No. birds per 10^3 hooks	Standard error
LIN 3 Nov-Dec	804.4	14	4	0.031	0.017
LIN 4 Nov-Dec	1 147.7	10	12	0.098	0.036
LIN 5 Nov-Dec	2 213.7	59	90	0.079	0.015
LIN 6 Jan-Feb	1 910.8	65	16	0.013	0.005
LIN 6 Aug-Sep	925.2	91	81	0.101	0.020

* The mean bycatch rate is given as the number of seabirds per 1000 hooks. The number of hooks for this computation comes from the number reported by the Ministry of Fisheries observer for each set. The actual number of hooks observed on each set is unknown; therefore these data must be treated with caution.

3.3 Seabird bycatch in trawl fisheries

The incidental capture of seabirds in trawl fisheries was recorded for about 2% of observed tows in 1999–2000, with the highest incidental capture rate in the squid fishery, where over 4% of observed tows caught seabirds (Table 9). Seabirds were observed caught in about 2% of observed hoki tows and scampi tows, and 1% of observed jack mackerel tows, whereas less than 0.5% of observed orange roughy and oreo tows had seabird bycatch. Multiple captures of seabirds (more than one seabird per tow) occurred in the hoki and squid trawl fisheries (Table 9). (A more detailed description of the trawl fisheries discussed below is given in Section 5.)

Table 9: Frequency of seabird bycatch for observed trawl fishing operations, 1999–2000.

No. birds per tow	Target trawl fishery*										
	BAR	HAK	HOK	JMA	OEO	ORH	SBW	SCI	SQU	SWA	Total
0	131	39	3 187	490	989	1 500	224	410	831	47	7 848
1	4	2	53	7	3	5	2	8	30	3	117
2			8						3		11
3			5						1		6
4			1						1		2
5									2		2
6			1								1
Observed birds	4	2	94	7	3	5	2	8	53	3	181
Observed tows	135	41	3 255	497	992	1 505	226	418	868	50	7 987
% observed tows with birds	3	5	2	1	< 1	< 1	1	2	4	6	2

* Fishery areas and species codes are given in Appendix B.

3.3.1 Seabird bycatch in hoki trawl fisheries

The incidental capture of seabirds in hoki fisheries was recorded for about 2% of observed tows in 1999–2000 (range 4% in CHAT to 0% in COOK) (Table 10). Observed trawls in the hoki target fisheries off the west coast of the South Island (WCSI), on the Chatham Rise (CHAT), in the sub-Antarctic area

(SUBA), and in the Puysegur fishery (PUYS) accounted for 94 of the 181 seabirds observed caught in trawl operations. No seabirds were reported caught from the Cook Strait hoki fishery (COOK) (Figure 5).

Most seabirds were observed caught in the CHAT fishery and the SUBA fishery off the Stewart-Snares shelf (Table 10). Of the 94 seabirds observed caught, 64 were returned for identification and these represented 77% of the 83 seabirds landed dead. Nine species were represented in those seabirds returned from CHAT, and 82% of the returned seabirds from CHAT were albatrosses (Table 11). Five species were represented in the SUBA bycatch and 60% were sooty shearwaters, and of the 4 species represented by the eight seabirds returned from the WCSI hoki fishery, three were albatross species.

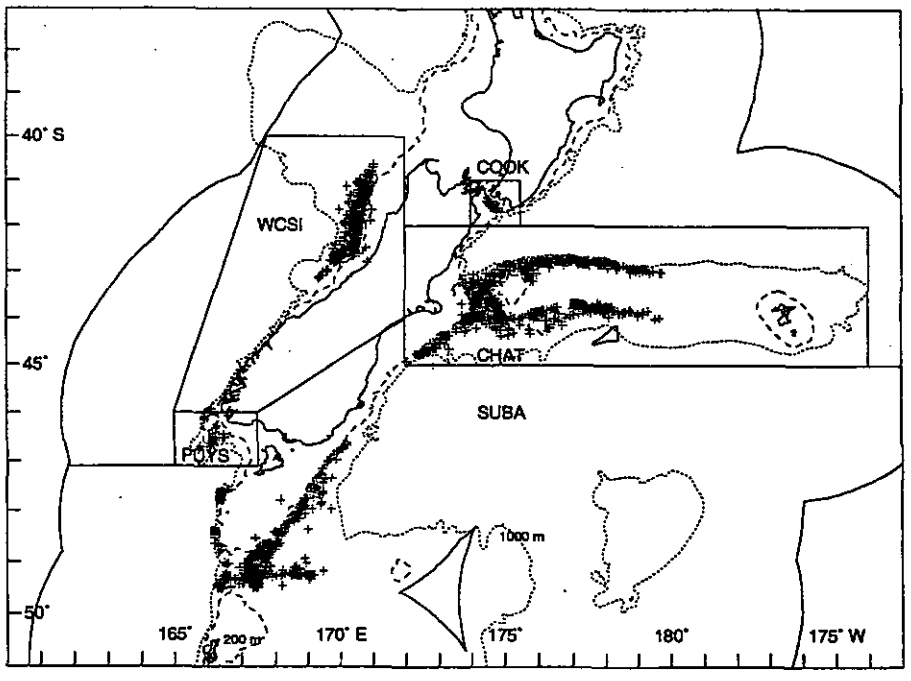

Figure 5: Start positions of observed hoki tows (+), including those with seabird bycatch (■), in the main hoki fisheries, 1999–2000.

Table 10: Frequency of seabird bycatch for observed hoki trawl operations, by area, 1999–2000.

No. birds per tow	CHAT	COOK	PUYS	SUBA	WCSI	Total
0	731	165	31	1 104	1156	3 187
1	24	0	1	24	4	53
2	2	0	0	3	3	8
3	4	0	0	1	0	5
4	0	0	0	1	0	1
6	1	0	0	0	0	0
Observed birds	46	0	1	37	10	94
Observed tows	762	165	32	1 133	1163	3 255
% observed tows with birds	4	0	3	3	1	2

* Fishery areas are given in Appendix B.

Table 11: Numbers of seabird taxa (Robertson & Bell 2002) observed caught during hoki trawl operations, by hoki fishery area*, 1999–2000.*

Seabird taxa	CHAT	COOK	PUYS	SUBA	WCSI	Total
Southern royal albatross	1	–	–	–	–	1
Buller's albatross	10	–	–	2	1	13
Campbell albatross	–	–	–	3	–	3
Black-browed albatross	1	–	–	–	1	2
Salvin's albatross	7	–	–	–	–	7
White-capped albatross	8	–	–	3	3	14
Northern giant petrel	2	–	–	–	–	2
Grey petrel	1	–	–	–	–	1
White-chinned petrel	–	–	–	2	–	2
Sooty shearwater	2	–	–	15	–	17
Southern cape pigeon	1	–	–	–	–	1
Fairy prion	–	–	–	–	2	2
Unidentified	13	–	1	12	3	29
Total	46	0	1	37	10	94

* Seabird scientific names and fishery codes are given in Appendix B.

Where it was possible to determine the sex of the seabirds, the data show that males represented 19% of Buller's albatrosses returned (n = 11), 50% of Salvin's albatrosses (n = 7), 64% of white-capped albatrosses (n = 14), and 69% of sooty shearwaters (n = 16) (Robertson & Bell 2002).

3.3.1.1 WCSI hoki fishery

Ten seabirds were observed caught during the June to September WCSI hoki fishery, with most caught in Weeks 4–6 where Week 1 starts 1 June 2000, (Figure E1 of Appendix E). These months represent 98% of the total hoki fishing effort here for 1999–2000, and there was no observer coverage outside these months.

The level of observer coverage in each month allowed estimation of the numbers caught in July, August, and September (Table 12). For the WCSI fishery in 1999–2000, 15% of the 7686 tows were observed and the mean bycatch rate of 0.009 seabirds per tow (s.e. = 0.004) gave an estimated seabird capture total of 69 seabirds (c.v. = 41%). If the life status on landing and species mix from identified seabirds are applied to the above estimate of 69 seabirds, an estimated 55 seabirds were landed dead, and of these 50% were white-capped albatrosses, and the remainder were black-browed albatrosses, Buller's albatrosses, and fairy prions (see Table 11).

Table 12: Fishing effort, observed effort, and mean bycatch rates (numbers of seabirds per tow) for the WCSI hoki fishery, 1999–2000.

Month	Total no. tows	No. observed tows	% tows observed	No. seabirds observed caught	Mean bycatch rate	Standard error	Estimated number caught	c.v. (%)
June	667	47	7	2	0.043	0.028	–	–
July	3 227	532	17	6	0.011	0.005	36	46
August	3 069	469	15	0	–	–	–	–
September	723	115	16	2	0.017	0.016	13	94

3.3.1.2 CHAT hoki fishery

The CHAT hoki fishery operated primarily between October 1999 and May 2000, and observed effort covered October-December, March-June, and September. Seabirds were reported from all these months, with the highest number observed caught during May and June (Table 13). Weekly seabird captures peaked at the end of November, in early March, and at the end of May (Figure E2 in Appendix E).

Estimates of total numbers of seabirds caught are given where observer coverage is over 10%, but because of the low numbers of captures, these estimates should be treated with caution, as is suggested by the c.v.s. The only viable estimates are those from May and June, and these estimates are substantially different. A total of 152 seabirds was estimated caught (c.v. = 33%) during these two months. When all the data are combined for the 1999–2000 fishing year, 6% of the 12 416 tows were observed and 46 seabirds were observed caught. Ninety-one percent of the observed seabirds were landed dead.

Seabirds were observed caught during tows west of 178° 30' E, where most of the observed effort took place (see Figure 5). Five albatross taxa were identified from seabirds returned from this area, with Buller's albatrosses accounting for 37% of the 27 albatrosses returned and white-capped and Salvin's accounting for another 55% (see Table 11). The six petrels returned for identification represented four taxa.

Table 13: Fishing effort, observed effort, and mean bycatch rates (numbers of seabirds per tow) for the CHAT hoki fishery, 1999–2000.

Month	Total no. tows	No. observed tows	% tows observed	No. seabirds observed caught	Mean bycatch rate	Standard error	Estimated number caught	c.v. (%)
October	1 377	35	3	1	–	–	–	–
November	1 431	152	11	1	0.007	0.007	9	100
December	1 664	81	5	2	–	–	–	–
January	1 390	0	0	–	–	–	–	–
February	999	0	0	–	–	–	–	–
March	1681	4	0	1	–	–	–	–
April	1355	39	3	1	–	–	–	–
May	907	290	32	10	0.034	0.010	31	29
June	588	107	18	22	0.206	0.071	121	35
July	139	0	0	–	–	–	–	–
August	134	0	0	–	–	–	–	–
September	751	54	7	8	–	–	–	–

3.3.1.3 COOK and PUYS hoki fisheries

Tows in the COOK hoki fishery were observed during the main fishing months (July-September), and no seabirds were observed caught. The observed effort represented 3% of the 4718 tows made during 1999–2000. About 580 tows were made during the 1999–2000 fishing year in the PUYS hoki fishery, and about 5% of these were observed, in October, June, and September. One unidentified seabird was landed dead in June, when 37% of a total of 27 tows were observed. No estimates are provided here because of the small amount of data.

3.3.1.5 SUBA *hoki fishery*

Observers reported 37 seabird captures during observed hoki trawls in SUBA in 1999–2000, with most being distributed around the Stewart-Snares shelf (see Figure 5). There was fishing effort throughout the fishing year, with a concentration of effort during January to June. These months also accounted for 94% of the observer coverage (Table 14) and 26 of the seabird captures. A further 11 seabirds were observed caught during October, when 7% of the 588 tows were observed. The weekly effort and observer data for the fishing year is shown in Figure E3 of Appendix E. The observer coverage was at least 18% during these months and the highest seabird bycatch rate was seen in April at 0.070 seabirds per tow (s.e. = 0.028), but this rate was not substantially different from the others.

For the 1999–2000 SUBA fishery, 18% of the 6406 tows were observed and the mean bycatch rate of 0.033 seabirds per tow (s.e. = 0.006) gave an estimated seabird capture total of 209 seabirds (c.v. = 19%). About 86% of seabirds were landed dead and 75% of these were sooty shearwaters, with white-capped albatrosses, Buller's albatrosses, Campbell albatrosses, and white-chinned petrels accounting for the remainder (see Table 11).

Table 14: Fishing effort, observed effort, and mean bycatch rates (numbers of seabirds per tow) for the SUBA *hoki* fishery, 1999–2000.

Month	Total no. tows	No. observed tows	% tows observed	No. seabirds observed caught	Mean bycatch rate	Standard error	Estimated number caught	c.v. (%)
October	588	40	7	11	–	–	–	–
November	297	0	0	–	–	–	–	–
December	508	0	0	–	–	–	–	–
January	951	173	18	0	–	–	–	–
February	568	147	26	0	–	–	–	–
March	638	122	19	3	0.025	0.013	16	51
April	859	158	18	11	0.070	0.028	60	40
May	1 056	269	25	5	0.019	0.009	20	46
June	772	199	26	7	0.035	0.011	27	32
July-September	169	25	15	0	–	–	–	–

3.3.2 Seabird bycatch in squid trawl fisheries

Of the 53 seabirds observed caught in the squid trawl fisheries during January-March, 30 were from around the Auckland Islands Shelf (SQU 6T), 20 were from tows on the Stewart-Snares shelf (STEW), and 3 from tows on the southeastern Chatham Rise (Table 15, Figure 6). Most seabirds were observed caught as single captures per tow.

The SQU 6T fishery operated during January to March 2000 (Table 16), and 36% of the 1206 tows were observed. Most of the fishing effort was in the southeastern part of SQU 6T, south of 50° 20' S (Figure E4 in Appendix E), where the peak of effort was in Week 6 of the fishery (which starts on 5 February) when there was a shift of effort from the Stewart-Snares shelf (Figure E5 in Appendix E).

About 26 vessels were involved in the SQU 6T fishery, and 42% of those fishing north of 50° 20' S, and 31% of those in the southern area were observed. The median number of tows made by each vessel was 10 (range 1–29) in the northern area and 34 (range 1–90) in the southern area. For the observer data, the median number of tows observed per trip was 9 (range 1–18) in northern waters and 30

(range 2–90) in southern waters. There was no difference in the mean seabird bycatch rates for the observed effort north and south of 50° 20' S, or between February and March for the whole area. When the season data are combined, the mean bycatch rate of 0.068 seabirds per tow (s.e. = 0.016) gave an estimated seabird capture total of 82 seabirds (c.v. = 19%).

White-capped albatrosses represented 68% of the 25 seabirds returned from SQU 6T (Table 17, Appendix C). The remaining seabirds identified from SQU 6T were sooty shearwaters and one diving petrel. About 93% of the seabirds from this area were landed dead. Males represented 65% of the white-capped albatrosses (n = 17) and 83% of the sooty shearwaters (n = 5).

About 42% of the 26 vessels targeting squid in the January-March squid fishery at the Stewart-Snares shelf were observed. The median number of tows made by each vessel was 59 (range 1–60), and observed trips had a median of 27 tows (range 19–73). The 20 seabirds observed caught were reported from February and March (Table 18). For the January-March 2000 squid fishery, 22% of the 1632 tows were observed and the mean bycatch rate of 0.057 seabirds per tow (s.e. = 0.02) gave an estimated seabird capture total of 93 seabirds (c.v. = 34%). Overall, the fishery in 1999–2000 was about one-third of that in 1998–99, and the mean seabird bycatch rates for February and March in 1999–2000 were not substantially different from those reported in 1998–99 (Baird 2001a). Sixteen seabirds were landed dead, and of the 14 returned for identification 8 (57%) were white-capped albatrosses, 5 were sooty shearwaters, and the remaining bird was a white-chinned petrel.

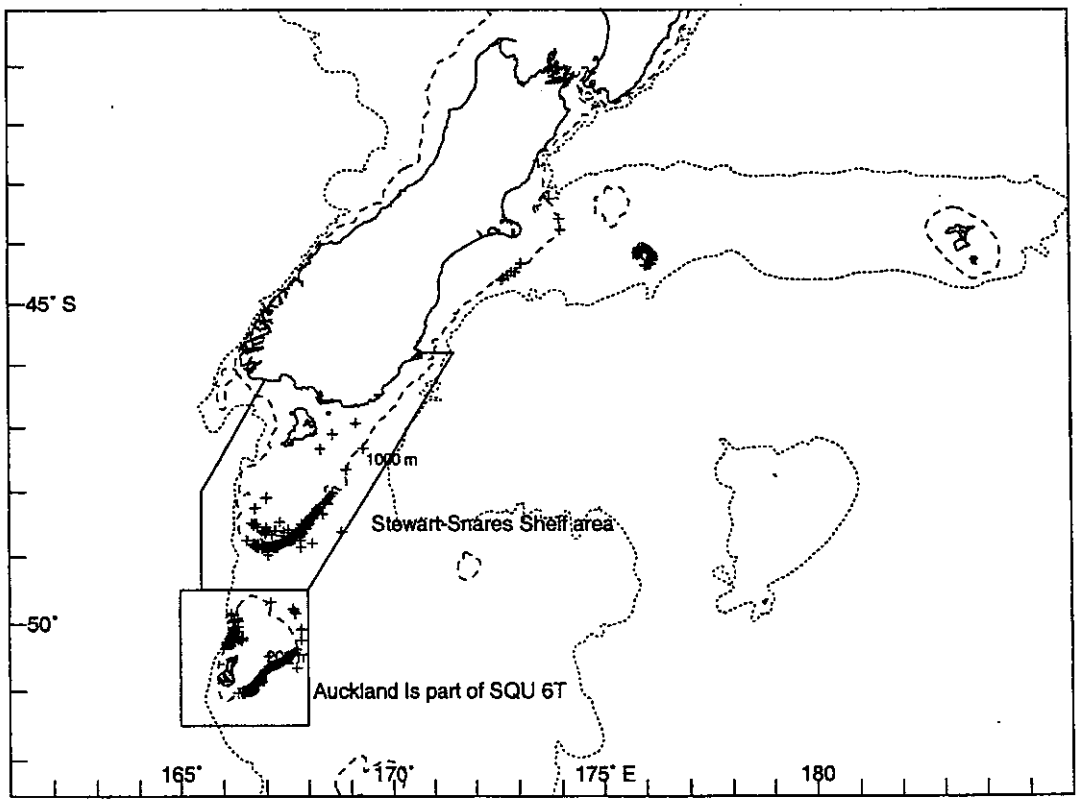

Figure 6: Start positions of observed squid tows (+), including those with seabird bycatch (▲), in the main squid fisheries, 1999–2000.

Table 15: Frequency of seabird bycatch for observed squid tows, 1999–2000.

No. seabirds per tow	SQU 6T	STEW	CHAT	Total
0	414	340	59	813
1	21	8	1	30
2	1	1	1	3
3	1			1
4	1			1
5		2		2
Observed birds	30	20	3	53
Observed tows	438	351	61	850
% observed tows with birds	5	3	3	4

* Fishery areas are defined in Appendix B.

Table 16: Fishing effort, observed effort, and mean bycatch rates (numbers of seabirds per tow) for the SQU 6T squid trawl fishery, 1999–2000.

Month	Total no. tows	No. observed tows	% tows observed	No. birds observed caught	Mean bycatch rate	Standard error	Estimated number caught	c.v. (%)
January	7	7	100	0	–	–	–	–
February	952	300	32	23	0.077	0.017	73	23
March	247	131	53	7	0.053	0.014	13	26
January-March north*	262	117	45	9	0.077	0.021	20	27
January-March south	944	321	34	21	0.065	0.016	61	25

* North of 50° 20' S.

Table 17: Numbers of seabird taxa (Robertson & Bell 2002) observed caught during squid trawl operations, by squid fishery area*, 1999–2000.

Seabird taxa	SQU 6T	STEW	CHAT	Total
Antipodean albatross	–	–	1	1
White-capped albatross	17	8	1	26
Sooty shearwater	–	5	–	5
White-chinned petrel	6	1	–	7
Diving petrel	1	–	–	1
Unidentified	6	6	1	13
Total	30	20	3	53

* Fishery areas are defined in Appendix B.

Fishing effort for squid on the Chatham Rise was also observed, mainly off the east coast of the South Island, and southeast of Mernoo Bank (Figure 6, Appendix A). The observed effort here (61 tows over February-March, and May-June) represented less than 4% of the total tows for the fishing year, and seabirds were observed caught in May, when one of the 10 vessels fishing the area was observed. Three seabirds were observed caught, one of which was released alive and the other two were landed dead and identified as a male Antipodean albatross and a male white-capped albatross. No estimates are presented for this interaction.

Table 18: Fishing effort, observed effort, and mean bycatch rates (numbers of seabirds per tow) for the Stewart-Snares shelf squid trawl fishery, 1999–2000.

Month	Total no. tows	No. observed tows	% tows observed	No. birds observed caught	Mean bycatch rate	Standard error	Estimated number caught	c.v. (%)
October-December	75	0	0	–	–	–	–	–
January	611	44	7	0	–	–	–	–
February	465	132	28	13	0.098	0.045	46	46
March	556	175	31	7	0.040	0.014	22	35
April-June	179	0	0	–	–	–	–	–

3.3.3 Summary of other trawl fishery-seabird interactions

Barracouta (*Thyrsites atun*) target fishing operations:

- 4 seabirds were observed caught: 2 were released alive (single captures in February on the Stewart-Snares shelf and March off the east coast of the South Island) and 2 landed dead (both caught in March in the same areas). The one seabird returned for identification was a male white-capped albatross caught on the Stewart-Snares shelf.

Hake (*Merluccius australis*) target fishing operations:

- 2 seabirds were observed captured from tows in November on the Stewart-Snares shelf: 1 was released alive and the other was landed dead and identified as a female white-capped albatross.

Jack mackerel (*Trachurus* spp.) target fishing operations:

- 7 seabirds were observed caught in March and April off the southern edge of the Stewart-Snares shelf: 3 were released alive and of the 4 landed dead, 3 were identified — 1 male sooty shearwater, 1 male white-capped albatross, and a female Salvin's albatross.

Oreo species target fishing operations:

- 1 seabird was released alive from a black oreo (*Allocyttus niger*) tow off the western edge of the Stewart-Snares shelf in November, 1 sooty shearwater was landed dead in November off the northeastern edge of the Stewart-Snares shelf, and 1 male white-capped albatross was landed dead off the western edge of the Auckland Islands Shelf in October during a smooth oreo tow.

Orange roughy target fishing operations:

- 5 seabirds were landed dead and unidentified: 3 from east of the Chatham Islands and 2 from waters west of the EEZ.

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

- 2 seabirds were landed dead from tows off the northeastern edge of the Campbell Plateau: both were identified as male grey petrels.

Scampi (*Metanephrops challengeri*) target fishing operations:

- 8 seabirds were landed dead and of these, 3 were returned for identification: 1 female flesh-footed shearwater and 1 female Salvin's albatross from off the Wairarapa Coast in November, and 1 male white-capped albatross from off the Auckland Islands Shelf in March. The remaining 5 seabirds were caught northeast of Mernoo Bank.

Warehou target fishing operations:

- 1 male Salvin's albatross was landed dead and identified from a silver warehou (*Seriolella punctata*) tow in October (near the Mernoo Bank), 1 male white-capped albatross was landed dead and identified from a white warehou (*Seriolella caerulea*) tow in November, and 1 seabird was released alive from a common warehou (*Seriolella brama*) tow in March (both off the Stewart-Snares shelf).

4. HOOKER'S SEA LIONS (*PHOCARCTOS HOOKERI*)

4.1 Hooker's sea lions and the southern squid (*Nototodarus sloanii*) trawl fishery in SQU 6T

The southern squid trawl fishery is based off the Stewart-Snares shelf and around the Auckland Islands in part of SQU 6T in depths of about 150–300 m. The Total Allowable Commercial Catch for SQU 6T has been about 30 000 t since 1990–91. Annual reported catches peaked in 1993–94 and 1994–95 when at least 30 000 t were reported. Since then reported catches declined and reached a low of 950 t in 1998–99 which resulted from reduced squid abundance and the early closure of the fishery as a management measure for Hooker's sea lions (Annala et al. 2001). Landings from this area increased to 6241 t in 1999–2000.

Breeding populations of Hooker's sea lions are located primarily in the Auckland Islands group. The overlap of the southern squid trawl fishery with the foraging grounds of the Hooker's sea lions has resulted in incidental catches of sea lions (Gales 1995). Pup production estimates in 2000 were very similar to those for 1999, and the mean population estimate (and 95% confidence intervals) for 1999–2000 for the main breeding locations (Sandy Bay and Dundas Island) was 14 104 (12 272–16 230) (I. Wilkinson, DoC, pers. comm.).

Hooker's sea lions are nearly always caught singly and are dead when landed. A maximum allowable level of fishing related mortality (MALFIRM) for Hooker's sea lions has been in place since 1993. Vessels operate under a code of practice designed to minimise marine mammal capture (Baird 1994) and are restricted to fishing outside a 12 n. mile zone around the Auckland Islands. The observed capture of sea lions during the squid fishery season is monitored to provide weekly in-season estimates of the total capture of sea lions, based on Ministry of Fisheries observed captures and commercial tow data from the Seafood Industry Council (Doonan 2000).

The fishery is closed if this in-season estimate of the bycatch of Hooker's sea lions nears the MALFIRM determined for that year, as happened in 1996, 1997, and 1998. The MALFIRM set for the 1999–2000 squid season was 65 sea lions (Anon. 2000b). During this season, trials were carried out on some of the observed vessels to test the efficiency of Sea Lion Excluder Devices (SLEDs). Results of these trials were not available at the time of writing this report.

There has been an increase in the annual bycatch rate for Hooker's sea lions in recent years, from 0.023 sea lions per tow in the 1996 squid season to 0.044 sea lions per tow reported for the 1998 season (Doonan 1999). The in-season Hooker's sea lion capture estimate for SQU 6T was 0.059 sea lions for the 2000 squid season; this gave a total estimate of 71 sea lions (c.v. = 16%) (Doonan 2000).

4.1.1 Bycatch of Hooker's sea lions in 1999–2000

The southern squid trawl fishery in SQU 6T began in late January and was closed in early March when the estimated number of Hooker's sea lion captures exceeded the MALFIRM (Doonan 2000). A total of 1206 tows were reported from this area. Most vessels targeting squid shifted from the fishery at the Stewart-Snares shelf in the first week of February (see Figure E5 in Appendix E) to the southeastern edge of the Auckland Islands Shelf (Figure E4 in Appendix E). Overall, 36% of tows were observed in the Auckland Islands part of SQU 6T during the 1999–2000 fishing year. The observed tows represented effort in two distinct areas of fishing delineated here by 50° 20' S. Over 22% of the total tows were just to the north of Auckland Islands, and 45% of these tows were observed. About 34% of tows in the southern

area were observed. About 30% of SQU 6T squid tows in February were observed and 50% during March were observed (Table 19).

Hooker's sea lions were reported caught from both fishing areas in SQU 6T. The distribution of the start positions of observed tows, including those that captured Hooker's sea lions, is shown in Figure 7. Ministry of Fisheries observers reported 25 Hooker's sea lion captures (all were landed dead); the 23 single captures included 13 during observed midwater tows by trawlers in the northern area and 11 from midwater tows and 1 from a bottom tow in the southern area. Two sea lions were observed caught in one tow in the northern area. Of the 11 observed vessels, 3 reported no sea lion captures and 2 accounted for 44% of the captures (these 2 vessels also accounted for 44% of the observed effort).

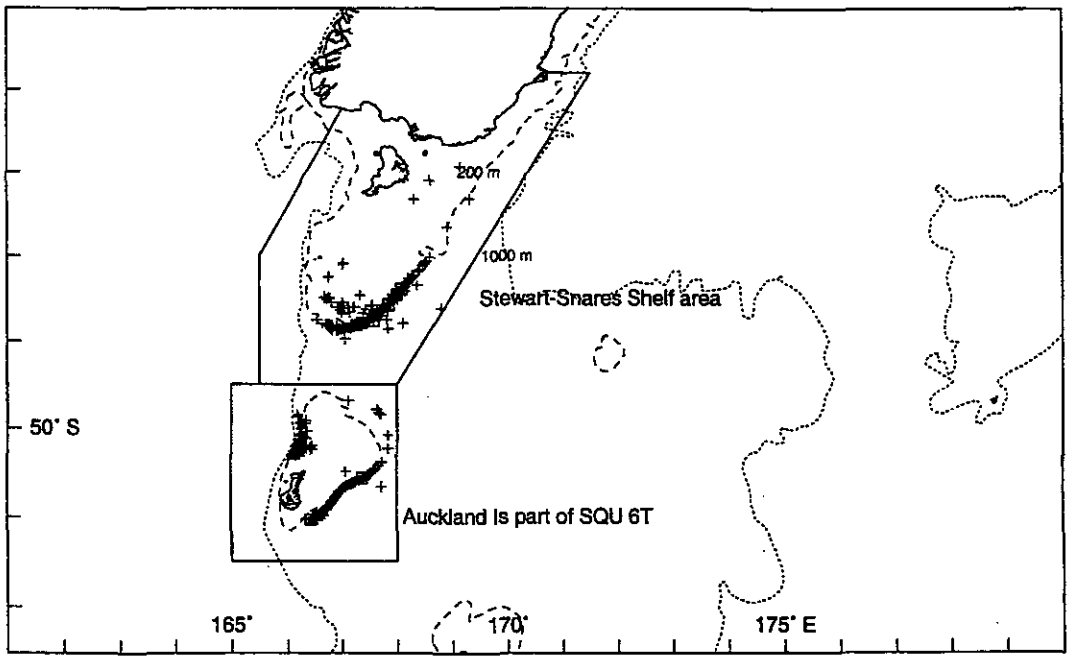

Figure 7: Start positions of observed squid tows (+) and those with Hooker's sea lion bycatch (▲), and New Zealand fur seal bycatch (□), *1999–2000*.

All estimates of Hooker's sea lion bycatch are considered reliable because of the good observer coverage. For the January to March 2000 squid season around the Auckland Islands part of SQU 6T, 36% of the 1206 tows were observed and the mean bycatch rate of 0.058 sea lions per tow (s.e. = 0.01) gave a total estimate of 70 Hooker's sea lions (c.v. = 17%) (Table 19). This result is similar to the in-season estimate by Doonan (2000) (71 sea lions, c.v. = 16%). One Hooker's sea lion capture was reported during the in-season monitoring as in SQU 1T (Doonan 2000); however, in the observer data this sea lion was reported as in SQU 6T.

The calculated mean bycatch rate exceeded those for previous years (see Doonan 2000). When the data are analysed by northern and southern area of SQU 6T, there are substantial differences in the January-March mean bycatch rates. However, these may well be confounded by the use of SLEDs and associated cover nets, and there is no information in the available data to establish which tows used SLEDs and what effect the use of SLEDs had on the catch rate of Hooker's sea lions.

Table 19: Fishing effort, observed effort, and mean bycatch rates (numbers of sea lions per tow) for the southern squid trawl fishery in SQU 6T, 1999–2000.

Month	Total no. tows	No. observed tows	% tows observed	No. sea lions observed caught	Mean bycatch rate	Standard error	Estimated number caught	c.v. (%)
January	7	7	100	0				
February	952	300	32	10	0.033	0.010	31	25
March	247	131	53	13	0.099	0.027	24	19
North of 50° 20' S	262	117	45	15	0.128	0.025	34	19
South of 50° 20' S	944	321	34	10	0.031	0.008	29	26

4.2 Hooker's sea lions and other trawl fisheries

One Hooker's sea lion was observed caught and released alive during a hoki tow in April 2000 off the southern edge of the Stewart-Snares shelf. Two sea lions were landed dead from two observed jack mackerel tows, one in February and one in March, from the same area.

4.3 Hooker's sea lions and tuna longline fisheries

One Hooker's sea lion caught and released alive during the haul of a tuna longline set off the southwestern edge of the Stewart-Snares shelf.

5. NEW ZEALAND FUR SEALS (*ARCTOCEPHALUS FORSTERI*)

New Zealand fur seals are caught in bottom and midwater trawl fisheries that operate around the coastline of the South Island and the offshore islands in the southern waters of the 200 n. mile EEZ (appendix 1 in Baird 1997). Descriptions of the target fisheries with fur seal bycatch (as listed below) are given in Annala et al. (2001).

During 1999–2000, 201 New Zealand fur seals were observed caught in bottom and midwater trawls in the following target fisheries:

- hoki (102 fur seals reported from 81 tows; 88 were landed dead),
- southern blue whiting (83 fur seals landed dead from 33 tows in August-October 2000),
- squid (12 fur seals reported from 12 tows; 10 were landed dead), and
- jack mackerel (4 fur seals reported from 3 tows; all landed dead).

Multiple captures, where more than one fur seal was caught per observed tow, occurred in southern blue whiting and hoki tows (Table 20). Less than 1% of observed tows in hoki fisheries at COOK, CHAT, and SUBA had fur seal bycatch, compared with 6% of observed tows in the WCSI hoki fishery and in the Southern blue whiting fishery at the Campbell Plateau. However, 75% of the observed southern blue whiting tows at the Bounty Platform had fur seal bycatch.

Data for the target fisheries with observed fur seal captures for 1999–2000 are analysed and discussed below. Means and associated standard errors are provided by month, but in most strata the sample sizes were inadequate and therefore to get better precision, data were aggregated by fishing year (or season) for the estimation of total catch.

Table 20: Frequency of observed fur seal captures in the main target fishery areas* for which there was reported incidental capture.

No. fur seals per tow	CHAT HOK	COOK HOK	SUBA HOK	WCSI HOK	Bounty SBW	Campbell SBW	Pukaki SBW
0	758	164	1 122	1 098	7	171	15
1	4	1	10	50	5	10	1
2	0	0	1	10	8	1	0
3	0	0	0	5	5	0	0
4	0	0	0	0	1	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
8	0	0	0	0	1	0	0
22	0	0	0	0	1	0	0
Observed fur seals	4	1	12	85	70	12	1
Observed tows	762	165	1 133	1 163	28	182	16
% observed tows with fur seals	< 1	< 1	1	6	75	6	6

* Fishery areas and species codes are given in Appendix B.

5.1 Hoki fishery — by fishery area

New Zealand fur seals are caught in bottom and midwater trawl nets that target hoki in HOK 1 (see Annala et al. 2001 for area). During 1999–2000, Ministry of Fisheries scientific observers recorded 102 fur seal captures during hoki fishing operations. Of these, 88 were landed dead. For this analysis, the observer data for tows that targeted hoki were stratified into the hoki fishery-areas that represent all the main hoki fisheries within HOK1: CHAT, COOK, PUYS, SUBA, and WCSI. Figure 8 shows the distribution of the observed effort and fur seal captures in these areas.

The observer coverage of vessels in each area was at least 23% in all areas but PUYS, where there was minimal fishing effort compared with the other areas (Table 21). The percentage of tows observed was less than 10% for CHAT, COOK, and PUYS, but higher coverage was achieved in SUBA and WCSI. Data for the areas will be discussed separately below.

Table 21: Fishing effort and number of observed New Zealand fur seal captures, by hoki fishery area, 1999–2000.

Hoki fishery	Total no. vessels	No. observed vessels	% vessels observed	Total no. tows	No. observed tows	% tows observed	No. observed fur seals
CHAT	55	13	28	12 416	762	6	4
COOK	22	7	36	4 718	165	3	1
PUYS	28	5	13	583	32	5	0
SUBA	43	14	29	6 406	1 133	18	12
WCSI	64	18	23	7 820	1 163	15	85

* Fishery areas are given in Appendix B.

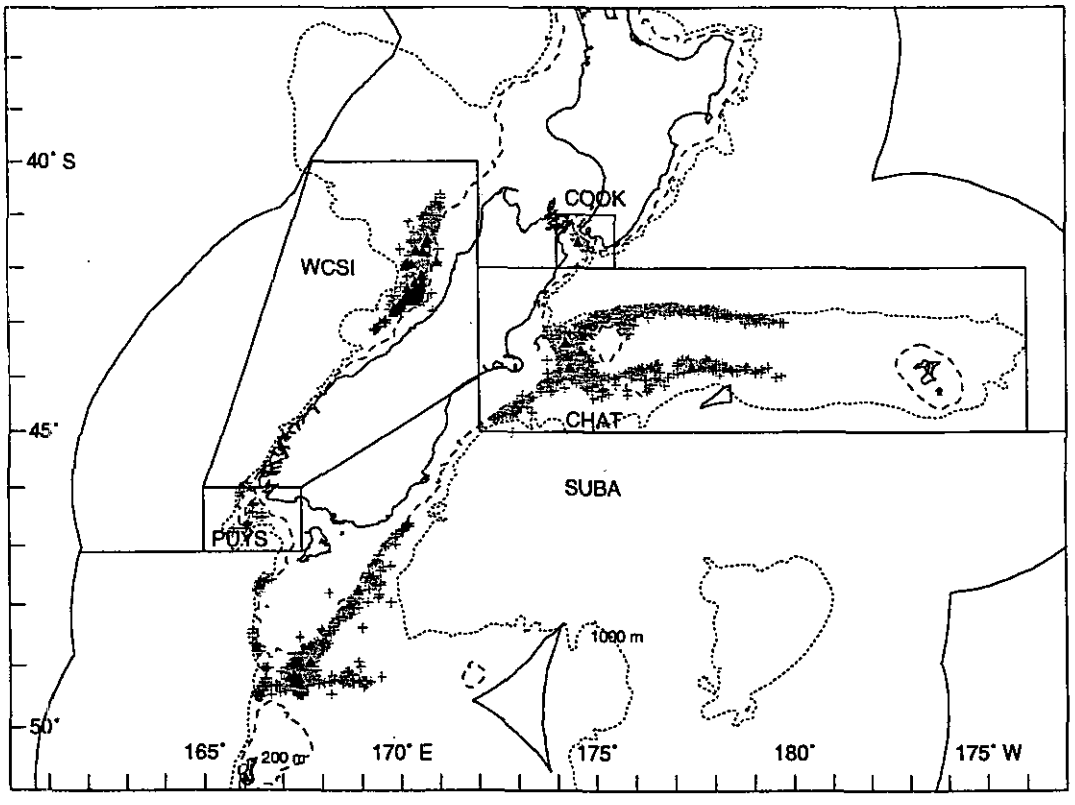

Figure 8: Start positions of observed tows (+), including those with New Zealand fur seal bycatch (▲), for the main hoki fishery areas, 1999–2000.

5.1.1 WCSI hoki fishery

During 1999–2000, 7686 tows targeting spawning hoki were made during the June to September WCSI fishery, and 15% of these tows were observed. This fishery accounted for about 24% of the hoki effort in 1999–2000, 35% of the observed hoki effort, and 83% of the observed fur seal captures from hoki fisheries. About 98% of the total effort (and observed effort) in this area during 1999–2000 took place during the June to September fishery, and 80% of the total effort, 86% of the observed effort, and 87% of observed fur seal captures occurred during July and August. About 78% of the observed tows were midwater tows and 81% of the observed fur seal captures were from midwater tows.

The number of fur seal captures peaked at Week 7 (in mid July), just before the main peak of observed activity (Figure E1 in Appendix E). The peaks of the fur seal captures were largely due to the observed fur seal bycatch on two vessels, one with multiple catches per tow in July and the other with multiple captures in August. These vessels accounted for 32% of the observed effort and 46% of the observed fur seal bycatch. The number of vessels in the fishery gradually built up to about 48 during Weeks 6–11, and at least 10% of these vessels were observed each week. The number of observed tows for each vessel ranged from 1 to 188 tows (median of 44), and the number of fur seals per vessel ranged from 0 to 25 (median of 2); 4 of the 18 vessels observed in the main spawning time had no fur seal bycatch.

Mean fur seal bycatch rates by month are given in Table 22. No estimates can be provided for June because of the low observer coverage. When all data are combined for the June-September fishery during

1999–2000, the mean fur seal bycatch rate is 0.073 fur seals were observed caught per tow (s.e. = 0.009); this gave a total estimate of 561 fur seals (c.v. = 13%). Seventy-seven fur seals were landed dead and 8 were released alive, which, when extrapolated over the estimated catch of 561 fur seals, equates to 508 dead fur seals and 53 released alive.

Table 22: Fishing effort, observed effort, and mean bycatch rates (numbers of fur seals per tow) for the WCSI hoki fishery for June to September 2000.

Month	Total no. tows	No. observed tows	% tows observed	No. observed fur seals	Mean bycatch rate	Standard error	Estimated no. fur seals caught	c.v. (%)
June	667	47	7	2	–	–	–	–
July	3 227	532	17	50	0.094	0.015	303	16
August	3 069	469	15	24	0.051	0.012	157	23
September	723	115	16	9	0.078	0.029	57	38

5.1.2 CHAT hoki fishery

This fishery represented about 40% of the hoki target fishing in 1999–2000. At least 55 vessels targeted hoki in this area, and 13 of these were observed at some stage. Effort was spread throughout the year, and tows were observed in most months of the year, but the observer coverage was not very representative of the fishing effort (see Table 13, Figure E2 in Appendix E). The observed tows in this area represented about 23% of the total observed hoki tows, but only 6% of the tows in CHAT. Observers reported four fur seal captures, all as single captures in bottom tows (which accounted for 88% of observed tows); three were caught and released alive (two in June and one in November) and one was landed dead in May. Mean monthly bycatch rates ranged from 0.003 fur seals per tow (s.e. = 0.003) in May when 32% of the 900 tows were observed to 0.019 fur seals per tow (s.e. = 0.012) in June when 18% of 588 tows were observed. No estimates of total catch are given here because the low numbers of fur seal captures result in c.v.s greater than 60%.

5.1.3 COOK hoki fishery

Target fishing for hoki in this fishery took place throughout the year, with July and August accounting for about 50% of the effort. Total fishing effort here accounted for about 15% of all hoki tows during 1999–2000. About 5% of all observed hoki tows were in this area, during July to September. Twenty-two vessels fished here during the year, and seven were observed. The 165 observed tows represented 3% of the total fishing effort of 4718 tows. One fur seal was observed caught and landed dead in a midwater tow in August. Data for this area were considered inadequate for further analysis.

5.1.4 PUYS hoki fishery

Of the 28 vessels that targeted hoki during 1999–2000 at PUYS, 5 were observed, and from a total of about 580 tows, 32 were observed and there was no reported fur seal bycatch.

5.1.5 SUBA hoki fishery

About 43 vessels targeted hoki in the SUBA area and contributed to about 20% of the hoki fishing effort in 1999–2000. Fourteen of these vessels were observed at some time and this observed effort represented 35% of all observed hoki tows. Most tows targeting hoki in this fishery were made during January to June (see Table 14, Figure E3 in Appendix E). The monthly observed effort was at least 18% for these months, and 11 fur seals were observed caught during this time (Table 23). One fur seal was also observed caught during October when less than 7% of the 588 tows were observed. Ten fur seal captures were reported from bottom tows, which were used in 95% of the observed tows in this area. Three fur seals were released alive and nine landed dead. Despite the good observer coverage for the main months of the fishery, the estimates given should be treated with caution (as is suggested by the c.v.s) because of the low number of observed fur seal captures and, in some months, of observed tows. During 1999–2000, 18% of the 6406 tows were observed and a mean bycatch rate of 0.011 fur seals per tow (s.e. = 0.003) was observed: this resulted in a total estimate of 70 fur seals (c.v. = 25%), which equates to about 53 dead fur seals and 17 released alive.

Table 23: Fishing effort, observed effort, and mean bycatch rates (numbers of fur seals per tow) for the SUBA hoki fishery, by month for January–July 2000.

Month	Total no. tows	No. observed tows	% tows observed	No. fur seals observed caught	Mean bycatch rate	Standard error	Estimated number caught	*c.v.* (%)
January	951	173	18	0	–	–	–	–
February	568	147	26	0	–	–	–	–
March	638	122	19	3	0.025	0.013	16	51
April	859	158	18	1	0.070	0.028	60	40
May	1 056	269	25	2	0.019	0.009	20	46
June	772	199	26	3	0.035	0.011	27	32
July	66	22	33	2	0.091	0.052	6	57

5.2 Southern blue whiting fishery

The southern blue whiting fishery operated during August, September, and October 2000 on the spawning grounds at Bounty Platform, Pukaki Rise, and Campbell Plateau, all within the bounds of QMA 6. Of the 603 southern blue whiting tows, 226 were observed and 83 fur seals were observed caught. Most of the observed effort was at Campbell Plateau (81%), where 16% of the fur seal captures (n = 12) were observed. About 12% of the observed effort was at Bounty Platform (Figure 9) and these tows accounted for 96% of the observed fur seal captures (n = 70). One fur seal was observed caught at Pukaki Rise.

Fifty percent of the vessels at Bounty Platform (6) and at Pukaki Rise (8) were observed, and 62% of 16 vessels fishing at Campbell Plateau were observed. All the observed fur seal captures at Pukaki Rise and Campbell Plateau were in midwater nets, whereas 54% of the fur seal captures at Bounty Platform were in bottom tows — though one of these tows accounted for 22 fur seals. Overall, 83% of the observed tows used midwater nets. All fur seals were landed dead.

The observed fishing effort peaked in Weeks 4 and 5 of the fishery (mid September) when vessels were fishing at the Campbell Plateau (Figure E6 in Appendix E). Fur seal captures peaked in Week 2 when all the observed effort was at the Bounty Platform. Mean fur seal bycatch rates are given in Table 24. The bycatch rate at the Bounty Platform (inflated by the multiple captures) (see Table 20) was the highest seen in 1999–2000 substantially higher than at Campbell Plateau.

The total number of fur seals estimated captured (and landed dead) in the 2000 southern blue whiting fishery is 246 (c.v. = 26%) at the Bounty Platform, and 29 fur seals (c.v. = 24%) at the Campbell Plateau in September. This gives a total for these areas of 277 fur seals (c.v. = 24%).

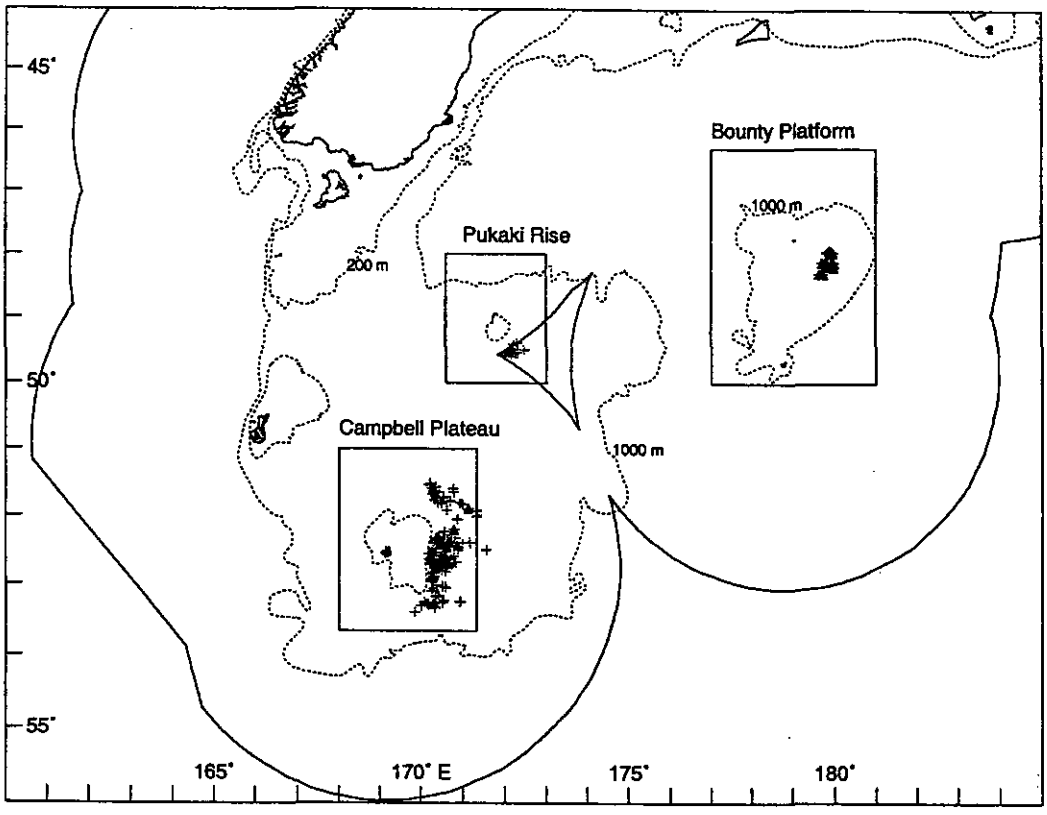

Figure 9: Start positions of observed tows (+), including those with New Zealand fur seal bycatch (▲), for the main southern blue whiting fishery areas, August-October 2000.

Table 24: Fishing effort, observed effort, and mean bycatch rates (numbers of fur seals per tow) for the southern blue whiting fisheries, August-October 2000.

Month	Total no. tows	No. observed tows	% tows observed	No. observed fur seals	Mean bycatch rate	Standard error	Estimated no. fur seals caught	c.v. (%)
Bounty Platform								
August	86	25	29	38	1.520	0.200	131	13
September	13	3	23	32	10.667	4.216	139	40
August-September	99	28	28	70	2.500	0.658	246	26
Campbell Plateau								
Sep	435	178	41	12	0.067	0.016	29	24
Oct	12	4	33	0	–	–	–	–

5.3 Squid trawl fishery on the Stewart-Snares shelf and in SQU 6T

The distribution of squid trawl fishing effort is defined by the areas SQU 1T and SQU 6T (see Annala et al. 2001 for areas). Ten fur seals were observed caught in squid trawls in 1999–2000 on the Stewart-Snares shelf and 2 on the Auckland Islands Shelf (see Figure 7). A description of the observer coverage of these fisheries is given in the seabird section (Stewart-Snares shelf) and the Hooker's sea lion section (SQU 6T). The fur seals reported from SQU 6T were caught in February and in March. No fur seals were reported from the fishery off the east coast of the South Island along the Chatham Rise.

About 21% of observed tows used bottom nets and these accounted for 6 of 12 observed fur seal captures. All fur seals were caught singly, and two were released alive (one from each area). Fur seal captures were observed in February and March (Figures E4 and E5 in Appendix E). Monthly estimates are given in Table 25, but the low number of fur seals observed caught results in less precise estimation. For the observed January-March part of the fishery, 22% of the 1632 tows made at the Stewart-Snares shelf were observed and the mean bycatch rate of 0.028 fur seals per tow (s.e. = 0.008) resulted in a total estimate of 46 fur seals (c.v. = 28%). Ninety percent of the observed fur seals were landed dead, and this equates to an estimated total of 41 fur seal deaths at the Stewart-Snares shelf. No estimates are presented for the SQU 6T part of the fishery because of the low numbers observed caught.

Table 25: Fishing effort, observed effort, and mean bycatch rates (numbers of fur seals per tow) for the Stewart-Snares Shelf squid trawl fishery, for October 1999 to June 2000.

Month	Total no. tows	No. observed tows	% tows observed	No. fur seals observed caught	Mean bycatch rate	Standard error	Estimated number caught	c.v. (%)
October-December	75	0	0	–	–	–	–	–
January	611	44	7	0	–	–	–	–
February	465	132	28	8	0.061	0.018	28	30
March	556	175	31	2	0.011	0.006	6	56
April-June	179	0	0	–	–	–	–	–

5.4 Jack mackerel trawl fishery

New Zealand fur seals were observed caught in 3 observed jack mackerel tows in March 2000 in JMA 3 (see Annala et al. 2001 for areas): 2 fur seals were landed dead from the southern edge of the Stewart-Snares shelf and 2 were landed dead from one tow off the east coast of the South Island where 11 of the 26 tows in March were observed. About 70% of the jack mackerel tows at the Stewart-Snares shelf were observed in March. Most of the fishing effort in JMA 3 was at the Stewart-Snares shelf and of the 1000 tows made in JMA 3 during January-April (the period of observer coverage), 38% of the tows were observed.

5.5 Tuna longline fishery

During 1999–2000, 49 New Zealand fur seals were observed caught on Japanese chartered tuna longlines; 3 were observed caught in Area 2 and 46 in Area 3 (Figure 10, Table 26). The observed captures peaked in June (Weeks 9–13, see Figure D1 in Appendix D) when vessels were fishing mainly off the west coast of the South Island. Three fur seals were landed dead, and the remaining 46 were released alive.

Table 26: Fishing and observed effort for the areas with fur seals bycatch during chartered Japanese tuna longline operations, in Areas 2 and 3, 1999–2000.

	Area 2				Area 3			
Month	Total no. sets	Total no. hooks	% hooks observed	No. fur seals	Total no. sets	Total no. hooks	% hooks observed	No. fur seals
April	21	64 850	100	3	16	47 440	100	2
May	–	–	–	–	88	268 030	99	14
June	–	–	–	–	79	246 060	86	29
July	–	–	–	–	9	27590	83	1

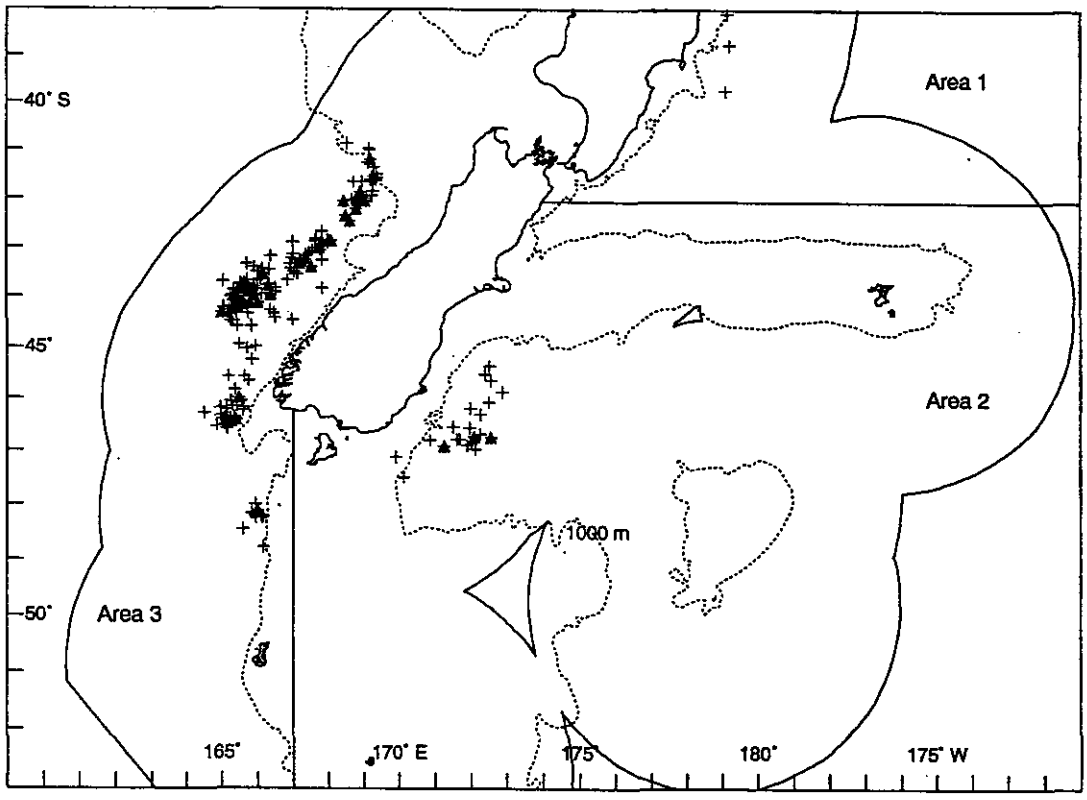

Figure 10: Start positions of observed chartered Japanese tuna longline sets (+), including those with New Zealand fur seal bycatch (▲), 1999–2000.

5.5 Ling longline fishery

One New Zealand fur seal was observed caught and released alive from a ling longline set in September 2000 in LIN 6, off the southern edge of the Stewart-Snares shelf.

6. OTHER NONFISH SPECIES INTERACTIONS WITH FISHERIES

Two separate incidents during observed jack mackerel tows in October resulted in the observed captures of one bottlenose dolphin and three pilot whales in October 1999 in JMA 7 at 40° S off the west coast of the North Island. All animals were landed dead.

7. DISCUSSION

The analysis of the occurrences of nonfish species bycatch in New Zealand fisheries is very dependent on the spatial and temporal distribution of observer coverage. The incidental capture of nonfish 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. Certain fisheries in New Zealand waters have 15–20% of the fishing operations observed, and for these fisheries annual estimates of the incidental capture of nonfish species can be made and compared.

7.1 Seabirds

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 which 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 2000a). These areas do not appear to be frequented by many of the seabird species which are deemed "at-risk" (Anon. 2000a). Bycatch rates here (Area 3) were lower in 1999–2000 than the two previous years (0.033 seabirds per 1000 hooks compared with 0.06 for 1998–99), but the rate for Area 2 was higher (0.162 seabirds per 1000 hooks compared with 0.020 in 1998–99).

In comparison, observer data for the domestic fleet continued to be poor, at less than 1% of total effort; this is largely a result of the difficulties in placing observers on these vessels as well as the huge increase in effort during the last three years. Most of these vessels fish in the northern waters and the few data that are available suggest that seabird bycatch rates from these vessels are high (0.86 seabirds per 1000 hooks, s.e. = 0.22, in 1999–2000) and that seabird species reported caught by these vessels are different from those reported from the larger chartered Japanese vessels when both vessel types are 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.

There are difficulties in the investigation of any differences in the way in which seabird species may be more likely to be caught, because only dead seabirds are returned for identification, and in some fisheries not all dead seabirds are returned. The percentage of seabirds released alive from chartered longlines was less than that seen in 1998–99 (Baird 2001a), but at 35% was still higher than the 5–10% for years up to 1998–99.

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. Observation work undertaken by the Department of Conservation in recent years may provide increased understanding of the interaction of the trawl operations and the seabirds.

The highest incident rates (numbers of seabirds per observed fishing operation) were from the longline fisheries: 44% of observed domestic tuna sets, 19% of observed ling sets in LIN 6, and 10% of observed chartered Japanese longlines had seabird bycatch. In comparison, about 2–3% of observed hoki and squid trawls at Stewart-Snares shelf and about 5% of observed squid tows at SQU 6T had seabird bycatch.

A summary table of seabird captures and estimates of 1999–2000 is given in Table 27. The highest seabird bycatch rates were reported from the tuna longlines set by chartered Japanese vessels off East Cape (Area 1) and off the southeastern coast of the South Island (Area 2). However, the numbers of seabirds caught here are low compared with numbers in other areas, such as on the Stewart-Snares shelf during trawl fishery operations and in the sub-Antarctic ling longline fisheries. Seabird bycatch rates for the SUBA hoki fishery were substantially lower in 1999–2000 than in 1998–99, and there was no real difference between the hoki and squid fishery seabird bycatch rates at the Stewart-Snares shelf.

Observer coverage of the ling longline vessels was more representative in 1999–2000 than in previous years, and estimation of total numbers of seabirds caught in some areas may be possible with improved data collection from both the observers and the fishers.

Table 27: Summary of seabird data from observed fishing operations for those fishery-areas for which data were adequate for 1999–2000*.

Area/ Month	Total no. tows/ hooks	% observed	No.. observed seabirds	Mean bycatch rate	Standard error	Estimated no. seabirds caught	*c.v.* (%)
Chartered Japanese tuna longline fishery							
Area 1	47 000	100	11	0.203	–	–	–
Area 2	64 850	100	11	0.162	–	–	–
Area 3	690 040	80	18	0.033	0.003	–	–
Area 4	22 500	100	0	0.000	–	–	–
Trawl fisheries							
WCSI hoki	7 686	15	10	0.009	0.004	69	41
SUBA hoki	6 406	18	37	0.033	0.006	209	19
SQU 6T	1 206	36	30	0.068	0.016	82	19
STEW squid	1 632	22	20	0.057	0.020	93	34

* 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. Where 100% observer coverage, the figure given is the known number of seabirds caught rather than an estimate.
Preliminary observed seabird mean incidental catch rates (seabirds per 1000 hooks) for the ling longline fishery:
LIN 3 (Nov-Dec) 0.031 (s.e. = 0.017); LIN 4 (Nov-Dec) 0.098 (s.e. = 0.036);
LIN 5 (Nov-Dec) 0.079 (s.e. = 0.015); LIN 6 (Jan-Feb) 0.013 (s.e. = 0.005), (Aug-Sep) 0.10 (s.e. =0.02).

7.1.1 Seabird species

The foraging behaviour, including the distance travelled and the direction in which the birds travel, has been studied for some seabird populations breeding in New Zealand (Nicholls et al. 1994, Walker et al. 1995, Sagar & Weimerskirch 1996). At present, knowledge of the at-sea distribution of many of the seabird species which interact with fishing operations is insufficient (Baird 2001a). There is some *ad hoc* data collection that relates to the distribution of seabirds 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 (Table 28). 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.

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 "at-risk" species. The seabird species that are reported from these vessels, especially the albatross species, are also reported from trawl fisheries.

Petrel taxa, especially the grey and white-chinned petrels, are most prevalent in the ling longline fisheries, which set throughout the 24 hours. Most of the grey petrels caught on ling longlines are male and in 1999–2000 they were observed caught during August-September in LIN 6. Murray et al. (1993) showed that grey petrel captures in more northern waters, off East Cape, in July-August were usually females.

Determination of the number of "at risk" species (Anon. 2000a) caught during fishing operations would be improved with the use of photographs taken by observers when seabirds are caught and released alive or are landed dead but cannot be returned. If these photographs have the associated trip and tow/set data assigned to them, they could add to the information gathered from those seabirds returned for identification.

Mitigation methods continue to be used in the tuna longline fisheries (Anon. 2000a), and the observed ling longline vessels use tori lines to distract the seabirds during setting (Ministry of Fisheries observer reports). Observers also report that when problems with the trawl gear result in the capture of seabirds (for example, loose wires on the trawl warp), the crew take action to correct the problem. However, anecdotal information suggests that many of the seabird-trawl warp interactions occur when the seabirds are in a feeding frenzy and a sudden swell movement occurs. Smaller seabirds are vulnerable when the net is at the surface and they attempt to dive for food (Ministry of Fisheries observer reports).

Table 28: Seabird taxa recorded for those seabirds returned from observed longline and trawl fishing operations, 1996–97 to 1999–2000, by Fisheries Management Area (FMA)*.

FMA	Tuna longline fisheries	Ling longline fisheries	Trawl fisheries
Albatross taxa			
FMA 1	Campbell		
FMA 2	Antipodean, black-browed, Buller's, Campbell, Chatham, Gibson's, northern royal, Salvin's, unidentified wandering, white-capped		Pacific, Salvin's, white-capped
FMA 3	Antipodean, Buller's, Campbell, Gibson's, light-mantled sooty, northern royal, unidentified wandering, white-capped	Salvin's	Antipodean, Buller's, Salvin's, southern royal, white-capped
FMA 4		Buller's	Black-browed, Buller's, Campbell, Salvin's, white-capped
FMA 5	Buller's, Campbell, Gibson's, light-mantled sooty, southern royal, white-capped		Buller's, Campbell, Salvin's, southern royal, white-capped
FMA 6		Salvin's	Buller's, Campbell, white-capped
FMA 7	Black-browed, Buller's, Campbell, Gibson's, light-mantled sooty, white-capped		Black-browed, Buller's, Campbell, white-capped
Petrel taxa			
FMA 1	Black, flesh-footed shearwater		Flesh-footed shearwater, sooty shearwater
FMA 2	Northern giant, black, grey, white-chinned, flesh-footed shearwater		Flesh-footed shearwater, sooty shearwater
FMA 3	Grey, white-chinned	White-chinned	Grey, sooty shearwater
FMA 4		White-chinned	Northern giant, grey-faced, white-chinned, sooty shearwater, Antarctic prion, southern cape pigeon
FMA 5	Grey, white-chinned	White-chinned	White-chinned, black-bellied storm, sooty shearwater
FMA 6	White-chinned	Northern giant, southern giant, grey, white-chinned, cape pigeon, Snares cape pigeon, southern cape pigeon	Grey, white-chinned, sooty shearwater, cape pigeon, diving pigeon,
FMA 7			Cape pigeon, fairy prion

* There were no seabirds returned from FMA 8, FMA 9, or FMA 10.

7.2 New Zealand fur seals

The 203 fur seals reported from observed trawl fisheries in 1999–2000 was similar to the 190 of the previous year. About 50% of the fur seal captures were observed in hoki trawls (83% of these were from the WCSI hoki fishery), and 42% from the southern blue whiting fisheries. About 6% of observed tows in the WCSI hoki fishery had fur seal bycatch, and a similar percentage occurred in the southern blue whiting fishery at the Campbell Plateau. However, of the 28 observed tows at the Bounty Platform, 75% had observed fur seal bycatch.

The reported fur seal catch from the 1999–2000 WCSI hoki fishery was higher than the low of 34 reported for 1999 season, but was lower than that seen in 1998 and 1996 (Baird & Bradford 2000b). The mean bycatch rate of 0.073 fur seals per tow (s.e. = 0.009) was substantially higher that that in 1999 (0.13 fur seals, s.e. = 0.05) and in 1994 and 1995, but similar to those reported for 1997 and 1998 (Baird & Bradford 2000b). Baird & Bradford (2000b) found that the mean bycatch rate observed south of 41° 30' S for 1991–98 was substantially higher than that for observed effort north of this latitude. This was also the situation in 1999–2000: mean bycatch rate for tows north of 41° 30' S was 0.006 fur seals per tow (s.e. = 0.006) compared with 0.083 (s.e. = 0.011) for the southern effort. However, the observed effort south of 41° 30' S represented 87% of the total observed effort and 84 of the 85 reported fur seals were from this area of the fishery.

The mean bycatch rate for the hoki fishery at SUBA (mainly off the southern edge of the Stewart-Snares shelf) was substantially less than that reported for the WCSI hoki fishery, but was within two standard errors of the mean bycatch rate reported from the squid tows at Stewart-Snares shelf (Table 29). The mean bycatch rate reported from the Campbell Plateau southern blue whiting fishery was similar to that at the WCSI hoki fishery. As in previous years, the highest mean bycatch rate was in the Bounty Platform southern blue whiting fishery, where a mean bycatch rate of 2.5 fur seals per tow (s.e. = 0.658) was reported and this was substantially higher than the other rates in 1999–2000. This result was also substantially higher than rates for the previous two years (Baird 1999, 2001a) and was characterised by the small number of observed tows and the occurrence of multiple captures per observed tow. As in previous years, fur seals caught at the Bounty Platform were more likely to be landed dead than those caught elsewhere.

Table 29: Summary of fur seal data from observed fishing operations for those fishery-areas for which data were adequate for 1999–2000.

Area	Total no. tows	% observer coverage	No. observed fur seals	Mean bycatch rate	Standard error	Estimated no. fur seals caught	c.v. (%)
Hoki fisheries							
SUBA	6 406	18	12	0.011	0.003	70	25
WCSI	7 686	15	85	0.073	0.009	561	13
Southern blue whiting fisheries (August-September 2000)							
Bounty	99	28	70	2.500	0.658	246	26
Campbell (September)	435	41	12	0.067	0.016	29	24
Squid fishery							
STEW	1 632	22	10	0.028	0.008	46	28

* Fishery areas are given in Appendix B.

8. ACKNOWLEDGMENTS

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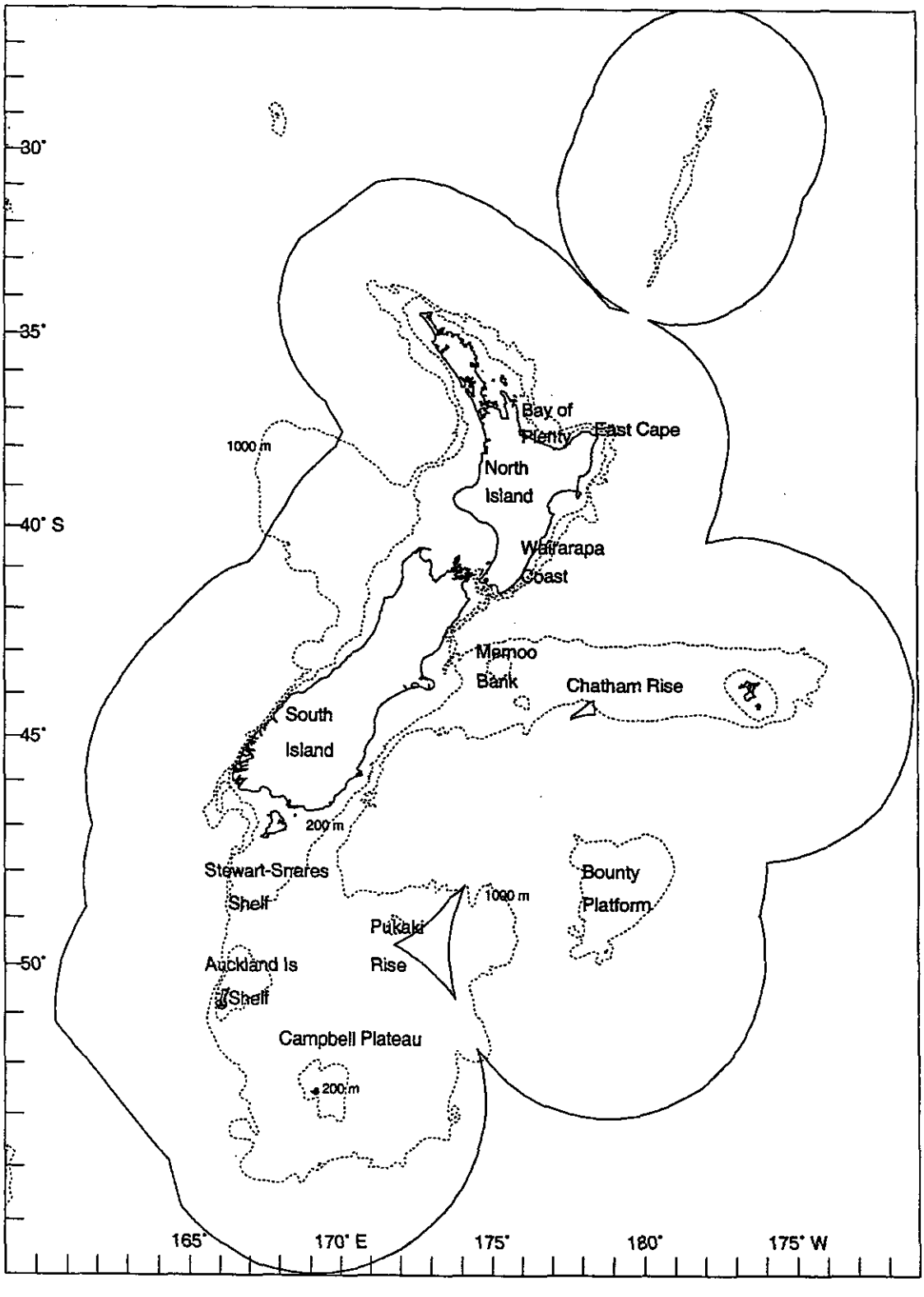
APPENDIX A: PLACE NAMES MENTIONED IN THE TEXT



APPENDIX B: FISH AND SEABIRD SPECIES CODES

Table B1: 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
Scampi	*Metanephrops challengeri*	SCI
Silver warehou	*Seriolella punctata*	SWA
Southern blue whiting	*Micromesistius australis*	SBW
Squid	*Nototodarus* spp.	SQU
Smooth oreo	*Pseudocyttus maculatus*	SSO
White warehou	*Seriolella caerulea*	WWA

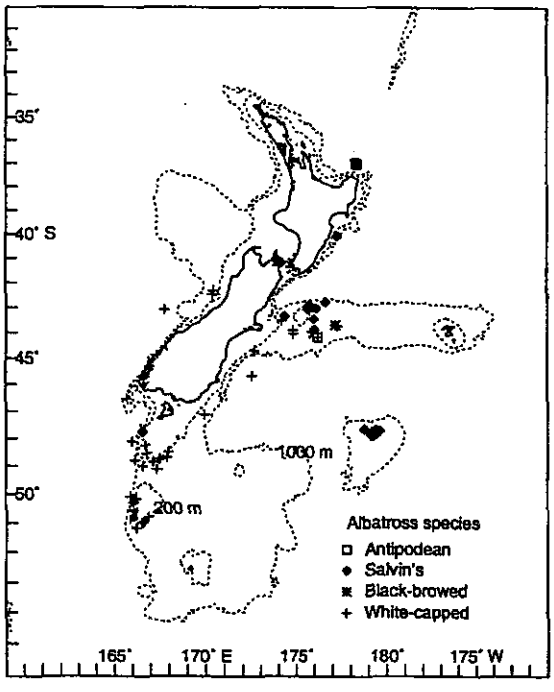
Table B2: Seabird species codes (those marked with * are "at risk" (Anon. 2000a))

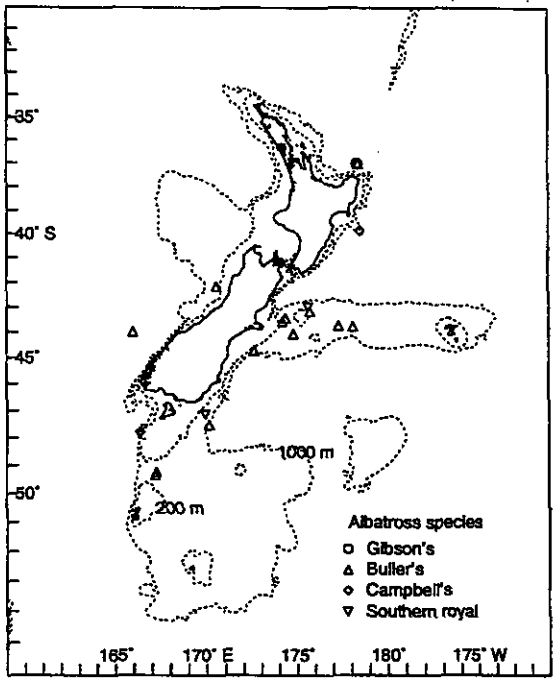
Common name	Scientific name	Seabird code
Albatross taxa		
Antipodean *	*Diomedea antipodensis*	XAN
Gibson's*	*Diomedea gibsoni*	XAU
Southern royal	*Diomedea epomophora*	XRA
Buller's	*Thalassarche bulleri*	XBM
Campbell*	*Thalassarche impavida*	XCM
Black-browed	*Thalassarche melanophrys*	XSM
Black-browed (unidentified)	*Thalassarche* spp.	XKM
Salvin's	*Thalassarche salvini*	XSA
White-capped	*Thalassarche steadi*	XWM
Petrel taxa		
Northern giant	*Macronectes halli*	XNP
Southern giant	*Macronectes giganteus*	XSP
Grey petrel*	*Procellaria cinerea*	XGP
White-chinned*	*Procellaria aequinoctialis*	XWC
Black petrel*	*Procellaria parkinsoni*	XBP
Flesh-footed shearwater	*Puffinus carneipes*	XFS
Sooty shearwater	*Puffinus griseus*	XSH
Diving petrel	*Pelecanoides urinatrix*	XDP
Southern cape pigeon	*Daption capense capense*	XCC
Fairy prion	*Pachyptila turtur*	XFP

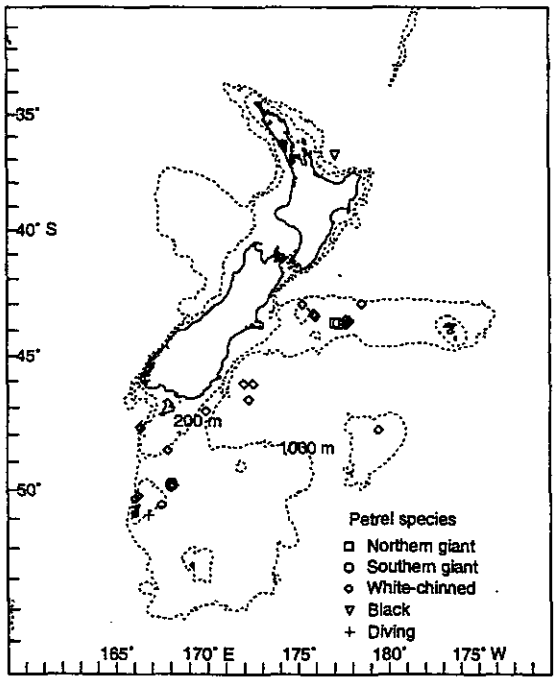
Table B3: Fishery area codes

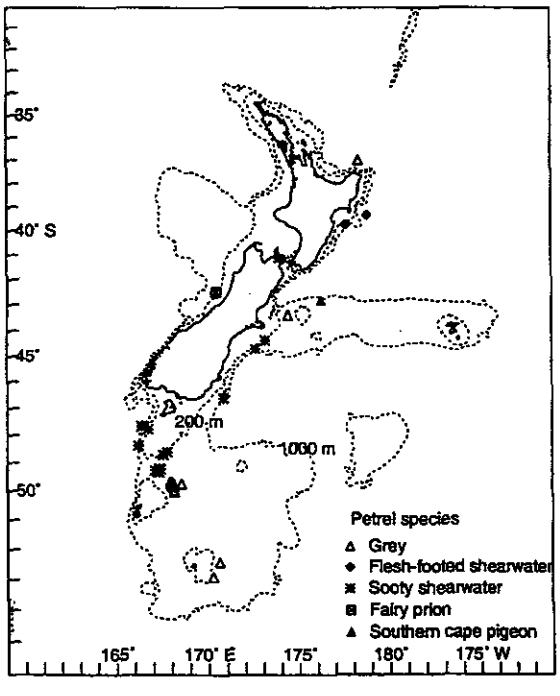
Fishery area	Code	Fishery area	Code
Chatham Rise	CHAT	East coast South Island	ECSI
Cook Strait	COOK	Stewart-Snares Shelf	STEW
Puysegur	PUYS	Bounty Platform	Bounty
Sub-Antarctic	SUBA	Campbell Plateau	Campbell
West coast South Island	WCSI		

APPENDIX C: START POSITIONS OF FISHING OPERATIONS WITH OBSERVED INCIDENTAL CAPTURE OF ALBATROSS AND PETREL SPECIES









APPENDIX D: WEEKLY DATA FOR LONGLINE FISHERIES

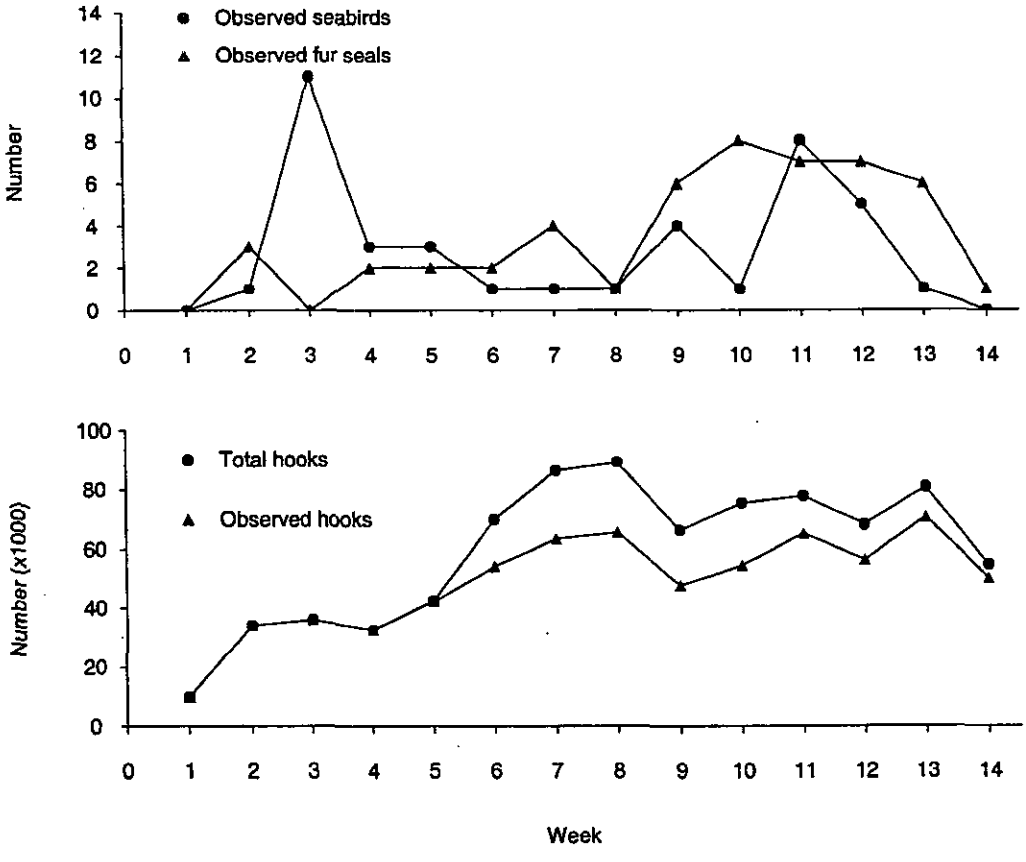


Figure D1: Observer data for chartered Japanese vessels in the tuna longline fishery, where Week 1 starts 1 April 2000.

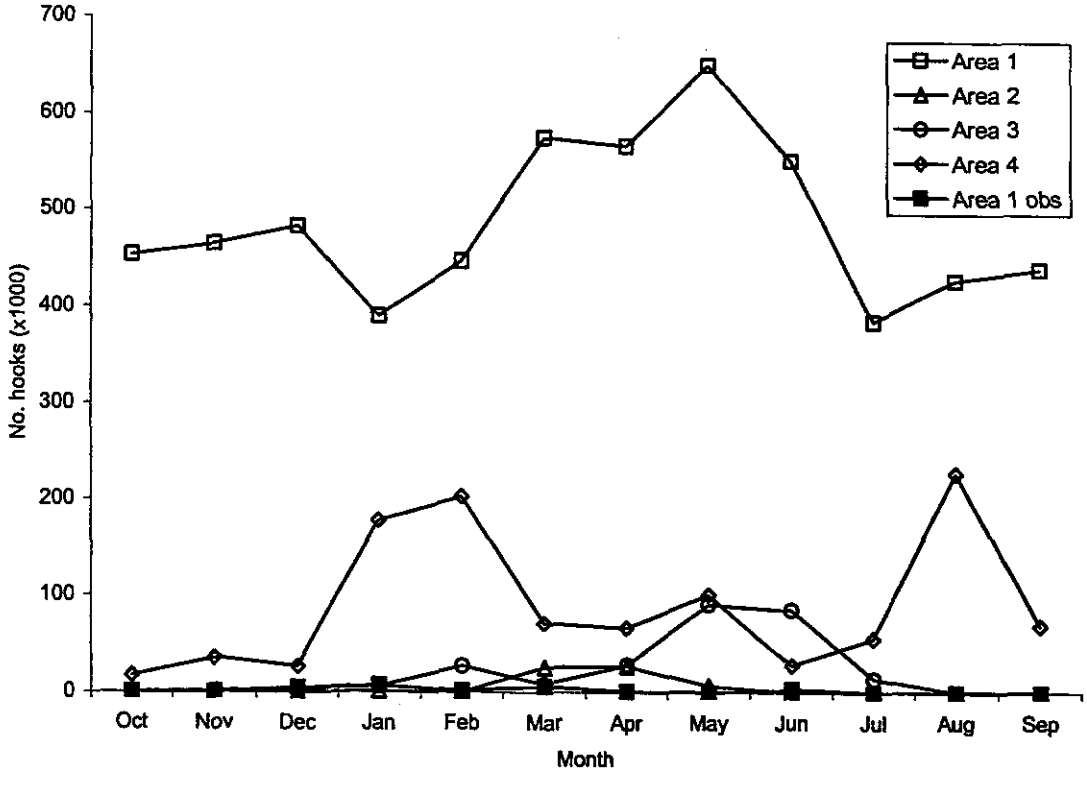


Figure D2: Total effort data (TLCER) and observer effort data (in Area 1 only) for domestic owned and operated tuna longline vessels, by month of fishing year 1999–2000.

APPENDIX D — *CONTINUED*

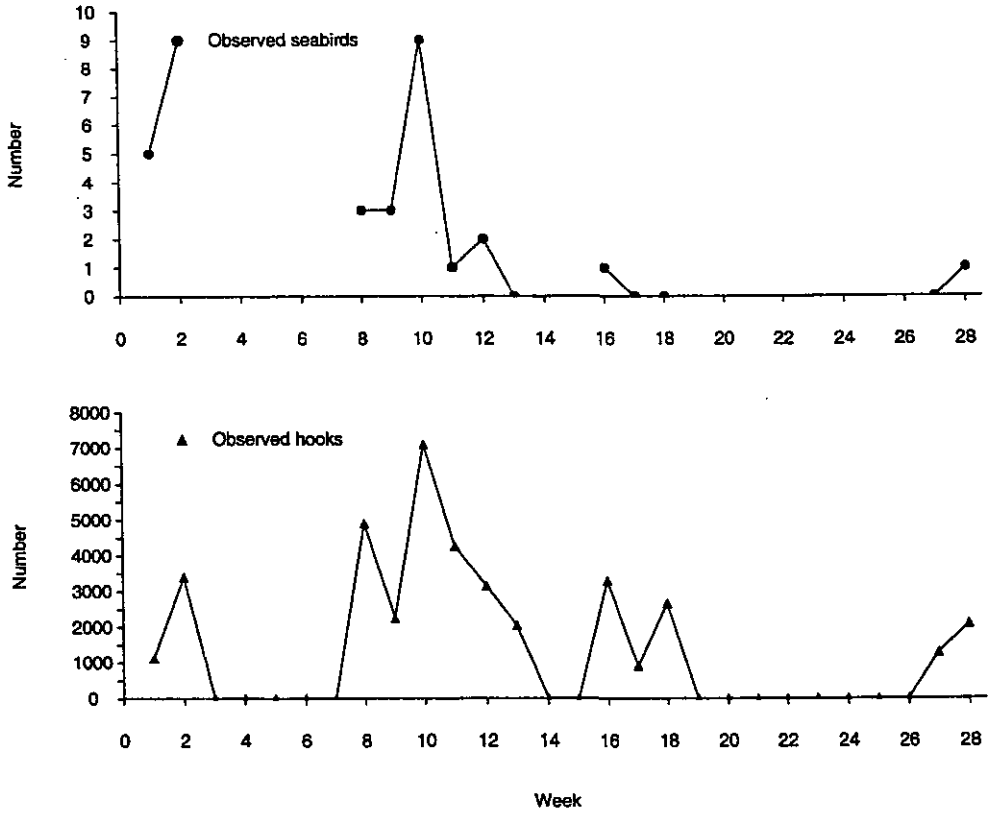


Figure D3: Observed data (Area 1) for domestic owned and operated tuna longline vessels, by week where Week 1 starts 1 December 1999.

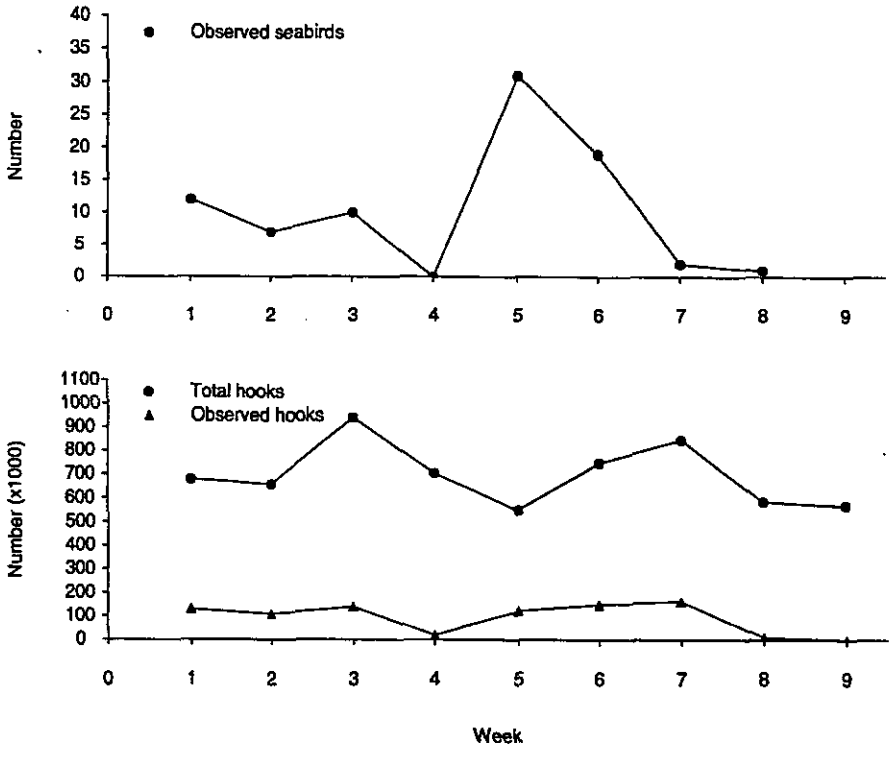


Figure D4: Domestic vessels in the ling longline fishery, where week 1 starts 1 November 1999 (November 1999–February 2000 inclusive).

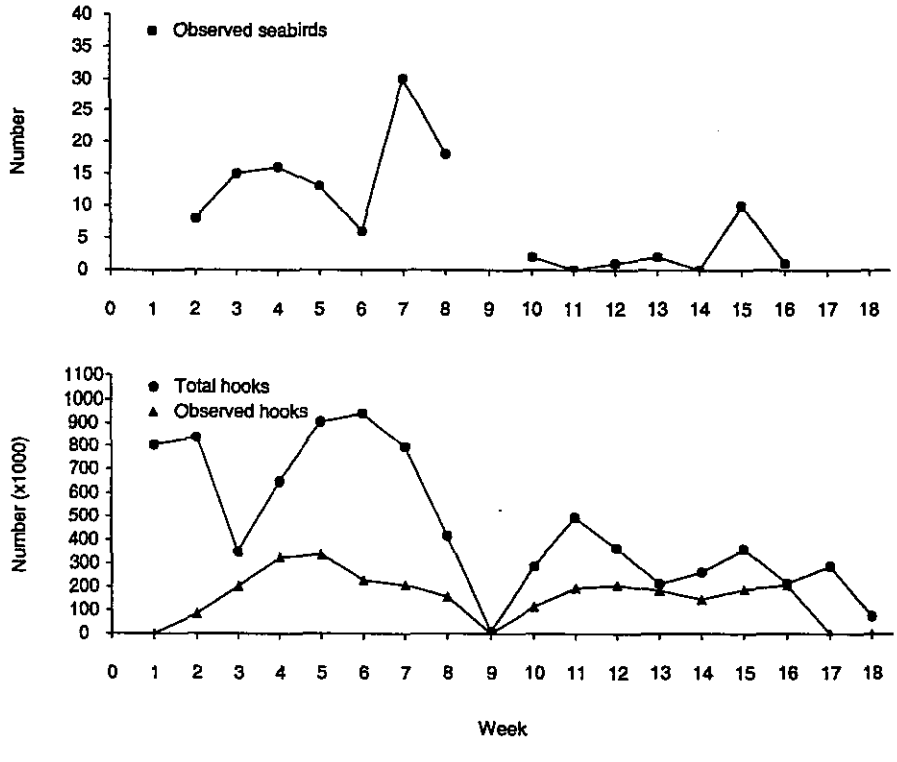


Figure D5: Domestic vessels in the ling longline fishery, where week 1 starts 1 August 2000.

APPENDIX E: TRAWL FISHERY OBSERVER DATA BY WEEK

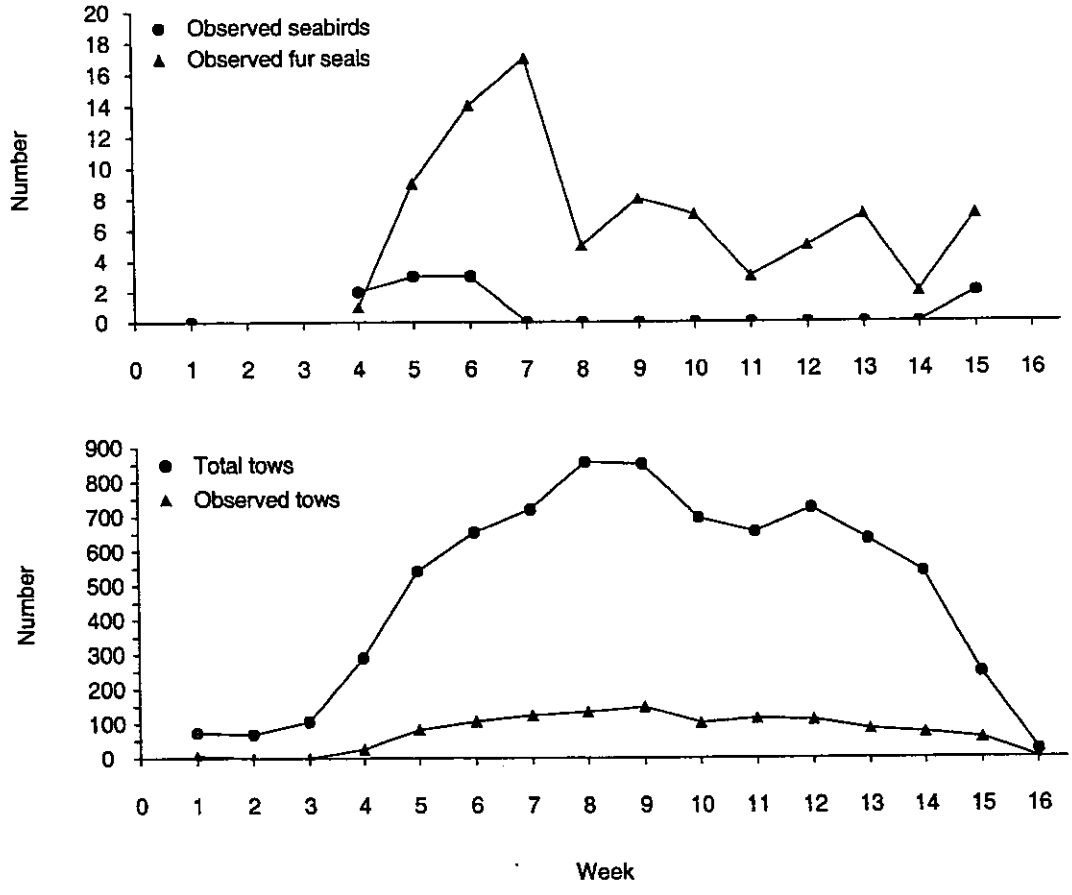


Figure E1: Number of observed tows and numbers of seabirds and fur seals observed caught during the June to September WCSI hoki fishery, where Week 1 starts 1 June 2000.

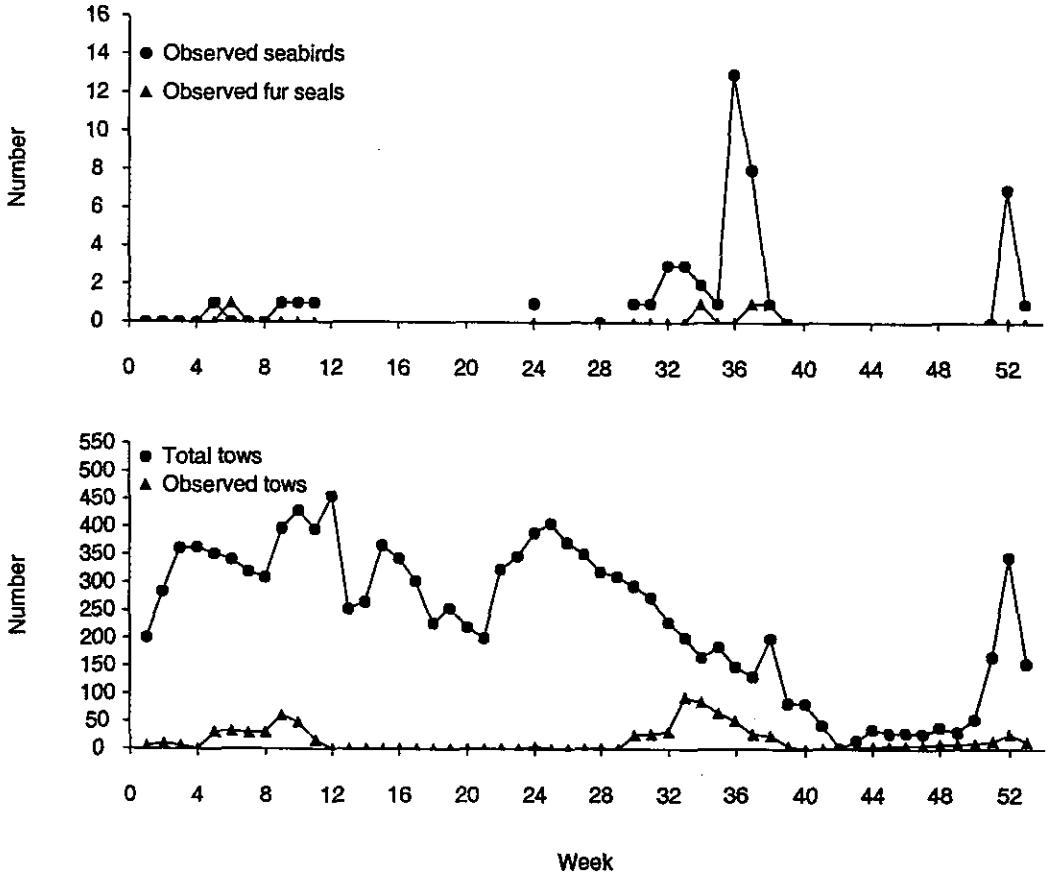


Figure E2: Number of all tows, observed tows, and numbers of seabirds and fur seals observed caught during the CHAT hoki fishery, where Week 1 starts 1 October 1999.

APPENDIX E — *CONTINUED*

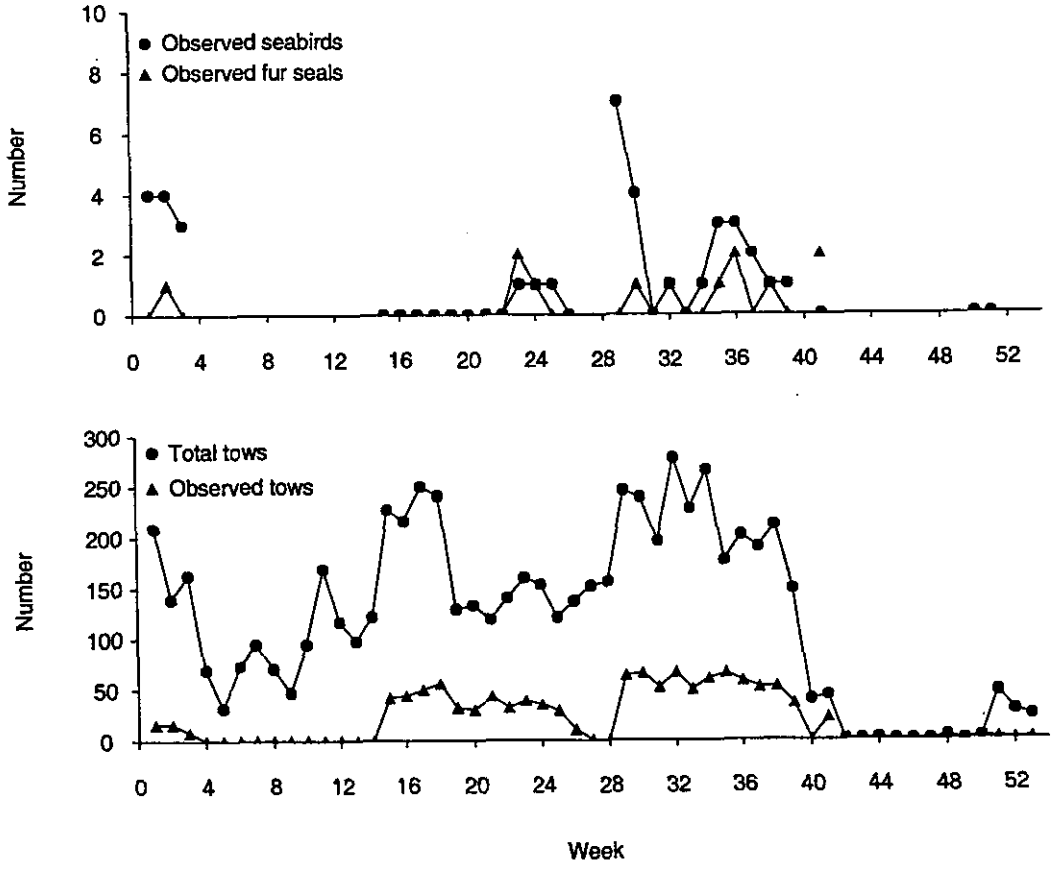


Figure E3: Number of observed tows and numbers of seabirds and fur seals observed caught during the observed SUBA hoki fishery, where Week 1 starts 1 October 1999.

APPENDIX E — *CONTINUED*

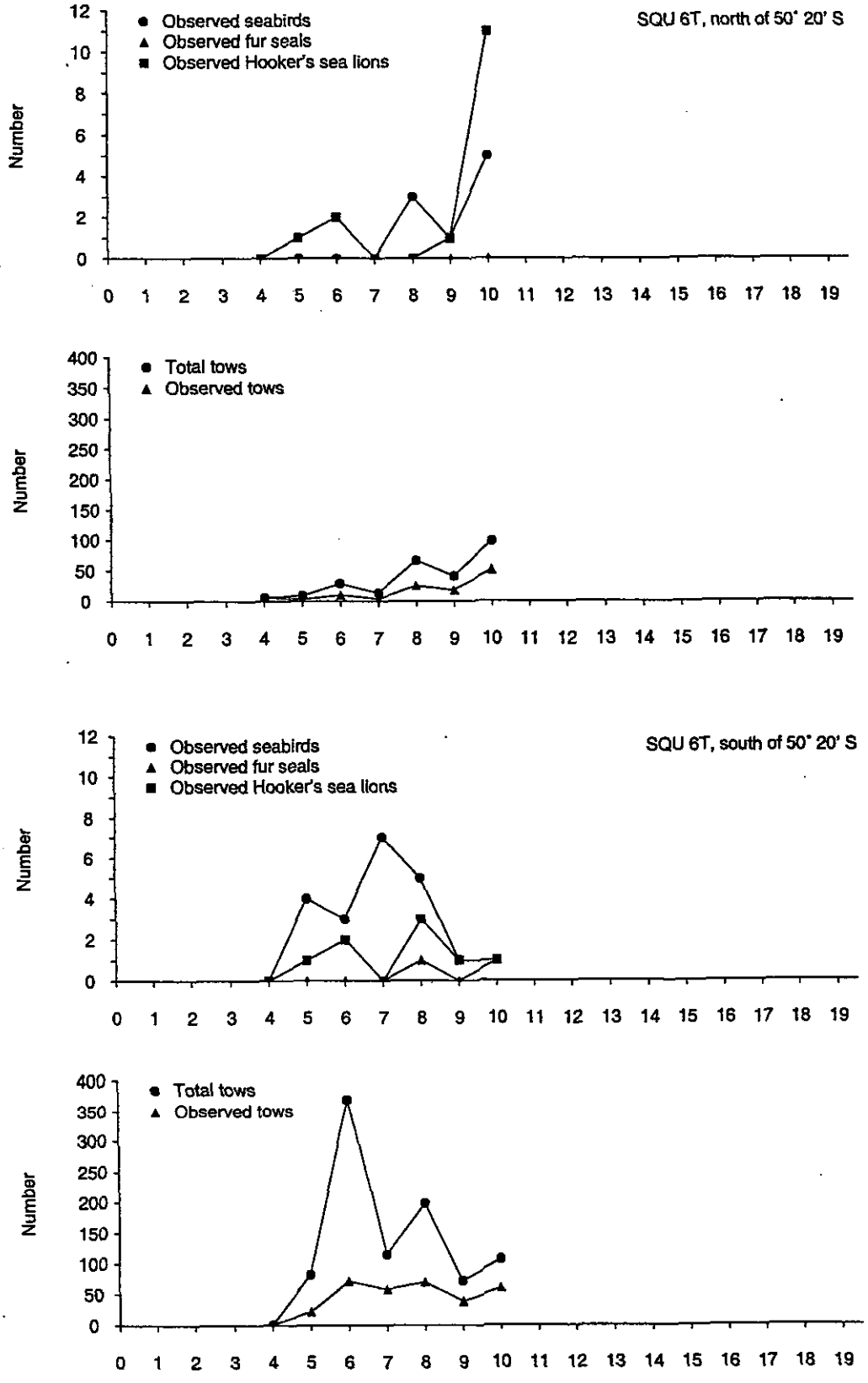


Figure E4: Number of observed tows and numbers of nonfish bycatch species observed caught during the observed SQU6T squid fishery, where Week 1 starts 1 January 2000.

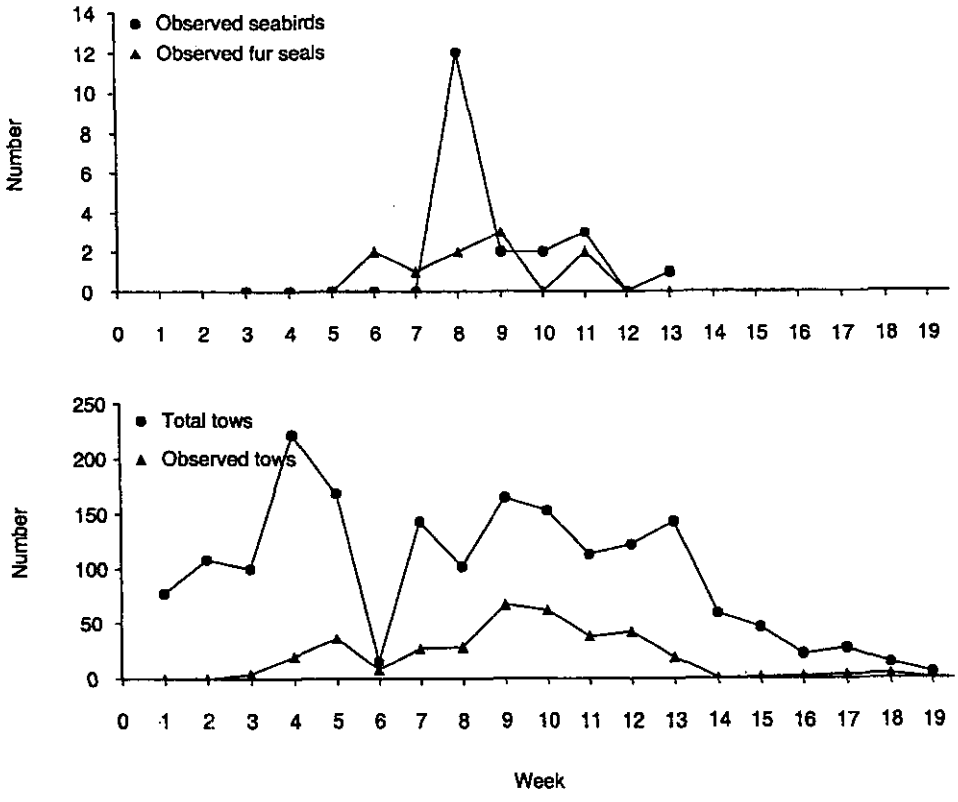


Figure E5: Number of observed tows and numbers of seabirds and fur seals observed caught during the observed STEW squid fishery, where Week 1 starts 1 January 2000.

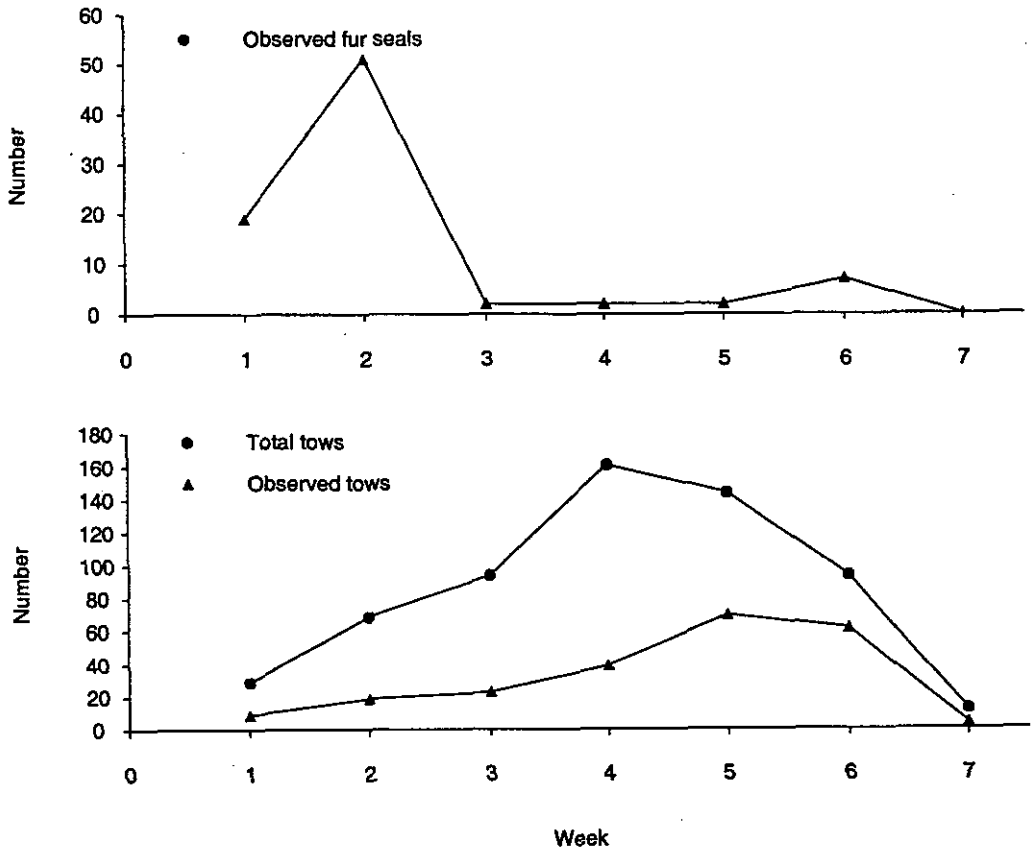


Figure E6: Number of observed tows and numbers of fur seals observed caught during the observed southern blue whiting fisheries. Week 1 starts 20 August 2000. Bounty Platform effort Week 1–3, Pukaki Rise effort Week 3 and 6, and Campbell Plateau effort in Week 3–7.