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Incidental capture of New Zealand fur seals (*Arctocephalus forsteri*) in commercial fisheries in New Zealand waters, 2001–02

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EXECUTIVE SUMMARY

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In 2001–02, Ministry of Fisheries observers recorded 148 New Zealand fur seal captures (82% landed dead) during trawl fishing operations that targeted at least eight commercial species, and 46 fur seals (96% released alive) on southern bluefin tuna (*Thunnus maccoyii*) longlines. About 73% of fur seal captures from trawl fisheries were from observed hoki (*Macruronus novaezelandiae*) trawls, 14% were from squid (*Nototodarus* spp.) trawls, and 5% from southern blue whiting (*Micromesistius australis*) trawls. Tows targeting jack mackerels (*Trachurus* spp.), silver warehou (*Seriolella punctata*), and scampi (*Metanephrops challengeri*) accounted for the remaining reported captures, mainly from tows off the Stewart-Snares shelf and along the Chatham Rise.

About 53% of fur seal captures from hoki trawls were from the west coast South Island fishery, where at least 1000 tows were observed. About 3% of these observed trawls had fur seal bycatch. Less than 1% of the 969 observed hoki tows on the Chatham Rise and 2% of the 720 observed squid trawls on the Stewart-Snares shelf caught fur seals. Higher incidence rates were observed in smaller fisheries, such as the hoki fisheries in Cook Strait and south of Puysegur Point, but the numbers of observed tows in these areas were limited. Few fur seals were observed caught in the southern blue whiting fisheries in 2001–02 relative to previous years. The lack of captures from these fisheries also resulted in a smaller number of multiple captures per tow reported for trawl fisheries.

Limitations in the data restrict the reliability of the results. Best estimates of total captures are from the hoki fishery off the west coast South Island and the squid fishery off the Stewart-Snares shelf. The total estimate for the July-September west coast South Island hoki fishery was 323 New Zealand fur seals (c.v. = 18%), based on a mean bycatch rate of 0.043 fur seals per tow (s.e. = 0.008). As in previous years, the mean catch rate of fur seals in this fishery area was higher for observed tows south of 41° 30' S than north of this latitude. About 75% of observed captures were landed dead. About 83 fur seals (c.v. = 22%) were estimated caught during August-September in the Cook Strait hoki fishery.

An estimated 74 fur seals were caught in the January-April squid fishery off the Stewart-Snares shelf, based on a mean bycatch rate of 0.023 fur seals per tow (s.e. = 0.006). About 89% of the observed captures from this area were landed dead. A similar mean bycatch rate was observed in the southern blue whiting fishery on the Campbell Plateau (SBW 6I). The total estimate of fur seals caught (and landed dead) during this August-October 2002 fishery was 18 (c.v. = 39%), based on a mean catch rate of 0.022 fur seals per observed tow (s.e. = 0.011).

All but one of the fur seal captures reported from tuna longlines were off the southern west coast of the South Island. In this area, 15% of observed sets caught fur seals. The observed mean catch rate of 0.061 fur seals per 1000 hooks (s.e. = 0.009) gave an estimated total catch of 49 fur seals (c.v. = 4%).

This report addresses Specific Objective 1 of ENV2001/03 "to estimate and report the total numbers of captures, releases, and deaths of *Arctocephalus forsteri* – by sex where possible – caught in fishing operations during the 2001/2002 fishing year".

1. INTRODUCTION

New Zealand fur seals (*Arctocephalus forsteri*) are distributed around the New Zealand coastline, on offshore islands, and on sub-Antarctic islands. The species was heavily exploited during the 18th and 19th centuries and protection was given to it in 1894, but restricted licences were still issued for seal harvest in certain locations. In 1978, New Zealand fur seals were given total protection under the New Zealand Marine Mammals Protection Act (Mattlin 1987).

Statutory obligations under the Fisheries Act 1996 require the Ministry of Fisheries (MFish) to monitor the bycatch of associated or dependent species during commercial fishing operations in New Zealand waters. The introduction of the New Zealand 200 n. mile Exclusive Economic Zone (EEZ) in 1978 led to an expansion of commercial fishing effort for middle depth and deepwater species, and this was paralleled with an increase in the bycatch of fur seals. The Ministry of Fisheries Observer Programme collects data on the incidental catch of nonfish species, including New Zealand fur seals, as part of its monitoring programme. Data on the interaction between trawl fishing operations and fur seals have been collected since the beginning of the observer programme in 1986, with data in the late 1980s mainly being collected from the west coast South Island hoki (*Macruronus novaezelandiae*) fishery where large numbers were observed caught in 1989 (Mattlin 1994).

Fur seals have also been reported caught from bottom and midwater trawl operations around the coastline of the South Island and the offshore islands in the southern waters of the EEZ, especially off the Stewart-Snares shelf and at the Bounty Platform (Baird 2001). A code of practice, with measures designed to avoid fur seal captures, was developed by the fishing industry in 1990 (see appendix 4 in Baird (1994)). The most recent code of practice used by vessels in the hoki and southern blue whiting (*Micromesistius australis*) fisheries 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 trawl fisheries, marine mammal exclusion devices are under evaluation as a potential tool to reduce fur seal bycatch. Ministry of Fisheries observers report that in some fisheries there are often many fur seals around the net during hauling, and that captures may occur when a vessel completes a turn with the gear near the surface or there are problems hauling the net in bad weather, such that the net is at the surface for longer than normal.

New Zealand fur seals have also been reported caught in southern bluefin tuna (*Thunnus maccoyii*) and ling (*Genypterus blacodes*) longline fisheries off the southern coast of the South Island (Baird 2004) and during bluenose (*Hyperoglyphe antarctica*) longline fisheries at around 40° S (Baird 2005). This report describes the main commercial fishery-fur seal interactions for the 2001–02 fishing year as required in Specific Objective 1 of ENV2001/03 "to estimate and report the total numbers of captures, releases, and deaths of *Arctocephalus forsteri* – by sex where possible – caught in fishing operations during the 2001/2002 fishing year".

2. METHODS

2.1 Data sources and treatment

The fisheries with observed New Zealand fur seal captures in 2001–02 included trawl fisheries that targeted at least eight commercial species and the southern bluefin tuna longline fishery in southern waters. Data extracted from MFish observer and commercial catch and effort databases were used for the analyses undertaken to estimate the total numbers caught.

These sources provided observed fur seal capture data, observed fishing effort data, and total fishing effort data.

Data were extracted for the target trawl and longline fisheries in which incidental captures of fur seals were recorded by MFish observers during the fishing year (1 October–30 September) 2001–02. The following observer data were extracted by target species for each fishing operation: trip, tow (or set and number of hooks), gear type, latitude and longitude, date and time, vessel identifier and nationality, number of fur seals, life status (alive or dead), handling code (released, discarded, or retained), and sex, as recorded by MFish observers. The following total fishing effort data for each fishing operation were extracted: trip, event, target species, gear type, gear parameters, latitude and longitude, date, time, and vessel identifier and nationality.

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.

Maps of all the areas used for each fishery are provided in relevant Appendices: tuna longline in Appendix B, general place names map in Appendix C, hoki in Appendix D, squid in Appendix E, and southern blue whiting in Appendix F.

2.2 Tuna longline fisheries

Tuna longline data (where the target was southern bluefin tuna) were extracted for chartered Japanese vessels and domestic owned and operated vessels fishing in southern waters where New Zealand fur seals were reported caught on tuna longlines. The areas used for the analysis include waters south of 40° S and equate to Areas 2 and 3 used in the analysis of seabird incidental captures by these vessels. Based on the Quota Management Areas (QMA) 1–10 described in Annala et al. (2004), the southern areas used here are defined as:

- 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; and
- Area 3 — west of longitude 167° E north to latitude 38° S.

For the tuna longline interaction analyses, total effort data were extracted from MFish database *tuna*, which consists of data collected from the Tuna Longline Catch Effort Returns. Data were groomed according to routine procedures (Wei 2003). Observer data were extracted from MFish database *l_line*, the groomed database developed from observer logbooks (Mackay & Griggs 2001).

All the chartered Japanese sets were observed and the total number of hooks reported per set by the observers was used to determine the total hook number for each stratum; the total number of hooks set as recorded by chartered fishers on TLCERs was 99% of that reported by observers. All the data for the domestic vessel were used as extracted from the *tuna* database, other than the hook data for one record (that was amended to match that of other sets). Observers may not observe the whole haul. Thus, the number of hooks used as the "observed number of hooks" for each haul is estimated from the proportion of the haul observed (based on the haul duration and the time recorded as unobserved in the observer events logs) multiplied by the number of hooks set.

2.3 Trawl fisheries

Commercial trawl effort records were extracted from the MFish *warehou* database developed from Trawl Catch Effort Processing Return forms (TCEPR) and Catch Effort Landing Return forms (CELR). Fur seal data from trawl fisheries were investigated by target fishery QMAs (defined by target species by Annala et al. (2004)). Position data (latitude and longitude) at the start of the fishing operation were used to determine the key areas for each interaction. Where appropriate, data were collated into individual species QMAs.

For some target fisheries, such as 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. (2004) 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). Baird & Bradford (2000) noted the apparent difference in fur seal capture rates north and south of about 41° 30' S in the WCSI fishery. Data for this fishery were also investigated using this division.

The areas used for the analyses of fur seal captures in the southern squid trawl fisheries were the Auckland Islands part of SQU 6T and the Stewart-Snares shelf (STEW). Squid trawls were also observed off the east coast of the South Island between 42° and 45° S and west of 174° 30' E (ECSI) and on the Chatham Rise east of 174° 30' E (CHAT). Fishing effort targeted at southern blue whiting was allocated to fishing areas at the Bounty Platform (SBW 6B), Pukaki Rise (SBW 6R), Campbell Rise (SBW 6I), and off the Auckland Islands Shelf (SBW 6A) (Annala et al. 2004).

General descriptions of characteristics of the fisheries, such as main season, vessel nationality, and gear type used are provided for each fishery area. The presence of meal plants on vessels is also noted in recognition of the anecdotal evidence that part of the attraction of fur seals to the vessels is the discharge of offal and the opportunity of a free meal.

2.4 Data analysis

The extracted observer data were stratified by target fishery, gear type (where appropriate), area, and month. Data were pooled, where appropriate, across months to provide mean fur seal catch rates for the 2001–02 fishing year, or a fishing season. Mean fur seal catch rates are expressed as the number of fur seals observed caught per 1000 hooks for longline fisheries and the number of fur seals observed caught per tow for trawl fisheries. The mean catch rate for a defined stratum ($\bar{y}$) is calculated by use of the ratio-of-means estimator:

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

where n_i is the number of observed tows or 1000 hooks, and c_i is the number of observed incidental captures of fur seals. Then the total catch of fur seals, $\hat{T}$, is estimated by

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

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

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

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. Furthermore, if vessels show different fur seal bycatch rates (and in some fisheries, some vessels have higher bycatch rates than others) then, where there are many vessels operating, the observer coverage (percent of all fishing operations that was observed) 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 representativeness of the observed effort. For some interactions, it was not appropriate to estimate the total numbers of fur seals caught, or to define the total numbers of fur seals 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. A stratum may be a month, a season (for example, July-September for the WCSI hoki fishery), or a fishing year. The incident rate is defined as the percent of observed longline sets or tows with observed fur seal incidental captures.

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

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

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

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

The above methods assume that, within a defined target fishery area, all vessels, observations, and fishing operations are independent, and that the available "pool" of fur seals for capture is evenly distributed in time and space. Further, they assume that the observed sample is collected randomly, is representative of the fishery, and approximates a normal distribution.

3. RESULTS

Summary statistics for the main target trawl and longline fisheries with observed fur seal incidental captures in 2001–02, by method and area, are given in Table A1 in Appendix A. Total estimates (or observed fur seal captures) for the main fisheries are given by fishing year for 1990–91 to 2001–02 in Tables A2–A4. The data used to generate the 2001–02 results are discussed below, with relevance to the fishing effort (both total and observed) and the observed captures for each fishing method by target fishery. Relevant tables and figures are presented in the accompanying appendices: longline fisheries in Appendix B, all observed trawl fisheries in Appendix C, hoki fisheries in Appendix D, squid fisheries in Appendix E, and southern blue whiting fisheries in Appendix F.

Ministry of Fisheries observers reported 148 captures (82% landed dead) during trawl fishery operations in 2000–01 and 46 fur seal captures (4% landed dead) during tuna longline fisheries.

3.1 Fur seals in the tuna longline fisheries

3.1.1 Description of the fishery

Four chartered Japanese vessels and 22 domestic vessels reported effort in waters south of 40° S in Areas 2 and 3 during February-June 2002. In these areas, the chartered vessels set an average of 3072 hooks per set (generally baited with a mix of squid and fish), with the average hooks set per vessel ranging from 2928 to 3344. Similar hook numbers were set by one large New Zealand domestic longliner that generally fishes in the same areas as the chartered vessels and uses squid as bait. This vessel accounted for 47% of the hooks set by domestic vessels in Area 3. The smaller domestic vessels set longlines of 400–2000 hooks along the west coast, generally further inshore than the chartered vessels and the large domestic vessel. No observers were placed on these smaller domestic vessels.

Observer coverage was limited to the five large vessels during March-June in Areas 2 and 3 (Figure B1 in Appendix B). This analysis is limited to these vessels only because nothing is known about the activity of the smaller domestic vessels in relation to fur seals and the vessels use different fishing strategies to those of the five large vessels.

All 230 of the chartered sets were observed: 95% of the 22 100 hooks were observed on the one vessel fishing in Area 2 in March and April, and 93% of the 692 372 hooks were observed in Area 3. There was no observer coverage of the 31 250 hooks set by the large domestic vessel in Area 2 in March, whereas 81% of the 120 650 hooks set by this vessel were observed in Area 3. The data for the five vessels in Area 3 were combined for the analysis (Table A1).

3.1.2 Fur seal incidental captures

New Zealand fur seals were observed caught on 15% of observed sets in Area 3 in 2001–02 during April-June and in one set in Area 2 in March (where 7 sets were observed). Of the 46 reported captures, 44 were released alive and 2 were landed dead. Most incidents were of single captures (36), with another five sets made by three different vessels that caught two fur seals per set. All observed vessels reported fur seal captures, with 29 reported from the chartered vessels and 17 from the large domestic vessel that often fishes in more inshore waters. Mean fur seal catch rates varied from 0.051 to 0.174 fur seals per 1000 hooks for the five vessels, and the mean catch rate of one vessel was substantially larger than the mean rates observed for the other vessels (Figure B2).

Observers reported that 78% of the 46 fur seals observed caught were hooked in the mouth, another 13% were hooked in the flipper or some other body part, and method of capture for the remaining fur seals was unknown. Of the 44 fur seals released alive, 84% were released with the hook and tracer (often 20–100 cm long), 7% with the hook, and 9% without the hook.

3.2 Fur seal bycatch in trawl fisheries

New Zealand fur seals are caught during trawl fishery operations in waters south of 40° S within the 200 n. mile EEZ. During 2001–02, 148 New Zealand fur seal captures were observed in at least eight target fisheries (Table C1 in Appendix C). Descriptions of these target fisheries were given by Annala et al. (2004).

Multiple captures, where more than one fur seal was caught per observed tow, occurred primarily in hoki tows (Tables C1 and C2). The highest incident rates were reported from

target fishery areas with very few tows observed and thus are not reliable. In the main target fishery areas (where at least 700 tows were observed), up to 3% of observed tows had fur seal bycatch in the WCSI hoki fishery and 2% of observed squid tows at Stewart-Snares shelf.

Data for the target fisheries with observed fur seal captures for 2001–02 are analysed and discussed below. Means and associated standard errors are provided by month and/or season, but in most strata the sample sizes were inadequate, and though total estimates are provided, they should be used with caution. Relevant tables and figures for hoki, squid, and southern blue whiting trawl fisheries are given in Appendices D, E, and F, respectively.

3.2.1 Fur seal bycatch in hoki trawl fisheries

Fishing effort targeted at hoki was concentrated at CHAT, SUBA, and WCSI (Table D1 in Appendix D). During 2001–02, about 50% of the 66 vessels that reported target fishing for hoki were observed at some stage in the fishing year. representing about 13% of the 25 570 tows made. Vessels had different fishing distribution patterns, with 16% targeting hoki in one area (see Section 2.3 and Figure D1 for areas), 37% in two areas, 18% in three areas, 28% in four areas, and 1% in five areas. About 64% of the observed vessels were observed in one area, 24% in two areas, 9% in three areas, and 3% in four areas.

New Zealand vessels dominated the fishery, with 39 vessels accounting for 71% of all effort. The remaining effort was from 12 Korean vessels (9% of tows), 7 Commonwealth of Independent States (CIS) vessels (6%), 5 Japanese vessels (3%), 3 Polish vessels (6%), and 1 Norwegian vessel (5%). Observer coverage was greatest on domestic vessels (73% of observed tows) on 18 vessels, with the remainder on 5 CIS vessels (13%), 6 Korean (9%), 2 Polish (4%), and 2 Japanese vessels (less than 1%). Meal plants were used on CIS, Polish, and half the New Zealand and Japanese vessels. The use of meal plants on a tow by tow basis is not known.

About 70% of all hoki tows (as recorded on TCEPRs and CELRs) used bottom trawl nets. However, the dominant gear used in the fishery areas differed: bottom nets were used predominantly in CHAT and SUBA fisheries, whereas midwater nets were usually used for the main hoki spawning fisheries in WCSI and COOK. Comparison with the observed data shows a similar trend with about 72% of observed tows using bottom nets, with coverage in the main fishery areas showing slight differences relative to the total effort.

During 2001–02, Ministry of Fisheries observers recorded 108 fur seal captures during observed hoki fishing operations, with 76% of all captures reported from midwater nets. Eighty percent were landed dead, and the incidental capture of fur seals in hoki fisheries represented 70% of all observed fur seal captures in trawl fisheries, with captures recorded in 2.5% of observed tows in 2001–02 (range from under 1% at CHAT to 26% at PUYS where there was little observed effort (see Tables C2 and D1)). About 53% of the fur seals were reported during WCSI fishing operations (Table D1).

3.2.1.1 CHAT hoki fishery

3.2.1.1.1 Description of the fishery

Fishing on the Chatham Rise was carried out throughout the fishing year, with 84% between October and May, when 600–1100 tows were completed per month. Effort (both total and observed) fluctuated throughout the main months of the fishery and peaked in January and April-May before dropping off. The number of TCEPR vessels operating in the fishery during these months ranged between 17 and 23 each month, and observer coverage exceeded 10% of

vessels in each month except October, December, and March during the main season. Of the 37 vessels in the fishery (number of hoki tows made ranged from 1 to 895, median of 127 tows), 11 were observed (1–236 tows per vessel, median of 83) and 8 of the 17 vessels that accounted for 95% of the annual effort were observed.

Twenty-two New Zealand vessels carried out 80% of the effort here, with the remainder made by eight Korean, three Polish, two CIS, one Japanese, and one Norwegian vessel. Observers were placed on nine New Zealand vessels that provided 98% of the observed records, with the rest from one Japanese and one Korean vessel. All vessels had meal plants on board except Korean and several New Zealand vessels.

3.2.1.1.2 Fur seal incidental captures

Fur seals were observed caught in less than 1% of tows (Table C2), with three captures observed in three separate bottom trawl nets in April, May, and July around the Mernoo Bank. Captures were from two New Zealand vessels operating with meal plants. Mean catch rates and estimates by month and for the fishing year are given in Tables D2 and A1 respectively, but because of the small number of observed captures, these results have little meaning.

3.2.1.2 COOK hoki fishery

3.2.1.2.1 Description of the fishery

New Zealand vessels targeted hoki during all months of the years, but in the main spawning fishery months of June-September, about 17 vessels completed 1095 tows, representing about 55% of the total effort for 2001–02. Observers were present in July and August and covered about 50% of the vessels and 23% of the 644 tows made in these months. All but four of the observed tows used midwater nets.

3.2.1.2.2 Fur seal incidental captures and estimates

Fur seals were observed caught in 12% of all observed tows. Six of the nine vessels that were observed reported fur seal captures. Of the 20 caught, 16 were caught singly and the remaining 4 were caught in two separate tows. All were caught in midwater nets, and 85% were landed dead. Fourteen were caught in July resulting in a mean monthly catch rate of 0.152 fur seals per tow (s.e. = 0.044), and the other six were caught in August to give a mean catch rate of 0.113 (s.e. = 0.044) (Table D2). When the data for the two months are combined, 89 fur seals (c.v. = 20%) were estimated caught (Table A1).

3.2.1.3 PUYS hoki fishery

3.2.1.3.1 Description of the fishery

About 70% of the effort at PUYS was concentrated in August-September following the spawning fisheries in the WCSI and COOK fisheries. During this time, 19 vessels reported hoki target fishing in the PUYS fishery in 2001–02, completing 387 tows. These vessels were from New Zealand (12), Poland (3), CIS (3), and Norway (1). Four vessels and 13% of the tows were observed. Only 3 tows were observed in August and 47 tows were observed in September on three vessels (two CIS and one Polish).

3.2.1.3.2 Fur seal incidental captures

Observers reported 19 fur seal captures, all in September. All were landed dead. The observer coverage was inadequate given that for one vessel only 8 tows were observed (with no fur seal captures); a second vessel made 7 tows and caught 4 fur seals; and a third vessel was observed for all of its effort (32 tows) and caught 15 fur seals. No estimates are provided here for this fishery area.

3.2.1.4 SUBA hoki fishery

3.2.1.4.1 Description of the fishery

Vessels targeted hoki in SUBA in all months, with about 93% of the 6540 tows made during October-May. Of the 38 vessels, 11 were observed, with almost 12% of the tows observed. The effort in this fishery area is spread widely from off the Stewart-Snares shelf, east towards the Pukaki Rise and south to the Campbell Plateau. The observer coverage was split north and south of 51° 30' S and there appeared to be a division in the effort at about 50° 30' S. Thus the data were split at this latitude for this analysis.

North of 50° 30' S, New Zealand vessels dominated the fishery, with 16 vessels completing 77% of all the effort. Other nations fishing here were from CIS (4), Korea (11), Japan (3), Poland (3), and Norway (1). Observers were placed on three Korean vessels, five New Zealand, one Polish, and one CIS vessel. The coverage of the New Zealand vessels accounted for 98% of all observed tows.

South of 50° 30' S, 68% of the 1386 tows were during October-December, with another (though smaller) peak of effort in February-March. Eight vessels fished here and three were observed, though one vessel (which made 17% of the tows here and was observed) accounted for 82% of the observer coverage (all in October). Thus the coverage here was not very representative.

3.2.1.4.2 Fur seal incidental captures

Nine fur seals were observed caught: one was released alive in May from a bottom net off the Stewart-Snares shelf, and eight were caught in the southern area on the Campbell Plateau during October and November. These captures were all from one vessel and one was released alive. Mean catch rates for each month are given in Table D2, and when the data for these months are combined, 34% of the 677 tows were observed and a total of 23 fur seals estimated caught (c.v. = 32%). When any area divisions are ignored, the estimated total for this fishery is 77 fur seals (c.v. = 24%) (see Table A1).

3.2.1.5 WCSI hoki fishery

3.2.1.5.1 Description of the fishery

The fishing effort in the WCSI spawning fishery was concentrated during July and August, when about 56 vessels completed 7586 tows (see Tables D1 and D2). Vessels from six nations fished during this season, with 43% of the effort by 28 New Zealand vessels, 20% by 12 Korean vessels, 19% by 7 CIS vessels, and the remainder by 5 Japanese, 3 Polish, and 1 Norwegian vessel. Observer coverage of the vessels was similar, with 41% of observed tows by six New Zealand vessels, 29% by five CIS vessels, 22% by four Korean vessels, and 8% by one Polish vessel. About 25% of vessels were observed in July and August and at least

17% of the tows were observed in these months (Table D2). About 62% of tows, and 53% of observed tows, used midwater nets.

3.2.1.5.2 Fur seal incidental captures

Fur seal incidental captures were observed on 10 of the 16 observed vessels. About 1% of observed tows caught fur seals, to give a total of 57 fur seals for the June-September fishery. One vessel caught 16 of the fur seals, with several incidents of multiple captures, including one tow with seven captures. About 75% of captures were in midwater nets and 53% were from three CIS vessels, 25% from three Korean vessels, 19% from three New Zealand vessels, and 4% from the Polish vessel.

There was no difference in the mean catch rates by month for July and August and if it is assumed that June and September tows have similar potential to catch fur seals, then for the WCSI fishery in June-September 2002, the mean bycatch rate of 0.043 fur seals per tow (s.e. = 0.008) gave a total estimate of 323 fur seals (c.v. = 18%).

Most observed vessels fished north and south of 41° 30' S on the same trip. More than twice as many tows were observed in the southern area, and the mean catch rate here was substantially higher than that for the northern waters (Figure D2), where two observed vessels caught four fur seals. In this southern area, the mean catch rates for midwater nets appeared to be higher than those for bottom nets, though the error around the means overlapped slightly (Figure D3), and there was no difference between the mean catch rates by nation. However, at the individual vessel level, the mean catch rates show substantial differences between some vessels (Figure D4). If the dataset is restricted to tows south of 41° 30' S, 16% of the 5991 tows were observed, and a mean catch rate of 0.055 fur seals per tow (s.e. = 0.011) gave a total estimate of 329 fur seals (c.v. = 19%).

3.2.2 Fur seal bycatch in squid trawl fisheries

Fishing effort targeted at squid in 2001–02 was primarily in the STEW and SQU 6T fisheries (Table E1). Squid trawls were observed in these two areas as well as in the ECSI fishery (Figure E1). This coverage accounted for 6% of all tows in ECSI, 34% in SQU 6T, and 21% in STEW. Vessels from CIS and Poland all used meal plants, as did some New Zealand and Japanese vessels, whereas Korean vessels did not have meal plants. All vessels other than CIS, Polish, and some New Zealand vessels used bottom trawl nets. Tables and plots of effort and observed data for squid trawl fisheries are given in Appendix E.

3.2.2.1 Squid trawl fishery in ECSI

Although squid target fishing was carried out throughout the year in this area, nearly 60% of the effort was in April and May when there was observer coverage. Two of the 18 vessels fishing in these months were observed, and this coverage represented 10% of the 527 tows. Twelve Korean vessels accounted for 77% of the April-May effort, and the two observed vessels (Korean) carried out 27% of the Korean effort. The remaining vessels were from Japan (two vessels completed 13 tows) and New Zealand (four vessels completed 109 tows). No fur seals were caught during the observed effort in this area.

3.2.2.2 Squid trawl fishery in PUYS

Fishing effort targeted at squid in the waters south of Puysegur Point amounted to fewer than 650 tows for the 2001–02 fishing year, with effort from December to June. Up to 15 vessels fished in a month and 85% of the effort was in March and April, mainly by Korean bottom trawlers. Observers were present on four Korean and two Japanese vessels in March and April when 37% and 8% of the monthly effort was observed. No fur seals were observed caught.

3.2.2.3 Squid trawl fishery in SQU6T

3.2.2.3.1 Description of the fishery

Twenty-eight vessels participated in southern squid trawl fishery in SQU 6T from February to April, with 1645 tows reported from this area between February and April 2002. Vessels from Korea (11) and New Zealand (3) completed more tows along the southeastern edge of the Auckland Islands Shelf than to the north of the Auckland Islands where Japanese (3) and CIS (8) vessels carried out most of their fishing. The effort of three Polish vessels was split relatively evenly between the two areas.

CIS vessels accounted for 52% of all tows, with another 15% each on Korean and New Zealand vessels, 14% on Polish vessels, and the remaining 4% on Japanese vessels. The CIS proportion of observed tows was greater, at 65% of observed tows on five CIS vessels, and the remainder of the observed effort was on four Korean vessels (15%), one Polish vessel, and two Japanese vessels (9%). No New Zealand vessels had observer coverage. About 70% of all tows and 73% of observed tows used midwater nets.

Sea Lion Exclusion Devices (SLEDs) were used in this fishery on some vessels in accordance with the operational plan for the management of New Zealand (Hooker's) sea lions (*Phocarctos hookeri*) (Anon. 2002). Of the 564 observed tows in SQU 6T, 168 used no SLED, 120 used a SLED with the cover net open to allow any caught animals to escape, 255 used SLEDs with the cover net tied down, and, for the remaining 21 tows, the use of a SLED was unknown. Observed tows with no SLED and those where the cover net was tied down are used here as "observed tows", given that any caught animals may have had the potential to escape from tows that used a SLED, but had the cover net left open. Thus a total of 423 tows are used as "observed", which represents an observer coverage level of about 26%.

3.2.2.3.2 Fur seal incidental captures

The distribution of the start positions of observed tows, including those that captured fur seals, is shown in Figure E1. Fur seals were observed caught on 1% of observed tows (see Table C2), with a total of four fur seals observed caught in separate tows: three captures were landed dead from three midwater tows made by one vessel during March and April off the south-eastern shelf edge, and one was released alive from a bottom net in February.

The few observed captures resulted in large variance around the mean monthly catch rates (Table E2). A mean catch rate of 0.009 fur seals per tow (s.e. = 0.005) was calculated for February-April giving a total estimate of 15 fur seals (c.v. = 48%). Too few captures were observed and these results should be used with caution.

3.2.2.4 Squid trawl fishery at the Stewart-Snares shelf

3.2.2.4.1 Description of the fishery

Thirty-five vessels targeted squid in the southern squid trawl fishery in 2001–02. These vessels completed 3514 tows on the Stewart-Snares shelf (Table E1), with effort concentrated during January-April (Table E2). These months accounted for 90% of the effort and vessels used bottom nets for 58% of these tows.

Observers were present on 12 vessels during January to April and covered 23% of the effort. During these months, most of the fishing effort was reported from the 12 Korean vessels (45% of all tows) and 8 CIS vessels (33%), with the remainder from 9 New Zealand vessels (10%), 3 Polish vessels (8%), and 3 Japanese vessels (4%). The observer coverage was concentrated on 5 CIS vessels (47% of all observed tows) and 4 Korean vessels (37%), with another 11% on 2 Japanese vessels and 5% on 1 Polish vessel. No New Zealand vessels were observed. Meal plants were on all the observed CIS and Polish vessels and one Japanese vessel, but not present on the second Japanese vessel or the Korean vessels. The Polish and CIS vessels generally used midwater trawl nets, whereas the Japanese and Korean preferred bottom nets.

3.2.2.4.2 Fur seal incidental captures and estimates

Fur seals were observed caught in about 2% of observed tows (see Table C2). Of the 17 fur seals observed caught, 14 were landed dead. Seven fur seals were reported from bottom trawls on two Korean (6 fur seals) vessels and one Japanese vessel (1), and 10 from midwater tows on one Polish vessel (3) and four CIS vessels (7). There were no differences between mean catch rates by month for those months where there was good observer coverage, by nation, or by gear type.

When the data for January-April 2002 are combined, 23% of the 3160 tows were observed, and from a mean bycatch rate of 0.023 fur seals per tow (s.e. = 0.006), an estimated 74 fur seals were caught (c.v. = 23%) (Table A1).

3.2.3 Fur seal bycatch in southern blue whiting trawl fisheries

3.2.3.1 Description of the fishery

The southern blue whiting fishery operated during August, September, and October 2002 in SBW 6B, SBW 6R, SBW 6I, and SBW 6A (Table F1 and Figure F1 in Appendix F). Of the 18 vessels fishing in this season, 8 were CIS, 6 were Japanese, 3 were Polish, and the nationality of 1 vessel was unknown. Nearly 90% of all the effort was expended in SBW 6I, where CIS vessels accounted for 50% of all tows. Midwater nets were used on 98% of all tows.

Observers were placed on three CIS vessels, three Japanese vessels, and one Polish vessel. The observed effort began at SBW 6B at the end of August when one of the six vessels fishing here was observed for only nine tows. About 95% of the 286 observed tows (all with midwater nets) were in SBW 6I, where 63% of the observed effort was on CIS vessels.

3.2.3.2 Fur seal incidental captures and estimates

Fur seals were observed caught in SBW 6B and SBW 6I, with 2% of the 273 observed tows in SBW 6I resulting in six fur seal deaths. Only nine tows from one vessel were observed in SBW 6B and two fur seals were landed dead in two separate tows. The observed effort in SBW 6B represented about 10% of the tows in the area, but no estimates are provided for this fishery area because the nine tows observed represented the total effort of one of the six vessels fishing in the area.

Monthly and seasonal mean fur seal catch rates in SBW 6I are given in Table F2. The total number of fur seals estimated captured (and landed dead) in the 2002 southern blue whiting fishery at SBW 6I is 18 (c.v. = 39%).

3.3 Summary of other trawl fishery-fur seal interactions

Eleven New Zealand fur seals were observed caught in at least five other target fisheries (see Table A4 in Appendix A and Table C1 in Appendix C). A brief summary of these reported captures is given below. Where available, the sex of the captured fur seals (as recorded by the observer) is provided below.

Ling (*Genypterus blacodes*) target fishing operations.
One male fur seal was released alive from an observed bottom tow in October 2001 off the southern edge of the Stewart-Snares shelf.

Jack mackerel (*Trachurus* spp.) target fishing operations.
Of the five fur seals landed dead from observed jack mackerel tows with midwater nets, one male was caught off the southern edge of the Stewart-Snares shelf in March, two males and one female were caught in separate tows in April off the Mernoo Bank, and one male was landed dead from a tow west of the Chatham Islands on May.

Scampi (*Metanephrops challengeri*) target fishing operations.
Three fur seals were landed dead from three scampi tows off the northern edge of the Mernoo Bank during July and August. Observers reported that all captures were males.

Warehou (*Seriolella* spp.) target fishing operations.
One male fur seal was landed dead in a silver warehou (*S. punctata*) bottom tow in March and one male fur seal was released alive from a white warehou (*S. caerulea*) bottom tow in October, with both captures from the Stewart-Snares shelf southern edge.

3.4 Summary of length data reported by observers for trawl-caught fur seals

Observer records of length and sex data are summarised for the main target fisheries covered in the previous sections (Table G1 in Appendix G). Comparison of the numbers reported here and the total numbers of fur seals reported from each fishery area will show that these data were recorded for most animals, but not all (particularly those released alive).

More males than females were caught in most target fishery areas and, as in 2000–01, animals caught during June-September off the west coast of the South Island appear to be smaller than those caught in other fisheries.

4. DISCUSSION

The number of fur seals observed caught in commercial fisheries in New Zealand waters in 2001–02 followed the trend of declining numbers reported in recent years, despite similar coverage of fishing effort in the fisheries which historically have accounted for most of the observed captures (Baird 2005). Most observed captures were from the west coast of the South Island, where tuna longlines resulted in most captured fur seals being released alive in the southern waters of this area, and hoki trawls resulting in fur seals landed dead in more northern waters closer to the 200 m contour. The other main areas were off Puysegur Point (the hoki fishery), the Stewart-Snares shelf where hoki, jack mackerel, ling, squid, and warehou tows resulted in captures, and the Campbell Plateau where hoki and southern blue whiting tows caught fur seals.

About 73% of the fur seal captures were observed in hoki trawls (53% of these were from the WCSI hoki fishery). This percentage is much greater than in previous years, mainly because of the large decrease in the number reported from southern blue whiting fisheries (for example, see Baird 2004, 2005). Also, fewer multiple captures per tow were observed in 2001–02. In those trawl fisheries with at least 500 observed tows, up to 3% of observed tows had fur seal captures. In the smaller fisheries (as measured by total effort), and those with fewer observed tows, higher incident rates were seen in the hoki fishery in Cook Strait and off Puysegur Point.

The mean catch rate of fur seals in the 2002 WCSI hoki fishery was similar to those observed in 1998–99 and 2000–01; the latter means were substantially lower than that reported for 1999–2000 (0.073 fur seals per tow; s.e. = 0.009) (Baird 2004, 2005). This area accounted for the greatest number of estimated captures (Table A2). Baird & Bradford (2000) 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, and Baird (2004, 2005) noted a similar distinction in recent seasons.

For some fisheries, the total numbers estimated caught varies greatly from year to year (Table A2). The higher (relative to earlier years) observer coverage of the 2002 Cook Strait hoki fishery provided an estimate for the first time for the main months of the fishery. This fishery area was always considered a less likely area for fur seal interactions because most vessels are "freshers", which retain the fish whole and do little offal dumping or discarding.

The lack of observer coverage, or the unrepresentative nature of the coverage, has limited the analyses in most fisheries. Further, the small numbers of fur seals observed and the inherent difficulties in dealing with these types of data (Bradford 2002), mean that the analytical approach used here provides little real information on the variance associated with the catch rates and total capture estimates (Smith & Baird 2005).

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APPENDIX A: FISHERY-FUR SEAL CAPTURE SUMMARY, 2001–02

Table A1: Summary fur seal statistics for commercial fisheries, 2000–01*. Estimates from fishery areas in each target fishery are summed only when at least 10 fur seals have been observed during a season.

Area/ Month	Total no. hooks/tows	% observed	No. observed fur seals	Incident rate (%)	Mean bycatch rate	Standard error	Estimated no. fur seals caught	*c.v.* (%)
Southern bluefin tuna longline fishery south of 40° S west of 167° E: estimate of 49 fur seals (c.v. = 4%)†								
Area 3	813 020	91	45	15	0.061	0.009	49	4
Trawl fisheries‡								
Hoki target: estimate of 559 fur seals (c.v. = 13%) for COOK, PUYS, and WCSI								
CHAT	8 907	11	3	< 1	0.003	0.002	27	16
COOK	644	22	20	12	0.138	0.031	89	20
PUYS	387	13	19	26	0.380	0.102	147	37
SUBA	6 539	12	9	1	0.012	0.004	77	24
WCSI	7 586	18	57	3	0.043	0.008	323	18
Squid target: estimate of 74 (c.v. = 23%) for STEW								
CHAT	27	0	–	–	–	–	–	–
ECSI	895	6	0	0	0.0	–	–	–
PUYS	623	20	0	1	0.0	–	–	–
SQU 6T	1 645	26	4	1	0.009	0.005	15	48
STEW	3 160	23	17	2	0.023	0.006	74	23
Southern blue whiting target: estimate of 18 fur seals (c.v. = 39%) for SBW 6I								
SBW 6I	833	33	6	2	0.022	0.011	18	39

* Mean catch rates are expressed as the numbers of fur seals per 1000 hooks for longline fisheries and the numbers per tow for trawl fisheries. Total estimates are provided for those fisheries where at least 10% of the tows were observed. Note that considerable uncertainty exists around many of the estimates because of the low numbers of captures observed. Discretion should be used when interpreting results for those fisheries where fewer than 10 fur seals were observed caught in a stratum. Note that these statistics are summary statistics for target fisheries by area for the fishing year or defined season, as requested by the Ministry of Fisheries.

† Data for Area 3 are for the four chartered and one large domestic vessel that fished in this area at the same time, targeting southern bluefin tuna. Another 20 domestic tuna vessels fished in this area during the year, predominantly during April-June and these vessels set another 261 425 hooks. These are not included in the estimate because of different fishing practices used by these vessels (see section 3.1.1).

‡ The COOK data are for July-August 2002 and PUYS data are for August-September 2002 inclusive. Outside these months, another 1343 tows were made in COOK and 165 in PUYS. Data for WCSI are for June-September 2002 for the whole area (see Section 3.2.1.5.2). Squid effort at STEW is from January to April and SQU 6T is from February-April 2002. Data for SBW 6I represent August-October 2002. Another 115 tows were made primarily in SBW 6B, and also in SBW 6A and SBW 6R during these months, but only 13 of these tows were observed.

APPENDIX A — *continued*

Table A2: Reported numbers (denoted by *) from MFish observers and estimated numbers† of New Zealand fur seals caught for fishing years, 1990–91 to 2001–02 for the main target fisheries. Note that different objectives and methods in some years resulted in variations in the way estimates were calculated. Reported numbers of fur seal captures from longline fisheries and from other trawl fisheries are given in Tables A3 and A4.

					Hoki‡
	CHAT	COOK	PUYS	SUBA	WCSI
1990–91	–	–	1* bt 48 (c.v.= 47%)mw	–	8 (c.v.= 95%) bt 96 (c.v.= 27%) mw
1991–92	–	–	17 (c.v.= 44%) bt 3 (c.v.= 80%) mw	28 (c.v.= 60%) bt	122 (c.v.= 29%) mw
1992–93	–	–		162 (c.v.= 25%) bt 13 (c.v.= 63%) mw	48 (c.v.= 34%) bt 111 (c.v.= 22%) mw
1993–94	–	–	7* bt 81 (c.v.= 41%)mw	16 (c.v.= 61%) bt	52 (c.v.= 57%) bt 186 (c.v.= 18%) mw
1994–95	8*	–	11*	2*	28*
1995–96	15*	1*	7*	4*	137*
1996–97	16*	–	2*	3*	54*
1997–98	65 (c.v.= 36%)	1*	–	8*	1 032 (c.v.= 17%)
1998–99	18*	13*	1*	94 (c.v.= 24%)	215 (c.v.= 18%)
1999–00	4*	1*	0*	70 (c.v. = 25%)	561 (c.v. = 13%)
2000–01	9*	11*	3*	7*	242 (c.v. = 20)
2001–02	3*	83 (c.v.=22%)§	19*	9*	323 (c.v.=18%)

		Southern blue whiting			Squid
	Bounty	Pukaki	Campbell	SQU 6T	STEW
1990–91	–	–	–	9 (c.v.= 95%)	–
1991–92	13 (c.v. = 70%)	–	–	–	11*
1992–93	141 (c.v. = 15%)	15 (c.v. = 50%)	28 (c.v.= 43%)	3 (c.v.= 84%)	122 (c.v.= 18%)
1993–94	218 (c.v. = 15%)	2 (c.v. = 72%)	5 (c.v.= 90%)	4*	46 (c.v.= 34%)
1994–95	112 (c.v. = 14%)	9 (c.v .= 38%)	3 (c.v.= 78%)	2*	3*
1995–96	48 (c.v. = 33%)	–	19 (c.v.= 57%)	64 (c.v.= 37%)	5*
1996–97	16*	3*	14*	4*	5*
1997–98	76 (c.v. = 13%)	–	32 (c.v.= 28%)	13 (c.v.= 50%)	180 (c.v.= 23%)
1998–99	117 (c.v. = 19%)	–	14 (c.v.= 43%)	0*	243 (c.v.= 18%)
1999–00	246 (c.v. = 26%)	1*	29 (c.v.= 24%)	2*	46 (c.v. = 28%)
2000–01	48 (c.v. = 23%)	0*	40 (c.v.= 17%)	3*	34 (c.v. = 53%)
2001–02	2*	–	18 (c.v.= 39%)	4*	74 (c.v.=23%)

* Reported numbers are direct extracts from Ministry of Fisheries observer data. No further analyses are undertaken on these captures because data were inadequate: the observer coverage was too low, was not representative of the fleet, or too few animals were observed caught.

† 1990–91 to 1993–94 data are from Baird et al. (1999), 1994–95 and 1995–96 from Baird (1997), 1997–98 from Baird (1999), 1998–99 from Baird (2001), 1999–2000 from Baird (2004), and 2000–01 from Baird (2005). Estimates are given for where observer coverage was at least 10% of the total fishing effort.

‡ bt denotes bottom trawl, mw denotes midwater trawl .

§ Total is for July and August 2002.

APPENDIX A — *continued*

Table A3: Summary of observed fur seal captures or total estimates for the main longline fisheries, since 1990–91. Fishery areas and codes are shown in Appendix C and the relevant fishery appendices.

Fishing year	Domestic tuna longline fleet		Chartered tuna longline fleet	
	Area 2	Area 3	Area 2	Area 3
1990–91	–	–	–	0*
1991–92	–	–	–	0*
1992–93	–	–	0*	6*
1993–94	–	1*	1*	30*
1994–95	–	8*	0*	55*
1995–96	–	5*	–	–
1996–97	–	11*	2*	34*
1997–98	7*	0*	–	41*
1998–99	0*	0*	1*	104*
1999–00	–	–	3*	46*
2000–01	–	13*	0*	31*
2001–02	0*	17*	1*	28*

	Ling autoline fleet					
	LIN 2	LIN 3	LIN 4	LIN5	LIN 6†	LIN 7
1998–99	–	–	–	–	–	–
1999–00	–	–	–	–	1*	–
2000–01	–	–	–	–	–	–
2001–02	–	–	–	–	1*	–

* Reported numbers are direct extracts from Ministry of Fisheries observer data. Historically, these numbers have not been extrapolated over the fleet's effort to get a total estimate. An estimated 47 fur seals (c.v. = 7%) were caught in Area 3 in 2000–01 (Baird 2005) and 49 fur seals (c.v. = 4%) were estimated caught in 2001–02 (see Table A1).

† LIN 6 includes the Bounty Platform, Campbell Rise, Pukaki Rise, and Auckland Islands Shelf (see Figure C1 in Appendix C). Other areas are shown in Annala et al. (2004).

APPENDIX A — *continued*

Table A4: Summary of observed fur seal captures for trawl fisheries other than those targeting hoki, squid, or southern blue whiting, since 1990–91. Fishery areas and codes are shown in Appendix C. – indicate no observer coverage.

Target species	Trawl fishery															
	BAR	BOE	EMA	FRO	HAK	JMA	JMM	LIN	ORH	SCI	SKI	SSO	SWA	WAR	WWA	Total
1990–91	0	0	2	1	0	0	–	0	0	0	–	0	0	0	–	3
1991–92	7	–	–	–	3	1	–	4	0	1	1	0	0	0	0	17
1992–93	3	–	–	–	23	8	0	0	2	1	2	0	2	–	–	41
1993–94	11	–	–	–	7	15	–	–	2	2	–	0	1	1	–	39
1994–95	0	0	–	–	0	2	–	–	1	0	0	0	0	–	–	3
1995–96	23	0	–	–	0	1	0	–	0	0	–	0	0	–	–	24
1996–97	4	–	–	2	0	19	–	–	1	0	–	0	0	–	–	26
1997–98	1	0	–	–	0	16	0	0	2	0	0	0	–	–	–	19
1998–99	4	0	–	0	0	20	0	0	0	2	0	3	0	0	–	29
1999–00	0	–	–	–	0	4	–	0	0	0	0	0	–	0	0	4
2000–01	2	1	–	–	1	6	1	–	0	1	–	0	0	3	0	15
2001–02	0	0	0	–	0	5	–	1	0	3	–	0	1	0	1	11
Total	55	1	2	3	34	97	1	5	8	10	3	3	4	4	1	231

* BAR is barracouta (*Thyrsites atun*), BOE is black oreo (*Allocyttus niger*), EMA is blue mackerel (*Scomber australasicus*), FRO is frostfish (*Lepidopus caudatus*), HAK is hake (*Merluccius australis*), JMA is jack mackerels (*Trachurus* spp.), JMM is Peruvian jack mackerel (*Trachurus symmetricus murphyi*), LIN is ling (*Genypterus blacodes*), ORH is orange roughy (*Hoplostethus atlanticus*), SCI is scampi (*Metanephrops challengeri*), SKI is gemfish (*Rexea solandri*), SSO is smooth oreo (*Pseudocyttus maculatus*), SWA is silver warehou (*Seriolella punctata*), WAR is blue warehou (*Seriolella brama*), WWA is white warehou (*Seriolella caerulea*).

APPENDIX B: TUNA LONGLINE DATA, 2001–02

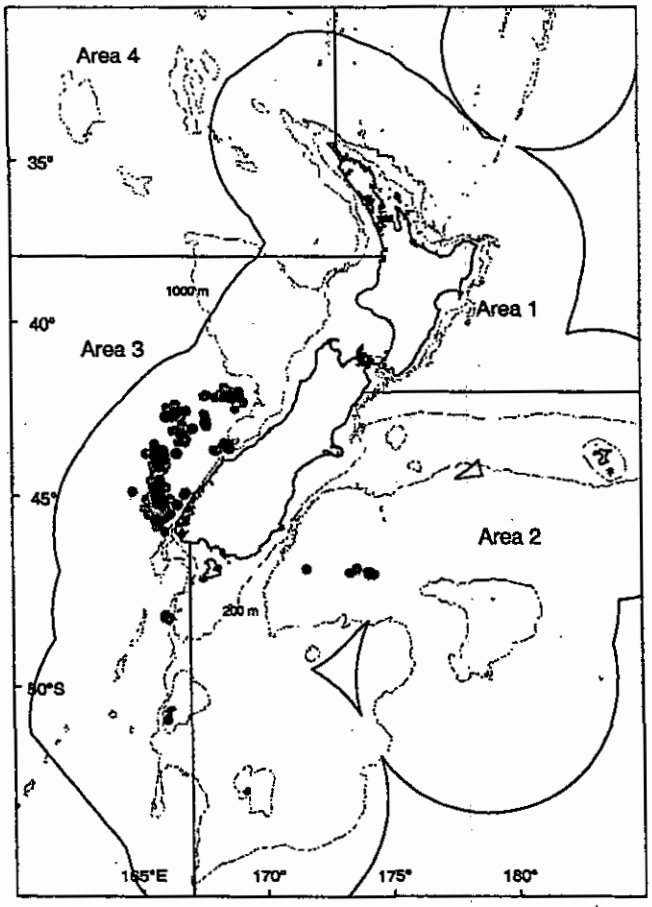

Figure B1: Start positions of observed chartered and domestic tuna longline sets in southern waters (•), including those with observed fur seal incidental captures (•), for 2001–02.

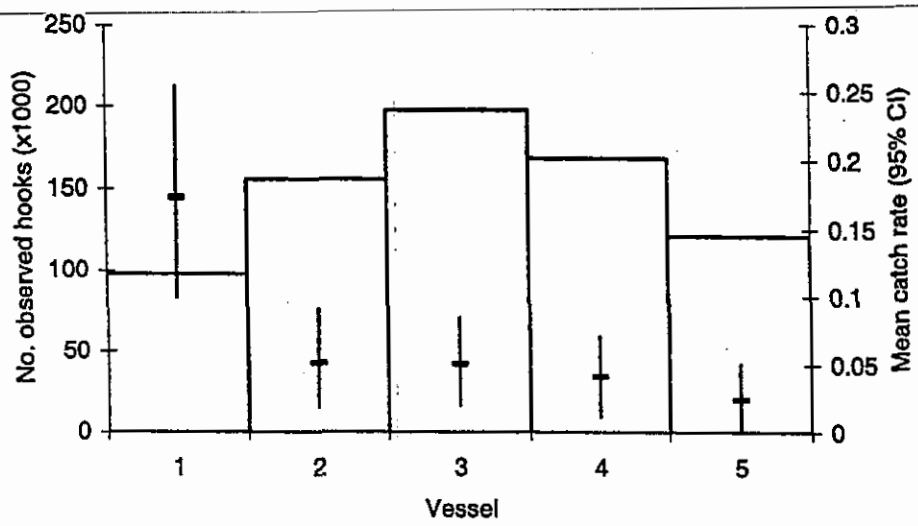

Figure B2: Number of observed hooks (histogram) and mean fur seal catch rate (number per 1000 hooks, ± 95% confidence intervals) for the four chartered tuna longline vessels and one domestic vessel fishing in Area 3 in March-June 2002.

APPENDIX C: TRAWL FISHERY DATA, 2001–02

Table C1: Frequency of fur seal catch for observed trawl fishing operations, 2001–02.

No. fur seals per tow	Target trawl fishery*							
	HOK	JMA	LIN	SBW	SCI	SQU	SWA	WWA
0	3 184	289	14	278	599	1 335	81	5
1	62	5	1	6	3	19	1	1
2	15	–	–	1	–	1	–	–
3	3	–	–	–	–	–	–	–
4	–	–	–	–	–	–	–	–
5	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	–	–
7	1	–	–	–	–	–	–	–
No. observed tows	3 265	294	15	285	602	1 315	82	6
No. observed fur seals	108	5	1	8	3	21	1	1
% dead fur seals	81	100	0	100	100	81	100	0
Incident rate (%)†	2.5	2	7	2.5	< 1	1.5	1	17

* See Table A4 in Appendix A for species codes for the target fisheries.
† Incident rate is the percent of observed tows with one or more observed fur seal captures.

APPENDIX C — *continued*

Table C2: Frequency of observed fur seal captures in the main target fishery areas (see Table C3), 2001–02.

No. fur seals per observed tow	CHAT HOK	COOK HOK	PUYS HOK	SUBA HOK	WCSI HOK	SBW 6B SBW	SBW 6I SBW	SBW 6R SBW	ECSI SQU	PUYS SQU	SQU 6T SQU	STEW SQU
0	969	127	37	753	1 298	7	268	3	52	124	419	720
1	3	16	8	7	28	2	4	–	–	1	4	14
2	–	2	4	1	8	–	1	–	–	–	–	1
3	–	–	1		2	–	–	–	–	–	–	–
4	–	–	–	–	–	–	–	–	–	–	–	–
5	–	–	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	–	–	–	–	–	–
7	–	–	–	–	1	–	–	–	–	–	–	–
No. observed tows	972	145	50	761	1 337	9	273	3	52	125	423	735
No. observed fur seals	3	20	19	9	57	2	6	0	0	1	4	16
Incident rate (%)*	< 1	12	26	1	3	22	2	0	0	1	1	2

* *Incident rate is the percent of observed tows with one or more observed fur seal captures.*

Table C3: Fishery area codes (see Figure C1 for place names and areas)

Code	Fishery area
Hoki (HOK) fisheries	
CHAT	Chatham Rise
COOK	Cook Strait
PUYS	Puysegur Point
SUBA	*Sub-Antarctic*
WCSI	West coast South Island
Squid (SQU) fisheries	
ECSI	East coast South Island
PUYS	Puysegur Point
SQU 6T	Auckland Islands Shelf
STEW	*Stewart-Snares shelf*
Southern blue whiting (SBW) fisheries	
SBW 6B	Bounty Platform
SBW 6I	Campbell Plateau
SBW 6R	Pukaki Rise

APPENDIX C — *continued*

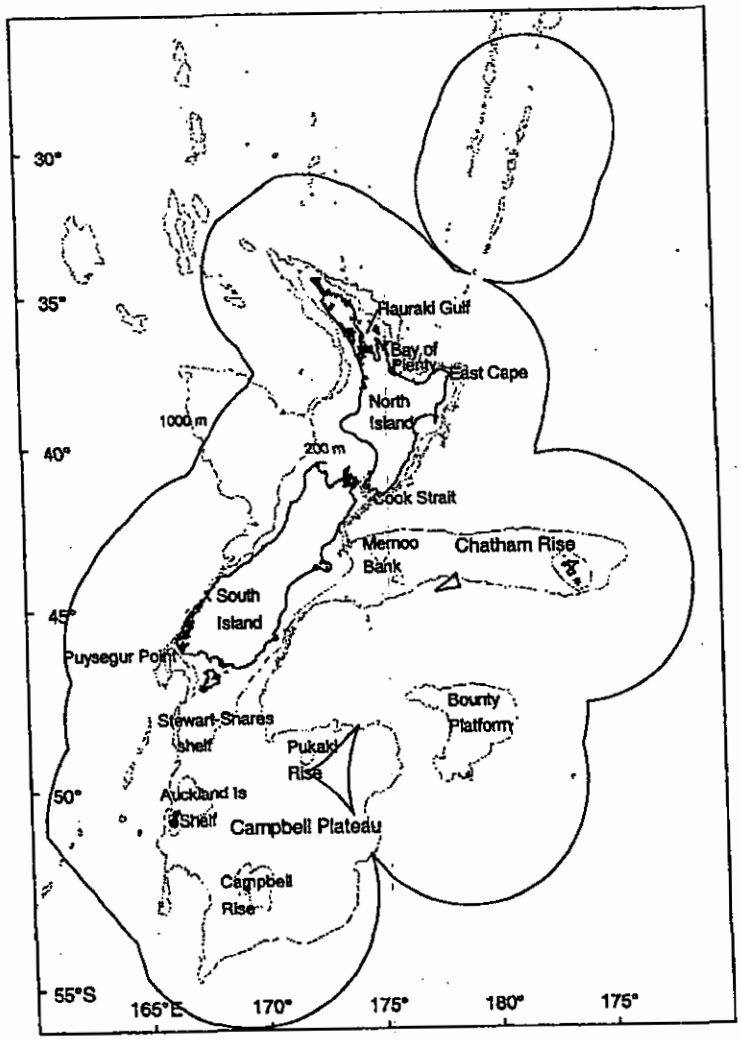

Figure C1: Place names mentioned in the text.

APPENDIX D: HOKI DATA, 2001–02

Table D1: Summary of commercial and observed hoki trawl effort by area, 2001–02

	CHAT	COOK	PUYS	SUBA	WCSI	All areas
No. vessels	37	19	27	38	56	66
No. observed vessels	11	9	4	11	16	34
% vessels observed	30	47	15	29	29	52
No. tows	8 907	1 998	552	6 539	7 586	25 582
No. observed tows	972	145	50	761	1 337	3 265
% observed tows	11	7	9	12	18	13
No. observed fur seals	3	20	19	9	57	108

* Fishery areas are given in Table C3 in Appendix C. Further capture data are given in Tables C1 and C2.

Table D2: Total number of tows, number of observed tows, number of fur seals observed caught, mean catch rates (numbers of fur seals per tow), and estimated number of fur seals caught for hoki fisheries with observed fur seal captures, by month, season, and fishing year 2001–02*. Note: estimates are given only where the observer coverage is ≥ 10% in a stratum. Discretion should be used when interpreting results for those fisheries where fewer than 10 fur seals were observed caught in a stratum.

Month	Total tows	% observed	No. fur seals observed	Mean fur seal catch rate	Standard error	Total fur seal estimate	c.v. (%)
CHAT							
October	1 014	5	0	0.0	–	–	–
November	602	23	0	0.0	–	–	–
December	842	6	0	0.0	–	–	–
January	1 144	18	0	0.0	–	–	–
February	747	3	0	0.0	–	–	–
March	988	0	–	–	–	–	–
April	1 112	19	1	0.005	0.005	5	89
May	1 068	23	1	0.004	0.004	4	88
June	540	0	–	–	–	–	–
July	190	25	1	0.021	0.020	4	83
August	10	10	0	0.0	–	–	–
September	650	0	–	–	–	–	–
COOK†							
July	262	35	14	0.152	0.044	40	23
August	382	14	6	0.113	0.044	43	36
SUBA south of 50° 30' S‡							
October	329	60	6	0.030	0.014	10	30
November	348	9	2	0.062	0.044	22	67
WCSI							
June	564	5	0	0.0	–	–	–
July	3 218	22	43	0.060	0.014	192	20
August	3 536	17	14	0.024	0.008	85	30
September	268	0	–	–	–	–	–
June-September	7 586	18	57	0.043	0.008	323	18

* For the PUYS fishery, see Section 3.2.1.3.2.

† In COOK, 192 tows in June and 259 tows in September completed the winter fishery; none of these tows were observed. Another 903 tows were made (with no observer coverage) during October to May.

‡ Data are presented for two months only for in this area. Another 709 tows were made between December and April and in September (50 were observed in April and September). North of here, 5153 tows were made during the fishing year and 480 were observed. One fur seal was caught during May in the northern area when 23% of the 518 tows for that month were observed.

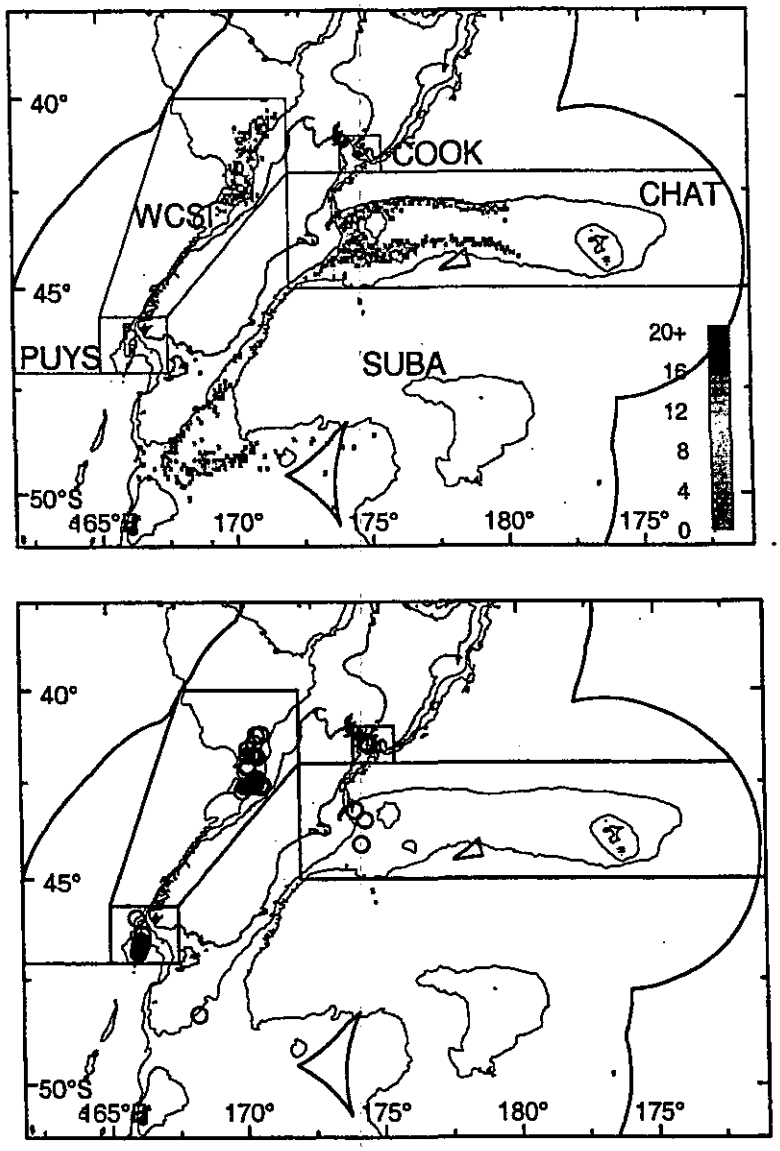

Figure D1: Distribution and density of observed hoki trawl effort (number of tows in 0.1 degree cells), based on start of tow positions (top), and start positions of observed tows with New Zealand fur seal incidental captures (○) (bottom), for hoki fishery areas, 2001–02.

APPENDIX D — *continued*

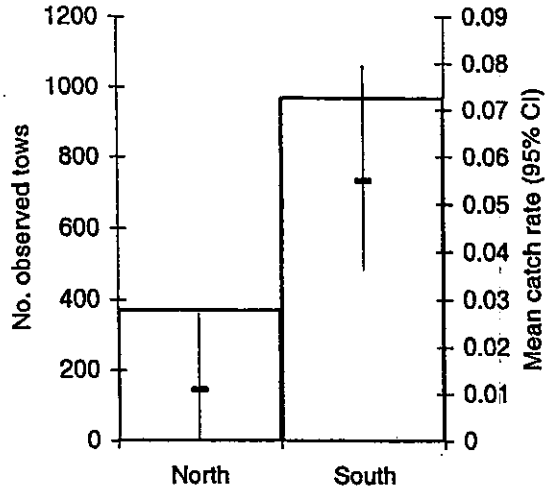

Figure D2: Number of observed tows (histogram) and mean fur seal catch rates (number per tow, ± 95% confidence intervals) in the WCSI hoki fishery, where effort is north and south of 41° 30' S, June-September 2002.

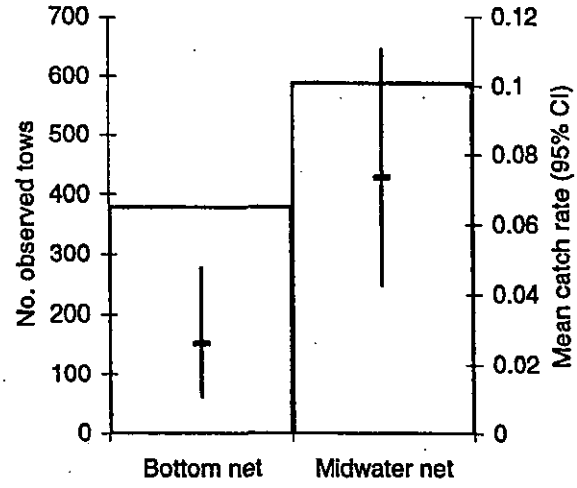

Figure D3: Number of observed tows (histogram) and mean fur seal catch rates (number per tow, ± 95% confidence intervals) in the WCSI hoki fishery, where effort is south of 41° 30' S, by gear type, June-September 2002.

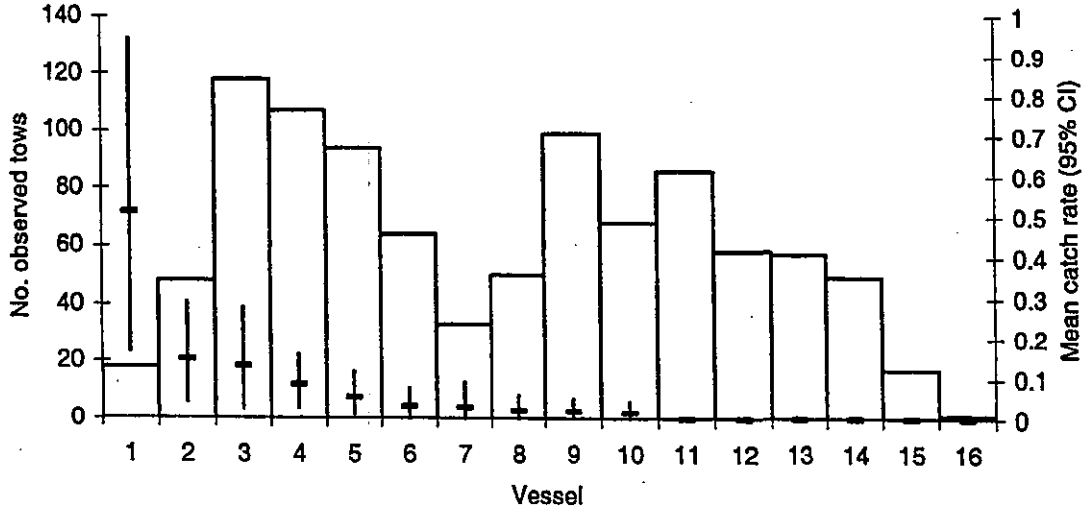

Figure D4: Number of observed tows (histogram) and mean fur seal catch rates (number per tow, ± 95% confidence intervals) in the WCSI hoki fishery where effort is south of 41° 30' S, by vessel, June-September 2002.

APPENDIX E: SQUID TRAWL FISHERY DATA, 2001–02

Table E1: Summary of commercial and observed squid trawl effort by area*, 2001–02

	CHAT	ECSI	PUYS	SQU6T	STEW	All
No. vessels	10	20	15	28	35	35
No. observed vessels	0	2	6	12	12	12
% vessels observed	0	10	40	43	34	34
No. tows	27	895	623	1 645	3 514	6 704
No. observed tows	0	52	125	423	735	1 335
% tows observed	–	6	20	26	21	20
No. observed fur seals	–	0	0	4	17	21

* CHAT effort is concentrated around Mernoo Bank. ECSI is west of 174° 30' E. Further capture data are given in Tables C1 and C2.

Table E2: Fishing effort, observed effort, and mean catch rates (numbers of fur seals per tow) for the SQU 6T and STEW squid fisheries, 2001–02.

Month	Total tows	% observed	No. fur seals observed	Mean fur seal catch rate	Standard error	Total fur seal estimate	c.v. (%)
SQU 6T							
January	3	0	0	–	–	–	–
February	535	23	3	0.025	0.014	13	49
March	737	26	1	0.005	0.005	4	86
April	373	31	0	0.0	–	–	
February-April	1 645	26	4	0.009	0.005	15	48
STEW							
January	1 109	1	0	0	0	0	
February	1 074	33	4	0.011	0.006	12	40
March	627	43	9	0.033	0.012	21	27
April	350	28	4	0.040	0.020	14	43
January-April	3 160	23	17	0.023	0.006	74	23

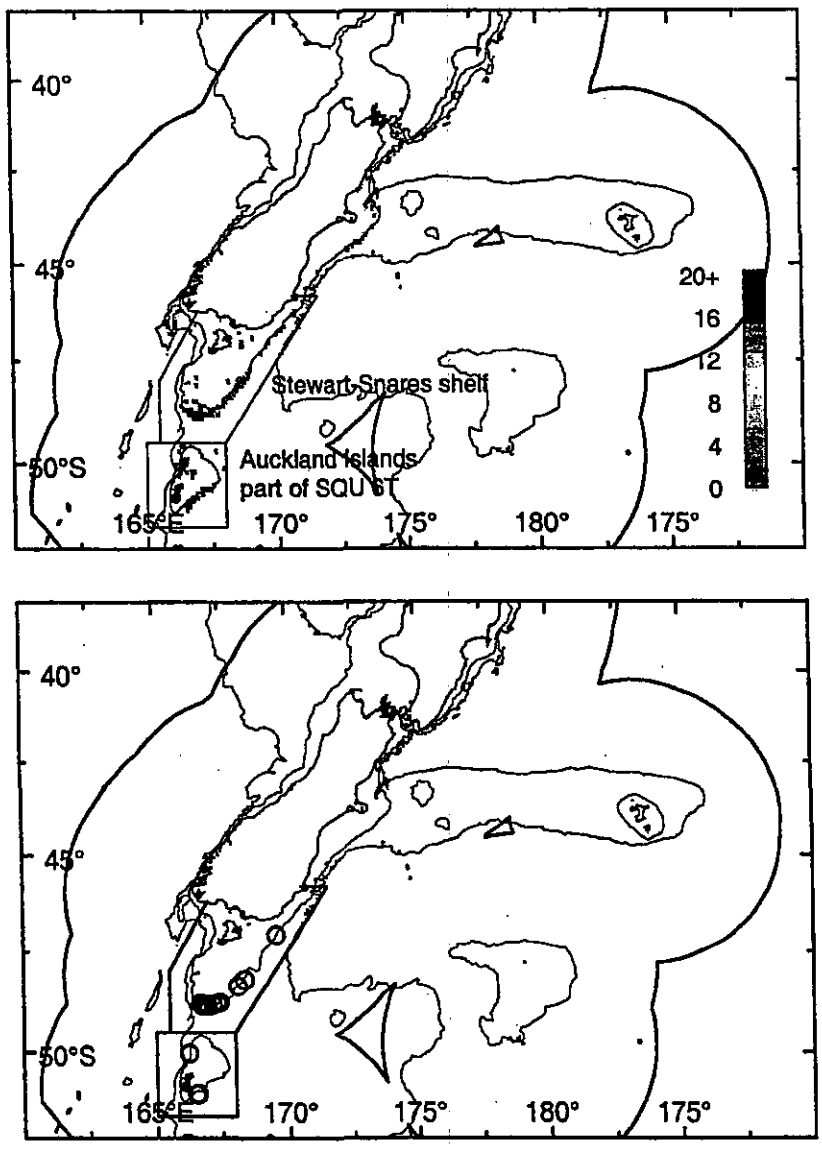

Figure E1: Distribution and density of observed squid trawl effort (number of tows in 0.1 degree cells), based on start of tow positions (top), and start positions of observed tows with fur seal incidental captures (o) (bottom), for defined fishery areas of Stewart-Snares shelf and Auckland Islands part of SQU 6T, 2001–02.

APPENDIX F: SOUTHERN BLUE WHITING DATA, 2001–02

Table F1: Summary of commercial and observed southern blue whiting trawl effort by area*, August-October 2002.

	SBW 6A	SBW 6B	SBW 6I	SBW 6R	All
No. vessels	2	6	18	5	18
No. observed vessels	1	1	7	1	7
% vessels observed	50	17	39	20	39
No. tows	6	94	833	15	948
No. observed tows	1	9	273	3	286
% tows observed	17	10	33	20	30
No. observed fur seals	0	2	6	0	8

* Fishery areas are shown in Figure F1. Another 185 tows were made in December 2001–July 2002, outside the main season. Further capture data are given in Tables C1 and C2.

Table F2: Fishing effort, observed effort, and mean bycatch rates (numbers of fur seals per tow) for the SBW 6I fishery, August-October 2002.

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.* (%)
SBW 6I (Campbell Plateau)								
August	49	0	0	–	–	–	–	–
September	752	264	35	5	0.019	0.010	14	44
October	32	9	28	1	0.105	0.101	3	82
August-October	833	273	33	6	0.022	0.011	18	39

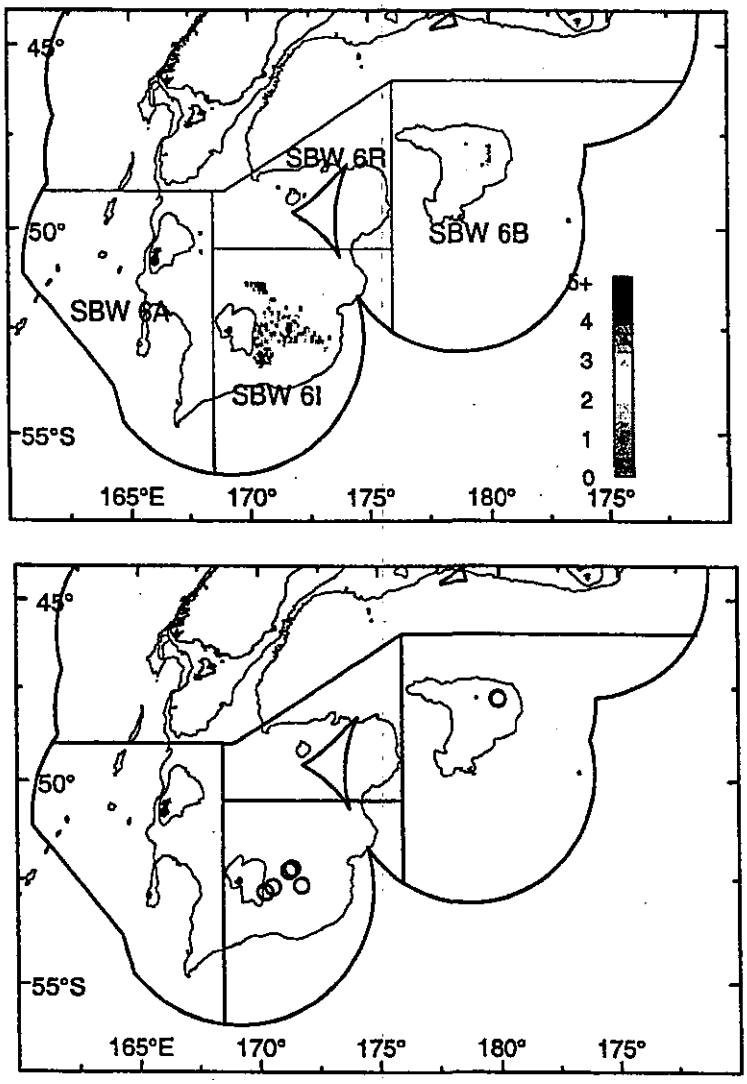

Figure F1: Distribution and density of observed southern blue whiting trawl effort (number of tows in 0.1 degree cells), based on start of tow positions (top), and start positions of observed tows with fur seal incidental captures (o) (bottom), for defined fishery areas, August-October 2002.

APPENDIX G: SUMMARY OF FUR SEAL LENGTH DATA BY SEX, 2001–02

Table G1: Summary of observer records for the sex and size (standard length) of those fur seals landed dead, by fishery area for the main hoki, squid, and southern blue whiting target fisheries*.

Fishery area	No. males (range, median)	No. females (range, median)
Hoki target		
CHAT	2 (138, 155 cm)	1 (142 cm)
COOK	12 (120–217 cm, 150 cm)	5 (137–170 cm, 148 cm)
PUYS	9 (137–172 cm, 152 cm)	10 (115–167 cm, 152 cm)
SUBA†	8 (134–191 cm, 180 cm)	–
WCSI	24 (99–153 cm, 121 cm)	18 (101–160 cm, 127.5 cm)
Squid target		
STEW	–	7 (128–160 cm, 151.5 cm)
Southern blue whiting target		
SBW 6B	1 (123 cm)	1 (154 cm)
SBW 6I	10 (140–190 cm, 171 cm)	2 (150, 154 cm)

* Target fishery areas are given in Table C3 in Appendix C.
† All SUBA capture records given here were from the Campbell Plateau.